

POWERING UP FOR THE **GREEN RECOVERY**

Oxfordshire's role in building a cleaner future.



**Advanced
Oxford**

Powering up for the green recovery: Oxfordshire's role in building a cleaner future

CONTENTS

(1)	Introducing Advanced Oxford's report and research	-4-
(2)	Oxfordshire's start-ups and scale-ups powering a green recovery	-6-
(3)	Why leading companies working on sustainability grow and stay in Oxfordshire	-14-
(4)	Fusion – meet the Oxfordshire pioneers creating the energy of tomorrow	-18-
(5)	Oxfordshire's innovation clusters create the places for new commercial opportunity	-22-
(6)	Greening the NHS in Oxfordshire	-28-
(7)	Creating the capability and an ecosystem for the green economy to flourish	-35-
	• University of Oxford	-34-
	• Oxford Brookes University	-36-
	• i-Hub, including Living Oxfordshire and MobOx	-37-
	• Oxfordshire Greentech	-38-
	• OxFutures	-38-
	• Low Carbon Oxford	-38-
	• Low Carbon Hub	-39-
	• Project LEO	-39-
	• Energy Superhub Oxford	-39-
(8)	What will drive the green recovery? Enablers and challenges	-42-
(9)	Acknowledgments	-57-



Introducing Advanced Oxford's report and research

The post-COVID green recovery, the green economy, the green industrial strategy – these are terms that are used in the media on an almost daily basis. The Government has announced investment and the intention to focus spending plans on driving this green recovery. Indeed, on November 18th 2020, it announced a ten-point Green Industrial Strategy that places building a more sustainable economy at the heart of the business development and environmental agenda. The opposition has also called for a 'green new deal' with a stimulus to the green economy of at least £30bn.

What is the green recovery though, what are the companies that will drive it and where will the jobs really come from?

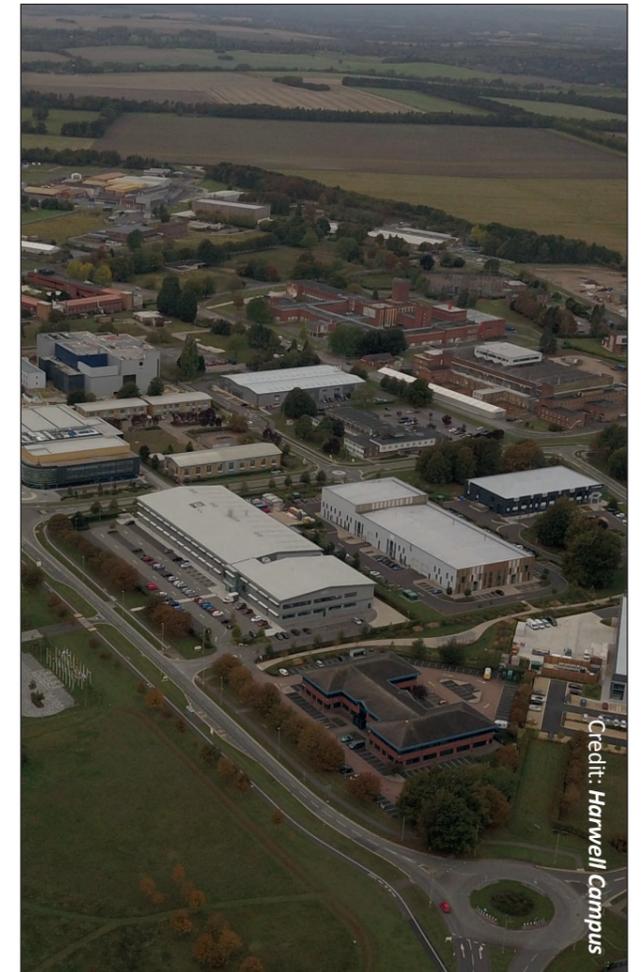
There are already many Oxfordshire-based companies that are developing technology that will help in the transition to a low carbon, more sustainable

economy. This report from Advanced Oxford looks at the wide range of technologies and companies working within the green economy; the businesses and organisations in the region that will be at the forefront of the post-pandemic green recovery. Many are small companies, pioneering new science and technology. We shine a spotlight on some of the exciting developments that are yet to reach the market - companies that are developing ground-breaking work to help solve the climate change emergency and address environmental challenges. As well as highlighting the technology and capability within the region, we detail a range of opportunities for companies working to develop low carbon and sustainable goods and services, including opportunities to work with the NHS, our universities and other industries and how to engage with local policy makers. Our report also examines what needs to be done to support growth in these areas and assesses the challenges faced by our innovative companies.



Key findings of the research

- Nearly nine in ten companies (88%) agree or strongly agree that Government's focus on the green recovery is an opportunity for them
- The majority of pre-revenue companies expect to be revenue generating within one to two years
- Hiring to meet anticipated demand will see head count rise across innovation-based companies, with all companies projecting growth in the next three years, ranging from 10%-500% growth
- Three in four companies will need to raise more funds to fuel growth over the next three years
- Investment (80%), access to skilled employees (50%) and grant funding (50%) are quoted as vital growth enablers
- Investment (60%), uncertain market (40%) and protecting IP (40%) are called out as key barriers to growth



This report has been developed through structured interviews, desk-based research, and data collection through surveys. We would like to thank all companies and organisations who have contributed to our research and report by sharing data, insights, and experience.

This report sits alongside other materials and resources gathered throughout the course of this project, including case studies and a Directory of innovative companies that are working within the low carbon and sustainable goods and services sector within the county. This Directory is dynamic, and we invite companies that are not listed within it to add their details. All of these materials can be found on our website – www.advancedoxford.com.

Dr Gillian Burgess, Chair, Advanced Oxford
Sarah Haywood, Managing Director, Advanced Oxford

Oxfordshire's start-ups and scale-ups powering a green recovery

Oxfordshire is building its reputation as a location for innovative ideas to turn into spin-outs, start-ups and then scale-ups.

The city's universities are world-renowned for delivering scientific and technological breakthroughs that fuel a steady stream of exciting new spin-outs. In fact, according to figures from the Higher Education Statistics Agency (HESA), the University of Oxford is far and away the country's most successful start-up creator. Between 2015 to 2019, it created 86 new companies, more than the combined output of University College London (46) and Imperial College (36) in second and third place.

Beyond 2019, the innovation and technology transfer arm of the University of Oxford, Oxford University Innovation (OUI), announced that in 2019 to 2020 it had helped 19 new companies form. This was achieved despite the disruption caused by the global coronavirus pandemic. Its latest figures also confirmed that, to date, companies spinning out via OUI have attracted a little over £855m (\$1.11bn) worth of external funding with 4793 new patents under management. OUI's annual report: <https://annualreview2020.innovation.ox.ac.uk>

Start-ups have several options on premises. The city, with its excellent rail links, offers the choice of several office and lab spaces, as well as business and science parks. Just outside the city, there are long-established tech clusters at Harwell, Culham and a new hub for water-related businesses at HR Wallingford.

Innovation centres and science parks

Oxford's innovation ecosystem is supported by a number of innovation centres, science parks and business parks that have been established in the city and surrounding region for science and tech businesses. These are some of the key centres:

Central Oxford :

Grassroots, OX2
One St Aldates, OX1
Oxford BioEscalator, OX3
Oxford Centre for Innovation, OX1
Oxford Foundry, OX1
Wood Centre for Innovation, OX3

Oxfordshire

Abingdon Science Park, OX14
Begbroke Science Park, OX5
Bicester Innovation Centre, OX26
Culham Science Centre, OX14
Grove Business Park, OX12
Harwell Campus, OX11
Heyford Park Innovation Centre, OX26
Howbery Park, OX10
Milton Science & Business Park, OX14
Oxford Business Park, OX4
Oxford Technology Park, OX5
The Oxford Science Park, OX4

ENERGY

Harnessing blue rays

Photovoltaic technology is already firmly established as a renewable alternative to fossil fuels. There have always been two obvious challenges to overcome before solar panels can achieve their full potential, though. They can only harness energy in day light hours, meaning power needs to be stored, and they have typically been able to harness only the red part of the spectrum, leading to an efficiency of around 20% to 25%.

University of Oxford spin-out Oxford PV is directly challenging this by adding, on top of a conventional silicon cell, its patented layer, that absorbs photons from the blue part of the spectrum. The company says this can increase efficiency to over 29%.

This will make PV panels built with the company's PV cells the most efficient commercially available option, CEO Frank Averdung claims. However, he expects to be able to boost this to around 33% as the company edges towards the theoretical limit of 43% when its technology is added to silicon solar cells which, on their own, have a theoretical limit of 29%.

The technology business refers to itself as "The Perovskite Company". However, the mineral is not used in the layer it adds to silicon solar cells to absorb photons in the blue spectrum. Rather, the additional layer is made to resemble the crystal structure of the mineral perovskite, using readily available synthetic materials.

Oxford PV is not only an interesting example of how technology from the region can aid the green recovery, it also serves as a warning that the final product could lead to manufacturing jobs elsewhere. Commercial production of the new solar cells will begin in 2021 in Germany, rather than Oxford.

"This is something where start-ups in the area are going to need a lot more support. Otherwise more will be tempted to take great technology like ours, that has been developed in Oxford, and produce it in another country where they are offered an attractive package on acquiring a production facility and tax breaks." Frank Averdung, CEO Oxford PV.

Improving battery performance

While Oxford PV is helping to answer the challenge of harnessing more of the sun's energy, other start-ups in the area are tackling the issue around battery storage.

Brill Power is expecting to make its battery management technology commercially available from 2021. It allows large batteries, typically the size of a dishwasher and above, to be charged and discharged in the optimum fashion to ensure a weaker cell does not hold back the performance of the entire battery.

At first its system is expected to be used in batteries for

storing electricity within homes, offices and schools. In the future they also hope to be used in electric vehicles. Its Faraday-funded worked with Aston Martin, based near Oxford, and Delta Motorsport at Silverstone is seeking to get the best of both worlds from battery technology.

Typically, a battery pack in a car will need to trade off either performance or range. Each requirement leads to a slightly different chemistry within a lithium ion cell. However, Brill Power is seeking to demonstrate its technology can be used to combine both types of battery within the same car so a performance vehicle can have speed when it needs it yet still provide a reassuring range.

Carolyn Hicks and her co-founders, like so many start-up creators, met at the University of Oxford and they have no intention to ever willingly leave the city. However, she does warn that any business looking to expand within the centre of the city faces challenges.

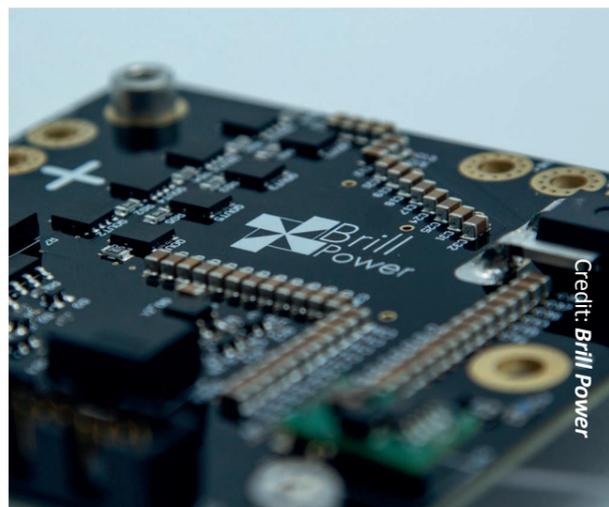
"Oxford is superb for access to very bright talent, which is vital for us, we need a highly educated, highly skilled team," she says.

"What it lacks is larger offices for start-ups in the city centre, and the same goes for lab space too. We love access to the train station and being able to take public transport to work and so it's going to be tough to find the right space for us to expand near to the city centre."

Algorithm helps ROI

This has also been an issue for another start-up in the area dedicated to helping companies storing energy in large batteries maximise their investment, although Habitat Energy CEO, Andrew Luers, reveals the business is rethinking how much office space it requires now mixing office and home working has become the norm. To encourage business to store renewable energy in batteries, the company's sophisticated computer modelling can help inform users when it is time to charge up capacity and at what moment it makes sense to discharge to the national grid.

"We're helping the grid with the balancing act of meeting demand with renewables that are intermittent and thus providing a key component of a net-zero carbon electricity sector," says Andrew Luers.



“Our typical customers will be owners of grid-scale battery storage as well as renewable energy assets like solar or wind, not always on the same site. Our algorithms can predict likely prices as they respond to fluctuation in weather and other conditions and determine when it’s best to charge up or discharge, taking into account the long-term health and economics of the asset and providing the flexibility the grid needs.”

ENVIRONMENT

Kinder laundry service calls for cycling lanes

Oxford residents have become used to the highly visible, everyday sight of Oxwash cyclists touring the city collecting bags of laundry. The employees are not only keeping fit with zero emissions, they are highlighting the way ahead for environmentally-friendly clothes washing. The service has already launched in Cambridge and London is expected to go live soon too.

The more environmentally-friendly way to wash clothes goes beyond pedal power to include solar-powered washing machines operating at 30 degrees centigrade using ozone to get fabrics clean. The machines also filter microfibres to prevent them being released into the water system where they can have a detrimental impact on wildlife.

The new approach was liked so much by Twitter co-founder, Biz Stone, he has become an Angel investor in the business, as has Paul Forster, the co-founder of jobs marketplace, Indeed.

Oxwash Growth Executive, Carla Lin, confirms Oxford will remain where the business is headquartered though, because that is where the founders studied together and where early staff come from.

“It’s a wonderful young vibrant city that provides access to so much bright talent,” she says. “The only downsides are the cost of living is high for our young work force. We’d also like to see more cycle lanes. It would be great, not just for our pick-ups, but we hire young environmentally-minded people who want to cycle to work so they minimise their carbon footprint.”

Biosensors give quick water tests

The green recovery will require economies all around the world to treat the environment with more respect by ensuring toxic chemicals are not allowed to enter rivers. Oxfordshire start-up, OMB, is in the process of developing a riverside kit that will be able to test water quality in minutes.

It is developing a 3D-printed test kit that will allow users to determine if hazardous chemicals have entered into a waterway in just minutes, rather than send off samples to a laboratory. Likely users will include water supply companies, industrial treatment plants, environmental groups and aquaculture businesses that need to act quickly if toxins are found.

It uses biosensors which go bright or dim if they pick up a particular hazardous chemical. The idea is to freeze-dry these biosensors in cassettes that can be used anywhere around the world.

The start-up has already begun working on several projects, including with the University of Oxford on the REACH programme, which aims to improve water quality for millions of people over the coming 5 years. The project has involved measuring water quality in parts of Bangladesh and Ethiopia and developing new models to predict hot spots and sources of toxicity. By the end of 2020, it hopes to start work on a new project closer to home, in London, CTO Cordelia Rampley reveals.

“We’re about to start working with the Environment Agency, looking at a potential role for the biosensors in water monitoring and re-use,” she explains.

“London is projected to have a substantial water shortage within ten years, and so some water agencies are considering taking treated grey water and pumping it back up stream so it can refill reservoirs. Before they can reintroduce the water, though, they need to consider the environmental impact, so they’re interested in how our biosensors could help.”

Protecting the oceans with satellites

It is not just rivers which require attention to ensure the green recovery is successful. To build a sustainable

global economy, we need to look to the 70% of the world’s surface that is covered by oceans.

Though it is hard to quantify, illegal fishing is estimated to account for up to a third of all the fish caught each year. This not only depletes fish stocks, impacting the biodiversity of the oceans, it also threatens the livelihoods of the 520 million people the World Wide Fund estimates rely on fishing. The illegal trade also encourages modern day slavery. Vessels acting with no regard for international law are often operated by crew working under forced labour conditions.

Given that this law-breaking can happen hundreds of miles offshore, authorities have found it very hard to police. Oxfordshire-based OceanMind has found that modern satellite capabilities are part of the answer.

This not-for-profit organisation helps preserve marine biodiversity, protects livelihoods and prevents slavery in the seafood industry, using satellites and artificial intelligence (AI), to identify fishing activities and suspected non-compliance, helping to protect the world’s vast oceans. They have proven to be some of the most difficult spaces to effectively govern and protect, but this innovative organisation has discovered that satellites can be used to find out what is happening anywhere on the seas, and AI is then used to identify where illegal fishing is happening. Their team of highly skilled analysts are then able to target these suspected problem areas far more effectively.

OceanMind is a not-for-profit spin out from Harwell Satellite Applications Catapult at Harwell Campus. It has decided to stay on the Harwell site to maintain strong working relationship with Catapult, remain part of the Harwell community and to keep enjoying the local transport links, including the popular shuttle services.

MATERIALS AND MANUFACTURING

Spinning like a spider

The textile industry has traditionally had a lamentable environmental and ethical record but now one Oxfordshire start-up is aiming to at least make silk production more sustainable.

It is normally produced from mass farming of silkworms but Spintex founder, Alex Greenhalgh, is convinced a more sustainable method is possible, through replicating how spiders spin webs.

“Spiders are amazing, they have several glands of a liquid silk solution which form a silk thread when a small pulling force is applied, self-assembling, completely at room temperature” he says.

“We’ve developed a protein solution, produced through a green chemistry approach that produces fibres in a similar way so they can be spun and turned into silk. You can’t farm spiders to do this for you because they eat one another.”

“Farming silkworms can be sustainable, but the processing of the cocoon is very energy intensive as alkali and toxic chemicals are heated so they can break down the sticky glue that holds the silk cocoon together, and allow unravelling of the up to one kilometre long fibre. The process leads to a lot of harmful water entering the water system, and large quantities of CO₂ are released. So, we’re replicating the way spiders spin silk so we can have environmentally friendly silk that doesn’t impact the environment.”

Greenhalgh began his career in science with the aid of a bursary from Science Oxford, an educational charity run by The Oxford Trust. In a full circle move, Spintex recently moved to larger new premises in the Wood Centre for Innovation in Headington, Oxford, which is owned by the Trust.

The business plans to use the new facilities to prove its technology can go beyond making fibres to produce full-size lengths of silk which could be perfected in 2021 before being made commercially available in 2022.

Greenhalgh will always ensure Spintex is based in his home city of Oxford where he also studied and met his co-founder. His hope for the city is that the universities deepen relationships with European colleges, institutions and research networks. Having received EU funding, the pair are hoping collaboration with Britain’s neighbours will continue. They also hope uncertainty over the future trading relationship with the EU will be ended soon because the company requires favourable trading conditions to set up an international market for its innovative material.

Bubbling under success

Improved heat exchange technology holds the key to getting higher performance from refrigerators and home heating systems with lower power consumption.

This is where Oxford nanoSystems is focussing its new metal coating process. It explains its technology works in much the same way tiny surface irregularities cause carbon dioxide to boil and rise to the surface of a glass of champagne as a stream of bubbles.

Metal that has been dipped in its coating immediately takes on a cauliflower, or dendritic, appearance which, in the words of CEO, Ian Russell, encourages 'boiling'. The result, he claims, is a performance improvement of up to 70%. An area where it could have a huge impact in the green recovery is encouraging people to switch from gas-burning boilers to heat pumps.

"Heat pumps are a good example where we can help," he says.

"They're typically the size of a domestic refrigerator and some people may find them a bit of an eye-sore standing next to their house. We can help the manufacturers get the same performance from a smaller unit. It's important we make them look more appealing because they will have a big role to play in replacing gas boilers. Every gas boiler uses up more energy than it delivers – but a heat pump will typically deliver four times more energy than it consumes. Our technology can take that to around a five-fold increase and in a smaller, more appealing box."

Oxford nanoSystems is also hoping to prove to supermarkets its technology could be used in warehouses and in-store refrigeration to reduce their power requirements, and carbon footprints.

TRANSPORT

Oxford tests for autonomous cars

A more sustainable economy will need a major rethink in transports systems and Oxford residents might have inadvertently sneaked an early peak at what that might entail.

Oxbotica has been running trials of a self-driving car

with a difference. Known as Project Endeavour, the programme is co-funded by an Innovate UK grant and sees autonomous-ready vehicles making the trip between the Oxford and Oxford Parkway stations with a safety driver in position ready to take control, if needed.

Rather than rely on GPS to guide a vehicle, Oxbotica's system combines a mixture of radar, laser and vision sensing to deliver autonomous operation in a vast range of settings, on any vehicle platform, under any conditions. This pioneering technology has already operated in a range of environments without access to GPS, such as in mines and quarries, and inside warehouses.

Though novel today, autonomous shuttles, similar to the trial car running between Oxford's two main train stations, could be commonplace before the end of the decade, according to Oxbotica's SVP of External Affairs, Graeme Smith.

"We think shuttles and delivery vehicles, that move people and goods en-masse, could be running autonomously sooner rather than later," he says. "Autonomy has the potential to enhance our safety, increase production, reduce carbon emissions and enrich our quality of life."

Oxbotica has bases both at the Oxford Business Park in Cowley and Culham Innovation Centre. It started out at the Culham tech hub run by the UK Atomic Energy Agency (UKAEA) because it has a private road network which was invaluable for early testing of its system.

Rocket engine leads to thermal management breakthrough

When the end goal is a decade or more away, it pays to be able to find an additional use for technology so it can be commercialised in the nearer term. That is what Reaction Engines is doing with elements of its supersonic hydrogen engine, SABRE, that will one day power aircraft at Mach 5 and space craft in orbit at up to Mach 25. The business has been set up by engineers who were working in the 1980s at Culham on British attempts to develop a space plane, called HOTOL.

The business, which has maintained its Culham base, believes its engine could be fitted to normal-looking



"We're talking to motor sport companies who are interested in how our heat exchangers might improve the performance of their engines to achieve better lap times. We're also discussing with energy companies how we could reclaim waste heat to make their operations far more efficient."

Building a cleaner future in Oxfordshire

Ian Pritchett knew it was time to act when his outdoor work renovating windmills and watermills convinced him climate change was very real. He was losing more days to adverse weather and realised the natural materials he was working with would be a far more environmentally-friendly way to build new houses.

The result is Greencore Construction which has already built 35 houses in two Oxfordshire villages and has plans on paper to build another 500. The business uses natural materials, such as timber, and ensures its houses are as heat efficient as possible with an environment plan in place to protect nature.

The business is based at Culham, because Pritchett is originally from the area and because Oxfordshire, he says, is the only region to have all local councils signed up to the One Planet Living principles of seeking to exist in harmony with nature. While local government has sound ideas, he does have questions about how these principles are backed up with procurement decisions. He has several suggestions for national government which he believes could improve green building.

"We enjoy local government support but my question to them would be why have they not decided to only work with builders offering zero carbon projects?" He asks.

"National government could also help. In the same way you don't have to pay road tax for an electric car, they could slash the average £15,000 Community Infrastructure Levy builders have to pay for every house they construct, if it is a carbon zero project. Once the current stamp duty holiday is over, they could choose to extend it for carbon zero housing. These tax changes could make a substantial difference to green housing businesses."

airplanes which could travel at supersonic speeds between airports and, when used in space, would have the advantage over today's rockets of being able to land and then take off again.

A crucial element is the pre-cooler at the front of the engine. The company has shown it can take super-hot air and cool it to minus 150 degrees centigrade in a fraction of a second. In aviation, this would allow air to be compressed to aid combustion – hot air cannot be compressed because it just becomes hotter under pressure.

While the engine concept is taken forwards over the next decade, the company expects this heat exchange technology to be put to good use in industry, reveals James Barth, Aerospace Engineer at Reaction Engines.

"We have a lot to offer any company working with thermal management issues because we can take that heat away using heat exchangers that are lighter and more compact, without sacrificing performance" he says.

A growing industrial landscape, but still more to do

The companies featured above provide examples of innovation and technology development from across the region and give us cause to be confident that the green economy will thrive and be well positioned to drive economic recovery for the UK. However, as we have seen, while the region provides many great opportunities, there is still much to do to ensure that the potential of these companies, many of which are pre-revenue, can be translated into commercial success, growth in employment and return for investors. In the final chapter of this report we look in more depth at some of the challenges facing companies, as well as examining what will enable growth.

During this project we have also attempted to identify the full range of innovative companies that are working as part of the Low Carbon and Environmental Goods and Services sectors within the Oxfordshire region. This is no easy task, as data is not readily available and Office for National Statistics (ONS) data is presented at the level of regions covering large areas, e.g. south-east of England, and is not available at county level. We have presented information about the companies we have found within a Directory, available on the Advanced Oxford website (www.advancedoxford.com). This Directory is not exhaustive, and we invite companies to add themselves to the list, so we can continue to assess the growth of the green recovery moving forward beyond the publication of this report.

Private and government funding go hand in hand

Oxford has the enviable position of offering spin-outs and start-ups a strong local seed and venture capital landscape which can dovetail with government grants to allow tech companies to convince large potential partners to collaborate with them.

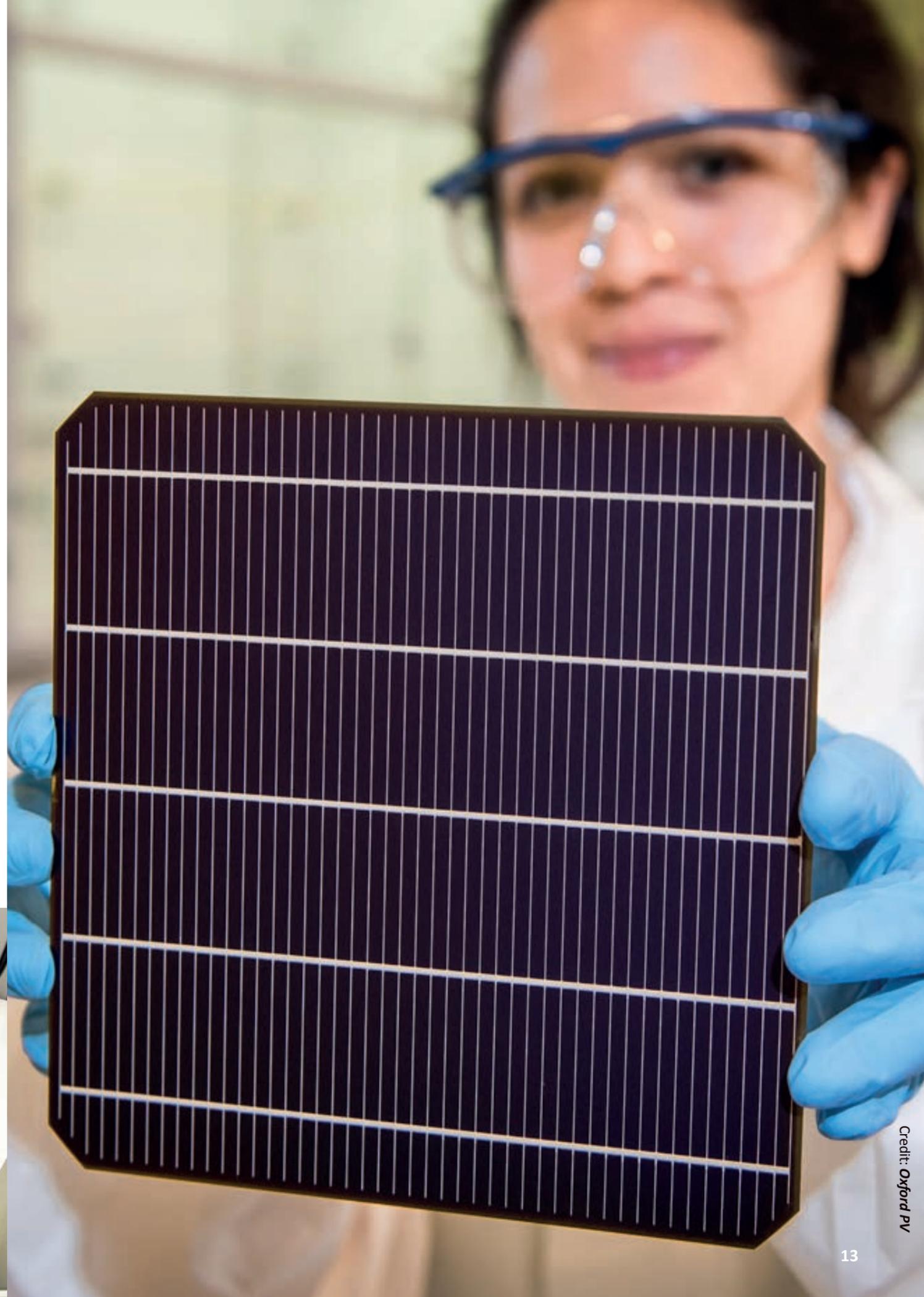
Brill Power's Chief Financial Officer and Chief Operating Officer, Carolyn Hicks, reveals the company's battery management technology benefited from government grants showing Oxford-based investors they were worth backing. That, in turn, led to high level collaboration.

"We've found that grants are great for inducing confidence in investors because if government bodies are awarding you money, it shows VCs you've got an idea that's worth backing," says Carolyn Hicks, Chief Financial Officer and Chief Operating Officer at Brill Power.

"We have won two grants with the Faraday Institution which have really helped us get local VC funding from Oxford Sciences Innovation and Oxford Investment Consultants. It also meant we got to form research collaborations with companies such as Aston Martin in automotive. It's amazing to get that access to how they work and to get an introduction that would otherwise be very difficult to achieve."



Credit: Oxford nanoSystems



Credit: Oxford PV

Why leading companies working on sustainability grow and stay in Oxfordshire

Technology giants are attracted to Oxfordshire's highly skilled work force and the chance for collaboration with the city's universities and tech hubs.

The Oxfordshire region is not just a focal point for exciting start-ups dedicated to powering the green recovery. It is also home to some of the country's biggest technology firms who are dedicated to building a greener economy.

These large companies fall into two main camps. Some have selected the area to tap into the talent and the opportunity for collaboration provided by the city's universities, as well as the region's tech hubs. There are also those who have spun-out from the University of Oxford and then scaled up in size thanks to access to a highly skilled work force which, in turn, is a major reason to stay in the area.

It is fitting, then, that one of the area's best-known technology companies, Oxford Instruments, has a foot in both camps. It is widely acknowledged as the area's first university spin-out to become a large commercially successful business. It set up at the end of the 1950s before floating on the London Stock Exchange in 1983. It is world-renowned for its work on superconducting magnets which have made MRI scanners possible.

Like many spin-outs from Oxford's universities, it stayed close to its roots to tap into highly skilled graduates. In so doing, Oxfordshire became a focal point for superconducting magnets to the point where global research and manufacturing giant, Siemens, decided to join forces with Oxford Instruments to create a joint venture.

Siemens attracted to a 'centre of excellence'

Siemens came to the area to collaborate with Oxford Instruments in 1989 but took sole ownership of the magnet business in 2003.

The German company's philosophy is to build companies around centres of excellence and so Siemens Magnet Technology has remained at Eynsham, just west of Oxford. It has provided an entry point for the wider Siemens business to seek out collaboration with University of Oxford and Harwell Campus, where it established a research base. This facility has grown to now incorporate new Siemens Energy and Technology teams, the latter led by Professor Paul Beasley, Head of R&D at Siemens UK.

"The region has an excellent reputation," he says. "The Technology team in Oxfordshire reports into HQ, coordinating Siemens innovation across all the UK businesses and acts as a gateway for the global organisation to collaborate with the national innovation ecosystem."

Siemens collaborations

These projects have included building a next generation particle accelerator with the Rutherford Appleton Laboratory at Harwell Campus as well as the campus's green ammonia demonstration facility, developed in partnership with the Science and Technology Facilities Council (STFC) and the University of Oxford. It has successfully demonstrated and showcased how ammonia could be produced in an environmentally friendly way, from air and water, to potentially support a future hydrogen economy.

The company's Harwell base has also explored a wide range of innovative green technologies in collaboration with local researchers. This included the use of data and AI to develop sustainable solutions to manage the charging of electric vehicles.

"The rapid growth and use of electric vehicles could create significant problems with the national grid network if they were all put on charge when we get home from work," Beasley says. "The same goes for a bus company putting its fleet on charge at the end of the day."

Siemens have also recently acquired a Didcot-based

company, CD-Adapco, offering software solutions covering a wide range of engineering disciplines including Fluid Dynamics (CFD), Solid Mechanics (CSM), heat transfer, particle dynamics, reactant flow, electrochemistry, acoustics and rheology.

The relationship with Oxfordshire could deepen in the near future as Siemens seeks a base for a "Living Lab" which it hopes would demonstrate environmentally friendly technology. The idea would enable businesses from all over the world to come to the facility to demonstrate green and digital technologies in use. The company has yet to make a decision where this may be based but the "innovative region" of Oxford is being actively considered.

YASA puts the performance in electric motors

The University of Oxford is a pivotal institution both in creating spin-outs, but then also retaining them, to the point where they can be classified as major companies.

YASA is borne out of research undertaken as a DPhil at University of Oxford by its founder, Tim Woolmer, and has now grown into an electric motor giant in the making. With the aid of part-funding from local venture capital firm, **Oxford Sciences Innovation**, the company has developed, and now manufactures, high performance and compact electric motors and controllers which are 'pancake' shaped, rather than the usual 'sausage' design. These produce a large amount of torque without overheating through an innovative technique using oil to move heat away from the engine's coils.

YASA's approach allows its electric motors to be used in cars and aeroplanes which require a lot of power, while keeping size and weight to a minimum. It is fitting, then, that they are already used in the Ferrari SF90 Stradale hybrid electric car as well as the all-electric aircraft with which Rolls Royce expects to

set a new single seater speed record in 2021. Plans are already underway for the business to supplement its Yarnton plant, just to the north of Oxford, with a new production facility. The company currently has a production capacity of up to 100,000 electric motors per year at its Oxford Industrial Park base at Yarnton but a major deal with a well-known car maker means it will need to seriously ramp up production in the next two to three years.

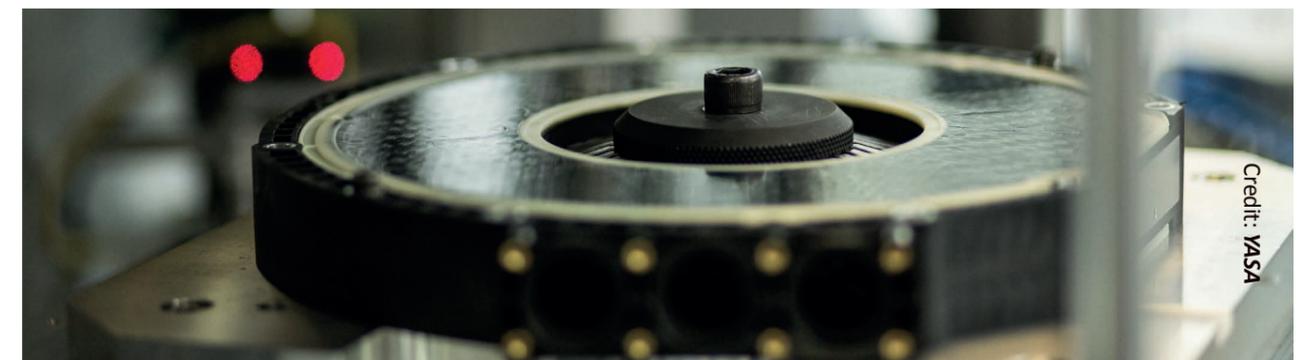
Committed to an Oxford HQ

Government support for areas of high unemployment, which do not include the Oxfordshire region, will mean other parts of the UK are more likely to be picked for YASA's larger volume facility. However, production at Yarnton is expected to still carry on and the base will remain the company's headquarters. This is not just down to the company's history but because of the area's highly educated work force, confirms its CEO, Chris Harris.

"Our most important asset is our people and they're at Yarnton, they live in the area and so our main base will remain here," he says.

"Oxford is where our technology was developed, and it gives us proximity to highly talented graduates from the universities. We work very closely with Oxford Brookes to offer students on sandwich courses a year-long placement. The University of Oxford doesn't have courses with a year in industry and so we offer these students placement roles over the summer holidays."

It is the highly skilled work force it has already assembled, and access to the new recruits which will allow it to increase its current headcount of 200 by 50% within the next two to three years. While some large companies might keep to an area because of local supply chains, this is less of a concern for YASA which makes the IP sensitive parts of its engines in-house, but other parts assembled at the plant are not made locally.



Infineum keeps the world moving

YASA is not the only large company in the region helping to keep people and products moving with less impact on the environment.

One of the region's more interesting facts is that the engines of roughly one in three of the world's vehicles are typically kept turning by lubricants developed by Infineum.

The joint venture between Exxon Mobil and Shell has been based at Milton Hill Business & Technology Centre, near Abingdon, for more than twenty years where it employs a core research team of 200. The business has additional research centres in the United States and China.

Like many companies of all sizes, it was attracted to the area because of the expertise at the University of Oxford in chemistry and engineering both in terms of potential collaboration as well as a source of highly educated staff. Proximity to Harwell Campus has also been instrumental in keeping the business near Abingdon. It sponsors a professor at the campus and uses its x-ray laser and neutron scattering equipment.

Robin Scott, Director of Product Innovation and Engineering at Infineum, explains the business is dedicated to developing new lubricants and fuel additives that reduce the global carbon footprint associated with transport. With an oil dedicated to match the requirements of each engine, service maintenance levels can be extended so less oil is used. Also, with the right lubricant in use, engines last longer and so the demand for new vehicles to be manufactured is reduced.

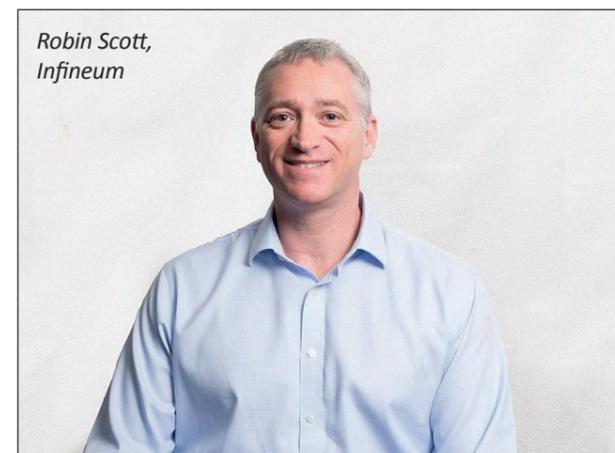
Lowering emissions

The same applies to fuel additives the company makes which improve efficiency. With the latest lubrication and improved fuel mixes, Robin Scott maintains the average new car now produces around 45% lower carbon emissions than at the turn of the century. This is made possible by efficiencies delivered by better fuel chemistry and engine design, as well as developing new lubricants matched to the specific requirements of each engine.

"Engine makers will approach us with their latest design that we develop a new lubricant for to make sure it runs more efficiently lower friction," he says.

"Our chemistry helps engines run more efficiently and last longer, so their impact on the environment is reduced. We also do a lot of work to anticipate future innovation and we have already seen a turning point this year in discussions with engine makers about electric engines and particularly engines running on e-fuels, such as hydrogen."

These new fuel requirements will see Infineum play a new role in helping to reduce the environmental impact of global transport. It has also been working on "getting its own house in order", according to Sustainability Manager, Michael Savage. The company will be publishing its first external report on sustainability in the Spring of 2021. It will detail how the business is reducing its own environmental impact through greener operations and corporate goals to reduce carbon emissions.



Robin Scott,
Infineum



Michael Savage,
Infineum

What keeps a giant in Oxfordshire?

Collaboration

Head of R&D at Siemens UK, Professor Paul Beasley, points to the collaboration opportunities with Oxford's universities and the region's science campuses and hubs. Among other projects, the business is currently collaborating with the STFC at Harwell Campus on a green energy ammonia demonstrator.

Centres of excellence

Successful businesses in the area attract the best talent and build up a supply chain. Oxford Instruments is a perfect example, attracting Siemens to a ready-made centre of excellence a little more than 30 years ago, and has kept it active in the area in multiple disciplines ever since.

Skilled work force

YASA says it is staying in Oxfordshire because it has built up a highly skilled workforce helped, but not reliant upon, proximity to Oxford's universities. It encourages university engineering students to take up year-long industrial placements as part of their course, as well as work in university holidays to gain experience. To date, the company has hosted over 30 such student placements, more than 10 of whom have returned to the company as full-time employees after finishing their degrees.

Location, location, location

Infineum adds the Oxfordshire location of its headquarters offers the advantage of commuter routes, plenty of green space and local wildlife as part of the working environment, as well as the space to provide impressive facilities. These include a multimillion pound, custom-built Technology Centre, testing facilities and modern office buildings that bring together essential business services and technical product development, which all help to attract a diverse range of talent that gives it a truly international feel.



Fusion – meet the Oxfordshire pioneers creating the energy of tomorrow

Oxfordshire is at the epicentre of the UK's drive to end mankind's reliance on fossil fuels by replicating how the sun heats the solar system – fusion energy.

Not only does the region benefit from University of Oxford attracting the brightest minds in academic research but the county is also home to the UK Atomic Energy Authority (UKAEA) – the UK's national fusion research centre, based at Culham, near Abingdon.

The site was originally a Royal Navy airfield repurposed in the early 1960s to be the home of the country's effort to develop fusion energy. The new base for fusion was set up to build on pioneering research carried out in the 1950s at the nearby Harwell Campus and universities including the University of Oxford.

Hotter than the sun

Fusion holds the promise of providing the globe with an abundant source of low carbon, safe electricity. Unlike today's fission reactors, which work through splitting atoms, fusion mimics the reaction that powers the sun – the sticking together or fusion of light nuclei. This is achieved by heating a very hot gas of fuels (or plasma) to more than 100 million degrees centigrade, causing fusion of deuterium and tritium – two heavy forms of hydrogen. When fusion occurs, a helium nucleus and a neutron are produced, a process which releases a huge amount of clean, safe energy.

While the rest of the world is also actively researching and developing fusion, UKAEA is operating the world's largest fusion experiment – JET – on behalf of European partners. JET has been running for nearly forty years and stands out as the only experiment in the world able to use both fusion fuels, deuterium and tritium, as well as having a full remote handling capability.

In Autumn 2020, UKAEA further announced that, after a seven-year build, a new UK fusion experiment, called Mega Amp Spherical Tokamak (MAST) Upgrade had started operation. MAST Upgrade is testing a

more compact configuration and crucial to this new, smaller design is an exhaust system which effectively removes excess plasma heat, more effectively, so the fusion reaction can last longer.

UKAEA CEO, Professor Ian Chapman, commented:

“MAST Upgrade will take us closer to delivering sustainable, clean fusion energy. This experiment will break new ground and test technology that has never been tried before. It will be a vital testing facility on our journey to delivering the STEP fusion power plant.” (see below for more on the STEP fusion power plant).

Commenting on the announcement at the end of October, Science Minister, Amanda Solloway, said:

“We want the UK to be a world leader in fusion energy and to capitalise on its amazing potential as a clean energy source that could last for hundreds of years. Backed by £55 million of government funding, powering up the MAST Upgrade device is a landmark moment for this national fusion experiment and takes us another step closer towards our goal of building the UK's first fusion power plant by 2040.”

Power plant design

UKAEA has also recently begun a three-year project, called STEP (Spherical Tokamak for Energy Production). It will draw on all the expertise of UKAEA, the supply chain, and academia in undertaking the concept design of a UK compact fusion power plant.

This not only maintains Oxfordshire's position at the heart of fusion research, it provides two clear opportunities for innovative companies. They can work with UKAEA in the materials and technology that will be needed to build and operate the fusion power station of the future. At the same time, UKAEA can help British businesses bid for high value contracts with the International Thermonuclear Experimental Reactor (ITER) – an international fusion device being constructed in Provence, France with funding from seven main members – the EU, USA,

China, India, Russia, South Korea and Japan.

“A lot of the work we're doing at UKAEA now is not just in the fusion reaction but in the technology around the fusion power station,” explains Chris Warrick, Communications Manager at UKAEA.

“There's been a real focus in the last five years in understanding, not just how to heat a fuel up to 10 times hotter than the sun and get it to fuse, but also to understand what the mechanics of a power station look like.”

“What materials do you build it with, so it can withstand what is a very harsh environment? How can you design robotics that can maintain the interior of the machine looking forward to a power station? There will be a level of activation in there, what remote handling techniques do you employ?”

This work is opening up the potential for companies in areas such as innovative materials, heat exchange and robotics to collaborate with UKAEA and, potentially, the ITER programme in France.

UKAEA has a burgeoning technology programme in various areas, including the Remote Applications in Challenging Environments (RACE) robotics facility which employs more than a hundred high tech engineers to remotely maintain its JET reactor and help design remote handling equipment for future powerplants. The facility also has testing facilities where innovative companies can test technology designed to be operated remotely in other harsh environments, attracting companies involved in autonomous driving, intelligent mobility, augmented reality and other industries – notably nuclear fission decommissioning.

Tokamak Energy attracted by magnets

Oxfordshire is not only home to the UKAEA, it is also a centre of expertise for superconducting magnets. They were the science breakthrough that helped the University of Oxford's first hugely successful commercial spin-out, Oxford Instruments, scale up and then float on the London Stock Exchange over thirty years ago. Oxford Instrument's success, in turn, attracted Siemens to the area to enter into a joint venture which the German giant went on

to buy full control of in 2003 (see more on this in Chapter 3 *“Why leading companies working on sustainability grow and stay in Oxfordshire”*).

Superconducting magnets are not only essential for MRI scans, they allow super-hot plasma created inside a fusion reactor to be held in suspension so it does not touch the sides. It was this local capability in super-conducting magnets that initially helped to attract Tokamak Energy to its base at Milton Park, not far from the decommissioned part of Didcot Power station.

The company is currently vetting local sites to build a demonstration facility to prove its approach to fusion technology is viable at industrial scale. It has already shown its fusion technology can work to produce plasma temperatures hotter than the centre of the sun and the next step is to upgrade the current 'ST40' device to reach 100m Celsius, the temperature necessary for controlled fusion energy.

The ST40 currently runs with pure hydrogen. Soon the switch will be made to using deuterium, known as heavy hydrogen, and eventually a mixture of deuterium and tritium will be used as fusion fuel.

Looking for support

Executive Vice Chairman, David Kingham, explains the company has recently developed its own superconducting magnets from the latest generation of high temperature superconductors. The materials are a key enabler for more compact, higher performance, fusion power modules, but also have many other applications – which could be commercially exploited with local partners.

To keep all this activity in Oxfordshire, and maintain the area's lead in fusion and in superconducting magnets, the key is for the government to invest in the new form of clean energy and support the required manufacturing supply chain.

“We're short-listing where we want to set up our fusion power demonstrator and the decision will ultimately come down to where is best for us and where we get the most support from government,” he says.

“That isn't just about direct support for us but also about the manufacturing support and supply chains we need in specialist areas. We currently buy

equipment from as far afield as Russia and Spain. What we would really find useful is local manufacturers for high temperature superconducting materials and we need the government to take the lead in investment in advanced manufacturing."

First Light Fusion's natural inspiration

It is often referred to as nature's most powerful weapon but the click of a pistol shrimp's claw, which instantly stuns prey, is the basis of research at University of Oxford, undertaken by First Light Fusion CEO and co-founder, Nicholas Hawker.

Hawker wanted to better understand and unlock the power of this bubble stun gun and modelled how, with a click of its claw, the shrimp sends out a bubble containing air that is heated to more than 5,000 degrees centigrade. The result is First Light Fusion, which is founded on the belief the shrimp's approach could unveil the secret of supplying the world with green energy by providing the answer to one of fusion's greatest challenges.

Targets

A process that requires atoms to be heated to the temperature of the sun is difficult to perfect, particularly if the atoms have to be at that temperature for a long period of time.

First Light, pursuing the inertial fusion approach, reduces the time the temperature needs to be maintained to nanoseconds. It does this by placing the fuel in the path of a fast projectile. This causes the fusion process to take place in a fraction of a second. Like the pistol shrimp, the 'bullet' hits the target, which resembles a bubble inside a small cube of plastic and releases its energy in an individual burst.

In a future power plant, the 'target' capsule will be replaced every few tens of seconds as the process continues. It is effectively a sequence of small amounts of fuel being used rather than a long process where the fuel of a plasma 'soup' is held in suspension by super conductive electromagnets for a protracted period of time.

Moving to the next demonstration phase is going to

be expensive and it is here that First Light is hoping national and local government support will help to keep the company in Oxfordshire, which is establishing itself as the UK's fusion hub.

Why Oxfordshire for fusion?

Both Tokamak Energy and First Light Fusion point to the UKAEA's Culham base, the academic excellence offered by Oxford's universities and the steady supply of highly qualified talent, all of which make Oxfordshire a natural hub for the UK's fusion effort.

Centre of excellence

"Like many technology companies in the area, we're a spin-out from a local research centre," says Tokamak Energy's Executive Vice Chairman, David Kingham.

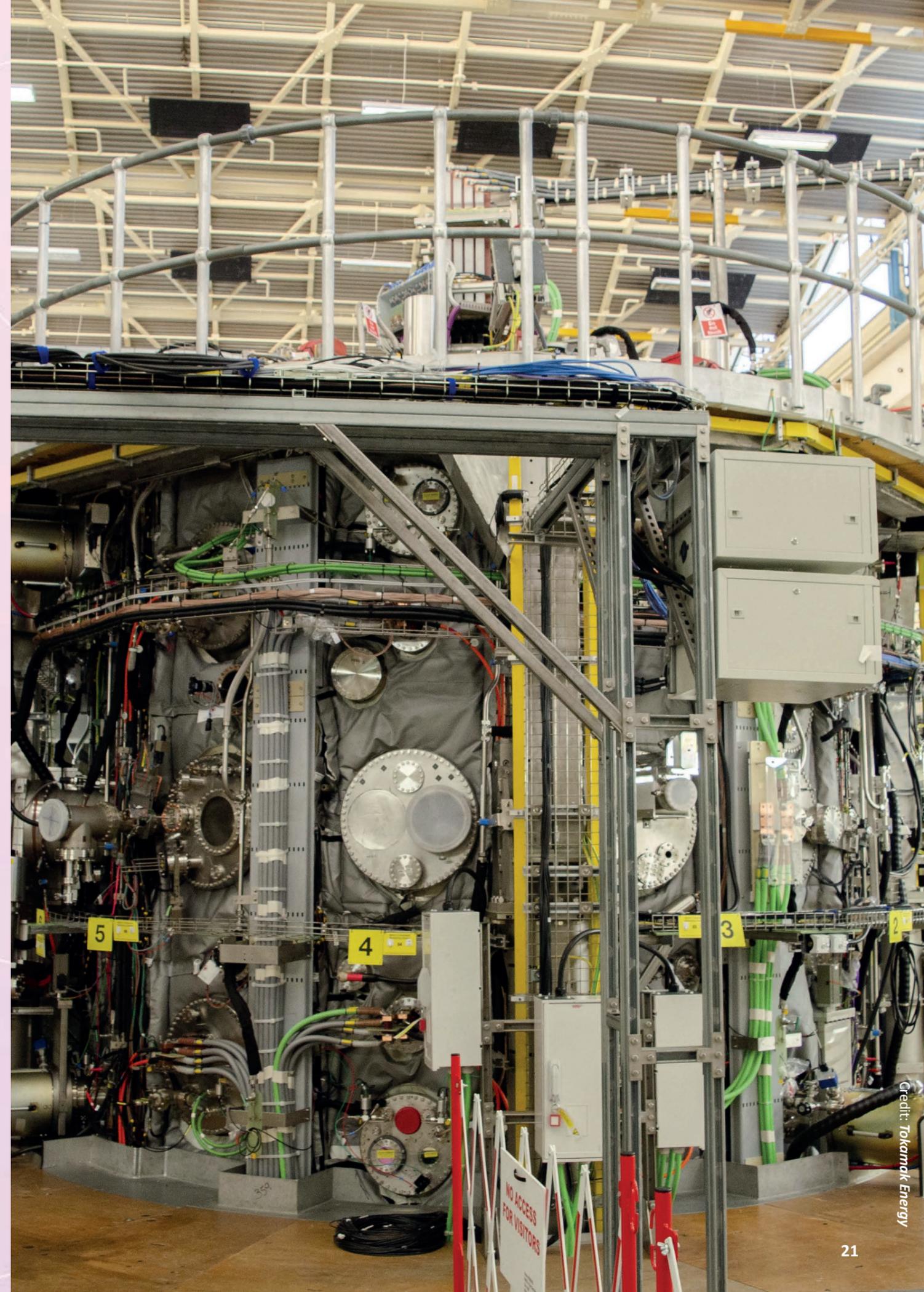
"We want to stay here in Oxfordshire because Culham Laboratory is still the world's leading fusion research centre. This is also the place where Oxford Instruments originally developed superconducting electromagnets for scientific research and for magnetic resonance imaging (MRI). This has attracted companies such as Siemens and a whole local supply chain and made Oxfordshire the country's leading region for exactly the technology we need."

The fusion cluster

"We're very fortunate to be in Oxfordshire not just for the access to the bright people it attracts but also because a 'fusion cluster' is developing here, thanks to the presence of UKAEA," says First Light Fusion's Chief Operating Officer, Gianluca Pisanello.

"UKAEA, and the other big international efforts, have developed a lot of the fusion science and engineering in the past decades and paved the way for private companies to participate in the global fusion effort," adds Pisanello

"We always believed in the value of cooperation, both with public and private entities. Being a small start-up, we would certainly benefit from infrastructure support in the area we operate in, such as land and premises," he concludes.



Oxfordshire's innovation clusters create the places for new commercial opportunity

Oxfordshire is seeing the benefits of clustering across the whole of the region, with industry hubs operating from campuses, science parks and facilities across the whole of the county.

There are many examples of clusters of green economy activity. Within this chapter we look at how clustering around core capabilities is providing the scientific, technical and business environment to support innovations to develop and to create new opportunities for collaboration across the region.

The EnergyTec Cluster at Harwell

Harwell Campus, just to the south of Oxford, is home to unique facilities, skills and knowledge, working across multiple disciplines. Over 6000 highly skilled people work there, and the campus provides the tools and national science infrastructure that can be used to accelerate the conversion of innovative ideas into solutions that work in the real world. The EnergyTec Cluster is one of three sector-facing clusters that are located at Harwell and is run by dedicated Cluster Manager, Emma Southwell-Sander.

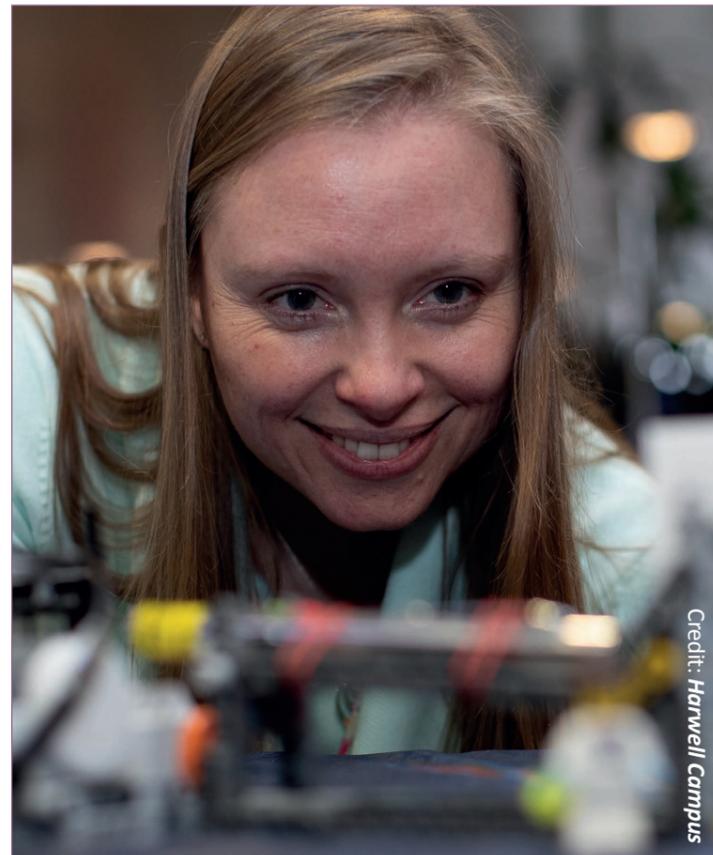
"We have a 75-year history of working in energy at Harwell and we are looking forward to continuing to grow the cluster here by attracting more organisations and investment, and by focusing on the importance of innovative net zero technology" says Emma Southwell-Sander.

The vision for the Harwell EnergyTec Cluster is "the place to accelerate innovative solutions to meet national and international energy challenges, enabled by embedded world-leading capabilities and skills."

The EnergyTec Cluster is growing rapidly and currently comprises 57 energy organisations on site, employing over 1100 people. The cluster aims to bring together the multiple capabilities located on Harwell's campus, reaching out across the UK and internationally to help address the UK's energy challenges. EnergyTec Cluster members include Siemens, Toyota, Johnson-Matthey, Williams Advanced Engineering, and the Energy Systems Catapult. Founded in October 2017, the Faraday Institution is headquartered at Harwell and is the UK's independent institute for electrochemical energy storage science and technology, supporting research, training, and analysis. It is an integral part of the

Cluster. With an outward-facing culture, the EnergyTec Cluster is inter-connected with over 100 organisations across the region belonging to Oxfordshire's energy sector and industrial base.

Harwell Campus has a raft of business support available, including networking, cluster events and Proof of Concept Calls that inject investment into cross-sector partnered projects. An unrivalled springboard for ambitious organisations to progress, the campus and cluster provide a well-established entrepreneurial ecosystem which facilitates collaboration, risk sharing and makes it easier to attract new investment.



Credit: Harwell Campus

Harwell Campus has a unique grouping of national science facilities under the Science and Technology Facilities Council (STFC), part of UK Research and Innovation (UKRI), with future developments underway, all of which contribute to the success of the Cluster, but are also open to other companies and organisations.

Diamond Light Source

Diamond Light Source (diamond.ac.uk) is the UK's national synchrotron facility. It harnesses the power of electrons and is 10 billion times brighter than the Sun, enabling scientists to study anything from aerospace components and batteries to viruses and vaccines. Diamond works directly with more than 150 companies in 19 countries and hosts over 8,000 visiting scientists each year to undertake experiments – 40% of these projects have industrial engagement. With state-of-the-art advanced materials characterisation facilities and expert staff, the techniques available allow scientists to examine the structure and chemistry of materials and processes in unprecedented detail. Energy research is a key area and R&D projects performed at Diamond include understanding chemical and structural changes in battery materials over long term charge and discharge cycles. Alternative energy storage technologies such as fuel cells and gas storage materials have also been investigated.

The Central Laser Facility (CLF)

The Central Laser Facility (clf.stfc.ac.uk) at the Rutherford Appleton Laboratory is one of the world's leading laser facilities, providing an unparalleled range of state-of-the-art laser technology and expertise across scientific disciplines. It provides a broad spectrum of laser facilities, from high intensity laser systems to ultra-fast sources and laser microscopy techniques. A vigorous development programme ensures that the CLF's facilities maintain their international competitiveness. A good example of this is Vulcan, a petawatt laser system used for experiments researching High Energy Density (HED) science including fusion energy, electron and ion acceleration, laboratory astrophysics and plasma physics.

Isis and Muon Source

The ISIS pulsed neutron and muon source at the Rutherford Appleton Laboratory is only one of three such facilities that are operating in the world today (isis.stfc.ac.uk). ISIS allows scientists to study materials at the atomic level using a suite of instruments described as 'super microscopes' and is the most productive research centre of its type in the world. ISIS is aiding organisations in the development of solar power, through ground-breaking polymers with the potential to improve the performance, efficiency, and economic attractiveness of solar cells, encouraging more widespread deployment of this renewable energy technology.

The Green Ammonia Demonstrator

A range of storage technologies are required to meet our decarbonised energy system needs. Producing hydrogen in low-carbon ways and using it to meet challenging demands in transportation, industry and power generation is an important part of the next stage of the UK's energy transition. Ammonia is a vector that enables the practical, carbon-free storage and transportation of hydrogen in bulk, as it has a high hydrogen density (both volumetric and gravimetric), and established infrastructure and procedures for storage and use.

The ammonia synthesis and energy storage system at Harwell Rutherford Appleton Laboratory is the only practical demonstration system in the UK and was the first of its kind in the world. The facility was designed and built both to show that such a system can be constructed and operated today by mature technology (and is therefore scalable), and to provide a development platform for further improvements in the processes involved.

Looking to the future, Harwell is developing plans for a Technical Living Laboratory, which will include 3 main components:

- **Optimising the environment:** Deploy integrated energy systems through a sustainability programme at Harwell Campus, with supporting data streams.
- **Testing the art of the possible:** Plug and Play Demonstrators and labs, including the Green Ammonia Demonstrator and the Faraday

Institution Battery Lab, will be accessed by stakeholders across academia and industry to trial solutions.

- **Championing cross-sector innovation**

This latter strand of the Technical Living Laboratory includes the expansion of the existing Proof of Concept and Demonstration Programme. A cluster Proof of Concept programme has been successfully running for 3 years, supported by STFC-UKRI. To date a total of £1.7m has been awarded to 44 projects, alongside industry matched funding from companies participating in the programme. Harwell would like to scale this up to £5m over 5 years, including a demonstration phase. This will de-risk innovation and forge new collaborations between industry, working across all of Harwell's cluster groups (EnergyTec, Space and Health) and the facilities on Campus and beyond, exploiting the shared infrastructure provided by the Plug and Play platforms developed by EnergyTec Stakeholders.

Dr Barbara Ghinelli, Director, Harwell Campus Business Development and Clusters sums up the potential for collaboration and evidence generation:

"The Harwell Living Laboratory puts us at the heart of emerging fields of 5G satellites, autonomous cars, energy storage solutions and innovative net zero technologies. These multidisciplinary projects are where Harwell's cluster model thrives – creating an environment where the space, health and energy sector can collaborate and trial green technologies that will underpin our net zero targets in years to come."

HR Wallingford

HR Wallingford provides another example of clustering within the region. Building on historic investments from Government, dating back to the 1940s, HR Wallingford is at the heart of a vibrant tech hub development taking shape in South Oxfordshire over the next two to three years. Ambitious plans are being drawn up to turn HR Wallingford's riverside site, Howbery Park in Wallingford, into a technology accelerator and proving ground for the latest science in coping with the challenge of climate change and its impact on water-related challenges. It is a crucial area of research because the UN predicts that by 2030 water demand will outstrip supply by 40%.

HR Wallingford's focus is the physics of water. After privatisation in the 1980s, it is constituted as a Scientific Research Association, with 75% of its income invested back into R&D. It undertakes both blue skies and translational research and the company is home to around 300 staff, most of whom are based at the Howbery Park site, as well as having international offices in 8 different markets. The work of the company is diverse, covering modelling, engineering design, software, equipment, and instrumentation design. As the owner of Howbery Park, the running of the whole estate, with its plans to develop as a hub for innovation, also falls to HR Wallingford, and the site is already a successful business park in its own right. It has built up world-leading simulation and modelling facilities on its site, with vast laboratories and the very latest technology attracting the best minds in the industry.

HR Wallingford's history of researching challenges, such as coastal erosion, flooding, droughts and silting of rivers and estuaries, places it at the heart of the green recovery.

"Water is central to generating green energy and in combating the effects of climate change," says Bruce Tomlinson, CEO at HR Wallingford. "Our mission is to better understand water so that we can work with it rather than against it and, where possible, make it work for us."

"We're seeing rising ocean levels as well as a lot more extreme and frequent storm and flooding events. It means we are starting to see areas that have no history of flooding are now flooding regularly and others, where water was plentiful, are now having to start to live with drought conditions."

"Our expertise is being used around the world to predict climate change's impact on water supplies as well as help authorities combat coastal erosion and manage building development in areas that are now starting to flood. We are also supporting the development of low carbon energy, through hydroelectric, wave and tidal power."



Credit: HR Wallingford



Credit: HR Wallingford

Building a new hub

The worldwide deployment of its expertise prompted the Scientific Research Association to wonder if it could do more on its own site to not only educate the public but inspire a new generation of start-ups. The question was made easier to answer by another government decision made decades ago that means its site is next to the UK Centre for Ecology and Hydrology. The Centre is also a former government research centre and hosts satellite offices for the British Geological Survey and the Met Office.

This pre-existence of an unofficial mini hub, through the two former public bodies neighbouring one another, has led HR Wallingford to draw up ambitious plans for the site, which the neighbouring Centre for Ecology and Hydrology is supporting.

“It seemed to us we were already pretty much a hub in the making for climate change and water technology,

so we drew up some plans to build on that,” says Bruce Tomlinson.

A masterplan has been developed for the site and there are plans to build an innovation centre and accelerator as well as a Centre of Excellence Academy. HR Wallingford is also planning to build visitor centres for flood resilience, water efficiency and zero carbon as well as creating what they intend to be the world’s most resilient building. It will be flooding-resistant, water efficient and zero-carbon.

The hope is the visitor centre will help educate the wider public and decision makers as to how to better cope with climate change’s dual impacts of drought and flooding, as well as an increase in serious storm events. At the same time, the Centre of Excellence Academy will attract researchers in water resilience and climate change from all corners of the planet and showcase the latest techniques being developed to manage climate change’s impact

on water. The Innovation Centre and Accelerator will further attract start-ups tackling climate change.

Howbery Park was the first official Business Park in the UK to adopt solar power and is aiming to be a zero-carbon site. They also have ambitious plans to support the development and adoption of green energy initiatives. For example, their river Thames frontage means they are well placed to assess the potential of heat exchange technology.

“Ultimately, we are blessed to have the unique combination of the existence of our technology cluster, space to develop the park to foster innovation and our location in a floodplain by the Thames to use as a living laboratory,” says Bruce Tomlinson

The plans for Howbery Park have been included in the region’s Local Industrial Strategy (LIS) drawn up OxLEP (Oxfordshire Local Enterprise Partnership). It has also attracted funding from DEFRA (Department

for the Environment Food and Rural Affairs).

Other cluster locations

Oxfordshire’s science parks and campuses provide a home to other green economy companies. A number of these are members of Advanced Oxford, including Milton Park (www.miltonpark.co.uk), The Oxford Science Park (www.oxfordsp.com) and Begbroke Science Park (www.begbroke.ox.ac.uk). Culham Science Centre (www.culham.org.uk) is another example, providing a home to Culham Centre for Fusion Energy. You can read more about Culham and their cluster within the Fusion Energy section of this report.



Greening the NHS in Oxfordshire

Addressing the NHS's carbon footprint requires action across a range of activities and issues. Oxford AHSN works end to end across the innovation pathway and is taking action to drive greater sustainability into the NHS supply chain.

The NHS, although one service, comprises many individual organisations – hospitals, GP surgeries, community services – each charged with decision making and procurement. England's fifteen Academic Health Science Networks (AHSNs) provide support to innovators looking to work with the NHS market and are also well placed to support greater sustainability within the NHS supply chain. This section of the report focuses on Oxford AHSN and their work with innovators working on sustainability projects.

Net Zero by 2040

NHS England has recently published Delivering a Net Zero NHS, which sets out the latest modelling of the NHS carbon footprint, the trajectory to net zero and the interventions required. (<https://www.england.nhs.uk/greenernhs/publication/delivering-a-net-zero-national-health-service/>).

The report sets two targets:

- for the emissions controlled directly (the NHS Carbon Footprint), net zero by 2040 with an ambition to reach 80% reduction by 2028 to 2032
- for the emissions the NHS can influence (the NHS Carbon Footprint Plus), net zero by 2045, with an ambition to reach an 80% reduction by 2036 to 2039

These are ambitious targets, and they provide the opportunity for innovation, creativity and behavioural change.

The NHS long term plan has also identified the need to:

- Reduce the carbon footprint and environmental impact of providing care
- Reduce air pollution and contribute to a cleaner environment
- Reduce the use of single-use plastics where appropriate and feasible
- Ensure that prevention and wellbeing are the focus of all healthcare activities
- Develop sustainable clinical practices in all specialities and services

Oxford Academic Health Science Network – a bridge for innovators and the NHS



Academic Health Science Networks (AHSNs) act as an innovation exchange transforming clinical practice, improving patient safety, outcomes, and experience, and generating economic growth through collaboration between the NHS, industry, and universities. Oxford Academic Health Science Network (Oxford AHSN) supports getting innovation into clinical practice in a region of three million people living in Berkshire, Buckinghamshire, Milton Keynes and Oxfordshire.

The AHSNs across England have recently established a community of interest on environmental sustainability, spurred by the need to take action to drive greater sustainability into the whole of the NHS. With the AHSNs' ability to work end-to-end across the innovation pathway and to support real world evidence generation, this capability is being applied to greening the NHS, and its supply chains.

“Sustainability principles need to be incorporated into innovation entering the NHS supply chain, with increased standardisation and interoperability, re-use, cleanable and recyclable materials”

– Paul Durrands, COO of Oxford AHSN.

Oxford AHSN already supports the development of projects and business cases in tandem, and is able to work with companies by providing:

- Clear understanding of the project potential in each NHS organisation across the region and the potential for collaboration

- Clear understanding of the state-of-readiness of each NHS organisation in relation to an innovation
- Packaged projects that fit within a single business case and how they might be procured/funded together
- Implementation, delivering resource efficiency

There are significant opportunities for local, innovative companies. However, companies need to understand the certification and regulatory pathways for bringing new products to the NHS. Oxford AHSN has supported the developers of the 'Oxford Box', a low-cost reusable aerosol shield, with promotion and a sales strategy (see more on this below).

So important is the need to embrace green, sustainable innovation, Oxford AHSN has just appointed their first Sustainability Manager, Carl Lynch.



“There are opportunities across the whole of the system – reusable PPE, waste, driving behavioural change.”

– Carl Lynch, Sustainability Manager

Carl cites a project at Great Ormond Street Hospital NHS Trust which has reduced consumption of single-use plastic gloves by 21 tonnes in 10 months, reduced usage of disposable gloves by 3.7 million from 11 million and saved £90,000. Closer to home, Oxford University Hospital has been championing the use of reusable theatre gowns – tracking, washing and reusing them.



Credit: Oxford AHSN

Innovation case study – The Oxford Box

The Problem

Covid-19 is presenting additional challenges to clinical teams when intubating and extubating patients following ventilation. Aerosol enters the room when the breathing tube is removed from the patient's throat and an additional risk of spreading the virus arises as a result.

Intubation and extubation procedures are performed extensively for both elective and emergency surgeries, which can take place in theatres, A&E and even by emergency first responders. As such the additional risk of spreading the virus from the aerosol to a great number of people is significant.

Medical staff are already wearing additional PPE to protect themselves during the COVID pandemic; they are also now having to allow a ~1-hour turn-around between patients for dispersion of the aerosol and cleaning of the room following extubation, severely limiting capacity of scarce resources.

The Solution

The Oxford Box is based on a concept that was first developed in Singapore and has been evolved by a team from Oxford University Hospitals, One Group Engineering and e-novation Consulting.

The Oxford Box is a transparent plastic box that fits over the patient's head and torso, with gloved hand access-ports to allow the breathing tube to be removed.

The box is designed to capture the aerosol that is generated upon extubation and limits its spread to the inside of the box rather than potentially filling the wider room.

The basic design has been iterated based on both real-world user feedback and through the use of Computational Fluid Dynamics (CFD), a technique usually used to model airflow over Formula 1 cars.

Oxford AHSN have been working with the project team to help them understand the value proposition of the Oxford Box and also to identify a sales strategy and possible routes to access a national market.

Impacts and Outcomes

By using the Oxford Box, cleaning is limited to the interior of the box itself and can reduce the turnaround time for the room from 1-hour down to approximately 5 minutes.

Users need to allow a "settling time" of the aerosol before dismantling it for cleaning, but a further planned design iteration is to add forced extraction to actively remove the aerosol allowing even faster turn-around.

Cost is relatively low (around £200) and it can easily be produced on a contract manufacturing basis.

Lessons Learned

The CFD modelling allowed re-design of the Oxford Box to maximise its efficiency in capturing the aerosol and to minimise the cleaning requirements.

Approximately 10 versions of this type of box are known to have been developed globally, but the Oxford Box is unique in that it can be flat-packed for storage when not in use and in the use of CFD to optimise its design and efficacy.

CE marking is not required for the product as it is classified as neither PPE nor a medical device. IP is not considered to be a barrier to commercialisation.

Future Plans/ Next Steps

The project team's objective is to achieve national uptake of the Oxford Box. Grant funding has been sought to allow further development of the design and options to market and sell the product are being investigated.

Oxford AHSN accelerator programme

Oxford AHSN runs an accelerator programme for innovators with an idea they want to bring to market. The programme guides you on developing your business plan and can help you discover fast-track routes to funding for commercialisation, scale-up and impact. For more details, view the AHSN's website <https://www.oxfordahsn.org/our-work/strategic-and-industry-partnerships/oxford-ahsn-accelerator-programme/>

Working with Oxford AHSN

Oxford AHSN offers a range of services and activities to help innovators to connect and collaborate with the NHS. Details of the Oxford AHSN's work can be found through their website: <https://www.oxfordahsn.org/our-work/>.

Reducing the NHS footprint nationwide

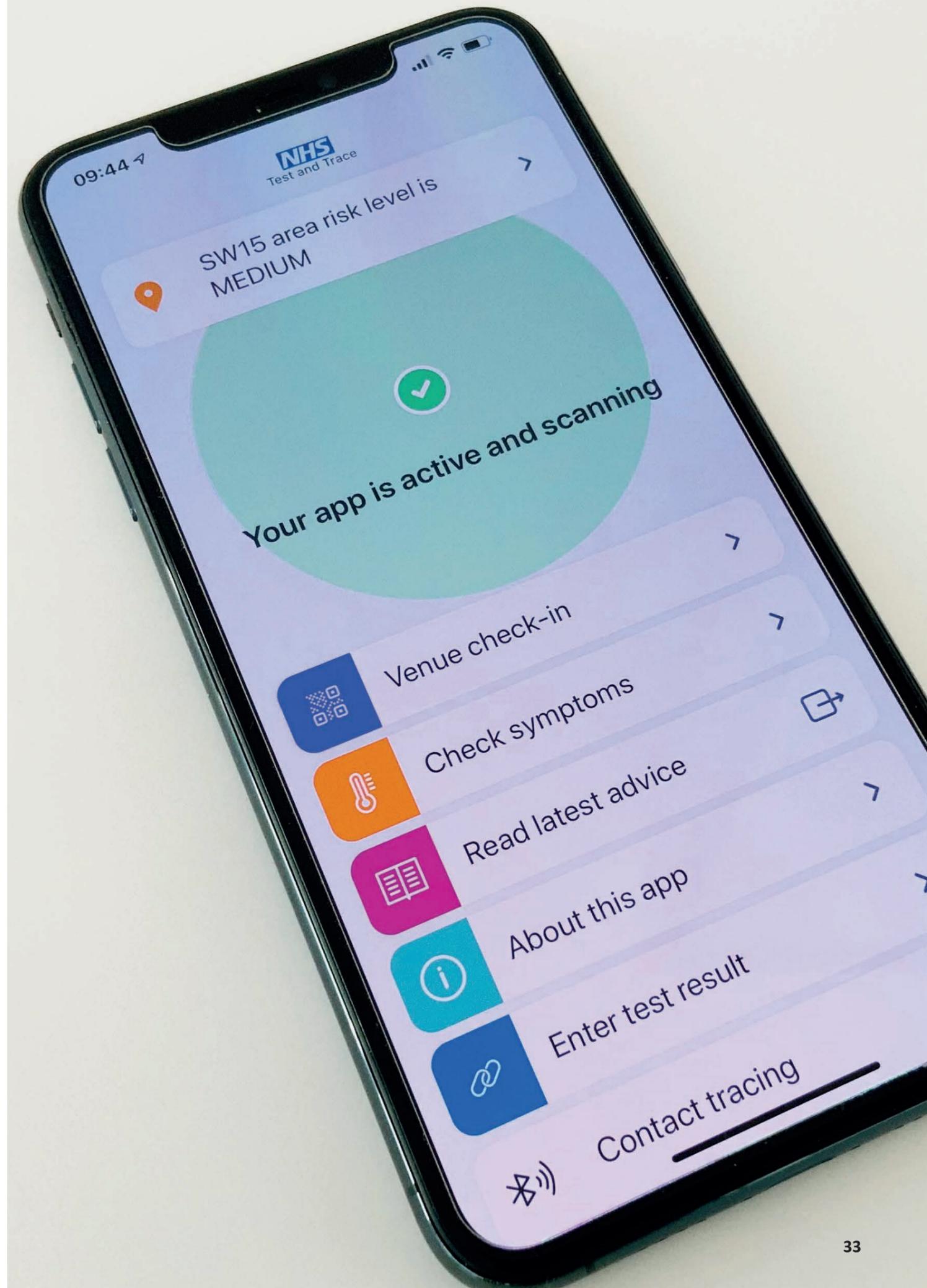
Addressing the NHS's carbon footprint requires action across a range of activities and issues. The **NHS estates** issues are well understood, with 10% of the total NHS carbon footprint associated with building energy. Even if the problem is well articulated, this does not mean that it is easily solved, as retrofit programmes for older hospitals such as the Churchill in Headington, Oxford, are challenging with a continued reliance on oil and gas for heating across the whole NHS estate. This provides innovation opportunities in the area of Green Heat.

The £50 million NHS Energy Efficiency Fund (NEEF) will be used to upgrade to LED lighting across the NHS estate, acting as a pilot for future work, with projected savings of £14.3 million and the equivalent of 34 kilo-tonnes of CO₂ per annum.

The NHS supply chain – medicines, materials, equipment – is responsible for 62% of the NHS's carbon footprint. The Covid-19 crisis has thrown into sharp relief the importance of PPE and the clear need for more reusable and sustainable

equipment. Throughout the crisis there has been a sharp increase in the use of single-use plastics associated with PPE which has highlighted the reliance on the international supply chain. As an example, from February to the end of September, NHS England distributed 2.1 billion plastic gloves and 596 million face masks for use by health and social care services. The majority of which has been placed into contaminated waste bags for incineration, driving significant additional costs from disposal of this waste. The AHSNs are working with the national PPE teams and NHS providers to assist in the implementation of the updated PPE strategy where the objective is to move away from disposable by default and assess new types of PPE that are designed for reuse from the outset, particularly through UK manufacturing.

The NHS has also experienced a dramatic change in operational patterns and resource utilisation, particularly with a shift to embrace digital/technology solutions and to facilitate remote consultations. These changes require a radical rethink about how patients engage with the NHS and future requirements of NHS estates. A continued reduction in patients visiting NHS providers will have a significant impact on the NHS's carbon footprint as, according to Delivering a Net Zero NHS, 14% of the NHS's carbon footprint is associated with travel of all kinds, including patients and visitors.



Creating the capability and ecosystem for the green economy to flourish

The industrial base within Oxfordshire is thriving, underpinned by a range of capabilities and soft infrastructure, which has placed the low carbon economy at the heart of the region's economic story.

Oxford's two universities provide a wide range of academic and translational capabilities which are active in working with the private sector. The universities, along with local councils are members of a number of consortia which are providing leadership and seeking to engage the business community in the move to net zero and a more sustainable future. The region is home to two innovative, large-scale demonstrator projects, developing new energy systems, as part of the Government's Industrial Strategy Challenge Fund. Yet, the landscape can be confusing for those sitting outside, with a number of organisations sharing similar names and missions. Here we set out the high-level capabilities and projects underway, highlighting the opportunities for business to engage.

University of Oxford

University of Oxford plays a key role in Oxfordshire's low carbon, green activities. As a leading academic institution creating human capital is at the core of its work. Over 200 academics groups are involved in energy research and details of these individuals, their teams and work can be found through www.energy.ox.ac.uk. Creating the next generation of talent is not the preserve of the engineering or the materials sciences departments, it is distributed throughout the university and across faculties. This symbolises the multi-disciplinary approach to the work of the university, which is focused on delivery of a net zero energy system in addition to the individual component parts. The MSc in Energy Systems is an exemplar of this approach – a cross-disciplinary course which draws together science and social science to explore all aspects of making energy, the market, regulation and policy fit for a net zero future.

Spin-out activity from the university has contributed to the industrial landscape, with companies such as YASA, Oxford PV and Mixergy among those translat-

ing university capability into commercial opportunity, supported through the technology transfer activities of Oxford University Innovation (<https://innovation.ox.ac.uk/>), and with Oxford Sciences Innovation (<https://www.oxfordsciencesinnovation.com/>) playing a key role in providing investment. Oxford University Innovation also has a range of technology available to license and details can be found through the website (<https://innovation.ox.ac.uk/technologies-available/technology-licensing/>).

The university is a delivery partner in Project LEO and The Energy Super-hub, two of the four national large-scale demonstrator projects that have come from the Industrial Strategy Challenge Fund: Prospering from the Energy Revolution programme (see more on these projects below). With both demonstrators, the approach is to look at how electricity, mobility and heat can be delivered to users as we move to net zero, using with a multi-disciplinary approach, which draws on social science disciplines. The projects also draw in economics, policy, regulation and, importantly, social capital, through wide engagement with the local population. It is this approach which provides the differentiator for the university's activities and places it in a leadership position with regard to energy and energy systems.

The Energy Systems Accelerator

The university has plans to continue to build on the issues of social capital and engagement within energy systems at a scale needed to deliver net zero before 2050. The Energy Systems Accelerator (TESA) will look at the whole system, creating an environment that will encourage cross-pollination of ideas. TESA will provide the physical infrastructure with academics, industry, policy makers, government coming together around shared challenges with the doors thrown open to external players. As well as providing a new physical location for academia and industry to sit alongside each other, there will be innovation and incubation space to continue the flow of ideas into new business opportunities.

TESA will be based in Osney Mead, an area close to the west end of the city centre and close to Oxford station, which has been identified as a site for a new innovation zone within the city. The project is one of the priorities for Oxfordshire Local Enterprise Partnership (OxLEP) and features in their investment plan and Local Industrial Strategy (<https://www.oxfordshirelep.com/lis>). The university expects to see TESA delivered in 2024. The approach will be about creating a shift from the current “*command and control*” way in which energy is generated and delivered to “*running it locally*” according to Andy Gilchrist, who manages Industry Research Partnerships for Energy within the university.

In the meantime, a ‘Mini’ TESA, comprising up to 100 people, will come into being much sooner. The university has already identified a location, again in Osney Mead, for a 1,000m² site that will be developed to be COVID compatible, with space to enable ideas to flow and to encourage interaction in a safe and appropriate environment. Mini TESA will have a small innovation space, setting the scene for what is to come later and will also provide accommodation for science and social science academics alongside post-graduate teaching facilities. The university plans to open this first stage of TESA in August, 2021.

“Mini TESA will point to what TESA will be” - Andy Gilchrist.

Collaboration underpins the university's approach

The university is keen to stress that its work needs to be seen in the context of Oxfordshire's approach to energy systems, as the region becomes a leader in a holistic approach to a net zero future. This means that collaboration underpins the university's approach and plans. Partnership with the Low Carbon Hub, Oxford Brookes University and with the industrial base is at the heart of the approach and the university believes that it requires working at this scale to help set the path for the whole of the UK to transition to the energy systems needed for the future. Collaboration nationally and internationally is critical and welcomed. Looking at what needs to change within the way we generate and use energy across modalities, Andy Gilchrist says, *“The shift that is required is enormous; our approach is about minimising dead-ends.”*

The university is also welcoming of the local and regional policy focus on innovation and on low-carbon technologies and energy systems. The Innovation hub (i-Hub – see within this chapter for more details) within Oxfordshire County Council has been a champion for projects, including recently setting up Living Oxfordshire, a Community Interest Company, which is planning a set of demonstrators through their living laboratory programme. The Living Laboratories will offer technical testing capability for energy technology within the Harwell Campus, but also real world testing that will take products out of the laboratory “into the wild” where innovation can be tested in multiple areas, including how it works with the market, with consumers and will allow the impact on policy and regulation to be assessed.

The Environmental Change Institute

The Environmental Change Institute (ECI) within the University of Oxford is a group of 70 researchers, with around 60 post-graduate students working together on pioneering research into global environmental change. The ECI works across five key themes:

- Biodiversity
- Water
- Food
- Energy
- Climate

The Institute takes a multidisciplinary approach, undertaking work on issues from forecasting model development, expertise in carbon flux within tropical forests, infrastructure planning to systems-driven analysis of how food gets from field to plate to waste. Another area of expertise is how energy is used in the home and how buildings should be improved. The ECI undertakes work within the UK and also undertakes research globally. While delivering high impact research, the ECI is also known for its teaching capability, sitting within the School of Geography and Environment within the university. The 30 places it offers on its Master's programme are highly competitive and draw an international student base. These students have typically already established themselves in careers and the ECI now has more

than 2,000 Masters' alumni in more than 80 countries around the World. Around 50 of these are still based in Oxfordshire and the ECI is keen to encourage people to stay in the region, with an increasing focus on internships and training opportunities with local businesses.

It is not your typical academic department. As well as producing academic publications, the team within the Institute undertake significant amounts of governmental and private sector commissioned research, each project operating typically over a two to four-year period. The majority of projects are delivered in partnerships or consortia, such as leading the national consortium of the Centre for Research into Energy Demand Solutions, which brings together 20 universities from across the UK, www.creds.ac.uk. ECI also leads the Infrastructure Transitions Research Consortium (ITRC), co-ordinating 7 UK universities and many collaborating partners from business and industry, www.itrc.org.uk.

The ECI is actively engaged in local projects too. The ECI produced Oxfordshire's Low Carbon Economy (2014) report, was significantly involved in the Oxford Citizens Assembly on Climate Change and is part of the Energy Superhub Oxford project, supported by the Industrial Strategy Challenge Fund (see below for more details). Oxford City Council has just announced the appointment of ECI's Professor Nick Eyre as its first Scientific Advisor.

Celebrating their 30th anniversary next year, the ECI welcomed a new Director, Professor Michael Obersteiner in September, 2020. The ECI works alongside the Smith School with its mission to address climate change and environmental sustainability by bringing business into the conversation. The Smith School has a focus on environmental economics and policy as well as enterprise management, financial markets, investment and law. Also sitting within the School of Geography and Environment is the Transport Studies Unit (<https://www.tsu.ox.ac.uk/>).

Find out more about the ECI and its work <https://www.eci.ox.ac.uk/>

More details of the research capability across the areas of Biodiversity, Water, Food, Energy and Climate can be found through the Oxford Networks for the Environment (ONE) <http://www.one.ox.ac.uk/> The ECI plays a key role in co-ordinating these ONE

networks, which involve several hundred researchers across more than 20 departments working on solutions across technology, business and society.

Oxford Brookes University

Oxford Brookes University has deep technical expertise in materials technology development, both for buildings and vehicles, bringing together large cross disciplinary teams comprising engineering, architecture, industry-facing scientific research and product innovation. Particular strengths lie in low energy building design, energy and occupier performance evaluation of buildings, vehicle fuel consumption and particulate matter emissions, as well as measurement and verification of product performance, including for renewable energy installations.

The Faculty of Technology, Design and Environment applies a breadth of life cycle environmental impact analysis and digital capabilities, operating at the intersection of energy systems design and real-world data on how the built environment is used. Oxford Brookes is supporting the UK Industrial Strategy Challenge Fund's Prospering from the Energy Revolution (PFER) programme. An example is the work that the University is leading, working with other universities and the national Energy Systems Catapult, to develop a knowledge integration 'toolkit'. This UKRI research project envisages buildings as components of interactive energy systems, which will contribute towards net zero carbon in buildings <https://www.brookes.ac.uk/be/research/research-groups/developing-a-tool-kit-for-knowledge-integration/>.

Deploying data and modelling capabilities

New technology and the latest digital approaches, such as Building Information Modelling (BIM), Dynamic Thermal Packages and Geographical Information Systems (GIS), are applied to building energy use, infrastructure and are used to simulate climate change adaptation. Oxford Brookes has strengths in data metrics, forecasting technologies, behavioural analysis and urban energy modelling using GIS. The Local Energy Mapping for Urban Retrofit project (LEMUR) addresses the significant challenges of tackling urban retrofit and integrating renewable energy within established residential communities.

(<https://www.brookes.ac.uk/architecture/research/low-carbon-building-group/carbon-mapping/lemur/>). Another project, The Energy Retrofit Learning Platform, is an approach across professional silos to integrate knowledge and expertise, both technological and managerial, in an interdisciplinary context to find buildable solutions that improve energy performance (<https://www.energyretrofitlearningplatform.org/>).

"The complex systems challenges of a zero carbon future require a multi-disciplinary collaborative approach which builds on a diverse range of research and expertise, and is well-suited to Oxford Brookes' capabilities." says David Hartley, Commercial and Knowledge Exchange Director, Oxford Brookes University.

A partner in the region's shift to Net Zero

The Eco-Bicester Living Lab is a joint collaboration between Oxford Brookes and BioRegional, through Oxfordshire Greentech (see below for more on the Oxfordshire Greentech network) which is looking to capture the learning and innovation that is happening through ongoing development of Bicester Eco Town. This includes energy data monitoring and pathways to implement modern methods of construction and deliver zero carbon sustainable development.

The University collaborates with partners on demand and supply side green economy initiatives too, focused on the realisation of a zero carbon Oxfordshire. Oxford Brookes' partnerships with business have been used to create and disseminate new operating models for SMEs in relation to energy consumption (ESCO in a box, which was delivered as part of the OxFutures programme detailed below). It is also a delivery partner in one of the two large scale demonstrator projects – Project LEO - part funded through the Industrial Strategy Challenge Fund. Oxford Brookes' contribution to Project LEO builds on its award-winning research through an earlier project, Project ERIC – Energy Resources for Integrated Communities (<https://www.brookes.ac.uk/about-brookes/news/energy-saving-community-project-wins-prestigious-energy-awards/>). Project ERIC demonstrated how distributed generation and smart home batteries can be managed to reduce peak grid load and increase self-consumption of local generated electricity.

Find out more about Oxford Brookes School of the Built Environment research groups: <https://www.brookes.ac.uk/be/research/research-groups/>

Oxfordshire County Council i-Hub

Oxfordshire County Council has been active in looking for ways to integrate innovation into Oxfordshire and the Council's activities. This work is run through the Council's i-Hub which is active in supporting, incubating, and developing new ideas and opportunities within the region. The i-Hub provides a focus for bringing business and academia together and acts as a partner in securing external funding for projects across the county. The i-Hub is open to new collaboration opportunities and has interests in:

- Connected and autonomous vehicles
- Integrated mobility
- Unmanned aerial vehicles
- Data access
- Electric vehicles
- Green fuel
- Smart cycling
- Integrated energy systems
- Innovation in planning policy and implementation and Green/pollution reducing infrastructure and barriers

The i-Hub set up MobOx CIC, a social enterprise, to facilitate mobility related activities and has recently established Living Oxfordshire CIC. The Council is one of the drivers of the living laboratory approach and is working to establish systems across Oxfordshire to provide testbeds for innovation and to accelerate the adoption of innovative solutions. The i-Hub can bring public policy perspectives to projects, including regulation and procurement expertise.

The i-Hub does not have a website, but details of activities, projects and priorities can be found within this brochure https://issuu.com/occihub/docs/occihub_2020_q4 along with details of the team within the County Council, www.oxfordshire.gov.uk; see also <https://mobilityoxford.com>

Oxfordshire Greentech



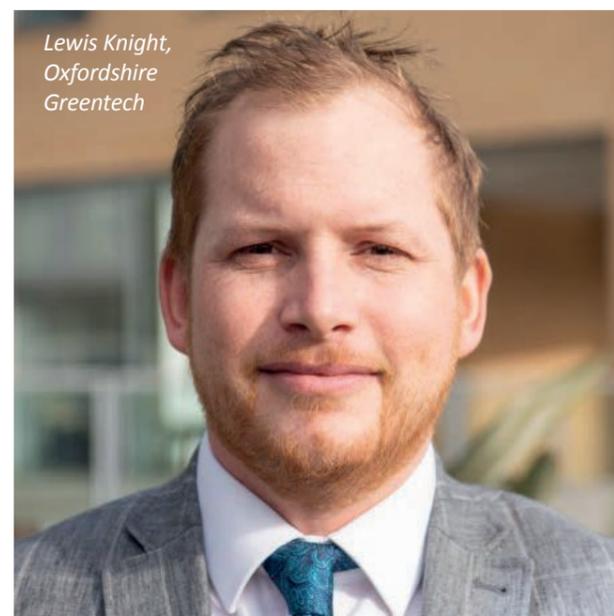
Oxfordshire Greentech is a business network supporting the growth of the low-carbon sector in Oxfordshire. The network brings together businesses and organisations to encourage innovation, collaboration and knowledge transfer and to facilitate the transition towards a sustainable, low carbon future in Oxfordshire.

Oxfordshire Greentech is a collaboration between sustainability charity Bioregional, Cherwell District Council and Cambridge Cleantech. The network is run from the Eco Business Centre in Bicester (the UK's first Passivhaus office building) but runs its events and activities across the region.

The network is open to companies of all sizes, ranging from start-ups with smart ideas in sustainable energy, water, and waste, to larger corporates and local authorities working to reduce their environmental impact. The network benefits from its close links with the Cambridge Cleantech membership, with a focus on sharing and transferring knowledge between these two academic centres of excellence.

Launched in February, 2019, the network runs regular events, specialist masterclasses and is working to support and encourage investment into companies working across the wide range of low carbon sectors. The creation of the Oxfordshire Greentech was one of the projects within the OxFutures programme.

Oxfordshire Greentech provides a key platform for research and innovation by bringing people and organisations together, to enable collaborative funding



Lewis Knight,
Oxfordshire
Greentech

bids. A key role is to facilitate networking and collaboration by providing a forum for networking with other key players and organisations in the low-carbon sector in Oxfordshire, through peer-to-peer introductions, workshops, and events. They also provide funding, investment, and commercial opportunities for businesses to grow and expand.

As well as providing access to innovators, investors and potential partners, the network also helps to both inspire and showcase best practice and can help organisations to develop their own strategies and action plans towards reducing their environmental impact.

"We want to increase the visibility of all of the fantastic companies and innovative projects happening across Oxfordshire. We represent the low carbon sector across the region and connect innovators, corporates, academic and investors to enable a smarter more sustainable future. Oxfordshire Greentech is working hard to celebrate and show the impact and strength right here in Oxfordshire." Lewis Knight, Programme Manager, Oxfordshire Greentech.

Website: oxfordshiregreentech.co.uk

OxFutures

OxFutures is a programme of work, aimed at boosting low carbon economic development in Oxfordshire. Part funded by the European Regional Development Fund (ERDF) the work has drawn together a number of partners: Oxford City Council, Cherwell District Council, University of Oxford, Oxford Brookes University, Bioregional and the Low Carbon Hub and saw the creation of Oxfordshire Greentech Hub, as one of its projects, aimed at networking the low carbon sector and knowledge sharing.

Working through the Low Carbon Hub and Oxford Brookes University, OxFutures offers energy audits to Oxfordshire based businesses. The programme will be open to new applications for audits in 2021. The programme also offers feasibility and implementation grants, worth up to £25,000 matched 50:50 by the recipient company, to support innovative business, product and service ideas and new technology development. The funding programme will run until December, 2022.

Website: OxFutures.org

Low Carbon Oxford

Low Carbon Oxford is a network of organisations, funded and run by Oxford City Council, all with a shared vision of Oxford as a low carbon city. Low Carbon Oxford works to share best practice, runs city-wide projects and runs regular events.

Website: lowcarbonoxford.org

Low Carbon Hub

The Low Carbon Hub is a social enterprise working to prove we can meet our energy needs in a way that is good for people and for the planet. The shift to renewable generation is gaining pace and gives us the opportunity to reshape the way we manage our energy.

The move to renewable energy generation is needed along with a shift away from a reliance on fossil fuels. In Oxfordshire, Low Carbon Hub is a central part of that shift, generating clean electricity through solar and hydro projects. As of January 2020, it manages 44 renewable energy projects with a total capacity of 4.4 GWh of electricity per year – enough to save 1,244 tonnes of CO₂.

To help fund projects to move towards 2030 energy targets, the Community Energy Fund offers investment opportunities for local people and organisations to help make the transition to a low carbon energy system a reality.

In addition to this, the Hub works with its community shareholder groups across the county, supporting them with expertise and small grant funding. It also involves communities in pathfinding innovation pilots to help the community energy sector in Oxfordshire expand more rapidly, bringing together people who can break through obstacles like grid constraints or technology gaps.

The Low Carbon Hub is a delivery partner in Project LEO (see more on this project below). Other Hub partnership programmes to support 'powering down' include the Cosy Homes programme, which is an eco-retrofit project for homeowners, OxFutures and Energy Solutions Oxfordshire for small and medium-sized enterprises in the county.

Website: lowcarbonhub.org

Oxfordshire's Large-Scale Demonstrators

Oxfordshire is home to two of the four demonstrator projects being run through the Industrial Strategy Challenge Fund *Prospering from the Energy Revolution* programme, part funded by Innovate UK. These two projects are *Project LEO* and the *Energy Superhub Oxford*.

Project LEO



Project LEO is creating a local energy system for Oxfordshire with the project running through to the summer of 2022.

The project addresses decarbonisation and rising demand on the electricity network. Project LEO is using technology and providing opportunities for new demand to be accommodated through a smarter, secure and flexible network. This Innovate UK part-funded collaboration draws together the latest innovation in energy, alongside forecasting and planning technologies and integrates a large portfolio of around 90 low carbon energy projects, including hydro-electricity generation, EV transport hubs and heat networks. The project aims to demonstrate how a local energy marketplace can function effectively and be replicated across the Country.

Project LEO is one of the most ambitious, wide-ranging, innovative and holistic smart grid trials ever conducted in the UK.

Project LEO seeks to create the conditions that replicate the electricity system of the future to better understand relationships and grow an evidence base that can inform how we manage the transition to a smarter electricity system.

Website: project-leo.co.uk

Energy Superhub Oxford



Energy Superhub Oxford is pioneering an integrated approach to decarbonising power, transport and heat to accelerate Oxford's zero carbon journey. It will showcase a powerful network of rapid electric vehicle (EV) charging, hybrid battery storage, low carbon heating and smart energy management, providing a model for cities across the UK to cut

carbon emissions and improve air quality.

A 50MW hybrid battery, combining lithium-ion and vanadium flow technologies, will help to integrate more renewable energy and future-proof the electricity system. It will share a connection to National Grid's high voltage transmission network with an 8km private wire network, delivering enough power to charge hundreds of EVs at once. Initially this will connect to a public superhub at Redbridge Park & Ride, but the aim is to expand it to support the electrification of the city's buses, council vehicles and other commercial fleets.

Three hundred properties in and around the city will be equipped with innovative low carbon heating solutions, combining ground source heat pumps with smart controls and a time of use tariff to optimise heat production for cost and carbon savings. Work is already underway in Blackbird Leys to install the technology at the first 60 properties. The project's unique approach aims to save 10,000 tonnes of CO₂ per year by 2021 – the equivalent of taking over 2,000 cars off the road – rising to 25,000 tonnes per year by 2032.

Partners in the project are Pivot Power, Habitat Energy (see more about Habitat Energy in this report and on our website), Kensa Contracting, Invinity Energy Systems, Oxford City Council and University of Oxford's Environmental Change Institute and Department of Engineering Science.

"Oxford is continuing to show world leadership in tackling the climate emergency. With this project we're encouraging the adoption of electric vehicles and the acceleration of our transformation into Zero Carbon Oxford. Energy Superhub Oxford gives Oxford strengths that no other city currently has: the world's most powerful charging network and the world's largest ever hybrid battery, and as a result we can accelerate our electric vehicle charging infrastructure for businesses and residents, and electrify the council's fleet, so that we can make a success of our Zero Emission Zone which restricts polluting vehicles in the city. It also enables the installation of low carbon heating across homes to tackle fuel poverty. I am looking forward to seeing this project flourish and secure further investment in Oxford, so that we can become an exemplar zero carbon city." Councillor Tom Hayes, Deputy Leader Oxford City Council and Cabinet Member for Zero Carbon Oxford and GreenTransport

Website: energysuperhuboxford.org

Kick-starting the innovation economy in Oxfordshire

Sir Martin and Lady Audrey Wood's experience of setting up Oxford Instruments, the University of Oxford's first spin-out, enabled them to appreciate the challenges facing young entrepreneurs. With their success, the Woods set up The Oxford Trust in 1985 to help fledgling companies get started and find affordable and flexible workspace and business support in Oxford. The Trust's initial innovation centre on Osney Mead was the first in the UK – and was the catalyst for Oxfordshire's ecosystem of innovation incubators and science parks that we see today.

There is now a new, growing cohort of start-ups and spin-outs working out of the Trust's Oxford Centre for Innovation and its new Grade A+ eco building Wood Centre for Innovation on the sustainability agenda. Habitat Energy is focusing on intelligent energy trading software and is involved in the development of the Energy Superhub Oxford whilst the Low Carbon Hub and SSEN are co-working on Project LEO. Another SME featured within our report is Spintex, which is using a spider-inspired spinning process to create an artificially spun high-performance and low-energy silk fibre which will impact on the sustainability of fabrics and is based within the Wood Centre.



Credit: Spintex



Credit: Energy Superhub Oxford

What will fuel the green recovery? Enablers and challenges

INTRODUCTION

Is Oxfordshire powering up for a green recovery? This report shows that the region has a strong industrial base, with innovation-based companies operating across the Low Carbon and Environmental Goods and Services sector¹ (LCEGS). These are the companies that will drive the Green Industrial Strategy announced by Government (18th November, 2020).

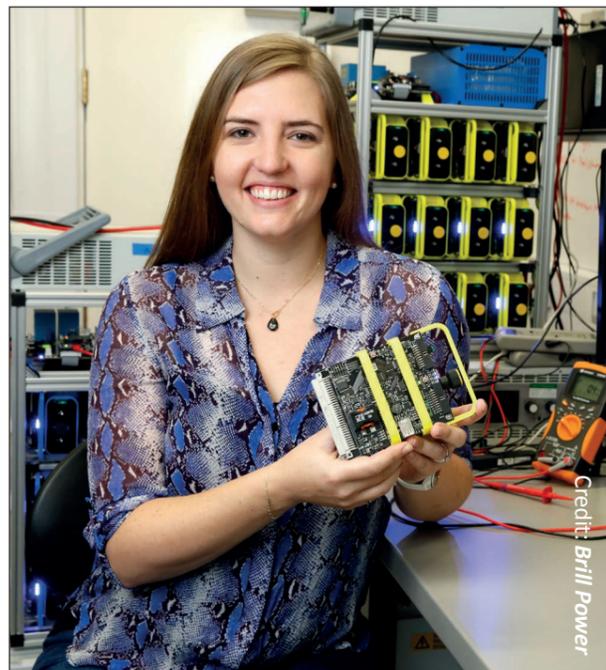
Through interviews with small and large companies conducted as part of this project, it is clear that the region is home to a fantastic array of ideas and technologies being pioneered and developed across the Oxfordshire ecosystem. However, this project also set out to understand whether these companies were actually growing, what would facilitate their growth, equally what challenges and barriers they are facing. This final chapter of the report examines these issues and presents a set of recommendations to ensure that the post-pandemic economic recovery, will indeed be a green recovery.

About the respondents to survey

A sample of 24 companies and one tech-transfer organisation, representing the issues relating to spin-out companies, contributed their views through a structured questionnaire. Companies range in size from micro companies (only 1 employee) to larger, high growth companies (275 FTEs). Although Advanced Oxford interviewed a number of large, multi-national companies for this report, data collected through these interviews has not been included within the analysis presented in this chapter. Consequently, all companies questioned on growth issues were either micro, small or medium sized companies.

The cohort represents a range of companies, including those developing products, as well as those providing services. Technologies being developed by companies within the cohort include sustainable

energy, battery technologies, control systems, climate change and sustainable fuels. One company is a not-for-profit social enterprise that works with SMEs to develop and implement energy efficiency plans, supporting the move to Net Zero. Of the companies responding, 13 were revenue generating and 11 were at the pre-revenue stage. Within the pre-revenue cohort, the majority expect to start generating revenues within the next 1 to 2 years. The exception to this were the commercial fusion energy companies within this group, for whom the path to commercialisation is much longer, and at least 5 to 10 years away.



Credit: Brill Power

Footnote 1

¹The term Low Carbon and Environmental Goods and Services sector (LCEGS) is used here to reflect the fact that companies within the group questioned fall across a range of recognised industrial sectors. The terms low carbon, clean, green, environmental, sustainable, and circular economy are frequently used with reference to companies within the industrial base. LCEGS is defined by the UK Office for National Statistics as providing “environmental products and activities, renewable energy and emerging low carbon activities such as alternative fuels, building technologies, nuclear power and carbon finance.” LCEGS is used by Dr Doug Crawford-Brown in his 2018 report for Oxfordshire Greentech <http://oxfordshiregreentech.co.uk/wp-content/uploads/2019/05/Prof-Doug-Crawford-Browns-report.pdf> but he also refers to ‘Clean-tech’ companies in relation to innovation-based companies.

88% of companies within our cohort think that Government prioritising a post-pandemic ‘green’ recovery provides an opportunity for their company

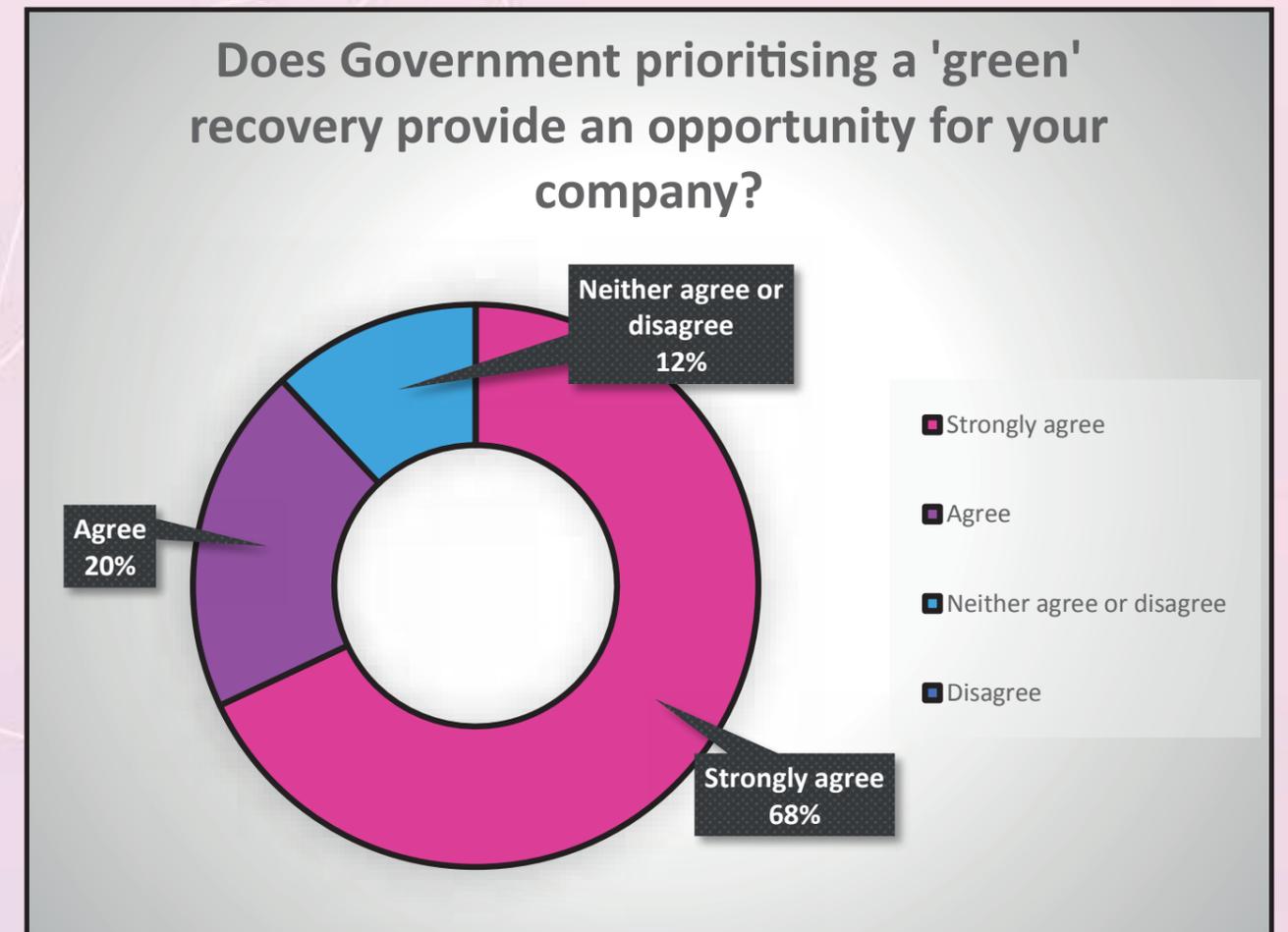


Figure (1) – does Government prioritising a green recovery provide an opportunity for your company?

The industrial landscape

Through all of the work undertaken as part of this project, Advanced Oxford has sought to better understand the innovation-based LCEGS industrial landscape and what factors will determine if the growth potential of this sector will be realised. Building an understanding of the LCEGS sector operating within the region is challenging, as Office for National Statistic (ONS) data is presented at regional level, i.e. the ‘South East’, does not allow for an easy analysis of employment and does not support an examination of innovation-based companies. A report produced for Oxfordshire

Greentech in 2018² identified 60+ firms that are advancing the state of LCEGS within the county and suggested that there were around 50 that are providing technological innovation. Advanced Oxford’s research suggests that this is a significant underestimate, although in turn, data collected by Advanced Oxford is likely to be an under-representation of the true picture given that there is no easy way of collecting data.

Around 160 companies have been identified, all of which have physical premises and activity within Oxford and Oxfordshire. Given Advanced Oxford’s

Footnote 2

²Dr Doug Crawford-Brown (2018) report for Oxfordshire Greentech <http://oxfordshiregreentech.co.uk/wp-content/uploads/2019/05/Prof-Doug-Crawford-Browns-report.pdf>.

focus on innovation-based businesses, all of these companies have science, technology and innovation at the foundation of their operation. They all have physical premises and activity within Oxford and Oxfordshire. Given Advanced Oxford's focus on innovation-based businesses, all of these companies have science, technology and innovation at the foundation of their operation. The term 'Clean-tech' is often used to describe the sub-set of companies within the LCEGS sector that are innovating, undertaking R&D and have a background in science, engineering, ICT and data science. A large number of growing LCEGS companies have been excluded from this list as they are providers or distributors of products or services and did not meet our criteria as innovation-based. As well as companies pioneering new science and creating new products, a small number of companies that are data/analysis driven have also been included, of which a number are providing advisory or consultancy services based on engineering or analytical capabilities.

Details of these companies are presented within a Directory which is accessible on the Advanced Oxford website www.advancedoxford.com/green-recovery/business-directory/. All information presented has been collected through desk-based research, and in a small number of cases has been supplemented by interviews. Advanced Oxford encourages companies included to review their data and to provide updates. There is also an opportunity for companies to provide data so that they can be added to the Directory. Data held within the Directory may also be added to other reference sites in due course, such as the Oxford Cluster map. The Directory has been created to assist business to business connections, collaboration and to support benchmarking and monitoring of growth.



Credit: Unsplash

WHAT FACTORS WILL DRIVE GROWTH?

Risk capital and funding

Respondents were asked to tell us about their funding. Thirteen companies are equity backed and are using a variety of different funders, including Angels (n=7), Family Offices (n=1), Venture Capital (n=8), Corporate Venture Capital (n=2). One company stated that they had received a convertible loan under the British Business Bank Future Fund. Nine of the companies stated that they were self-funding with investment provided by directors or through revenues.

Where is investment coming from?

Regardless of how they are currently funded, 75% of the companies stated that they would be looking to raise new funding within the next 3 years.

Of those willing to indicate how much they needed to raise, all were in the venture bracket, series A and beyond, typically in the range of £2–5 million. There were a small number of companies that indicated that the level of investment required was significantly higher, with 2 companies identifying the need to attract investment of £100 million and beyond.

Companies in receipt of equity investment were asked to identify where their investors were located. Oxford Sciences Innovation is an investor into a number of the companies and as a result, Oxfordshire-based investors appear to be well represented as backers of Oxfordshire based companies. It is clear that companies are prepared to look to international investors but backing from the UK investment community outside Oxfordshire is also strong (see figure below).

Fourteen companies were in receipt of grant funding, with the many of these receiving Innovate UK funding (n=10) and others being recipients of other public sector/charitable foundation funding (n=10).

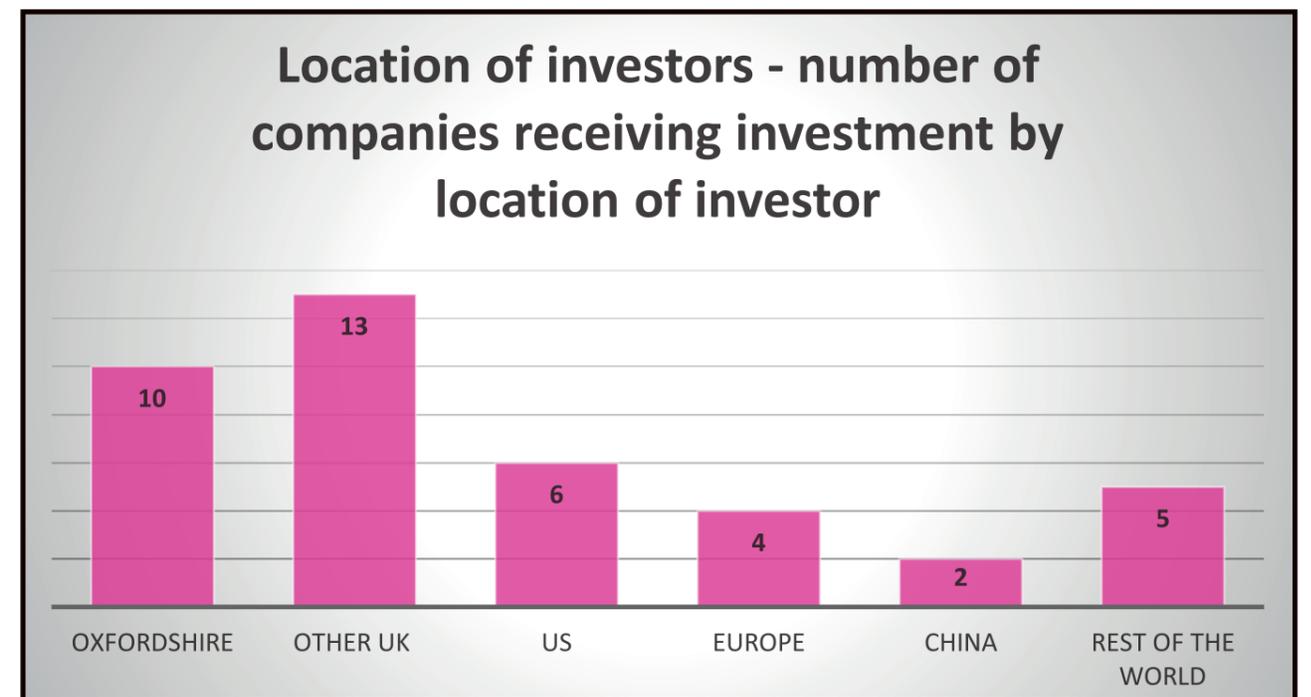


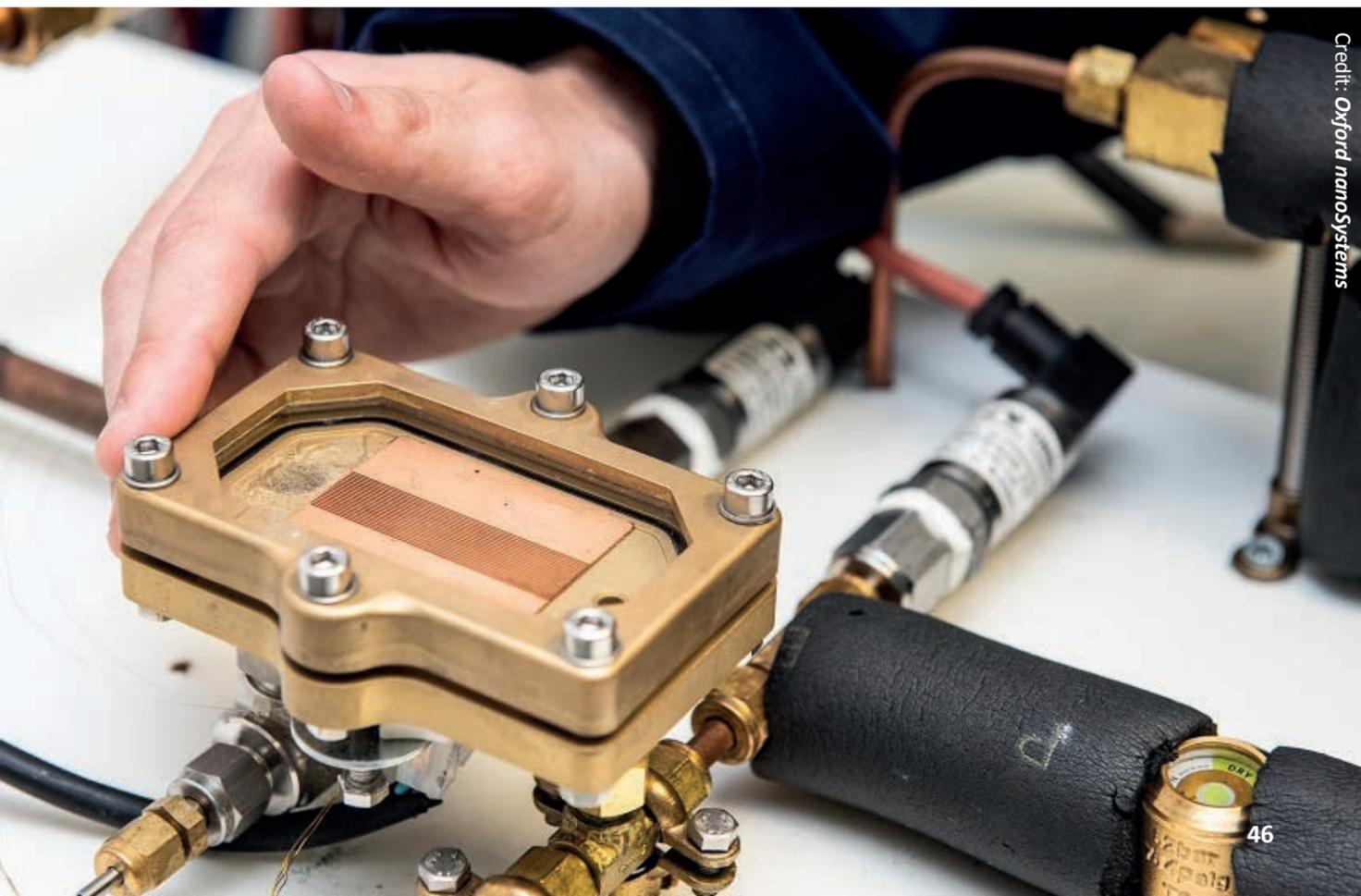
Figure (2) – location of investors in companies within Oxfordshire clean-tech. Companies typically have investors from more than one location.

Employment and growth

Twenty-three companies provided information about their employment levels, using full time equivalent (FTE) data. The technology transfer organisation is excluded from this part of the analysis. The smallest company within the cohort has one person employed and the largest has 275 FTEs, with a total combined workforce of 1377 FTEs. All 23 companies stated that they expected their employment levels to grow in the next 3 years, with growth ratings in a range of 10% to 500%. Some companies gave a range, e.g. 10–20% growth. Taking the upper limit of those providing a range and assuming that growth projections are accurate, an additional 107 jobs will be added across this group of companies in the next three year, representing a 7.8% growth in employment across the cohort of 23 companies.

Existing workforce by FTE within companies questioned (N = 23)		Expectations in terms of percentage growth of the workforce within the next 3 years	
	Number of FTEs		Percentage growth
Min	1.0	Min	10%
Max	275	Max	500%
Mean	42	Mean	179%
Median	20	Median	200%
Total no. FTEs in cohort (n = 23)	1377	Total no. FTEs in 3 years if growth projections are met	1484

Table (1) workforce data for 23 companies surveyed, based on full time equivalent (FTE) numbers and expectations in terms of growth in the next 3 years.



Credit: Oxford nanoSystems



Credit: Bidwells

What is needed to enable growth in your company?

The cohort were asked to identify the issues that would enable growth within their company, providing each company with a set of 11³ options, set out below, and the ability to identify others, not already specified. Each respondent could identify up to 5 issues.

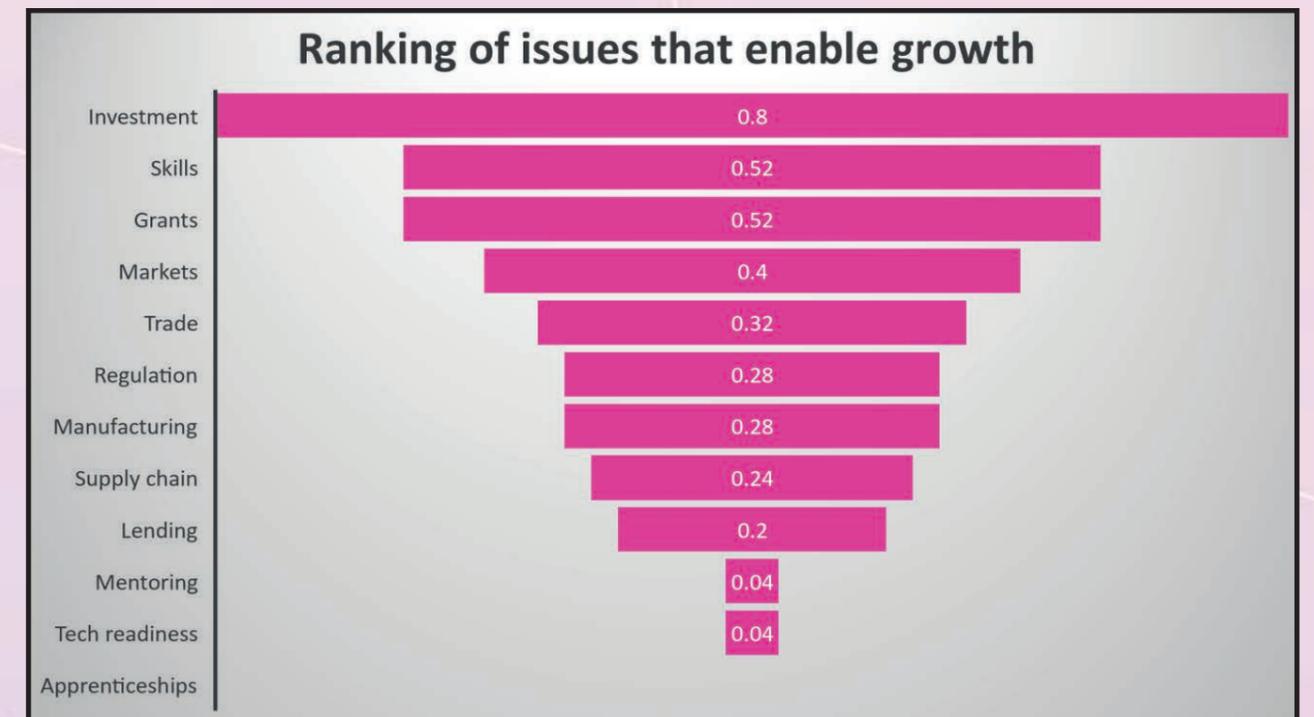


Figure (3) Participants identified the key enablers of growth for their company. Responses have been weighted and ranked, where a score of 1.0 is an issue identified by all respondents.

Footnote 3

³ The options related to growth enablers were: (i) Investment, (ii) Access to lending, (iii) Regulatory change, (iv) Creation/developments of the market. (v) International trading opportunities, (vi) Availability of skilled employees, (vii) Apprenticeships, (viii) Development of the supply chain, (ix) Mentoring, (x) Grant funding from public bodies, (xi) Manufacturing capability.

Given that three quarters of the companies had already stated that they would need to raise investment in the next three years, it is not surprising that investment was identified as the highest ranked enabler of growth, identified by 80% of respondents. It is interesting to note that access to lending scored weakly, suggesting that funding through debt is not a significant issue for companies at this stage in their development. Investment is followed by access to skilled employees and grant funding, both of which were identified by just over 50% of respondents.

While access to skilled employees scored highly, and was an issue identified through interviews conducted as part of this project, apprenticeships was not identified once by any respondent. Advanced Oxford is unable to offer any further analysis to

“Oxford is superb for access to very bright talent which is vital for us, we need a highly educated, highly skilled team.”

“Oxford is great for scientists but, like the rest of the UK, needs engineers who can take a problem and find practical solutions.”

Only one respondent identified an issue not already listed, and this was technology readiness. It is interesting to note that no-one identified availability or suitability of workspace as an issue in response to the survey. However, a number of the companies within the cohort not only completed the questionnaire, but were also interviewed as part of this project and access to suitable and affordable workspace was identified as an issue by a number of the companies that were interviewed.



Credit: RAEng

determine why apprenticeships failed to score at all, but given the emphasis given to this form of training by both national Government and by the Oxfordshire Local Enterprise Partnership (OxLEP) Local Industrial Strategy, this is an area where further research should be conducted. Given the growth potential within this cohort, it will be important to understand whether apprenticeships can play a role for companies like those questioned, or whether they will continue to look to draw in higher level skills within the labour market.

“What Oxford lacks is larger offices for start-ups in the city centre, and the same goes for lab space too. We love access to the train station and being able to take public transport to work and so it’s going to be tough to find the right space for us to expand near to the city centre.”

What challenges are companies facing?

The cohort was asked if their growth plans had been affected by Covid-19. Only one company stated that their plans had been positively affected, with 17 (68%) stating that they had been negatively affected.

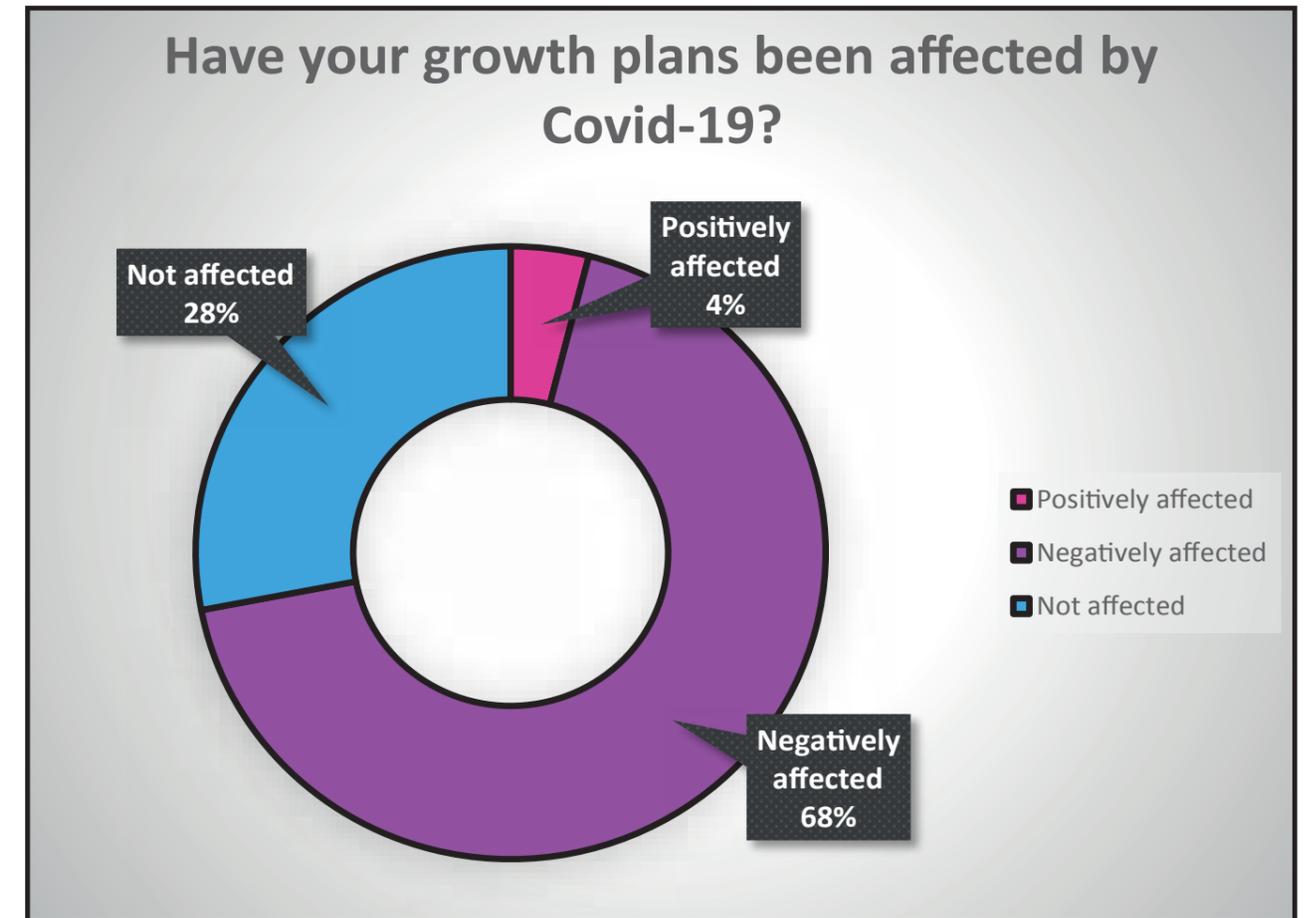


Figure (4) – Have growth plans been affected by Covid-19

What are the key business challenges that you face?

Having been asked about enablers, respondents were asked to identify the most significant business challenges they were facing. A set of 16 options⁴ were offered, drawing on previous research conducted by Advanced Oxford, again, with the option to identify other issues. Given the wider set of options available to respondents, there was a greater spread of responses. These have been weighted and are ranked below.

Footnote 4

⁴ The options related to business challenges were: (i) Raising investment, (ii) Access to lending; (iii) Uncertain trading conditions; (iv) Regulation; (v) Protecting Intellectual Property, (vi) Cost of living in Oxfordshire, (vii) Housing, (viii) Transport, (ix) Uncertain market for my product/service, (x) Supply chain capacity, (xi) Manufacturing capacity, (xii) Business support, (xiii) Accessing the right skills, (xiv) Training and developing the workforce, (xv) Business development capability, (xvi) Management and leadership skills.



Figure (5) Participants identified the key business challenges facing their company. Responses have been weighted and ranked, where a score of 1.0 is an issue identified by all respondents.

In common with the question on growth enablers, the issue of raising investment was the highest ranked challenge identified by respondents. Sixty percent of respondents scored raising investment as a challenge. The next highest ranked challenges are uncertain market for my product/services and protecting my intellectual property with each of these challenges having been identified by 40% of respondents. In common with the questions relating to enablers, access to the right skills scored highly (36%) as did business development capacity, which also was identified by 36% of respondents. This latter issue is perhaps indicative of the current environment where travel is restricted, and conferencing and networking activities have been curtailed. Other research activities conducted by Advanced Oxford relating to the impacts of COVID have also suggested that companies are finding it challenging to undertake business development activities in the current environment and this is an area where companies are increasingly looking for support and new paradigms.

Protecting intellectual property was identified by a number of companies, as noted above, with companies of different sizes and maturity having flagged this as a challenge. Oxfordshire LEP (OxLEP)⁵ is currently undertaking a project in conjunction with the Intellectual Property Office (UK IPO) looking at the needs of companies in relation to IP protection and management. The OxLEP/IPO project will be looking at what local support can be offered to companies and the findings from this research suggest that companies have on-going and developing needs in this area.

Issues that scored at the end of the ranking scale were business support, transport, and housing. Training and development was not identified as a challenge by any respondent. Three different companies added 'Other' challenges, one identifying technology maturity as a challenge. Two others identified issues relating to business premises/space, 'office space availability' and 'availability of land/the planning system'.

Footnote 5

⁵ <https://www.oxfordshirelep.com/news/article/oxlep-and-ipo-survey-oxfordshire-businesses-%E2%80%98using-intellectual-property-drive-success%E2%80%99>

Why Oxfordshire?

Our research has attempted to build an understanding as to the basis for companies locating or starting in the region. Importantly, companies were also questioned on what would keep them within the county⁶. This was something that was also explored with larger companies through interviews that were conducted as a part of this research. Reasons that leading companies gave for operating in Oxfordshire are set out in an earlier chapter of this report, *Why leading companies working on sustainability grow and stay in Oxfordshire*.



Figure (6) – Respondents identified the reasons that their company is located in Oxfordshire. More than one option could be selected

A strong influence on the decision to locate in Oxfordshire is the preferences of founders, either as a result of studying in or living in/coming from the region, along with the company being originated as a spin-out, from one of Oxford's universities (n = 11) or from other local institutions - two companies identified themselves as spin-outs from the Satellite Applications Catapult and from Culham Science Centre. Access to a skilled workforce is also a strong influence, reflecting the importance of skills, identified earlier within this chapter as both an enabler of growth, and as a challenge for companies

Other factors affecting the location of the business: one had a pre-existing relationship with UKAEA at Culham, so decided to locate the company within their incubator; one cited proximity to London, without being in London, another proximity to international airports; another company noted proximity to Oxford-based investors as a factor, and finally one company is based in Oxfordshire due to historic Government investment

into the county from which they trace their heritage.

Respondents were also invited to identify the factors that will keep them in Oxfordshire, using free-text responses.

“There is a strong R&D base already here, but the company needs co-investment in infrastructure for its next stage of manufacturing. Oxford is great for scientists, not as great as other countries for access to engineers and government co-investment in production facilities.”

Footnote 6

⁶ Respondents were asked to list all factors to the question, why is your business located in Oxfordshire. Possible responses were, (i) the founder(s) studies here; (ii) the founder(s) come from or live in Oxfordshire; (iii) attracted by the cluster; (iv) access to highly skilled workforce; (v) the company is a spin-out from one of Oxford's universities; (vi) collaboration potential with Oxford's universities; (vii) collaboration potential with Oxfordshire-based companies; (viii) proximity to scientific infrastructure; (ix) access to supply chain; (x) proximity to market/potential customers; (xi) other (please specify).

A range of issues were identified by respondents, but this quote from one of the CEOs within the cohort sums up the most highly cited issues: (i) availability and access to people, skills and talent, and (ii) access to the affordable office and laboratory space, with two companies specifically identifying the need for expansion premises in the foreseeable future. There is also a strong culture of collaboration with

Oxford's two universities, although companies collaborate with other UK-based Higher Education Institutions (HEIs) and with academic institutions outside the UK. While it is not surprising that innovation-based companies are collaborating with HEIs, it is encouraging to see high levels of academic collaboration amongst this cohort of small and medium sized businesses.

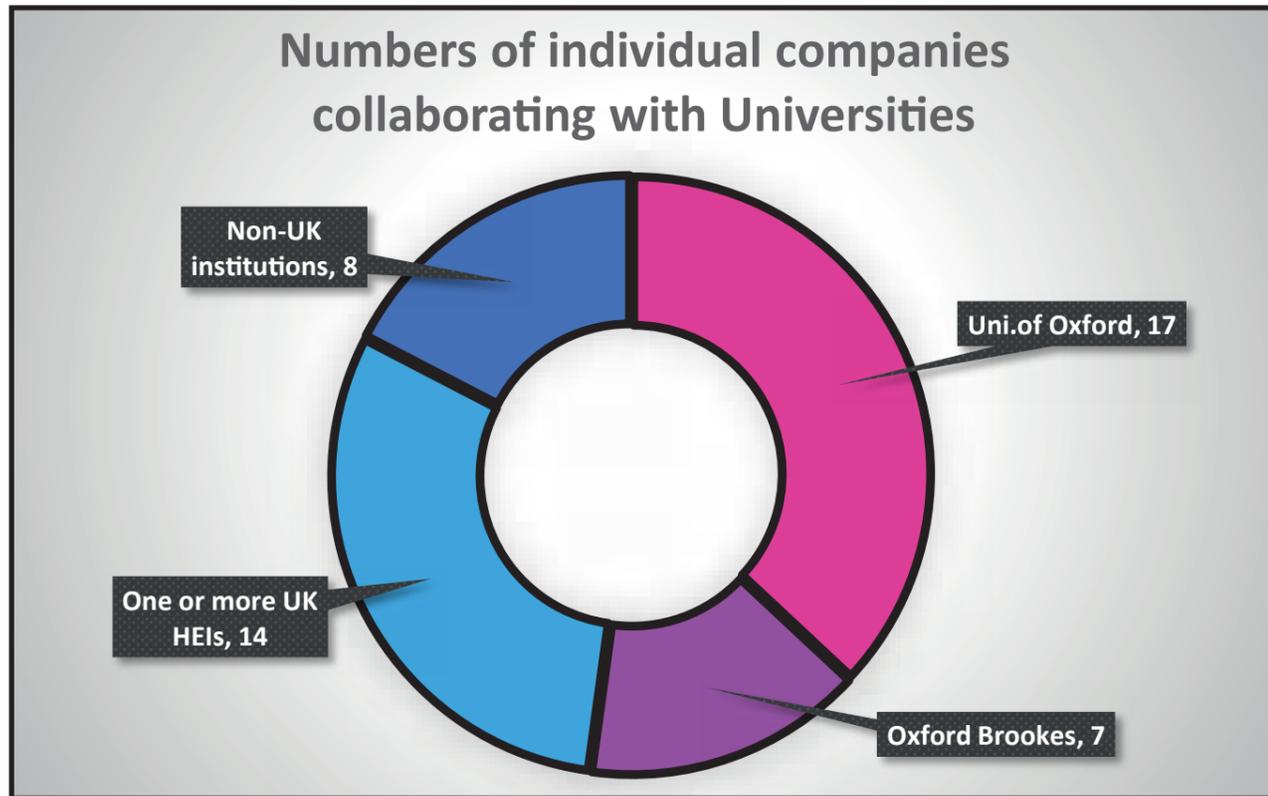


Figure (7) – there are high levels of collaboration with universities and research institutions



Conclusions and recommendations

Investment is key

In common with other research undertaken by Advanced Oxford in 2020, the priority issue for innovation-based companies working within the Low Carbon and Environmental Goods and Services sector is investment. Investment from Oxfordshire-based investors is strong, but the picture is somewhat skewed by the investment provided by Oxford Sciences Innovation (OSI) which is only available to science-based companies emerging from the University of Oxford. OSI has provided invaluable seed and follow-on funding for University of Oxford spin-outs, but the levels of investment required by companies within the cohort surveyed means that there is an increasing need for venture, corporate and institutional investors to be active within the region.

Advanced Oxford has already called for more to be done to swell the availability of risk capital within the county. It is recommended that OxLEP and Department of International Trade work to encourage international investors to set up offices within the region, to encourage greater flows of risk capital into the ecosystem.

National Government has an important role to play in supporting the financing of the green recovery and economy and announced its 10-point plan for a green industrial strategy a week before publication of this report. Through this research and associated interviews, one company has cited an example of another international market attracting manufacturing capability and jobs away from the UK by providing funding and incentives to support company growth. Within this cohort, there are a number of companies that will need co-investment from Government and continued support from research funding bodies, if they are to reach their potential and to see returns through growth in jobs and new industries permanently headquartered within the UK. Although this research has not benchmarked the number of innovation-based, 'clean-tech' companies within the Oxfordshire region against other parts of the UK, it is clear that we have a density of companies and a level of projected

growth. Investment into the south-east of England should not be neglected and levelling-up must not be at the expense of strength and opportunity within this region.

"We're short-listing where we want to set up our demonstrator and the decision will ultimately come down to where is best for us and where we get the most support from government." Tokamak Energy.

The need for continued grant funding and the value attached to the support provided by funding bodies like Innovate UK is clear. The work by Harwell Campus to encourage multi-disciplinary research collaboration across sectors and technologies through their proof of concept fund, which actively seeks to build collaboration between different sector clusters on site (energy, space and health) is a good example of the opportunity to drive greater inter-disciplinary activity. The Industrial Strategy Challenge Fund large-scale demonstrator projects included within the report provide examples of collaborations that draw in large industry, SMEs, academia and social enterprise and again provide a good example of funding mechanisms that encourage collaboration. Continued investment into innovation funding and collaboration funding programmes is needed and will be essential to ensure that the Government's 2.4% target for R&D investment is met, recognising that the LCEGS sector is a significant contributor to research and development activity and investment within the region.

Employment and skills

The companies within this cohort have the potential for significant growth in employment in the next three years. Across the 23 companies that have provided data, there is potential to add over 100 new jobs into the economy. This growth trajectory was echoed by YASA (see Why leading companies working on sustainability grow and stay in Oxfordshire within this report). While this research has identified around 160 innovation-based companies operating within the county, it is not possible to extrapolate the growth in employment across these companies as there is no means to establish baseline data on employment levels across all of the 160 companies. Nevertheless, given the growth trajectory across the companies within the survey cohort, it is reasonable to expect the same

percentage of growth across all companies within the region. It is also likely that access to talent is a common issue for all companies within the region, including the large companies interviewed for this research, which voiced the need for talent and skills.

This issue was identified both as an enabler and a challenge across the study cohort and was also identified as a significant factor in retaining companies within the region. Access to skills draws companies to Oxfordshire and is one of the factors that will keep companies here. It would appear, based on the views of the companies within this cohort, that the need is for higher skilled talent and there was a call for greater access to engineering skills and software development skills. It is notable that the companies participating in this research have an international workforce and for some roles, the labour market is global. 2021 will bring new systems for securing talent from outside the UK and new rules and obligations must work in concert with companies and their need to secure skills and capability at pace.

“Like many tech companies we have a need for highly talented software developers and there is perhaps less of an established network and pool for these candidates in Oxford than perhaps in other cities, or I would have expected in an innovation hub like Oxford.”

Given the focus on high-level skills, it is perhaps not surprising that apprenticeships were not identified by any respondent as an enabler of growth, nevertheless, given the significant focus on youth employment policies at both the national and regional level, this is an area worthy of further exploration. No further insight or conclusions can be drawn from this data, but it should also be noted that no company interviewed in greater detail for this project raised apprenticeships as an issue, either from a positive or negative perspective. This is an issue that requires further investigation. It would be particularly worthwhile to explore the issue of higher-level apprenticeships at degree level and whether these could be encouraged as a means of injecting more engineering skills into the local economy. There would appear to be an opportunity for universities and further education (FE) within the region to be actively engaged in this issue, with the potential for greater partnership between FE and higher education providers, working with industry to increase provision of graduates with hardware and software engineering skills, not only into the LCEGS sector, but into the high tech industries within the county.

Location, location, location

The questionnaire did not carry any specific questions about workspace or premises, but this was an issue that came through strongly in face-to-face interviews and in response to questions about what will keep companies in Oxfordshire. A number of companies identified the need for affordable space, both office and laboratory, others indicated that they would be looking to expand, and that suitable premises, land availability and planning are factors that are key to their decision making. It was also interesting to note the considerable interest among a small number of companies, founded on data/ICT, in operating from the centre of Oxford. It was not surprising that this was such a prominent issue as it has been echoed in other work conducted by Advanced Oxford. For example, Oxford Sciences Innovation has been clear that retaining their portfolio of investment companies within Oxfordshire is a key issue and availability of suitable property is a major impediment. There is a need to see concerted and timely action on this front particularly from local and regional government and through planning authorities.

Creating the market for goods and services

In an earlier chapter of this report, Creating the capability and ecosystem for the green economy to flourish, some of the soft infrastructure and policy making vehicles that have been established across the county to support the adoption and uptake of low carbon and environment goods and services were identified, including the work of i-Hub within the County Council. The role of Oxford AHSN in supporting the evidence generation and the business case development for innovation adoption within the NHS has also been highlighted. Nevertheless, the market for products and services needs continued attention, with a focus on policy interventions such as public procurement. Supply side business support are valuable, but demand side support activities are also needed.



Credit: YASA

Intellectual property and business development are also key to success

IP protection and business development are also areas that have been presented as challenges and it is recommended that OxLEP/IPO's current work to examine what IP support is needed across the region notes and explores this issue further. It is likely that the IP strategy needs of companies within this cohort are complex and sophisticated and may not be within the scope of services that can be provided through Growth Hub/local IPO services. There would appear to be a good level of IP service provision through the private sector professional services sector within the county/region and it is therefore important that a better understanding is built relating to the challenges being faced and how these can be addressed. Equally the challenges of business development, particularly in the current COVID environment, have been identified previously by Advanced Oxford. It is likely that this is an area where businesses could benefit from greater support, expertise and shared learning. This is an area of activity that could be incorporated into Growth Hub and scale-up activities within the region.



Credit: Oxwash

Summary of recommendations

- National Government investment and co-investment alongside private sector investors into high risk, strategic industries is required, along with support to ensure that high potential companies are retained within Oxfordshire in particular and in the UK, with the potential for spill-over effects into other regions of the UK, for example through manufacturing and supply chain developments. Support and incentives for companies looking to stay within the UK need to be competitive with other international markets that are looking to attract companies.
- Increased support to the green recovery from Innovate-UK and other funding bodies is essential, is valued and continues to play a critical role in helping companies of all sizes and ages to attract risk capital investment.
- Attract more investors to operate within the region – OxLEP and DIT to attract more national and international investors to establish a presence within Oxfordshire. It is recommended that OxLEP actively explore the opportunities to develop seed funding and co-investment funds that can support young, high-growth potential companies, particularly those that cannot easily access other pools of capital.
- Engineering and software engineering/development skills need to be bolstered across the region. Partnerships between business, Oxford's two universities and other education providers should be explored to determine if the supply of these skills can be increased within the region.
- Given the national policy imperative relating to youth employment, the role of apprenticeships within the LCEGS sector should be explored further, with work to understand and address barriers to their use and determine how apprenticeships can contribute to the skills pipeline for the LCEGS. It is, for example, possible that there is a poor understanding of the role of higher-level apprentices and improved communication could help with their uptake into high tech industries. However, it should be noted that apprenticeships was not raised as an issue by any respondent either within the survey responses or during face to face interviews.
- The OxLEP/IPO intellectual property project should determine what local support can be offered to high-growth potential companies as the findings from this research suggest that companies have on-going and developing needs in this area which are not currently being addressed.
- Market-making and business development are areas that require further support at national and regional level. It is recommended that this an area that is incorporated into Growth Hub and scale-up activities within the region and that policy interventions that create reference markets for innovation products and services within the UK will be as important to a green recovery as supply side support.
- Planning and development of innovation spaces, providing office, laboratory and manufacturing premises should be prioritised, including within Oxford city centre by local and regional government and by planning authorities.

Acknowledgments

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Sarah Haywood - 25th November, 2020

About Advanced Oxford

Advanced Oxford is a not-for-profit membership organisation with members drawn from R&D based/innovative companies working across Oxfordshire. Our membership includes companies, Oxford's two universities, the NHS through Oxford Academic Health Science Network and providers of innovation infrastructure and support.

Advanced Oxford is research-led, providing analysis and a united voice for our members on the key issues affecting the development of the innovation ecosystem in the Oxford region. We generate our own research and work to support and inform key stakeholders involved in the development of the business environment, infrastructure and policy. Advanced Oxford is working to support the long-term development and success of the Oxford region as a place to live and work. We do this by drawing on our collective experience of setting up, running or working in knowledge-based, innovation-focused businesses and organisations. We use our connections to other businesses to generate evidence and undertake research.

Advanced Oxford was set up in response to the Oxford Innovation Engine Update report. Published in 2016, the report identified the need for stronger engagement from the innovative businesses in Oxfordshire in the work to develop the region as a centre of excellence and an engine room for innovation. Work to scope and set up Advanced Oxford started in 2017. Further information about Advanced Oxford, our members and our work can be found on our website, www.AdvancedOxford.com. You can follow us on twitter @advanced_oxford and on LinkedIn <https://www.linkedin.com/company/advanced-oxford>