HM Government

HM Government Response to Professor Dame Angela McLean's Pro-Innovation Regulation of Technologies Review

Advanced Manufacturing

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Introduction

At Autumn Statement 2022, the Chancellor announced a programme of work to advise how the UK can better regulate emerging technologies, enabling their rapid and safe introduction.

The aim of this Review is to establish the UK as the best regulated economy in the world in key growth sectors ensuring that industry and investors have the certainty they need to drive innovation, investment and growth through anticipating new developments in emerging technologies.

The work was initially led by Sir Patrick Vallance, in his role as the Government Chief Scientific Adviser and National Technology Adviser. Since stepping down as Government Chief Scientific Adviser, the work has been taken on by his successor, Professor Dame Angela McLean.

Two leading experts – Steve Bagshaw and Brian Holliday – have supported Dame Angela in the development of this Advanced Manufacturing report, working closely with industry to identify barriers to innovation and getting emerging technologies to market. The government is grateful to them for their comprehensive work to inform this report.

This is the government's response to the Review's advanced manufacturing report, the fifth in the series and the final sector-specific report. The Review has already published reports on Digital Technologies, Green Industries, Life Sciences and Creative Industries, and will separately be publishing a cross-cutting report.

Pro-innovation regulation will unlock new opportunities for manufacturers to develop, test and introduce advanced processes and products in the UK. The government is already taking forward activity that will support advanced manufacturing from the recommendations in previous reports, including on drones and autonomous vehicles from the Digital Technologies report; waste and the circular economy, and use of hydrogen in the Green Industries report; and novel foods in the Life Sciences report. This report and the government's response builds on that work. The government accepts all of the report's recommendations and this response sets out further detail on the government's position and how we plan to implement them.

Response to recommendations

Section 1: Global leadership in the safe deployment of new tech

Recommendation 1 – Technical standards

The government should work with the UK National Quality Infrastructure (NQI) and UK industry and academia, to shape global technical standards to achieve interoperability in key technologies, with a particular focus on cyber security.

Response

1. The government accepts this recommendation. Technical standards are a key component of the UK's approach to technology governance and to ensuring cyber security is built into technologies from the outset. They are a critical aspect of the UK's ambition to ensure the governance framework for digital technologies is rooted in democratic values and that technologies deliver for all. The UK's Science and Technology Framework emphasises the importance of a system of regulation and standards that is pro-innovation and easy to navigate.

2. The government recognises the important role of the UK National Quality Infrastructure (NQI) and UK industry and academia in ensuring that technical standards agreed in global Standards Development Organisations (SDOs) meet UK needs and support interoperability and innovation in key technologies. The government is already working with partners to build capability and awareness across the UK's industry and research and innovation (R&I) sectors and improve coordination across stakeholder groups, nationally and internationally. The joint action plan on Standards for the Fourth Industrial Revolution set a strong precedent, bringing together government and the NQI partners to work in partnership and implement actions to unlock the full potential of standards to support innovation and enable its swift and safe commercialisation. The government will continue to explore opportunities to ensure it builds on the achievements and collaboration accomplished to date. We will continue to strengthen UK influence in global SDOs relating to priority technologies and cyber security considerations.

Recommendation 2 – Collaborative robots (cobots)

The government should work with the BSI and the HSE to launch a standards programme to establish clear principles for the deployment of cobots in manufacturing that cover issues such as risk assessments and liability. To support foreign investment, this standards programme should look to influence the deployment of international best practice in this area.

Response

3. The deployment of collaborative robots (cobots) within industrial settings offers significant opportunities to increase flexibility, productivity and export potential for UK manufacturers. The government supports the development of internationally aligned best practice standards for the safe, effective and responsible implementation of collaborative robots in industrial settings. We also recognise that compliance with health and safety legislation is of paramount importance and would not expect manufacturers to invest in and adopt technologies that put their employees at risk.

4. The government, along with HSE and BSI, will review how standards in this area could be developed or updated to assist in demonstrating legal compliance and reducing duty holder uncertainty, utilising the skills and knowledge of the regulator, industry and academia. The full scope of this work will include issues of risk assessments and liability.

5. The review will look to influence the development of international standards, ensuring as far as possible that they remain proportionate to worker safety and neither diminish protections nor gold-plate requirements in ways which could restrict cobot deployment. BSI, as the national member of the international standards bodies ISO and IEC, will work with UK-based experts to influence the development of international standards that will enable the UK to be world-leading in the deployment and use of collaborative robots.

Recommendation 3 – HSE secondments

HSE should explore secondments where manufacturing staff in industry and/or trade association representatives are placed within the regulator, and regulatory staff within industry. The secondments should seek to drive innovation and address knowledge gaps.

Response

6. The government recognises the need for the continued effective sharing of skills and knowledge between industry and regulator. Noting the need to maintain the independence and transparency of regulatory approaches and decisions, HSE will explore with industry representatives how best to achieve this. This could be through direct secondments or as part of a wider programme of engagement with industry and trade associations, including knowledge-sharing workshops, HSE's Shared Research Programme and ongoing

involvement with industry in regulatory sandboxes. This will help to develop a common understanding of issues and to promulgate validated knowledge.

Recommendation 4 – Automation in agriculture

The government should review the Supply of Machinery (Safety) Regulations 2008 as they apply in Great Britain, as part of its future thinking on product safety, with the aim of putting in place an up to date, proportionate regulatory regime that supports early-stage innovation and automation in agriculture.

Response

7. The Supply of Machinery (Safety) Regulations 2008 as they apply in Great Britain place obligations on the manufacturer to ensure that the machinery products they place on the market are safe for consumers and workers. The government believes that the Regulations are providing a high level of safety and protection for machinery users. However, we are seeking to reform the UK's product safety framework through the Product Safety Review to ensure it is fit for the digital age and meets the needs of UK consumers and businesses. Our consultation, which was open from 2 August 2023 until 24 October 2023, explored various options to improve how we regulate all products on the GB market, including machinery. The consultation document set out the ambition for reform, basing a new framework on a core set of principles that will protect consumers and support businesses to innovate and grow. The consultation is now closed and we are reviewing the responses received and will publish a government response in due course.

Section 2: Clean Transport and Future Mobility

Recommendation 5 – The future of air mobility

The government should evolve the existing regulatory framework to enable the safe testing and rollout of electric Vertical Take-off and Landing (eVTOL). The government should work with industry, regulators and local authorities to consider opportunities to clarify and simplify consenting processes to enable testing of eVTOL.

Response

8. The government believes that eVTOL can provide significant benefits to the UK and agrees with this recommendation. We are currently taking this forward through the Department for Transport's Future of Flight programme, including:

a. **Establishing the Future of Flight Industry Group** (FFIG) to ensure government and industry are working in partnership to unlock the potential of Advanced Air Mobility (AAM) aircraft. The

FFIG is co-chaired by the Aviation Minister, includes key companies including eVTOL operators and vertiport providers, and will publish a Future of Flight Action Plan over the coming months.

b. **Working with the CAA** to help it focus on developing regulation at pace for new forms of aviation technologies including eVTOL. This includes the establishment of the AAM challenge, which is working to accelerate the development of new policies and regulations for Advanced Air Mobility for an initial commercial operation of a passenger carrying service by eVTOL aircraft over the coming years. The CAA is reviewing how testing and trialling of innovative technologies, including for eVTOL and drones, can be facilitated to enable tests to be carried out safely via a more streamlined and simple process. In line with the recommendations of the recent public bodies review, the CAA is also reviewing its risk appetite for new activities to ensure it is consistent with the delivery of government policy as far as possible whilst recognising the CAA's independent statutory responsibility for safety.

c. **Funding and supporting the Future Flight Challenge**, a £300m programme to accelerate the progress of new aviation technologies – including eVTOLs – by funding 17 innovative projects that bring together diverse stakeholders around public good use cases, as well as developing the Future of Flight ecosystem. This includes the Air Mobility Ecosystem Consortium (AMEC), which is bringing together the leading experts of UK aviation to develop and demonstrate end-to-end operations that will drive the development of a commercially viable AAM network in the UK.

Recommendation 6 – Additive manufacturing

The NQI and The Welding Institute (TWI) should develop 3D printing standards to enable the certification of the entire production process, rather than individual parts. This would bring 3D printing standards in line with traditional manufacturing standards.

Response

9. The government accepts the recommendation to support the NQI and TWI develop 3D printing standards to enable the certification of the entire production process, rather than individual parts. We will also work to influence global standards in this area through engagement with the ISO and American Society for Testing and Materials (ASTM) standards. The Ministry of Defence will continue to work with its manufacturing supply base, the High Value Manufacturing Catapult, and the Manufacturing Technology Centre (including the National Centre for Additive Manufacturing) to facilitate cross-sector engagement using the Aerospace Technology Institute and others to achieve a collegiate effect.

Recommendation 7 – Digital twins

The government, through its National Digital Twin Programme, should work with BSI to convene a group of relevant stakeholders, including regulators, to determine and develop the standards needed to accelerate the deployment of digital twins. This should build on the success of Building Information Modelling (BIM) and ensure use of the technology is safe, secure, trustworthy, ethical, sustainable, adaptable and, where required, interoperable.

Response

10. The government accepts this recommendation and recognises the importance of standards for the deployment of digital twins and wider Cyber-Physical Infrastructure. We welcome the development of fora of stakeholders and regulators to collaborate on the research, development and innovation of digital twins and connected cyber-physical systems to support the development of cross-sector standards and frameworks. This approach is reflected in the government's response to the Cyber-Physical Infrastructure consultation, which sets out our vision to enable greater innovation in the UK through a Cyber-Physical Infrastructure. The government is working with industry to develop a Cyber-Physical Infrastructure ecosystem to accelerate collaboration for the development and adoption of digital twins and connected cyber-physical systems and foster best practice needed for the development of standards and frameworks.

11. The National Digital Twin Programme (NDTP) is managed by the Department for Business and Trade (DBT) on behalf of the government and represents a critical endeavour in the advancement of digital twinning capabilities across the United Kingdom. The Programme is committed to the development of standards, frameworks, guidelines, and methodologies that ensure digital twins can be developed and used, individually and within connected systems, in a way that is safe, secure, trustworthy, ethical, sustainable, adaptable and, where required, interoperable. This will empower organisations and individuals alike, providing tangible benefits for businesses, society, government, and the environment. Advancements in digital twinning are not only instrumental in enhancing business efficiency and driving innovation, but also play a pivotal role in reinforcing the UK's ambition to become a global technology superpower by 2030. Recognising these benefits, through the NDTP, the government will continue to work with BSI to convene a group of relevant stakeholders, including regulators, to determine a roadmap for and develop the standards that will be needed to support the development and use of digital twins.

Recommendation 8 – Non-road mobile machinery (NRMM)

The government's forthcoming strategy on decarbonising NRMM should make clear how a regulatory framework could support the use of hydrogen combustion for NRMM.

Response

12. The government is already considering how a regulatory framework could support the uptake of hydrogen, including by NRMM. For instance:

a. The Low Carbon Hydrogen Standard sets a maximum threshold for greenhouse gas emissions allowed in the production process for hydrogen to be considered 'low carbon hydrogen', and a methodology for calculating emissions. Compliance with the standard will help ensure new low carbon hydrogen production makes a direct contribution to our carbon reduction targets.

b. The Department for Transport is preparing a legislative amendment to allow the road use of non-road mobile machinery (NRMM) fuelled by hydrogen where that machinery would otherwise be allowed to be driven on the road if powered by conventional fuels. This would allow such machinery to be driven on the road, provided they meet all other applicable safety and environmental requirements. This will enable, for instance, the movement of hydrogen powered mobile machinery, such as diggers, for short distances between construction sites. To achieve this, in 2024 the government plans to consult publicly on the draft text of a Statutory Instrument to amend Regulation 94 of The Road Vehicles (Construction and Use) Regulations 1986 in 2024.

13. Low carbon hydrogen is a critical component of our strategy to deliver energy security, drive economic growth and support net zero. The UK Hydrogen Strategy, published in August 2021, outlines a comprehensive roadmap for the development of the wider hydrogen economy over the 2020s to deliver the government's 2030 ambition, and the UK Hydrogen Strategy Updates to the Market, published in July and December 2022 and August 2023, outline the government's progress against our ambitions. Our ambition is to deliver up to 10GW of low carbon hydrogen production capacity by 2030, subject to affordability and value for money. To achieve this, we have launched the Net Zero Hydrogen Fund (capital support) and the Hydrogen Production Business Model (revenue support). This will help unlock private investment by providing a subsidy to close the gap between the cost of producing hydrogen and the price it can be sold for.

14. Hydrogen is an option for decarbonising NRMM, alongside electrification, biofuels, and synthetic fuels. Hydrogen is likely to be particularly well suited for NRMM applications, which require greater mobility, are operated in settings without a grid connection, and where other considerations, such as efficient refuelling, are priorities. NRMM can be powered by hydrogen either through use

of a fuel cell or an internal combustion engine, and there are also opportunities to retrofit existing NRMM to use hydrogen.

15. Since the introduction of the renewable transport fuels obligation (RTFO) development fuel obligation in 2019, hydrogen combustion has been an eligible use case to generate development renewable transport fuel certificates (dRTFCs).

16. In advance of the publication of a NRMM decarbonisation strategy, we will continue to engage with regulators and others to assess how a regulatory framework could further support the use of hydrogen combustion for NRMM.

Recommendation 9 – Clean fuels in maritime

The government should use its upcoming Clean Maritime Plan to send a clear signal to industry of its support for zero emission fuels and set out plans to stimulate demand in the sector.

Response

17. The government is in the process of refreshing the 2019 Clean Maritime Plan, which set out the route to net-zero for domestic shipping. It will build on the achievements of the previous Clean Maritime Plan and the 2021 Transport Decarbonisation Plan to accelerate maritime decarbonisation and efforts to reduce the sector's environmental impacts. The government recognises that zero emission fuels will have a key role to play in decarbonisation, which is why the refreshed Clean Maritime Plan will set out our commitment on how we will increase the uptake of these fuels in domestic maritime, alongside a clear trajectory for domestic decarbonisation and emissions reduction out to 2050. We will also reflect the work done at the International Maritime Organization in their latest greenhouse gas (GHG) negotiations, which agreed a revised GHG Strategy including a commitment to developing an international fuel standard and maritime emissions pricing mechanism to encourage the uptake of zero and near zero emission fuels.

Section 3: Driving a circular economy

Recommendations 10 and 11 – Composites, plastics and chemical recycling

Recommendation 10: The government should work with sectoral trade bodies, Catapult centres, sector councils and other relevant bodies to encourage the development of repair, reuse and recycling technology and capability for composites and other problematic waste streams, with a particular focus on how products can be made recyclable and to minimise waste.

Recommendation 11: The government should work with industry, academia and bodies such as UKRI to support innovation that embeds sustainable composites into the next generation of wind turbines and transport, through the creation of new fibres and matrices, sustainable design methods and new market dynamics that will encourage a circular materials ecosystem for composites.

Response

18. The government is supportive of initiatives which promote keeping products in use for longer and considers that improving the circularity of existing composites ("circular composites") will be as important as improving the recyclability of the next generation of materials ("sustainable composites"). Waste prevention and reuse have significant benefits, both environmentally and economically, through value retention, jobs growth and potential money saving for consumers. We want to prolong the lives of the materials and goods that we use and move society away from the inefficient 'linear' economic model of 'take, make, use, throw'. We recognise the importance of collaboration with a range of partners to engage businesses and encourage the development of repair, reuse and recycling technology and capability for composites and other problematic waste streams.

19. Decisions made at the design phase influence the durability of the product, the materials it is made of, how it is manufactured, if it can be repaired and recycled, and what happens to it at the end of life. Whilst linear take-make-waste supply chains are environmentally degenerative, circular supply chains can be regenerative as they place far less pressure on the Earth's planetary boundaries and hence its natural ecological carbon sinks and biodiversity.

20. Moving towards a circular economy will contribute to both the UK's Net Zero and Aichi Biodiversity Targets commitments. An analysis published in 2019 jointly by the Ellen MacArthur Foundation and Materials Economics in their joint article "Completing the Picture"[1] indicates that a shift towards a circular economy can help to reduce greenhouse gas emissions by 40% by 2050. Deloitte's 2023

[1] https://ellenmacarthurfoundation.org/completing-the-picture

Circular Economy Gap Report[2] also highlights the importance of circular supply chains for addressing the environmental challenges we face.

21. Our ambitions for waste prevention are reflected in Maximising Resources, Minimising Waste (MRMW), which constitutes the new Waste Prevention Programme for England and was published in July 2023. MRMW sets out our priorities for action to manage resources and waste in accordance with the waste hierarchy across three cross-cutting areas (designing out waste, systems and services, and data and information) and seven key sectors (construction, textiles, furniture, electronics, food, road vehicles, and plastics/packaging). It embeds our circular economy approach by retaining materials and goods in circulation for as long as possible and at their highest value, including through increasing reuse, repair and remanufacture.

22. The High Value Manufacturing (HVM) Catapult is working to establish a Design for Sustainability and Circularity Framework to help UK-based manufacturers to design products, services, supply chains and business models that are sustainable by design. This includes designing products for repair, extended life, reuse, remanufacture and recycling, taking into consideration environmental, societal, and economic viability. It will ensure UK-based businesses, including SMEs, have the expertise and tools they need to innovate and design the next generation of sustainable products and services.

23. The HVM Catapult is also helping UK businesses to develop new circular materials, technologies, and processes, including through recycling of electric batteries, packaging, glass, electrical machines, metal parts and advanced composites, as well as using chemical solvent processing for the recovery of valuable metals and minerals from e-waste. Several of the HVM Catapult's centres, including the National Composites Centre (NCC), Centre for Process Innovation (CPI), Advanced Manufacturing Research Centre (AMRC), National manufacturing Institute Scotland (NMIS) and Manufacturing Technology Centre (MTC), have well established collaborative activities for circular composites, including developing manufacturing technologies for recycling composite fibre.

24. The NCC's SusWIND programme brings together stakeholders across the wind energy sector to look at every aspect of the wind turbine product lifecycle to achieve a sustainable future.

25. The government recognises the importance of continuing to innovate in the renewable energy sector and is supportive of efforts to embed circular composites into wind turbines in the future. This is recognised in both Section 4.1.2 of the government's Net Zero Research and Innovation Framework[3] and Challenge 2.1 of the Net Zero Research and Innovation Delivery Plan[4].

[2] https://www.circularity-gap.world/2023
[3] https://www.gov.uk/government/publications/net-zero-research-and-innovation-framework
[4] https://www.gov.uk/government/publications/uk-net-zero-research-and-innovation-framework-delivery-plan-2022-to-2025

Recommendation 12 – Mass balance

The government should work with BSI, industry, academics and end users to support the development of common standards around what constitutes a mass balance approach in chemical recycling, with the aim of decoupling value creation from the consumption of fossil resources.

Response

26. The government recognises the importance of chemical recycling when used to complement mechanical recycling and the role of mass balance in creating the right conditions for further investment in the UK chemical recycling sector. Mass balance is a particular chain of custody model, by which inputs and outputs and associated information are transferred, monitored and controlled as they move through each step in the supply chain, ensuring credibility and transparency of associated recycling and sustainability claims. It is an established method already used by many businesses to allocate chemically recycled plastic to products made from plastic which are used in a range of applications including packaging, automotive and construction.

27. The government is currently consulting on whether to allow a mass balance approach to be used for the purpose of Plastic Packaging Tax. We are keen to hear from all interested stakeholders, including industry representatives, BSI, environmental organisations and experts to help inform the government's position and ensure any changes support the environmental aims and integrity of the tax. Should changes be introduced following the consultation, these will support further innovation and investment in the UK chemical recycling sector, helping to boost its commercialisation and supporting jobs and economic growth.

Recommendation 13 – Chemical safety

The government should consider with regulators, research institutions and industry how the design, manufacture and use of more efficient, safe and sustainable chemicals[5] can be facilitated. This could involve exploring bio-chemical alternatives to the most harmful Poly-fluorinated Alkyl Substances (PFAS). Where regulatory barriers to innovation are identified as part of this work, one option to consider might be the development of a regulatory sandbox in the north-east of England, given the density of chemicals manufacturing in this part of the UK.

Response

28. The government recognises there are opportunities to use innovation to develop alternatives to hazardous chemicals, noting that new technologies should be designed in a manner that does not risk undermining mechanical recycling. UK REACH already allows a five-year exemption from the registration duty when it is for the purposes of product and process orientated research and development. We will work with the Environment Agency and HSE to consider

[5] https://www.oecd.org/chemicalsafety/risk-management/sustainable-chemistry/

further how a regulatory sandbox could support the design, manufacture and use of more efficient, safe and sustainable chemicals.

Recommendation 14 – Building materials and techniques

The UK Green Building Council should convene industry and relevant members of the Catapult network to encourage greater testing and piloting of innovative solutions in the built environment, including advanced manufacturing solutions to support the transition to net zero.

Response

29. The UK Green Building Council (UKGBC) has an established innovation workstream, which seeks to identify and showcase best practice sustainability solutions for the built environment and support start-ups and innovators to access opportunities to scale their solutions and gain insight into the real estate market. The built environment ecosystem can be complex for innovators to navigate, particularly when it comes to identifying opportunities to pilot and test solutions.

30. UKGBC does not test or pilot solutions itself but is a membership organisation that is well placed to bring together various stakeholders across the built environment value chain to help facilitate this. UKGBC embraces this role to act as an industry convener to encourage greater piloting and adoption of innovative solutions in support of the UK's transition to net zero.

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