MANCHESTER 1824
The University of Manchester

Research beacons

GLOBAL CHALLENGES
MANCHESTER SOLUTIONS

BREAK THROUGH

The University of Manchester's research beacons are answering some of the biggest questions facing the planet.

Contents

Research at Manchester

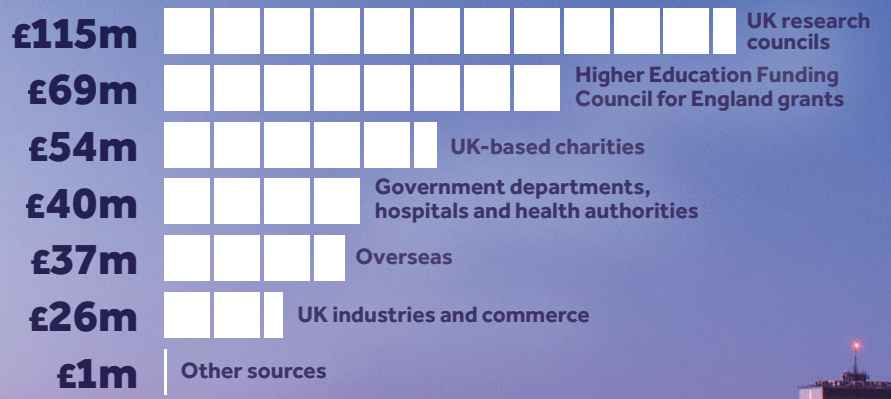
Research is fundamental to The University of Manchester. We're committed to both the discovery of new knowledge and its application for social and economic value.

Our place as one of the UK's top research universities was confirmed in the results of the 2014 Research Excellence Framework, where 83% of our research activity was judged to be "world-leading" (4*) or "internationally excellent" (3*).

We produce a range of first-class research that is rivalled by few other institutions. Our size and breadth afford us excellent opportunities to combine our expertise across disciplines, bringing together some of the country's best minds to develop new advances in many fields of enquiry.

Our five research beacons exemplify this unique capability.

In 2015/16 we attracted more than £342 million in external research funding.



Global challenges, Manchester solutions

Manchester's research beacons are exemplars of interdisciplinary collaboration and cross-sector partnerships. They are unique to this University, enabling pioneering discoveries and improving the lives of people around the world.

Researchers in our beacon areas are at the forefront of the search for innovative solutions to some of the biggest challenges facing the planet today.

Working together, we're advancing knowledge for a better future.

Our research beacons

- **Advanced materials**
- **Cancer**
- **Energy**
- **Global inequalities**
- **Industrial biotechnology**

Advanced materials

As the modern global age evolves, we need new, transformational materials to enable us to work in the harshest, most demanding environments, such as chambers that can contain fusion reactions similar to those powering the sun. Advanced materials have the ability to transform almost every industrial sector and every aspect of our lives.

The birthplace of graphene research, The University of Manchester is today a world-leading hub for advanced materials expertise. We work with dozens of international industrial and academic partners to turn discoveries from the lab into revolutionary applications to improve the lives of people across the globe.

"You cannot help but wonder what else graphene has in store for us."

Sir Andre Geim
Professor of Condensed Matter Physics

Why Manchester?

- We're investing **£280 million** into live advanced materials projects.
- The UK's Henry Royce Institute, based in Manchester, will open a nine-storey **£150 million purpose-built centre** in 2019 dedicated to research and commercialisation of advanced materials.
- Manchester researchers are pioneering **biomaterials** that will help recreate tissue and bone in our bodies, giving a better quality of life into older age.
- Manchester is pioneering **materials for the new manufacturing revolution**, such as advanced printing technology, which includes the 3D printing of food.
- **Materials that can survive hostile environments** are being developed at Manchester to produce aeronautical engines that operate at much higher temperatures.
- Our researchers are developing **resilient and smart materials** to build the next generation of low-carbon nuclear power reactors.

Global challenges

Advanced materials

Globally, corrosion costs more than **£1.5 trillion a year**.[1]

Every two minutes a child under the age of five dies somewhere in the world from a diarrhoeal disease caused by dirty water and poor sanitation.[2]

Just **8.3%** of UK energy consumption in 2015 was provided by renewable sources.[3]

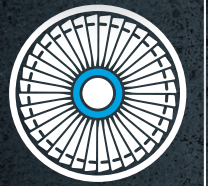
Transport accounts for **more than one fifth (21%)** of the UK's carbon emissions.[4]

21%

[1] World Corrosion Organization 2012
[2] WHO/UNICEF 2014, 2015
[3] Digest of United Kingdom Energy Statistics 2016
[4] Transport Statistics Great Britain 2015

Manchester solutions

£60bn



Manchester pioneered a new process to strengthen aero-engine fan blades, which has now been used on a range of engines, including 1,200 Trent XWB turbofan jet engines worth over £60billion.

Our world-leading **3D characterisation capability** enables us to study the properties of new protective coatings for materials, such as aluminium used in aeroplanes.

The BP International Centre for Advanced Materials works on research projects at the University to **improve the safety, reliability and performance** of materials across the oil and gas industry.

We're working on **'accident-tolerant' nuclear fuels** that can survive much higher temperatures, providing improved safety; and **extended lifetime fuels** with better thermal conductivity, offering improved economic performance.

Two Manchester scientists first isolated graphene in 2004; now **Nobel laureates**, they work alongside **more than 250 researchers** set to revolutionise global health care, water supplies, consumer electronics and the energy industry.

Cancer

One in two of us will be diagnosed with some form of cancer in our lifetime.[1] The disease can have a devastating impact on the lives of patients and on their friends and family who feel its emotional and economic fall-out.

The University of Manchester has a rich history of cancer research, stretching back to the early 20th century research of Sir Arthur Schuster into X-radiography and radium. Today we're working on countless ways to reduce cancer's impact on our patients, our health services and our society.

"There aren't many other places where researchers, clinicians, charities and patients mingle so freely. By working together in the same space, we deliver results faster and more effectively."

Professor Sir Salvador Moncada
Director, Manchester Academic Health Science Centre (MAHSC)
Cancer Domain

[1] Cancer Research UK

Why Manchester?

- We're home to the **Manchester Cancer Research Centre (MCRC)**, a unique collaboration between the University, Cancer Research UK and The Christie NHS Foundation Trust, which also coordinates research across the **Manchester Academic Health Science Centre (MAHSC)**.
- The Cancer Research UK Manchester Centre – one of only two such major centres – **provides £39 million** for translational research across five key themes.
- We opened a **£28.5 million** new building for MCRC scientists in 2015 to house an additional **150 researchers** and **100 clinical trials support staff**, plus new and advanced equipment.
- We've **invested £30 million** into attracting researchers to the MCRC.
- We collaborate with **six NHS organisations** as part of MAHSC, and partner with companies such as **AstraZeneca** and **GlaxoSmithKline** to bring new drugs to the market.

Global challenges

Cancer

14m

14.1 million new cases of cancer

There were **14.1 million** new cases of cancer, **8.2 million** cancer deaths and **32.6 million** people living with cancer worldwide in 2012.[1]

33%

Around **33% of cancer deaths** are due to behavioural and dietary risks: high body mass index, low fruit and vegetable intake, lack of physical activity, and tobacco and alcohol use.[2]

70%

Around **70%** of all cancer deaths occur in low- and middle-income countries.[1]

Cancer rates are predicted to **increase by 70%**, from 14 million in 2012 to 22 million in 2020.[1]

£870bn

The financial costs of cancer are estimated at **£870 billion** a year, as of 2010.[1]

[1] World Cancer Report 2014, World Health Organization

[2] World Health Organization Factsheet no 297

Manchester solutions

1.5m

1.5 million women with breast cancer across the world are now benefiting from endocrine therapy approaches developed at Manchester.

Our academics and medics are helping to roll out a national programme of cervical cancer screening in **Uganda**.

25% of people with lung cancer live for **two or more years** after diagnosis thanks to ground-breaking treatments developed at Manchester.

25%

90,000

We've contributed substantially to government initiatives that have helped the **90,000 working people a year** diagnosed with cancer **return to work** after treatment.

100,000 patients a year benefit from **better nutrition** before and after cancer treatment thanks to our enhanced use of the malnutrition universal screening tool.

100,000

Energy

As the world develops, we're using more and more energy in our everyday lives, raising big questions about where energy comes from, how smartly we use it, how accessible it is and what impact it has on the environment.

We're seeking solutions to some of the biggest energy challenges the world faces – from the sustainability of sources to the social factors that stand in the way of equal access to energy.

With more than 600 academics and researchers working across energy generation, networks and usage, our researchers are looking at the whole energy system in order to produce technologies and approaches to secure the world's energy future.

"The size of the University and the sheer breadth of knowledge here allows us to bring people together from a huge range of research areas. This helps us to find innovative ways to tackle some of the world's biggest energy challenges."

Ian Cotton
Professor of High Voltage Technology and Director, Manchester Energy

Why Manchester?

- Our leading energy research facilities include **the world's highest energy dual-beam accelerator system**, **a range of world-leading X-ray imaging systems,** a **1MW energy storage test bed** and the only **400kV-capable HV lab** of any UK university.
- Our strategic partnerships include **Arup**, **BP**, **EDF Energy**, **Electricity North West**, **National Grid**, **National Nuclear Laboratory**, **Rolls-Royce** and **Siemens**.
- We're working on a **€25 million** project with partners in the UK and Europe to develop the sustainable smart cities of the future.
- We're home to the **Dalton Nuclear Institute**, a world-leading centre of expertise delivering applied research across the nuclear fuel cycle.
- The Manchester-led **European Energy Poverty Observatory** offers advice to governments tackling fuel poverty.
- We host Tyndall Manchester, **a world-leading climate change and energy research centre** that helped to directly shape the UK's Climate Change Act, thereby setting us on a path to a significantly **lower carbon future**.

Global challenges

Energy

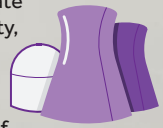
The average growth rate for global electricity demand is about 3% a year, meaning **global electricity use could double** by 2038 compared to 2015 levels.[1]

CO_2 ↓

The UK is legally required to reduce greenhouse gas emissions to **80%** of 1990 levels by 2050, meaning a reduction in our reliance upon fossil fuels.[2]

Ever-growing energy demand is not sustainable. We need measures to reduce demand, improve efficiency and use more sustainable energy sources. One such source is biomass, which provided 46% of renewable energy in Europe in 2014.[3]

Our existing nuclear power stations currently generate 21% of the UK's electricity, yet are all due to retire between 2023–35. In the coming years, the UK will need to build 60GW of new electricity generating capacity.[4]



Every year a typical large coal-fired power station produces around **10 million tonnes** of CO_2.[5]

[1] BP Statistical Review of World Energy

[2] 2008 UK Climate Change Act

[3] University of Manchester PhD thesis (Laura Cragg 2016)

[4] NIA 'Nuclear Energy Facts'

[5] International Energy Agency

Manchester solutions

We're working closely with industry to deliver projects such as VISOR, a **£7.4 million** initiative to demonstrate the role of **measurement and monitoring technologies in electrical power systems** – an essential step in ensuring the success of a low-carbon future.

£7.4m

We're helping the hydrocarbon sector to extract bridging fuels **more efficiently** from conventional reserves – and we're investigating the **technical and social implications** of extracting from unconventional reserves.

We're designing an amphibious remote-operated vehicle that can easily access nuclear facilities, carry neutron detection and navigation equipment, and withstand radioactive environments for **safely decommissioning** sites such as Sellafield.

Our graphene and quantum dot technologies **increase solar cell efficiency**, and our **Virtual Power Plant** project (MYSTORE) facilitates research into low carbon generation, energy storage technologies and how to balance supply and demand more flexibly.

We established that the UK could generate **44%** of its energy needs from biomass by 2050[1] – we're also producing fuel from algae and helping developing countries make better use of rice straw waste by turning it into gas.[2]

[1] 'Securing a Bioenergy Future Without Imports', Energy Policy Volume 86

[2] ricestraw.irri.org/rice-straw-energy

Global inequalities

There are pronounced inequalities across the world. Food, infrastructure, health care, resources and opportunities remain plentiful for some, scarce for others.

Social injustice, discrimination and constraints on social mobility heavily impact on some communities by gender, ethnicity, educational background and other characteristics.

For almost two centuries The University of Manchester has been leading the way in tackling global inequalities. From poverty and social justice to living conditions and equality in the workplace, we seek to understand our world – and change it for the better.

"The University has much to contribute to shaping research, ideas and policies across the world. The international nature of our students and researchers helps us to make this happen."

Armando Barrientos
Professor of Poverty and Social Justice

Why Manchester?

- **335** academic staff and PhD students at Manchester are working to address global inequalities.
- Specialist hubs of expertise include our **Global Development Institute, Humanitarian and Conflict Response Institute** and our **Work and Equality Institute**.
- Our Humanitarian and Conflict Response Institute is a **leading international training centre that is facilitating improvements to our global crisis response.**
- Our Global Development Institute is **Europe's largest dedicated development research and teaching institute** and contains the world's first doctoral college for international development: **The Rory and Elizabeth Brooks Doctoral College**. At the forefront of development studies for **60 years**, many of our researchers are deemed to be **"world-leading"**.[1]

[1] Research Excellence Framework 2014

Global challenges

Global inequalities

Ethnic minorities identifying as African, Arab, Bangladeshi, Caribbean and Pakistani are more than twice as likely as the white British ethnic group to live in **England's most deprived neighbourhoods**.[2]

767 million people – one in ten people in the world – are estimated to be living below the international poverty line of $1.90 a day. [4]

767m

x 8=

Eight men own the same wealth as **half the world's population**.[1]

800 MILLION

Around **800 million** people go hungry in the world every day.[5]

19,000 children under five will die today, most from easily preventable health problems.[3]

19,000

[1] Oxfam, 2017

[2] The Dynamics of Diversity: Evidence from the 2011 Census

[3] UNICEF

[4] World Bank, 2013

[5] International Federation of Red Cross and Red Crescent Societies

Manchester solutions

UN

Our employment expertise has informed the **European Commission**, the **European Parliament** and the **United Nations' International Labour Organization**.

Our research led to the creation of the **UK International Emergency Trauma Register** and **UK-Med** who deployed medical teams to some of the most significant global humanitarian crises of recent times, including **Typhoon Haiyan** in the Philippines, the 2014 **Israeli-Gaza conflict** in Gaza, and the **Ebola** virus epidemic in Sierra Leone.

Our insight into humanitarian efforts and technologies has influenced **Médecins Sans Frontières**, **Save the Children**, **Handicap International** and the **International Federation of Red Cross and Red Crescent Societies** – and has been recognised by the **British Academy**.

Manchester

In 2017 we launched a **Human Development Report for Greater Manchester** to mirror the United Nation's annual global Human Development Report, providing new indices for comparing Greater Manchester to national benchmarks.

Industrial biotechnology

In a century where society seeks sustainability alongside efficiency, industrial biotechnology offers an attractive alternative to traditional oil and gas technologies, using biological resources such as plants, algae, fungi, marine life and micro-organisms to create cleaner, sustainable chemicals, materials and energy.

The University of Manchester is leading the way towards a bio-industrial revolution. Our multiskilled, interdisciplinary teams give us unique capabilities, making us ideally placed to translate knowledge into application in areas from agriculture to medicine.

"There is no industry better positioned than industrial biotechnology to respond to society's grand challenges as we tackle an ageing and ever-increasing population, affordability of health care, resource efficiency, food security, climate change and energy shortages."

Professor Nigel Scrutton
Director, Manchester Institute of Biotechnology

Why Manchester?

- We're home to the **Manchester Institute of Biotechnology (MIB)**, one of Europe's leading industry-facing research facilities driving bio-based chemicals synthesis in the UK.
- A hub for **EU- and industry-funded** programmes, we have a strong track record of forging **industry and stakeholder collaborations** in the fine chemicals sectors, including work with GlaxoSmithKline, Shell and Pfizer.
- Our flagship **€26.4 million** CHEM21 project brings together six pharmaceutical companies, 13 universities and four SMEs from across Europe.
- **52** lead MIB investigators collaborate with many more colleagues across the University, while **30%** of MIB's research portfolio involves overseas partners.
- We lead **four** national Biotechnology and Biological Sciences Research Council networks in Industrial Biotechnology and Bioenergy.

Global challenges

Industrial biotechnology

The chemical industry is the UK's largest manufacturing sector, worth **£50 billion** in exports every year.[1]

Hepatitis C affects approximately **150 million** people worldwide.[2]

150m

Pravastatin, a leading drug that lowers cholesterol levels in order to decrease the risk of **cardiovascular disease**, is currently produced via a costly dual-step fermentation and biotransformation process.

Around **20 million tonnes** of propane gas is extracted each year to fuel motor vehicles across the globe.[3]

Industry accounts for nearly **two-thirds** of EU chemical consumption.[4]

[1] Chemical Industries Association
[2] The World Health Organization
[3] World LP Gas Association
[4] The European Chemical Industry Council

Manchester solutions

Our **£10.2 million** SYNBIOCHEM centre is developing new products and methods for drug discovery and production, focusing on new antibiotics and agricultural chemicals, as well as new materials for sustainable manufacturing.

We've helped to devise an efficient synthesis of **telaprevir**, ensuring that this leading medicine in the treatment of hepatitis C will become more **widely available** and **affordable**.

We've helped to create a **synthetic pathway** for biosynthesising propane gas, bringing us one step closer to the commercial production of **renewable propane**.

We're developing **faster and greener** routes to fine and speciality chemical production, partnering with GlaxoSmithKline to engineer bacterial strains to produce flavours and fragrances, enhancing their market value and **reducing the environmental impact** associated with traditional chemical synthesis.

We've developed a superior biocatalyst that will allow **efficient**, **industrial-scale production** of pravastatin.

Advanced materials

Cancer

Energy

Global inequalities

Industrial biotechnology

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