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1. Introduction to the Energy Catalyst

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 millions of pounds in grant funding backed with 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.

2. Further data on Energy Catalyst Rounds

This Directory includes projects that received funding through Round 3, Round 4 and Round 5. Data provided for each project includes the project number, project title, project lead and partner organisations, start and end dates for the project and the total project costs.

More information on previous rounds can be found under the links below.

Directory of Projects, Energy Catalyst Round 1

Directory of Projects, Energy Catalyst Round 2
3. Energy Catalyst Funding Round 3

3.1. 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](http://gtr.rcuk.ac.uk/projects?ref=EP%2FP510385%2F1)

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3.2. Thermal under PV roofing SIP (TUPROOFS)

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

Telemetry Associates Limited
ECO Design Consultants
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](http://gtr.rcuk.ac.uk/projects?ref=132333)

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3.3. 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.
3.4. 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](http://gtr.rcuk.ac.uk/projects?ref=132359)

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3.5. **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

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3.6. 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, NOx, 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

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3.7. 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
3.8. 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](http://gtr.rcuk.ac.uk/projects?ref=132389)

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3.9. 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
3.10. 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 on to 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](http://gtr.rcuk.ac.uk/projects?ref=132398)

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3.11. 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 $168N. 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 trails, 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](http://gtr.rcuk.ac.uk/projects?ref=132399)

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<tr>
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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](http://gtr.rcuk.ac.uk/projects?ref=132402)

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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

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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.
3.15. 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
S25

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](http://gtr.rcuk.ac.uk/projects?ref=132410)

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### 3.16. 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](http://gtr.rcuk.ac.uk/projects?ref=102594)

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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 word 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](http://gtr.rcuk.ac.uk/projects?ref=102595)

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3.18. 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](http://gtr.rcuk.ac.uk/projects?ref=102738)

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3.19. 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](http://gtr.rcuk.ac.uk/projects?ref=102605)

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3.20. 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
4. Energy Catalyst Funding Round 4

4.1. World Engine for Distributed Generation of Electricity (WEDGE)

102761, Mid Stage, 1 March 2017 to 31 August 2019, £963,062

OakTec
EP Barrus Limited

OakTec has developed the multi-gas Pulse-R engine concept. Pulse-R delivers proven benefits in emissions, fuel economy and performance. The WEDGE project will develop a multi-cylinder Pulse-R suited to many developing economies where gas fuels are prevalent, low cost and in secure supply. The new WEDGE engine will replace a diesel engine in an existing generator power system for test and demonstration purposes building on OakTec’s and Barrus’s existing activity in this sector.

Market opportunity
The market opportunities for WEDGE and the Pulse-R technology are huge. The global growth in the use of gas fuels, driven in part by energy security concerns and by environmental considerations, is strengthening the case for the Pulse-R technology. Talks have already begun with a rapidly-growing anaerobic digester (AD) manufacturer regarding the supply of up to 4,000 generators for AD plants in South America and Africa.

Innovation
WEDGE builds on OakTec’s extensive development work on the Pulse-R concept and on the successful EDGE project, funded within Energy Catalyst 1, that focused on biogas. EDGE produced a single-cylinder prototype engine, which is now reaching the point of commercialisation. WEDGE will apply the technology to a multi-cylinder engine, which will allow significant further benefits to be realised through the use of Pulse-R’s unique gas dynamics. The project will deliver a working prototype generator set using a multi-cylinder Pulse-R engine.

Exploitation route
OakTec and Barrus have a strong partnership and will work together to exploit the technology in power generation applications. By developing a highly-efficient, clean and robust product the partners will capitalise on Barrus’s existing market knowledge and customer base to promote the product for domestic markets. By continuing to build relationships with customers in developing economies the partners will seek to enter these markets and build market share.

Outcomes and next steps
The outcomes of the project will be the design and manufacture of a prototype multi-cylinder Pulse-R engine. That engine will be integrated into a demonstrator generator. Substantial work will also be undertaken to build a detailed understanding of markets and customer base to ensure a viable and attractive solution is reached. Next steps will be the commercialisation of both the generator
product and of the multi-cylinder Pulse-R engine. Both partners are actively engaged in building the contacts and relationships necessary to the commercial success of this project.

Further information: http://gtr.rcuk.ac.uk/projects?ref=102761

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4.2. Extra-light and sustainable textile wind turbine blade

102764, Mid Stage, 1 March 2017 to 28 February 2018, £1,488,196

ACT Blade Ltd
Offshore Renewable Energy Catapult Ltd
BVG Associates Ltd
NCC Operations Limited
Williams Advanced Engineering

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 to weight ratio problems involved in achieving this. We are developing an extremely light and sustainable textile blade, enabling the installation of longer blades without placing excessive loads on the turbine, as well as lowering the costs of manufacture, transportation and therefore the cost of energy.

Market opportunity
The wind industry is forecast to grow steadily over the next 5 years. It is 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 £6.3 billion in the 5 years following ACT Blade’s commercialisation in 2019.

Innovation
Lengthening fibreglass wind turbine blades would present several challenges. Blades would become unfeasibly heavy, placing enormous loads on turbines. The costs of producing huge moulds for
manufacture would also outweigh any potential benefit. In addition, the blades would be very
difficult to transport. ACT Blade has developed blades made of lightweight 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 envisions 2 routes to market - the licencing of ACT technology and the direct supply of
blades. Both routes are proven within the renewables industry, providing revenue flexibility. An
assembly facility with 50-100+ employees will be in Scotland with harbour access, while the research
and development (R&D) team, composed of at least 30 high-skilled engineers, will provide the
design for both ACT Blade’s direct sales and for licencing purposes.

**Outcomes and next steps**
This Catalyst project is allowing us to prototype and test in a simulated environment a scaled version
of a 55m long blade to optimise design and demonstrate key structural behaviours of the ACT Blade.
Following the conclusion of this project to consolidate the technology and the market acceptance,
we will pilot the technology on a real turbine.

**Further information**: http://gtr.rcuk.ac.uk/projects?ref=102764

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4.3. **Solar Steam – a novel application of Fresnel lenses as a solar thermal collector to benefit industry**

102765, Mid Stage, 1 March 2017 to 28 February 2019, £507,696

Larkfleet Ltd
Cranfield University

The project aims to develop an innovative solar thermal collector using Fresnal lenses. The system
will have an automatic tracking system to provide accurate alignment with the sun throughout the
day to maximise efficiency and produce low/medium temperature thermal power for use in the
manufacturing sector specifically.

**Market opportunity**
The initial market opportunity is in developing countries. Once the prototype is completed, Larkfleet
forecasts the installation of 400 plants by 2030 with a cumulative installed capacity of 12,000kWth
(kilowatt thermal). The demand for solar thermal technology is highest in Asia-based manufacturing
industries.
Innovation
A patent has been registered to protect the key innovations of the system - an innovative solar thermal collector using Fresnel lenses (a modular array of plastic magnifiers that focus the solar radiation onto a linear receiver).

Exploitation route
With exclusively local companies supplying solutions at this scale, and to reduce barriers to entry, exploitation will be achieved on a licensing basis giving regional exclusivity.

Outcomes and next steps
Larkfleet’s solar steam prototype will be completed and operational by January to March 2019 and will be installed in India. Once completed, Larkfleet will partner up with regional companies in order to market and install the product. The system can also be installed in rural areas for the production of electricity, supply of clean water or sanitation process.

Further information: http://gtr.rcuk.ac.uk/projects?ref=102765

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4.4. Vertical cubic GaN LEDs on 150mm 3C-SiC substrates

102766, Mid Stage, 1 February 2017 to 31 March 2018, £852,836

Anvil Semiconductors Ltd
University of Cambridge
Plessey Semiconductors Ltd

The ability to produce cubic GaN (gallium nitride) on large-diameter silicon wafers is clearly recognised as a key enabler for increasing the efficiency and reducing the cost of light emitting diode (LED) lighting, but it has never been done before. Building on a previous Innovate UK project, this project will produce high-performance LEDs in cubic GaN by combining Anvil’s intellectual property (IP) that enables the growth of cubic silicon carbide on silicon (Si) wafers; the University of Cambridge’s renowned expertise in growing GaN on large area Si substrates; and Plessey’s capability of large volume production of LEDs in GaN-on-Si.

Market opportunity
High-efficiency LEDs are viewed as the only viable replacement for today’s inefficient lighting. The global LED market, which totalled US$12.4 billion in 2013 and is set to reach US$17 billion by 2018, is looking for a breakthrough to improve efficiency. This technology of GaN-on-SiC/Si delivers the cost
advantages of a silicon substrate with improvements in performance, and could clearly shape the industry’s future.

Innovation
Today, LEDs are produced from hexagonal GaN and, as a result, their performance is limited by the quantum-confined stark effect (QCSE). This effect can be overcome by the use of cubic GaN (c-GaN). C-GaN has been grown on Anvil’s 3C-SiC layers, the first time this has been done by a commercially-scalable process. This project builds on previous work, that demonstrated the feasibility of the technology, to develop reliable material and LEDs using processes consistent with a large-scale production facility.

Exploitation route
Plessey Semiconductors, which already has traction in the LED market and has a worldwide distribution network, anticipates exploiting this new technology through the same channels and working with its existing partners to introduce it into lighting products. Anvil and UoC intend to combine their IP in a single vehicle to further develop and license the technology for 3C-SiC / c-GaN material to Plessey and other LED manufacturers.

Outcomes and next steps
The project has further developed the growth of cubic GaN on 150mm-diameter wafers and early processes to produce vertical LEDs in the new material. It will go on to fabricate vertical GaN LED devices which demonstrate target efficiency particularly in the green spectral range. The next stage is to optimise both material growth and production techniques and demonstrate its use in producing high-efficiency, low-cost LEDs in the production fabrication facility at Plessey.

Further information: http://gtr.rcuk.ac.uk/projects?ref=102766

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4.5. India-UK innovative solar cooling (Indiacool)

102767, Mid Stage, 1 December 2016 to 31 March 2018, £632,850

Imperial College  
Hyperion Private Limited
This project aims to optimise the technology developed by Solar Polar in the markets identified in India for on-farm food storage and preservation. It also aims to investigate the market for low-cost solar air conditioning in India. Demonstrators are being placed in Chennai and Ahmedabad.

**Market opportunity**
In India, 400 million people are without mains electricity. Most of these are rural small farmers with an average farm size of 2.4 hectares. The result is that hardly any of these people have access to the on-farm pre-cooling necessary to get product to market in good condition. Solar cooling allows waste to be minimised (currently 48%), allows quality to be improved, allows the use of refrigerated transport, increasing the range of the produce, and allows for a longer selling window for the farmers.

**Innovation**
Solar Polar’s technology involves no electricity at all. It uses non-greenhouse gas refrigerant that has no ozone-depleting effect and it has no moving parts, making it maintenance-free apart from occasional cleaning. The modularity, simplicity and ease of manufacture mean that it delivers the lowest cost watt of cooling of any solar cooling technology.

**Exploitation route**
Solar Polar will set up a joint venture with Hyperion to manufacture and sell the products. Hyperion is part of the Mamata Group, a well-established manufacturing group of companies with many decades of experience of selling in the Indian market.

**Outcomes and next steps**
The project is still underway with many improvements and optimisations being introduced into the product to enhance the performance, the user-friendliness and the manufacturability of the products. The remainder of the project is devoted to increasing the number of units on test and further optimisation of the performance.

**Further information:** [http://gtr.rcuk.ac.uk/projects?ref=102767](http://gtr.rcuk.ac.uk/projects?ref=102767)

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### 4.6. Rice straw to biogas (R2B) project

102769, Mid Stage, 1 March 2017 to 29 February 2020, £1,508,210

Straw Innovations Ltd  
QUBE Renewables Ltd  
University of Southampton
University of Manchester

Rice straw is one of the world’s largest biomass resources and it is largely wasted by burning in the field for disposal. This project will demonstrate a novel technology for making biogas from rice straw, with the gas used as clean cooking fuel. Building the pilot plant in the Philippines, it will also demonstrate a more efficient logistical operation for gathering the straw and inclusive business models that could benefit low-income communities.

Market opportunity
In Asia, around 300 million tonnes of rice straw are burned every year as waste. Meanwhile, in South and Southeast Asia, more than 600 million people lack energy access. The market opportunity is to take this polluting waste and convert it into a clean fuel, delivered affordably to those who need it most.

Innovation
Rice straw is expensive to collect and difficult to digest for biogas production. This project will demonstrate innovations that will reduce the cost of straw collection and enable biogas to be produced via a novel, low-cost dry anaerobic digester that avoids many of the problems associated with wet anaerobic digestion such as floating and mixing.

Exploitation route
Previous research has found that barriers to entry include a lack of proven business models, the high cost of straw collection, a lack of energy technologies for processing rice straw, and a lack of policy support. This unique project will seek to address all of these barriers simultaneously for the first time. The innovative technologies demonstrated here will reduce costs across the supply chain while additional co-products (mushrooms, vermicomposting) will further enhance the economics.

Outcomes and next steps
After successfully demonstrating the technology and supply chain from field to fuel in this project (phase 1), a second, full-scale commercial unit will be set up in phase 2. This may well happen before the 3-year project ends. After this, the model will be scaled out to other areas across South and South East Asia where most of the world’s flooded rice production occurs.

Further information: http://gtr.rcuk.ac.uk/projects?ref=102769

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4.7. Electricity and zero emissions from landfill gas

102770, Mid Stage, 1 February 2017 to 31 January 2018, £652,553

Cambridge Carbon Capture Ltd
WRK Design & Services Limited
Ylem Energy Limited

The objectives of the project are to demonstrate that CO2LOC technology is capable of removing CO₂ and possibly other contaminants from landfill gas (LFG) and emissions from LFG-fuelled gensets enabling zero-emissions electricity generation or low-carbon source of methane for the UK Gas Networks. This project will result in the trialling of a containerised-demonstrator on an active landfill site.

Market opportunity
There are 3 different market opportunities we address: the retrofit market, installed at sites where methane content drops to below 30% and where the driver is to improve profitability and reduce the cost of ongoing remediation of landfill sites; the direct gas grid injection market where the driver is to get higher revenues from LFG than from the sale of electricity and the feed-in tariffs generated from it; the zero-emissions market whereby natural gas and/or electricity is produced for local communities.

Innovation
The project involves many technical and business innovations:
- ambient pressure carbonation process based on Mg(OH)2 represents a world first and Cambridge Carbon Capture (CCC) has a granted patent
- this project is aimed at assessing the application of this technology to LFG remediation which in itself is innovative, offering big eco and commercial benefits
- current CCS technologies are not economically viable for smaller scale flue-gas CO₂-sequestration applications such as LFGE due to necessary CO₂ pipeline infrastructure costs

Exploitation route
A route to market will be offered through project partners, WRK and YLEM Energy, a landfill site operator and supplier of gas engine gensets, and through the UK Gas Networks which require low-carbon methane. CCC will licence the technology to YLEM offering them competitive advantage securing greater market share. Successful demonstration through this project will lead to a project
to deliver a pilot plant at one of YLEM’s sites in Liverpool. Once successfully demonstrated, CCC will be securing new intellectual property (IP) generated with their partners.

**Outcomes and next steps**

This project will lead to the development of new IP for CCC and WRK with licencing opportunities and future sales of equipment and design services. ENP will gain a competitive advantage, leading to increased sales and export opportunities helping UK gross domestic product (GDP) growth. It also will encourage further investment in the technology leading to access to other markets where the economics of CO2 capture are more challenging thereby reducing UK greenhouse gas emissions economically with benefits to the UK and global economy.

**Further information:** [http://gtr.rcuk.ac.uk/projects?ref=102770](http://gtr.rcuk.ac.uk/projects?ref=102770)

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**4.8. Bringing profitability to small-scale on-farm AD through cryogenics**

**102772, Mid Stage, 1 February 2017 to 31 January 2019, £448,370**

**Bennamann Ltd**  
Chynoweth Farm

Bennamann is developing a low-cost biogas upgrading system to make the capturing of methane on small dairy farms economically viable. This is achieved through innovative technical and business model solutions. The technical improvement is brought about by a one-stage cryogenic process that uses renewable energy for biogas refining. The business model uses the existing farm infrastructure to capture the biogas and converts it to its most valuable outputs.

**Market opportunity**

Approximately 100 million tonnes of slurry are produced on UK farms, with GHG emissions, attendant odour, as well as run-off, which pollutes watercourses. On-farm anaerobic digestion (AD) offers a significant step towards more sustainable farming, but a number of macro-economic factors
have made diffusion at the small/micro-scale difficult. The high cost of capital equipment, coupled with constraints of grid connection and capacity, has slowed diffusion. There are 11,000 dairy farms in the UK that could become energy-independent if the economics of micro/small-scale plant improve. This market has the potential to generate an additional £1.9 billion in revenue annually.

Innovation
The project combines the best attributes of several technologies to relieve the infrastructure limitations of a typical small dairy farm. It incorporates a novel distribution system based around an energy recovery capability at the point of use. This results in 30% of the energy that is used to process the biogas being recovered, which improves the financial viability of the solution dramatically.

Exploitation route
Through collaboration with a number of leading industry partners, we intend to develop sales channels in a number of markets. Once a full-scale plant has been developed and tested, we intend to manufacture commercial plant on the premises of our project partner. Income is generated via plant sales and the sale and distribution of the outputs of the biogas processing plant.

Outcomes and next steps
Proving the technical and economic feasibility of our solution is the key outcome of our project. Next steps will involve building a full-scale system that integrates renewables to power the plant. The distribution channel will be developed in tandem, which will result in revenues for both Bennamann and the farm.

Further information: http://gtr.rcuk.ac.uk/projects?ref=102772

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4.9. Final development of a zero-energy dehumidification and cooling system

102774, Late Stage, 1 March 2017 to 28 February 2019, £276,665

Free Running Buildings
Advanced Manufacturing Research Centre

Free Running Buildings, in collaboration with the University of Sheffield’s Advanced Manufacturing Research Centre, are developing a zero-energy dehumidification and cooling passive ventilation system. This system will be deployed in Abu Dhabi, UAE, creating the region’s first passively-cooling school campus, reducing the energy demand for mechanical air-conditioning by up to 60%.
Market opportunity
It is estimated that the energy demand for air-conditioning systems will increase ~13 fold between 2000 and 2050. This accounts for an increase from ~300TWh in 2000 to ~4000TWh in 2050. It is expected that 75% of this is due to increasing income in emerging market countries and 25% from climate change. By marketing a zero-energy system as an alternative or complementary technology to mechanical air-conditioning, total energy demand can be reduced.

Innovation
Free Running Buildings has integrated 2 passive technologies to deliver a system that is capable of delivering the required supply air rates for good indoor air quality and occupant health, whilst reducing the temperature of incoming air. This reduces the reliance on mechanical air-conditioning systems which, in climates such as the Middle East, can account for up to 60% of the total energy demand.

Exploitation route
Free Running Buildings will ship and assemble 24 cooling systems to the Shaikh Khalifa School in Abu Dhabi, UAE. This will serve as the long-term trial installation of the technology in the region. It is envisaged that by the conclusion of the project, Estidama certification of the technology will have been approved as a green technology for energy reduction. This will enable Free Running Buildings to tender for cooling systems for the planned 70 to 110 new schools to be built in the UAE.

Outcomes and next steps
The systems shipped to the Shaikh Khalifa School will be close to market-ready design. Upon ESTIDAMA certification as an approved green technology product for energy reduction, the system will be available for full commercialisation in the region. The technologies included also open up several other markets where air-conditioning demands are high, such as South and South-East Asia, North and Central America, along with central Europe. Further developments to the technology will see passive heating and dehumidification technologies utilised, opening up all markets where air-conditioning and space heating are required.

Further information: http://gtr.rcuk.ac.uk/projects?ref=102774

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4.10. Buffalito platform

102775, Late Stage, 1 February 2017 to 31 August 2018, £596,959

BuffaloGrid
Spark Create
Integra Microsystems

BuffaloGrid (BG) developed solar-powered BG Hubs for affordable and safe off-grid phone charging. BG sees an opportunity to develop portable modular Buffalito batteries, which are charged at BG Hubs and deliver solar-power to households. This project will develop Buffalito units and clip-on accessories (low-energy adjustable LED light and Breeze cooling unit using phase-change materials). It will also develop a system to lock Buffalito charge/discharge to BG Hub/accessories (so BG can provide hardware for free) and an ownership-transfer mechanism between fully charged and empty Buffalitos.

Market opportunity
Off-grid consumers spend £14.8 billion each year on kerosene. The off-grid solar market was worth £700 million in 2016, 34% compound annual growth rate (CAGR) to £3.1 billion by 2021. 100 million off-grid households will use solar lighting by 2021 (World Bank, 2016). 50% of off-grid people earn £1.4 to £7 per day. Trends: pay as you go (PAYG) solar models are gaining traction (15% of market by 2021). After lights, fans are fastest growing product with 7 million used by 2021.

Innovation
BG electricity will be affordable to low-income users. A 10 INR (10p) charge delivers enough power for 40 hours of light. Usage data analytics (number of charges, devices powered) are stored on Buffalito and automatically uploaded when connected to a BG Hub to allow dynamic pricing based on loyalty/risk. Buffalitos can only be charged via a BG Hub, allowing BG to provide Buffalitos and accessories free, confident that hardware cost will be paid back through paying for charge.

Exploitation route
The exploitation method is to complete the product, supply chain development and commercialisation plans with regular competitor monitoring and first-to-market recognition during the first 3 months of 2019. Buffalito charges are £0.10 each (this gives 40 hours of light) and we estimate a Buffalito + LED light will cost £5 to produce. Reduced kerosene subsidies will save the Indian government £110 million per year. Buffalito will save users time and money compared to kerosene and increase business and productivity. There will be increased employment with 14 BG R&D staff and £1 million per year R&D spend. BG will increase the number of Indian Hub agents employed to 55,000.

Outcomes and next steps
Outputs from the project include the Buffalito platform (server, Buffalito unit), accessories (LED light, Breeze Cooling Unit), business/intellectual property plan and investment pack. Patent lawyers, HGF LLP, advise ownership-transfer and locking technologies are patentable (UK, US, EU). Buffalito’s launch in India during the first quarter of 2019 will serve Indian remote banking partner Integra’s 3 million off-grid customers. There will be a launch in Africa during the third quarter of 2019 with BG
partner Schluter S.A’s cooperative of 110,000 off-grid farmers. Over 5 million Buffalitos will be in use in India and sub-Saharan Africa by 2022.

Further information: http://gtr.rcuk.ac.uk/projects?ref=102775

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4.11. Disaggregated energy-sensing for the smart grid

132462, Early Stage, 1 March 2017 to 30 November 2017, £77,774

42 Technology Limited

This feasibility study investigates the use of an innovative, low-cost, high-frequency smart metering technology to disaggregate demand from a number of different electrical appliances at a single metering point using a frequency domain algorithm. Ultimately the aim is to provide householders with a pie chart of their total electricity consumption divided up by appliance. This provides much improved behavioural cues to help them cut consumption, cost and emissions.

Market opportunity
The distinct market opportunities have been identified. Firstly, demand disaggregation which will improve consumer behavioural cues to cut their consumption and deepen the engagement between consumers and their energy supplier. Secondly, appliance condition monitoring that can distinguish, for example, a full vacuum cleaner from an empty one which may be of value to high-end domestic appliance manufacturers. Finally, there are industrial condition-monitoring applications, for example monitoring pumps operating in explosive atmospheres (where it is complex and costly to add sensors and data transmission systems) from a remote, non-explosive atmospheric location.

Innovation
The metering technology itself is novel and patented - it is a poly-phase metering technology that does not require current transformers yet provides no phase-phase cross talk. However, in this study the focus of the innovation was on the collection of current and voltage data at very high frequencies and then developing algorithms that use that data to tease apart different types of load.

**Exploitation route**
We are currently exploring all 3 market opportunities through conversations with incumbent companies in the domestic supply and metering industry, with domestic appliance manufacturers and with the offshore oil and gas industry and its supply chain. Two possible commercialisation routes are commercial development projects and/or technology licencing to specific markets.

**Outcomes and next steps**
The project has shown that the approach works - but significant development is needed before this technology will be commercial. The next step is to create a strategic relationship with an incumbent company to develop an FPGA version of the hardware and algorithm that can, in turn, be used to develop a very low-cost ASIC for widespread adoption and rollout.

**Further information:** http://gtr.rcuk.ac.uk/projects?ref=132462

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**4.12. SCORRES - Smart Control of Rural Renewable Energy and Storage**

132469, Early Stage, 1 April 2017 to 31 March 2018, £297,717

Heriot Watt University (HWU)  
Auraventi (AV)  
Scene Connect (SC)  
Findhorn Foundation College (FFC)  
Auroville Consulting (AVC)  
Auroville Centre for Scientific Research (CSR)

India is undergoing a profound energy transition in which renewable energy and smart, local systems play a key role. The project involves innovative UK technology that integrates highly accurate weather forecasting with sensors and energy and irrigation controls. The aim is to define a farm
management system that reduces energy and water usage, whilst increasing crop yields and reducing labour requirements.

**Market opportunity**
Groundwater pumping irrigates 60% of agricultural land in India and is an essential requirement for food production/security. Pumping usually uses diesel fuel and is not-optimised, leading to wastage of energy and money, alongside sub-optimal crop yields. Micro-irrigation and the use of solar pumps both aim to reduce resource use on farms but can be paired with smart management and control systems in order to produce better results with fewer resource inputs.

**Innovation**
Using Innovate UK funding, we have developed highly-localised weather forecasting technology, combined with local know-how on irrigation needs and soil conditions, to produce a ‘right time, right volume’ approach to micro-irrigation. At present, farm conditions are being monitored using a range of sensors, but SCORRES seeks to use machine-learning to reduce reliance on physical sensors, thereby increasing farm performance through a low-cost, packaged intervention.

**Exploitation route**
SCORRES is currently trialling with one farm in the Indian state of Tamil Nadu. A cost-optimisation process will be undertaken within the project period, with the intention of enacting a series of lower-cost installations after that. The initial markets of interest are Tamil Nadu, and thereafter other Indian states. We will work with the growing body of farmers that utilise micro-irrigation.

**Outcomes and next steps**
Our initial results are promising, showing that our automated ‘right time, right volume’ irrigating system is reducing water and energy usage and is producing a substantial increase in vegetative growth compared with manual irrigation. By learning from our results, we aim to reduce the hardware requirements, and hence costs, of the system before seeking to commercialise.

**Further information:** http://gtr.rcuk.ac.uk/projects?ref=132469

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4.13. Monolithic metal-organic framework materials for exceptional natural gas uptake

132472, Early Stage, 1 April 2017 to 31 March 2018, £296,664

Immaterial
Centre for Process Innovation (CPI)

Natural gas (NG) is a cheaper, cleaner alternative to oil and coal. A critical bottleneck in the value chain is the need to liquefy it for shipping. Immaterial develops metal-organic frameworks (MOFs); porous materials that can adsorb gas much like a sponge absorbs water. These allow NG to be efficiently stored at far lower pressures without the need for liquefaction, offering colossal cost and energy savings. The project aims to scale-up production to a pilot plant level.

Market opportunity
Around 250 million tonnes of LNG are shipped annually, a figure expected to double in the next 20 years. Replacing LNG with adsorbed natural gas (ANG) is predicted to save around £400 and 400kg CO₂e per tonne. This is an innovation in which major gas companies have shown significant interest, and have indicated they are keen to progress.

Innovation
MOFs have existed for over 2 decades, and have potential applications for many different gases and many different industries. Despite their exceptional performance, they have only rarely reached commercialisation. This is because MOFs form as powders, which are notoriously difficult to use with compressed gases. Immaterial has developed and patented the only known way of producing MOFs as large single crystals (monoliths). Immaterial therefore sits on a platform technology that can revolutionise the entire field.

Exploitation route
The ultimate goal is to revolutionise the storage and transportation of NG, both for shipping and as a vehicle fuel. These, however, are both large markets with long R&D cycles, and so other applications are being targeted in the medium term. We also see exceptional performance as a sorbent for oxygen, and as a filter for ammonia. For these, we are in contact with a rebreather manufacturer and with the US Department of Defense respectively.

Outcomes and next steps
Once the current project finishes in April, we will have a sufficient understanding of the process to be able to design a pilot plant. We will be applying for an Innovate UK manufacturing and materials grant to fund the next stage in our development, and will do a series A round to secure match funding. We expect to be making sales before the end of the next project.

Further information: http://gtr.rcuk.ac.uk/projects?ref=132472

132474, Early Stage, 1 March 2017 to 28 February 2018, £193,696

Dycotec Materials Ltd
Faradion Ltd
Warwick Manufacturing Group

PHOENIX develops an environmentally-friendly, high-performance electrode for use in sodium ion batteries. These batteries offer safer use over lithium ion batteries and find particular application when combined with PV for energy generation in domestic and remote location use. PHOENIX will enable sodium ion batteries to achieve improved energy density, longer life and lower lifetime cost.

Market opportunity
The main motivation for PHOENIX is to provide a low-cost option for residential energy storage (RES) to combine with PV using a novel sodium ion battery technology. The stationary energy storage market is a global emerging market and set to grow from its current level of US$0.75 billion to US$2.4 billion by 2025. The partners will profit from sales of carbon paste for Dycotec Materials and licence/royalty incomes for Faradion.

Innovation
A novel, environmentally-friendly carbon paste will be developed that enables increased energy density, longer life and lower lifetime cost. The pastes are being developed specifically on the formulation know-how developed by Dycotec Materials which supplies a broad range of printed electronic materials to the automotive, energy and telecommunications sectors.

Exploitation route
The new electrodes will become an integral part of the patent protected know-how package of Faradion enabling it to increase its licensing/royalty income from battery manufacturers. Dycotec will manufacture and provide the pastes required for the electrode system.
Outcomes and next steps
The 12-month project is ongoing. Results are already encouraging with target energy density already achieved. Next steps are to commence R2R manufacturing at Warwick Manufacturing Group.

Further information: http://gtr.rcuk.ac.uk/projects?ref=132474

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4.15. Smart biogas network

132479, Early Stage, 1 April 2017 to 31 March 2018, £255,764

CREATIVenergie
Scene Connect Ltd
University of Nottingham
ECHO East Africa Impact Centre, Tanzania
CAMARTEC, Tanzania

Wood smoke is responsible for more deaths globally than malaria and HIV combined¹. An alternative clean and renewable fuel source can be provided by biogas digesters (transforming waste organic matter into methane gas). However, maintaining functionality has proven to be a worldwide challenge because the aftersales service sector is non-existent or sparse. Hence the creation of the Smart Biogas Network (SBN), connecting broken/defective biogas digesters with service personnel to enhance energy security in off-grid locations.

**Market opportunity**
SNV (Dutch NGO) supported the establishment of national biogas programmes globally, estimating that the potential of biogas is 18.5 million installations in Africa\(^2\) and 155 million in developing countries worldwide\(^3\). Maintaining functionality has proven challenging. Reportedly only 25% of installed digesters in some areas of sub-Saharan Africa are operational\(^4\). The SBN could be retrofitted or installed with new digesters to monitor performance, detect and communicate potential issues, hence ensuring that problems are resolved promptly.


\(^3\)SNV, [www.snv.org/sector/energy/topic/biogas](http://www.snv.org/sector/energy/topic/biogas), (last accessed 7 February 2017)


**Innovation**
This feasibility study created the SBN, an Internet of Things (IOT) platform designed to monitor numerous geographically dispersed household/institutional biogas digesters at minimal cost. It collects data on the functionality of each biogas digester, utilising machine learning and real-time analytics to detect anomalies in performance, for example, potential faults, substandard installation/operation. This data is transmitted to a cloud platform that sends messages to local maintenance/service personnel, facilitating prompt repairs or further user training.

**Exploitation route**
The SBN has been developed in partnership with CAMARTEC (National Implementation Agency of the Tanzanian Domestic Biogas Program) with advisory support from SNV. We intend to conduct further field trials of the SBN in collaboration with both organisations’ networks of installers and existing biogas digesters. We are discussing commercialisation with public and private sector biogas organisation in Kenya and exploring routes to market in Asia’s booming biogas market, through Scene Connect’s presence in India.

**Outcomes and next steps**
Prototype communication hardware was designed and installed with sensors on biogas digesters in the Arusha region, Tanzania, during the first half of the year. Real-time analytics, an end-user web dashboard and mobile applications are being created in the last half of the year. Next steps include seeking investment; manufacturing hardware at scale; partnering with national biogas programs and private sector biogas companies for a larger scale trial in East Africa; exploring how the SBN can facilitate carbon financing in the biogas sector.

**Further information:** [http://gtr.rcuk.ac.uk/projects?ref=132479](http://gtr.rcuk.ac.uk/projects?ref=132479)

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4.16. Development of a sustainable solid-state barocaloric cooler

132481, Early Stage, 1 April 2017 to 31 March 2018, £213,590

Department of Materials Science & Metallurgy, University of Cambridge
Beko plc

Vapour-compression systems have long been used for cooling applications. However, the energy efficiency of these systems is relatively low, and the working fluids harm the environment if released to the atmosphere. We aim to develop the first solid-state cooling demonstrator based on barocaloric materials that are made of cheap abundant elements. Barocaloric cooling technology could reduce the power consumption that is required for refrigeration and air-conditioning, and remove the need for harmful gases.

Market opportunity
The global cooling market is large. Transparency Market Research placed a value on the market of £130 billion in 2013, predicted to rise to £190 billion by 2020. For consumers in developed countries, energy efficiency is the largest driving factor in model choice when selecting a new fridge. For consumers in developing countries, low cost is one of the largest driving factors. The business opportunity is to demonstrate the feasibility of barocaloric materials for the next generation of affordable gas-free energy-efficient cooling appliances.

Innovation
In 2015, the research group led by Xavier Moya discovered giant barocaloric effects near room temperature in a non-magnetic material that is made from cheap abundant elements and is commercially available. This research group found giant barocaloric effects that outperform those observed in the best magnetic materials. Since then, the research group has been investigating a number of barocaloric materials with even better performance.
Exploitation route
The project will pursue these 2 milestones by:

1. characterising to the full the materials’ properties of candidate barocaloric materials, with optimisation and selection of the best candidate
2. designing and modelling cooling systems that employ the selected material
3. prototyping a demonstrator cooling device, based on the optimal barocaloric material and system design

Outcomes and next steps
The exploitable outcomes expected from this Early-Stage Award include:

1. optimised materials and composites for barocaloric cooling applications
2. system design for a cooling apparatus based on barocaloric materials
3. demonstration of sustained barocaloric cooling
4. patents, publications and talks

Once the feasibility of barocaloric cooling has been demonstrated, funding will be sought for lengthier mid-term development to integrate the technology in a product.

Further information:  http://gtr.rcuk.ac.uk/projects?ref=132481

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4.17. Response Algorithmic Enterprise (RAE)

132482, Early Stage, 1 April 2017 to 31 March 2018, £172,092

AND Technology Research
University of Reading

This project addresses the energy trilemma – security, cost and emissions, by developing new algorithms for energy control using appliance signature data. Energy balancing and the extent to which affordable secondary power sources (for example, PV, wind and battery storage) can help with balancing are being considered across communities and developing nations such as Montenegro. The algorithms will be designed to rectify previously identified issues when simple demand response is applied using aggregated energy data.
Market opportunity
The opportunity is for supply of monitoring running algorithms utilising aggregated data to predict energy needs such that loads can be balanced and managed. A gap in the market for provision of meso-level monitoring solutions that could collect aggregated data but instigate control based on changes at the micro, appliance-level energy usage, was identified. The need is particularly relevant to SMEs where affordability of monitoring equipment is an issue.

Innovation
The main innovation is the creation of non-intrusive, low-cost energy monitoring systems to satisfy a gap in the market. A particular challenge is the implementation of control within small embedded processors such as are used in Internet of Things (IoT) devices. This will be achieved through:

1. enabling intelligent identification of appliance energy usage from aggregated data
2. developing responsive control algorithms which can manage loads through energy budgeting or use of secondary sources

Exploitation route
The outputs from the project will be exploited both commercially and academically. Commercially the algorithms will be combined with ANDTR’s IoT Connect Platform designed to exploit the availability of data across many different appliance sources. Academically the results are being used to address unanswered questions such as ‘What is the spread of errors in developed probabilistic forecasts and can we determine computationally affordable forecasts without compromising the forecast’s quality?’ Dissemination is through publication and presentation.

Outcomes and next steps
The project has been successful in identifying an algorithmic approach for DSR which is implementable in embedded devices. Simple algorithms have been tested using data from an SME and the options for utilising secondary sources simulated. The next steps are to amalgamate the outcomes into commercial offerings aimed at the growing IoT market. Further research work on the robustness of the algorithms and reduction of errors is also envisaged.

Further information: http://gtr.rcuk.ac.uk/projects?ref=132482

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4.18. Assessing the potential for smart, wireless electricity meters in off-grid sub-Saharan Africa

132483, Early Stage, 1 December 2016 to 30 November 2017, £295,347

SteamaCo

Small distributed mini-grids have long been touted as a clean solution to supplying electricity across vast distance and replacing the use of harmful fossil fuel sources to the 620 million unconnected in rural Sub-Saharan Africa (SSA). However, the inability to monitor, control and collect payment for electricity in off-grid SSA is cited as one of the biggest barriers to the development of the mini-grid market.

Market opportunity
1.2 billion people lack access to basic electricity services across the globe. Prevailing assumptions are that a third of this need will be met by solar mini-grids, representing 350 million homes and businesses. As a total, this represents a US$7.0 billion smart metering hardware and a US$2.3 billion recurring annual SaaS (software as a service) revenue opportunity.

Innovation
SteamaCo designed a low cost, ruggedised, LPWAN (low-power wide area network) wireless smart meter and mobile payment system designed explicitly for rural, off-grid SSA. Our system uses emerging mobile technology to connect thousands of energy consumers to mini-grid electricity. Using cloud technology, advanced data analytics, pay-as-you-go mobile payments and a range of intelligent power and data algorithms, our system allows the retail of affordable electricity even in the most challenging, remote locations.

Exploitation route
SteamaCo sells smart meters and platform SaaS services directly to solar mini-grid developers. Further, advances in solar home systems (SHS) are creating opportunities for applications of the technology in localised nano-grids - sold directly through major SHS companies.

Outcomes and next steps
The product enables the widespread roll-out of affordable metered electricity to rural communities, significantly reducing the economic, health and environmental damage caused by unsustainable energy sources. SteamaCo is aiming to capture 25% of the market share for off-grid smart metering.

Further information:  http://gtr.rcuk.ac.uk/projects?ref=132483

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EMBOSSA: Energy Management in Botswana and Sub-Saharan Africa

132486, Early Stage, 1 March 2017 to 28 February 2018, £233,345

Swanbarton Ltd
University of Bath
University of Botswana
Yuasa Battery UK Ltd

EMBOSSA will improve consumers’ energy security in sub-Saharan Africa by providing an inexpensive back-up energy supply during network outages. EMBOSSA will provide sufficient energy to support domestic lighting and phone charging for a few hours. EMBOSSA is unique in coordinating battery charging to mitigate network load peaks and in using recycled parts for its main components. Improving energy security for consumers will improve their physical security and their access to education and commerce.

Market opportunity
Our target market is the 62 million grid-connected households in sub-Saharan Africa. Their number is being driven upwards by grid extension work and population growth. Our market proposition is to make the EMBOSSA designs available open source, for local enterprises to manufacture, largely from recycled materials, but to sell (and retain control of) the smartphone app that is essential for the system’s operation.

Innovation
EMBOSSA uses mobile phone hardware to measure not only battery state of charge but also battery state of health; it recycles batteries and smart phones; it delivers energy security for consumers in a way that’s coordinated with the energy security needs of the electricity supplier; it uses mobile technology to integrate the home system to the optimisation system; it addresses the diversity of customers’ needs by tailoring battery management to each household.

Exploitation route
The design for the hardware and control systems will be open source, allowing local suppliers to freely manufacture and assemble the system hardware. EMBOSSA will generate revenues through a paid download of the control app onto the recycled smartphone.

Outcomes and next steps
The EMBOSSA product prototype has been successfully tested in a laboratory environment and will be field tested in Botswana in February 2018. Swanbarton has applied for patent protection for innovative methods for monitoring battery state of charge and state of health.

Further information:  http://gtr.rcuk.ac.uk/projects?ref=132486
4.20. Extreme low-energy server cooling

132490, Early Stage, 1 April 2017 to 31 March 2018, £207,114

Extreme Low Energy Ltd (ELe)
Queen Mary University of London

This feasibility study investigates a novel cooling solution for electronic devices, specifically focused on servers for datacentres (DC) alongside a DC power infrastructure. The project aims to address the energy trilemma by significantly reducing the energy use of computer servers in datacentres and subsequently the heat generated. Through reducing wasted heat generation, the project will reduce energy demand of ICT infrastructures, thereby helping simultaneously address energy security, energy equity, and environmental sustainability.

Market opportunity
The global market for thermal management products is expected to see a 6.8% compound annual growth rate (CAGR) between 2014 and 2019. Around 80% of the total market was accounted for by hardware, such as fans and blowers, and heat sinks. Growing at a projected CAGR of 2.0%, the computer-related market for all types of thermal management products will exceed US$3.9 billion by 2019. With the continuous growth in the big data and cloud technology, datacentres’ energy use is growing at a very high speed of 11% per year.

Innovation
Combined with ELe’s proven DC power technology, the project looks to replace conventional rotational fans which wear with alternative air movers containing no moving parts. The project will deliver a design for the most optimal cooling of high performance processing servers. The combined technology of using alternative air cooling and DC power will significantly reduce the demand of electricity required from ICT infrastructures and the cost of operating such systems, cutting the energy use for server cooling by approximately 75% compared to the conventional technology.

Exploitation route
A comprehensive commercialisation strategy is being created alongside an intelligent disruptive technology business model. The project will deliver a working pre-production prototype, which will be used for comprehensive BETA testing. ELe has an existing network of potential end-users in the UK and worldwide including African countries for existing product lines. The commercialisation strategy will be to initially exploit its existing contacts and resources to generate revenue and market awareness, followed by approaches to ‘mega-datacentres’ operated by large service providers.
Outcomes and next steps
The industrial and academic partners have worked closely together to assess the feasibility of an alternative air moving system. Preliminary new designs have been developed in comparison to conventional fan technology. Parametric numerical simulations have been performed by the academic partner. The next steps include system testing and analysis for further development and optimisation of the innovative technology for server cooling in datacentres.

Further information: http://gtr.rcuk.ac.uk/projects?ref=132490

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4.21. MARLIN - modular floating platform for offshore wind

132491, Early Stage, 1 February 2017 to 31 October 2017, £299,937

Frontier Technical Ltd. (lead participant)
PDL Solutions (Europe) Ltd.
Howell Marine Consulting Ltd.
University of Strathclyde - Advanced Forming Research Centre (AFRC - HVM Catapult)
University of Strathclyde - Naval Architecture Ocean and Marine Engineering (NAOME)
University of Sunderland - Automotive Manufacturing Advanced Practice Institute (AMAP)

The MARLIN project has been focused on assessing the concept of modular construction of floating offshore wind structures. To achieve this design, finite element analysis (FEA) modelling, static hydrodynamic modelling and dynamic wave tank tests have been carried out, as well as physical part scale prototypes tests with float modules.

Market opportunity
The modular floating platform technology will be developed for commercial exploitation and will form the basis of a new UK-based business. The project could provide 'energy access' to locations with regional energy demand with deeper water and suitable wind conditions. Modular configurable designs for underwater assembly will be developed.
Innovation
Frontier Technical has filed for intellectual property protection using the Patent Cooperation Treaty system. The innovation is focused on:

- the obviation of the need for large marine or oil and gas construction yards
- the elimination of the need for crane vessels
- the underwater construction of floating offshore wind platforms

Exploitation route
Prohibitive costs and advanced infrastructure requirement have limited the growth of floating offshore wind even in developed countries. In developing countries the resource has remained entirely unexploited. The intended route to market will be through collaboration, partnering and licencing with engineering consultants, developers and public energy agencies.

Outcomes and next steps
Analysis and test data has now provided sufficient information and confidence to move to the second phase of a 6-stage full manufacturing capability programme. Floating offshore wind in deep waters is a massive renewable energy resource ready to be tapped into to provide volume-produced high-quality product to order and realistic energy access to multiple global regions. A consortium will apply for phase 2 project and investors will be sought to enable a Phase 3 2MW demonstrator to be certified, built and demonstrated.

Further information: http://gtr.rcuk.ac.uk/projects?ref=132491

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4.22. Tide Mills UK and Africa

132492, Early Stage, 1 March 2017 to 31 March 2018, £299,097

Tide Mills Limited
James Fisher Marine Services Limited
Coastal Science Limited
Community Energy Plus
Mylor Ventures Limited
University of Cape Town

The UK was once home to over 200 tide mills, which used water mills driven by flood and ebb tides, in a similar way to inland water mills. Indeed, the first generation of tidal energy is thought to date back to 60AD, at a site on the Thames. The TiMUKA (Tide Mills UK and Africa) - project is designed to enable the restoration of historic tide mills in the UK, using technologies and civil engineering installation methods that may also be used to install advanced tide mills in developing countries, starting in sub-Saharan Africa. The project will draw on ground-breaking work by UK leading tidal energy experts, Tide Mills Limited supported by Mojo Maritime, in a challenging programme designed to rapidly deliver clean, renewable and predictable tidal energy at community scale to coastal communities, starting in the UK and Africa but ultimately worldwide.

Market opportunity
The market opportunity is the significantly accelerated exploitation of UK and international tidal range opportunity, at mini-micro[1] scale (100KW to 1MW), through: renovation of historic tide mills in the UK and Europe; installation of advanced tide mills worldwide, starting in Cornwall and the developing countries of sub-Saharan Africa. Tidal range energy is already being exploited, but in large and extremely capex-intensive projects such as the La Rance Barrier (240MW) and the envisaged Swansea Bay Lagoon (320MW). Whereas historic and advanced tide mills will be generating power at much smaller scale, in the mini (100KW-1MW) and micro (5KW to 100KW) scale; but much more rapidly than the large-scale schemes, be this in historic sites in UK or advanced sites starting in sub-Saharan Africa.

Innovation
Three key technologies are needed to unlock this opportunity:

1. bespoke mathematical planning software – the project is developing this including through the employment of world-leading tidal range mathematical modeller, Dr Ian Walkington
2. portable, modular and cost-effective civil engineering installation technologies – the project is developing this under a work package led by Mojo Maritime, part of James Fisher Marine Services, and the world’s leading tidal and wave energy installer
3. tidal range turbines at mini-micro scale – the project is engaging with a large number of potential suppliers, for a mini-micro turbine, with a 6 mode Kaplan Turbine as base case, with encouraging results

Exploitation route
The exploitation strategy envisages leveraging the Innovate UK outcomes to establish a leading position in the, as yet non-existent, tide mills sector. The plan has 5 complementary and overlapping phases. Phase 1 - concept was the successful conceptual analysis, completed on the Cornish tide mill site in Hayle. Phase 2 - technical development in progress with the successful securing of the £300,000 Early Stage Energy Catalyst grant, and the R&D work to develop the tide mills technology, planned to complete by mid-2018. This will be followed by Phase 3 - demonstration, potentially in the Isles of Scilly or at Hayle in Cornwall. Phase 4 – pilot commercialisation will have 2 key strands, the first national seeking to develop pilot historic tide mills in Cornwall, the second seeking to develop pilot advanced tide mills in Mozambique. Phase 5 - international roll-out would take the tide mills approach UK-wide and worldwide.

Outcomes and next steps
The R&D work is progressing very well indeed, with the potential of an integrated systems approach being delivered by mid-2018. The energy modelling results, using a levelised cost of energy method, show that it should be possible to deliver power initially at costs below £100 MWH⁻¹, and with further reductions in sight. In parallel, the work to investigate the streamlining of the planning system, to deliver tidal energy at community scale, has gone well, with positive engagement across a range of planning and environmental authorities. Potential project sites have been identified and investigated in Cornwall and the Isles of Scilly, with a view to selecting a demonstration site. In parallel, potential project sites have been identified and modelled in Mozambique, and will be investigated on site, in mid-2018, with the assistance of SubTech Group, a James Fisher company. Finally, the project has the support of a leading green energy utility, with the willingness and capacity to underwrite the first UK demonstration site, once selected.

Further information: http://gtr.rcuk.ac.uk/projects?ref=132492

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4.23. Reaching the sun with solar coins and smart solar panels

132705, Early Stage, 1 January 2017 to 31 March 2018, £297,387

Trusted Renewables Ltd
University of Hertfordshire
Active Development Ltd

Smart solar panels support new ways of rewarding investors in affordable clean energy. These contain embedded tamper-resistant smartcard and wireless chips which link them to a smart energy ecosystem. They also support innovative business models such as crowdsourcing-funded ‘solar gardens’. Panels power a building or micro-grid via the generation meter whilst the smart card chip in each panel provides a ‘cryptographic root of trust’ linked to an e-wallet. Investors receive tradable rights to be rewarded for the renewable energy from their panels and these digital leases using smart contracts based on distributed ledger technology.

Market opportunity
The solar PV market is growing exponentially. Worldwide installed capacity may exceed 500GW by 2020 - around 2 billion panels. Grid parity - where the levelised cost of solar power is less than electricity from the grid, has been reached in around 30 countries. This means governments can eliminate subsidies (for example, feed-in-tariffs) and investment justified solely on the renewable energy produced and possibly stored locally.

Innovation
Smart solar panels are a big opportunity to exploit emerging ‘system on a chip’ devices. Analysts say there could be 50 billion Internet of Things objects by 2020. Future electricity grids will contain many of these smart objects. There are already tens of billions of smartcard chip in use for payment and security round the world. These will stimulate new trading models and significantly improve the security of distributed energy resources and cost around US$1.

Exploitation route
We are in a good position to exploit intellectual property rights and share results of our test bed with commercial partners. This includes a UK-based custom solar panel manufacturer which has produced prototypes containing our embedded circuits. These have been exhibited at several key industry events. We are now considering the possibility of manufacture under licence in a number of countries including the UK, India and Australia. In the latter case this includes peer-to-peer energy trading.

Outcomes and next steps
Our test-bed allows us to evaluate various use cases and technical options. As well as focusing on rapidly-maturing technical concepts and opportunities to scale up and become market ready, we are addressing commercial and societal issues related to the adoption of new innovation in developing countries. We think distributed ledger technology will improve energy security while we manage large numbers of smart solar panels and associated local energy storage.
Further information: http://gtr.rcuk.ac.uk/projects?ref=132705

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4.24. STARFLOAT – multifloat-spar for enabling the economic exploitation of deep water wind

Oceanflow Energy Ltd

Floating foundations for offshore wind turbines will allow wind farms to be built further offshore in the deeper water that exists around the northern North Sea and Atlantic Margins of the UK. For this market to be realised innovative solutions are required to arrive at costs of energy that are competitive with nearshore wind turbines. Starfloat, which is a novel multifloat-spar structure employing an innovative cost cutting build, assembly and deployment process, can achieve the required cost reductions to enable deepwater wind to be exploited. The project also investigated the use of offshore wind to power desalination plants for drought-stricken coastal communities in southern Africa.

Market opportunity
The UK and EU countries have set ambitious targets for reductions in greenhouse gas emissions. In the UK, the National Grid has put forward scenarios that address these targets which involve between 150 to 300TWh from wind by 2050 (2016 production was about 35TWh). This targeted massive increase in electricity production from wind can only be met by exploiting deeper water areas which demand floating solutions. A similar massive growth in electricity from wind is part of the strategy of other EU countries including Germany. The Starfloat solution is specifically developed to make use of fabrication facilities in the UK and EU.

Innovation
The innovative Starfloat combines a highly stable platform that can resist the overturning movement of large capacity horizontal axis turbines (HAT) with physical dimensions that are more compact than competitor structures and a simple, low-cost build and installation strategy that drives down the capex of floating wind turbine. The innovative platform design and assembly process, which is the subject of patent protection, opens up construction to existing UK and EU facilities.

Exploitation route
Oceanflow is seeking to license the Starfloat design to wind farm developers or their major subcontractors, the offshore construction companies that take responsibility for the procurement and installation of wind turbines and their foundations and who operate inshore jack-ups and anchor handling vessels that will be used in the assembly and deployment of Starfloats. The route to market will be through collaboration with a consortium consisting of steelwork fabricators and offshore construction companies who are willing to participate in a pre-commercial demonstration project in order to promote the merits of Starfloat to future deepwater wind farm developers.

Outcomes and next steps
The project has demonstrated that:
- the Starfloat multifloat-spar solution can support large capacity HATs in the harshest of ocean environments as demonstrated by detailed simulations backed up by large scale model trials

132706, Early Stage, 1 February 2017 to 31 January 2018, £122,224
• the innovative structure is economical to build while meeting the desired fatigue life
• the overall economics are attractive and justify moving to the next stage of deploying a grid-connected demonstrator

Further information: [http://gtr.rcuk.ac.uk/projects?ref=132706](http://gtr.rcuk.ac.uk/projects?ref=132706)

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4.25. Engaging household energy savings and demand response opportunities

132707, Early Stage, 1 March 2017 to 28 February 2018, £293,447

Element Energy Ltd

As smart meter data becomes more widely available, valuable new opportunities to engage household energy saving and demand-side response (DSR) are emerging. This feasibility project tests a new type of online display that provides users with real-time feedback on how their electricity consumption compares with similar households (shown to initiate up to 6% energy savings) as well as a direct DSR engagement and comparative feedback facility (to reward households that reduce demand when required).

Market opportunity
This project addresses 2 key opportunities:

1. to unlock a clear and quantified opportunity for increasing household electricity savings through the provision of real-time online comparative feedback
2. to provide a simple, low-cost online system for engaging and optimising domestic DSR (for example, to reduce demand during network peaks, in response to intermittent renewables generation)

The potential value of this market is estimated at £800 million in Great Britain and £25 billion globally by 2020.

Innovation
This project develops new innovations around how households are engaged with energy savings and DSR. This is the first time that comparative feedback is provided in a real-time online system and involves innovative new customer archetyping and smart meter data analysis approaches. The project also opens new areas of commercial innovation around how energy consumers are engaged by their suppliers and other third-parties to achieve energy savings, DSR, greater end-user engagement and customer retention.
Exploitation route
The target exploitation route for the outputs of this project is via a business-to-business licensing agreement with energy suppliers and other key stakeholders in the sector. By circumventing the requirement for households to change energy tariff when engaging in DSR services, the low-cost online platform developed in this project offers considerable benefits over existing routes for engaging households in demand reduction and shifting.

Outcomes and next steps
The project is progressing well to the planned milestones with work currently focusing on the development of the online interface for the prototype demonstrator.

Further Information: http://gtr.rcuk.ac.uk/projects?ref=132707

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4.26. Enhancing the methane generation from food waste anaerobic digestion mediated by fluidic oscillator-generated microbubbles

132708, Early Stage, 1 June 2017 to 31 May 2018, £279,789

Perlemax
University of Sheffield

Food waste is a major source of greenhouse gas emissions. If landfilled, greenhouse gases CH₄ and CO₂ are indiscriminately released, aside from being a waste of resources. Anaerobic digestion (AD) is used to produce usable CH₄ and fertiliser from food waste. By periodic sparging of CO₂ microbubbles AD can be enhanced in order to provide nutrients and strip waste products. Early laboratory results show a 100 to 110% increase in CH₄ yield and this project is to demonstrate the concept at a pilot scale.

Market opportunity
The UK produces 15MT of food waste annually. There is an increasing use of AD to deal with this.

Innovation
Microbubbles have not been considered in AD due to the high power cost until fluidic oscillator has been shown to produce microbubbles at low cost. By using CO$_2$ in the AD process the production of methane is enhanced. This will be of particular interest to AD operators.

**Exploitation route**
Exploitation will be via AD equipment suppliers and current operators once the improvement can be shown at the pilot scale.

**Outcomes and next steps**
After the project completion we expect to make our findings known to major suppliers and operators via trade forums, magazines and exhibitions.

**Further Information:** http://gtr.rcuk.ac.uk/projects?ref=132708

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4.27. Low-cost, graduated PAYG solar home systems for Africa

132709, Early Stage, 1 April 2017 to 31 March 2018, £300,004

Africa Power  
Divi LLC  
University of Southampton

Through Innovate UK funding we will design, manufacture and distribute to East Africa an upgradable set of solar home systems that operate on a pay as you go (PAYG) basis with follow-up testing in country. We are concurrently completing research on an assessment of self-contained businesses suitable for rural Africa with the production of energy through solar at their core.

**Market opportunity**
Much of East Africa does not have access to electricity, especially rural areas. Grid connections require long-term infrastructure investments from governments and are unlikely in the near/medium term for a number of reasons. In order to light their homes and charge their phones
people burn kerosene and candles and use diesel generators. Solar-powered systems are better quality and more affordable than the current baseline.

**Innovation**
Solar home systems exist in the market today (although market penetration is still light) but currently no system is truly upgradable – allowing the customer to grow their energy generation over time for an affordable fee. Secondly, so far there has not been strong focus on the productive use of power and tailoring bundles to specific business uses.

**Exploitation route**
Africa Power’s mission is to empower rural off-grid communities in sub-Saharan Africa by providing sustainable electricity for all to provide power to unconnected households, micro-enterprises and community facilities thereby reducing poverty, increasing local economic activity and jobs, as well as improving health, education, communication and gender equality.

**Outcomes and next steps**
Outcomes - a fully-functioning upgradable set of solar home systems installed in country and conclusions on the most appropriate businesses to match to a solar power system.

Next steps – take results from testing and improve system, increase the range of the upgradable family to include larger systems, develop and distribute the first solar systems for business use. Continue research into productive uses of power to assess and create more businesses.

**Further Information:** http://gtr.rcuk.ac.uk/projects?ref=132709

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4.28. Robust decentralised low-energy faecal sludge dewatering leading to sustainable energy resource, sanitation and clean water

132711, Early Stage, 1 February 2017 to 31 January 2018, £307,982

**Natural Synergies Ltd**
**Practical Action**
**Blue Vine Consultants**
**University of Strathclyde**

The project concerns faecal sludge dewatering/treatment leading to energy security/generation, sanitation utilising locally-available resource and GHG emission savings. The technical/financial feasibility study is to develop standalone dewatering process for rural UK/EU, increasing energy efficiency/generation, reducing transport costs/carbon footprint and in developing countries (DC) as a low-cost faecal sludge management (FSM) system for decentralised/localised sanitation leading to integrated anaerobic digestion (AD) based off-grid energy generation.

**Market opportunity**
Two primary business opportunities aimed at UK/EU and DC markets. UK/EU opportunities are based on energy efficiency and energy generation using underutilised energy resource potential of rural primary sludge/industrial waste waters whereas in DC it is based on providing low-cost off-grid energy generation via AD, replacing current non-existent and poor localised sanitation systems and leading to the developments of local entrepreneurship with sales of renewable electricity/biogas/heat, FSM services (non-sewered sanitation provision), fertiliser and clean water. A Millennium Development Goal is to provide sanitation to 50% of estimated 2.6 billion people globally without sanitation with a global annual sanitation market of ~US$8 billion.

**Innovation**
Testing will build on preliminary work in developing a prototype system that will assess system throughput and efficacy to meet a commercially-viable technology. System design will be tested on a bench scale unit and design and findings will be further enhanced by CFD modelling using Fluent software. Financial viability will be completed together with a detailed system LCA.

**Exploitation route**
The project will undertake discussions with water companies for an energy-efficient and cost-effective, modular (pre-cursor to AD) and potentially transportable dewatering unit as a valuable process unit operation addition for treating rural primary sludge, with extension to high COD waste waters for wastewater collection companies. The project will further develop financial model reflecting TCO, ROI, IRR and NPV and will determine optimal range for both capex and opex. A similar approach with DC-established teams will approach NGOs/Charities and funding agencies (such as UNDP, DFID).
Outcome and next steps
Present work includes confirming technical and financial viability of the technology and its potential to address all aspects of the energy trilemma in providing a sanitation and localised energy generation solution that significantly impacts on GHG emissions. Next stage of the project will aim at the building of a pilot-scale unit that will be tested in the UK and in a DC to commercialise the technology.

Further information: http://gtr.rcuk.ac.uk/projects?ref=132711

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4.29. Solar oil – solar fuels and feeds from waste

132713, Early Stage, 1 March 2017 to 28 February 2018, £89,989

Phycofeeds Limited
Cranfield University

Phycofeeds brings solar biofuels and aquaculture feeds from waste. We allow global biotechnology enterprises to fully exploit large scale bio-processing bringing new products and services to market, improving our customers’ capabilities in energy efficiency, waste recycling, business processes, product innovation and commercial performance.

Market opportunity
Global biofuels is valued at US$168.18 billion (€149.05 billion) in 2016 to reach US$246.52 billion by 2024 at 4.92% CAGR. Global aquafeed is set to grow to US$155 billion by 2022, with CAGR of 13.2% with fish and mollusc feed accounting for 75% of the market. A 5% market penetration with aquafeed from bio-sources equates to US$7.8 billion globally. Biofuels and fish feed from waste nutrients using solar energy has the potential to address this growing market.

Innovation
Phycofeeds provides modular and scalable solar reactors, operational in non-agricultural land and deserts. The solar thermal reactor is designed for high heating and cooling rates, optimal heat transfer and product throughput capacity with lower capex vs conventional CSP. Waste is recycled for both fuel and feed markets and for economic viability. Techno-economic modelling for microalgae-based biofuel achieved a minimum sale price of US$1.23 per kg, further cost savings are expected using waste.

Exploitation route
Prototype testing has delivered pre-commercial feasibility in India, discussed at SolarPACES 2017, Santiago, Chile, and the Indian Institute of Petroleum, Dehradun, at the UK India Workshop on Energy for Economic Development and Welfare. Phycofeeds will make and produce biofuels via its own scaled deployments initially and with global partners looking to diversify renewable fuels and bio-sourced aquafeed. In parallel, annually renewable global, site and group licences for Phycofeeds’ technology will be offered to customers in the oil and gas and aquaculture sectors. Strategic customer relationships will be developed to seed new markets such as high value chemicals and nutraceuticals.

Outcomes and next steps
Field testing will validate the integrated model and quantify bio-oil, fuel and water byproduct fertiliser potential. Pilot installation to refine the core technology at pre-commercial stage with design, proven process engineering and predictable outputs is further ahead. Our strategy will focus on improving TRLs at the pilot stage leading to market deployment, based on proven pilot installation to demonstrate commercial viability. Post-pilot, commercialisation will follow a combination of technology licensing, joint development and consulting services.
Further information: http://gtr.rcuk.ac.uk/projects?ref=132713

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4.30. DryGro energy crops

132714, Early Stage, 1 April 2017 to 31 March 2018, £275,102

DryGro
Maybarn Consulting
Green Fuels Research

The DryGro energy crops project seeks to explore the market potential for biodiesel and bioethanol production using lemla as a feedstock. This project is testing new technology for the production of duckweed at industrial scale in arid regions using very little water. Using this technology could open up previously unproductive arid land for the production of biofuel crops, enabling greater energy security in emerging markets around the globe.

Market opportunity
Global biofuel production is expected to grow from 24 billion gallons in 2012 to 51 billion gallons in 2019. This market is expected to further grow in value to US$185 billion by 2021.

Innovation
DryGro has developed a new technology to grow crops using very little water. This technology can be used to produce biomass in arid environments very cost-effectively. This project is exploring the economic and technical feasibility of using this technology to produce lemla as an input crop for biofuel.

Exploitation route
DryGro launched their first test-farm in late 2017 in Kenya. A second expansion farm is expected in April to June 2018. Expansion will be managed through partnerships with biofuel producers and business-to-business relationships with biofuel consumers and traders.

Outcomes and next steps
This project is ongoing and will run until March 2018.

Further information: http://gtr.rcuk.ac.uk/projects?ref=132714
4.31. GravityLight - creating an affordable and viable off-grid energy solution

132716, Early Stage, 1 April 2017 to 31 March 2018, £199,844

Deciwatt Limited

Development of a new range of self-generating, on-demand, off-grid lighting systems, in view of the limitations of the current GravityLight system. Requested improvements from the field are: lower cost, brighter light, longer runtime, easier to demonstrate/set-up, smaller units for shipping, serviceability, ability to power a radio/charge phone. Most of these issues are inherent in weight-driven technology where the restriction of a finite weight falling from a limited height sets a limit to the amount of energy that can be stored, which is the Achilles heel of GravityLight.

Market opportunity
The new system can be used in many different scenarios, named here as examples: KeroseneReplacementLight, SchoolLight, LatrineLight, EmergencyLight, ShedLight, PorchLight, PatioLight, RemoteHutLight and WinterLight. Each scenario will use the same underlying flexible technology, with different default settings for brightness and runtime.

Innovation
In order to overcome the weight limitation, Deciwatt is developing a new system using a battery for energy storage, rather than a weight. This change will allow the new system to match the brightness and flexibility of solar-powered systems, but with the benefit of being always ready and on-demand. It will enable a range of new devices to meet the needs of different users around the world.

Exploitation route
The intention is to establish licensing partnerships for global distribution to both off and on-grid communities. We will use the existing GravityLight network to drive the sales of the next generation product.

Outcomes and next steps
A key programme target is to manufacture a pilot batch for field trials research to ensure impact data is achieved during the second quarter of 2018. The intention is to gear up for production in parallel with the trials to expedite product to market during the second half of 2018. The new
product is called NowLight and has a new brand identity, with a visual connection to the existing GravityLight.

**Further information:** [http://gtr.rcuk.ac.uk/projects?ref=132716](http://gtr.rcuk.ac.uk/projects?ref=132716)

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### 4.32. Using energy storage to help climate change victims and to stop modern slavery

132717, Early Stage, 1 April 2017 to 31 March 2018, £254,150

**Power Migration Partners Ltd**  
**KERA Charity - Sri Lanka**

Power Migration Partners Ltd (PMP) has invented a novel flow battery technology that is low-cost, durable and easily scalable. This is called the graphite-sulphur Single-Liquid (SLIQ) flow battery. PMP and KERA Charity, a Sri Lankan-based charity, carry out R&D and assemble a trial feasibility prototype of a backpack emergency energy supply unit (EESU) to support disaster relief efforts. When not used as an EESU, this will be used as an energy storage system.

**Market opportunity**
Outcome of this feasibility study will target 3 key industries, which will allow governments and charities to use energy storage systems installed in these facilities, during a natural disaster in a nearby geographical location. These market segments are:

- energy storage systems for telecom towers (market size of £12 billion)
- energy storage systems for renewable energy generation (market size of £50 billion)
- EESUs for disaster relief (market size of £20 billion)

**Innovation**
This project demonstrates innovations in 3 areas:

- technical innovations - major improvements to PMP's SLIQ flow battery
- innovations in application - design a modular, water-resistant and easily-deployable single liquid flow battery which can be carried around on shoulders or dragged along flooded streets using boats
- commercial innovations - innovative marketing strategy and business model which involves working and cost sharing amongst charities and industries together who value publicity gained by investing for disaster relief operations
Exploitation route
Routes to market for this product will be established by building strong relationships with suitable partners such as charitable networks, mobile network operators, media operators and renewable energy consulting firms. PMP will have assured projects worth £40,000 by 2020 as a direct result of this project and will have access to a £2.6 billion market with the support of KERA Charity especially in the telecommunication industry.

Outcomes and next steps
The aim of this project is to carry research and development and then to assemble a basic pre-feasibility prototype of a low-cost, modular, safe and durable EESU that can be carried around as backpacks for disaster relief operations. The next step would be to partner up with suitable industries such as mobile phone operators to provide the EESU as back-up power for telecom towers thereby taking the prototype to production phase.

Further information: http://gtr.rcuk.ac.uk/projects?ref=132717

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4.33. Zero-Emission vehicle Battery Remanufacturing for energy storage Applications (Project ZEBRA)

132718, Early Stage, 1 April 2017 to 31 March 2018, £246,315

Aceleron Ltd
Bluevine Consultants
Alp Technologies

Project Zebra explores the development of a biofuel generator transformed to a hybrid, where Alp Technologies’ wood pellet generator is coupled with Aceleron's energy storage transitioned from an electric vehicle. These technologies combine to provide a zero-emissions power generation ideal for microgrid or rural off-grid scenarios. The wood pellet generator fits perfectly in developing regions with limited access to fossil fuel while the second life energy storage allows efficient and affordable utilisation of power.

Market opportunity
East Africa, Central America, India are key regions affected by no or poor energy infrastructure. A zero-emission solution such as Project Zebra could help build this infrastructure sustainably. Emergency power is also an opportunity for Project Zebra. For scenarios such as hurricanes, a rapidly

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deployable, affordable, zero-emissions power generation would be a viable substitute to diesel counterparts.

**Innovation**
The combination of a biofuel generator with second life energy storage provides the perfect balance of sustainability and cost-effectiveness. The second energy storage improves the efficiency of the generator via effective storage and delivery of energy as needed.

**Exploitation route**
Aceleron particularly intends to demonstrate and deploy its affordable second life energy storage in first response and backup power solutions in areas such as the Caribbean where hurricanes significantly damage the grid infrastructure and no redundancies are available.

**Outcomes and next steps**
The project aims to explore the technical feasibility of the hybrid solutions. Next steps include an initial evaluation of potential economic viability as well as field trials.

**Further information**: http://gtr.rcuk.ac.uk/projects?ref=132718

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**4.34. Efficient Versatile Energy Services Solution Through DC (EVERESST DC)**

**132719, Early Stage, 1 April 2017 to 31 March 2018, £257,941**

**Solapak Systems Ltd**
**University of Soutampton**
**Great Lakes Energy Ltd**
**Trade Without Borders (HK) Ltd**

EVERESST DC promotes a DC Micro-Grid Platform (DCMGP) or system encompassing a unique product and business solution for organisations seeking to provide modern energy services into energy-poor regions. Our solution is not just hardware, it is a partnership approach to modern energy access that actively engages end-users and stakeholders to encourage efficiency as a natural way of modern energy life.
Market opportunity
As of 2016 only 24% of the population of Rwanda has access to modern electricity services. The Rwanda Rural Electrification Strategy calls for 100% access to electricity by 2020, to come through a combination of on-grid and off-grid supply. This represents an opportunity for standalone, localised solar micro-grids. By accessing just 0.5% of this share the 5,750 to 9,500 households are expected to require between 250 to 1000 DCMGP s valued at £28.75 million to £47.5 million.

Innovation
The DCMGP will avoid the inefficiency, limited operational life and safety-critical skilled resource associated with AC. It will engage the consumer through a user display and user energy hub to enable efficiency and maximise value. A range of quality, energy efficient and ethically produced DC devices and appliances will be supplied to users to drastically reduce electricity requirements (and therefore consumption cost). Combined with a proven, reliable PV system we produce complete service solutions.

Exploitation route
The DCMGP holds commercial value for clients including households, businesses of all sizes, NGOs and governments. We will promote value throughout global markets – the developing world, small island states, disaster and emergency response, and refugee camps. The DCMGP offers significant value for the provision of modern energy services for all major sectors such as education, healthcare, cold-chain supply (vaccines and consumables), rural infrastructure and agriculture.

Outcomes and next steps
This work seeks to develop a DC micro-grid platform based on a PV system with 20-year industrial proven reliability and system integration with modern, high efficiency devices employing a high degree of user engagement. Reducing emissions will be a direct result of the DCMG platform because its electricity is generated from clean solar PV. Cost reduction to the user will be achieved through provision of efficient end-user services, inherent throughout the design.

Further information: http://gtr.rcuk.ac.uk/projects?ref=132719

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4.35.
Development of low-cost alkaline solar cells

132720, Early Stage, 1 March 2017 to 28 February 2018, £299,661

Solaris Photonics

Our aim is to lower the cost of conventionally-generated electricity at point of use. This is achieved through reducing production cost of solar cells down to $0.13/W by simplifying solar cells’ manufacturing steps.

Market opportunity
Alkaline photovoltaics (APV) aims at very low-cost electricity generation that is competitive with the cost of conventionally-generated electricity at point of use. APVs offer following advantages over existing PV and other renewable energy technologies:
1. high sustainability using low-cost inorganic materials and reliable supply chain
2. high performance PV cells, with high efficiencies (>13%)
3. utilising current manufacturing facilities (no need for substantial capital investment)
4. lower process temperatures
5. non-toxic constituents and unrestricted end-of-life
6. compatibility of APVs with a wide range of substrates

Innovation and exploitation route
1. Far higher energy return on investment due to reduced production cost of APVs compared to existing PVs
2. A reduction in energy bills that will increase disposable income as well as contribute to overall GDP
3. Reduced energy cost will have a positive impact on the UK manufacturing industry

Outcomes and next steps
We are looking for strategic partners to accelerate our route to market and provide:
1. funding, to build a manufacturing plant or to subcontract manufacturing
2. market access, industrial partners for joint-venture, joint development and with established sales channels

Further information: http://gtr.rcuk.ac.uk/projects?ref=132720

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4.36. African off-grid solar power and mobile connectivity

132721, Early Stage, 1 March 2017 to 28 February 2018, £534,650

Ubuntu Power

Ubuntu Power provides affordable zero-waste power and internet to off-grid communities across sub-Saharan Africa, starting with Kenya. Our innovation lies in integrating these utilities into one modular and scalable system and using the revenue from multiple services to cross-subsidise the provision of affordable electricity, thus creating a sustainable way to provide 2 of the most pivotal services for development - access to power and access to information.

Market opportunity
With 600 million people in sub-Saharan Africa lacking energy access, decentralised, standalone mini-grid solutions like Ubuntu Power’s are expected to meet 70% of the demand of newly-connected customers over the next 25 years, according to the International Energy Agency. Additionally, between governments’ renewables targets and actual deployment trends, there is a sizeable gap. The African Renewable Energy Initiative’s goal is to deploy 300GW by 2030 requires a 680% increase in current deployment rates, which the current infrastructure is simply incapable of achieving.

Innovation
Ultimately, Ubuntu Power sits above and across existing providers, integrating the best hardware and services into our solution. The off-grid utility market has recently seen increased interest, with numerous providers operating in East Africa. However, most of these providers focus on a single utility and are hampered by their sunk capital in factories and tooling. Consequently, they are often unable to service the communities needing power the most and cannot scale. Moreover, the market is highly fragmented with suppliers inefficiently operating in silos. This is compounded by their inability to effectively combine multiple utilities and reduced focus on ongoing community engagement. This fragmentation is, therefore, an opportunity for us, as we can remain agile through our integration of potential competitors. Our focus then shifts to grassroots engagements where we can leverage the existing resources, technology and capital invested in the fragmented market to provide the optimal solution for each community.

Exploitation route
Our community hubs are more than just hardware integrators. They are designed to become integral parts of the communities by adding a number of additional benefits. As central Wi-Fi hotspots, providing perimeters of safe lighting, charging points and educational opportunities after dark, we maximise their appeal and value to residents.
As we grow, we will leverage the revenues generated from the initial peri-urban deployment to expand into more remote, less densely-populated communities, thus allowing more affluent communities to effectively offset the cost of providing power to more impoverished areas. As part of our rollout, we will recruit local brand ambassadors to engage communities and communicate our system’s benefits. These ambassadors will also drive a customer referral campaign, where existing users can share discount vouchers and incentives with new users that sign up to our service, to encourage word of mouth.

**Outcomes and next steps**
We are powering and providing community Wi-Fi to over 800 people near Mt Kenya with our PV-biogas hybrid mini-grid and currently gearing up to scale up across the country and deploy in Kakuma Refugee Camp.

**Further information:** [http://gtr.rcuk.ac.uk/projects?ref=132721](http://gtr.rcuk.ac.uk/projects?ref=132721)

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**4.37. Feasibility study for an off-grid, cutting-edge, low-cost PV product**

132722, Early Stage, 1 May 2017 to 30 April 2018, £175,134

Big Solar  
TERI (The Energy & Resource Institute)

Over 1.2 billion people globally are without access to electricity. The level of PV adoption in off-grid rural areas, particularly in India, SE Asia and Africa has been very low, primarily due to prohibitively high cost and weight limiting take-up in remote locations. Big Solar Limited (BSL) is developing Power Roll, a ground-breaking flexible, ultra-lightweight and ultra-low-cost solar PV product to enable consumers to generate and potentially store affordable renewable energy.

**Market opportunity**
The global PV market in 2016 was 75GW with >100GW forecast by 2019. Although India plans to deploy >100GW of solar power by 2022 including 30,000 rural villages, the off-grid PV market is significantly under-developed (<1% market share). Power Roll has the potential to transform this market, overcoming the current barriers of high cost, long paybacks and deployment challenges.

**Innovation**
Big Solar is developing a highly-innovative, low-cost (7x cheaper than silicon PV), lightweight (50x lighter than silicon PV) thin film PV product. Power Roll uses a simple 4-step manufacturing process
using a patented 3D structure on a plastic substrate, eliminating many costly and energy intensive steps required by other PV technologies. Advantages are: ultra-low manufactured cost (5p per w), ultra-low weight (250g/m²), 40%+ saving in installation/BOS costs and LCOE cheaper than hydro-carbon energy sources.

**Exploitation route**
This feasibility project aims to further develop the very significant market opportunity in the Indian and SE Asian markets confirming suitable Power Roll applications as well as routes to market, channel partners and local supply chain companies able to support both the installations and ongoing service requirements for future deployment.

**Outcomes and next steps**
The initial plan is to work with NGOs and other local agencies to disseminate the PR product and its off-grid benefits. Also, to further develop strategic relationships with companies already working in these communities. The outline business plan for this market (post project) assumes an initial demonstration roll-out in 500 villages followed by significant annualised growth.

**Further information:** http://gtr.rcuk.ac.uk/projects?ref=132722

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4.38. **Automated diagnostics for solar enabling ‘power by the hour’**

**132723, Early Stage, 1 February 2017 to 31 January 2018, £79,924**

**Senseye Ltd**

The aerospace sector has a substantial lead over others in the area of advanced condition monitoring to decrease maintenance costs and optimise available operating hours. This has led to new business models with aircraft flying time being contracted as ‘power by the hour’. This early stage feasibility project is to evaluate the application of IoT-inspired machine learning technologies to improve the efficiency and productivity of solar sites and lay the groundwork for the adoption of new business models.

**Market opportunity**
At a macro-economic level, investments in the renewables market stood at US$254 billion in 2013 and will continue to increase as governments seek to meet national and international emissions targets. The potential is enormous. Considering the solar market alone, this has been forecast to
reach US$137 billion by 2020. UK solar-installed capacity is currently at 5.2GW with a value of £2.5 billion and is forecast to grow to 10GW by 2020. Sub-Saharan Africa installed capacity figures are estimated at over 10TW. Both markets are still a long way from their targets. UK operators are taking advantage of generous government subsidies to make their businesses viable with true market dynamics not yet in play. Less reliance on subsidies is expected in developing countries and this drives the need for more innovative business models.

Innovation
There is no product at this price point right now in the solar market or, indeed, in any other market (as low as US$1 per measure per month). This lower price point is achieved through the automation of the previously highly-manual diagnostic processes. Once deployed, operators will be able to make cost savings, achieve higher availability and run solar installations more efficiently.

Exploitation route
Success of the project will result in technology being incorporated into Senseye’s existing product (currently used in the manufacturing sector) - combining it with the results from the previous Innovate UK-funded project - and preparing it for cross-sector expansion. Project output will also guide both the technology roadmap (better understanding of the challenges and needs of operators) and the sales and marketing plan (better product-market fit).

Outcomes and next steps
Project only just started so too early to say.

Further information: http://gtr.rcuk.ac.uk/projects?ref=132723

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4.39. eCook - a transformational household solar battery-electric cooker for poverty alleviation

132724, Early Stage, 1 May 2017 to 30 April 2018, £269,134

Gamos Ltd
Loughborough University
University of Surrey

The project examines in greater detail the feasibility of using solar electric cooking (eCook) in Africa and Asia. The proposition is that if the current downward trends in solar photovoltaic technology costs and in energy storage costs (specifically lithium iron phosphate batteries) continue, then by 2020 a system sized for cooking would have a lifetime monthly cost comparable to the monthly spend on biomass (mainly charcoal) made by a sizeable proportion of biomass users. Biomass-based
cooking is a root cause of acute respiratory infections which leads to millions of deaths per year. It is also a contributor to climate change emissions, and a cause of local deforestation with wider impacts. Increases in urban populations are leading to increases in charcoal prices. Globally some 300 million households currently spend more than US$10 a month on biomass fuel. Sustainable Development Goal 7 calls for 'access to affordable, reliable, sustainable modern energy for all' by 2030. The strategic use of solar photovoltaics and batteries for cooking would be a gateway enabling households to convert their current biomass expenditure into decentralised electrical infrastructure.

**Market opportunity**
The current market of polluting fuels (including Kerosene) used for cooking in Africa is considerable and as described in the introduction harmful to health, particularly women and children. It can also be harmful to the local environment and contributes to global climate change. A modern energy solution that utilises renewable energy that could reach those in rural and peri-urban areas at an affordable monthly cost would have considerable developmental and economic impact in developing countries.

**Innovation**
Over the last 3 years, Gamos has undertaken a number of pre-feasibility studies, and in 2015, the Department for International Development (DFID) commissioned peer reviewed papers to examine the validity of the concept. Each of these papers stated that further research would be beneficial. Gamos has been pursuing a technology development programme including a proof of principle prototype (off the shelf components with no regard to shape or form) now used for daily family cooking for 30 months. This has informed a first generation prototype now under development.

**Exploitation process**
This work is focused on DAC countries and is part of ODA commitment of the UK Government. A larger programme of work is being developed with a consortium of organisations, including the World Bank. Further research consortia are being explored with funding coming from a number of sources. As a part of the InnovateUK-funded work, a utility company and various solar lighting and cookstove companies in Africa have become strongly interested in the concept.

**Outcomes and next steps**
The core outcome of this current phase of work has generated a global scan of markets identifying where the concept has the highest viability (based on international and national-level data). The work continues with an in-depth market scan in three countries: Zambia, Myanmar and Tanzania. Each country has yielded research into cooking styles and energy consumption, and these have been fed back into a system design and economic model. These market scans have generated considerable interest in these countries, opening the door to further collaboration to support the roll-out of eCook. This work is for the benefit of those in DAC countries and our next steps will be to secure further relevant ODA funding to ensure that the UK remains a leader in this potentially landscape-changing proposition.

**Further information**: http://gtr.rcuk.ac.uk/projects?ref=132724

**Dr Simon Batchelor**
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5. Energy Catalyst Funding Round 5

5.1. Establishing Mutually Beneficial Local Energy Markets (EMBLEM)

133216, Early Stage, 12 months, total project cost £299,051

Scene Connect Ltd
Swanbarton Limited
Iona Renewables

Most of the remarkable growth in renewable energy production has occurred among variable technologies (wind power and solar PV), raising concerns about the challenges of integrating large shares of variable generation into power systems. Establishing Mutually Beneficial Local Energy Markets (EMBLEM) aims to test the feasibility of a pioneering energy trading system for local energy economies that aims to be a cost effective demand response solution to securing efficient energy supply. The concept is a win-win-win for producers, consumers (and prosumers) of energy, and also national grid and distribution systems, aiming to reduce network stress and power outages. EMBLEM integrates cutting-edge UK innovations - Scene Connect’s Cloud Solar, off-grid energy metering and control hardware, and Swanbarton’s Smart Trading platform - to deliver a product that goes beyond the current state-of-the-art. This product promises to disrupt current energy markets by increasing the viability of small renewable energy installations, and the electrical grid’s ability to incorporate them. The key usage of the resultant technology will be in the developing world where grid systems are rapidly expanding and are under significant stress.

Further information will be available at:
http://gtr.rcuk.ac.uk/projects?ref=133216

5.2. Catalysing energy access in Africa through smarter energy storage management

133217, Early Stage, 12 months, total project cost £309,758

M-KOPA UK Limited
University of Oxford
Microsoft Limited

Pay-as-you-go solar home systems are rapidly providing clean and affordable power to the 600 million people in Africa who live beyond the grid. These systems allow people to stop burning kerosene for lighting, to charge their mobile phones, and to have their children study safely at home.
However, one core component of the system - the battery - can limit the effectiveness of the system, and the lifetime of the system as a whole. Applying data science and machine learning in an entirely new context, M-KOPA and its research partners will develop new technologies to remotely manage the batteries of its 500,000 customers, and to maximise the lifetime and functionality of these batteries. The research will ultimately lead to reduced product costs, and costs of serving customers, whilst ensuring that solar home system users are able to enjoy the full benefits of clean and safe energy in their homes.

Further information will be available at:
http://gtr.rcuk.ac.uk/projects?ref=133217

5.3. **Entrust Smart Home Microgrid**

133218, Early Stage, 1/12/17–30/11/18, total project cost £97,268

Entrust Microgrid LLP

The project will develop an innovative smart home microgrid (Ensmarthome) with integrated solar PV and energy storage system, aiming to maximise self-consumption of domestic solar PV power and significantly reduce the end-user’s energy bill. Ensmarthome will significantly reduce domestic peak power demand on the electricity grid, allow more solar PV installation under current electricity grid regulations, which will bring maximum benefit to the electricity grid and the public. Ensmarthome enables both on-grid and island operation of domestic solar PV system, which is absolutely essential for homeowners in developing countries where electricity grids are often unreliable or unavailable. Success of the project will facilitate further large scale installation of domestic solar PV system both in the UK and globally based on its significant benefit to the end-users and the public. Success of the project will promote the UK smart grid business and create/secure high tech/value jobs in the UK. The innovative technology will play a key role in tackling energy security, reducing cost of energy, battling CO2 emission and climate change.

Further information will be available at:
http://gtr.rcuk.ac.uk/projects?ref=133218

5.4. **SolaFin2Go**

133219, Early Stage, 12months, total project cost £291540

Ulster University
dpSUN Limited
Empowered Pty
SolaForm Ltd

The SolaFin2Go project will address the challenge of providing stand-alone solar systems to make available cost effective and affordable access to electricity and thermal hot water for off-grid households in sub-Saharan Africa. The objective is to test the feasibility of ‘entry level’ technological
solutions combining novel PV and solar thermal technologies financed through improved business PAYG models (enabled by the innovative FinTech platform through Mobile, Cloud and Blockchain technologies) that fit with household/community circumstances to provide basic electrification and hot water. Combining the partner technologies, resources and knowledge in this study has the potential to create a viable, cost effective off grid standalone solar solution to meet many of the challenges identified by the Sustainable Energy for All (SE4All) initiative and directly relates to the Botswana Off Grid Plan and Energy Efficiencies plan. This unique project combines traditional PV systems with battery storage and solar thermal technologies packaged together under an energy, payment and customer management platform that has customer relationship at the heart of the finance model and also has significant potential to add to economic momentum in rural communities and to Transform Energy Access for all.

Further information will be available at:
http://gtr.rcuk.ac.uk/projects?ref=EP%2FR035954%2F1

5.5. Development & demonstration of a unique low cost scalable PV technology

104001, Mid Stage, 24 months, total project cost £974,691

Big Solar Ltd
The Energy & Resources Institute (TERI)
Unilever PLC
Newcastle University

Over 1.2 billion people globally are without access to electricity. The adoption of solar panel (photovoltaic, ‘PV’) technology has expanded dramatically from 6GW in 2009 to >70GW in 2016 [Greentech Media], but its use in off-grid rural areas, i.e. India, SE Asia and Africa, has been very low, due to prohibitively high cost and weight. BSL has developed a ground-breaking flexible, ultra-lightweight and ultra-low-cost product called PowerRoll. It is a unique PV technology that provides renewable energy at a cost cheaper than any carbon-based technology, and significantly cheaper than current PV products. PowerRoll can be manufactured at a fraction of the cost of conventional panels, and can weigh as little as 2% of current PV products, removing the principal barriers to widespread deployment of solar energy solutions in rural areas. BSL has successfully proven the PowerRoll concept. This project is focussed on the development and demonstration of applications to address the needs of rural off-grid communities in the Sub Saharan African, Indian and SE Asia. We are working with expert sub-contractors and three partners to support the demonstrators across several test sites in these markets: The Energy and Resources Institute, India (TERI); Unilever; and Newcastle University (JSCE).

Further information will be available at:
http://gtr.rcuk.ac.uk/projects?ref=104001
5.6. Optical Transfer of Heat with Electrical and Light Output (OTHELLO)

104002, Mid Stage, 18 months, total project cost £562,796

Palliser Engineers Ltd
Polysolar Limited
Swansea University

With demand for clean, reliable and affordable energy rapidly growing, the ability to apply the solar spectrum wherever sunlight is available becomes ever more important. By combining valuable unexploited strengths of thin film Photovoltaics (PV) and solar optics we co-generate electricity and high temperature heat with the part of the spectrum not used by PV, without sacrificing the level of electricity generation for PV alone, unlike existing products. The optics generates high enough temperatures to efficiently drive air conditioning, refrigeration, and even cooking. As the thermal part can be fabricated at little extra cost this approach is economic even without the benefits of increasing useful energy per square metre. High-rise buildings are particularly challenging in this respect but our system can be designed for economic production of energy on walls receiving direct sunlight. This makes it possible to provide cooling in summer, heating in winter and refrigeration at any time, allowing the panels to be sized for maximum load and offering these services at the point where they are needed in the building, a space efficient and city friendly solution wherever the markets can respond to the relentless demand for better living standards.

Further information will be available at:
http://gtr.rcuk.ac.uk/projects?ref=104002

5.7. Transforming electricity access through smart sensors & grid efficiency algorithms

104003, Mid Stage, 18 months, total project cost £389,447

Orxa Grid Ltd
SCOPE T&M Pvt Ltd
University of Reading

Electricity distribution network operators (DNOs) in developing countries are facing significant challenges to address the energy trilemma – offering clean, affordable and secure energy. Increased demand for electricity coupled with the rapid shifting of supply to distributed generation requires DNOs to increase monitoring, analytics and optimisation to continue to provide a cost-effective service. Instead of installing expensive, cumbersome SCADA systems and making costly grid expansions, OrxaGrid provides a smarter, lower cost alternative through retrofitting IoT enabled devices on critical grid nodes and monitoring them for efficiency improvements. In this project, OrxaGrid will collaborate with SCOPE, an established Indian electrical sector company and University of Reading’s energy systems team to take the system to the next level. We will develop a unique
interoperable gateway and add advanced algorithms that improve grid efficiency by forecasting demand and renewable generation, predicting theft and technical outage locations and identifying spare capacities in the grid. Grid operators can use OrxaGrid’s web/mobile dashboard to take active steps at mitigating the energy trilemma.

Further information will be available at:
http://gtr.rcuk.ac.uk/projects?ref=104003