Results of Competition: Catalysing Green Innovation: Strand 1, Advancing PEMD Supply Chain

Competition Code: 2006_ISCF_CRD_MMM_DER_S1

Total available funding IS £5,750,135

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
WAVEDRIVES LTD	Industrialisation investigation for Wavedrives' radical magnetically geared electric actuator	£161,819	£113,273
University of Bristol		£62,932	£62,932

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
Use the Competition Code given above to search for this competition's results

Project description - provided by applicants

Actuators convert energy into force and movement, for moving or controlling things. They exist in all shapes and sizes within just about every mechanical device. Automation, specificity and pervasiveness of modern technology has increased this already huge global market while also creating a requirement for more sustainable, lightweight and powerful actuators. For example, energy efficiency requirements are driving electrification in aerospace and automotive sectors; logistics and manufacturing are becoming fully automated within low-powered smart facilities; and the distinction between therapeutic robotics and prosthetics is becoming increasingly blurred. However, it is becoming clear that existing mature, power-hungry technologies are not able to evolve to meet these new challenges, due to fundamental design limitations.

In response to market need, WaveDrives has developed a radical electric actuation technology, motivated by two decades' experience developing commercial robots and powered prosthetics. Inspired by the structure and performance of human muscle, their **_S_**arcomere **_I_**nspired **_L_**inear **_A_**ctuator(**_SILA)_**, is more controllable and efficient than comparable technologies because its contactless transmission has no energy wasted due to friction. WaveDrives has built up an impressive array of partners who are evaluating the embedding of SILA within their products and systems.

Early indications are positive, however **_SILA_** is an advanced prototype; time-consumingly manufactured by highly-trained engineers. Increasing manufacturing productivity is now business critical. In this project, WaveDrives and an interdisciplinary team from the University of Bristol will combine forces to industrialise SILA manufacture. We need to develop new automated manufacturing technology for **_SILA_**'s novel magnetic components, taking us beyond the industry SOTA which is still manual assembly. We also need to understand how manufacturing tolerances in these assemblies affect actuator performance and evaluate relevant new manufacturing methods.

Project results will accelerate **_SILA_** industrialisation. Other benefits include seeding new avenues of scientific research and informing research-based education at the University of Bristol. It provides knowhow on automation methods for potential UK exploitation in other high-tech magnetics applications.

Specifically, the project will help secure WaveDrives' first UK manufacturing partner(s), providing a UK-patented competitive technology to support long-term business growth for that manufacturer and supply-chain. Further economic benefits would accrue through innovative and competitive products adopting **_SILA_** technology and to product users, e.g. of innovative powered prosthetics, more environmentally sustainable transport and more energy efficient logistics.

Thus the project lies at the heart of establishing the UK as"a global leader in the manufacture of core technologies which underpin electrification"(ISCF DER challenge \[[URKI][0]\]).

[0]: https://www.ukri.org/innovation/industrial-strategy-challenge-fund/driving-the-electric-revolution/

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
RAD PROPULSION LTD	PMD Rim Drive Propulsion Technology Manufacturing in the Marine Market	£215,848	£151,094
INETIC LIMITED		£231,799	£162,259
NCC OPERATIONS LIMITED		£50,487	£50,487

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
Marine propulsion is a multi-billion pound industry undergoing a rapid change from direct drive diesel and petrol to electric. To support this change there is an urgent need for innovative electric propulsion systems like those being developed by RAD. The technology that RAD has developed is safer (no external rotating blades), more robust to becoming entangled with debris and has minimal moving parts. Reducing product and manufacturing complexity and costs are critical if such a product is to fill this current gap in the marine UK PEMD market. This is a collaborative project between RAD Propulsion Ltd, iNetic Ltd and the National Composite Centre. The team will undertake industrial research targeted at significantly reducing Bill Of Material (BOM) costs, improving manufacturability and enabling early life product monitoring of the PEMD element of the marine rim-drive hubless propulsion system that RAD has developed. This project is focused on the manufacturing element of our products PEMD technology and so directly underpins the UKs move towards electrification and is a key step in Driving the Electric Revolution Electric rim drives and hub-less propellers are not new technologies but the merging of the two together into a single product to achieve the levels of performance needed in the target market means its introduction will be transformative to the marine market in the sub 50kW power range. The operating environment, the required manufacturing tolerances and the performance demands placed on the product in this market introduces specific technological /manufacturing process challenges that this project will address, namely: * the hydrodynamic drag effects from the motor housing are critical if the required boat speed is to be achieved. * the rim drive and the materials its manufactured from must withstand submergence in salt water for prolonged periods Our product not only opens the way to a huge new market sector but is a stepping stone towards the introduction of green technologies into a sector that is traditionally dominated by fossil fuel engines. There is clear commercial opportunity and conservative analysis indicates that the current global electric propulsion market in this size range is ~£150-200m/year with strong indications of growing to £1.5Bn+/year over the next decade. We have assembled a strong and experienced project team consisting of RAD Propulsion Ltd (Lead Partner), iNetic Ltd (motor supplier) and are supported by the National Composite Centre (NCC) who will provide specialist materials and manufacturing expertise in the use of composite materials.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
RIFT TECHNOLOGY LIMITED	RIFT 10-30 kW EV motor - Manufacturing Readiness and Supply Chain development (RIFT-MaRSC)	£278,585	£195,010
University of Warwick		£83,178	£83,178

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
Use the Competition Code given above to search for this competition's results

Project description - provided by applicants
Developed by RIFT Technology Ltd, the RIFT 10-30 kW integrated machine and power electronics (RIFT-10) is an innovative approach to an ultra-efficient Electric Vehicle (EV) motor, bringing forward a unique range of advantages including: significant weight reduction (circa 50%); lower cost; plus various other features that combined results in a range increase of up to 75% along with other benefits. Several patents protect the innovative RIFT array design, which since 2014, has been established as an electric machine for valve actuator products at our sister company: RIFT Actuator in their line of industrial actuators. During a 2019/20 NVN (Niche Vehicle Network): Production Readiness project, we have advanced our novel RIFT-10 design to TRL7 (Technology Readiness Level) and production readiness to MRL5-6 (Manufacturing Readiness Level). The performance results gained to date validate the design and evidence the vehicles light weighting potential. Our next core milestone is to advance RIFT-10 production readiness and refining the supply chain to enable initial sales of trial units that then would fund future development or at least advance the technology position to allow further possible investment. Today, in the industry, most EV motor components are imported from Asia. For UK manufacturers to compete, it is necessary to decrease the production labour required in manufacture. During this project, we will advance RIFT-10 to MRL7 -- accelerating us closer to market integration. This will be achieved by making Design for Manufacture (DfM) advancements, reshoring our supply chain to the UK, and advancing our UK production capacity to be able to produce 300 units p.a. at a low production unit cost of £2,000 /unit. Innovation is expected in the development of the supply chain to supply the bespoke components required for the novel design, the DfM of RIFT-10 and in the production process. Warwick Manufacturing Group (WMG) is active in the improvement of supply chain and manufacturing competitiveness. The collaborative partnership of RIFT and WMG bring together innovation, supply-chain/production expertise, customer knowledge and route to market. Our initial target market is the SEUV market (Small Electric Utility Vehicles) i.e. golf-buggies, airport vehicles, passenger shuttles, industrial burden carriers, etc. RIFT-10's intended first adopter: BradshawEV is a UK, SEUV OEM that currently import Siemens motors manufactured in China. We identify commercial opportunity to manufacture motors in the UK, leveraging a UK focused supply chain, to supply Bradshaw with a solution that is cheaper, more efficient, smarter, lighter and more compact.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
HYPROMAG LTD	REAP - Rare-Earth Extraction from Audio Products	£42,860	£30,002
EUROPEAN METAL RECYCLING LIMITED		£137,083	£68,542
University of Birmingham		£76,201	£76,201

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
Rare earth magnets based upon neodymium iron boron (NdFeB) are a key material in electric vehicles where they are used in drive motors,generators, power steering and in loudspeakers. In recent years the supply of rare earths has come under considerable constraint from the main producer, China. Recycling of rare earth magnets presents a significant opportunity and REAP aims to develop a recycling supply chain for the loudspeaker market. REAP (Rare-Earth Extraction from Audio Products) will investigate novel ways of liberating rare earth magnets from automotive and consumer audio modules. EMR will pre-process automotive and flat screen TV loudspeaker scrap to provide a feed of scrap components containing NdFeB magnets to HyProMag Ltd. HyProMag will evaluate a patented process in conjunction with the University of Birmingham to extract the magnets as a demagnetised alloy powder, which can be used in the remanufacture of magnets. The quality, quantity, availability and value of the scrap will be determined for speakers from various sources and a calculation of value added to the scrap will be made. The short loop recycling processes which are being developed by Hypromag Ltd will have a significant environmental benefit compared to primary production of magnets.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
INEX MICROTECHNOLOGY LIMITED	M-PowerD - Manufacturing PSJ GaN Power Devices in the UK	£363,162	£254,213
COMPOUND SEMICONDUCTOR APPLICATIONS CATAPULT LIMITED		£27,021	£27,021
University of Sheffield		£98,615	£98,615

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants

M-PowerD -- **M**anufacturing PSJ GaN **Power D**evices in the UK

This is a project to build capability in the UK's only commercial GaN fab, INEX Microtechnology Ltd, to manufacture the world's first, low cost, high voltage GaN power transistors. Our project aims to develop a polarisation super-junction high electron mobility transistor (PSJ HEMT) and process wholly in the UK. We will use this project to build a low cost bi-directional 3kV GaN PSJ HEMT.

Gallium Nitride (GaN) is a semiconductor like silicon, but it can be used to make higher performance power transistors than silicon. Silicon carbide is another high-performance semiconductor, but GaN has greater potential for cost reduction.

PSJ technology is a patented break-through concept for GaN developed in the University of Sheffield with Powdec of Japan. This concept enables ultra-high-performance power devices that have been proven to achieve more than 3x higher voltage than existing GaN technologies.

We will use the PSJ technology to make bi-directional transistors. Bi-directional transistors can switch AC more efficiently and at lower cost than the conventional approach using two transistors back-to-back. Bi-directional transistors are not available commercially at present, so our project will be a key enabler for new power electronics, machines and drives (PEMD) applications. Our initial target application will be for a smart power grid to replace the UK's ageing infrastructure.

There are three partners in the consortium:

The **University of Sheffield (UoS)** who will design the device, and wafer and will work with INEX to develop the process and publish the results.

INEX **Microtechnology Limited** who will develop their power GaN processing capabilities to manufacture test structures and complete wafers of these PSJ GaN HEMTs. This capability will place INEX as world class manufacturing facility for power GaN.

The **Compound Semiconductor Applications Catapult (CSAC)** who will define target applications for these devices, test the completed parts and publish the results.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
SG TECHNOLOGIES LIMITED	Improved Loss Modelling of SMC Components	£194,613	£116,768
Newcastle University		£68,914	£68,914

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
From a manufacturing perspective, powdered metal has the potential to deliver cost effective manufacture for high volume parts in electric motors. Soft Magnetic Composite SMC is an iron powder that can be compressed into component parts. Each individual iron particle is magnetically isolated from its neighbours, preventing the flow of eddy currents which cause iron loss. The resulting component is isotropic, meaning it has the same magnetic properties in all directions. This gives the edge over conventional motor constructions, which are constrained to operate in two dimensions as they require the use of laminations to prevent eddy currents. The use of SMCs thus has the potential to offer cheap high performance electric motors compared to laminations. Unfortunately, calculation of the exact iron loss associated with each SMC motor component is challenging as it is a function of the temperature, pressure and geometry used in the pressing process and the shape of the component itself. Data provided by SMC suppliers and used by machine designers to model losses are based on measurements of a single standard SMC ring. The result is that losses measured in real SMC machines can vary from those predicted using design software. Conventionally, expensive prototyping is an integral part of SMC motor development. This is a huge barrier to the widespread adoption of SMCs, as loss mechanisms in laminated machines is better understood. In this project, academic loss modelling capability is combined with component pressing expertise in order to provide a flexible loss prediction method. This will allow motor designers to confidently design low loss high efficiency electrical machines and promote a dynamic UK supply chain with an improved time to market.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
CUSTOM INTERCONNECT LIMITED	GaNSiC	£201,774	£121,064
COMPOUND SEMICONDUCTOR APPLICATIONS CATAPULT LIMITED		£85,870	£85,870

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
Project GaNSiC (Gallium Nitride Silicon Carbide) will develop a unique manufacturing process for electronic devices based on Compound Semiconductors (CS). Next-generation electronic devices will be based on technologies such as GaN and SiC which enable processing speeds up to 100x faster than silicon transistors. GaNSiC will develop an ink jet/direct dispense manufacturing process that deposits a silver sinter paste onto pre-populated circuit boards to provide a suitable die-attachment method meeting CIL's mechanical and thermal efficiency requirements. Focus of the innovation will be given to the following: (1) Process Development: using existing material jetting hardware within CIL, GaNSiC will demonstrate the feasibility of an automated manufacturing process that can selectively place silver sinter paste onto pre-populated circuit boards and (2) Quality & Validation: This technology will be used by demanding industries who will require evidence that the die attach layer is of a sufficient quality. This will be achieved using X-Ray, CSAM, SEM, FTIR and EDX imaging and comprehensive thermal and dynamic testing. GaNSiC brings together experts in electronics manufacturing, material jetting and SiC/GaN device design. GaNSiC will quickly develop a required manufacturing process that will readily be commercialised as it would meet customers' requirements. It will enable both SiC and GaN arrays to be incorporated into mixed technology products enabling the development of next-generation SiC and GaN products. This innovation will result in an entirely unique SiC and GaN die attach capability in the UK, if not globally.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
TIME TO ACT LIMITED	Development of Coil Winding and Magnet Assembly Manufacturing Processes for a Ferrite Based Permanent Magnet Generator	£447,115	£312,980
University of Warwick		£52,884	£52,884

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
The UK has set an ambitious target to increase its offshore wind capacity to 30GW by 2030\. However, to achieve this target, it is reliant on imported wind turbines. The Covid-19 pandemic has highlighted this dependency and vulnerability to disruption, particularly in terms of the supply of critical raw materials, such as rare-earth magnets. For these reasons, it is of strategic importance that the UK develops its own wind turbine supply chain to meet its renewable energy targets. This would significantly reduce exposure to market risks, whist simultaneously supporting the development of its own manufacturing sector. GreenSpur believes it has a solution that will catalyse the development of a new UK wind turbine generator supply chain. All wind turbine Permanent Magnet Generators (PMGs) use conventional designs that rely on one key material, rare-earth magnets. GreenSpur, a Time To Act subsidiary, has invented and patented a new and highly innovative approach, with a PMG that substitutes scarce and expensive rare earth magnets for cheap and abundant ferrite magnets. The global wind turbine market currently uses large volumes of rare-earth magnets, materials almost exclusively sourced from China (\>80%), with supply shortages forecast from the mid-2020s onwards (Roskill). GreenSpur's innovation can eliminate this supply chain risk, which will prove crucial in the coming years and decades. The long-term vision of GreenSpur's project is to stimulate the development of a UK supply chain and manufacturing network that can build multi-MW generators for the UK wind market. This project follows on from two successful projects; (i) a 250kW prototype testing at Blyth in August 2019 validating the technology and manufacturing processes and (ii) a 'Business-led innovation in response to Covid' project, to identify potential UK based manufacturing and engineering partners to support the commercialisation of GreenSpur's technology. GreenSpur has now successfully identified several UK manufacturers. This project aims to develop: (i) the manufacturing processes to pre-production rates for: a.the unique aluminium strip coils, b.the magnetization of large magnet assemblies supporting multi-MW generator configurations (up to 5MW), and (ii) a production line monitoring system to verify key coil design specifications. This project is in collaboration with established partner, Warwick Manufacturing Group (WMG) and will be supported by specialist manufacturing subcontractors. The project will improve GreenSpur's manufacturing readiness level in support of supplying rare-earth free generators to the UK wind turbine market by the mid-2020s.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
SPTS TECHNOLOGIES LIMITED	SOCRATES - SilicOn Carbide tRAnsistor Trench procEsS (SOCRATES)	£64,966	£32,483
COMPOUND SEMICONDUCTOR CENTRE LIMITED		£34,467	£17,234
CS CONNECTED LIMITED		£15,012	£10,508
Newport Wafer Fab ltd		£50,431	£25,216
Swansea University		£64,979	£64,979

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
SOCRATES will introduce silicon carbide (SiC) and GaN trench processing technologies to the UK, establishing a critical capability into the PEMD supply chain for power transistors. This 9-month project will define the critical semiconductor manufacturing processing steps required for introducing a disruptive SiC power MOSFET supply chain for automotive power electronics to the UK, aligned with the goals of the Driving the Electric Revolution (DER) initiative. We will establish a new UK SiC manufacturing capability - developing Trench MOSFET technology within the Materials and Components DER Centre and critically, pilot SiC trench etch processing, whilst also developing a backside SiC etch process module for future VGaN-on-SiC devices. Current SiC diodes and transistors are still based on planar devices commercialised in 2001 and 2011 respectively -- which are limited in terms of efficiency and reliability. The proposed trench technology will revolutionise the performance of SiC transistors, with lower on-state resistances, and enhanced energy efficiencies -- to be employed in automotive systems. VGaN-on-SiC devices will further drive performance and costs advantages. This project intervention will accelerate their development at little additional cost. This project addresses clear gaps in the PEMD UK supply chain; The lack of (1) a trench SiC power MOSFET process and (2) a high-volume supplier of SiC transistors for UK EV industry, with no current UK-based, high-volume 6"-8" SiC wafer fabs. In contrast, our international competitors are establishing key strategic PEMD links, in order to supply SiC devices to the future EV market; Infineon with Hyaundai, STMicroelectronics (already producing 4000 wafers per month) with Tesla and XFab with General Motors and Ford. Thus, the UK is in danger of losing its security of supply of this crucial technology to the UK automotive sector.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
RICARDO UK LIMITED	UK-Alumotor	£176,191	£88,096
ASPIRE ENGINEERING LIMITED		£84,084	£58,859
C.BRANDAUER & CO. LIMITED		£42,799	£29,959
GLOBAL TECHNOLOGIES RACING LIMITED		£54,722	£32,833
PHOENIX SCIENTIFIC INDUSTRIES LIMITED		£60,000	£42,000
University of Warwick		£80,000	£80,000

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Funders Panel Date: 25/08/2020

Project description - provided by applicants
UK-Alumotor, supported by Driving the Electric Revolution (part of the Industrial Strategy Challenge Fund), will develop a dedicated supply chain to manufacture a patented electric machine (e-machine) which will exploit UK-based high-value manufacturing technology. The e-machine will leverage specialist material, transferring technology developed within the aerospace & motorsports sectors, together with commodity materials. The e-machine will make use of aluminium & iron, rather than copper and rare earth metals (used in permanent magnet motors) which suffer price volatility and import tariffs. This provides the UK supply chain with competitive advantage to fulfil the growing market demand for traction e-machines during the next decade and beyond. The UK-Alumotor consortium, led by Ricardo, is a diverse team of partners from across the UK in conjunction with non-grant claiming OEM stakeholders McLaren and JCB. Our manufacturing partners Aspire, Brandauer, GTR and PSI will assess, select and develop low-cost, lean manufacturing processes that can be scaled to deliver the e-machine at appropriate volumes. These scalable processes will ensure quality, minimise material waste together with the lifecycle assessment impact of the e-machine. JCB and McLaren will provide application sector feedback to the supply chain throughout the work, ensuring that the product meets the specific needs of the performance sports car and off-highway markets. By aligning our approach to application requirements, we ensure the final "design for manufacture" product remains suitable for adoption into multiple sectors including aerospace, marine and rail. Our academic partner WMG will support the programme through literature review, technical workshops and dedicated advisory work. They will deploy learning from the programme to improve their e-machine models in support of virtual validation. The lifecycle impact of the product will be considered throughout the supply chain. Using widely available, and recycled, metals within the e-machine will reduce the lifecycle impact of the e-machine compared with permanent magnet-based motors. UK-Alumotor is a transformative programme that will build a UK supply chain to deliver a high performance, e-machine at a reduced cost and volume in order to drive the electric revolution, both within the UK and the export market.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
CLAS-SIC WAFER FAB LIMITED	SiC-MAP	£404,276	£282,993
COMPOUND SEMICONDUCTOR APPLICATIONS CATAPULT LIMITED		£88,455	£88,455

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
Project SiC-MAP, **S**ilicon **C**arbide **M**OSFET **A**pplications unlocked by **P**DK, takes the 1200V planar SiC MOSFET process, which Clas-SiC is developing, and develops it further to include 1700V and 3300V capability. Once the 1700V and 3300V capabilities have been demonstrated, SiC-MAP will then go on to extract relevant electrical parameters from the fabricated SiC MOSFET's (including reliability) along with design and layout parameters, into a Process Design Kit (PDK) (a PDK is quite simply a menu of options which the designer can choose from to construct his device, along with a set of limitations he must abide within so that the device can be feasibly fabricated and be expected to pass basic reliability testing). The PDK will then be made generally available such that customers with a custom power device requirement can use this PDK to define their device which can then be fabricated at Clas-SiC Wafer Fab in Scotland using standard design elements, process modules and processes. Having a PDK available for SiC power devices is not an option which is known to be available in commercial SiC power device foundries (but it is a very common practice within the silicon integrated circuit industry). The lack of a PDK means that customers are limited to selecting standard devices off the shelf, from manufacturers such as Cree or Infineon, or commissioning a custom product of their own design, which can be lengthy, expensive, and not without risk. Innovation lies in Clas-SiC's PDK which will initially enable customers to have 1200V SiC MOSFET devices tailored to their specific requirements using established design elements, modules and processes which have had basic reliability proven. For the customer, this will de-risk and shorten the time to market for New Product Introduction (NPI).

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
HAYWARD TYLER LIMITED	Development of PEMD for Nuclear Coolant Systems	£272,992	£163,795
University of Sheffield		£86,409	£86,409

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Project description - provided by applicants
In support of broader UK Government objectives toward electrification and net-zero carbon, nuclear is seen as a critical part of the government's plans for future clean electricity generation. The next generation of nuclear reactors has regulatory requirements to deliver primary reactor machinery and components built from low and zero cobalt metal alloys. The UK supply chain lacks experience in these materials. This project includes the design and supply of electric pumping machinery, forming part of the primary nuclear safety systems of upcoming Small Modular Reactors, with specific consideration for UK capability in low and zero cobalt metals. This project, a collaboration between Hayward Tyler and the University of Sheffield's Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC), will support initial conceptual design through to a theoretically proven drive system design specifically to target Small Modular Reactor Cooling Pumps. Aspects of the design require comprehensive analysis and simulation to ensure the design is robust enough for the application and life span requirements. The experience of Hayward Tyler and the manufacturing innovation expertise at Nuclear AMRC will be used to deliver a design optimised for manufacture while maintaining the quality expected of the nuclear sector. The supply chain for this product is not established in the UK due to its infancy and strong competition from outside of the UK market. This project aims to leverage Nuclear AMRC's existing supply chain relationships and detailed supplier database to better understand current UK capabilities. The knowledge and experience acquired during this project will provide a framework to engage with UK suppliers on specific product designs facing the same issue, with the overall goal of establishing a motivated UK-based supply chain that is suited for future nuclear applications. By delivering this project Hayward Tyler and Nuclear AMRC can demonstrate a process and route to product development that meets quality and regulatory expectations of new nuclear plants. This process can be reapplied to achieve a greater proportion of UK content in future reactors and will capitalise on the expected growth in the UK and international nuclear markets. The forecast electrification in the UK to achieve the net-zero carbon emission targets will see huge investment in many different low-carbon generating technologies, including the nuclear sector. A thriving UK nuclear supply chain is the best way to deliver the planned nuclear new build capacity and to ensure the investment translates to value for the UK from manufactured content and jobs.

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Results of Competition: Catalysing Green Innovation: Strand 1, Advancing PEMD Supply Chain

Competition Code: 2006_ISCF_CRD_MMM_DER_S1

Total available funding IS £5,750,135

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
ZF Automotive UK Limited	Moto - Supply-chain Talent Accelerating Revolution (Moto-STAR)	£305,327	£122,131
ROMAX TECHNOLOGY LTD.		£123,500	£61,750
ROYAL ENFIELD UK LIMITED		£10,172	£5,086
University of Sheffield		£59,831	£59,831

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Project description - provided by applicants
[Back to application overview][0] **Moto - Supply-chain Talent Accelerating Revolution (Moto-STAR)** This project brings together a strong partnership comprising: • UK-based motorcycle manufacturer Royal Enfield • Tier-1 PEMD-based automotive system supplier ZF Automotive UK Limited • World-leading supplier of simulation software for mechanical and electromechanical drivetrain analysis Romax • The Electrical Machines and Drives group at the University of Sheffield As part of the automotive electrification challenge and industrial strategy, the potential advantages of electric two-wheeled vehicles -- e-motorcycles and e-scooters -- are well documented: reduced noise, reduced emissions, reduced?weight,?versatility for congested city-centre transportation, etc. The UK e-motorbike supply chain this project addresses is an emerging one: despite the existence of actual products and concepts, many aspects still remain to be addressed in the emerging supply chain for e-motorbikes: technical issues such as range, charging time, choice of components and?materials (e.g. battery type), system integration options, etc.; high initial product cost; lack of automotive electrification infrastructure; and so on. But these issues also present an opportunity: the opportunity, in addressing them, of simultaneously addressing the wider?issues to do with future sustainability -- in all its aspects. Through this project, the partnership seeks to develop a demonstration e-motorbike concept, based around a vision of a future supply chain. Based on aligned design and manufacturing processes that fully embrace the wider issues which are at the heart of DER -- sustainability, improved quality of life, and the future circular economy, both in the UK and beyond: and doing this in a way that -- and doing this in a way that allows engineering students the opportunity to undertake their final year projects in parallel with the live development work ongoing within the partner companies -- which also begins to address the need for developing young, highly skilled PEMD specialists in the UK. [0]: https://apply-for-innovation-funding.service.gov.uk/application/77801

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
SUPPLY DESIGN LIMITED	CoolSync	£255,343	£178,740
COMPOUND SEMICONDUCTOR APPLICATIONS CATAPULT LIMITED		£91,034	£91,034

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Project description - provided by applicants
Project **CoolSync's** vision is to develop an innovative **GaN** **based Rectifier Cooling unit** by applying Design for Manufacture principles. For datacentre market CoolSync offers energy and space savings on the datacentre floor (reduced costs) and an increase in power quality. CoolSync is applicable to PEMD sectors including Industrial, Energy and Maritime. The GaN drives and packaging is also expected to suit e-mobility sectors, industrial drives, Aviation and Space. The main technology objective is developing a solution demonstrating application understanding in **UK PEMD** supply chain to enable short-term commercial exploitation within approximately 5 years and to establish a robust foundation for longer term industrial engagement for a future generation of cooling techniques. For this project the consortium is formed between the industry partner **Supply Design (SD**), who will provide the Power Electronics design expertise for the electronic design and the RTO, **CSA Catapult (CSAC)** who will offer expertise in advanced PCB modelling and simulation and Thermal modelling & analysis techniques.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
S2S ELECTRONICS LTD	Recovery of Gallium from Ionic Liquids (ReGaIL)	£45,483	£31,838
E.C.WILLIAMS LIMITED		£39,324	£27,527
ENVAQUA RESEARCH LTD		£120,346	£84,242
HSSMI LIMITED		£100,320	£100,320
INSTITUTE OF MATERIALS FINISHING		£15,661	£10,963
RECOLIGHT LIMITED		£14,602	£10,221

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
Recovery of Gallium from Ionic Liquids (ReGail) aims to develop a recovery process of Gallium from bulk sourced end-of-life (EoL) LEDs to supply the uptake of Gallium Nitride (GaN) semiconductors in power electronics, machines, and drives (PEMD). The work in developing this EoL process will also lay the foundation for upscaling EoL recovery of GaN in PEMD. GaN is mostly used in LEDs but are increasingly being adopted by PEMD due to their superior qualities as semiconductors compared to its silicon counterpart. GaN has a wider band gap, switches faster, loses less heat and takes up less space. These qualities make it very desirable as a transistor for all sectors of interest (aerospace, automotive, energy, industrial drives and robotics, maritime, off highway, and rail), making it a desirable material to urban mine and build a UK supply chain for. The innovation is to create a circular sourced supply chain of Gallium in the UK. Building on established recycling methods and expanding it to encompass bulk sourced EoL LEDs. The recovered Gallium will then be used in new GaN transistors for PEMD, creating a sustainable supply chain, avoiding virgin mining, increasing the UK's supply chain resilience, and laying the foundation for establishing the EoL recycling process for PEMD. The project will analyse the current gallium recycling and LED end of life practices, will subsequently optimise the pre-treatment, demonstrate electroplating, and simulate the entire process. The impact of the process will be assessed with recommendations and a business plan provided. The findings will then be exploited and disseminated by a professional association.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
PERFORMANCE PROJECTS LIMITED	Design for manufacture of integrated e-hubs for agricultural vehicles	£337,901	£236,531
ARWAC LIMITED		£19,991	£13,994
PRINTED MOTOR WORKS LIMITED		£101,244	£70,871
SAGA ROBOTICS LIMITED		£19,934	£13,954
University of Lincoln		£19,933	£19,933

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Project description - provided by applicants
Rapid advances are being made in the world of agritech, which is itself driving demand for integrated electric hubs (e-hubs) to provide the speed, torque, efficiency and durability required. The project aims to drive the electric revolution by undertaking design for manufacture, integrating the motor, gearbox, brake and controller modules into a single unit designed specifically for agritech requirements. The product design will be available in a range of power outputs, and thus will facilitate scaling up and easy adoption by a multitude of vehicle and robot manufacturers. Key to the project will be a close working relationship with two original equipment manufacturers with different agritech applications. These relationships will confirm duty cycles and running requirements, optimise the relationship between the gearbox/hub design and motor design, and focus the design for manufacture/scaleup. As part of the design for manufacture, an assessment for automation will also be performed. The project will result in two power variants (at opposite ends of the power range) of the e-hub being manufactured. They will be dyno tested for efficiency and durability, then fitted to appropriate vehicles for preliminary confirmation of dyno results by means of agricultural field trials.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
PERKINS ENGINES COMPANY LIMITED	Development of a PEMD supply chain for Off-Road vehicles	£350,234	£175,117
University of Nottingham		£149,379	£149,379

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
Perkins Engines Company Limited and the University of Nottingham are working together to improve capability in virtual process development (VPD) and virtual product validation of Power Electronics, Motors and Drives (PEMD). Significant advancements in processes for assessment of lifecycle and embedded carbon, remanufacturing, refurbishment and recyclability analysis of PEMD will be realised, supporting the development of the circular economy.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
MAGNOMATICS LIMITED	WIND Electric Revolution (WINDER)	£353,760	£247,632
OFFSHORE RENEWABLE ENERGY CATAPULT		£117,474	£117,474

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
This project is part of a plan to bring the manufacture of large generators for offshore wind to the UK. Magnomatics Pseudo Direct Drive (PDD(r)) combines a magnetic gear with a permanent magnet generator. The PDD is very efficient and very reliable with no meshing gear teeth. Independent analysis has shown this provides lower cost of energy. The novel component in this technology is a pole piece rotor (PPR), a cylindrical structure comprising multiple axial steel pole pieces within a non-magnetic composite structure. In operation these pole pieces are subject to massive forces and complex cyclical loads. In previous demonstration units the construction methods used in the PPR were expensive and labour intensive. There are now several alternative concept designs for scaling up the technology but building and testing these at full scale would be very expensive. The PPR for a 15MW generator will be approximately 9m diameter. In this project new instrumentation will be installed in the 500kW CHEG generator and then extensively dynamometer tested to better understand the behaviour of the PPR under wind turbine loads and cycles. The testing carried out at the ORE Catapult will capitalize on previous testing carried out there during the Demo Wind project. Magnomatics will then develop sophisticated computer-based modelling software which can then be used to design robust PPRs including dynamic modelling of the pole piece loads to predict wear and possible erosion of the composite structure. These methods will be validated using the new test data from the ORE Catapult. A virtual product validation will be performed on concept designs. ensuring the PPR achieves the expected product lifetime of 25+ years. Wind turbine generator unit volumes could reach 800 units per annum therefore it would be essential to manufacture the PPR cost effectively. The AMRC, Sheffield, are providing input and support to Design for Manufacture of the PPR to achieve this. Proving this technology provides a credible route to UK construction of direct drive generators for offshore wind leading to annual sales of £1.2bn and dramatically increasing the proportion of UK content in offshore wind farms. This aligns perfectly with UK Industrial Strategy for PEMD and the Offshore Wind Sector deal. The technology can also apply to rail, marine propulsion and industrial drives, improving efficiency and reducing CO2 emissions.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Semefab Limited	Trench Clustered Insulated Gate Bipolar Transistor Manufacturing Process Capacity and Productivity Improvement	£399,398	£239,639
ECO SEMICONDUCTORS LIMITED		£0	£0
University of Sheffield		£98,785	£98,785

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
Semefab,the indigenous, open access semiconductor and MEMs sensor design and manufacturing company with three wafer fabrication facilities in Glenrothes, Scotland, intends to become a mainstream, indigenous manufacturer of power semiconductors. The IGBT component is mainstream in PEMD switching semiconductor device applications. Semefab's application is based around establishing patented, performance leading 1700V Trench clustered IGBT (TCIGBT) manufacturing capability at Semefab in Fab 3 on 6 inch wafers. This will create a high current density, high performance component applicable to mainstream industrial drive, solar, wind farm and electric vehicle applications and create a platform for higher and lower voltage applications. Semefab's strategic development objective for power electronics follows our belief that there is a clear and present need for establishing this manufacturing capability within UK to enhance critical infrastructure, increase UK industrial supply chain resilience and deliver tangible benefits to existing and future UK users of such devices.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
GE ENERGY POWER CONVERSION UK LIMITED	Conmotator: Advanced, Integrated Machines for Efficient Manufacture & Operation	£210,213	£105,106
University of Nottingham		£90,000	£90,000

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Project description - provided by applicants
Vision: Advancing PEMD through integrating large electric machines and convertors. Today almost all motor applications take advantage of variable speed for efficiency, deploying a power electronic convertor between machine and grid to achieve this. Especially for high power applications, motors and convertors have become functionally inseparable, but industry continues to make them physically two discrete components, cabled together. **Innovation: integration of power electronics and electrical machines into a single housing to form an integrated electrical drive brings several benefits** such as, increased power density, reduced overall footprint, cabling, cooling, overall system layout flexibility and cost. Because of these benefits, integrated drives are gaining market share in small drives of ratings below 1 MW, but there are some integration and manufacturing challenges to commercially exploit these benefits and achieve this fusion at multi-megawatt scale. **Focus**: Often in megawatt-scale power electronics and electrical machines, the design and manufacturing of the electronics and electrical machines are undertaken by separate teams. To fully realise the benefits of their fusion, an integrated design and manufacturing team with skill sets ranging from power electronics to electrical machines and advanced manufacturing is paramount. This collaborative project will draw expertise from industrial disciplines and academia to unlock the key design-for-manufacture, integration and manufacturing aspects to allow a multi-megawatt machine with integrated power electronics at scale to be brought closer to market, by derisking key areas. The 'Conmotator' project (combined convertor-motor to electronic commutator) project investigates and addresses the key technological, integration and manufacturing challenges to allow the commercial exploitation of an integrated electrical machine where the power electronics and motor are contained within a single physical unit at the multi-MW level. The project develops and tests the interfaces that bridge between existing Motor and Drive elements and investigates manufacturing/supply chain aspects related to megawatt scale integrated electrical machines to pave the way for full commercial exploitation, targeting the benefits at a worldwide market, placing UK industry as world class leader in this field.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
GRANTA DESIGN LIMITED	EV-Join	£164,754	£82,377
TWI LIMITED		£70,534	£70,534

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Project description - provided by applicants
Electrification of vehicles is key to achieve global legislative requirements for CO2 emissions reductions. Zero emissions within cities, higher quality and higher performance electrified vehicles (EVs) is also making them more attractive. \>2 million EVs were sold globally in 2018, 68% were battery electric vehicles (BEV) and 31% were plugin hybrid electric vehicles (PHEV), with an annual growth rate of 57%. Pack costs are expected to reduce from €155/kWh today to €90/kWh in 2030, through technological advancements and economies of scale. However, several issues currently limit further exploitation. High-volume EV production is still in its infancy in the UK and even the leading manufacturers lack the knowledge to design systems that can be readily manufactured by processes suitable for volume production. These EV systems are assembled, and must finally all be connected together (individual cells, to modules, to battery packs to motors, to complex PEMD systems), with potentially 10,000 -- 100,000+ welds per EV power train required. However, numerous complex issues are associated with the joining processes required to achieve these connections. EV producers, SME through to Original Equipment Manufacturer (OEM) level, struggle to select compatible materials and joining processes, to specify and design the required EV systems and to select suitable manufacturing processes. _The EV-Join project will provide a user friendly software tool that addresses major issues faced by companies developing EV systems_, namely: * A selection process that allows feasible joint designs to be created, taking into account materials to be joined and required geometries. * A selection of suitable joining processes for the materials combinations and joint geometries. * Assistance with a calculation of production rates and costs to aid a user in selecting a production process. * Assistance for planning of production line processes taking into account the requirements and limitation of each joint combination and production process. This will include requirements for critical upstream and downstream processes. * In service joint properties, manufacturing process requirements to achieve those properties. With this, EV-Join will unlock, for manufacturing as a whole: * Reduced time-to-market for all sizes of manufacturing businesses in the UK supply chain. * More efficient selection of the joining process, taking into account materials to be joined, productivity and geometries requirements. * Improved - and maintained - weld quality. * Increased productivity and reduction in repairs and scrap. * Reduced and potentially eliminated need for expensive and time-consuming post-weld Non-Destructive-Testing (NDT).