Towards A Business Case for Resource Recovery: Proceedings from the RRfW Annual Conference

Anne P.M. Velenturf, Resource Recovery from Waste, University of Leeds

The annual conference from the Resource Recovery from Waste programme (RRfW) was held on 21-22 November 2017 in Leeds, on the theme of "Making the Business Case for Resource Recovery". The successful implementation of ideas, frameworks and technologies for resource recovery from waste will require the formulation of strong "business cases" for a variety of actors in industry and government. Why should we be interested in adopting resource recovery as part of a circular economy? What are the motivations and challenges? Which problems does it solve and for who? This goes beyond financial gain and carbon reductions, including a broad range of economic, social, environmental and technological impacts and benefits.

Building business cases for governments and companies

The conference kicked-off with four excellent presentations introducing various ingredients for the preparation of business cases for governments and companies transitioning towards a circular economy. Jan Jonker from the Radboud University in the Netherlands introduced the broad societal changes of which the circular economy is part. Society is transitioning towards a "WEconomy" which is a circular-, functional-, biobased-, collaborative-, sharing- and self-production (3D) economy. This includes changing the values that are created by companies, with increasingly integrated value propositions including financial, social and environmental benefits. In the Netherlands, business and government agreed to go 100% circular by 2050 in the ground breaking Circular Economy strategy.

Such transition is paved with business challenges, and David Fatscher from BSI introduced the world's first circular economy standard for business model innovation. The new standard BS 8001 was developed to meet mutually beneficial goals of financial, social and environmental value creation. It explains what the circular economy is and why moving towards a more circular mode of operation might be beneficial and relevant to organisations such as companies. Moreover, it offers guidance for the practical implementation of the principles of the circular economy to create value through process, product, service or business model innovation. The standard is not a prescriptive and can be used flexibly by those organisations who adopt it – irrespective of size, sector, or where they are on the 'circular journey'.

To adopt circular practices, companies require the right infrastructure and policy context that enables the emerging circular economy. Phil Purnell discussed whether our current and planned waste and resource recovery infrastructure will be able to deliver the goal of a circular economy. The circular economy offers strategic benefits for the British economy such as increased resource efficiency which reduces reliance on imports, reduce carbon emissions and help build a more sustainable future. However, current regulation based on waste management driven by concerns on health and environment leads to deficiencies in availability of data and investment in the required infrastructure for a high-value circular economy. It is time for a new paradigm, viewing the availability of secondary materials as an economic opportunity to build a more sustainable society with greater resource productivity.

Such paradigm shift needs to be reflected with a change in the governance structure, for example by introducing the long-discussed Office for Resource Stewardship to support innovation and investment for the growing circular economy.

To contribute to solving the issue of data deficiencies and support investment, a study has been carried out in Scotland to identify wastes and resources available. Ian Archer from the Industrial Biotechnology Innovation Centre (IBioIC) presented the new report Biorefining Potential for Scotland. Ian described the Feedstock Mapping Model which aimed to:

- Identify key data sources on arisings (waste or co-products) of materials streams with potential value to someone
- Assess the quality of these data sources and review composition
- Map quantified material arisings regionally
- Use known fate to generate figures of available bio-resources

The model is searchable and can be used to identify resources, available quantities and locations in support of circular economy opportunities. Such knowledge on bio-resource availability and understanding the potential market is crucial for investor confidence. In total there are 27 million tonnes of bio-resources available in Scotland every year, including waste, by-products, agricultural residues, wastewater sludge, forestry waste and macro algae. This offers considerable business development opportunities through high-value applications. Such applications were discussed in the parallel sessions.

Parallel sessions

Three parallel sessions were organised around core subjects in the RRfW programme, including bioeconomy, mining of industrial legacy landfills, and new approaches for sustainability assessment and business models.

Landfill mining

The Resource Recovery from Waste programme has various projects investigating the potential to recover valuable materials from legacy landfills. There are thousands of such landfills with mining and manufacturing wastes in the UK. These sites contain resources that are increasingly valuable as they can be used in, for example, batteries necessary for low carbon infrastructures and technologies. Moreover, if the resources are not recovered then they can leak away from the landfill sites and pose risks for people and environment. In sum, recovering resources from legacy landfills can have both economic and environmental benefits. However, in reality it is not that simple to make the business case.

Jason Love from the University of Edinburgh presented his research group's work on metal recovery and recycling by urban mining of waste electronic and electrical equipment (WEEE). While such resource recovery of, for example, gold is technically possible, the translation of the technological advances into economically, environmentally, and socially relevant processes and procedures depends on strong collaboration with, and insight from, industry and government. Other challenges include the selective separation of materials and removing contamination, and reaching economies of scale. While metal contents in WEEE is very high per unit, this is generally not the case for legacy landfill sites from industries such as steelmaking and copper processing.

Devin Sapsford from the INSPIRE project at Cardiff University argued that such waste streams "Anthropogenic ores" including mine tailings and mine waste piles often fall outside what is commonly considered within the circular economy. These low-grade waste streams need development of alternative technologies than those developed for the recycling of post-consumer wastes, to ensure recovery is economically feasible. Technologies can include eletrokinetics and microbial processing, and through development of applications where metals are not only extracted from these wastes but where the residues are also valorised (e.g. for aggregate) and/or other "value" is realised through provision of decontaminated land, ecosystems services or landscape services.

In line with the results from the INSPIRE project, Carmen Falagan from Bangor University presented outcomes from B3 on the bioleaching of metal-mine waste and the selective precipitation of target metals. A highly efficient technology was developed recovering 95% of zinc in waste water from a river flowing through a legacy landfill with the use of mineral-degrading acidophilic bacteria. Using another biogeochemical technology "biosulfidogenesis", 99% recovery of zinc and aluminium was achieved. Such methodologies offer an effective low-cost strategy for metal recovery and mine waste treatment and should be considered as a more environmentally-benign alternative to chemical treatment of mine waters. In this way, waste materials from metal mining can be converted from a long-term environmental hazard into a business opportunity.

Bioeconomy

The Resource Recovery from Waste programme has an important bioeconomy element to it, both in terms of directly valorising biowastes as well as in projects using biowastes to help with the extraction of metallic resources from legacy landfills as discussed above. Commercialisation of resource recovery from biowastes will require viable business cases for companies and government.

Shahid Rasul from Newcastle University presented a new technology to convert CO_2 into valuable chemical compounds such as synthetic fuels, offering a more sustainable intermediary stepping stone for the aviation, marine and long-range haulage sectors until even more sustainable fuels become available. The development of industries using CO_2, instead of emitting it into the atmosphere, aligns well with governmental policies on CO_2 reduction. However, while it is technically possible to produce fuels from CO_2, there are multiple challenges in the upscaling of this technology.

Upscaling is also a challenge in the valorisation of residues from the bioenergy sector. Alfonso Jose Lag-Brotons from the Lancaster Environment Centre presented the latest findings from the AVAnD project, which researches how the use of digestate from anaerobic digestion, and biomass ash from thermal conversion, could contribute to improved soil health and nutrition in agriculture whilst contributing to issues of national concern such as soil health, reducing GHG emissions, energy and food security and improving waste management. Although the beneficial effects of ash and digestate on soil fertility and crop yields have been proven, the application is faced with upscaling challenges pertaining to bulk formulation and supply chain integration. From a regulatory perspective it is most important that the use is safe for human health and environment; and adding to that, it is crucial to prove to industry that application

is effective, scalable and has pathogen reducing abilities, and dewater the mixture to reduce costs and improve application to land.

David Newman from the Bio-based and Biodegradable Industries Association (BBIA) explained how carbon pricing can support the circular economy. Globally the interest in carbon pricing has grown and this is reflected in policies developed in the EU. On the other hand, it is anticipated that the implementation of the EU Circular Economy package will be riddled with obstacles. A carbon tax which prices in the externalities of resource use is one instrument to make the recovery of resources economically viable and contribute to the circular economy. Resource recovery through improved waste management is essential in achieving the global goals in the Post-2015 Development Agenda, for example regarding climate change, poverty reduction, food and resource security, and sustainable consumption and production.

Sustainability assessments and models

Such broad range of factors needs to be included in the sustainability assessment of existing and new circular practices. It is of key importance that the increasingly circular supply chains are more sustainable and better than the linear systems they replace. This requires the development and implementation of sustainability assessment approaches and models.

Suzana Matoh from the Sustainability Research Institute at the University of Leeds delved further into the circular business models, introduced earlier that day by Jan Jonker. Using the company Interface as an example, she explained how multiple metrics such as the percentage of recycled and bio-based content, energy efficiency and renewable energy use are driving decision making. These metrics are integrated in Life-Cycle Assessment (LCA) to inform decision making and as a result transform the business model. LCA also provides a way to collaborate in the supply chain; the use of LCA is a requirement for supply chain partners, giving insight into ways in which changes in feedstock can contribute to reducing the environmental impact of the overall product produced within the supply chain.

Sophie Archer from the B3 project at University of Birmingham explained how LCA is applied to compare the use of fossil and renewable resources, with interactions between economic and environmental factors. Such interdependencies between the different dimensions of sustainability are not easily captured by LCA. Hence customised software is under development in the MeteoRR project, as introduced by Jhuma Sadhukhan from the University of Surrey. The new LCA software enables assessment of techno-economic factors alongside social and policy analyses for design and decision making of technical systems for RRfW. A robust set of sustainability metrics drawn from technical, social, economic and environmental dimensions needs to be assimilated that can help to differentiate between design choices and thus in decision making.

Although LCA is used in business decision making, it has been criticised to be sensitive to subjectivity and limited transparency. As an alternative, the CVORR project develops a sustainability assessment approach based on "systems of provision" integrating multiple dimensions of value including environmental, social, economic and technical metrics, as explained by Oliver Zwirner from the Leeds University Business School. The approach seeks to capture the complexity and dynamics of the technical, economic and social reality in a way

that is useful and accessible to policy and decision makers. In this way, it strives to support a transition to a circular economy where not primarily the *mass* but rather the *value* of resources is preserved in the technosphere. The CVORR framework has the potential to further improve sustainability assessment methods for evaluating resource recovery from waste systems and thereby support companies as well as governments in the transition towards a circular economy.

The parallel sessions suggest that resource recovery is technically possible. However, implementing technologies for increased resource efficiency and circularity can be difficult due to upscaling challenges, dependency on collaboration, and the legislative environment.

Waste and Resource Policy after Brexit

The conference concluded with two presentations on the policy dynamics impacting on waste and resource management. The UK is going through a volatile period with many changes to policy and regulation pending Brexit. In this session we discussed how resource productivity can be increased within this context, and how we can ensure that the government strategy supports a high value circular economy for the UK, generating the most environmental and social benefits in addition to economic progress.

Libby Peake from Green Alliance presented findings from the recently published report "A new direction for UK resource strategy after Brexit". After decades of increasing proactivity and long-term planning, the UK seems to have been stepping back from waste policy in the past years. The EU has been a strong driver for waste and resource policy but as Brexit unfolds Defra will become solely responsible for creating primary legislation on resource use. Defra is faced with the immense task of reworking over 1100 pieces of legislation, translating the Common Agricultural Policy as well as fishing legislation and working on new trade deals. Moreover, the EU Circular Economy package will be ready before Brexit, yet countries will have two years to adopt it and hence there is a risk that it becomes zombie legislation in the UK. While time demand on Defra is increasing, there are significant capacity gaps and this makes the challenge to prepare and implement Brexit even greater. Therefore it would make the most sense to retain the current framework for resource use for as far as possible and that policy momentum is maintained in the government's promised renewed resource and waste strategy. This strategy will pay particular attention to plastics, an acute matter given the quality demands on plastics and paper introduced by China. As discussed earlier that day by Phil Purnell, this requires investment in new infrastructure in the UK. Further investments will be necessary, to achieve the government's ambition to achieve zero "avoidable" waste to landfill by 2050 and ban all food waste from landfill by 2030. Focus areas for the waste and resource policy are expected to include resource productivity, designing out waste, and managing materials at end of life.

Brexit poses a number of threats but also opportunities for responsible resource stewardship in the UK. Risks pertain to:

- Eco-design: to continue trading with the EU, environmental standards need to be upheld and this requires continued collaboration with the EU and application of eco-design principles in the UK.

- REACH: it will be difficult to replicate this complex legislation in the UK via the proposed "BREACH" and it would be more efficient to negotiate full access to the REACH system.
- Regulatory framework: while the ways in which EU waste regulations are implemented in the UK are considered burdensome to business (for example, definition of waste) rules and definitions are needed for waste management and trade which requires continued collaboration.

Despite the threats outlined above, Brexit also offers considerable opportunities. Once outside the EU, the UK can go further in realising a circular economy without being constrained by EU legislation. The UK post-Brexit should take waste management beyond recycling targets, including targets for minimisation, commercial and industrial waste, and productivity. Such targets would drive resource efficiency and provide stable environment for investment. Moreover, food waste needs to be collected separately throughout the UK and used as a source for energy and soil improver through anaerobic digestion. Finally, the extended producer responsibility needs a system-wide overhaul to minimise taxpayer's money being spend on dealing with the consequences of wasteful design and inefficient recycling, for example in the case of packaging materials and coffee cups. To capitalise on these opportunities, however, the government needs to be willing to introduce mandates rather than relying on voluntary measures.

Ian Boyd, Defra's Chief Scientific Advisor, took a positive stance on resource policy after Brexit, stating that European legislation is not the gold standard and that the UK can do better making its own decisions that are tailored to its own needs. He spoke about the recently published report "From Waste to Resource Productivity" which focuses on how the UK can make the most of its resources and shift the policy focus away from simply managing waste. While a fully circular economy may not be possible due to the laws of thermodynamics, zero *avoidable* waste needs to be strived for. However, in the UK the total amount of waste is still increasing posing a large-scale problem, much of which is exported for a value of £3.5 billion p/a. Instead of creating and exporting wastes we should make use of the huge opportunities associated with preventing materials from entering waste pathways. While reducing demand for resources should be our first priority to solve the paradox of growing resource exploitation and waste generation, second priority is to increase resource efficiency. The logic consequence of increasing resource prices is that the best performing economies in 10-20 years will be the most resource efficient ones. Resource efficiency is worth investing in. In addition to economic benefits, increasing resource productivity is also vital to meet the growing global demand for resources and limit the environmental impacts of materials during extraction, use and disposals. The resource and waste sector contributes £7 billion to the British economy and a further £6 billion in cost reductions could be added to that through better product design, such as indicated by Libby Peake regarding extended producer responsibility, and other measures stimulating resource efficiency. Crucial in such a shift towards resource productivity is the internalising of externalities by letting manufacturers and consumers (instead of local authorities, society and the planet) bear responsibility of the costs.

As the UK leaves the EU, there are opportunities to change legislation and adopt policy levers that motivate companies to cost-in current externalities, adopting more systematic

approaches to valuing resources throughout their lifetime. However, echoing the points made in the morning by Phil Purnell and Ian Archer, better data are needed to understand how resource productivity can be improved and design new approaches. Data such as discussed by Ian Archer on the types, amounts and quality of materials as well as where it is generated and transported are crucial. Use of digital technologies and better reporting on waste flows, even for those exempt from environmental regulations, will aid this. Academia can support the increase of resource productivity through the necessary innovations in business models and technologies, while also helping to keep government to account on effective policy and regulation for waste and resource management. The British government needs to formulate a long-term vision for the systemic change to realise a resource efficient economy. Defra is working on a Resources and Waste Strategy to maximise resource value and minimise impact of waste disposal. Coordination with other initiatives is crucial, such as with the Clean Growth Strategy linking resource efficiency to carbon reductions (as explained by David Newman in the bioeconomy session above), the Industrial Strategy, Defra's 25 Year Environment Plan, and the on-going work carried out by the National Infrastructure Commission – which is working to establish a clear understanding of our infrastructure needs to support the transition to a more resource efficient economy.

An overview of the conference programme and all presentations can be found on the RRfW website.

Next steps

The conference proceedings and data collected during the conference on motivations and challenges for companies, governmental organisations and academics when formulating the business case for resource recovery will be further analysed and published. Please follow RRfW on LinkedIn, Twitter, Researchgate and sign up for the newsletter to hear about our latest publications and other news as well as upcoming events including our next and final annual conference focused on policy.

Conference participation

Building bridges between academic research and its application in government and business is crucial for the success of RRfW. Together with our industry partner AquaEnviro, RRfW co-organised a lively debate on end-of-waste at the European Biosolids and Organic Resources conference. In the evening delegates from AquaEnviro and RRfW's got together for a dinner and networking.

On 22 November RRfW welcomed a good mix of delegates (see figure on the right); and with 51% of delegates from outside RRfW, the programme reached out well beyond its existing network bringing in fresh ideas and insights.

The conference was rated by participants as good to very good, 92% reporting the conference was useful for them and 100% suggesting actions as a result of the conference.