Circular Economy Opportunities

Tayside

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Foreword

“The Circular Economy not only supports innovative businesses in the local area but also helps meet challenging targets to reduce carbon emissions and waste over the coming years. The benefits of utilising the principles of the circular economy are already evident in a number of creative businesses in the Angus area and hope this encourages more people to consider these opportunities in the future.”

Councillor Ron Sturrock, Economic Development spokesperson, Angus Council

We are delighted to be working in partnership with Perthshire and Dundee & Angus Chamber of Commerce in support of Circular Tayside, 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 Tayside, this preliminary report has found to be centred around the engineering/manufacturing 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.

“The promotion and uptake of circular economy principles and practices offers benefit and opportunity for businesses and organisations across the region. The project will highlight opportunities and best practice in delivering economic growth in a sustainable way, with the aim of reducing environmental impact and costs to business and organisations operating in the region.”

Councillor Angus Forbes, Perth and Kinross Council

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, Perthshire and Dundee & Angus 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 Tayside area. Looking ahead to stage two, through a series of events, engagement activity, tools, and support, the Circular Tayside 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 Tayside region, led by Perthshire and Dundee & Angus 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

In order to work towards a Circular Economy we need to embrace new habits. We need to unlearn our old, wasteful ways of production and consumption and shift to a new way of thinking about our resources. From a Perthshire business perspective the potential economic benefits are huge, from resource efficiency and reduced emissions to the creation of new businesses, products, services and jobs. This is why it is important for Perthshire Chamber to be part of the Circular Tayside initiative and help drive this change through our business community, their suppliers and customers. We want to promote the fact that there is substantial business and financial support available for those open to the possibilities - of which there are many. The World Economic Forum has stated that the circular economy is a "trillion-dollar" opportunity and we are keen to secure as much of that locally as possible and help stimulate ideas and innovations.

Vicki Unite, CEO, Perthshire Chamber

In Dundee we are committed to a strong and sustainable city economy that creates healthy communities with an excellent quality of life.

A considerable amount of work is already being done to achieve this, but more is needed, which is why I welcome any moves towards a circular economy.

This report helps to raise awareness of the benefits to businesses and communities and I would encourage decision-makers to engage with it.

Councillor John Alexander, leader of Dundee City Council

We are delighted to be connecting the Dundee & Angus business community with the Circular Tayside project - it's important that we are keen advocates for the Circular Economy. Helping businesses to adopt circular economy strategies to save on costs, or create new revenue opportunities from working with waste from another business - these are all great economic opportunities for local businesses and our area. Seeing larger businesses work with their supply chains to encourage circular economy practices and policies is also a vital component of our partnership work.

Alison Henderson, CEO, Dundee & Angus Chamber

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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, Tayside (comprising the council areas of Angus, City of Dundee and Perth & Kinross) could achieve economic benefits of around £404 million across the four identified sectors (i.e. construction and the built environment, energy infrastructure, manufacturing, and food and drink and the wider bio-economy).

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 several 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. Tayside is characterised by an incredibly rich set of resources arising from communities and households, industry and agriculture.

Tayside has a population of more than **490,000 people** and is home to over **15,500 businesses**.

In 2014, the Tay Cities economic region generated around 8% of Scotland's gross value added (GVA) worth just over **£9 billion**.

Tay Cities Deal has identified growth opportunities in the following sectors:

- Tourism
- Creative industries
- Digital
- Biomedical
- Food and drink
- Eco innovation
- Oil and gas decommissioning
- Health and care
- Engineering

Predicted economic benefits in Tayside from adopting a circular economy are around **£404 million**:

Construction and the built environment sector – **£185 million**

Energy infrastructure sector – **£186 million**

Manufacturing sector – **£19 million**

Food and drink sector, and the wider bio-economy – **£14 million**

Sector Opportunities

The key circular economy opportunities we identified in Tayside are summarised below.

Food and drink and the wider bio-economy

- **Opportunity 1 – Unused fruit valorisation**
  By-products from fruit and vegetable processing have been identified as an underused feedstock. In Scotland, over 140,000 tonnes per year of harvested fruit and vegetables are not valorised. Tayside accounts for 70% (1,300 hectares) of the total land in Scotland used for orchards and growing soft fruit.
- **Opportunity 2 – Potato residue valorisation**
  Tayside accounts for 49% (12,700 hectares) of the total land used for growing potatoes. Potato industry co-products and waste streams, such as proteins, fibres and starch, consist of a significant amount of valuable biomass. It is possible to recover these and use them in a bioerfinery process.
- **Opportunity 3 – Starch production from by-products**
  In Tayside there are 29,521 tonnes of carbohydrate arisings. Of this, 10,985 tonnes (37%) come from potato haulms, 7,571 tonnes (26%) come from animal and mixed food waste, and 5,119 tonnes (17%) come from harvested carrot waste. This demonstrates the potential to replace starch from virgin sources with waste-derived starch.
- **Opportunity 4 – Plastics as part of the circular economy**
  The plastics industry in Scotland is worth £1.5 billion and has grown at a rate of 8.5% since 2012[1]. At the current rate of production and consumption, there will be more plastic by weight in our oceans than fish by 2050[2]. Creating new ways of producing, using and recycling plastics could generate a wealth of opportunities and benefits to both the economy and environment we live in.
- **Opportunity 5 – Tackling food waste across the value chain**
  It is reported that Scottish households throw away around 630,000 tonnes of food waste every year, costing the average household around £460 per year. Taking action to cut food waste could not only help to boost the economy, but also help reduce carbon emissions and save natural resources.

Construction and the built environment

- **Opportunity 6 – Circular economy in infrastructure procurement**
  Gross output for the construction and built environment sector in Tayside is £1.5 billion. The significant quantities of money spent on infrastructure projects in the UK, combined with the vast material requirements for their construction, presents a substantial opportunity to reduce resource use and create cost savings through the adoption of circular economy principles.
- **Opportunity 7 – Building refurbishment and regeneration**
  Circular economy opportunities available to architects and design contractors in connection with house building and refurbishment include designing for longevity and ease of maintenance, repair and refurbishment, adaptability (e.g. designing housing that can be adapted to future use by a different demographic), disassembly/deconstruction and refurbishment.

Manufacturing

- **Opportunity 8 – Innovative circular economy manufacturing**
  Using circular economy principles in manufacturing would strengthen the engineering capabilities and capacity of the regional engineering and advanced manufacturing sector to boost investment and innovation, encourage greater internationalisation and future-proof the skills base.

Energy infrastructure

- **Opportunity 9 – Oil and gas decommissioning**
  Tayside has and continues to play an important role in supporting oil and gas operations in the UK Continental Shelf (UKCS), and in other oil and gas-producing basins across the world. The sector in the North Sea continues to progress and decommissioning is now a significant emerging economic opportunity in Scotland and the UK, with a projected £17.6 billion spend in the next 10 years.

[1] http://www.bpf.co.uk/events/spr.aspx
[2] https://www.zerowastescotland.org.uk/content/thinking-big-future-plastics

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 in this report are to be realised (i.e. cross-sectoral resource sharing and using circular economy principles for procurement).

Sectoral knowledge sharing

It is strongly recommended that a sectoral approach is adopted 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

To 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

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'[3]. 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[4].

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[5] 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.

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

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

5 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 does not 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 two stage approach being delivered by Zero Waste Scotland. It 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 Perthshire Chamber of Commerce and Dundee & Angus Chamber of Commerce as their local business engagement partners. 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 three local authority areas of Tayside: Angus, City of Dundee and Perth & Kinross.

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 the 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

This study 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 the 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.

Tayside has a population of approximately 500,000 people and 15,500 businesses. In 2014, the Tay Cities economic region accounted for around 8% of Scotland's economic output (or GVA) at a little over £9 billion. The urban core of the region around Dundee and Perth accounts for approximately 70% of this output[6].

Tayside has two key development strategies which will provide significant investment across the region in the future. These are:

TAYplan is a Strategic Planning Authority for the Tay Cities region. It has prepared a Strategic Development Plan that sets out land use planning policies to guide development over the next 20 years and beyond. This document considers a variety of issues including housing and infrastructure planning and sustainable economic growth and sets out ten key policies[7]. These include:

- Shaping better quality places
- Homes
- Energy, waste and resources
- Green Networks
- Connecting people, places and markets

The Tay Cities Deal is a collaboration of public, private and voluntary organisations in Angus, Dundee, Fife and Perth & Kinross with the aim of delivering a smarter, fairer and more sustainable region. This will be achieved by negotiations between the local authorities and the UK and Scottish Governments to secure investments for several proposals across the region. These are expected to generate an additional £900M of GVA per annum for the Scottish economy and create up to 15,000 job opportunities over ten years[8]. Opportunity areas for growth outlined in the deal include:

- Oil & Gas decommissioning industry
- Food & Drink
- Engineering
- Eco-innovation

[6] Tay Cities Deal
[7] https://www.tayplan-sdpa.gov.uk/strategic_development_plan
[8] https://www.taycities.co.uk/sites/default/files/tay_cities_deal_0.pdf

4 Economic mapping: a sector focus

4.1 Total savings

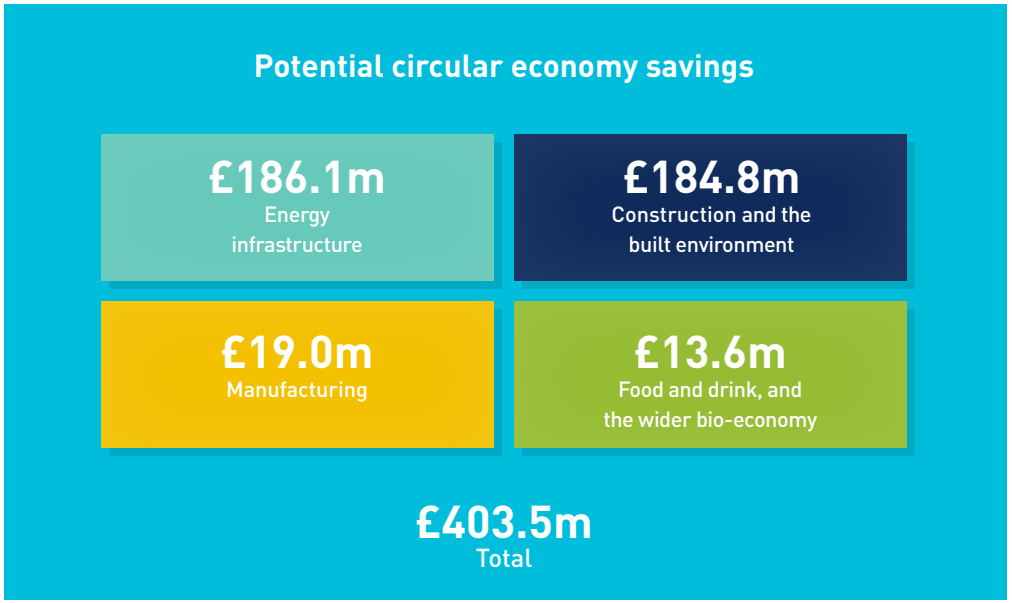
By adopting circular economy principles, the Tayside region could achieve economic benefits of around £404 million across the four priority sectors (i.e. construction and the built environment, energy, infrastructure, and food and drink and the wider bio-economy). These savings result from reductions 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 enterprise (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, water and others) 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. Figure 3, 4, 5 and 6 present the priority sectors in Tayside in terms of GVA and the top inputs to production for each of the priority sectors in Scotland[9]. This data provides 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. 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.

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

4.2 Construction and the built environment

4.2.1 Total inputs and output values

Based on estimates of local gross output in 2016, the construction sector in Tayside is worth £1.5 billion. The value of the total inputs to production is £870 million and the GVA is £625 million. 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 Tayside and top inputs to production in Scotland for the construction sector

4.2.2 Potential circular economy savings

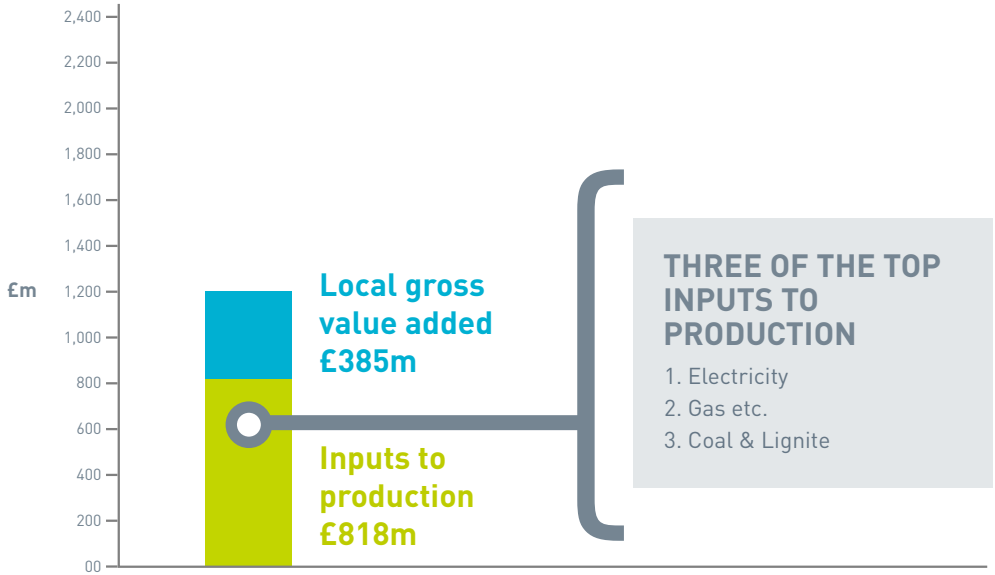
Through the adoption of circular economy opportunities – such as the refurbishment or re-use of construction materials – there is an estimated £185 million (30% of GVA) of potential economic savings for the construction sector in Tayside.

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 energy infrastructure sector in Tayside is worth £1.2 billion. The value of the total inputs to production was £818 million and the GVA was £385 million. Figure 4 identifies the top inputs to production 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 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. 'Curtailed' renewable energy is energy that cannot feasibly be imported to the grid because it is not needed at the time it is available.

Figure 4: Gross value added (GVA) in Tayside and top inputs to production in Scotland for the Energy Infrastructure sector



4.3.2 Potential circular economy savings

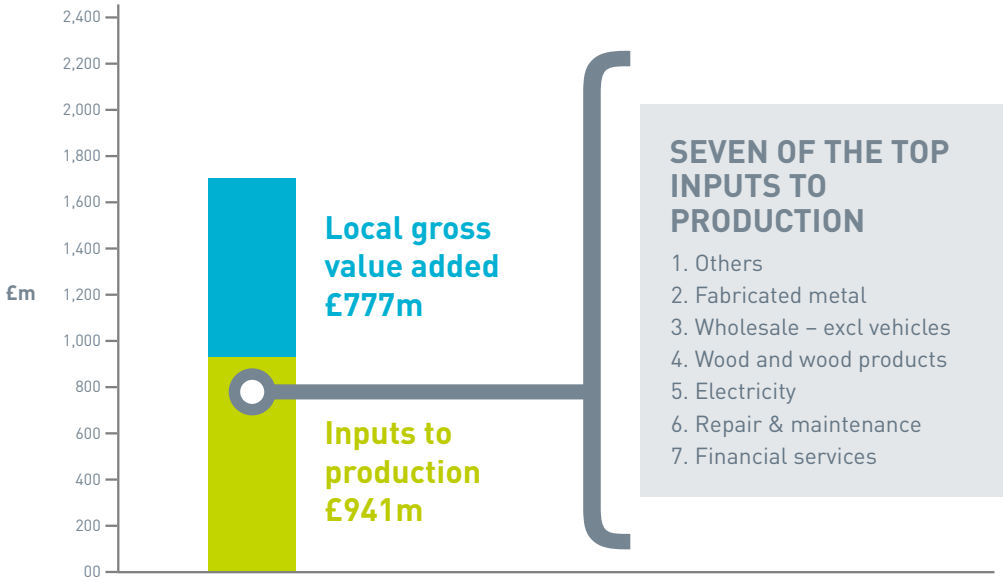
Through the adoption of circular economy opportunities, such as re-use of materials after decommissioning or valorisation of underused energy, there is an estimated £186 million (48% of GVA) of potential economic savings for the energy Infrastructure sector in Tayside.

4.4 Manufacturing

4.4.1 Total input and output values

Based on estimates of local gross output in 2016, the manufacturing sector in Tayside is worth £1.7 billion. The value of the total inputs to production is £941 million and the GVA is £777 million. Figure 5 identifies the top inputs to production 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 Tayside and top inputs to production in Scotland for the manufacturing sector



4.4.2 Potential circular economy savings for key sub-sectors

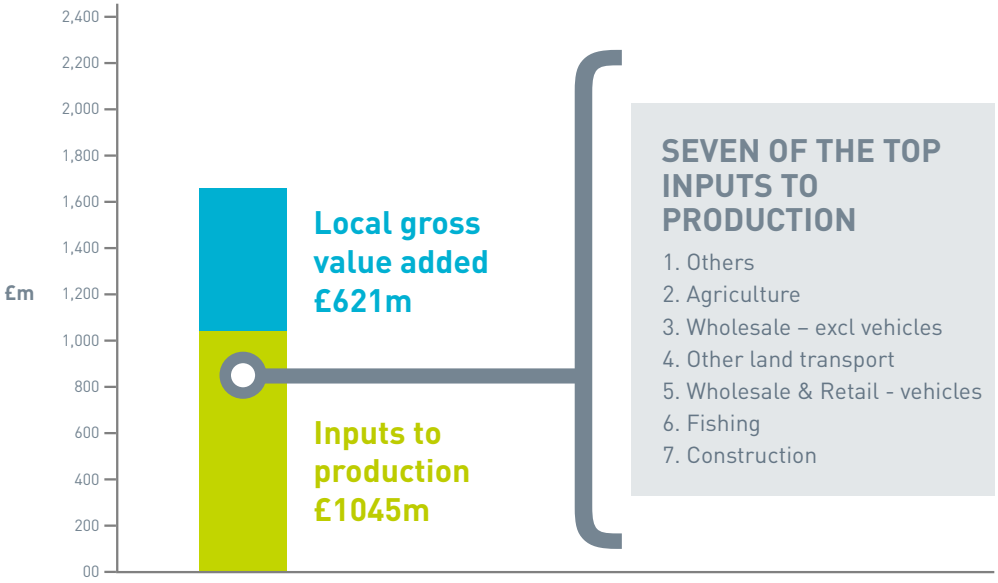
Through the adoption of circular economy opportunities – such as leasing, servitisation of products and remanufacturing – there is an estimated £19 million (2% of GVA) of potential economic savings for the manufacturing sector in Tayside.

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 food and drink sector in Tayside is worth £1.7 billion. The value of the total inputs to production is £1 billion and the GVA is £621 million. 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 wholesale, land transport and others. This suggests that these areas are good places to identify circular economy opportunities.

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



4.5.2 Potential circular economy savings for key sub-sectors

Through the adoption of circular economy opportunities – such as, starch valorisation and biorefining – there is an estimated £14 million (2% of GVA) of potential economic savings for the food and drink sector in Tayside.

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.

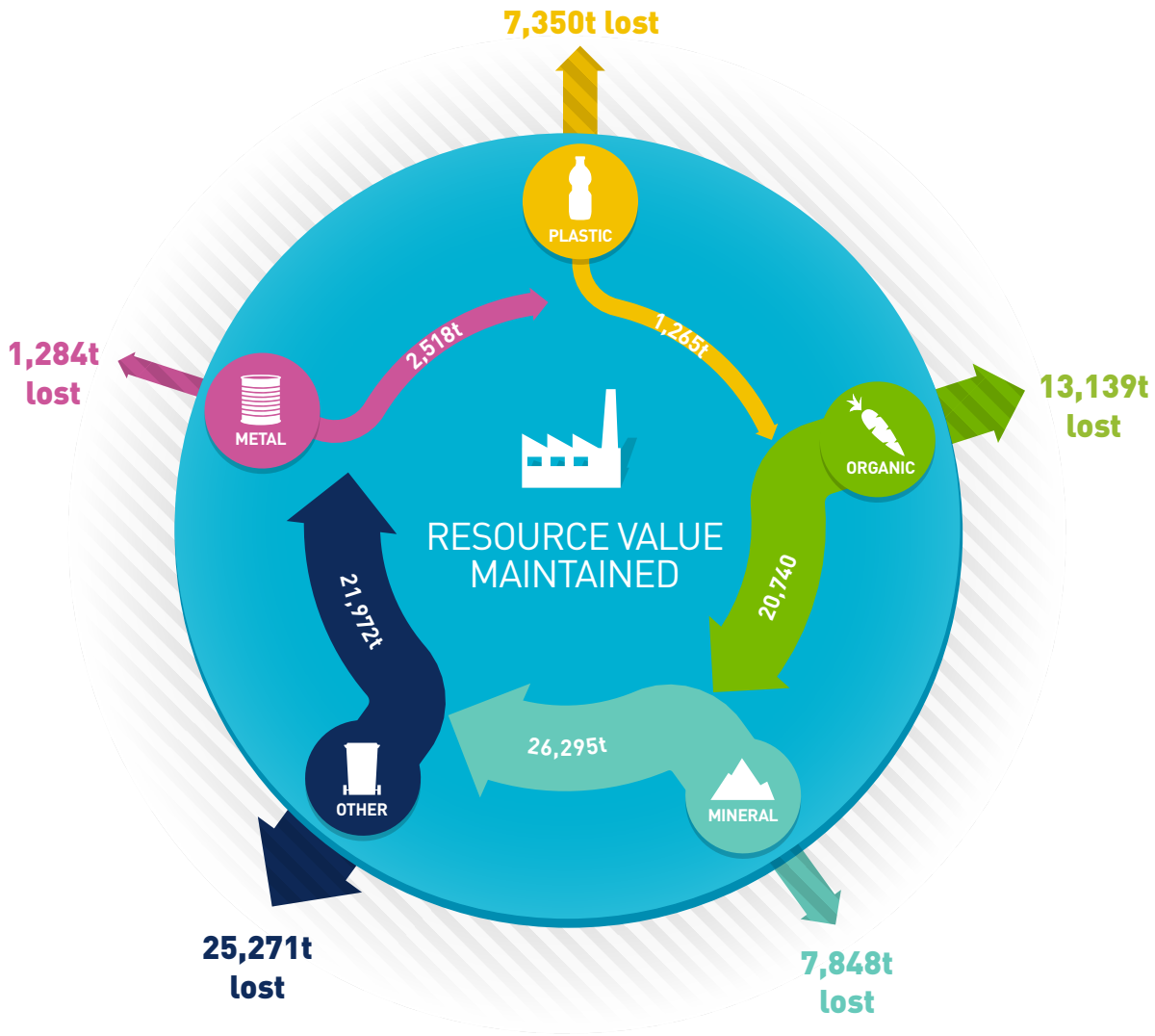
5 Material and transport flows

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 was reviewed and analysed to understand the key household, commercial and industrial, and bioresource flows in Tayside. Figure 7 shows the total household waste split by fraction and fate for Tayside.

This shows that a significant proportion 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 an opportunity to capture and recover these wasted resources as part of the circular economy.

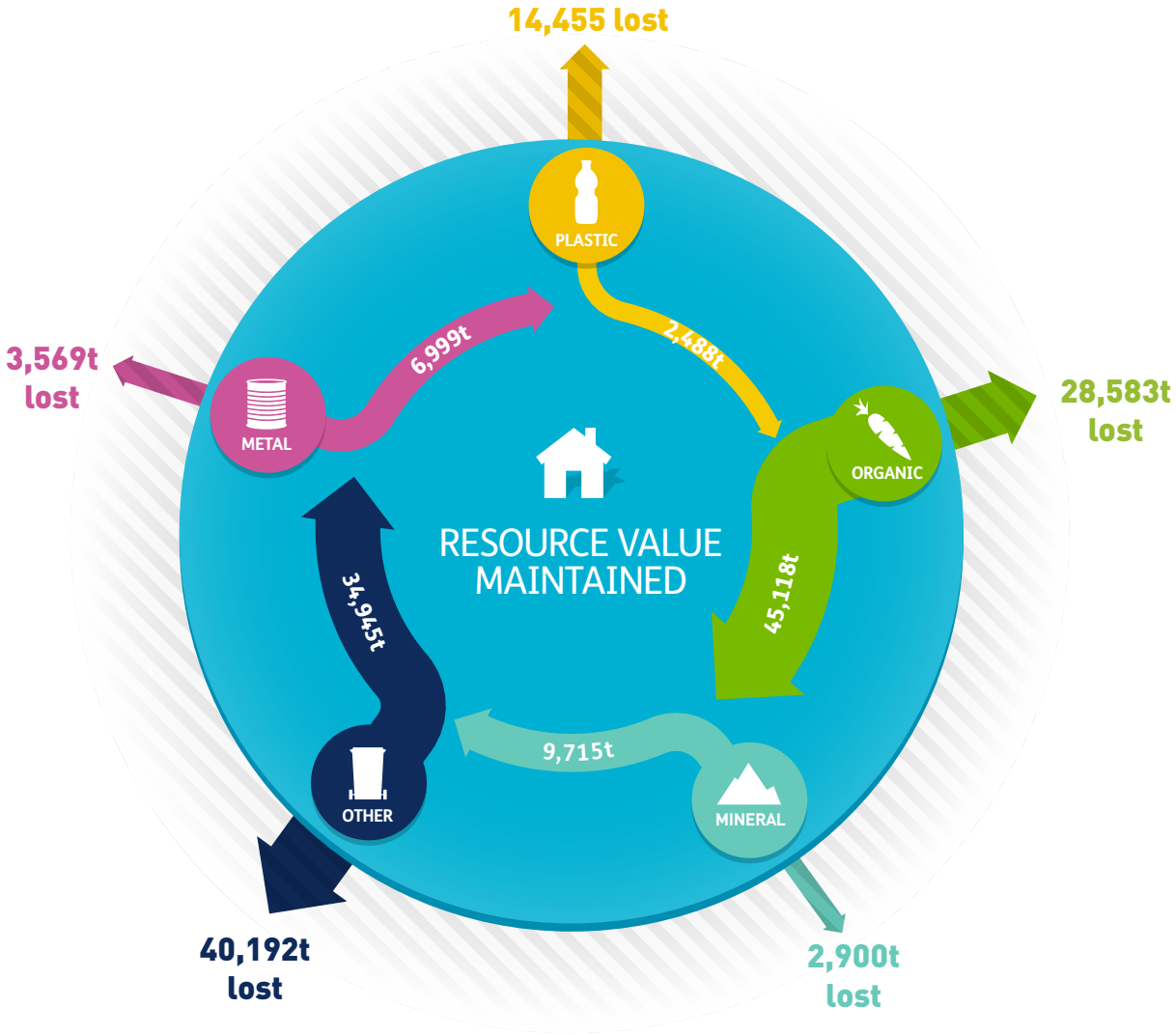
Figure 7: Household waste material flows in Tayside (lost and recovered)



5.2 Commercial and industrial material flows

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

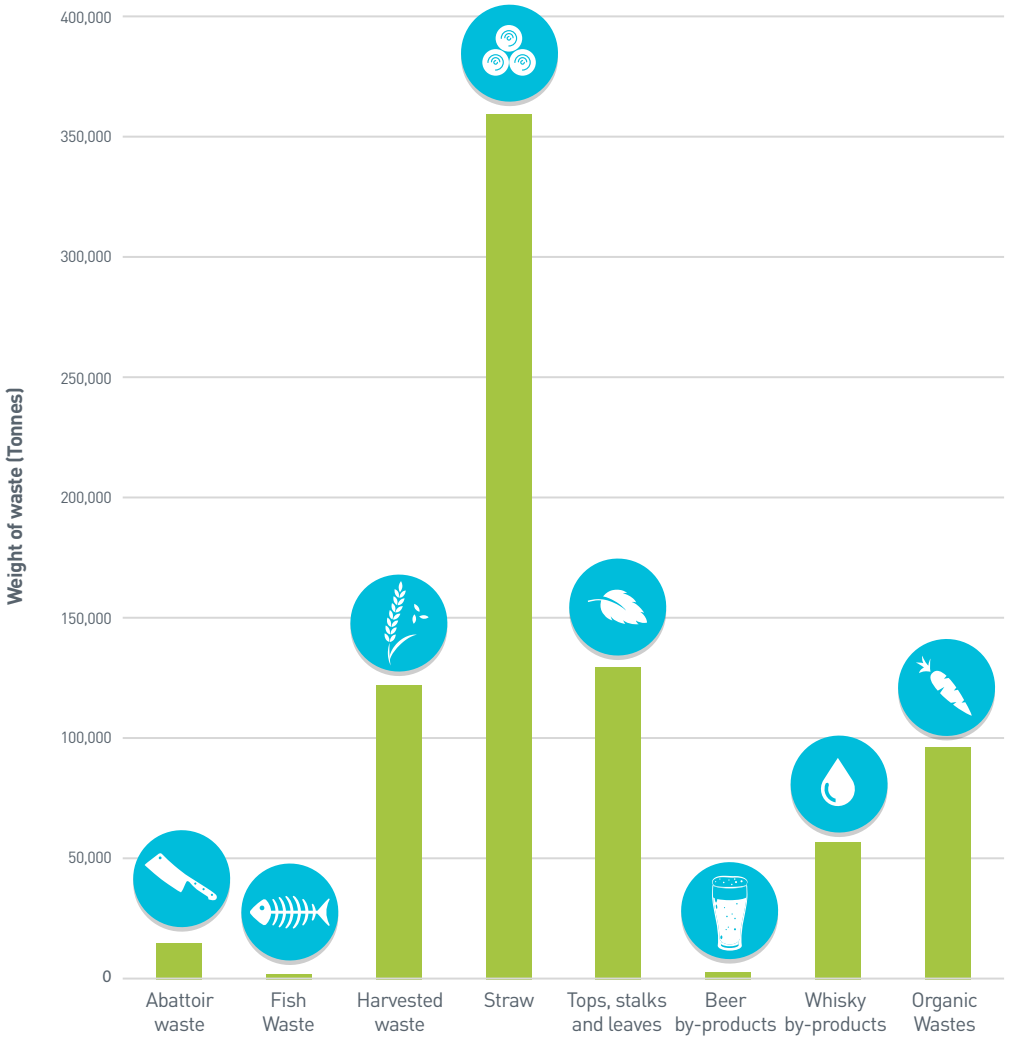
Figure 8: Commercial and industrial waste material flows in Tayside (lost and recovered)



5.3 Bioresource flows

Figure 9 represents the key by-products and agricultural residues for Tayside, excluding manure slurry and 'other' wastes. This shows that the largest bioresource is straw (360,288 tonnes) followed by tops, stalks and leaves – including potato haulms – (129,872 tonnes) and harvested waste (122,166 tonnes).

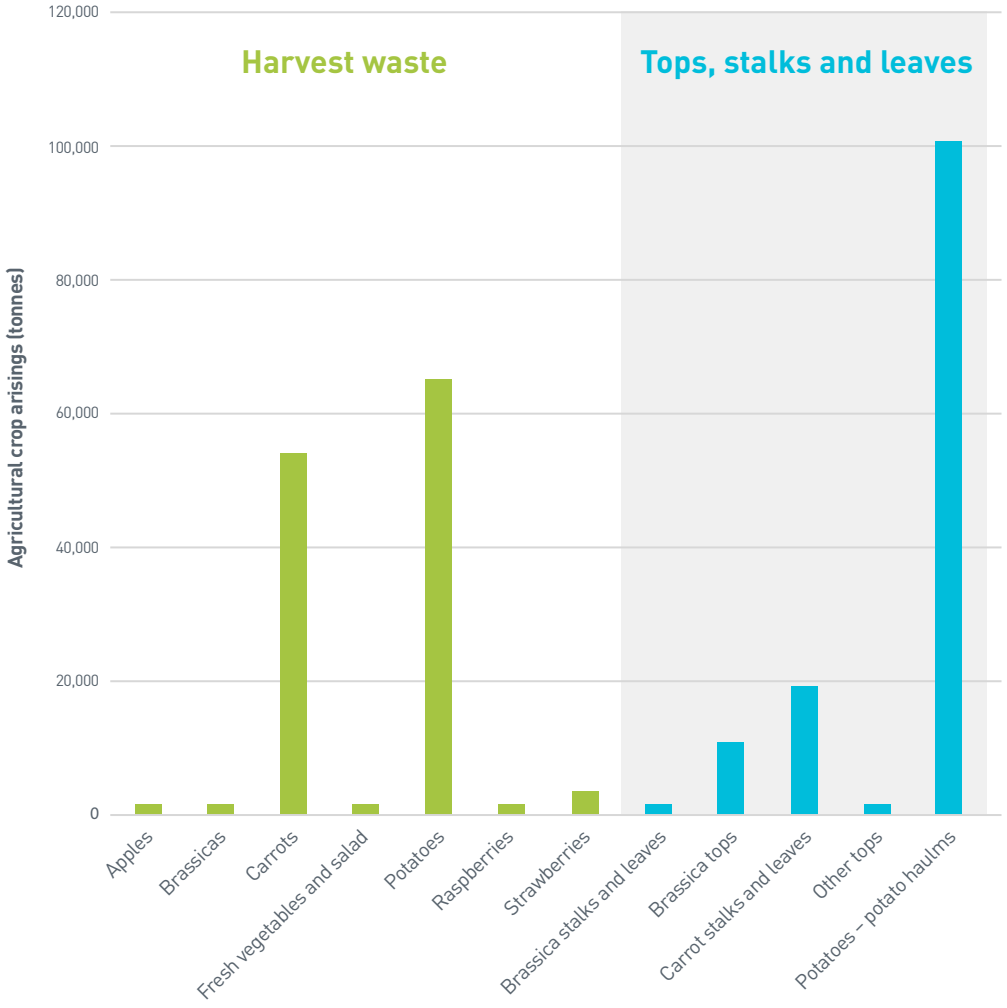
Figure 9: Total bioresources for Tayside split by fate and fraction



5.3.1 Agricultural crop arisings

Figure 10 gives the total agricultural crop arisings in Tayside. 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 10: Agricultural crop material arisings in Tayside

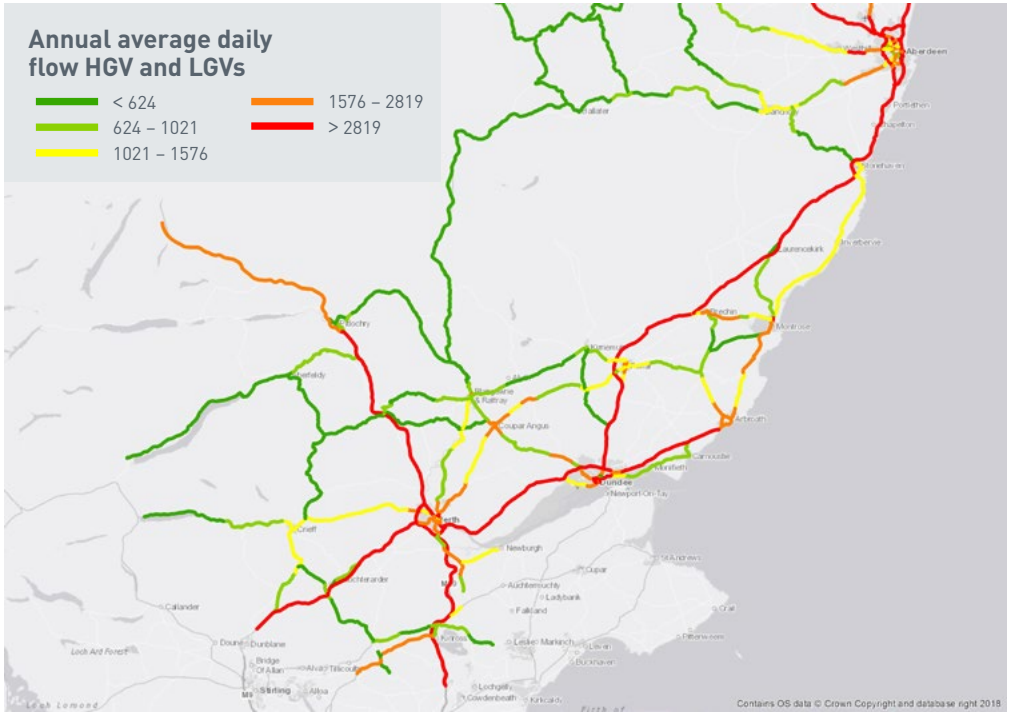


5.4 Transport

Figure 11 shows a transport 'heat map' for light goods vehicles and heavy goods vehicles across Tayside. 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 **780 million kilometres (480 million miles)**[10].

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



[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 opportunities cover the four priority sectors (Food and drink, and the wider bio-economy, construction and the built environment, manufacturing and energy infrastructure) and, for each of these, a sector action plan has been developed that highlights the scale of the opportunities, the key stakeholders and suggested next steps. The shortlisted opportunities from the four sector action plans are detailed below.

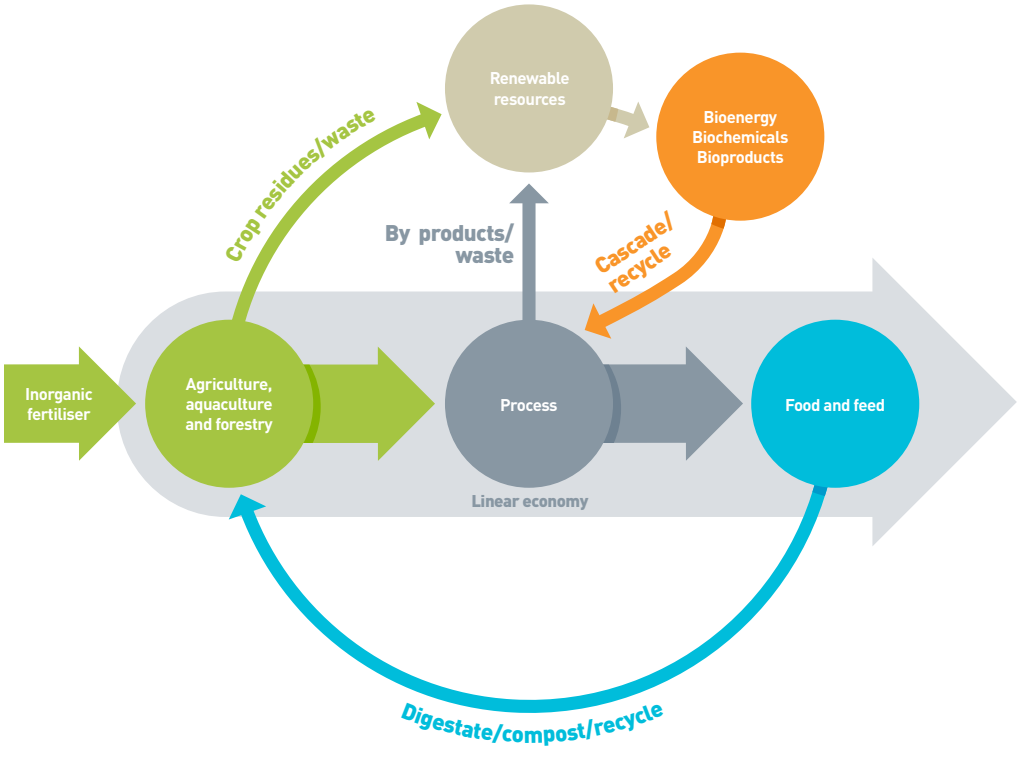
6.1 Food and drink, and the wider bio-economy

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]. Tayside makes a disproportionately large contribution to this and employs over 13,000 people in the food and drink primary production and manufacturing sector[13].

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



[11] Bauen, A. et al. (2016)
[12] http://www.moray.gov.uk/minutes/data/DC20151020/Item%2015-Appendix%201-Food%20and%20Drink.pdf
[13] www.taycities.co.uk/sites/default/files/tay_cities_deal.pdf

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

In 2016, Tayside had the largest area of land used for wheat production compared with other regions (23,900 hectares, which is 21% of the total Scottish area)[14]. The region also had the second largest area of land used for barley production after Grampian, and the third largest area of land used for rapeseed crops after Grampian and Scottish Borders. Furthermore, Tayside accounted for 70% (1,400 hectares) of the total land in Scotland used for orchards and growing soft fruit and 47% (8,100 hectares) of the land used to grow vegetables for human consumption[15].

The opportunities

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

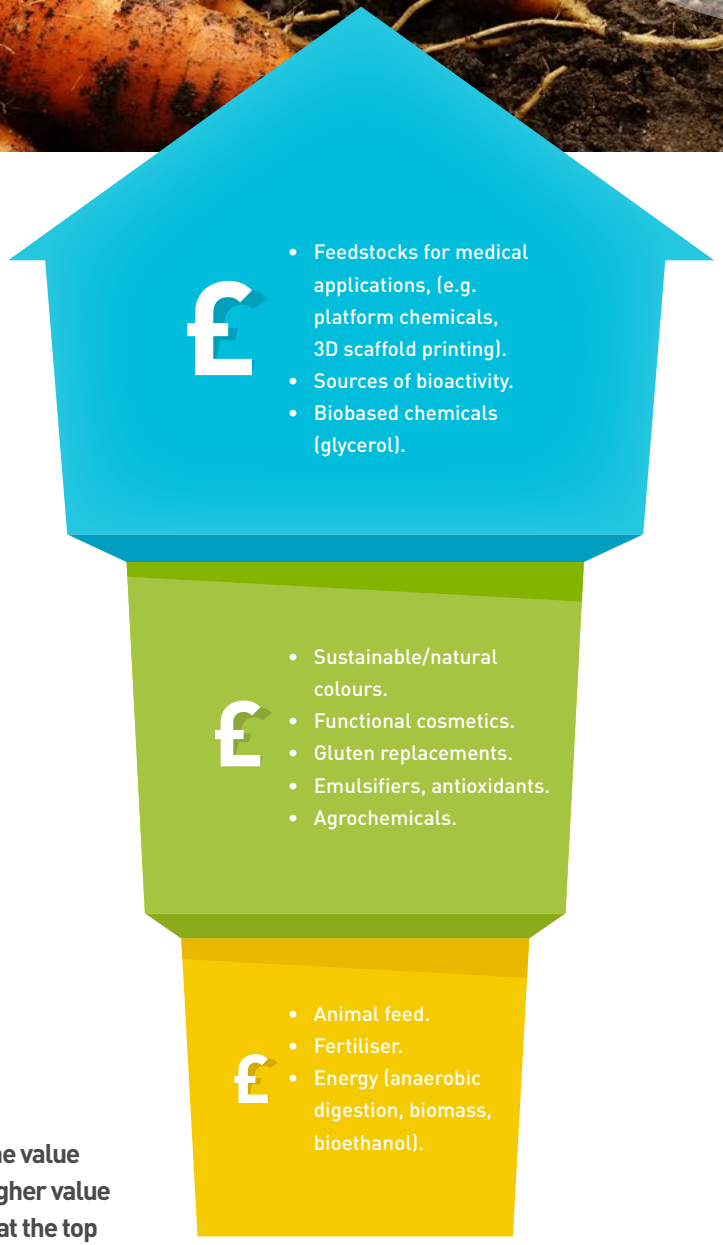


Figure 13: The value chain with higher value applications at the top

[14] http://www.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/agritopics/CerealsCombine
[15] https://www.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/agritopics/Horticulture

Opportunity 1 –

Unused fruit valorisation

Background

Fruit and vegetable supply chains and processing result in a range of substantial co-products and waste streams, the disposal of which is becoming costlier. Many of these co-products and wastes are rich in phytochemicals, flavours, aromas and fibres, which have the potential to be exploited for the production of new food and feed ingredients, and related products.

Causes of food waste and losses on farm as identified by farmers include pests and diseases, weather, storage, harvest, cosmetic specifications (size and shape), and supply and demand. WRAP found that just over 9% of mature strawberry crops ended up as waste in 2015 – equivalent to 10,000 tonnes of product across the whole sector and valued at £24 million – mainly because they didn't meet market requirements[16].

The opportunities

Throughout Scotland, over 140,000 tonnes/year of harvested fruit and vegetables are not valorised. Through the use of the bio-resource mapping tool[17] it is possible to map the availability of wasted fruit and vegetables in Tayside to understand the scale and shape of the potential market in the region. This would open up an opportunity to work with the fruit growers and processors in Tayside, and Angus in particular, to identify ways of adding value from unused or rejected fruit. Figure 14 presents some of the opportunities that exist to add value to soft fruit waste.

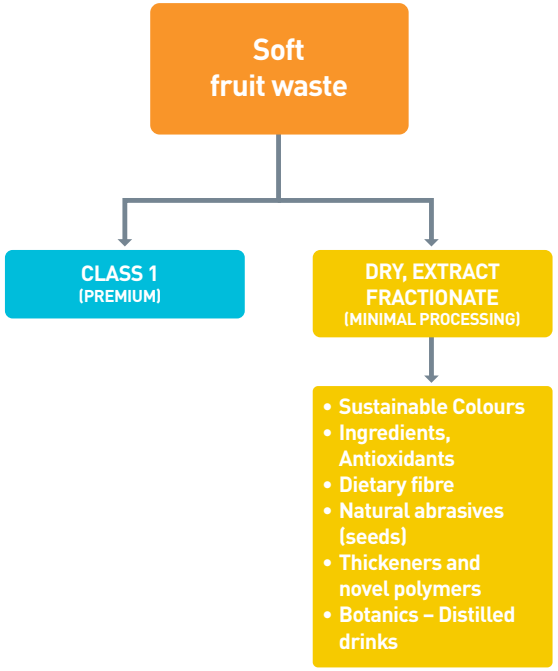
What next?

- Engage with stakeholders to qualify and quantify the opportunity.
- Map the availability and cost of underused fruit.
- Identify the most viable technologies and conduct a trial to assess the economic opportunity.

Key stakeholders

- Angus Council.
- James Hutton Institute.
- Zero Waste Scotland.
- Scottish Enterprise.
- Industrial Biotechnology Innovation Centre.

Figure 14: By-products from soft fruit waste



[16] http://www.producebusinessuk.com/insight/insight-stories/2017/09/28/31m-of-strawberries-lettuce-goes-to-waste-in-the-uk
[17] https://www.zerowastescotland.org.uk/research-evaluation/biorefining-potential-in-scotland

Opportunity 2 –
Potato residue valorisation

Background

Potatoes are the fourth main crop consumed worldwide and are important constituents in the human diet. As a result, potatoes are widely used in food-processing industries. However, massive amounts of potato peel are generated from these industries as a by-product, but is usually treated as a waste product. Research suggests that potato peel is a valuable source of bioactive compounds, which can be converted into value-added products [18]. These include phenols and carbohydrates that contain commercially important enzymes, such as cellulose, alpha-amylase, glucoamylase and xylase. Furthermore, there is a significant amount of protein in potato haulms. This could be exploited as a co-product and put back into the food and feed markets to supplement the whole potato waste biorefining operation. In addition to being used as a dietary fibre or medicine, the value-added products obtained by fermenting potato peel have many uses, including as biocomposites, packaging materials and biopolymer film development.

In Tayside, there are around 252,000 tonnes of agricultural crop arisings, of which 40% are potato haulms.

The opportunities

Potato industry co-products and waste streams, such as proteins, fibres and starch, consist of a significant amount of the original biomass. It is possible to recover these and use them in a biorefinery process. A biorefinery approach for potato wastes will increase the value of this waste by producing a plethora of value-added products and reducing extensive waste generation. Through the use of the bio-resource mapping tool [19] it is possible to map the availability of potato waste in Tayside to understand the scale and shape of the potential market in the region. This would open up an opportunity to work with potato growers in the region to identify ways of generating value-added products from this waste.

What next?

- Engage with stakeholders to qualify and quantify the opportunity.
- Assess possible sources of potato by-products from processors and primary producers. In particular to identify potato processors to understand the volume of by-products i.e. potato peel.
- Further assess the market opportunity for starch to help define the business case.

Key stakeholders

- Potato processors and growers.
- The James Hutton Institute.
- Heriot-Watt University.
- Scotland's Rural College.
- Zero Waste Scotland.
- Scottish Enterprise.
- Industrial Biotechnology Innovation Centre.

[18] https://www.tandfonline.com/doi/abs/10.1080/07388551.2017.1331337
[19] https://www.zerowastescotland.org.uk/research-evaluation/biorefining-potential-in-scotland

Opportunity 3 –

Starch production from by-products

Background

Carbohydrates are the body's main source of energy and help fuel the brain, kidneys, heart, muscles and central nervous system. In Tayside, there are 29,521 tonnes of carbohydrate arisings [20]. Of this, 10,985 tonnes (37%) come from potato haulms, 7,571 tonnes (26%) come from animal and mixed food waste and 5,119 (17%) tonnes come from carrot harvested waste. This demonstrates the potential to replace virgin sources of starch and other carbohydrate substances with that derived from waste and by-products.

PeelTech, based in Kinross, has developed a technology that extracts starch from potato peel waste by removing and separating the potato skin and then compacting it [21]. Please see case study 1.

The opportunities

There are many opportunities for valorising this starch. Figure 15 highlights a few examples of different uses – many of which could be explored in Tayside to convert bioresources into a value added product.

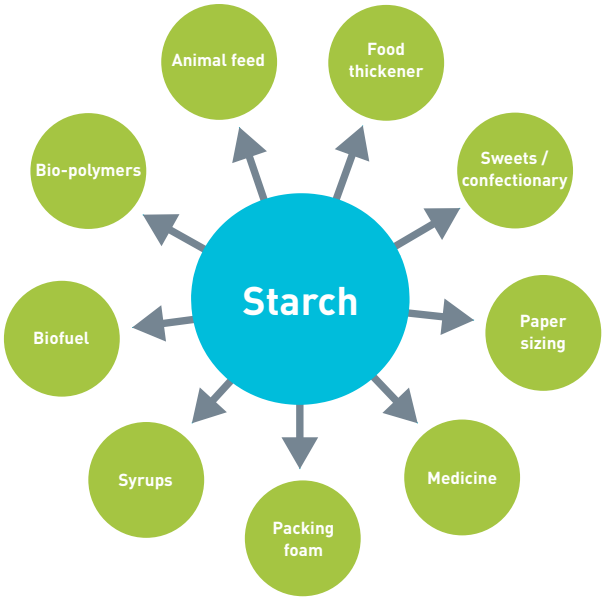
What next?

- Engage with stakeholders to assess the availability of different sources of starch and their suitability for further processing.
- Conduct further research to develop a process to extract the valuable biochemicals in starch-rich residues.
- Explore the opportunity to pilot the feasibility of a biorefinery process.

[20] https://www.zerowastescotland.org.uk/sites/default/files/Biorefining%20Potential%20for%20Scotland%20Final%20report.pdf

[21] http://www.peeltech.co.uk/how-it-works/

Figure 15: Value added products arising from starch valorisation



Key stakeholders

- Angus, City of Dundee and Perth & Kinross councils.
- The James Hutton Institute.
- Industrial Biotechnology Innovation Centre (IBioIC).
- Primary producers and processors.

Opportunity 3 –

Starch production from by-products

Case study 1:

Peel Tech

PeelTech, based in Kinross, has developed a technology that takes waste from a potato peeler, separates the skin and compacts the potato starch, enabling the operator to easily remove the waste afterwards[22]. Not only does this allow drains to be kept free of waste, but the peelings can be used as animal feed once they have been removed[23]. The technology is being rolled out in a number of fish and chip shops across Scotland, helping businesses comply with the Waste regulations[24].

22 http://www.peeltech.co.uk/how-it-works/
23 https://circulartayside.co.uk/be-inspired-post/peel-tech/
24 http://www.peeltech.co.uk/why-its-important/

Opportunity 4 –
Plastics as part of the circular economy

Background

Plastics pervade modern life; plastics production has been growing exponentially since the 1960s and is expected to double by 2036 [25]. At the current rate of production and consumption, there will be more plastic by weight in our oceans than fish by 2050 [26]. We are at a juncture in history where societies relationship with plastic is changing. There is a strong and growing need to rethink the way that plastics are produced and used within the economy. Our research highlighted that there is over 20,000 tonnes of plastic that is lost across Tayside that is either landfilled or incinerated.

Scotland is already starting to respond to the challenge with charging for single use plastic bags, banning plastic straws and work on a deposit return scheme. Creating new ways of producing, using and recycling plastics could generate a wealth of opportunities and benefits to both the economy and environment across Tayside. Significant resource and monetary savings could be made, and less virgin material used.

The opportunities

A circular economy implies reducing waste to a minimum and moving up the plastics value chain by improving recycling, promoting re-use, and redesigning products. A regional approach to plastic provides an economy of scale that facilitates a specific focus on plastics.

The Agricultural sector in Tayside uses a lot of plastic for growing crops, especially fruit and vegetables, and also in silage making. The opportunity exists to improve the collection of this plastic and also to identify alternative types of plastics that could replace plastic used from petrochemicals.

In addition, procurement can play a key role in reducing the use of plastic and also in driving markets to increase the use of the amount of recycled plastic in products. Construction is the second largest user of plastic, other than packaging [27]. The opportunity exists to use procurement to specify the use of recycled plastic and the use of bio-plastics supporting organisations like MacRebur who recycle plastic into asphalt – see case study 2.

Key stakeholders

- British Plastics Federation and Scottish members
- Scottish Government and Dundee, Perth and Angus City Councils
- Scottish Plastics and Rubber Association
- Zero Waste Scotland

What next?

- Continue to drive the move towards a plastics circular economy in Tayside through establishing a short-lived working group of key stakeholders to develop innovative ideas
- Explore the opportunity to adopt a zero plastic to landfill policy across Tayside
- Engaging with Tayside Contracts to understand procurement choices and options
- Engage with businesses and start-ups in Tayside and continue to promote circular practices and other case studies

[25] http://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_BRI%282017%29603940

[26] https://www.zerowastescotland.org.uk/content/thinking-big-future-plastics

[27] http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/603940/EPRS_BRI(2017)603940_EN.pdf

Opportunity 4 –

Plastics as part of the circular economy

Case study 2:

MacRebur

MacRebur, based in Dumfries and Galloway, have developed a pioneering new way of building roads whilst diverting plastic waste from landfill and incineration. The company takes waste plastic and adds it to roads to improve the strength and durability, whilst reducing the bitumen used in a traditional road mix [28]. The pellets they have created, which are made from 100% recycled plastic, can be added to asphalt, giving it flexibility so that it can expand and contract with the weather conditions, preventing cracks and potholes. All of the plastics used in the MacRebur products are single-use plastics that would otherwise be sent to landfill or incineration. MacRebur reported that for every 10 tons of asphalt made with their products, they use the equivalent of 714,000 plastic bottles, 4.3million plastic bags and 324,000 disposable nappies [29].

In 2017, they laid a road 400m long by 20m wide using 1000 tonnes of asphalt. Cumbria County Council were the first council to trail their product and have used it in their £200,000 resurfacing project on the A7 into Carlisle [29].

Case study 3:

Project Beacon

Project Beacon has combined exciting and innovative mechanical and chemical recycling technology to create an Advanced Plastics Reprocessing facility at Binn Park in Perthshire where plastics are kept in the economy for longer and diverted from landfill and incineration. The technology enables all household plastics to be recycled at kerbside, thereby reducing householders' confusion over which plastics to recycle. The project is supported by Zero Waste Scotland and has just been awarded £1.7 million by the Circular Economy Investment Fund. The aim is to have the demonstrator facility operating by the end of 2018 [30].

[28] https://www.macrebur.com/about-us/
[29] https://www.dailyrecord.co.uk/lifestyle/motoring/macrebur-lay-down-plastic-take-12550652
[30] https://www.zerowastescotland.org.uk/case-study/project-beacon

Opportunity 5 –

Circular food policy

Background

It has been estimated that between one-third and a half of all food produced around the world is lost or wasted (i.e. up to 2 billion tonnes of food). In the EU, food waste is expected to rise to about 126 million tonnes a year by 2020. Clearly, there is an opportunity to re-use this wasted material to produce additional resource where it is needed most.

There is a need for both businesses and householders to take a different approach to the way we procure, produce and consume food in order to reduce the amount of food wasted along the whole supply chain, from farm to plate.

The Scottish Government has set a food waste target of reducing food waste by 33% by the year 2025. The proposal is included in Scotland's 'Making Things Last' Circular Economy Strategy[31].

The opportunities

The pledge to cut food waste by a third by 2025 is predicted to save households and businesses across the country at least £500 million[32]. It will also put Scotland on track to deliver the UN Sustainable Development Goal of halving food waste by 2030. With a large proportion of food and drink businesses in Tayside the opportunity exists to engage with procuring authorities, producers and consumers to develop a circular food policy across Tayside. Specific opportunities for a circular food procurement policy are:

- Optimise packaging use.
- Reduce food miles through sourcing locally and shared vehicle capacity.
- Use of organic based fertilisers derived from waste organics.
- Increase circularity and reduce waste sent to landfill (e.g. food recycling plants, donate excess food to local charities and use as animal feed).

Key stakeholders

- Dundee, Angus and Perth and Kinross City Councils
- Tayside Contracts
- Soil Association
- Nourish Scotland
- Community Food and Health (Scotland)
- Scottish Enterprise
- Scotland Food & Drink
- James Hutton Institute
- Zero Waste Scotland

What next?

- Establish a food procurement working group.
- Adopt a region-wide sustainable food procurement policy.
- Introduce and embed circular economy principles into the food and drink sector innovation plans for Tayside
- Encourage collaboration between a variety of stakeholders to identify a package of actions to deliver food waste reductions and work towards the food waste reduction target
- Support SMEs and other food businesses to prevent food waste and comply with waste regulations; introducing ideas from the Love Food Hate Waste campaign

[31] https://www.letsrecycle.com/news/latest-news/scottish-strategy-targets-food-waste-and-producer-responsibility/

[32] https://news.gov.scot/news/make-things-last-and-save

Opportunity 5 –

Circular food policy

Case study 4:

Jaw brew

Jaw Brew is an independent micro-brewery based in Glasgow. In 2016, it partnered with Aulds the Bakers to pioneer a beer made from leftover morning bread rolls. The benefits are twofold – creating a tasty product from otherwise wasted material and contributing to the circular economy. The spent grains and bread that result from the mash go to a local farm as cattle feed and the hops are used as mulch by a local gardening club. Heat is also recovered where possible from the brewing process and retained for the next batch [33].

Case study 5:

Angus Soft Fruit

Angus Soft Fruit is Scotland's first soft fruit glasshouse research and production facility which has created a year-round production model, reducing the need for imports and thereby reducing the resources required and lost along the value chain [34].

Case study 6:

CelluComp

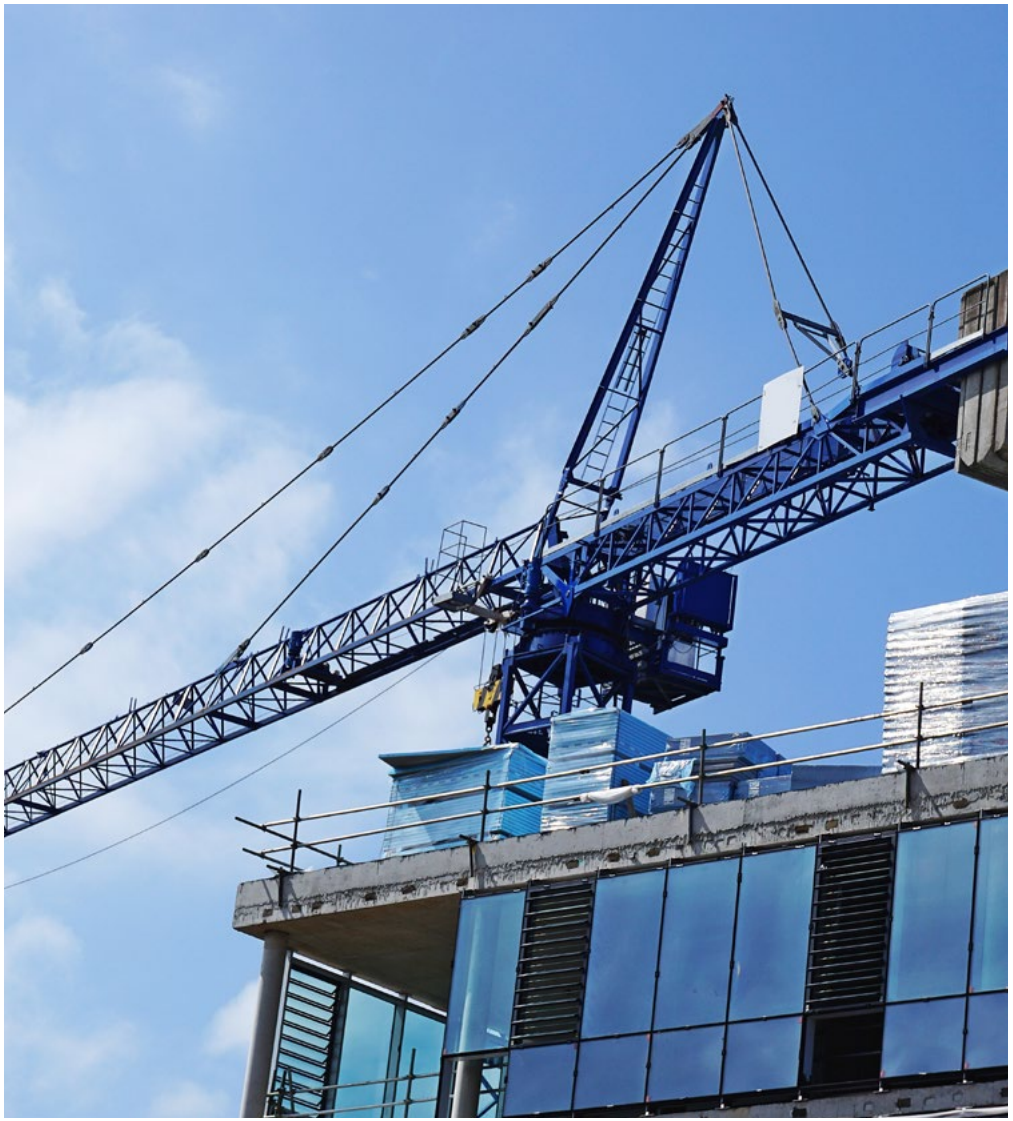
CelluComp is a good example of innovation in the food and drink area. The company has developed a process that allows the properties of cellulose nanofibers, named Curran®, to be fully utilised. Curran is manufactured from waste streams produced by the food processing industry. Common raw materials are carrots and sugar beet. Because only materials otherwise discarded by the food industry are used, it does not compete with food crops for scarce land. CelluComp is working with other major players in the food processing industry to optimise use of other vegetable wastes. Curran has a low carbon footprint, uses far fewer chemicals and emits no toxic gases into the atmosphere [35].

[33] https://www.jawbrew.co.uk/
[34] http://www.angussoftfruits.co.uk/
[35] https://www.cellucomp.com/

6.2 Construction and the built environment

Gross output for the construction sector in Tayside is £1.5 billion, made up from a GVA of £625 million added and the value of the total inputs to production of £870 million. The estimated £185 million (approximately 30% of GVA) potential economic savings for the construction sector is top of the four priority sectors, being virtually equal with energy infrastructure (£186 million), and higher than manufacturing (£19 million) and food and drink (£14 million).

There are a number of key circular economy construction opportunities in the region, including the regeneration works being undertaken by Dundee City Council and its partners in several areas. These include the Dundee Waterfront which is currently undergoing a £1billion transformation, encompassing 240 hectares of development land. A key development within the waterfront is the V&A Museum of Design. These projects present an excellent opportunity to embed circular economy principles and practices into these plans, such as the re-use of materials in construction. This will require collaboration and engagement between designers, construction contractors and the Council.



Opportunity 6 –

Circular economy in infrastructure procurement

Background

The significant quantities of money spent on infrastructure in the UK, combined with the vast material requirements for the construction, presents a substantial opportunity for reducing resource use and creating cost savings through the adoption of circular economy principles. However, existing technical standards often stifle innovation. Success depends on effective engagement between procurement teams, project managers, operators and suppliers to ensure circular economy principles are adopted early in a project's life-cycle; and cross-sector collaboration.

The opportunities

Tayside Contracts is a commercially based local authority contracting organisation providing a variety of services, including roads maintenance, throughout the Tayside area. Given the economy of scale across the region, there is a valuable opportunity to explore how circular economy principles can be integrated into the work delivered by Tayside Contracts, particularly in the area of maintenance. In addition, developers should include circular economy requirements in their construction contract specifications so that circular economy opportunities relating to the materials used and the construction process itself can also be realised. Major contractors should require the same of their sub-contractors. For example, this could include requirements such as repurposing or adaptive use; on-site waste minimisation; upcycling; and using re-used materials, reverse logistics and performance contracting.

Key stakeholders

- Construction Scotland Innovation Centre (CSIC)
- Dundee & Angus Chamber of Commerce.
- Perthshire Chamber of Commerce.
- Angus, City of Dundee and Perth & Kinross councils.
- Zero Waste Perth.
- Dundeecomm.
- Scottish Enterprise.
- Scottish Government.
- Zero Waste Scotland.
- Major civils construction contractors.
- Waste and resource management companies.

What next?

- Engage with stakeholders to discuss and agree how the circular economy opportunities available and listed above can be matched up to the individual infrastructure procurements planned.
- Agree which actors will carry out which specific actions to realise the project opportunities identified.
- Set objectives and agree key performance indicators for monitoring progress.

Opportunity 7 –
Building refurbishment and regeneration

Background

Working with the construction sector to ensure building designs consider waste reduction in both new build and refurbishment is a key priority of the Scottish Government's Circular Economy Strategy. This will include supporting SMEs to deliver building projects that will deliver significant impacts that can be scaled up and repeated .

Dundee City Council and its partners have been undertaking regeneration works in several areas including Dundee Waterfront which is currently undergoing a £1billion transformation, encompassing 240 hectares of development land. [36] A key development within the waterfront is the V&A Museum of Design. Waste reduction appears to feature as a key priority within the proposal, through policies such as seeking to ensure that waste management solutions are incorporated into the development and design of the building [37].

The opportunities

The regeneration works occurring in Dundee present an excellent opportunity to embed circular economy principles and practices into these plans, such as the re-use of materials in construction. This will require collaboration and engagement between designers, construction contractors and the Council. Lessons learned through the process should be captured and shared with the other areas in Tayside for future regeneration projects and significant new build developments.

Many of the companies involved in the supply chain of these developments, as well as other businesses involved in house building or refurbishment in the region, may be SMEs. As such, they will be eligible for support or funding through Zero Waste Scotland's Circular Economy programme.

[36] https://www.dundeecity.gov.uk/service-area/city-development/planning-and-economic-development/development-plans-and-regeneration/regeneration-and-area-masterplans
[37] https://www.dundeecity.gov.uk/reports/plan_apps/13-00224-FUL.pdf

Key stakeholders

- Dundee & Angus Chamber of Commerce.
- Perthshire Chamber of Commerce.
- Angus, City of Dundee and Perth & Kinross councils.
- Construction Scotland Innovation Centre.
- Local housing associations.
- Local house builders and refurbishment contractors.
- Construction waste and resource management companies.

What next?

- Encourage collaboration and engagement between designers, construction contractors and the Council to embed circular economy principles into the ongoing regeneration works in Dundee
- Support SMEs to identify the circular economy opportunities available to them, and develop specific objectives and actions that would help them to implement them within their own building and refurbishment projects
- Set key performance indicators for monitoring progress

6.3 Manufacturing and energy infrastructure

Scotland's 2016 manufacturing action plan, 'A Manufacturing Future for Scotland'[38], 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.'

Based on estimates of local gross output in 2016, the manufacturing sector in Tayside is worth £1.7 billion. The value of the total inputs to production is £941 million and the GVA is £777 million. Through the adoption of circular economy opportunities – such as leasing, servitisation of products and remanufacturing – there is an estimated £19 million (2% of GVA) of potential economic savings for the manufacturing sector in Tayside.

The energy infrastructure sector is involved with energy generation, transmission technologies and transmission equipment. Based on estimates of local gross output in 2016, the energy infrastructure sector in Tayside is worth £1.2 billion. The value of the total inputs to production is £818 million and the GVA is £385 million. Through the adoption of circular economy opportunities, such as re-use of materials after decommissioning or valorisation of underused energy, there is an estimated £186 million (48% of GVA) of potential economic savings for the energy Infrastructure sector in Tayside.

[38] https://www.skillsdevelopmentscotland.co.uk/media/41516/a-manufacturing-future-for-scotland-1.pdf

Opportunity 8 –

Innovative circular economy manufacturing

Background

The engineering and advanced manufacturing (EAM) sector contributed £7.7 billion GVA to the Tayside economy in 2014 – 16% of all output in that year. The sector is a particularly large component of the Angus economy, accounting for a third of all output from the area in 2014. There were 775 manufacturing companies in Tayside in 2015, the majority of which were small businesses employing fewer than 10 people. There were 8,700 people working in the EAM sector in Tayside in 2015, accounting for 6% of all Scottish jobs in the sector and 5% of all jobs in the region. Tayside has high concentrations of employment in a range of EAM sectors, including architecture, engineering, and the manufacture of metals and machinery[39].

The opportunities

The Tay Cities Deal aims to strengthen the engineering capabilities and capacity of the region's engineering and advanced manufacturing sector to boost investment and innovation, encourage greater internationalisation and future-proof the skills base. Advanced manufacturing shares many of the principles of a circular economy with innovative technologies that drive greater circularity including 3D printing and adaptive bonding.

Tayside has a long history of providing engineering training and apprenticeships through the technical colleges and organisations. Given this capacity, Tayside offers an excellent opportunity to engage and support SMEs in the manufacturing sector to develop new circular economy technologies.

In 'Making Things Last' (2016)[40] the Scottish Government outlined the need to 'embed the development of new skills and thinking in the next generation of designers, business leaders and innovators.' Zero Waste Scotland and Skills Development Scotland have created a vision for a Circular Economy Skills Hub. This will take the form of a collaborative network of stakeholders, with a central coordinating 'hub' to provide leadership and strategic direction. This would be a truly cross-sectoral initiative. One of the first pilots of the Skills Hub will focus on the manufacturing sector.

Key stakeholders

- Angus, City of Dundee and Perth & Kinross councils.
- Tay Cities Deal.
- Tayside Engineering Network.
- Colleges and vocational training institutes.
- Zero Waste Scotland.
- Scottish Enterprise.

What next?

- Engage with partners involved in the Tay Cities Deal to understand progress.
- Build on the City Deal objectives to explore new circular economy employment and training opportunities/needs.
- Develop specific objectives with key stakeholders to deploy new, advanced, manufacturing equipment in the sector.

[39] https://www.angus.gov.uk/sites/angus-cms/files/2017-07/47_Appendix.pdf
[40] https://www.gov.scot/Publications/2016/02/1761/0

Opportunity 8 –

Innovative circular economy manufacturing

Case study 7:

Chemical leasing

The leasing of chemicals is a rental and servitisation model where, instead of selling a chemical, the supplier of the chemical leases it out to the user and charges for the service the chemical provides. For example, in the case of industrial solvents the service could be surface cleaning. The service provider periodically collects and replaces the solvent and then regenerates it at its own premises. For example, an Austrian company, Tiefenbacher GmbH, changed its business model from selling solvents to selling the cleaning of surfaces of metal, plastic and wood objects to industrial customers.

Opportunity 9 –
Oil and gas decommissioning

Background

The Oil & Gas Decommissioning Action Plan, published by Scottish Enterprise and Highlands and Islands Enterprise in 2017, identifies that the existing infrastructure in the UK Continental Shelf (UKCS) will eventually be decommissioned and includes over 300 oil and gas installations, nearly 400 subsea installations, 16,000km of pipelines and more than 5,000 wells [41].

Tayside has, and continues to play, an important role in supporting oil and gas operations in the UKCS, and in other oil and gas producing basins across the world. The sector in the North Sea continues to progress and decommissioning is now a significant emerging economic opportunity in Scotland and the UK, with a projected £17.6 billion spend in the next 10 years [42].

Specific opportunities from decommissioning in Tayside are captured within the Tay Cities Deal and include:

- Creating between 5,539 and 7,754 new full time equivalent jobs.
- Generating additional GVA of between £163 million and £228 million.
- Maximising decommissioning spend within the UK.
- Developing exportable skills and knowledge.

The opportunities

Decommissioning offers significant potential for Scotland to capture a share of emerging re-use activity and for this to contribute towards the 40% cost saving target that the industry has set in the North Sea [43]. Decommissioned materials can be re-used at any scale from whole accommodation modules down to individual fixtures and fittings.

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 [44]. Equally, manufacturers and contractors can benefit from using refurbished equipment or products in their own production, operations or services.

Key stakeholders

- Decom North Sea
- Scottish Environment Protection Agency (SEPA)
- Oil & Gas Authority (OGA)
- BEIS-OPRED
- Oil & Gas asset owners and operators
- Dundee City Council.
- Dundeecomm.
- Tayside Engineering Network.
- Zero Waste Scotland.
- Scottish Enterprise.

What next?

- Engage with the oil & gas asset owners (i.e. oil & gas operators), rectification and liability/ insurance organisations and other stakeholders in Tayside 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.

41 Scottish Enterprise Oil & Gas Decommissioning Action Plan
42 https://www.taycities.co.uk/sites/default/files/tay_cities_deal.pdf
43 The RSA Great Recovery and Zero Waste Scotland Programme - North Sea Oil and Gas Rig Decommissioning & Re-use Opportunity Report
44 https://www.sea.co.uk/subsea/products/legacy-locker/

Opportunity 9 –

Oil and gas decommissioning

Case study 8:

Re-use of decommissioned oil and gas materials

Montrose-based scrap metal reprocessors and decommissioning specialists, 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 up to 100% of the around 200,000 tonnes/year of end-of-life materials it processes, with around 45% of materials sold for re-use [45]. Examples quoted include old anchor chains used to weigh down subsea pipelines or fish farm cages and nets, re-use of pipes and tubulars as piling in construction projects.

Case study 9:

Refurbishment and re-use of pipe thread protectors

Peterhead-based, Norkram Ltd [46], refurbishes used 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.

Case study 10:

Dundeecom

Dundeecom [47], is a new private/public sector partnership aimed at creating a major centre in Scotland for oil and gas decommissioning at the Port of Dundee. The project brings together the main ports in the area, together with the councils and proposes to establish the region as a multidisciplinary, internationally recognised centre of excellence in the practice of, and research into, oil and gas decommissioning. The project seeks to ensure maximisation of economic and social benefits for the region, Scotland and the UK while achieving reductions in the cost of decommissioning and reducing the leakage of expenditure beyond the UK through minimising the exportation of decommissioning activity.

45 https://www.agcc.co.uk/circular-economy-case-studies
46 https://www.norkram.co.uk/
47 https://www.taycities.co.uk/sites/default/files/tay_cities_deal_0.pdf

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 lifecycle 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. Through the co-location and cascading of reprocessing, businesses value can be added to wastes, by-products and surplus materials. Several platforms already exist that help exchange materials across and within sectors. However, further research into how these are performing, and developing an understanding of what aspects are/aren't working, could really help these platforms to strengthen and grow. In addition, developing an in-depth understanding of local industrial networks to identify material flows could help identify more opportunities to share resources. This could be achieved through a regional waste-mapping exercise to capture and analyse the material quantities and availability across the region.

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. This energy that cannot feasibly be imported to the grid at the time it is available is known as 'curtailed' energy. 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.

Dundee City Council already has an ambitious hydrogen strategy and will deploy hydrogen buses as part of the JIVE 2 project [48].

7.4.2 Carbon capture and use

The recovery of carbon 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 utilisation 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.

[48] https://www.scotlandeuropa.com/city-of-dundee-successful-in-eu-hydrogen-bus-funding-application/

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 the 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 [49].

Case study 12:

'Green' ammonia demonstration programme

Innovate UK is supporting an all-electric ammonia synthesis and energy storage system demonstration programme at the Rutherford Appleton Laboratory, near Oxford [50]. Participants in the demonstrator include Siemens.

Case study 13:

SHARC Energy Systems: Borders College project

SHARC Energy Systems captures thermal energy from wastewater to provide sustainable heating and conditioning for a wide range of building types. This is achieved through their heating recovery system which intercepts wastewater from a sewer close to the local treatment works operated by Scottish Water. The system uses a heat pump to enhance the heat released from wastewater, which is then sold to Borders College under a 20-year purchase agreement. As a result, energy, cost and carbon emission savings are generated and around 95% of the heat needed by the College is provided [51].

[49] https://docs.wixstatic.com/ugd/27f091_614b25efd0f343be85e1abd6fc6799f1.pdf
[50] https://www.siemens.co.uk/en/insights/potential-of-green-ammonia-as-fertiliser-and-electricity-storage.htm
[51] http://www.sharcenergy.com/what-we-do/

8 Next steps

Zero Waste Scotland is working with a local business engagement partner (Perthshire Chamber of Commerce and Dundee & Angus 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 can provide, 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 Tayside 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 many 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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