

Oxfordshire Sector Profile Electronics and Sensors



Contents

Foreword	3
Executive Summary	4
Introduction	6
Electronics and Sensors	7
Research and Development	11
Education and Skills	13
Population and Profile	14
Sites and Premises	15
Connectivity	16
Business Support	18

This is one of a series of five Oxfordshire Sector Profiles.

- Automotive and Motorsport
- Creative and Digital
- Electronics and Sensors
- Life Sciences
- Space Technologies

Please visit www.investinoxfordshire.com for more information.

Foreword



Nigel Tipple CEO Oxfordshire Local Enterprise Partnership

Oxfordshire is renowned across the globe for its academic excellence, innovative business culture and quality of the built and natural environment. We have Europe's largest concentration of multi-million pound science research facilities, underpinning our leading position in advanced engineering, manufacturing and life sciences, in addition to being at the heart of the UK's growing international space cluster.

With one of the strongest economies nationally driving a GVA output of £19.2bn annually, Oxfordshire is one of only three areas that positively contribute to the Exchequer.

World leading research and innovation sits at the heart of our success - the use and application of knowledge is a key feature – indeed the county was recently cited as the most innovative in the country.

Our success is driven by a number of distinctive features:

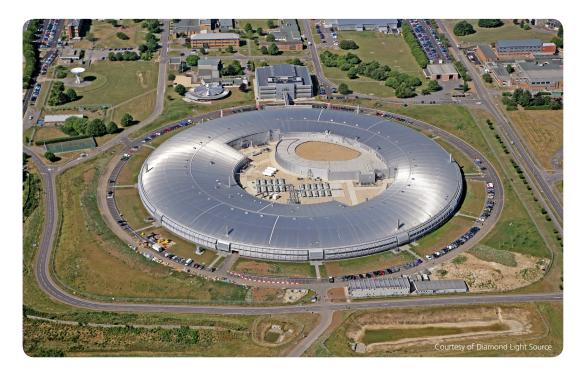
- Two leading universities the University of Oxford is rated one of the best in the world and Oxford Brookes is one of the top performing modern universities nationally.
- We are home to an internationally significant group of large science and research facilities including Harwell Campus (home to the Rutherford Appleton Laboratory, Diamond Light Source and the gateway to the UK space sector where the newly established European Space Agency sits alongside the Satellite Applications Catapult Centre) and the UK Atomic Energy Authority Culham Centre for Fusion Energy home to the UK's national fusion research laboratory.
- The area is also home to globally recognised companies like MINI Plant Oxford, Oxfam, Oxford University Press, Siemens, Oxford Instruments and more.
- We have a highly skilled workforce; 49% are graduates and we have the lowest rate of residents with no qualifications and the lowest Jobseeker's Allowance claimant count nationally.

We are primed for investment with solid economic foundations and a strong ambition to create 85,000 new jobs by 2030. Our integrated approach, driving 'economic growth through innovation', presents government and business with a compelling case for investment.

Oxfordshire has a well established electronics industry with global companies including Sharp, Toshiba and CN Innovations

Executive Summary

- A well established electronics industry. Oxfordshire has over twice the national proportion of people employed in the field of optoelectronics, representing a workforce of 3,800 people.
- An ideal location for testing, analytics and diagnostic companies. Oxfordshire has nearly five times the proportion of employees working in scientific R&D than the national average.
- A diverse commercial base. Commercial activity in Oxfordshire is diverse and encompasses R&D, design and manufacturing, with expertise ranging across photonics and microelectronics systems.
- A track-record in attracting global electronics companies. Toshiba and Chinese owned CN Innovations are based locally and Oxfordshire is also home to Sharp Laboratories of Europe, the European research centre for Sharp Corporation.
- Leading Research and Development academic expertise. The University of Oxford is in the Top 10 universities in the world for Electrical and Electronics Engineering and Physics.
- World class R&D centres and testing facilities. Harwell Campus is a national R&D facility which provides facilities of particular relevance to the electronics industry, including Diamond Light Source, the UK's national synchrotron science facility.
- **Specialised state-of-the art testing facilities for harsh environments.** The Remote Applications in Challenging Environments Centre (RACE) at Culham Science Centre can be used on a commercial basis for the testing of autonomous systems and embedded sensors in applications across the nuclear and space sectors.



The University of Oxford is in the 'Top 10' universities in the world for Electrical Engineering and Physics.

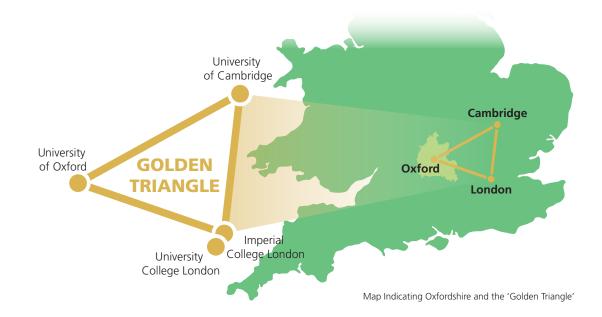
- A total annual student population of over 43,000 students provides a young dynamic source of new talent. The University of Oxford and Oxford Brookes University provide an average of just under 2,000 1st and Higher Degree qualifiers in science and technological based subjects each year.
- A wide range of cost effective commercial properties. These range from incubator space, laboratories and testing facilities to buildings for light industrial use. The average rental is £22 per sq. ft, 35% less compared to Cambridge and 29% less Reading.
- With its excellent motorway, rail and airport links, Oxfordshire is an ideal location from which to access national and international clients and markets. Frequent and direct train services puts London only 56 minutes away. Heathrow Airport is an hour's drive from Oxford.



Oxfordshire has a world class base of R&D facilities and expertise, including the University of Oxford, rated No 1 in the UK for its research excellence

Introduction

- Oxfordshire is part of the UK's 'Golden Triangle'. This triangle is formed by the University of Oxford, the University of Cambridge, and the four universities in London (including Imperial College London and University College London). The universities within the 'Golden Triangle' have a combined annual research income of over £1.4bn.
- Excellent local infrastructure connects Oxfordshire to the rest of the UK's motorway network including direct access to the M25, putting the rest of the country within easy reach. There is an average of five direct train services an hour to London from Oxford's main station (journey time of 56 minutes). Heathrow Airport is just an hour's drive away.
- In addition to electronics, Oxfordshire has strengths in a number of other sectors including medical technologies and medical devices, automotive and Formula 1, digital and cyber security, Big Data and space related technologies.
- Oxfordshire has a strong track record in attracting foreign direct investment (FDI), with global companies including Sharp, Toshiba, Siemens, BMW, Lockheed Martin, and Thales Alenia Space.
- Companies locating to Oxfordshire are supported by a collaborative base of partners. This includes industry networks, as well as outstanding research organisations including the University of Oxford and Oxford Brookes University.
- In addition to the Universities, Oxfordshire has world class scientific centres including: the UK's national laboratory for fusion research, Culham Centre for Fusion Energy, and the UK's national synchrotron science facility, Diamond Light Source.



Electronics and Sensors

Oxfordshire has a well-established electronics industry, with over twice the national proportion of people employed in the field of optoelectronics.

- The electronics sector in Oxfordshire is represented by global companies including Sharp and Toshiba, as well as indigenous and spin-out companies including Oxford Instruments Plc and Oxsensis.
- Oxfordshire has a depth of commercial expertise in optoelectronics with a total of 3,800 people employed in the manufacture of computer, electronics and optical products almost a 2.5 times higher proportion of employees than the national average.
- There are 6,500 employees in engineering activities and technical testing and analysis, together with a deep base of employees in the field of computer programming.
- The combination of electronic and software skills highlights Oxfordshire as an ideal location for companies developing and manufacturing embedded systems and sensors.
- Commercial activity in Oxfordshire is diverse and encompasses R&D, design and manufacturing, with expertise ranging across photonics (e.g. optoelectronics, lasers, LED, LCD displays, photodetectors) and microelectronics systems.
- Chinese owned CN Innovations has its research technology development centre, M-Solv, headquartered in Oxford. M-Solv has expertise in large area and flexible electronics manufacturing technologies, including capacitive touch panels. OCZ, a Toshiba owned Semiconductor and Storage business division, has its strategic design centre based in Abingdon.

Number and Proportion of Employment, by Selected Sectors and Sub-sectors, 2014

Selected Industries by Standard Industry Classification (2 and 4 digit)	Oxfordshire No.	Oxfordshire %	England %
26 : Manufacture of computer, electronic optical products	3,800	1.2	0.5
27 : Manufacture of electrical equipment	700	0.2	0.3
62 : Computer programming, consultancy and related activities	8,500	2.6	2.2
7112 : Engineering activities and related technical consultancy	5,500	1.7	1.1
7120 : Technical testing and analysis	1,000	0.3	0.2
72 : Scientific research and development	6,100	1.9	0.4

Source: BRES from ONS, 2014

the proportion for England

Oxfordshire

times higher

of employees in electronic

proportion

and optical

products than

has almost 2.5



The market for sensors and related technologies is predicted to grow to \$154.4bn by 2020 Sensor and instrumentation companies in Oxfordshire are developing innovative sensor systems with intelligence and optimised control combined with the ability to function in harsh environments such as space, nuclear and oil and gas.

- Whilst Oxfordshire has expertise in a range of electronics based technologies, it is particularly strong in sensors and instrumentation technologies.
- The global market for sensors and related technologies is expected to grow to \$154.4bn by 2020 (BCC 2014). This in part is driven by the predicted growth of the 'Internet of Things', where the networking of objects is enabled through the use of embedded sensors and other devices.
- Oxfordshire's academic R&D expertise in sensors and instruments combined with local commercial activity, provides an ideal location for companies in this field.
- Sensors and instrumentation related companies based in Oxfordshire serve a wide range of industries from medical devices, consumer electronics, space and harsh environments to automotive and motorsport..

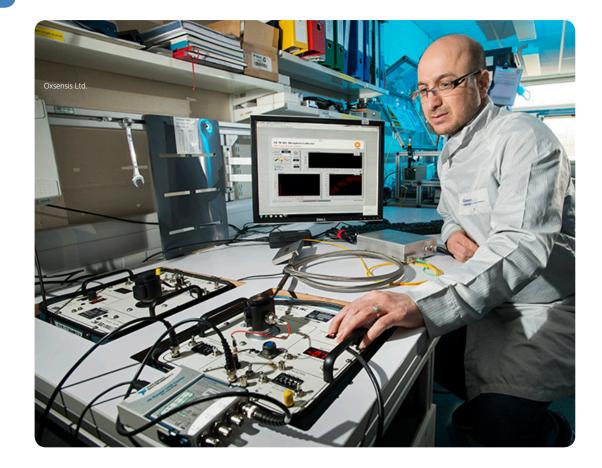
Harsh Environments and Space

- Oxfordshire has international expertise in cryogenics; an area which originated from the R&D expertise in the Department of Physics at the University of Oxford and the Rutherford Appleton Laboratory in Harwell.
- Notably, Oxford Instruments Plc was one of the University of Oxford's first significant spin-outs in the 1950s. The company now employ approximately 600 people who develop and manufacture equipment that can fabricate, analyse and manipulate matter at the atomic and molecular level. Specialisms include the manufacture of cryogenic systems such as cryostats for spectroscopy measurements.
- Salunda, based in the north of Oxford, has developed networked sensor technology for harsh environments including oilfields. A recent university spin-out, Oxsensis, make optical sensor instrumentation for harsh environments, including extreme low temperatures, oil and gas and nuclear facilities.
- The UK nuclear sector has a current turnover of over £4bn and it is estimated that it will attract between £15-70bn of additional investment over the next decade. This new investment is likely to provide significant opportunities for specialised sensors and instrumentation.
- The Remote Applications in Challenging Environments Centre (RACE) at Culham Centre for Fusion Energy, will capitalise on the remote handling systems developed at Culham for the Joint European Torus (JET) fusion project. The centre can be used on a commercial basis, with testing of robotic equipment and advanced sensors in applications ranging from space to the advanced nuclear fission industry.

Oxfordshire's strengths in Life Sciences has meant a growing number of medical device companies using sensors at the heart of their technologies.

Medical Applications

- The area's strengths in Life Sciences has led to a base of companies serving the medical sector. As well as space applications, Bartington Instruments also develop measuring instruments used to monitor magnetic fields surrounding sensitive instrumentation used in medical equipment.
- Abbott Diabetes Care, part of US owned medical company Abbott, has its Global Centre of Excellence for Medical Devices in Witney, where over 600 people are employed. In 2014, the company launched the 'FreeStyle Libre System Flash Glucose Monitoring System'. The sensor (about the size of a 2p piece) is worn under the arm and constantly monitors glucose levels and displays results on a hand-held reader.
- Oxford Nanopore Technologies has developed an electronic, single molecule sensing system based on nanopore science. The range of products can be used for the analysis of DNA, RNA, proteins and small molecules, with a range of applications in personalised medicine and crop science



World class R&D expertise and facilities in Oxfordshire has helped to facilitate the growth of a diverse base of sensor and instrumentation companies Oxfordshire's strengths in R&D and Innovation make the area an ideal location for Sharp to locate its European research and development centre

Sharp Laboratories of Europe, Oxford Science Park

- Sharp Corporation, headquartered in Osaka, Japan, is a global leader in the design and manufacture of electronic products. Sharp Corporation has an international network of laboratories, with its European Laboratory based in Oxford. The technologies being developed in Oxford have been used globally in Sharp products; with applications ranging from mobile phones, laptops, displays for cars, home appliances and translation software.
- The R&D activity undertaken by Sharp Laboratories of Europe has helped Sharp maintain its position as a world leading manufacturer of optoelectronic components, including lasers and LEDs. The laboratory has world class expertise in the research, development, design and fabrication of optoelectronic devices. The technology is vital for further developments in next generation of energy efficient LED lighting and will be expanded to new markets in sensors.
- Other areas of expertise include optical imaging. Next-generation display technology research helps Sharp remain a world-leading supplier of LCDs used in everything from smart phones and games machines to large-area flat-panel TVs.
- Sharp has collaborated with the University of Oxford on the commercialisation of a number of technologies including the application of neural networks in domestic appliances, the development of a hardware compiler for integrated circuit design and various early stage technologies.
- The centre is based in a purpose-built laboratory on the Oxford Science Park, consisting of cleanrooms, optics labs, chemistry and battery development facilities and a range of test, analytical and characterisation facilities. The team at Sharp Laboratories of Europe also benefit from a physical proximity to the University of Oxford's facilities as well as access to academic research expertise.

Ian Thompson, Managing Director of Sharp Laboratories of Europe

Ltd commented that "Many of the team here have pursued some or all of their education at the University of Oxford, and having a world class University on our doorstep opens up excellent opportunities for collaboration."

Research and Development

Electronics related companies located in Oxfordshire can benefit from close proximity to world class expertise, research centres and facilities. Both the University of Oxford and Oxford Brookes University undertake collaborative R&D with a large range of electronics based companies.

UNIVERSITY OF OXFORD

- The University of Oxford is ranked No.1 in the UK for its research power in the Research Excellence Framework (REF) 2014 and ranked in the top 10 Universities in the world for Electrical and Electronics Engineering and Physics. (QS World University Rankings 2015).
- The University has a number of research groups of relevance to the electronics industry. These include the Microelectronics Circuits and Systems Group, the Photovoltaic and Optoelectronic Device Group and the Semiconductor and Silicon Photovoltaics Group.
- The University of Oxford is at the forefront of research in photonics; from quantum photonics and metrology to super-resolution optical imaging, biophotonics, ultrafast spectroscopy, sensing and laser processing.
- There is an important base of expertise in microelectronics and microelectromechanical (MEMS) systems, with research interests spanning a broad spectrum of analogue circuits and sensors for biomedical, as well as other commercial applications.
- The University also has a number of electronics testing facilities which can be utilised by businesses including a state of the art semiconductor processing testing facility at Begbroke Science Park.

94%

The University

of Oxford is ranked No.1

in the UK for

its research

power

of Oxford Brookes University research is ranked as being of INTERNATIONAL STANDARD

OXFORD BROOKES UNIVERSITY

- Oxford Brookes University has a growing international reputation for research with 94% ranked as being of international standard in the REF 2014 results.
- A number of the University's research groups are of particular relevance to the electronics industry. This includes the Communications, Media and Electronic Technologies (COMET) Research Group which has interests in areas such as medical electronics and instrumentation and intelligent wireless network design. Current projects include biomedical sensors, analogue front end chip design and instrumentation amplifiers.
- The Intelligent Systems Engineering Research Centre has sensor expertise which relates to robotics and autonomous vehicles. Current research is being undertaken on ways to exploit the availability of multiple heterogeneous sensors in autonomous vehicles.

Harwell Campus, a £1bn world leading research infrastructure and the base for over 2000 scientists

HARWELL CAMPUS

Harwell Campus is a national R&D centre which houses over £1 billion of worldleading research infrastructure. It is also the base for over 150 research organisations and technology led businesses. On-site facilities with particular relevance to the electronics industry include the following:

- Diamond Light Source the UK's national synchrotron science facility. Diamond Light Source is a research centre of global importance, where intense beams of light are used to investigate the structure and properties of a wide range of materials and components. Over 3,000 researchers from both academia and industry use Diamond to conduct experiments, assisted by approximately 500 staff.
- **Rutherford Appleton Laboratory (RAL).** The Electronics and Optics Group at RAL provide a wide range of facilities and tools for all aspects of instrument assembly, inspection and testing. RAL research includes work on magnetic nearfield communications and sensing in applications across the oil, gas and defence sectors.
- ISIS the pulsed neutron and muon source at RAL. This facility is a suite of
 instruments which provides insights into the properties of materials on the atomic
 scale. The ability of neutron scattering can be used to map out magnetism at the
 atomic scale to create ultra-sensitive sensors to read back the data, and develop
 new types of computer memory.
- **ChipIR** is a new European based testing facility designed to investigate how silicon microchips respond to cosmic neutron radiation. It can replicate cosmic radiation which interacts with the earth's atmosphere to assist manufacturers to build more reliable and robust electronic systems.
- **Detector Systems Centre (DSC).** The sensor and instrumentation community is well supported by the DSC which works in partnership with academia and industry in the area of innovative detector designs and sensor systems.

Education and Skills

Higher Education and Further Education provision locally ensures businesses can draw from a diverse range of skills, particularly within science and technology based subjects

- In 2010/11 there were a total of 1,935 1st and Higher Degree qualifiers in science based subjects, representing an important source of new talent for electronics based companies.
- The University of Oxford has one of the largest physics departments in the world and has recently established a new Masters in Mathematical Physics. Also its Department of Engineering Science is one of the largest unified engineering departments in the UK.
- The Faculty of Technology, Design and Environment at Oxford Brookes University incorporates the Department of Mechanical Engineering and Mathematic Sciences and the Department of Computing and Communication Technologies. These departments deliver a number of electronics undergraduate courses, both at Foundation and Degree Level.

Further Education Colleges

- There are three FE Colleges in the locality Banbury and Bicester College, City of Oxford College and Abingdon and Witney FE College. The latter offers electrical and electronic engineering courses, including apprenticeships.
- The UTC Oxfordshire (ages 14-19) which opened in September 2015 has specialisms in science and engineering. Industry partners include Oxford Instruments and BMW.

No. of Qualifiers by Selected Broad Subjects, University of Oxford and Oxford Brookes University

Subject	1st Degree	Higher Degree (research)	Higher Degree (taught)
Physical Science	465	170	115
Engineering and Technology	300	85	110
Mathematical Science	235	50	105
Computer Science	125	25	150
Total	1,125	330	480

Professional Development

 The University of Oxford provides internationally recognised professional development courses in electronics, telecoms and engineering which are delivered by leading research and industry experts. These include Digital Electronics, RF/Microwave Design and Digital Signal Processing. Participating companies have included Huawei, Texas Instruments, Toshiba and Hutchison 3.

Source: HESA, 2010/11

STUDENT Population of

43,000+

Making it the

youngest city

in England and Wales 49%

of the resident **Working Age**

Population are

qualified to degree

level and above which is over **13%** higher than the UK proportion

Population and Profile

Oxfordshire is an ideal location for scientific and R&D related operations. With 97,000 people employed in professional occupations, almost 9% higher than the UK proportion, this enables electronics related companies to effectively recruit employees with the relevant skills base.

- Situated within the UK's most densely populated region, the South East, Oxfordshire has a large population, estimated at nearly 700,000 (Mid Year Population Estimates, 2013). In addition, the Oxfordshire area has a Working Age Population of over 430,000. The Working Age Population of the wider region is over 5.5 million.
- Oxfordshire benefits from the presence of a considerable pool of highly educated employees. 49% of the resident Working Age Population are qualified to diploma level and above, which is over 13% higher than the UK proportion (36%) and 10% higher than the proportion for the South East (39.1%).



Economic Activity Rate (16-64), ONS 2014

	Oxfordshire No.	Oxfordshire %	England %
Economic activity rate - aged 16-64	344,100	81.1	78.3



Source: Midyear Population Estimates, ONS

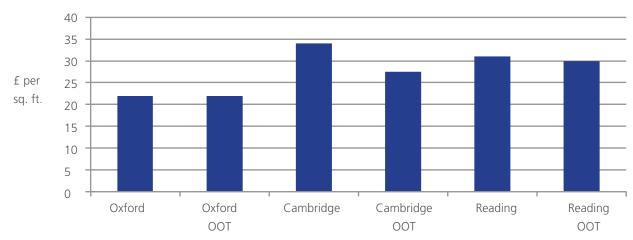


Almost 11% higher than the UK proportion.

Sites and Premises

Oxfordshire has a wide range of cost effective commercial properties together with available sites for Design and Build, including a 92 hectare Enterprise Zone.

- Oxfordshire has a range of high quality commercial, business and science parks as well as serviced offices. The average office rental per sq. ft. (Grade A) is £22.00 for both Oxford City Centre and Out of Town (OOT) locations.
- The average rental per sq. ft is considerably less compared to other locations. It is 35% less than Cambridge and 29% less than Reading. The average rental for industrial space (based on 10,000 sq. ft.) is £8.00 per sq. ft. in Oxford and £7.00 per sq. ft. in Banbury, whereas in other locations such as Reading, the average industrial rental is £9.00 per sq. ft.
- Science Parks include Oxford Science Park and Begbroke Science Park. The latter houses the mathematics, physics and life sciences faculties of the University of Oxford. It also has a number of facilities available to businesses such as cleanrooms.
- Banbury, to the north of Oxford, has two business parks located close to Junction 11 of the M40 (Banbury Business Park and Central M40). These provide new and existing space from 10,000 sq. ft., as well as design and build opportunities.
- The Science Vale Oxford Enterprise Zone is a 92 hectare site to the south of Oxford that comprises parts of Harwell Campus and MEPC Milton Park. The latter is a science and business park located near to Didcot which provides office, laboratory space and light industrial premises. The success of Milton Park has led to further expansion, with up to 370,000 sq. ft. (34,374 sq. m.) of new, high quality commercial office and research space to be developed. In addition, Harwell Campus is also an expanding site, with 470,000 sq. ft. (43,664 sq. m.) of new commercial space planned for future development.
- Science Vale Oxford Enterprise Zone can offer occupiers a number of benefits including a business rate discount worth up to £275,000 over five years and support for superfast broadband.



Average Grade A Office Rentals, Collier International, 2014



£22.00

per sq. ft.

AVERAGE Grade A

Connectivity

Oxfordshire has outstanding transport infrastructure; with excellent motorway and railway access to the UK's main cities – London is just one hour 30 minutes drive away.



Distances and Drive Times from Locations in Oxfordshire to Selected Cities

Location	Oxford	Banbury
Birmingham	80 miles 129 km 1hr 50mins	52 miles 83 km 1hr 5min
Cambridge	106 miles 107 km 2hr 30 mins	86 miles 138 km 2 hr 10mins
London	60 miles 97 km 1hr 30mins	78 miles 126 km 2hr 10mins
Manchester	161 miles 259 km 3hr 30mins	135 miles 217 km 2hr 50mins
Bristol	85 miles 137 km 1hr 50mins	79 miles 127 km 2hr

From Oxfordshire, key UK cities are easily and efficiently accessible by motorway: London and Birmingham in one hour and 30 minutes and Manchester in under three hours.





Oxfordshire is within quick and easy access to key UK international airports; Heathrow and Birmingham are accessible by road in one hour and Gatwick in two hours.

Superfast Broadband

Businesses based in Oxfordshire can benefit from access to superfast broadband, with over 90% of Oxfordshire able to access broadband at a minimum of 24Mb/s. SuperConnected Oxford is a programme to enable superfast broadband access for everyone and everywhere in Oxford. Wifi Hotspots are being created as part of an extensive Wifi zone around the city.

Distances from locations in Oxfordshire to Selected Airports

Airport	Oxford	Banbury
Heathrow	47 miles 76 km 1hr	65 miles 105 km 2hrs
Gatwick	85 miles 136 km 2hrs	102 miles 164 km 2hrs 30mins
Birmingham	66 miles 106 km 1hr 30mins	40 miles 64 km 1hr



With its excellent

and airport links,

an ideal location

motorway, rail

Oxfordshire is

from which to

access national

clients and

markets

and international



Business Support

Invest in Oxfordshire provides a comprehensive package of support to assist companies in establishing their new operation in the area:

- Co-ordination and identification of commercial premises and property viewings
- Facilitation of introductions to the University of Oxford and Oxford Brookes University
- Introduction to other research facilities, including the Science and Technology Facilities Council (STFC) and Rutherford Appleton Laboratory
- Connecting businesses with professional service providers, signposting to business support organisations such as Oxfordshire Business Support and sector specific networks as well as Network Navigators
- Assistance in recruitment of new staff, including graduate recruitment, as well as training support including apprenticeships
- Support in the relocation of employees and their families moving into the area
- Provision of ongoing aftercare to Oxfordshire based companies

There is a wide range of support for electronics related businesses. This includes amongst others the following:

- **The British Cryogenics Cluster** which is centred in Oxfordshire, provides a strong support infrastructure for businesses in this field. The industry is also supported by a Network Navigator, whose role includes facilitating collaborations between businesses.
- **Microelectronics Support Centre at STFC Harwell.** The Centre provides a comprehensive range of services including technical consultancy and access to industry-leading electronic design tools.
- Electronics Group Oxford, Department of Physics, University of Oxford. This group specialise in custom design of electronics systems from prototype to small production series. The group translates ideas emanating from businesses into working designs.

Invest in Oxfordshire is comprehensive service to support companies in establishing their operations locally

For more information contact:



invest@investinoxfordshire.com
 www.investinoxfordshire.com
 @InvestInOxon

Our Priorities



people

Deliver and attract specialist and flexible skills at all levels, across all sectors, as required by our businesses, with full, inclusive employment and fulfilling jobs.



place

Provide the quality environment and choice of homes needed to support growth and capitalise upon the exceptional quality of life, vibrant economy and the dynamic urban and rural communities of our county.



enterprise

Encourage innovation led growth, underpinned by Oxfordshire's strengths in University research and development, business collaboration and supply chain potential.

connectivity

Allow people to move freely, connect easily and provide the services, environment and facilities needed by a dynamic, growing and dispersed economy.

If you require this document in any other format, please contact info@oxfordshirelep.com.



