Circular economy skills demand in Scottish manufacturing 2019

The circular economy is an all-encompassing approach to life and business where everything has value and nothing is wasted. In simple terms, it can be explained as 'make, use, remake' as opposed to 'make, use, dispose.'

The ultimate goal is to keep products and materials circulating in a high-value state of use for as long as possible and maximise resources.

This is achieved by designing products smartly with their whole life cycle in mind, re-using and repairing to extend their useful life, and then when their life is deemed over, remanufacturing to create new products from old.

Foreword

The circular economy has huge potential and is increasing in its importance to the Scottish economy. The remanufacturing industry is on track to grow to £1.7 billion a year by 2020, and evidence suggests that a circular approach could not only ensure these economic benefits but will also boost jobs.

We therefore see the manufacturing industry as a hotbed for circular economy opportunities, with the potential for new business models to deliver products with an extended lifecycle or designed to be re-used time and again, in their original form or by making alterations. All of this is focused on harnessing a lucrative and expanding market.

To help support the transition to a more circular economy it is critical to find out what motivates business leaders in order to influence their current way of working, and there is a recognition that skills is a key part of that.

This is why Zero Waste Scotland has worked in partnership with Skills Development Scotland in order to develop this report, and why a key strand of the report is understanding the level of awareness businesses have when it comes to circular approaches and skills.

Start-ups are already coming forward with agile and dynamic approaches as the trend for circular businesses grows. Highland Galvanizers, which worked on the Forth Road Bridge, the Queensferry Crossing, and the Kelpies Project, is an example of a manufacturing business reimagining the traditional linear economy. The company re-coats barriers before rust sets in, so the steel is preserved and can remain in use far beyond its original anticipated lifetime.

From our work with Scottish businesses, we have seen first-hand the excitement to get on board. There is a recognised opportunity for closed-loop initiatives that cut down on the amount of resources required and the waste produced. Businesses are being encouraged and empowered to get creative, collaborate and develop new approaches to both new challenges as well as some historic problems.

The circular economy is definitely happening in Scotland and the will is there to push it forward through a combination of policy business support initiatives on the ground and open dialogue between businesses within and across sectors.

We look forward to making the most of the opportunities presented by the circular economy and developing the skills of the workforce that will deliver a resilient manufacturing sector based on a circular framework is key to success. This will allow us to make the most of our resources and deliver the maximum value to the country's economy.

Iain Gulland
Chief Executive, Zero Waste Scotland

Contents

Executive summary

Research results suggest a relatively low in-depth knowledge on circular economy and business models within manufacturing businesses which is largely due to the perceived cost of educating employees, unclear business benefits and lack of in-house expertise.

There was a distinction regarding business adoption of circular economy practices between startups and larger businesses within the study: larger businesses required more time whereas start-ups tend to be more agile and can more easily incorporate circular economy practices into their business models.

Research data suggests manufacturing businesses within Scotland demand three levels of circular economy skills and training provision to adopt circular practices:

- **in-house/operational skills**
  (e.g. repair, maintenance, reuse)
- **technical skills**
  (e.g., material property analysis, design, coding and designing programmes to monitor/control design of products)
- **systemic skills**
  (e.g., life cycle analysis, designing out waste within product development, systems theory approach).

The study highlighted the need for a period of transition from the traditional linear business model (life cycle of product ends at point of sale) towards a circular approach – thus skills and training for manufacturing businesses would require operational skills initially to support prolonged life of plant equipment, remanufacturing capacity, and material and energy efficiencies, with the aim of progressing to systemic skills over time.

Key findings

Further knowledge and skills are required to enable Scottish manufacturing businesses develop innovative approaches for designing products and sourcing new materials, developing new business models and fostering collaboration with other partners to enhance design capacity.

Research highlighted that innovation is needed at all levels within the manufacturing industry and is largely driven by executive level personnel, thus education and skills provision should focus on Scottish industry leaders who are already pioneering circular approaches.

What key skills are needed in manufacturing for the circular economy implementation?

- making skills: creative, biomaterial, repurposing
- digital design skills (cad)
- mechanical engineering
- electrical engineering
- stakeholder relationships and cooperative skills

What key factors and knowledge are needed in manufacturing for the circular economy?

- in-depth circular economy frameworks knowledge
- global raw materials knowledge + forecast
- IT and smart technology skills for:
  - reverse logistics and operations
  - governance and finance management
- digital manufacturing technologies (3d printing)
- circular business models
- industrial ecology (what other industries are around us).

What needs to be done in education to equip manufacturing for the circular economy?

- life cycle analysis
- systems thinking
- environmental impact assessment
- public private partnerships
- knowledge transfer
- service design
- “circular” start-up thinking for entrepreneurs
- biomimicry
- raw material and biomaterial knowledge

Context and research objectives

Recent years have seen Scotland becoming a global player in setting the circular economy agenda. In 2016, the Scottish Government published 'Making Things Last – A Circular Economy Strategy' that detailed the country's approach to move towards a more circular economy by aligning its economic and environmental objectives. The main objective was to develop a more comprehensive approach to producer responsibility by setting up a single framework for all product types that drives choices for reuse, repair and remanufacture, while more fully exposing and addressing the costs of recycling and disposal. The approach outlined within the strategy seeks to embed the development of new skills and ways of working in the next generation of designers, business leaders and innovators. As well as new skills, the circular economy will require new approaches, behaviours and business models to be developed and incorporated into existing practices.

The strategy focused on four priority areas, which were based on resource use, environmental impact and importance to the Scottish economy. This research study focuses on one of these priority areas, remanufacturing, which currently contributes £1.1 billion per year to Scottish GDP and could contribute £1.7 billion a year by 2020.

There is significant potential within this sector, as detailed in Appendix 4 which provides an overview of labour market within Scottish manufacturing. Illustrating the economic and environmental integration of the approach, action within remanufacturing is being delivered in close collaboration with Scotland's enterprise agencies, the Scottish Environment Protection Agency and Zero Waste Scotland.

This research study commissioned by Skills Development Scotland in cooperation with Zero Waste Scotland, builds upon Scottish Government's strategy by identifying the knowledge, skills and training requirements for manufacturing businesses to enhance the uptake and adoption of circular economy practices. Specifically, this research study aims to address:

- knowledge and understanding of the circular economy within manufacturing businesses
- skills for manufacturing employers to adopt circular economy practices within their business
- when skills requirements are likely to come on stream and what level of skill are required
- potential skills issues or skills gaps relating to these requirements
- skills for sub-sectors and localities and whether these covered in existing sectoral Skills Investment Plans (SIPs)
- skills for manufacturing employers to adopt circular economy practices within their business
- current circular economy training provision opportunities and what's required in the future, how this will impact with labour market landscape within Scotland
- role of innovation and leadership with circular economy skills and training approaches.

This report summarises the skills' issues facing the manufacturing sector as it adopts circular economy principles and provides the basis for an action plan which prioritises and seeks to address these issues.

Research approach

The report findings are based on an extensive research study between March and August 2018 by Aurora Sustainability Ltd. & Partners, adopting a mixed research methods approach, including: desk based literature review and synthesis; three Focus Group Discussions (FGDs) in Edinburgh, Glasgow and Inverness; thirty-six online surveys; and ten in-depth semi-structured interviews with Scottish businesses within the manufacturing sector. For a detailed account of the research methodology refer to Appendix 2. The research findings are grouped into three thematic areas:

- skills and training
- knowledge and education
- innovation and leadership.

This approach enabled the research team to identify what actions (e.g., circular economy education, training and leadership) are required for manufacturing businesses and what results are desired (e.g., circular economy knowledge, skills and innovation).

Thematic areas identified incorporate all research study data (e.g., literature review, survey, interview and focus group discussion information).

Research data did not include 'medium sized' companies (between 50-500 employees) as 95% of Scottish businesses employ fewer than 50 people, thus the lack of data has minimal effect on results (Scottish Government 2017).

Research design

78 participants

13 locations

10 interviews

3 focus group cities

32 online survey responses

5 researchers

15 days of desk research

74 online survey participants

The highest percentage of respondents came from Moray (15%) and the Highlands (12%)

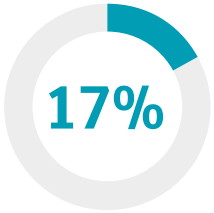
Research summary

Knowledge and education

businesses have a 'good grasp' of the main elements of circular economy

businesses have a 'good grasp' of circular economy business models

businesses already have (or plan to in next 12 months) integrated circular economy principles into business



businesses stated that 'full life cycle design for materials' was necessary for implementing circular economy practices into their business models

Startups are more inclined to develop circular economy business models

Innovation and leadership

Circular economy innovation is more likely to be driven by smaller startups and businesses, rather than larger organisations – this provides start-ups and businesses with a competitive advantage:

> **...As a start up it's churlish not to be implementing circular economy practices. I imagine it's harder to do for larger, more ingrained organisations."**
>
> Focus Group business

> **The biggest challenge facing society isn't resource depletion, climate change or anything like that...it's a lack of proper leadership."**
>
> Focus Group businesses

Innovation is required at all levels of industry and is largely perceived to be driven by executive level personnel.

Skills and training

General skills

Over 20% of businesses identified general circular economy skills a necessity for implementing circular practices within the business model (e.g., maintenance and repair of products, circular metrics and measurements, sales and marketing of 'preused products').

Technical skills

Many businesses who selected 'knowledge of recovery and sorting of materials' as a barrier to circular business model adoption, justified responses focusing on material development and designing out waste:

> **In short – modular design and end of life concerns are an important consideration."**
>
> Focus Group business

Systems skills

Over 17% of businesses surveyed scored Systems Skills 'Full life cycle design' as a top skill required to implement circular economy practices within the business.

3 Drivers for upskilling

- accreditation
- competitor circular activities
- regulatory and policy support for circular economy practices

Knowledge and education

The research study identified knowledge levels and understanding of the circular economy within manufacturing businesses in Scotland.

General understanding of the circular economy and business models

The circular economy is perceived to be widely understood with 80% of businesses identifying themselves as having a 'good grasp' of the main elements of circular economy (e.g., recycle, reuse, repair, remanufacture). However, only half (50%) of the businesses surveyed scored themselves as having a 'good grasp' of circular economy business models.

The data suggests that the businesses understanding of circular economy is potentially 'superficial' as there is limited theoretical knowledge regarding general circular practices, prior to practically implementing changes within the business model. This is evidenced by a handful of businesses who elaborated on their score, stating that, 'waste reuse' and 'repair processes' equated as a 'circular' business model. Few businesses mentioned the long term material cost increases as the availability of resources decreases, which suggests a lack of understanding regarding circular economy products. For example, one business focused on 'waste reuse' as circular:

> **"Our aim is to minimise further consumption of scarce resources taken from the earth by repurposing and reusing existing resources."**
>
> Surveyed business

Thus, the lack of understanding of circular economy and business models highlights the opportunities that are currently being missed by businesses, of which 55% state they have already integrated circular economy principles into their business and a further 26% have plans to do so in the next 12 months. This suggests the majority of businesses are attempting to practically implement what they do know of the circular economy into their business models, however the business benefits of such an approach many not be realised fully, given their limited understanding. Conversely, businesses that scored themselves as having a 'poor grasp' of circular economy business models (30%) highlighted the knowledge challenges identified:

> **"There has been some effort to identify the areas where improvements can be made but actual change has been minimal.**
>
> **Access to guidance and advice on best practice models and practical implementation is required to ensure we have appropriate objectives and plans before we commit resources."**
>
> Surveyed business

Circular economy knowledge, skills and training for businesses is required: businesses that both do and do not understand circular economy practices are either not implementing changes into their business model or are doing so, but in a very limited capacity.

Qualitative data collected suggested that circular economy language and terminology adopted by industry leaders and policy makers (e.g., waste management, recycling) could potentially contribute to the businesses lack of understanding or knowledge as what constitutes as 'circular' – skills and training provisions must use consistent language that can identify and accurately describe varying levels of circular economy implementation within a business model.

The research identified that the current 'catch all' definition of the circular economy could be revised, as respondents argued that it does not help businesses understand the opportunities and scale of circular economy – limited resources for businesses require a step-by-step approach to circular economy knowledge training. However, within the Focus Group Discussion (FGD) businesses discussed the use of circular frameworks (such as ReSOLVE, The Natural Step, Planetary Boundaries framework) that provided practical actions were useful as they highlighted what were needed, removing 'first adopter' anxiety and providing manageable steps.

The research identified the three main drivers for understanding and implementing the circular economy into the business:

- environmental responsibility
- 'green' marketing
- the potential economic opportunity for the business.

The latter in particular could be realised further with improved educational opportunities.

Understanding of circular materials and design

- survey results suggest circular economy implementation could be adopted with an increased awareness of what is available amongst modern bio-materials and knowledge of the long-term performance of materials (e.g., material reuse)

- furthermore, approximately a third (28%) of businesses surveyed stated 'knowledge of recovery and sorting of materials' and under a fifth (17%) stated that 'full life cycle design for materials' was necessary in order to implementing circular economy practices into their business models

- certification systems for material quality assurance of pre-used materials or components could potentially standardise circular principles within the remanufacturing sector (certification systems for material Life Cycle Analysis exist, such as ISO 14040, but not specifically for material quality assurance).

However, certification may differ depending on sub-sector requirements, for example, several biotech companies mentioned 'raw material variability' as a challenge - this is currently being examined by IBioIC.

In other sectors, such as energy engineering, businesses such as 4C Engineering stated their business has been impacted by new materials capabilities. As a bespoke engineering company, they are required to have in-house in-depth awareness of materials and their place in the design process.

Qualitative data from interviews with businesses identified that general knowledge and understanding of material design manufacturing technologies (e.g., 3D printing for repair and remanufacturing, biomimicry products, regenerative design and digital skills) have the potential to unlock more circular economy opportunities.

The lack of knowledge and understanding of 'how' to design products for a circular economy at the design stage of production is a significant barrier to how are products made.

> **"We are getting products manufactured in Europe because we couldn't find anything appropriate in Scotland, and manufacturers that we know directly are not familiar with the (CE) concept and aren't willing to work like this for our product at this stage."**
>
> Surveyed business

This suggests an increased awareness of circular materials and design could enhance the adoption of circular economy practices into their business models. Service design online modules are available within Scotland at the 'Service Design Academy' in Dundee, whose course provides understanding and practice in utilising key tools and methods of service design (e.g., how methods can be applied at various stages in the service design process). However, training is not aimed at the business market or experienced designers, thus there is a gap in the market for this type of training provision.

Recommendations

Knowledge and education challenges

The research study identified four main elements that have prohibited Scottish Manufacturing businesses understanding and knowledge of circular economy practices:

- **finance:** perceived cost of implementing new business practices as a key limiting factor to transition to circular-practices (12.5% businesses surveyed). A step-by-step approach is required for businesses, as they need to sustain revenue alongside redesigning their business model - implementing circular practices is perceived as a long-term commitment (financial and resource wise). One business stated: 'There are more possibilities but no time or resources to implement them yet'
- **finance for innovation:** lack of finance for innovation - businesses were aware new innovative approaches are required for circular practices but lack the internal funding to adopt practices (12.5% businesses surveyed). Practice support and guidance (e.g., ReSOLVE framework) could enable businesses to identify innovative approaches for circular economy
- **lack of clarity:** unclear business benefits of remanufacturing or other circular economy practices (10% businesses surveyed). If benefits could be realised, it is likely businesses surveyed would resource the up-skilling of their workforce.

More research required regarding job description creation for new professions – narrowing the scope of the research with in-depth research in specific sectors.

Information on practical business model frameworks online and delivered through workshops would enable businesses to realise the circular potential of their manufactured product and apply practices to their specific business. Knowledge and understanding should focus on material development and design. For example, the workshops and masterclasses provided by Zero Waste Scotland as part of their business support programme are one way to increase awareness and practical knowledge of the circular economy.

Guidance on circular economy practices and business model is required to expand businesses understanding of circular terminology, activities and frameworks that are appropriate for a various manufacturing sub-sectors seeking to disrupt established delivery of goods and services. Support of this type is available through Zero Waste Scotland's Circular Economy Business Support Service, for example. For more information, contact Zero Waste Scotland directly.

Skills and training on materials choice and identification prior to reuse/recycling are necessary.

Open up service design training opportunities for industry.

Skills and training

Equipping the Scottish manufacturing workforce with more circular skill-sets

The research study identified skills and training for circular economy adoption within manufacturing businesses in Scotland.

General Circular Economy Skills and Training

There is a clear need for circular economy skills and training, as evidenced in the previous section, specifically focusing on reuse, repair, recycling and other basic circular practices. Over 20% of businesses surveyed identified general circular economy skills as a necessity for implementing circular practices within the business model (e.g., maintenance and repair of products, circular metrics and measurements, sales and marketing of 'pre-used products'). Businesses interviewed expressed a need for general circular economy skills and training to be taught within schools, to accelerate a long-term behaviour shift that will force businesses to respond to customer needs:

> **"I'd recommend foundational education on circular economy in secondary school, then specific vocational training that is discipline relevant. It's challenging to turn circular economy into a 'skill' – it's about changing mindset."**
>
> Glasgow Focus Group business

However, for businesses to implement circular economy practices within their business, their general knowledge and understanding of what circular practices are and how to adopt them within their business models and processes require step by step guidance:

> **"The parts of circular economy that businesses are not doing just now are not particularly scary, they just need the building blocks to do it initially. Circular economy needs to be an established part of the business model, otherwise there is 'no incentive' for re-use within the design."**
>
> Edinburgh Focus Group business

The research identified a catch-22: in a nutshell a paradoxical situation with contradictory rules; businesses require step by step guidance how to implement circular economy practices within their business models and processes, whilst simultaneously training up their employees to learn new technologies that will enable the identification of new processes:

> **"...When a business applies those technologies would the skills be different to do that? It's changing the mindset of how the product is made in the first place."**
>
> Edinburgh Focus Group Business

Thus, this study supports the assertion that general circular economy skills and training is required as a first step for businesses, but progressively specialised technical and systems thinking skills should be built upon within training modules over time.

Technical circular economy skills and training

As outlined in the previous section, technical skills are required to foster the adoption of circular economy practices. Many businesses who selected 'knowledge of recovery and sorting of materials' as a barrier to circular business model adoption, also justified their responses focusing on material development and designing out waste:

> **'In short – modular design and end of life concerns are an important consideration."**
>
> Edinburgh Focus Group business '

> **The company operates a zero waste policy by reusing off-cuts and design-out waste at design stage."**
>
> Inverness Focus Group business

The Focus Group Discussion (FGD) support this, with businesses discussing skills and training requirements for materials, specifically, long life material properties (performance and degradation) and how this could be applied within reuse cycles in a circular business model. This led to discussions around modern manufacturing techniques and the skills required to equip designers with the necessary training for contemporary production (e.g., advanced manufacturing, 3D printing, co-design capacity, code design programmes to monitor, control and model material processes), shifting from traditional manufacturing processes. This shift raised concerns among business participants, who stated that:

> **'The manufacturing infrastructure change will take time."**
>
> Interviewed business

Coupled with the time it takes to process circular products and materials (e.g., 'small volume, large effort'), the effort to implement circular practices was perceived as resource intensive, regardless of training up employees. Following this, many business participants discussed future manufacturing processes and ways of working, highlighting that circular economy practices (e.g., materials sorting, reuse) could be automated, but this would require higher technological, digital and robotics skills to maintain this type of manufacturing and would require upfront investment in new infrastructure.

Systems circular economy skills and training

The research study identified that shifting from a linear to circular methods of production requires a systems level view of whole product ecologies from raw material to long term functional life cycles. Over 17% of businesses surveyed scored 'Full life cycle design' as a top skill required to implement circular economy practices within the business. Data collated from the interviews and Focus Group Discussions centre on Systems Theory and a Life Cycle Analysis (LCA) skills and training provision are necessary but are specialised (e.g., Cradle to Cradle).

Many businesses questioned whether LCA in-house training was necessary, considering that it takes too long time to train staff up (e.g., degree courses required) and such a specialist skill could be subcontracted.

> **"It's not something you would necessarily look to up-skill businesses to have the knowledge in-house, it's about knowing when they need to bring it in."**
>
> Glasgow Focus Group business

Whereas other businesses suggested short online courses for employees on LCA would enable them to start making key decisions about the design processes (e.g., online MOOCs). Designers in particular need skills and training on the whole material life cycle, such as raw materials extraction, conditions for processing, cyclical use properties to a systems level approach.

The research identified the three main drivers for circular economy skills and training development for businesses: accreditation is a significant incentive (e.g., ISO 140001) as it enables businesses to be awarded large contracts; competitor circular activities (e.g., if 'competitors are doing it', other businesses will be lead by example); and, regulatory and policy support for circular economy practices (e.g., Scottish Government support for circular businesses and advantages this may bring, such as PR). Further circular economy skills and training could potentially impact job growth within the sector – for more information see Appendix 3.

Skills investment plans

Skills Development Scotland offers various skills investment plans (SIPs) which enable growth and opportunities in Scotland's sector and regions. An analysis of the plans available identified that there were no plans that focused on the circular economy:

- the food and drink SIP, cites the need for 'driving leadership and management excellence'. This aligns closely with our research findings that leadership is a necessity for innovation within an business, however the plan does not focus on the need for innovative business model practices
- the construction sector SIP recognises the need for new skills for the 21st century and engaging with new innovative practices. It does not specify whether these 'innovative practices' are linear or circular in nature
- the engineering and advanced manufacturing SIP highlights the flow of talent from our educational facilities to the sector, skills shortages and an ambitious development plan. Circular economy is not mentioned within the text, yet much of the content of the development agenda could easily be drawing on circular approaches and rationale.

To conclude, all of the SIPs available could be updated to reflect the circular economy model shifting away from the traditional linear business model. This transition can only be achieved if the circular model is fully understood by senior management within businesses and requires further skills and training for business leaders in all manufacturing sub-sectors. Many senior management skills required are strategic and are already available (e.g., Cradle to Cradle). The strategic and interpersonal skills are also necessary for cross sectoral partnerships for the circular economy and are transferable between manufacturing sub-sectors. Many strategic skills are part of the originating schools of thought of the circular economy – Cradle to Cradle, Blue Economy, Planetary Boundaries – all of which we advocate being made widely available for businesses.

Recommendations

Circular economy skills and training provision

The research study surveyed manufacturing businesses on their awareness of circular economy skills and training provision within Scotland and identified that:

- approximately 60% of businesses were not aware of any training opportunities in their local area or across Scotland generally
- however, 60% of businesses have attended circular economy training (e.g., workshops, training days), thus there is a clear need for new skills, but businesses are not necessarily aware of the current training provision available to them
- around 50% businesses have not engaged with Zero Waste Scotland or Skills Development Scotland, this is evidenced by the fact that the majority of businesses are not aware of training opportunities.

Skills and training courses to explore the circular economy generally (online MOOCs, workshops), followed by more specialised technical and systems thinking skills are required (e.g., Edx courses currently available or longer term course modules).

Technical skills – focus on digital skills, design skills (e.g, CAD), 3D Design (e.g., Lynda's 3D training), material design (e.g., Edx courses, MIT's material science and engineering courses).

Systems skills – understanding, appreciating and identifying interdependence, flows, stocks (e.g., Open Design Academy's service design modules, UCL Life Cycle Assessment training courses).

Accreditation and certification for materials, design processes and life cycle analysis. Improve awareness and skills for critical raw materials through suitable frameworks like The Natural Step, Cradle to Cradle, EU raw material courses and information sources available online.

Current training provision offered by public bodies is not engaging enough with businesses within Scotland – **more could be done to market support available**.

Innovation and leadership in Scottish manufacturing

The research study identified the importance of innovation and leadership in accelerating the adoption of circular economy practices within manufacturing businesses in Scotland.

Circular economy innovation

In the modern world, speed of learning has become a new unfair advantage for businesses. Businesses that are agile and responsive to market changes and consumer demands tend to 'out learn' their competition and develop sustainable products that customers demand. This enables businesses to stay relevant to their customers and innovate their business models. Research interviews with manufacturing businesses identified that circular economy innovation is more likely to be driven by smaller startups and businesses, rather than larger organisations. New circular economy business models can facilitate the development of disruptive and innovative practices – this provides start-ups and businesses with a competitive advantage:

> **"It's the right thing to do – reduces our impact and increases the sustainability of everything involved. As a start up it's churlish not to be implementing circular economy practices. I imagine it's harder to do for larger, more ingrained organisations."**
>
> Inverness Focus Group businesses

Circular economy can provide opportunities for smaller companies to develop more innovative business models. However, there is a clear need for finance for innovation (see skills and training section) as businesses were aware new innovative approaches are required for circular practices but lack the internal funding to adopt practices. Skills and training requirements include the development of practice support, guidance and case study examples of where businesses have innovated their business models – tangible examples of how a business can realise its circular economy potential.

Circular economy leadership

Innovation is required at all levels of industry and is largely perceived to be driven by executive level personnel. Interview data highlighted the need for educating people at the top (e.g., Directors, policy makers), to help them understand the longer-term benefits of the circular economy and how to innovate their business models.

> **"The biggest challenge facing society isn't resource depletion, climate change or anything like that... it's a lack of proper leadership."**
>
> Glasgow Focus Group business

> **"We need leaders to drive consumers in a way that will drive industry, because the industry follows."**
>
> Edinburgh Focus Group business

> **"Educating people at the top – Directors – helping them to understand the benefits of this, a one day course for executives."**
>
> Inverness Focus Group business

This research has identified the link between leadership and innovation. Businesses that mentioned the need for innovation simultaneously mentioned the need for effective leadership to make it happen.

Recommendations

Leadership and cooperation

Skills and training provision for circular economy is required at various levels within the public sector (e.g., developing a common circular 'language' and increasing awareness of circular economy practices),

- leading circular public sector agencies (e.g., showcasing businesses that have innovated their business models) providing tangible examples as well
- advertising support available to businesses, from senior business leaders (e.g., executive courses for leaders, top-down approach) to business employees (e.g., designing, carbon accounting, life cycle analysis).

The audience for each depends on the course appropriate, for example, businesses surveyed suggested shorter courses for senior audiences and longer modules for employees required to design new processes and incorporate whole systems thinking.

Networking and interpersonal skills were also identified within the one to one interviews as imperative for circular economy – networking and collaboration, identifying links between businesses to collaborate on material development and energy flows is essential for learning and improving skills.

Business leadership is crucial for innovation – more executive education is required to foster business model change. Senior management buy-in to circular economy practices may accelerate the uptake, thus executive education (short, condensed courses) could offer significant traction in businesses uptake.

Tailoring skills and training provision is necessary to ensure businesses aren't put off with complex concepts. Providing step by step advice alongside powerful statistics that showcase the economic opportunity for circular economy is advised.

Skills and training courses must be easily accessible and deliver information at the appropriate level of detail for the intended audience (e.g., short term business leaders courses should differ from product design modules and life cycle assessments).

Developing networks for manufacturing businesses to collaborate on new material development, learn from competitors and identify training needs. Location specific or sector specific networks will offer knowledge exchange and learning for businesses interested in implementing circular practices into their business.

Recommendations

Priorities for circular economy

raise public awareness & through circular product advertisement and marketing campaign

introduce circular design + remanufacturing **into early public education**

public private innovation **partnership**

Skills & training for circular economy

traditional making

engineering

material science

bio tech

innovation

systems thinking

Existing manufacturing

circular business modelling

networking and shared platform capacity

digital and marketing

financial skills for product design innovation

negotiation/consultation/ facilitation skills

boost small batch manufacturing
startup creation with incubators

More investigation needed

- job creation
- design best practices
- market comms and social media

Conclusion

This report has identified the level of circular economy understanding and skills and training provision requirements within the business manufacturing sector in Scotland and provided recommendations that will enhance the uptake and adoption of circular economy practices.

There is a high level of 'general knowledge' regarding circular economy practices but low level of businesses demonstrating knowledge and understanding of circular economy business models.

- more training and support is required to help businesses understand the concept and provide clear definitions of what the term means

- lack of understanding and knowledge regarding the benefits of implementing circular economy with many businesses stating finance, time, unclear business benefits and no in-house expertise as reasons for not doing so. Further support is required to communicate the business benefits of a circular business model. Step by step advice would provide businesses with key 'takeaways' they could integrate into their business model.

Smaller businesses are more agile, can innovate quickly and can more easily implement economy practices than larger organisations, giving them a competitive advantage. There is a need to foster this innovation within startups who are more responsive to a changing market.

However, support for larger organisations is equally important as they often have the capital to invest and up scale innovative ideas.

There are three levels of circular economy skills and training provision for businesses to adopt circular practices, all of which increase in complexity and would thus need to be developing into training modules that built upon knowledge of each:

General skills
(e.g., reuse, repair)

Technical skills
(e.g., materials, design skills)

Systems skills
(e.g., life cycle analysis, systems theory)

Leadership is a prerequisite for innovation within a business:

- senior management buy-in is crucial for circular practice adoption. Leaders within the manufacturing sector can influence both employees internally (direct influence) as well as other external businesses within the sector (indirect influence), thus leadership can significantly accelerate circular economy adoption

- fostering collaboration with other businesses is a necessity to enhance design capacity and circular economy learning within businesses offering workshops, networks and communicating support services available for businesses may increase the number of businesses interested in the circular economy.

Support of this type is available through Zero Waste Scotland's Circular Economy Business Support Programme. Targeted at SMEs within Scotland, the Circular Economy Business Support Service specifically provides a bespoke consultancy service to SMEs wishing to explore how circular economy concepts can apply to their business or even develop an existing circular economy idea from concept to commercialisation.

Zero Waste Scotland is working to increase awareness and practical knowledge of the circular economy and how it works for business through delivering workshops and masterclasses. The Innovation Workshop programme is an excellent way to develop an early stage idea with circular economy expertise from Zero Waste Scotland sector managers.

Zero Waste Scotland's Manufacturing Masterclass Programme brought 40 companies together to tackle issues as diverse as remanufacturing and servitisation, plus implementation and change management. For more information, visit www.zerowastescotland.org.uk/circular-economy/business-support-service

Appendices

Appendix 1: Acknowledgements

The 'Circular Economy Skills Demand in Scottish Manufacturing' research project was commissioned by Skills Development Scotland with the support of Zero Waste Scotland. Aurora Sustainability and partners delivered the research project.

This report was written by Iain Findlay, Dr. Isabella Guerrini de Claire, Katherine Maxwell and Dr. Paul Smith. Editorial support was provided by Yvonne Cuneo and Katherine Maxwell.

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The report reflects the views and voices of members of Scottish Manufacturing businesses who were consulted from May to June 2018.

Our sincere appreciation goes to the businesses who participated in this process, most of them anonymously.

Aurora Sustainability would like to thank our dedicated staff as well as the many individuals and organisations that contributed to this report, without whom it would not have been possible.

Appendix 2: Research methodology

The team adopted a blended research methodology approach, drawing on both primary and secondary data to collate, synthesis and analysis for this report. The sequential research methodology is detailed in the order it was delivered by the team.

Literature review

Secondary sources data collection such as a literature review, contextualises various perspectives regarding skills development and economic opportunities, identifying organisations involved within the circular economy and the types of job creation through resource efficiency. The sources noted provide a synthesis of relevant information in relation to the circular economy: economic development potential; skills development; barriers to implementing circular economy within an SME; skills and training within Scotland; and SMEs within the manufacturing sector.

Publication dates of circular economy literature such as academic literature, national strategies, consultations, policy documents and reputable organisational reports, were limited to the last ten years (2008-2018.). The UK has experienced significant shifts in the economy recently, specifically within in the labour market, thus data collated was as up to date as possible. From this, relevant articles that directly relate to the research project and themes were utilised. All documents were scrutinised to ensure authenticity as research project relies on the correct identification of key organisations (e.g. SMEs and training providers) operating within the circular economy sector.

Online survey

Based on a systematic literature review, the team utilised structured online surveys (QuestioPro) with both open questions (qualitative data) and closed questions (quantitative data) to gather information from research participants (SMEs within the manufacturing sector) on their knowledge of the circular economy and their skills and training requirements. Online surveys were an appropriate research methodology for this project: the research required insight from SMEs around Scotland (wide geographic reach), thus online surveys offered an efficient, direct data entry and low cost of gathering data; time constraints to deliver the project, the online survey enabled data to be gathered quickly; research participants could be contacted by email first, ensuring higher response rates; participants could remain anonymous if they provided any sensitive information, and lastly, research data could be collated and analysed quickly (pie charts, graphs) – this was vital as the results informed the questions for the focus group discussions that followed.

Focus group discussions

Three focus group discussions (FGDs) were held in Scotland, specifically Edinburgh, Glasgow and Inverness (research participants are detailed in the table below). FGDs were deemed an appropriate research methodology as it brought people from similar backgrounds or experiences to discuss the specific research project. FGD questions were synthesised from the literature review and the online survey results – this signposted the research team towards specific skills and training needs that the FGD could then explore further. The group of participants were guided by a moderator who introduced set questions for discussion – this enabled a lively and natural discussion amongst themselves. FGDs were utilised to

explore the meanings of survey findings that cannot always be explained statistically, the range of opinions/ views on a topic of interest and to collect a wide variety of local (or, SME specific) terminology. In bridging research and policy, FGD can be useful in providing an insight into different opinions among different parties involved in the change process, thus enabling the process to be managed more effectively.

Number of research participants	FGD Location
13	Edinburgh
15	Glasgow
17	Inverness

FGD consisted of four thematic research questions to be answered over a one and a half hour period – responses were recorded live and then transcribed and analysed (the research team sought signed permissions from all participants prior to recording).

Semi-structured interviews
Semi-structured in-depth interviews were conducted with the research participants (SMEs within the manufacturing sector in Scotland) – participants selected were informed by the initial preliminary literature review (see thematic areas above). The content of the interview questions was informed by the literature review, responses to the online survey and the in-depth discussion within the FGD. The questions combined the open and closed questions to enable the interviewer to draw out and illicit further information regarding key thematic areas deemed important for the research project. Open-ended questions were constructed in order to elicit additional themes, allowing further enquiry on the initial questions. Closed questions ensure thematic responses are consistent between SMEs. Semi-structured interviews represented a suitable method for data collection – the 'non-standardised' approach was beneficial for this exploratory research project.

Appendix 3: Circular economy growth on jobs

Overview – Scottish context
There have been a significant number of studies which report the potential for the circular economy to provide greater economic stability through increased resource efficiency, offer new business opportunities and create employment (up to 43,000 new jobs by 2030) in an expanding sector within Scotland (Scottish Government 2016). Most studies focus on the following parameters that comprise the circular economy: reuse (current turnover in Scotland is £244 million supporting 6,500; closed and open loop recycling; biorefining (current turnover in Scotland is £190 million); repair and remanufacturing (with annual economic activity of £1.1. billion within the Scottish, cutting across 16 manufacturing sub-sectors and supporting 17,000 jobs), and servitisation (Scottish Government 2016; WRAP 2015).

Implementing circular economy activities has the potential to produce better welfare, positive employment outcomes and GDP that the traditional development path. This increase would be attributed to higher spending (lower prices and labour intensity of recycling activities) as well as highly skilled jobs within remanufacturing (McKinsey & Co. 2016).

Scottish SMEs manufacturing
Recent studies suggest that action across eight manufacturing sub-sectors has could bring about annual cost savings of £0.85 – £1.5 billion in Scotland, equating to 5 - 9% of total turnover of these manufacturing sub-sectors (Green Alliance 2015). However, the Scottish Government has prioritised four areas to focus circular economy activity: food and drink (potential savings of half a billion pounds per year); remanufacture (currently contributing £1.1 billion per year to Scotland's economy); construction and the built environment (accounts for 50% of waste in Scotland) and energy infrastructure (re-use of equipment) (Scottish Government 2016).

The expansion of circular economy activities will create employment across Scotland, with the largest increases in Glasgow, Dundee and Clackmannanshire (areas with higher unemployment rates than elsewhere in Scotland) (Green Alliance 2015). Job creation in these past industrial heartlands could be sizeable due to their potential for remanufacturing. The circular economy will create employment across all employment types, but the largest increases will be seen in skilled, 'operatives and elementary occupations' (Green Alliance 2015; WRAP 2015).

Potential impact of circular economy within Scotland
The potential impact of circular economy growth on economy stability and job creation largely depends on how circular it becomes by 2030. Various scenarios have been presented by the Scottish Government and Zero Waste Scotland: 'no new initiatives' where Scotland continues on existing trajectory (creating 3,400 jobs); 'current development scenarios' with new policies developed at same rate of current policies (projected 19,200 jobs created); and 'Transformation' accelerating the development of new ideas and policies (creating up to 43,000 jobs).

Challenges
There are significant challenges in identifying whether growth in the circular economy creates additional (net) jobs or simply replaces or displaces existing ones. As a result, net job creation in a growing sector such as circular economy will be lower than gross job creation and can even be non-existent or negative (WRAP 2015).

Appendix 4: labour market landscape in scottish manufacturing

This section provides an overview and links on the labour market in the manufacturing industry in Scotland.

Manufacturing sector data

Aerospace
The UK has the world's largest aerospace industry outside the USA. Over the last few years Scotland, specifically in Glasgow, has built more satellites than any other city in Europe.
Thanks to Scotland's established strengths in engineering, science and technology, our small country punches above its weight when it comes to the space industry – particularly around the NewSpace area of small satellite systems (smallsats) and space data solutions companies.

With a turnover of more than £22 billion, it supports a highly skilled workforce of over 276,000 in UK. Aerospace is the second largest contributor to the UK economy after pharmaceuticals. The UK has around 13% of the world market. Scotland has 80 aerospace companies employing more than 7600 highly-skilled people. With around 10% of the UK aerospace industry in Scotland, there are 150 companies in the civil aerospace and defence equipment industries.

Aerospace accounts for 3-4% of manufacturing as a whole. There are three main parts of the industry in Scotland:

- maintenance, repair and overhaul. The fastest growing part of the industry in Scotland, with growth concentrated in the west of Scotland
- manufacture and design. The most widely distributed part of the industry in Scotland
- avionics. The electronic equipment that goes on to aircraft and related products. This is the most technically advanced part of the industry.

More information from Scottish Enterprise.

Chemicals and pharmaceuticals
- the Scottish chemicals manufacturing sector has an annual output in excess of £3.1 billion
- over 16,000 people are employed directly
- over 60% of products manufactured in Scotland are exported
- world scale companies such as AstraZeneca, Akzo Nobel, Avecia, Innovene, Ciba, Exxon, GlaxoSmithKline, Rhodia and Syngenta have Scottish operations
- chemical exports account for 12% of manufacturing exports in Scotland (£1.7b), second only to the electronics industry
- Grangemouth represents 33% of the Scottish chemicals industry in turnover terms.

More information from Scottish Enterprise.

Technology and engineering
- more than 1000 companies that design, develop or supply electronic products or services are located in Scotland
- over 45,000 people are employed directly and approximately 29,000 indirectly
- electronics contributes 14% to Scotland's GDP
- Scotland makes 28% of Europe's PCs; more than 7% of the world's PCs and 29% of Europe's notebooks
- electronics accounts for 12% of Scotland's total manufacturing employment and for more than half of Scottish exports
- the biggest export products are PCs and peripherals such as printers.

More information from Scottish Enterprise.

Food and drink
- today Scotland employs 45,000 people in the food and drink processing sector and its associated supply chain, which generates £6 billion in sales
- a further £2 billion comes from agriculture, aquaculture and fish catching
- food and drink is the largest employer within Scottish manufacturing and accounts for more than a quarter of manufacturing exports
- in 2017, food and drink exports from Scotland have increased by 11% to £6bn
- £3.65 billion worth of food and drink were exported in 2005
- our gross value added to the economy is £3.8bn, 30.7% of Scottish manufacturing value added
- Scotland's food and drink industry makes a remarkable contribution to the economy in terms of turnover (~ £13.5bn) and GVA (~ £5.2bn)

- the sector has experienced significant turnover growth in recent years (between 2008–2015), with an increase by about 17%
- food exports have achieved significant growth in recent years and now account for over £1.6bn of exports, with 2017 seeing Scottish food and drink exports reach £6bn for the first time ever.

More information from FDF Scotland and Scottish Enterprise and from the sector skills council Improve.

Life sciences

- there are over 590 organisations in Scotland's life sciences community - employing over 29,500 people
- Scotland is home to 15% of the UK's life sciences companies
- over 50 academic institutions and 80 companies are engaged in drug discovery
- there are more than 100 Scottish-based medical devices companies
- Scottish researchers work in many areas, from developing new therapies for cancer and heart disease, through to understanding the causes of Alzheimer's disease
- since 2010, there has been a 29% growth in turnover and 24% growth in gross value added, in monetary values it is £4.2 million and £2 million respectively.

More information from Scottish Enterprise.

Paints, inks and other coatings

Note: the statistics in this section are for the UK as a whole rather than Scotland alone.

- approximately 450 companies employ around 20,000 people
- combined sales turnover is over £2.2 billion with exports of £400 million
- coatings are produced for a variety of uses, including the automotive sector, marine, wood finishing, DIY paints, packaging, coatings for plastics, and, in the case of printing inks, newspapers
- the industry is changing, with the introduction of modern manufacturing systems, and a strong emphasis on customer service
- five of the largest manufacturers of coatings in Europe are based in Britain
- the coatings industry comprises a handful of large multinational companies and hundreds of small and medium-sized enterprises
- formulations are increasingly sophisticated - protecting, beautifying, insulating, reflecting light etc
- 100 tonnes of ink is used each day for printing newspapers
- a jumbo jet needs 2 tonnes of paint.

A new interactive website based on a typical street scene helps young people learn about careers and products in the process and manufacturing sector. More information from the sector skills council Proskills.

Textiles

Scotland's textile sector is a highly technical industry in a competitive global market. The industry has an annual turnover of £942 million. In recent years the textile and clothing industry has seen continuous change. Expertise in design, production and innovation underpin recent success.

- there are currently over 500 textile companies in Scotland, directly employing over 10,900 people
- with textile exports valued at over £335m
- after several decades of steady decline in employment numbers, this is now slowing
- productivity has increased 12% in the last five years. It remains lower than other manufacturing industries, but the gap is narrowing
- a higher proportion of the workforce is now employed in highly skilled jobs, in areas such as design and product development
- 5.7% of Scottish manufacturing jobs are in the textiles sector
- in the last five years, the proportion of the workforce employed in non-manufacturing jobs has risen from 15% to 32 %,with managerial and professional occupations accounting for 13% of jobs
- average wages in the textile sector remain below the Scottish average, but the gap has decreased significantly as low skill jobs move offshore.

More information from Scottish Enterprise and Textile Scotland. More information for the sector skills Textile Skills.

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Skills Development Scotland: Business Interviews July 2018
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IndiNature, Construction, Edinburgh:
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4C Engineering, 4C Engineering, Inverness:
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Beyonder, Textiles, Glasgow:
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Gaeltel, Energy, Inverness:
https://www.gaeltel.co.uk/

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