

ADVANCED  
MATERIALS  
RESEARCH &  
INNOVATION

HENRY · · · ·  
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INSTITUTE

# National Materials Innovation Strategy Framework

Stage 1

Consultation Draft  
April 2023

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# Preface

## Background

Materials innovation is a key driver of economic growth and competitiveness in the global marketplace and pervades almost every technological challenge facing society. For a cleaner energy future, we need materials with more efficient energy harvesting, storage and use. Likewise, health improvements for an ageing population, or better anti-viral coatings, cannot be achieved without major strides in our ability to tailor surfaces and add functionality to materials systems.

We have now reached a tipping point where the UK will struggle to achieve its ambitions for a healthy and resilient nation operating in a prosperous net zero economy, in the timescales demanded, without the support of a specific, clear, and standalone national strategy for materials innovation and technology translation. Critically, there is a need for a strategy that is sustained over the 10-20 years needed to deliver this change to which all parties remain committed, embracing the sustainable use of our resources.

The development of such a strategy also raises considerable challenges because it touches on almost every manufacturing sector in the UK, as well as nascent and emerging areas. It also spans a diverse set of stakeholders whose requirements, ambitions and desired outcomes may not necessarily immediately align and it must anticipate requirements for the development of an appropriately skilled UK workforce.

## Material's place in UK innovation

The potential offered by materials innovation<sup>1</sup> is acknowledged at the highest level of Government. The UK Innovation Strategy<sup>2</sup> laid out areas where the UK needed to build further upon its knowledge to become a global hub of innovation. It also singled out materials innovation and manufacturing as one of the seven key technology families that will 'transform our economy in the future'.

The expectation afforded by materials innovation also accurately reflects the world-renowned strength of UK research in material science, the highly skilled and innovative materials industries in the UK, and the central role materials advances

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<sup>1</sup> Innovation in any material (system) to which substantial 'value' is added through demanding application, processing or modification. Materials innovation can therefore range from advances in materials and improvements in our understanding/predictive capability of their performance through to the development of new functional systems and devices.

<sup>2</sup> <https://www.gov.uk/government/publications/uk-innovation-strategy-leading-the-future-by-creating-it>, BEIS, 2021

play in the drive toward achieving each of the four key innovation pillars – business, people, places and technology missions.

The UK's strengths in materials research and innovation also cut across many different sectors. This is significant given the overwhelming need for effective cross-sector collaboration to drive the wider growth, efficiency and productivity of the UK's economy.

### The vision

The vision is a national strategy for materials innovation which delivers coherency through the government, industry and the materials community, giving the UK a world-leading position in the rapidly expanding multi-billion-pound materials markets, substantially enhancing the value of UK-based industries.

The strategy will not only seek to grow and further develop our materials industry (both developers and users) but ensure that this capability remains strongly rooted in the UK and delivers long-term benefits to society as a whole.

This report describes the strategic framework development to deliver this ambition, along with the necessary strands of activity.

## Executive summary

As UK Research and Innovation's (UKRI) national institute for materials research and innovation, the Henry Royce Institute for advanced materials (Royce) has motivated the need for a National Materials Innovation Strategy, to be developed in partnership with the entire materials community. This topic has considerable inherent breadth and complexity. The challenge is to establish how and in which areas, the UK should take a leading role in the discovery, development, production, commercialisation and deployment of materials innovations at scale, recognising the constraints of sustainable use of our finite resources.

This initial study has been conducted to establish the framework for a National Materials Innovation Strategy, with an emphasis on technology translation. Specifically in the context of materials, innovation covers the path from materials discovery to value delivered, whether that be economic, environmental or social value.

The Strategy Framework presented provides a rigorous and robust way to:

1. Identify priorities for materials innovation aligned with national priorities and industrial demands
2. Identify the required enablers to deliver results for industry and the nation more broadly, including the commissioning of research, skills training, regulatory frameworks, investment and infrastructure barriers to innovation
3. Develop a set of preliminary investment cases for materials innovation so that industry, academia, financiers and Government can act in concert to deliver on the strategy

An initial selection of key reports of the UK context around materials innovation was reviewed and international comparisons have been made. A consultation was then undertaken with a broad selection of key stakeholders. These stakeholders included:

- Government departments including Department for Science, Industry and Technology, UK Treasury and agencies
- Industry including large manufacturers, SMEs and startups and wider industry
- Research and Technology Organisations (RTOs)
- Business Groups
- Funders, Banks, Private Equity Organisations and Venture Capitalists

The following key points are drawn from the research, interviews and subsequent analysis.

- Materials innovation and the associated manufacturing processes are fundamental to addressing key national priorities including net zero, productivity, resilience, security, health, welfare and economic and scientific development.
- At present, the UK is one of the largest global manufacturing nations contributing £203 billion per annum in GVA supporting, 5 million jobs across the value chain. 84% of this manufacturing takes place outside London and the South East - materials innovation is a bedrock of this far-reaching activity.
- The UK has many of the same drivers as other nations and is a leader in primary research in the field. However, it lags substantially behind many countries in technology translation to commercial reality.
- World-class materials innovation capability and capacity will require skills development of the current workforce and new talent.
- A step change in innovation across key industrial sectors may be delivered by drawing in public and private investment in the field.
- Materials and sustainability issues are increasingly linked and pervasive in and across global supply chains.

Moreover, materials innovation presents a particular challenge because of its pervasiveness and the breadth of influence which has traditionally led to an inability to focus national effort:

- Materials innovation cannot be considered in isolation as there are strong links to other strategic priorities of Government and industry. Despite or perhaps because of this, the topic is rarely top of mind with industry or policymakers and is very broad with many interconnecting aspects. There is a tacit assumption that materials innovation will just happen and respond to market or societal needs.
- Developments to date have failed to identify the combined economic, environmental, and societal benefits that come with a full cross-sector approach to materials innovation.
- Fragmented innovation funding to date has been inimical to effective large-scale innovation.

In summary, a system-wide perspective is required to address critical weaknesses in the lengthy and expensive commercialisation cycle. The strategy must identify and address gaps which hinder commercialisation such as:

- Absent or declining skills and capabilities in critical areas of the workforce.
- A lack of transparency around facility access for smaller companies that are key to innovation in the field.
- Underdeveloped cross-fertilisation from and translation across traditional sectors.

## Strategy Framework

The Framework presented here is a combination of both the underlying methodology and the practical processes required to deliver the strategy outputs. Its use is

challenge-led, meaning that it identifies the key national and global trends and drivers, which in turn inform the right opportunities for further exploration and development. Finally, it is acknowledged that developing a strategy is just the start; the plans and actions need to be implemented if national priorities are to be realised.

The proposed structure of the Strategy Framework and the methodology for gathering and assessing data, information, and opinions are summarised in Figure 1 under three broad themes:

- **WHY?** Identifying trends and drivers which require innovation
- **WHAT?** Clarifying and grouping the applications (products, services, solutions) and process development which provide the opportunities for value creation/impact
- **HOW?** Grouping materials innovation that will contribute to realising these opportunities and identifying the enablers required to support the materials innovation

Today <span style="font-size: 2em;">→</span> 2050	
<b>WHY?</b>	Global and National <b>Trends &amp; Drivers</b> (including 6 Policy Missions), Market and business needs, National and Regional Strategy, International and national competition
<b>WHAT?</b>	Value Creation: <b>Applications</b> (Products, Systems, Solution) and <b>Processes</b>
<b>HOW?</b>	<b>Technologies and Capabilities:</b> Advanced Materials, Production, Design, Digital Technologies
	<b>Enablers:</b> Infrastructure, Skills, Research, Policy, Standards, Regulations etc

**Figure 1: Structure of Materials Innovation Strategy Framework**

This top-down structure facilitates the effective identification, prioritisation and exploration of commercial opportunities in the field and the link to national priorities. It will support a prioritised approach through:

- Identification of relevant economic, social, and environmental ‘pull’ for new and emerging materials developments.

- Stimulating a cross-sector<sup>3</sup> dialogue offering a common language for engagement and analysis.
- Identification and selection of cross-sector ‘opportunities’ for detailed assessment.
- Identification and analysis of the materials innovation contribution to each of these opportunities including the impact and the feasibility of delivery.

All of the above would be enabled by partnering between industry, Government, and academia to identify and realise the true value inherent in the research, development, and innovation pipeline.

The strategy should be developed and delivered by a core project team, supported by a cross-sector advisory/steering group, drawn from the identified key stakeholders, including industry, Government and innovation agencies. This steering group is required to confirm the priority challenges to be adopted, and the associated industry groups involved, champion the strategy development, encourage involvement and comment on conclusions as they emerge.

The proposed approach is new because it is the first time that it is attempted to identify the cross-sector impact of selected, priority materials innovations. This will open up a significantly greater appreciation of the potential social, economic and environmental benefits and hence the justification of more concerted investment of time and funding in the selected priority areas.

This is a consultative document intended as input to the future development of the strategy, and comments and [feedback are welcomed](#).

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<sup>3</sup> **Sector**, an industrial grouping of companies fulfilling a broad customer need – Aerospace for passenger and military air transport.

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# 1. Background and Objectives

## 1.1 Background

As UKRI's national institute for materials research and innovation, the Henry Royce Institute for advanced materials (Royce) has motivated the need for a National Materials Innovation Strategy developed in partnership with the entire materials community.

The scope of materials innovation is economy-wide touching on markets, applications, supply chains, multiple associated technologies and capabilities and entire ecosystems. Materials interact with many other capabilities at varying degrees of 'technology readiness' to provide solutions to many pervasive challenges and opportunities. The challenge of this strategy will be to establish how the UK can take a global leading role in the discovery, development, production, technical deployment, application and commercialisation of materials, recognising the constraints of sustainable use of resources. To do this, the UK needs to be competitive in all aspects of the commercialisation pathway – from research to scale-up.

The development of a National Materials Innovation Strategy has been under consideration for many years. Reports by, for example, the *Materials Innovation Leadership Council*, [Advanced Materials for evidence by BEIS](#), and individual sectors' strategies have provided valuable input to the rapid advancement of this framework.

This document outlines a Strategic Framework for materials innovation which will support the scoping, definition and appropriate grouping of,

- National and industrial sector priorities including trends and drivers, market needs and industrial sectors
- Key application and process developments to which materials innovation can contribute via value-creation opportunities
- Materials innovations to support these applications and processes and further highlight the need for cross-sector collaborations
- The associated non-technological supporting enablers

In addition, mapping the main elements of supply and value chains for key markets will enable, during the strategy process, the identification of value-creation opportunities and key material innovations that generate the most economic, societal and environmental value. Advancing those will offer the greatest future value potential and impact national priorities.

The key associated gaps, barriers, enablers and interfaces in technology translation and commercialisation will be considered. Ultimately, the strategy should provide recommendations for:

1. Funding and other support for the commercialisation and translation of materials capabilities, technologies, and know-how, to support the acceleration of the materials commercialisation cycle. It is also possible that new areas of materials research are signalled to existing funding bodies.
2. Encouraging the development of investment vehicles – including public-private partnerships – may bridge the gap between basic research and commercialisation, and can lead to the development of new materials.
3. Providing incentives for companies to invest in new materials innovation and adoption. This can include tax credits, grants, and other forms of financial support to help offset the costs of research and development. In addition, the Government can provide regulatory incentives to encourage the adoption of new materials in key industries.
4. Supporting education and training programmes in materials science and engineering. The development of a skilled workforce in materials science and engineering is critical to the success of a National Materials Innovation Strategy.
5. Highlighting any substantial gaps in national infrastructure or capability which are a barrier to technology translation due to their absence, particularly concerning proof-of-concept and pilot trials.
6. Reviewing the impact which any relevant regulatory environment may be having on innovation opportunities

## 1.2 Why is a national strategy for materials innovation needed?

The following key points are drawn from the research, interviews and subsequent analysis.

- Materials innovation and the associated manufacturing processes are fundamental to addressing key national priorities including net zero, productivity, resilience, security, health, welfare and economic and scientific development.
- At present, the UK is one of the largest global manufacturing nations contributing £203 billion per annum in GVA supporting, 5 million jobs across the value chain. 84% of this manufacturing takes place outside London and the South East - materials innovation is a bedrock of this far-reaching activity.

- The UK has many of the same drivers as other nations and is a leader in primary research in the field. However, it lags substantially behind many countries in technology translation to commercial reality.
- World-class materials innovation capability and capacity will require skills development of the current workforce and new talent.
- A step change in innovation across key industrial sectors may be delivered by drawing in public and private investment in the field.
- Materials and sustainability issues are increasingly linked and pervasive in and across global supply chains.

Materials innovation presents a challenge because of its pervasiveness which has traditionally led to an insufficient focus of the national effort:

- Materials innovation cannot be considered in isolation as there are strong links to other strategic priorities of Government and industry. Despite or perhaps because of this, the topic is rarely top of mind with industry or policymakers and is very broad with many interconnecting aspects. There is a tacit assumption that materials innovation will just happen and respond to need.
- Developments to date have failed to identify the combined economic, environmental, and societal benefits that come with a full cross-sector approach
- Piecemeal innovation funding and associated development set-up to date have been inimical to effective large-scale innovation.

In summary, a system-wide perspective is required to address critical weaknesses in the lengthy and expensive commercialisation cycle. The strategy must identify and address gaps which hinder commercialisation such as:

- Absent or declining skills and capabilities in critical areas of the workforce
- A lack of transparency around facility access for smaller companies that are key to innovation in the field.
- Underdeveloped cross-fertilisation from and translation across historic sectors.

### 1.3 Objectives of the strategy

The goals in the development of the strategy will be to:

- Stimulate innovation, applications and market opportunity in the UK and overseas aligned to societal, environmental and economic goals
- Enable a strong foundation of capability in the UK
- Foster collaboration between academia, industry, and Government

- Better coordinate and (re)allocate the portfolio of investments in materials innovation and identify opportunities for gearing of international and national investment
- Grow and diversify a skilled UK workforce in materials innovation
- Create the right social and regulatory context across diverse market sectors to maximise the benefit to the UK through international engagement
- Address global challenges such as climate change, resource depletion and security through the development of sustainable materials and processes
- Identify key barriers in the required national infrastructure and opportunities to benefit from agile regulatory frameworks

The UK needs to focus resources and effort and make decisions about priorities. The framework will systematically prioritise the needs and opportunities in a consultative and traceable way and provide clear and transparent evidence for policy interventions.

#### 1.4 Key stakeholders for the strategy

The key stakeholders identified in consultations as having high involvement in and high impact on the strategy, and there potentially the most significant are listed in Table 1 below.

Stakeholders	Role	Require from the strategy
<b>DSIT</b>	Establish the priorities for funding as a champion of materials innovation.	Clear explanation, justification, and requirements for materials innovation
<b>UK Treasury</b>	Inform hard decisions on national growth and strategy to support the delivery of national aims, providing a managed consensus on a rational basis.	
<b>High Tech/ Innovative Manufacturers</b>	Users need the best function from and understanding of materials, to underpin world leader ambitions, attract investment and build reputation. They influence Government to bring materials innovation up the agenda and can act as advocates generally.	Require clarity on capability developments and business opportunities, provided by engaging in the development of strategy.

<b>Stakeholders</b>	<b>Role</b>	<b>Require from the strategy</b>
<b>Wider industry</b>	To grow by being responsive and innovative through use of materials innovations. Be fast, winning first mover advantage and gaining competitive edge in sustainability.	Provide coherence, confidence and mitigate risks inherent in development.
<b>Small companies, start-ups.</b>	Take risks to innovate that others cannot. This group is a key part of the innovation cycle, being early adopters or developers of new materials and/or approaches.	Place-based interventions. Understanding what areas of materials innovations may be the most commercially productive. Access to data/market knowledge, kit, engaging with big companies, accelerators, and facilities (scaling, financial support and so on.).
<b>RTOs</b>	Are influencers and support the translation/scaling of innovation and thereby growth of UK GDP. Undertake the difficult translation from research to commercialisation.	Want to see materials innovations as being publicly recognised (high-level messaging). A coherent ecosystem, application and scale-up, with a long-term plan to give confidence to invest and to reduce risk.
<b>Funders, VCs, Charities and Private Equity(PE).</b>	Financing and venturing investment.	Bring attention to materials innovation compared to other areas of investment, and insights into best opportunities, understanding risk implications, to make informed decisions on where to focus/bet.

## 2 The Strategy Framework

This section details the Strategic Framework for materials innovation developed through this project in consultation and testing with the materials community. It explains the structure of the framework and how it would be applied in a practical process.

### 2.1 Background

Strategy has been likened to a bridge linking where an organisation is at present to where it wants to be. A quotation from one of the early books on strategy sums up the essence of strategy,

*“The determination of the basic long-term goals and the objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals”.* (Chandler, 1962)

The focus of any strategy should be on goal setting, adopting a course of action and the allocation of resources to carry out the task. For developing a National Materials Innovation Strategy, many different considerations need to be considered such as the needs of different stakeholders, the relevant industrial sectors involved and the diversity of materials options at different stages of development.

The overall goals for a successful Materials Innovation Strategy should therefore:

1. Identify and prioritise high-potential areas where materials innovation can make an impact in creating new and significant forms of value while addressing national priorities. This needs to draw on existing data and information from a wide range of experts.
2. Select high-potential areas of opportunity for deeper-dive exploration, to further prioritise opportunities for value creation and identify the specific materials innovations and associated enablers to make these a reality.
3. Integrate across the opportunities and materials innovations the actions that will enable their development and provide a coordinated response with maximum impact.

For this reason, the overall methodology proposed here is based on the strategic roadmapping process<sup>4,5,6</sup>. Roadmaps<sup>7</sup> provide a structured visualisation of

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<sup>4</sup> [http://www3.eng.cam.ac.uk/research\\_db/publications/rp108](http://www3.eng.cam.ac.uk/research_db/publications/rp108)

<sup>5</sup> Phaal, R., Farrukh, C.J.P., Probert, D.R. (2004). “Customizing Roadmapping”, *Research Technology Management*, 47 (2), pp. 26–37.

<sup>6</sup> Phaal, R., Farrukh, C.J.P., Probert, D.R. (2007). “Strategic Roadmapping: A workshop-based approach for identifying and exploring innovation issues and opportunities”, *Engineering Management Journal*, 19 (1), pp. 16–24.

<sup>7</sup> Visual representation of strategic intent mapped over time.

information for specific strategic objectives. They are used to support planning across a broad spectrum of applications. This approach helps to collect, analyse, and validate data from a large number of relevant stakeholders and multiple perspectives systematically and objectively.

Roadmapping is a well-researched method that has been applied successfully to hundreds of highly complex challenges for Government, industry and academia, internationally. It combines both breadth and depth of information and can be scaled to the desired degree of information granularity while maintaining the traceability of input.

To make efficient, timely progress, and deliver actionable insights, a set of guiding principles for the design and operation of the strategy development process are

- A. To strive for simplicity while not being simplistic. Making trade-offs between breadth and depth in the materials innovation ecosystem. Providing sufficient granularity and robust evidence necessary to effect Government, industry, and academic action.
- B. Led by value and impact to anchor the purpose of materials innovation to the creation and delivery of significant positive economic, environmental and societal impacts for the UK.
- C. The necessity to prioritise, identifying cross-sector areas of high potential value, and hence advise where to deploy finite national resources for the biggest impacts. This will facilitate breaking down the silos between sectors that presently hinder much materials innovation.
- D. Not waiting until the end of strategy development to get the answers. Running a sequential programme activity with deskwork, workshops, and communications that deliver actionable insights.
- E. A process that encourages engagement of the membership of the materials innovation ecosystem.

## 2.2 Process for developing the Strategy Framework

The proposed Strategy Framework has been developed from a wide-ranging review and community consultation in three phases.

### **Phase (1): Research review and interviews**

Review of available published and unpublished materials, selected individual interviews with key stakeholders and the design of a first-pass Strategy Framework for review in phase two. A list of documents and individuals consulted, with a summary of findings is available.

## **Phase (2): Framework development**

An initial draft Strategy Framework was developed and populated with example data and a possible high-level approach to stage 2 strategy development was produced. A workshop was held on 9<sup>th</sup> March 2023 with a selected group of key stakeholders in collaboration with Royce and Urban Foresight, to develop and validate the emerging framework and prepare for a national launch event to announce the development of the strategy. In the workshop, the following activities were conducted:

- Understanding key stakeholders and their needs
- Developing the main messages to be presented at a future launch event for the strategy development
- Reviewing the overall framework and the process for the strategy development

Details of delegates at the workshop and key outputs are available.

## **Phase (3): Data analysis and reporting**

All data collected from the previous two phases were analysed and the outputs are summarised in this report. An outline of a process for the development of the strategy is included.

### **2.3 Governance for the development of the strategy**

An important starting point before deploying the Strategy Framework is to establish a core project team, supported by a cross-sector advisory/steering group, drawn from the identified key stakeholders, including industry, Government and innovation agencies. This team is currently called the **Materials Innovation Leadership Group**. This group will confirm the priority challenges to be adopted and the associated industry groups and research/innovation organisations involved, own and champion the strategy development, encourage involvement, comment on recommendations and conclusions as they emerge, own the outputs and drive implementation plans.



## 2.4 The Strategy Framework structure

The Strategy Framework will adopt a roadmap structure. This typically contains two axes. There is a horizontal, time-based axis; encompassing the current, short-, medium- and long-term, as well as the vision. The vertical axis contains perspectives, addressing the ‘Why’, ‘What’ and ‘How’ questions of the roadmap<sup>8</sup>. These are often represented as horizontal layers, forming a matrix across the time dimension. The timeframe of the strategy is expected to stretch to 2050.

The principle of ‘Why’, ‘What’, and ‘How’ is central to the roadmapping methodology adopted. This is outlined in Figure 2 below and then described in more detail.

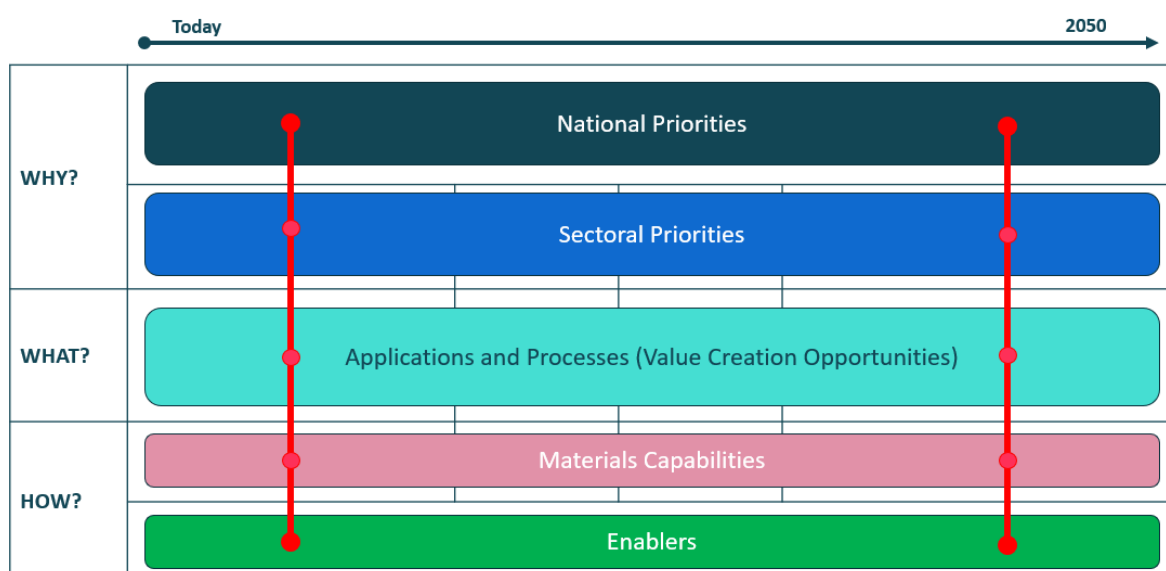


Figure 2: A roadmapping framework for materials innovation

Global and national trends and drivers which will be specific to an identified particular cross-sector opportunity<sup>9</sup> constitute the ‘Why’ layer. Information in the ‘Why’ layer typically addresses the external environment relevant to a particular opportunity. The specific cross-sector value creation application and process opportunities will be explored through relevant and specific applications and processes and will form the ‘What’ layer. This is a key layer of a roadmap that captures and explores tangible application and process opportunities that have the most potential for generating value, impact and delivering benefits to stakeholders. The ‘How’ layer will explore the specific materials capabilities and associated enablers required to realise the specific applications and processes.

<sup>8</sup> ‘An architectural framework for roadmapping: Towards visual strategy’, Robert Phaal and Gerrit Muller, *Technological Forecasting & Social Change* 76 (2009) 39–49, doi:10.1016/j.techfore.2008.03.018

<sup>9</sup> See next section for details on the process of identifying cross-sector opportunities

## 2.5 Process for applying the Strategy Framework

The framework has been designed to be used in a series of sequential steps. Multiple priority value creation opportunities can be explored and analysed in parallel enabling numerous cross-sector insights and actions to emerge. As the sequence is followed, consolidation of the outputs will aggregate key materials innovations, recommendations and actions so that industry, academia and policymakers may act in a coordinated fashion, thus addressing the need for the materials community to “speak with one voice.” The process of applying the framework has six key steps:

- A. Cross-sectoral **clustering**<sup>10</sup> of the national materials innovation scene for engagement and deeper analysis
- B. Identification of **national priorities** for the relevant economic, social, and environmental trends and drivers for new and emerging materials developments
- C. From A and B, the **Identification of high-priority** cross-sector areas of opportunity for detailed exploration and development
- D. Identification and assessment of the materials innovation contribution to each opportunity area, including associated risks and uncertainties in the **opportunity workstreams**
- E. Confirmation of cross-sector priorities and identification of associated enabling actions required by the **opportunity workstreams**
- F. **Strategy consolidation** including overall recommendations and actions

Figure 3 below is a schematic of the process, which is then described in more detail.

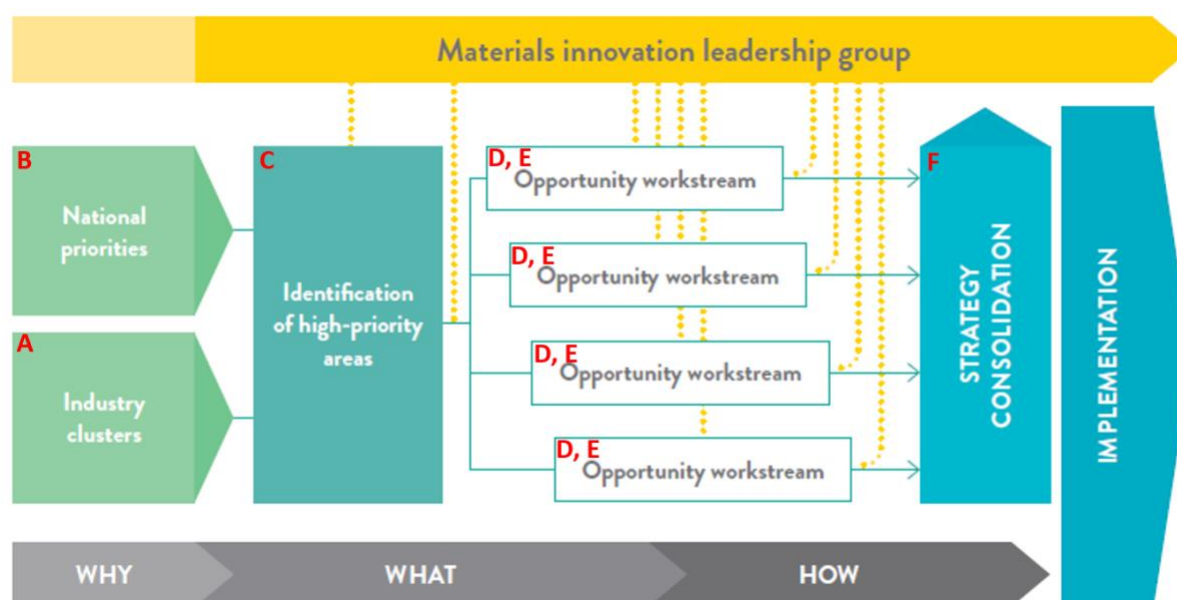


Figure 3<sup>11</sup>: High-level representation of the Strategy Framework and process.

<sup>10</sup> Note: Industry and cross-sector clusters are the same and may be used interchangeably.

<sup>11</sup> Graphic by Urban Foresight in the Launch Prospectus.

It is recommended that the following process steps will be followed in developing the strategy:

### **A. Cross-sectoral industry clustering of the national materials innovation scene for engagement and deeper analysis**

This activity may be delivered by an initial literature review, knowledge collated during this framework development, and desk research of existing information, such as previous national and international reports, and industry analysis reports (if available).

A series of interviews would be conducted with relevant experts in industrial sectors to collect preliminary data using custom-designed interview questionnaires. This will provide initial information on industry needs and requirements, areas of relative strength in the UK sector, existing capabilities and possible gaps.

Following this initial research the identification and clustering of sectors with common interests, or requirements can occur. These common interests may be related to similar drivers and/or similarly utilised materials. This will enable the development of a common roadmap structure (i.e. Strategy Framework) across multiple sectors for data gathering analysis and engagement.

Some examples of potential cross-sector clusters are as follows:

- *Infrastructure* (e.g. Construction, Buildings, Transport, Retail – focussed on sustainable development of physical infrastructure, connectivity and supply for society and industry)
- *Equipment, products, and life sciences* (e.g. Electronics and ICT, Automotive, Aerospace and Space, Machinery and Equipment, Furnishings, Marine, Rail, Defence & Security, Agritech and Agri Science)
- *Healthtech, Pharma* (Healthcare, Pharma, Medtech – focussed on development, supply and support of products and services, sustainably used)
- *Primary industries* (e.g. Foundation industries (Polymers, Metals, Chemicals, Cement, Ceramics, Glass, Paper), Energy, BioTech, Agriculture, Refinery and Fossil fuel, and new materials industries – focusing on the development and supply of inputs sustainably produced)
- *Food and fabric* (e.g. Food, Drink, Textiles) – which have a focus on both sustainable supply and use)

### **B. Identification of national priorities for the relevant economic, social, and environmental trends and drivers for new and emerging materials developments**

This activity would be delivered by a combination of a literature review and desk research of existing information, and a participant survey to enable the collection of data across different sectors within a cross-sector cluster. Interviews can also be used to clarify or supplement the data collected via other methods.

This activity will provide two types of important evidence i.e. common trends and drivers within a specific cross-sector cluster and common trends and drivers between the different cross-sector clusters. The former is important for guiding the identification and selection of important cross-sector opportunities within a cross-sector cluster. The latter will be important for identifying and selecting cross-sector opportunities relevant across different clustered sectors to leverage their development.

These can be for example national priorities, such as those below identified in consultations which formed part of this stage of work:

- Getting to net zero
- Growing a high-wage, highly-skilled workforce
- Supporting national resilience and Security
- Enabling healthy, happy lives
- Strengthening the UK as a global technology leader
- Rebalancing the UK economy

### **C. Identification of high-priority cross-sector areas of opportunity for detailed exploration and development**

This activity will review the key needs, trends and drivers (uncovered in activity A above) to identify relevant industry cross-sector application and process opportunities against the national and sector priorities relevant to each cross-sector cluster (as identified in Activity B above). This approach is what is different to what has been attempted before and should reveal materials innovation opportunities which span historically distinct industry sectors.

The identification of relevant cross-sector opportunities will be delivered by data analysis and consolidation of the information collected from the previous two steps and workshops. The workshops will be conducted with the Materials Innovation Leadership Group or their delegates to review and agree on the most appropriate cross-sector opportunities that will be the most appropriate for further development.

Opportunity prioritisation should involve the production and deployment of objective selection criteria that when taken together, provide a means to select high-potential

opportunities. These need to be developed in detail, but an example of possible assessment criteria<sup>12</sup> is shown in table 2 below.

Table 2: Example impact assessment criteria

Impact Assessment	
5	Very substantial and persistent improvement in UK competitiveness
4	Substantial medium-term improvement in UK competitiveness
3	Short-term improvement in UK competitiveness
2	Minor or temporary improvement in competitiveness
1	No improvement in UK competitiveness or negative impact

#### **D. Identification and assessment of the materials innovation contribution to each opportunity area, including associated risks and uncertainties in the opportunity workstreams**

For each selected cross-sector high-priority area, the following activities will be undertaken through a sequential programme involving a combination of research, analysis, information consolidation and prioritisation and stakeholder engagement. This will include desk research, surveys and facilitated workshops to develop cross-sector opportunity-specific strategies.

- Understand the national and international perspectives and current innovation ecosystem via desk research
- Using the key cross-sector trends and drivers identified in step A, derive high-potential application or process developments for materials innovation via desk research, surveys and workshops
- Understand the role of specific materials innovation or classes<sup>13</sup> of materials innovation in supporting the application and processes in concert with other relevant capabilities. This will be done via desk research, surveys and workshops
- Develop a Strengths, Weaknesses, Opportunities and Threats (S.W.O.T) assessment and agree on actions required to reduce uncertainty and/or take the opportunity forward including the competitive situation. This will be accomplished in facilitated workshops attended by industry and other experts.

<sup>12</sup> <https://www.tandfonline.com/doi/full/10.1080/08956308.2022.2026185>

<sup>13</sup> Importantly, not of the area of materials innovation is about new materials. More broadly, **Materials Capability Class** are the new and existing materials and capabilities, eg ability to predict or control corrosion.

- Develop a set of high-impact, enabling actions and recommendations, resource requirements and any new/redirected investments needed. This will be accomplished in facilitated workshops with materials innovation experts.

Each materials innovation developed through this process will be characterised as a ‘Hot spot’ or ‘White space’.

A ‘**Hot Spot**’ will be materials innovation which offers a significant opportunity to support a large-scale application and/or process development.

‘**White space**’ is a new and potentially attractive area of development. These areas will be identified where applicable and their requirements will be detailed to allow further development. This may include requirements for further research.

Figure 4, below, shows an example of materials capability development for Lightweight Structural Materials with linkage to applications and processes and national and sectoral needs.

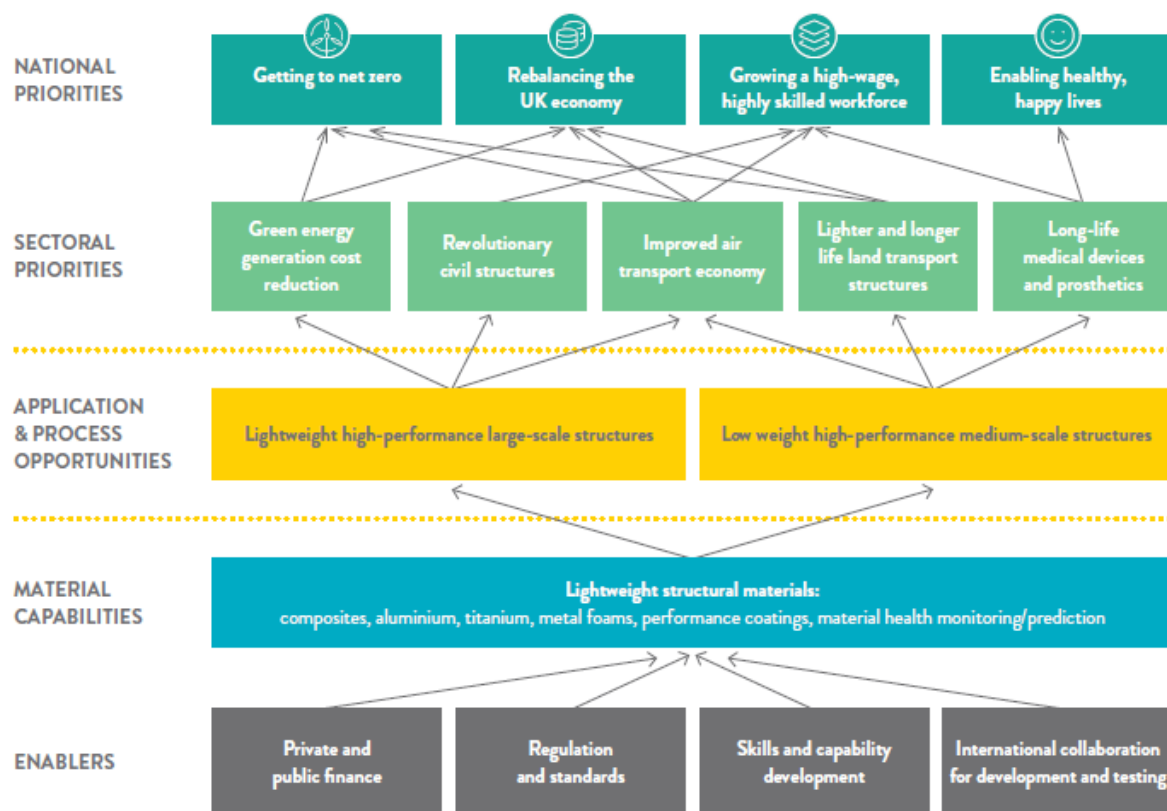


Figure 4: Example of materials capability development linkage to applications and processes and hence to national and sectoral needs

## **E. Confirmation of cross-sector priorities and identification of associated enabling actions also in the opportunity workstreams**

This step will be primarily conducted by desk research. It will be followed by the validation of workshop outputs, where the output from each cross-sector opportunity workstream will be summarised and specific recommendations and actions will be proposed.

Types of actions identified within each cross-sector opportunity workstream could be for example, innovation initiatives or research, the formation of consortia, the development of skills and capabilities programmes, the establishment of scale-up facilities, or policy interventions. Figure 5 next page, shows an example of how a priority material innovation opportunity output can be presented.

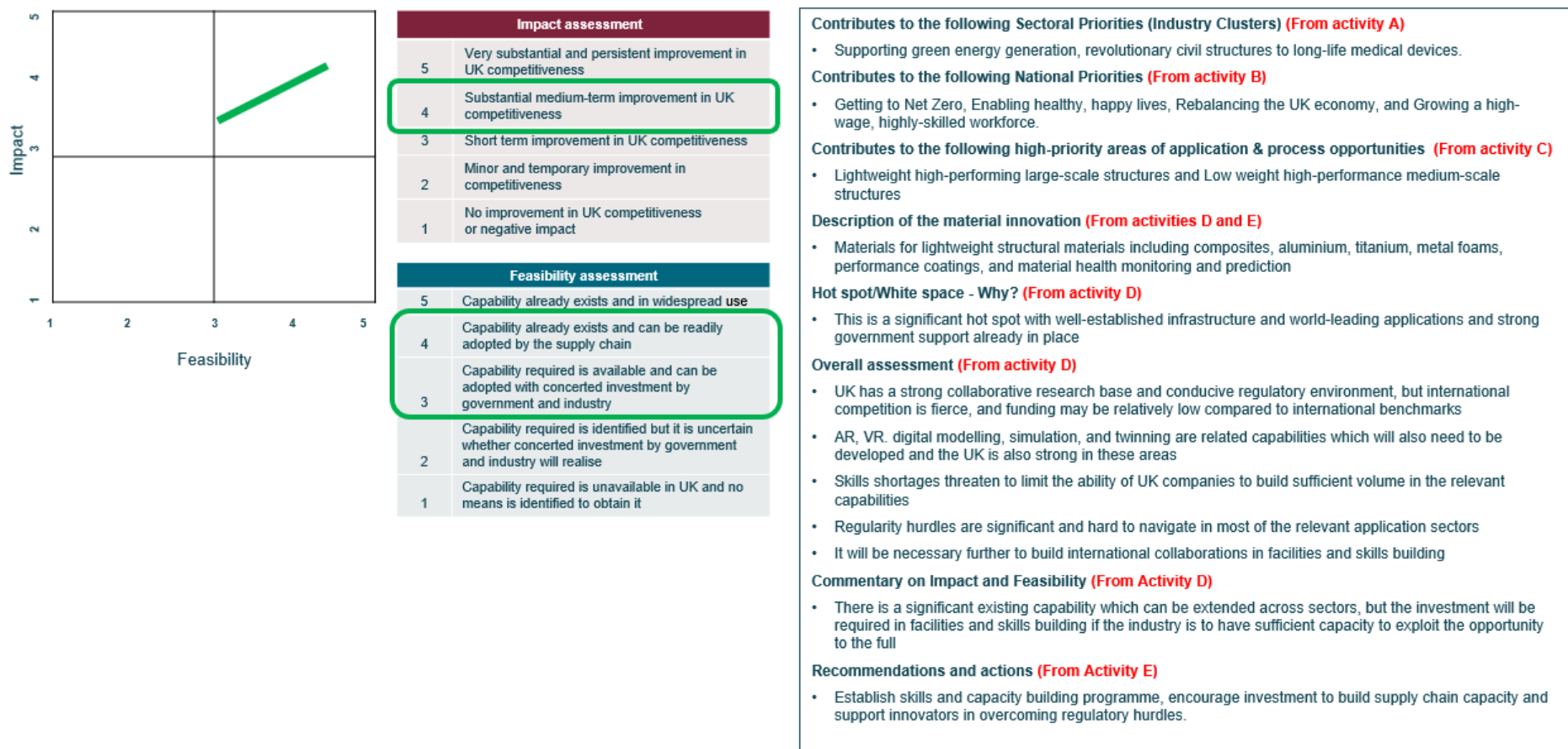


Figure 5: Example output for a material innovation in **Lightweight Materials**. The Impact-Feasibility chart on the left shows the relative importance of this material innovation. The tables in the middle highlight the Impact-Feasibility assessment criteria used and the score of this material innovation opportunity. The box on the right shows the summary of the information collected for this material innovation opportunity across all the different strategy steps.



## **F. Strategy consolidation including overall recommendations and actions**

The activities and outputs from the high-priority opportunities will develop a wide range of recommendations and actions. There is merit to consolidating these outputs to look for areas where activity can be leveraged thereby accelerating the impact potential. This step will also support strategy stakeholders in providing support across the materials innovations with investment and policy responses.

The framework takes a wide perspective of the materials innovation environment. In doing so, this strategy will identify and address areas where significant cross-sector funding can target gaps in innovation capabilities across the economy. It will therefore encourage collaboration between sectors, and broker connections that will endure as the ecosystem continues to realise its potential.

### 3. Next Steps

This is a consultative document intended as input to the future development of the strategy. Following feedback from key stakeholders, the following immediate actions are proposed:

1. Launch the Strategy Framework, take constructive feedback and create collective buy-in to resource the strategy's development.
2. Identify and establish the materials innovation leadership group and associated governance arrangements.
3. Finalise the methodology under that governance.
4. Appoint delivery support resources.
5. Build communication channels across industry, academia and key public and private sector organisations to enable participation throughout the strategy's development.

[Click here](#) to feedback on this Materials Innovation Strategy Framework

This report was commissioned by Henry Royce Institute for advanced materials to support the development of the National Materials Innovation Strategy Framework.

IfM Engage partners with organisations across industry, government and academia to support them in solving complex challenges, using approaches and knowledge developed at the Institute for Manufacturing (IfM), a division of the University of Cambridge's Department of Engineering. IfM Engage's offerings are grounded in exceptional research, combined with a breadth of industrial expertise.

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