National Engineering Policy Centre

Royal Academy of Engineering

Invest 2035: The UK's Modern Industrial Strategy
The National Engineering Policy Centre's response
November 2024

Methodology

1. How should the UK government identify the most important subsectors for delivering our objectives?

2. How should the UK government account for emerging sectors and technologies for which conventional data sources are less appropriate?

2.1. Engineering is pivotal in the UK's emerging economy, with engineering accounting for the majority of businesses in 80% of the UK's emerging economic sectors, such as quantum and space[1].

2.2. Technology prioritisation necessitates a rigorous research and analysis procedure. Businesses have become increasingly adept at undertaking granular analysis and the UK government should learn from their methods and approaches through collaboration with industrial partners[2].

2.3. An effective analysis procedure should be undertaken with detailed consideration of international competition and collaboration, assessing how other countries and stakeholders are competing to occupy technology spaces. The UK does not operate in isolation; it is fundamental to monitor and understand the actions of international stakeholders and identify areas of economic or security-related comparative advantage. The UK is vulnerable to falling behind in science and technology intelligence gathering and needs to improve its capabilities in this area[3].

2.4. Extensive stakeholder engagement, collaboration from industry, and cross-government input is necessary to provide real-world context and address data gaps. Well-connected communities that form around a technology can help identify the needs of different stakeholders, in addition to opportunities and practical considerations for action. They can also be rapidly mobilised when needed. A 'connect-and-convene' approach that engenders a sense of ownership and commitment among all those involved is preferable to a 'command and control' approach[4].

2.5. To make the most of emerging opportunities, address new threats, effectively deploy resources, operate at timescales that work for business, and compete globally, the UK needs to be able to act at pace, recognise the need to fail fast and modify priorities when

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[1] Engineering Economy and Place, Royal Academy of Engineering, 2023
[2] Critical technologies: past and future, Royal Academy of Engineering and The Foundation for Science and Technology, 2024
[3] Critical technologies: past and future, Royal Academy of Engineering and The Foundation for Science and Technology, 2024
[4] Strategic advantage through science and technology: the engineering view, Royal Academy of Engineering, 2023

needed. Expertise is required to assess whether and when changes are needed, so that any changes in direction are informed decisions[5].

3. How should the UK government incorporate foundational sectors and value chains into this analysis?

3.1. It is essential that foundational sectors and value chains are incorporated into the Industrial Strategy's analysis. A broad definition of 'foundational sectors' should be taken, including, but also going beyond, the common and increasingly out-dated definition for foundation industries: glass, cement, metals, paper, chemicals and ceramics. Foundational sectors that provide the critical inputs essential to growth driving sectors will be varied, are likely to be reliant on engineering, are likely to have overlaps and interdependencies, and may be critical to multiple growth-driving sectors. Examples include essential resources such as critical minerals and water; and essential products such as lasers and batteries. Some of these foundational sectors may warrant their own subsector plans, given their own contribution to the UK's comparative advantage. Please see the responses from NEPC partners the Institution of Chemical Engineers for detail on the chemicals sector and IOM3 (Institute of Materials, Minerals and Mining) for more on materials, minerals and mining.

3.2. Businesses have become increasingly adept at undertaking granular analysis of supply and value chains, and the UK government should learn from their methods and approaches through collaboration with industrial partners[6].

3.3. National security and resilience concerns should become integral drivers in the foundational sector prioritisation process, with technologies and sectors that provide improvements in sovereign capability weighted appropriately, despite potentially lower commercial opportunity. Improvements in the resilience of energy supplies and critical minerals in the UK are becoming increasingly important[7].

3.4. A cross-government materials strategy should be developed[8]. Materials are critical to many foundation and growth-driving sectors. The UK is economically and physically dependent on many materials that are mined elsewhere, and specific technological components that are not made here. Projected demands for critical materials are likely to outstrip available supplies. This poses a risk to the resilience of the UK; if material demand significantly exceeds supply, it would interfere with not only economic prosperity but also the capacity of the UK to achieve the infrastructure transformation required to reach net zero. The need to build large amounts of renewable energy technologies, in line with the Clean Energy Industries growth-driving sector, is among the major drivers of the forecast increase in demand of critical materials, though other growth-driving sectors are also drivers of demand, especially Digital and Technologies.

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[5] Strategic advantage through science and technology: the engineering view, Royal Academy of Engineering, 2023
[6] Critical technologies: past and future, Royal Academy of Engineering and The Foundation for Science and Technology, 2024
[7] Critical technologies: past and future, Royal Academy of Engineering and The Foundation for Science and Technology, 2024
[8] Critical materials: demand-side resource efficiency measures for sustainability and resilience, National Engineering Policy Centre, 2024

3.5. The materials strategy should sit across infrastructure planning, design regulation, market regulation, industrial strategy, trade policy, and recycling and waste policy. It should align these policy areas towards strategic goals such as reducing dependency on critical materials and reducing embodied carbon, as well as being integrated with the net zero strategy.

3.6. Alternative technologies for reducing critical material use are an area for potential economic growth in the UK. One such opportunity is sodium-ion batteries. Targeted research funding, supporting facilities to test manufacturing processes, sponsoring standards production, and building connections to industry to ensure take-up, would be needed. Material innovation is another potential growth opportunity. The UK has a strong materials research base, with advanced skills and R&D capabilities. However, it is often difficult for new materials to be taken up by industry. The UK risks falling behind international communities such as the EU and US, who have begun initiatives to support this, such as the EU's Critical Raw Materials Innovation Network, and US grants in this area. There may also be opportunities for the UK to lead in developing UK and international capacity for recycling critical material intensive products, in particular wind turbines and batteries, reducing dependence on existing supply chains and providing domestic sources of critical materials. For more details see Critical materials: demand-side resource efficiency measures for sustainability and resilience[9].

Growth-driving sectors

4. What are the most important subsectors and technologies that the UK government should focus on and why?

4.1. A successful Industrial Strategy depends on setting a strategic direction, developed in partnership with industry. It should make informed choices about the outcomes and advantages the UK wishes to achieve by harnessing engineering, including both established and disruptive technologies, supported by a plan for development, delivery and adoption, and the resources to realise that plan. Therefore, we welcome the identification of growth-driving sectors, efforts to identify priority subsectors and intention to create subsector plans[10].

4.2. Engineering and engineers are pivotal to shaping and achieving the ambitions set out in *Invest 2035*. Engineers comprise 19% of jobs nationally[11] and the engineering economy represent 32% of total national economic output[12]. Engineering traverses the modern economy, and engineers are involved in almost every economic sector, including the growth-driving sectors identified.

4.3. **Advanced Manufacturing –** We welcome the recognition that the has broad strengths in advanced manufacturing built on innovation expertise. Engineers are central to delivering and revolutionising the manufacturing sector, using cutting-edge

[9] Critical materials: demand-side resource efficiency measures for sustainability and resilience, National Engineering Policy Centre, 2024
[10] Engineering a resilience and prosperous future, National Engineering Policy Centre, 2024
[11] Engineering Footprint, Update March 2024, Engineering UK, Engineering Council, Royal Academy of Engineering, 2024
[12] Engineering Economy and Place, Royal Academy of Engineering, 2023

technologies to adapt processes and improve efficiencies. EngineeringUK reported that around 36% of people working in engineering in the UK in 2021 worked in manufacturing[13]. Aerospace, and the advanced manufacturing that underpins emerging technologies such as materials, integrated photonics and optics, cryogenics systems, characterisation and metrology all warrant focus.

4.4. **Clean Energy Industries** - The decarbonisation of the energy and power industry will rely on engineering solutions, both new (e.g. low-carbon air travel) and existing (e.g. solar and wind power). Renewable energy and cleantech should be areas of focus, and should include transmission and distribution infrastructure. Developing wind, solar, and nuclear, including emerging areas like floating offshore wind, is vital for a clean power system. Floating offshore wind, though not yet commercial, has significant potential. Nuclear fusion, while a longer-term possibility, should be monitored and backed as appropriate. Energy storage technologies are fundamental to a low-carbon system, providing the balance needed to manage supply fluctuations from renewables, and should thus also be an area of focus.

4.5. **Creative industries** – Engineering contributes to the creative industries through technological advances like AI in areas such as gaming and film production, design-led engineering and conservation, bringing architecture to life, and in major art installations[14].

4.6. **Defence -** Engineers help the UK maintain its technological and operational edge in the defence sector through innovation. A 2023 survey revealed that engineering skills are the most common skills shortage areas for defence firms, with 48% of the defence sector organisations that participated experiencing a shortage of engineer skills, 33% for cyber and digital skills, 25% for manufacturing and mechanical skills and 20% for artificial intelligence skills[15].

4.7. **Digital and Technologies** – The digital sector cuts across all the other growth-driving sectors, and, like other technologies, it depends heavily on engineering. Comparative advantage should continue to be pursued in the five critical technologies, identified and supported by the previous government: AI, Engineering Biology, Future Telecommunications, Quantum and Semiconductors.

4.8. **Financial services** – Financial services are enabled by digital information and technology like AI, data and software to support financial modelling and forecasting, management and planning. Many engineering graduates also end up working in the finance sector as they have both the technical and problem-solving skills required—6.22% in 2018[16].

4.9. **Life Sciences** – Engineering underpins and is vital to innovation in life sciences, from medical devices and diagnostics, to biomanufacturing; and leading-edge life sciences advances such as regenerative medicine and engineering biology.

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[13] Trends in the engineering workforce, EngineeringUK, 2022
[14] Harnessing Research and Development in the UK Creative Industries, Council for Science and Technology, 2023
[15] Delivering the Defence Workforce of the Future, Defence Online and guidant global, 2023
[16] The Supply & Demand for Engineering in the UK, ECITB, 2018

4.10. **Professional and business services** –Innovation and improvement in the professional and business services sector such as new data or management systems, automation and the use of AI, relies on engineers.

4.11. Given the overlaps and interdependencies across the growth-driving sectors, the emerging sectors and technologies, and the foundational sectors, a systems approach must be taken to understand the interdependencies between different parts of the strategy, in order to identify both fragilities and opportunities to aggregate value and reinforce outcomes.

4.12. It is essential to recognise the role engineering plays in providing the critical infrastructure, and ensuring its resilience, for all of these sectors. Transport, including maritime, water, utilities and the built environment play a pivotal role in enabling growth across the UK while reaching net zero. Consideration of any sector should include how it is served by these essential services, as neglect of these engineered systems will be a detriment to growth. The 10-year Infrastructure Strategy, driving the delivery of sustainable economic infrastructure including transport, electricity, telecoms, water and wastewater will provide clarity and continuity, important for crowding-in investment. The Industrial Strategy should go beyond a parliamentary term to support future infrastructure assets.

4.13. The National Engineering Policy Centre (NEPC) is a partnership of 42 professional engineering organisations that cover the breadth and depth of our profession, led by the Royal Academy of Engineering. Together we provide insights, advice, and practical policy recommendations on complex national and global challenges. This NEPC response primarily focusses on cross-cutting engineering issues. Please refer to the individual responses of the NEPC's partners for detailed information on subsectors and technologies, including the partners: BCS (The Chartered Institute for IT), CIHT (Chartered Institution of Highways and Transportation), Institution of Chemical Engineers, IET (The Institution of Engineering and Technology); Institution of Mechanical Engineers; IOM3 (Institute of Materials, Minerals and Mining); and The PWI (Permanent Way Institution).

5. What are the UK's strengths and capabilities in these subsectors?

5.1. **Advanced Manufacturing – Aerospace.** The UK excels in advanced manufacturing, including composite materials, additive manufacturing (3D printing), and precision engineering, as well as aerospace propulsion and avionics, with an established R&D ecosystem driving innovation in sustainable aviation and digital technologies. The UK has a long-standing and globally recognised position in the aerospace industry. The UK plays a leading role in the global supply chain, with significant exports. A highly skilled workforce and robust regulatory framework are a further boost to the aerospace sector. In addition, the UK has strengths in the space sector, especially in small satellite manufacturing, with Glasgow building more small satellites than any other place in Europe[17]. The UK contributes to international space missions and has a robust space

[17] Manufacturing, Scottish Government, accessed November 2024

science community. See NEPC partner, the Royal Aeronautical Society's position paper for the UK government, 2024 for more detail[18].

5.2. **Advanced Manufacturing – for emerging technologies**. The UK has a vibrant and diverse manufacturing capability relevant to emerging technologies, especially quantum. These capabilities are across materials (including composites, optics, metamaterials, and chemicals), integrated photonics and optics (including 1,500 photonics companies making up about 20% of Europe's total), cryogenics systems (e.g. The National Physical Laboratory) and nanofabrication facilities (e.g. Kelvin Nanotechnology and James Watt Nanofabrication Centre, IQE, and Cornerstone)[19]. This manufacturing capability can be supported by advanced technologies such as automation, robotics, and digital manufacturing.

5.3. **Clean Energy Industries.** In renewable energy and cleantech the UK is a global leader in offshore wind, especially fixed-base offshore wind, with advanced expertise in both technology development and deployment. Floating offshore wind, though not yet commercial, has significant potential but will require financing, infrastructure, and risk management support to achieve scalability. The UK has extensive expertise in battery storage and in hydrogen production and storage, positioning the UK to support daily and seasonal storage needs as well as industrial decarbonisation.

5.4. **Digital and Technologies - Artificial Intelligence (AI).** AI represents a major opportunity for deep tech development in the UK. The UK has great strengths in AI research, spinouts, startups and scale-ups. There are more than 500 AI-based companies established in the UK, with widespread application in industries such as drug discovery and manufacturing[20]. AI companies also feature highly in the UK's spinout ecosystem, based on a bedrock of significant strength in AI within our universities[21]. UK spinouts are crucial to improving economic growth and they play a pivotal role in helping to solve some of the most pressing challenges we face. The UK will realise the greatest benefits by focusing on solving real world problems, for example optimising use of our infrastructure, manging NHS operations, increasing energy efficiency of industrial processes and improving productivity in the financial services sector.

5.5. **Digital and Technologies – Quantum.** The UK has significant strengths across the breadth of quantum technologies, with sustained investment having established a range of quantum enabled capabilities ripe for further exploitation[22].

5.6. **Digital and Technologies - Engineering Biology.** The UK has extensive research strengths in engineering biology, predominantly located in universities and spread across a wide range of disciplines including data science, molecular biology, biomathematics, and control and systems engineering, reflecting that engineering biology is inherently multidisciplinary. The UK is already a world-leader in data science research, and this

[18] Keeping the UK aerospace sector globally connected, sustainable and secure for 2025 and beyond, Royal Aeronautical Society, 2024
[19] Quantum Infrastructure Review, Royal Academy of Engineering, 2024
[20] State of UK Deep Tech, Royal Academy of Engineering and Beauhurst, 2023
[21] Spotlight on Spinouts 2024, Royal Academy of Engineering and Beauhurst, 2024
[22] Quantum Infrastructure Review, Royal Academy of Engineering, 2024

position is integral to progress advances in engineering biology in the UK. The UK is also strong in its engineering biology spinouts and startups.

5.7. We refer to the individual responses of the NEPC's partners for further information on strengths and capabilities of subsectors.

6. What are the key enablers and barriers to growth in these subsectors and how could the UK government address them?

6.1. **Advanced Manufacturing – Aerospace.** Key enablers for UK aerospace growth include R&D, a skilled workforce and a sustainability focus within the aerospace sector, while barriers are high R&D costs, regulatory challenges and supply chain disruptions. Government interventions can support growth by addressing these issues, as well as by investing in infrastructure and skills development. Strategic partnerships and financial incentives can further enhance the UK's competitiveness and resilience.

6.2. **Advanced Manufacturing – for emerging technologies**. Key enablers should include grants for industry, inspired by the Life Sciences Investment Manufacturing Fund, but geared towards the common advanced manufacturing needs of quantum, semiconductors and photonics. Innovation challenges that encourage companies from different sectors to collaborate on projects requiring advanced manufacturing capabilities should be launched, with the aim of developing new manufacturing technologies and solutions with applications across industries. Innovate UK Contracts for Innovation also have an important role, however, current terms for liability and IP can make it difficult for quantum and advanced manufacturing companies to engage in a meaningful way[23].

6.3. **Clean Energy Industries**. Support for cleantech R&D, high value late-stage R&D and early-stage deployment to spur innovation and industry expansion is needed. For low carbon solutions and technologies, there is a need for more physical and digital infrastructure to support late-stage R&D by accelerating and de-risking the testing, certification, development and deployment of new products, processes, services and technologies safely and effectively. Developments such as hydrogen and CCUS will require strategic approaches to transport and storage infrastructure. As highlighted by the National Infrastructure Commission, new networks for low carbon hydrogen and carbon capture will also support a decarbonised economy[24]. In addition to such a network, projects such as HyNet and East Coast Cluster are building hydrogen storage facilities that repurpose existing gas storage sites and explore new underground storage options, such examples highlight the value of preserving gas storage capacity. Please refer to the response by NEPC partner, the Institution of Chemical Engineers for additional information.

6.4. **Digital and Technologies - Artificial Intelligence (AI).** A key barrier is currently access for AI SMEs to core compute and next generation exascale supercomputing facilities, secure encryption, data storage and high-speed broadband internet. This requires

[23] Quantum Infrastructure Review, Royal Academy of Engineering, 2024
[24] Second National Infrastructure Assessment, National Infrastructure Commission, 2023

government investment in compute infrastructure, with a focus on environmentally sustainable compute.

6.5. **Digital and Technologies – Quantum.** Key barriers are the lack of major infrastructure, existing infrastructure not always being fit for industry use, and insufficient advanced manufacturing capabilities. For the UK to grow its quantum industry, more advanced manufacturing capability in the industrial base is needed and existing capabilities need to be upgraded. Infrastructure where quantum industry is a user must meet industry requirements; for existing infrastructure, upgrade programmes should be focused on meeting industry needs. A quantum technology coordination function that provides guidance to industry on navigating the UK's quantum technology landscape and coordinates and facilitates access for industry to infrastructure should be established[25].

6.6. **Digital and Technologies - Engineering Biology.** Key barriers are insufficient support to help companies manage the risks of the translation stage, including late-stage R&D and translational infrastructure. Funding mechanisms such as the Industrial Biotechnology Catalyst, which are targeted at supporting the engineering biology through the translation stage, have often been intermittent, creating uncertainty and impacting the confidence of businesses to participate and invest. This is also an area where government procurement mechanisms can act to reduce risk and provide a source of investment for engineering biology businesses. The government should also support the establishment of facilities to support the translation and testing of technical scaling activities.

6.7. We refer to the individual responses to this consultation submitted by a number of the NEPC's partners for further information on the enablers and barriers to growth in subsectors and how the UK government can address them.

6.8. When developing the Sector Plans, we advise that they align with the following principles[26]:

6.8.1. **Long-term** - setting the strategic direction to deliver the desired economic and social benefits across the UK means planning for the long-term and sticking to that direction. Industrial Strategy is a long-term endeavour. It takes time for new discoveries to be commercialised, for new industries to grow, and for existing industries to adopt new innovations. Harnessing science and technology means taking action now, while returns will not be seen in the immediate future. 'Long term' in this context also means 'beyond five-year political cycles,' longer-term budgets, durable institutions, and stability to enable the research and innovation system to deliver and provide confidence for businesses to thrive.

6.8.2. **Agility and pace** – to make the most of emerging opportunities, address new threats, effectively deploy resources, operate at timescales that work for business, and compete globally, the UK needs to be able to act at pace, recognise the need to fail fast and modify priorities when needed. This may seem paradoxical to the 'long-term' and 'stability' requirement, but it isn't. Agility will be required within long-term strategic direction without compromising the long-term outcome being pursued.

[25] Quantum Infrastructure Review, Royal Academy of Engineering, 2024
[26] Strategic advantage through science and technology: the engineering view, Royal Academy of Engineering, 2023

Expertise is required to assess whether and when changes are needed, so that any changes in direction are informed decisions.

6.8.3. **Leadership and capability** – trusted and capable leadership is needed. Government must own this agenda, ideally with cross-party engagement. Non-political and expert leadership will also be key when it comes to delivery. Leaders will need to be empowered to make decisions at pace, deploy resources, and accept and learn from failure. Leaders need to have a good understanding of their sector domain and excellent access to expertise. A lack of science, engineering and technology capabilities is an ongoing challenge within the UK's civil service and parliament. The Royal Academy of Engineering's Policy Fellowships programme is one means of addressing this gap[27].

6.8.4. **Coherence** - coherent and sustained strategies that align actions across regulation, funding, infrastructure, skills and the government's convening power will be needed. Coherence requires extensive engagement and alignment across central government departments, devolved governments and regional and local institutions, and extensive industry input. Lack of coherence is a weakness of the UK's system – engineers and engineering companies find strategic engagement across UK government organisations frustrating, fragmented and siloed. Given the overlaps and interdependencies across the growth-driving sectors, the emerging sectors and technologies and the foundational sectors, a systems approach must be taken to understand the interdependencies between different parts of the strategy.

6.8.5. **Connections and networks** – well-connected communities across industry, academia and government, around a technology or goal can help identify the needs of different stakeholders, opportunities and practical considerations for action. These can then be rapidly mobilised. Communities provide consistent access to expertise and experience to support informed decision-making. These interfaces should be relatively permeable, and the networks and organisations that provide a bridging capability, such as public sector research establishments and catapult centres, must be optimised. A 'connect-and-convene' approach that engenders a sense of ownership and commitment among those all involved is preferable to a 'command and control' approach.

6.8.6. **Build on what already exists** - given the limited resources available, it is crucial that the industrial strategy assimilates and builds on existing successful initiatives, institutions, and infrastructures. It must coordinate and align with other interconnected strategies and government objectives.

6.9. There are cross-cutting barriers and enablers for all the growth-driving sectors and subsectors. These are addressed throughout the rest of this response, either because the Green Paper has already identified them, such as People & Skills (questions 8 & 9), Scale-up finance (questions 22 & 23) and Regulation (questions 18-20), or because we cover them in more detail in response of other questions: such as late-stage R&D (questions 8, 11 and 22), R&D infrastructures (questions 8, 11 and 22) and procurement (questions 8 and 22).

[27] https://raeng.org.uk/policyfellowships

6.10. Given the dependence of the growth-driving sectors, as well as the emerging sectors and technologies, and the foundational sectors on engineers, ensuring the provision of the right number of adequately trained people will be a significant enabler to the success of the Industrial Strategy. However, it is currently at risk of being a barrier. More engineers with a broader range of expertise, from environmental awareness to greater data skills, are needed. Yet the UK already faces an engineering skills shortage and demand is expected to rise over the next decade. With a quarter of all UK job postings in engineering and technology roles[28]. A holistic plan that covers all routes into engineering and lifelong learning is required. Skills shortages will continue to evolve, and it is crucial to have an education and careers system that responds to changing labour-market needs. Therefore, the NEPC has called for a National Engineering and Workforce Strategy to equip the UK with the skilled workforce needed to meet the challenges of sustainability and technological advancement. This must deliver a long-term holistic plan encompassing all education stages, including reskilling and upskilling, to deliver a diverse engineering profession equipped for the future.

Pro-business environment

7. What are the most significant barriers to investment? Do they vary across the growth-driving sectors?

7.1. We welcome that the Industrial Strategy is seeking to address one of the biggest barriers to investment - lack of certainty by providing policy stability.

7.2. Many of the policy areas identified in the Green Paper as barriers to investment are relevant to the growth-driving sectors underpinned by engineering and engineers:

7.2.1. **People and skills** - The growth-driving sectors, the emerging sectors and technologies, and the foundational sectors depend on engineers. Ensuring that there are sufficient appropriately trained people within these sectors, will be a significant enabler of the Industrial Strategy. Currently however, there are insufficient numbers of such people, placing the success of the Strategy at risk. Global challenges and opportunities such as the climate emergency and the rapid progress of AI and emerging digital technologies are also placing greater demands on engineers. These issues require engineers to possess a broader range of expertise. Yet the UK has an engineering skills shortage. Frequent changes to education and skills policy have made it harder for employers to plan and invest in staff and their development. Leaving employers unsure of what qualifications or apprenticeships to invest in. Recent changes to student visas only further exacerbate the UK's engineering skills shortage now and over the coming decade. The UK's visa system needs to contain within it the flexibility to attract and retain global talent which fills the skills and knowledge gaps in the growth-driving sectors. This flexibility could be provided within the context of agreements that enable investment in key markets and global projects as well as mutual recognition of professional qualifications. With a quarter of all job postings in engineering roles, a holistic plan that covers all routes

[28] Engineering Skills Needs – Now and into the Future, Engineering UK, 2023

into engineering, industry investment in skills, lifelong learning and a visa system that recruits global talent to fill shortage areas is required.

7.2.2. **Innovation** – Engineering research and innovation is a strength of the UK, and it is critical to the flourishing of the growth-driving sectors as well as many of the emerging sectors and technologies, and the foundational sectors. Government has a pivotal role to play in stimulating innovation. While innovation offers many potential benefits at the level of an individual firm, government support is often essential to encourage companies to engage in innovation. This is because innovation is an inherently risky process with an uncertain outcome. The benefits may only materialise over very long timescales and the innovator often accrues only a small proportion of the overall benefit generated. Key barriers and enablers include:

7.2.2.1. **Late-stage R&D** is a key part of the innovation process and accounts for the majority of R&D that businesses do. It comprises the activities required to take a proof of concept or prototype through to commercial application, ultimately delivering new products, processes, technologies and services to market. Many businesses choose global locations for these high value late-stage R&D activities, from multinationals with multiple R&D sites to mobile innovative SMEs with growth ambitions. But existing UK support for late-stage R&D is not meeting businesses' needs, and is considered poor compared to competitor countries[29] . There is a choice to be made – enable companies to take bold risks in the UK, or they will go elsewhere. Solutions are further explored in our response to question 11.

7.2.2.2. **R&D infrastructure** can facilitate and accelerate R&D commercialisation by providing facilities to support translation, integration and rigorous testing to meet performance, safety and reliability standards, as well as demonstration in real-world environments with potential users. The infrastructure to achieve this can be prohibitively expensive for a company to invest in alone. Increasing the provision of high-quality open-access infrastructure for scale-up and commercialisation in priority subsectors should be considered. While the UK does have some open-access infrastructure, more needs to be done to ensure this is fit for purpose for use by industry, in terms of availability, accessibility, affordability, compatibility with industrial and commercial standards and processes, and is staffed by skilled personnel.

7.3. **Energy and Infrastructure.** Sustainable, effective, and efficient transport has a critical role in driving a sustainable and growing economy. The ineffectiveness of significant elements of the UK's transport networks and their relative saturation is an important factor in the lack of vibrancy and robustness in the UK economy. Please see responses from individual NEPC partners for more detail on how transport can support the aims of the Industrial Strategy, particularly the responses from The PWI (Permanent Way Institution) and CIHT (Chartered Institution of Highways and Transportation). Another vital infrastructure sector is maritime, which has cross-cutting significance in energy, trade, and innovation, in particular clean energy (offshore wind) and advanced manufacturing (shipbuilding and marine technology). For the government to be able to

[29] Increasing R&D investment: business perspectives, Royal Academy of Engineering, 2018

provide the infrastructure that the public needs, actors need to believe that their commitment is stable. There must be pre-specified time limits on programmes that are part of the Industrial Strategy to ensure projects happen on time. A secure pipeline and more certainty are needed for this to be possible, as well as the implementation of the Construction Playbook to improve procurement and faster infrastructure delivery. Please see the response from NEPC partner ICE (Institution of Civil Engineers) the more on policy stability for successful infrastructure and construction.

7.4. **Crowding-in investment.** Government has a key role in leveraging private sector investment[30]. Key enablers and barriers include:

7.4.1. **Public procurement** has the potential to have a transformative effect on companies' investment in R&D in the UK. It provides a huge opportunity to stimulate innovation. However, engineering companies have found that decisions on public procurement prioritise low cost over best value, and risk aversion hinders the introduction of innovative solutions. If public procurement processes discourage R&D and innovation, it can push businesses to move those activities to other more receptive countries. Solutions are further explored in our response to question 22.

7.4.2. **Scale-up finance** remains a challenge in the UK, despite being third in the world for VC investment, the UK is proportionally weak at scale-up, particularly in comparison to the US. This is especially a concern for 'deep tech' companies, for whom the most common scaling challenges are felt more acutely. This is further explored in question 22.

7.4.3. **Coherence** - Engineering companies find strategic engagement across UK government organisations frustrating, fragmented, and siloed. This makes the UK less attractive for businesses to invest in[31].

7.4.4. **Working with the NHS** can be a real challenge. The NHS does a good job proving and demonstrating technologies, but it remains a challenge to implement new technologies across the NHS. More can be done to scale successful innovation within the NHS.

People & Skills

8. Where you identified barriers in response to Question 7 which relate to people and skills, what UK government policy solutions could best address these?

8.1. The UK's need for a workforce with the skills that better match industry needs has been well established. We know that skill-shortage vacancies have been increasing in recent times and could now account for over one-third of all job vacancies[32]. The engineering sector is especially affected by a skills shortage, but this major need for skills also presents a significant opportunity in terms of providing quality work across the UK. It is

[30] Increasing R&D investment: business perspectives, Royal Academy of Engineering, 2018
[31] Increasing R&D investment: business perspectives, Royal Academy of Engineering, 2018
[32] Employer Skills Survey 2022, IFF Research, Government Social Research, 2023

estimated that there will be 173,000 additional jobs in engineering and technology by 2030[33].

8.2. The government should deliver a National Engineering and Technology Workforce Strategy. The Strategy should aim to equip the UK with the skilled workforce needed to meet the challenges of sustainability and technological advancement. It should deliver a long-term holistic plan encompassing all education stages, including reskilling and upskilling, to deliver a diverse engineering profession equipped for the future.

8.3. There are a range of issues that industry and employers confront when trying to recruit people with the right set of skills for their business. Most common among these are work experience, basic educational knowledge for example GCSE/National 5 maths and English, and vocational qualifications. The UK government is currently consulting on potential reforms to England's curriculum and assessment processes, and post-16 qualifications options in England, to which we have provided a separate response regarding ways that new policy could boost the take-up of engineering and technology skills training among students. Here however, we address industry's role in the provision of work experience and work placement and apprenticeships.

8.4. **Work experience**. Work experience provides a young student with valuable insights into the world of work, what career opportunities are available to them, and better informs the choices they make in subject selections. This, in turn, will set them up to more easily pursue their career aspirations. The Gatsby Benchmarks of Good Career Guidance[34], benchmark five, set recommendations for employer engagement with schools and colleges. This benchmark supports the need for at least one meaningful encounter with an employer per year, from age of 11. This is critically important in ensuring students get experiences in what a career in STEM can be. Unfortunately, this kind of meaningful engagement with industry is not comparative across the UK. A recent report by Engineering UK highlighted that 'only 59% of respondents to their survey agreed that their school engages with employers annually, and specifically with STEM employers'[35]. This low engagement is also apparent in the type and length of work experience, which is not always available to the students that need or want it. Approximately one-quarter of students find themselves in such a position[36].

8.5. Benchmark six of the Gatsby Benchmarks sets out the contextual need of work experience for young people in the education sector. According to the Careers & Enterprise Company data for 2023/24, 72%of institutions fully achieved Benchmark 6 (experiences of workplaces). Within this, 76%of schools reported the majority of students had workplace experiences by the end of Year 11, and 84%by the end of Year 13[37]. Students themselves also require greater encouragement to participate in work experience when it is available to them. Many are worried about entering a workplace for the first time, however around one-third find the costs associated with work experience prohibiting[38].

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[33] Engineering Skills Needs – Now and into the Future, Engineering UK, 2023
[34] Good Career Guidance, Gatsby, 2024
[35] Advancing STEM careers provision in England: Key lessons and opportunities, EngineeringUK, 2024
[36] Work experience and related activities in schools and colleges, NatCen Social Research and SQW, 2017
[37] Gatsby Benchmark results for 2023/24, The Careers & Enterprise Company, 2024
[38] Employer Skills Survey 2022, IFF Research for Department for Education, 2023.

8.6. Government and industry working together to address the problems associated with work experience for students would be a strong starting point for addressing the UK's longer-term skills challenges. If students are unaware of, or unable to make informed decisions about the educational pathways to pursue, they will not be able to make choices that lead to the acquisition of the skills that employers need when they graduate particularly in STEM. We note that the Government's manifesto contained a commitment to provide students with meaningful work experience. We encourage fulfilling this commitment quickly, and supporting industry with new guidance on how to engage with work experience for students.

8.7. **Staff training and development.** Industry faces a continual challenge to upskill their own workforce as business needs change, markets and customers change, and technology develops. This skills gap between current capabilities and current needs has impacted nearly two-thirds of businesses[39]. Yet the provision of learning and development within businesses continues to stagnate in various ways. Over one-third of Learning and Development professionals have said that limited budgets have hampered their ability to address the skills gaps within their firms, despite it being their number one priority[40]. It has further been reported that overall budgets made available for learning and development have continued to be far behind what was previously available in the earlier part of this decade[41].

8.8. At an overall level in 2022, the total UK employer expenditure on training and development over the previous 12 months was £53.6 billion, a 7.7% decrease in real terms on the 2017 figure of £58.1 billion (taking into account inflation). Training expenditure decreased across all nations compared with 2017. The total investment in training was equivalent to around £2,950 per person trained and £1,780 per person employed.[42]

8.9. Ensuring that people working within the engineering and technology sectors stay at the very forefront of developments in their fields, while also growing their skills in other business and socially orientated fields, is vital. While Continuing Professional Development is a requirement for practicing engineering at certain levels, it is not a requirement of everyone. However, engaging in appropriate levels of training and development helps engineers improve their career prospects, enhance their professional reputation, and contribute to the advancement of the engineering profession. It also ensures that they can provide high-quality services to their clients and employers. We recommend that the government consider options to incentivise industry to make greater offers of relevant training and development opportunities to employees.

8.10. **Apprenticeships** offer an invaluable opportunity to young people and those looking to change or enhance their career, to enter the engineering and technology sectors. They also offer the prospects of higher wages,[43] and higher returns to the economy overall[44].

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[39] Employer Skills Survey 2022, IFF Research for Department for Education, 2023
[40] Learning at work 2023, CIPD, 2023
[41] Learning at work 2023, CIPD, 2023
[42] Employer Skills Survey 2022, IFF Research for Department for Education, 2023.
[4343] 6225e5d4ecf9d41a117e44c2_Essential Skills Tracker 2022 vFinal.pdf, Skills Builder Partnership
[44] The economic benefits of vocational education and training in the UK, City&Guilds Group

However, just one in five businesses offer apprenticeships.[45] Increasing the number and regional availability of apprenticeships in engineering and technology, will go a substantial way to addressing the UK skills gap. It will also, over time, help address the government's concurrent stated aims on increasing economic growth through increased workforce participation from communities often underrepresented in engineering, while reducing the overall reliance on skilled migration. Overall, we would recommend that Skills England play a particularly active role in the development of apprenticeship schemes, including working with professional engineering institutions, professional standards and regulators (including the regulator Engineering Council), training providers, industry, and students.

8.11. In a recent report prepared by Lord Knight and Lord Willetts in conjunction with EngineeringUK, the decline in offering and starts of new engineering apprenticeships was set out[46]. For example, it found that engineering-related apprenticeship starts have dropped by 9% between 2014/15 and 2021/22, with those in engineering and manufacturing technologies down by over a third (34%). The decline has been driven predominantly by the drop-off in lower-level apprenticeships, particularly at Level 2, with engineering-related Level 2 apprenticeship starts falling by more than half between 2014/15 (63,250) and 2021/22 (down to 30,980), which are predominantly targeted at young people. Notably these have not recovered to pre-pandemic levels[47]. While there are several factors contributing to the overall decline in the availability of engineering related apprenticeships, there are steps government should consider taking so that industry can continue to play a large role in this important part of skills and training provision. An overall reduction in the complexity and frequency of regulatory changes are steps government can take that will enhance industry confidence in apprenticeship schemes and give industry greater confidence to take on more apprentices.

8.12. It has been reported that industry is reluctant to take on new apprenticeships because of the perceived poor quality of training provided by local colleges, poor management of apprentices and poor communication regarding the student's progress and performance. Further, it has been suggested that colleges are not offering the right courses for the businesses' needs. We recommend that the government provide forums for local businesses and training providers to come to together and agree training provision and demand requirements. As further devolution of skills and training to regional authorities in England occurs, city deals and other such agreements transferring funding and responsibilities should include such requirements. This is particularly important as the development and expansion of Skills England comes into fruition.

8.13. There may be some unintended consequences of the requirement for apprentices to have a GCSE or equivalent maths and English qualification before they can complete their qualification. This has been questioned by some industry sectors who rely on the achievement of practical skills. This is particularly problematic for people at the lower levels of qualification, who may also be facing other life challenges with consequential

[45] Employer Skills Survey 2022, IFF Research for Department for Education, 2023.
[46] A 5-point plan to grow and sustain engineering and technology apprenticeships for young people, Lord Knight and Lord Willetts in partnership with EngineeringUK, 2023
[47] Further education and apprenticeship pathways into engineering, EngineeringUK, 2023

affects for social mobility.[48] We encourage government to re-examine the need for such qualifications to be achieved in consultation with industry.

9. What more could be done to achieve a step change in employer investment in training in the growth-driving sectors?

9.1. We have seen employer spending on skills training and development for their employees continue to decline since 2017. The Department for Education's Employer Skills Survey shows that per trainee spending has decreased from £4,095 per trainee in 2011 to £2,971 per trainee in 2022.[49] This decline in spending stands in contrast to the over £17 billion in revenue the government has raised since the Apprenticeships Levy was introduced in 2017, including over £3.5 billion in last financial year alone. The government's own figures show that millions of pounds of levy money is not spent every year which could be used to reverse this trend in lower trainee spending.

9.2. Further, research has shown that the introduction of the levy has had little impact on the amount of training provided, or potentially even reduced the amount of training. Other affects include distorting the training market and training behaviours of industry, rebadging and adapting existing training programmes so that levy monies could be reclaimed.[50] Perhaps most concerningly is the drop in the number of apprenticeships being completed since the introduction of the levy. From 67.7% completion rates prior to the levy introduction, in 2022/23, that figure stood at 54.6%. A 13% decrease.[51]

9.3. We therefore welcome the government's commitment to reform the levy into the Growth and Skills Levy. We would further recommend that the government look to promote and increase business participation with apprenticeships, especially among SMEs, by expanding support, reducing bureaucracy, and trialling targeted financial mechanisms such as grants and fiscal measures.

9.4. A more coherent, joined-up and settled approach to workforce planning will be essential to addressing skills shortages, meeting evolving labour market needs and giving employers the confidence to invest in education, skills, and apprenticeships. To achieve this, the new Industrial Strategy Council must work closely with Skills England and counterparts in the Devolved Administrations to identify and address skills shortages in growth-driving sectors. It must also work with the Migration Advisory Committee, Labour Market Advisory Board, the mission boards, and other relevant departmental bodies such as the Office for Clean Energy Jobs, to deliver a series of targeted workforce plans in key sectors, including engineering.

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[48] A 5-point plan to grow and sustain engineering and technology apprenticeships for young people, Lord Knight and Lord Willetts in partnership with EngineeringUK, 2023

[49] Employer Skills Survey 2022, IFF Research for Department for Education, 2023.

[50] Balancing act: Youth apprenticeships and the case for a flexible skills levy, CIPD, 2024

[51] Balancing act: Youth apprenticeships and the case for a flexible skills levy, CIPD, 2024

Innovation

10. Where you identified barriers in response to Question 7 which relate to RDI and technology adoption and diffusion, what UK government policy solutions could best address these?

10.1. **Boost support for late-stage R&D** to accelerate R&D in internationally competitive sectors and technologies that are vital to the delivery of national priorities such as net zero and infrastructure[52]. Existing initiatives, institutions and infrastructures that support late-stage R&D should be strengthened and scaled to help businesses strengthen and scale their innovation activities and, in turn, their growth. Government and industry should co-design new industry-led programmes, drawing on the successes of the Aerospace Technology Initiative (ATI) and Advanced Propulsion Centre (APC), to accelerate R&D in internationally competitive sectors and technologies that are vital to the delivery of national priorities such as net zero and infrastructure. Innovate UK and the British Business Bank should work together to develop financial mechanisms designed to plug the gap in existing financial support for late-stage R&D (prototype to commercialisation, or Technology Readiness Levels 5 to 9).

10.2. **Support for adoption and diffusion** is needed. Initiatives such as Made Smarter, which focus on enabling digital adoption in SMEs in the manufacturing sector in the Northwest can build a community of digital technology providers, developers and users and manufacturers and enable more targeted messaging and relatable success stories. Offering bespoke packages of support spanning technology and business advice, guidance for skills development, leadership development and funding opportunities mean that businesses can access the appropriate support for where they are on their technology adoption journey. Please see the response from NEPC partner BCS (The Chartered Institute for IT) for more detail on digital adoption.

11. What are the barriers to R&D commercialisation that the UK government should be considering?

11.1. **R&D infrastructures** can facilitate and accelerate R&D commercialisation by providing facilities to support translation, integration and rigorous testing to meet performance, safety and reliability standards, as well as demonstration in real-world environments with potential users. The specific infrastructure to achieve this can be prohibitively expensive for a company to invest in alone. Increasing the provision of high-quality open-access infrastructure for scale-up and commercialisation in priority subsectors should be considered. While the UK does have some open-access infrastructure, more needs to be done to ensure this is fit for purpose for use by industry, in terms of availability, accessibility, affordability, compatibility with industrial and commercial standards and processes, and is staffed by skilled personnel. There are also lessons UK facilities can learn from 'problem-solving organisations'/ 'intermediate institutes' such as Fraunhofer (Germany) and VTT (Finland), which successfully bridge the gap between R&D and commercialisation.

11.2. **Deep tech companies have specific infrastructure needs.** Deep tech companies are those with technologies grounded in innovative engineering and cutting-edge scientific

[52] Late-stage R&D: business perspectives, National Engineering Policy Centre, 2021

advances, and the companies are recognised as being capital-, time- and R&D-intensive. The capital requirement is significant and is inextricably linked to the extensive and complex infrastructure requirements faced by deep tech companies. These companies can require high energy and water supplies, and are dependent on stable grid connectivity, stable and high-speed telecoms (5G/6G), access to compute, transport, and amenities, among others. More generally, and while not unique to deep tech, the need for physical lab and office space is a key part of the infrastructure equation. As businesses scale-up both their headcount and their operation, the need for space is imperative and in certain areas of the country it is becoming a premium resource. Nowhere is this clearer than in London and the Golden Triangle where demand for lab space is far outstripping supply in areas of Life Sciences and beyond[53]. Also, it can be costly and arduous for companies to navigate the various planning and construction processes and providers to get their needs met. Finally, these companies require access to manufacturing and production facilities and R&D infrastructures.

11.3. The Royal Academy of Engineering is undertaking a project to assess whether the infrastructure needs of deep tech scale-up stage companies in the UK are being adequately met, and determine if interventions are needed to promote their growth and development. The project will take a cross-cutting approach, looking at evidence for infrastructure availability and requirements across the multi-sector deep tech landscape and assessing any overlapping infrastructure needs and common scaling challenges.

11.4. The recommendations from the government commissioned independent review of university spinout companies should continue to be implemented. Additionally, to ensure that the UK spinouts can grow faster and attract greater investment, we call for the division of equity that incentivises academic founders, the expansion of training programmes for academics interested in commercialising their research, and improved access to domestic scaleup capital.

Data in the Industrial Strategy

12. How can the UK government best use data to support the delivery of the Industrial Strategy?

12.1. Data will provide useful insights about where the Industrial Strategy is attracting investment, creating high-quality jobs and delivering growth. If there is a high enough granularity, data can be used to identify potential blockers in the system or to draw out examples of good practice across the sectors.

13. What challenges or barriers to sharing or accessing data could the UK government remove to help improve business operations and decision making?

13.1. Government can encourage private sector organisations to collect and release data, leading by example, and sharing best practice. It can create the parameters as a regulator, such as data quality standards, and fund platforms and infrastructure for trusted and, where needed, privacy-preserving data access.

[53] The shortage of lab space in the UK's "Golden Triangle", KnightFrank, 2023

13.2. The development of robust and trustworthy frameworks for enabling access to data would make these practices more acceptable to companies and other types of organisations, and the public – a key consideration if personal data is being accessed.

13.3. Issues can arise from data stored with private companies outside the UK. Secure cloud storage like AWS or Azure would be useful where there are questions of data sovereignty.

13.4. Creating, storing and using data creates environmental impacts. To minimise these impacts, it is important to carefully curate proportionate datasets that can provide useful insights for business decisions.

13.5. Government can improve access to the skills that are required for identifying opportunities for data sharing, and for developing and implementing data sharing models. This requires business skills, and the soft skills required to lead, be part of multidisciplinary teams and work in partnership. It also requires technical skills for developing appropriate architectures and applications of technologies, and for data engineering and linkage. Please see the response from NEPC partner BCS (The Chartered Institute for IT) for more detail on digital skills.

Energy & Infrastructure

14. Where you identified barriers in response to Question 7 which relate to planning, infrastructure, and transport, what UK government policy solutions could best address these in addition to existing reforms? How can this best support regional growth?

14.1. Sustainable, effective, and efficient transport has a critical role in driving a sustainable and growing economy. We believe that the ineffectiveness of significant elements of the UK's transport networks and their relative saturation are important factors in the lack of vibrancy and robustness in the UK economy. Deploying sustainable, resilient and fully accessible integrated transport networks is not just a critical element of a UK response to the challenges of a rapidly changing climate, it should be a first step in broadening the UK economy so that cities and regions outside of London can play a fully proportionate role in the country's economic growth. Please see responses to this consultation from individual NEPC partners for more detail on how transport can support the aims of the Industrial Strategy, particularly the responses from The PWI (Permanent Way Institution) and CIHT (Chartered Institution of Highways and Transportation).

14.2. There are five areas that are often highlighted as opportunities for significant improvement to the planning framework relating to energy infrastructure. These are: the introduction of spatial planning; providing consistency for decision makers; improving public engagement; taking a strategic approach to environmental assessment; and sufficient resourcing of the planning system.

14.3. To develop a hydrogen economy at pace, collaboration with local authorities, co-ordinated by NESO and aligned with the national hydrogen development goals and Local Area Energy Planning, will be essential. Manchester stands as an example of a regional model for hydrogen strategy development in partnership across sectors. The Manchester Fuel Cell Innovation Centre, which is based at Manchester Metropolitan University and part of the broader Greater Manchester Strategy for achieving net zero by 2038, was part funded through regional development funding. The Centre is notable for its success in

fostering co-operation between local authorities on funding and planning. The partnership includes support for many regional projects, from demand generation through to technical R&D and hydrogen education programmes. This initiative highlights how establishing shared aims on key areas (skills, employment, and investment, for instance) will help guide the direction of travel across local authorities. These successes could be replicated elsewhere, fostering a common vision across local authorities, through consultation and collaboration.

15. How can investment into infrastructure support the Industrial Strategy? What can the UK government do to better support this and facilitate co-investment? How does this differ across infrastructure classes?

15.1. Government investment in infrastructure to enable greater connectivity and resilience can also encourage business investment. The 10-year Infrastructure Strategy, driving the delivery of sustainable economic infrastructure including transport, electricity, telecoms, water and wastewater will provide clarity and continuity, important for crowding-in investment. It is important this does not focus only on new infrastructure. Alongside new investments it is vital to maintain our existing infrastructure to enable continued service delivery and avoid economic disruption. There is also an opportunity to join up existing sub-national strategies to ensure infrastructure continues to deliver economic and societal benefits across the UK.

15.2. A clear vision of the future energy system, to 2030 and beyond, is key to unlocking supply chain investment in Clean Energy Industries. Government can have a huge influence on the costs, benefits, and success of the transformation of the energy system by adopting an evolved approach to risk, including financial risk, to reflect a changing world. For example, this could be born out in a more open approach to anticipatory investment (in for example, transmission and distribution infrastructure) delivering ahead of need, rather than lagging need in this fast-changing sector. In addition, a change to procurement approaches, by providing industry with a long-term order book, would enable the government to balance the risk of a constrained global supply chain which is already pushing up costs in the energy sector and bring investment into the UK.

15.3. To expand the production of green hydrogen, the spatiality of the future hydrogen system is a central strategic planning consideration. Optimally locating renewable electricity generation, green hydrogen production, and industrial end use marks a key challenge for industrial decarbonisation. A focus on industrial clusters in the UK and the growing knowledge and implementation around these holds strong opportunities to anchor technological development and investment in the UK while encouraging job creation, local and national upskilling and local and national economies.

Energy

16. What are the barriers to competitive industrial activity and increased electrification, beyond those set out in response to the UK government's recent Call for Evidence on industrial electrification?

17. What examples of international best practice to support businesses on energy, for example Purchase Power Agreements, would you recommend to increase investment and growth?

Regulatory Environment

18. Where you identified barriers in response to Question 7 which relate to competition, what evidence can you share to illustrate their impact and what solutions could best address them?

19. How can regulatory and competition institutions best drive market dynamism to boost economic activity and growth?

19.1. To enhance market dynamism and economic growth in electricity decarbonisation, regulatory and competition institutions can focus on: regulatory certainty - providing stable, long-term policies that give businesses the confidence to invest in decarbonisation; encouraging and unlocking investment - streamlining regulatory processes to attract investment in renewable and innovative energy technologies; market incentives - designing incentives that favour efficient, low-carbon solutions and reward flexible, demand-responsive systems; enhancing competition - increase market access for diverse players, including smaller firms, to stimulate innovation and price efficiency; and infrastructure modernisation - supporting grid upgrades and infrastructure expansion to accommodate renewable energy growth and integration.

19.2. The government should include regulators such as the Engineering Council when negotiating the inclusion of provisions for recognition of professional qualifications within trade agreements, and development of recognition agreements to facilitate mobility of engineering professionals and expertise, such as the agreement between the UK's Engineering council and the USA's National Council of Examiners of Engineers and Surveyors.

20. Do you have suggestions on where regulation can be reformed or introduced to encourage growth and innovation, including addressing any barriers you identified in Question 7?

20.1. Outcomes based regulation is an enabler for responsible innovation, it provides the necessary guardrails to ensure positive outcomes for people and the planet, while creating opportunities for new technical solutions. International alignment of standards is important to increase market access and to ensure that ethical organisations are not out-competed by those that cut corners at the expense of societal and environmental wellbeing.

20.2. There is a need for CPD courses and training for regulators to better understand foundational technologies, such as AI. There is a role for the Regulatory Innovation Office to enable greater cross sectoral coordination and make it easier for innovators to navigate the system. Language across regulations and standards should be made consistent to make it easier for innovators to effectively understand and interpret between standards and regulations produced by different bodies. This may require standardised terminology and collaboration to build unified understanding.

Crowding in investment

21. What are the main factors that influence businesses' investment decisions? Do these differ for the growth-driving sectors and based on the nature of the investment (e.g. buildings, machinery & equipment, vehicles, software, RDI, workforce skills) and types of firms (large, small, domestic, international, across different regions)?

21.1. Many investment decisions, particularly those faced by R&D intensive engineering and technology companies in the growth-driving sectors, involve risk. The risk is multifaceted, arising from the scale of the technical challenge, cost, timings, certainty of market opportunity, competitive environment and opportunities or barriers to commercialisation. There is a compelling case for the public sector to support businesses to manage the risks associated with late-stage R&D and incentivise business investment – the socio-economic benefits from the new products, processes, services and technologies are shared, so the risk must be too. Effective risk-sharing is essential, particularly for capital-heavy, emerging technologies.

21.2. Fiscal policy stability and certainty, as recognised in the Green Paper, are key to influencing investment decisions. One such example of the impact of instability from recent years has been an unstable fiscal environment for small firms planning R&D investment. R&D tax reliefs are critical for small R&D-intensive firms but uncertainty around their stability complicates long-term financial planning for investors and companies.

21.3. The availability of skilled people is a major factor in influencing business investment: being able to hire the right people with the right skills at the right time is vital for successful R&D. The UK engineering skills base is of good quality but quantity is a limiting factor: more engineers are needed in the UK, particularly in emerging fields such as artificial intelligence (AI) and software engineering. Engineering R&D in the UK is undertaken by an international workforce, so visa regimes need to be proportionate, especially for small engineering technology companies. Accessing, attracting and retaining the skilled talent AI and quantum companies need is a major challenge. There are a multitude of reasons for this, from startups unable to complete with big tech salaries, skills shortages and frequent changes to visa policies risk deterring international talent. Coordinated public and private initiatives are needed to increase the level of digital skills in our domestic skill base.

21.4. Resilient, localised supply chains, or the potential to build these can influence investment decisions. This is particularly relevant to production of renewable energy components (e.g., solar panels, batteries) to ensure resource availability and mitigate reliance on international imports.

21.5. Public procurement has the potential to have a transformative effect on companies' investment in R&D in the UK. It provides a huge opportunity to stimulate innovation. However, engineering companies have found that decisions on public procurement prioritise low cost over best value, and risk aversion hinders the introduction of innovative solutions. If public procurement processes discourage R&D and innovation, it can push businesses to move those activities to other more receptive countries[54]. While the legal

[54] Increasing R&D investment: business perspectives, Royal Academy of Engineering, 2018

framework created by the Procurement Act 2023 and the developing National Procurement Policy Statement is welcome, the cultural change required to realise the potential of public procurement should not be underestimated. The government should make innovation a central component of the public procurement process by identifying a Ministerial Champion for procurement reform and setting clear targets for an associated change programme[55].

21.6. The government should enhance the reporting obligations required of public authorities to disclose details of the subsidies they award by uploading them to a national database, as part of the UK's Subsidy Control Act 2022. This requirement is an important and valuable feature of the subsidy control regime, representing an important innovation that can deliver value for money and advance the government's goals of economic growth and a green energy transition. Please see the response from NEPC partner ICE (Institution of Civil Engineers) for more detail.

21.7. Ways of working with government - Engineering companies find strategic engagement across UK government departments and organisations frustrating, fragmented, and siloed. This makes the UK less attractive for businesses to invest in, especially in contrast to packages of tailored support and stewarding offered by other countries. There is also a need for government to operate at pace to match businesses' timelines. In the 2017-2019 Industrial Strategy it took 43 and 72 weeks to select and approve challenges for the second and third Waves of Industrial Strategy Challenge Fund funding respectively[56].

21.8. Support for investing in capital intensive equipment and advanced manufacturing capability - While there is a reasonable argument to be made that industries should be willing to invest in equipment themselves, and that the market should drive demand, this argument negates the disadvantage companies in the UK find themselves with, compared to countries where there are government initiatives in place to enable increasing the capability of its advanced manufacturing firms[57]. Subsidies could support strategic sectors, particularly those with high initial capital needs but significant growth potential. There is a risk of UK companies relocating their business outside of the UK to take advantage of internationally subsidised programmes. Semiconductors and quantum are areas of where there have been notable international subsidies.

21.9. Support for late-stage R&D and R&D infrastructures – see answer to questions 8 and 11.

21.10. Ensuring deep tech companies' infrastructure needs are met - see answer to question 11.

[55] Engineering a resilience and prosperous future, National Engineering Policy Centre, 2024
[56] UK Research and Innovation's management of the Industrial Strategy Challenge Fund, NAO, 2021
[57] Quantum Infrastructure Review, Royal Academy of Engineering, 2024

Scale-up finance

22. What are the main barriers faced by companies who are seeking finance to scale up in the UK or by investors who are seeking to deploy capital, and do those barriers vary for the growth-driving sectors? How can addressing these barriers enable more global players in the UK?

22.1. Despite being third in the world for VC investment, the UK is proportionally weak at scale-up investment, particularly in comparison to the US. This is especially a concern for 'deep tech' companies, for whom the common scaling challenges are felt more acutely. There is no universal definition of deep tech, and other terms like hard tech and tough tech are also in the mix. By its very nature, the term encompasses a broad and evolving spectrum of innovative technologies, and what constitutes deep tech may vary based on the perspectives and metrics of different stakeholders. What is common in the definition of deep tech companies is that the technologies are grounded in innovative engineering and cutting-edge scientific advances, and the companies are recognised as being capital-, time- and R&D-intensive.

22.2. Narrowing the financing gap compared with the US is a priority. While early-stage investment is relatively healthy in the UK, it remains more challenging for deep tech companies who are unable to promise rapid returns on investment like those that can be achieved in software companies. Deep tech companies, especially those not operating in established sectors, require more UK investors with specialist knowledge.

22.3. Accelerate delivery of Mansion House Reforms. The Mansion House Reforms aim to support growth across the economy by unlocking capital for high-growth companies. The speed at which these reforms materialise and start making a difference will be key to accelerating growth of UK high-tech companies.

22.4. Ensure the British Business Bank (BBB) and British Patient Capital (BPC) are backing innovation, including by supporting deep tech companies. The BBB and BPC are key levers to address structural funding failures in the UK. However, there is a perception that they are no longer fulfilling their remits of 'backing innovation' and enabling longer-term investment in innovative UK companies as well as they once did. We call for a greater focus on and accountability of the BBB and BPC in supporting the growth of innovative deep tech companies, especially beyond life sciences firms. They must have appropriately specialist skilled investors.

22.5. Create a roadmap of support for scaling deep tech companies. Together Innovate UK, the BBB and BPC deploy financial mechanisms to support innovative companies from proof of concept to scale, while the UK Infrastructure Bank focuses on infrastructure. These organisations should work together to identify gaps in existing support to meet the scale of need and the distinct challenges deep tech companies face, and design mechanisms to address them. Cliff-edges should be removed, weak spots fixed and funding initiatives joined-up where appropriate. The roadmap should be used to signal the UK's ambition to investors and deep tech companies, as well as making navigation of the UK's support system simpler.

22.6. Increase Corporate Venture Capital (CVC) in the UK. There is an opportunity for the UK to increase the amount the CVC investment in the UK, as it is at lower levels than in

comparator countries. CVC can be of particular importance to engineering startups, including deep tech companies. Efforts are needed to increase conventional VCs' and entrepreneurs' understanding of the role and motivation of CVC, which is often more to do with technology synergies rather than control or acquisitions. Government should incentivise CVC from both UK and global corporates.

22.7. Instability of tax incentives makes it difficult to demonstrate long-term financial planning to investors and companies alike. Consistency is the key to building confidence, empowering risk-takers, and encouraging founders to take the next step in the development of their idea. The Enterprise Investment Scheme (EIS) and Seed Enterprise Investment Scheme (SEIS) have been transformative to improving the UK's startup ecosystem. R&D tax reliefs play a crucial role in increasing available finance to small innovative companies. Unlike innovation grants allocated to specific projects, this allows them to respond to emerging business opportunities and threats as they arise, including through further R&D investment. Returns from R&D tax reliefs can be a lifeline in periods of challenging cash flow.

23. The UK government currently seeks to support growth through a range of financial instruments including grants, loans, guarantees and equity. Are there additional instruments of which you have experience in other jurisdictions, which could encourage strategic investment?

International Partnerships

24. How can international partnerships (government-to-government or government-to-business) support the Industrial Strategy?

25. Which international markets do you see as the greatest opportunity for the growth-driving sectors and how does it differ by sector?

Place

26. Do you agree with this characterisation of clusters? Are there any additional characteristics of cluster definition we should consider?

26.1. In Engineering Economy and Place, the Royal Academy of Engineering, characterised the UK's engineering economy at local authority level[58]. By combining indicators that look at the engineering economy, engineering enterprise and place economics, a typology of five categories and seven sub-categories has been developed. They remove a barrier to describing the local and national role of engineering, and highlight that engineering is present across economies and places of all shapes and sizes. The engineering economy takes a different role and exhibits different features in each, whether it is the volume of engineers, the level of innovation activity, the economic output delivered by businesses or the diverse sectoral activity. In doing so it broadly supports the Green Paper's characterisation of clusters and offers a more granular typology which the Strategy may wish to draw from.

[58] Engineering Economy and Place, Royal Academy of Engineering, 2023

26.2. While acknowledging that R&D and innovation is an important characteristic of clusters, it shouldn't be overweighted. Engineering Economy and Place provides insight on the balance of employment in engineering R&D and practice, and on jobs in the engineering economy for non-engineers[59]. Unsurprisingly, simple conclusions cannot be reached. High concentrations of R&D roles do occur in areas where you might expect them – London, the South East and in many large UK cities, but also in the East Midlands, Cheshire, the South West and South Derbyshire. However, this isn't a pre-requisite for engineering to be a significant contributor to the economy, with the potential for future economic growth. For example, the 'Local Engines' in Engineering Economy and Place are areas where engineering plays a very significant role in the local economy, providing at least 25% of overall employment. Some of these places have large engineering businesses which are major employers and have high GVA output, while others have concentrations of engineering businesses but have not been able to transfer this into more significant economic benefit. Similarly, Value Hotspots are high-value engineering economies, where jobs are on average worth at least £80,000 in GVA per engineer, £10,000 higher than the engineering economy average. These places are lower in engineering volume and despite their high value, are not seeing widespread growth in their engineering business base. This is instead limited to specific concentrations, many of which are located either around or in key and core cities.

26.3. We agree that clusters can take any geographical shape and often span large geographical areas without arbitrary restrictions. For example, the research found that groupings can be made based on shared characteristics and trends, rather than geographical proximity – although naturally, some within each category share boundaries or regions.

27. What public and private sector interventions are needed to make strategic industrial sites 'investment-ready'?

28. How should the Industrial Strategy accelerate growth in city regions and clusters of growth sectors across the UK?

28.1. While engineering is everywhere, it is nowhere the same. Having a better understanding engineering's role in different places enables exploration of how places can better leverage engineering to improve prosperity and advance the UK's technology and growth ambitions. It is for places to determine how best to develop their economy. In some places engineering is already strong and could be enhanced. In some places the economy is weak and through its engineering economy, could be enhanced. Places need to tell their own story – and set policy at local levels. One-size-fits-all policy will not work so any interventions need to be considered in context of place, to both manage the risk posed and to exploit opportunities.

28.2. The benefits from connections between city-centre R&D activity and engineering in surrounding city regions and towns that can accommodate physically larger businesses and have strong engineering performance should be leveraged to encourage high value engineering and innovation. London and the South East have a strong gravitational pull on high-value, innovative engineering in the UK, but there is still potential for them to

[59] Engineering Economy and Place, Royal Academy of Engineering, 2023

expand their proximal regional connections. Other city centres that have dense R&D-intensive activity should look at how they can strengthen connections with specialised 'near city' engineering in connected surrounding rural/town economies. The West Yorkshire Combined Authority is a good example of this. For rural areas outside of a city-region centre of gravity there are very few instances of high-value, high-R&D engineering. For those areas, such as Mid Wales and the Marches, Cornwall, Cumbria, East Anglia and the North West of Scotland, creative solutions must be found to increase connectivity and innovation. Rural or out-of-town should not mean disconnected.

28.3. The Industrial Strategy should seek to maximise the potential of highly specialised industry concentrations, for local and national prosperity. There are several places in the UK with very highly specialised concentrations of engineering businesses, often connected to strong industrial heritage, but structurally weaker economies. Frequently, though not exclusively, coastal town communities experience complex, multifaceted socioeconomic challenges that are less directly connected to R&D infrastructure. These places require targeted support to be able to capitalise on a dense industry foundation that should be an asset. This will require enabling the enterprise environment where engineering is strong, but the enterprise infrastructure/wider economy is weak. Here the interventions might not need to be engineering-specific to result in beneficial engineering outcomes.

28.4. Driving digital transformation and technology adoption across engineering is important for future growth. There is a higher automation risk to applied engineering jobs that carry out technical production and application of products and technologies, and standardised operation of existing products, processes, machinery and technologies, compared to engineering R&D jobs. The impact of automation will inevitably be much deeper in places where applied practical engineering jobs dominate the engineering economy. Adoption of new technologies is a case of when, not if. Through a combination of progressive modernisation, pursuit of efficiency improvements and drive to goals such as net zero, change is inevitable. It will bring significant disruption to workforces in these areas. Managed well, business transformation to invest in kit and skills development should replace old jobs and create new opportunities but business owners and leaders will need the vision and support to achieve this. This will require focused interventions for leaders of established businesses, as well as those at the start of their enterprise journeys. A one-size-fits-all policy will not work, so any interventions need to be considered in context of place, to both manage the risks posed and to exploit opportunities.

28.5. Please refer to the Engineering Economy and Place report and dashboard for further information and detailed analysis (Engineering Economy and Place, Royal Academy of Engineering, 2023).

29. How should the Industrial Strategy align with devolved government economic strategies?

29.1. A new Industrial Strategy presents the UK government with an opportunity to engage meaningfully with the devolved administrations and English local authorities on their economic plans for their communities, including their Industrial Strategies and key institutions.

29.2. Ensuring that education and skills systems across the UK and at every level of government are complimentary, rather than in competition, is vital to providing the workforce that the UK needs to achieve economic growth. At a strategic level, providing fora where ministers and officials can meet to discuss or consult on policy development and share information on education and skills programmes currently underway, would be a positive first step. For the UK government specifically, as Skills England continues to develop, ensuring that it has obligations to consult with the Devolved Administrations and local authority counterparts should also help prevent policies and programmes being implemented at cross-processes or inefficient ways.

29.3. As a devolved subject matter, education and skills training presents a challenge in a single market economy. We know that UK businesses trade across jurisdictional lines, just as people live their lives without regard to internal borders. We would encourage the UK government, as part of this Industrial Strategy, to examine options for sharing of educational and skills resources across borders. We know that delivering design, technology and engineering training and skills can be resource intensive. Enabling training providers to share resources across borders could boost the supply of people with skills relevant to local industry needs, while enabling people to learn and work across borders.

Partnerships & Institutions

30. How can the Industrial Strategy Council best support the UK government to deliver and monitor the Industrial Strategy?

30.1. The success of the Industrial Strategy depends in large part on the Strategy adopting a systems approach. Systems-based approaches are an essential enabler for achieving the government's objectives; applying systems thinking principles and tools across the Industrial Strategy will enable better results with fewer resources in more lasting ways. Adopting a systems approach will enable risks to be mitigated more effectively and ensure that the different elements of the strategy work together as a coherent whole. A key element of this approach is understanding interdependencies between different parts of the strategy, in order to identify both fragilities and opportunities to aggregate value and reinforce outcomes. This is crucial given the overlaps and interdependencies across the growth-driving sectors, the emerging sectors and technologies and the foundational sectors, and the policy levers. A clear strategic framework will also be needed within which central government, devolved governments and regional and local institutions can collaborate and cooperate and so are mutually reinforcing rather than competing. The Industrial Strategy Council should ensure that such a systems approach is being taken.

31. How should the Industrial Strategy Council interact with key non-government institutions and organisations?

31.1. The NEPC brings engineering thinking to the heart of policymaking, creating positive impacts for society. We are a partnership of 42 professional engineering organisations that cover the breadth and depth of our profession, led by the Royal Academy of Engineering. Together we provide insights, advice, and practical policy recommendations on complex national and global challenges. The NEPC is pleased to offer its services to

the Industrial Strategy Council, both as a source for insights and collaborative policymaking, but also as a route to the 42 partners of the Policy Centre to connect with their specific and extensive expertise, many of whom have international footprints.

31.2. The NEPC has expertise in systems thinking. Engineers and policymakers working together have the opportunity to employ systems approaches to better understand and intervene to solve challenging policy problems, through collaboration and knowledge sharing across sectors. Engineers tackle complex challenges, including through examining whole systems and how their elements interact with one another in order to optimise outcomes that take into account a diversity of stakeholder approaches. When these principles are applied outside the world of engineering to tackle the societal challenges, they can have transformational effects, as already recognised in the health and care sector[60]. Further embedding systems expertise and engineering insights into the policy process is essential. We encourage the next government to increase access to external engineering expertise, including through the NEPC and its partners.

31.3. The NEPC's partners represent all engineering sectors, with their members numbering over 450,000 of the engineering workforce. As such, it can connect the Industrial Strategy Council to leading, practising engineers across all sectors in the strategy, with experience and insight on all issues covered in the strategy, from R&D, to deployment of infrastructure at scale, to developing our future workforce.

32. How can the UK government improve the interface between the Industrial Strategy Council and government, business, local leaders, and trade unions?

Theory of Change

33. How could the analytical framework (e.g. identifying intermediate outcomes) for the Industrial Strategy be strengthened?

34. What are the key risks and assumptions we should embed in the logical model underpinning the Theory of Change?

35. How would you monitor and evaluate the Industrial Strategy, including metrics?

[60] Engineering better care, Royal Academy of Engineering, The Academy of Medical Sciences, Royal College of Physicians, 2017