Innovate UK

Directory of projects

Energy Catalyst – Round 2

Contents

Introduction

Energy markets around the world – private and public, household and industry, developed and developing – are all looking for solutions to the same problem: how to provide a reliable, resilient energy system that delivers affordable and clean energy with access for all.

The need for secure, clean and low-cost energy creates a wealth of opportunities across different markets and energy supply chains that UK technology and business innovators have the capacity to address. Opportunities may lie in any market area where energy is generated, converted, stored, distributed or used, and they may represent innovations that are ready for market now or depend upon long-term technology, market or regulatory developments and may involve high technical or business risk.

To help UK innovators seize these opportunities and manage their risks, the Energy Catalyst was established as a national open competition, run by Innovate UK, funded by multiple partners and overseen by an expert advisory board. A panel of independent expert energy and business assessors rigorously reviews applications and identifies the very best and most commercially promising innovative UK energy projects.

Since 2013, the Energy Catalyst has provided support to UK innovators to help them explore and develop the energy market opportunities that they themselves have identified and are willing to back with their own private money. The grant funding support has been provided across a sequence of competition rounds by Innovate UK, the Engineering and Physical Sciences Research Council (EPSRC), the Department for International Development (DFID), the Department for Business, Energy & Industrial Strategy (BEIS) (including, previously, the Department of Energy and Climate Change, DECC).

This Directory summarises the 30 projects and organisations that were selected for funding in Round 2 of the competition – the very best out of more than 200 high-quality applications. These projects came together to showcase their achievements to the investor and business audience attending Rushlight 2017 in London on 25 January 2017. Many have already won awards, secured investment, created new business partnerships and increased their sales and staff as a direct result of pursuing these innovative projects. We hope this Directory will be a valuable resource for other potential investors, supply chain partners and customers. If you see something here that you think may be relevant to your business, I urge you to make enquiries with the projects directly or via Innovate UK.

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Low-cost, high-efficiency LEDs using 3C-SiC substrates

Early stage, 1/10/15–31/12/16, £291,790

Anvil Semiconductors Ltd, CB4 2HY (SME)
University of Cambridge, CB3 0FS (Research)
Plessey Semiconductors Ltd, PL6 7BQ (SME)

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 LED lighting, but it has never been done before. Building on a previous Innovate UK project, we demonstrated the growth of cubic GaN layers on 150mm-diameter 3C-SiC (silicon carbide) wafers, developing early-stage LEDs.

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 but, despite considerable investment, no one has previously been able to produce cubic GaN in a commercially viable form. This project has achieved that.

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 anticipates licensing its technology for substrates to grow cubic GaN to Plessey and other LED manufacturers.

Outcomes and next steps

The project has demonstrated the growth of cubic GaN on 150mm-diameter wafers and produced early-stage LEDs. The next stage is to optimise this growth and demonstrate its use in producing high-efficiency, low-cost LEDs in the production fabrication facility at Plessey Semiconductors. We have recently won a follow-on Innovate UK grant to assist with this further development and exploitation.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132135

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Commercialising diamond power electronics

Early stage, 1/5/16–31/5/17, £330,000

Evince Technology Ltd, TS21 3FD (SME)

Evince is developing a new class of power electronic devices based on diamond. Diamond is perceived as having limitations as a semiconductor but the principles underpinning Evince's approach overcome these. The aim is to pave the way for inherently high-voltage/high-power devices suitable for the energy industry at the distribution level. The current project focuses on the simplest embodiment of the technology: a fast diode.

Market opportunity

The immediate and initial application of the project will be protective diodes for today's insulated-gate bipolar transistors (IGBTs) at more than 2.5kV, which have their performance limited by the pin diodes rather than the transistor. The initial market is estimated to be worth more than US$400 million. The technology is additive and future development of a complementary switching device could result in a market worth over US$2.5 billion.

Innovation

The innovation lies in the approach to working with synthetic diamond. Rather than adopt conventional semiconductor strategies (i.e. doping), the project has embedded electron emission sources within the substrate. This exploits diamond's inherent insulation strength (50 times greater than silicon), and its electron mobility (4 times greater than silicon). The result is a device that is unique to diamond and rewrites the electronics rulebook.

Exploitation route

Evince is a focused research and development (R&D) business. Our route to market will be through licensing and collaborative development with semiconductor manufacturing partners seeking to take our disruptive technology to market.

Outcomes and next steps

The project will culminate in the manufacture and demonstration of diodes with target ratings of <5V forward voltage drop and a >10kV revise bias capability at TRL 4. At this point, we will be looking for potential manufacturing partners to undertake the industrialisation process, and further investors to expand our capability.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132136

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Demonstrating a low-cost SiC hybrid power module

Early stage, 1/11/15–31/1/17, £239,910

Anvil Semiconductors Ltd, CB4 2HY (SME)
Manufacturing Technology Centre (MTC), CV7 9JU (Research)

Anvil Semiconductors is developing power devices in 3C-SiC, which have the potential to provide the efficiency of SiC (silicon carbide) at the cost of silicon. This project develops a low-cost hybrid module using 3C-SiC devices, enabling close coupling of devices and ancillaries and so reducing inductances. This significantly increases efficiencies and reduces the size and weight of the module, by removing the need for ancillary components and heat sinks.

Market opportunity

The total power semiconductor market, which is completely dominated by silicon, is predicted to exceed US$23 billion by 2020. According to IHS Markit research, the existence of low-cost SiC modules would have the effect of doubling the penetration of SiC devices by 2020. The market value would increase from US$1 billion to US$2 billion, with potential applications in LED lighting, photovoltaic (PV) converters, general power supplies and electric vehicles.

Innovation

The 3C-SiC devices are highly innovative but the inherent advantages of low-cost SiC devices need to be realised in cost-effective, low-inductance packages and modules. This simplicity of function is addressed particularly through layout and simulations of novel structures for tracks, wire bond configurations and packaging, so that the efficiency and cost reduction potential is not undermined.

Exploitation route

Anvil Semiconductors' expectation is to follow its business model for discrete devices using a fabless / contract manufacture model. It intends to seed the market and build value before licensing the technology to one or more existing large semiconductor companies who already have the large volume capacity and supply chain. We are already working with potential device licensees.

Outcomes and next steps

The first-generation module will feed into another Innovate UK project to develop a low-cost 99% efficient 400V/230V converter for residential networks, which is planned for commercialisation by Schneider. We expect this project to be followed by a further commercialisation phase producing and qualifying the second-generation product and further developing relationships with potential licensees.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132137

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Hybrid PV–battery unit for LV grids using GaN transistors

Early stage, 1/10/16–30/9/17, £298,697

Navarino Electric Systems Ltd, DH3 1QT (SME)
IQE (Europe) Ltd, CF3 0LW (Large)
Aston University, B4 7ET (Research)

This project will investigate the technical and economic viability of a hybrid photovoltaic (PV)–battery unit using GaN (gallium nitride) transistors, which will provide advantages for both the electricity consumer and the electrical distribution network operator. This unit would form a key component of the so-called smart grid and contribute to improving the efficiency, capacity and flexibility of the local distribution network.

Market opportunity

Ernst and Young documented the economic benefits of the smart grid in a report in 2012 for SmartGrid GB, a cross-industry stakeholder group, which informs the Department of Energy & Climate Change (DECC) and Ofgem. The report forecast savings of £19 billion for the UK if it opts for a smart-grid solution over conventional investment. Using smart-grid technology will generate around 9,000 jobs up to 2030, and exports of £5 billion.

Innovation

The innovation is in increasing the penetration of distributed generation (DG) and energy storage through: i) developing a hybrid PV–battery unit incorporating GaN: high-frequency circuit design and control will exploit the capabilities of GaN leading to increased power quality, reduced size and weight and cost benefits; and ii) high power density, for example by integrating power electronics into the battery stack.

Exploitation route

IQE has the capability to design/manufacture GaN devices for the PV and hybrid inverter market. Navarino will design circuits to customise the inverter to the application market. Other components/modules, software and controls for the inverters could be made in the UK (the consortium has existing suppliers in the UK). Assembly/packaging may be performed by IQE or by Turbo Power Systems.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132138
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509954%2F1

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GridDuck – fridge demand response

Early stage, 1/12/15–31/8/16, £78,826

DuckDuck Ltd, W2 2JZ (SME)

This project is a feasibility study for a low-cost system of demand response (DR). DR helps balance out demand peaks and intermittent supply across the National Grid. Our cloud-based wireless solution uses smart plugs and relay switches to turn down heating and cooling devices automatically at certain times. Electricity users get paid (about 10% of electricity costs). Our system is installed by aggregators, who pool electric loads on behalf of the National Grid.

Market opportunity

The global DR market totalled US$1.6 billion in 2014, and the US accounted for 85% of it. In the US, 8% of peak demand can be managed via DR, compared with 1% in the UK. DR equipment spend will grow by 22% per annum to US$1.3 billion in 2024. In the UK, the GridDuck system expands the market from 20,000 business sites to 200,000, and to 2.5 million electrically heated homes.

Innovation

Until now, it was not economical to connect smaller companies and households to demand response systems. But our low-cost hardware and simple software make it possible. We have built a complete proposition around our cost advantage. Wireless communication and our user interface make the system easy to install. The software enables control of each asset, with its own set of rules and over-rides.

Exploitation route

Our target customers are aggregators who sell to businesses. Our product enables them to earn money from demand response. We have demonstrated our system for Short-Term Operating Reserve (STOR) and Frequency Response schemes. We also target energy resellers who sell to households and businesses. Soon they will be able to save money with a variable tariff, by automatically turning down consumption during times when prices are high.

Outcomes and next steps

We have built the core of our system and have trialled it with domestic and commercial loads (fridge, electric heating, uninterruptible power supply (UPS) battery etc.). We are now completing the product in preparation for commercial trials with aggregators and similar companies in the UK and Asia. We are looking for trial partners (from business, housing, academia), and for knowledgeable, well-connected seed investors.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132139

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Metal hydride hydrogen storage tank (TANK)

Early stage, 1/12/15–28/2/17, £180,684

University of Nottingham, NG7 2RD (Research)
ITM Power Ltd, S4 7QQ (SME)
Luxfer Gas Cylinders Ltd, NG4 2BH (Large)
Arcola Energy Ltd, E8 3DL (SME)

This project has developed an innovative pressure vessel, made from metal hydride and lightweight aluminium, with a COMSOL modelled internal thermal management design. This allows hydrogen to be stored in a low-pressure vessel. This is safer and smaller in volume for the same mass of gas than the equivalent 350-bar pressure cylinder currently needed.

Market opportunity

The market for low-pressure hydrogen stores is undeveloped. However, it is estimated that the energy storage industry could grow from US$200 million in 2012 to US$19 billion by 2017/18. Hydrogen energy storage could play a significant role in this market if it can be competitive with other technologies in terms of cost, and if suitable markets for hydrogen can be found, particularly for transport refuelling.

Innovation

Safe, low-pressure, low-cost metal hydride tanks can store large amounts of hydrogen at a low volume. In addition, metal hydride compressors remove the need for expensive and high-maintenance mechanical compressors. An overall decrease in the amount of hydrogen stored at high pressure also effectively reduces land usage due to reduced blast zone requirements.

Exploitation route

The University of Nottingham's metal hydride design and heat management system is currently being shown to be compatible with a standard cylinder manufacturing route with Luxfer. We are developing large-scale storage applications and small-scale business models with ITM Power and Arcola. We envisage a spin-out business, although other routes are being explored.

Outcomes and next steps

The project is progressing well. We have designed, modelled and fabricated the internal architecture in the tank, and the initial fitting tests are positive. The next stage involves validating the modelled performance through hydrogen cycling at electrolyser delivery rates and fuel cell feed rates. After validating the prototypes, the next steps will be to scale up the project further.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132140
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509851%2F1

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Low-cost copper transparent electrode material (LOCUST)

Early stage, 1/12/15–28/2/17, £258,164

Applied Materials Technology Ltd, LN6 3RU (SME)
Cranfield University, MK43 0AL (Research)
Exergy Ltd, CV1 2TT (SME)
Solaris Photonics Ltd, UB7 9EL (SME)

This project is working on the production of low-cost, high-performance transparent conductive electrodes (TCEs) using copper nanowires, for use in solar photovoltaic (PV) cells. TCEs are essential for PV cells, and are currently made using silver and indium tin oxide (ITO). However, ITO is expensive, limited in supply, and tends to degrade in performance under stress, so there is great interest in an alternative technology.

Market opportunity

The copper technology reduces the cost of TCEs by 50% compared with ITO and improves the security of supply, as copper is more geographically diverse and abundant than indium. The global share of non-ITO TCEs is expected to be one-third of the global TCE market by 2017 (£1.3 billion per annum), with an annual growth rate of 8% by 2020.

Outcomes and next steps

The consortium aims to develop low-cost, superior, sustainable copper nanowires-based TCE for solar cells, and explore its application to other devices.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132141
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN50984X%2F1

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Offshore renewable energy cable health using integrated distributed sensor systems (ORCHIDS)

Early stage, 1/11/15–30/4/16, £60,088

Fraunhofer UK Research Ltd, G1 1RD (Research)
Synaptec Ltd, G1 1XW (SME)
European Marine Energy Centre Ltd (EMEC), KW16 3AW (SME)

This project has developed, through a feasibility study, the opportunity to add novel multi-functional monitoring solutions to existing power transmission cables used in the offshore renewable energy industry. The combination of electrical current and voltage sensing capability, alongside cable vibration and motion detection – using standard optical communications fibre – enables operational monitoring and maintenance capabilities not currently available.

Market opportunity

Offshore renewable energy, such as tidal, wave and offshore wind, is an increasingly important part of the UK energy supply. However, there are challenges when it comes to operating in an offshore or marine environment. The cable infrastructure can be vulnerable to being dragged or worn. The transmission capacity can limit the amount of energy taken from a device or device array. Repair of offshore cables or infrastructure is costly.

Innovation

The project is looking to enhance sub-sea cable monitoring capabilities. The innovation is in the combination of emerging optical sensing techniques, which enables a smart cable management system that can be used during manufacture, transport and installation, through to end of life.

Exploitation route

This project is the first step towards a combined smart cable system and it has allowed partners to map out the technical and commercial challenges. The use of optical fibres found within modern power cables as a cable condition monitor, combined with innovative current and voltage sensors, makes an attractive prospect for offshore infrastructure monitoring.

Outcomes and next steps

Outcomes include a system-level design with technical and commercial development plan to fully exploit this technology. This project has led on to a follow-on project also supported by Innovate UK, which starts in early 2017. This will take the technology forward from the test bench through to tests on offshore cables at EMEC's facilities in Orkney and with Systems Engineering & Assessment Ltd (SEA) in Aberdeen.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132142
http://www.emec.org.uk/press-release-orchids-project-to-address-ocean-energy-electrical-infrastructure-integrity/

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Automated spiral-wound pipe for large-scale applications

Early stage, 1/6/16–30/6/17, £298,763

Sustainable Pipeline Systems (SPS) Ltd, SG14 3DW (SME)

Pipelines are the most efficient means of distributing energy in fluid form. However, pipeline fabrication and installation has not changed fundamentally for 75 years. Spiral-wound pipe could transform pipeline construction and enable mobile automated machines to form continuous pipe in the field. This would dramatically reduce transport emissions, eliminate labour-intensive manual welding, and significantly reduce pipeline costs.

Market opportunity

The total annual global market for pipeline construction is estimated as US$52 billion, of which US$10 billion relates to the larger-diameter onshore pipelines that this project addresses. There is unsatisfied global demand for 300,000km of pipelines over the next 10 years and this, together with the UK's gas transmission and distribution network, are the primary markets that we intend to address.

Exploitation route

The route to market is to work on technology readiness with pipeline operators like the National Grid, and to position SPS as a key supplier to the main construction contractors preferred by operators. The business model estimates that SPS can earn sufficient revenue from pipe machine leasing to return the capital cost within 1 year of fully deployed operation.

Innovation

Innovation includes the forming and winding of high-strength steel in mobile units for continuous pipe manufacture. The key is an asymmetric interlocking rib, formed from a flat steel strip, to lock the overlapping steel layers without the need for welding or adhesive. This design enables separate optimisation for chemical and fluid resistance, for example using a low-cost plastic liner.

Outcomes and next steps

The exploitable outputs of the project are feasibility demonstration, initial pipe designs, initial automated machine designs, and an independent cost and emissions benefit study. Patent protection for interlocking spiral-wound pipe is already secured. We are developing a group of 'critical friends' within operators to establish a roadmap dialogue for full commercial implementation on specific projects internationally.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132143

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Odorant removal by chemical looping combustive desulphurisation (ORACLE)

Early stage, 1/11/15–31/10/16, £230,356

Gas Recovery and Recycle Ltd (GR2L), RH1 5DZ (SME)
Department of Engineering, University of Cambridge, CB2 1PZ (Research)
Johnson Matthey (JM) PLC, RG4 9NH (Large)

Distributed electricity generation using stationary fuel cells is recognised as one option for addressing the energy trilemma (energy security, equity and sustainability), by improving the security of supply and reducing emissions in a cost-effective way. This project aims to establish the technical and commercial feasibility of an innovative concept to remove the sulphur odorants that are present in the fuel gas supply and would otherwise poison these fuel cells.

Market opportunity

This technology is estimated to offer at least a 50% reduction on the cost and emissions of current approaches to desulphurisation, and is also applicable to a broader range of fuel compositions. The stationary fuel cell market is projected to grow exponentially over the next 5 years to around £1 billion in 2022. A relatively modest market share will generate significant business opportunities.

Exploitation route

JM is a technology supplier to the fuel cell manufacturers and is well acquainted with the stationary fuel cell market. In conjunction with JM, GR2L will visit manufacturers and seek to win acceptance of CLCD as an improvement on the existing technology. We will also look to exploit opportunities in the biogas market.

Innovation

This technology is based on 2 granted patents held by GR2L, one of the project partners. The project aimed to establish fully the technical feasibility of chemical looping combustive desulphurisation (CLCD), as an improvement on current state-of-the-art technologies in fuel cell applications. A patent on the practical application of CLCD is in progress.

Outcomes and next steps

This project has demonstrated the feasibility of CLCD to remove sulphur odorants from biogas. It is hoped that this can be extended to fuel cell applications using natural gas. Design feasibility of a prototype has been completed. The next steps are to seek funding to construct the prototype unit and install it at customer sites in the fuel cell and biogas processing markets.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132144
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509887%2F1

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Low-cost solar absorption cooling

Early stage, 1/10/15–31/10/16, £127,650

Solar Polar Ltd, PE1 3PA (SME)

This project has focused on modelling the first solar cooling system that is affordable on a domestic and small commercial scale. It is electricity free, and significantly reduces the cost per watt of cooling produced, compared with other solar cooling technology. The project has also involved discovering and quantifying the markets for the solar cooling system and identifying partners to bring the product to market.

Market opportunity

The global air conditioning market was US$80 billion in 2014 and rising. This represents a massive increased strain on electricity supply worldwide and is in opposition to targets for emissions reduction from generation. Our solar cooling system is electricity free and represents a solution to the problem. We aim to target at least 5% of this market.

Exploitation route

We have identified, as part of the project, partners who are in the air conditioning market worldwide and are committed to rolling out our technology.

Innovation

The innovation is the patented (granted) design, which dramatically reduces the cost per watt of cooling produced, compared with other solar cooling technology.

Outcomes and next steps

The project was very successful. It resulted in further investment being raised, as well as a further Innovate UK grant. We have identified a partner who will take the product to market.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132145

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Singlet fission photon multiplier film to increase photovoltaic efficiency

Early stage, 1/11/15–31/12/16, £297,003

Eight19 Ltd, CB4 0FE (SME)
Department of Physics, University of Cambridge, CB3 0HE (Research)

This project will assess the commercial feasibility and demonstrate the technical feasibility of a photon multiplier film, which splits blue and green photons from sunlight into 2 infra-red photons. When used over photovoltaic (PV) modules, the photon multiplier film increases the photon flux striking the module and so can increase the total power generated from silicon modules by up to 25%.

Market opportunity

As the cost of silicon photovoltaics continues to be driven down, manufacturers wish to increase panel efficiency. By including a photon multiplier film within a panel, the efficiency can be increased by up to 4%. In 2015, around 50GWp of silicon panels were produced. If each one contained a film costing US$88 per square metre, the addressable market would be US$2.4 billion.

Innovation

The innovation is the photon multiplier film that is incorporated within solar panels. The film splits photons through a process called singlet fission (SiFi). As the film is passive, having no electrical connections, it is far easier and cheaper to incorporate than tandem photovoltaic layers, such as perovskites, which require complex voltage or current matching and which tend to darken with age, thus reducing the silicon panel efficiency.

Exploitation route

Eight19 will develop the photon multiplier film technology and will either license it to panel manufacturers or will work with their material suppliers to provide the coatings on panel elements that will be integrated by the panel manufacturers. It could also manufacture plastic film coated with a photon multiplier layer, to supply panel manufacturers using its in-house formulation and coating expertise.

Outcomes and next steps

This project has produced a world-first demonstration of a manufacturable coated layer in which photon multiplication is occurring, moving the technology to TRL 3. We have filed several patents. We are seeking new investment to expand the research and development (R&D) effort and further increase the efficiency and lifetime of the film. We are seeking to partner with panel manufacturers, their material suppliers and solar asset owners and operators.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132146
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509929%2F1

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Improved energy efficiency of solar PV systems via low-energy surface coatings (SOL+)

Early stage, 1/11/15–31/1/17, £299,931

Opus Materials Technologies Ltd, CB4 0WS (SME)
Cornelius Specialties Ltd, CM23 5RG (SME); **TWI Ltd,** CB21 6AL (Research);
Loughborough University, LE11 3TU (Research)

This project is focused on the development of a durable super hydrophobic anti-reflective self-cleaning coating for solar photovoltaic (PV) modules. The accumulation of dust or debris on the surface of PV modules leads to a significant loss in the incoming solar irradiance, reducing power output by up to 50%. This project addresses that problem with the development of our coating called SOL+.

Market opportunity

The cumulative global solar PV capacity is expected to be 500GW by 2019. This project has validated the market for a permanent self-cleaning coating for PV modules at a price of £1.50 per square metre. The projections for the first 5 years following commercialisation show £15 million in revenue, and £3.1 million in net profit.

Innovation

The use of nanotechnology makes SOL+ superior to current coatings and manual cleaning or robotic systems. It reduces water wastage and optimises energy yield. It is cost-effective, reduces operation and maintenance (O&M) costs and reduces the risk of cleaning-related damage. By encouraging the wider adoption of solar, it also addresses the energy trilemma (energy security, equity and sustainability).

Exploitation route

We have developed a global customer base for SOL+, including solar manufacturers, EPC (engineering, procurement and construction) and O&M contractors, utility scale operators and developers. SOL+ will be licensed for manufacture to facilitate rapid and wide commercialisation. We also have a supply chain in place for the manufacture and distribution of SOL+, which can operate in parallel with licence deals.

Outcomes and next steps

The coating has achieved the planned TRL 4. We have filed for a patent and trademark and are planning publications for January 2017. Field testing will take place in early 2017 in the Middle East and North Africa region, with test options in South East Asia and South America. Further research and development (R&D) work is ongoing through collaboration projects. Rapid commercialisation of SOL + could benefit from inward investment.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132147
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN510014%2F1
https://vimeo.com/184829760

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Direct carbon dioxide capture

Early stage, 1/11/15–30/11/16, £300,000

University of Cambridge, CB3 0FS (Research)
Cambridge Carbon Capture (CCC) Ltd, CB3 0GT (SME)

Cambridge Carbon Capture is developing technology to capture and store carbon dioxide permanently as a rock. This creates a number of valuable mineral/metal by-products that could more than offset the cost. This project enabled the University of Cambridge to collaborate with CCC to test the feasibility of combining CCC's current 2-step process into a single process, reducing costs.

Market opportunity

Existing carbon capture and storage technologies are struggling to find a business case to justify the necessary capital and operational expenditure needed for widespread usage, forcing the UK government to consider significant incentives. If this project can demonstrate technology that is profit generating (or neutral cost), rapid take-up is likely.

Innovation

Direct carbonation of magnesium hydroxide using flue gas is virtually unknown in the academic or patent literature. An ambient-temperature, ambient-pressure carbonation reactor process based on magnesium hydroxide represents a world first, and CCC has a granted patent for this process.

Exploitation route

Our exploitation route is to develop our technology further through partnerships with end customers and large engineering project partners. We plan to negotiate intellectual property (IP) licensing and form joint ventures, with operating costs being covered by consultancy income on subsequent projects, to develop pilot projects and future profits from IP licensing and joint venture profit share.

Outcomes and next steps

The project successfully demonstrated that carbon dioxide capture is possible in a single process, and reaction kinetics were improved by 600%. Next steps are to seek further funding for technology demonstration through grants and partnering with end customers and/or equity investment.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132148
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509966%2F1

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Syngas and emissions filtration platform technology for cleaner energy

Early stage, 1/1/16–31/12/16, £296,849

Smart Separations Ltd (SSL), N1 7GU (SME)
University of Surrey, GU2 7XH (Research)

SSL has developed an advanced, cost-effective, highly efficient and robust membrane filter to separate micron-sized particles. In this project, we worked on improving the technical side (creating a better and stronger microstructure) and the route to market for particulate removal in energy-generating applications. Successful studies to scrub flue gases from wood-burning stoves have confirmed our initial hypothesis.

Market opportunity

The world market for flue gas and scrubber technologies is forecast to be £38 billion by 2019, with annual growth of 5.1%, and a fabric filter market of £4.7 billion. But this is for filters with numerous drawbacks: low chemical resistance, significant pressure drop, the need for regular maintenance, low temperature and dry feed, etc. Our technology can address these issues, while efficiently scrubbing emissions.

Innovation

Our patented technology is a unique membrane filter with microfiltration pores (<1–50µm). This allows the production of tailored pore sizes, high pore densities and excellent mechanical strength, which can be used to scrub microparticulates (PM_{10}, $PM_{2.5}$) from emissions. A large, stable and flat surface area allows coating with catalysts that can degrade volatile organic compounds, such as carbon monoxide and mono-nitrogen oxides.

Exploitation route

Our membrane filter can be used either in improving room-temperature air quality, or in reducing high-temperature flue gas emissions. We have partnerships with key manufacturers, such as Ahlstrom, and end-user products such as our external investors (one of the world's largest ventilation equipment companies). SSL will produce membranes through a partnership with the Manufacturing Technology Centre, and these will be sold through strategic partners.

Outcomes and next steps

This project was successful in a number of ways: i) new research and development (R&D) facilities; ii) new method to control pore sizes; iii) new one-step coating method for catalysts; iv) successful tests at BSRIA to scrub microparticulates; v) further investment; and vi) moved from TRL 3 to TRL 5. Next steps include developing our manufacturing capabilities to market the membranes as an original equipment manufacturer.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132149
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509930%2F1
http://smartseparations.com/microfiltation

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UAV gas monitoring system for the energy sector

Early stage, 1/11/15–31/3/17, £290,557

British Geological Survey (BGS), NG12 5GG (Research)
QuestUAV, NE65 0PE (SME)

This project is examining the technical feasibility of using small unmanned aerial vehicles (UAVs) to detect and monitor methane. This has immediate application for emissions monitoring (natural and industrial) of shale gas operations, underground gas storage sites and gas pipeline routes. Our approach incorporates novel technology development and is based on a collaboration between the British Geological Survey and QuestUAV.

Market opportunity

Industry forecasts of shale gas well drilling suggest that up to 200 wells per year could be drilled in the UK by 2020, so there is clear scope for a methane monitoring service in the UK. The UAV system will fill a niche in the market between time-consuming on-site point monitoring and expensive monitoring with conventional manned aircraft.

Exploitation route

The primary customers are the energy operators. BGS has the geological and gas emissions expertise, while QuestUAV will produce the UAVs. QuestUAV will seek to capitalise on increased UAV unit sales, and BGS will seek to develop services using the expertise gained. We aim to demonstrate proof of concept to draw investment from stakeholders and potential partners and customers.

Innovation

Innovation on this project includes modifying sensors and their integration into customised fixed-wing UAVs to undertake rapid and cost-efficient site-wide monitoring. Other innovations include the ability to locate the source of the gas release, either by narrowing down its geographical location and integrating with surface analysis, or through novel modelling of concentration and wind speed data.

Outcomes and next steps

The project is still running and we expect to complete our test calibration flights in the near future. These flights will confirm technical feasibility at which point we will look to further funding (and potentially additional partners) for a mid-stage project to bring the concept to market as a service.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132151
http://www.bgs.ac.uk/research/earthHazards/epom/UAVGasMonitoringProject.html

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Thermodynamically efficient heat exchangers (TEHEx)

Early stage, 1/3/16–31/7/17, £287,356

Oxford nanoSystems (OnS) Ltd, OX11 0QX (SME)
Brunel University, UB8 3PH (Research)

The project is the development of a high heat transfer coating and coating system for deposition onto small channelled brazed plate heat exchangers. We implemented testing to observe an improvement and therefore a reduction in the size and material usage of these coated exchangers.

Market opportunity

The heat exchanger market will be worth over US$5.5 billion in 2020, based on technology that has not changed since the 1950s. OnS is focusing on the growing brazed plate heat exchanger market and has achieved major commercial traction by talking to multiple manufacturers.

Exploitation route

OnS is working with major heat manufacturers for the purpose of developing and implementing pilot plants initially, to demonstrate the effectiveness of the coating process, followed by full-scale production.

Innovation

OnS has developed a technology that aims to revolutionise the heat exchanger industry. The technology can be used after manufacture, so no change to existing facilities is needed and it allows for smaller and more efficient units to be created.

Outcomes and next steps

This project has allowed OnS, working with Brunel University, to develop a heat exchanger test rig, which will allow OnS to fully optimise the system ready for commercialisation. The coating moved from TRL 4 to TRL 8, and the results of the project and the commercial traction achieved has allowed OnS to move forward to a new Innovate UK funding round.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132152

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Ultra low temperature battery (ULTB)

Early stage, started 1/7/15, £187,247

Hyperdrive Innovation Ltd, SR5 3NY (SME)
OXIS Energy Ltd, OX14 3DB (SME)

The ultra low temperature battery (ULTB) project will explore the feasibility of high energy density battery chemistry, and innovative packaging and control electronics that will be capable of operating in one of the harshest environments on the planet. Such a battery would allow the British Antarctic Survey (BAS) significantly to increase autonomous scientific measurements, but without increasing transport costs or emissions.

Market opportunity

OXIS Energy will develop the lithium-sulphur (Li-S) chemistry to work at very low temperatures, as the current technology only operates down to -30°C. A high energy density rechargeable battery that can operate at -80°C has applications for Antarctica survey organisations and several other crossover markets for energy storage and unmanned systems.

Innovation

The ULTB project aims to develop two key technologies: a chemistry-agnostic battery management system (BMS) with associated battery packaging, and a Li-S rechargeable battery chemistry, both of which can operate at -80°C. These technologies will provide a light, high energy density battery that BAS can use to power sensor systems across 100 Antarctic sites.

Exploitation route

We expect BAS to write a technical paper on the project work and results, as well as release some public interest articles in the press. OXIS Energy will initially target customers who have a low temperature requirement for their system. The 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=132153

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Steam ejector/water turbine micro-CHP system (WaterGen)

Early stage, 1/1/16–31/12/16, £298,848

University of Nottingham, NG7 2RD (Research)
Ashwell Biomass Ltd, LE4 8AT (SME)
Environmental Process Systems Ltd, PE7 3HS (SME)
Geo Green Power Ltd, NG12 5QT (SME)
Venturi Jet Pumps Ltd, ST3 2QE (SME)

This project developed a micro-CHP (combined heat and power) system using a steam ejector/water turbine to reduce carbon by using waste heat or hybrid sources. It is intended to address the energy supply issues in the UK as a result of its ageing power generation system. Based on existing technology, the WaterGen system could be introduced to address the generating gap and improve supply from the intermittent renewables output.

Market opportunity

The technology is to be introduced into existing large-scale industrial systems where excess generated heat is emitted as waste. These include existing power stations, chemical processing facilities or manufacturing bases. The aim is to build a market of £500,000 in year 1, £2 million in year 2, £5 million in year 3 and £15 million by project completion.

Innovation

The innovation is based on a combination of established systems to form a physical process for generating electrical power from waste heat sources. Currently, a few small-scale CHP units are marketed by companies, including Baxi, E.ON and British Gas, but they are all expensive, use very complex expanders and employ harmful refrigerants. This is in contrast to the simple, water-based WaterGen technology, using easy-to-manufacture parts.

Exploitation route

The business model involves exploiting WaterGen via service providers owning, supplying and maintaining installations, making return on the sales of power and heat to customers and the National Grid. An attractive market route is the manufacturing and operation of self-contained 'skid-mounted' sets in the power range 5–100kW. The project tested a 5kW WaterGen prototype to prove the concept.

Outcomes and next steps

The prototype was built and tested in the project timescales, and was operated with an output optimisation unit. We will present and publish the outputs from this at a scientific conference, once intellectual property (IP) has been formalised. The next step is the upscaling of the prototype in a follow-up project, and the consortium is actively seeking an industrial partner for this.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132154
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509875%2F1

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Low cost Na-ion batteries (LOCONIBs)

Early stage, 1/2/16–31/1/17, £264,678

Queen Mary University of London (QMUL), E1 4NS (Research)
Johnson Matthey (JM) PLC, RG4 9NH (Large)

This project is focused on the use of waste biomass to produce hard carbon anode materials with a cost of £5 per kilogram to use as anodes in sodium-ion (Na-ion) batteries.

Market opportunity

This project addresses the creation of a new generation of electrode materials for Na-ion batteries from biowaste. This will significantly lower the cost of Na-ion batteries and facilitate their commercialisation and competitiveness. The demand for new energy storage devices is around £308 per kilowatt hour, as calculated by the Knowledge Transfer Network return on investment estimation tool. Na-ion batteries will become commercially available by 2020.

Innovation

We have introduced a new way of converting biowaste into hard carbon spheres using hydrothermal processes under mild temperatures and low pressures. We can have good control over the morphology and level of order into the resulting materials. When used as the negative electrodes in Na-ion batteries, our electrodes perform very well in terms of both gravimetric and volumetric energy density.

Exploitation route

Johnson Matthey will be responsible for future commercialisation.

Outcomes and next steps

This project was a feasibility study proof of concept with JM. QMUL was responsive for the production of the anode and JM for the cathode. We have assembled a full cell with good performance for both gravimetric and volumetric energy density. The next step will be the production of battery packs and testing them as domestic stationary energy storage systems.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132155
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509899%2F1

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Electrochemical conversion of nitrogen to ammonia

Early stage, 1/3/16–28/2/17, £299,658

Inorganic Chemistry Laboratory, University of Oxford, OX1 3QR (Research)
Siemens PLC, OX11 0QX (Large)
Science and Technology Facilities Council (STFC) Daresbury Laboratory, WA4 4AD (Research)

This project will demonstrate the feasibility of producing ammonia, an energy vector with multiple applications, in a carbon-free synthesis powered by renewable energy. The study aims to test a lab-scale electrochemical cell for synthesising ammonia at low temperatures and pressures from nitrogen and water. We will do this using electrocatalytic materials selected using state-of-the-art theoretical modelling approaches.

Market opportunity

Ammonia is a commodity and the sole differentiators from the customers/market perspective are price and environmental impact. The business opportunity is to deliver a carbon-free production process for ammonia, which can then be used as a flexible asset for seasonal energy storage, green energy export (e.g. for the transportation sector), and a feedstock for fertilisers and other chemical processes.

Exploitation route

The route to market is through Siemens, as a provider of electrochemical ammonia synthesis plants, control and ancillary equipment. Customers are current ammonia producers, and energy companies with a particular focus on the storage and transportation of renewable energy.

Innovation

This project seeks to develop an electrochemical ammonia synthesis process, at lower temperatures and pressures than the existing (thermochemical) Haber–Bosch process. This will increase the efficiency of ammonia production, particularly when powered by renewable energy, which is inherently intermittent.

Outcomes and next steps

Outcomes include the successful demonstration of the test cell, and identification of electrocatalytic materials. Next steps are to determine if these can be protected with appropriate patents, and conduct follow-on work to optimise their properties further.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132156
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN510026%2F1
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN510038%2F1

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Adding predictive capabilities to photovoltaics

Early stage, 1/11/15–30/4/16, £78,867

Senseye Ltd, SP6 3HY (SME)

This project is to research the feasibility of applying proven technology, performance management and efficiency principles from the aerospace sector to the solar energy sector. This is through prototyping of advanced predictive analytics, leveraging the technical and market innovations provided by the Internet of Things (IoT). The study will have a stakeholder group of solar companies.

Market opportunity

In terms of the specific market identified for this project, 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. Considering the solar energy market alone, this has been forecast to reach about US$137 billion by 2020.

Exploitation route

Senseye for PV will be sold as a 'software as a service' offering, with flexible rentals with increasing levels of predictive capability. Sales will be achieved through brand awareness and direct marketing campaigns. Larger enterprise customers will require bespoke work (e.g. visualisations, sensor installations), which will deliver additional revenue streams.

Innovation

The concepts of integrated operational support, availability and power by the hour business models have proven benefits within aerospace in reducing emissions, improving reliability and reducing costly unplanned maintenance. Powerful predictive analytics can forecast equipment health, spares demands and maintenance scheduling. This project seeks to explore similar solutions for photovoltaics (PV) and the solar energy sector.

Outcomes and next steps

This project will refine the business case for marketing Senseye in the solar market. We will produce a feasibility report to capture the commercial and technical challenges and then develop a concept demonstrator for use in an early trials programme. This will involve 4 to 6 deployments.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132157

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Non-vacuum deposition and metallisation of CIGS solar cells (NOVA-Cell)

Early stage, 1/11/15–31/10/16, £299,857

Precision Varionic International (PVI) Ltd, SN5 5WB (SME)
University College London (UCL), WC1E 6BT (Research)

This project addresses the cost per watt of CIGS (copper indium gallium selenide) solar cells by undertaking a feasibility study to assess the application of novel non-vacuum chemical spray-assisted vapour deposition of CIGS. This application would replace the existing high-cost vacuum-based technologies. In addition, the project will study the application of innovative ESJET printing of fine structure finger copper metallisation to replace expensive screen-printed silver pastes.

Market opportunity

This project is principally designed to accelerate the uptake of CIGS building-integrated photovoltaic (BIPV) technologies. NOVA-Cell supports the UK's Renewable Energy Directive to deliver 15% of our energy demands from renewable sources by 2020. It also supports the UK's High Value Manufacturing agenda by developing the understanding, design and manufacturing of formulated products.

Innovation

UCL's innovation is in improving the low deposition rate by application of a novel non-vacuum chemical spray-assisted vapour deposition (CSAVD) of CIGS. PVI's innovation is in the application of novel ESJET printing of copper metallisation to replace expensive screen-printed silver pastes to increase cell efficiency and reduce the overall cost of the cell per watt.

Exploitation route

PVI will launch a spin-out company dedicated to the development of the photovoltaic application, which will be focused upon the sales of a turnkey CIGS manufacturing system through the CSAVD and ESJET process equipment. We will concentrate on existing solar cell manufacturers looking to move into thin film CIGS, and substrate manufacturers and installers.

Outcomes and next steps

CIGS manufacture has been successful. The ESJET deposition of copper ink has been achieved. Laser sintering on CIGS for copper metallisation has been achieved. Copper diffusion into P-N junction remains the issue. Silver nano-ink and silver ROM inks are being applied as alternatives to copper.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132158
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN510002%2F1

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Integrated whole energy storage with hydrogen (iWESH)

Early stage, 1/11/15–31/1/17, £298,474

ULEMCo Ltd, L3 1BG (SME)
Clean Power Solutions Ltd (CPSL), L40 2QP (SME)
Revolve Technologies Ltd, CM13 1XA (SME)

This is a technical feasibility project to explore the opportunity for an innovative whole system approach to energy storage using hydrogen (H2) generated from renewables. The project has developed a SMART control system to optimise H2 storage, validated a techno-commercial model to assess the value of 'green' hydrogen to displace diesel in dual-fuel vehicles, designed a low-cost refueller, and demonstrated the practical use of recycled nickel-cadmium (NiCad) batteries.

Market opportunity

The whole system solution to energy storage challenges is targeted at grid-constrained sites with access to vehicles, and heated buildings where the hydrogen can be used to increase the use of renewable energy on site, such as business parks, logistics centres and local community energy facilities.

Innovation

The innovation is based on the novel control system, the low-cost refueller design, the practical use of the NiCAD batteries, the real-time validated techno-commercial model and the application directly into dual-fuel vehicles to displace diesel. This is the first real-world UK demonstration of this scale of directly integrated H2 energy storage system.

Exploitation route

ULEMCo will market the technology to address the 'chicken and egg' problem for hydrogen infrastructure, by providing an integrated back-to-base solution for commercial vehicle operators, enabling self-generation of fuel from onsite renewables. CPSL will market the system to investors in renewable generation that have local access to vehicles, where the commercial case is benefited by increased local storage.

Outcomes and next steps

All the components of the system are installed and in use on a daily basis. The farmer uses the H2 in his Ford Ranger, saving money on his diesel. The model has been validated and has helped define some case studies where the whole system approach will be cost-effective. The next step is to demonstrate at a larger-scale site.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132159

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Electrochemical electricity generation using waste water as fuel (SWEETGEN)

Early stage, 1/2/16–31/1/17, £299,729

C-Tech Innovation Ltd, CH2 2HD (SME)
Department of Chemistry, Imperial College, SW7 2AY (Research)

Using an innovative electrochemical device, this project will add value to organic materials dissolved in waste-water streams by generating electricity upon their electrochemical oxidation in a low-cost but high-power fuel cell and simultaneously reducing their organic content thus reducing disposal costs. C-Tech Innovation and Imperial College are co-operating to further develop and scale up this technology.

Market opportunity

Large amounts of waste water contaminated with sugars and other high-energy organic molecules arise from industrial activity in many sectors, including food manufacturing, beverage production, breweries, wineries and biofuel generators. These waste-water streams represent an increasing problem, as expensive and slow water-cleaning procedures are mandatory prior to municipal disposal.

Exploitation route

The product arising from this collaboration would be a modular water treatment technology. Based on current waste disposal costs, the payback is expected to be less than 2 years for industrial customers with suitable waste streams. Further development will be required to produce a product.

Innovation

A low-cost cathode oxygen reduction catalyst has been developed, which is resistant to poisoning by organic molecules. This enables the design of a low-cost high-power fuel cell (15 mW per sq cm) that uses organic molecules as a fuel. Existing technologies are capital intensive with low electrical generation efficiency (anaerobic digestion) or uneconomic (microbiological fuel cells with very low power densities).

Outcomes and next steps

The project has demonstrated: i) the applicability of the technology to a range of real industrial waste waters; ii) the scalability of the core technology (catalyst production and hardware engineering), increasing the TRL level from 2 to 3/4. We have filed for patents. Further development will be required to get to market and this may be undertaken by the consortium as a whole or a spin-off.

Further information

http://gtr.rcuk.ac.uk/projects?ref=132160
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN50998X%2F1
https://www.imperial.ac.uk/energy-futures-lab/research/case-studies/sustainable-power/sweet-sweet-power/

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Wind turbine integrated lidar (WinTIL)

Mid-stage, 1/10/15–31/3/17, £1,352,251

ZephIR Ltd, HR8 1EU (Large)
Fred. Olsen Ltd, SW1P 2NU (Large)
Heason Technology Ltd, RH13 0SZ (SME)

The project will develop the technology for the first generation of lidar systems suitable for integration into wind turbines, so as to provide advance information about the incident wind field across the entire rotor area. This data can then be used to minimise fatigue loads and to optimise energy extraction.

Market opportunity

Since 2000, installed wind capacity has grown at around 24% per year. Costs must be reduced to make wind projects financially viable. A turbine integrated lidar offers this possibility by enhancing understanding of wind characteristics to enable adjustments to turbines. ZephIR aims to capture 0.47% of new turbine installations in 2017, 1.99% in 2018 and 4.99% in 2019.

Innovation

To access the turbine lidar market, systems need to be inexpensive, capable of integration within the turbine and tailored to each turbine. This approach offers benefits over rival technologies, which are inflexible in their integration and specification. This concept allows flexibility across a range of turbines and customer requirements.

Exploitation route

The route to market is to develop the optical heads and associated intellectual property (IP) revenue potential. Heason Technology holds manufacturing and assembly competence, which can be grown to form an effective UK supply chain partner for ZephIR. ZephIR will exploit project outcomes through its direct and partner sales network and client base of 200+ companies.

Outcomes and next steps

Funding from Innovate UK has progressed technology to TRL 7, to demonstrate the value proposition and align the technology to early adopter requirements. Next steps are to explore larger-scale commercial deployments to unlock the full commercial benefit. Commercial contracts will be negotiated with turbine manufacturers and wind farm operators to provide product in significant volumes.

Further information

http://gtr.rcuk.ac.uk/projects?ref=102467

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Advanced industrial manufacture of next-generation MARBN steel (IMPULSE)

Mid-stage, 1/5/16–30/4/19, £1,888,140

Doosan Babcock Ltd, PA4 8DJ (Large); **Alstom Power Ltd,** CV21 2NH (Large); **E.ON Technologies (Ratcliffe) Ltd,** NG11 0EG (Large); **Goodwin Steel Castings Ltd,** ST1 3NR (Large); **Loughborough University,** LE11 3TU (Research); **Metrode Products Ltd,** KT16 9LL (Large); **University of Birmingham,** B15 2TT (Research); **University of Nottingham,** NG7 2RD (Research); **Wyman-Gordon Ltd,** EH54 5BZ (Large)

This project is to develop a novel production route for next-generation MARBN steel pipe and matching weld consumables for use in thermal power plants. Improving the high-temperature performance of MARBN, compared with P91 or P92 steels, will increase plant efficiency, thereby reducing greenhouse gas emissions. It also increases plant availability and minimises the cost of introducing new technology.

Market opportunity

The *International Energy Outlook 2007* predicts that electricity demand will double from present levels by 2030, predominantly from fossil-fuelled plant. The 2007 White Paper on Energy predicts a 20% reduction in emissions through increased plant efficiency. MARBN steel, with 20% improved creep strength over P92, can contribute to increased plant efficiency, through usage in a new plant or modernisation of an existing plant.

Innovation

UK production of MARBN pipe will be a novel combination of casting and extrusion. Weld metal development will take place in parallel to provide a matching weld consumable. Both industrial and academic partners will evaluate the properties of pipe and welded materials, to ensure satisfactory performance and provide data for life management of MARBN material.

Exploitation route

New materials for boilers require evaluation and acceptance by relevant standards bodies. The data from this project will be exploited to strengthen and speed up the case for acceptance of MARBN material for boiler fabrication. Industrial partners (original equipment manufacturers and their clients) will gain advance knowledge of working with MARBN to boost their credentials as suppliers of MARBN material and components.

Outcomes and next steps

The project hopes to increase the TRL status of MARBN material from laboratory material to useable commercial product by successful manufacture of pipe and welded product. Academic partners are planning publications of their work and industrial partners aim to promote MARBN for new build of plant and upgrading/modernisation of existing plant.

Further information

http://gtr.rcuk.ac.uk/projects?ref=102468 ; http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509991%2F1
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509942%2F1 ; http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509978%2F1
http://gow.epsrc.ac.uk/NGBOViewGrant.aspx?GrantRef=EP/N509991/1

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Enabling electrolyser manufacturing capability

Mid-stage, 1/1/16–30/6/17, £882,134

ITM Power Ltd, S4 7QQ (SME)
Gwent Electronic Materials Ltd, NP4 0HZ (SME)
Escubed Ltd, LS23 7FZ (SME)

With the roll-out of hydrogen refuelling stations (HRS) and power-to-gas (P2G) energy storage systems, the requirements for electrolyser production are set to grow rapidly from 2015 onwards. This project addresses the technical challenges associated with manufacturing and scale-up of low-cost polymer membrane electrode assemblies for hydrogen electrolysers, in order to meet international demand.

Market opportunity

ITM Power is the market leader for rapid-response polymer electrolyte membrane (PEM) electrolysis energy storage, which maximises the use of intermittent renewable power. ITM's systems provide zero-carbon hydrogen that can be used as a fuel directly or as a chemical feedstock for alternative renewable fuels. The potential market is huge and this project aims to improve the manufacturing processes to help meet future demand.

Innovation

ITM Power manufactures fully integrated hydrogen solutions that meet the requirements for grid balancing, energy storage and the production of clean fuel for transport, renewable heat and chemicals. This project developed innovative printing inks and processes for the rapid production of large-scale membrane electrode assemblies at low cost, and has scaled this up to production-sized electrodes.

Exploitation route

The technology will be integrated into ITM's international product line. The order of magnitude increase in production capacity will keep manufacturing within the UK, as international demand for renewable hydrogen continues to grow. The cost savings will maintain the UK's competitive advantage and help to develop new markets for hydrogen as a renewable feedstock in the chemical industry.

Outcomes and next steps

Inks and quality control processes have been successfully developed and scaled to production levels, with the additional processes involved in the rapid manufacture currently being optimised. The next stage will involve the production of a pilot-scale manufacturing facility and the newly manufactured products integrated into ITM's electrolyser products for final durability testing before being launched to the market.

Further information

http://gtr.rcuk.ac.uk/projects?ref=102469

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High-resolution printing of solar photovoltaic electrode structures (HI-PROSPECTS)

Mid-stage, 1/5/16–31/10/18, £2,552,883

Precision Varionic International Ltd, SN5 5WB (SME)
Intrinsiq Materials Ltd, GU14 0LX (SME); **Johnson Matthey (JM) PLC,** RG4 9NH (Large); **Pilkington Technology Management Ltd,** L40 5UF (Large); **Queen Mary University of London,** E1 4NS (Research); **Swansea University,** SA2 8PP (Research); **University College London (UCL),** WC1E 6BT (Research)

This project addresses the limited uptake of photovoltaics (PV) due to high investment costs. It does this by developing: novel high-resolution electrostatic jet printing technology, cost-effective copper conductive inks, transparent conductive oxides and fine line copper grid structures.

Market opportunity

Photovoltaics offer clean renewable energy and are well proven, with over 2.5GWp installed in the UK. However, despite substantial installation, unsubsidised PV uptake is still limited due to the high investment costs and slow payback timescales. Therefore, to accelerate the uptake of PV technologies, developments in both the cell efficiency combined with material cost reductions are necessary.

Innovation

Challenges are addressed by developing: novel high-resolution electrostatic jet printing technology to reduce material usage and shading losses; cost-effective copper conductive inks, designed to replace expensive silver pastes; novel transparent conductive oxides combined with fine line copper grid structures to replace expensive indium tin oxide-coated glass.

Exploitation route

The project has two clearly identified exploitation routes, namely within silicon PV manufacturing, for the application of fine copper grid structures for transparent conducting oxide (TCO) enhancement and for the direct application in thin film PV. The supply chains for each of these routes are understood and the post-project exploitation activities and benefits for each industrial partner have been identified.

Outcomes and next steps

Project is at an early stage.

Further information

http://gtr.rcuk.ac.uk/projects?ref=102470
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509905%2F1
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509917%2F1

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Low-cost storage of renewable energy

Mid-stage, 1/10/15–31/10/18, £1,962,337

Faradion Ltd, S1 4DP (SME)
Moixa Technology Ltd, SE1 3LY (SME)
WMG, University of Warwick, CV4 7AL (Research)

Faradion, the innovator of sodium-ion battery technology, is partnering with smart energy storage specialists Moixa Technology, and WMG, University of Warwick to develop sodium-ion (Na-ion) cells. These are a low-cost alternative to lithium-ion batteries for solar energy storage.

Market opportunity

Faradion's technology could make solar storage more accessible, opening up the possibility of domestic renewable energy storage to a greater number of households and businesses worldwide. Developments in this area could lead to a reduction in carbon dioxide emissions of 500,000 tonnes per year. This market is cost-sensitive and the potential value is at least US$300 million per year for off-grid and domestic storage.

Innovation

Cells based on sodium-ion technology can deliver long cycle lives (>2000 cycles) and can reduce the costs of storage by 25–30%. Sodium-ion materials are significantly cheaper than their lithium equivalents and materials comprise 41% of total long-term battery costs. Sodium-ion raw materials are available in much greater amounts than lithium materials so the technology is more sustainable than lithium-ion batteries.

Exploitation route

Faradion will license the technology to cell and battery manufacturers worldwide. Moixa will have the opportunity to acquire low-cost sodium-ion batteries for global supply to build its next-generation batteries. It will also commercialise the Na-ion batteries for the UK residential energy storage market and therefore enhance the return on investment of private customers investing in solar panels.

Outcomes and next steps

The project is moving along the planned milestones, with the manufacturing and testing of Na-ion cells to be integrated into the Moixa design battery.

Further information

http://gtr.rcuk.ac.uk/projects?ref=102471
http://gtr.rcuk.ac.uk/projects?ref=EP%2FN509863%2F1

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Notes

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