Department for Business, Energy & Industrial Strategy

bsi.

NPL National Physical Laboratory

UKAS United Kingdom Accreditation Service

Standards for the Fourth Industrial Revolution

HMG-NQI Action Plan to unlock the value of standards for innovation

July 2021

Any enquiries regarding this publication should be sent to us at:
enquiries@beis.gov.uk

Contents

Ministerial foreword

As we emerge from the challenges arising from the global pandemic, the UK Government's action is firmly focusing on building back better and unleashing innovation to propel an agile and strong long-term recovery. Our new, and recently published, Innovation Strategy provides the platform for the UK to be among the top three countries in the Global Innovation Index by 2030. At the same time, we are committed to capitalising on the opportunities of our new regulatory autonomy and forging Global Britain's place in the world as an independent trading nation.

We are already internationally recognised for our world-beating research and vibrant start-up community. But we need to do more to harness the full social and economic benefits that innovation can bring. Voluntary standards that describe agreed good practice can be a great enabler of innovation, playing a critical role in bridging the gap between brilliant ideas and commercial success. Standards come in many forms, from creating definitions and a vocabulary when a new sector starts to form, through to technical specifications that enable infant technologies to make that crucial jump to commercialisation.

We need to be first in developing the new standards required, as we were with the first standard anywhere on automated vehicle safety trials. Through standardisation, we can disseminate knowledge and know-how, speed up the adoption of cutting-edge technologies and maximise the benefit flowing from our target of increasing total UK Research and Development expenditure to 2.4 per cent of GDP by 2027. By offering leadership within international standardisation fora, we will promote our best practices, build on our first-mover advantages, support UK exports and help protect our citizens.

This UK Action Plan for standards and National Quality Infrastructure (NQI) will help unlock the potential of new technologies. We have a proud history of excellence and our organisations that lead on standardisation, measurement and accreditation – the British Standards Institution, the National Physical Laboratory and the United Kingdom Accreditation Service – are seen as world-leading. This Plan sets out how Government and the NQI partners will build on these strong foundations to ensure that standardisation rises to the challenges of the future by unlocking the synergies between stakeholder-led standardisation and Government's innovation priorities.

Delivery against the Plan's six actions will set the basis for a concerted collaborative effort between NQI, Government, businesses and our research community. And if necessary, we will refresh the Plan to ensure that our standards ecosystem continues to be internationally agile and supportive towards innovation and emerging sectors.

Lord Callanan, Minister for Business, Energy and Corporate Responsibility

Introduction

The world is changing faster than ever. Our economy and wider society are experiencing technological innovation at unprecedented scale and pace. The Fourth Industrial Revolution is characterised by the emergence of new technologies and their convergence in novel approaches. This process is creating new industries, changing existing ones and transforming the way things are produced and consumed. The increasing use of robotics and Artificial Intelligence in "smart" factories is driving productivity growth across the economy and new products and services – such as 'Internet of Things' devices, self-driving cars, drones and the hydrogen economy – offer real and significant opportunities to boost the UK's prosperity and raise our quality of life.

Securing the full economic and social benefits from innovation will be paramount to build back better and stimulate economic growth and productivity. Unleashing innovation will also enable us to tackle some of the most pressing challenges of our time, including climate change, cyber security and public health. Establishing policy frameworks that are fit for purpose and in which innovation can flourish whilst delivering safety, quality and efficiency will be critical to achieve these objectives.

Standards, measurement, and accredited conformity assessment play a critical role to support innovation and enable its swift and safe commercialisation. At the early stages, standardisation, as a process in itself, can create 'network effects' by bringing communities of innovators together to establish a common language and understanding around new technologies and foster collaboration. By codifying an agreed way of doing things, standards also act as a means of knowledge transfer to leverage R&D outputs and ensure interoperability, facilitating widespread adoption and deployment of new technologies. In interplay with measurement and accreditation, standards underpin a system that fosters trust in novel and complex technologies throughout the supply chain and with consumers, thereby helping drive up investment. Furthermore, engagement in international standardisation can project UK thought leadership and protect the interests of British consumers and businesses by ensuring that their voices are directly represented in the agreement of international standards.

The critical link between standards and innovation is well documented in academic work and literature. Evidence shows that different types of standards can support the development and deployment of emerging technologies at different stages of the innovation cycle, from early-stage terminology right through to standards that are concerned with interoperability, compatibility and quality.[1] It has also been suggested that public policy should actively consider and utilise standardisation processes to support

[1] O'Sullivan, E. & Brévignon-Dodin, L. (2012), *Role of Standardisation in support of Emerging Technologies*.

innovation.[2] The promotion of standards as part of innovation systems is also considered best practice internationally.[3]

Our domestic system of standards, measurement and accredited conformity assessment is known as National Quality Infrastructure (NQI). The UK is recognised as a leader internationally in how we deploy our NQI and the institutions underpinning it are considered to be a world-leading national asset. Our NQI supports the innovation process – from brilliant ideas through to commercial success – and is an integral part of the innovation ecosystem alongside agile regulation and intellectual property rights.

Standards and the National Quality Infrastructure

Standards describe agreed good practice in how things are made and done. They are developed through a stakeholder-driven process based on the principles of consensus, openness and transparency and allow businesses to maximise efficiency, reduce costs, manage risk and ensure trust. They differ from regulation in that they are of themselves voluntary. However, certain standards can also enable businesses to demonstrate that their product is safe and compliant with requirements set out in legislation and are recognised by Government for that purpose. Standards can contain technical requirements, guidance, vocabularies or other information. Where they contain parameters that can be verified, then measurement and accredited conformity assessment form an assurance framework that can provide consumer and industry confidence that the standards are being implemented correctly and consistently and will deliver the desired outcomes relating to safety, performance, or other criteria. Collectively, the system of standards, measurement, accredited conformity assessment and market surveillance is known as the National Quality Infrastructure (NQI). The UK's NQI is largely delivered by four internationally respected institutions:

- The British Standards Institution (BSI) is the UK's National Standards Body responsible independently for preparing national standards and for representing the UK in key international standardisation bodies.

- The National Physical Laboratory (NPL) is the UK's National Measurement Institute responsible for maintaining the UK's primary measurement standards that ensure the accuracy and consistency of measurement and providing the measurement capability that underpins the UK's prosperity and quality of life.

[2] Blind, K. (2013), *The Impact of Standards and Standardization on Innovation,* Nesta Working Paper No. 13/15. www.nesta.org.uk/wp13-15.

[3] OECD/Eurostat (2018), *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition*, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg, https://doi.org/10.1787/9789264304604-en.

- The United Kingdom Accreditation Service (UKAS) is the UK's National Accreditation Body and assures the competence, impartiality and integrity of testing, calibration, inspection and certification bodies by assessment against recognised international standards.

- The Office for Product Safety and Standards (OPSS), part of the Department for Business, Energy and Industrial Strategy, is responsible for Government policy on standards and accreditation and provides the regulatory and market surveillance infrastructure for many product sectors. OPSS is the national regulator for consumer product safety and legal metrology.

The Department for Business, Energy and Industrial Strategy (BEIS) has a Memorandum of Understanding with BSI and UKAS, which set out the relevance of their operations to public policy and describe their relationship with Government. NPL is a Public Corporation fully owned by BEIS.

The Better Regulation Executive (BRE)**,** within BEIS, leads the regulatory reform agenda across Government including in relation to innovation. As part of its policy responsibility to evolve the UK's regulatory system to best support innovation, BRE takes an interest in the role standards can play as a complement and alternative to statutory regulation. In addition, other Departments across Government take an interest in and lead on standardisation in their specific policy areas.

However, standardisation can face challenges in responding to technological innovation. The development of standards and agreement by consensus can be a time-intensive process and may delay the availability of relevant standards at the right point in the innovation cycle. A further issue is that, while the standardisation process is open for anyone to participate, innovators and SMEs find it more difficult to sustain effective participation and thus make their voice heard. Existing standards can also risk inadvertently locking in specific technological solutions and thereby hindering the swift deployment of new technologies across sectors. Whilst the NQI partners are aware of these challenges and already have measures in place to mitigate these risks, all partners recognise that further action is needed.

The UK Government and the NQI partners have agreed to work in partnership to implement actions to unlock the full potential of standards to support innovation and enable its swift and safe commercialisation. This joint Action Plan aims at a) making sure the NQI's tools and processes respond to the challenges posed by fast-paced technological change and b) securing effective synergies between standards, policy making and strategic research. To achieve this, Government and the NQI partners will work in partnership to implement six actions:

Number	Action
1	**Deploy an agile approach** to develop and review standards in priority areas to respond to the challenges of fast-paced technological change.
2	**Accelerate the digitalisation of standards** to foster greater efficiency and flexibility for industries of the future.
3	**Upscale engagement with stakeholders**, in particular innovators, smaller businesses and consumer representatives, to boost their participation in standardisation and draw in their views.
4	**Strengthen the strategic coordination** between Government, the NQI partners and UK Research and Innovation on future priorities for standardisation and the wider NQI to support innovation.
5	**Raise awareness of how standards** and the wider NQI can help inform and support the delivery of Government policies, in particular to enable innovation and the deployment of emerging technologies.
6	**Embed consideration of standards** in the policy-making process to unlock their value in fostering growth and innovation.

The ambition of this Action Plan is to place standards and the wider NQI at the centre of the UK's efforts to grow an inclusive, prosperous and green economy through technology-driven innovation. It is intended to complement and support the Government's recently published Innovation Strategy[4] to make the UK a global hub for innovation. Delivering against the Action Plan will help towards securing the full economic and social benefits from innovation and R&D and, thereby, foster economic growth and productivity, supporting the Government's aspiration to build back better as articulated in the Plan for Growth.[5] In doing so, it will assist the development of a knowledge-based and technology-driven economy across the country and help to level up opportunities and growth across the UK. It will also aid the efforts to cement the UK's position as a science superpower as articulated in the R&D Roadmap[6] and pave the way for a green recovery and transition to Net Zero through the use of new technologies. Finally, the Action Plan will also support our ambitions for Global Britain, as articulated in the Integrated Review of Security, Defence, Development and Foreign Policy[7], by leveraging our leadership in international standardisation to promote ethical use of new technologies and innovation in line with open societies and democratic values. This Action Plan complements Government's wider outreach and engagement efforts to support inclusive, multi-stakeholder approaches for

[4] Available at: https://www.gov.uk/government/publications/uk-innovation-strategy-leading-the-future-by-creating-it.
[5] Available at: https://www.gov.uk/government/publications/build-back-better-our-plan-for-growth.
[6] Available at: https://www.gov.uk/government/publications/uk-research-and-development-roadmap.
[7] Available at: https://www.gov.uk/government/publications/global-britain-in-a-competitive-age-the-integrated-review-of-security-defence-development-and-foreign-policy.

maximising UK benefits and opportunities from global standards throughout the innovation cycle.

The scope of this Action Plan is focused on those standards and wider outputs that are within the remit of the NQI partners, either directly or through participation in their relevant international fora and partnerships. It, therefore, does not cover other types of standards, such as professional standards, or global digital technical standards that are developed by other fora and organisations. In delivering the Action Plan, Government and the NQI partners will be mindful of the broader standardisation landscape in relevant areas.

Our approach to collaborative working

The Prime Minister's Council for Science and Technology, in its proposals for reforming the governance of technological innovation in 2018[8] called on Government to "consider as a matter of course the role of guidance, codes and standards alongside formal regulation". The White Paper on Regulation for the Fourth Industrial Revolution[9] asked the NQI partners to set out their future vision for how standards could be developed and reviewed, in a timely and inclusive way, to respond to the challenges and opportunities of the Fourth Industrial Revolution. Following the initial joint response from BSI, NPL and UKAS, Government and the NQI partners embarked on a distinct endeavour of collaborative working to develop this joint Action Plan.

A series of workshops involving representatives from BRE, OPSS, BSI, NPL, and UKAS explored the themes that underpin our future vision of standards. These workshops drew in relevant subject matter experts from across Government, Innovate UK (IUK) and the NQI partners. Together, representatives considered evidence and assumptions, and critically assessed associated challenges to identify required actions. This work was supported and driven forward by a joint working group comprising representatives from BRE, OPSS and the NQI partners.

Government and the NQI partners engaged external stakeholders, with a particular focus on the innovation community, to seek constructive challenge and feedback in shaping this Action Plan, ensuring that it reflected their input and expectations. In particular, a series of roundtables with a variety of organisations and experts helped inform this work. The resulting actions are listed on pages 19 to 23.

[8] Available at: https://www.gov.uk/government/publications/reforming-the-governance-of-technological-innovation.
[9] Available at: https://www.gov.uk/government/publications/regulation-for-the-fourth-industrial-revolution.

Our future vision for standards

An agile approach to develop and review standards

The fast-paced technological changes associated with the Fourth Industrial Revolution challenge the traditional way of developing and reviewing standards. The introduction and convergence of technologies like gene editing, quantum computing and the extensive use of Artificial Intelligence have the potential to swiftly transform business practice and the definition of "what good looks like" in a given sector or industry. The established process to develop and review standards therefore faces challenges in both keeping pace with and underpinning these developments in the economy. This risks missing opportunities for standards to support the roll-out of new products and services and, at worst, may lead to existing standards hindering new innovations from successfully entering the market.

Government and the NQI partners recognise that a different approach to standards-making is needed to keep up with fast-paced technological developments. To rise to this challenge, BSI has developed a new pathway to develop standards in a more agile way, called BSI Flex[10]. The aim is to provide a flexible approach to standardisation where there is still uncertainty around good practice and where approaches are likely to change rapidly. This approach shares the key characteristics of all standards in that they are developed by consensus between stakeholders and according to open consultation.

The BSI Flex approach works through a series of iterations of the standard, whose scope and pace are market-driven. It aims to deliver faster development times, early testing with users, and facilitated feedback mechanisms to reflect the views of stakeholders in a timely manner. Importantly, the iterative nature of the approach ensures responsiveness to changing definitions of "what good looks like" and the emphasis on online working to discuss and resolve issues responds to the needs of stakeholders in highly innovative areas. To ensure the legitimacy of Flex standards, versions are open for consultation, review and use by anyone. This ensures that any good practice agreed in "agile" standards reflects the thinking and views of a wide range of stakeholders, thus representing true consensus across industry, consumer interests as well as society more broadly.

The Flex approach was trialled in the development of a vocabulary for connected and autonomous vehicles[11] to establish a consistent, reliable set of terms and definitions in this sector and, more recently, in the development of guidelines for safe working in the Covid-

[10] Further information at: https://www.bsigroup.com/en-GB/our-services/standards-services/flex/.
[11] Available at: https://www.bsigroup.com/en-GB/CAV/cav-vocabulary/.

19 pandemic. BSI is now developing Flex standards to provide a framework for professional competencies in the built environment.

BSI Flex process to develop Safe Working Guidelines
BSI piloted the Flex process through the rapid development and iteration of a set of guidelines for safe working during the Covid-19 pandemic. The guidelines provided a framework to enable ongoing continual improvement and ensured that organisations could respond to changes as the business community learned more about safe working, and as Government requirements evolved. BSI published its first Safe Working Guidelines Flex standard in May 2020, and Versions 2 and 3 followed rapidly in July and August 2020[12] .
Following widespread international interest, BSI proposed Version 3 as the "seed" document for an international (ISO) standard, which was published in three months as ISO/PAS 45005:2020 Occupational health and safety management — General guidelines for safe working during the COVID-19 pandemic and adopted by BSI as PD ISO/PAS 45005. Depending on the future international course of the pandemic and the emergence of new information, the document will continue to be updated.

BSI Flex represents a targeted approach to respond to a specific need to move faster and in a more flexible way in certain sectors, complementing existing standards development routes. The identification of further areas that could benefit from the use of an agile approach will require horizon-scanning and engagement with stakeholders. In order to maximise the impact that BSI Flex can have to spur innovation, BSI will work with Government to identify critical priority areas that would benefit most from, and be appropriate for, this approach. An effective coordination function between Government, the NQI partners and Innovate UK will help inform these considerations. BSI will also consider any potential implications for measurement, certification and accreditation that flow from Flex standards and coordinate with NPL and UKAS as appropriate.

BSI will continue to refine the Flex approach and look to learn and share more widely from its experiences in agile standards, to see how it can support all standards development with new tools and techniques, such as those around collaborative authoring.

Digital transformation

The unprecedented scale of digital innovation across our economy and society offers real and significant opportunities to foster prosperity and raise our quality of life. The increasing use of digital technologies is already fundamentally transforming existing business models and ways of production by driving up efficiency through automation and the use of Artificial Intelligence and robotics in "smart" factories, as well as the increasing uptake of digital

[12] Available at: https://www.bsigroup.com/en-GB/topics/novel-coronavirus-covid-19/covid-19-guidelines/

tools by small businesses. Digital innovation has also enabled the emergence of entirely new products and services that are based on interconnected systems and the convergence of technologies, blurring the lines between the physical and digital world. The digital products and services associated with the Fourth Industrial Revolution are already profoundly changing how we produce, consume and interact socially. This has been both evidenced within, and accelerated by, the Covid-19 pandemic, for example through the large-scale move to virtual collaboration and social interaction.

The NQI has a fundamental role to play in supporting the digital transformation of the wider economy and to fully capitalise on the opportunities it offers. Standards underpin interoperability across different systems and technologies, including the Internet, telecoms, smart cities, and AI. Measurement, standards and accreditation provide the required infrastructure that enables data quality and ensures that decisions are driven by reliable, accurate and trusted data that is assured as being fit for purpose. Standards and agreed measurements for data collection, transmission, processing, storage, curation, analysis and, ultimately, disposal can help enhance the traceability of data and promote confidence in its use.

Standards that are underpinned by accreditation can also help mitigate risks that arise from the introduction of new digital technologies and processes for users and wider markets, for example cyber threats, data and identity theft and fraud. NQI partners, together with Government, have a key role to play facilitating and participating in standardisation to ensure that digital technologies promote safety and security by design, as the UK economy goes through a period of rapid digital transformation.

Measurement support for digital testing of PPE

Industry is increasingly exploring how to replace costly and time-consuming physical testing with modelling and simulations. Regulatory bodies are having to consider how to certify products and services that have not been physically tested (and in many cases not even produced yet). NPL is championing the move towards digitalisation of testing, working with industry to create the tools and know-how needed to generate data that can be trusted across supply chains and used with confidence to make traceable decisions.

A recent example of this is in the development of a digitalised test rig to test PPE face masks to recognised international standards, while delivering validated data for digital certification. The physical and digital test methods developed provide direct feedback to the design process, while assuring the quality of data throughout to provide traceability of the decisions made. When applied in conjunction with a controlled measurement process, a digital model of this kind can be used to significantly reduce the requirement for end-of-line physical testing, accelerating the time for product development and reducing the cost.

To best support the digitalisation of the wider economy, the NQI partners are committed to accelerating the digitalisation of standards to foster greater efficiency and flexibility for industries of the future. Specifically, NPL will develop the frameworks, good practice guides and skills training materials needed for innovators to adopt digitalised standards, in partnership with Government, BSI, UKAS and end users. BSI will further develop its capabilities to deliver machine-readable standards (standards as code) that are better suited and responsive to the needs of industries of the future. It will work with UKAS to identify opportunities where such standards could be underpinned by accredited certification.

Accredited certification enabling trust in electronic transactions
The UK eIDAS (Electronic Identification and Trust Services) Regulations set out rules for UK trust services and establish a legal framework for the provision and effect of electronic signatures, seals, time stamps, documents, registered delivery services and certificate services for website authentication. The Regulations were created to establish trust in electronic transactions between individuals, organisations and government entities. They require the auditing of Trust Service Providers (TSPs) – bodies providing digital certificates and creating and validating electronic signatures – by a certification body accredited by UKAS as the national accreditation body to the requirements of ISO/IEC 17065. UKAS worked with the Information Commissioner's Office to produce guidance for the implementation of the UK Regulations and bodies that certify TSPs under the ETSI (European Telecommunications Standards Institute) standards for the certification of TSPs. This example of certification underpinned by accreditation enables Government and end users to have confidence in the reliability and safety of services provided by TSPs.

While supporting digital transformation in the wider economy, the NQI is itself undergoing fundamental and radical change to adapt and fully exploit the benefits of new digital and data-driven tools, as evidenced by the rapid rollout of remote assessment procedures as an agile response to changing circumstances during the Covid-19 pandemic. For example, UKAS is progressing a 'digital evolution' of its business by using digital technology to improve and deliver accreditation, including through the use of blockchain technology for the introduction of new e-Certificates, allowing real-time verification of accredited certification status. BSI will work with stakeholders to overhaul its digital platforms to improve accessibility of, and mechanisms of feedback on, existing standards and to facilitate comment during their development. This will enable users to influence standardisation and to make an informed decision to select and use the standards best suited to their needs.

Openness and stakeholder participation

The introduction of entirely new products and services into our economy and society has the potential to foster prosperity and wellbeing, but can also raise important ethical, trust and security issues, creating new risks for consumers and businesses alike. It is, therefore, important that the development and delivery of standards that support innovation is based on, and reflective of, the views of the broadest possible range of stakeholders.

In the development of standards, different industry stakeholders – ranging from innovators and disrupters, through SMEs to multinationals – all provide valuable insights into market attitudes and emerging best practices and capabilities. Considered and effective engagement with all stakeholders, including the public and private sectors, is critical to ensure that standards are fit for purpose, facilitate innovation and can open market access to non-incumbents. This engagement is vital to help identify and evidence areas, or sectors, where standards need to be developed, or reviewed, to support innovation and adoption of new technologies. Standardisation can also be an avenue to engage the public and consumers in dialogue on emerging technologies, by permitting robust and constructive challenge, and thereby fostering confidence, leading to better products and services.

Whilst openness, transparency and engagement with stakeholders are integral and well-established elements of the standardisation process, Government and the NQI partners recognise that additional action is needed to ensure that all relevant views are effectively drawn in. In particular, innovators in SMEs, who are at the heart of the innovation community, often struggle to sustain effective participation in the standards-developing process.

In order to boost stakeholder participation, the NQI partners will conduct outreach campaigns targeted at innovators to raise awareness of, and demonstrate how, standards and other NQI outputs can support them with a focus on scale-up and commercialisation. These will focus on relevant facilitators and multiplier organisations, including the Catapult Network[13] and link into existing programmes such as Innovate UK EDGE[14], which is aimed at successful grant applicants, as well as targeting venture capital firms and angel investors. This engagement will seek to reposition the narrative around standards as a critical enabler of innovation and, in particular, serve as an opportunity to highlight routes into committee membership for innovators and SMEs and how, through feedback mechanisms on existing standards, they can influence prioritisation for future review. The engagement will also highlight the benefits of the BSI Flex approach as a reference point

[13] Further information at: https://catapult.org.uk/.
[14] Further information at: https://www.innovateukedge.ukri.org/about-us.

within the spectrum of standard development routes for innovators to foster greater adaptability and resilience to technological changes and other market shocks.

To lower the barriers for innovators and SMEs to participate in standardisation and to draw in their views more effectively, BSI will extend the use of virtual collaboration, including by routinely considering at what point in the development (or review) of a standard to organise virtual roundtables and/or webinars. In addition, BRE will work with Innovate UK to explore the possibility of creating future funding programmes that could facilitate and support the participation of innovators in standardisation programmes.

To support innovators' use of standards, BSI has worked with Innovate UK EDGE to make the full collection of standards on British Standards Online[15] available for Innovate UK's business advisers and the SMEs with growth potential they support. The collaboration will also enable BSI and Innovate UK to understand the uptake, recognise trends and gather insight on the use of standards for these innovators.

Standards to leverage strategic research

Strategic research and the new technologies and industries it creates is key to meeting the opportunities and challenges of building back better. Research outputs can maximise opportunities for a strong and durable economic recovery, charting our course as an independent global trading nation, as well as tackling climate change and the challenges posed by an ageing society. As the UK looks to cement its position as a science superpower and take a leading role in the new and emerging technologies of the Fourth Industrial Revolution, strategic research that lays the groundwork for industries of the future will become ever more important.

The NQI has a vital role to play in support of research at all stages, helping secure the maximum economic and social benefits it can yield. At the early stages, the NQI's horizon-scanning and engagement activities offer a unique source of insights to help detect emerging trends. Use of common standards to codify knowledge and insights in research reduces transaction costs and fosters collaboration through network effects. As research progresses, the NQI provides the confidence and assurance that accuracy and repeatability of results can be trusted, driving up investment and supporting scale-up of applied research. Standardisation can also act as a means to disseminate knowledge generated through research and so leverage research outputs to support the adoption of new technologies right across the economy.

Standards, measurement and accreditation thereby help to bridge the gap from brilliant ideas to commercial success. The value the NQI can bring to research and innovation is illustrated through NPL's leadership role within the UK National Quantum Technologies

[15] Accessible at: https://bsol.bsigroup.com/.

Programme[16] and BSI's role in supporting some of the Industrial Strategy Challenge Fund[17] areas such as the Faraday Battery Challenge.

BSI's support in the Faraday Battery Challenge
There is growing demand for batteries in electric vehicles, with the market estimated to be worth £5 billion to the UK and £50 billion to Europe by 2025. The Faraday Battery Challenge (FBC) is investing to scale-up and advance the production, use and recycling of batteries. This will help reduce emissions and air pollution, whilst creating new opportunities and industry in the UK.
Sponsored by Innovate UK through the FBC, BSI launched a standards programme in 2019 to develop and codify good practice and build public confidence in batteries and electric vehicles. This has enabled the development of three new standards covering health, safety and environmental considerations in battery manufacturing, design and use, and a strategic roadmap for future standards and their uptake.
This work is already demonstrating the effectiveness that strategic standardisation support can offer innovators and an emerging sector. Through targeted engagement, in-depth knowledge gathering activities, and BSI's fast-track standards creation process, a broad and diverse network of stakeholders has been established. Initial analysis has shown high levels of interest and involvement in the standards creation process from a broad range of stakeholders, and industry specifically.

Both Government and the NQI partners recognise the need for a more consistent approach that ensures the role of standards, measurement and accreditation is fully reflected in research programmes and innovation policy. In this context, the NQI should be considered part of the wider national innovation ecosystem and a key delivery partner, enabling the successful commercialisation of research outputs and innovation in the UK.

To achieve this, we will put in place effective mechanisms to coordinate between Government, the NQI partners and UK Research and Innovation (UKRI) to identify opportunities where standardisation, measurement and accreditation can support strategic research and leverage its outputs. This enhanced coordination will strengthen the links between the different horizon-scanning and foresight activities within both NQI and Government and use combined insights to inform future priorities. By bringing together expertise from across Government and the NQI partners, we will ensure that systematic consideration of, and early engagement with, the NQI is hardwired into policy development to shape the context in which future research programmes are developed.

To further support this effort, Government will empower Innovate UK to ensure that the scope and delivery of future innovation programmes and challenges reflect the potential

[16] Further information at: https://uknqt.ukri.org/.
[17] Further information at: https://www.ukri.org/our-work/our-main-funds/industrial-strategy-challenge-fund/.

opportunities for NQI outputs to support the commercialisation of innovation, helping to boost returns on public investment in strategic research.

Standards as a tool for public policy

Standards and the wider NQI can be a powerful tool to help achieve public policy objectives. While they are generally voluntary by nature, standards – supported by accreditation and measurement – can help boost productivity, facilitate trade, ensure quality, consistency and security and enhance the protection of consumers and the environment. In the context of the Fourth Industrial Revolution, the interplay between standards and Government policy can greatly facilitate the swift and safe introduction of innovative products and services.

Standards can support policy making in a variety of ways. For instance, insights and best practice generated through early-stage standardisation in areas of innovation, or emerging technology, can help inform regulatory approaches and make sure they are rooted in the emerging consensus within industry. Under certain circumstances, standardisation can act as a form of self-regulation, potentially reducing the need for direct Government or regulator intervention. In other cases, standards can complement outcome-focused regulation by providing an accepted means to demonstrate compliance with essential regulatory requirements. This presumption of conformity[18] empowers businesses to innovate whilst maintaining vital public safeguards. Measurement and accreditation can support this by enabling independent, third-party verification.

Government recognises that more consistent awareness amongst policy makers of the role standards can play is needed to ensure they are being used most effectively to support public policy. Therefore, through this Action Plan, Government will establish a ‘Standards Network’ for policy officials to share experience and best practice and to empower them to champion the use of standards in their Departments and across Government. The Network will also help identify suitable policy teams across Government for mutual secondments with the NQI partners to further strengthen the flow of information and knowledge exchange between organisations.

To help build capability within the policy profession and to raise the profile of standards across Government, the NQI partners will review and develop resources and toolkits for policy makers to inform good practice. The NQI partners will also develop and deliver a bespoke learning offer for policy makers to demonstrate how standards can support public policy. Government will work with the NQI to disseminate and promote these resources and learning opportunities to maximise their impact with policy makers, including through

[18] Since 1 January 2021, businesses are able to use ‘designated standards’ to provide presumption of conformity with GB law. A designated standard is a technical specification which may be recognised by Government in part or in full by publishing the reference on GOV.UK.

the Policy Profession Network and by inclusion in existing Government guidance and toolkits for policy officials.

Government and the NQI partners agree that consideration of standards and the wider NQI should be embedded upstream at an early stage of policy development. To support this, Government will explore how potential changes to its Better Regulation Framework[19] could help ensure more consistent consideration of standards throughout the policy cycle. Finally, the NQI partners, will continue to engage with the independent Regulatory Horizons Council to set out the potential opportunities for standards and the wider NQI to support the Council's recommendations for regulatory reform to unlock the safe deployment of emerging technologies. This approach will help towards standards being used more systematically and strengthen the effectiveness of Government policies.

Leading the world

Government and the NQI partners fully recognise the importance of international standards with a global reach, particularly for emerging technologies and products and services associated with the Fourth Industrial Revolution. The adoption of internationally accepted standards enables UK innovators and businesses to integrate into global supply chains and sell their cutting-edge products and services across the world. Our ability to shape these standards is key to projecting UK thought leadership, opening up markets and protecting the interests of British consumers and businesses for the future.

The UK's Integrated Review of Security, Defence, Development and Foreign Policy[20] sets out the imperative for the UK to embrace innovation in science and technology to boost national prosperity and strategic advantage and to shape the future frontiers of cyber, digital and emerging technology governance. It envisages a prominent role for the UK in shaping international standards, as an integral part of the broader ecosystem of international governance, including soft law and norms, international treaties and national regulation. International standardisation is also a critical vector for the UK to play a leading role in tackling global challenges such as climate change, cyber-security and public health.

Our success will depend on our ability to benefit from a first-mover advantage and put UK expertise at the forefront of international standardisation through engagement in the relevant international fora, as well as our ability to forge strategic alliances and partnerships with other countries. The UK, through our trade and mutual recognition agreements with partner countries and membership of the World Trade Organization (WTO), can complement this by promoting global convergence around international standards, reducing technical barriers to trade. This can be achieved by supporting

[19] Available at: https://www.gov.uk/government/publications/better-regulation-framework.
[20] Available at: https://www.gov.uk/government/publications/global-britain-in-a-competitive-age-the-integrated-review-of-security-defence-development-and-foreign-policy.

cooperation between standards bodies and promoting globally accepted standards as a basis for trading partners' regulations. Government recognises that the international standardisation landscape is complex with a variety of different organisations involved in the development of standards globally, both within, and outside of the WTO-recognised system.[21]

The wide range of existing international engagement activities puts the NQI partners in a unique position to support these efforts, exert soft power and help project UK interests on a global stage. This includes the membership and leading roles BSI, NPL and UKAS take in their respective international organisations, including the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC) and the International Accreditation Forum (IAF). In addition, the NQI partners have established fruitful partnerships and collaborations with specific groups of countries, helping to build support for UK positions and influence international standardisation activities. In particular, the Commonwealth Standards Network provides a platform for the UK to promote uptake of international standards and best practice and test proposals with a broad range of countries, which represent a majority of ISO members.

International representation in metrology

As an example of the reach of the NQI partners, NPL is influential in the work of both the international and European scientific metrology organizations, BIPM and EURAMET respectively, that collaboratively explore, and agree upon, how things are measured. NPL is currently represented on more than 400 international committees or professional bodies and also contributes to the Mutual Recognition Arrangements whereby institutes worldwide recognise the validity of each other's calibration and measurement certificates. Such representation is critical to the UK economy, reducing technical barriers to trade and increasing participation in global trade, resulting in a net positive balance of payments.

NPL is working with domestic and international partners to take a lead in the development of data quality frameworks that will capture standard procedures and good practice for capturing monitoring, quantifying and tracing data quality. This is vital to enabling UK industry to adopt internationally recognised digitalised processes and standards and to provide evidence of compliance that enables trade.

[21] The WTO has adopted principles to guide its member states in international standards development. The three major international standards bodies are the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and the International Telecommunication Union (ITU). Based in Geneva, they all operate on a national delegation principle (i.e. each member state is represented by their National Standards Body or, in the case of ITU, by their government). In addition to this formal (or *de jure*) standardisation system, there are a number of Standard Developing Organisations (SDOs) with a global reach and technical expertise in specific areas, which may not operate fully in line with the WTO Principles.

Government and the NQI partners are committed to ensuring that their respective international engagement activities are in lockstep and reinforce each other with a focus on strategic priorities. To that effect, we will establish an ongoing dialogue between our organisations to share information and coordinate on international engagement activities, drawing on the expertise of both sides, including cross-Government science and technology governance, the Regulatory Diplomacy initiative and the Government's efforts to strengthen International Regulatory Cooperation (IRC)[22]. It will also include consideration of the complex institutional landscape of international standardisation with a view to maximising Government and NQI partners' impact in relevant international fora, as part of the UK's wider strategic approach. Finally, the Agile Nations intergovernmental network, which the UK has recently established with six other countries, provides a forum for focused and ambitious engagement on the potential role of the NQI as part of wider agile approaches to regulating new technologies.[23]

Influencing international standardisation

The UK can take a strategic view of where standards will be internationally relevant. A large number of the most widely used international management standards, including those for quality management (ISO 9001), environmental management (ISO 14001), occupational health and safety (ISO 45001), information security (ISO/IEC 27001), and business continuity (ISO 22301) have their origins as British Standards developed in the UK, but which are now developed according to international consensus. In the digital space, the Cabinet Office originally sponsored standards in the PAS 1192 series on building information modelling (BIM) to help reduce costs in government construction procurement and to promote the uptake of BIM across the industry. A number of standards have now been taken up and developed for international consensus in the ISO 19650 series, founded on BS 1192 and PAS 1192-2. The UK continues to lead the work of the international committee.

To leverage the NQI's international engagement most effectively, policy makers across Government need to be fully aware of the role the NQI partners can play to support HMG strategic priorities.[24] To achieve this, Government and the NQI partners are committed to highlighting the opportunities for international engagement through the NQI as part of relevant guidance material for policy makers, including the cross-Government guidance on

[22] Department for Business, Energy and Industrial Strategy (2020), International Regulatory Cooperation for a Global Britain: Government Response to the OECD Review of International Regulatory Cooperation of the UK, https://www.gov.uk/government/publications/international-regulatory-cooperation-for-a-global-britain-government-response-to-an-oecd-review.

[23] Further information at: https://www.weforum.org/press/2020/12/nations-sign-first-agreement-to-unlock-potential-of-emerging-tech/.

[24] Available at: https://www.gov.uk/government/publications/global-britain-in-a-competitive-age-the-integrated-review-of-security-defence-development-and-foreign-policy.

science and technology, an IRC toolkit, as well as inclusion in materials and training on Regulatory Diplomacy made available to the network of UK overseas posts and UK-based trade advisers. This input will reflect good practice examples covering the breadth of the NQI partners' international engagement. Enhanced awareness of the NQI partners' international engagement activities will help ensure policy makers recognise its value and consider options to engage through them.

List of actions

Government and the National Quality Infrastructure (NQI) partners, BSI, NPL and UKAS, will work in partnership to implement the actions listed below to unlock the full potential of standards to support innovation and enable its swift and safe commercialisation by bridging the gap between brilliant ideas and commercial success.

1. Deploy an agile approach to develop and review standards in priority areas to respond to the challenges of fast-paced technological change. Specifically:

a) BSI will further develop governance principles for “Flex” standards setting out how and when this capability will be deployed, how the output relates to other types of standards and how a “Flex” standard can be moved into a more stable framework once the sector has matured.

b) BSI, supported by BRE, will work with Government to identify suitable priority areas in line with current strategic priorities to deploy the “Flex” standards capability and continue to refine it based on stakeholder needs.

c) BSI will work with NPL and UKAS to identify and coordinate on any potential interdependencies that may arise between “Flex” standards, measurement, and accreditation.

2. Accelerate the digitalisation of standards to foster greater efficiency and flexibility for industries of the future. Specifically:

a) BSI will further develop its capabilities to deliver machine-readable standards (standards as code), including by working and consulting with relevant stakeholders to reflect user needs. BSI will work with UKAS to identify opportunities where standards as code can be underpinned by accreditation to maximise confidence and assurance.

b) BSI will work with stakeholders to overhaul its digital platform to improve the accessibility of standards content and information and to facilitate feedback on existing standards and comment during their development. Links may also be made to BRE’s work to develop a potential Digital Regulation Navigator.

c) UKAS will further accelerate its use of innovation and digital technologies to deliver accreditation services. This includes further rolling out the use of blockchain technology for real-time verification of assessment data.

d) Once established, the Strategic Advisory Committee of UKAS will advise on areas where skills and capacity will need to be developed to respond effectively to the Fourth Industrial Revolution and future technologies.

e) NPL will develop the frameworks, good practice guides and skills training materials needed for innovators to adopt digitalised standards, in partnership with BSI, UKAS and end users. NPL will work with international partners through the International Committee for Weights and Measures (CIPM) Task Group on the “Digital SI Framework” (the International System of Units, the SI) to develop a world-wide uniform, unambiguous

and secure data exchange format for use in Internet of Things (IoT) networks. This will support the digital science and open-science paradigms and help get metrological services ready for artificial intelligence.

3. Upscale engagement with stakeholders, in particular innovators, smaller businesses and consumer representatives, to boost their participation in standardisation and draw in their views. Specifically:

a) BSI, NPL and UKAS will conduct outreach campaigns targeted at innovators to raise awareness of and demonstrate how standards and other NQI outputs support innovation at different stages. This will showcase the benefits of the 'Flex' approach, highlight routes to BSI committee membership with a view to draw in innovators and point to mechanisms for feedback on existing standards and their prioritisation for future review.

b) BSI will routinely consider, throughout the development (or review) of standards, opportunities for virtual collaboration to lower barriers for participation for innovators and SMEs and capture their views to maximise participation. BSI will proactively flag these opportunities through relevant channels and networks. In work conducted under the 'Flex' approach and/or in highly innovative areas, use of virtual collaboration should become the norm.

c) BSI will monitor the uptake of standards that have been made available as part of the BSI-Innovate UK EDGE agreement to support innovators' use of standards and will consider a potential extension to include the Catapults Network.

d) BSI, NPL and UKAS will work to leverage the UKQI web presence to increase the visibility of the role the National Quality Infrastructure can play to support innovation, including by showcasing good practice examples and highlighting benefits of the 'Flex' standards approach and machine-readable standards.

e) BRE will work with Innovate UK to explore the possibility of creating funding programmes that could set specific standards challenges as a complement to regulatory challenges. This will be used to facilitate and support the participation of innovators in the standardisation process and/or deployment of the 'Flex' standards approach on strategic priorities.

4. Strengthen the strategic coordination between Government, the NQI partners and UKRI on future priorities for standardisation and the wider NQI to support innovation. Specifically:

a) BRE will establish a coordination function between relevant teams across Government, the NQI partners and Innovate UK to:

   i. Provide a platform to share knowledge and insights on forthcoming priorities from different groups/fora from across Government, the NQI and Innovate UK;
   ii. Help shape innovation policy and programmes (e.g. future Challenge Funds) at the early stages by considering the NQI as part of the wider infrastructure and as a delivery partner;

iii. Identify critical priority areas that would benefit most from the deployment of a 'Flex' standards capability; and
iv. Ensure alignment of the NQI's international engagement activities with HMG strategic objectives as well as feeding back insights.

This will, in the first instance, take the form of bi-annual meetings involving representatives from relevant teams within each organisation. Specific arrangements will be kept under review.

b) BRE will invite the NQI partners to participate in its International Regulatory Cooperation (IRC) community of stakeholders, formed to promote alignment of HMG's international influencing on regulation and governance with the priorities and activities of regulators, standards bodies and business groups.

5. Raise awareness of how standards and the wider NQI can help inform and support the delivery of Government policies. Specifically:

a) OPSS will create a cross-Government Standards Network to enable sharing of experience and best practice between officials. Longer-term, members of the Network should be empowered to act as champions to raise the profile of standards within their Departments. The Network should also help identify suitable policy teams across HMG for potential NQI secondees.

b) BSI, NPL and UKAS will work together to develop a policy framework about the role that standards and the wider NQI can play as tools for public policy, including practical approaches and good practice examples. This should, in particular, highlight the value for innovation through the 'Flex' approach and pathways for international influencing through the NQI. OPSS and BRE will provide guidance and support to make sure this is relevant to the target audience of policy makers, regulators and diplomats in post. OPSS and BRE will work to disseminate this effectively and reference in relevant guidance documents and toolkits.

c) BSI, NPL and UKAS will work with the Policy Profession Network and Civil Service Learning to design and deliver a learning offer for officials to socialise how standards and the wider NQI can support public policy and be integrated in the knowledge and skills framework of the policy profession. BRE and OPSS will support the effective dissemination of this offer, including through the cross-Whitehall Policy Profession Network, as well as possible inclusion in induction courses.

d) BRE and the NQI partners will work with Innovate UK to a) set out the role of standards and the NQI as part of the wider infrastructure and b) consider the NQI as potential delivery partners in Innovate UK's strategic ambition and c) raise awareness of NQI amongst those who scope future innovation programmes and challenges.

6. Embed consideration of standards in the policy-making process to unlock their value in fostering growth and innovation. Specifically:

a) The Regulatory Horizons Council will engage with the NQI partners as part of evidence gathering to identify opportunities for standards and other NQI outputs to form part of the Council's recommendations for regulatory reform.

b) BRE will, as part of an ongoing review, explore and consult on changes to the Better Regulation Framework aimed at achieving a more systematic consideration of standards, including existing international standards or potential opportunities to develop these, as a complement or alternative to regulation.

c) OPSS will consider, as part of a future update, how the potential of standards and other NQI outputs to support innovation-friendly regulatory delivery could be reflected in the Regulators' Code.

Monitoring and evaluation

To monitor and evaluate the implementation of this Action Plan, a Standards for the Fourth Industrial Revolution Project Board will be set up, with senior-level representation from each partner organisation (BRE, OPSS, BSI, NPL, UKAS and Innovate UK). The Board will:

a) Provide overall guidance and direction to implementing the Action Plan, ensuring it remains viable and operates within known constraints for each partner organisation.

b) Review, and, where appropriate, challenge progress made against the agreed actions and provide steers and advice as appropriate to enable their effective delivery.

c) Identify any potential barriers to the delivery of the actions and agree necessary steps to deliver the desired outcome and implement them in a collaborative approach.

d) Approve actions when completed and transfer responsibility for realising any longer-term benefits to individual partner organisations.

e) Gather necessary evidence to assess the impact the actions have had in supporting the swift and safe commercialisation of innovative products and services in the UK and consider any future actions on that basis.

f) Work to publish a progress report one year on from publication of this Action Plan. The report will outline the progress made to date on each of the actions, and evaluate the impact they have made, as appropriate, including through stakeholder engagement.

Initially, the Board will meet twice a year. Specific arrangements will be kept under review with a focus on achieving outcomes. The Board will be supported by a joint working group, convened by BRE, with working-level representation from each partner organisation. The working group will share quarterly progress updates and work collaboratively to support the implementation of actions in a flexible way. It will also act as a joint secretariat for the Board and report progress and identify issues to be escalated to the Board.

This publication is available from: www.gov.uk/beis

If you need a version of this document in a more accessible format, please email enquiries@beis.gov.uk. Please tell us what format you need. It will help us if you say what assistive technology you use.