



Circular Economy Opportunities Edinburgh



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Contents

1	Executive Summary	6
2	Introduction	7
	2.1 Background	7
	2.2 Methodology	7
	2.3 Relevant policies and strategies	8
3	Key Opportunities	10
	3.1 Knowledge Hub	10
	3.2 ICT refurbishment and remanufacture	11
	3.3 Alcohol by-products	13
	3.4 Hospitality, events, and festivals	14
	3.5 Facilities Management	17
4	Secondary opportunities	19
	4.1 Tyres	19
	4.2 Glass	20
5	Economic baseline	22
	5.1 Overview of Edinburgh	22
	5.2 Economic performance by industry	22
	5.3 Employment	23
6	Material flows	25
	6.1 Waste material streams in Edinburgh	25
7	Implementation support	26
	7.1 Support organisations	26
	7.2 Circular Economy Business Support Service	26
	7.3 Circular Economy Investment Fund	26
8	Appendix	27
	8.1 Relevant policies and strategies	27
	8.2 Longlist of opportunities	29
	8.3 Opportunity scoring	34
	8.4 Case studies	35



A nighttime photograph of a city street with light trails from cars and a prominent clock tower in the background. The scene is illuminated by streetlights and building lights, creating a vibrant urban atmosphere. A large white circle with a blue border is overlaid on the center of the image, containing text.

The Edinburgh region has a diverse economy which could benefit economically, socially and environmentally from incorporating circular economy principles and practices.

Foreword

We are delighted to be working in partnership with Edinburgh Chamber of Commerce on the Circular Edinburgh project, a 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 has the potential to isolate opportunities based on regional specialisms unique to the area. In the case of Edinburgh, this preliminary report has found particular potential in the events and festivals sectors; in facilities/buildings management; ICT and data infrastructure; and by-products from the production of alcohol. Regional evaluations allow for the uncovering of these unique opportunities – which are not the same in other areas of the country. 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.

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, Edinburgh 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 Edinburgh area. Looking ahead to stage two, through a series of events, engagement activity, tools, and support, Circular Edinburgh 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 Edinburgh city region, led by Edinburgh Chamber of Commerce seeing how the vast opportunities identified in this report become realised in stage two of the Circular Edinburgh project.



Iain Gulland

A handwritten signature in black ink, appearing to read 'Iain Gulland', written in a cursive style.

Chief Executive, Zero Waste Scotland



We very much welcome this report looking at the potential of circular economy opportunities within Edinburgh to help the city reduce its carbon emissions and

transition to a low carbon economy.

The Council's Sustainable Energy Action Plan (SEAP) is the key policy document tasked with sustainable energy transformation across the city and part of that programme includes encouraging the sustainable use of resources and minimising waste. The Resource Efficiency programme within the SEAP is now being increasingly shaped by the circular economy agenda.

We view the circular economy as having the potential to transform urban policy and economic development in Edinburgh and to future proof the city to the twin challenges of resource scarcity and a growing population and the pressures that places on housing, transport and the wider environment. For Edinburgh this agenda offers significant opportunities to build an economy and a new urban system that is restorative and regenerative by design, that benefits communities, businesses and the environment, generating prosperity, liveability and resilience.

The circular economy has the potential to support energy systems that are resilient and renewable and transport systems that are low carbon, multi modal and accessible. In terms of Edinburgh's economy and businesses there are a range of benefits to replacing the traditional model with one that is circular by design. This encourages the development of new business models in the areas of re-use, remanufacturing and materials innovation. This can lead to major benefits including new employment opportunities and the growth of social enterprise.

Outlined within the Council's new Economy Strategy is a commitment to promote business opportunities arising from the circular economy. As such we see this agenda as a very important strand of that work. We very much support the findings outlined in this report and hope that they act as a springboard towards the development of a more circular economy in Edinburgh.

Cllr Lesley Macinnes
Convenor of Transport and Environment
Committee, City of Edinburgh Council

Cllr Kate Campbell
Convenor of Housing and Economy
Committee, City of Edinburgh Council



Creating a circular economy creates only wins – nobody loses. That is the exciting truth behind Scotland's strategy to drive innovative

ways to re-use and upcycle materials that might otherwise go to waste. It is a new way of thinking – it's the philosophy that one person's waste is another person's wealth.

When we create this virtuous cycle, we will help reduce emissions, create opportunities for new jobs and wealth, and reduce landfill.

Edinburgh Chamber of Commerce is delighted and proud to be in the vanguard of driving the circular economy in Edinburgh and the Lothians. Utilising our network of businesses, harnessing our ability to bring together commerce, academia and the public sector, will be pivotal in making the wheels of a circular economy start to spin.

We will achieve this through the development of a suite of support services designed to help business understand and adopt the opportunities that exist to become more circular.

And more importantly this should not just be an 'add on' for business but should be embedded into our values and core philosophy. Then circular economy will become a day to day routine rather than an additional business activity.

Liz McAreavey
Chief Executive, Edinburgh Chamber
of Commerce

1 Executive Summary

The Edinburgh region has a diverse economy which could benefit economically, socially and environmentally from incorporating circular economy principles and practices. Traditional business models have failed to derive maximum benefits from the materials used and by-products produced which has led to many tonnes of potential feedstocks being landfilled. This practice is not only environmentally unsustainable, it reduces the economic performance of Edinburgh's economy.

There are numerous Scottish and Edinburgh policies which require a change of focus from the business as usual approach towards a more circular outlook. Through analysing Edinburgh's economy and the material flows within that economy, a long list of circular economy opportunities were identified.

The five most beneficial opportunities were selected for further investigation to determine the potential benefits for the Edinburgh region. These opportunities cross many of the significant sectors of the Edinburgh economy from tourism (festivals), information communication technology (ICT) and manufacturing.

It was found that there is a significant opportunity to leverage the world class tertiary education institutions of Edinburgh to create a CE Knowledge Hub which would be a focal point for providing solutions to many of the material flows currently deemed to be 'waste'.

The twelve festivals held annually in Edinburgh also provide the opportunity for these to be held in a more circular fashion, from reducing single use cups and containers to identifying opportunities for surplus food.

The ICT sector is expanding and through the use of refurbished components this sector can benefit economically and reduce the environmental impact of the industry. Reclaiming precious metals and materials from obsolete stock can also be achieved through the use of cutting edge technology and processes.

Edinburgh is home to many breweries and distilleries where current practice is to transfer the by-products of these processes to animal feed. There are numerous opportunities to maximise the economic benefits of these

products through extracting proteins and using spent grains in human food production.

Edinburgh houses significant office space and through the incorporation of servitisation of products such as light and furniture a more circular supply chain can be created which improves economic performance.

Edinburgh's large population results in significant volumes of 'waste' materials such as tyres and glass being generated locally. Identifying alternate uses for glass, such as in insulation or as a filtration media, will maximise the economic benefit from this resource.

Tyres can be converted into usable materials which can then be used for other products which create resilient supply chains. Circular Edinburgh in conjunction with Zero Waste Scotland are ideally positioned to assist Edinburgh's SMEs to explore these opportunities to improve business profitability, create jobs and provide improved environmental outcomes.



2 Introduction

2.1 Background

A circular economy is one where systems are designed to make better use of valuable products and materials - changing the way they are produced and managed to have less impact on finite natural resources, and create greater economic benefit.

This is in contrast to a linear economy in which raw materials are extracted to manufacture products (which are generally designed to have a single economic life) - the products are used then disposed of - often to landfill or recycled. This results in massive losses of raw materials and economic value.

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

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

2.2 Methodology

This report seeks to identify circular economy opportunities which are of particular relevance to Edinburgh. In order to identify these opportunities, we analysed the material flows and waste generated within the city; the current economic make up of the city; and relevant local policy and strategy.

We also engaged with a number of local stakeholders to understand where circularity could complement other activity and offer opportunity for business growth, economic resilience, and carbon reduction.

A long-list of opportunities were identified from our initial research - these were prioritised based on set criteria including job creation potential, carbon savings, and scalability - and a short list of five 'target' opportunities are described in more detail in the following sections.

Where possible, we have provided an indication of the potential circular economy savings that could be realised from the implementation of these opportunities. These savings figures are intended to illustrate the 'size of the prize' and provide a starting block from which to explore the potential in more detail. It should be stressed that these figures do not include the cost of change and there are significant variables which would impact on the ultimate savings that can be achieved.

As part of this project, Zero Waste Scotland have engaged a local 'business engagement partner' to raise awareness of these opportunities and help to support the implementation of new CE activity in the city. Edinburgh Chamber of Commerce are the business engagement partner and have launched the [Circular Edinburgh](#) initiative.

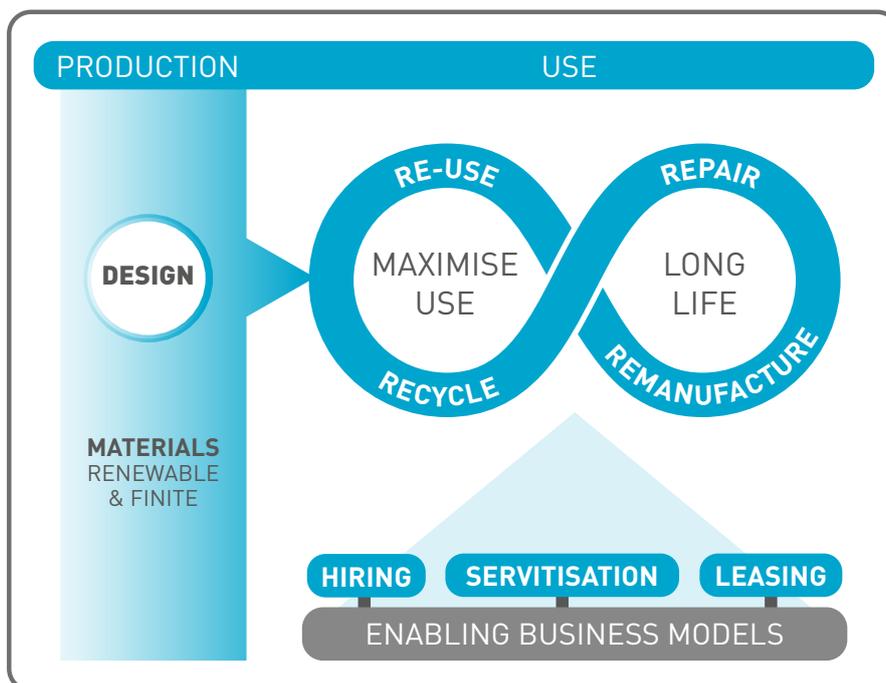


Figure 1: Circular Economy

2.3 Relevant policies and strategies

Momentum towards a circular economy is being generated by a number of policies and strategies that aim to decrease waste and increase reuse. For example, the City of Edinburgh Council's recently published Economy Strategy includes a commitment to promote the business opportunities arising from the circular economy.

The Edinburgh and South East Scotland Region City Deal has identified a number of headline initiatives where circular economy principles could be implemented. For example:

- £300 million has been allocated for world leading data centres. These developments would be an ideal opportunity to explore opportunities to stimulate a

supply chain re-using high quality ICT equipment. This is explored further in Section 3.2.

- Domestic and non-domestic developments totalling £85 million have been earmarked. This presents an opportunity to ensure circularity is considered as early as possible in the process, i.e. at design stage, thus ensuring both the construction and life of new builds demonstrate the principles of Circular Economy.
- The City Deal has also allocated £25 million to support improved career opportunities which will involve the upskilling of the labour force to provide the competencies which are required as part of transitioning towards a circular economy.



Appendix 8.1 presents the detail of relevant policy and strategies and their alignment with circular economy principles. The following table highlights some of the key

policies and strategies which are complementary to moves towards a more circular economy.

Name of Policy/Strategy	Aims/Targets/Goals	Alignment with circular economy principles
Edinburgh's Sustainable Energy Action Plan	Reduce emissions by 42% by 2020.	Reuse of materials and parts, will reduce the need for additional energy required for processing virgin material. In search of further efficiencies, heat recovery or heat exchanges in industrial processes will ensure heat/energy is not being wasted.
Edinburgh City Vision 2050	Edinburgh becoming carbon neutral by 2050.	As above.
Sustainable Edinburgh 2020 (SE 2020)	The Council's vision for Edinburgh in 2020 is of a city that will be low carbon and resource efficient. It aims for Edinburgh to become a leading knowledge, demonstration and development centre for sustainable development.	The concept of Edinburgh being a leader in knowledge aligns with the development of a circular economy knowledge platform based in Edinburgh and managed by its universities.
Edinburgh Adapts, Action Plan (in line with SE2020)	Climate change adaptation action plan developed to help the city prepare for and adapt to the impacts of climate change	The whole-city approach of the action plan aligns well with the circular economy approach of considering inputs and outputs from all sectors and stages of the production process.
Sustainable lighting strategy for Edinburgh	Encourage lighting designs that will reduce energy use, cost and minimise light pollution.	Links with the pay per lumen circular economy business model (discussed further in section 3.5).
Edinburgh's Waste and Recycling Strategy 2010 -2025	To allow Edinburgh to maximise recycling and move towards being a 'zero waste city' in terms of household and commercial waste.	Circular economy opportunities can increase reuse, minimise waste to landfill and increase recycling rates. E.g. reuse of mattresses and textiles.
Ambition 2030	Scotland Food & Drink partnership aim to double annual turnover in the sector to £30 billion through innovation.	Closed loop manufacturing and sourcing of inputs in this industry will complement the circular economy vision of making better use of materials to impact less on natural resources. This more efficient use of resources will enable businesses to increase their turnover.
Economy Strategy	Five year strategy for economic growth in the city focusing on three themes of innovation, inclusion and collaboration.	Commitment to developing a road map for SMEs on circular economy opportunities including efficient sourcing and use of energy and materials, efficient sharing of assets and resources, and market opportunities around design and manufacture of products for ease of re-use.

Table 1: Summary of policies and strategies relevant to circular economy in Edinburgh

3 Key Opportunities

The data obtained from our research and feedback from stakeholder engagement were used to identify a longlist of circular economy opportunities in the Edinburgh region.

This longlist was reviewed in a prioritisation workshop where the list of opportunities were scored against a matrix to determine the opportunities with the greatest benefit to the Edinburgh region. Stakeholder engagement was undertaken with interested parties within the Information and Communication Technologies (ICT), food and drink, facilities management, food packaging and tertiary education sectors in addition to advisory bodies such as the Scottish Futures Trust and Scottish Enterprise.

The five key opportunities are described below.

3.1 Knowledge Hub

Establish a Circular Economy Knowledge Hub that acts to bring together universities and commerce to drive innovation and increase sustainable practices in Edinburgh, and provide business support from start-up incubation to proof of concept and the commercialisation of circular economy initiatives.

The journey towards a circular economy requires the development of new technology, practices, and research. The development of a specialist CE Knowledge Hub and business incubation centre could support the transition to a circular economy. As well as linking universities and businesses within Edinburgh, a Hub could utilise knowledge exchange expertise to make connections globally to enhance CE knowledge and support the implementation of CE practice in Edinburgh (and more widely across Scotland).

Scotland's Economic Strategy seeks to increase sustainable economic growth through innovation. The creation of a Knowledge Hub would be able to support this strategy through the development and support of new circular economy businesses. Edinburgh has four major universities and a thriving third level education sector with 43,600 Undergraduates and 16,555 Postgraduates with expertise in a variety of fields pertinent to developing the circular economy, including science, engineering and finance and business. The development of circular economy business support (proof of concept and

commercialisation), technologies and processes would be accelerated through greater collaboration between the education sector and industry. This collaborative approach would provide businesses with inspiration, support and best practice guidance, whilst allowing students and academics to put their ideas forward and develop practical solutions. Overall, this partnership between academia and commerce would drive innovation and the development of a more sustainable economy for Edinburgh. Additionally, a Knowledge Hub would focus on engagement with commerce, therefore producing a unique partnership that would have the capabilities to participate in challenge based procurement and projects.

The Edinburgh Futures Institute (EFI) could present an opportunity to host a CE Knowledge Hub. The aim of the EFI is to assemble resources and expertise to provide solutions for complex problems facing Scotland and the world. This innovative approach to providing solutions would provide the ideal environment for tackling the challenges of accelerating the transition to a circular economy.

This opportunity would also be comparable in concept to the innovation centres set up by the Scottish Funding Council to promote innovation in certain areas through collaboration between universities and business in Scotland. This provides the opportunity for a hub to focus solely on circular economy challenges.

3.1.1 Recommendations

- **Further exploration of this opportunity** in collaboration with the 4 universities in the Edinburgh region, and other key city stakeholders.
- **Government and public authorities** could utilise the Knowledge Hub for challenge procurement opportunities. This will assist in embedding the hub and provide confidence for industry to utilise the hub.
- **Identify relevant commercial partners** to assist with the funding of the Knowledge Hub.

3.2 ICT refurbishment and remanufacture

Explore opportunities for the re-use of components and equipment within data storage facilities.

Harvesting gold, and other precious metals, from ICT equipment presents an opportunity to extract a high value material that can be used in many industries.

The increasing demand for data is being met by the construction of more data storage centres around Scotland and Edinburgh; this presents a significant opportunity for the use of remanufactured parts in a data centre and the remanufacture of parts eventually discarded by a data centre to be utilised in technology with lower performance requirements.

According to Zero Waste Scotland's [Remanufacturing Study](#), there are 17,000 people employed in the remanufacturing sector in Scotland which annually contributes £1.1 billion to economic activity. Our research indicates that the top three employers in Edinburgh have significant ICT requirements with replacement programmes every 3-5 years. Edinburgh University alone dispose of more than 800 laptops per year, which exemplifies the opportunity within ICT procurement to develop more circular models.

There are several planned developments that will result in an increase in data capacity and the associated equipment, including: 50,000m² Pyramid Data Centre, 23,000m² South Gyle Colocation Datacentre Services, and 3,000m² Onyx Group Edinburgh Data Centre and a £11.3m investment to create three new data hubs in Aberdeen, Edinburgh and Glasgow resulting in over 300 new jobs. This highlights the increasing demand for data based innovation within cities that will be accompanied by an increased demand for data storage and a resulting increase in storage capacity in Edinburgh and other parts of Scotland. These data centres will utilise equipment that will be updated and discarded

every 3-4 years. This upgrading cycle presents an opportunity for Edinburgh based SMEs to remanufacture, refurbish, and reuse ICT components. Furthermore, there is an opportunity for SMEs to explore new circular business models for ICT equipment such as leasing equipment and components and creating value added supply chains that extract the maximum value from materials through increasing the usable life of these components.

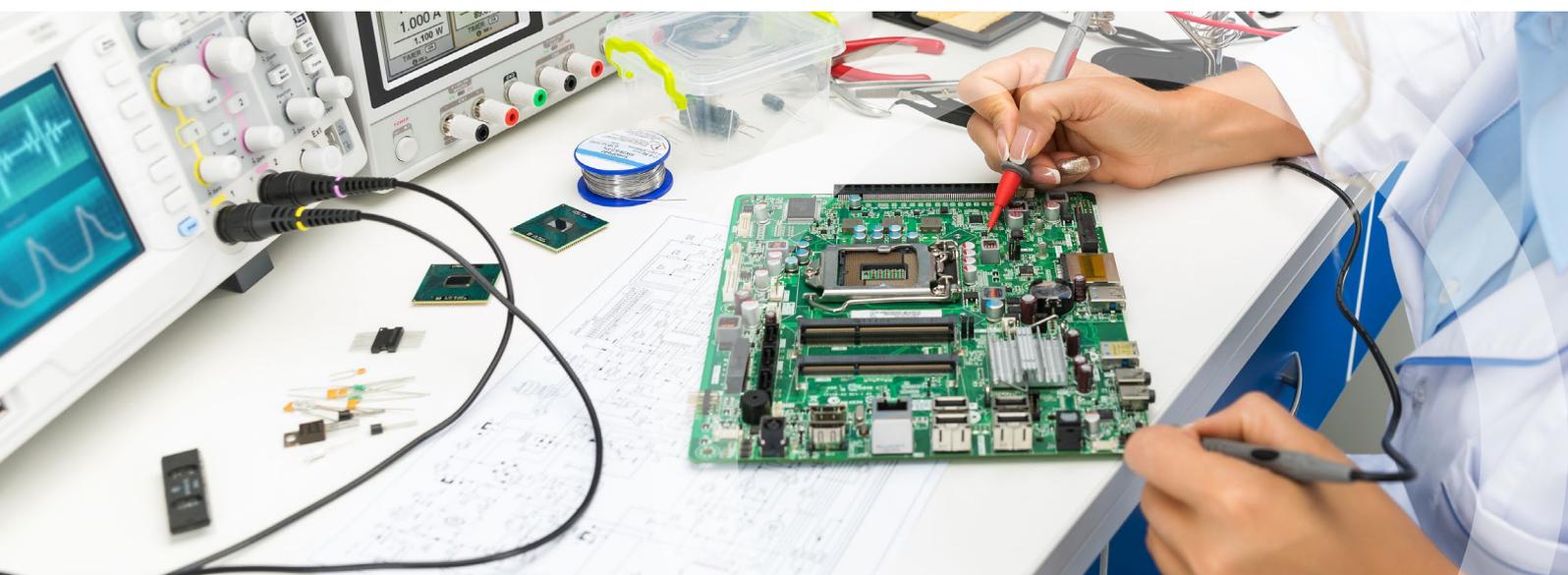
The use of remanufactured machines in data centres is an opportunity that is being taken by market leaders such as Google, where in 2015, 52% of components consumed in Google's Machine Upgrades program were refurbished inventory.

Edinburgh Remakery are an example of an organisation whose expertise in reuse and remanufacture could be harnessed given their workshops in computer repair skills together with the selling of refurbished computers on a small scale. They are currently involved in remanufacturing the University of Edinburgh ICT equipment and have capacity to increase component refurbishment volumes.

3.2.1 Component Reuse and Resource Recovery

Waste Electrical and Electronic Equipment (WEEE) contains significant volumes of precious and semi-precious metals. In order to extract the maximum value from electronics, a degree of manual disassembly is required to extract the various high value components. In addition to recovering components that can be re-used, printed circuit boards (PCBs) contain numerous precious and semiprecious metals such as gold, palladium and silver. It is estimated that 37% of WEEE is currently landfilled illustrating that there is significant feedstock to recover these valuable commodities from.

Manual disassembly allows for the recovery of precious metals which would otherwise be lost through mechanical recovery processes such as smashing or shredding. Manual segregation requires high labour costs; however, this is offset by the relatively low capital outlays required and the increased gross financial yield. Traditional methods to recover these metals required the use of cyanide and other toxic chemicals. The University of

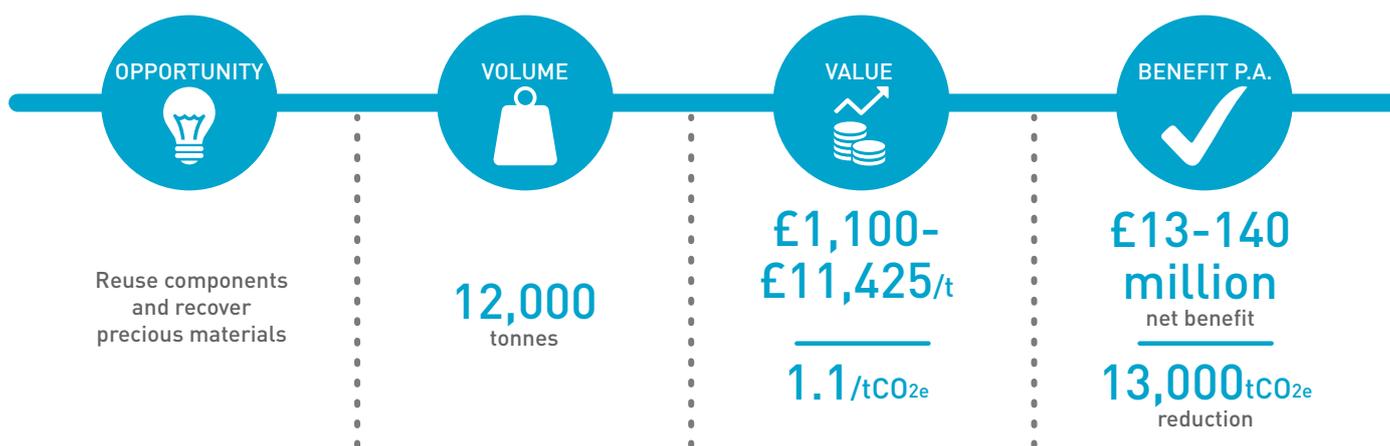


Edinburgh has identified an alternative method of [gold recovery](#) from electronics which has a reduced impact on the environment through the use of less toxic chemicals. This process has been proven at a laboratory scale, however it is yet to be commercialised and therefore is an opportunity for the future.

The economic viability of this opportunity is reliant on the price of gold. In addition to the value of the other metals, each tonne of PCB yields 300 grams of gold which is valued at circa £10,000. Dell computers have entered into an agreement with [Bayou with Love](#) to create gold jewellery which is sourced from gold recovered from Dell PCB.



3.2.2 Potential circular economy savings



3.2.3 Recommendations

- **Support SMEs in the ICT sector** to diversify into the re-use and refurbishment of equipment, and to explore resource recovery opportunities. In parallel, take steps to influence large users of ICT equipment and data centre management companies to work with their local supply chain during the upgrading, repair and 'disposal' of equipment.
- **Explore the existing barriers** that are restricting the commercialisation of more environmentally beneficial metal extraction process.

3.3 Alcohol by-products

Use by-products from whisky, gin, and beer brewing industries as inputs in the production of a number of goods such as high quality protein feeds and the generation of biogas for heating/power generation.

As part of Ambition 2030, Scotland's food and drinks sector aims to double the value of the sector to £30 billion by 2030. This strategy states that to achieve this target, the industry is required to implement improved processes or technologies along the supply chain ensuring businesses become more resource-efficient, profitable, productive and sustainable. An example of this is the use of spent grain and pot ale in increasingly efficient ways.

The brewing and distillation industry is one of Edinburgh's most ancient and important industries and there are still a large number operating in the area such as Caledonian Brewery, Stewart Brewing and Edinburgh Gin. The main by-products produced by the brewing process are spent grain, spent yeast and spent hops. According to a study led by Harper Adams University, the main method of disposal for spent brewer's grain was animal feed, regardless of the location of the brewery. This is the case in Edinburgh where the spent grains are commonly used directly as feed. It was also

found that smaller breweries opted to have their spent grain used to produce compost and some small ones sent it to landfill. The most common method of disposal of spent yeast was via sewage system and for spent hops was for fertilisers.

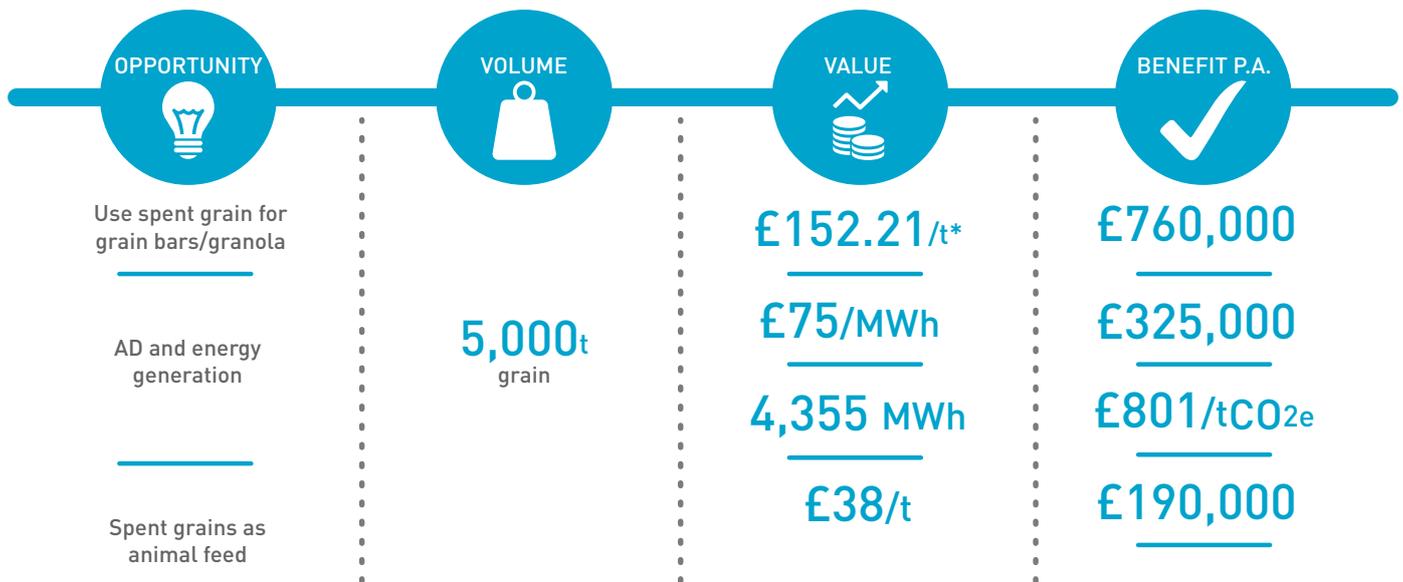
The by-products from the brewing and distilling industry can be used to generate significant material savings. Spent grain can be used in the production of a range of different food items such as the production of bread, granola bars, barley flour and dog treats. [AB InBev](#) have funded a drinks company, 'Canvas' which utilises spent grain to create protein drinks. Spent yeast can be used in food manufacturing to provide flavour. There are numerous food businesses in Edinburgh, where these by-products could be introduced into recipes. The majority of spent grains are currently used as animal feed and as such, the agriculture sector would have to identify alternate supply chains when these materials are diverted to higher value processes.

Spent hops are suitable for composting and used as fertiliser which can be used to grow new crops for the brewing process, thereby closing the material loop. Salmon food can be derived from distillery by-products creating a high value product, as shown by the operation of Horizon Proteins and their production of high quality and consistent protein feeds. (See appendix for further information.)

There are currently over 25 breweries and up to 10 distilleries in the greater Edinburgh region. The mix of breweries range from small craft to large internationally owned breweries, which create significant feedstock through brewing and distilling processes. The majority of independent breweries on average produce 50 hectolitres of beer with larger breweries producing over 20,000 hectolitres¹ pa. Every [50 hectolitres](#) of beer will produce approximately 1 tonne of spent grain.

¹A hectolitre is 100 litres

3.3.1 Potential circular economy savings



*Note: Substitute for flour prices.

3.3.2 Recommendations

- **Circular Edinburgh** (the local business engagement partner) promote the economic and environmental benefits of this opportunity.
- **Identify the business links** where the maximum economic benefit can be derived from the supply chain of by-products. This could include: identifying new markets for these spent grains in the food and pet food manufacturing sectors.
- **Link brewers/distillers** which dispose of significant volumes of spent grains with existing operations or start-ups based on capacity.
- **By identifying suitable and receptive agriculture** enterprises to receive digestates and soil conditioning by-products, circularity will be achieved within this subsector.

3.4 Hospitality, events, and festivals

Decreasing use of single use plastics presents an opportunity to produce and utilise reusable alternatives.

Redirecting waste/recycling material to higher wealth opportunities generation such as popup food outlets, that source surplus ingredients from food and beverage businesses, or biodiesel production from spent cooking oil.

Increase reuse of festival stage, costume and prop equipment by utilising existing forums and promoting the incorporation of design principles that are conducive to reuse of equipment.

Annually 4.5 million tickets are sold for the 12 major festivals held in Edinburgh which contribute [£280 million](#) to the Edinburgh economy. These festivals are staged throughout the year, however are concentrated within the months of August and December. These festivals attract hundreds of performers and thousands of participants.

The festivals provide the ideal vehicle to implement the concept of circular economy in Edinburgh. Festivals Edinburgh is an umbrella organisation supporting the 12 major festivals held in the city. Several broad environmental initiatives are already ongoing at various festivals and Festivals Edinburgh have developed an Environmental Policy to which all festivals must comply.

Through the application of circular economy specific practices, the festivals would be able to champion circular economy concepts during periods of increased population within the city.

3.4.1 Single use cups and containers

Currently there is a significant waste stream generated from the consumption of single use plastics for food and beverage services. This presents an opportunity to implement more circular solutions utilising reusable alternatives. For example, [Glasgow coffee festival](#) did not issue any disposable coffee cups during their 2018 event; reusable coffee cups were available to hire and/or buy which created additional revenue streams for the event operator.

Alternatively, organic substitutes could be utilised which can then be 'disposed' of alongside other organic materials such as food waste. This policy is currently implemented during [The Book Festival](#) where all caterers are mandated to use compostable packaging, plates, cups and utensils.

3.4.2 Food

There are opportunities for popup food outlets to be created during August and December which utilise surplus food from various food and beverage businesses (supermarkets, breweries, and producers) within Edinburgh. The menu will revolve around what surplus food is available on certain days, however there will be some consistency if sourcing food from a secure supply chain.

Festival organisers may offer reduced rates for social enterprise food operations to support this circular economy opportunity. Revenue generated during these peak periods can be invested into operating a permanent outlet to expand this opportunity's benefit. This could take the form of increasing the frequency or reach of the '[Feeding 5000](#)' initiative or supporting surplus food restaurants such as [InStock](#).

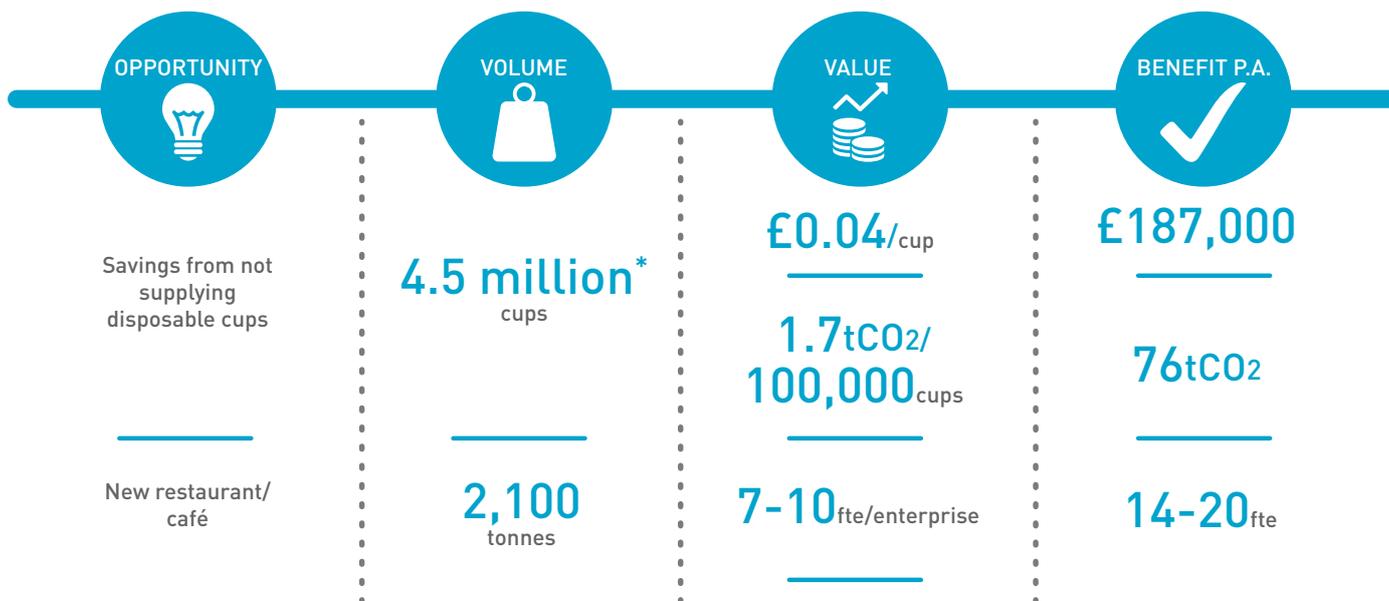
3.4.3 Reuse

There is a significant opportunity to integrate circular economy initiatives into the construction of stage props and costumes. By incorporating principles to design out waste from these builds and ensuring materials can be deconstructed easily and reused, new sets and costumes can reuse these materials in a circular fashion. The 'Fringe Swap Shop' is currently offering the opportunity for people to take unwanted materials at the end of the Fringe Festival. By leveraging this existing forum, the circular economy opportunities can be expanded and become more integrated through the different festivals.

The City of Edinburgh is well placed to provide support services regarding warehousing/storage to facilitate increased uptake of this opportunity to incorporate all festivals and other similar events held throughout the year.



3.4.4 Potential circular economy savings



*Note: It is assumed that one drink is purchased per ticket

3.4.5 Recommendations

- **Circular Edinburgh takes a lead** on identifying local businesses which can provide alternatives to single use plastic packaging, cups and utensils, liaising closely with Festivals Edinburgh.
- **The lack of storage was identified as a barrier**
Engagement with organisations that may have access to appropriate storage which could be utilised for the festivals is recommended. Festivals Edinburgh could utilise this storage and create an inventory of stock which would then be reused where applicable. A digital platform would be created to advertise the inventory of stock and provide a market place for these resources to be reused.
- **The creation of secure supply chains** for surplus food is required to increase the uptake of this opportunity. It is expected that these supply chains are created and maintained from non-seasonal sources and supplemented during the festivals. Circular Edinburgh should take a lead on identifying businesses with surplus food.



3.5 Facilities Management

Explore opportunities to integrate CE practice into the management of facilities, notably offices and university and public sector property. This will create opportunities for local SMEs, lengthen product life-cycles and reduce waste sent to landfill.

There are large volumes of office space within Edinburgh, which traditionally have been utilised mainly by banking, insurance and legal professions; in addition, Edinburgh Park has been a chosen location for various companies to locate their offices and there are plans for expansion in the area which indicates continued growth in this sector. In 2017 there was 31,401m² of office building space complete and in 2016 over 96,000m² of office space was leased. This volume of office space provides significant opportunities to embed circular economy activities within the construction and operation of office spaces.

Facilities management (FM) encompasses a wide variety of services where circular economy principles can be incorporated. For example, waste reduction plans can be readily incorporated within commercial buildings and result in significant economic and environmental benefits. Strategic planning of office moves can result in reducing fitout costs by utilising the existing infrastructure that has been installed. Facilities management can extend to ICT equipment, catering and food services, soft furnishings, uniform, cleaning, maintenance of indoor and outdoor space so there is significant opportunity to integrate CE. Some of these opportunities are described in greater detail below.

Servitisation is the process of offering goods on a pay-per-use/service basis instead of offering them to be purchased outright. This shift from a buy-to-own business model to buying services is an opportunity to increase resource efficiency through influencing the design of products – producing higher quality products with CE principles built in such as ease of disassembly for repair, re-use, or remanufacture or producing modular components. These business models create growth and innovation opportunities for businesses and will result in a reduction in waste sent to landfill. By moving away from a buy-to-own model, the upfront costs to businesses are also reduced which in turn improves cash flow. Alternatively, landlords can incorporate the costs of these services into lease costs. The benefit in this scenario is that the office space leased is more efficient which justifies an increased lease charge. Through this business model the office space is continually improved and the materials used will re-enter the supply chain as inputs in the circular economy. This will be achieved through refurbishment and reuse through to lower value inputs such as resource recovery.

3.5.1 Lighting

There is significant scope to provide light as a service. If an asset manager leases light as a service rather than buying lighting fixtures, these fixtures remain the responsibility of the lighting contractor who installed them. The lighting contractor is responsible for the costs associated with providing this service, including energy. This would encourage the lighting contractor to install smart lighting systems that maximise natural sunlight, include LED lights, motion sensor and controller systems to reduce operation costs. The maintenance and upgrades of lights are also the contractor's responsibility. At the end of the contract period or through upgrades, the lighting products are collected and the raw materials are reused in the manufacturing of new lighting systems. [Philips](#) has integrated servitisation by partnering with an architectural agency (the service provider) and diversified their business model of one-time sales to "pay-per-lux". There is an opportunity for SMEs to utilise the supply chain created by Phillips and other lighting companies for smaller projects.

This business model could also be extended to heating and air-conditioning of offices, schools, universities, libraries and shops. The introduction of this business model across services would support Edinburgh's waste agenda and Edinburgh's Sustainable Energy Action Plan by ensuring higher levels of reuse, recycling, and generating energy savings.

3.5.2 Furniture

Servitisation of office furniture is another market with high growth opportunities. According to the Remanufacturing Study, the market for office furniture in Scotland is estimated to be £61 million and each year thousands of tonnes of furniture is sent to landfill in Edinburgh alone. Two different examples of circular business models have been identified for the furniture sector. One was developed by Furnishare in the USA, who collect unwanted furniture and through a subscription fee leases them to people seeking furniture at lower price than rental stores.

The leasing revenue is split between Furnishare and the person who donated the furniture and once the leasing period is over, the furniture is collected, cleaned and maintained for future leases. Although this company focuses on household furniture the similar business model could be used for office furniture. [Rype Office](#) offers an alternative opportunity as it allows customers to lease new, remade or "refreshed" furniture or purchase with a buy-back option. Servitisation of furniture can extend to carpets as [Desso Carpets](#) provides a commercial carpet leasing service which include installing, cleaning, maintenance, removal, and recycling.

There are sizable commercial markets in Edinburgh which could be targets for this type of business model and provide opportunity for innovative SMEs to diversify into offering these services.

3.5.3 Building design

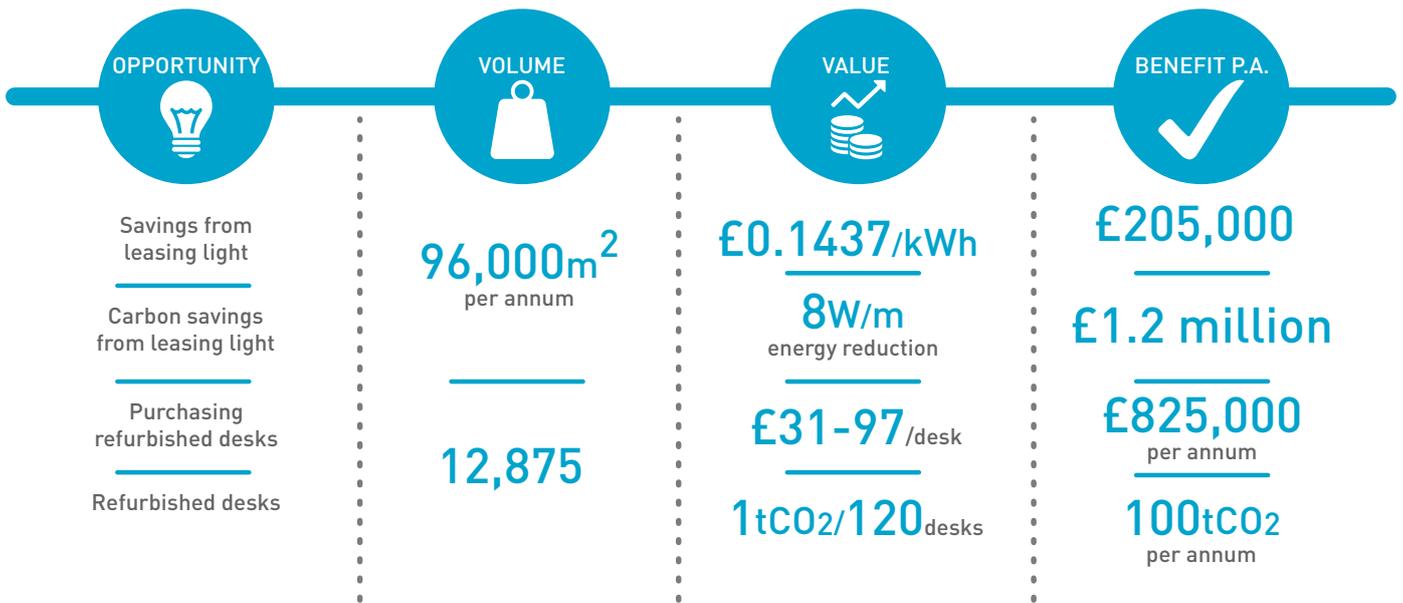
Facility managers can implement circular economy practices during the design phase of new buildings. Planning flexible buildings that allow for straightforward access to electrical and mechanical services ensures that when the reconfiguration of office space occurs savings on materials and time will be realised. It is estimated that this movement of people currently costs UK business over [£2 billion](#) a year.

Buildings are currently designed for a 50 year economic life, however with the speed of change in technology and the shifting requirements of physical offices, increased consideration of building design is required as the economic life is significantly reduced and the timeframes of refurbishment diminish. The design of buildings which consider both conversion opportunities and the demolition process will result in improved economic returns as the volume of waste is minimised and salvaged building materials can be reutilised.

3.5.5 Recommendations

- **Circular Edinburgh should explore** the wide range of opportunities for this sector in more detail in collaboration with key sector stakeholders to understand what is feasible and practically deliverable given the current make-up of FM services in Edinburgh.
- **Regular dissemination of information** relating to new circular economy supply chains is required to ensure up to date knowledge of what products and suppliers can be incorporated into the servitisation business model.
- **Large corporate and public-sector organisations** can support this opportunity through taking a more circular approach to procurement and support is available to assist with integrating circularity into procurement.

3.5.4 Potential circular economy savings



4 Secondary opportunities

A number of opportunities were identified due to Edinburgh's significant population and the proximity of people to products and materials. We have highlighted two of these opportunities here which offer significant opportunity to deal with somewhat challenging products. Further exploration and promotion of these opportunities through Circular Edinburgh could lead to new business opportunities in Edinburgh.

4.1 Tyres

Through the reclamation of the materials used in producing car tyres, raw materials could be obtained. Approximately 10kg will yield 4 litres of oil, 4kg of carbon, 2kg of steel which can then be utilised in a number of production processes.

Approximately 3,500,000 tyres (35,000 tonnes) are disposed of in Scotland annually of which an estimated 15-25% is disposed of in the Edinburgh region. Tyres have been banned from disposal at landfill since 2006 so must be recycled or repurposed.

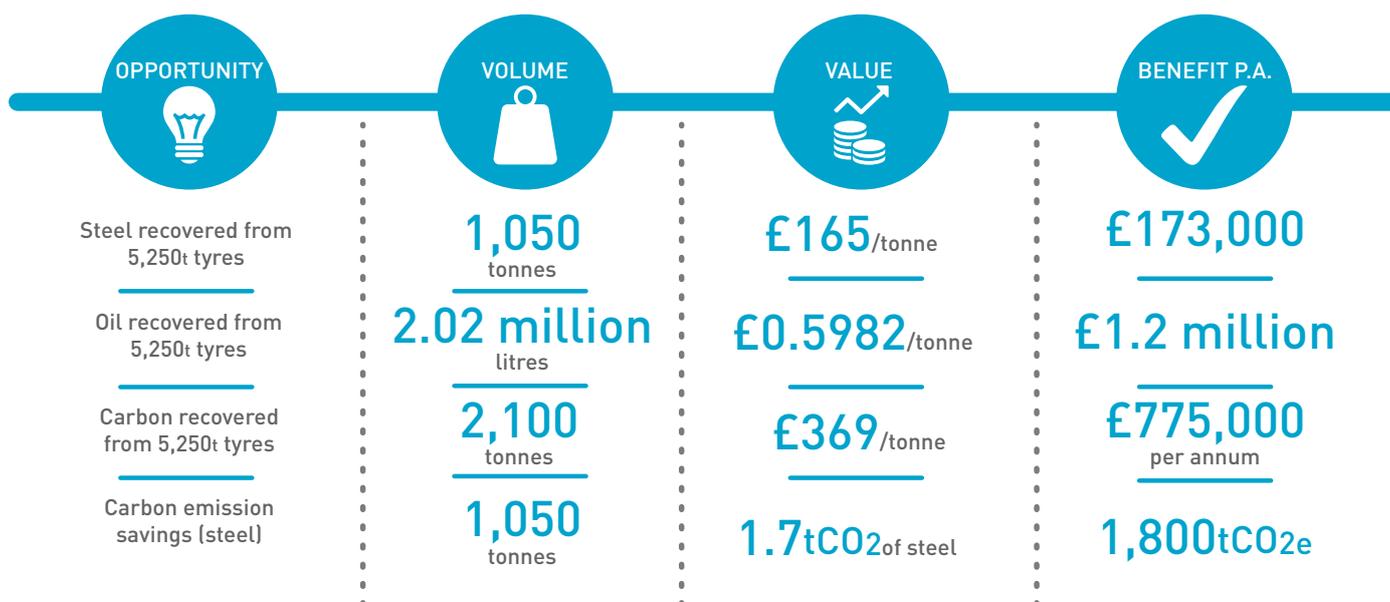
Through 'deconstructive distillation', tyres can be returned to their constituent compounds of oil, carbon and steel. An average passenger tyre will yield 4 litres of oil, 4kg of carbon, 2kg of steel. These materials can then replace virgin materials in existing supply chains.

Technology exists to extract these compounds and it may be practical to locate a plant hosting this technology in Edinburgh due to the population size and proximity to a large feedstock of used tyres.

Furthermore, there may be alternative uses for the oil from used tyres which could be explored by the Knowledge Hub as identified in section 3.1.



4.1.1 Potential circular economy savings



4.1.2 Recommendations

- **Installing a tyre processing plant** requires significant financial investment to cover the high cost of the installation of the plant and the planning and licensing requirements. As this is a new technology there may be significant regulatory hurdles to overcome and therefore this opportunity ought to be regarded as a long-term opportunity.
- **Circular Edinburgh is well positioned** to facilitate building business networks to identify supply chains for the recovered materials and liaise with regulatory bodies and support agencies to explore the detail of this opportunity.

4.2 Glass

Opportunity to maximise the value of glass cullet through utilising it in different applications – in fibreglass insulation, as filtration media, and finally in concrete.

Glass cullet is generally recycled into bottles, however, there is a surplus of glass due to importation of glass bottles which, historically, has been predominantly green glass. Clear glass is recycled for use in the whisky and food industry, however there is a limited market for reusing green glass in Scotland, thus creating a surplus of green glass cullet. SEPA estimates there was 2,226 tonnes of glass waste generated by businesses in 2015 in Edinburgh. Edinburgh has the potential to divert 4000 tonnes of glass from landfill each year.

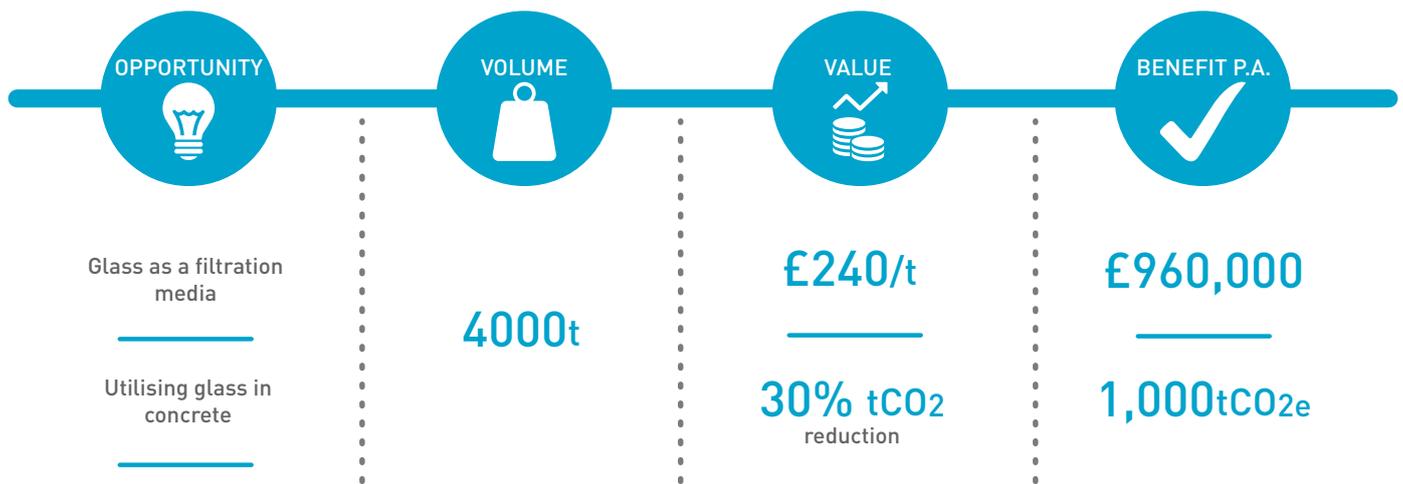
Glass cullet of all colours can be used in the manufacture of fibreglass insulation. Glass insulation is currently manufactured in [Scotland](#) and [WRAP](#) indicates that half of

the raw materials used in production could be substituted with repurposed glass cullet. This insulation could be used during the construction of the homes as part of the City Deal scheme in addition to retrofitting existing housing as part of the [Home Energy Efficiency Programme for Scotland](#).

Glass cullet can also be utilised as a feedstock for filtration media (please refer to case study from Dryden Aqua in the Appendix). The processed glass is used to replace sand as a filter media in a range of scenarios in the treatment of water in swimming pool, potable, waste and industrial settings.

If surplus feedstock is available after the higher value opportunities, there is an opportunity to utilise recycled glass as a substitute in the production of concrete and asphalt for buildings and infrastructure of which, in Edinburgh, there is considerable activity given current works planned for expansion of the trams network and the development of the St James Centre. Edinburgh Council's new regional housing company plans to construct a minimum of [1,500](#) homes over the next 15 years as part of the City Deal. An Ellen MacArthur foundation report on the use of glass in concrete, asphalt, and road base suggests that this substitution would reduce CO₂ footprint of a tonne of concrete by 20-40%.

4.2.2 Potential circular economy savings



4.2.3 Recommendations

- **Circular Edinburgh to identify** the existing glass insulation manufacturers and glass filtration media specialists in Scotland and assist in the identification of glass supply chains.
- **Circular Edinburgh is well positioned** to create business linkages between existing glass recyclers and concrete producers to facilitate the establishment of new supply chains.

5 Economic baseline

5.1 Overview of Edinburgh

Information presented in the Edinburgh by Numbers 2017 report suggests that Edinburgh is a prosperous city and is one of the strongest performing city economies in the UK. Edinburgh currently has the highest proportion of high skilled occupations (40.1%) and the second highest (behind London) gross value added per capita (£37,000), compared to other major UK cities.

Between 2005 and 2015 Edinburgh’s output, in terms of Gross Value Added (GVA), grew from £14.15 billion to £18.4 billion. As shown in Figure 5.1, the GVA of the “Public Administration; Education and Health” sector and the “Financial and Insurance” sector were the most prominent contributors to Edinburgh’s total GVA in 2015. Edinburgh has a strong representation of professional occupations and a highly qualified workforce.

5.2 Economic performance by industry

Whilst the ‘Financial and insurance activities’ sector makes a significant contribution to GVA, it’s overall proportion of GVA has been decreasing in recent years. In contrast, “Distribution; transport; accommodation and food” has

increased in proportion. ‘Production’ has been reasonably stable whilst “Construction” and “Manufacturing” have been decreasing slightly. It is important to consider how these sectors can contribute to a more circular economy, for example, through directly changing their processes and products in the ‘Manufacturing’ sector, or through procurement decisions in the ‘Public administration, education, and health’ sector.

In Edinburgh, there are over 18,000 enterprises with approximately 10,400 of these considered relevant to the circular economy (determined within the scope of this project), as shown in Table 2. The data highlights that there are large numbers of construction, accommodation and food services, and professional, scientific and technical enterprises. This provides an opportunity for Circular Edinburgh to assist in identifying businesses that can provide inputs for use within the circular economy and partner those businesses with an end user. There is a significant number of relevant organisations where these linkages can be developed to reduce costs and environmental impact. The manufacturing sector for example, has significant scope for growth through the implementation of the circular economy within Edinburgh.

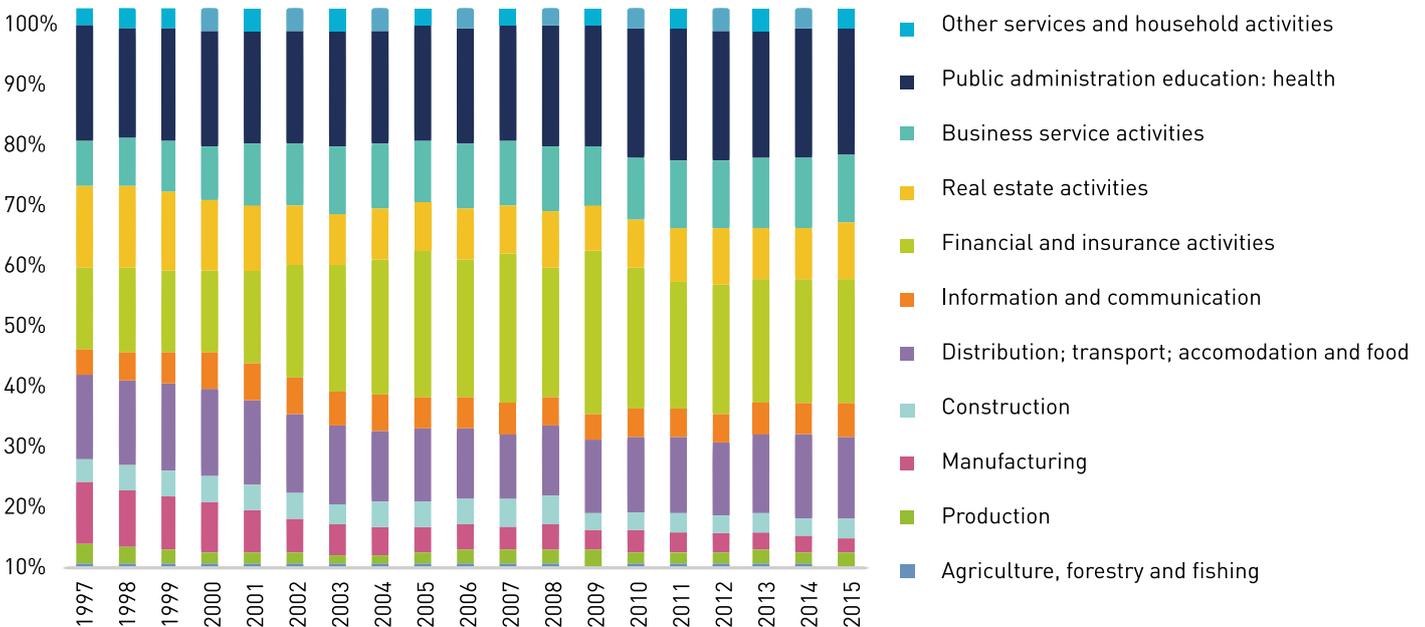


Figure 2: Industry proportion as a % of GVA in Edinburgh, 2015

Industries	Number of enterprises
Construction	1,460
Accommodation & food services	1,615
Manufacturing	500
Information & communication	2,440
Professional, scientific & technical	4,380
Total – Circular economy	10,400
Other industries	8,135
Total – Overall	18,530

Table 2: Number of enterprises in Edinburgh, 2017

5.3 Employment

5.3.1 Occupation

Total employment in Edinburgh grew by 2.2% to 327,000 from 2015 to 2016. Figure 3 below shows the top 5 industries with greater percentages of employment and highlights that Human Health and Social Work Activity is the largest employment sector in Edinburgh (15%),

followed by Wholesale and Retail Trade (11.3%) and Finance and Insurance (11%). Banks alone have the largest employment numbers with 21,000 employees, followed by hospital activities with 18,000 employees. NHS Lothian, Royal Bank of Scotland group and Lloyd’s banking group are amongst the top employers.

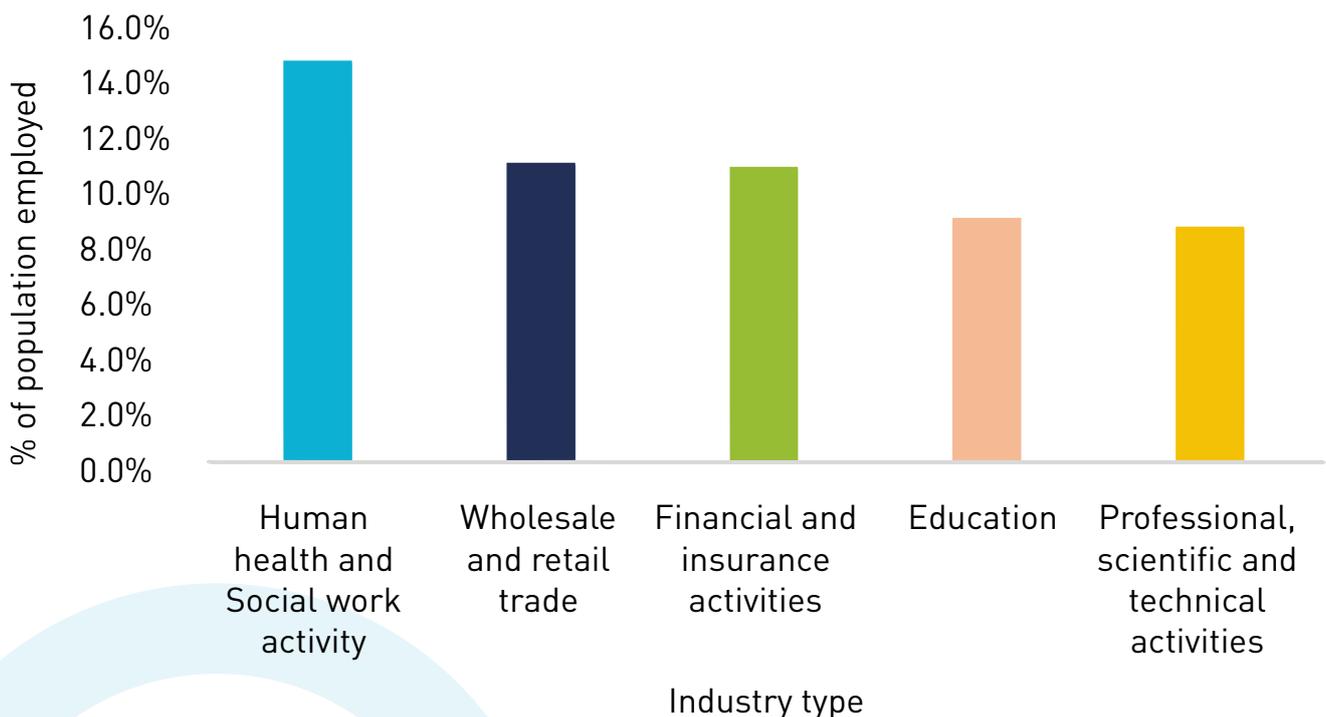


Figure 3: Percentage of All in Employment by Industry, Edinburgh, 2016

Examining the same figures in more detail, within the Construction sector, the largest number of people are employed within the Development of Building Products (1,750), Construction of domestic buildings (1,500). This is of particular relevance to the circular economy opportunities identified in this report. Electrical Installation (700) is also a significant employment sector which ensures that the refurbishment of ICT components has a skilled and experienced workforce to tap into.

Regarding the Manufacturing sector as of 2016, "Manufacture of Electronic Instruments and Appliances for Measuring, Testing, and Navigation" employs 2,000, followed by the manufacture of food products with 1,500. According to the State of Environment – Economics Trends report by Edinburgh City Council, the number of people working in manufacturing jobs has consistently been decreasing since 1991. During that period, total employment in the manufacturing sector has reduced from 29,300 to 8,000. This trend indicates that there is a pool of labour that can be reskilled back in manufacturing jobs

associated with the circular economy opportunities. Edinburgh's current economic activities are predominantly service-oriented. From 2011 to 2015, the largest growth sectors in terms of number of business were "Financial Services" and "Information and Communication". The current number of office-based enterprises signifies opportunities for opportunities both in ICT infrastructure and facilities management.

Compared with most UK cities, Edinburgh has a very strong representation of professional occupations (34%). The qualified skill set of the working-age population in Edinburgh is higher than that of Scotland (21%) and Great Britain (20%). Edinburgh has the highest proportion of high skilled occupations of all other major cities in the UK, with 40.1%. The above average percentage of professional occupations within Edinburgh creates the opportunity for a potential Knowledge Hub to access a diverse talent pool to assist in collaboration between the private and education sectors.



6 Material flows

6.1 Waste material streams in Edinburgh

Figure 4 illustrates the composition of business waste generated in Edinburgh. The total volume of business waste generated in Edinburgh in 2016 (the most recent year for which data is available) was 128,753 tonnes. This doesn't include waste from construction and demolition companies – construction and demolition waste make up 40-50% of the total waste generated in Scotland and is reported separately. Data is not readily available that indicates the disposal route for business waste, but the data below does give us an indication of the composition of waste and therefore what could potentially be diverted to a more circular solution.

All business waste in Edinburgh is collected by private waste management companies – City of Edinburgh Council does not provide a business waste service (but does collect from Council properties such as schools and libraries).

Engagement with private waste management companies servicing Edinburgh businesses may also provide greater insight into current material flows.

The largest waste streams are 'household and similar waste' (27%) and 'vegetal waste' (19%). We can assume that the large number of hospitality businesses and food and drink manufacturers in Edinburgh generate a significant proportion of vegetal waste. Household waste generally comprises of 23% food waste; 20% paper and cardboard; 17% garden waste; 8% glass; and the remaining 32% is dominated by healthcare waste, plastic films and dense plastic. Further analysis of this data suggests there could be opportunities in the glass and discarded equipment waste streams. There may be opportunity to delve more deeply into particular waste streams to fully understand the volume of waste that is being discarded that could potentially be utilised as a resource.

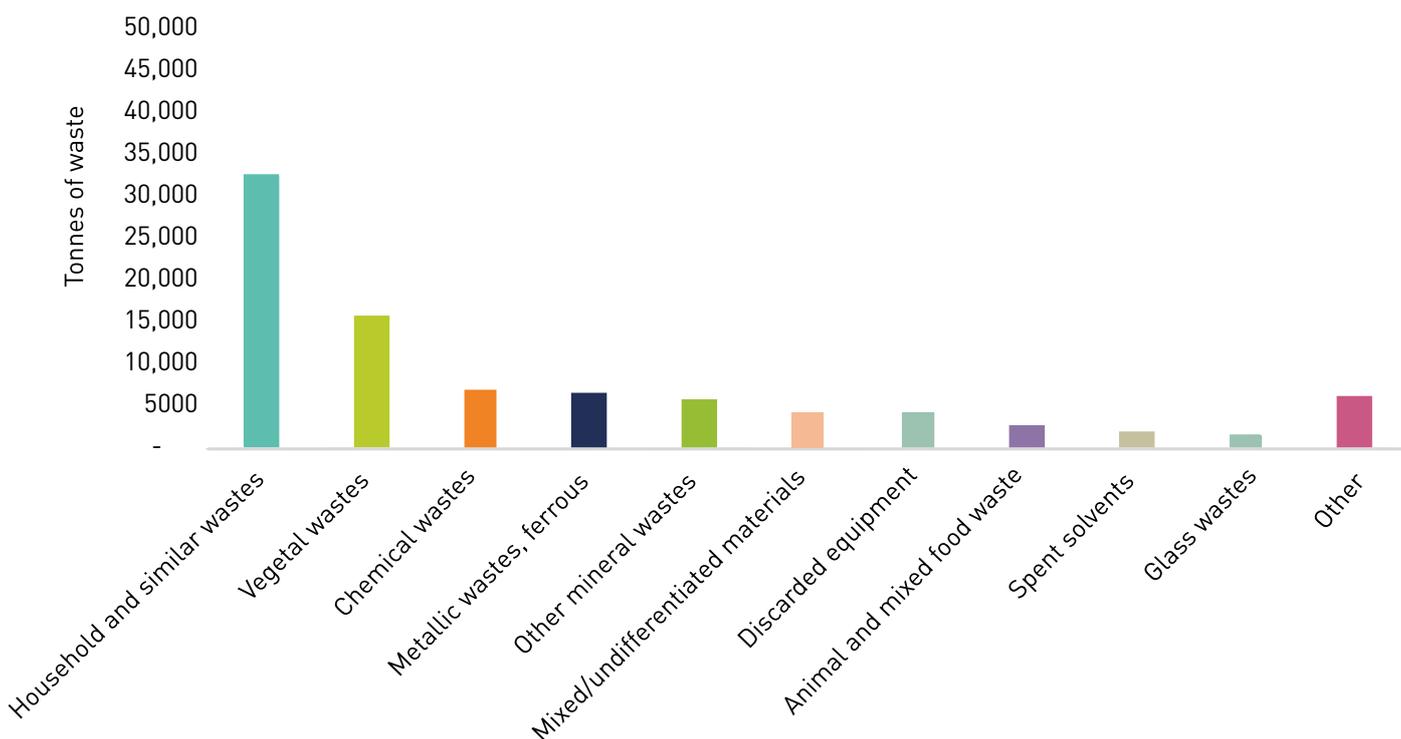


Figure 4: Waste streams in Edinburgh², 2016

²For clarity, the following Waste Types below 2,000 tonnes of waste were aggregated into "Other": Metallic wastes, non-ferrous, Wood wastes, Paper and cardboard wastes, Common sludges, Discarded vehicles, Used oils, Health care and biological wastes, Sorting residues, Plastic wastes, Metallic wastes, mixed ferrous and non-ferrous, Rubber wastes, Industrial effluent sludges, Soils, Animal faeces, urine and manure, Batteries and accumulators wastes, Acid, alkaline or saline wastes, Textile wastes, Mineral waste from construction and demolition, Waste containing PCB, Sludges and liquid wastes from waste treatment, Combustion wastes, and finally Dredging spoils.

7 Implementation support

7.1 Support organisations

There are significant economic and environmental outcomes to be achieved by implementing the recommendations in this report. Zero Waste Scotland are working in partnership with a local business engagement partner (Edinburgh Chamber of Commerce) in Edinburgh to support the realisation of these opportunities. The Chamber will work with its business network and beyond to raise awareness of circular economy, the benefits for businesses of implementing a more circular approach, and the bespoke opportunities that have been identified in Edinburgh. Through a series of events and engagement activity the Chamber will facilitate collaboration between businesses and help them to access sources of further support and funding. Scottish Enterprise provides the opportunity to assist businesses across a wide range of industry sectors. This services support companies to innovate through research and development and business model advice in addition to investment through the Scottish Investment Bank.

Planning and licencing approval is required for a number of identified opportunities. Support to business is necessary to assist them in navigating the legislative and regulatory landscape. Additional support from SEPA may be sought regarding the deconstructive distillation opportunity in particular.

Further knowledge transfer between Edinburgh and other circular economy leading countries and cities is to be promoted to share best practice, innovation and lessons learned. Zero Waste Scotland is favourably positioned to facilitate building and maintaining these relationships.

7.2 Circular Economy Business Support Service

The Circular Economy Business Support Service, administered by Zero Waste Scotland, offers dedicated and expert one-to-one business support directly to small and medium sized businesses across all sectors in Scotland. It is designed to help companies explore more circular ways of doing business which can result in resource efficiencies, improved profitability, higher quality products, increased customer base and alternative supply chains for business. The service is open to businesses and organisations seeking to develop and/or implement new business models, technologies, practices, products or services which can embed circular economy principles. This includes circular economy business models around sharing resources, modular design, reuse and repair, remanufacturing and reprocessing.

For more information, please visit <http://www.zerowastescotland.org.uk/circular-economy/business-support-service>.

7.3 Circular Economy Investment Fund

Zero Waste Scotland administers an £18million Circular Economy Investment Fund, which provides grant funding to small to medium sized businesses (SMEs) to:

- Explore markets for new circular economy products
- Commercialise innovative business models for new circular economy products and services
- Develop innovative technologies, products and services to support a circular economy

Funding is available from £50,000 to £1m to support SMEs pioneering alternatives to the 'make, take, dispose' approach, and keeping products and materials in a high-value state of use for as long as possible. For more information, please visit <http://www.zerowastescotland.org.uk/circular-economy/investment-fund>.



8 Appendix

8.1 Relevant policies and strategies

As per section 2.3 , Table 3 presents a detailed summary of policies and strategies relevant to circular economy opportunities within Edinburgh.

Name of Policy/ Strategy	Aims/Targets/Goals	Alignment with circular economy opportunities
Edinburgh's Sustainable Energy Action Plan	<p>Reduce emissions by 42% by 2020 (from 2005 baseline of 1,379kt CO₂).</p> <p>Largest reductions are required from industry and commercial users – (43%, 592 kt CO₂).</p>	<p>Reuse of materials and parts will reduce the need for additional energy required for processing virgin material.</p> <p>Heat recovery or heat exchanges in industrial processes will ensure heat/energy is maximised.</p>
Edinburgh City Vision 2050	<p>Edinburgh becoming carbon neutral by 2050.</p>	<p>As above.</p>
Sustainable Edinburgh 2020 (SE 2020)	<p>The Council's vision for Edinburgh in 2020 is of a city that will be low carbon and resource efficient whilst delivering a resilient local economy and vibrant flourishing communities in a rich natural setting.</p> <p>The Council's objectives for 2020:</p> <ul style="list-style-type: none"> • Maintain a good quality of life for all its citizens while consuming minimum resources. • Be a leading knowledge, demonstration and development centre for sustainable development. • Have a new trademark – the “Sustainable City” – attracting visitors, industry and investors. • Create significant new employment opportunities in low carbon and green technologies. 	<p>The concept of Edinburgh being a leader in knowledge aligns with the development of a circular economy knowledge platform based in Edinburgh and managed by the universities within the city.</p>
Edinburgh Adapts, Action Plan (in line with SE202)	<p>Food production is highly visible in the city.</p>	<p>Under the action plans for Built Environment, there are actions relating to embedding climate resilience within the Edinburgh planning guidance through the Edinburgh Local development plan and design guidance. Action BE13 is about permeable surfaces promotion. There might be circular economy opportunities to explore new surface materials that can increase permeability from other industries</p>
Economy Strategy	<p>Economy Strategy</p>	<p>Commitment to developing a road map for SMEs on circular economy opportunities including efficient sourcing and use of energy and materials, efficient sharing of assets and resources, and market opportunities around design and manufacture of products for ease of re-use.</p>

Name of Policy/Strategy	Aims/Targets/Goals	Alignment with circular economy opportunities
<p>Edinburgh Adapts, Action Plan (in line with SE2020)</p>	<p>“Edinburgh Adapts” is the city’s first climate change adaptation action plan, has been developed to help the city prepare for and adapt to the impacts of climate change. The Action Plan is themed into five sections on Governance, Natural Environment and Greenspace, the Built Environment and Infrastructure, Flood Prevention, and Society and Economy. All these themes are interlinked and try to capture a whole-city approach to adaptation.</p>	<p>The whole-city approach of the action plan aligns well with the circular economy approach and provides an opportunity for both ideologies to work in syncopation.</p>
<p>Zero by 2040</p>	<p>The University of Edinburgh has committed to become zero carbon by 2040.</p>	<p>Edinburgh’s universities will play a central role in the development of the circular economy knowledge hub and the ideas and opportunities identified through the hub can help the University of Edinburgh progress towards its vision of being zero carbon by 2040.</p>
<p>Sustainable lighting strategy for Edinburgh</p>	<p>Objective 3: To encourage lighting designs that will reduce energy use, cost and minimise light pollution.</p>	<p>There are synergies with the pay per lumen circular economy business model and this objective.</p>
<p>Edinburgh’s Waste and Recycling Strategy 2010 -2025</p>	<p>The Scottish Government has set recycling and composting targets for Scotland as a whole and for various cities and towns.</p> <p>The key national objective for the Council is to minimise the use of landfill. In 2000, approximately 5% of waste was diverted from landfill and, by 2025, no more than 5% should still go to landfill. In 2010, City of Edinburgh Council launched its waste strategy which aligns with the Scottish Government’s Zero Waste Plan for Scotland. The strategy outlines how the Council will reach the targets set by the Zero Waste Plan.</p> <p>The aim of the strategy is to allow Edinburgh to maximise recycling and move towards being a ‘zero waste city’ in terms of households and commercial waste for which the council is responsible. Circular economy opportunities can help minimise waste to landfill and increase recycling rates. E.g. reuse of mattresses and textiles.</p>	<p>Circular economy opportunities can help minimise waste to landfill and increase recycling rates. E.g. reuse of mattresses and textiles.</p>
<p>Ambition 2030</p>	<p>The vision for 2030 as set by the Scotland Food & Drink partnership is to double annual turnover in the Scottish Food and Drink sector to £30 billion. The strategy is industry led and will depend upon the commitment of the partnership between industry, government and its agencies to succeed.</p> <p>In the pursuit of accelerated growth, the 2030 strategy gives farming, fishing, food and drink a stronger ambition and direction. The strategy has identified three key pillars for growth: people and skills, supply chain, and innovation.</p>	<p>Under the third pillar – innovation – the strategy emphasises that new or improved technologies along the supply chain will make businesses more resource efficient, profitable, productive and sustainable.</p> <p>Close loop manufacturing and sourcing in this industry will be complimentary to the circular economy vision and more efficient use of resources will enable businesses to be more productive and increase their turnover.</p>

Table 3: Policies and strategies relevant to circular economy in Edinburgh

8.2 Longlist of opportunities

Using data from the economic baseline and the material flows, a list of opportunities across different resource groups and waste types were identified through research and stakeholder engagement, and are summarised in Table 4. The primary opportunities that have been shortlisted are discussed in greater detail in section 3.



Resource/Waste Type	Opportunity	Category
Agricultural Waste	<p>Agricultural by-products (oats) can be collected from regional farms cleaned and introduced in to mycelium (root structure of a mushroom) to create fungus-based biodegradable product for packaging which can be used to substitute polystyrene and polyurethane foam. Using the same process, a replacement for engineering wood can be created and potentially used for furniture.</p> <p>Potential to use agricultural waste (from root crop) to create a mechanical enhancer with thickening properties that can be used in paints, coatings and concrete.</p>	Secondary
Animal Waste	<p>For each animal we eat, approximately 44-49% goes to waste. The opportunity here lies in the decomposing process of animal waste. Its attracts flies and their larvae can be used as feed for fish and fowl. There are financial benefits of using larvae as fish-feed as it is cheaper compared to other feeds and a higher price can be obtained for larvae fed fowl as their eggs can be sold as organic. Maggot enzymes cleanse wounds and produce electro-magnetic environment that stimulates health growth and could replace antibiotics for healing wounds, thus maggots could be sold for medical means.</p>	Secondary
Automotive Parts	<p>The remanufacturing of automotive components is an already established market in Scotland. This is a high value activity and most remanufacturing operations in Scotland are of small capacity. There are no remanufacturers in Scotland of automotive air conditioning and electronics. This could be a potential niche market to develop.</p>	Secondary
Bakery Waste	<p>Leftover bread could be collected and mashed to create a beer, without the need for fermentable sugar to be added. This has the potential of saving 1/3 of the resources utilised in the brewing process.</p>	Secondary
Clothing Made from Flax Fibres	<p>Flax is a renewable resource and has limited environmental impact and is twelve times stronger than equivalent cotton products. The plant grows well in Scotland and linen has been produced locally for many centuries. The processing of flax involves stripping off the seeds and then soaking the plants in water for a couple of weeks to soften the outer layers of the stalk. 'Retting ponds' where this process was carried out are common in the Scottish countryside. Flax may be a suitable crop to ensure the continued productive use of former landfills or similar sites.</p>	Secondary

Resource/Waste Type	Opportunity	Category
Coffee Grounds	Used coffee grounds can be used for horticultural purposes in the soil of plants that prefer acidic soils and growing oyster mushrooms, in large scale and at a small scale at home and in the production of bio-oils, biofuel.	Secondary
Cooking Oil	Cooking oils and fats can be collected from retailers and fast food outlets and then processed into biodiesel.	Secondary
ICT Equipment Reuse	Recent developments indicate an increase in data capacity via the construction of new data centres: the development new data centres (Pyramid Data Centre, South Gyle Colocation Datacentre Services, and Onyx Group Edinburgh Data Centre) in addition to the existing 8-10 commercial data centres in greater Edinburgh and an £11.3m investment to create three new data hubs in Aberdeen, Edinburgh and Glasgow. This highlights the increasing demand for data based innovation within cities that will be accompanied by an increased demand for data storage and a resulting increase in storage capacity in Edinburgh and other parts of Scotland. Given the large amount of ICT equipment required by these data centres, presenting two circular economy opportunities: firstly, the use of ICT equipment that has been remanufactured when setting up the data centres and secondly, the reuse of the ICT that is discarded when the data centre's ICT equipment will eventually require updating. This approach is used by market leaders in the industry of data storage as in 2015, 19% of servers Google deployed were remanufactured machines and 52% of components consumed in Google's Machine Upgrades program were remanufactured inventory; businesses in Edinburgh could follow this trend. Edinburgh Remakery are an organisation that teaches computer repair skills in workshops and sell refurbished computers at a very small scale.	Primary
Fruit and Vegetable Waste	Fruit and vegetable waste contain valuable bio resources including carbohydrates/fibres and other higher value compounds such as flavours, colorants and vitamins. These can be utilised in colouring and health products.	Secondary
Food Waste	Food waste of sufficient quality can be utilised in the production of fruit brandy; this is a similar concept to the bread to beer production in Glasgow/Amsterdam.	Secondary
Glass	Recycle glass back into glass products, a substitute for cement in the production of concrete, fibreglass insulation and in water treatment.	Primary

Resource/Waste Type	Opportunity	Category
Hospitality, events and festivals	Increase reuse of festival equipment such as stage and props. Decrease use of single use cups and containers (creating a new revenue stream) and redirect waste to revenue generating opportunities such as popup food outlets that utilise surplus materials from food producers and sellers.	Primary
Knowledge Hub	Build a Knowledge Hub in Edinburgh for students, academics and businesses to come together to develop possible circular business models and key technologies. This collaborative approach would provide businesses with support and best guidance on how to transition into a circular economy, whilst allowing students and academics to put their ideas forward and developing practical sustainable solutions.	Primary
Facilities Management	Servitisation is the process of offering goods on a pay-per-use/service basis instead of offering them to be purchased outright. This change is an opportunity for closing the material cycle and increase resource efficiency. Paying for light or HVAC as a service diversifies the conventional business model of one-time sales, creates competitive advantages and increases jobs opportunities. This business model ensures higher levels of reuse, recycling, greater control over disposal of lamps and generates energy savings.	Primary
Mattresses	A recycling service could be established to dismantle and extract steel springs, polyurethane foam, and latex foam and forward it to other production processes of gym mats, carpet underlay and insulations.	Secondary
Medical Equipment	There is an opportunity for refurbishing and remanufacturing of medical equipment mainly for medical imaging. Medical imaging represents a quarter of the expenditure of medical equipment by NHS Scotland and is an established area of remanufacturing in other countries.	Secondary
Milk Residues	Sour milk unsuitable for consumption can be used for making an eco-friendly textile. The process involved heating the milk and combining it with ingredients such as such as beeswax and then spinning the material into thread. This fabric is called Qmilch and is softer, odourless and presents anti-bacterial, moisturising and hypoallergenic properties. There could be an opportunity to use this fabric for clothing for medical patients or people that are sensitive to fabrics.	Secondary

Resource/Waste Type	Opportunity	Category
<p>Online Platform</p>	<p>An online platform for material trading with sufficient uptake could allow businesses to highlight the availability, quantity and location of surplus materials, waste or by-products and then trade them with other businesses. The online platform would also facilitate resource sharing amongst businesses in terms of facilities, machinery and possibly personnel. The online platform would also include a database for material passports of products and constructions. This provides and makes available information on the characteristics of materials in products/ construction. The aim is to give these products value for recovery, recycling and reuse.</p> <p>There are existing platforms such as Superuse in the Netherlands, Materials Market Place in Ohio and Circle Market which focuses on textiles. These are not used over a wide geography and are usually industry specific. A generic platform called Floop2 allows users to set up their own market place and trade anything from materials to equipment and services. However, this platform, whilst available globally, has not garnered significant support from UK businesses. Construction Material Exchange offers a platform based in Scotland therefore the benefits obtained by increasing user numbers and site traffic would be the facilitation of more localised loops that in turn encourages the trading of raw materials. This will enable loops to be closed, reduce the demand for new resources and reduce waste.</p>	<p>Secondary</p>
<p>Plasterboards</p>	<p>Plasterboard waste is a regular component of construction and demolition waste, and will be generated during the construction, refurbishment and demolition phases across Edinburgh's buildings, particularly in housing and commercial sectors. There are significant opportunities to improve design to minimise offcuts and recycling offcuts.</p>	<p>Secondary</p>
<p>PVC in Construction</p>	<p>PVC from electrical cables, pipes and hoses can be extracted and used for making separators on roads.</p>	<p>Secondary</p>
<p>Alcohol By-products</p>	<p>Spent grain from brewing/distilling can be used in the production of a range of different food items such as the production of bread, cereal products, barley flour and dog treats. Spent yeast can also be used in food manufacturing to provide flavour. Proteins can be obtained from spent grains. Residual material from these sub processes through AD produce biogas which can be used to produce energy and heat. Digestate can be used as fertiliser. Millerhill currently receives the organic waste produced by the domestic households of Edinburgh and has excess capacity to be utilised.</p>	<p>Primary</p>

Resource/Waste Type	Opportunity	Category
Textiles	Old clothes can be collected and recycled into new clothing. This can be achieved through mechanical and potentially chemical reprocessing to create new textiles without having to use new raw materials. Lower grade textiles can be re-processed and used for industrial cleaning, furniture stuffing, insulation and carpets. This is not limited to clothes, textiles from sofas, mattresses, transport seat covers, curtains and others can be used. A close loop model could work by connecting businesses that are looking to dispose of their textiles to a textile recycling plant.	Secondary
Tyres	Deconstructive distillation of car and HGV tyres producing oil, carbon and steel. Queensland University of Technology's (QUT) Biofuel Engine Research facility have undertaken testing on 10 and 20% diesel blend achieving a 30 per cent reduction in nitrogen oxide and particle mass. An average passenger tyre 10 kg will yield 4 litres of oil, 4kg of carbon, 2kg of steel ^[xxxiv] .	Primary

Table 4: Longlist of circular economy opportunities in Edinburgh

8.3 Opportunity scoring

The long-list of opportunities were scored against the following criteria: CO₂ reduction; Material Flow; Job Creation; Capital intensity; Scalability; Maturity; Policy/ Strategic Compatability. Following this, the five primary opportunities were selected on the basis of score; relevance to Edinburgh; and compatibility with the economic baseline, material flows, and city policy and strategy.

8.4 Case studies

8.4.1 Dryden Aqua

Currently there is a surplus of green glass in the UK which is primarily due to the importation of wine bottles and the local industry (whisky) preference for clear glass. Dryden Aqua has developed a solution by utilising this surplus glass as part of a water filtration system. Currently 40-50,000 tonnes of glass feedstock are processed by Dryden Aqua's Bonnyrigg plant. The success of this circular opportunity has allowed expansion into Europe, China and the Subcontinent.

Glass is processed into uniform sized particles which have a large surface area. These glass particles then undergo an activation process prior to being able to replace sand as a filter media in a range of scenarios in the treatment of water in swimming pool, potable, waste and industrial settings.

Benefits of glass over sand:

- Reduced maintenance due to biofouling
- Improved water quality
- Decrease OPEX
- Improved system performance

8.4.2 Horizon Proteins

Food and beverages is Scotland's largest export sector, and as such the associated waste streams provide the opportunity to identify value from these material flows.

Horizon Proteins has identified a process which converts waste from the whisky industry into food for the salmon industry.

This process extracts proteins and yeast from pot ale resulting in a carbohydrate rich material which is suitable for anaerobic digestion. The protein is suitable as a feedstock for the aquaculture industry, which will result in a more secure and sustainable supply chain.

Pot ale and draff were previously sold for low prices or collected onsite for free to be used as an animal feed. A carbohydrate rich by product is produced during this process which can be utilised in anaerobic digestion and combined heat and power which yields further economic benefits.

Large scale trials have been undertaken in Dufftown with plans to expand commercially in the Speyside region of Scotland. It is predicted that the first plant will provide about 15% of Scotland's salmon farming requirements.





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