Building the UK's smart machines economy

Nuclear leadership, circular manufacturing and regulatory readiness







Professor Samia Nefti-Meziani OBE
Director, Birmingham Robotics Institute; Director, RESCu-M² Hub; Academic Chair, NCRRS

Rav Chunilal
Head of Robotics and Artificial Intelligence, Sellafield Ltd

Vaibhav Puri OBE
Chair, NCRRS; Director of Sector Strategy, Rail Safety and Standards Board

The question today is which country will build the robotics capability, standards and assurance frameworks that let intelligent machines be trusted and deployed at scale. The Government's Smart Machines 2035 Strategy[1] estimates adoption could raise UK Gross Value Added from around £6.4 billion to £149.9 billion by 2035.

This paper argues that circular manufacturing and nuclear robotics – two of the UK's distinctive strengths – should be treated as connected parts of one national strategy, where regulation and standards, not hardware, will determine success.

At a joint Hazards Forum and Parliamentary and Scientific Committee webinar[2] the authors highlighted that industrial and regulatory policy must be designed together, not treated as sequential concerns.

The scale of the opportunity

The robotics market is shifting from fixed, predictable automation towards adaptive, intelligent machines that perceive and adjust their behaviour dynamically, through the convergence of:

- robotics
- artificial intelligence
- advanced sensing
- digital twins
- synthetic environments
- edge computing
- secure communications
- machine-readable lifecycle data
- digital product passports
- quantum capabilities

Combined, these technologies will let machines sense and understand their surroundings and increasingly predict conditions and act on them proactively.

This convergence opens a broader commercial opportunity: the largest economic prize may lie in the software, infrastructure, assurance frameworks and system-integration. The potential gains span construction, health, energy, logistics, manufacturing and agriculture – value will come chiefly from productivity and resilience, not robot sales, and with a focus on building new industrial capabilities, like circular manufacturing.

The next decade is a narrow but significant window for the UK. As countries race for leadership in robotics and AI, advantage will go to whoever deploys these technologies safely and at scale – connecting the UK's existing strengths into a coherent advantage.

The rise of circular manufacturing

The UK's transition to electric vehicles, renewable energy, batteries and advanced electronics is creating a new challenge: large volumes of high-value products reaching the end of their first life, from wind-turbine blades to EV battery packs. Deciding whether to repair, reuse, remanufacture or recycle depends on manual labour, since existing automation was built for predictable new production.

Robotics and AI offer a way through this. A "smart circular machine" could identify a product, retrieve its lifecycle data and determine the best pathway – before disassembling, testing and recording components. Applied to an EV battery, it could establish whether to keep it in use, remanufacture it, or send it for material recovery. The goal is intelligent value retention at scale, not automated recycling.

The £34.6 million EPSRC RESCu-M² Hub[3], led by the University of Birmingham, is a major national investment in using robotics and AI to recover, reuse and retain products and critical materials at end of life – reducing waste, improving resource security and strengthening the UK's manufacturing resilience.

Nuclear: the UK's living laboratory for smart machines

The nuclear sector is one of the UK's most advanced environments for robotics, driven by operational necessity. Through programmes led by Sellafield Ltd (SL) and the Nuclear Decommissioning Authority group, the UK has built an internationally recognised ecosystem for deploying robotics and AI where human access is hazardous or impossible[4]. Few countries combine this operational challenge, scientific capability and regulatory maturity.

This has built significant UK expertise in remote handling, teleoperation and hazardous-environment engineering, strengthened through collaboration with academic institutions including the University of Manchester and Birmingham Robotics Institute.

At Sellafield, robotics are already central to high-hazard work – contamination monitoring, remote inspection and intervention that keeps workers out of dangerous areas. Sellafield, one of the world's largest proving grounds for nuclear robotics, is moving from bespoke deployments towards fewer, reusable, standardised systems. Examples include SL's hands-out-of-gloveboxes (RrOBO),

Spot, microUAV inspection, Underwater ROVs. Collectively, these deployments are helping establish the operational evidence, assurance approaches and deployment models required for trusted autonomy in safety-critical environments. Many of the lessons being developed through Sellafield and the wider NDA group are directly transferable to emerging commercial sectors seeking to deploy intelligent machines at scale.

This matters well beyond nuclear: it is a real-world laboratory for trusted autonomy where failure is not an option, solving a problem shared with circular manufacturing – how to operate reliably amid uncertainty, using systems that are safe, assured and maintainable.

The transferable asset is not just the hardware, but the underlying model – real-world applications, early assurance and close regulator engagement – adaptable to battery disassembly and hazardous-material processing.

Resource security and a cross-sector platform

This has both strategic and commercial dimensions. The UK remains dependent on international supply chains for battery, motor and electronics materials. Recovering more from products already in the UK economy would strengthen domestic resource resilience – placing Value Retention Processes within industrial and economic security policy.

Because the same challenge recurs across automotive, energy, electronics, aerospace and manufacturing, a more strategic approach, modelled on nuclear's experience, would identify shared capabilities and build reusable cross-sector platforms rather than bespoke systems for every application.

Why regulation and standards matter

Historically, nations derive the greatest value from transformational technologies when they also define the rules and standards on which those technologies scale. The UK's opportunity lies in shaping the trusted frameworks intelligent machines operate within worldwide.

As robotics matures, the binding constraint is increasingly not whether a technology can be built, but whether it can be deployed, insured, certified and trusted. This is especially true for circular robotics, which may handle hazardous materials and straddle multiple regulatory regimes, often with no single regulator responsible.

Nuclear robotics offers a model. Safe deployment is accelerated when operators, developers and regulators engage early, inside an established regulatory relationship. The lesson for circular manufacturing is to adopt these principles – early assurance and sustained regulator engagement – rather than import nuclear regulation wholesale. A 2024 cross-sector initiative involving Sellafield, the NDA, the ONR and wider nuclear partners produced new UK standards for glovebox and containment engineering, enabling safety across sectors[5]. Rail is starting a similar journey via the RSSB, with research like T1389 on autonomous inspection systems (AGBIS)[6].

What government should do

To better coordinate the existing system, Government should:

- recognise circular robotics explicitly as a strategic technology priority;
- fund national demonstrators testing robotic systems on end-of-life batteries, turbines and electronics;
- build stronger routes for transferring nuclear approach into commercial sectors;
- ensure Digital Product Passports and lifecycle-data systems are machine-readable,
- not just human-readable; and
- prioritise standards covering robotic disassembly, AI-enabled inspection and remanufactured components.

Government should also create a clearer mechanism for coordinating the regulators, standards bodies and industry involved. HSE's 2026–27 Regulation Action Plan[7], is a welcome step. Government should also use procurement to create early markets and ensure smaller innovators aren't priced out of assurance processes. NCRRS is already convening regulators and 400+ experts across 16 sectors, supporting projects such as RoboPASS with Milton Keynes, a licensing framework for public-realm robotics[8].

Conclusion

The UK's robotics opportunity has two dimensions: making existing production more productive, and building new industrial capability. Circular manufacturing sits in the second category, and nuclear robotics shows what is required – machines that are trusted, assured and deployed within a regulatory system built to keep pace.

Nuclear provides the proving ground on which safety-critical robotics has already been developed with Sellafield serving as one of the UK's largest operational environments for demonstrating application in practice; circular manufacturing offers it an expanding commercial market. Regulation and standards sit between the two and can either slow this transfer or accelerate it.

The priority for Government is not further regulation, but better coordination across the system, clearing the path to safe deployment. This would let the UK move from being an adopter of robotics to a global exporter of technologies, standards and trusted-autonomy frameworks – an industrial opportunity, and a strategic national capability.

References

[1] Department of Science, Innovation and Technology (2025). *Smart Machines Strategy 2035*. www.gov.uk/government/publications/smart-machines-strategy-2035/smart-machines-strategy-2035

[2] Parliamentary and Scientific Committee (2026). Webinar – *Unlocking the Potential of Robotics and Autonomous Systems.* www.youtube.com/watch?v=rnhPea-E2j8

[3] University of Birmingham (2026). *RESCu-M2 - The UK's Hub for Robotics and AI, Automation, and Smart Machine Enabled Circular Manufacturing and Materials.*

[4] ONR (2023). *Innovative use of robots and unmanned aerial vehicles.*

[5] Sellafield Ltd et al (2024). *Setting new standards in nuclear engineering*. www.gov.uk/government/news/setting-new-standards-in-nuclear-engineering

[6] RSSB (2026). *Rules and standards to enable autonomous movement of inspection technologies (T1389).*

[7] HSE (2026). *HSE Regulation Action Plan: Growth Goals 2026 to 2027.*

[8] Milton Keynes City Council (2025). *Milton Keynes to become national robotics trailblazer.*