# EXPRESSION OF INTEREST FOR SFC ALLIANCES FOR RESEARCH CHALLENGES (ARC)

## CHALLENGE AREA:

**Accelerating Productivity, Circularity and Resilience in a Decarbonised Manufacturing Sector**

This Expression of Interest is submitted by the Scottish Research Partnership in Engineering (SRPe) as lead partner of the proposed 'Scottish Alliance for Research in Advanced Manufacturing' (SARAM).

## RELEVANT CONTACT DETAILS:

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## INTERESTED PARTNER UNIVERSITIES / ORGANISATIONS:

| | | |
|---|---|---|
| Scottish Research Partnership in Engineering (SRPe) (Lead / Co-Investor) | University of Aberdeen<br>University of Dundee<br>University of Edinburgh<br>Edinburgh Napier University<br>University of Glasgow | Glasgow Caledonian University<br>Heriot-Watt University<br>Robert Gordon University<br>University of Strathclyde (host)<br>University of the West of Scotland |
| National Manufacturing Institute Scotland (NMIS) (Co-Investor) | National centre and part of the UK High Value Manufacturing Catapult & including the Advanced Forming Research Centre; Capability Network; Digital Factory; Lightweight Manufacturing Centre; Manufacturing Skills Academy. | |
| National Robotarium (NR) (Co-Investor) | World-leading centre for Robotics & AI, creating innovative solutions to global challenges & including Data Driven Innovation; ORCA Hub; Edinburgh Centre for Robotics. | |
| CENSIS | Scotland's Innovation Centre for sensing, imaging and IoT technologies | |
| Built Environment – Smarter Transformation (BE-ST) formerly CSIC | Innovation centre prioritising the built environment's transition to zero carbon and improving the sector's contribution to the fight against climate change. | |
| The Scotland 5G Centre | National centre for 5G, to accelerate the demand, deployment and adoption of 5G. | |
| Energy Technology Partnership (ETP) | University of Aberdeen<br>University of Dundee<br>University of Edinburgh<br>Edinburgh Napier University<br>University of Glasgow<br>Glasgow Caledonian University<br>The Glasgow School of Art | Heriot-Watt University<br>University of the Highlands & Islands<br>Robert Gordon University<br>University of St Andrews<br>University of Stirling<br>University of Strathclyde<br>University of the West of Scotland |
| Scottish Universities Physics Alliance (SUPA) | University of Aberdeen<br>University of Dundee<br>University of Edinburgh<br>University of Glasgow | Heriot-Watt University<br>University of St Andrews<br>University of Strathclyde<br>University of the West of Scotland |

## DISCIPLINES THAT WOULD BE INCLUDED:

Architecture
Biological Sciences
Biomedical Engineering
Business & Management Sciences
Behavioural Sciences
Chemical & Process Engineering
Civil & Environmental Engineering
Robotics & Autonomous Systems
Computer & Information Sciences
Data and Informatics
Design, Manufacturing & Engineering Management
Economics
Education
Environmental Sciences
Electrical & Electronic Engineering
Government and Public Policy
Humanities
Infrastructure & Environment
Interdisciplinary Studies
Mathematics & Statistics
Materials Engineering and Materials Science
Mechanical and Aerospace Engineering
Medicine
Naval Architecture, Ocean and Marine Engineering
Nanoscale Engineering
Planning
Process and Systems Engineering
Psychological Sciences and Health
Pure and Applied Physics
Pure and Applied Chemistry
Safety and Ethics
Social Policy
Social & Political Science
Systems, Power & Energy
Transition Engineering

## 1. A BRIEF DESCRIPTION OF THE PROPOSED CHALLENGE AREA

**Manufacturing[A] is at the heart of Scotland's economy and will play a critical role in meeting our future energy, infrastructure, transport and healthcare needs, driving inclusive economic impact and in meeting our sustainability goals towards net zero.** It accounts for over half (54%) of business R&D spend[1] and is our largest international export sector (£18.6bn, 53%)[2] and second largest export sector to the rest of the UK (£10.9bn, 21%)[2] contributing £12.8bn (8%) in Gross Value Added (GVA)[3] to the economy and employing ~170,000 people in 2019[3].

Scotland's future economy must thrive in a challenging global environment of diminishing natural resources and supply chain vulnerabilities due to climate change, geopolitical and economic instability and global health crises. The way we live and work is changing due to the emergence of transformative technologies such as digital, AI, robotics & automation, big data, IoT, photonics, quantum and advanced communication technologies. **Scotland's commitment for a just transition to Net Zero 2045 requires a systemic approach to decarbonisation of its industries and infrastructure**; this involves a complex cross-sectoral challenge extending beyond the energy sector and our domestic activities to our international export markets and supply chains. Our departure from the EU and the impacts of the pandemic have compounded further complex challenges and opportunities for Scotland's post-pandemic green economic recovery around health, economic growth and stability, sustainability and resilience.

The recent SG National Strategy for Economic Transformation (NSET) 2022[4], recognises that **there remain long-standing challenges, such as weak productivity, compared to international competitors**. Economies with strong productivity also score highly on the indicators of a wellbeing economy. Although Scotland has been closing the productivity gap with the rest of the UK, **its productivity performance remains below that of other small advanced economies.** NSET calls for action to 'shift the dial' on productivity by working together drawing upon the strengths from across all sectors of the economy: a Team Scotland approach to **make Scotland more productive and innovative,** strengthen our position in new markets/industries, focus resources on opportunities that will transform our economy and our society, and attract international investment in research and innovation in the industries of the future**. It recognises that the success of Scotland's internationally tradeable sectors such as manufacturing are key to providing the wealth on which our domestic services sectors rely**.

The productivity, circularity and resilience of Scotland's manufacturing sector and its supply chains are critical to unlocking our green economic recovery, future-proofing our international competitiveness and more efficiently utilising natural resources to meet sustainability goals as we transition to a decarbonised nation. We cannot rely on incremental improvements and **urgently need to act to accelerate a step-change in the productivity, circularity and resilience of Scotland's manufacturing sector and its supply chains**. This requires a systemic 'Team-Scotland' approach to drive synergy, by better connecting and leveraging our world-class research and technology base, industry innovation, collaborative networks and intellectual capital, and drawing upon all sectors of the economy.

**In response to this critical challenge, the research and innovation community in Scotland has come together to form the proposed 'Scottish Alliance for Research in Advanced Manufacturing' (SARAM)**: a multidisciplinary, cross-sectoral alliance to coordinate and build upon Scotland's centres of excellence and collaborative networks, its research excellence (across engineering, physical and social sciences, the humanities and arts) and its strengths in business and innovation to provide enhanced synergy and impact to drive this critical step-change. SARAM will be a research-focused network and will work with and complement the more applied and industry-focused NMIS[B] Network and SG's Making Scotland's Future[5] network. SARAM will attract increased research funding to Scotland, supporting increased BERD, FDI and onshoring of our supply chains, and maximising the overall economic, environmental and societal benefits to Scotland. **SFC funding (£150k pa) would be matched by SARAM partners (£225k pa) providing £1.5m over four-years.** This would enable horizon scanning of funding opportunities, coordination of multidisciplinary collaborative workshops, formation of leadership groups and the fluid formation of tailored collaborations and bids targeted at large-scale research funding opportunities across Scotland, the UK and internationally. PGRs and ECRs would be integral to SARAM building upon the successes of SRPe's PECRE[C] and industry doctoral schemes[6].

**SARAM will deliver a coordinated 'Team-Scotland' approach to tackle the urgent challenge of accelerating the productivity, circularity and resilience in a decarbonised manufacturing sector, and exploiting the opportunities ahead, significantly strengthening Scotland's international competitiveness, and leveraging an additional target of £40m of challenge-led collaborative research funding to Scotland.**

### 1.1 ALIGNMENT OF THE CHALLENGE AREA WITH SCOTTISH GOVERNMENT PRIORITIES

The challenge area is strongly aligned with SG (and UKG and BEIS/UKRI) strategic priorities, the SG (and UKG) net zero strategies, the SG economic growth, innovation and internationalisation strategies, and the research

[A] Manufacturing encompasses industries that produce a finished, usable product or are involved in construction.
[B] National Manufacturing Institute Scotland (NMIS) – one of SARAM's co-investing partners
[C] Postgraduate and Early Career Researcher Exchanges (PECRE)

strategies of Scottish HEIs. It directly supports the SG National Strategy for Economic Transformation (NSET)[4] and its call for action to shift the dial on productivity recognising the importance of Scotland's internationally tradeable sectors such as manufacturing (and aligns directly with the UKG Industrial Strategy 2017[7], the subsequent UKG Innovation Strategy[8] which set out to improve UK innovation and productivity, and the UKG Made Smarter Review 2017[9]). Having a more circular and sustainable manufacturing (including construction) sector[10] is critical in meeting the SG statutory targets and commitments to Net Zero 2045 and commitments to post-pandemic green economic recovery[11]. The challenge aligns with the upcoming SG Innovation Strategy described in the SG economic strategy (NSET)[4], where the focus will be on Scotland's R&D strengths as part of a ten-year economic plan, and it strongly supports the Making Scotland's Future - A Recovery Plan for Manufacturing[5] objective to drive the sustainable growth of manufacturing, support Net Zero 2045, boost productivity and drive innovation via transformative solutions that enable manufacturing to become more resilient, productive, digitally-enabled, sustainable and competitive.

### 1.2 THE NATURE OF THE MULTIDISCIPLINARY RESPONSE REQUIRED AND HOW AREAS OF EVIDENCED SCOTTISH SECTOR RESEARCH EXCELLENCE AND QUALITY WOULD BE REQUIRED TO BE INVOLVED

The challenge is highly complex and multi-dimensional requiring an interdisciplinary collaborative approach across academia-industry-public sectors, drawing upon multiple research disciplines and industry sectors including: precision manufacturing (photonics, quantum, medical devices, space/satellites, communications); medium-scale manufacturing (automotive, aerospace, defence); large-scale fabrication (shipbuilding, renewables & low carbon, wind turbines, hydrogen, marine, nuclear/fusion); food & drink; mining & processing; chemical; pharmaceutical; oil & gas; oil refining and processing; materials production (metals, glass, paper/pulp, cement, ceramics); textiles; agriculture; rail; healthcare/medical; infrastructure/construction; and, environment.

The acceleration of circularity and sustainability practices requires a focus across the full life-cycle from design, to manufacturing and end-of-life (repurposing, remanufacturing, recycling) of manufactured products and buildings (construction) and requires an integration of inputs from across a broad range of disciplines across engineering, science, arts, business, economics, social sciences and government & public policy. The research, design and development of manufactured products, such as healthcare devices, requires inputs from across the end-user communities (such as the NHS) and draws upon medical disciplines such as biomedical and medical imaging. The acceleration of manufacturing productivity and supply chain resilience requires a systemic interdisciplinary approach, and the social sciences (including government & public/social policy, economics, humanities, psychological sciences & health) play key roles in ensuring adoption of new technologies that will bring about the required improvements.

The Industry 4.0, and the now emerging Industry 5.0 technologies e.g. digital, advanced & smart materials, AI, robotics & automation, cyber-physical systems, big data, IoT, photonics, quantum and 5G, are transforming manufacturing and are all areas where Scotland has internationally recognised research strengths and centres of research, technology and innovation excellence. Research excellence within the Scottish universities is demonstrated through their strong performance in REF 2014[12] and REF 2021[13]. This encompasses not just excellence in the manufacturing and engineering domains but also in related business, science, social sciences and humanities areas.

### 1.3 JUSTIFICATION OF THE BALANCE THE CHALLENGE STRIKES BETWEEN BREADTH AND SPECIFICITY

Manufacturing's research challenges are complex consisting of key themes such as the development and impact of AI & automation, and the drive towards net zero, as well as a series of multiple interconnected and independent sub-challenges addressing specific sectoral needs. To address the broad sectoral needs an approach that combines addressing specific issues along with a broad cross-sectoral perspective is crucial. The challenge needs a systemic multidisciplinary approach drawing upon the expertise in Scotland across a wide range of research disciplines and technology innovation centres. Based on the proposed duration and level of SFC funding the challenge strikes the appropriate balance to produce realistic tangible impacts adding value to the manufacturing sector and the economy and attracting increased research funding, BERD and FDI to Scotland. SARAM will provide significantly increased connectivity, synergy and leveraging of existing research collaborations, innovation centres and national centres of excellence already heavily invested in by the SG/SFC/UKG around this challenge-led mission. By focusing its world-class research community and centres of excellence in manufacturing and advanced technologies, Scotland is uniquely positioned to capitalise upon the opportunities ahead. Based on similar levels of investment SRPe[D] has previously demonstrated the level of impact possible in attracting research funding and providing multidisciplinary research solutions by pulling together and aligning the collaborative research activities of key stakeholders across the Scottish ecosystem to target large-scale UK research funding opportunities.

[D] SRPe Case Study: *Robotics, Autonomous Systems & Artificial Intelligence Industrial Impact Acceleration Initiative* - SFC investment of £50k: leading to five project awards (EPSRC, and IUK/Industrial Strategy Challenge Fund) bringing total funding £7.2m with £4.2m directly to Scottish universities.

## 2. SUGGESTED FUTURE OR CURRENT DEFINED FUNDING OPPORTUNITY(IES) WHICH AN ARC FOCUSED ON THIS CHALLENGE WOULD BE WELL-PLACED TO TARGET

Manufacturing is a key focus area of research funding within Scotland and the UK, particularly through UKRI's Manufacturing the Future Theme[14] and SG Recovery Plan for Manufacturing: Making Scotland's Future[5] initiative. The Comprehensive Spending Review research allocation has yet to be completed hence specific UKRI funding calls from 2023 onwards (the timescale for ARCs) have not yet been fully cascaded. Looking forward, given the interdisciplinary intersectoral nature of the challenge, SARAM is strongly positioned to secure future UKRI funding from not just across EPSRC (e.g. UKRI Manufacturing the Future Fund[14] (£3m per quarter with grants up to £2m) and IUK, but also across AHRC and ESRC where alliance members already hold awards appropriate to the challenge. Most UKRI funding is awarded through Programme Grants (£4-£8m) and Standard Research Grants (£0.5-£1m); given the strong alignment of the challenge with BEIS/UKRI strategic priorities SARAM is well-positioned to secure funding. It is anticipated that EPSRC will launch another round of CDTs within the next 18-months and SARAM is well-placed to submit a collaborative bid for a pan-Scottish CDT, and there are likely to be further EPSRC Future Manufacturing Hub[15] calls (up to £12m per award) which SARAM would be well equipped to respond to.

The challenge perfectly aligns with the SG Making Scotland's Future[5] priority themes which require a triple-helix collaborative framework across academia-industry-public sector to create the desired impact. SARAM will provide a key part of the triple-helix working closely with industry and the public sector to respond to funding opportunities. For example, the Low Carbon Manufacturing Challenge Fund[16] (£25m over the next four years) has been launched to support research and innovation in low carbon technology, processes and infrastructure within manufacturing, and SARAM is strongly positioned to work with industry to target this. It is also well placed to target future opportunities under the SG Energy Transition Fund[17] (£62m from 2020) helping Scotland meet its ambitious targets on climate change, and aligned with the UK Ten Point Recovery Plan[18] for a green industrial revolution where the Net Zero Innovation Portfolio (£1bn) provides funding for low-carbon technologies and systems.

Scotland currently 'punches below its weight' in terms of IUK funding. However, the challenge is strongly aligned with the IUK Action Plan for Business Innovation (2021 to 2025)[19] to support the development of a range of technologies (including advanced manufacturing, AI, digital, quantum) and the UKRI Industrial Strategy Challenge Fund[20] Clean Growth Theme (Industrial Decarbonisation (£170m); Made Smarter Innovation (£147m); Smart Sustainable Plastic Packaging (£60m); Transforming Construction (£170m)). Under the Made Smarter Innovation Fund[21], UKG/BEIS has invested £53m in five UK Made Smarter Research Centres (three based at Strathclyde) plus the InterAct Network (bringing together economics, social science, manufacturers and technology providers) providing SARAM with further opportunities for broad-sectoral collaboration and targeting of future funding opportunities.

## 3. A BRIEF DESCRIPTION OF THE PROSPECTIVE OR POTENTIAL COALITION OF UNIVERSITIES AND OTHERS INVOLVED WHICH COULD DELIVER AN ARC IN THIS AREA

SARAM comprises eight partners (national research collaborations; innovation centres; centres of research & innovation excellence). SFC investment of £600k will be matched with £900k over the four-year programme.

| Research Pools[E] | National Centres of Excellence | Innovation Centres |
|---|---|---|
| SRPe (Lead / Co-Investment £600k) | NMIS (Co-Investment £200k) | CENSIS |
| ETP | National Robotarium (Co-Investment £100k) | BE-ST (formerly CSIC) |
| SUPA | Scotland 5G Centre | |

Building upon its partner networks SARAM will collaborate extensively across the broader network of academia-industry-public sector stakeholder organisations across all regions of Scotland, including:

| Other Centres of Excellence / Research Centres | Public Sector | Industry / Industry Trade Associations |
|---|---|---|
| Fraunhofer UK | Interface | Michelin Scotland Innovation Park |
| Medical Devices Manufacturing Centre (MDMC) | Scottish Government / Policy Teams | Scottish Engineering |
| Scottish Institute for Remanufacture (SIR) | Enterprise Agencies (SE/HIE/SOSE) | Technology / Photonics Scotland |
| Quantum Innovation Hubs | Scottish Manufacturing Advisory Agency | CeeD |
| UK Made Smarter Research Centres | Zero Waste Scotland | Scotland Food and Drink |
| SEFARI | Scottish Environment Protection Agency | Industrial partners (including SMEs) |
| Fraser of Allander Institute (Economics) | Skills Development Scotland | |
| | Scottish Development International | Other Research Pools |
| Other Innovation Centres and Catapults | Scottish Government International Hubs | ScotCHEM |
| DataLab | NHS Innovation Hubs | SICSA |
| IBioIC | Scotland Europa | SULSA |
| Digital Healthcare Institute | Transport Scotland | SAGES |
| High Value Manufacturing Catapult | Royal Society of Edinburgh | MASTS |
| Net Zero Technology Centre | Royal Academy of Engineering | Sinapse |

[E] Collective Partner HEIs (14 of the 19 US members) - Aberdeen; Dundee; Edinburgh; Napier; Glasgow; Glasgow Caledonian; Glasgow School of Art; Heriot-Watt; Highlands & Islands; Robert Gordon; Stirling; St Andrews; Strathclyde; West of Scotland.

SARAM will build upon the foundations and track-record of the lead partner SRPe and the strategic major investments already made across the other alliance partners. It will grow the network to maximise the impact of its challenge-led collaborative activities, drawing upon the expertise of a wide range of disciplines across engineering, science, medicine, humanities & social sciences, business & economics and the arts, working seamlessly across the academic, industrial and public agency sectors and government / policy networks in Scotland. NMIS is an integral part of the UK High Value Manufacturing Catapult and SARAM will also collaborate closely with the BEIS funded (£53m) UK Made Smarter Research Centres[14] to fully capitalise upon the wider UK and international funding opportunities.

## 4. THE ADDED BENEFIT THAT WOULD BE BROUGHT BY SFC FUNDING

SFC funding will have a major impact in leveraging research funding to Scotland and accelerating a step-change in the productivity, circularity and resilience of Scotland's manufacturing sector. It will support a 'Team-Scotland' scaling-up of multidisciplinary collaborative research activities to tackle the challenge and exploit the opportunities. SARAM will deliver large-scale bids **targeting an additional £40m of SG/UKG/UKRI/EU research funding to Scotland** over the four-year programme**.** It will seek to secure **SG/EPSRC investment of £7.5m, leveraging a further industry investment £6m and university investment £1.5m** via 150 new industry doctoral projects - adding to the 47 already launched by SRPe[6]. **SARAM is committed to promoting Equality, Diversity and Inclusion** and will succeed by attracting and supporting all available talent in Scotland. **This is an exciting opportunity for SFC in partnership with the Scottish research community to play a pivotal role in supporting Scotland's green economic recovery as we transition to a decarbonised net zero Scotland.** Activities, deliverables and impacts will include:

<u>Horizon Scanning</u>

- Horizon scanning to identify, evidence and prioritise the key vulnerabilities, strengths/capabilities and opportunities in Scotland, analysis of their impacts and interactions taking a systemic approach.
- Horizon scanning of large-scale funding opportunities across Scotland, UK, and Europe.

<u>Programme Planning and Impact Monitoring</u>

- Identification and prioritization of action programmes to address the challenge/exploit the opportunities.
- Outcomes, impacts and progress indicators co-developed with SFC to create an evaluation framework.
- Develop a programme of planned activities, deliverables and events central to the challenge mission.

<u>Leadership, Influencing and Policy Shaping</u>

- Creation of priority leadership groups and coordination of proactive engagement with UKRI research councils and EU funding bodies, shaping research agendas via membership of boards/panels/working groups, targeted workshops, programmes meetings, and events.
- Provision of informed guidance on the research and policy landscape in relation to manufacturing's role in meeting SG targets through coordinated community-wide briefings, white papers and consultation responses.

<u>Network Coordination and Collaboration</u>

- Challenge-focused, multidisciplinary collaboration and coordination of key stakeholder networks across academia-industry-public sector and delivery of a programme of mission-led workshops and events.
- Harnessing of complementary initiatives with the potential to support the acceleration of the mission and to stimulate further collaboration, innovation and research portfolio growth.
- Knowledge exchange across research disciplines, public sector/government and industry via targeted events, conferences and via digital platforms and networks.
- Provision of enhanced and diversified capacity for collaborative challenge-led, action-oriented research, building on the existing networks and providing evidence for impact statements for future REF submissions.

<u>Development of Collaborative Research Bids and Investment Cases</u>

- Creation of multidisciplinary cross-sectoral mission-led collaborations to target large-scale funding opportunities, create collaborative research bids and secure funding for Scotland.
- Creation of proactive investment cases for new strategic initiatives to support the challenge mission.

<u>Leveraging of External Investment and Provision of High-Value Skills</u>

- Identification of large-scale funding opportunities and delivery of targeted multidisciplinary collaborative bids to leverage an additional target of £40m of funding to Scotland over the four-year programme.
- Delivery of collaborative research projects and high-value skills: aim to secure £7.5m SG/EPSRC investment leveraging industry investment £6m and university investment £1.5m for 150 new industry sponsored doctoral projects, building upon SRPe's existing 47 IDPs (30 NMIS-IDPs + 17 SRPe-IDPs)[6].
- Delivery of a SARAM bid targeting the next EPSRC Centre for Doctoral Training call (within ~18 months).
- Guidance, training and development of PGRs and ECRs via integration across SARAM activities.

<u>Promotion and Outreach</u>

- Promotion (Scotland, UK, internationally) of Scotland's manufacturing research and technology strengths towards a productive, resilient and sustainable manufacturing sector, and its contributions to post-pandemic green economic recovery, just transition to net zero and other SG priorities.

## APPENDIX 1 – REFERENCES

[1] A Manufacturing Future for Scotland: Action Plan
[2] Export Statistics Scotland 2019, Scottish Government
[3] Scottish Government - Scottish Annual Business Statistics 2019
[4] Scotland's National Strategy for Economic Transformation: Delivering Economic Prosperity - March 2022
[5] Making Scotland's future - a recovery plan for manufacturing: June 2021
[6] SRPe NMIS Industry Doctorate Programme in Advanced Manufacturing / SRPe Industry Doctorate Programme
[7] UK Industrial Strategy 2017
[8] UK Innovation Strategy: Leading the Future by Creating it (July 2021)
[9] UK Made Smarter Review 2017
[10] SSAC Report - Environmental Impacts of the Scottish Manufacturing Industry
[11] Update to the Climate Change Plan 2018 – 2032: Securing a Green Recovery on a Path to Net Zero
[12] Research Excellence Framework 2014
[13] Research Excellence Framework 2021
[14] UKRI: Manufacturing the Future Theme
[15] EPSRC Future Manufacturing Hubs
[16] SG Low Carbon Manufacturing Challenge Fund
[17] SG Energy Transition Fund
[18] The Ten Point Plan for a Green Industrial Revolution
[19] UKRI/IUK Building the Future Economy: Plan for Action for UK Business Innovation
[20] UKRI Industrial Strategy Challenge Fund
[21] UKRI Made Smarter Innovation Challenge