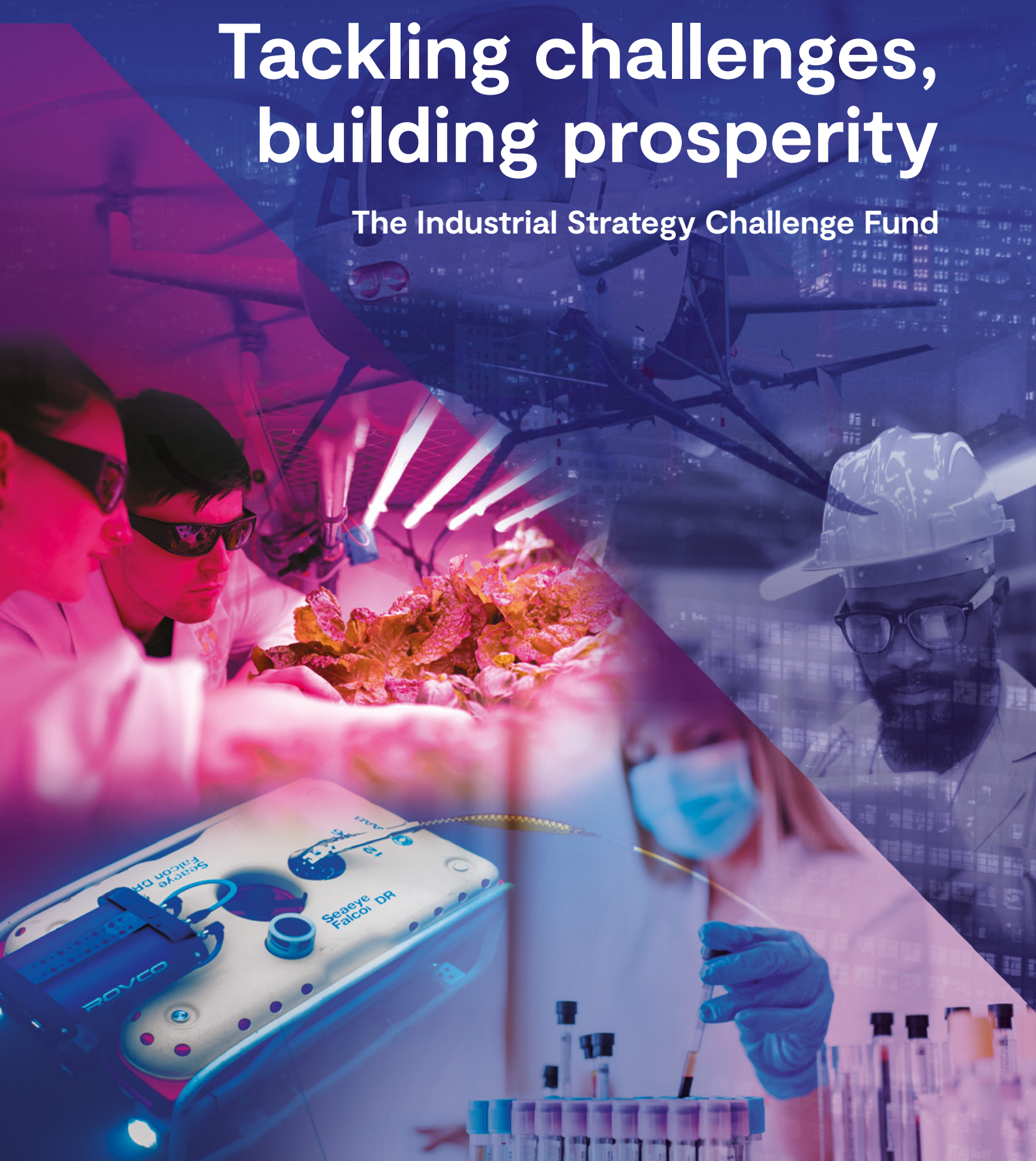




UK Research
and Innovation

Tackling challenges, building prosperity

The Industrial Strategy Challenge Fund



The Industrial Strategy Challenge Fund is part of the greatest single increase in UK science and innovation funding for over 40 years.

Led by UK Research and Innovation, it is working with business and researchers to tackle some of the biggest challenges of our time – finding new solutions, creating jobs and building prosperity.

The Industrial Strategy Challenge Fund in numbers*

£5.8 billion

total expected investment (£3 billion from UKRI, target of £2.8 billion from industry)

£1.9 billion

invested by UKRI to date

£488 million

industry funding unlocked so far,
with more to come

175

 competitions run

1,111

 projects funded

249

 projects completed

44%

 of projects are business/
academic collaborations

1,672

 businesses involved

169

 academic institutions
involved

*Figures as at April 2021; Wave 1a funding not included

Foreword

When the Prime Minister announced the Industrial Strategy Challenge Fund (ISCF) in November 2016, it was a significant moment for those of us in research and innovation – and for the future of the UK.

The Challenge Fund is part of the greatest single increase in UK science and innovation funding for over 40 years. With around £3 billion of public money, plus industry co-investment, it represents a total of more than £5 billion additional spending on research and development in the UK.

UK Research and Innovation – formed by bringing together the Research Councils, Innovate UK and Research England – has led the delivery of the fund. So, when UKRI launched in 2017, we had a huge opportunity and a great responsibility. We had the chance to shape a far-reaching programme, working with business and research, to tackle some of the biggest challenges of our time.

Now, four years later, we can reflect on the great strides taken so far. We have identified over 20 key challenge areas, in line with major societal and economic themes. We have set up challenge programmes in each, and already enabled over 1,600 projects large and small - many of them nationally-important facilities or game-changers in their field.

Our investments are already driving innovation and collaboration, developing new solutions and creating jobs and prosperity. Looking just at the projects already completed, turnover across the companies involved has grown by over £1 billion. There is much more to come. The programme is moving fast, and much of its work has now gained additional urgency as part of the race to net zero carbon emissions by 2050.

None of the achievements so far would have been possible without the entrepreneurial businesses, researchers and other organisations that drive these projects. Our challenge teams from across UK Research and Innovation work hard every day to bring new partners together, help encourage them to take bigger risks in a managed way through funding, and unlock private investment - but ultimately it is the UK's world-class businesses and researchers who make the projects happen.

In the following pages, the directors of each challenge area give a flavour of the amazing work being done, the impact so far, and how the ISCF programme is shaping the future.



Mike Biddle
Programme Director, ISCF



Guy Woolley
Director, ISCF Governance

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Net zero

Challenge programmes

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1 Faraday Battery Challenge



Challenge Director
Tony Harper

To drive 'clean growth', one of the most urgent needs is to develop better energy storage; batteries that are cost-effective, high-performing, long-lasting, safe, light and recyclable.

In 2030 the UK will end the sale of new petrol and diesel cars and vans. The sale of hybrid vehicles that can drive a significant distance with no carbon coming out of the tailpipe will continue until 2035. After that point all cars and vans sold will be zero emission. Many markets are introducing similar bans and it is anticipated many more will follow.

Manufacturers know that their core range will have to be fully electric – and they have to make major investment and procurement decisions imminently. The challenge and opportunity for the UK is to build an industry and supply chain to ensure the UK prospers from this transition.

It is not just about cars, or even just transport – new and better batteries will be needed in all kinds of contexts, on land, sea or in the air. This is a huge opportunity for UK business, with the battery market projected to be worth £8 billion by 2035.

The UKRI Faraday Battery challenge was one of the earliest challenges identified under the ISCF. With up to £317.75 million available, the programme is investing in a range of large-scale projects and facilities to catalyse the growth of a strong battery industry in the UK. It includes:

- **A £90 million collaborative research and development programme**
Backing great UK business-led collaborations to bring cutting-edge battery solutions to market and build capability across the value chain.
- **The £100 million [Faraday Institution](#)**
Nine major multi-institution, multi-disciplinary research programmes addressing battery related scientific challenges at scale.
- **The £125 million [UK Battery Industrialisation Centre](#)**
Creating giga-factory capability in an open-access manufacturing development facility, allowing businesses to bring new technologies to market.

This programme represents a major drive to create a new innovation and manufacturing ecosystem – one that will make the UK a global centre for the battery technologies the world will need.



I-CoBat

New ways of cooling batteries could encourage more of us to drive electric vehicles.

Electric vehicles (EVs) have made big strides in recent years, both in their design and in the charging stations that are available for them. So what's stopping us all from going electric?

When asked, people most frequently raise concerns over the time it takes for EVs to charge. We all have an idea of how quickly our petrol cars take to fill up, and until EVs' charging times get close to this, they will always be at a disadvantage.

Aiming to do something about this is the Immersion Cooled Battery (I-CoBat) project, which is supported through the Industrial Strategy Challenge Fund, as part of the [Faraday Battery challenge](#).

Battery cooling has long been a stumbling block on the road to faster charging of EVs: fast charging can indeed reduce waiting times for EV drivers, but it makes batteries hotter than they get under normal driving conditions. Getting too hot could mean batteries ageing prematurely, or failing altogether.

I-CoBat has been testing the viability of new cooling techniques for EV batteries. The company leading the project, [M&I Materials Ltd](#), had already developed an environmentally-friendly synthetic liquid called [MIVOLT](#), which it knew had potential for efficiently cooling batteries through immersion (immersion cooling being a promising alternative to existing techniques, such as air cooling). The problem was the amount of liquid that this would take and the weight of that liquid.

During the I-CoBat project, M&I has teamed up with engineering consultancy Ricardo Ltd, which has designed an innovative module that sits on an EV battery like a jacket, and directs the coolant only to where it is needed, meaning that much less liquid is required.

A large part of I-CoBat has involved simulations and tests to see how well these methods perform. Tests carried out by project partner WMG at the University of Warwick have shown that the new immersion cooling techniques enable EVs to charge 43% quicker. Just as importantly, tests carried out at the University of Liverpool showed no unwanted reactions between the MIVOLT liquid and the internal chemistry of batteries.

For M&I, the I-CoBat project has already led to further collaborations with EV manufacturers, who are interested in making immersion cooling work with their own particular batteries. In January 2021, for example, it was announced that MIVOLT would be used by California-based mobility specialists Faraday Future, in the battery pack they have developed. Further projects are looking at possible applications in the aerospace sector.

M&I's Technical Director, Mark Lashbrook, said: "As an SME, working with the support of the ISCF's Faraday Battery challenge and being able to use the facilities and research know-how of our partners has meant that we could get much quicker to where we wanted to be. The opportunity to work with renowned companies like Ricardo and research partners such as WMG has really raised our profile, too."

"With the positive results of I-CoBat, we've shown that there are no show-stoppers that would prevent these techniques from being used. With immersion cooling, we can get charging down to less than seven minutes for 200 miles in range: enough for you to plug in your EV, go and have a coffee, and have enough charge to be well on your way!"

"We can get charging down to less than seven minutes for 200 miles in range."

Mark Lashbrook, technical director, M&I Materials Ltd

LiNaMan

New kinds of batteries are helping with the move to sustainable energy

From using more solar and wind power to electrifying transport, reducing our carbon emissions depends on having safe, compact, low-cost batteries to store energy. Currently, rechargeable lithium-ion batteries are the gold standard in battery technology, but an exciting alternative is on the horizon.

Sodium-nickel-chloride (Na/NiCl₂) batteries are safer than the more common lithium-ion cells. They operate at a higher temperature, simplifying cooling systems in varying ambient conditions - a boon to engineers. Na/NiCl₂ batteries require less complex balance of plant, they don't use scarce materials (such as cobalt, which is expensive and difficult to source), and they're mostly recyclable.

Na/NiCl₂ batteries have been around since the 1980s, but the technical difficulties in making them affordable have not been overcome until now. By exploiting recent advances in nano-ceramic materials and laser manufacturing processes, LiNa Energy (a Lancaster University spin-out) has produced an innovative design of a Na/NiCl₂ cell and stack that offers the prospect of mass manufacture at a price the market will embrace.

“This has huge disruptive potential.”

Dr Richard Dawson, technical director, LiNa Energy

A 12-month feasibility study, supported by a grant of £198,712 through the Industrial Strategy Challenge Fund's Faraday Battery Challenge, has demonstrated the new batteries' viability. The LiNaMan project, a collaboration between LiNa Energy, Lancaster University and the Centre for Process Innovation, has applied modern material engineering and processing to Na/NiCl₂ chemistry.

LiNa Energy's technical director Richard Dawson said: “We knew that the fundamental chemistry of sodium batteries was safe and out of patent, which allowed us to update the design in a radical way to deliver greatly improved power and energy density.

“The original cells were big – as tall as a drinking glass, and if you held one, your fingers wouldn't meet around it. But because of the nano-engineered materials we use, the new planar cells are much more compact and can be efficiently arranged in flexible pack designs to maximise mass and volume specific performance.”

The project demonstrated proof of concept by its completion in October 2019, but as Richard explained, “The aim wasn't just to create a prototype that performs brilliantly in the lab, but one that can be manufactured at a reasonable price. The success of project LiNaMan gave confidence to

our investors, who contributed £1.6 million at the end of 2019, several times more than our fundraising target.” LiNaMan was also crucial in LiNa Energy obtaining funding for a £1 million project from the Department for Business, Energy and Industrial Strategy's (BEIS) Energy Entrepreneurs Fund, to help bring the new batteries to market.

“Our head count has increased to 15 skilled staff and we are planning further skilled, technical hires,” said Richard. “Our aim is future mass-manufacture at low cost. The net impact of this is hard to quantify, as this has huge disruptive potential. Our goal is to replace lithium-ion batteries with something safer, cheaper and better for the environment in high-volume applications such as the automotive and energy-storage sectors.”



2 Prospering from the Energy Revolution



**Challenge Director
Rob Saunders**

To meet the Government's goal of net zero carbon emissions by 2050 will require fundamental changes in how we generate and use energy.

In the traditional centralised system, energy from different sources moves separately, and in one direction only – from supply points to use (or wastage). It is inefficient and unsuited for the latest clean energy technologies.

With rapid advances in electric vehicles, renewable generation, battery technology and intelligent data use, there is another way - to design energy systems that are cheaper, cleaner and have the interests of local communities at heart.

Integrated local energy systems can provide cleaner, cheaper, more efficient energy and help communities prosper. But setting them up can be complex. It requires social change and new business models, driven by vision and collaboration, delivering across heat, power and transport services. It also takes innovation, in areas from energy storage to complex data management, and confident investment from industry.

The Prospering from the Energy Revolution programme is investing around £102 million, matched by industry, in helping to develop and prove these kinds of systems. We have funded over 60 projects, with three large-scale demonstrators and many innovative concept, design and technology projects still under way.

It is also funding the [Energy Revolution Integration Service](#), which supports projects with practical help and knowledge-sharing, and the [EnergyRev](#) network of 22 universities advancing expertise in this field.

By helping businesses, researchers and local organisations to develop real-life examples of smart energy systems that can reduce carbon emissions and increase prosperity, the programme is showing the way to a better net zero future.

GreenSCIES

London South Bank University leads a consortium funded by the Industrial Strategy Challenge Fund's Prospering from the Energy Revolution programme to develop a low carbon smart energy grid which connects mobility, power and heat.

The UK has ambitious targets to reduce its carbon emissions to [net zero by 2050](#). One solution lies in how inner cities generate, transport and store energy, and critically how they reuse heat. A Green Smart Community Integrated Energy System (GreenSCIES) will transform homes and businesses into sustainable energy districts which will not only reduce the effects of carbon-fuelled climate change but also tackle fuel poverty.

This current GreenSCIES project is funded by the Industrial Strategy Challenge Fund's Prospering from the Energy Revolution programme and follows a smaller Innovate UK-funded feasibility project which focussed solely on Islington. The north London borough hopes to reach [net zero carbon by 2030](#). Over a decade ago, Islington invested in a combined heat and power (CHP) system in Bunhill with the involvement of London South Bank University (LSBU). Phase 2, which upgraded heat and converted energy from the London Underground, [opened this year](#).

GreenSCIES is a more integrated solution than Bunhill which adds mobility (electric vehicles) and more secondary energy sources – including electricity substations, sewers, supermarkets, canals, cable tunnels and data centres – into its smart grid. Professor Graeme Maidment explained how LBSU became project lead:

"We're specialists in heating and cooling and we're also quite well connected. We know the good people working in this area and two years ago we brought them together."

The new GreenSCIES project, launched in February 2020, will focus on additional energy districts proposed in Sandwell in the West Midlands and Sheffield. Each grid has different energy sources. For example, the ambient heat loop which forms the basis for heat transfer, would be very different. In Sheffield, GreenSCIES hopes to capture heat from underground mine water, whereas in Sandwell it will take [advantage of the canal network](#). Graeme said that a diversity of areas allows them to test GreenSCIES replicable design methodology.

"We're hoping that the principles we're trying to develop will be applicable and generic"

Professor Graeme Maidment

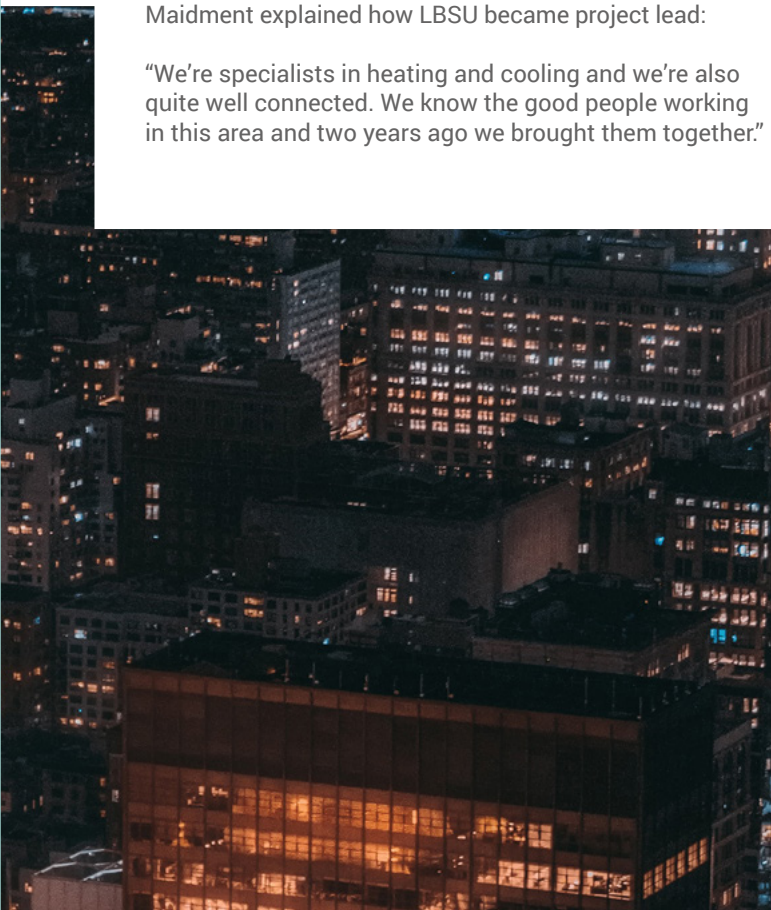
"The principles that we're trying to develop we're hoping will be applicable and generic. So they will create a big push for these technologies across the UK," said Graeme.

The West Midlands is also developing the technology behind the smart energy network. A startup called GridEdge from Aston University is developing the system which will even out the 'demand-side response' in the smart grid. The artificial intelligence system connects flexible electricity demands from heat pumps and electric vehicles to intermittent renewable sources such as solar power.

Being able to offer mobility, power and heat means there's an opportunity to offer a bundled all-in-one service. This makes it more cost-effective which can be passed down to the end-user, known as 'energy as a service'.

"It's a bit like buying things from your local farm shop," said Graeme, "A lot of people do that because they perceive quality and have the added benefits of supporting the local community."

Rob Saunders of UKRI, Prospering from the Energy Revolution's challenge director, said, "This is a groundbreaking project. The approach the GreenSCIES team is taking combines thorough engagement with local people, communities and organisations alongside the development of a novel heat network design. This will enable energy services for heating, cooling, mobility and power across Islington. All this in a manner that is attractive for people and businesses in the local area, as well as investors in infrastructure projects."





ReFLEX Orkney partners and funders, January 2020
© Colin Keldie

ReFLEX Orkney

This first-of-its-kind integrated energy system will use sophisticated technology and pioneering business models to provide green and affordable energy services for residents and businesses.

Over the last 20 years the Orkney Islands off the north coast of Scotland have been going through a major energy revolution. Since 2013 Orkney has produced enough renewable power from the wind and sun to provide over 100% of its electricity needs. However, heating and transport are still heavily dependent on oil.

The ReFLEX Orkney project, which was launched in 2019 and funded by Innovate UK through the Industrial Strategy Challenge Fund, aims to dramatically increase and broaden the use of local renewables. It will do so by providing additional energy storage alongside the rapid expansion of electric vehicles and smart heating systems, as well as exploring the use of green hydrogen.

To back up this technology revolution ReFLEX is also launching a new energy services delivery model based on a community-level energy company, and new tariffs and charging mechanisms that will help ensure energy is affordable for all.

Led by the European Marine Energy Centre (EMEC), the ReFLEX Orkney project brings together an expert consortium of Orkney-based partners – Solo Energy, Aquatera, Community Energy Scotland, Heriot-Watt University and Orkney Islands Council.

Mark Hamilton, Managing Director and co-founder of Solo Energy, said: “On Orkney we have made a significant transition to renewables and generate more than we can use. But we also need to balance the timing of electrical supply and demand by introducing added storage capacity and flexible control systems. The ReFLEX

Orkney project will allow us to demonstrate how this kind of system can work to maximise local decarbonisation alongside the need for affordability.

“Our ‘FlexiGrid’ virtual power plant will allow minute-by-minute control of household or business power generation, storage and usage, including capacity from any plugged-in electric vehicles. This integrated system will optimise energy flows and at the same time provide valuable flexibility services to the grid.”

In parallel with this electrical system package ReFLEX also offers customers access to a wide range of electric vehicles, other mobility solutions and smart heating systems to provide an integrated whole energy service.

Gareth Davies, Managing Director of Aquatera, said: “We realised early on that for rapid decarbonisation to be achieved we need to make it as easy as possible for customers. ReFLEX aims to take away the technical and financial pain of energy transition by making the technology choices very simple and by providing the technologies needed on a pay-as-you-use, lease or rental type basis.

“Our initial target is to work with 1,000 households and 100 businesses, about 10% of the population on Orkney, but our wider target is to reach full decarbonisation by 2027 and at the same time to roll out the ReFLEX model to other communities across the UK and elsewhere internationally – we already have over 20 interested communities engaged.”

3 Transforming Food Production



Challenge Director
Katrina Hayter

One of the greatest problems facing humanity is how to produce enough food for a growing population, without irreversibly damaging our planet's climate, ecology and biodiversity.

The scale of this challenge is huge, and it may seem hard to make an impact. However, we know that multiple targeted interventions on complex systems such as food production can yield hugely positive advances in the long term. The ISCF is investing around £90 million in the Transforming Food Production challenge programme, with industry contributing at least the same again.

Our funding builds on UK scientific excellence and encourages researchers, entrepreneurs and innovative farmers to create new collaborations and find new solutions. We focus on technologies, methods and approaches that have the potential to transform existing agriculture and spur the development of whole new novel food production industries.

We have co-funded more than 80 collaborative projects, some focused on 'traditional' production systems such as arable and livestock, and some on future food production industries. They include the world's first autonomous robotic growing system, and a way to use power station carbon dioxide emissions to make protein for animal food.

Most projects are at an early stage but we can already see significant impact – whether in the form of new technologies, new research/business collaborations, or the growth and development of innovative UK companies.

The aim is for the UK to lead the way in developing innovative farming systems that will benefit the environment, build prosperity, and help people everywhere.

LettUs Grow

With support from UK Research and Innovation, a vertical farming startup has established its roots with leafy greens and is scaling up to larger crops and trees.

The world population is growing. Keeping everyone fed is challenging for traditional farms, which until now have had limits to their productivity. There is also a growing demand for produce that is grown without the use of pesticides and which has a minimal carbon footprint. LettUs Grow believes that their aeroponic system can provide the green shoots of change for the farming industry.

Co-founder and CTO Ben Crowther said, "We're looking to build the farms of the future. We're primarily involved with creating indoor vertical farms but we're also looking at how traditional farms and greenhouses can increase their productivity."

The benefits of vertical farming are well known. Stacking plants in an artificial environment mitigates extreme weather and pests, and is space-efficient. And by placing production closer to consumption, it shrinks the carbon cost of transport.

LettUs Grow has proved that its aeroponic system has significantly faster growth rates than hydroponic systems - as much as 70% faster for certain crops. The system also uses fewer nutrients and, obviously, less water than its better-known counterpart.

Ben Crowther said, "We create a nutrient-dense mist, which allows the plants to breathe more readily and produces a voluminous, healthy set of roots."

According to Ben, LettUs Grow has removed some of the issues of existing aeroponic systems: "We remove all of the high-pressure plumbing and create an airbed, which is as simple as a hydroponic grow-bed to install and operate."

LettUs Grow formed in Bristol in 2015. Co-founders Jack Farmer (Operations Lead) and Charlie Guy (Managing Director) organised food sustainability events at Bristol University. They met Ben Crowther who was interested in the production side.

Some early Design Foundation Call funding from Innovate UK helped the trio put their words into action.

Ben said, "It gave us a real chance to explore the technology and do some important early-stage planning. We had much more headspace than most people have within a startup to look ahead and change."

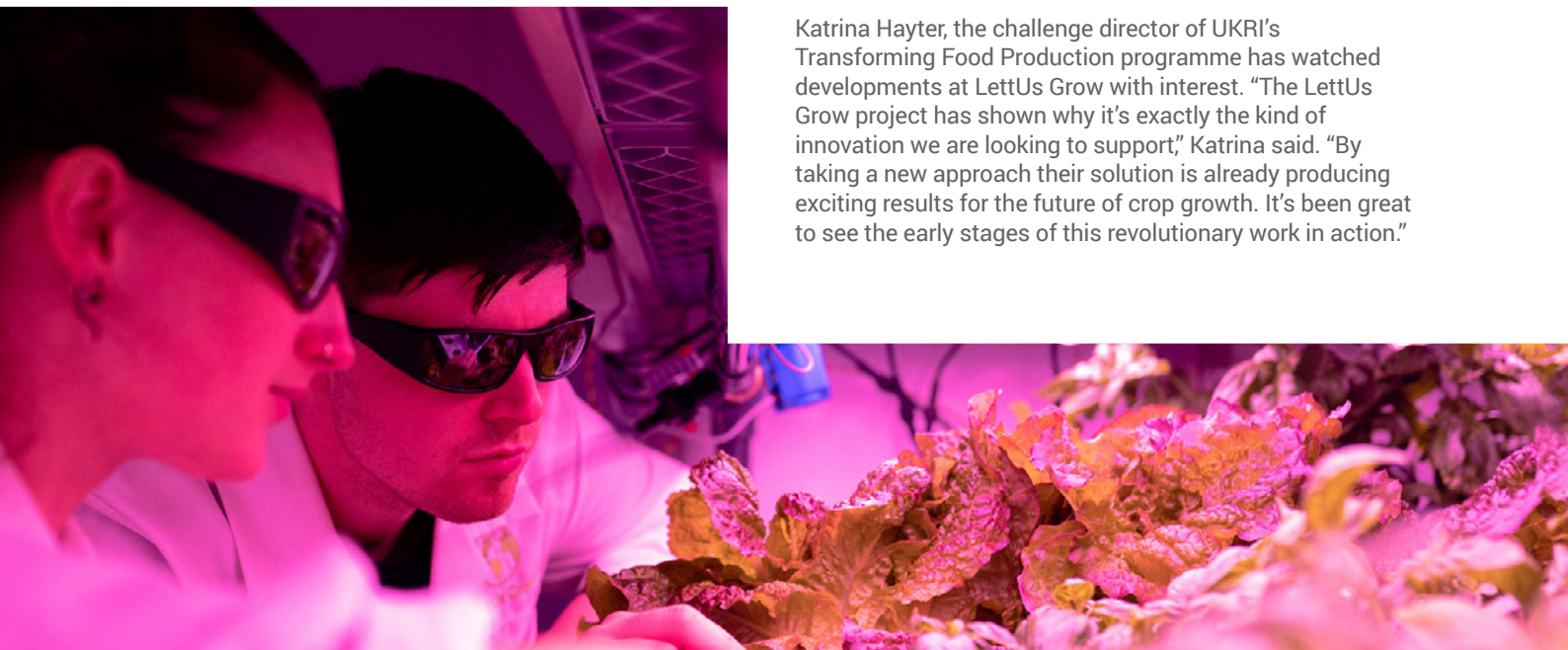
The second grant was from the Industrial Strategy Challenge Fund's Transforming Food Production challenge, and was used to scale the business. LettUs Grow deepened its relationship with indoor, urban farm Grow Bristol, formed partnerships with ECH Engineering to improve the efficiency of its climate control system and worked closely with renewable energy supplier [Octopus Energy](#) to create a vertical-farming tariff.

"We're looking to build the farms of the future."

Growing as a business has meant that the company has been able to expand far beyond the micro-greens and 'lettuce' of its namesake and is now looking at further propagation including strawberry rootstock and tomatoes for greenhouses, crops and biomass production for farms, and even reforestation.

"We can produce more healthy tree whips in an incredibly efficient way compared to the market prices of production and import. We always used to joke that trees were impossible in vertical farming, but actually we have proved we can fulfil at least the early stages."

Katrina Hayter, the challenge director of UKRI's Transforming Food Production programme has watched developments at LettUs Grow with interest. "The LettUs Grow project has shown why it's exactly the kind of innovation we are looking to support," Katrina said. "By taking a new approach their solution is already producing exciting results for the future of crop growth. It's been great to see the early stages of this revolutionary work in action."



Spray Saver

With increasing regulation and concern around the use of fungicides, a new detection system enables farmers to target when and where they are needed – and reduce the amount they need to spray.



When it comes to protecting their crops, UK farmers are facing increasingly difficult decisions. Excessive use of fungicides can lead to resistance, potentially impact biodiversity, and cost farmers a lot of money in chemicals. But failure to spray could result in the loss of an entire harvest.

Now, a new detection system aims to help farmers make better decisions about when chemical sprays need to be used. [SpraySaver](#) aims to be the world's first automated field-analyser system designed to identify the presence of potential pathogens in a crop, and has been developed through a collaboration between electronic-measuring specialist [Agri Samplers Ltd](#); agricultural research scientists at [Rothamsted Research](#) and [ADAS](#); reagent specialist [Perpetuus Carbon Technologies](#); and growers [Velcourt](#), [Spearhead Potatoes](#) and [Hutchinsons](#).

"SpraySaver brings together sampling equipment and risk-prediction modelling to give farmers the scientific information they need to assess the risk of disease in their crops," explains Stuart Wili, managing director of Agri Samplers Ltd and project lead. "Tightened regulation means farmers have fewer chemicals available in their tool kit, so this enables them to take a more targeted approach to spraying and hopefully reduce the amount they need to use."

SpraySaver started life in 2010 as an Innovate-UK funded project where biosensors measured the spores of a fungal plant pathogen in the air. A further £926,000 Innovate UK grant in 2019 has allowed the team to develop faster, more accurate sampling by replacing biosensors with a newly-designed DNA sampler.

"We developed methods to release DNA from captured spores. Once broken open, these are transferred to a tube of dried reagents within the device which fluoresces when in contact with DNA of a specific pathogen. This fluorescence is measured to indicate the levels of spores in that sample," explains lead scientist Professor Jon West,

"SpraySaver brings together sampling equipment and risk-prediction modelling to give farmers the scientific information they need to assess the risk of disease in their crops"

Stuart Wili, managing director of Agri Samplers Ltd

Rothamsted Research. "A lateral flow device, developed by Worcester College Group, was also added to detect a wider range of pathogens." The system allows a sample to be taken in the day and the results available to the farmer on the SpraySaver website that evening.

Each sampling unit also has its own inbuilt weather station, which transmits information every 10 minutes for analysis. "The disease sclerotinia in rape seed, for example, needs a period of warm and wet weather for spores to be released and then contaminate a plant. There might be a large release of spores but if the forecast is then dry, the likelihood of infection is low," says Stuart. "SpraySaver processes all this information to advise whether a farmer needs to spray."

Although field trials of the prototype systems are ongoing (having been hampered by COVID-19), the initial feedback from farmers is positive, says Stuart. "With chemicals, tractors and labour, it can cost around £80-£100 per hectare to spray, and this can be done 20 times per season. So a tool that can reduce this could make major savings and conserve the best chemicals for high-risk periods."

4 Transforming Construction



Challenge Director
Sam Stacey

The built environment is critical to the wellbeing of society and underpins 43% of GDP. Buildings currently produce around 40% of UK carbon emissions. Quality failings, including fire safety issues, are rife. Those working in the industry find it dangerous and unprofitable. It is this – a system that works for no-one – that the Transforming Construction challenge programme is setting out to fix.

Current approaches are labour-intensive and in effect deliver every building as a new prototype. Standardising construction processes can vastly improve the speed, cost and productivity of construction. This will involve major changes in the way society commissions, designs, builds and uses buildings - which is why we are investing around £170 million in this programme, with industry contributing another £250m.

We have co-funded over fifty projects since 2018. The results show that buildings can be delivered with 50% lower emissions, 50% faster, 33% more cost effectively, and with 15% greater productivity.

The urgent task now is for government, clients and supply chains to move together to adopt this thinking. To drive this change, we have invested in:

- [The Construction Innovation Hub](#) – working on new ways to procure, design, deliver and operate buildings and infrastructure.
- [The Active Building Centre](#) – accelerating commercialisation of buildings which are embedded with capability to generate, store and distribute green energy. All to be integrated with the wider energy system.
- A new national community, [Transforming Construction Network Plus](#).
- Projects developing and piloting new techniques.

By enabling the development of technology and tackling barriers to change, this challenge programme is set to transform the construction sector, helping to create the buildings we will need for a low-carbon future.

The Forge

A commercial building project funded by the Industrial Strategy Challenge Fund offers a glimpse of how the construction sector might emulate the productivity gains seen in the manufacturing sector over the last 20 years.



Landsec is building an office block created from a structural frame that could be manufactured offsite as a kit-of-parts and assembled onsite using an automated process that is faster and lower cost than traditional construction methods.

Landsec and its partners Bryden Wood and EasiSpace wanted to address the frustrating logistical challenges associated with office builds by trialling an automated kit-of-parts approach to construction.

They took an existing office project that was due to follow a traditional design and build route, and changed the approach to demonstrate how innovation and automated construction could be used to deliver a better outcome. Having secured planning permissions based on a traditional build, the project team prototyped a method that used a standard 9x9 metre planning grid combining fabricated standardised steelwork components, reusable formwork and in-situ concrete fills which can be installed using an automated process.

The office block, known as [The Forge](#), is in Southwark, London. It was digitally redesigned away from the traditional build using a standardised grid and a repeating unit constructed the same way each time to make up 95% of the structure.

Building Information Modelling (BIM) was used to design the building and sequence the construction, and then model the cost savings. Using virtual reality headsets, the team created a walk-through simulation – ahead of construction – to check for clashes, risks and potential improvements. The digital model has made it easier to simulate and tune the building performance, which informs the energy system installation and the glazing performance requirements.

The structural design has been re-engineered from five different floor heights to just two, to promote repeatability. While instead of a conventional perimeter grid with beefy columns every nine metres, microcolumns have been

introduced three metres apart to reduce the structural zone. These take up less space and get incorporated into walls. These innovations have allowed more floors to be incorporated for the same building height, boosting return for the investment. Critically that has been achieved for a greater daylight penetration and the same perceived ceiling height for users.

“This approach led to a 10% capital cost saving, 13% reduction in programme time, 13.5% improvement in onsite productivity due to requiring half the number of workers and 20% less embodied carbon.”

Sam Stacey, Challenge Director for the Transforming Construction Challenge

By making use of multi-skilled labour teams and automated assembly processes to create components for repeat deployment, the build showed higher accuracy levels using fewer people on site. The repeatable structural unit was used in conjunction with a wider kit-of-parts framework which included cladding elements, mechanical and electrical services cassettes and other standardised components.

Sam Stacey, Challenge Director for the Transforming Construction Challenge said: “This innovative process approach led to a 10% capital cost saving, 13% reduction in programme time, 13.5% improvement in onsite productivity due to requiring half the number of workers and 20% less embodied carbon (the building itself is net zero in use).”

Value Toolkit

The construction industry has come together to end the culture of cheapness that is shaping the way we build, and instead introduce a new approach that is focused on whole-life value.

[The Value Toolkit](#) will embed value-based decision making throughout the investment lifecycle to deliver buildings that better meet the needs of the client and those who will use it.

Construction has had too narrow a focus on controlling cost and transferring risk in the capital phase. The selection process at all stages along the supply chain is typically focused on the cheapest bid, often drawing on wasteful processes and sustaining a system that works for no-one. By focusing solely on cost, the industry is foregoing broader societal and environmental benefits that a building can deliver.

[The Construction Innovation Hub](#) was funded under the [Transforming Construction challenge](#) to establish the ecosystem needed for the sector to transform itself to begin delivering more value to society and adopting processes with the potential to reduce cost, time and emissions. A key activity was to deliver a consistent, consensus-based process for defining value. This enables the market to develop innovative, value-adding solutions that directly address client needs.

The Value Toolkit was the result and is designed to ensure end-user benefits, as well as social and environmental impacts, are baked into the way programmes are planned and delivered. The Value Toolkit is focused around improving the procurement process so that value-based decisions sit at its heart.

The Procuring for Value module draws on an Investment Value Index (IVI) which is determined at the Value

Definition stage and acts as the primary means to evaluate choices between suppliers. It will provide transparency to the market on how purchasing decisions have been made.

“The four capital value categories of the Value Toolkit – people, social, natural and manufactured – will enable clients to make decisions based on their impact on society and the environment, not just the cost and risk to capital investors.”

Sam Stacey, Challenge Director for the Transforming Construction Challenge

The four capital value categories – people, social, natural and manufactured – will broaden decision-making beyond cost and capital risk. The value indices and measurement tools create transparency and accountability around delivery and impact. The Delivery Model and Client Selector tools allow clients to weigh up risk and benefit and create a viable commercial strategy with whole-life value at its heart. And the Procuring for Value tool supports purchasing decisions with a long-term impact, not short-term savings.

Initiated by the Construction Leadership Council, over 120 organisations are working with the Construction Innovation Hub to develop and test the Value Toolkit. These include the Departments for Education, Transport and Health, the Ministry of Justice, the Defence Infrastructure Organisation (DIO), the Welsh Government, Environment Agency, YTL Developments, Landsec, National Association of Construction Frameworks and Scottish Futures Trust. Also, there has been wide support from businesses, industry experts and government, including the Business Minister, Nadhim Zahawi.

Sam Stacey, Challenge Director for the Transforming Construction Challenge said: “The four capital value categories of the Value Toolkit – people, social, natural and manufactured – will enable clients to make decisions based on their impact on society and the environment, not just the cost and risk to capital investors.”



5 Driving the Electric Revolution



**Challenge Director
Will Drury**

To reach net zero carbon emissions, industries of all kinds must move to clean technologies and electrification. This is happening across every sector of society, from energy generation for our homes to how we move around.

Electrification will generate a massive need for next-generation power electronics, electric machines and drives – whether for electric vehicles, hybrid aircraft, trains, or a host of other applications and appliances.

We are investing up to £80 million in projects that will help the development of a strong UK supply chain in these essential components.

It is a field where the UK already has a track record, but our investment is rapidly accelerating innovation, building partnerships across industries, and helping ensure the UK can develop capabilities fit for the future.

We have already invested in over 40 innovative projects, from wind turbine generators to electric propulsion for boats, and from electric hub motors for farm vehicles to nuclear coolant system components.

Our investments are helping business and researchers to fill gaps in electrification supply chains, and funding centres to develop the next generation of products using power electronics, electric machines and drives. Other projects focus on the new approaches and tools needed to make these components in volume, and in the right timescales, to help manufacturers grow.

Reaching net zero by 2050 will not be possible without the supply of power electronics, machines and drives on a large scale. The Driving the Electric Revolution challenge programme is helping the UK grasp the huge economic opportunities from this global transition.

New skills for the electric revolution

To build a low-carbon economy, we must convert our industries to make a wide range of innovative products which use electric power. But this transition will take an army of engineers and technicians with new skills – and in the race to net zero, it is increasingly urgent.

To help meet this need, the Driving the Electric Revolution challenge programme funded a project to develop new free and accessible online training, aiming to quickly and significantly build up the UK engineering workforce's skills in key areas of electronic power conversion.

Led by design and training company [Electronic Minds](#), the project initially focused on the key skills needed in the UK supply chain for electrification of transport. It is now going on to develop an industry-driven collaborative initiative with academia, enhancing engineering skills in the broader UK workforce.

This innovative project combines the best elements and experience from experts in industry and research, covering many aspects of real-world power conversion, to create a class-leading online training programme.

Innovative magnets for wind power generation

The UK Government has announced an additional 30GW of offshore wind capacity to be developed by 2030, at a cost of £45 billion. This is only the UK picture; across the world, wind generation, and therefore the need for turbines, is set to grow rapidly.

However there is a major risk in the supply chain that could curb this growth and hamper the UK's ability to compete in wind turbine manufacture. Generators used in current turbines rely on scarce and expensive rare earth magnets. Sourced almost exclusively from China, these magnets will be subject to production shortages from the mid-2020s.

[GreenSpur Wind Ltd](#) has developed a highly innovative generator that uses magnets made with readily-available ferrites instead, making them cheaper and not reliant on the increasingly competitive supply chains for critical rare earth minerals.

The Driving the Electric Revolution challenge programme has now co-funded GreenSpur, working with the Warwick Manufacturing Group and specialist partners, to design and develop advanced manufacturing processes for these innovative generators – with the ultimate aim of delivering long-term benefit to the UK economy.



Advances in clean marine power

Propulsion for boats is a multi-billion pound industry. At the moment most are powered by polluting diesel or petrol engines, but the move to electric power is already under way and gaining pace.

However to support this change on a large scale, there is an urgent need for new and better electric propulsion systems for marine use.

[RAD Propulsion Ltd](#) has combined an electric 'rim drive' with a hubless propeller which has no external rotating blades. These are not new technologies in themselves, but bringing them together into a single high-performance product is expected to transform the market in drive systems for smaller boats.

As well as creating no emissions, the new drive is safer than conventional motors, less likely to get tangled in debris, and has far fewer moving parts.

Now, with co-funding through the Driving the Electric Revolution challenge programme, a consortium of RAD, the National Composites Centre and motor supplier iNetic Ltd is researching how to manufacture the new drive system to the demanding standards needed, in quantity, and at a competitive cost.

Achieving this will open the doors to a new global market, which could be worth over £1.5 billion per year by the 2030s.

Keeping the UK at the forefront of semiconductor manufacturing

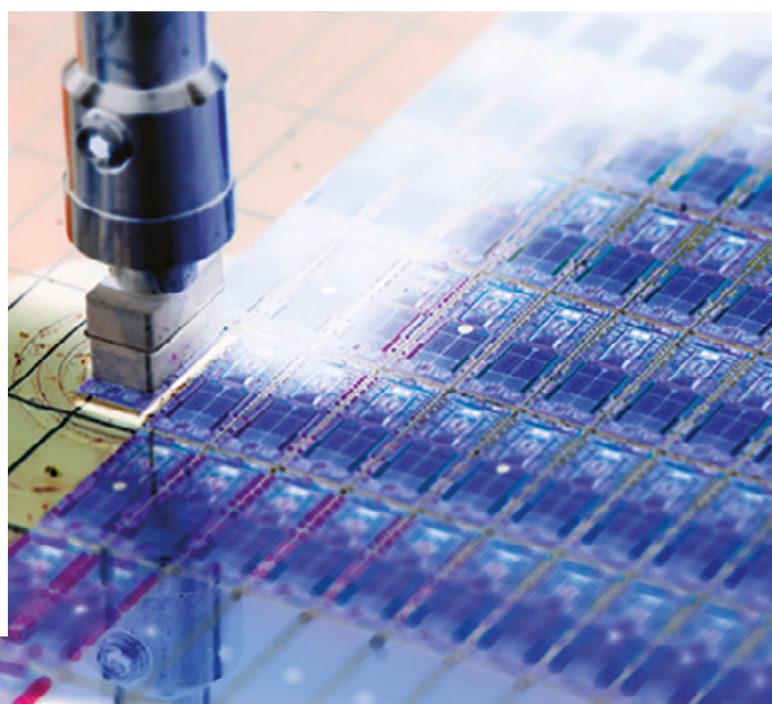
As the electric revolution gathers pace, demand is growing for increasingly powerful, fast and durable transistors for power electronics, machines and drives.

Transistors have traditionally used silicon as a material for semiconductors, but new semiconductor materials have been developed that perform considerably better than silicon. One such material is gallium nitride. Transistors using these new semiconductors, known as 'wide band gap' devices, can operate at much higher voltages, frequencies and temperatures, and are invaluable for a wide range of applications including electric vehicles.

As part of the Driving the Electric Revolution challenge programme, UKRI has co-funded a project led by the [Compound Semiconductor Centre](#) to develop a cost-effective and scalable manufacturing process for high-quality gallium nitride based transistors.

The project draws on the complementary experience and capabilities of compound semiconductor manufacturing specialists IQE and Newport Wafer Fab, which both have world-leading facilities in Wales. To complete the collaboration, Bristol University is providing its expertise in assessing and controlling the quality of semiconductor wafers during the manufacturing process.

By developing effective manufacturing processes for the advanced semiconductors that the world will need, this project will help keep the South Wales cluster of semiconductor specialists - and therefore the UK - at the vanguard of this fast-growing industry.



6 Industrial Decarbonisation



**Challenge Director
Bryony Livesey**

The industrial regions of the UK are major emitters of carbon and greenhouse gases, both through industrial processes themselves and through the power they use. Decarbonising industry generally is vital for clean growth, and UKRI defined this as one of the key ISCF challenge areas in 2019.

Early on we realised that the best approach is to focus on regional clusters of industries. This is the most cost-effective way of tackling the issue: by bringing major industries and other players in a high-emission region to work together, collaborating to find new solutions.

Through this programme, we are investing up to £170 million to help business develop technologies such as carbon capture and storage and hydrogen fuel switching, and deploy them on a large scale in the UK's largest industrial clusters - increasing competitiveness and supporting the drive for clean growth. The investment will be matched by £261 million from industry, making a very significant investment in innovation for decarbonising industry.

We are helping the UK's highest-emitting regions to come up with plans to move to net zero, and co-funding projects to achieve this. These include developing plans for carbon capture and storage in several industrial areas, for production and use of hydrogen, and for small-scale renewable energy power stations in the Midlands.

With the help of ISCF funding, the UK is on course to achieve the first net zero industrial cluster in the world by 2040, as an example for industrial regions everywhere.

Industrial regions plan low-carbon futures

A key part of the Industrial Decarbonisation challenge programme is focusing on regional clusters of industries

In January 2021, six of the country's most heavily industrialised regions won a share of £8 million from the Industrial Decarbonisation challenge programme to kick-start their ambitious transformation plans.

This second phase of the [Industrial Decarbonisation Challenge](#) is looking to develop infrastructure that can yield significant emissions reductions while creating highly skilled jobs to revive the fortunes of deprived communities.

Central to the vision for a net zero future are low-carbon technologies that will thrive and grow, halting the drift of young talent from industrial towns and cities, especially in the north of the country.

Bryony Livesey, Challenge Director, Industrial Decarbonisation, said: "This represents a huge opportunity for the next generation entering the world of work.

"The heavy industries that created these communities will give way to clean-growth infrastructure creating many thousands of jobs, attracting young women as well as men."

The projects cover the Tees Valley, the North West, the Black Country (West Midlands), the Humber region, Scotland and South Wales.

The objective is to establish the world's first net zero industrial clusters by 2040, largely through carbon capture, utilisation and storage and by establishing hydrogen networks.

For example, [Net Zero Tees Valley](#) aims to decarbonise a cluster of carbon-intensive businesses by 2030, supporting up to 5,500 direct jobs.

The plan is to capture up to 6 million tonnes of CO₂ emissions each year, equivalent to the energy used in two million homes. Storage would typically be under the North Sea, opening up further technically demanding career opportunities.

Bryony Livesey said: "Our industrial regions have got to attract investment from new 'clean' industries or decarbonise the ones they already have. So what the challenge programme is doing is to kick off the investment needed to decarbonise existing industries. Even closing them down would only mean importing the same products from overseas, which does nothing to reduce carbon emissions globally. We also need to attract new industries and new investment."

"Industrial regions have got to attract investment from new 'clean' industries."

Bryony Livesey, Challenge Director

She said: "Investment in decarbonising needs to be at an industrial scale. In building the carbon capture infrastructure for a power plant you can also support other industries in the cluster, including hydrogen production."

The six projects are:

- South Wales Industry - A Plan For Clean Growth (led by CR Plus consultancy);
- Repowering The Black Country (Black Country Consortium);
- Net Zero Tees Valley (Tees Valley Combined Authority);
- Scotland's Net Zero Roadmap (Neccus);
- Net Zero North West (Peel Environmental); and
- Humber Industrial Cluster (Humber Local Enterprise Partnership).



7 Smart Sustainable Plastic Packaging



Challenge Director
Paul Davidson

Single-use plastic packaging, as we all now know, is a major environmental threat. Discarded plastics are increasingly prevalent, persistent, and potentially dangerous to ecosystems.

The world needs viable solutions, and this is what the Smart Sustainable Plastic Packaging challenge programme is working to achieve.

Plastics will continue to play a vital role in our lives, but we have to change the way we live with them. It will not be easy, but we need to make wholesale changes in how we design products and packaging, choose materials and production processes, and use what has been made – and we must find new answers to what happens at the end of the life cycle.

Reduce, Reuse, Recycle.

By de-risking projects through this challenge programme, we are helping business and researchers find solutions that will cut the amount of packaging used, boost reusable packaging concepts and systems, and improve recycling rates – both through better capability and through behavioural change.

The programme will invest £60 million over 5 years, with industry contributing a further £149 million, and is the largest such plastic packaging initiative the UK has ever seen.

We have already invested over £28 million in 20 projects. These include four demonstrator projects for cutting-edge recycling plants – which, with £20 million from the challenge programme and over £65 million from industry, represents the largest investment the UK has ever made in plastic packaging recycling technologies.

Our funding is already catalysing business collaboration as well as accelerating academic research, both of which are vital for systemic change.

Our aim is to establish the UK as a leading innovator in smart and sustainable packaging and help deliver a dramatic reduction in waste plastics entering the environment by 2025.

SSPP Demonstrator projects

As part of the Smart Sustainable Plastic Packaging challenge, four demonstrator projects for cutting-edge recycling plants will save UK plastic waste from being dumped in landfill or incinerated.

Plastic packaging waste is one of society's most pressing environmental challenges. Of the 2.26 million tonnes produced annually in Britain, much ends up in landfill or being incinerated.

This could change with the development of four technology demonstration plants for recycling, which will place the UK at the forefront of next-generation plastic recycling systems.

The four demonstrator projects have received £20 million funding through ISCF's [Smart Sustainable Plastic Packaging](#) (SSPP) challenge, along with over £65 million of industry backing, which represents the largest investment the UK has made in plastic packaging recycling technologies.

The projects were the winners of the SSPP Demonstrator Round 1 competition, and bring together academic research and industry to develop innovative solutions, with an aim to help make the plastics packaging supply chain more circular, increase the amount of recyclable plastic packaging and improve UK productivity in plastics, leading to a reduction in plastic waste entering the environment.

"To help protect the planet from waste pollution we need to reduce and re-use, but it is also critical that plastics are more readily recycled and sustainable," explained Paul Davidson, Challenge Director of SSPP. "The work of these projects will go a long way to reinstate plastic as a sustainable packaging choice."

The projects include [ReNew ELP](#), in partnership with University of Warwick and Wood Group UK, which plans to set up a plant centred on a Catalytic Hydrothermal Reactor at Wilton, Teesside. The process turns end-of-life plastic into chemicals and oils for use in the production of new virgin-grade plastics, and a bitumen-like residue suitable for use in road construction.

"The work of these projects will go a long way to reinstate plastic as a sustainable packaging choice."

Paul Davidson, SSPP Challenge Director

[Recycling Technologies](#) is working with its industry partners Neste Corporation and [Unilever](#) to develop a chemical recycling plant in Perth, Scotland. It uses a 'thermal cracking' procedure to turn a wide range of hard-to-recycle plastic packaging (such as films, sachets and pouches) into hydrocarbon oil, allowing it to be recycled an unlimited number of times.

The UK's first dual PET bottle and tray recycling facility is being developed by [Veolia](#) in collaboration with [Unilever](#), [Chapak Ltd](#) and [HSSMI](#). This will make it possible to recycle PET pots, tubs, trays and bottles to create non-food-contact recycled material for use in home and personal care product packaging.

The next [ISCF Smart Sustainable Plastic Packaging Demonstrators](#) competition will see a further investment of £16 million into large-scale plastic packaging projects. Recycling is one element of the SSPP challenge, and now this new competition also aims to find solutions to reduce the amount of packaging used and boost reusable packaging concepts.



8 Low-Cost Nuclear



**Challenge Director
Richard Deakin**

The global demand for energy and power, to drive economies and lift people out of poverty, continues to grow. In the UK, the Committee on Climate Change (May 2019) has forecast that by 2050 the demand for electricity is likely to almost double.

But, with 2050 also the deadline for the UK reaching net zero carbon emissions, this energy will increasingly have to be supplied from low-carbon sources.

Increased use of wind, solar and tidal energy will be important but cannot reliably meet the demand; there will still be a pressing need for another reliable, continuous source of low-carbon electricity in the mix.

The UK has a long track-record of successful nuclear energy generation, but building large-scale nuclear power stations can be extremely expensive with the site-based construction of gigawatt-capacity stations taking many years.

The challenge: to show that there is another way.

This ISCF programme is developing an alternative approach – small modular reactors that can be made quickly as a standardised factory-built product, using advanced manufacturing design and construction techniques to drive down costs.

These small power stations will create low-cost, low-carbon electricity for up to 60 years. Each 440 MW unit could produce enough electricity to power 450,000 homes and more than 62,000 electric cars. In future they will be able to power the production of hydrogen and synthetic fuels, adding more momentum to the net zero transition.

We launched the programme in November 2019 with an initial £18 million investment, matched by industry. Working with government, we brought together leading industrial companies, led by Rolls-Royce, to develop these innovative ideas into a concept design, with the support of the UK's leading innovation centres, national labs and academic institutions.

The consortium has made good progress and now, as announced in the Prime Minister's Ten Point Plan for a Green Industrial Revolution, further public funding of £215 million is to be provided through the ISCF for the challenge.

With match funding, the total public and private investment is expected to be more than £500 million and will stimulate further commercial investment across the UK to enable supply and development of a UK low-carbon small nuclear sector.

If successful, small nuclear reactor units could be deployed in the UK by the early 2030s, with a number of units potentially in use by 2050 supplying gigawatts of low-carbon electricity to the UK.

The industry created would enable the UK to share in a global market which could exceed £300 billion. It could generate up to 40,000 jobs in engineering and manufacturing, many for newly-trained engineers, technicians and manufacturers in regions of the UK most in need of long-term economic growth. But most importantly, it promises to make an essential contribution to achieving a net zero carbon society, for the future of the planet.



9 Manufacturing Made Smarter



Challenge Director
Chris Courtney

The UK already has world-leading manufacturing industries. But advances in digital technology have the power to radically transform how we create the products and services of today and the future.

The ISCF Manufacturing Made Smarter challenge programme is aligned with the national [Made Smarter](#) movement. Its purpose is to help business develop the digital innovations that will transform the capability of UK manufacturing, working with our vibrant technology sector and world-leading scientific and research community.

The programme has up to £147 million to invest in the development of smart connected factories, connected and versatile supply chains, flexible manufacturing, and new ways to design, test and make products. The investment is matched by £147 million from industry.

Projects funded so far include a digital robot able to quickly design a bespoke product, artificial intelligence to help businesses with product development, and a digitised food supply chain.

In November 2020 we announced a £30 million investment into the [Made Smarter innovation hubs](#) programme. These hubs – the Smart Factory Innovation Hub and the Digital Supply Chain Innovation Hub – will form a national network helping innovative manufacturers and technology providers of all sizes to work together on transformative digital solutions.

The Manufacturing Made Smarter programme will help the UK to capitalise on its strength and make the most of this huge opportunity: accelerating digital innovation in manufacturing to boost competitiveness, productivity and sustainability, and build the industry of the future.

Made Smarter Technology Accelerator

Advanced technology, such as artificial intelligence and 5G, could help the UK's manufacturing industries navigate the challenges of our time. A new programme aims to drive digitalisation and push forward the fourth industrial revolution for the sector.

The UK's manufacturing industries are facing unprecedented challenges – not least the impact of COVID-19 – but a new programme is helping manufacturers tackle key issues with the latest innovations in digital technology

The [Made Smarter Technology Accelerator](#) is a national programme set to fast-forward and shape the UK's technology adoption directly into industry. Delivered by [Digital Catapult](#), and funded by UK Research and Innovation through the Industrial Strategy Challenge Fund's Manufacturing Made Smarter challenge, it is part of the national [Made Smarter](#) movement that aims to drive growth amongst UK manufacturers and, as a result, advance the UK economy.

"This last year has been incredibly difficult for many industries, and manufacturing has not escaped the impact of COVID-19," said Dr Jeremy Silver, CEO of Digital Catapult. "At the same time, the industry is grappling with the major global challenge of reaching net zero by 2050 and figuring out how technology can help to do that. The combination of these forces means that innovation and collaboration have never been more necessary.

"The Made Smarter Technology Accelerator is designed to help boost productivity and aid the recovery of industry. Ultimately, we hope this will lead to the creation of a more sustainable and resilient manufacturing sector in the UK."

Research commissioned by Digital Catapult and Made Smarter Technology Accelerator reveals that while 71% of UK manufacturers recognise implementing advanced technologies (such as artificial intelligence, blockchain, the internet of things or 5G) would benefit their operations, a combination of budget, cyber security concerns and lack of relevant skills act as a barrier.

The Made Smarter Technology Accelerator is empowering established manufacturers to overcome these hurdles by connecting them with innovative technology start-ups and scale-ups. Industry partners – including BAE Systems,



Babcock and Sainsbury's – have set challenges for these technology businesses in key areas, such as intelligent factory management and control, intelligent product verification and digitally-enabled factory workforces.

The successful applicants are provided with up to £20,000 funding each and a platform to grow as they develop prototypes. In return for both match-funded financial and in-kind contributions, the industry partners gain direct access to the outputs and learnings of the programme, as well as the proof of concepts developed for challenges they set.

"The Made Smarter Technology Accelerator is designed to help boost productivity and aid the recovery of industry."

Dr Jeremy Silver, CEO of Digital Catapult

Also funded through the Manufacturing Made Smarter challenge is [GKN Aerospace](#), which builds and supplies an extensive range of advanced aerospace systems and components, is leading the [Smart Connected Shop Floor](#) project. It focuses on trialling advanced digital technologies and smart devices to exploit the productivity opportunities of the digital space and aid cost-effective manufacturing decisions across supply chains.

The smart connected factory alters production based on smart-connected machines and smart products. These include augmented reality headsets for engineers, so manufacturing businesses can guide them through repairs, and smart devices to exchange information between old and modern computer systems.

"Smart manufacturing can lead to a step change in competitiveness for the UK aerospace industry, as well as having significant benefits in reducing our environmental footprint," said Russ Dunn, Chief Technology Officer and Head of Strategy at GKN Aerospace.

The Smart Connected Shop Floor project was awarded £1,298,070 as part of the Manufacturing Made Smarter Fast Start competition in 2020.

10 Transforming Foundation Industries



**Challenge Director
Dr Bruce Adderley**

Foundation industries produce materials such as metals, glass, paper, cement, ceramics and chemicals. They supply the majority of these to other wealth-generating sectors in the UK including construction, aerospace, automotive and packaging. They employ half a million people and account for around £50 billion of economic value (gross value added, GVA).

These materials cannot realistically be replaced as part of the economy before 2050, and indeed are unlikely to be even within our children's lifetimes. As we move ever more rapidly towards both a net zero carbon and sustainable future it is therefore imperative that these materials are produced in a more environmentally sound, but commercially viable, manner.

The Transforming Foundation Industries challenge programme is designed to both stimulate and pull through the multi-sector innovations that are required to make this happen.

These industries have individually done much to improve their performance in recent decades. It is now clear though that in some key areas it will take their combined efforts to meet these challenges. This programme is therefore also designed to significantly increase the levels of cross-sector innovation being undertaken.

The case studies that follow are two early examples of the above but are just the start. By 2024 the Transforming Foundation Industries challenge programme will have invested in over a hundred innovation projects on the way to meeting its objectives, by deploying £66 million of public funding and at least £83 million of private sector investment.

South Wales With Both Eyes Open

Funding from the Transforming Foundation Industries challenge has shown that by using resources and energy more efficiently across a whole region, collaborative innovation has a dramatic effect on aiding the transition towards a circular economy.

We need to reduce the amount of carbon going into the atmosphere, but that means more than just finding cleaner ways of generating energy. There's also the vital question of how we make stuff.

The production of steel, cement, aluminium, plastic and paper alone accounts for over half of the world's industrial carbon emissions. Yet doing without these materials seems unthinkable; in fact, demand for them is increasing. How can we meet this growing demand without destroying the planet?

'By using materials more efficiently' is the broad answer put forward in an influential book, [Sustainable Materials With Both Eyes Open](#), recently produced by a Cambridge University research team. And applying the book's ideas in one particular part of the UK is the project South Wales With Both Eyes Open.

The project is funded by [UK Research and Innovation's](#) (UKRI) Industrial Strategy Challenge Fund via its [Transforming Foundation Industries](#) challenge, and is led by consultancy [Environmental Resources Management Ltd](#) (ERM). As ERM consultant Hannah Watts explained: "We've brought together a consortium of 13 partners from South Wales covering the foundation industries, industries that produce the materials (cement, glass, ceramics, paper, metals, chemicals) that much of the rest of the economy relies on.

"The aim is to identify opportunities for companies to work together to improve their energy and resource efficiency, creating a local circular economy, where resources can be pooled, or where one company's waste can be used by another."

This kind of cross-sector collaboration might seem obvious, as a way of pursuing not just environmental policies but economic and social ones too – in South Wales's case, giving a valuable efficiency boost to foundation industries that had been in decline.

But in practice there are obstacles in the way of open cooperation: obstacles that have prevented these industries from working together until now. "Companies can't do this themselves," said Hannah. Though they have a wealth of plant data between them, analysing that data, mapping material and energy flows across South Wales and identifying potential opportunities for collaboration, is a complex business.

There are information silos within companies. And there is the more subtle question of trust: helping companies feel comfortable with the idea of sharing potentially sensitive information.

That's what is new about South Wales With Both Eyes Open, and with support from UKRI it has already succeeded in getting backing from major industry players in the region. For Hannah, the project is about "getting the right people round the table, environmental managers and operational managers. And confidentiality is key. We have a legal partner to help frame collaboration and non-disclosure agreements, making them as stringent as our partners need them to be."

With research input from its academic partners, the project has broken new ground in mapping material and energy flows on the large scale. The next stage will involve companies beginning to use this information to pursue efficiencies; for example, through the recovery and reuse of materials, or using waste heat.

Moving to a circular economy in South Wales alone is estimated to be worth £50 million per annum. But this is about more than just Wales. As Transforming Foundation Industries Challenge Director, Bruce Adderley, said: "As a first step in transforming material flows in the UK, this project also offers transferable lessons for other industry clusters in other regions, showing the benefits of cross-sector collaboration, and how resource mapping works in practice."





Glass Futures

A new centre of excellence in glassmaking supported by £15 million of funding from the Industrial Strategy Challenge Fund will help to develop greener ways of working in this and other important Foundation Industries.

Glass Futures is a not-for-profit membership organisation that brings the global industry together with researchers to develop new ways of making glass. The organisation has recently been awarded a £15 million grant from UK Research and Innovation, via the Industrial Strategy Challenge Fund's **Transforming Foundation Industries** challenge, to create a new centre of excellence where new, greener and more efficient manufacturing techniques can be developed.

The centre will be built on the brownest of brownfield sites in St Helens, not just land that had been previously developed, but the site of a former glassworks – testament to the rich history of glassmaking in this part of the UK.

The centre will be built around an experimental furnace, the only one of its kind in the world, that is capable of producing up to 30 tonnes of glass each day. Companies in the glass industry, large and small, will be able to team up with researchers to test new raw materials, develop new products and processes, and provide training in more sustainable ways of working. Glass Futures will offer an environment where manufacturers can work out how to make changes in what they do, without interrupting regular production.

Developments at the centre will also have important implications for companies in other Foundation Industries – businesses making such things as chemicals, ceramics, paper, steel and cement, which (like glass) we cannot do without. These industries share common challenges (such as the need to reduce carbon emissions and use less energy), and the aim is that projects to improve efficiency in the glass industry will provide valuable lessons more widely.

The rest of the cost of the £54 million centre of excellence will be met by the glass industry itself, as well as St Helens Borough Council and Liverpool City Region Combined Authority (who understand that the new facility will bring skilled jobs and inward investment to the north-west of England). As Glass Futures' Director, Richard Katz, explained, while the world as a whole needs to move to low-carbon, more efficient manufacturing processes, that takes collective effort and investment: "No single organisation can enable a global shift in industrial practice, but Glass Futures has begun to show a new path in collaboratively pooling knowledge, resources and effort."

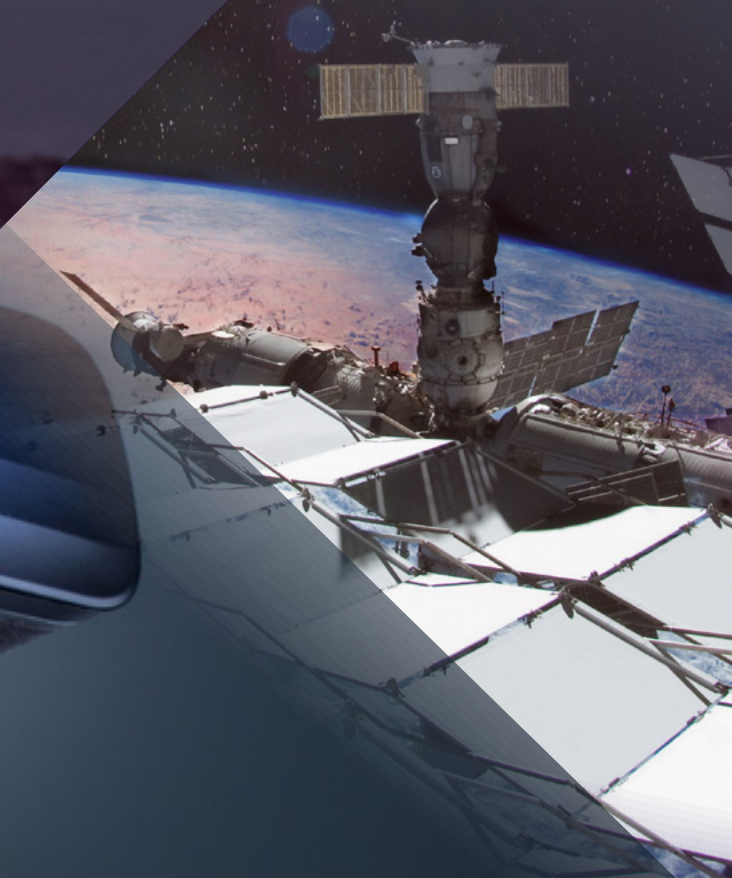
The Transforming Foundation Industries challenge aims to bring the UK's best businesses in sectors such as construction, aerospace, automotive and packaging together with world-leading researchers, to transform how we live, work and move around. Its particular focus is on helping businesses in the Foundation Industries to share expertise, adapt to new technology and find new ways to reduce their carbon footprint.

As Transforming Foundation Industries Challenge Director, Bruce Adderley, explained: "The goal of the challenge is to help industries such as glass, steel, ceramics and chemicals develop new green technologies and more efficient ways of working together. The UK aspires to create the world's first net-zero carbon cluster of heavy industry, and the facility at St Helens is an important contribution to this ambitious project."

Transformative technologies

Challenge programmes

- 1 Robots for a Safer World
- 2 Self-Driving Vehicles
- 3 Audience of the Future and Creative Clusters
- 4 National Satellite Test Facility
- 5 Next Generation Services
- 6 Commercialising Quantum Technologies
- 7 Digital Security by Design
- 8 Future Flight



1 Robots for a Safer World



Challenge Director
Andrew Tyrer

Innovation and technology change has enabled mankind to develop products and services hardly dreamt of a generation or two ago. For example power generation – nuclear and wind – has changed beyond all recognition to keep up with demand, and communication technology is now reliant on the use of satellites.

In our always-connected, always-on society, robotics and autonomous systems (RAS) are truly keeping the lights on.

Many of these new technologies operate in extreme and challenging environments which can be dangerous to work in or hard to reach, including nuclear power, off-shore energy and space-based activity. RAS offer huge potential for safer and easier working in these environments, and that is the main focus of this challenge programme.

The market opportunities are vast. In 2018 the European Commission estimated the European nuclear decommissioning and waste management market to be more than €405 billion.

The Robots for a Safer World challenge was set up in 2016, with ISCF funding of over £97m. Industry has since contributed over £85 million more. With this major investment, we have co-funded 96 industry-led projects across many sectors – from drones inspecting offshore wind farms, to autonomous satellites capturing and decommissioning defunct satellites – as well as four industry-inspired academic led robotics research hubs.

Many successes are already emerging – whether in the form of entirely new robotics applications, or rapid growth of some of the companies involved.

In autumn 2020 the fund gained a further £15 million to continue its work, including addressing new needs resulting from the COVID-19 pandemic such as robotic sanitising of care facilities. As the crisis demonstrates, robots can have an important wider role in creating a ‘low touch economy’ and building a more resilient future.

Whether in extreme environments or everyday life, robots will make our lives safer and easier – and innovative UK businesses will be there.



CEO Mike Jones
with SMD's Quantum
electric ROV

Soil Machine Dynamics

A world-leading manufacturer of underwater remotely operated vehicles is developing electrical systems that benefit the offshore renewables sector.

A consequence of the growing number of offshore wind farms is that there is a lot of cabling on the seabed: cables that need checking and sometimes repairing. While a diver could do it, it is much safer to send a machine.

UK-based Soil Machine Dynamics Ltd (SMD) is the world's largest independent designer and manufacturer of underwater remotely operated vehicles (ROVs). Its ROVs can work just like a diver, detecting faults in under-sea infrastructure and carrying out repairs.

Currently there are around 1,000 ROVs in operation around the world and most have tended to use hydraulic systems because of their need for large amounts of power, delivered quickly. There are problems with hydraulic systems, however, including the fact that they leak oil into the sea. This presents a strong green argument for underwater ROVs to go over to electric power. And with the move to increasingly autonomous vehicles, there is a place for reliable systems that do not require the same degree of maintenance as hydraulic systems.

A grant of £1.8 million from the Industrial Strategy Challenge Fund (ISCF) has supported several strands of work in this area, around a common theme. Named Anemoi after the Greek gods of the wind, one project has focused particularly on developing the electrical components needed to improve the ROVs' manoeuvrability and sensing.

SMD's strategic business and development manager Stephen Wilson explained: "Offshore environments can be extreme. Underwater vehicles can have problems with strong currents, and so a smaller, more compact and more manoeuvrable electric ROV is better able to cope."

SMD collaborated on the Anemoi project with the Offshore Renewal Energy Catapult (ORE) and Magnomatics to develop the core electrical systems that are required for the new ROV, taking them to the prototype stage.

The ISCF grant was then followed by a further £2 million investment by SMD, enabling it to build and test the new vehicles. Key partners Magnomatics designed and developed the new thrusters for the ROVs, using innovative magnetic gearbox technology.

Another feature of the new ROVs is that electrical power can be distributed to wherever it is needed on the vehicle. Electricity can also be sent down to the ROV from a boat up to 6km away: new technologies enable the DC current used on the boat to be converted to the 680 volts used by the ROV.

Other aspects of the Anemoi project included work on cable repair, with testing being carried out at the facilities of the ORE Catapult. With cables buried in the seabed, being able to find, lift and repair them is no easy job.

While the new, all-electric ROVs are particularly important for the offshore renewables sector, they have value in others, too, including the oil and gas sector where they are used to support drilling, for maintenance and repair, and for underwater construction.

Historically, SMD has had a market share of around 20% of all independently supplied ROVs (of which there are around 1,000 worldwide). With increased control, greener credentials and the ability to operate the ROVs over long distances, the move to electric power should enable SMD to remain a key player in the market.



Rovco

Rather than using human divers, it's much safer to have machines working on undersea structures. But for that, we need to see clearly what they're looking at...

Increasingly, remotely operated vehicles (ROVs) are being used for underwater construction and decommissioning, especially around offshore wind farms. But gone are the days when a human operator would have to spend hours looking at a poor-quality video stream, trying to make sense of what the ROV was seeing through murky seawater.

With support from the Industrial Strategy Challenge Fund, undersea robotics specialists Rovco have been developing 3D autonomous vision technology for underwater ROVs, meaning that the vehicles can send back a much clearer picture of what's down there.

Rovco's innovations have been in two main areas. The first has been the development of its SubSLAM x2 system: two cameras that sit on top of the ROV and help to build up three-dimensional models of underwater assets. These 3D models give much more detail than could be seen on a video feed. Yet because the models need much smaller data packets than are required for video streams, they can be sent back more easily to an operator in a boat or on shore (communications between the shore, a support vessel and the ROV being limited by bandwidth). The operator can see in real time exactly what the ROV is looking at, and make decisions accordingly.

The other aspect of Rovco's work has to do with artificial intelligence. Using machine learning, underwater debris or damage can be automatically identified, as can the different features on a pipeline. A human operator can focus their attention on those things that the AI has identified as being a problem.

The ISCF-funded project was in two phases, the first being a feasibility study, developing initial versions of the technology and testing them to show they would work.

This was then followed by development of the cameras, the point cloud reconstruction software used to build the 3D models, and the machine learning software.

The Offshore Renewable Energy Catapult helped by engaging with end users, including Scottish Renewables, to find out exactly what they need. The Catapult's dry dock facility at Blythe has also enabled testing – the base of a wind turbine was installed in the dock when it was empty, and it was then scanned. When the dock was filled with water, the 'dry' scan could then be compared with what the underwater ROV interpreted as being there.

“We're removing people from potentially dangerous areas of work.”

Helen Murray, technical project manager, Rovco

For Rovco's technical project manager Helen Murray, giving underwater ROVs better vision is another step in making offshore renewables viable. “There are economic benefits in terms of cutting down the number of people who are needed on offshore support vessels. This means that smaller vessels can be used, and those vessels need less fuel – so there are environmental benefits too. Finally there are safety benefits: as ROVs improve, we're removing people from potentially dangerous areas of work, and moving them more to the analytical side of things.”

SubSLAM x2 has already been used successfully on projects in Egypt, Taiwan and Malaysia, as well as on sites around the UK.

2 Self-Driving Vehicles



**Challenge Director
Paul Gadd**

In the near future, self-driving vehicles will transform urban environments. Autonomous vehicles will travel the streets, available for people to share their journeys. This revolution will massively reduce traffic congestion and make car transport more accessible and cheaper for all.

To help the UK become a world leader in self-driving vehicle technologies, we are investing £28 million to help businesses and researchers develop next-generation artificial intelligence and control systems and prove they can work in the real world.

We have co-funded three major projects under this programme.

The Robopilot project led by Arrival (see next page) is demonstrating autonomous driving for an electric delivery van, potentially opening up the future market for self-driving light commercial vehicles including trucks and buses.

The other two projects are DRIVEN (see page 37), which is trialling a fleet of fully autonomous vehicles within and between cities, and **Streetwise**, which is demonstrating how new technology, safety validation, insurance and service models can come together to make self-driving cars a reality.

The Government estimates that the global market for connected and autonomous vehicles could be over £650 billion by 2035. Together, this challenge programme and investment from the **Centre for Connected and Autonomous Vehicles** have helped ensure the UK is a world-leading destination to develop and deploy self-driving vehicles. This in turn is allowing the UK to reap the economic and societal benefits.



Arrival

UKRI-backed firm achieves 'unicorn' status

UK electric vehicle maker Arrival attained a valuation of €3 billion following backing from the Industrial Strategy Challenge Fund

A UK maker of electric, autonomous-ready vehicles backed by UKRI has achieved 'unicorn' status (a valuation of more than \$1 billion). Arrival's valuation in early 2020 put the company's value at €3 billion (around \$3.34 billion at the time) following an investment of €100 million from Hyundai Motor Group. The investment is part of a strategic partnership between Arrival and Hyundai whose aim is to help facilitate a global transition to electric vehicles.

The news of Arrival's 2020 valuation was followed by an announcement that UPS had placed an order for 10,000 of Arrival's electric delivery vehicles with the option of a further 10,000 over the coming years. Arrival claims its vehicles represent an advance over previous iterations of commercial electric trucks and vans by costing the same as petrol and diesel equivalents and providing a better experience for all stakeholders. The move is part of UPS's strategy to transform its fleet to zero emissions.

In October 2020, Arrival announced that it had secured a further \$118 million of investment from funds managed by BlackRock, to continue its growth.

Nick Clay, head of homologation and regulatory affairs at Arrival, said, "Arrival's vehicles represent a new category of electric transportation that surpasses traditional equivalents in their design and their cost.

"Arrival's focus is on the experience for everyone who interacts with an Arrival product – that might be the driver, the passengers, a cleaner or fleet operator. In addition, we have worked so that our zero-emissions vehicles achieve price parity with fossil-fuel equivalents, with customers making even greater savings over the lifetime of the vehicle."

To meet the anticipated demand from the transportation and logistics industry, Arrival will build microfactories located close to areas of demand and utilising local supply chains, the first of which has opened near Bicester, Oxfordshire.

Nick said, "Our microfactories have been designed with a minimal footprint so they can be located closer to urban areas and produce products that are custom for the local market. This smaller footprint also means that they will cost less to build and be quicker to deploy so we can bring our products to market more rapidly."

Arrival's recent success comes off the back of government-funded research and development. The company took part in five research projects in 2018 and received total funding of £7.5 million. Of this, £5.6 million was funding for the Robopilot project, through the ISCF Self-Driving Vehicles challenge programme in partnership with the [Centre for Connected and Autonomous Vehicles](#). Led by Arrival, this project is developing autonomous driving capability for the company's electric delivery vans and demonstrating their use on a ten-mile trial route of mixed public roads - paving the way for self-driving commercial vehicles in the future.

As of 2021 Arrival's valuation has grown to £9.5 billion, and its staff to 1,600 globally, as it has focused efforts on developing the wider ecosystem around its zero-emission vehicles, including self-driving technology, charging and software, with the goal of creating an integrated transportation system for cities that is sustainable. The company's most recent product, the Arrival Bus, is described as a 'best-in-class' zero-emissions bus designed with the end user's experience in mind, focusing on providing an attractive, hygienic and comfortable environment for urban travel. Trials with FirstBus, one of the UK's largest transport operators, are planned for autumn 2021.

Said Nick, "Through projects with Innovate UK, we have fostered relationships with industry leaders such as UPS, EDF and First Group, helping to build our reputation and expand our knowledge as we seek to make urban environments sustainable."

Oxbotica

Autonomous software business supported by the Industrial Strategy Challenge Fund (ISCF) raises \$47 million investment and new partners as it takes its autonomy platform to market.

Oxbotica has used the latest techniques in computer vision, machine learning, robotics and artificial intelligence to build a platform that can automate vehicle systems indoors and outdoors on any scale.

The software, developed with funding from UK Research and Innovation (UKRI) and the [Centre for Connected and Autonomous Vehicles](#) (CCAV), is already being trialled and deployed around the world in a range of environments including mines, quarries and city streets.

Oxbotica recently attracted a \$47 million investment led by [bp Ventures](#). bp aims to deploy its first autonomous vehicle for monitoring operations at its Lingen oil refinery in Germany by the end of 2021 after a successful trial of the Oxbotica software. It has signed partnerships with businesses that will help it incorporate its software into commercial products. Partners include automotive technology firm ZF, mining technology expert Wenco, IT leader Cisco and developer of high-tech radars Navtech Radar.

Oxbotica's Vice President for External Affairs, Graeme Smith, said: "We see self-driving vehicles rolling out at different paces in different environments. The simpler environments come first. Mining, construction, logistics, freight and low-speed shuttles are areas where we can deploy quickly."

Oxford-based Oxbotica was founded as a spin-out in 2014 by University of Oxford professors Paul Newman and Ingmar Posner, who had developed the science with support from the Engineering and Physical Sciences Research Council. The company has more than tripled in size over the last couple of years, with over 150 of the brightest minds in the industry now working towards their Universal Autonomy vision.

The company went on to win UKRI and CCAV funding for major trials of autonomous vehicles including:

- taking part in the GATEway project that saw a fleet of driverless pods provide a trial shuttle service in Greenwich
- leading the DRIVEN project that led to the demonstration of a fleet of vehicles in Stratford over several weeks in 2019
- leading ENDEAVOUR, the UK's first multi-city autonomous vehicle demonstration, with trials taking place in Oxford, London and a third major UK city throughout 2021.

Smith added: "These projects have been an opportunity to follow our own vision and to showcase what we can do on a world stage. We wouldn't be where we are today without all the support we have had. We'd still be in the early stages. It's not just the funding, but equally important has been the support and advice we have had from the individuals working at Innovate UK and CCAV."



3 Audience of the Future and Creative Industries Clusters



Challenge Director
Professor Andrew Chitty

The UK's creative industries lead the world. The sector's growth over recent years has made it even more central to our economy, contributing more than £11 billion per year.

But technology moves fast, and this sector is like any other; staying ahead depends on making the most of the opportunities that science and innovation bring.

UKRI's Audience of the Future and Creative Clusters programmes aim to ensure the UK maintains its leadership position in creative content, products and services.

The Audience of the Future programme deals in immersive experiences and their associated technologies – virtual reality, augmented reality and mixed reality.

We can now blur the line between these technologies and other sensory interfaces together with data. Offering powerful new experiences, this promises to have the most disruptive impact on the creative industries since the world wide web in the 1990s.

By 2024 the global immersive technology market could be worth as much as £101 billion. If the UK does not embrace this opportunity, it becomes a threat to our competitiveness.

This programme is investing £39.3 million in helping UK business and researchers to develop and exploit these technologies, including:

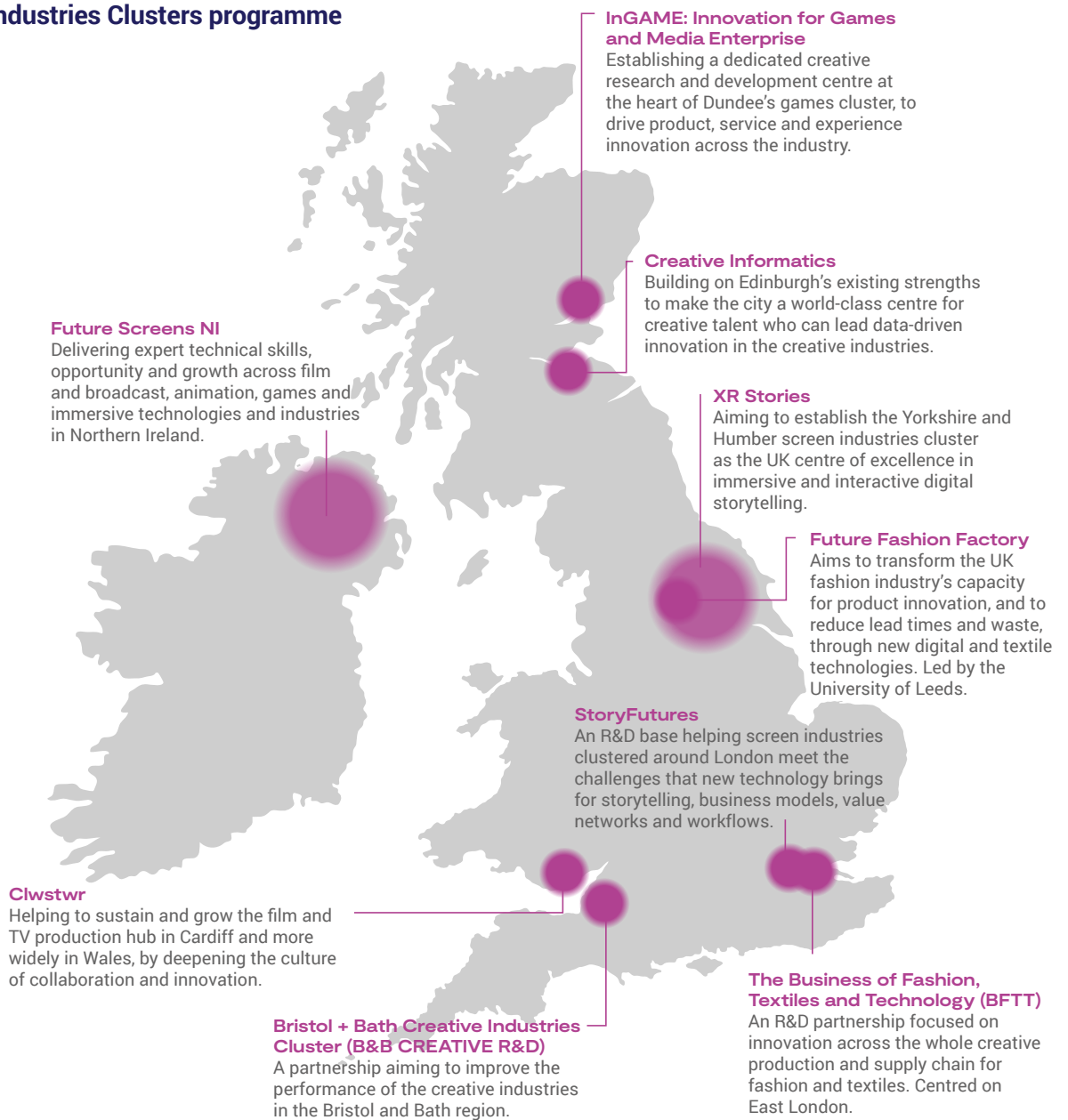
- large-scale demonstrators to show how immersive technologies can be used to reach new audiences and build new business models for the screen industries, live performance, learning, museums and sport
- a range of investments in innovation to build platforms to create immersive content faster and more efficiently, drive adoption and explore human-centred design
- an immersive technology investment accelerator to support early-stage businesses.

Creative Industries Clusters

But immersive technology is only one aspect of creative sector innovation, and in 2018 UKRI launched the £80 million [Creative Industries Clusters programme](#).

Clusters often grow naturally, as collaborations thrive and groups of symbiotic companies become established in specific locations, working with local universities and investors and developing a skilled workforce.

The Creative Industries Clusters programme



Recognising their power, we have invested in nine clusters – which bring together some of the finest creatives in fashion, film and television, informatics, design, gaming, performance and immersive technology and link them with leading academic minds.

Together, they are redefining how industry and researchers can work together, in regions across the UK, to develop new creative products, services and experiences.

From bringing 16th-century art to life through virtual reality, to exploring how artificial intelligence can help journalists in an age of fake news, to a new national centre for immersive storytelling, the projects promise to create a pipeline of new products, services and talent for years to come.

Together, the ISCF's investments will help the UK to remain an economic powerhouse for creative industries in this rapidly-changing world.

Wallace & Gromit: The Big Fix Up

A cutting-edge new platform for storytelling supported by the Industrial Strategy Challenge Fund is using the latest in augmented and mixed reality to create an immersive adventure for Wallace & Gromit fans.

Fans have watched Wallace & Gromit conquer the moon, vanquish evil penguins and foil a plot to steal sheep – and now state-of-the-art storytelling technology means they can take part in the duo’s next epic adventure.

[Wallace & Gromit: The Big Fix Up](#) brings together the latest in augmented and mixed reality to create a first-of-its-kind, story-driven multiplayer adventure which blends storytelling and gaming into one world. Available as an app for mobiles and tablets, it allows players to conjure up the traditional clay characters in front of them and interact in an entirely new way – creating a new platform for storytelling and engaging with audiences of all ages.

It was created by [Fictioneers](#), a consortium of British companies, including [Potato](#), [Sugar Creative](#) and [Tiny Rebel Games](#), with research support from the University of South Wales, and in collaboration with the creative team at [Aardman](#) (creators of Wallace & Gromit).

“We’re thrilled to be working with our friends at Aardman to deliver the first augmented Wallace & Gromit story. At Fictioneers, we are on a mission to innovate storytelling with our groundbreaking methodology. It is a rare privilege to be able to do so with some of the most beloved animated characters in the world and to give fans the first opportunity to join in Wallace & Gromit’s story,” said Susan Cummings, Co-Founder of Fictioneers.

“At Fictioneers, we are on a mission to innovate storytelling with our groundbreaking methodology.”

Susan Cummings, Co-Founder of Fictioneers

Fictioneers received a £2.4 million Audience of the Future grant via the Industrial Strategy Challenge Fund to explore and pioneer cutting-edge immersive experiences. The story, based around Wallace & Gromit’s new business venture ‘Spick & Spanners’, plays out in a variety of media, including multi-user augmented reality gameplay, new computer-generated animations, in-character phone calls, comic strips, Extended Reality (XR) portals and more.

Launched in November 2020, the experience can take place entirely within a user’s home and garden. The story is set in the city of Bristol (the home of Aardman), which Wallace is given a contract to ‘fix-up’. However, the job is too big for him and so the audience is ‘employed’ to help. People from all across the UK will be able to take part in the full end-to-end adventure, with future plans for a global roll-out.

Fictioneers is also looking to add further technological features, including Wallace & Gromit Snap lenses, within the app experience before the 2021 launch. The team is seeking 5G sponsorship for an HD experience at live events, and is creating ‘Rogue Lad’, a spinoff adventure to license to theme parks as a ‘play-at-resort’ experience.

© Aardman Animations/W&G Ltd. &
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ScanLAB Projects

Pioneering technology allows scientists and the public to see natural processes in a unique new way.

While many of the effects of climate change are known, they can often be difficult to visualise. But now a team at London-based creative company [ScanLAB Projects](#) has developed technology that allows both scientists and the public to see – and even ‘experience’ – some of the most complex natural processes in 3D.

Led by architects Matthew Shaw and William Trossell, ScanLAB Projects specialises in 3D scanning to create digital replicas of buildings, landscapes, people and objects for use in film, television and immersive media, such as gaming and virtual reality.

While existing 3D technology is able to capture a single moment in time, ScanLAB Projects has created [FRAMERATE](#): technology that can scan moving things – from the small scale of a bird in flight all the way up to the changing seasons in a forest.

“At the small scale, existing technology to scan moving people is expensive and you have to go to a big studio,” explains Matthew Shaw. “FRAMERATE produces similar quality 3D capture at a fraction of the cost. The equipment is also much smaller, so you can take it on location; for example, to capture lions in the Serengeti.”

With the company’s background in work for television and film, it was originally envisioned that FRAMERATE would grab the attention of creative industries, but the greatest interest has come from the scientific community.

Using a £174,000 audience of the future grant from UK Research and Innovation, ScanLAB Projects was able to fund research and development into FRAMERATE technology, and also produce sample content. These included scans of woodlands, a National Trust garden and, most dramatically, a section of Norfolk coastline subject to erosion.

“3D scanning creates point clouds – millions of precisely measured points in a space – so it looks three dimensional

and, if you use a VR headset, you can ‘step into’ that world,” explains Matthew. “The software we developed for FRAMERATE allows lots of single point-cloud images to be played together, like the difference between a photograph and a film.”

FRAMERATE scans moving things – from the small scale of a bird in flight all the way up to the changing seasons in a forest.

The technology works both at scale (capturing 1 km sections of coastline at a time) and in detail (down to individual pebbles). The result was a few minutes of immersive film that captured the interest of the [British Geological Survey](#) (BGS).

“Their jaws dropped when they saw it,” says Matthew. “These are processes they’ve studied for years, but they’ve never seen them visually in this way before.” BGS went on to fund £45,000 to continue the scanning process and is using the data for research.

ScanLAB Projects has also had interest from research institutions, councils and government agencies, and it is exploring ways to finance a wider exploration of the scientific implications of FRAMERATE. “We also believe it could be used as an effective communication tool,” says Matthew. “Concepts like climate change and coastal erosion can seem quite nebulous. This technology offers a way for the public to see months’ or years’ worth of these processes in just a few seconds – and with VR they can even explore them.”

4 National Satellite Test Facility



**Professor
Chris Mutlow**
Director of RAL Space

The UK space sector is thriving. UK space industry income was £14.8 billion in 2016/17, equivalent to 5.1% of the global space economy – and the ambition is to reach 10% by 2030.

As well as its own contribution, the space sector supports some £250 billion of the UK economy by providing space-enabled data and applications that are widely used in other sectors.

But to maintain and develop the UK's position in this global market is a continual challenge. In 2017 the UK Space Agency published a Facilities Review, which highlighted a particular gap in the UK – for a comprehensive and accessible set of satellite test capabilities, at a single location.

To address this need, the ISCF is investing £105 million to build a new facility at RAL Space, part of the Science and Technology Facilities Council at the Harwell Campus in Oxfordshire.

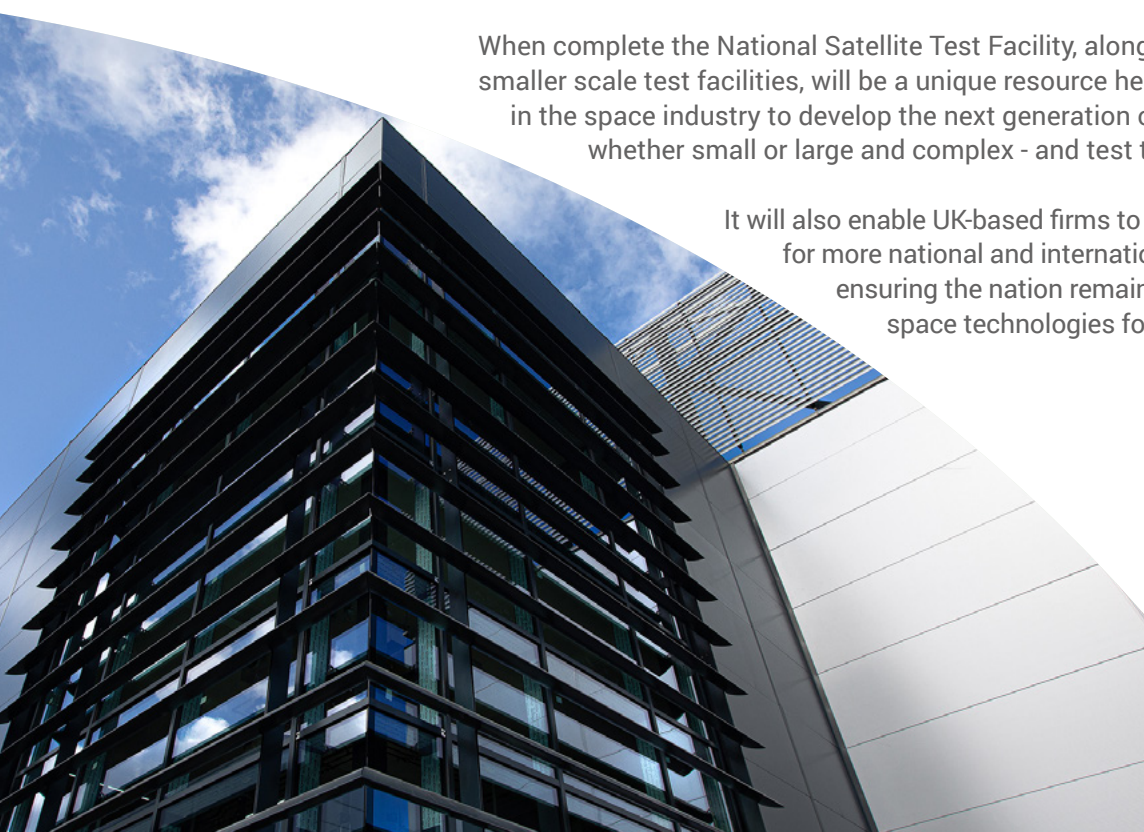
The National Satellite Test Facility will be run on a commercial basis and adds to RAL Space's existing space test capability. It will enable assembly, integration and testing of large space payloads and satellites up to seven tonnes.

The new facilities include large 'clean rooms' for satellite assembly and preparation, as well as equipment for testing on aspects of satellite technology such as inertia, vibration, electromagnetic emissions and performance in a vacuum.

Construction and installation are well under way and the new specialist facilities will be open from summer 2022.

When complete the National Satellite Test Facility, alongside our existing, smaller scale test facilities, will be a unique resource helping companies in the space industry to develop the next generation of spacecraft – whether small or large and complex - and test them in the UK.

It will also enable UK-based firms to bid competitively for more national and international contracts – ensuring the nation remains a world-leader in space technologies for decades to come.



5 Next Generation Services



**Challenge Director
Stephen Browning**

The UK's professional and financial service industries, whether law, accountancy or insurance, have a world-leading reputation and are vital to the UK economy. The financial and professional services sectors alone are worth £190 billion and employ 2.2 million people.

But with the rise of artificial intelligence (AI) and the increasing use of data, these industries are on the verge of significant disruption. Many countries are jockeying to take a lead in AI, and foreign governments are going out of their way to help their professional services companies adopt new technologies and become more efficient and productive.

To maintain and grow our leadership position we must invest in research and development, using technologies such as AI and data analytics to develop the next generation of services. There is catching-up to do, as in the past professional services have been less focused on R&D than many other sectors.

That urgent need is the aim of this challenge programme under the ISCF.

To date, we have invested around £20 million in more than 40 research and development projects and the **AI for Services Network**. Some are developing the potential of artificial intelligence and data technologies to transform the UK accountancy, insurance and legal industries. Some are looking at ethics and developing responsible data access or sharing methods. And some are investigating the behavioural, social and technical barriers to take-up of these technologies in these service sectors.

AI is potentially the most transformative technology of our time. This programme will help ensure UK professional and financial services can benefit, using innovation to compete in the global service economy of the future.

Xavier Analytics

A company supported by the Industrial Strategy Challenge Fund is helping SMEs take accounting beyond taxation and use financial reporting to drive their businesses forward.

Many small companies see accountancy as a simple tool to help them pay their taxes and keep on the right side of HMRC.

But a UK Research and Innovation-backed firm, [Xavier Analytics](#), has developed an innovative app-based accountancy review system that not only makes basic financial data error identification and clean-up straightforward, it also helps provide meaningful, data-driven business insights.

“Getting real clarity of your financial situation can be a massive asset when it comes to making strategic business decisions,” says Richard Nicolson, one of Xavier’s founding team and head of operations.

To achieve this Xavier provides a comprehensive toolkit of intelligent bookkeeping and compliance tools that use AI-assisted analysis to identify problems such as mis-codings, as well as track key liabilities, detect payment anomalies and quickly spot unwanted changes to historical data.

Customer Aaron Sutton, cloud systems and integration advisor at [Garbutt + Elliott](#), said that using Xavier had helped speed up processes that would have previously taken a lot of time, such as the multi-coded contacts feature that highlights account and tax rate mis-coding.

Another customer claims Xavier enabled him to spot £39,000 of missed VAT claims over a 20-month period.

Richard said: “Normally, these kinds of insights are only available to large companies with big accountancy teams. But our software helps small firms get the same kind of meaningful financial clarity. We help save them time and reduce errors on a daily basis.”

Xavier is the result of a partnership between accounting agency [FD Works](#) and web development agency Hatch Apps (now incorporated into Xavier Analytics).

Xavier won second-place prize for Best New App (EMEA) in the 2018 Xero hackathon, and was soon after accepted into [SETsquared Bristol](#), an incubator for high-tech, high-growth startups based in Bristol.

“The idea was to help reduce small business failure rates through greater preparation and understanding.”

Richard Nicolson, co-founder and Operations Director, Xavier Analytics

In 2019 the company was granted £380,000 of funding from the Industrial Strategy Challenge Fund’s Next Generation Services challenge for a feasibility project exploring the use of AI in accounting to create a comprehensive benchmarking dataset and insights for SMEs.

“The idea was to help reduce small business failure rates through greater preparation and understanding,” said Nicolson.

In June 2020, Xavier was acquired by leading digital accounting platform [Receipt Bank](#), to become part of the Receipt Bank product portfolio, although the founding team have remained working on the project in Bristol.

Richard said: “It’s a really cool story, a real journey. We’ve come a long way in a short time and had a big impact. We couldn’t have done it without UKRI.”



Orbital Witness

New technology spots key legal issues in real estate transactions.

Anyone who has ever bought a house will know the time and expense involved with legal checks. It's a system that is complicated for individual homeowners and further amplified when it comes to complex commercial real estate transactions.

Now a team at London-based, legal-tech firm [Orbital Witness](#) has developed AI-powered software to make the process more efficient and transparent, with a long-term aim of creating a 'one-click' legal risk rating similar to those used to instantly assess credit ratings.

"The process of recording and registering property rights hasn't really changed in over 100 years. Property lawyers still have to collect and read through information on numerous issues, such as rights of way, planning constraints and boundary walls. It's laborious and unprofitable for legal teams, and costly and frustrating for clients," said Will Pearce, who co-founded Orbital Witness in September 2018 with Ed Boule.

Using £384,080 in Innovate UK funding via the Industrial Challenge Strategy Fund's [Next Generation Services challenge](#), Orbital Witness began working with [Stuart Middleton](#) of University of Southampton, an expert in [Natural Language Processing](#), a sub-field of AI. Their aim was to "bring due diligence into the 21st Century" and develop algorithms that could extract and analyse legal rights and obligations from [HM Land Registry](#) documents (a project sponsor).

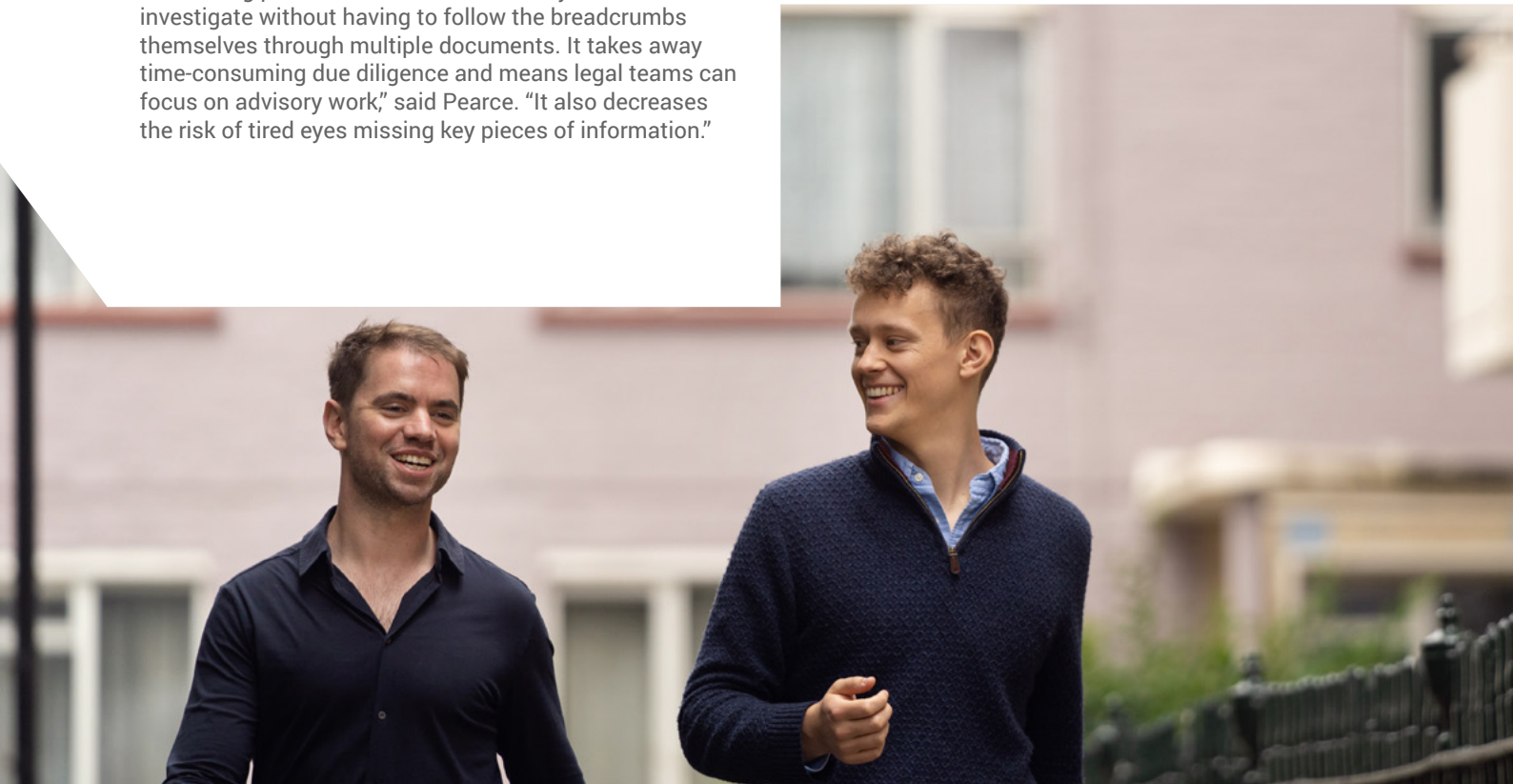
"The technology trawls through the information and is able to flag potential risks, which the lawyer can then investigate without having to follow the breadcrumbs themselves through multiple documents. It takes away time-consuming due diligence and means legal teams can focus on advisory work," said Pearce. "It also decreases the risk of tired eyes missing key pieces of information."

"The technology trawls through information and is able to flag potential risks, which the lawyer can then investigate."

Will Pearce, co-founder of Orbital Witness

The project was supported by leading London law firm [Mishcon de Reya](#) and insurance broker [Lockton Companies](#) who helped provide input on commercialisation within the legal and insurance industries. The technology is currently being used on around 2,000 properties a day with a focus on commercial real estate investment and development. The company has raised £3.3 million in seed funding and is now working with all five of the prestigious 'magic circle' law firms.

Future plans include analysis of a broader range of data – including non-legal and geographic information, such as flood risk – to provide a comprehensive risk-rating tool for the real estate and insurance sectors. "Real estate is the world's largest asset class but there is very little transparency," said Pearce. "Our aim is to make it possible to transact real estate far more quickly, and for anyone to understand the potential legal constraints surrounding a property with a click of the button."



6 Commercialising Quantum Technologies



**Challenge Director
Roger McKinlay**

We already live in a quantum world. Quantum science is behind the optical communication systems in the internet and the chips in our smartphones. A second generation of quantum technologies will transform our lives with more powerful computing, resilient navigation and timing systems, sensitive imaging for medical diagnostics and secure communications.

Our ISCF challenge programme, Commercialising Quantum Technologies, is playing a key part. In 2020 alone we committed £75 million to 38 exciting new projects (involving 84 businesses and 29 universities and research organisations) as part of our £153 million programme. Some of these projects will keep the UK in the forefront of quantum computing, while others will produce sensing and communications devices for markets which are emerging fast. The gas leak sensing project by QLM featured on the next page is a good example.

The four Quantum Pioneer projects in which we invested £20 million in 2018 will complete in 2021. The projects include sensors for underground surveys, secure encryption technologies, advanced receivers to flag if data has been accessed by others, and a prototype of a miniature atomic clock as a back-up for crucial infrastructure services.

The **National Quantum Technologies Programme** – of which ISCF is an important part – is on track to invest £1 billion of public funding over its ten-year life.

In January 2021 we launched the first of a new competition round to allocate the remaining £63 million of programme funding. We already have successes under the belt. The portfolio of companies we have invested in is attracting private finance faster than our grant funding is being used – over £100 million of private investment over the past two years. We are part of a new quantum-ready economy – not just creating amazing technology.

SPLICE

Revolutionary new technology funded by the Industrial Strategy Challenge Fund's Commercialising Quantum Technologies challenge will make industrial gas leaks easier to detect.

As the world transitions to sustainable energy, natural gas is seen as the 'least bad' fossil fuel to use in the meantime, as it burns the cleanest. However, natural gas is mostly made up of methane (many times worse for the atmosphere than CO₂), so industrial gas leaks, vents and exhausts are a problem for the planet, as well as being expensive.

The trouble is, detecting leaks of an invisible gas is a costly and time-consuming business, involving painstaking inspection by hand. When a particular leak is found, it can be difficult to measure how much gas is being lost, and so how urgent it is to fix. Furthermore, traditional inspections only provide a snapshot – if an otherwise leaky component happens not to be leaking on a certain day, it may be missed until the next survey, months down the line.

The two-year [Single Photon Lidar Imaging of Carbon Emissions](#) (SPLICE) project is developing a better alternative, aiming to bring to market highly sensitive gas imagers that can monitor facilities continuously, detect, quantify and model the development of leaks, and notify plant operators immediately when gas escapes. Costly losses of gas will be reduced, facilities made safer, and greenhouse gases kept out of the atmosphere.

The SPLICE consortium is using some revolutionary UK research in this, in the field of quantum technology. Using quantum single photon detection coupled with tunable diode lidar technology, new imaging techniques are able to visualise and quantify concentrations of gas with a clarity that is impossible with traditional methods.

Together with QuantIC, the Quantum Enhanced Imaging Hub, and commercial photonics expert IDQ, project leader [QLM Technology Ltd](#) (a spin-out of the University of Bristol) had already demonstrated the potential of quantum gas imagers. But the technology remained at prototype level and limited to the detection of a single gas (methane).

With support from the Industrial Strategy Challenge Fund's [Commercialising Quantum Technologies](#) challenge, SPLICE is developing the prototype to the point where it can be sold. As QLM's Applications Manager, Doug Millington-Smith, explained: "The new sensors will be robust, cost-effective and eye-safe, and because they need only a few hundred photons a second, they do not need co-located mirrors to reflect the laser back to the detector – the light scattered back from the lidar is more than enough."

The SPLICE consortium includes gas emissions experts at the National Physical Laboratory, and natural gas and industrial sensor leaders National Grid, AMETEK Land and bp, who will be helping to validate the imagers for commercial use.

The Universities of Sheffield, Aston and Bristol, meanwhile, are working to expand the range of gases that the new sensors can detect, to include many other greenhouse gases. This means that, while initial applications will be based around leak detection and repair (LDAR) in the oil and gas industry, the sensors could soon be used in other industry sectors where unplanned gas emissions are a problem; for example, in the agriculture and automotive industries.



7 Digital Security by Design



Challenge Director
John Goodacre

Cybersecurity is a major UK government strategic priority. The World Economic Forum Risks Report of 2020 states cyberattacks have become a common hazard for individuals and businesses, ranking them as the seventh most likely and eighth most impactful risk, and the second most concerning risk for doing business globally over the next 10 years. Hacking, cyber-attacks and malicious software use are growing, with major breaches increasingly occurring in critical infrastructure and across society.

Despite the high risk, the fact is that global economies are underpinned by computing platforms that are insecure in their very design – and have been like that for decades, with market dynamics failing to address the issue. Studies show that 70% of computer vulnerabilities are associated with errors in the way computer software manipulates memory; the entry point for hackers in most cyberattacks.

UKRI is investing up to £70 million from the ISCF, which is then more than matched by £117 million of industry co-investment. Together this will address the market failure, investigating and delivering a prototype system and technologies that together can create a step-change in the security of future computing systems.

To achieve this vision, the Digital Security by Design challenge programme has three key objectives:

1. To create a prototype secured hardware platform which can protect the integrity and resilience of software, blocking most memory vulnerabilities so future products can meet cyber-security requirements
2. To enable the core technologies for more secure platforms, stimulating investment in new scalable businesses and speeding up the delivery of more secure digital products and services.
3. To accelerate digital transformation through demonstrator projects showing increased productivity and reliability of digital services.

We are co-funding a range of projects to help researchers, with industry, to develop the prototype hardware platform and build the software skills and development tools needed – working to create a future of digitally secured-by-design products and services.

Arm Morello Project

Working up from the central processor to block global cyber vulnerabilities.

The processor technology used in most of the world's computer systems is based on a processing model that was first defined in the 1960s, and that has subsequently been adopted by most computer chip vendors. But by the 1970s this model was already being criticised because of the security issues that arise when software makes errors in its handling of data. These errors have accounted for around 70% of all reported computer vulnerabilities, and they are at the heart of many of the major cyberattacks around the world.

Researchers have investigated this problem and proposed solutions to it, but a market failure has prevented research outcomes from being commercially adopted. Without software support the development of new hardware has been hampered, while there has been little commercial motivation to write new software for hardware that does not yet exist.

The aim of the Digital Security by Design Challenge (DSbD) is to overcome this market failure, and help develop the technology that is required to protect the digital economy, products and services of the future, not just in the UK but worldwide. DSbD is bringing about a step change, looking at how the processors that are at the centre of all digital systems can be modified, to protect them from those who would attempt to exploit cyber vulnerabilities.

A key part of the DSbD programme is a project in which Arm, a leading British semiconductor and software design company, is working with Cambridge University and other key collaborators to create what they have called the Morello platform, a prototype that will drive a radical shift in the approach to combating cyber threats.

The Arm Morello project will show how key research ideas, developed with the University of Cambridge over the last few years, can be taken from the lab and applied on a commercial scale. The project involves building a new processor, and working with the broader community of participants in the DSbD programme to raise awareness of the new DSbD technologies, and so help them to be adopted and used.

Since the base computer model that it uses is common to most computer chips, the essential design of the new prototype is openly available for adoption by any processor vendor. As such this work could affect every computer everywhere in the world – making them more secure, and reducing the cyber harm that is inflicted on businesses, infrastructure and society in the years to come.



THG Soteria Project

A demonstrator project is testing the benefits of new Digital Security by Design technologies for improving online cyber security.

Along with any e-commerce platform comes constant cyberattacks, especially cyberattacks that are aimed at sites that have a high profile and large presence.

The Digital Security by Design Challenge (DSbD) aims to bring about a step change in the way that cyber security can tackle threats such as these, using digital security that is designed into the heart of the computer.

As an important part of Digital Security by Design, £5.8 million has been awarded to a consortium led by THG Holdings plc. Together with academic researchers from the University of Manchester and the University of Oxford, THG will test the benefit of DSbD technologies to enhance the foundations of e-commerce computing infrastructure.

Digital security for customers and clients is at the heart of what THG does, as a leader in pioneering new ideas and technology within this space. THG has become a globally renowned end-to-end tech platform, specialising in direct-to-consumer e-commerce worldwide. Using its Ingenuity platform that it has developed, THG focuses on beauty, nutrition, consumer and luxury brands, and currently supports e-commerce sites in 31 languages, using 39 currencies, across 169 countries.

As a demonstrator of technologies being developed through Digital Security by Design, the THG Soteria project will bring together technical expertise on managed runtimes, smart network technologies, business optimisation and formal verification, to assess how we can improve the security that we as a society have come to rely upon.

The THG demonstrator will test the benefits of the new technology, to improve the security of e-commerce, increase productivity, and help with the development of future world-leading services and products, with the outcome of the project ultimately improving the online security of THG products and offerings.

The THG project will add a crucial demonstration element to the Morello project, which is developing the DSbD technology platform prototype led by Arm.

A successful outcome of the project will be the creation of knowledge and skills that will be required for UK businesses to benefit from the anticipated step-change in cyber security, as they are able to deliver more secure online services.

THG operates both as a business-to-consumer e-commerce company and a business-to-business online platform company. The purpose of its involvement in the Digital Security by Design Challenge programme is to understand the impacts and opportunities of these technologies, and will help gain the interest of many other online businesses, as well as end consumers of online commerce services.



8 Future Flight



**Challenge Director
Gary Cutts**

Flight, in all its guises, is an intrinsic and growing part of modern society – and UK businesses and technologies have a strong global presence in every aspect of aviation.

But environmentally, we cannot afford to indefinitely expand flight in its traditional form – using large, heavy fossil-fuel powered machines to lift people and goods into the air.

The ISCF Future Flight challenge programme is exciting because it combines two opportunities: finding entirely new ways to move people and things around the planet, and helping to reduce the human carbon footprint.

We are investing up to £125 million into the programme, with an additional £175 million from industry. The projects we co-fund will help create the aviation system of the future.

We are speeding up the development of new, greener ways to fly such as all-electric or hydrogen aircraft, and autonomous drones for deliveries. We are helping researchers and businesses addressing future challenges in areas such as air traffic management, operating models, ground infrastructure, and integration between new aircraft and new aviation systems. And we are helping to develop new flight concepts such as rural connectivity and small ‘pop-up airports’ that can be deployed, for example in disaster emergencies. Read on for more about some of the projects.

In the Future Flight challenge programme, we do not pre-determine which technologies will prevail in future markets. But through our investments we are integrating and accelerating a wide range of UK-led innovations, many of which will become commercial reality in the near future.

Managing security in tomorrow's crowded skies

The rapid advance of new technologies is fostering a revolution in the flight sector which will drastically change the way people and goods are transported, potentially improving connectivity and alleviating environmental and societal issues.

As the skies become crowded with manned and unmanned aircraft, new solutions will be needed to manage increasingly complex traffic. Unmanned Traffic Management (UTM) systems are emerging as the answer; systems of systems, made up of many participants including aircraft operators, service providers and public authorities.

These complex, interconnected and automated systems will inevitably open doors to security threats. A malicious intruder could impersonate an authorised user, potentially causing great damage. Being able to foil such attempts is vital for the safety of the integrated airspace.

One of the projects co-funded by the Future Flight Challenge is working on a solution to this, led by IT security firm Angoka. The consortium, which includes the Connected Places Catapult and Cranfield University, will adapt Angoka's hardware authentication mechanism – already applied to secure communication between self-driving cars – for use with unmanned air systems (UAS).

The [UAS Authentication Service project](#), which includes flight demonstrations using a drone, aims to prove that the system is robust and can maintain the verified identity of an unmanned aircraft as it moves from one communication network to the next, making it impossible for attackers to forge their identity.

Testing a new vision for sustainable aviation

If we are to reach net-zero targets, innovation in clean aviation technologies and airport infrastructure is key. The SATE (Sustainable Aviation Test Environment) project will create the UK's first remote low-carbon aviation test centre at Kirkwall Airport in the Orkney Islands in Scotland.

Led by Highlands and Islands Airports Limited (HIAL), the [£3.7 million project](#) brings together a consortium of aviation industry specialists, local businesses, public sector bodies and academia.

At the centre, technology companies Ampaire, ZeroAvia, Loganair, Windracers and Flarebright will trial low-carbon aircraft using electric, hydrogen or sustainable aviation fuels to replace conventional fossil fuels – as well as drone applications for supplying medical supplies on demand to remote health centres.

The centre will also enable partners to work together on a host of associated sustainable aviation issues, from zero-carbon airport infrastructure using green energy sources to digital networking and resilient communications, and from developing new supply chains to analysing the potential demand and benefits for the local economy.

As well as aviation technology innovators the project's other partners include the European Marine Energy Centre, Denchi Group, Orkney-based Cloudnet, Air Service Training, University of the Highlands and Islands, the Highlands and Islands Transport Partnership, Highlands and Islands Enterprise and Orkney Islands Council. With new advances in technology, cleaner air travel will become more viable and in particular could transform short flight travel between remote communities. This project gives the UK an opportunity to be at the vanguard of the development, testing and early adoption of low-carbon aircraft.

First flight of ZeroAvia hydrogen-electric passenger plane, September 2020





Drones to the rescue in a time of crisis

Some ISCF projects focus on long-term challenges, while others respond to a pressing need in the here and now. A good example is the Cornish Drone Airbridge project.

During the COVID-19 crisis, cuts to the Isles of Scilly ferry and air services caused problems with the supply of medical test kits, PPE and other urgent supplies needed by the remote island community.

So, in 2020 the Future Flight challenge programme co-funded a project to trial a service using unmanned aircraft, to provide fast and cost-effective deliveries to the islands.

The project is trialling the use of large unmanned aircraft to deliver to the islands, working from Land's End Airport and St Mary's Airport in the Isles of Scilly, and also smaller vertical take-off drones to allow goods to be moved flexibly between multiple sites around the islands.

The project consortium, led by [DronePrep](#), works alongside Cornwall Council and the Isles of Scilly Council and includes Windracers, a pioneer in using drones for humanitarian use; drone management specialist Consortiq; and the University of Southampton.

The project is using the Windracers ULTRA UAV (pictured), a twin-engine, fixed-winged aircraft designed and built at the University of Southampton, which can carry up to 100Kg in a space around the size of an estate car boot. Special airspace permissions have been granted by the UK Civil Aviation Authority for the project.

In December 2020 the ULTRA aircraft completed its first flight bringing medical supplies to the islands, paving the way for future services and demonstrating the global potential of unmanned aerial vehicles in delivering humanitarian aid.

Health, ageing and wellbeing

Challenge programmes

- 1 Medicines Manufacturing
- 2 From Data to Early Diagnosis and Precision Medicine
- 3 Accelerating Detection of Disease
- 4 Healthy Ageing



1 Medicines Manufacturing



Challenge Director
Andy Jones

The UK excels at discovering, developing and manufacturing medicines – already generating around £10 billion per annum for the UK economy.

However, the health challenges facing the world mean that there is far more to do – and a far greater opportunity. To protect us from threats and save lives, we need treatments that not only are better, but can be developed and made faster.

The COVID-19 pandemic has brought this home. It is one thing to discover a new vaccine, and quite another to make it at scale, fast enough to stay ahead of a pandemic.

Innovation is vital, but economic pressures have tended to drive a conservative approach to innovation in healthcare manufacturing.

Through this programme, launched in 2017, we are investing in accelerating the development and delivery of new medicines and treatments. Our investment, totalling £188 million, has enabled:

- The UK's first national [Medicines Manufacturing Innovation Centre](#), working on small molecule and pharmaceutical manufacturing in Renfrewshire, Scotland.
- The [Vaccines Manufacturing and Innovation Centre](#), in Harwell, which has been fast-tracked as a priority project with extra funding and is due to open in 2022; its staff have already helped with the manufacture of the Oxford/AstraZeneca vaccine for COVID-19
- Three [Advanced Therapy Treatment Centres](#) across the UK, working to provide ready-to-use systems and solutions to accelerate adoption of advanced therapies
- £12 million to enable the expansion of the [Cell and Gene Therapy Catapult manufacturing centre](#) in Stevenage
- A £25 million fund for collaborative research and development in medicines manufacturing
- The £35 million Digital Health Technology Catalyst, accelerating digital healthcare innovations.

Building on solid foundations, this challenge programme will make the UK one of the best places in the world to manufacture medicines.



Challenge Director
Sarah Goulding

Advanced Therapy Treatment Centres

The use of patients' stem cells, genes and tissues to treat disease may sound like technology of the future, but these centres are making it a reality for patients.

Advanced Therapies are a new approach to medicine and include cell therapies, gene therapies and tissue engineering to tackle disease at a biological level. While some treatments might be used for several patients with the same condition, others can be tailored specifically for a single patient.

These therapies offer a way of treating some conditions where conventional drugs may not work and, in some cases, may even be able to cure diseases. Unlike typical medicines, advanced therapies rely on 'living cells' that require very careful handling. The normal supply chain from pharmacy to patient can't be used. Instead, bespoke systems are needed to handle and track the samples so they reach the right patient and maintain their activity.

To establish the infrastructure needed for advanced therapies UKRI invested in the Advanced Therapy Treatment Centres (ATTCs) network programme. It consists of three centres coordinated by the Cell and Gene Therapy Catapult: Midlands and Wales Advanced Therapy Treatment Centre, Innovate Manchester Advanced Therapy Centre Hub and Northern Alliance Advanced Therapies Treatment Centre.

The ATTC network has brought together clinicians, academic and industrial partners, and the public sector to develop the necessary processes, skilled staff and infrastructure at scale for these novel treatments. One of the companies involved in the ATTCs is Asymptote, part of Cytiva (formerly GE Life), which has been developing systems to handle frozen therapies.

Asymptote chief executive officer, John Morris, says: "Cytiva has found the access to the NHS and ATMP [advanced therapy medicinal product] developers through the ATTC network invaluable. Being part of this collaborative initiative has accelerated the development of Cytiva's cryogenic technologies and solutions for cold chain logistics."

To make sure the frozen material is correctly treated throughout the cold chain and delivered to the correct patient, Asymptote developed Chronicle, sophisticated tracking software that allows both manufacturers and clinics to follow the therapy while in transit.

"There's no doubt that advanced therapies have been developed faster on these programmes than if organisations had tried to do this on their own."

Bill Shingleton, alliances manager, Cytiva

Asymptote has grown dramatically since 2010, when it had only 10 employees, and has created more than 100 UK jobs in the hardware and software supply chain since 2017 when it was acquired by Cytiva.

Cytiva coordinates tool or technology provision for all three ATTCs. Bill Shingleton, alliances manager at Cytiva, is tasked with the delivery of these therapies into the NHS hospitals that are trialling the approach.

Bill says: "The power of this network cannot be underestimated. There's no doubt that advanced therapies have been developed faster on these programmes than if organisations had tried to do this on their own."

An important part of the ATTC trials is scaling and delivering Advanced Therapies across the NHS. The process is currently overseen by specialists, but the tools and processes developed under the programme are designed to be used by non-specialist medical staff at any hospital.

Bill says: "What we're learning is how we can adapt and where novel tech can smooth the process for the next generation of products that come through."

Asymptote's Chronicle software monitors workflow in advanced therapies





VMIC

A new centre of excellence will give UK vaccine manufacturing a shot in the arm.

It was always envisaged that the new [Vaccines Manufacturing and Innovation Centre](#) (VMIC) being built at the Harwell Science and Innovation Campus in Oxfordshire would have a role in emergency response, should an epidemic strike some time in the future, but it was not anticipated just how significant that role would be. “It was part of our remit, in case an emergency ever happened,” said VMIC’s CEO, Dr Matthew Duchars. “But it was not primarily what we were intended for.”

The plans for VMIC go back to 2017. Supported by the Industrial Strategy Challenge Fund’s Medicines Manufacturing challenge, the aim was to make the UK’s first bespoke facility dedicated to manufacturing vaccines, as well as developing them to the point where they could be made – to enable the UK again to produce, at scale and pace, the vaccines that it is so good at creating in the first place.

With Harwell announced as the site of VMIC in the summer of 2019, pre-planning was well underway. Then along came the biggest pandemic in a century. “COVID-19 completely changed the landscape,” said Duchars. “With COVID-19 we had to get out of the gate immediately. The message coming from government was ‘we need a vaccine yesterday.’”

VMIC staff were involved in the response to the pandemic from the start – and well before they had a building to operate from. They contributed manufacturing expertise to the University of Oxford’s Jenner Institute by leading it through the development and scale-up of the vaccine for clinical trials. At the same time, VMIC worked with Oxford Biomedica to establish a national rapid deployment center so it could start making the Oxford/AstraZeneca vaccine in 2020 while the VMIC facility was being built.

“Collaboration has been vital in the response to COVID-19. From the Oxford consortium to the collaboration with Oxford Biomedica and our continued work with the Vaccines Taskforce, we have shared our experience, our equipment and our brilliant people to help drive the successful delivery of the UK vaccination programme,” said Duchars.

And in terms of developing the physical VMIC facility, the pandemic has led to a significant acceleration: the planning approval process was fast-tracked and operational readiness is now planned for 2022, a year ahead of the original date. Manufacturing capacity is expanding too: when fully operational, in a pandemic situation, VMIC will be able to produce up to 70 million vaccine doses within a six-month timeframe, enough to cover the UK and provide for other countries, too.

But as Duchars made clear, the VMIC story started before the pandemic and is bigger than COVID-19. “We made a significant contribution to the national response to COVID-19, but we’re not just about pandemics. We’re driven by a wider purpose: to grow vaccine capability across the world, moving vaccines from discovery to licensed product, growing the supply chain, and providing training to grow and upskill the vaccines community.”

VMIC is about much more than just manufacturing, then. When it is ready, it will be a resource for private- and public-sector researchers, including those outside the UK, helping developers on the journey from small-scale batches up to vaccines being made on a commercial scale.

2 From Data to Early Diagnosis and Precision Medicine



Challenge Director
Alison Cave

Enabling an earlier diagnosis of disease, combined with better-targeted treatments, has the potential to revolutionise the delivery of healthcare and transform the life-long health and wellbeing of UK citizens.

The perennial challenge for healthcare is to identify diseases early enough to not only prevent them progressing, but also enable new treatment options which may not be possible at later disease stages. Early diagnosis, coupled with a better understanding of disease pathogenesis, will open up new precision medicine opportunities so diseases can be better managed to deliver improved patient experiences and outcomes.

Through enabling the use, integration and application of data, artificial intelligence (AI) and innovation the challenge seeks to transform the prevention, early diagnosis and treatment of life altering diseases and address two of the government's Grand Challenge missions, namely artificial intelligence and data, and ageing society. The opportunity to work across sectors to develop and harness the power of AI and data technologies is considerable, and the programme will create a dynamic digital health ecosystem across the UK supporting clusters of innovative diagnostic and tech companies that will drive economic growth, reduce inequalities and improve the health of the nation.

UKRI is investing up to £210 million to enable businesses and researchers to work on this challenge – capitalising on and combining biological and health-related data generated through the delivery of normal healthcare to create new diagnostic products and services and better therapies.

The programme includes an ambitious project to sequence the whole genomes of all 500,000 UK Biobank volunteers (see case study); the creation of five regional centres of excellence for digital pathology and radiology (see case study for example), where digital images from tissue sections and in-vivo imaging techniques can be combined with AI and machine learning to improve diagnosis, research opportunities and efficiency; and supporting innovative companies to develop new diagnostics and therapies by unlocking the power of health data in collaboration with **Health Data Research UK**.

Through this programme we aim to cement the UK's leadership position in diagnostics and therapeutics and increase its share of the global market by over £1 billion per year within 10 years.

UK Biobank

Using a unique store of medical samples, a new project looks set to revolutionise gene-based medicine.

Why do some people develop diseases, while others don't? In many cases the answer lies in our genes, and so genetic research has huge potential to unravel the causes of some of the most serious diseases. As we live longer and suffer increasingly from chronic diseases, it becomes increasingly important that we understand such diseases, enabling us to diagnose them earlier, and (where possible) prevent them from occurring altogether.

With funding from a consortium put together by UK Research and Innovation (including £50 million from the Industrial Strategy Challenge Fund), the world's largest genetics project is now under way. The [Whole-Genome Sequencing Project](#) will sequence the entire genetic code of half a million volunteers, helping to build up the most detailed picture yet of such serious and life-threatening illnesses as cancer, heart diseases, dementia and diabetes.

What makes the project possible is the [UK Biobank](#), a vast storehouse of samples of blood, urine and saliva that are kept together with detailed information about the people who (anonymously) provided them. Set up in 2006 by the Medical Research Council and Wellcome Trust, until 2010 the UK Biobank recruited people from across the UK aged between 40 and 69. Regularly updated with new samples and hospital and GP records, the UK Biobank is now a mine of medical data that can be interrogated in a number of different ways. And as time goes on and it is possible to track how the volunteers have fared in terms of their health, increasing the value of the data held by UK Biobank.

The UK Biobank has grown into the largest and richest dataset of its kind. Numbers matter in genetic research: with 500,000 participants in the programme it is more likely that rare conditions will show themselves, and more subtle comparisons can be made, helping to explain why some people are more prone to some diseases than others.

Since it was established, the UK Biobank has been made accessible around the world to approved researchers studying serious diseases. As a research resource, the UK Biobank is a major contributor to global health. Recently the UK Biobank project has been central to the research response to COVID-19. UK Biobank recruited over 115,000 volunteers in only four weeks, allowing researchers to track the antibody responses to the [virus](#).

The Whole-Genome Sequencing Project brings health experts together with leading biopharmaceutical and healthcare companies Amgen, AstraZeneca, GlaxoSmithKline (GSK) and Johnson & Johnson, who between them have contributed £100 million to the endeavour (a further £50 million comes from the Wellcome Trust). Not only will the project help improve the diagnosis of a wide range of diseases, but in time it should also support the development of new, personalised forms of treatment, consolidating the UK's position as a leader in healthcare, and ultimately saving lives.



National Pathology Imaging Co-operative

A new centre of excellence, set up through the Industrial Strategy Challenge Fund, is harnessing the power of artificial intelligence in healthcare.

Pathology (the study of the causes and effects of disease or injury) is still one of the cornerstones of medicine. But with digital pathology, things are changing. Where once a pathologist could only peer through a microscope at a piece of tissue, trying to work out what was wrong with a patient, slides can now be digitised. This means they can be viewed, managed, shared and analysed on computer screens.

Your samples can be seen instantly by an expert who may not even be in the same country as you. Or they can be compared to others that were taken from you in the past, to see if anything has changed.

Of all the possibilities that digital pathology opens up, one of the most exciting is the chance to bring artificial intelligence (AI) to bear in diagnosis. Computer algorithms can be trained to spot the signs of disease. Qualified human pathologists are in short supply, and even the best of them can make mistakes: using AI has the potential to reduce human error, and improve the accuracy and speed of diagnoses.

To speed up the use of AI in pathology, the [National Pathology Imaging Co-operative](#) (NPIC) was one of five centres of excellence across the UK established in 2019 through the Industrial Strategy Challenge Fund (ISCF). Data to Early Diagnosis and Precision Medicine is one of the ISCF's [Ageing Society challenges](#). It aims not just to improve outcomes for patients, but to create a new generation of diagnostic and tech companies that will drive UK economic growth by bringing together British strengths in different sectors, especially healthcare and IT.

The NPIC is headed by the University of Leeds and Leeds Teaching Hospitals (a global leader in the area of digital pathology). Its partners include 10 leading medical technology companies, seven universities and nine NHS hospitals. And in 2020 the initial investment of £10.1 million from the ISCF (matched by £7 million from the industry partners involved in the programme) was boosted by a further £20 million in government investment.

The NPIC already represented the largest regional deployment of digital pathology in the world. The extra investment will mean that it can extend digital pathology to another 25 hospitals across the whole country, for complex cases such as cancer in children and soft tissue tumours, all to be coordinated from a new National Training Centre for Digital Pathology based at Leeds.

The NPIC will now deploy digital pathology scanners across over 40 hospitals across England, scanning over 2.3 million images per year and generating three petabytes of image data per year. Using this vast amount of information it will develop new techniques of automated image analysis to improve the efficiency and reliability of diagnosis, especially for cancers.



3 Accelerating Detection of Disease



**Challenge Director
Alison Cave**

This ambitious programme has one focus: to create a world-leading national resource to transform our ability to detect disease early and save lives. It will focus on the prevention, and earlier detection, of many of the common chronic diseases which are the biggest causes of death and disability today. It complements the ISCF challenge ‘from data to early diagnosis and precision medicine’.

UKRI is investing up to £79 million in the project, with an additional investment of up to £160 million coming from industry and healthcare related charities.

This funding will establish a new national resource for academic and commercial researchers which will support new approaches to the early diagnosis of diseases including cancer, dementia and heart disease, potentially even before symptoms occur, as well as providing the opportunity to recontact individuals considered at risk of disease for further studies.

In the largest-ever study of its kind, the project will recruit up to five million volunteers. Their genomic data will help UK scientists and researchers invent new ways to predict the risk, detect such diseases and prevent their development.

This project has the potential to dramatically improve the way people are diagnosed and treated for chronic diseases, while boosting the UK’s artificial intelligence, healthcare and diagnostics industries.

This programme is unique in the world for its scale and ambition, and will place the UK at the forefront of global research into early diagnosis of disease.

4 Healthy Ageing



Challenge Director
George MacGinnis

The UK population is getting older. One in 12 people today are over 75; by 2040, it is likely to be around one in 7. With a third of children born this year expected to live to 100, people's post-retirement years continue to increase.

Our aim in this challenge programme is to help people spend more of this time actively, healthily and happily – by 2035, helping towards adding five extra healthy years to the average life.

Adapting to an older population is a huge societal change and as much about changing social attitudes and adapting living environments as it is about how science and technology can help change individual behaviours and experience. With the growing number of people looking for a better later life, it also represents a huge business opportunity.

We are investing up to £98 million in accelerating new services and products that will help people live better for longer along with innovative business models to enable them to scale. The funding is being applied in three main ways:

- 'Trailblazer' projects with around £30m, helping businesses develop and scale up new services with innovative business models for healthy ageing
- Working with the investment community on an accelerator programme to co-fund innovative SMEs to develop new products and services, and unlock future investment
- Social, behavioural and design research to look at the needs and opportunities of an ageing population and engage with businesses to help them innovate for these markets.

We also support the Community of Practice run by the [Centre for Ageing Better](#), and the [Healthy Ageing Catalyst Awards](#).

The Healthy Ageing programme aims to create a step change in the quality of people's later years – with UK businesses and researchers leading the way.

Blackwood Homes and Care

The combination of innovative home design and care technology is enabling older people to live healthier and more independent lives.

For many older people, being able to stay in their own home as they age is key to quality of life. Now a team at Edinburgh-based specialist housing and care provider [Blackwood Homes and Care](#) is using design and technology to help create houses and communities that support an ageing population to live healthier, more connected lives.

“People are living longer but health inequalities are growing,” said Colin Foskett, Head of Innovation at Blackwood. “The Blackwood Neighbourhoods for Independent Living project has been co-designed and co-created to rebalance inequalities, and empower, encourage and reward people to take an active role in their ageing journey.”

A partnership approach is core to this multi-disciplinary project. Using a £100,000 grant from the [Healthy Ageing Challenge](#) fund, the team collaborated with residents in three demonstrator neighbourhoods (in rural, semi-rural and urban settings), as well as local authorities, health providers, industry, and academia, to meet the challenges of designing age-friendly homes, sustaining physical activity, managing common complaints of ageing, and supporting social connections.

A ground-breaking house design – The Blackwood House & Design Guide – provides the blueprint for affordable, accessible and connected homes that adapt as people age and enable them to live independently within their neighbourhood. Co-designed with customers and architects, it features a barrier-free core to the home, allowing easy movement for any level of mobility.

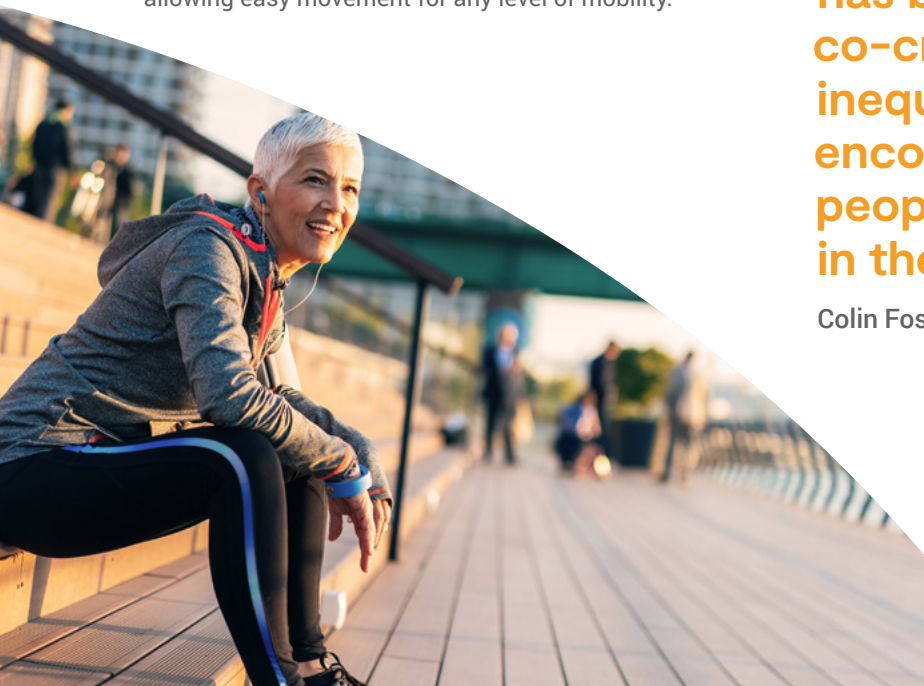
It also includes innovative automation through [CleverCogs™](#), a platform that allows individuals to take control of things like lighting, as well as access platforms to communicate with carers, family and friends, and health services. Customers personalise their system picking the ‘cogs’ that support their ageing journey.

The team worked with researchers at University of Edinburgh and community workshops to co-design a value-exchange model, which encourages and rewards participation in the neighbourhood. “For example, if someone gives an elderly neighbour a lift to a hospital appointment, they may get some free credit for the electric vehicle club. Or data from wearable devices could reward people who keep active with free classes. The model is designed to reduce social isolation through participation in activities,” explained Foskett.

“Blackwood shows that through the thoughtful, collaborative design of new homes and empowerment of residents to help self-manage health and wellbeing, we can create great places in which to grow old,” said UK Research and Innovation’s Healthy Ageing Challenge Director, George MacGinnis.

“The Blackwood Neighbourhoods for Independent Living project has been co-designed and co-created to rebalance inequalities, and empower, encourage and reward people to take an active role in their ageing journey.”

Colin Foskett, Head of Innovation at Blackwood



onHand

A new app aims to revolutionise the way corporate volunteering is carried out, bringing vital support to thousands of older people and providing employers a platform to support their communities.

Loneliness is a pressing social issue; in 2016, there were [1.2 million chronically lonely older people in the UK, with over half of all people aged 75 and over living alone](#). The COVID-19 pandemic has exacerbated social isolation, making it harder for families and friends to manage care of loved ones, and for vulnerable people to leave their homes.

A new app, [onHand](#), aims to address this issue by mobilising corporate volunteers who can provide help at the click of a button. This enables volunteers to deliver support to those in need, relieving the strain on the NHS and local councils, and delivering environmental, social and governance (ESG) impact for businesses.

onHand is like “Uber for volunteering”, said Sanjay Lobo, founder of BeOnHand, the company behind the innovative app. “Older adults request help, whether that’s shopping, medicine collection/drop-offs, dog walking or simply a friendly chat on the phone. These are then matched with our network of vetted, local volunteers.” Requests can be posted by those in need, by their family or carers, or by local NHS or council teams.

By working with businesses, onHand is tapping into the growing number of employee volunteering schemes, which give employees an estimated 11 million days of paid volunteering time every year. However, actual engagement is much less, with around 200 million hours going unused. “Corporate volunteering today isn’t designed for the mobile-first world. We give employees a Netflix-like experience: simple and engaging,” said Lobo.

As the app shows requests for help that are local to employees it works for our new remote-working world, and as many of the tasks take just an hour, it offers potential for shift and seasonal workers (groups often overlooked by traditional corporate volunteering schemes) to get involved.

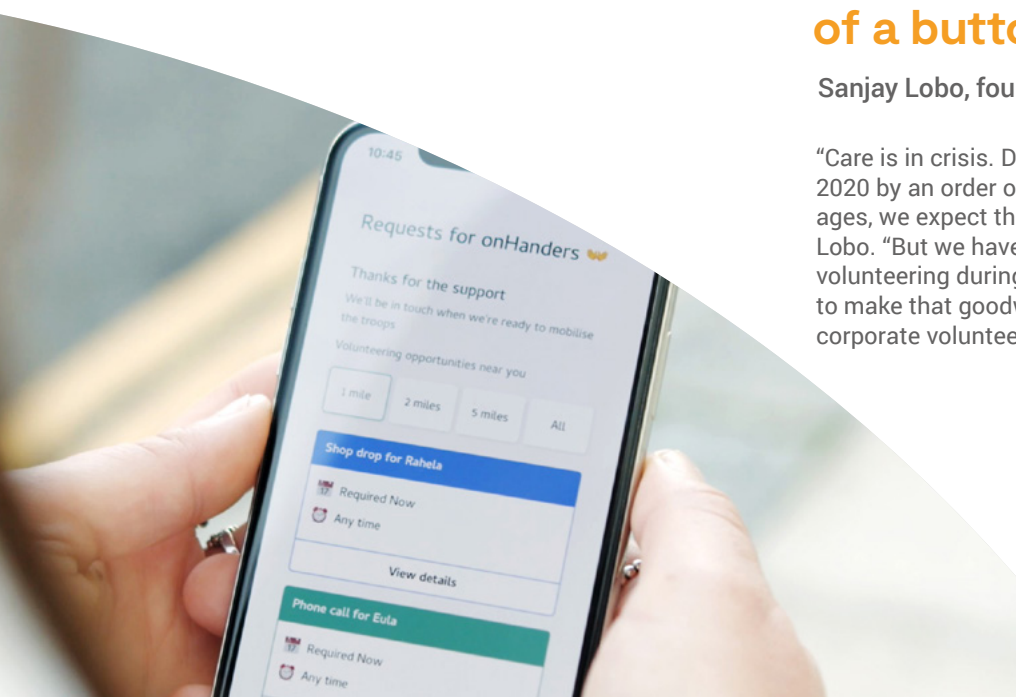
onHand was developed with the support of a £75,000 grant from the Industrial Strategy Challenge Fund’s Healthy Ageing challenge via [COVID fast track](#) funding. This allowed the team to automate the end-to-end volunteer matching experience – including built-in automated ID and DBS checking, the ability for volunteers to search for help opportunities and contact the person in need directly through the app, as well as submission and daily automated refunding of reimbursement (such as for shopping).

Launched in 2018, onHand has expanded from London-only to helping service users across the UK, including a collaboration with the [National Innovation Centre for Ageing](#) and [Newcastle Building Society](#). In 2020 it was commissioned by Lambeth and Hammersmith & Fulham councils to provide support to thousands of elderly and vulnerable residents. Since April 2020, more than 36,000 meals have been delivered and 1,650 hours of befriending phone calls have been made.

“onHand aims to address social isolation by mobilising corporate volunteers who can provide help at the click of a button.”

Sanjay Lobo, founder of BeOnHand

“Care is in crisis. Demand for our service increased over 2020 by an order of magnitude and, as the population ages, we expect that trend to continue post-COVID,” said Lobo. “But we have also seen a phenomenal surge in volunteering during the pandemic. With onHand, we want to make that goodwill a permanent legacy by making corporate volunteering easy.”



Embedding equality, diversity and inclusivity

As in industry and society generally, there are social inequalities in many areas of innovation and technology. Recognising this, equality, diversity and inclusion (EDI) are being embedded into the work of the Industrial Strategy Challenge Fund.

The aim is to take a strategic approach to EDI using both top-down and bottom up tactics, demonstrating good practice, building consistency and creating new interventions for the future. It is a complex task because of the different needs and maturity levels of the various challenge areas.

The ISCF team created a group of EDI advocates – with the aim of empowering people with specialist training to become internal thought leaders on EDI across the Challenge Fund’s work and create a growing community of good practice.

The next step is to look beyond internal processes and make sure that EDI is a reality for the programmes, projects and businesses funded.

UKRI recognises that the best ideas for innovation can come from anyone, and to tap into the full range of talent available, ISCF funding must be accessible to all. Previous work such as Innovate UK’s Women in Innovation campaign have made a real difference, but there is much more to do.

Olivia Ogbomo, a project manager in ISCF, has been leading on the EDI progress review and action plan. She says, “we are uniquely placed to influence change by taking action and leading by example. Fear of getting it wrong should not be the reason we don’t move forward on this agenda”.

Through its EDI strategy, the Challenge Fund aims to be a leader in equality, diversity and inclusion – in line with UKRI’s vision of an inclusive research and innovation system where everyone is treated with dignity and has the opportunity to flourish and succeed.



Olivia Ogbomo
EDI leader for the ISCF

Building gender equality

UK Research and Innovation's Transforming Construction Challenge advisory group has achieved a vital and proactive 50:50 gender balance. So how is the representation of women in the construction industry growing – and what more can be done?

In 2015, women represented approximately [11% of the workforce in the construction sector](#). Fast forward to 2020, and women in the UK construction industry account for 12.5% of the workforce, with only one in eight construction workers [being women](#). While this slight rise is encouraging, according to the trade union GMB, it could still take [up to 200 years](#) to achieve gender equality in the construction sector. There is clearly more progress to be made, so what is being done?

The Industrial Strategy Challenge Fund is playing its part. Its Transforming Construction Challenge (TCC) programme has achieved a 50:50 gender balance on its advisory group despite the sector having fewer women in the industry. With a commitment to equality, diversity and inclusion (EDI) from the start, the challenge was determined that its advisory group should be gender-balanced, having a female chair in Dr Diana Montgomery, chief executive of the [Construction Products Association](#) since 2012.



Dr Montgomery said: "My theory is that you always look for a balanced group of people. You understand what you can do and understand what you can't do, and then get all those people from all diverse backgrounds and different experiences, so you fill those gaps.

"Construction is changing, especially this side of COVID. We're moving to digitisation, robotics and artificial intelligence. It's changing not only how we do business, but it's creating opportunities that are more attractive to women."

This evolving face of construction is leading to increased evidence of stronger female representation across a construction industry that, mid-COVID and post-Brexit, needs to adapt to thrive.

Eva Magnisali is the founder of [DataForm Lab](#), an architectural robotics start-up in the architecture engineering and construction (AEC) industry. She is investigating ways of bringing innovation into construction, bridging design to fabrications by using efficient digital workflows. She has witnessed some positive shifts in gender roles.

Magnisali said: "The last few decades, the preconception that construction is a male-only field has been slowly giving way to a more inclusive mentality as women have proven to be perfectly capable of handling all kinds of tasks. This is allowing more and more women to consider a career in construction. What still needs to be improved is seeing more women in leading positions in the field."

One such leading position comes in the form of Zara Riahi, founder and CEO of [Contilio](#). Contilio is an AI-based analytics platform, empowering the construction industry to understand, predict and significantly improve the performance of multi-million dollar projects. Riahi sees this as the time to forge more gender balance in the construction industry as it evolves with new technology.

Left: Dr Diana Montgomery, chief executive of the Construction Products Association and TCC advisory group chair



Far left: Asha Panchal, innovation and systems engineer at Keltbray
Left: Zara Riahi, CEO of Contilio
Below: First meeting of the ISCF TCC advisory group
Below left: Eva Magnisali, founder of DataForm Lab

Riahi said: “As far as tech goes, while venture capital (VC) investment in female-led start-ups is increasing, there is still a big bias towards all-male founding teams, particularly in hard areas such as deep tech and enterprise [only 3% of total VC goes to [women-led businesses](#)].”

“Yes, many VCs, corporates and governments have done a lot to create awareness, but what we need to start asking ourselves is whether the next ‘200 women in tech’ or

“We need everybody in the industry to be a bit braver and perhaps not take the comfortable, easy route.”

Dr Diana Montgomery

‘female founders VC hours’ event will do much to create positive change. Such change requires actions, and it’s time we realised and acted upon that.”

So, when it comes to actions, what about bigger construction companies? How do these organisations see the industry developing to afford even greater, lasting female representation?

Asha Panchal is innovation and systems engineer at [Keltbray](#), one of the country’s largest and best-known specialist engineering and construction subcontractors. Despite having only joined Keltbray in late 2018, Panchal is responsible for developing and managing a groundbreaking project funded by Innovate UK to change the way piles – deep foundation constructions – are built.

For Panchal, who believes education is a crucial factor in the role women can play in engineering, the support given by Keltbray and the wider industry has been key.

Panchal said: “Construction has typically had the reputation of being a male-dominated environment, with jobs being physically demanding. To some extent it is still male-dominated, but only because a limited number of women make the choice to join the industry.

“In current times, there is a wider range of positions available within the industry that may be more appealing to women. The mindset of managers has also shifted, so they are more socially aware and able to provide an amicable environment for women to grow and develop in. Personally, I have not felt any prejudice against women in engineering, and have always been encouraged to contribute and have felt supported by my peers.”

Female representation in construction is improving. Yet with more to be done, TCC advisory group chair Dr Diana Montgomery sums up the approach now needed: “To get more women into the construction sector, we need everybody in the industry to be a bit braver and perhaps not take the comfortable, easy route.”



The ISCF: looking forward

The Industrial Strategy Challenge Fund (ISCF) is clearly having a major impact. But with the most recently-established challenge programmes just starting, and scheduled to run until 2024/25, to date we have only seen a small part of the full transformative benefit the Fund is expected to bring.

At the time of its conception the ISCF represented a new way to fund research and development in the UK, by using a mission-orientated approach to solve the pressing societal, economic and environmental challenges of our time.

Now, we are building on the early successes seen by the fund to develop a new challenge-led capability within UK Research and Innovation (UKRI). This new challenge-led approach will be closely aligned with cross-Government economic and social priorities to help drive collaboration across the research and innovation system and develop bold new solutions in a flexible way.

The new approach will be agile and responsive, with deep engagement across the whole of the research and innovation funding landscape to ensure we are sourcing new ideas and novel solutions from across all of UKRI's rich networks and communities.



Ottoline Leyser
Chief Executive, UKRI

“Developing the ISCF programmes over the past few years has been an exciting journey. We have shown the power of challenged thinking in mobilising public and private research and innovation funding, and focusing it on the things that really matter for society and the economy.

“As part of the UK’s innovation strategy we look forward to evolving this approach, working with the entire research and innovation community, to tackle existing and new challenges, build prosperity and improve wellbeing.”

Ottoline Leyser, Chief Executive, UKRI

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