Think Piece: Energy

Circular economy opportunities for a decarbonised Scottish future: Why circular economy practices should underpin Scotland's decarbonisation ambitions

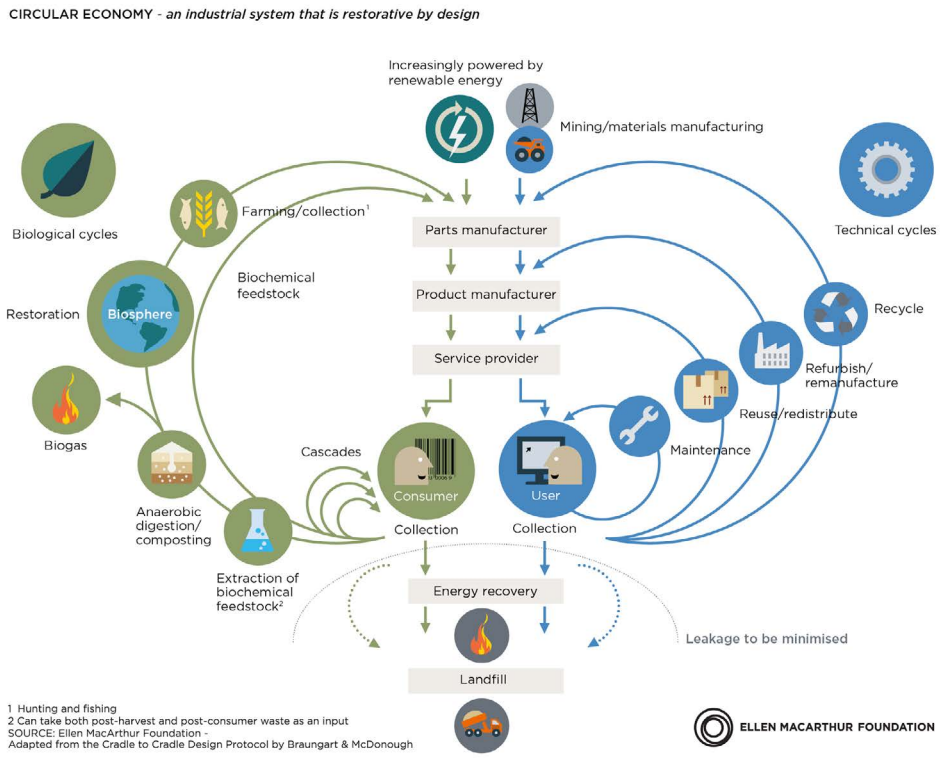
Zero Waste Scotland's Low Carbon Heat (LCH) team is supporting the decarbonisation of Scottish businesses and local authorities by providing advice on district heating, waste heat recovery and industrial decarbonisation opportunities. But as a leader in circular economy thinking, Zero Waste Scotland is also working to find solutions that maximise the value of limited resources and reflect the carbon impact of materials across their entire life-cycle[1]. Here we consider why rethinking the design, manufacture and use of low-carbon heat technologies, services and systems in a circular manner not only enhances the decarbonisation effort but has the potential to increase the uptake of low-carbon heating solutions.

What is the circular economy?

The circular economy circular economy recognises that everything has value. Imagine a world where we design and manufacture products in such a way that they can be used and re-used for as long as possible, maximising their value. And then, at the end of their life, they can be refurbished or remanufactured into other high value, high quality products.

Key to realising a circular economy is the adoption of new business models and the design of products with their whole life cycle in mind: modular building for deconstruction, remanufacturing and reprocessing. Minimising the leakage of material, but also energy, from the economic system is a fundamental principle of the circular economy.

The realisation of a circular economy necessitates radical change and new, innovative solutions in some sectors. In others, such as the renewable energy sector, **circular economy thinking aligns with existing sustainability principles and practice**.



1. Zero Waste Scotland currently supports more than 100 organisations with expert advice or financial support to make them more circular.

Energy recovery technologies are a good example of this: waste water and sewer heat recovery, for instance, intercept a waste stream, maximise value from waste, and reduce carbon emissions. Especially for **urban areas in Scotland, the scale of opportunity** to maximise the potential of such technologies is large and currently unexploited.

Waste water heat recovery potential for Scotland

An enormous amount of thermal energy supplied to Scottish homes is lost to the drains as warm water from baths, showers, washing machines and dishwaters floods daily into our urban waste water systems. Industrial processes from a range of industry sectors adds yet more thermal energy resulting in minimum Scottish sewer temperatures of around 11°C. Much of this heat is recoverable using waste water heat recovery technologies, which could **reduce demand for energy** sourced from fossil fuel combustion thereby reduce carbon emissions, **generate revenue for local authorities**, and **create jobs**.

Example: Waste water heat recovery has been deployed as a core enabler of regeneration at Southeast False Creek in Vancouver where the Olympic and Paralympic Winter Games were held in 2010. The Games kickstarted the renewal of a rundown area of the city, with the waste water heat recovery system providing the base load for a district heating scheme that will supply over 11,000 homes when fully built. The first phase of the scheme saw CAN $14million invested and aimed to break even in 3 years.

It is estimated that around 15% of a large city's heat could be supplied using the waste water infrastructure in this way. Zero Waste Scotland's Low Carbon Heat team has expertise and experience to be a leading partner in this exciting transition.

How circular economy thinking can help Scotland reach its decarbonisation ambitions?

Systematically designing out material leakage and disposal has not been a focus for the renewable energy sector to date. We see two main opportunities for circular economy thinking to underpin Scotland's decarbonisation ambitions:

1) Embedding circular economy thinking in the **procurement process, initial design** and the **end-of-life treatment** of major infrastructure equipment and materials such as

- high-grade steel in pipelines;
- rare earth metals in industrial batteries, solar panels and electric motors and;
- high-volume insulation products.

2) Adopting circular economy **business models for the manufacturing and deployment** of equipment such as

- heat pumps,
- electrical heating systems and;
- electrical control systems.

Why should the energy sector care?

Adopting circular economy approaches can **bring down the levelized cost of energy and heat provision** by maximising equipment lifetimes and minimising end-of-life disposal costs (potentially even having inherent economic value left in the equipment deployed). Adopting circular economy approaches can also enable the **cost-effective deployment of comparatively very expensive low-carbon heating technologies** like heat pumps by providing customers offerings such as "heat as a service". Providers can facilitate the uptake of low-carbon heating products (and potentially even expensive insulation via energy performance contracts) by eliminating or reducing the upfront cost to the end-customer.

Example: Best Green is a Danish company that provides **"heat as a service"** to homes and non-residential clients through pay per kWh(heat) via heat pumps. Best Green retains ownership of the heating equipment, leasing it to clients, and can therefore optimise its use as well as control the components used and their potential refurbishment.

Example: FOAMGLAS®

FOAMGLAS® provides a cellular glass insulation material that is impervious to moisture, non-combustible, resistant to insects and can be used for the entire building envelope such as insulation roofs, walls, and below ground. The product is manufactured primarily from sand, limestone and abundant natural raw materials. The end-product usually comprises at least 60 % recycled content: partially highly selected postconsumer glass and partially re-use of production scrap. These ingredients are mixed and melted into a molten glass, which is cooled and crushed into a fine powder. The powder is poured into moulds and a small amount of finely ground carbon-black is added. The moulds pass through an oven and afterwards through a closely controlled cooling (annealing) process. Millions of hermetically sealed glass cells make up the cellular structure; resulting in a vapour tight, waterproof material with an extraordinary structural strength. FOAMGLAS® cellular glass insulation is totally free of environmentally harmful flame retardants, propellant gases or carcinogens.

What is the scale of the opportunity?

Heating and cooling our homes and businesses accounts for over 50% of Scotland's energy consumption, impacting on fuel poverty and greenhouse gas emissions. Scottish Government's Energy Strategy[2] provides the vision for energy supply and demand reduction to 2050, mapping out a major transition to a low carbon future over the next three decades.

This transition can be achieved partly through the replacement of carbon intensive heating systems and further retrofitting of building fabrics. We estimate that Scotland's homes and businesses will need **hundreds of thousands of windows, floors and walls retrofitted** over the next decades. Additionally, to decarbonise our heating systems, we estimate that over 1.2 million gas and oil-fired boilers could be taken out of homes across the country and **replaced with low carbon alternatives**, including **17,000** biomass boilers, **1.1 million** air source heat pumps and over **200,000** ground source heat pumps ground source heat pumps till 2050[3].

Retrofitting and replacing infrastructure on this scale will have considerable implications on resource use and waste generation:

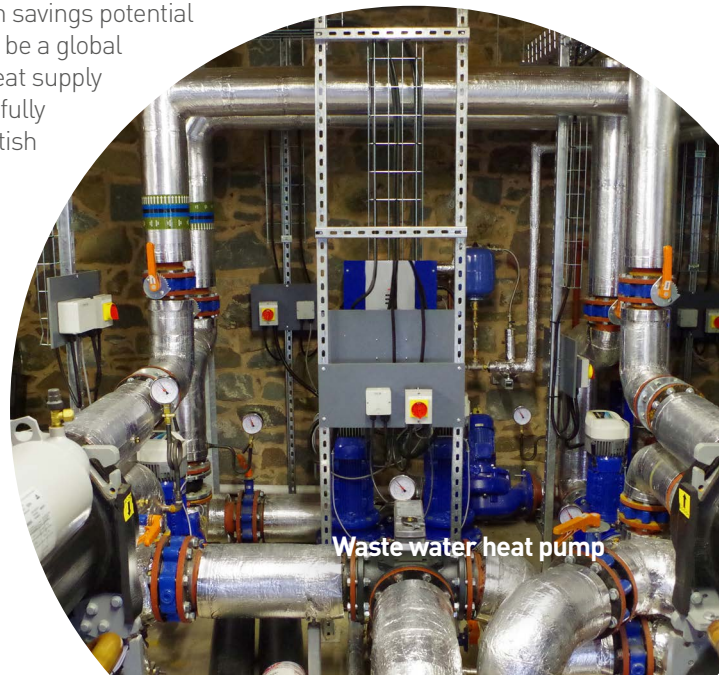
- **Significant amounts of building material waste** will be generated;
- Carbon-intensive heating systems that will be removed will need to be recovered if they are not to end in landfill;
- Unless we innovate the manufacture and deployment of low-carbon heating systems, insulation solutions and fabric improvements, we may **lock-in new significant tonnages of non-recoverable materials and 'embodied carbon'**[4], to be landfilled when they will become obsolete.

Retrofitting our buildings for energy efficiency and decarbonisation of our heating systems is critical to drastically reduce energy consumption related emissions. **But if we are to avoid locking-in large amounts of 'embodied carbon' destined for landfill, we need to underpin this transition by adopting circular principles** that consider how we can design and manufacture these products in a way that they can be used and re-used for as long as possible. Globally, these practices are still in its infancy, but the carbon savings potential is considerable, and Scotland could be a global leader in both decarbonisation of heat supply and circular economy practices if it fully seizes the opportunity that the Scottish Government's Energy Strategy provides.

What difference has the Low Carbon Heat team made so far?

Zero Waste Scotland's Low Carbon Heat team is supporting Scottish Government in the delivery of the decarbonation of our heat supply. The team has delivered support to identify and develop industrial decarbonisation, district heating and waste heat recovery opportunities. The team has been key to the development of Low Carbon Heat and Energy Efficiency Strategies (LHEES) for Scottish local authorities by outlining the scope of the strategies and through the development of the technical methodologies and standards required. These strategies are envisaged to be area-wide plans for the implementation of energy efficiency and heat decarbonisation projects; prioritising projects and enabling the private sector to easily identify portfolios of projects that utilise their product ranges.

Members of the Low Carbon Heat team are embedded in the Scottish Government's delivery unit. Zero Waste Scotland's Resource Efficient Scotland programme offers capacity building support for LHEES to local authorities and data on regional energy use.



Waste water heat pump

2. https://www.gov.scot/publications/scottish-energy-strategy-future-energy-scotland-9781788515276/
3.These estimates are based on a scenario modelled using Resource Efficient Scotland's Scottish Carbon Routemap tool which is based on the Scottish Housing Condition Survey, combined with 2050 requirements to reduce carbon emission by 80% on 1990 levels. In practice, heating system replacements will depend not only on energy and material efficiency, but also affordability, in line with Scottish Government's ambitions to reduce fuel poverty.
4. These are all greenhouse gas emissions associated with the production and end-of-life management of a product or material.

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