

Innovate UK

Directory of projects

Energy Catalyst – Round 3

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Introduction

Innovate UK is the UK's innovation agency. We work closely with business, policy-makers and the research base to help support the development of new ideas, technologies, products and services, and to help companies de-risk their innovations as they journey towards commercialisation.

Energy markets around the world – private and public, household and industry, developed and developing – are all looking for solutions to the same problem: how to provide a reliable, resilient energy system that delivers affordable and clean energy with access for all. This need for secure, clean and low-cost energy creates a wealth of opportunities across different markets and energy supply chains that UK technology and business innovators have the capacity to address.

To help UK innovators seize these opportunities, the Energy Catalyst was established as a national open competition, run by Innovate UK and co-funded with the Engineering & Physical Sciences Research Council (EPSRC), the Department for Business, Energy & Industrial Strategy (BEIS) and the Department for International Development (DFID). Since 2013, the Energy Catalyst has invested more than £75m of grant funding, backed with around £45m of private money, to help commercialise the very best of UK energy technology and business innovation.

Support from the Energy Catalyst has enabled many companies to validate their technology & business propositions, to forge key development partnerships, to accelerate their growth and to secure investment for the next stages of their business development.

This Directory showcases the 58 energy innovation projects and the nearly 150 collaborating partner organisations that we have funded in Round 3 of the Energy Catalyst Competition. Two similar directories are available for the projects funded in Round 1 and Round 2 of the Energy Catalyst. More on these and other projects we have funded through Energy Catalyst and other Innovate UK competitions can be found at the end of this directory in the Further Information section.

We hope the project information and company details summarised here will be a valuable resource for financial and corporate investors, supply chain partners and customers. If you see technology or an organisation here that you think may be relevant to your business, I urge you to make enquiries with the named contacts directly or via Innovate UK or the Knowledge Transfer Network (KTN-UK.org).



Michael Priestnall

Innovation Lead for the Energy Catalyst

michael.priestnall@innovateuk.gov.uk

07767 311451

<https://connect.innovateuk.org/web/energy-catalyst>

www.innovateuk.gov.uk

Platforms for tidal energy convertors

132330, Early Stage, 1/10/16 – 30/9/17, £123,830

Tidal Harness Ltd
Cranfield University
Offshore Renewable Energy Catapult

This project proposes a disruptive simplification of floating platform technology for supporting tidal turbines. This technology reduces the capital and operating expenditures and is substantially more reliable and cost effective than competing tidal energy systems and offshore wind.

Market opportunity

Tidal Harness' innovation is timely to meet the demand as the global tidal energy market is expected to expand at compound annual growth rate (CAGR) of 23.2% from 2016 to 2024 [Transparency Market Research 2016]. The UK is estimated to install a total of 4.7 GW of tidal power by 2050 with the potential of generating 18 TWh/year [DECC 2050 Energy Calculator].

Innovation

The floating platform's unique selling point is that it does not have any moving parts and obviates the need for offshore crane or specialised vessels for installation and maintenance. The elimination of moving parts increases the reliability. The commercial product would be a floating platform supporting either two or four utility scale turbines.

Exploitation route

Our target customers are system integrators. The route to market is through collaboration with a system integrator and project developer for a commercial demonstration. Income is generated from the sale of floating platforms and turbines, including part operational & maintenance.

Outcomes and next steps

Early estimation reveals that the levelised cost of energy of our floating platform and tidal turbine solution is at a level competitive with offshore wind. This project will help define the route to make tidal energy more reliable and cost effective with correspondingly greater return-on-investment and environmental benefits than competing tidal energy generators and offshore wind. The next stage is to develop a scaled floating platform for wave tank tests.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132330>

Steve Khoo

Tidal Harness Ltd
steve.khoo@tidalharness.com

Simon Cheeseman

Offshore Renewable Energy Catapult
simon.cheeseman@ore.catapult.org.uk

Maurizio Collu

Cranfield University
maurizio.collu@cranfield.ac.uk

Low cost high energy density anode for stationary energy storage

132331, Early Stage, 1/06/16 – 31/3/17, £199,927

**University College London
Sharp Laboratories of Europe**

This project is to investigate the feasibility of bulk synthesis of a low cost high energy density anode for sodium ion batteries (NIB). Specifically, the research will involve synthesis of nanoparticle materials (at UCL) which will then be made into small rechargeable sodium ion batteries and tested in SHARP uk labs. The project will then involve scale-up of the highest performing materials and they will be made into larger cells which will validate the materials on scale-up.

Until recently, NIB technology had been neglected and work focussed on Li ion based systems. Developments in materials chemistry and electrode fabrication are necessary to ensure NIB is a commercially viable alternative to Li ion batteries (LIB). The invention of new materials for use as anodes in these batteries is an important step in preparing the technology for market. We have identified a range of materials which we believe are suitable for use as high energy density anodes. We propose to synthesise a number of these materials, using state of the art synthesis facilities, and subject the new materials to extensive testing and optimise the most suitable materials for use in an energy storage device.

As well as developing an optimised anode material for NIB (as well as validate new manufacturing facilities up to pilot plant scale) we anticipate that the materials developed as part of this project are likely to find uses in other technologies, both new and existing, e.g. LIB and supercapacitors.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=EP%2FP510385%2F1>

Prof Jawwad Darr
University College London
020 7679 4345
j.a.darr@ucl.ac.uk
www.ucl.ac.uk

Upgrading woody biomass to biocoal using a novel microwave induced plasma technology

132332, Early Stage, 1/06/16 – 31/5/17, £199,909

Stopford Energy & Environment
Liverpool John Moores University

The Plasmergy microwave induced plasma torrefaction process (MIP) is a novel technology developed to upgrade woody biomass pellets into a 'bio-coal' that can be readily used in pulverised coal fired power plants to enable biomass co-firing without the need for costly retrofitting. As well as applications in the low-carbon energy generation sector, the torrefied biomass pellets can also be used as a source of pure carbon for chemicals synthesis and the production of transport fuels.

Market opportunity

Energy is the dominant contributor to climate change, accounting for around 60 per cent of total global greenhouse gas emissions. The development of biomass to energy schemes provides an opportunity to mitigate against climate change and provide a secure and affordable source of energy. The global biomass pellets market was valued at \$4.52 billion in 2014 and is forecast to reach \$8.34 billion in 2020.

Innovation

The principal technical advantages of the Plasmergy MIP Torrefaction process compared to existing technologies are:

- Ability to torrefy biomass pellets directly (as opposed to biomass chip which is subsequently pelletised, resulting in the removal of a process step in the production of torrefied biomass pellets and significantly reduced plant footprint and CAPEX
- Self-striking MIP torches enable rapid operational plant start-up and shut-down
- Unparalleled process temperature control

Exploitation route

Through collaboration with leading technology companies and academic institutions, Plasmergy is seeking opportunities to scale-up the technology and to extend the applications of MIP torrefaction to include the up-grading of low-worth process by-products into solid fuel and for the generation of high value chemical intermediates from a torrefied biomass feedstock.

Outcomes and next steps

The outcome of this project is the development and validation of a technology that:

- Reduces carbon emissions associated with the transportation of biomass fuel
- Provides a source of bio-coal suitable for co-firing in existing coal fuelled power plants
- Reduces carbon emissions associated with energy generation
- Provides a homogenous and clean feedstock for advanced applications including chemicals synthesis and transport fuel production.

Next Steps:

- IP protection
- Identification of follow-on funding, investment, and development partners

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132402>

Dr. Ben Herbert

Director of Research & Environment
Stopford Projects Ltd
ben.herbert@stopford.co.uk
www.stopford.co.uk

Thermal under PV roofing SIP (TUPROOFS)

132333, Early Stage, 1/06/16 – 31/5/17, £199,996

Telemetry Associates Limited
ECO Design Consultants
University of Hertfordshire
Flint Engineering

Putting photovoltaic panels on a roof delivers some energy and may be a cost effective investment but can compromise a roofs integrity and installation costs money. Putting solar thermal on a roof is similar. Using Structural Insulated Panels for a roof, keeps heat in a building and may contribute towards energy reduction. TUPROOFS looks at the feasibility and benefits of integrating all three technologies.

Market opportunity

The market opportunity is the many hectares of commercial roof installed every year and high spec new build. If it is feasible to create roof cladding that does away with intermediate purlins, cost is taken out of the roof structure and with directly integrated PV and thermal solar most of their installation costs disappear.

Innovation

Large integrated roofs for houses and long span integrated roofs for commercial buildings. Several innovative methods of construction have been explored.

Exploitation route

A route to market is probably via a commercial roofing supplier such as SIG Group or TATA Steel.

Outcomes and next steps

Next, we are looking to progress a project funded by a commercial roofing supplier or large builder.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132333>

Stephen Pattenden

Director
Telemetry Associates Limited
telemetra@telemetra.com
www.telemetra.com

Alan Budden

Director
Eco Design Consultants
alan@ecodesignconsultants.co.uk
www.ecodesignconsultants.co.uk

Zhijun Peng

Professor
University of Hertfordshire
z.peng2@herts.ac.uk
<http://www.herts.ac.uk>

Stephen Lester

Director
Flint Engineering Ltd
stephen.lester@flintengineering.com
www.flintengineering.com

Lower-energy routes to commercial soda-lime-silica glass manufacture (EnviroGlass Melting)

132334, Early Stage, 1/07/16 – 30/9/16, £186,639

Glass Technology Services Ltd
Sheffield Hallam University

Each year the glass manufacturing sector contributes £1.3bn to the UK economy, producing 3MT of glass, using 4.5TWh of energy and emitting 2MT of CO₂. The fundamental issue in glass making is the inefficiency of melting processes which consumes 75% of the total energy. Commercial furnaces operate at 50-60% efficiency because temperatures of 1500-1600 deg.C are required to melt the raw materials (known as the 'batch'). This project is developing lower energy routes to produce glass by (1) changing the chemical composition of the batch materials and (2) substituting raw materials with waste-stream by-product materials.

Market opportunity

The glass industry is under pressure to both reduce energy costs and reduce CO₂ emissions. Small reductions in furnace operating temperatures can offer significant energy savings, as well as reduced wear of refractories. Opportunities to reduce raw material costs through substituting the existing mix with waste by-products from other industries also offers an opportunity to reduce manufacturing costs whilst reducing waste in other sectors. In proving the feasibility of such route, this project will open up a new area of research to support the glass industry in minimising its CO₂ emissions.

Innovation

The project has identified modifications to the batch composition that can reduce the melting temperature of the glass, which can be made more cost effective through utilising certain waste streams from other sectors. We have demonstrated that these waste materials can be used in the glass making process without adversely affecting the physical properties of the final glass produced. Glass manufacturers have been engaged to identify how these findings can be implemented into their glass melting processes.

Exploitation route

The consortium has been disseminating the findings from the project to the glass industry through the British Glass trade association and are looking to secure further funding from the industry to progress and implement the findings from the project. GTS is also looking to secure a licence fee from industry raw materials suppliers who are interested in selling the waste by-products, identified within the project, into the glass sector.

Outcomes and next steps

A number of manufacturers from the glass industry have shown an interest in the findings from the project; manufacturers of the waste by-products are also keen to explore opportunities for selling their materials into the glass sector. The project partners are now in the process of building a consortium of manufacturers, raw materials suppliers and producers of the waste by-products to progress this work, most likely through an IUK funded project.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132334>

Robert Ireson

Innovation Programme Manager Glass
Technology Services Ltd
R.ireson@glass-ts.com
www.glass-ts.com

Dr. Paul A. Bingham

PhD BEng(Hons) FSGT FHEA
Reader in Materials Engineering
Sheffield Hallam University
P.A.Bingham@shu.ac.uk
www.shu.ac.uk

Variable Pitch Vertical Axis Turbine (VAWT, Cyclone)

132393, Early Stage, 1/10/16 to 31/12/17, £199,155

**Vertogen Ltd
Inventya Ltd**

Vertogen have developed the mechanism to create a unique VAWT that not only has variable pitch but includes adaptable and adjustable pitch control system with a fully mechanical integrated governor. This equates to a turbine that can be tuned to start easily and operate at a given RPM without any external control automatically.

Market opportunity

There is no product currently in the market place that includes these features. The turbine can operate in urban environments with turbulent conditions, operate with low noise emission, is more compact and a less intrusive appearance. The design is scalable, can function in a wind farm type environment using much less space and can operate closer together than normal HAWT.

Innovation

The VAWT can fulfil a wide market with design from micro to medium and large turbines. Initial markets would be micro, rural communities, small commercial, emergency and charging stations. Licensing IP sales would be global and could be a very effective way to promote the design and produce profit.

Exploitation route

There is no current design that directly addresses the failures of the fixed pitch VAWT with a fully mechanical solution involving an integrated governor. The issues are the inability to start in low wind conditions, control constant RPM, regulate maximum RPM, adjustable RPM and torque for various output requirements without external devices, easily adaptable central core to different sizes easily (arms and blades sizes).

Outcomes and next steps

We require partners such as turbine manufactures, investors to take the product through the next phases: finish the complete unit, fund more testing, certification, marketing, manufacturing, IP exploitation such as licensing the design globally.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132337>

Michael Chung

Inventor and Director
Vertogen Ltd
mike@vertogen.co.uk
www.vertogen.co.uk

Dave Dunphy

Designer and Director
Vertogen Ltd
Dave@vertogen.co.uk
www.vertogen.co.uk

A Revolutionary Rotary Ericsson Heat Pump/Engine

132357, Early Stage, 1/10/16 – 30/9/17, £198,700

University of Nottingham
Geo Green Power Ltd
D'Ascanio Research Ltd

This feasibility project developed a revolutionary Ericsson heat pump system. The closed cycle, HFC free system is radically simple compared to current systems, with only four moving parts. The Ericsson heat pump is applicable to refrigeration, air conditioning, ASHP/GSHP, and many other applications. The highly efficient system will allow replacement of less efficient HFC systems, and will have a major positive impact in global warming reduction.

Market opportunity

The Ericsson system is ideally suited for small (<5kW) heat applications such as mobile and fixed small commercial refrigeration systems, mono-block and split air conditioning systems, ASHP and GSHP applications. The system does not require any specialized material or fabrication, being constructed from simple, machined aluminium elements. Development of the system will lead to a low-cost system applicable to very large and rapidly growing worldwide markets.

Innovation

The revolutionary concept utilizes two pairs of rotors as compression and expansion chambers. This allows a very large heat conduction surface area to maximize heat exchange. Each rotor is individually driven by a motor-generator, allowing the cycle to be optimized for conditions and system demands, allowing near isothermal segments. The rotation allows a valve-less design connected by a counter flow heat exchanger, allowing the Ericsson cycle system to more closely approach Carnot efficiency.

Exploitation route

This proof of concept allows the revolutionary technology to be demonstrated to manufacturers. The immediate market need for HFC free systems that are also higher efficiency and simpler than current systems will lead to market specific development projects. This in turn will lead to licensing and additional R&D of other applications of the concept. The completely novel concept is completely covered by existing and applied for patents.

Outcomes and next steps

This project demonstrated the feasibility of the Ericsson heat pump system and the superiority over current systems. Follow-on development will focus on a 3kW air conditioning demonstrator (50 million units pa worldwide) and 2kW refrigeration demonstration system (30 million units pa worldwide). The cycle can also be run in reverse, allowing a highly efficient external heat engine system with similar size markets (mCHP, waste heat, CSP, generators, etc).

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132357>

Andrew Cunningham

Geo Green Power Ltd
andrew.cunningham@geogreenpower.com
www.geogreenpower.com

Chris Benson

D'Ascanio Research Ltd
mcbenson@dascanioresearch.com
www.dascanioresearch.com

Wenbin Zhang

Theoretical Modelling, University of Nottingham, Dept of Architecture and Built Environment
Wenbin.Zhang@nottingham.ac.uk
www.nottingham.ac.uk/engineering

Portable solar powered Electricity Supplies Using Recovered Batteries (PESURB)

132358, Early Stage, 1/7/16 – 30/6/17, £196,329

Valpak
MTG Research

PESURB has developed a process whereby 'end of (first) life' batteries can be evaluated, recovered and integrated into new portable, low cost, lightweight, rechargeable power supply units that can be used to power a range of electronic devices. This project utilises end of life batteries, where their value is retained and where they can be utilised for the benefit of the energy storage they can supply.

Market opportunity

It has been estimated that 65 GWh of second life vehicle batteries will be available by 2035 (LUX Research 2017). Many batteries suited to second life applications will come from electric vehicles and consumer goods. The batteries from vehicles will have 80% of their original power, making them an ideal source of energy for many other applications. These batteries can be sourced from waste, help reduce waste treatment costs, be cheaper than new batteries and improve resource sustainability.

Innovation

The University of Oxford have driven this innovative approach using unique battery management algorithms built onto micro-controllers. This innovative control of the batteries allows for improved operation, function, power delivery and lifetime. The major benefit from using this innovative technology is the ability to combine battery cells from different manufacturers, brands, chemistry and power capacity. In addition, the management system provides assurance that the product is not limited by the weakest cell.

Exploitation route

Multiple avenues of exploitation are being followed. This includes use and incorporation of the unique power management control system (to manage cells intelligently in a variety of devices), a rapid cell testing device (to identify quickly reusable cells), resource inventories and databases to support supply, battery selection and quality of selected end-of-life batteries, and a self build kit to supply to developing regions for educational purposes or cottage industry development.

Outcomes and next steps

Outcomes include a demonstrator unit, powered by solar energy, using second life batteries and able to power small devices, rapid cell testing unit for cell quality testing and a database of batteries suited to second-life applications. Next steps are: external investment to fund battery management system integration in new and second-life devices; development of end-of-life battery supply chain information system to encourage second-life use; interaction with not-for-profit organisations to establish trials of self build kits.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132358>

Christoph Birkel

Technology Lead, Research Associate,
Energy and Power Group
University of Oxford
christoph.birkel@pmb.ox.ac.uk
<http://users.ox.ac.uk/~engs1053/>

Alison Quinn

End-of-life Treatment & Resource Supply
Valpak Ltd
alison.quinn@valpak.co.uk
<http://www.valupak.co.uk>

Martin Goosey

Recovery of End-of-life Materials
MTG Research Ltd
martingoosey@mtgresearch.co.uk

David Howey

Principle Investigator, Department of
Engineering Science, University of Oxford
david.howey@eng.ox.ac.uk
<http://users.ox.ac.uk/~engs1053/>

Michael Green

Battery Legislation Expert
Valpak Ltd
michael.green18@btinternet.com

Wind Turbine Blade Optical Health Monitoring (BOHEM)

132359, Early Stage, 1/9/16 – 31/8/17, £173,643

WideBlue Ltd Offshore Renewable Energy Catapult

BOHEM is an innovative blade health monitoring technology that integrates motion capture technology into the root of wind turbine blades to provide unprecedented access to low cost blade health data. Understanding global deflection trends, local in-plane buckling and debonding of the trailing edge will help inform blade design as well as more effective maintenance campaigns and alarm monitoring. The project will address all elements of the energy trilemma: reducing emissions, improving security of supply and reducing cost.

Market opportunity

Existing technologies include ground-based optical systems which are limited to onshore use. Other sensor technologies located inside the blade are limited to the blade root area only and offer no more than a snapshot of the blade health. BOHEM's novel approach provides a picture of structural health from the root, past the maximum chord to deep inside the blade, while doing away with vast arrays of sensors and kilometres of cabling.

Innovation

BOHEM's robust root-mounted vision system tracks the displacement of a series of low-cost passive reflective markers installed in the blade's most critical areas. Proprietary software automates the analysis of captured video data and compares against a known target profile acquired when the blade is stationary. Vision system optics, marker pattern, target metrics and output format can be customised to suit specific blade geometry and application requirements.

Exploitation route

BOHEM technology will initially be offered at blade test facilities as a service to install, monitor and provide vital health data to manufacturers during the certification of new blade designs. BOHEM's full potential will be realised when integrated into offshore service blades to provide a monitoring and alarm value added service to blade operators.

Outcomes and next steps

The development of a compact vision system and complete analysis package will see BOHEM deployed into the ORE Catapult's 7MW demonstration offshore wind turbine at Levenmouth in Fife. It is the world's most advanced, open-access offshore wind turbine dedicated to research and product validation.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132359>

Russell Overend

Director
Wideblue Ltd
0141 9458015, 07740 599043
russell.overend@wide-blue.com
<http://www.wide-blue.com>

Stephen Robertson

Head of Business Development
Offshore Renewable Energy Catapult
01670 543053, 07872 836180
stephen.robertson@ore.catapult.org.uk
www.ore.catapult.org.uk

Briquetting of Recycled Glass Fines for energy and CO2 reduction in the glass industry

132360, Early Stage 1/10/16 – 30/9/17, £195,409

Wright Brothers Industrial Services Ltd
Sheffield Hallam University

The global glass industry uses 140-220TWh of energy and emits 50-60MT of CO2 p/a. The introduction of recycled glass cullet significantly reduces melting energy but there is not sufficient cullet available because approx 20% is rejected due to it not being processable and therefore sent to alternative uses or landfill. We have developed the ability to process this and briquette it into a form suitable for recycling.

Market opportunity

Glass is one of the most widely traded global commodities. Container and flat glass production is currently 107.7MT p/a and it is forecast to grow by approx 7% p/a over the next 5 years. The value of the UK cullet market is in excess of £25m per annum but there is insufficient to meet demand. If techniques can be developed to recycle the 20% of glass that is currently rejected we expect an annual demand in excess of 300kT p/a for processing.

Innovation

The rejected glass is contaminated by ceramics and organics which must either be removed or processed to avoid contamination of the final melt. Techniques have been developed to do this. The fine glass must then be consolidated into briquettes in order to be able to recycle them into the melting process. The chemistry of the binder is critical in that it must hold the fines together in the briquetting and be accretive to the melting process. We believe we have achieved that.

Exploitation route

The early stage project is to prove the binder suitability and do laboratory melting trials testing the quality of the final product when the briquettes are added. The next stage will be to develop the techniques to manufacture the fines in sufficient bulk to conduct a full scale melting trial at a current container producer. Wright Engineering are working to perfect the recycling technique and develop a production line which can be sold commercially within the UK and abroad.

Outcomes and next steps

The project has demonstrated the ability to make briquettes and recycle them into glass melting. Further work is ongoing to refine the binder chemistry to give the maximum energy efficiency to the melting process and characterise the savings. Work is ongoing to plan a full stage melt at the next stage.

Further Information: <http://gtr.rcuk.ac.uk/projects?ref=132360>

Richard Wright

Project Consultant, Wright Brothers
Industrial Services Ltd
Richard.wright31@btinternet.com
<http://www.wrighteng.co.uk>

Dr Paul Bingham

Research Leader
Sheffield Hallam University
P.A.Bingham@shu.ac.uk
www.shu.ac.uk

Development of Power Roll, ultra-low cost & ultra-lightweight PV

132361, Early Stage, 1/9/16 – 31/10/17, £198,037

Big Solar Ltd Loughborough University

Big Solar Ltd is developing a next generation PV product – Power Roll. This unique architecture allows Power Roll to exploit roll to roll manufacturing techniques widely used in the packaging industry, enabling it to be made at an ultra-low cost. Ultra-low manufacturing costs enable the generation of renewable electricity at a cost comparable to (or cheaper than) hydro-carbon energy sources. This project will develop the active solar absorber material deposition process, using roll to roll printing techniques and this is a critical step. Big Solar are collaborating with Loughborough University and work closely with the National Centre for Printable Electronics to raise this product to a higher technology readiness level with a clear route to future commercialisation.

Market opportunity

Power Roll will initially target two core markets: commercial rooftops and off grid installations for developing countries. Lightweight Power Roll will allow PV to be deployed on commercial rooftops including non-load bearing structures. Remote areas in developing countries will be accessible due to the ultra-low cost and ease of transportation. Other market sectors, currently dominated by silicon PV (e.g. ground mounted PV and domestic PV) as well as military /consumer devices will be explored in the longer term.

Innovation

Power Roll is a highly innovative and unique horizontally integrated PV Cell. It eliminates many of the process steps utilised by existing solar PV technology and allows low cost scalable manufacturing processes to be deployed. This results in a manufacturing cost which is a fraction of the existing solar PV technology.

Exploitation route

Successful conclusion of this project will enable further investment to be raised to fund larger pilot and full scale manufacturing at Big Solar. Big Solar is forming strategic partnerships with companies operating in our chosen markets to facilitate mass deployment of Power Roll.

Outcomes and next steps

The project is ongoing and is expected to be completed late 2017.

Further Information: <http://gtr.rcuk.ac.uk/projects?ref=132361>

Neil Spann

Managing Director
Big Solar Ltd
0191 543 9254
Neil.spann@powerroll.solar
www.powerroll.solar

Bio-GaTe – Advanced Biomass Gasification Technologies

132362, Early Stage, 1/1/17 – 31/12/17, £199,865

Computational Modelling Cambridge Limited (CMCL Innovations)
University of Glasgow

A large number of biomass feedstocks, including energy crops, wastes and wood pellets, can be transformed into syngas and used to produce energy, or synthesise biodiesel and other chemicals. The aim of this project is to implement physics-based virtual engineering strategies to enable cost-effective technical development of advanced biomass gasification technologies (Bio-GaTe) capable of converting biomass feedstocks and wastes efficiently to alternative energy and high purity synthesis gas.

Market opportunity

The Department of Energy and Climate Change (DECC) estimates that by 2020 8-11% of UK's total primary energy demand could be supplied by sustainably sourced bioenergy, and that this contribution could grow up to 21% by 2050. As set out by the 2011 UK Renewable Energy Roadmap, bioenergy plays an important role in the Government's plan to meet the objective of the EU Renewable Energy Directive to produce at least 20% of its total energy from renewables by 2020.

Innovation

Our approach combining state-of-the-art CAE-based optimisation with experimental feasibility research will potentially lead to a gasifier technology concept effective for various conditions and feedstocks. The most common problem faced by current gasifiers is the inefficient thermochemical process of pyrolysis. The resulting emissions (e.g. CO₂, NO_x, etc.) are also a great concern for the environment. The Bio-GaTe consortium brings together a collection of extensive expertise to tackle these challenges.

Exploitation route

The Bio-GaTe technology will be presented to the wider energy stakeholders community to grow market interest. The Bio-GaTe project will increase market exposure for CMCL's proprietary software kinetics™ and MoDS, and open significant IP opportunities for the new biomass gasification technology, possible benchmark against incumbent state-of-the-art technologies. A final exploitation plan will be delivered by the partners to define sensitive routes to commercialisation of the technology, when this is deemed appropriate based on the techno-economic assessment.

Outcomes and next steps

The Bio-GaTe project will produce a new disruptive flexible biomass gasification technology proven at lab scale, effective for various conditions and feedstocks, able to produce cleaner fuels with improved LHV efficiencies, an innovative biomass gasification technology at a technology readiness level TRL3-4, ready for pilot evaluation in a subsequent project, and a detailed and robust physico-chemical model for biomass gasification processes that integrates both biomass gasification reaction kinetics and gasifier fluid dynamics.

Further Information: <http://gtr.rcuk.ac.uk/projects?ref=132362>

Dr Nico Bianco

Applications Engineering Manage, CMCL Innovations
nbianco@cmclinnovations.com
<http://www.cmclinnovations.com>

Dr Manosh Paul

Senior Lecturer (Systems Power and Energy), University of Glasgow
Manosh.Paul@glasgow.ac.uk
www.gla.ac.uk/

Optimisation of Wind Energy O&M Decision Making Under Uncertainty

132380, Early Stage, 1/10/16 – 30/9/17, £162,108

Romax Ltd
Datalytics Ltd
University of Strathclyde
SSE plc
ScottishPower Renewables Ltd

The volume of real-time data available from wind turbine assets is staggering – however this data needs to be utilised by control room engineers to support good decisions in order to be commercially useful. This project accelerates an early-stage technological concept that unlocks a substantial cost reduction by utilising data to directly support quick and reliable decision making in the everyday operation of a wind farm, either on or offshore.

Market opportunity

This project directly taps into the rapidly growing market for O&M services for wind power. Today the wind asset base in the UK onshore is around 10 GW, and 15GW could be deployed by 2020. The potential savings that the technology can generate today is c£30m per annum (UK onshore & offshore market). The savings that can be realised in future years is more significant due to asset ageing, at around £80m per annum.

Innovation

Real options theory has never been applied to operational decision making in wind. Real options lets the manifold uncertainties (asset health, weather, vessel cost etc) be treated in a single decision-making framework. This has the effect of unifying very diverse sets of knowledge. It also enables decision makers to quantify the impact of deferring decisions, e.g. curtailing turbines to delay degradation of assets. This flexibility ensures OPEX reduction.

Exploitation route

Ultimately a software product that can be used by the wind farm operators to improve their decision making process, offered in SaaS model to generate recurring revenue and to capture a wider customer profiles from IPPs to large utilities. Romax global customer base comprises wind, rail, automotive, aerospace, off-highway and marine industrial sectors with well-established sales channels which may be utilised for upselling the products

Outcomes and next steps

Initial user interface and blade life case study have been presented at All-Energy 2017, and IEA wind forecasting task in Copenhagen. Final objective is to refine the user interface to offer best interaction for multiple levels of user (budget holder, control room lead, technician etc). This final version of the decision support tool will then be commercialised by the partners.

Further Information: <http://gtr.rcuk.ac.uk/projects?ref=132380>

Dr David McMillan

Project lead
University of Strathclyde
dmcmillan@eee.strath.ac.uk
<http://www.strath.ac.uk/windenergy/>

Dr Evgenia Golysheva / Dr Xiaoqin Ma

Head of Technology
Insight Analytics Ltd
xiaoqin.ma@romaxtech.com
www.romaxtech.com

Dr James Sheffield / Dr Ashley McMinn

CEO
Datalytics Ltd
james.sheffield@dlyticstech.net
www.datalytics.co.uk

WakeBlaster – faster than real-time wind farm flow simulation for optimised operational control

132381, Early Stage, 1/10/16 – 30/9/17, £197,150

ProPlanEn Ltd

Wind energy is a widely available, predictable, but also fluctuating source of energy. This project makes electricity production from wind energy more secure by making improvements to operational modelling, monitoring and control of the interaction between turbines, wind farms and the atmospheric boundary layer. ProPlanEn has developed with WakeBlaster a technology base that delivers cost effective, faster than real-time, yet accurate modelling of even very large wind farms. WakeBlaster will lead to more efficient wind farms.

Market opportunity

Most wind turbines are sited in wind farms where curtailments and wake losses can be quite substantial. WakeBlaster models production in real-time for the current meteorological and operational situation on the wind farm(s). The potential benefits of this enabling technology are enormous, spanning from controlled wake deflection, optimised maintenance, lifetime extension to optimised technical or environmental curtailment, allowing a reduction of the levelized cost of energy by 1-3%.

Innovation

Wake research is literally rocket science (of jets) being used in a new context. WakeBlaster fills a gap between sophisticated models used in research and fast but simplified models predominantly used in industry. The improvements in performance is achieved through a new highly specialised numerical solver, purpose-made for the problem and designed to make use of recent and future advances in hardware.

Exploitation route

A new market for wind farm operational performance products will be opened using the WakeBlaster technology. Primary target markets are in Europe, China and the Americas. The principal clients of WakeBlaster will be wind farm owners and operators and manufacturers providing wind farm operational services. The anticipated delivery method as a third party component / web based service ensures widespread use and commercial success.

Outcomes and next steps

Pilot and demonstration projects will show the viability and the commercial benefit that can be gained by using WakeBlaster technology. Early adopters that have shown interest will be independent software suppliers and solution providers for wind resource assessment, wind power forecasting, and wind farm performance verification.

Further Information: <http://gtr.rcuk.ac.uk/projects?ref=132381>

Wolfgang Schlez

Director
ProPlanEn Ltd
wolfgang.schlez@proplanen.com
www.proplanen.com

Wave energy converter for small communities

132382, Early Stage, 1/10/16 – 30/9/17, £199,084

Clean Energy Ltd
DesignFlow, University of Plymouth
Mott MacDonald Limited

This project involves development of a novel wave energy converter made from waste materials. The work proposed in this project builds on existing modelling and engineering work already carried out by the academic partner, and extends both these aspects to prove feasibility of the device. The multinational engineering partner expertise defines the most effective ways to use the supplied flow of pressurised seawater, such as for electricity generation and for fresh water.

Market opportunity

There is significant need – as stated in the Sustainable Development Goals – for low carbon power and fresh water in Less Developed Countries (LDC's). In 2015, 663 million people still lack improved drinking water sources. Countries in which less than 50% of the population uses improved drinking water sources are all located in sub-Saharan Africa and Oceania. Additionally, the UK marine energy industry has been forecast to be worth £6.1bn creating nearly 20,000 jobs by 2035.

Innovation

The design addresses many of the problems conventionally associated with device development in the wave energy sector – particularly cost of the wave device, accessibility of materials, maintenance, local community involvement, and the absence of sliding point contact seals (a major cause of failure), and adopts a low tech small scale approach to implementation.

Exploitation route

Through licensing the manufacture and sale of WEC “kits”, along with provision of expertise on how to manufacture, deploy and maintain the device. This will be done via collaboration with NGO's and LDC-based organisations.

Outcomes and next steps

The device has been successfully tested at 1/8th scale in UoP's wave tank, and work is ongoing to feedback results to optimise the Numerical Modelling tool. Onshore design has been outlined. Potential deployment sites globally have been initially ascertained. Future work includes development of route to market, updated financials, full scale device engineering, and detailed specification of onshore design.

Further Information: <http://gtr.rcuk.ac.uk/projects?ref=132382>

Alan Rogers

Clean Energy Ltd
ar@cleanenergyltd.co.uk

Sam Friggens

Mott MacDonald
Sam.Friggens@mottmac.com

Development of a new generation of high efficiency heat pumps using pre-heated air supply

132383, Early Stage, 1/10/16 – 30/9/17, £160,754

Energy Transitions Limited

It has long been recognised that combining solar energy technology with heat pumps offers the prospect of an effective renewable heating solution with mass market potential, but to date methods for such a combination have not been technically and commercially feasible. We are investigating novel methods for combining air flows heated by solar air collectors with heat pumps, which our work to date indicates will be very feasible.

Market opportunity

As most countries around the world aim to reduce substantially the carbon emissions from use of energy within buildings, heat pumps are widely forecast to become the predominant heating technology. The International Energy Agency (IEA) forecasts that solar energy and heat pump combinations will achieve a significant market share in all IEA countries. The market opportunity for a technically and commercially feasible method of combining solar air collectors with heat pumps is therefore substantial.

Innovation

Several projects around the world have sought to combine solar air collectors with heat pumps but with consistently poor results. We have formulated innovative methods for combining the two technologies which overcome the technical limitations experienced by the prior state of the art. We are preparing patent applications based on these innovative methodologies.

Exploitation route

Once we have proven the concept for our novel system methodologies, we aim to negotiate collaborative agreements with major heat pump companies. Our innovative technology has potential application in dwellings (small scale heat pumps), commercial buildings such as hotels and leisure centres (medium scale heat pumps) and within district heating and industrial process heating (large scale heat pumps) and we aim to develop collaborative agreements to exploit the technology within each of these market sectors.

Outcomes and next steps

Our project will continue until 30th September 2017. The outcomes to date, derived based on extensive computational modelling (using Engineering Equation Solver), indicate that our novel methodologies for connecting solar air collectors and heat pumps will achieve an improvement in heat pump Coefficient of Performance from 25% to over 100%. Our next steps will be to establish prototype systems and conduct experiments to achieve proof of concept for our innovative system configurations.

Further Information: <http://gtr.rcuk.ac.uk/projects?ref=132383>

John Blower

CEO, Energy Transitions Limited
07719 006912
johnblower@energytransitions.uk

Dr Richard Hall

Chief Technical Officer
Energy Transitions Ltd
07903 866548
drnichardhall@energytransitions.uk

Development of Hybrid Mechanical and Compressed Air Energy Storage System

132384, Early Stage, 1/10/16 – 30/9/17, £184,431

Gravitricity Ltd

Gravitricity is developing a novel technology using a combination of Gravity and compressed air for grid-connected electrical energy storage. It has major advantages including rapid response (<2s to full power) and high energy efficiency (>90% round-trip efficiency) with no cyclic deterioration (performance is not affected by number of storage cycles or by part-loading). The project includes engineering work to develop all aspects of the technology (including methodologies to vertically drill holes up to a km deep and 5m in diameter) alongside parallel commercial work to ensure the technical offering will suit the emerging demand for energy storage on power grids. The project will output plans for a proof-of-concept prototype to be deployed within 3-5 years.

Market opportunity

Energy Storage and other grid-flexibility solutions are required as we move towards deep-penetrations of renewable energy, as well as shifting to electrification of heating and transport. Market size estimates are in the hundreds of billions of dollars to 2050. Gravitricity's long life solution provides a permanent storage facility that can be located exactly where the grid requires it.

Innovation

Gravitricity's technology takes components from established industries – mining and salvage for the heavy-lifting component; plus motor-generators and electric drives – and combines these for a completely new purpose. Technical testing in 2018 will confirm that the speed-of-response is as modelled, and that complex mechanical and electrical systems will interact with the grid as expected. Innovation is required in whole-system integration, as well as in winch-design, synthetic cables, and shaft-sinking machinery use.

Exploitation route

We are developing an industrial consortium to take the Gravitricity technology to market. This currently includes heavy-lifting OEMs from deep mining and salvage, and will include power-electronics equipment providers and storage project developers (utilities). These industrial partners all stand to benefit as suppliers or users from Gravitricity's success, but do not compete with each other. We expect one or more of these major industrial companies to take a controlling stake in Gravitricity after our full-scale prototype is deployed in 2019 or 2020.

Outcomes and next steps

The Energy Catalyst Project is confirming technical and commercial feasibility of the technology, and allowing Gravitricity to develop the Industrial Consortium to take the concept to market. The next step is System Component testing, due in 2018 with partner DavyMarkham, followed by full-scale system demonstration in an existing UK mineshaft in 2019. We expect to deploy initial commercial projects from 2020 in existing shafts, and in purpose-sunk shafts from 2022.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132384>

Charlie Blair

Managing Director
Gravitricity Ltd
Charlie.blair@gravitricity.com
<https://www.gravitricity.com>

Electricity Generation Using Geo-engines powered by HP Fluids

132385, Early Stage, 1/10/16 – 31/3/17, £195,612

**KPI Consultants (part of Tayhope Ltd)
Lloyds Register (formerly Senergy
Development Solutions)**

The project looked at the engineering challenges of recovering work from, sour or sweet, High Pressure High Temperature (HPHT) subsurface sourced fluids without damage to or loss of these fluids. With many possible solutions to evaluate, the criteria of robustness, theoretical energy yield, resistance to deleterious effects and reliability were paramount considerations. Working with HPHT fluids can be very technically challenging from an engineering perspective and, if sour, they can also contain lethal components if a loss of containment occurs.

Market opportunity

HP and HT fluids are found globally, and as lower P&T reserves are used up, the development of these challenging resources will become more pressing. Recovering energy from production fluids without utilising the same to power the extraction process saves this valuable commodity and limits the carbon dioxide release associated with conventionally powered production and cleaning plants.

Innovation

The evaluation process eventually discounted many possible solutions for a variety of reasons and the results include a more focused route towards developing new technology to maximise work yields, coupled with the highlighting of a method of producing moderate levels of work by combining existing technologies as an interim stage to full development.

Exploitation route

The energy resources highlighted and studied in the project are too powerful for any existing technology to utilise fully, so further work will be required to develop engines capable of harvesting the full energy potential. Lower yield engines that harvest only part of the energy potential may be commercially viable in some markets, although further explorative work is required to understand capex, opex and infrastructure requirements.

Outcomes and next steps

The next stages will be evaluated in the coming months.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132385>

Julian Parker

Project Manager
KPI Consultants (Tayhope Ltd)
01224 861046
julian@kpiconsultants.co.uk
www.kpiconsultants.co.uk

Paul Masterson

Project Manager
Lloyds Register (formerly Senergy
Development Solutions)
01224 267400
paul.masterson@lr.org
www.lr.org

INnovative smarT coatings for incREased Performance of Thin Film PV Solar Cells (INTREPID)

132386, Early Stage, 1/10/16 – 31/8/17, £195,000

Dycotec Materials Ltd
TWI LTD

The objective of INTREPID is to develop a cost effective smart coating technology for application to PV cells to demonstrate a ~1% increase in efficiency. The coatings have the potential to improve efficiency through the optical design of the film as well as providing self-cleaning performance. Films are being developed for >20 years lifetime performance.

Market opportunity

Market forecasts predict that global smart coatings market will grow from US\$363 million in 2013 to ~US\$3.0 billion in 2018. Currently 70% of smart coatings are for the construction and automotive industry. By 2020, this will have fallen to 37% with the energy sector emerging to account for 25% of all smart coatings sales, with much of this growth coming from sales of self-cleaning coatings for solar panels.

Innovation

The innovation is based on nanosilica based additives being developed by TWI. These materials are being incorporated into high durability coatings by Dycotec Materials. The optical performance of the films ensures more sunlight reaches the solar cell increasing cell efficiency. The coatings are designed for high durability use (>20 years) and hydrophobic properties to provide self-cleaning capabilities.

Exploitation route

Dycotec Materials already provides a wide range of materials into the solar cell industry including conductive and insulative inks involving materials with tailored optical performance. Dycotec Materials will approach this existing customer base once technical and durability performance has been reliably demonstrated. In addition to working with solar cell manufacturers, there is also the potential to retrofit the coatings for existing solar cell installations.

Outcomes and next steps

The partners have already demonstrated, via simulation, that a >1% performance uplift is achievable on state of the art thin film solar cells. Reliability testing is ongoing but the partners have demonstrated, to date, no loss in performance following durability testing. Further work is being undertaken on both film optimisation and durability testing and this is expected to take another 6 months of development.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132386>

Anna Wojdyla-Cieslak
anna.wojdyla-cieslak@twi.co.uk
<https://www.twi-global.com/>

Richard Dixon
rdixon@dycotecmaterials.com
www.dycotecmaterials.com

Development of novel and reliable microSOFCs for use in APUs & other applications (CATALYST)

132387, Early Stage, 1/10/16 – 31/8/17, £199,932

Adelan
Conrad Anderson
University of Birmingham

Distributed electricity generation using fuel cells (FCs) addresses the energy trilemma (energy security, equity and sustainability). The key barrier to widespread FC deployment is cost, as products are not yet mass manufactured, and development cycles are expensive. This project establishes the technical and commercial feasibility of an innovative FC product for a high value niche market (campervans), operating on a readily available fuel (LPG), and meets stringent size/weight expectations. The team combines a FC SME (Adelan), a company in leisure vehicles (Conrad Anderson), and materials academics from University of Birmingham.

Market opportunity

This product aims to ease the use of appliances on RVs, extend off-grid trip duration and enhance the user experience. Experienced recreational vehicle (RV) partners Conrad Anderson identified a clear commercial opportunity for FCs operating on hydrocarbon fuels to enter a growing RV market, with further commercial potential in other markets for clean portable/distributed generators. However, there remain technical challenges in identifying the right materials and designs to enable sustained performance, financial risk in building and testing low-cost systems, and some uncertainty about how the technology will satisfy the market.

Innovation

The project has delivered a portable 100We prototype FC system based on unique, patented fuel cell (FC) technology, and plots the commercial route to market for the product based on a UK supply chain and international sales. Adelan is the go-to microtubular solid oxide fuel cells (mSOFCs) system developer in Europe, with unique in-house system designs and technical knowledge. The first 100We system was designed and tested during the SAPIENS project, and is being improved using market feedback from Conrad Anderson to provide self-cleaning capabilities.

Exploitation route

Commercially, we assessed the market and engaged with the Aston Business School and Manufacturing Technology Centre (MTC) to build a robust business plan. Low-cost manufacturing is central to reducing costs going forwards to penetrate into cost sensitive markets. The strategy aims to build, assess and protect key intellectual property within the Consortium, then attract/engage potential commercial partners such as Dometic to enable market entry, and manufacturers to deliver the component supply chain.

Outcomes and next steps

This project has demonstrated the feasibility of a portable 100We FC prototype operating on LPG. New materials were integrated into an optimised design to meet the market requirements for cost, size and weight. The next steps are to progress the system up the Technology and Manufacturing Readiness Level (TRL, MRL) scales, and engage with early adopters to assess how the product can best satisfy the market.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132387>

Dr Michaela Kendall

Adelan
0121 427 8033
michaela@adelan.co.uk
www.Adelan.co.uk

Steve Anderson

Conrad Anderson
steve@conrad-anderson.co.uk

Prof Tim Button

University of Birmingham
T.W.Button@bham.ac.uk

Two-Dimensional graphene-related TRansition metal dichalcogenides for ultracapacitor ENergy storage Devices (2D TREND)

132388, Early Stage, 1/10/16 – 31/8/17, £199,978

DZP Technologies Ltd
National Physical Laboratory (NPL)

Two-dimensional transition metal dichalcogenides (2D-TMDs) are new materials which, similar to graphene, can be exfoliated into atomically thin nano-sheets with unusual electronic and optical properties. Our project is developing a method to scale up the production of 2D-TMDs for use in ultra-capacitor (UC) energy storage for the smart grid and electrical vehicle applications. This is complemented by advanced structural and chemical characterisation to develop understanding of the material properties and optimise the electro-chemical performance.

Market opportunity

To date, UCs have remained a niche market because of their high cost and low awareness in the industry about the technology and its benefits. However, UCs are expected to emerge as a replacement for batteries in the coming years, or used alongside batteries, with exponentially growing installation capacity. The global UC market is expected to reach \$3.12 billion in 2019, growing at a CAGR of 25.2% from 2013 to 2019.

Innovation

There is a constant demand in the energy storage sector for new chemistries to improve performance, reduce cost and minimise reliance on scarce and toxic materials. To date, most research on 2D-TMDs has remained in the laboratory, in contrast to graphene which is already applied in new commercial products. Our innovation is in the scale-up of the production, large-area coating, and electrochemical characterisation of the 2D-TMD materials, to reliably evaluate their potential for real-life applications.

Exploitation route

DZP Technologies will commercialise the new materials through business partnerships with other organisations in the supply chain, especially with established manufacturers which already operate in the energy storage market. The characterisation protocols developed by NPL will be disseminated and exploited throughout the UK and world via commercial characterisation services.

Outcomes and next steps

The main outcome of the project is the reliable evaluation of the 2D-TMD materials and their capability to provide secure, sustainable and low-cost UC energy storage at a scale that is relevant to their intended use in smart grids and electrical vehicles. As a next step, the consortium is looking for business partners from the energy storage sector who can work with us to take the technology to market.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132388>

Dr Zlatka Stoeva

Managing Director
DZP Technologies Ltd
zlatka.stoeva@dzptechnologies.com
www.dzptechnologies.com

Dr Andrew J Pollard

Research Scientist
National Physical Laboratory
andrew.pollard@npl.co.uk
<http://www.npl.co.uk>

Self Erecting Nacelle and Service System – for a large offshore wind turbine (SENSE)

132389, Early Stage, 1/10/16 to 30/9/17, £198,884

SENSE Offshore Ltd Industrial Systems and Control Ltd

SENSE can transport, install and service offshore wind turbines without the requirement for large jack up or floating crane vessels, instead using more readily available offshore construction vessels. It can take advantage of short weather windows, leading to significantly shorter project construction programmes, improved power production availability and lower life time cost of energy. SENSE is readily scalable for future larger turbines and is also cost effective for onshore wind projects.

Market opportunity

Wind energy dominates the global provision of new renewable energy and will continue to do so for the foreseeable future. In the 2020's global offshore wind is estimated to grow by 7 to 10GW annually. SENSE allows the economic exploitation of wind projects in deeper waters and further offshore compared to current methods so has the potential to corner market share and open otherwise no-go sites, perhaps pushing this growth rate even higher.

Innovation

Currently, wind turbines are installed in multiple pieces. As turbines have increased in size, so too has the installation equipment, with ever larger, more expensive cranes and vessels. In contrast, SENSE uses a standard construction vessel which installs the fully assembled nacelle and rotor onto the tower in one short operation. Nacelle installation can be reversed to remove a failed unit and replace immediately with a new one, rapidly returning the turbine to production.

Exploitation route

SENSE will be developed in collaboration with an existing offshore contractor and/or wind turbine manufacturer, which will gain, and pay for the advantage of early implementation. The technology will then be licensed for use on projects or by contractors. In the longer term, the development of standard SENSE interfaces on all turbines will benefit the wider industry and provide a growing revenue stream.

Outcomes and next steps

The main outcome of the project is the reliable evaluation of the 2D-TMD materials and their capability to provide secure, sustainable and low-cost UC energy storage at a scale that is relevant to their intended use in smart grids and electrical vehicles. As a next step, the consortium is looking for business partners from the energy storage sector who can work with us to take the technology to market.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132389>

Patrick Geraets

Director
SENSE Offshore Ltd
patrick.geraets@phgconsulting.co.uk

George Ballard

Director
SENSE Offshore Ltd
gballard@gbg.co.uk

Andy Clegg

Managing Director
Indus
andy@isc-ltd.com

Creating electricity by reducing cost, payback time and carbon foot print – An exploitation of a novel method into manufacturing Crystalline Silicon Photovoltaic solar Cells

132390, Early Stage, 1/10/16 to 30/9/17, £69,950

Printed Electronics Limited (PEL)

Victrex Plc

De Monfort University

This project will develop and demonstrate the making of silicon (from micro to nano metre size) structures deposited on plastic and glass substrates for photovoltaic (PV) solar cell application. Silicon is a versatile material that is used extensively for energy generation in photovoltaic solar panels. Current methods for producing poly-Si involve high temperatures above 600 degrees centigrade, but with our method deposition is carried out at temperatures below 400 degrees Celsius.

Market opportunity

Currently seven of the world's top 10 PV solar panel manufacturers are based in China and there are no Europeans in the Top 10. In manufacturing terms China has > 60% total production worldwide, EU 10%, US 4%, ROW 25%, however Europe and the UK have strong PV installation markets. Unsurprisingly, UK government policy initiatives (BRE KTN UK Solar voltaic roadmap – a strategy to 2020) call for investment in scaling manufacture, identifying new sustainable materials and increasing PV market share via emerging technologies and niche applications.

Innovation

This process, deposit silicon structure, is at significantly lower temperatures of < 400 degrees Celsius. Our searches show no evidence of other similar process existing. The new deposition method will solve many design limitations which could result in a number of new product ideas in consumer electronics and PV markets.

Exploitation route

Exploitable outputs of a successful feasibility project could be widespread. Demonstrable feasibility and industrial scalability of a novel low cost, low production energy PV module – aligned with existing manufacturing technology – will provide new production options for existing products (panels) and potential next generation PV devices such as building integrated photovoltaics –BIPVs – a niche market of strategic interest to the UK.

Outcomes and next steps

Develop a prototype of Photovoltaic solar cells using the optimised procedures and evaluate its performance. Following the completion of feasibility study, the consortium will look into the funding (e.g. Energy catalyst – Mid-stage call) and invite additional members to be a part of the consortium.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132389>

Dr Shashi Paul

Emerging Technologies Research Centre
De Monfort University
spaul@dmu.ac.uk
<http://www.dmu.ac.uk/research>

Dr Neil Chilton

Printed Electronics Ltd
neil.chilton@printedelectronics.co.uk
<https://www.printedelectronics.com>

Dr Stuart Green

Victrex Manufacturing Ltd
stuart@victrex.com
<https://www.victrex.com/en/>

Simulation to enable Asset Life Extension of wind turbines (SALE)

132391, Early Stage, 1/10/16 to 31/12/17, £173,784

Ocean Array Systems Ltd (OAS) Offshore Renewable Energy Catapult

The wind energy industry needs more accurate and efficient tools to calculate unsteady loads. Used on operational wind farms, these tools will be used to reduce operations and maintenance costs and hence cost of energy.

The SALE project is demonstrating OAS' TurbineGRID and validating its predictions of unsteady loads. It is also exploring the feasibility of simulating whole-farm interactions to facilitate intelligent control of the entire farm asset for life extension and yield.

Market opportunity

Improved wind farm control strategies reduce wake losses and turbine fatigue loading, cutting the cost of energy. One factor holding back developments has been that flow turbulence is difficult to simulate, contributing to low accuracy in yield and component lifetime estimations. We are validating the use of: (1) improved flow characterisation (accounting for the effects of turbulence); (2) site-specific turbine simulations and (3) exploring the use of machine learning, to improve farm-wide control strategies.

Innovation

Today, turbulence assessment provides indicative metrics at hub height, despite extreme variation across the rotor disc. Our approach spans the whole turbine disc. Uniquely, we use this turbulent inflow in our simulations, to give an accurate representation of site turbulence. In a novel application we plan to use large simulation results databases to train an Artificially Intelligent (AI) "Predictive Module" which augments existing control systems by providing recommendations.

Exploitation route

These tools will be provided as highly automated data analysis and modelling services securely accessed via OAS' web platform, running simulations on the cloud. We will sell these services to consultants and turbine operators. The use of ORE Catapult's Levenmouth 7MW offshore wind demonstration turbine ensures that project results may be widely disseminated. In addition, ORE Catapult will publicise the report within the industry.

Outcomes and next steps

The project will validate TurbineGRID as a means of gaining cost effect, timely and accurate blade loading predictions. It will also investigate the opportunities and barriers for third party non-OEM turbine control. We are recruiting a wind farm operator for a follow-on project demonstrating the predictive module for intelligent whole-farm control. We will seek independent accreditation of the system.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132391>

Nicola Pearson

Commercial Director
Ocean Array Systems
nicola.pearson@oceanarraysystems.com
www.oceanarraysystems.com

Andy Kay

Innovation Manager
The Offshore Renewable Energy Catapult
andrew.kay@ore.catapult.org.uk
www.ore.catapult.org.uk

The Multi-float WaveSub Wave Energy Converter (WEC)

132392, Early Stage, 1/10/16 to 30/9/17, £199,946

Marine Power Systems (MPS)
University of Bath (UoB)

The project is a collaboration between Marine Power Systems (MPS) and University of Bath (UoB) to simulate, design, build, test and validate a next generation multi-float version of the WaveSub Wave Energy Converter (WEC). WaveSub is a novel, patented WEC that promises to address the energy trilemma with innovative deployment and subsurface orbital energy capture mechanisms. The multi-float version allows further reduction in Cost of Energy by increasing energy capture and reducing capital costs.

Market opportunity

The UK could capture a slice of the global marine energy market worth £76Bn (cumulative, undiscounted) and separately this could contribute around £4 billion cumulatively to UK GDP by 2050. High value jobs will continue to be created close to areas of energy resource, often where other economic development opportunities are limited. Wave (and tidal stream) energy could supply 20% of UK electricity avoiding 30 million tonnes of CO2 emissions each year.

Innovation

The four key challenge barriers that WEC technologies must overcome in order to be competitive are: effective energy capture; reliability and survivability; low capex costs; Low opex costs. Most WEC technologies don't meet these. Second generation devices are developing (Wello, Seabased, Carnegie) though no dominant player has emerged. To fully address the energy trilemma, WaveSub WEC is designed to address these four challenges as a large MW scale, low LCOE device.

Exploitation route

MPS is currently engaged in a 1:4 scale WaveSub prototype project with the Welsh Government and the Wales European Funding Office to deliver and test a WaveSub prototype in the sea (FaBTest) in parallel with the Innovate UK project. The projects will provide TRL, TPL and cost of energy validation of single and multi float WaveSub prototypes. MPS owns a globally filed Intellectual Property (IP) patent family and will exploit this by production of commercial devices.

Outcomes and next steps

Outputs will undoubtedly leverage further support from industry, investors and grant providers to build and test the full scale WaveSub demonstrator, prior to commercialisation activities via a 30MW WaveSub array. This project will identify the design of the full scale WaveSub demonstrator.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132392>

Graham Foster

Technical Director
Marine Power Systems
graham@marinepowersystems.co.uk
<http://marinepowersystems.co.uk>

John Chapman

Chief Engineer
Marine Power Systems
john@marinepowersystems.co.uk
<http://marinepowersystems.co.uk/>

Craig Whitlam

Design and Development Engineer
Marine Power Systems
craig@marinepowersystems.co.uk
<http://marinepowersystems.co.uk/>

Andrew Hillis

Senior Lecturer in Mechanical
Engineering
Bath University
A.J.Hillis@bath.ac.uk

Reducing the Cost of Solar Thermal: Integrating a Novel Freeze Tolerance Approach with Flat Plate Solar Thermal Panels

132393, Early Stage, 1/10/16 to 31/12/17, £199,155

AES Solar
Soltropy Ltd
Heriot-Watt University

The aim of the project is to integrate Soltropy's patented freeze tolerance solution, developed for vacuum tube solar thermal collectors, with AES Ltd's (AES Solar) flat plate solar thermal collectors. This will enable a water based solar thermal flat place collector to be integrated directly into a water heating system. This will help to significantly reduce the installed cost of their solar thermal systems.

Market opportunity

The main target market for AES solar thermal collectors is the Scottish and UK market. The market penetration of solar thermal in these regions is still very small. Only 0.7 % of the 27.6 million homes in the UK have a system installed. About 50 % of UK homes still have a hot water tank installed which the other 50 % have had the tank removed when a new combi boiler was installed. This leaves an addressable market of about 13.3 million homes. Unfortunately, the demand for solar thermal in the UK and Europe has been shrinking in recent years for a number of reasons and urgent action is needed to redress this.

Innovation

Most solar thermal systems in the UK do not run water directly through the collector panels as it can cause freeze damage. Soltropy patented ice-immune technology works by using a compressible tube inside the copper piping which takes up the expanded volume of the water if/when it freezes. Thus the system is resistant to the expansion of freezing of water and no longer requires a separate antifreeze loop.

Exploitation route

The short to medium term AES aim is to significantly grow the market demand for its solar thermal collectors in Scotland and the rest of the UK while sticking with the existing business model i.e. manufacturing and installing their own collectors in Scotland and selling their manufactured collectors to other installers in the rest of Scotland and the UK. Although AES is well known in the solar industry in the UK it is likely that a new sales strategy will need to be developed for selling the newly developed ice immune flat plate collectors to installers in Scotland and the UK, particularly if the technology is patentable.

Outcomes and next steps

Firstly, the benefits of solar thermal urgently need to be broadcast more widely in order to help redress the balance of public discourse which at the moment leans very much in favour of PV. AES aims to address this through continued work with the Solar Trade Association. Secondly, a specific marketing plan will be developed to promote/market the new technology to installers and potential customers.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132393>

Josh King

Design Engineer
AES Solar
info@aessolar.co.uk
www.aessolar.co.uk

Stuart Speake

CEO
Soltropy
stuart.speake@soltropy.com
www.soltropy.com

Tadhg O'Donovan

Professor
Heriot Watt University
t.s.odonovan@hw.ac.uk
www.hw.ac.uk

Zero Energy Distributed Micro Pumped Hydro

132394, Early Stage, 1/10/16 to 30/9/17, £195,402

Water Powered Technologies Ltd
University of Strathclyde

Using the recently patented Venturo –the world’s largest ‘water powered’ pump – surplus water from a small stream was used to fill a higher level water storage facility using nothing more than the gravity flow of the stream for a power source. This allowed the stored water to be discharged to generate power for local grid balancing (when the local solar or wind power is not available) The new Venturo pump is designed to allow the lowest cost per MW of stored power and with greater climate resilience/ environmental benefits than other power storage technologies.

Market opportunity

Pumped hydro is a net consumer of electric power in the UK and there are few large central water storage sites spare to develop into power storage sites which can be too expensive and environmentally disruptive anyway. However, enabled by the Venturo, for the first time, large quantities of surplus water can be moved long distances to networks of smaller upland ponds or lakes to be used for power generation and when needed for agricultural/ community drought resilience.

Innovation

The Venturo pump has already won an Environment Agency Innovation award and has progressed through the TRL levels receiving patents globally. The Venturo design builds on the advantages of its already commercialised smaller cousin- the Papa Pump; with low maintenance needs, debris durable and scalable design. A Venturo double the size of the current DFID project has already been tested for 4 years giving the Company confidence much larger Venturos could be used for higher pumping needs such as flood mitigation and power generation from tidal lagoons.

Exploitation route

The original focus market was for the water utility sector but with Ofgem’s encouragement of the grid balancing/ power reserve sector- this is the focus market in the UK. However, much larger markets exist outside the UK where entire regions need water for vital irrigation of food crops and flood management- as well as power generation. The Venturo is projected to be a key tool in making regions more climate resilient in a way which costs almost nothing to operate.

Outcomes and next steps

The current DFID funded project has moved the TRL level to be ready for commercialisation so the Company can now confidently find the right finance and installation partners to offer the Venturo to UK grid balancing / power storage projects. Importantly, financing and installation partners can now be found for projects outside the UK where customers are waiting for Venturos to be demonstrated in both mining, agriculture and hydro power sectors.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132394>

Hugh Swire

Commercial Director

Water Powered Technologies Ltd
hugh@wptglobal.net
www.waterpoweredtechnologies.com

Dr Doug Bertram

Knowledge Exchange Fellow & Director of Learning, Dept of Civil and Environmental Engineering
University of Strathclyde
<http://douglas.bertram@strath.ac.uk>
www.strath.ac.uk/civeng/

SinePost for a Low Carbon Future

132395, Early Stage, 1/9/16 to 31/8/17, £146,316

Nortech Management Ltd

Nortech supply specialist monitoring technology products and services to power utilities and system integrators. The increase of renewable generators installed on the UK power grid is leading to problems around the stability of the network at all voltage levels. This project makes practical assessments of novel means to measure voltage (V) and current (I) to determine the direction of power flow on 11kV Overhead Line (OHL) networks.

Market opportunity

For the UK to meet its target of reducing greenhouse gas emissions by 34% by 2020, Distribution Network Operators (DNOs) are being asked by the government to connect more Distributed Generators (DGs) as quickly as possible and at a lower cost. More DG connection often entails expensive reinforcement of the distribution network. Nortech aims to provide cost-effective techniques that will speed up the connection of more DGs while providing remote network monitoring capabilities.

Innovation

Nortech is carrying out an assessment of two approaches that can be used to determine power flow direction on 11kV OHL networks. The first approach involves remotely measuring voltage and current on an OHL and includes a novel investigation to determine if weather parameters affect electric field measurements. The second approach entails correlating time-stamped remote current and substation voltage measurements. Patents and paper searches show that these investigations have not been carried out before.

Exploitation route

UK DNOs are Nortech's main target as they are currently faced with the challenge of connecting more low voltage DG to an already congested distribution network. Nortech is proposing cost-effective Active Network Management (ANM) schemes for managing 11kV distribution networks with DG connection. ANM solutions at this voltage level (11kV and below) are of interest to UK DNOs. Other markets outside the UK will be targeted via our partner company 'Horstmann GmbH'.

Outcomes and next steps

The project outputs include: E-field measuring sensor for an 11kV OHL was designed and built. Agreement with DNOs to trial Nortech's OHL fault indicator at a larger scale. Ongoing trial of an ANM scheme that is informed by a load flow engine. Paper on Nortech's ANM accepted for conference publication.

The next stage will involve fully incorporating the two proposed ANM techniques in Nortech's ANM engine and getting the designed sensors to a market-ready product stage.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132395>

Julian Brown

Managing Director
Nortech
08700 111 992
julian.brown@nortechonline.co.uk
www.nortechonline.co.uk

Preye Ivry

Network Innovation Engineer
Nortech
08700 111 992
preye.ivry@nortechonline.co.uk
www.nortechonline.co.uk

Wake Anemometry for Yaw control: Laboratory Demonstration, Ruggedisation and Field Testing

132396, Early Stage, 1/10/16 to 30/9/17, £199,992

**Wood Group (formerly SgurrEnergy Ltd)
Fraunhofer UK Research Ltd**

This project seeks to explore novel techniques to reduce the cost of wind LIDAR for use in wind energy applications such as wake analysis and turbine power performance assessment. This use specific wind LIDAR can have a reduced specification of components and therefore reduced costs of system can be achieved. Novel signal analysis, beam steering and optical design are being combined to further reduce the size, weight, power and cost of the measurement device.

Market opportunity

The opportunity for reduced costs of wind LIDAR systems can open up new measurement opportunities to improve performance at different stages of a wind energy project. With the UK leading the way in offshore wind energy, there is an immediate UK market and an extended global one. Applications such as wake analysis and transition piece mounted turbine performance assessment are just two of the applications areas this technology will address.

Innovation

The innovative measurement concepts for yaw control have been explored in this project alongside the innovations in the wind LIDAR design. New methods for performance assessment that do not require nacelle mounting are also being pioneered in this project.

Exploitation route

The main industrial partner Wood Group (formerly SgurrEnergy Ltd.) are well placed to exploit the prototype systems and the measurement concepts they enable at the end of this project. The field data and test reports will be vital evidence to convince potential partners and customers as we take the technology closer to market with extended field trials in follow-on projects.

Outcomes and next steps

The scope has been changed to include power performance assessment from the transition piece of a turbine and to reduce the effort on yaw control as the benefits of the former have been found to outnumber the benefits of the latter. An advanced field demonstrator will come out of this project with which more measurement concepts can be proven and consortia assembled for future projects.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132396>

Henry Bookey

Fraunhofer Centre for Applied Photonics
henry.bookey@fraunhofer.co.uk
www.cap.fraunhofer.co.uk

Craig McDonald

Wood Group (formerly SgurrEnergy Ltd.)
Craig.mcdonald@woodgroup.com
www.woodgroup.com

Biomass Gasification with High Temperature CO2 Capture (GHTC)

132397, Early Stage, 1/10/16 to 30/9/17, £199,771

Pyro Yield Ltd
Heriot-Watt University

Bio-CCS is considered the only large-scale technology that can remove CO2 from the atmosphere. This project aims to test the technical feasibility of a novel integrated biomass waste gasification system with CO2 utilisation able to convert biomass wastes from a variety of industries into carbon neutral renewable energy and added value products.

Market opportunity

In Europe, bio-CCS by synthetic biofuels via thermochemical processes could remove 800 Mt of CO2 from the atmosphere every year by 2050, representing a market rich of opportunities, since its development started only recently. The development of small delocalised systems able to convert biomass to heat/energy saving CO2 emissions is key to meet the ambitious biofuels and GHG directives. Although the system to be developed aims to be applicable across a variety of sectors (e.g. RDF etc), the initial target market for the GHTC is the brewing industry. Pyro Yield considers the brewing market to be significant and accessible, since ~900 UK breweries are accessible by the GHTC technology.

Innovation

The innovation proposed will deliver economic, social and environmental benefits. The GHTC technology can deliver affordable decentralised renewable energy to agriculture, small enterprises (e.g. drink processing) thanks to the waste to energy/materials carbon negative technology solution. The GHTC system provides viable sustainable energy solutions over existing technologies that require larger capital expenditure. This competitiveness has to be attributed to the proprietary system design, its ease of transport and the production of marketable materials and emissions reduction.

Exploitation route

The initial target market for the GHTC system are the 80% of microbreweries in the UK. Companies that have shown an interest and that we are actively engaged with are:

- Canberra/Merion
- Sellafield Limited (Chris Hope, Sellafield challenges), Innovus programme
- Clearfleau – AD plants and digestate
- Inverhouse distillers

We intend to roll out innovative solutions across their operations primarily in Europe and US. The total potential number of systems and its customers would be hundreds. Sales will be achieved through brand awareness and direct marketing campaigns.

Outcomes and next steps

This project delivers innovative solutions that address all elements of the energy 'trilemma': reducing emissions, improving security of supply and reducing cost. It aims to prove the feasibility of capturing CO2 from a biomass waste gasification plant producing carbon neutral renewable energy and added value products with growing markets valued at a billion pounds. The overall output of the project will be the evaluation of the technical and economic (high level) feasibility of the integrated system and the effective capacity to render the process carbon negative at pre-commercial scale. Further to that we look to work with our interested clients in the funding and development of a commercial scale pilot demonstration plant.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132397>

Dan Morgan

Pyro Yield Ltd
07938999495
dan@pyroyield.com
www.pyroyield.co.uk

Aimaro Sanna

Heriot-Watt University
01314513299
A.Sanna@hw.ac.uk
<https://www.hw.ac.uk>

Transmission heAlth Monitoring (TAM)

132398, Early Stage, 1/10/16 to 31/3/18, £199,948

GSS Avionics Ltd
University of Oxford

The TAM project is aimed at providing the Wind Energy Sector with gearbox failure detection technology that will reduce through-life costs and improve the supply, efficiency and reliability of UK wind energy. To this end, this industry led collaborative project will investigate the development of a new gear tooth eddy current sensor monitoring system that has the potential for being more effective at detecting the onset of damage, wear and failure prediction mechanisms than current monitoring systems.

Market opportunity

Generally high costs result from frequent, unpredictable failures of high-value transmission components (e.g. gearboxes), which can be prevented if early signs of fault development were reliably and accurately detected. Existing systems only detect faults when failure of the unit is imminent – they also lack prognostic capability. The wind turbine sector, including operators, turbine and gearbox suppliers, require robust and reliable sensor systems that provide in-situ, real-time remote sensing for fault detection.

Innovation

TAM will provide the development of a new gear tooth eddy current sensor monitoring system that has the potential for being significantly more effective at detecting wear and predicting gear failure mechanisms than current monitoring systems. The proposed programme is inspired by eddy current sensor and electronics technology developed by Oxford University for health monitoring in gas turbine engines. Recent concept development has demonstrated the versatility and potential of this technology for use in a variety of new, challenging rotating machinery applications.

Exploitation route

Under the TAM programme, Oxford University will team with networking electronics specialists GSS Avionics Ltd and wind turbine industry specialist partners to advance the current technology readiness level to a proof of concept demonstrator stage, which the British Gear Association (BGA) will support through trialling on a representative wind turbine transmission system. This consortium has been brought together with the aim of commercialising the technology initially within the wind energy sector, then following successful integration into wind turbine gearboxes move onto other industries such as aviation and marine.

Outcomes and next steps

The innovation in the TAM programme will advance the current technology readiness level to a TRL 3/4 proof of concept demonstrator which members of the BGA and their members could trial on a transmission system facility. The development will focus on providing a robust eddy current based sensing system that is able to provide real-time information on the condition of the gear teeth similar to laboratory based non-destructive testing (NDT). A successful outcome will lead to direct feedback on the health of the gearbox for better maintenance as well as provide data to improve the design and manufacture of gearboxes.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132398>

David Howells

Head of Business Development
GSS Avionics Ltd
dave.howells@gssavionics.com
www.gssavionics.com

Prof. Kam Chana

Commercial & Technology Director
Department of Engineering Science
University of Oxford
kam.chana@eng.ox.ac.uk
www.eng.ox.ac.uk/thermofluids

Thermal Energy Storage System (TESS)

132399, Early Stage, 1/10/16 to 31/12/17, £192,334

Helios Advanced Energy Systems Ltd

Zero Pressure Thermal Energy Storage System. A unique storage system utilising patent pending thermal switch – enabled high temperature thermal energy to be stored and released at zero pressure. Based on initial prototype testing results, this system will deliver extremely low cost energy storage. Helios’s thermal switch is the only way to achieve zero pressure which is the only way to achieve low cost commercially viable Thermal Energy Storage, which is aligned with majority of global energy demand being thermal.

Market opportunity

Renewable energy systems require energy-storage(ES). Current ES solutions are too expensive. TESS stores energy cheaper than any other system at <£0.01 per kwh. The ES market is forecast to grow to \$16Bn. Another market segment is micro-grids which is forecast to grow from \$16.58Bn in 2015 to \$38.99Bn by 2022. Finally the cooling market – 2% of global electricity production cools data centres – is forecast to grow from \$7.12Bn in 2016 to \$14.28Bn by 2021.

Innovation

The thermal switch is the unique innovative feature of the system and has multiple patents pending. This device optimises the concept of contact heat transfer and is the only method of storing and releasing high temperature thermal energy at zero pressure and without a primary working fluid, thereby making the system extremely cheap and much safer than pressurised systems. It is therefore suitable for commercial, domestic and grid applications.

Exploitation route

The project will develop the market demonstrator suitable for deployment in trials with Power Generation OEM’s. Overall funding required to get the Helios TESS system to a market ready solution will be in the region of £1.5M, this will be partly financed through our plan to develop JDV’s with target brands such as Siemens, GE, ABB, Alstom Power etc. following successful Phase II field trials, with the remaining coming from a further fund raising round.

Outcomes and next steps

Project will produce a Thermal Energy Storage System capable of field trials with target partners

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132399>

Paul Gooch

CEO
Helios Advanced Energy Systems Ltd
paul.gooch@heliosaes.com
www.heliosaes.com

Andrei Horvat

CTO
Helios Advanced Energy Systems Ltd
andrei.horvat@heliosaes.com
www.heliosaes.com

Piers Cave

COO
Helios Advanced Energy Systems Ltd
piers.cave@heliosaes.com
www.heliosaes.com

Electrical Generator for Tidal Turbines

132400, Early Stage, 1/1/17 to 30/9/17, £67,990

Tidal Harness Ltd
National Oceanography Centre

This project proposes a disruptive simplification of tidal turbine technology where there is only one moving component. This technology reduces the capital and operating expenditures and is substantially more reliable and cost effective than competing tidal energy systems and offshore wind.

Market opportunity

Tidal Harness' innovation is timely to meet the demand as the global tidal energy market is expected to expand at compound annual growth rate (CAGR) of 23.2% from 2016 to 2024 [Transparency Market Research 2016]. The UK is estimated to install a total of 4.7 GW of tidal power by 2050 with the potential of generating 18 TWh/year [DECC 2050 Energy Calculator].

Innovation

The key enabling technology is its highly differentiated electrical generator which is direct-drive, submersible and uses induction generation rather than rare-earth magnets. The turbine has only one moving part and there are not any intermediaries or rotational sealing. With extreme simplicity comes greater reduction of cost and greater reliability.

Exploitation route

Our target customers are system integrators. The route to market is through collaboration with a system integrator and project developer for a commercial demonstration. Income is generated from the sale of turbines, including part operational and maintenance.

Outcomes and next steps

Following our successful sea trials of a 5kW proof-of-concept (funded by Innovate UK SMART), this project aims to consolidate the lessons learned for designing future commercial scale tidal generators (up to 1MW rating). The next steps are to scale up to intermediate size and full scale commercial tidal generators.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132400>

Steve Khoo

Tidal Harness Ltd
steve.khoo@tidalharness.com

Kevin Saw

National Oceanography Centre
ksw@noc.ac.uk

Modular system for production of heating, cooling and electricity using ejector-boosted absorption (TRIGEN)

132401, Early Stage, 1/10/16 to 30/9/17, £194,315

**Exergy Ltd
Cranfield University**

The TRIGEN project will confirm the technical feasibility of a tri-generation system, based on an integrated system of solar linear collector and a hybrid absorption heat pump, in the range of 50-100 kW for decentralized applications of energy production. The system is targeted at residential and services sectors although it can be applied across all scales including industrial premises. The advantage of TRIGEN is its low capital cost, it can be mass produced and there is no cost and emissions associated with its energy input (i.e. solar – free and clean source of energy). All of these benefits contribute to the energy “trilemma” by reducing emissions, reducing cost of generation and by increasing security of supply through the increased uptake of decentralised generation systems. If successful, TRIGEN will bring solar energy closer to the user by developing a solution that makes it attractive and competitive for industries & households.

Market opportunity

There is significant potential for energy savings across existing buildings, new builds and major refurbishments. The heat pump and cogeneration market has been rapidly growing in the UK and EU. Note that non-domestic sector consumes a much higher proportion (63%) of the total electricity for all regions across the UK. They are especially cost effective when heating and/or cooling demands are present throughout the year. Therefore, our primary target market is the district/community level sites that are suitable for on-site electricity generation. Market penetration for TRIGEN will occur by engaging sites that have high demand for heating and cooling, such as hotels, universities, hospitals, industrial laundry centres, data centres and swimming pools.

Innovation

The innovations in this project can be listed as: A) To take advantage of the direct generation of vapour by integrating the absorber tubes of solar trough collectors in the generator of an absorption cycle, which are especially suitable for micro and small scale when compared with Thermo-solar powerplants. B) The application of a hybrid booster cycle without a compressor to increase the vapour production when needed, thus increasing the capacity of the chiller, which is suitable for sub zero cooling. This feature is an

efficient alternative to the installations based on single effect absorption cycle with a segregated back-up mechanical compression machine for cold peak demand fulfilment, with insufficient solar irradiation. C) Produce electricity with an optional expander that diverts part of the superheated vapour coming from the collector and expands it towards the low pressure side of the absorption cycle. D) A single machine could produce heat, cold and electricity. There is a clear competitive advantage with respect to trigeneration based on direct water vapour steam generation technology or Organic Rankine Cycles (ORC). E) Direct generation of vapour, therefore the cost associated with thermal fluid circuit is avoided: piping, heat exchangers, controls and the fluid itself (generally toxic and harmful, and require frequent maintenance operations).

Exploitation route

There is an initial plan for the project, but the final route and outcome will be updated when the results are known.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132401>

Sreenivaasa R Pamidi

Research Engineer
Exergy Ltd
spamidi@exergy.uk.com

Gravitational Energy Storage & Synchronous Inertial Stability (GENSSIS)

132402, Early Stage, 1/1/17 to 31/3/18, £188,473

Energy SRS Ltd
The University of Bristol
UK Power Reserve Ltd
Marriott International Ltd

Caley Ocean Systems Ltd
Bayliss Consulting Ltd

By using an innovative combination of gravitational potential energy storage & existing technologies this project aims to examine the feasibility of commercialising a concept to provide a range of ZERO EMISSION ancillary services to National Grid power transmission systems. Having a potential to contribute emission free services such as Short Term Operating Reserve and Frequency Response, the project could also provide cutting edge solutions for the renewable energy sector, facilitating the increased integration of sustainably produced energy.

Market opportunity

The market for Ancillary Services, relevant to this project, is provided by 3rd party contractors, costing National Grid (NGET) £560m in 20-14/15; specifically 1) Short Term Operating Reserve (STOR) £98.4m in 20-13/14 & 2) Frequency Response, £174m 2013/14 (source NGET 2013/14 report). An NGET' report, "Fuel Type Analysis, Oct/2014 to Feb/2015", Diesel represents 22% of the current fuel source. Justification to gain an early market share advantage is the ability to provide a NICHE, ZERO EMISSION, service.

Innovation

Gravitational potential energy of itself is an established concept where $E=Mgh$, the technical challenges are those of scaling, i.e. the construction of a viable utility scale installation. The project design will expand this principle exponentially to achieve a utility scale technology in a way that has not been done before. The prototype will have a target output of 3.4 MW and a storage capacity of 1.2MWh's using a coherent concept to store and regenerate electrical energy.

Exploitation route

With UK Power Reserve, (UKPR) currently the largest independent provider of STOR, and a collaborating partner to the project, a commercial link has been established. UKPR have provided a number of own-site locations to the project for targeted analysis & participate in the evaluation of commercial & technical pre-prototype modelling studies relating to these sites. UKPR involvement constitutes a strategic commercial alliance during prototype development, facilitating an immediate access to current industry markets, operating dynamics and established infrastructure.

Outcomes and next steps

Currently the project is has just completed its first 3month period, this involved the geological assessment of four potential UK sites adjacent to power distribution infrastructure. Half of the sites are suitable and they are considered as potential sites for the installation of a fully working prototype. The next 3 months will see production of the main borehole specifications and parameters based on the selected sites in tandem with other major system parameters.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132402>

Prof. Mike Kendall

University of Bristol
gljmk@bristol.ac.uk
<http://www.bris.ac.uk/earthsciences/people/michael--kendall/>

John Beswick

Director
Marriott Group
john@marriottdrilling.com
<http://www.marriottdrilling.com/>

Brendan McGrath

Director
Energy SRS Ltd
brendanmc@energysrs.com
<http://www.energysrs.com>

Paul Graham

Director of Development
UK Power Reserve Ltd
paul.graham@ukpowerreserve.com
<https://ukpowerreserve.com>

David Bayliss

Director
David Bayliss Consulting
david@baylissconsulting.co.uk
<http://www.baylissconsulting.co.uk>

Acoustic Tagging Technologies Applied to Cables and subsea Hardware (ATTACH)

132403, Early Stage, 1/10/16 to 30/9/17, £242,211

**Subsea Asset Location Technology Ltd
Precision Acoustics Ltd
University of Birmingham**

The ATTACH project is carrying out a feasibility study to identify remote-sensing, acoustic methods of labelling high-value subsea energy assets, such as cables and pipelines. The aim of this project is to design synthetic sonar targets that float above the asset and are significantly easier to detect using a sonar system than the asset itself. One can imagine that being able to see a string of such targets over a range of a few hundreds of metres (cat's-eyes) would dramatically increase the detectability of such assets.

Market opportunity

There is a substantial commercial market available to any technology able to improve on the rapid detection, classification and identification of offshore energy industry facilities including: power cables, pipelines and infrastructure such as valves, switchgear and junction boxes. These are items that may be buried, partially exposed, or totally exposed and whose location may have moved since the last survey or maintenance operation.

Innovation

This project addresses the Energy Trilemma by making underwater interconnection assets significantly faster to find and follow. Thus, with the proposed technology, maintenance down times, through-life costs and disposal costs are reduced (cost of energy and security of supply aspects), and enables earlier adoption of offshore renewables (reducing emissions). The innovation lies in the ability of future-generation asset owners being able to reliably locate and identify underwater hardware at long-range and at minimal recurrent cost.

Exploitation route

The exploitation of this work will be via SALT and Precision Acoustics who both have a substantial footprint in the subsea and cable industry, a cable manufacturer will be chosen as a partner and the development of a product will be assisted and driven by requirements from these partners.

Outcomes and next steps

Work has already started with a cable partner in preparation for exploitation as the technical work starts to mature. The project will complete towards the end of this year so our plan is to have a contract in place with this partner to exploit the R&D part funded by Innovate.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132403>

Carl Tiltman

CEO
Subsea Asset Location Technologies Ltd
ctiltman@cesalt.co.uk

Phillip Atkins

Senior Lecturer
University of Birmingham
p.r.atkins@bham.ac.uk

Andrew Hurrell

Principal Research Physicist
Precision Acoustics Ltd
andrew@acoustics.co.uk

Excalibur – A novel subsea infrastructure solution for the deployment of tidal arrays

132405, Early Stage, 1/10/16 to 30/6/17, £124,543

Jee Ltd

Excalibur consists of subsea support structures, together with array and export cabling – everything you need offshore in order to plug-and-play tidal energy converters (TECs). It facilitates in-air installation of TECs and their in-air maintenance or replacement, dry-mate connection, fully protected cables, frequency conversion, and a 33kV grid-synchronised array, all in a modular design with rapid consent to construction time.

Market opportunity

The UK is fortunate in having large amounts of tidal energy close to large centres of population and must capitalise on that to harvest low-cost predictable power and then go on to develop tidal energy abroad. A lot of work has already gone into the tidal energy converters, and Excalibur complements this through providing the subsea infrastructure to support them and connect them reliably to the onshore grid.

Innovation

Excalibur's innovations will bring down costs, decrease time to construct, and increase availability. The TECs are attached above the waterline, permitting 24 hour working and dry-mate connectors. They are also maintained above the waterline, however, during operation everything is submerged and the array has no surface-breaking elements. The cables are fully protected, particularly against vibrational failure due to environmental loading. There is a separate electric pod on the structure allowing a reduced size and complexity of nacelle, whilst enabling a 33kV grid-synchronised array.

Exploitation route

Jee would act as designer for a developer, interfacing with the TEC supplier, selecting and managing suppliers, fabricator and installation contractor to get Excalibur built. Alternatively, Jee would work with the supply chain to fulfil a subsea infrastructure EPC contract based on Excalibur, driven by requirements from these partners.

Outcomes and next steps

The concept selection phase of design is done. There are three next steps: There are several promising design avenues for further evaluation; we would like to build and factory-test key components; and we would like to put our ideas to further design review, particularly by parties in the supply chain.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132405>

Trevor Jee

Managing Director
Jee Ltd
01732 371371
trevor.jee@jee.co.uk
www.jee.co.uk

Microgrid Energy Storage using Lithium Sulphur Batteries (MESS)

132406, Early Stage, 1/10/16 to 30/9/17, £194,167

University of Southampton
OXIS Energy Ltd

The Microgrid Energy Storage (MESS) project will explore the feasibility of a new rechargeable battery technology capable of achieving high cycle life at competitive costs to target this market. The project will exploit OXIS Energy's core Lithium Sulphur technology using a new electrolyte classification to extend cycle life. UoS will exploit their extensive knowledge of novel electrochemical test techniques to assess candidate electrolyte formulations and then test their performance credentials in the laboratory.

Market opportunity

This technology, which addresses static energy storage, will reduce consumer costs and carbon emissions, and will have a direct impact on energy affordability and access, whilst improving the UK's energy security by being less reliant on foreign imports of fossil fuels. The size of these improvements would depend on market penetration and replacement of more polluting alternatives.

Innovation

The MESS project aims to develop new electrolytes that fundamentally change the reaction in the lithium sulphur cell and provide enhanced performance. The objective is to achieve a lithium-sulphur cell able to operate over 3000 cycles at costs < 250 \$/KWh. The key to achieving a breakthrough in performance required to achieve the requirement of stationary energy storage is to alter and control the reaction mechanism, for which the electrolyte nature is key.

Exploitation route

We expect UoS to write a technical paper on the project work and results, as well as release some public interest articles in different conferences. Once the cell has been fully developed and tested, OXIS Energy will target customers who have compatible requirements for their system. The new successful electrolytes will be patented and added to the OXIS library of lithium sulphur materials.

Outcomes and next steps

Project is still in early stages of development.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132406>

Lisset Urrutia

MESS Project Manager
Lisset.Urrutia@oxisenergy.com
www.oxisenergy.com

CO2 storage & CO2-enhanced oil recovery subsurface simulations, using open-source software in the Cloud (CO2CloudSim)

132406, Early Stage, 1/10/16 to 30/9/17, £194,167

OpenGoSim Ltd
TotalSim Ltd
Heriot-Watt University
British Geological Survey

As we are transitioning to a green economy, the portion of oil and gas still needed will have to reduce its environmental impact, therefore oil corporations are investing in technologies to cut CO2 emissions. This project is developing a state-of-the-art simulator based on open-source software, to simulate CO2 storage and CO2-enhanced oil recovery subsurface processes in the cloud. Unique features are: modelling of strong temperature effects and efficient exploitation of parallel computing technologies.

Market opportunity

The global CO2-enhanced oil recovery (EOR) spending in 2015 reached \$4.74bn, with the EOR sector, including CO2-EOR, due to grow by an average yearly rate of 18% from 2014 to 2019. The size of the global carbon capture and sequestration market is estimated to be \$4.25 Billion in 2016, and is projected to grow 13.6% yearly from 2016 to 2021, to reach \$8.05 Billion by 2021.

Innovation

Current reservoir simulators have significant limitations to deal with thermal effects and to scale above a large number of processing units (i.e. 2-3k). Both aspects play a crucial role when modelling CO2 applications such as CO2-EOR and CO2 storage. This project is developing new software components and algorithms to handle thermal effects robustly, and to push scalability to a much larger number of processing units (i.e. 200-300k).

Exploitation route

We target large oil corporations seeking to develop new CO2-EOR and CO2 storage technologies, requiring strong software customisations. But we are also aiming to sell support services to consulting firms that want to exploit parallel computing technology at affordable rates. In fact, the cloud technology makes very large computer servers available on demand, removing the burden of purchasing and maintaining large IT infrastructures.

Outcomes and next steps

The project has implemented software components for thermal CO2 applications that can scale to hundreds of thousands of processing units. It has also developed a cloud system prototype. Early-user tests are planned in the next three months, while fresh R&D funding is being sought for large scalability tests and to further develop the parallel algorithms and the cloud system. OpenGoSim has just closed a funding round of c.£250k to support commercialisation of the software.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132407>

Paolo Orsini

CEO, OpenGoSim Ltd
paolo.orsini@opengosim.com

Prof. Gabriel Lord

Dept. of Mathematics and Maxwell Inst.,
Heriot-Watt University
G.J.Lord@hw.ac.uk

Gareth Williams

Geophysicist
British Geological Survey
gwil@bgs.ac.uk

Ivor Annetts

Project Team Leader
TotalSim Ltd
ivor@totalsim.co.uk

Energy from Transportable Bio-Char Equipment (ENTRANCE)

132408, Early Stage, 1/10/16 to 30/9/17, £199,398

Carbon Compost Company Ltd

TWI Ltd

Helec Ltd

Hieta Technologies Ltd

ENTRANCE will establish the feasibility of a transportable system for the combined production of electrical power, heat and biochar products from waste wood and biomass. The output is also a route for carbon sequestration into soils. Building on the successful CCC Exeter Retort, the ENTRANCE project will evaluate processing, storage and electrical generation from the waste gas from the retort. The ENTRANCE system is transportable to the site of the feedstock to minimise transport costs.

Market opportunity

The market requires a robust transportable system to generate electricity continuously from biogas with minimal pollution, to provide useable heat and to produce valuable biochar products (charcoal for cooking, biochar for soil conditioning and carbon sequestration, and wood tar preservatives). The electricity produced can meet local demand or be fed to a grid. The demand has come from wood and agricultural waste processors, animal bone processing for fertilisers and military field power and accommodation.

Innovation

The challenge is to produce a transportable system which fits to a standard container trailer, includes the biochar retort and the project's innovations of a compact high performance heat exchanger to cool the gas from 500°C, a compact gas processing system to remove tars and smoke and water, an extendable large scale gas store (40m³) and a compact Combined Heat and Power unit for electricity and heat output as hot air or water.

Exploitation route

CCC will use its customer base for biochar producing retorts and its licencees. Through these they have interest already in production based applications such as saw-mills, agri-applications such as crop drying and phosphate reclamation from feedlot cattle bone, and remote energy production. HiETA's compact heat exchanger production technology has additional applications. ENTRANCE demonstrates the capabilities of gas stores from Outsourced Manufacturing Services, flexible CHP designs from Helec, and engineering prototypes by TWI.

Outcomes and next steps

The ENTRANCE feasibility stage project will demonstrate the gas has high calorific value, the gas can be processed in a compact system, large scale storage can be incorporated into a transportable system, a large CHP unit can be coupled in, and the system operate sustainably without pollutants. The next steps will be to use the results to generate even further interest and to use the feasibility study's designs to progress to a full prototype system.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132408>

Robin Rawle

Proprietor
Carbon Compost Company Ltd
admin@carboncompost.co.uk
<http://www.carboncompost.co.uk>

Ashley Grist

Owner
Helec Ltd
ashley.grist@helec.co.uk
<http://helec.co.uk>

Andrew Whitaker

Consultant Engineer
TWI Ltd
andrew.whitaker@twi.co.uk
<https://www.twi-global.com/>

Henry Greenhaigh

Project Engineer
HiETA Technologies Ltd
henrygreenhalgh@hieta.biz
<https://www.hieta.biz>

Energy Harvesting e-Textile Platform

132409, Early Stage, 1/10/16 – 30/9/17, £199,800

KYMIRA Ltd

This project is a feasibility study for a human and environmental energy harvesting technology for future textile embedded electronic solutions. The goal is to develop a sustainable and long lasting energy source which could power any body-worn electronic monitoring and communication system. To do this the current state of the art in energy harvesting will be explored and further refined through experimentation in order to develop an embedded e-textile solution.

Market opportunity

The wearables industry is relatively new but estimates already place this market as being worth £2 billion globally and this is expected to grow to £34 billion by 2024 across sectors such as healthcare, military and sports. As more and more portable devices enter the market, powering them becomes an issue.

Innovation

Though there is a focus to develop better batteries, human energy harvesting is still relatively unexplored and presents a huge opportunity to develop a new type of clean and sustainable power source for wearable electronics. Moreover, being able to embed such a solution into the very clothing worn by the user creates a much better universal solution and increases the chances of market acceptance and consumer long term use.

Exploitation route

Our initial route to market will be through licensing the technology to established businesses with the need for a compact energy harvesting solution for their wearable technology: products like personal fitness monitors (e.g. Fitbit) or head-mounted displays (e.g. Skully). KYMIRA has also positioned itself as a technical sportswear brand and, through existing and future channels, we will later seize further market share in the health and fitness sector by developing our own range of products.

Outcomes and next steps

The project is progressing well and we will soon have working prototypes to demonstrate the feasibility of energy harvesting for powering wearable electronics. In the next stage, we will undertake industrial development to bring the technology closer to scaled production. We will also continue to refine the technology to achieve higher and more stable power outputs. The first realisation for consumers will be a health monitoring solution completely powered by the wearer and the surroundings.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132409>

Tim Brownstone

Chief Executive Officer
tim@kymira.co.uk
<https://www.kymirasport.com>

Philip Kunovski

Chief Technology Officer
phil@kymira.co.uk
www.kymira.co.uk

Low Cost Power Supplies for Developing Countries – Repurposing Computer Power Supplies (RECOMPS)

132410, Early Stage, 1/9/16 to 31/8/17, £149,772

ECO3

University of Sheffield

S2S

Due to the rapid rate of development seen within the ICT sector it is not unusual for equipment to become obsolete and be replaced before it fails due to age. This makes ICT equipment a prime source of potential components for repurposing. In the RECOMPS project the feasibility of producing a battery charger which can operate from a renewable power source, and is built from primarily components obtained from computer power supplies, is assessed.

Market opportunity

This project is expected to lead to number of market opportunities across a range of stakeholders. These include: WEEE recyclers looking to optimise their waste (according to the waste hierarchy) through licensing of testing procedures and tools developed within RECOMPS; policy makers aiming to support the repurposing of WEEE and charity and international organizations supporting development in developing nations through the supply of cheap power supply units that have multiple applications.

Innovation

The project looks at innovative ways of repurposing existing systems found within ICT hardware which would otherwise be treated as WEEE. As these systems generally haven't reached the end of their useful life reuse is preferable to recycling. For this to be possible it is necessary to define the required steps to reconfigure the system, including modifying the target hardware and altering its control system to allow it to perform its new purpose.

Exploitation route

The opportunity to exploit developments from the RECOMPS project will primarily be focused around the development of suitable supply chains for the targeted application. However, work conducted during RECOMPS will also support the positive view of reusing end-of (first)-life ATX units. Whilst repurposing ATX has been demonstrated at lab bench scale, the use of actual WEEE selected from waste streams has not been investigated. The tools for identifying and selecting suitable second life units will be instrumental in developing protocols and standards in the UK and EU.

Outcomes and next steps

The outcome of this project is a blueprint specifying the steps necessary to repurpose a computer power supply for use as a renewable energy (solar) powered battery charger. Analysis will also be performed to consider the best way to market this product, either as a complete product or a kit for self-assembly.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132410>

Leigh Holloway

Eco3
leigh@eco3.co.uk

Alan Dukinfield

S2S
alan.dukinfield@s2s.uk.com

Martin Foster

University of Sheffield
M.P.Foster@sheffield.ac.uk

Enhanced electricity generation through waste heat utilisation and thermodynamics of supercritical CO₂

132411, Early Stage, 1/9/16 to 31/8/17, £133,793

PJH Partnership Ltd

PJH Partnership has identified an innovative process that can both cycle CO₂ and efficiently convert waste heat to power using a highly efficient working fluid. The system manipulates multiple phase changes of CO₂ to maximise the thermodynamic potential of a fluid that is both highly stable, readily available and inert.

Market opportunity

In the short term, PJH will target the retrofit microgeneration market in the UK. Commercialisation will start at large established AD & solar plants. The UK's current position on retrofit energy generation has focused on the use of biomass which is now less viable with public funding being reduced. Capital costs for biomass are also higher than scCO₂ turbine projected by PJH.

Innovation

PJH Partnership has identified an innovative process that can both cycle CO₂ and efficiently convert waste heat to power using a highly efficient working fluid. The system manipulates multiple phase changes of CO₂ to maximise the thermodynamic potential of a fluid that is both highly stable, readily available and inert.

Exploitation route

PJH would take advantage of the stage 1 pilot plant location at a waste disposal site, using this site to develop our generation technology at scale, and PJH also has good contacts with Drax power station, RWE & SSE. Communication would begin for long term exploitation with larger grid based companies.

Outcomes and next steps

This 12-month project aims to assess the technical feasibility of generating supercritical CO₂ using the process methodology and evaluate its efficacy in power generation using turbine technology. The modular retrofit system targets fossil fuel generators and renewable operators with future commercial deployment anticipated end-2018.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132411>

Alexander Hammond

Project Manager
PJH Partnership Ltd
ajhammond@criticalapplication.com
www.criticalapplication.com

Peter Hammond

Company Director
PJH Partnership
pjhammond@criticalapplication.com
<http://www.criticalapplication.com>

Reducing the Cost of Solar Thermal: Integration of Thermal Storage with Solar Collector Design

132412, Early Stage, 1/10/16 to 30/9/17, £199,893

Soltropy Ltd
Heriot-Watt University

This project combines the Soltropy Ice Immune TM solar thermal system with heat storage capability. The energy will be stored inside the evacuated tube itself negating the need for a hot water cylinder or external storage. This will make the overall system more effective and expand the use of solar thermal by making it affordable. The project's focus is to:

- 1** Reduce the cost of the system for installations where space heating is required.
- 2** Reduce the cost of the system for installations where there is no existing hot water tank.
- 3** Increase the performance of the system.

Market opportunity

This project is relevant to domestic and commercial properties in making solar thermal affordable for properties without existing hot water cylinders and for larger arrays for space and hot water heating. The social housing sector is especially relevant with ~4.6 million social housing homes in the UK alone. A typical roof could hold around 150 evacuated tubes making a real contribution to both space and hot water heating and help combat fuel poverty.

Innovation

Storing energy in the evacuated tube has advantages over a separate heat store: the containment for the storage already exists, it has exceptional insulation, getting energy out uses the evacuated tubes existing heat pipe and as the evacuated tube is of small diameter, the energy flow in and out of the storage is quicker when compared to larger sized containment.

Exploitation route

The system will be supplied to both distributors and partner installation companies initially in the UK and then supplied into the EU and North America.

Outcomes and next steps

This 12-month project aims to assess the technical feasibility of generating supercritical CO₂ using the process methodology and evaluate its efficacy in power generation using turbine technology. The modular retrofit system targets fossil fuel generators and renewable operators with future commercial deployment anticipated end-2018.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132412>

Stuart Speake

Director
Soltropy Ltd
stuart.speake@soltropy.com
www.soltropy.com

Feasibility study for innovative remote sensing to increase onshore UK gas production

132413, Early Stage, 1/10/16 to 30/9/17, £190,000

Adrok Ltd IGas Plc IGas Plc

This project will determine the feasibility of using innovative remote sensing techniques to improve the rate of success in hydrocarbon exploration and development of onshore UK gas fields. Adrok has been researching atomic dielectric resonance (ADR) as a method of determining elements in the subsurface and the depths of subsurface layers. Using IGas' oil fields and exploration blocks, the objective of the feasibility study will be to investigate how ADR results can be integrated with geological, geophysical and geochemical data to find and develop new onshore UK gas fields more efficiently.

Market opportunity

The nature of the problem is that the pursuit of locating petroleum from the ground surface has relied heavily on the same core technology principles over the past 70 years – seismic surveys, wellbore petrophysical measurements and well tests. This project aims to generate a faster, better, cheaper and greener solution for finding oil and gas onshore in the UK, using cutting-edge technologies. Visiongain (Sept.2010) believes that the global advanced oil and gas exploration technologies market will grow at a CAGR of 2.7% over the next 10 years, from total revenue of \$9,563m in 2010 to \$12,785m in 2020.

Innovation

Adrok is a cutting edge technology company headquartered in the UK with exclusive global patents to Atomic Dielectric Resonance (ADR) technology. This novel technology is based on transmitting pulses of electromagnetic waves at the speed of light into the subsurface from a transmitter while simultaneously recording reflected pulses with an adjacent receiver. This technology has been adapted for use in the geotechnical, mining and oil and gas sectors. There have been good results obtained using a field portable system that can acquire sufficient measurements at a series of surface locations for subsequent data processing and mapping. The technologies 2 unique selling points are: deep penetration of radio waves through opaque solid rocks in the ground up to 4000m below ground level and material classification of key lithological layers and rock layer sequences ahead of drilling. As the evacuated tube is of small diameter, the energy flow in and out of the storage is quicker when compared to larger sized containment.

Exploitation route

Economic benefits: ADR and other remote sensing technologies can potentially reduce the number of dry holes drilled and could increase exploration success rates to over 80%. By locating additional conventional and shale reserves more quickly and inexpensively, there will be immediate costs savings which could ultimately reduce the cost of energy for UK businesses and homes within 10 years.

Route to market: Adrok will offer geophysical survey services directly to oil companies. IGas intend to be a customer.

Outcomes and next steps

The results of the project will be exploited and disseminated by: (a) further development of the ADR hardware and software, (b) offering of enhanced ADR measurement services to the oil and gas industry, (c) offering of enhanced ADR measurement services to other sectors, such as the mineral industry, (d) sharing research results with our university colleagues such as Professor Worden at Liverpool University, Professor Gulyas at Durham University and Professor Fraser at Imperial College, (e) presentations by Adrok to potential clients, (f) presentations by IGas to current and potential partners, (g) joint presentations at conferences, (h) publication of technical papers, (i) funding and undertaking an industrial research project, (j) funding and undertaking an experimental development stage project.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132413>

Gordon Stove

CEO & Co-Founder
Adrok
gstove@adrokgroup.com
<https://adrokgroup.com>

Dr Mark Young

Technical Director
IGas plc
Mark.Young@igasplc.com
<http://www.igasplc.com>

Power Generation and Heat Recovery from Biomass with Advanced CO₂ Thermodynamic Power Cycles

132414, Early Stage, 1/12/16 to 30/11/17, £199,798

**Ashwell Biomass Ltd
Brunel University**

In this project, one test rig of a small-scale biomass power generation (5kW_e) system will be established and measured. The system is based on an advanced thermodynamic power cycle and uses CO₂ as a working fluid. Special designs and controls will be applied to the proposed system so as to achieve a high thermal efficiency. Simultaneously, a detailed mathematical model for the proposed biomass power generation system and components will be developed and validated.

Market opportunity

We have identified one market that would benefit from a Biomass-CO₂ technology: farming/rural communities. According to Defra, annually there are about 10 MT, equivalent to 41.7 TWh waste straw from farming which can be used to deliver power and heating. There are 222,000 active farms in the UK as well as other agricultural businesses (DEFRA – Agriculture in the United Kingdom – 2012) of which 100,000 could benefit from the new power system being proposed.

Innovation

In view of current research and development in small-scale power generation using biomass and Organic Rankine Cycles (ORCs), the critical issues that impede their widespread application are their low thermal (electric) efficiencies and identifying appropriate working fluids to be used in the ORCs. The main task in this project is to utilise CO₂ as the working fluid and explore an advanced thermodynamic power cycle that can achieve high efficiencies for the biomass-CO₂ power system.

Exploitation route

Ashwell and Brunel University will respectively exploit the technology by integrating a supercritical CO₂ heater with Ashwell's biomass boiler and developing CO₂ power generation systems with advanced thermodynamic power cycles. Each will own foreground IPR for their respective components, allowing each partner to continue to freely develop and exploit their technology.

Outcomes and next steps

The project will carry out comprehensive experimental and theoretical investigations into the feasible conversion efficiencies of a small scale biomass – CO₂ power generation system operating with advanced thermodynamic power cycles. Detailed mathematical models for the proposed system will be developed and experimentally validated. Significant experimental and simulation results will be obtained for the system optimal designs which will lead to application of the proposed system and system scale up for the next steps.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=132414>

Barry West

MD, Ashwell Biomass Ltd
barry.west@ashwellbiomass.com
www.ashwellbiomass.com

Dr. Yunting Ge

Brunel University London
yunting.ge@brunel.ac.uk
<http://www.brunel.ac.uk/people/yunting-ge/>

Kite Energy Scheme (KESS)

102591, Mid Stage, 1/6/16 to 30/11/18, £1,499,670

Kite Power Systems Ltd
Artemis Intelligent Power Ltd
Banks Sails Ltd
BVG Associates Ltd

Imperial College London
Keynvor Morlift Ltd
National Composites Centre

Kite Power Systems Ltd (KPS) is developing a renewable energy system using kites to harness the wind. There are key technical challenges to be addressed in the technology development associated with offshore floating platforms, moorings, installation, kite performance, kite life and manufacturing methods. These items are key cost drivers which have significant impact on the Levelised Cost of Energy (LCoE). The results from the project are used to confirm assumptions in the KPS LCoE projections.

Market opportunity

The UK has over 5GW (RenewableUK) of offshore wind installed, a further 8GW is consented for construction. The global offshore wind capacity is 14.4GW (GWEC) and will double in the next 5 years. Conventional offshore wind uses monopiles and jackets in water depths up to circa 60m; floating concepts are being developed to address water deeper than this. KPS systems can address deep water with an LCoE substantially lower than conventional wind.

Innovation

Using kites to harness wind energy to produce electricity is novel. Within this programme KPS is working with the collaborators to evaluate materials and novel manufacturing processes to address the issues of kite life and automated volume manufacture of kites. Additionally, floating platforms, mooring designs, installation methods and marine maintenance processes were evaluated and costed to be fed into the LCoE model.

Exploitation route

KPS are building and testing a 500kW system in Scotland during 2017/2018. A 3MW system is being designed and will be built and tested in Scotland in 2019/2020. In parallel KPS are identifying a pilot demonstration site for a 10 x 500kW system array to be built and operated on a commercial basis in 2019/2020. To service this requirements investment in kite manufacturing facilities will be required within this time frame.

Outcomes and next steps

The project has demonstrated that:

- Kite materials and process for manufacturing will achieve the target kite life and cost
- The floating platform for a kite is substantially simpler and lower cost than concepts for a conventional wind turbine
- The overall LCoE for offshore wind can be substantially lower than conventional HAWT

KPS will use the outputs of this project to support future investment in the 3MW system development and the 10 x 500kW array development.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=102591>

David Ainsworth

Business Development Director
Kite Power Systems
david.ainsworth@kitepowersystems.com
www.kitepowersystems.com

Giles Hundleby

Associate Director
BVG Associates
geh@bvgassociates.com
<https://bvgassociates.com>

Anne Van Houten

Commercial Development Manager
Keynvor Morlift Ltd
anne.vanhouten@keynvormorlift.co.uk
www.keynvormorlift.com

Henry Dodson

Project Manager
Artemis Intelligent Power
H.Dodson@artemisip.com
www.artemisip.com

Prof Mike Graham

Imperial College
m.graham@imperial.ac.uk
www.imperial.ac.uk

Phil Slack

Technology Project Lead – Emerging
Sectors and SME Engagement National
Composites Centre
Phil.Slack@nccuk.com
www.nccuk.com

Gary Owen

Research Consultant
Banks Sails
gary@banks.co.uk
www.banks.co.uk

Low Temperature Waste Heat to Power Generation

102592, Mid Stage, 1/9/16 to 31/8/19, £1,240,628

Spirax Sarco
Arctic Circle
Industrial Power Units
Cooper Tire and Rubber Company

Brunel University
Howden Compressors

A substantial portion of final energy usage for industrial processes in the industrial sector is being wasted through losses, the majority of which is available at low temperatures. Building on successful trials at small scale, the aim of this project is to fill a gap in the market and develop a commercially compelling technology at industrial scale, with a higher thermal to electrical energy conversion ratio than currently available technologies.

Market opportunity

The potential market for waste heat recovery is expected to reach £35 billion by 2018 with Europe accounting for approximately 40% of this market. At present there is no technology on the market that can convert low temperature waste heat to electrical energy effectively, hence the market opportunity for the CPC system is substantial with its applicability in a range of different markets.

Innovation

ORC systems are now commercially available to convert low temperature heat into electrical energy. However they have limited power generation potential at heat source temperatures below 100°C and require an additional cooling system when the waste heat stream needs to be cooled to near ambient conditions. In contrast to the ORC, the proposed technology has the potential to maximise heat recovery and power generation from the waste stream, obviating the need for an extra cooling tower and generating up to 3 times more power than an ORC based system

Exploitation route

There are a number of target applications which will be considered initially: Cooling Towers, UHT production equipment and Condensate Returns. Spirax-Sarco with its 42 operating companies and a technical sales force of 2000+ working in the process and energy sectors, is in a prime position to unlock the market for these applications in 70 countries around the globe for this UK innovation.

Outcomes and next steps

The technology has been proven through extensive experimental and modelling work and we are currently developing a large scale test to be installed and tested at an industrial tyre manufacturing plant with Cooper Tire and Rubber Company. Further market analysis is being performed simultaneously in preparation for commercialisation.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=102592>

Obadah Zaher

Research Team Leader
Spirax Sarco
obadah.zaher@uk.spiraxsarco.com
<http://www.spiraxsarco.com/pages/home.aspx>

Stuart Kennedy

Design and Development Engineer
Howden Compressors
stuart.kennedy@howden.com
<https://www.howden.com>

Shawn Shepherd

Divisional Director – Engine Controls
Industrial Power Units Ltd
Shawn.Shepherd@ipu.co.uk
www.ipu.co.uk/controls

Nick Franzen

Commercial Director
Arctic Circle Ltd
Nick.Franzen@acl-online.com
www.acl-online.com

Savvas Tassou

Director Institute of Energy Futures
Brunel University
Savvas.Tassou@brunel.ac.uk
www.brunel.ac.uk

Derek Brightman

Site Electrical & Energy Manager
Cooper Tire & Rubber Co Europe Ltd
DBrightman@coopertire.com
<http://www.coopertire.co.uk>

High Efficiency Recuperator for stationary power Micro-Turbine (HERMiT)

102593, Mid Stage, 1/5/16 to 31/10/17, £1,301,265

Hieta Technologies Ltd Bladon Jets UK Ltd

This project applies additive manufacturing to develop a novel recuperator technology for micro turbine generators (MTGs). MTGs have a number of benefits compared to diesel or other reciprocating internal combustion engines, however, current markets for static power generators are limited by the inherent fuel-to-electrical efficiency and higher equipment cost, where the recuperator is a key driver of both. This project addresses both through the development of a highly efficient integrated recuperator at a competitive cost.

Market opportunity

The market is currently estimated globally at c. \$31 billion with further significant growth expected by the end of the decade. Within this global figure, specific opportunities lie in the backup and prime power requirement for mobile phone towers, a \$7.3 billion market which constitutes circa 650,000 generator sets per annum.

Innovation

The project will develop a novel, integrated and compact recuperator solution using highly efficient transfer surfaces that could not be produced through other means. We will also develop high productivity selective laser melting parameters to reduce the system cost. Through integration and reduction of system losses, we are working towards the improvement of the MGT cycle efficiency towards 30%.

Exploitation route

The high efficiency recuperator has a clear route to market as a part of the Bladon Jets microturbine genset product for power generation. There will also be further exploitation routes in range extender applications for electric vehicles but the primary route will be in stationary power and via Bladon Jets existing customers in telecommunications around the world.

Outcomes and next steps

We have developed a number of novel recuperator concepts which have demonstrated how the use of additive manufacturing can dramatically reduce the size of the system, and with that potentially system losses. We have also shown how expensive connecting components can be reduced or eliminated through integration. These concepts will be down selected, and developed, using advanced CAE methods and manufactured for cycling and performance testing.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=102593>

Stephen Mellor

Senior Project Engineer
HIETA Technologies Ltd
stephenmellor@hieta.biz
www.hieta.biz

Mike Whiteman

Senior Engineer
Bladon Jets (UK) Limited
mike.whiteman@bladonjets.com
<http://www.bladonjets.com>

Mike Adams

Director
HIETA Technologies Ltd
mikeadams@hieta.biz
www.hieta.biz

Wide-Area Instrumentation of Power Networks using Existing Infrastructure

102594, Mid Stage, 1/7/16 to 30/6/19, £1,464,145

Synaptec Ltd
University of Strathclyde
National Physical Laboratory
Bellrock Technology Ltd

Instrument Transformers Ltd
GE Grid Solutions

This project will prototype and test a novel distributed photonic sensing technology that provides wide-area monitoring of electrical and mechanical parameters on the electricity grid from central locations such as transmission substations. By piggy-backing on pre-installed optical fibre on power networks, it allows network operators to leverage existing infrastructure to improve awareness and resilience in order to bring on more distributed and renewable generation and reduce the impact of faults or outages.

Market opportunity

This project will develop products with a far-reaching market impact on all power and energy industries. Focusing initially on transmission networks, operators have helped to determine that this technology could substantially reduce costs while providing a unique opportunity to improve network resilience. From National Grid's Ten Year Statement, the UK market is estimated at £450m. Synaptec will target this market before expanding into the EU/US (£11b) and further export markets including India, China and Africa.

Innovation

Synaptec is developing an innovative optical fibre technology to allow power and energy network operators to measure both electrical and mechanical parameters with high accuracy over broad geographic areas. The technology utilises existing fibre infrastructure, does not require power supplies, and can operate over distances of up to 100 km. The patented technology enables multiple key products in the power industry relating to fault identification and location, remote monitoring and control, and long-distance measurement synchronisation.

Exploitation route

The projection consortium contains the main elements of the future UK supply chain for this innovation, including software development, hardware components, channel partners, and academic generation of secondary IP. The technology developed within this project will be commercialised and manufactured by Synaptec with the input of all elements of the consortium, and marketed both directly to end users as full products and via international channel partners as OEM components.

Outcomes and next steps

The principal outputs of the project will be a range of products and prototype installations tested at NPL and PNDC facilities, and reports detailing the performance of these systems with reference to commercial applications identified and prioritised with input from GE Grid Solutions. The project will fully develop the hardware, software, assembly processes and know-how to underpin commercial deployment.

Product development will include assembly processes, bills of materials, and product-specific commercialisation plans.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=102594>

Dr Philip Orr

Synaptec Ltd
philip.orr@synapt.ec
<http://synapt.ec/>

Protected Anodes for Lithium Sulphur Batteries (PALIS)

102595, Mid Stage, 1/8/16 to 31/8/17, £1,545,584

Johnson Matthey plc
Warwick Manufacturing Group
Williams Advanced Engineering Ltd

University of Oxford
Ilika plc

Lithium Sulphur batteries can provide advantages of lower cost, longer lifetime and higher capacity if suitable electrode materials improvements can be made and critically the detrimental 'polysulphide shuttle' process can be controlled. This technology is particularly suitable for smart grid/small scale energy storage systems where lower cost, reduced weight, low maintenance and ease of installation are all significant advantages. The Protected Anodes for Lithium Sulphur Batteries project aims to develop advanced technology for this market area and achieve improved cell performance, by developing novel anode concepts and improved materials for Li-S cells.

Market opportunity

The project will align cell performance data and the simulated module performance with the various energy storage applications to show market awareness and pre-commercialisation of the materials. Components of the Li-S cell are low cost C, S, Li and organic solvent combined with a thin protective layer. Protected anode technology is enabling for Li-S, Li-Air (high capacity, storage and EV) and Li-ion capacitor use (hybrid drive bus, EV and broader sectors of grid storage market).

Innovation

The technical approach of the project is to identify and develop novel Li protected anode components, explore advanced cathode structures and produce a high capacity and long lifetime Li-S pouch cell. The design of novel protected anode components is a key feature of the project approach, where techniques such as PVD screening and deposition, development of various solid state Li conductors and non-PVD deposition routes will be used.

Exploitation route

The different stages of the commercialisation process include predicting a production ready protected anode manufacturing process by 2022 and prototype packs in real world trials (combination with renewables, PV, wind etc) by 2025, followed by full commercialisation. Solid electrolytes & protected anode concepts are exploitable in related technology areas requiring a stable Li containing anode, such as lithium ion capacitors and lithium air batteries, opening markets in hybrid drive train, EV and wider penetration into grid storage markets.

Outcomes and next steps

Different project partners have been exploring various approaches to make the protected anode layer such as polymer composites deposited by casting and PVD methods. Novel C/S materials have been prepared using low cost routes and fundamental materials and interface characterisation has also been carried out. Next step will be to test the different protected anode formats in realistic A6/A5 formats using roll to roll C-S cathodes.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=102595>

Noelia Cabello

Principal Scientist
Johnson Matthey plc
Noelia.cabello@matthey.com
www.matthey.com

Graeme Purdy

CEO, Ilika plc
Graeme.Purdy@ilika.com
www.ilika.com

Peter Bruce

Wolfson Professor Of Materials,
University of Oxford
peter.bruce@materials.ox.ac.uk
[www.pgbgroup.materials.ox.ac.uk/
people/bruce](http://www.pgbgroup.materials.ox.ac.uk/people/bruce)

Marcus Jahn

Project Manager, WMG
University of Warwick
Marcus.Jahn@warwick.ac.uk
<http://www2.warwick.ac.uk/fac/sci/wmg/>

Tony Booth

Senior Commercial Manager, Williams
Advanced Engineering Ltd
Tony.Booth@williamsf1.com
[http://www.williamsf1.com/advanced-
engineering](http://www.williamsf1.com/advanced-engineering)

Engineered Textile Blade with Actively controlled surface/profile

102738, Mid Stage, 1/10/16 to 30/9/18, £1,396,604

ACT Blade Ltd
Offshore Renewable Energy Catapult Ltd
University of Glasgow

Lengthening wind turbine blades is recognised as the easiest way to improve wind farm productivity, allowing wind energy to compete economically with other renewable sectors. ACT Blade aims to overcome the length – weight ratio problems involved in achieving this. We are developing an extremely light engineered textile blade, enabling the installation of longer blades without placing excessive loads on the turbine, as well as lowering the costs of manufacture by discarding expensive moulds.

Market opportunity

The wind industry is projected to grow steadily over the next five years, viewed as a secure energy source as opposed to finite resources or expensive alternatives such as nuclear energy. Market predictions show that an extra 50GW of wind power capacity is expected to enter service annually. Independent research conducted on behalf of ACT Blade shows a total addressable market of some £6.3 billion in the five years following ACT Blade's commercialization in 2019.

Innovation

Lengthening fibreglass wind turbine blades would present several challenges. Blades would become unfeasibly heavy, placing enormous loads on turbines. Moreover, the costs of producing huge moulds for manufacture would outweigh any potential benefit. Additionally, the blades would be very difficult to transport. ACT Blade is made of light-weight textiles, enabling longer blades. Its modular manufacturing process does not require the use of moulds and means that blades can be transported in small parts, lowering costs.

Exploitation route

ACT Blade envisages two routes to market: the licensing of ACT technology and the direct supply of blades. Both routes are proven within the renewables industry, providing revenue flexibility. We may consider a strategic partnership with a renowned blade manufacturer, which would give us access to commercial channels and the support of a grounded reputation within the market. An assembly facility with +50/700 employees will be in Scotland with harbour access, while the R&D team office composed of at least 30 high skilled engineers will provide the design for both ACT Blade direct sale and for licensing purposes.

Outcomes and next steps

With our current Mid-Stage Catalyst project, the team has carried out wind tunnel and textile test. Two patents have been filed. We are now seeking to develop prototype blades which will undergo intense testing to optimize design and demonstrate key structural behaviours of the ACT Blade. This will eventually lead to a finalised version of the design of a full-size blade and its manufacturing process. Meanwhile, we will continue to build up supply chain contacts, finalise commercialization strategy and meet potential clients and energy providers to both validate our strategy and communicate our technology benefits.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=102738>

Sabrina Malpede

CEO
ACT Blade Ltd
s.malpede@actblade.com
www.actblade.com

NanocompEIM Phase II- Nanocomposite Advanced Electrical Insulation System for Enhanced HVAC & HVDC Energy Networks

102739, Mid-Stage, 01/10/2016 – 31/03/2019, £1,475,023

**GE Grid Solutions
GnoSys Global Ltd
The University of Southampton**

NanocompEIM Phase 2 will establish thermoset based nanocomposite material formulations and component manufacturing processes scaled to full-sized components for future power transmission networks including HVDC and HVAC equipment for new, smaller and more efficient network installations to meet the needs of our emerging, low-carbon smarter energy grids. The project will produce selected full-size, nanocomposite containing prototype components for specific HVDC and also HVAC applications to support the reliable operation of on and offshore energy networks.

Market opportunity

There is an immediate, global opportunity for the supply and exploitation of application-optimised nanocomposite materials and components for HVAC and HVDC substation equipment and systems. This is a multi-£b UK and global growth market, particularly for On and Offshore energy grids. The project focuses on Grid Operators and OEM needs and addresses the complete supply chain. Our Industry Reference will drive immediate HVAC and HVDC market uptake.

Innovation

Our development yields a new paradigm in performance, electrical thermoset-based insulation materials with enhanced properties imparted by our affordable, surface engineered nano and micro fillers and innovative dispersion and mixing technologies. The novel materials can be processed with existing commercial manufacturing to yield components with differentiating performance gains. Our innovation allows reduction in asset footprint, weight and cost up to 30% and improved reliability needed for next generation, maintenance-free, low-mass On and Offshore compact substations.

Exploitation route

The project includes a dissemination phase, designed to fast-track whole industry adoption of nanocompEIM advanced materials technology. This is a vertically integrated project, which engages the complete supply chain from materials producers to original equipment manufacturers to end-users with initial priority for UK and European Transmission System Operators seeking to be first implementers of robust and efficient, low-carbon, smarter energy grids.

Outcomes and next steps

Phase I of this project demonstrated step-change improvement in targeted materials properties with a number of material formulations up-scaled to industrial quantity levels. Phase II of this project optimises and verifies materials and component processing technologies for first-market, priority applications with full-size component manufacture and industrial equipment test. The NanocompEIM project is well positioned to succeed in delivering substantial economic, social and environmental benefits.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=102739>

Fabrice Perrot

GE Grid Solutions
Fabrice.perrot@ge.com
www.gegridsolutions.com

Alun Vaughan

The University of Southampton
asv@ecs.soton.ac.uk
www.ecs.soton.ac.uk

Gary Stevens

GnoSys Global Ltd
g.stevens@gnosysgroup.com
www.gnosysglobal.com

Improving the reliability, longevity and lifetime performance of Magnetic Cooling technology

102741, Mid Stage, 01/10/2016 – 31/03/2019, £1,410,000

**Camfridge Ltd
Imperial College
Beko plc, Cambridge R&D Centre**

Magnetic refrigeration represents an environmentally friendly alternative to the conventional gas compressor, used in most cooling appliances. By utilising magnetic fields and special metal alloys this approach is significantly more energy efficient (50% more than a typical domestic fridge in operation) and avoids all environmentally harmful refrigerant gases. The objective of the project is to improve the reliability, longevity and the lifetime performance of magnetic cooling to reach a point where manufacturers can test a baseline system.

Market opportunity

Almost 200 million new domestic refrigeration appliances are sold annually worldwide, representing a market of over \$50 billion per annum. Regulators worldwide are driving appliance manufacturers to ever increasing levels of efficiency and consumers are responding positively to high-efficiency products which are taking a rapidly growing market share. Camfridge's technology will cut the incremental manufacturing cost of making high-efficiency appliances from \$180 to \$100.

Innovation

Camfridge has developed advanced regenerators (the core cooling component) made of a magnetic refrigerant based on low-cost iron-alloys (rather than expensive rare earth materials). The resulting magnetic cooling engine that exploits these components is no larger or heavier than a conventional gas compressor used in domestic cooling applications – a key requirement for the adoption of the technology. free, low-mass On and Offshore compact substations.

Exploitation route

Camfridge intends to work with major appliance manufacturers (such as Beko) to test the magnetic cooling technology, and aims to license the intellectual property to such companies. The objective would be to target a range of applications (fridge, fridge-freezers, beverage coolers, vending machines etc) and geographies (Europe, North America, Japan, China etc) to rapidly deploy the technology globally.

Outcomes and next steps

The project should deliver a new version of the magnetic cooling engine that has been improved in terms of performance and reliability and rigorously tested and evaluated against customer need. An important outcome would be a baseline design, whose manufacture is well understood and only requires standard production techniques, that can be licensed, produced and sold.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=102741>

Neil Wilson

CEO
Camfridge Ltd
nwilson@camfridge.com
www.camfridge.com

Pre-commercial technology validation of a clean cold renewable syngas production plant

102605, Late Stage, 1/6/2016 – 31/5/2017, £869,203

Syngas Products Group Limited Cranfield University

The project is supporting an extended validation programme on a pre-commercial stage modular waste-to-energy plant. Syngas Products is completing extended 24/7 running on its 10,000 tonnes per annum (tpa) pre-production pyrolysis unit that generates 0.8 megawatts of electricity. Cranfield University has developed a process model to predict syngas composition and performed sensitivity analysis, including alternative feedstock modelling. The process model is being used to understand/influence plant operations and to identify new input markets.

Market opportunity

There is an 11+ million tpa under-capacity of waste-to-energy infrastructure in the UK. In 2016, 3 million tonnes of UK refuse-derived fuel (RDF) was exported to Europe for incineration and 8 million tonnes of suitable feedstock was landfilled. This technology is modular, with each module sized at 10,000 tpa, and addresses the under-capacity at a town-scale (50,000-150,000 tpa opportunities). The technology can be placed locally where waste arises or where there is a need for fuel.

Innovation

The complete system is patented. The process model developed is comprehensive and scientifically novel. The system produces a cold clean syngas free from tars, oils and acid gases that is of a sufficiently high quality to allow the gas to be utilised in directly fired kilns, spark ignition engines or gas turbines. One of the unique aspects of this development is the small scale modular system can be built alongside the gas or electricity customer.

Exploitation route

The technology is receiving strong interest in the UK and internationally. Wide commercial deployment is possible, with potential customers attracted by the flexibility of modularity and a low entry point (10,000 tpa modules). The technology is attracting interest within the waste management sector (as expected) and other markets are opening-up, including the waste water sector where the technology can be used to convert dewatered sewage sludge into energy. Strategic partnerships are sought to accelerate commercialisation.

Outcomes and next steps

Innovate UK funding has assisted the technology to progress to TRL 7, with the pre-production unit being successfully demonstrated. Next steps are to scale-up the existing company-owned demonstration facility in Dorset and to achieve the first commercial deployments.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=102605>

Shaun Gomm

Finance Director
Syngas Products Group Limited
shaun.gomm@syngas-products.com
www.syngas-products.com

Dr Stuart Wagland

Lecturer in Renewable Energy from
Waste, Cranfield University
s.t.wagland@cranfield.ac.uk
www.cranfield.ac.uk

Mark Harradine

Technical Director, Syngas Products
Group Limited
mark.harradine@syngas-products.com
www.syngas-products.com

Dr Nelia Jurado Pontes

Research Fellow in Energy Process
Modelling, Cranfield University
n.juradopontes@cranfield.ac.uk
www.cranfield.ac.uk

Commercialisation of plastic waste derived fuel for generating electricity

102606, Late stage, 1/9/2016 – 31/8/2018, £1,892,496

Recycling Technologies Ltd
University of the West of England

At Recycling Technologies, we are developing a technology to process residual plastic waste, and turning it into a hydrocarbon product called Plaxx®, an ultra-low sulphur [$<0.01\%$] alternative to crude oil-derived Heavy Fuel Oil. The Plaxx produced can be used in generators to produce cleaner and cheaper electricity. The engine trials carried out so far have shown promising results and the aim of this project is to conduct industrial trials of Plaxx and to establish a pathway to market.

Market opportunity

3.6Mt of plastic waste was generated in 2010, out of which 2.8Mt was sent to landfills and Energy-from-Waste plants in UK. This is not only an alarming scenario for the environment, but also a loss of a valuable resource, that we aim to turn into a great opportunity. Plaxx is a potential cleaner alternative to the approximately 728,000tonnes of HFO that was used in 2014 in the UK and refined from imported crude oil.

Innovation

The use of plastic derived fuel in an engine to produce electricity is a novel technology and Recycling Technologies has acquired a patent for it. Unsuccessful attempts have been made in the past using plastic gasification to run gas turbines producing electricity. In Recycling Technologies' process, Plaxx production and its use is decoupled, reducing the fuel variability and therefore differentiating the process from the previous attempts.

Exploitation route

The upstream exploitable outcome from this project includes to install the coupling of an RT7000 with an engine genset at waste producers' sites to generate the required electricity. Any excess electricity will be supplied to the National Grid. The downstream exploitation path relies on trialling Plaxx as crude oil-derived HFO substitute and power generation. The first target market will potentially be the shipping industry, due to latest IMO regulations on low-sulphur.

Outcomes and next steps

As a result of this project, Recycling Technologies will attract VC investments. With two successful reference sites in 2017/18, we will lead the installation of 45 units by 2022, generating annual revenue of \$65 million and employment for 93 technicians/engineers in the UK. This would divert 5.985Mt of residual plastic waste from incinerators and landfills between 2018-22 and will produce 4.48Mt of clean fuel, offsetting 3.6% of UK's fossil fuel demand, or 1.8 GWh of cleaner electricity.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=102606>

Adrian Griffiths

CEO
Recycling Technologies
adrian@recyclingtechnologies.co.uk
<http://recyclingtechnologies.co.uk>

Farid Dailami

Associate Professor for Knowledge
Exchange in Manufacturing
University of the West of England
farid.dailami@uwe.ac.uk
<http://www.uwe.ac.uk>

Pivoting Deck Vessel prototype construction

102742, Late Stage, 1/12/16 – 30/9/18, £3,704,394

D & D Armstrong Limited
(trading as North Sea Logistics)
Denley Hydraulics Limited
Offshore Wind Accelerator

This project will build the first full-scale prototype Pivoting Deck Vessel (PDV) ready for trial on one or more UK offshore wind farms. The PDV concept is shown here: <https://youtu.be/905x-tlqds4>

Market opportunity

Offshore wind farm operators require work boats to transfer crew and cargo for offshore wind turbine maintenance and construction. Current work boat designs do not allow for safe and cost-effective access to wind turbines in higher sea states to fix costly turbine outages and maintain vital infrastructure. Operators are therefore looking for solutions to improve turbine access.

Innovation

In response, UK work boat operator North Sea Logistics has developed a novel vessel with a pivoting deck technology, designed to increase safe access to offshore wind turbines in higher seas, cutting the number of lost electricity generation days by increasing maintenance days, thus increasing electricity generated and related revenues. Two UK patents were granted in 2012.

Exploitation route

The project will build on past development work with consortium partner, the Offshore Wind Accelerator (www.carbontrust.com/client-services/programmes/offshore-wind/), to build a first full-scale prototype. Consortium partner Denley Hydraulics' role is to design and supply the hydraulic system required to operate the pivoting deck. Post-project, the prototype will be trialled by Offshore Wind Accelerator partners before going into service and more PDVs will be built.

Outcomes and next steps

The initial structural and hydraulic design has been completed and we have appointed a boatyard to start the boat build, which will be complete in mid to late 2018.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=102742>

Dave Armstrong

North Sea Logistics
dave@northsealogistics.co.uk
<http://www.northsealogistics.co.uk>

WindSurf- Smart energy for the 21st century

102743, Late Stage, 1/10/2016 – 31/12/2017, £1,135,712

Swift TG Energy (Scotland) Ltd

The WINDSURF turbine developed by Swift TG Energy (Scotland) is, literally, a revolutionary breakthrough in the next generation of wind turbine technology. Its individually controlled Active Pitch Blades, arranged around a vertical axis, will enable wind energy to be harvested in turbulent zones where first generation devices cannot operate effectively. This opens the way for deployment in urban & industrial areas, enhancing the smart city concept and boosting energy density significantly compared to first generation turbines.

Market opportunity

Until now it has not been possible to effectively harvest the turbulent wind energy available in the urban & industrial environment. The Windsurf Active Pitch turbine developed by Swift TG Energy Scotland is capable of operating effectively in these areas allowing the smart cities of the near future to harvest their own wind energy. This technology also opens up new opportunities in the rural environment where it reduces visual impact and harmonises with the background.

Innovation

The blades on the Windsurf turbine are autonomous; independently and continuously optimising energy harvesting in real time. This enables instantaneous response to turbulence allowing the Windsurf to extract the energy available without having to reposition itself while keeping all the blade surface in operation unlike other vertical axis devices whose operational & aerodynamic envelope is narrow or ineffective. Windsurf's low blade speed minimises noise and risk to wildlife making the Windsurf deployable in sensitive areas.

Exploitation route

The versatility of the Windsurf allows deployment in a wide range of urban situations e.g. dispersed urban such as car parks and waste ground, "linear orchards" on canal banks, central reservations, site perimeters and transport corridors etc. In rural settings, the height and size of the device will compliment rather than dominate the view. Deployment as part of HIVES© (Hybrid Integrated Variable Energy Systems) is implicit in the design philosophy with versatility at the core.

Outcomes and next steps

With the wide operational envelope of the Windsurf turbine and the adoption of the Swift HIVES© approach, the ability to increase the energy density from renewable sources in the urban & industrial environment will be boosted significantly. The adoption of interconnected micro-grids with HIVES© will allow a smart cities shift from consumer to producer. With the Windsurfer as the starting point of HIVES©, the options are numerous and flexible enabling the right solution for the application.

Further information: <http://gtr.rcuk.ac.uk/projects?ref=102743>

Mike McLean, Sam Dickinson

Swift TG Energy (Scotland) Ltd
info@swifttgenergy.com
www.swifttgenergy.com

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Further data on Innovate UK funded projects:

Directory of Projects, Energy Catalyst Round 1

<https://admin.ktn-uk.co.uk/app/uploads/2017/01/ECR1-Collaboration-Nation-Project-Directory-FINAL-11-2-16.pdf>

Directory of Projects, Energy Catalyst Round 2

https://admin.ktn-uk.co.uk/app/uploads/2017/01/2905992_RushlightDirectory_acc.pdf

List of Innovate UK competition winners

<https://www.gov.uk/government/publications/innovate-uk-funding-competition-winners-2016>

List of all Innovate UK competitions and funded organisations

<https://www.gov.uk/government/publications/innovate-uk-funded-projects>

Gateway to Research (further information on publicly-funded projects)

<http://gtr.rcuk.ac.uk/>

Innovate UK

Innovate UK is the UK's innovation agency. Innovate UK works with people, companies and partner organisations to find and drive the science and technology innovations that will grow the UK economy - delivering productivity, new jobs and exports. Our aim at Innovate UK is to keep the UK globally competitive in the race for future prosperity.

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Telephone: 0300 321 4357

Email: support@innovateuk.gov.uk

www.innovateuk.gov.uk

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