ZERO WASTE SCOTLAND

Circular Economy Opportunities

North East Scotland

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Investing in a Smart, Sustainable and Inclusive Future

Foreword

“Moving toward a circular economy will be vital for the future profitability of businesses in the North East of Scotland. This project will raise awareness of the benefits and assist companies in making the transition to more sustainable operation.”

Councillor Peter Argyle, Deputy Leader and Chair of Infrastructure Services Committee, Aberdeenshire Council

“This study offers opportunities to identify waste problems and generate innovative solutions to them through the principles of the circular economy. By identifying such resources, opportunities for local business and market diversification could be provided here within the North East.”

Councillor Philip Bell, Aberdeen City Council Operational Delivery vice convenor

We are delighted to be working in partnership with Aberdeen & Grampian Chamber of Commerce in support of Circular North East, a regional circular economy project which will help local businesses to realise circular opportunities.

With large populations and an abundance of resources in a small geographic area, cities offer an ideal location for new circular economy business models such as reverse logistics, material recovery, re-use, leasing and sharing. In addition, the volume of businesses and people give sufficient scale to enable the change. In Scotland, it is also estimated that over half the population live in cities.

As a result, a key strand of our circular economy strategy at Zero Waste Scotland is to take a cities and regions approach, as it allows for a cross-sectoral focus, taking advantage of the benefits and potential synergies between businesses from different sectors. This not only encourages innovation but also can help create jobs.

A cities and regions approach also focuses on regional specialism – which in the case of Aberdeen City and Aberdeenshire, this preliminary report has found to be centred around the construction, oil and gas and the agriculture and food and drink sectors, maximising the opportunities in areas of strength and potential – which are not the same all over Scotland. We can understand and raise awareness of the benefits of a circular approach, support opportunities in ‘horizontal’ sectors, build relationships with local stakeholders and link with other relevant activity taking place on a regional basis, e.g. City Region Deals, economic development priorities and sustainability goals.

“This report identifies the scale of the economic opportunity for the North East associated with the circular economy. We look forward to working with Zero Waste Scotland to help realise these opportunities which will support innovation and the economic diversification of the Aberdeen city region.”

Russell Borthwick, Chief Executive, Aberdeen & Grampian Chamber of Commerce

In implementing our cities and regions work, it has been critical to adopt a close working relationship with long-established regional partners, such as in this case, Aberdeen & Grampian Chamber of Commerce who know their city inside-out – its needs, its potential and who to talk to.

This report is the culmination of the first stage of the project, where a combination of desk research and stakeholder engagement, thanks to the support of local authorities, identified a number of high-level circular opportunities reflective of the local economy and aligned with local authority strategic priorities in the Aberdeen City and Aberdeenshire area. Looking ahead to stage two, through a series of events, engagement activity, tools, and support, the Circular North East project will help businesses to embrace these circular opportunities, which will deliver the greatest economic impact and carbon savings, as well as the potential to create new business and jobs.

We look forward to the future: enhancing our partnerships within the Aberdeen City and Aberdeenshire region, led by Aberdeen & Grampian Chamber of Commerce seeing how the vast opportunities identified in this report become realised in stage 2 of the project.

Iain Gulland,
Chief Executive
Zero Waste Scotland

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Executive summary

The conventional understanding of economic activity is based on a linear model – natural resources are extracted and transformed into products, which are then bought and used by consumers who, as soon as the products no longer fulfil their needs, throw them away. However, this model is unsustainable in the long term because it ignores the high economic, environmental and social costs related to the extraction, transformation and disposal of resources.

The limitations of the linear model are becoming even more apparent as the availability of natural resources can no longer be taken for granted (e.g. due to water shortages or diminishing worldwide stocks of raw materials). A circular economy offers an alternative model where the value of products, materials and resources is maintained for as long as possible and waste is significantly reduced or even eliminated.

This study reports that, by adopting a circular economy, the Aberdeen and Aberdeenshire region could achieve economic benefits of over £625 million across the four identified priority sectors (i.e. construction and the built environment, energy infrastructure, manufacturing, and food and drink).

This report is designed to help readers understand the economic activities at the local and regional level and to highlight the scale of some of the circular economy opportunities. It provides a number of high-level sector action plans that serve as a guide for the next stage of the regional strategy, which is to engage with businesses and to facilitate the implementation of the circular economy opportunities within this report.

The breadth and scale of the opportunities confirm the unique and strategic role cities and their surrounding areas (from here onwards referred to as regions) will play in the transition to the circular economy. Regions can act as innovation centres and frontrunners for a circular economy transition due to their scale and diverse economies. Aberdeen and Aberdeenshire is characterised by an incredibly rich set of resources arising from communities and households, industry and agriculture/fisheries.

The North East Scotland region is one of the **top five most economically productive areas in the UK** – 25% of Scotland's food and drink exports are from this area.

Predicted economic benefits in Aberdeen and Aberdeenshire from adopting a circular economy are approximately **£625 million**:

- Construction and built environment sector – **£286 million**.
- Energy infrastructure sector – **£250 million**.
- Food and drink sector, and the wider bio-economy – **£52 million**.
- Manufacturing sector – **£37 million**.

Aberdeen and Aberdeenshire is one of the most productive agricultural regions in Scotland, accounting for the largest proportion of land in Scotland used for **barley (41%)** and **oilseed crops (30%)**.

In 2015, the Scottish food and drink sector generated over £14 billion turnover. A disproportionately large proportion of this was generated in the North East Scotland region, which supported **18% of employment** and generated **17% of gross value added (GVA)** in the food and drink sector.

£8.9 billion of infrastructure projects planned for the North East Scotland region up to 2030.

£100 billion investment in offshore wind.

North Sea decommissioning opportunity estimated at **£40 billion**.

131,016 tonnes of household waste is landfilled. Around **42,595 tonnes (33%)** of this is organic waste, which could be used as a valuable resource.

Over 4.1 million tonnes of bioresources are sent to landfill or discharged to land, sea and rivers across the region.

A total of **61,241 tonnes** of fish processing waste is generated across the region.

A total of **55,024 tonnes** of protein arisings are generated across the region.

Sector Opportunities

The key circular economy opportunities we identified in the north east are summarised below.

Food and drink and the wider bio-economy

- **Opportunity 1 – Biorefining straw**
  There are approximately 468,000 tonnes of straw arisings in Aberdeen and Aberdeenshire. This creates an excellent opportunity to make use of valuable compounds contained within to produce other products, for example, paper or ethanol. The cellulose and lignin fractions can also be exploited to make paper and ethanol.
- **Opportunity 2 – Oilseed rape valorisation**
  The region has over 50,000 tonnes of oilseed rape crop residues that could be used as a novel protein source by extracting the residues from the production of edible oils.
- **Opportunity 3 – Fish processing waste valorisation**
  In Aberdeen and Aberdeenshire there is approximately 61,241 tonnes of fish processing waste. Through co-location and cascading of reprocessing businesses, value added products including proteins, oils and amino acids can be harnessed.
- **Opportunity 4 – Protein production**
  There are over 340,000 tonnes of protein arisings from waste and by-products in Scotland each year with 55,024 tonnes arising in Aberdeenshire alone. With the world population growing at a rate of 1.14% per year, the demand for food and protein will increase. Therefore, finding alternative sources will become ever more important. Biorefining (i.e. the sustainable processing of biomass into bio-based products and bioenergy) offers an opportunity to provide more protein (e.g. by extracting it from the non-edible parts of plants or from food waste).

Construction and the built environment

- **Opportunity 5 – Engaging with the small and medium sized enterprises (SME) supply chain in house building and refurbishment**
  Several new-build housing developments are planned for Aberdeen and Aberdeenshire in the coming years, including a new £160 million social housing improvement framework contract. A variety of circular economy opportunities will be available to architects and design contractors including designing for longevity and ease of refurbishment. For example, by standardising components, fixtures and fittings (e.g. windows, doors and heating systems) future repair or replacement can be made easier and less resource intensive.

Manufacturing and energy infrastructure

- **Opportunity 6 – Innovative circular economy business models (leasing and servitisation)**
  Leasing and servitisation are two key circular economy business models. There is a significant opportunity for the engineering, contracting and manufacturing industries to adopt leasing and servitisation models whereby products are rented out or services in support of product use are provided. In the North East Scotland region, there is a very high level of engineering and manufacturing activity, particularly in support of the energy infrastructure industry.
- **Opportunity 7 – Re-use, repurposing, remanufacturing and refurbishment**
  It is estimated that over 300 oil and gas installations, nearly 400 subsea installations, 16,000km of pipelines and more than 5,000 wells will eventually be decommissioned on the UK Continental Shelf (UKCS). Therefore, decommissioning presents a huge opportunity for sourcing materials and equipment for re-use, remanufacturing, refurbishment and recycling.

Recommendations

Set appropriate regional conditions to promote a circular economy

Regions should integrate their commitment to a circular economy into relevant strategic documents, setting out local priorities, planned measures and forms of support available.

Stakeholder collaboration

Industry stakeholders and those organisations involved in economic development should collaborate to provide a coordinated service.

Multi-agency collaboration to share learnings, agree actions and avoid duplication

This joined-up approach will be essential if the strategic recommendations identified at the end of this report are to be realised (i.e. cross-sectoral resource sharing and and using circular economy principles for procurement).

Sectoral knowledge sharing

It is strongly recommended that a sectoral approach is adopted by the business engagement partner when engaging with businesses. Sectors have well-defined communication and engagement channels through trusted stakeholders that are well placed to promote the benefits of a circular economy.

Cross-sectoral resource sharing

Facilitate cross-sector resource sharing to make it easy for one business's waste, surplus material or by-products to become another's feedstock.

Regional procurement strategy that drives a circular economy

Stakeholders should develop and embed circular economy procurement approaches within supply chains across the region.

Circular economy indicators

Indicators will allow progress, made through regional policy and interventions, to be measured.

1 Introduction

1.1 Importance of a circular economy

The current problem

We live in a predominantly extractive linear economy of 'take, make, use and dispose'[1]. With the world's population estimated to reach 9 billion by 2050, the cost and demand for resources will continue to rise. This increasing demand, combined with the earth's limited supply of resources, will have a significant impact on environmental health, economic development and the planet's ability to meet the needs of future generations[2].

A potential solution

A circular economy is an alternative economic model where resources are kept circulating in use for as long as possible – extracting the maximum value from them, and then recovering and regenerating them into products and materials at the end of their life. The breadth and scale of the opportunities confirm the unique and strategic role cities and their surrounding areas (from here onwards referred to as regions) will play in the transition to the circular economy.

Importance of a circular economy in Scotland

Scotland is one of the pioneering nations in transitioning to a circular economy. A previous study calculated that the circular economy could deliver £1.5 billion[3] of economic benefit to the Scottish Economy. Zero Waste Scotland supports acceleration to this transition in a number of ways, including the Circular Economy Investment Fund, running the Circular Economy Business Support Service and administering the Scottish Circular Economy Business Network.

1 http://www.wrap.org.uk/about-us/about/wrap-and-circular-economy - WRAP and the circular economy

2 https://docs.wixstatic.com/ugd/27f091_614b25efd0f343be85e1abd6fc6799f1.pdf - Circular Glasgow City Scan report

3 https://www.zerowastescotland.org.uk/content/scotland-and-circular-economy-report

1.2 Identifying circular economy opportunities in cities and regions

Zero Waste Scotland has recognised the important economic and environmental potential of developing circular economy strategies at a regional level to benefit from the economies of scale that a city and region can offer.

This study is not intended to be an academic exercise in providing a complete understanding of the economic and material flows – the available data don't allow this. This is a review of the major sectoral opportunities that exist and a means of presenting these opportunities in a meaningful and engaging way. This is stage 1 of a 2-stage approach being delivered by Zero Waste Scotland. Stage 2 will involve the further development of the opportunities presented here through 'local business engagement partners' who will work with Zero Waste Scotland and other stakeholders to implement the recommendations detailed within this study. Zero Waste Scotland have engaged Aberdeen & Grampian Chamber of Commerce as their local business engagement partner. ZWS have engaged Aberdeen & Grampian Chamber of Commerce as their local business engagement partner. The intention of this report is to facilitate this engagement process with businesses and identify the key stakeholders who will be instrumental in delivering circular economy opportunities across the region.

This study focused on the two local authority areas of Aberdeen and Aberdeenshire.

1.3 Importance of a regional circular economy

Circular economy principles are often adopted at a local or business level. While this approach is important, it is also important to understand the circular economy from a regional perspective. **A region offers significant economies of scale that make opportunities viable that would not be possible at a smaller, more local level. As such, regions enable a step change in a move towards a more circular economy**. In the coming decades, cities and regions can expect greater rates of urbanisation and, subsequently, greater waste generation, resource consumption, economic developments and infrastructure investments. Furthermore, cities and regions will be well placed to drive the transition towards a circular economy due to the level of resources, economic activity, data and innovative capability. As such, there is a growing need to understand the opportunities within regions to help them thrive and flourish in the future.

Table 1 gives some of the advantages of taking a regional approach to circular economy thinking.

Table 1: Advantages of taking a regional approach to a circular economy

1	**Material flow data are often understood on a regional level.**
2	**Enables links to be established with relevant activities, policies and initiatives taking place at a regional level.**
3	**Enables a sector-based approach to be taken.**
4	**Presents opportunities to build relationships between stakeholders on a larger scale.**
5	**Provides an opportunity to maximise potential synergies between businesses from different sectors.**
6	**Presents opportunities to raise awareness and share resources, information and ideas at a larger scale.**

2 Approach

The approach sought to identify the linkages between economic and material flows to highlight where the most beneficial circular economy opportunities could be developed. Figure 1 shows the key stages in this approach.

Figure 1: Flow diagram showing the key stages undertaken for this study

Step 1: Material and economic flow mapping

A combination of economic and environmental data helped to identify the priority sectors within the region. These priority sectors are defined as those where the greatest economic activity occurs and that have the greatest impact through resource use, waste generation and logistical needs.

Step 2: Understand regional priorities

A desk-based study was undertaken to identify key political, economic and environmental drivers across the region and any possible barriers that could impede the adoption of a circular economy. Following this, key stakeholders (referred to as the Stakeholder Advisory Group) were consulted. The aim of the Stakeholder Advisory Group was to gain key insight into the region and better understand the appetite, ambitions and priorities for a circular economy.

Together, the data obtained from Steps 1 and 2 enabled the affirmation of the priority sectors that form the basis of the rest of this study (i.e. construction and built environment, energy infrastructure, manufacturing, and food and drink, and the wider bio-economy).

Step 3: Identify priority sectors

This stage of the study involved two key tasks:

- Task 1: Identify the sector circular economy 'hotspots'
  The priority sectors were then further interrogated to inform the interface between the priority sectors to identify sector 'hotspots'.
- Task 2: Assessing and quantifying the economic prize

The purpose of this task was to provide a 'top-level' indication of the possible size of the economic prize associated with implementing circular economy projects in the hotspots identified. Potential savings in terms of gross value added (GVA) were calculated for each of the priority sectors.

Step 4: Identify and map circular economy opportunities

The circular economy covers many types of opportunities that can differ significantly by sector. Steps 1 to 3 helped to identify the priority sectors and sector interfaces. Using this information, a high-level mapping exercise was carried out for each sector, using a structured framework based around the following four key circular economy principles:

- Refurbishment and remanufacture.
- Re-use.
- Recycle/regeneration.
- Prevention (e.g. resource and product sharing, design for disassembly, servitisation and maintenance).

From this mapping exercise, a longlist of circular economy opportunities was formed. These opportunities were then shared with Stakeholder Advisory Group members to seek their insight into the appropriateness and attractiveness of the various opportunities. The valuable knowledge and insights of the stakeholders helped to ascertain the political appetite for various initiatives and subsequently develop a revised, shortened list of opportunities.

Step 5: Impact quantification – develop a shortlist of opportunities

The opportunities identified in Step 4 were then further prioritised and a shortlist of favoured opportunities that would maximise the economic and environmental benefits was developed. A qualitative scoring mechanism – based on economic impact, resource savings, carbon impact and likelihood of implementation in the region – was used to rank these opportunities.

Step 6: Develop sector action plans

Each of the selected opportunities identified in Step 5 was then researched and developed into mini action plans, detailing the key aspects, benefits, case examples, relevant stakeholders and next steps. This was carried out in collaboration with the Business Engagement Partners. These mini action plans were then compiled for each priority sector to form the sector action plans. As part of stage 2 of this regional strategy (this report being stage 1), the business engagement partners will use the action plans to engage with businesses and key stakeholders to develop and implement the opportunities.

3 Understanding the local agenda

The value of this stage was to understand the regional and local priorities in terms of the economic, environmental and political drivers to help identify the priority sectors.

The Aberdeen and Aberdeenshire region is home to almost 500,000 people and covers an area of approximately 6,500 square kilometres (2,500 square miles). The North East Scotland region is one of the top five most economically productive areas in the UK and 25% of Scotland's food and drink exports are from this area[4]. Aberdeen is often referred to as the 'oil capital of Europe', and the oil and gas sector has a considerable influence on the area.

An Aberdeen Region City Deal has been submitted and agreed. The total value of committed funding to date from the UK Government, Scottish Government, Aberdeen City Council and Aberdeenshire Council is around £524 million[5]. This includes several commitments across a range of categories including:

- Innovation.
- Digital connectivity.
- Harbour expansion.
- Transport.

This significant investment provides real circular economy opportunities, since circular economy principles such as energy recovery, circular economy procurement and design for circularity for construction projects can be embedded into existing and planned projects. Projects included in the City Deal cover infrastructure, transport and energy/low carbon.

There are ambitious plans for the North East Scotland region, including strategic investment priorities for Aberdeen and Aberdeenshire across key sectors to sustain, diversify and grow the regional economic base and achieve an equitable distribution of economic success[6]. The Aberdeen and Grampian Chamber of Commerce has identified infrastructure investment of over £8 billion over the next 15 years. Applying circular economy principles to these construction projects will provide enormous economic opportunities and contribute towards sustainable economic growth.

Below is a list of existing and planned projects in Aberdeen City and Sire and their respective value[7].

- Aberdeen City Region Deal projects – £524 million.
- Transport and other infrastructure projects – £4.48 billion.
- Leisure and retail projects – £984 million.
- Culture projects – £42 million.
- Education projects – £263 million.
- Office and business space – £82.25 million.
- Ports and marine development – £2.38 million.
- Aberdeen City Masterplan projects – £134 million+.

4 ONE – Regional economic strategy
5 From Chamber of Commerce investment tracker
6 ONE – Regional economic strategy
7 Chamber of commerce investment tracker

4 Economic mapping: a sector focus

4.1 Total savings

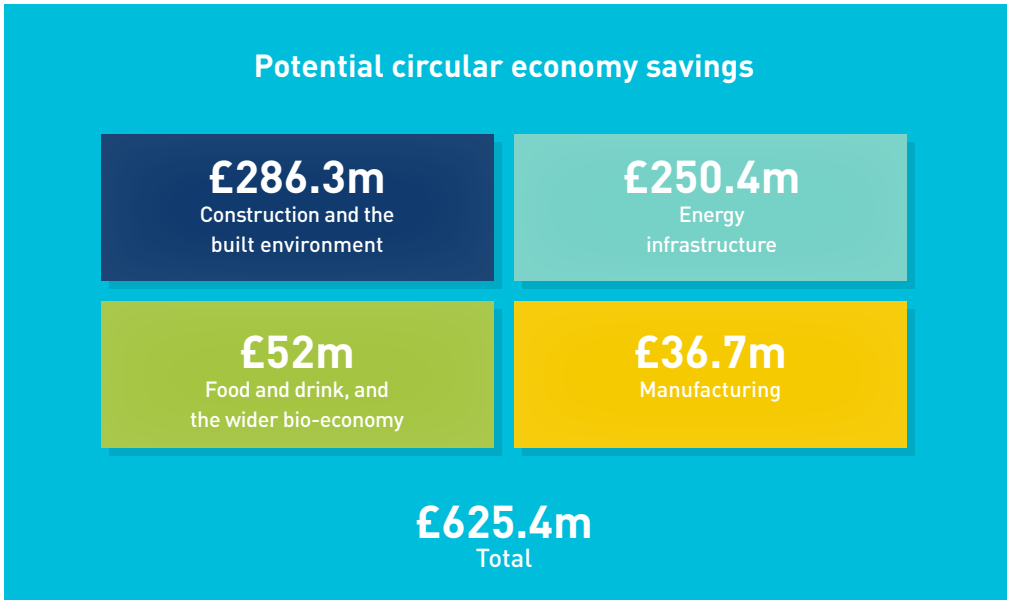
By adopting circular economy principles, the Aberdeen and Aberdeenshire region could achieve economic benefits of over £625 million across the four identified priority sectors (i.e. construction and the built environment, energy infrastructure, manufacturing, and food and drink, and the wider bio-economy). These savings result from reductions in raw material, water and energy consumption which also generate significant carbon savings in the long-term.

To assess the potential economic benefit of adopting circular economy opportunities, a review was undertaken of 1,500 case studies about small and medium sized enterprises (SMEs) that had implemented circular economy/resource efficiency savings covering raw materials, energy and water. From this data, assumptions were made for percentage savings (upper and lower bound) for the inputs to production (raw material inputs, processed/manufactured inputs, energy, waste disposal, other services and water) for each priority sector. These assumptions were then applied to estimates of the value of intermediate purchases in each priority sector in the local area to calculate the scale of circular economy savings for each priority sector in terms of GVA.

For all priority sectors, the same savings assumptions for an input to production were applied as a percentage of all intermediate purchases of that input. For example, within manufacturing, the percentage savings for energy input would be applied to purchases of both electricity and gas (as they are both energy inputs), although they could differ between the wood & wood products sector and the fabricated metals sector (which are different activities in the manufacturing priority sector). The component sectors (activities) that make up each priority sector are consistent with those in the 2014 Scottish Input-Output (I-O) Table.

For each component, local GVA estimates were calculated from circular economy's productivity data by 45 sectors and local employment data from the Business Register and Employment Survey (BRES). Gross output was then estimated using sector specific ratios of gross output to GVA for Scotland as a whole from the I-O table. Finally, a similar method was used to estimate intermediate purchases as a percentage of gross output, taking into account the supply chain of each sector where savings could be made.

Figure 2: Total estimated circular economy savings across the four priority sectors



These proposed savings would be achieved over the long term and would require a combination of collaboration, investment, commitment of stakeholders and innovation. It is important to note that in addition to these monetary savings, other circular economy benefits would also be generated such as new products, services and jobs.

The following sections provide an economic snapshot of the four priority sectors. Using the methodology discussed in Sections 2 and 4.1, the potential savings for each sector were quantified, as summarised in Figure 2. Figures 3, 4, 5 and 6 present the priority sectors in Aberdeen and Aberdeenshire in terms of GVA and the top inputs to production for each of the priority sectors in Scotland[8]. This data provide a valuable understanding of what each sector buys in terms of inputs and, as a result, create a 'lens' through which circular economy opportunities can be identified (Steps 4 and 5 in Section 2).

In effect, the data reveals where materials flow across the economy and between sectors. This enables an understanding to be gained of the types of materials that are used in the sector, which, in turn, enables potential opportunities to prevent raw material use or reduce waste at source and across the supply chain to be identified and understood. It also enables the likely manufacturing and processing of these materials to be understood, which then helps identify the raw material flows, the products manufactured and the wastes generated.

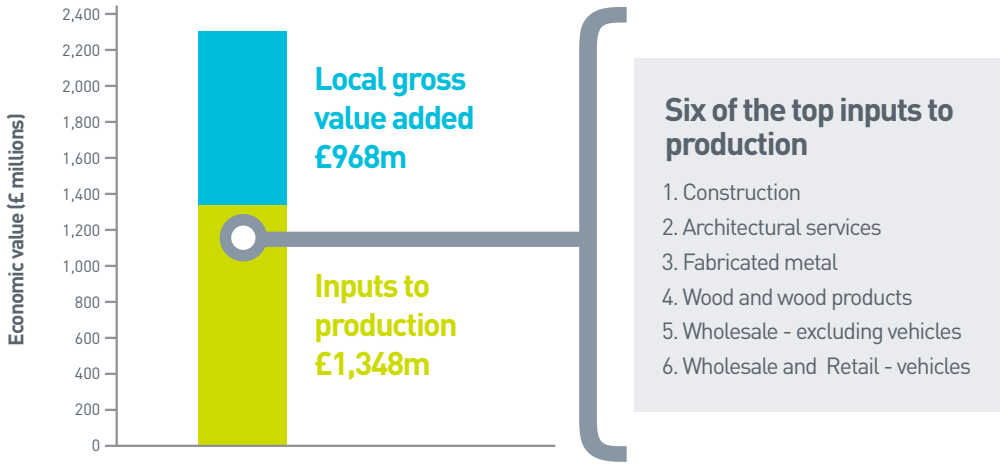
[8] The GVA figures are derived from Cambridge Econometrics databanks

4.2 Construction and built environment

4.2.1 Total input and output values

Based on estimates of local gross output in 2016, the construction sector in Aberdeen and Aberdeenshire is worth £2.3 billion. The value of the total inputs is £1.3 billion and the GVA is £968 million[9]. Figure 3 identifies the top inputs to production (in terms of economic value) for the construction sector in Scotland. This shows that organisations in the construction industry purchase a substantial proportion of goods and services from other organisations in the sector. This means there is a lot of potential to work in the sector to engage with stakeholders, tighten networks and close loops though circular economy opportunities. In addition, it highlights the key role procurement can play in driving a new model of construction that controls how goods and services are bought, specifying the use of re-used materials and material with recycled content, and designing out waste.

Figure 3: Gross value added (GVA) in Aberdeen and Aberdeenshire and top inputs to production in Scotland for the construction sector



4.2.2 Potential circular economy savings

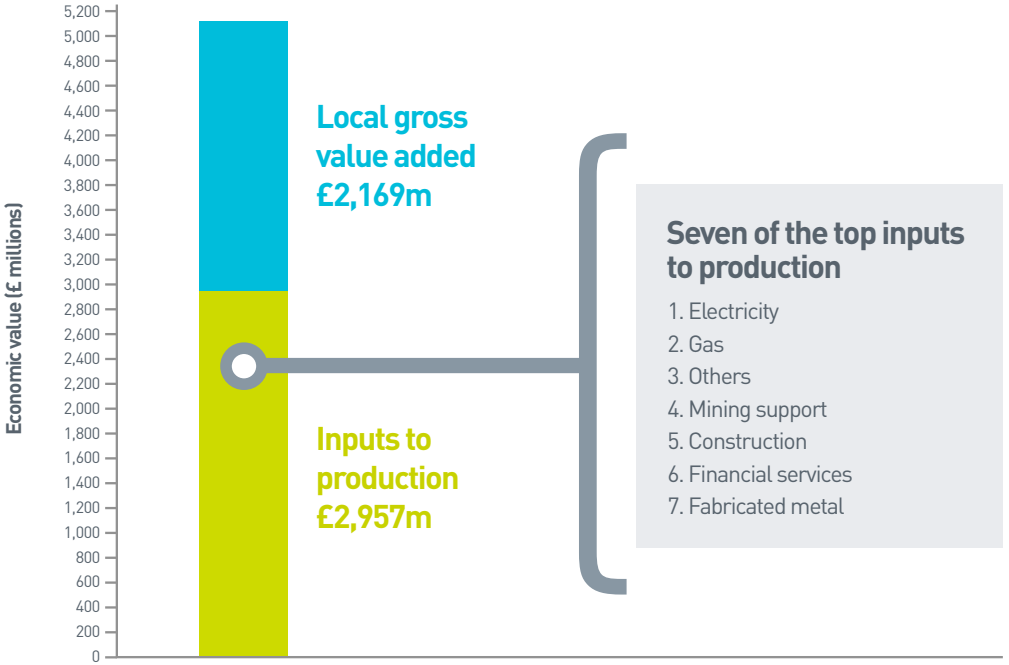
Through the adoption of circular economy opportunities – such as the refurbishment or re-use of construction materials – there is an estimated £286 million (30% of GVA) of potential economic savings for the construction sector in Aberdeen and Aberdeenshire.

4.3 Energy Infrastructure

4.3.1 Total input and output values

The energy infrastructure sector is involved with energy generation, and transmission technologies and equipment. Based on estimates of local gross output in 2016, the gross output for the energy infrastructure sector in Aberdeen and Aberdeenshire is £5.1 billion, the value of the total inputs to production is £3 billion, and the GVA is £2.2 billion. Figure 4 identifies the top inputs to production (in terms of economic value) for the energy infrastructure sector in Scotland. This shows that many of the goods and services purchased come from the electricity and gas sectors, with others from the mining, construction, financial and fabricated metal industries. The scale of the savings related to electricity infrastructure illustrates the opportunities to reduce energy consumption and, importantly, the reliance on traditional non-renewable electricity generation. Adopting circular-economy principles by using renewable sources of energy and seeking to be more efficient with the energy that is generated is key. This includes exploring more innovative sources of energy (e.g. underused heat and hydrogen) as a mechanism to store curtailed renewable energy, so making it more readily available when the grid is stressed.

Figure 4: Gross value added (GVA) in Aberdeen and Aberdeenshire and top inputs to production in Scotland for the energy infrastructure sector



[9] Cambridge Econometricss

4.3.2 Potential circular economy savings

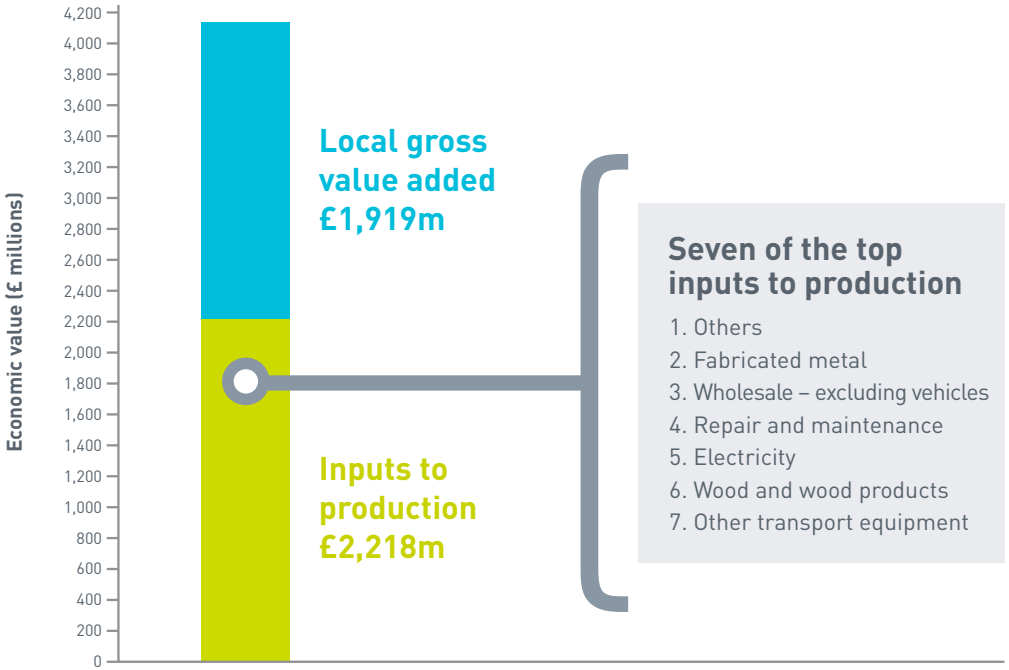
Through the adoption of circular economy opportunities, such as re-use of materials after decommissioning or valorisation of underused energy, there is an estimated £250 million (12% of GVA) of potential economic savings for the energy infrastructure sector in Aberdeen and Aberdeenshire.

4.4 Manufacturing

4.4.1 Total input and output values

Based on estimates of local gross output in 2016, the gross output for the manufacturing sector in Aberdeen and Aberdeenshire is £4.1 billion, the value of the total inputs to production is £2.2 billion, and the GVA is £1.9 billion. Figure 5 identifies the top inputs to production (in terms of economic value) for the manufacturing sector in Scotland. This shows that a large proportion of the goods and services purchased are from the fabricated metal sector, along with wholesale, repair and maintenance and other sub-sectors. This suggests that these areas are good places to identify circular economy opportunities.

Figure 5: Gross value added (GVA) in Aberdeen and Aberdeenshire and top inputs to production in Scotland for the manufacturing sector



4.4.2 Potential circular economy savings for key sub-sectors

Through the adoption of circular economy opportunities – such as leasing, servitisation of products and remanufacturing – there is an estimated £37 million (2% of GVA) of potential economic savings for the manufacturing sector in Aberdeen and Aberdeenshire. Process optimisation when fabricating metal, and the use of machinery and equipment are the areas that show the greatest opportunities to adopt more circular economy practices.

4.5 Food and drink, and the wider bio-economy

4.5.1 Total input and output values

Based on estimates of local gross output in 2016, the gross output for the food and drink sector in Aberdeen and Aberdeenshire is £2.9 billion, the value of the total inputs to production is £1.9 billion and the GVA is £1 billion. Figure 6 identifies the top inputs to production (in terms of economic value) for the food and drink sector in Scotland. This shows that a large proportion of goods and services are purchased from the agriculture sector, along with fishing, fish processing and others. This suggests that these areas are good places to identify circular economy opportunities.

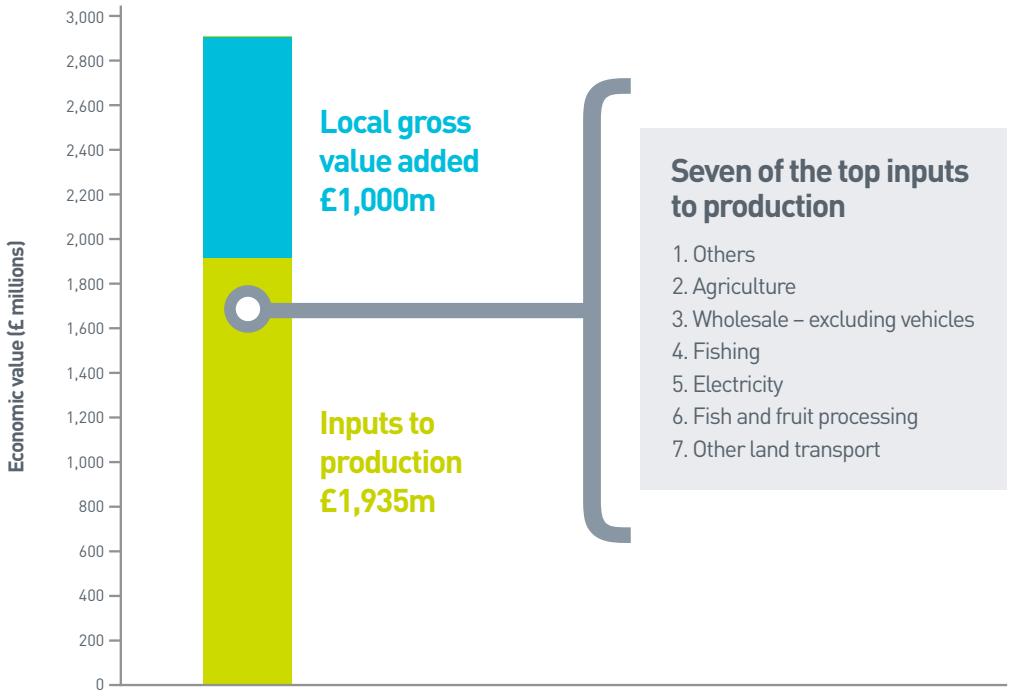
4.5.2 Potential circular economy savings for key sub-sectors

Through the adoption of circular economy opportunities – such as fish processing, starch valorisation and biorefining – there is an estimated £52 million (5% of GVA) of potential economic savings for the food and drink sector in Aberdeen and Aberdeenshire.

The scale of the sector illustrates the importance of a circular economy from an economic perspective. Finding new and exciting ways of using and extracting more value from the waste and by-products generated in the agricultural and processing industries can help to reduce the volume of organic material wasted and generate new business through innovative techniques. However, it is interesting to note that the savings are relatively small. The reason for this is that the circular economy savings identified in the case studies reviewed as part of the methodology (Section 4.1) focused mostly on resource efficiency and waste prevention.

To date, little has been done to understand the waste and by-product arisings from the agriculture sector. Therefore, the savings potential is lower than that for the other sectors. The importance of the agricultural/food and drink sector comes from the sheer volume of agricultural residues that could be valorised. This is also true for the by-products from the food and drink sector which account for 100,000s of tonnes of bioresources. As a result, new revenue streams and value-added products are generated.

Figure 6: Gross value added (GVA) in Aberdeen and Aberdeenshire and top inputs to production in Scotland for the food and drink sector

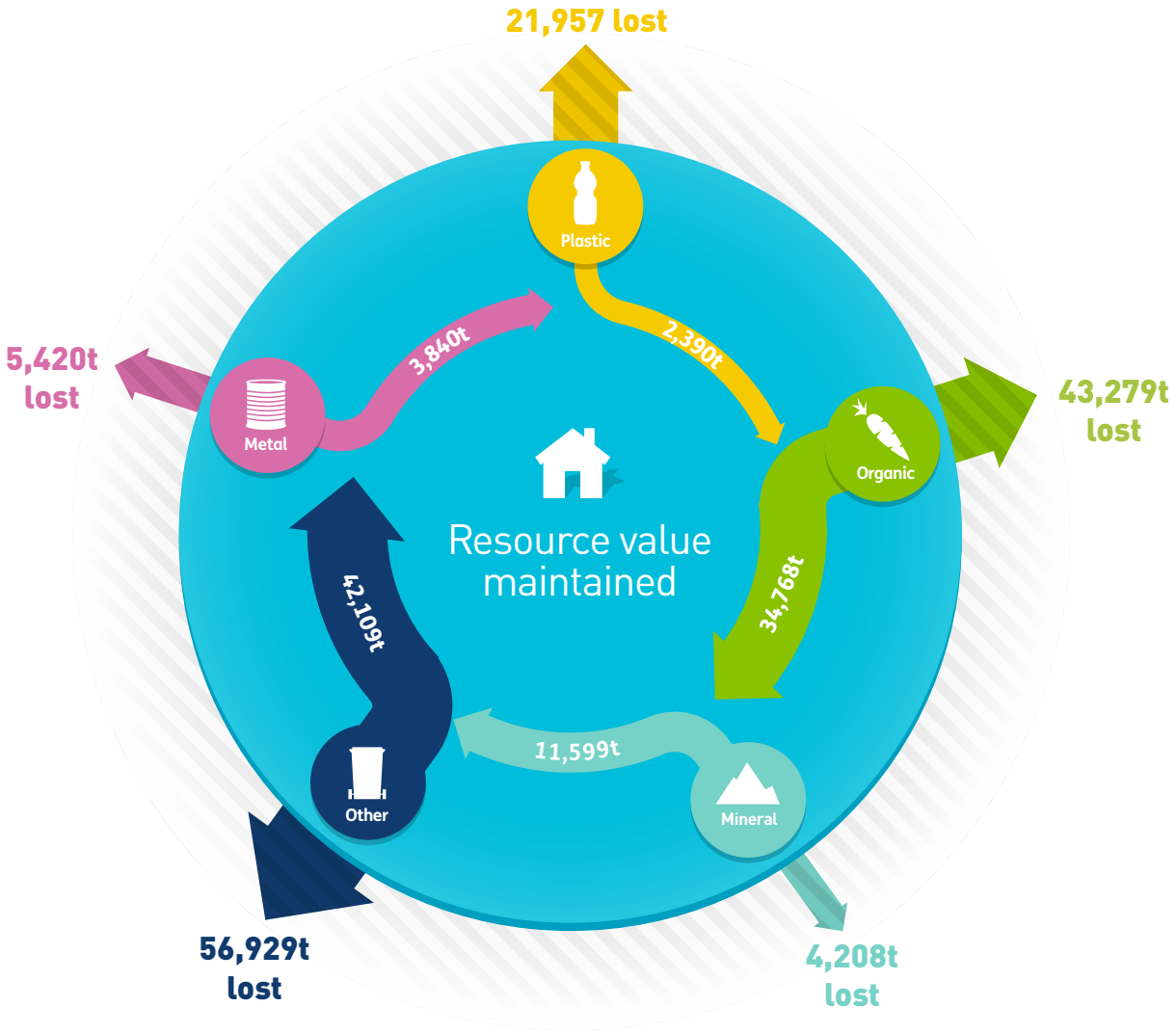


5 Material and transport flows

5.1 Household material flows

To identify the circular economy opportunities, it was important to understand the material flows within the region. Regional waste and material data were reviewed and analysed to understand the key household, commercial and industrial, and bioresource flows in Aberdeen and Aberdeenshire. Figure 7 shows the total household waste, split by fraction and fate, for Aberdeen and Aberdeenshire. This shows that the majority (58%) of household waste is lost, either to landfill or via incineration, and a large proportion of this is organic waste. This suggests that there is huge potential to capture these wasted resources through circular economy opportunities.

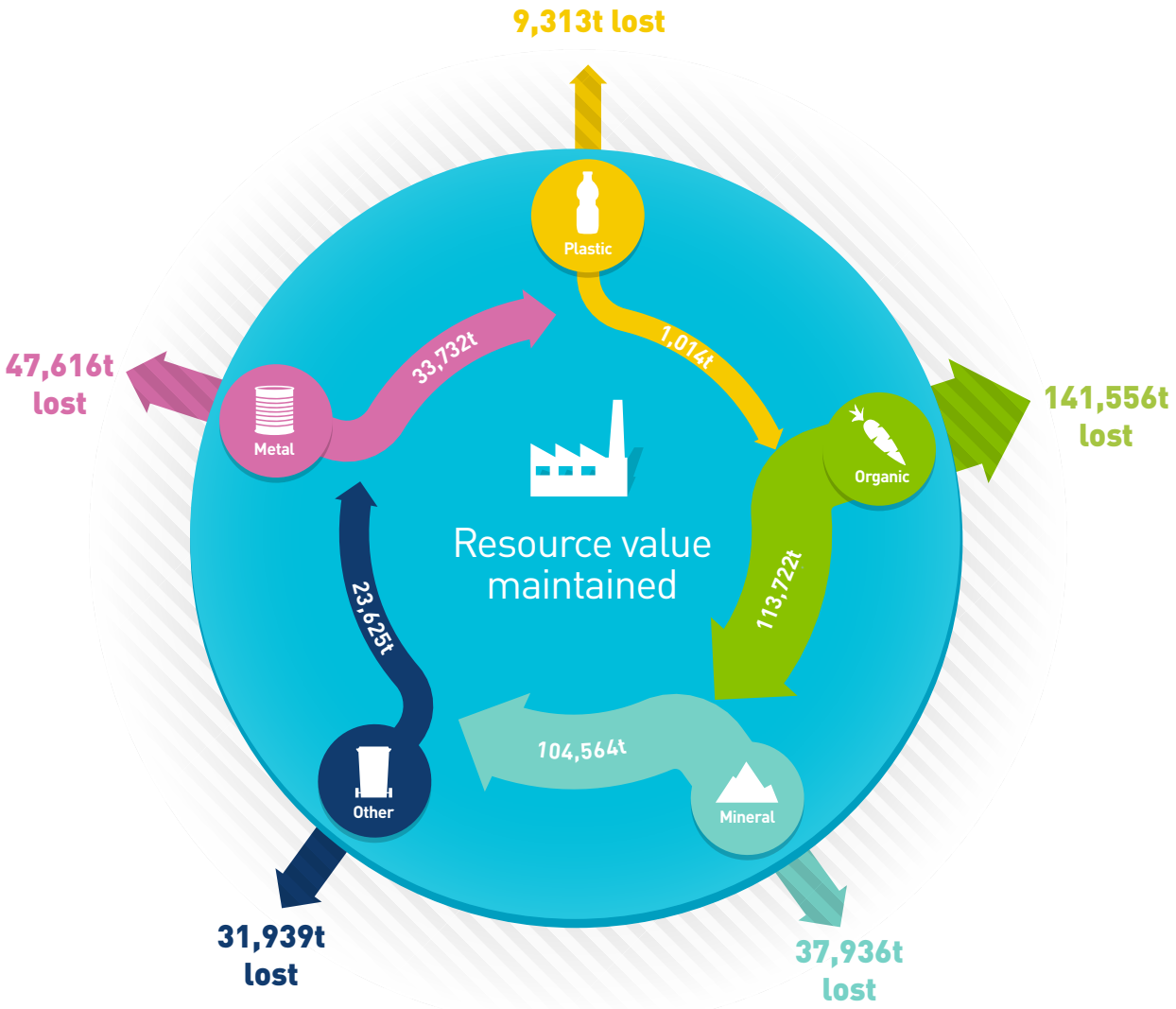
Figure 7: Household material flows in Aberdeen and Aberdeenshire (lost and recovered)



5.2 Commercial and industrial material flows

While data on commercial and industrial waste arisings were available, data on their fates were not. Therefore, the relative proportions used for the household waste have been applied to the commercial and industrial waste arisings, as shown below in Figure 8.

Figure 8: Commercial and industrial material flows in Aberdeen and Aberdeenshire (lost and recovered)



5.3 Bioresource flows

Figure 9 and represent the key by-products and agricultural residues for Aberdeen and Aberdeenshire, excluding manure slurry and 'other' wastes. This shows that the largest resources are whisky by-products (578,102 tonnes) followed by straw (468,013 tonnes). The majority of whisky by-products are lost via discharge to sea or land, whereas the majority of straw waste is used or recovered, but to a low value.

5.3.1 Agricultural crop arisings

Figure 10 gives the total agricultural crop arisings in Aberdeen and Aberdeenshire. The volume of carrots and potatoes being grown is represented by the volume of harvest waste and tops, stalks and leaves, as shown in the graphs below.

Figure 9: Total bioresources for Aberdeen and Aberdeenshire split by fate and weight

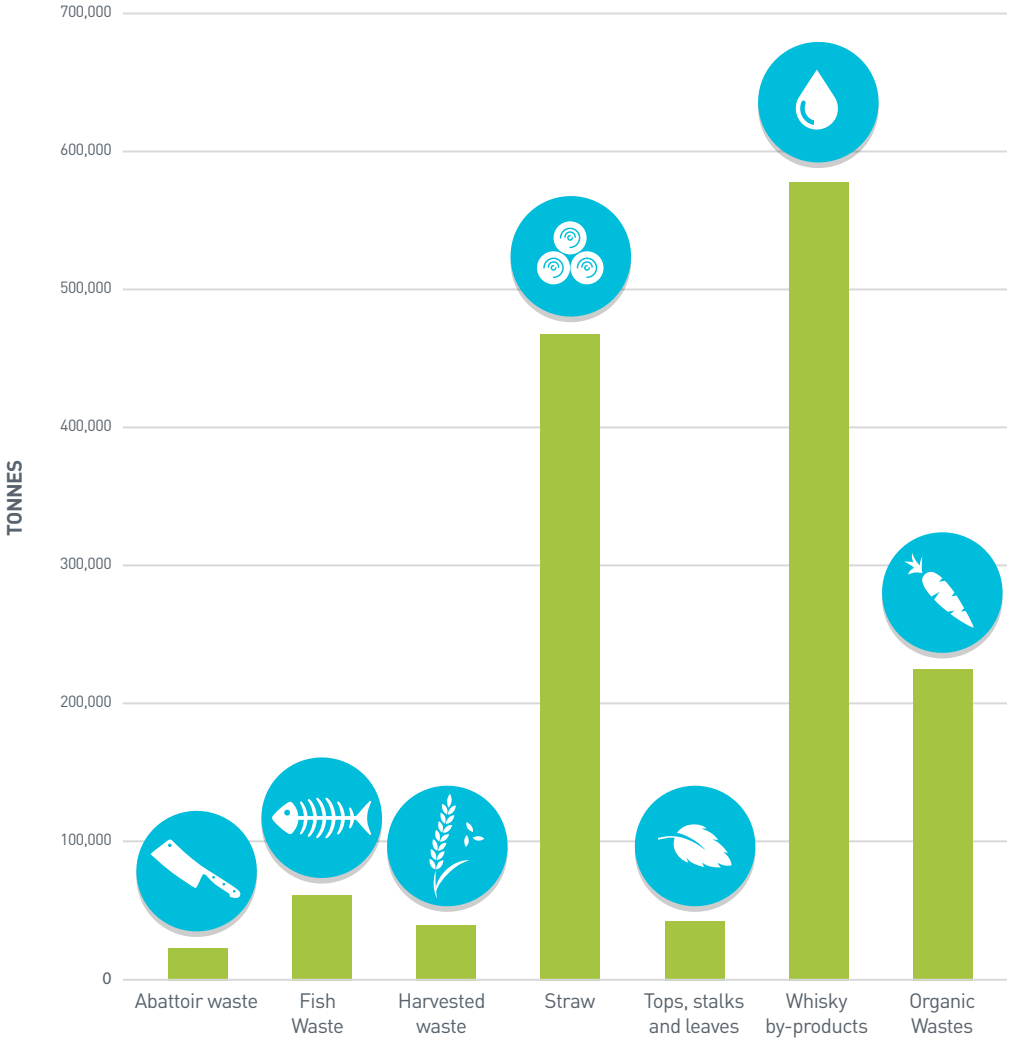
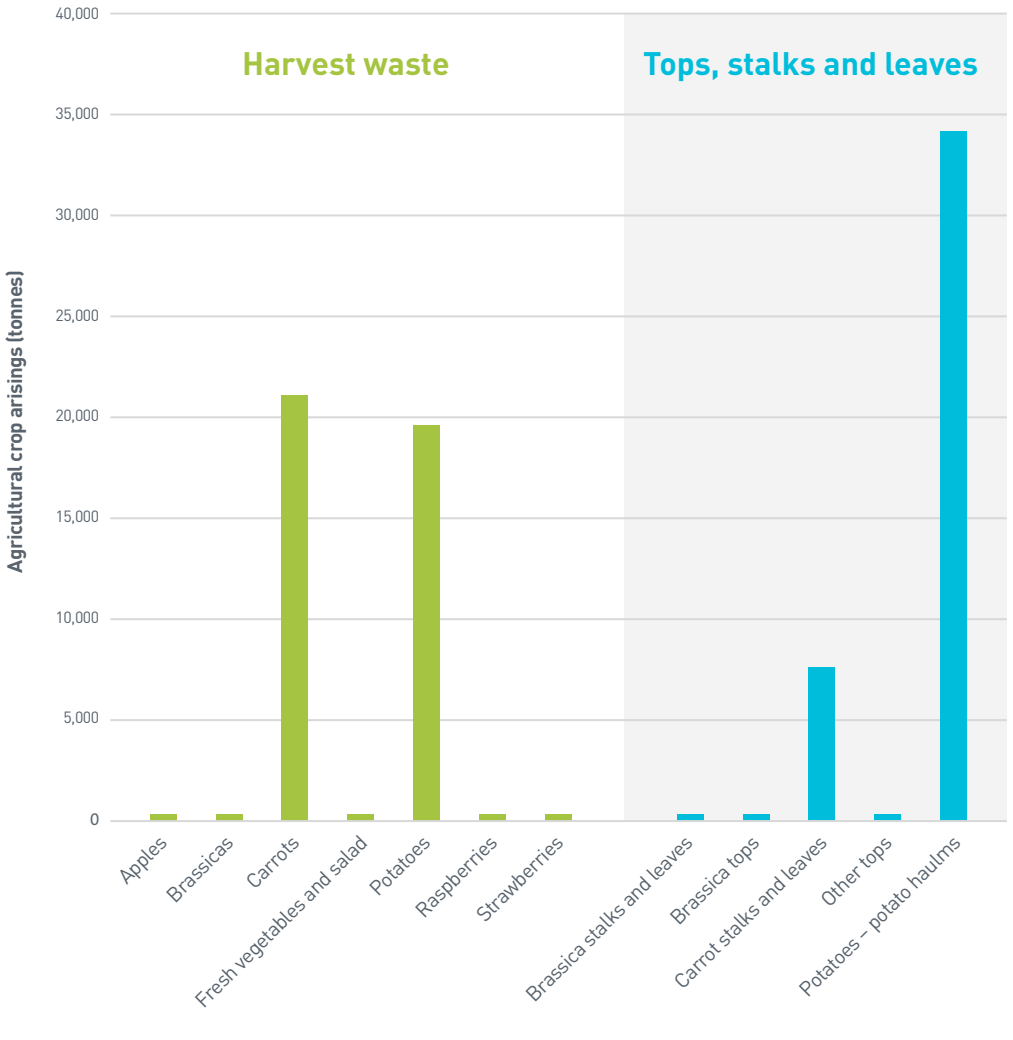


Figure 10: Agricultural crop material arisings in Aberdeen and Aberdeenshire

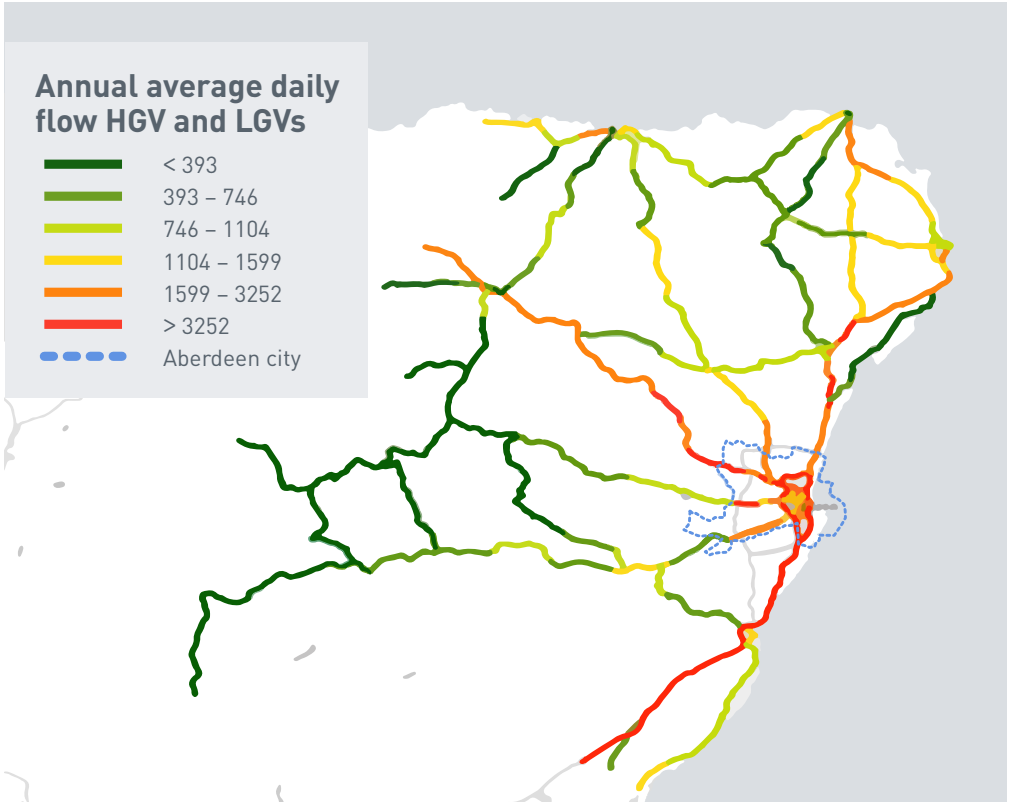


5.4 Transport

Figure 11 shows a transport 'heat map' for light goods vehicles and heavy goods vehicles across Aberdeen and Aberdeenshire. It demonstrates the relatively high volumes of traffic movements from the rural areas which provides an opportunity to reduce these miles through shared logistics and 'final-mile' deliveries.

The total distance travelled by commercial vehicles across this region is over **522 million kilometres (324 million miles)**[10].

Figure 11: Transport 'heat map' for light goods vehicles and heavy goods vehicles across Aberdeen and Aberdeenshire



[10] National Atmospheric Emissions Inventory

6 Sector action plans

Following a stakeholder consultation, feedback was used to reduce the longlist of circular economy opportunities to a focused shortlist. The criteria used to assess the opportunities centred on carbon and economic impact, and the likelihood of implementation.

The shortlist of seven opportunities cover the four priority sectors and each opportunity was developed into a sector action plan that highlighted the **scale of the opportunity**, **the key stakeholders** and **suggested next steps**. The shortlisted opportunities form the sector action plans and are detailed in the following sections.

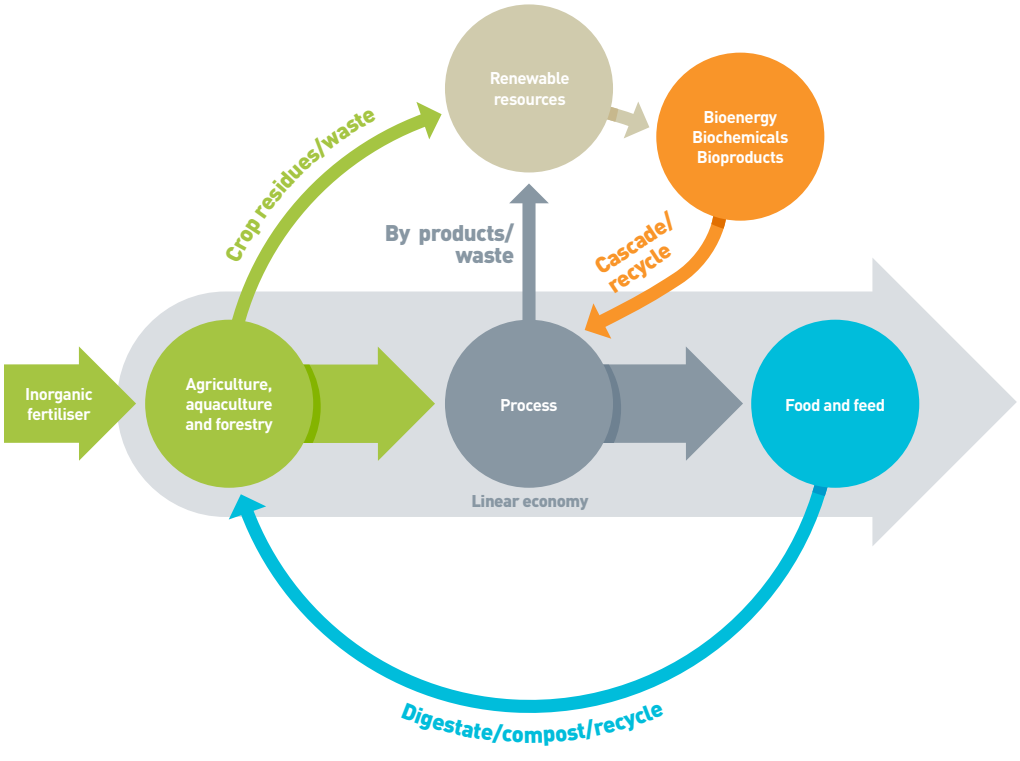
6.1 Food and drink, and the wider bio-economy

The bio-economy refers to parts of the economy that use renewable biological resources from land and sea (crops, forests, fish, animals and micro-organisms) and convert them into food, feed, materials and energy via innovative and efficient biotechnologies. This is illustrated in Figure 12.

The UK bio-economy is one of the largest in the EU and is underpinned by strong research and development (R&D). A report commissioned by the Biotechnology and Biological Sciences Research Council (BBSRC) estimated that the transformational bioeconomy, comprising agriculture and fishing, forestry and logging, water and remediation activities, food products and beverages and industrial biotechnology and bioenergy, has a value of £56 billion[11]. Food and drink manufacturing accounted for almost 40% of that total, with industrial biotechnology and bioenergy contributing 13%. Almost half the employment in the transformative bio-economy was in agriculture and fisheries.

At the Scottish level, the food and drink sector generated £14 billion turnover and employed around 118,000 people[12]. The North East Scotland region made a disproportionately large contribution to this, supporting 18% of employment and generating 17% of GVA despite being home to just 11% of the Scottish population[13].

Figure 12: Linear and circular material flows within the agriculture, aquaculture and forestry sectors



[11] Bauen, A. et al. (2016)
[12] http://www.scotlandfoodanddrink.org/news/article-info/6230/food-and-drink-turnover-hits-record-high.aspx
[13] http://www.gov.scot/Topics/Statistics/Browse/Business/SABS/KeyFacts

Valorisation of fruit and crop residues

Processing and harvesting fruit, vegetables and agricultural crops results in high amounts of waste materials such as peels, seeds, stones and straw. The cost of drying, storing and transporting these waste materials puts additional economical limitations to valorisation. Therefore, fruit and crop residues are often used as feed or fertiliser, which does not realise the full economic value of these materials. New opportunities to use these residues as feedstock for further exploitation in the production of food additives or supplements with high nutritional value have gained increasing interest because they are high-value products and their recovery may be economically attractive.

Background

The Aberdeen and Aberdeenshire region is one of the most productive agricultural areas in Scotland. It accounts for the largest proportion of land in Scotland used for barley (41%) and oilseed crops (30%). It also has one of the highest numbers of livestock. This intensive agricultural activity produces huge volumes of agricultural by-products and residues, including:

- 83,000 tonnes of agricultural crop residues (41% potato haulms, 25% carrots and 23% potatoes).
- Around 468,000 tonnes of straw – just over 61,000 tonnes of this is wheat straw.
- Over 50,000 tonnes of oilseed rape straw.

The opportunities

The business case for biorefining agricultural residues depends on identifying the most economically viable uses – the value chain, as detailed below in Figure 13, which presents the highest value opportunities at the top of the diagram.

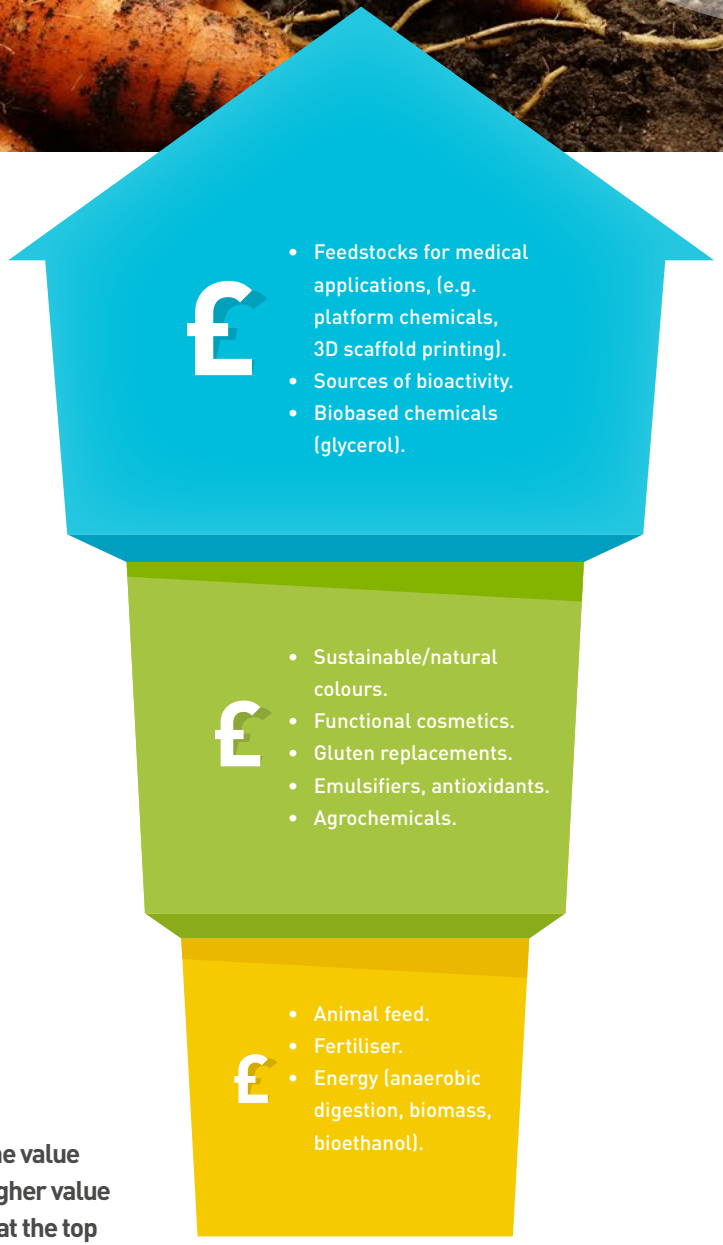


Figure 13: The value chain with higher value applications at the top

Opportunity 1 –

Biorefining straw

Background

Straw is a good example of a low-value, high-volume agricultural by-product that can be used as fuel/input into a biorefinery. Wheat straw contains significant quantities of valuable wax compounds (fatty alcohols, alkanes) and the lignocellulosic fraction can be used to make paper or ethanol. The business case for extracting plant waxes is strong in the UK as plant waxes are imported and demand is outstripping supply. An important additional factor is a growing reluctance to use animal-derived products (even extending to lanolin from sheep wool). The potential for providing new business opportunities to rural areas, where farming income, for example, has been at a record low, completes the triple bottom line benefit through social advantage.

The opportunities

Straw should be viewed as a resource rather than a waste material. It could become a chemical feedstock for industry and could be converted into a variety of high-value wax products, and several energy and chemical products. Most straw, including barley, is naturally coated by a layer of crystalline-like wax. This this wax can be extracted and has many uses in the cosmetics industry and daily life. In addition, the energy potential of biomass could be well realised using pyrolysis conversion.

What next?

- Engage with stakeholders to qualify and quantify the opportunity.
- Map the availability and cost of accessing straw.
- Further research to develop a process to extract the valuable components within straw.
- Conduct a desk-based feasibility study
- Depending on the outcome of the study, consider the possibility of undertaking a pilot biorefinery process to further test the feasibility

Key stakeholders

- Aberdeen and Aberdeenshire Councils.
- The James Hutton Institute.
- The Rowett Institute.
- Opportunity North East.
- Industrial Biotechnology Innovation Centre.
- Scottish Agricultural Organisation Society Ltd.

Opportunity 2 –
Oilseed rape valorisation

Background

Aberdeenshire grows more cereals than any other region in Scotland, so benefiting from a vast supply of crop residues. The worldwide increasing demand for proteins for human nutrition and animal feeding leads to a growing interest in novel protein sources. Therefore, rapeseed, as an established raw material for the production of edible oils, could be a promising alternative as large amounts of press cakes and residues of oil extraction are available. The fractionising of rapeseed kernels and press cakes by extractive processes opens a lot of possibilities for new vegan protein ingredients which offer an alternative to imported sources (e.g. soy). The fibrous content can be extracted and used to fuel other processes (e.g. anaerobic digestion and fermentation) or extract substances (e.g. biopolymers/biocomposites and technosols/bespoke soils).

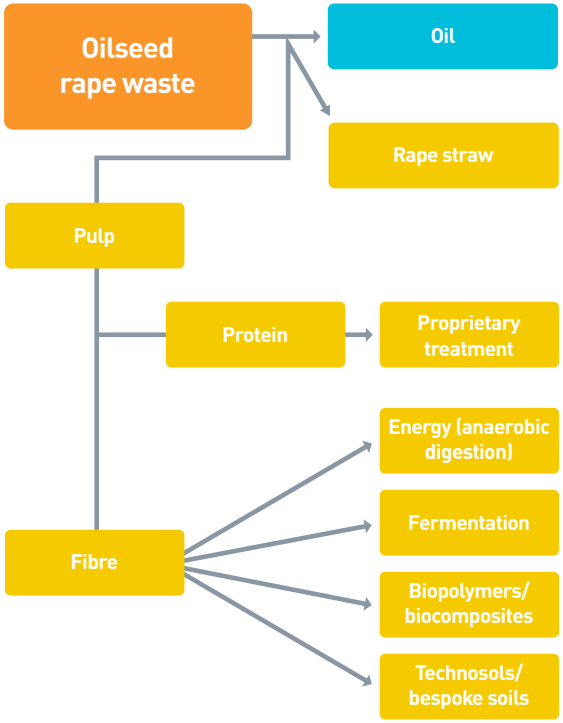
What next?

- Engage with stakeholders to qualify and quantify the opportunity.
- Map the availability and cost of rapeseed cake.
- Further research to develop a process to extract the valuable biochemicals within rapeseed.
- Conduct a desk-based feasibility study.
- Depending on the outcome of the desk-based study, consider the possibility of undertaking a pilot biorefinery process to further test the feasibility.

Key stakeholders

- Aberdeen and Aberdeenshire councils.
- The James Hutton Institute.
- The Rowett Institute.
- Opportunity North East.

Figure 14: Summary of opportunities arising from oilseed rape waste



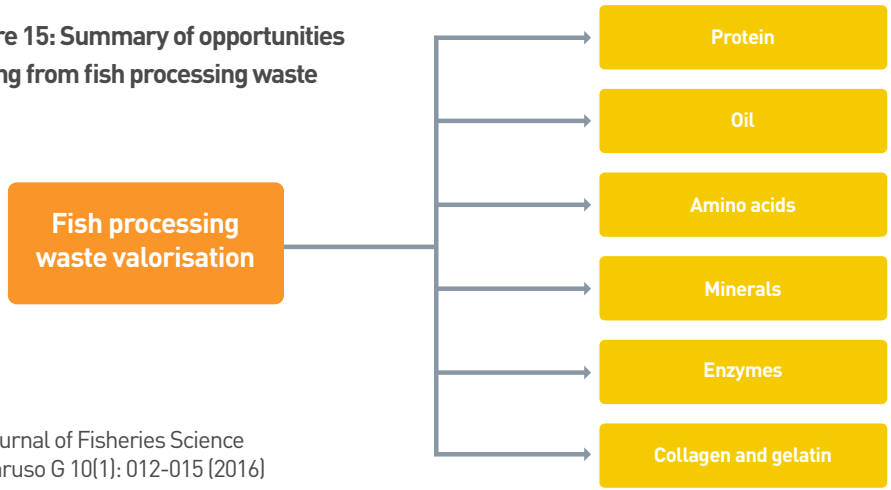
Opportunity 3 –
Fish processing waste valorisation

Background

It has been estimated that more than 50% of fish tissue including fins, heads, skin and viscera are discarded as they are considered 'wastes'[14]. Every year, discards from the world's fisheries exceed 20 million tonnes, which is equivalent to 25% of the total production of the marine fishery catch so causing not only a significant environmental impact, but also a loss of the potential value of such products. This stresses the importance of good fish waste management, taking into account the possibility of using the waste as fish feed and a potential source of bioactive compounds.

The GVA of fish and fruit processing in Aberdeen is £229 million. About 70% of fish is processed before final sale, which results in the total weight of fish processing waste in the north east of Scotland is 61,241 tonnes per year. It is not clear what happens to this waste, although we understand some of this is processed into fish meal.

Figure 15: Summary of opportunities arising from fish processing waste



[14] Journal of Fisheries Science Caruso G 10(1): 012-015 (2016)

In addition, in 2016, the number of jobs in Scotland as a whole of 'Processing and preserving of fish, crustaceans and molluscs' was at least 100,000.

There are many examples of how additional value can be added to this waste as set out in Figure 16. The nature of the opportunities resulting from fish processing creates an excellent opportunity to reprocess these wastes into value added products.

What next?

- Engage with Seafish Scotland who have been working with organisations to help deliver tailor-made support to the Scottish seafood industry to exploit opportunities.
- Engage with stakeholders to better understand what happens to the fish processing waste.
- Shortlist opportunities and identify possible sources of funding.
- Identify possible pilot projects.

Key stakeholders

- Seafood Scotland.
- Seafish.
- Scottish Seafood Association.
- Scottish Aquaculture.
- Scottish Aquaculture Innovation Centre.
- Industrial Biotechnology Innovation Centre.

Opportunity 3 –

Fish processing waste valorisation

Case study 1:

Commercial nutraceuticals from fish protein hydrolysates

The USA and Canada have produced a product called Seacure®, prepared by hydrolysing deep-ocean, white-fish proteins. This is used as a dietary supplement to help support the cells in the gastrointestinal tract and regulate bowel function.

In the UK, the product Stabilium®200 has been developed, which is prepared from Molva dypterygia (blue ling) by autolysis This is used to support the body's response to stress and provide nutritional support for memory and cognitive function. The product Protizen® has also been developed by enzymatic hydrolysis of white-fish proteins. It is known as a 'mood food' to combat stress and symptoms such as weight disorders, work pressure, sleep troubles and difficulty concentrating.

Case study 2:

Fish oil – Rossyew Ltd

Rossyew Ltd was formed in 2001 to maximise the conversion of Scottish Salmon by-products into specialty oil and protein ingredients. These ingredients have applications in pig, poultry, pet and aqua feeds. Even at low inclusion rates, Scottish salmon oil is a rich source of long-chain omega-3 fatty acids which confer health benefits to pigs, poultry and cattle.

Case study 3:

Amino acids to produce drug substances

Genentech. Inc uses the amino acid L-arginine (concentration of 55mg/ml) from fish waste to produce the drug substance TNKase®, a human tissue plasminogen activator (tPA). The company also uses the same amino acid (concentration of 35mg/ml) to produce the drug substance Activase®, another human tPA. In addition, the company uses the amino acid L-glycine to produce the drug substance Nutropin®, a human growth hormone.

Opportunity 4 –
Protein production

Background

Protein is a key compound for the human diet. Exploiting and using crop protein, particularly crop by-products, is essential in a global bio-based economy. Suitability of particular biomass as a protein source depends on the availability and characteristics of the biomass and its protein. A study calculated that there are over 340,000 tonnes of protein arisings in Scotland each year with 55,024 tonnes arising in Aberdeen and Aberdeenshire – 24,692 tonnes (45%) comes from distillery by-products and the remainder comes from agricultural residues[15]. The model also shows that, due to the current value of protein set at over £1,500 per tonne, there is a considerable opportunity in Aberdeen and Aberdeenshire to exploit the available protein.

The opportunities

The world population is 7.6 billion and growing at a rate of 1.14%, increasing the population by 86 million per year[16]. Consequently, more food is needed. Biorefining can provide more protein if it is collected from the non-edible parts of plants, such as stems, straw, bran and hull. Even more protein is available if we also consider collecting it from other sources (e.g. food waste – one third of all food produced for human consumption is being wasted[17]).

What next?

- Engage with stakeholders to qualify and quantify the opportunity.
- Identify possible food and drink manufacturers with an interest in using alternative sources of proteins.
- Further assess the market opportunity for protein to help define the business case.

The western diet is changing and there is a significant shift away from meat, but there remains the need to supplement dietary protein from other sources. Plant protein is an obvious replacement and the exploitation of crops already part of primary food production is a significant opportunity.

The opportunity exists to extract clean, food-grade protein from plant-based sources that are of very low value or used for animal feed.

Key stakeholders

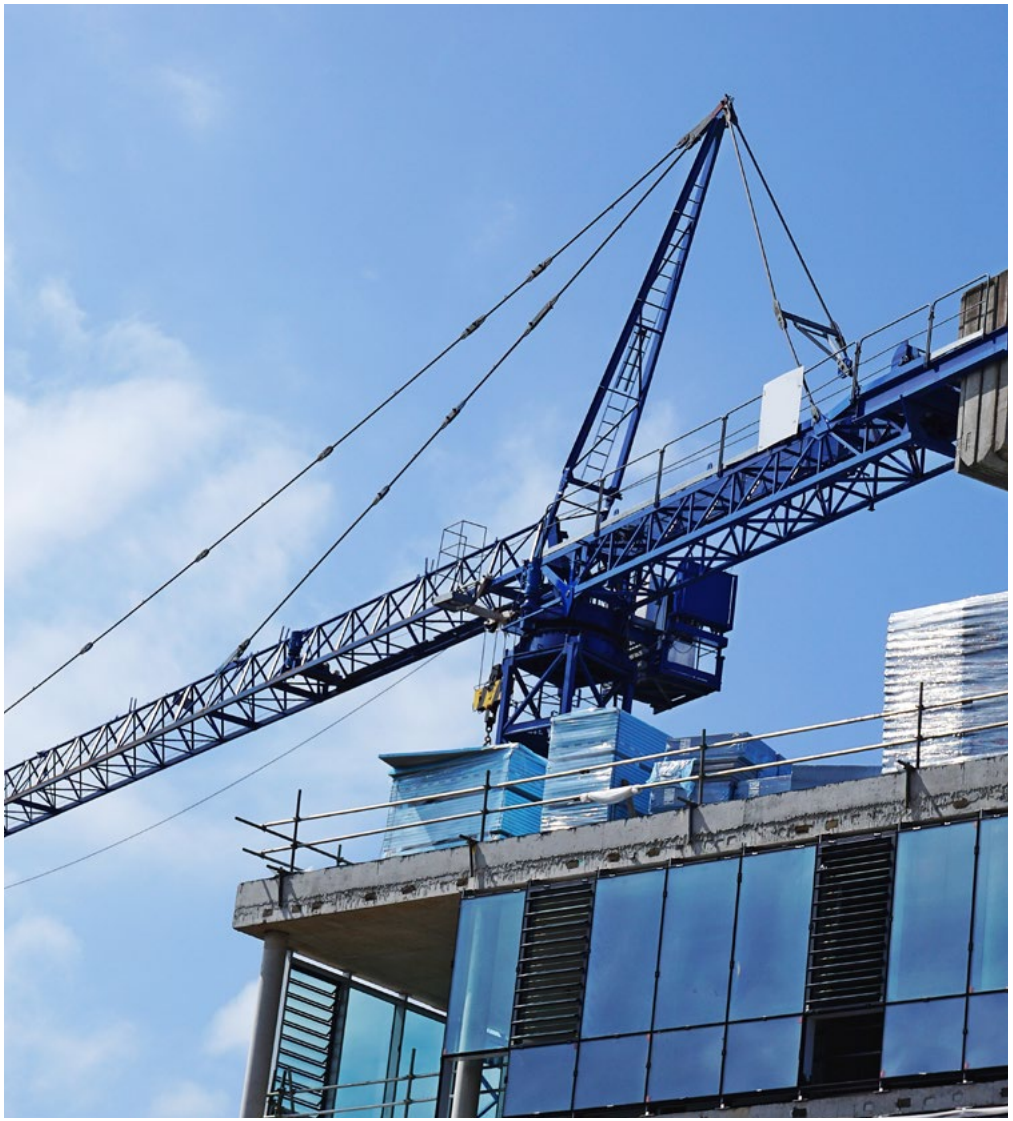
- Aberdeen and Aberdeenshire councils.
- The James Hutton Institute.
- The Rowett Institute.
- Scotland's Rural College.
- Opportunity North East.
- Scottish Enterprise.
- Industrial Biotechnology Innovation Centre.

[15] ZWS bioresources mapping study
[16] https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html
[17] http://www.fao.org/food-loss-and-food-waste/en/

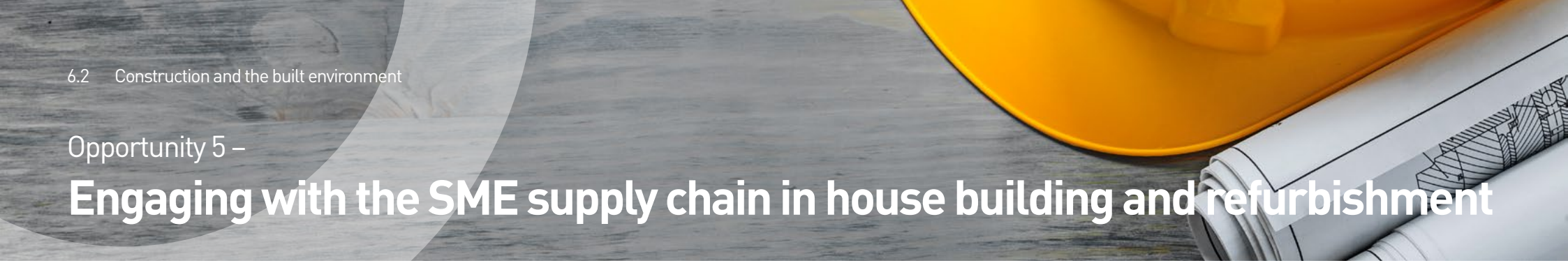
6.2 Construction and the built environment

The total value of public and private investment for projects planned for the North East Scotland region up to 2030 is £8.9 billion. These projects involve transport, leisure and retail, culture, hotels and business space, marine and renewables[18]. The construction sector in Aberdeen and Aberdeenshire is worth £2.3 billion. The value of the total inputs is £1.3 billion and the GVA is £968 million. Although these figures are a little lower than the corresponding figures for the other three main sectors, the estimated £286 million (30% of GVA) potential economic savings for the construction sector is higher than that for any of the other three sectors.

A number of new-build housing developments are planned for Aberdeen and Aberdeenshire in the coming years; Aberdeenshire Council appointed contractors in October 2017 for a new £160 million social housing improvement framework contract. Opportunities exist to embed circular economy principles, such as designing for longevity, disassembly and deconstruction, into these developments. This will require a collaborative approach between the contractors themselves, Councils and other organisations.



[18] https://www.agcc.co.uk/news-article/chamber-documents-over-89bn-of-investment-benefiting-the-north-east-of-scotland



Opportunity 5 –
Engaging with the SME supply chain in house building and refurbishment

Background

A number of new-build housing developments are planned for Aberdeen and Aberdeenshire in the coming years, as highlighted in documents such as the Aberdeen City Strategic Infrastructure Plan and the Aberdeen City Region Deal.

Aberdeenshire Council appointed contractors in October 2017 for a new £160 million social housing improvement framework contract. This will deliver construction, renovation and maintenance improvements to thousands of council houses throughout Aberdeenshire over 4 years. Work will include installing new roofs and solar panels, upgrading wall insulation, renewing windows and external doors, upgrading heating and electrics, and installing new bathrooms and kitchens.

The opportunities

Architects and design contractors

Circular economy opportunities available to architects and design contracts in connection with house building and refurbishment include:

- Design for longevity and for ease of maintenance, repair and refurbishment.
- Design for adaptability (e.g. housing that can be adapted for future use)
- Design for disassembly and deconstruction.

The build phase

Developers, building and refurbishment contactors can build circular economy principles into their operational business models through opportunities such as:

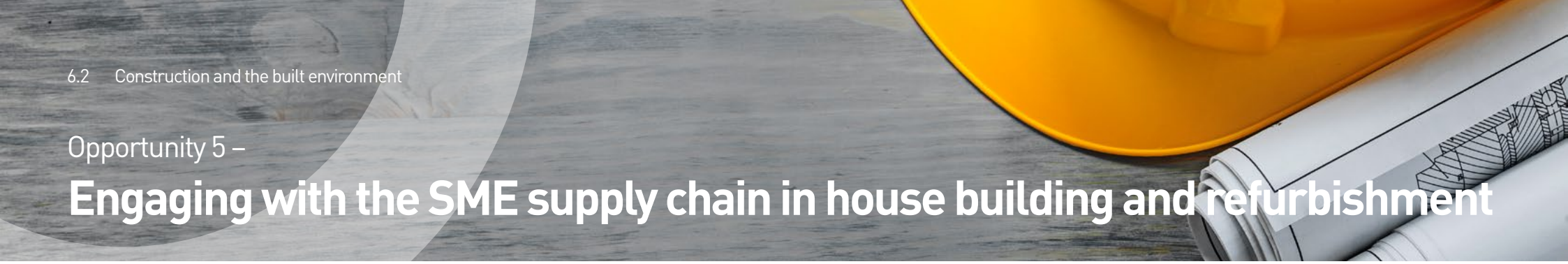
- Repurposing obsolete or underused buildings for new housing.
- On-site waste minimisation during construction (e.g. on-site additive manufacturing such as 3D printing)
- Upcycling and use of re-used or secondary components or materials
- Use of reverse logistics e.g. to ensure unused materials are returned to suppliers without damage
- Use of performance contracting, linked to whole-life costing, to achieve the long-term benefits of circularity.

What next?

- Engage with stakeholders to qualify and quantify the opportunity.
- Identify possible food and drink manufacturers with an interest in using alternative sources of proteins.
- Further assess the market opportunity for protein to help define the business case.

Key stakeholders

- Aberdeen and Aberdeenshire councils
- Opportunity North East
- Scottish Enterprise
- Construction contractors
- Grampian Housing Association



Opportunity 5 –

Engaging with the SME supply chain in house building and refurbishment

Case study 4:

Re-use of pipelines in steel structures and piling

The London Olympic Delivery Authority reported[18] that surplus steel from a gas pipeline project was used to form the ring beam for the main Olympic stadium roof for the London Olympics in 2012. The benefits were that this reduced the risk of not being able to source large diameter steel tubes and, potentially, reduced carbon emissions.

John Lawrie, an Aberdeen-based scrap metal reprocessor and decommissioning specialist, supplies used tubular stock for markets including piling and micro-piling. The company has a global stock of over 50,000 tonnes[19].

Case study 5:

Using residual plastic waste in road construction

A Lockerbie-based company, MacRebur, makes a recycled product used for road construction. According to MacRebur's website[20], the company uses 100% recycled plastic to replace part of the bitumen in asphalt mixes at levels of up to 1% of the total asphalt, depending on road design requirements. The MacRebur waste plastic pellets are melted into the bitumen in the asphalt so that no pellets remain present in the mix.

[18] http://learninglegacy.independent.gov.uk/documents/pdfs/sustainability/425009-145-reducing-carbon-aw.pdf

[19] https://johnlawrie.com/tubulars/piling-pipe

[20] http://www.macrebur.com/

6.3 Manufacturing and energy infrastructure

Gross output for the combined manufacturing and energy infrastructure sectors in Aberdeen and Aberdeenshire is £9.2 billion, the value of the total inputs to production for the combined sectors is £5.2 billion and the GVA is £4.1 billion.

For the important oil and gas industry of the North East Scotland region, maximising economic recovery remains a priority. With the expertise in applied science and engineering in the region, there are also significant circular economy opportunities in complementary areas such as:

- Renewable energy – £100 billion investment in offshore wind and a proposed high voltage distribution hub for Peterhead offer a key role to the oil and gas supply chain.
- Decommissioning – North Sea decommissioning estimated at £40 billion[21] where a proportion of which will have circular economy opportunities.
- Carbon capture, storage and use – the Peterhead carbon capture and storage project offers wider commercialisation opportunities for the supply chain and research centres in the north east.

Scotland's 2016 manufacturing action plan, 'A Manufacturing Future for Scotland'[22], sets out the benefits for manufacturing companies in leading the transition to a circular economy:

- 'Increased productivity: eliminating wasted materials and maximising the value of products and materials they use.
- Efficient production: an effective way to compete against lower-cost products in key growth markets.
- Stimulating product and supply-chain innovation: working across supply chains to re-design products for a longer lifetime and for disassembly and re-use.
- Greater resilience: to supply constraints and price spikes in relation to finite raw materials (e.g. copper and indium).
- Job creation: by offering a wider range of customer services from product manufacture to maintenance, repair and remanufacturing.'

[21] Sir Ian Wood (February 2014), UKCS Maximising Recovery Review: Final Report
[22] https://www.skillsdevelopmentscotland.co.uk/media/41516/a-manufacturing-future-for-scotland-1.pdf

Opportunity 6 –

Innovative circular economy business models (leasing and servitisation)

Background

Leasing and servitisation are very much examples of circular economy business models in two main ways:

- They allow greater value to be obtained from products by intensifying their use (i.e. products that would otherwise be used only intermittently by a single user are made available to a succession of users at precisely the time they have a need for them).
- The provider of the product retains ownership, so has a full incentive to make the product last as long as possible by supplying well-designed products and ensuring effective cleaning, maintenance and repair.

The opportunities

There is a significant opportunity for the engineering, contracting and manufacturing industry to adopt leasing and servitisation models whereby products are rented out or services in support of product use are provided, rather than using the conventional transfer of ownership business model. In the North East Scotland region, there is a very high level of engineering and manufacturing activity, particularly in support of the energy infrastructure industry, including oil and gas recovery, decommissioning, renewables, and the development of novel energy storage and carbon storage/use techniques.

What next?

- Conduct desk-based research to understand the variety of specific leasing and servitisation models, and identify other companies that are active in the area.
- Engage with the Oil and Gas Authority, and the Offshore Petroleum Regulator for Environment and Decommissioning to promote re-use and repurposing.
- Support greater collaboration between the Government's circular economy and oil and gas decommissioning strategies. Look at the Netherland's 'Nexstep'[23] as a good example.
- Following this research, engage with stakeholders to discuss the types of products, services, providers and customers that could benefit from leasing and servitisation models, particularly within Aberdeenshire.
- Agree specific actions to develop the leasing and servitisation models identified.
- Conduct analysis of the likely economic value of realistic re-use and repurposing opportunities in decommissioning versus business-as-usual scrappage or recycling.

Key stakeholders

- Aberdeen and Aberdeenshire Councils.
- Opportunity North East.
- Oil and Gas Authority.
- Oil & Gas Technology Centre.
- Offshore Petroleum Regulator for Environment and Decommissioning (part of the Department for Business, Energy and Industrial Strategy).
- Zero Waste Scotland.
- Scottish Enterprise.
- Companies in the oil and gas value chain (e.g. service companies, operators and end-users/customers).
- Waste and resource management companies.

[23] https://nexstep.nl/

Opportunity 7 –

Re-use, repurposing, remanufacturing and refurbishment

Background

The Oil & Gas Decommissioning Action Plan[24], published by Scottish Enterprise and Highlands and Islands Enterprise in 2017, identifies infrastructure on the UKCS that will eventually be decommissioned including over 300 oil and gas installations, nearly 400 subsea installations, 16,000km of pipelines and more than 5,000 wells. These figures show that decommissioning presents a huge opportunity for sourcing materials and equipment, especially steel components, for re-use, remanufacturing, refurbishment and recycling. Decommissioned materials can be re-used at any scale from whole accommodation modules down to individual fixtures and fittings.

At the same time, the planned infrastructure projects described in the Sector Action Plan for Construction and the Built Environment present a significant opportunity to profit from re-using the materials sourced from decommissioning.

The opportunities

There are opportunities for engineering service companies to offer clients repaired, refurbished or remanufactured products and equipment. There are also opportunities for brokerage services to match users with providers of secondary or end-of-life materials and equipment. Equally, manufacturers and contractors can benefit from using refurbished equipment or products in their own production, operations or services.

What next?

- Engage with clients and supply chain stakeholders to discuss and agree how the decommissioned structures, equipment and materials available can be matched with re-use opportunities in the infrastructure development, engineering and manufacturing sectors – especially locally.
- Agree specific actions and which actors will carry them out to develop and implement the project opportunities identified.
- Set objectives and agree key performance indicators to monitor progress.

Key stakeholders

- Aberdeen and Aberdeenshire Councils.
- Opportunity North East.
- Oil & Gas Innovation Centre.
- Oil & Gas UK.
- Decom North Sea.
- International Association of Drilling Contractors.
- Zero Waste Scotland.
- Scottish Enterprise.
- Companies in the oil and gas value chain (e.g. service companies, operators and end-users/customers).
- Waste and resource management companies.

[24] https://www.scottish-enterprise.com/knowledge-hub/articles/publication/oil-gas-decommissioning-action-plan

Opportunity 7 –

Re-use, repurposing, remanufacturing and refurbishment

Case study 9:

Re-use of decommissioned oil and gas materials

An Aberdeen-based scrap metal reprocessor and decommissioning specialist, John Lawrie Group, processes end-of-life materials from various sectors including oil and gas decommissioning. The company states that its primary objective is to maximise re-use and recycling, and minimise disposal. In most cases, the company can recover and recycle nearly all of the 200,000 tonnes/year of end-of-life materials it processes, with around 45% of materials sold for re-use[25]. Examples quoted include:

- Old anchor chains used to weigh down subsea pipelines or fish farm cages and nets.
- Well tubulars re-used for piling, with 25km of pipes having been re-used in the construction of the Aberdeen Exhibition and Conference Centre.

Case study 10:

Refurbishment and re-use of pipe thread protectors

Peterhead-based, Norkram Ltd [26], refurbishes used plastic pipe thread protectors and bumper rings, and supplies them for re-use. Damaged thread protectors and bumper rings that cannot be re-used are broken down into their original plastic and steel components, and sent for recycling. Norkram recycles some of the recovered plastic material itself by using it in the production of its own-brand bumper rings.

[25] https://www.agcc.co.uk/circular-economy-case-studies

[26] https://www.norkram.co.uk/

7 Strategic non-sectoral opportunities

7.1 Circular economy procurement

Procurement is a key enabler to drive the circular economy. This is because it can influence how materials and products are sourced, so minimising waste and maximising resource efficiency throughout the supply chain.

The easiest way for local and regional authorities to stimulate the take-up of circular economy approaches and solutions is to lead by example. As consumers, local and regional authorities can include circular economy considerations in their purchasing decisions by using green public procurement criteria and mechanisms such as pre-commercial procurement. In practice, this means assessing all costs related to the entire life-cycle of a product, including criteria related to maintenance, recycling and sustainable sourcing of raw materials.

Circular economy principles in the design and procurement of products, services and infrastructure should be embedded into the evaluation criteria. Specific clauses within tender documents can also be added, which enables circular economy principles to be embedded in the design and build phases. Successful examples where procuring authorities have delivered circular economy projects have used weighted scores for circularity and sustainability of up to 30%, and taken into consideration the lifetime impacts.

7.2 Design

Design is at the heart of any successful circular economy product or service – design for disassembly, design for maintenance, design for refurbishment, design for remanufacture and design for recycling.

When it comes to the product design stage, local and regional authorities can lead by example in purchasing products and solutions that are resource efficient and durable, can be easily repaired or upgraded and are finally recycled or re-used. This encourages the market to develop such solutions and makes them not only more accessible, but also more affordable for other actors.

“Procurement and design are inextricably linked as procurement can facilitate the specification of products and services, so influencing the design.”

7.3 Cross sectoral resource sharing

To fully realise the potential scale of benefits offered through a regional circular economy approach, it is recommended that support is provided to facilitate cross-sectoral resource sharing. Understanding the dynamics of industrial cooperation and industrial systems remains an area that requires further investigation. There is a need to better understand the local industrial ecology, or industrial systems networks, to identify material flows and the opportunities to share resources. This can be achieved through the co-location and cascading of reprocessing businesses to add value to wastes, by-products and surplus materials.

There are two aspects needed to make this work. Firstly, a regional waste-mapping exercise to capture and analyse the material quantities and availability across the region. Secondly, a platform to help exchange these materials across and within sectors. To do this, it will be important to develop mechanisms and opportunities to bring together practitioners, policy leaders and other local stakeholders to help engagement and data capture.

7.4 Circular economy for energy and carbon

Circular economy does not apply just to physical materials and solid resources. A true circular economy is powered by renewables with full use of underused or wasted energy and heat. Therefore, recovering energy and carbon that would otherwise be wasted is a key principle within a circular economy.

7.4.1 Valorising underused or curtailed energy

At its heart, a circular economy must be based on renewable energy and this is used as the impetus to drive the shift from fossil-based fuels to renewables. As part of this shift, there is a need to generate value-added electricity products (e.g. hydrogen, graphene and ammonia) to allow for the greater uptake of renewables.

One of the biggest challenges of moving from a fossil fuel-based to a renewable-based economy is that renewable energy generators that use sources such as wind and solar cannot save money by being 'turned off' when they are not needed. 'Curtailed' renewable energy is energy that cannot feasibly be imported to the grid because it is not needed at that time. One of the most promising ways of addressing this challenge, and to make use of curtailed energy, is energy storage, but this presents its own challenges. A potential solution is to produce hydrogen and ammonia using electricity generated at times (of the day and of the year) when there is reduced demand. They have a high energy density – higher than batteries for example – and can be used in a variety of ways, such as to generate electricity (e.g. through fuel cells in vehicles), through combustion for heating and as a feedstock in chemical processes to make a range of useful materials.

Aberdeen City Council already has an ambitious hydrogen strategy and action plan[27] which presents a significant circular economy opportunity.

7.4.2 Carbon capture and use

Carbon recovery is a circular economy opportunity that will have the valuable benefit of reducing greenhouse gas emissions. Carbon captured from combustions processes in the form of carbon dioxide can be pumped to geological storage or used for useful purposes such as mineral carbonation (production of carbonates), growing microalgae or producing chemical feedstocks. Although these carbon capture, storage and use techniques represent a valuable circular economy opportunity, they are all still at the research stage. In some industrial processes, there is no viable alternative to fossil fuels (e.g. coking coal in iron and steel making). Therefore, research activity should focus on the long-term role of fossil fuels in industry with the aim of developing techniques and technologies to capture and use the carbon from these processes.

[27] http://www.h2aberdeen.com/nmsruntime/saveasdialog.aspx?lID=924&sID=231

Case study 11:

Heat recovery in industrial processes

In the Circular Glasgow project, it was found that waste heat from bakery ovens could be recovered and used to preheat the cold-water feed to boilers through heat exchangers, saving up to 30% of the energy used in the baking process. The typical payback time was between 18 and 27 months[28].

Case study 12:

'Green' ammonia demonstration programme

Ammonia is a compound of nitrogen and hydrogen and can be produced using the Haber-Bosch process. This relies on fossil fuels, such as natural gas, to make ammonia. The process also produces carbon dioxide. However, ammonia production can be made completely carbon free by using renewable electricity and electrolysis – a process that produces hydrogen from water. By switching to renewable electricity to make ammonia, it is reported that over 40 million tonnes of carbon dioxide could be saved each year in Europe alone and over 360 million tonnes worldwide[29]. As described in Section 7.1.3 (curtailed energy), stored ammonia can also be combusted to make electricity when renewable energy sources are not available (e.g. when the wind is not blowing or at night when solar technologies will not work). Ammonia is a carbon-free fuel as it generates mainly water and nitrogen during combustion.

Innovate UK is supporting an all-electric ammonia synthesis and energy storage system demonstration programme at the Rutherford Appleton Laboratory, near Oxford[30]. Participants in the demonstrator include Siemens.

[28] https://docs.wixstatic.com/ugd/27f091_614b25efd0f343be85e1abd6fc6799f1.pdf

[29] http://www.siemens.co.uk/pool/insights/siemens-green-ammonia.pdf

[30] https://www.siemens.co.uk/en/insights/potential-of-green-ammonia-as-fertiliser-and-electricity-storage.htm

8 Next steps

Zero Waste Scotland is working with a local business engagement partner (Aberdeen & Grampian Chamber of Commerce) to support further development of the opportunities presented in this report. As the circular economy may be a new concept to many businesses, Zero Waste Scotland will be undertaking key activities to raise the business community's awareness of the opportunities it provides, and to highlight the economic and environmental benefits of adopting new business models. In addition, the local business engagement partner is taking steps to facilitate collaboration between businesses, particularly those from different sectors, and signpost to sources of support and funding. This includes Zero Waste Scotland's Circular Economy Business Support Service and Circular Economy Investment Fund. These are designed to accelerate uptake of circular economy opportunities in the region, and to build capacity and develop a legacy that will see the circular economy thrive.

This report suggests a number of recommended next steps to be implemented to support the development of the circular economy across the Aberdeen and Aberdeenshire region. It is expected that these recommendations would be delivered using a collaborative approach involving the stakeholders detailed in the action plans provided in Section 6.

8.1 Stakeholder collaboration

The geographical scale across a region naturally includes a large number of businesses and associated stakeholders. Therefore, it is important to ensure businesses are provided with the support needed to develop circular economy opportunities and that the stakeholders work together to provide a comprehensive and joined-up support to their business members. In particular, it is suggested that industry stakeholders and those organisations involved in economic development collaborate to provide a coordinated service.

8.2 Sectoral knowledge sharing

Businesses usually associate themselves with a sector. This study identified four priority sectors – construction and the built environment, energy infrastructure, manufacturing, and food and drink, and the wider bio-economy. It is strongly recommended that a sectoral approach is adopted in engaging with businesses. Sectors often have well-defined communication and engagement channels through trusted stakeholders, which are well placed to promote the benefits of a circular economy.

8.3 Setting regional conditions for a circular economy

Regions should integrate their commitment to a circular economy into relevant strategic documents, setting out local priorities, planned measures and forms of support available. This sends a clear signal to local and regional stakeholders, enabling them to plan their activities in the long term. This is particularly important for cities where various strategies are being developed to help meet climate change objectives. Good examples are the Local Heat and Energy Efficiency Strategy and Sustainable Energy and Climate Action Plans being developed by cities in Scotland. These strategies need to embed circular economy principles and provide a framework for coordinated action.

8.4 Establishing some circular economy indicators

The progress made through policy instruments and interventions can be measured by introducing specific indicators that focus on the circular economy. An established indicator that could be adopted is tracking the number of businesses/SMEs that are engaged in resource or product sharing. The indicator will help guide progress and should include material and economic factors.

8.5 Regional circular economy procurement

Procurement holds the key to drive change across the food and drink, and construction and the built environment supply chains.

- A sustainable food policy, which supports local growers and links across the food chain from production to recycling, could help to encourage local food production and minimise food waste by working with individual consumers and with restaurants, supermarkets and food distributors.
- A circular economy construction procurement policy has the potential to drive improved practices across the construction phase and the operational/refurbishment phase.

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