Catalysing innovation: Protecting and strengthening the contribution of Chemical Engineering to the UK

What is Chemical Engineering?

Chemical engineers are problem solvers, often working with substances reacting or changing state on an industrial scale. They are experts in scaling things up. A chemist or biologist may discover a promising new compound in a lab, but it is the chemical engineer who figures out how to make it in the quantities needed to actually put it to use, and who makes that production happen safely, efficiently and sustainably. Chemical engineers can be found designing large scale industrial plants, and processes to treat – or make use of – waste or hazardous materials of various kinds. They work with things like pipelines, distillation columns, reactors, sensors, storage tanks and electrochemical cells. They can also be found applying their unique ways of thinking in a wide range of other environments.

Because chemicals are involved in so many areas of life, this is an extremely broad field, covering manufacturing, energy, food production, pharma, healthcare, sustainability and beyond. Chemical engineers address global challenges such as accelerating the transition to Net Zero, smart and sustainable manufacturing of tomorrow's products at scale, and food and water security in a rapidly changing world. They design complex processes that add significant economic value - such as manufacturing facilities for chemicals, or water treatment plants - and often involve serious hazards, uncertainties and tight regulatory constraints. Chemical engineering is inherently multidisciplinary, involving the application of expertise in physical sciences, mathematical modelling, working with large datasets, and engineering design in addition to knowledge of safety, economics, and sustainability.

To ensure that chemical engineering can continue to contribute to the UK, we call on the government to:

- publicly recognise the pivotal role of chemical and process engineers - and chemical and process engineering - in achieving a sustainable world;
- designate chemical and process engineering as subjects of national strategic importance, alongside explicit references to chemical and process engineering in relevant discussions, documents, and legislation;
- prioritise funding research into key chemical and process engineering-related topics, and for this funding to reflect to the full economic costs of generating that research;

- support the UK chemical engineering research sector to attract and retain the best UK and international talent
- prioritise chemical and process engineering education and training at all levels

Chemical Engineering in the UK

The UK has historically been at the forefront of chemical engineering, with a strong record of innovation dating back to the Industrial Revolution. The UK enjoys a comparative and competitive advantage in the field, with world-leading research,[i] industrial innovation, well established clusters of industrial activity, and access to the skills and cutting-edge technology needed to drive growth and address the key issues of the day. However, for us to continue to enjoy these benefits, investment to protect the UK's position is required.

Chemical engineering plays a vital role in the UK economy. Chemical processing is central to the production of about 95% of all manufactured goods.[ii] Chemical engineers provide vital input to a range of industries including pharmaceuticals, food, construction, waste collection, treatment, disposal and materials recovery power generation, transport services, agriculture and biotechnology. For example: the energy sector supply chain contributes £176bn annually to the UK economy[iii] and the chemicals sector £30bn, alongside employing 140,000 people.[iv] Chemical engineering is predicted to continue to create new jobs in the future at a faster rate than both the broader economy and engineering in general.[v]

Research in chemical engineering is a vibrant field of activity across the UK, and an area of comparative advantage, supporting the economy and showcasing the UK's ability to address critical challenges. There are 53 UK universities with chemical engineering departments and three of the top ten institutions in the world for chemical engineering are in the UK.[vi] This strong capability positions the UK at the forefront of exciting new research, developing new technologies, spinning out new startups and boosting our soft power as a leading voice in this field.

Chemical engineering is crucial to numerous key domestic and international agendas, including the UK Government's missions. Chemical engineering contributes directly to:

- **Transitioning the UK to green energy by 2030 -** making Britain a clean energy superpower and accelerating to net zero requires large scale chemical engineering input, ranging from finding ways to replace fossil fuels with renewable and climate-neutral alternatives to designing and implementing battery systems to allow us to harness power from intermittent sources such as wind and solar**.**
- **Realising the Government's aim of securing the highest sustained growth in the G7** requires widespread input from chemical engineers including cutting edge innovation in sectors including engineering biology, pharmaceuticals and water treatment.

Chemical engineering research case study: Tackling harmful algal blooms[vii]

Harmful algal blooms are overgrowths of algae in water caused by excess nutrient supply, which affect drinking water supplies, agriculture, fishing, recreation and tourism. They are more common across the world as temperatures rise, and there is a growing need for ways to clean them up that are cost-effective and environmentally friendly.

Researchers at Nottingham Trent University developed innovative ways to clean up these blooms, with chemical engineering playing a central role. Their approach employs modified local soil to remove algae, improve water quality, clean up polluted sediment, and turn the excess harmful nutrients into resources for aquatic ecological restoration and biodiversity conservation. This technology has already seen successful commercial application, including cleaning large lakes in China.

Threats and challenges

The UK's position of relative advantage in chemical engineering is under threat, and with it, its ability to help deliver the Government's priorities. This threat is driven both by competition from other countries strategically investing in their STEM capacity, and by a shift towards new industries and areas of innovation such as green energy, which both present vital new opportunities for the UK, but also possibilities for other countries to pull ahead. Given how central chemical engineering will be to addressing the Government's priorities, this threat to the UK's chemical engineering capability could have serious consequences.

The UK chemical engineering workforce is highly skilled and productive, but not large or diverse enough to meet our current or future needs. Without sufficient people in chemical engineering roles, the UK will not achieve its ambitions for growth or clean energy and will miss out on the full benefits that work in this field can bring – to individuals, the country and globally. Like other engineering disciplines, chemical engineering has a shortage of available talent to fill current job opportunities, and an additional challenge on the horizon as a significant proportion of the current workforce reaches retirement age.[viii] There has been significant progress in encouraging more people to train and work in this area over the last few years, and to draw on a wider, more diverse pool of talent, [ix] but more progress is needed.

The strong position of UK chemical engineering research is under threat from external competitors and internal pressures. Chemical engineering is not immune to the general challenges experienced by UK universities - including their financial situation, with funding per student at its lowest level in more than 25 years,[x] and the fact that "[p]ublicly funded teaching and research make a loss across the sector once the full economic costs of those activities are taken into account."[xi] The UK chemical engineering research sector is in a global battle for talent, and to stay at the cutting edge, the UK must continue to be an attractive place for the best international talent to come and work.

Chemical engineering research case study: Transforming cassava to improve livelihoods in sub-Saharan Africa

Cassava is a tropical root crop and a staple food critical to the lives and livelihoods of around 450 million people in Africa. The value of this crop is limited by many factors including the fact that it typically perishes in 48 hours and contains naturally occurring forms of cyanide. There is also inadequate processing technology and a lack of developed market opportunities.[xii]

Long-term research at the Natural Resources Institute aimed to improve the way cassava is harvested and processed and taken to market, making it better able to support the people who depend on it. Chemical engineering has been a critical part of this work, helping solve problems such as how to dry the cassava in a way that minimises energy use and avoids problems with mould and mycotoxins, and how to turn the perishable casava roots into shelf-stable products more effectively.

The project has had a significant impact, with increased tonnages of cassava roots mobilised and gross income from its sale and processing increasing more than tenfold.

Maximising the future value of chemical engineering to the UK

Chemical engineering has a crucial role to play in contributing to the UK economy, society and the success of the Government's missions. To ensure that chemical engineering can continue to contribute to the UK, we call on the government to:

- publicly recognise the pivotal role of chemical and process engineers - and chemical and process engineering - in achieving a sustainable world;
- designate chemical and process engineering as subjects of national strategic importance, alongside explicit references to chemical and process engineering in relevant discussions, documents, and legislation;
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Chemical engineering research case study: Using microwaves to mine copper more productively and energy efficiently. [xiii]

Minerals such as copper are critical for a wide range of products and global demand continues to increase, yet the extraction of these materials has a significant environmental impact. It is therefore crucial to develop better mining technologies.

Research at the University of Nottingham has focused on developing a new way to extract copper, using a new process based on microwave technology. This new technology heats and expands the copper grains, causing them to split from the encasing rock. The resulting microfractures weaken the host rock and make it possible to extract the copper without completely grinding the ore. This reduces copper extraction energy consumption by over 20% whilst increasing production by almost a third. This technology has currently been demonstrated in a system processing over 150 tonnes of rock per hour.

About IChemE

The Institution of Chemical Engineers (IChemE) is the qualifying body and learned society for chemical, biochemical, and process engineers in the UK and worldwide, with over 30,000 members. Our mission is to champion the input of chemical engineers to create a sustainable future. We are the only organisation permitted to award Chartered Chemical Engineer status and Professional Process Safety Engineer registration.

Find out more about IChemE and our strategic vision of Engineering a Sustainable World at icheme.org

About HCEUK

Heads of Chemical Engineering UK (HCEUK) is an independent body established in 2015 to facilitate channels of communication between key chemical engineering stakeholder groups across universities and higher education establishments, so furthering the interests of chemical engineering in higher education teaching and research.

Working closely with IChemE, in particular the Education Special Interest Group and Research and Innovation Community of Practice, HCEUK has over 30 members including heads of chemical engineering schools, departments and divisions at universities, as well as those representing the interests of those engaged in chemical engineering education, scholarships and research.

IChemE /Heads of Chemical Engineering UK
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[i] For instance, Three of the top ten institutions in the world for chemical engineering are in the UK https://www.topuniversities.com/university-subject-rankings/chemical-engineering

[ii] https://www.cia.org.uk/Portals/0/Chemical%20Strategy%20-%20CIA%20Position_Final2.pdf

[iii] See https://www.energy-uk.org.uk/

[iv] See https://cefic.org/a-pillar-of-the-european-economy/landscape-of-the-european-chemical-industry/united-kindgom/

[v] https://www.engineeringuk.com/media/318944/engineering-skills-needs-now-and-into-the-future_report_fv.pdf

[vi] https://www.topuniversities.com/university-subject-rankings/chemical-engineering

[vii] See https://www.ntu.ac.uk/research/groups-and-centres/groups/natural-environment2#:~:text=Emeritus%20Professor%20Gang%20Pan%20and,resources%20for%20aquatic%20ecological%20restoration and https://results2021.ref.ac.uk/impact/c30b010a-2c3c-4db4-98f5-c50fea66b4a2?page=1

[viii] See, for instance, https://www.thechemicalengineer.com/features/sleepwalking-towards-a-net-zero-skills-shortage/ and https://www.engineeringuk.com/media/wlob5doo/net-zero-workforce-2023-11-02.pdf

[ix] See, for instance, https://www.icheme.org/media/8893/social-mobility-in-uk-chemical-engineering-report-2018-final.pdf or, for data on chemical engineering students see https://www.engineeringuk.com/research-policy/educational-pathways-into-engineering/higher-education and https://www.engineeringuk.com/media/318867/engineering-in-higher-education_chem_euk_march23.pdf . For engineering education statistics more generally, see https://www.ciip.group.cam.ac.uk/innovation/science-and-engineering-workforce-2/

[x] PWC (2024), UK Higher Education Financial Sustainability Report, available at https://www.universitiesuk.ac.uk/sites/default/files/field/downloads/2024-01/pwc-uk-higher-education-financial-sustainability-report-january-2024.pdf

[xi] House of Commons Public Accounts Committee (2022). Financial sustainability of the higher education sector in England. https://committees.parliament.uk/publications/22593/documents/166272/default/

[xii] See https://nri.org/impact/case-studies/transforming-cassava-to-improve-livelihoods-in-sub-saharan-africa and https://results2021.ref.ac.uk/impact/410319a1-45ba-4c92-973c-dfbf23ccc286?page=1https://results2021.ref.ac.uk/impact/c30b010a-2c3c-4db4-98f5-c50fea66b4a2?page=1

[xiii] See https://www.nottingham.ac.uk/engineering/research/impact/research-impact-success-stories/microhammer.aspx