

ANNEX D – Further Information on Practical Recommendations

SSAC Report - Environmental Impacts of the Scottish Manufacturing Industry

PR1: STRATEGIC COORDINATION OF SUSTAINABLE / CIRCULAR MANUFACTURING IN SCOTLAND

Urgent need to establish strategic pan-Scottish **coordination** of sustainable and circular manufacturing to drive the transition to Net Zero. Reporting to Scottish Government Policy and with financial support required for coordination, administration and potential project delivery.

DRIVERS

- There are many organisations working on sustainable circular manufacturing in Scotland towards Net Zero but there is a lack of coordination at a strategic pan-Scottish level.
- It is important to have independence between the owners of the ‘manufacturing environmental challenge’ and the ‘business growth challenge’.
- As a responsible nation where manufacturing is important, it is essential that Scotland avoids offshoring the challenge of manufacturing sustainability.

SPECIFICATION / KEY FEATURES:

- Coordination at a strategic level; holistic and cohesive pan-Scottish strategy; Scotland’s ability to balance internal supply on a sustainable basis.
- Strategic coordination should be carried out by a multi-disciplinary collaboration comprised of existing organisations across academia-industry-public sector¹
- A whole system approach must be adopted including supply chain integration, supported by policy and technology innovation.
- Reporting directly to Scottish Government policy teams².
- Provision of financial support is required for coordination, administration and for delivery of other key recommendations (e.g. PR2: Manufacturing Environmental Impact Roadmaps).

TERMS OF REFERENCE:

- Independent and have the ability to challenge and inform. It is important there is independence between the owners of the manufacturing environmental challenge and the owners of the business growth challenge (NMIS / industry / public sector agencies).
- Informs and challenges on climate change / environmental drivers, barriers, opportunities and impacts.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- Making Scotland’s Future programme; National Manufacturing Institute Scotland programme; COVID-19 Green Recovery Response.
- Coordinate with UK / wider initiatives where possible e.g. UK Strategic Leadership Councils³.
- All other Primary Recommendations (PR2 to PR11); SR1 Fiscal Measures for Materials Markets and Transition to Circular Economy; SR2 Offsetting Metrics and Credit for End-of-Life

¹ For example, ZWS; SEPA; CXC; NMIS; SE/HIE/SMAS; SRPe; key industry partners.

² Advanced Manufacturing policy (lead); other Manufacturing and industries division teams; Circular economy team; Climate change team.

³ For example, www.gov.uk/government/groups/synthetic-biology-leadership-council

reprocessing / Circularity; SR3 Investment Approach to R&D and Innovation towards Net Zero; SR6 Procurement Legislation for Environmental Impacts / Circularity.

PR2: MANUFACTURING ROADMAPS TO NET ZERO

Develop a suite of manufacturing sector **roadmaps to Net Zero**, including resilience and supply chain, at both the general manufacturing level and at the key sectoral levels. Identify priority activities and investments with a dual focus on product and process.

DRIVERS

- Some manufacturing sectors are advanced in their strategic planning towards sustainability and Net Zero, others are less so and more focused on economic priorities.
- It is important for each manufacturing sector to have a clear roadmap and strategy for Net Zero and to be aware of the current impacts and opportunities for improvement.

SPECIFICATION / KEY FEATURES:

- The roadmaps should be at both the general manufacturing level and sub-sector specific level.
- They should identify sustainability and resilience priorities and gaps, and highlight priorities for activity and investment⁴.
- Highlight priorities for activity / investment e.g. supply chain (including materials); resilience issues; new technology priorities / opportunities.
- They must focus on both product and process covering all sustainability, circularity and end-of-life issues.
- There must be cross-sectoral integration and adaption both within sector and cross-sector (e.g. SME innovation transfer across sectors).
- The first step should be an in-depth review of existing roadmaps and road mapping activities on national and international basis.
- The work should be extended beyond development of roadmaps, actively catalysing partnership working for sharing transferable lessons across other sectors.
- Delivered by PR1 Strategic Coordination of Sustainable / Circular Manufacturing in Scotland

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- They must align with existing sector strategies and roadmaps⁵⁶⁷⁸.
- All other Primary Recommendations (PR1, PR3 to PR11)
- Secondary Recommendations (SR1 to SR9)
- The UK Strategic Leadership Council roadmaps

⁴ For example, supply chain (including materials); resilience issues; new technology priorities / opportunities.

⁵ Scottish Environmental Protection Agency (SEPA) SEPA sector plans (<https://sectors.sepa.org.uk/>)

⁶ Zero Waste Scotland (ZWS) Zero Waste Scotland 'Industrial Decarbonisation and Energy Efficiency Roadmaps: Scottish Assessment' (<https://energy.zerowastescotland.org.uk/sites/default/files/downloadable-files/Industrial%20Decarbonisation%20and%20Energy%20Efficiency%20Roadmaps%20Scottish%20Assessment.pdf>)

⁷ High Value Manufacturing Catapult (HVMC) is at the outline planning stage of development of UK roadmaps: 'Road to Net Zero – Sustainable Materials & Manufacturing in UK (2020-2050)', and 'Road to Integrated Place & Resilience UK Manufacturing Strategy'

⁸ Relevant UK Strategic Leadership Council roadmaps

PR3: SKILLS FOR A GREENER MANUFACTURING FUTURE

Develop an integrated environmental impacts **training programme** for SMEs and industry targeted at supply chain opportunities and linked to Scottish Government Just Transition. Delivered by the National Manufacturing Institute Scotland (NMIS) and developed around existing courses.

DRIVERS:

- Scotland must develop the necessary skills to drive the transition to Net Zero manufacturing.

SPECIFICATION / KEY FEATURES:

- Develop an integrated environmental impacts training programme (CPD) for SME and industry targeted at supply chain opportunities.
- The programme should be a recognised and branded continuous professional development (CPD) and through-life portfolio of courses targeted at SMEs / industry with circularity and sustainability at its core.
- It should link to the Scottish Government Just Transition programme⁹
- It should be fully integrated with the SG / SDS¹⁰ Climate Emergency Skills Action Plan
- It should link to any employment issues around the COVID-19 Green Recovery
- Green economy / circularity / sustainability
- Targeted at SMEs / wider industry
- Branded integrated 'CPD and through-life' programme portfolio
- Holistic / full life cycle
- Could involve a qualification system (like six sigma belt)
- The programme should be developed by integrating and enhancing pre-existing materials / courses
- Delivery of modules across Scotland to cohorts from different disciplines and organisations should be through the existing network of universities and research organisations (e.g. NMIS)
- Offering CPD for all levels of business (from senior management to operations / technical)
- Delivered by a combination of face-to-face, virtual and blended delivery (virtual live streaming).
- Circularity and its practices key feature of the programme.
- Training / skills development programmes around Scottish supply chain opportunities should also be part of this.
- Potential to export this skills agenda raising Scotland's profile in this important area and contributing to the economic recovery agenda.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- SG Just Transition programme
- SG / SDS Climate Emergency Skills Action Plan
- Link to COVID-19 Green Recovery employment issues
- PR4: Scottish Supply Chain Opportunities; PR5: Product Design for Circularity; PR10 Sustainable Manufacturing Case Studies).

⁹ Scottish Government Just Transition programme <https://www.gov.scot/groups/just-transition-commission/>

¹⁰ Skills Development Scotland <https://www.skillsdevelopmentscotland.co.uk/>

PR4: SCOTTISH SUPPLY CHAIN OPPORTUNITIES AROUND NET ZERO

Identify **opportunities in supply chains** where Scotland is in a potentially strong position to lead in manufacturing in the context of domestic and global Net Zero. Link to Skills and to Scottish Government Just Transition.

DRIVERS:

- There is a priority requirement to increase supply chain resilience.
- There is continuing fragmentation of the manufacturing value chain and the operation of supply chains will play a major role in determining future changes¹¹.
- Most UK manufacturers have part of their supply chain located overseas¹².
- Reducing logistical / supply chain emissions, re-shoring whilst maintaining Scotland's position in international supply chains is a key challenge.
- Net Zero pressure is likely to increase the vulnerability of supply chains globally.
- The manufacturing sector is one of sectors most exposed to international supply chain disruption, changes in international demand and impacts on operations as exemplified by COVID-19.
- The reach of the intervention is important, as Green Economic Recovery requires a pan-Scottish approach and engagement with SMEs / industry.
- We are a trading nation and must not lose sight of this.
- Scotland is small so potentially can have a more joined-up supply chain than in larger countries and could become a global exemplar.

SPECIFICATION / KEY FEATURES:

- Opportunities should be identified where Scotland is potentially in a strong position to lead in manufacturing whilst meeting global and domestic low Net Zero commitments.
- The first step should be a detailed review of the existing manufacturing supply chain in Scotland.
- Both the manufacturing and supply aspects should be considered to avoid the risk of unintended consequences e.g. leading to offshoring.
- Identify opportunities where Scotland is well placed to lead in manufacturing whilst meeting global and domestic low Net Zero commitments and there is a priority requirement to increase supply chain resilience.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- Should be closely linked with SG Just Transition (skills redeployment / reskilling); Making Scotland's Future programme; High Value Manufacturing Catapult (HVMC) sustainable and resilient manufacturing road mapping activities currently underway.
- PR3: Skills for a Greener Manufacturing Future for identification of priority training / skills development.

¹¹ Future of manufacturing: a new era of opportunity and challenge for the UK

<https://www.gov.uk/government/publications/future-of-manufacturing>

¹² Sustainability and Manufacturing: Future of Manufacturing Project: Evidence Paper 35 Foresight, Government Office for Science

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/283909/e-p35-sustainability-and-manufacturing.pdf

PR5: PRODUCT DESIGN FOR CIRCULARITY

Integrate **circularity into the design of products**, with second life, reuse and reassembly addressed at product design stage, and approached from both a product and process perspective.

DRIVERS:

- Circularity¹³ must be at the heart of product design and all through the product lifecycle.
- Current understanding and adoption of the Circular Economy¹⁴ requires enhancement and with a much greater focus on the design activity as this is where the greatest impacts can be achieved.
- Disposal of raw materials/ adoption of circularity is currently a major issue.

SPECIFICATION / KEY FEATURES:

- Tackling climate change requires consideration not just of the immediate energy-related impacts of production, but the lifecycle carbon impacts of the materials used and products manufactured.
- Inclusion of embedded carbon impacts provides a more complete picture and highlights interventions required such as designing for longer life/ repairability/ modularity¹⁵.
- Must approach circularity in manufacturing from both a product and a process perspective

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- PR3 Skills for a Greener Manufacturing Future

¹³ Circularity involves innovation, product specification and design, the manufacturing process, product manufacturing and remanufacturing, and supply chains. At end of life, products are reused, remanufactured, or recycled.

¹⁴ Circular Economy = end-of-life - products are reused, remanufactured, recycled

¹⁵ Zero Waste Scotland internal summary document: Embodied carbon in the manufacturing industry.

PR6: INCENTIVES AND FINANCIAL INVESTMENT / RISK MANAGEMENT

Conduct a holistic review of incentives and tax based approaches covering the full product life cycle and manufacturing value chain. **Support for investment in new technology** using targeted fiscal measures and incentives with loans or grant e.g. from Scottish National Investment Bank.

DRIVERS:

- Investment in new technologies which often have long pay back times and high risks is a key challenge for the manufacturing industry, particularly for SMEs.
- The wider impacts of Brexit and COVID-19 further increase the level of uncertainty and pressure on finances.
- Additional support is required to incentivise the uptake of green state-of-the-art technology
- Scotland is a leader in renewables so there is a key opportunity to lead in green manufacturing.
- There is a need for financial support under the right circumstances. SMEs and innovators need support for environmental technology innovation to open up new potential markets.

SPECIFICATION / KEY FEATURES:

- Conduct a holistic review of incentives / tax-based approaches.
- Must ensure it covers the full product lifecycle and manufacturing value chain
- Support should include targeted fiscal measures e.g. new or additional tax credits in R&D investment; carbon tax benefits; incentives.
- Loans or grants from Scottish National Investment Bank¹⁶ should be considered as a potential mechanism for priority technologies.
- Tax benefits for moving to renewable energy sources / lower carbon inputs, and for using energy at the most carbon efficient times could support the transition.
- It is important to avoid any measures that risk rendering Scottish industry uncompetitive and displacing production overseas / carbon leakage.
- Financial pressures due to COVID-19

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- SR1: Fiscal Measures for Materials Markets and Transition to the Circular Economy; SR2: Offsetting Metrics and Credit for End-of-Life Reprocessing / Circularity; SR3: Investment Approach to R&D and Innovation.

¹⁶ Scottish National Investment Bank <https://www.gov.scot/policies/economic-growth/scottish-national-investment-bank/>

PR7: ENHANCED KNOWLEDGE EXCHANGE / COORDINATION FRAMEWORK

Develop an enhanced **knowledge exchange coordination framework**, based on the existing network of support organisations, to act as a 'one-stop shop' for decision-makers in manufacturing to seek advice and as a central portal for signposting of funding.

DRIVERS:

- Effective accessible mechanisms for industry-academic cooperation are key to achieving the accelerated pace of change required to meet Net Zero.
- An enhanced national-level knowledge exchange and coordination framework should be developed to act as a 'one-stop-shop' for decision-makers to seek advice and act as a central portal to signpost funding opportunities and key priorities.

SPECIFICATION / KEY FEATURES:

- It must be easily accessible to SMEs / industry and the database must be updated continuously.
- It will identify key requirements and facilitate holistic and tailored support provision to SMEs / industry.
- An environmental diagnostic approach / service like SMAS's digital manufacturing review¹⁷ should be adopted to review and establish companies' baseline positions and identify priority enhancements.
- The framework should be established by building upon and integrating the existing network of support organisations (e.g. ZWS; SEPA, NMIS etc.) and adopting a national centralized coordinated and strategic approach.
- The remit for each organisation must be clear including lead responsibility¹⁸.
- It should facilitate shared understanding of the economic and market growth opportunities from more sustainable manufacturing (e.g. energy cost reduction, access to socially responsible markets, etc.)

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- SR7 Research & Development and Innovation Coordination Framework.

¹⁷ Reviews and establish companies' baseline positions and identifies priority enhancements.

¹⁸ For example, the National Manufacturing Institute Scotland (NMIS) could lead the skills / CPD and R&D aspects in collaboration with Skills Development Scotland (SDS) and the Scottish Research Partnership in Engineering (SRPe).

PR8: STANDARDS AND CERTIFICATION FOR ENVIRONMENTAL IMPACTS / CIRCULARITY

Benchmark global best practice for **certification and standards** on environmental impacts and circularity for products and processes underpinning the future development or adoption of a recommended toolkit and Life Cycle Assessment (LCA) standard for Scotland.

DRIVERS:

- There are disparate approaches to incentives, certification and standards with varying degrees of activities across the manufacturing sectors towards Net Zero.
- Standards and certification must take account of impacts in Scotland and beyond including supply chain (trade agreements are important).

SPECIFICATION / KEY FEATURES:

- Global benchmarking and a holistic review of best practices for environmental standards and certification should be conducted.
- Both products and processes must be part of this.
- A certification similar to BREEAM¹⁹ in construction should be developed and implemented.
- The measurement and reporting framework must avoid burdening business with onerous administrative costs.
- The activity must join up with other existing initiatives (Scotland and beyond).

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- SR4 Life Cycle Assessment and SR5 Full Life Cycle Assessment Toolkit, Metrics and Monitoring.

¹⁹ BREEAM is the world's leading sustainability assessment method for master planning projects, infrastructure and buildings. <https://www.breeam.com/>

PR9: RESILIENT AND GREEN MANUFACTURING (COVID-19 GREEN RECOVERY)

Launch a dual initiative to tackle **resilience and environmental** aspects for responsible local production and supply. Form alliances with other nations with synergistic supply chains. Align this with SG COVID-19 Green Recovery Response and capture lessons learned from other sector responses to COVID-19.

PR9 considered as immediate priority in response to COVID-19.

DRIVERS:

- The manufacturing sector is one of the sectors most exposed to international supply chain disruption, changes in international demand and impacts on operations due to external national and global factors.
- COVID-19 has highlighted some existing vulnerabilities in the Scottish / UK manufacturing supply chains e.g. the ability to supply the NHS with key medical equipment and PPE.
- Supply chain resilience and the green / environmental aspects of manufacturing are two different challenges / issues, with potentially a shared solution, i.e. responsible and local production and supply.

SPECIFICATION / KEY FEATURES:

- A dual initiative should be launched with immediate priority tackling supply chain resilience and environmental aspects for responsible local production and supply.
- Activities should integrate efforts and approaches aimed at supporting decarbonisation / reducing the environmental impacts of the Scottish manufacturing sector into the green recovery programme.
- The highest priority issues must be identified and tackled first.
- Potential alliances should be explored and established with other nations with similar situations but different / complementary supply capability.
- The lessons learned from response to COVID-19 e.g. food / 3rd sector, should be captured.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- Link with the COVID-19 Green Recovery Response
- Link with HVMC sustainable and resilient manufacturing road mapping²⁰ activities currently underway.

²⁰ Within this HVMC is exploring the post COVID-19 priorities commencing 2020.

PR10: SUSTAINABLE MANUFACTURING CASE STUDIES

Collate and develop a suite of **case studies** across selected manufacturing sectors as part of a nationwide initiative building on the disruption caused by the COVID-19.

PR10 considered as immediate priority in response to COVID-19.

DRIVERS:

- Net Zero requires a major communication initiative with multiple stakeholders, including consumers, to ensure supply chains offer lower carbon / environmental impact alternatives, and to ensure that customers will be supportive and want to buy the greener potentially much more expensive options.
- There is potential to use Scotland's ongoing sustainability activity and credentials as a catalyst for sustainable manufacturing enhancement and increased sector awareness driving stakeholder buy-in.
- It is recognised that catastrophic climate change could have an even bigger impact on the economy than COVID-19

SPECIFICATIONS / KEY FEATURES:

- A suite of case studies / exemplars should be collated and developed with immediate priority across selected manufacturing sectors as part of a nationwide initiative.
- The case studies should showcase the processes adopted and what companies have achieved to make their business more environmentally friendly and they should be disseminated across the manufacturing sectors and supply chain.
- Lessons should be learned from delivery of previous communication / stakeholder awareness and influencing initiatives and campaigns²¹.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- Linked to COVID-19 Green Recovery Response
- Linked to PR3: Skills for a Greener Manufacturing Future programme

²¹ For example, smart meters.

PR11: INTEGRATED DIGITAL LEAN PRODUCTION SYSTEM

Develop an integrated **digital lean production system** integrating technologies to reduce waste and address sustainability allowing Scotland and the UK to move the dial simultaneously on sustainability and supply chain resilience.

PR11 considered as immediate priority in response to COVID-19.

DRIVERS:

- Elimination of waste is at the heart of both sustainability and manufacturing improvement.
- COVID-19 has heightened awareness of the fragility / vulnerability of Scottish / UK supply chain for certain critical items.
- Data, analytics and an evolution of lean thinking could be an important part of the solution.
- Better situational awareness of the global provision of critical items at the manufacturing logistics level has the potential to both eliminate unnecessary waste in manufacturing and provide genuine environmental benefits.
- The development and rapid exploitation of a next generation of continuous improvement thinking is timely and new innovative approaches should be considered.

SPECIFICATION / KEY FEATURES:

- A novel concept for integrating digital and lean production systems / technologies²² enabling waste reduction whilst addressing sustainability should be developed as an immediate priority.
- This provides an excellent opportunity for Scotland / UK to move the dial simultaneously on sustainability and supply chain resilience.
- An implementation route is possible through the Scottish Manufacturing Advisory Service²³ (SMAS) and this could be a SMAS / academic / industrial collaborative initiative.
- A local example of such a novel integrated system concept is LEAN4.0GREEN²⁴.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- Link to PR9 Resilient and Green Manufacturing

²² A local example of such an integrated system concept is LEAN4.0GREEN. Prof Michael Ward, University of Strathclyde developed the LEAN4.0GREEN concept via discussions with UK FIRES project (<https://ukfires.org/>) / HVMC. He wishes to retain the right to publish and develop spin-off research propositions in this area.

²³ Scottish Manufacturing Advisory Service (SMAS) <https://www.scottish-enterprise.com/support-for-businesses/develop-products-and-services/support-for-manufacturers>

²⁴ Professor Michael Ward, University of Strathclyde has developed the LEAN4.0GREEN concept through combined activities in UK FIRES and the HVMC. He wishes to retain the right to publish and develop spin-off research propositions in this area.

SECONDARY RECOMMENDATIONS

SR1: FISCAL MEASURES FOR MATERIALS MARKETS AND TRANSITION TO THE CIRCULAR ECONOMY

Develop and implement fiscal measures to ensure **stability of material demand** and insulate secondary from primary materials market fluctuations.

DRIVERS:

- The Circular Economy is a critical but currently underutilised tool in the climate change toolbox and improving material data is key to driving the transition to the Circular Economy²⁵, both at a company and national level.
- The existing waste industry is somewhat reactive with disconnect between producers, and waste management.
- Novel products and materials are placed on the market with little consideration of the end-of-life requirements. Addressing this is the key to a low-carbon, more circular economy.
- Established and ongoing megatrends²⁶ will have major material impacts in terms of material demand and secondary material supply²⁷.
- Planning for and investing around these known trends will ensure Scotland is positioned to take economic advantage of this.
- Currently, secondary materials compete with primary production irrespective of their lower environmental impacts. Hence, volatility in primary commodity markets can erase demand for secondary alternatives overnight.
- Decoupling secondary material markets from commodity price fluctuations is essential to drive long-term demand and investment in domestic reprocessing.

SPECIFICATION / KEY FEATURES:

- Fiscal measures are required to ensure stability of materials demand in the use of secondary materials and insulate demand for secondary materials from primary material market fluctuations.
- Fiscal measures could include e.g. primary material taxes, or minimum recycled content requirements.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- Linked to PR6 Incentives and Financial Investment / Risk Management; SR2 Offsetting Metric and Credit for End-of-Life Reprocessing / Circularity; SR3 Investment Approach to R&D and Innovation.

²⁵ Zero Waste Scotland (ZWS) <https://www.zerowastescotland.org.uk/> has already carried out considerable work in this arena.

²⁶ For example, rollout / retirement of renewable infrastructure

²⁷ For example, increasing windmill decommissioning, retirement of combustion vehicles, batteries and heating systems

SR2: OFFSETTING METRICS AND CREDIT FOR END-OF-LIFE REPROCESSING / CIRCULARITY

Establish a policy for driving **tax benefits incorporating offsetting** via Key Performance Indicators (KPIs) on low carbon. Credit end-of-life reprocessing, or moving to renewable energy.

DRIVERS:

- End-of-life reprocessing credit is required in Scotland for assets that do not then end up in the Scottish economy to offset some areas that are difficult to make circular in Scotland.
- Circularity may be difficult to achieve at the level of Scotland's economy and manufacturing and supply base, but offsetting could show how the country fits into a global view of the Circular Economy.

SPECIFICATION / KEY FEATURES:

- Develop a Scottish policy incorporating offsetting in the form of Key Performance Indicators (KPIs).
- Scotland's relatively strong maintenance, repair and overhaul (MRO) sector should be a feature of the policy.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- PR6 Incentives and Financial Investment / Risk Management; SR1: Fiscal Measures for Materials Markets and the Transition

SR3: INVESTMENT APPROACH TO R&D AND INNOVATION TOWARDS NET ZERO

Stimulate R&D and Innovation investment by **softening the investment boundaries between research and implementation of new technologies** towards Net Zero whilst adopting more of a 'course-correction' approach to testing / monitoring.

DRIVERS:

- Financing the research, development and applications of new and often unproven novel manufacturing and production methods, materials, technologies, products and services is a key challenge for the engineering / manufacturing sectors in moving towards Net Zero.
- There are many potential novel research ideas but R&D investment payback is often too long and the technical / financial risks too high for companies without government support and revised approaches to R&D and innovation / deployment.
- Currently the key issue for the manufacturing sector is that it is slow to embrace and adapt to these changes causing it to be vulnerable to supply chain issues and rising resource costs.

SPECIFICATION / KEY FEATURES:

- A review is required of the investment approach to R&D and innovation towards Net Zero.
- The review should be carried out with a view to softening the investment boundaries between research versus implementation, and adopting a more 'trial and error' and 'course-correction' type of approach to the interface with appropriate testing and monitoring via Key Performance Indicators (KPIs).
- The need for this has been escalated by the COVID-19 pandemic where rapid and timely translation of novel research to implemented solutions is critical.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- PR6 Incentives and Financial Investment / Risk Management; SR1 Fiscal Measures for Materials Markets and the Transition to the Circular Economy; SR2 Offsetting Metrics and Credit for End-of-Life Reprocessing / Circularity.

SR4: LIFE CYCLE ASSESSMENT (LCA) STANDARD FOR SCOTLAND

Review existing Life Cycle Assessment (LCA) standards for full lifecycle analysis including end of life and supply chain (nationally and globally). Identify the most appropriate and develop a **portal for standardised LCAs** to increase accessibility for SMEs / industry, and encourage wide adoption.

DRIVERS:

- Wide adoption of a LCA standard and traffic light / passport system would encourage data gathering and linkage between private sector procurement and support private sector procurement decisions potentially forming the basis of a future policy.
- LCAs are a significant challenge for SMEs as they do not typically have in-house expertise or the finances available to pay for this expertise.

SPECIFICATION / KEY FEATURES:

- Review existing LCA's and identify which is most appropriate to apply as a standardised measurement of emissions through the full life cycle from manufacturing process through to product end of life, including integration of design for circularity (design for reuse / remanufacture) and supply chain at both a national and global level.
- Ensure the LCA standard is applied consistently and comprehensively across Scotland.
- Incorporate a traffic light / passport system for measuring 'greenness'²⁸.
- Create a central portal for standardised LCAs to increase accessibility by SMEs / industry, and to encourage wide adoption.
- Any policy created must avoid unintended consequence of offshoring manufacture so the scope must be broad and consider manufacturing and supply.
- A potential source of funding for this development could be the Scottish National Investment Bank (SNIB)¹⁷.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- Integrate with PR7 Enhanced Knowledge Exchange / Coordination Framework.
- Link to PR5 Product Design for Circularity; PR8 Standards and Certification for Environmental Impacts / Circularity; SR5 Full Life Cycle Assessment Toolkit, Metrics and Monitoring; SR6 Procurement Legislation for Environmental Impacts / Circularity Impacts / Circularity.
- The UK FIRES project²⁹ is currently developing such a system / standard using a sustainability passport and traffic light approach.
- The European Commission believes that LCAs provide the best framework for assessing the environmental impacts of products. Need more consistent data and consensus LCA methodologies. Current project 'European Platform on Life Cycle Assessment (LCA)'³⁰ standardising LCA of some key products.

²⁸ Analogous to the nutrition label on food products and the 'smart meter' approach for in-factory standards.

²⁹ UK FIRES project <https://ukfires.org/>

³⁰ The European Commission believes that LCAs provide the best framework for assessing the potential environmental impacts of products, with a need for more consistent data and consensus LCA methodologies <https://ec.europa.eu/environment/ipp/lca.htm>.

SR5: FULL LIFE CYCLE ASSESSMENT TOOLKIT, METRICS AND MONITORING

Develop a **toolkit and standardized database** for SMEs/ industry with holistic systems thinking addressing full lifecycle impacts and circularity enabling reporting and monitoring of sectoral and national trends.

DRIVERS:

- For circularity and sustainability there is a requirement to embed holistic systems thinking and address full life cycle impacts / circularity (cradle to eventual grave of manufactured products) leading to a standardised toolkit approach with an underpinning database.

SPECIFICATION / KEY FEATURES:

- Develop a toolkit / suite of assessment tools, easily accessible to SME's / industry
- Create an enhanced sectoral reporting and monitoring framework against common metrics to enable monitoring of sectoral and national level trends.
- A potential source of funding for this development could be the Scottish National Investment Bank (SNIB)

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- Link to PR5 Product Design for Circularity; PR7 Enhanced Knowledge Exchange / Coordination Framework; PR8 Standards and Certification for Environmental Impacts / Circularity; SR4 Life Cycle Assessment (LCA) Standard for Scotland.

SR6: PROCUREMENT LEGISLATION FOR ENVIRONMENTAL IMPACTS / CIRCULARITY

Embed **environmental, low carbon and circularity** considerations as key criteria and levers in **procurement** in the private and public sectors through legislation.

DRIVERS:

- In addition to being embedded in the public sector procurement there is a requirement for environmental, low carbon and circularity considerations to be embedded as key criteria in private sector procurement through levers such as legislation.
- The Scottish Government Sustainable Procurement Guidance³¹ provides a range of guidance to help public sector organisations embed sustainability into their procurement processes.
- ZWS has conducted considerable work on the Circular Economy and is supporting implementation of sustainable procurement practices in the public sector^{32 33}.

SPECIFICATION / KEY FEATURES:

- Implementation of environmental, low carbon and circularity considerations outside the public arena requires to be addressed through levers such as legislation.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- Link to PR5: Product Design for Circularity; PR7 Enhanced Knowledge Exchange / Coordination Framework; PR8 Standards and Certification for Environmental Impacts / Circularity; SR4 Life Cycle Assessment (LCA) Standard for Scotland; SR5 Full Life Cycle Assessment Toolkit, Metrics and Monitoring.

³¹ Scottish Government Sustainable Procurement Guidance <https://www.gov.scot/collections/sustainable-procurement-guidance/>

³² Sustainable procurement - Implementing sustainable procurement practices in the public sector <https://www.zerowastescotland.org.uk/content/sustainable-procurement>

³³ Circular Procurement <https://www.zerowastescotland.org.uk/circular-economy/circular-procurement>

SR7: RESEARCH & DEVELOPMENT AND INNOVATION COORDINATION FRAMEWORK

Launch a **coordinating framework for R&D** and industry support for coordination of existing capabilities and activities across Scotland, and for identification of gaps and opportunities at a pan-Scottish strategic level.

DRIVERS:

- Multiple high impact activities are already underway across Scotland towards Net Zero. However, the landscape can be disjointed and confusing for key industry stakeholders.
- There is an urgent need to launch a strategic level coordinating framework for R&D / industry support for coordinating all of the existing capabilities and activities across Scotland and for identification of gaps and opportunities.

SPECIFICATION / KEY FEATURES

- NMIS can provide such a strategic framework for pan-Scottish R&D and industry support activities to drive economic growth across the Scottish manufacturing sectors.
- The framework should be developed by bringing together existing capabilities across Scotland via collaborative partners³⁴ by identifying new R&D and technology development capability / skills gaps and opportunities.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- Link to the cross-cutting strategic theme across NMIS activities towards reduction of GHG emissions and environmental impacts in manufacturing.
- Link to the Scottish Government Making Scotland's Future programme's low carbon & sustainability cross-cutting theme.
- PR3 Skills for a Greener Manufacturing Future; PR7: Enhanced Knowledge Exchange / Coordination Framework.

³⁴ For example, the Scottish Research Partnership in Engineering (SRPe) <https://www.srpe.ac.uk/>; the Scottish Institute of Remanufacture (SIR); the Industrial Decarbonisation Research and Innovation Centre (IDRIC) <https://idric.org/>

SR8: DIGITAL APPROACHES TO CIRCULARITY AND MANUFACTURING VALUE CHAIN

Develop **digital approaches to environmental impacts and circularity** through digital twins at the planning stage. Gather data during product use, develop a framework of digital models for the manufacturing sectors and develop a digitized manufacturing value chain.

DRIVERS:

- There are some key opportunities for the increased adoption of digital approaches to environmental considerations / circularity³⁵ and during product use³⁶.
- There are also key opportunities in relation to the development of digitised manufacturing value chains.

SPECIFICATION / KEY FEATURES:

- Gather data during product use across the full lifecycle and use this to develop a framework of key digital models on a manufacturing sectoral basis.
- Use advanced computing, software and sensor technologies to transform the manufacturing value chain and improve customer relationship management, process control, product verification, logistics, product traceability and safety systems.
- Develop greater design freedom through the uses of simulation and create new ways to bring customers into the design process and suppliers into complex production processes.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- PR5 Product Design for Circularity; PR7 Enhanced Knowledge Exchange / Coordination Framework; PR8 Standards and Certification for Environmental Impacts / Circularity.

³⁵ For example, through digital twins at planning stage, enhanced monitoring through manufacturing processes and better data collection.

³⁶ For example, smart product; remote diagnostics.

SR9: INNOVATION IN BUSINESS MODELS FOR REDUCED ENVIRONMENTAL IMPACT

Launch a **review of business models and develop a framework and tools** for enhancing optimization and reduction of environmental impacts across business processes.

DRIVERS:

- New innovative business models can be a key tool in reducing environmental impact.

SPECIFICATION / KEY FEATURES:

- Launch a review of existing manufacturing and product through-life business models.
- Develop a framework and tools for reducing environmental impacts and enhancing optimization across business processes.

LINKS TO OTHER PROGRAMMES / RECOMMENDATIONS:

- PR7 Enhanced Knowledge Exchange / Coordination Framework.