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Article

Co-producing a Vision and Approach for the Transition towards a Circular Economy: Perspectives from Government Partners

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Abstract: The UK economy is overly reliant on unsustainable production and consumption practices, depleting finite resources at rates that will increase production costs, business risk and economic instability. This over-consumption produces emissions and waste that cause climate change and environmental degradation, impacting on the wellbeing of people in the UK and beyond. The Resource Recovery from Waste programme (RRfW) promotes a transition towards waste and resource management in a circular economy that restores the environment, creates societal benefits and promotes clean growth by engaging relevant actors in the transition process. RRfW collaborates with academia, government, and industry to co-produce a shared vision and approach to realise such a transition. Reflecting insights from RRfW's government engagement, this article presents a positive outlook for changing the UK economy and society. It envisions a long-term future for waste and resource management that maximises the value of materials by circulating them in the economy for as long as possible. Four themes and an approach are proposed, including recommendations for regulatory instruments and a stable policy framework. It recommends further collaborative research to capitalise on opportunities for economic growth, innovation and resilient infrastructure whilst contributing to quality jobs and welfare in all four UK nations.

Keywords: Resource efficiency, Zero waste, Resource Recovery from Waste, Low-carbon economy, Circular economy infrastructure, Clean growth, Resource productivity, Sustainable Development Goals, Transdisciplinary research, Participatory action research

1. Introduction: Moving away from the resource scarcity and waste overload paradox

Current patterns of production and consumption drive the emerging environmental crises of resource scarcity and waste overload [1-4]. Waste and resource management are directly related to the crossing of planetary boundaries that indicate the safe operating space for our society [5, 6]. While growing resource use has increased welfare of people, the resulting environmental degradation, climate change and pollution violate human rights [7]. Hence, transforming management practices is crucial in solving global sustainability issues; radical changes in the way that waste and resource flows are organised, i.e. the resource economy, are necessary [8].

The Resource Recovery from Waste (RRfW) programme envisions a circular economy that contributes to a resilient and healthy environment, creates benefits for people such as reduced air pollution and high-quality jobs, and clean growth associated with greater resource productivity. The programme aims to facilitate far-reaching change in the waste and resource management landscape in the UK. While the urgency of such a transition is well-recognised, progress requires action and hence strongly increased engagement from all relevant actors [8]. RRfW collaborates with actors in academia, government, and industry to co-produce a more desirable future as well as an approach

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to realise such shared vision. This article presents the outcomes of RRfW's initial government engagement.

2. Methods: Co-producing a shared vision and approach for a circular economy

2.1 Overview of Resource Recovery from Waste co-creation process

RRfW coordinates an academic, industrial and governmental co-creation process to formulate a shared vision and approach aiming to bring waste and resource management within environmental and social boundaries. The process consists of four steps (Figure 1):

1. Formulate initial vision within academic RRfW team
2. Develop vision and approach to realise it with RRfW's governmental partners
3. Extend findings with insights from RRfW industry partners
4. Publish shared vision on waste and resource management

The first step has been completed [8]. This article is the result of the second step of the co-creation process detailed further in this section.

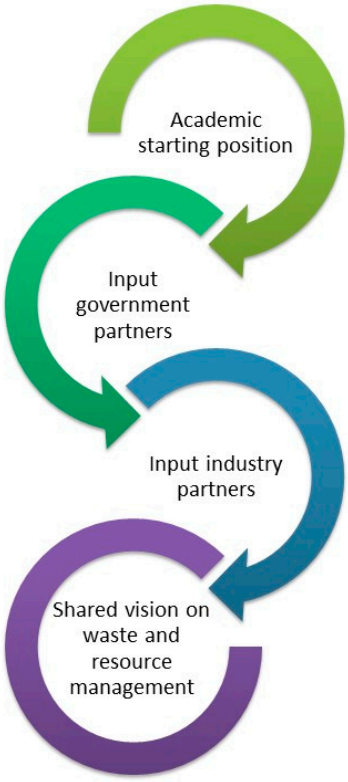

Figure 1: RRfW co-creation process

2.2 Engaging governmental partners

Governmental partners were engaged in an iterative process of data collection and analysis (Figure 2), designed following the principles of participation process management and participatory action research [9-11]. The RRfW process aimed at the co-production of a vision and approach with individuals active in policy-making and regulation for waste and resource management to create ownership of the results and build commitment for uptake. The process design was shaped by the RRfW academic team in collaboration with governmental partners including Department for food and rural affairs (Defra) and the Environment Agency (EA).

Engagement activities were structured to capture broad perspectives, and then consolidated into the coherent vision and approach presented here, to minimise any bias caused by anchoring around early or particularly strongly presented perspectives. Governmental partners of RRfW were invited

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to take part; further participants in related organisations were engaged through snowball sampling (see [12]).

First, participants were interviewed to capture the wide diversity of individual perspectives. Interviewees were asked to express their personal views; findings in this article thus do not represent formal organisational views, but are informed by participants' individual expertise in policy-making and regulation for resource recovery from waste. Interviewees included five participants from Defra, two from Zero Waste Scotland, and further interviewees from the Department for Business, Energy and Industrial Strategy (BEIS), EA, and Scottish Environmental Protection Agency (SEPA). Semi-structured interviews covered four questions:

1. For which organisation(s) are you working and what is your role in waste and resource management?
2. What would the resource and waste management landscape ideally look like by 2020, 2030 and 2050?
3. If we would like waste management to be driven by environmental and social benefits in addition to economic benefits, what would be the key policy and regulatory approaches?
4. How could RRfW best engage governmental organisations to translate knowledge into practice?

Notes from each interview were transcribed and shared with the participant for review and to add any further points. In addition, RRfW participated in the BEIS "2050 Industrial Roadmaps and Circular Economy" workshop in October 2016, with presentations from senior staff of BEIS and Defra on industrial strategy and circular economy. Notes from the workshop were included in the analysis. A qualitative analysis extracted key themes for a vision for waste and resource management, policy and regulatory approaches, and engagement recommendations for academia.

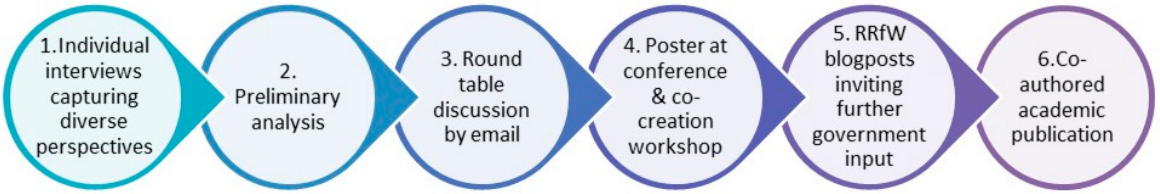

Figure 2: Government engagement process during data collection, analysis and presentation.

The preliminary analysis was organised into a table including a) preliminary results, b) questions to clarify similarities and differences in perspectives and c) space for comments by participants. The table was shared in a 'virtual roundtable', engaging interviewees in an email discussion of the preliminary results. The additional comments were included in the data analysis, which resulted in two outputs. First, a poster was presented at the annual RRfW conference and engagement workshop for industrial partners. Second, results were presented in a blogpost series via the RRfW social media channels in January 2017, with a membership of over 300 followers including key senior individuals active in governmental organisations working on waste and resource management[1]. Further contributions to the shared vision and approach were invited and included in the final analysis presented here. Finally, this publication is co-authored by RRfW (former) governmental partners. In sum, participants active in policy-making and regulating waste and resource management were involved in the engagement process, from its early design in 2016 and throughout data collection, analysis and presentation of first results in 2017 and publication in 2018.

[1] https://www.linkedin.com/pulse/working-towards-shared-vision-waste-resource-3-key-resource

3. Results

The engagement process identified key themes as well as policy and regulatory approaches to realise increasingly sustainable waste and resource management; and processes through which academia and governmental organisations can collaborate effectively in the transition process.

3.1. Key themes for vision on waste and resource management

Participants from across government generally envisioned a long-term future for waste and resource management that moves away from end-of-pipe approaches towards maximising the value created from materials whilst keeping them in the economy for as long as possible. End-of-pipe approaches address waste management issues only by recovering valuable resources, rather than integrating a focus on waste prevention and improved whole system design for resource management; for example, by offering a technology to deal with plastic packaging waste without other system interventions to design recoverable or reusable packaging solutions. The value of materials can be maximised by adopting more proactive strategies that consider how resources are transformed during each stage of the product life cycle including end-of-life options for reuse, dismantling and/or recycling. All participants agreed that waste elimination was the preferred prospect, but opinions differed around its feasibility, how the vision should be realised, and the associated wider contextual changes that this might entail. These differences will be discussed in the key themes below.

3.1.1. Integrating economic with social and environmental values

The first theme focussed on the ways in which economic benefits can be integrated with- and bring about social and environmental values. While there appeared to be a general agreement that the current growth model needs to change, perceptions differed regarding compatibility of economic growth with the realisation of a circular economy. Perceptions around what constitutes growth varied and, arguably, were not focussed solely on economic progress but also included social and environmental improvements. Even when an economy does not grow in financial terms, it can still grow in terms of environmental and social progress. For example, indicators for wellbeing, equality and cultural diversity are just as relevant. However, valuing these on equal terms with economic growth requires a fundamental shift in economic theory and practice, particularly in Government.

Integrating environmental and social values into valuation methods for economic progress requires the development of new metrics. Views differed on the ways in which metrics that represent environmental and social values could be integrated with economic value. Environmental and social externalities can be internalised into economic costs and benefits. This implies monetising currently externalised impacts, such as carbon pricing, landfill and extraction taxes, etc. but such approach can be prone to manipulation (see for example [13]). As a more transparent alternative, environmental, social and economic values could be assessed in an integrated manner without being collapsed onto financial value alone [14] but only few modelling approaches are available. Despite recognising the limitations of focusing on money only[2], many government departments still appear to keep sole focus on economic metrics. One way forward would be including social and environmental metrics in models used by the Treasury.

Decoupling of consumption rates from economic growth, as well as resource use from waste production, could be supported by such altered set of metrics to help internalising currently externalised benefits and impacts. Decoupling is partly about dematerialisation i.e. making better material choices and using less materials in products, and partly about extending life cycles through improved design, reuse, repair and remanufacturing. In current economic models this would appear as a reduced consumption rate; such systemic failures demonstrate that metrics need to be adapted

[2] See for example Guidance to the Green Book on valuing infrastructure https://www.gov.uk/government/publications/green-book-supplementary-guidance-valuing-infrastructure-spend

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to support maximising the economic, social and environmental values created and destructed throughout the life cycles of products, materials and components.

3.1.2 Supporting secondary resource markets

The second theme revolved around the ways in which secondary resource markets could be supported. Participants agreed that markets for wastes and by-products need to emerge to close resource loops in our economy. In addition to transformation disussed in 3.1.1, a range of additional potential market and cultural changes were proposed.

Transaction costs for secondary resources tend to be higher than the use of primary materials [15, 16]. This is particularly the case for construction and demolition waste (e.g. glass, timber). Such barriers need to be removed. For example, some participants suggested the use of secondary resources could be supported by a ban/restriction on primary materials, currently mainly in place to reduce pollution, when secondary resources are available; and incentivise the use of recyclates further with levies, such as strived for through the Aggregates Levy[3], combined with green procurement government policies. Information and control on recyclate quality must be improved to support uptake of secondary materials. Upstream in the supply chain a level playing field could be created by internalising the real environmental and social costs into the extraction or production of primary resources.

Cultural changes were closely associated with market evolution. While some participants believed far-reaching changes would occur before 2050, others did not foresee radical shifts in behaviour patterns at all; this uncertainty will have major implications for installing the physical and economic infrastructure required for the processing of secondary resources. Moving from the current supplier-led markets to demand-led markets would arguably reduce waste arisings. Rather than producers driving up demand, consumers could indicate what they really need e.g. through 'on demand' business models [17]. Digitisation could help build the required connections between suppliers and consumers, but also poses challenges through increased opportunities for business to generate demand using targeted marketing (further discussed in the next paragraph). Behaviour change requires a clear, strong regulatory framework in support of positive behaviours. However, not everyone was convinced far-reaching changes in consumption patterns are feasible (although governmental bodies have been proven wrong before in industry appetite for change, for example in the case of electric vehicles uptake). If one accepts that consumerism will keep centre stage in our society, then infrastructure and markets need to have sufficient capacity to provide demanded products *and* recycle them as well. In such scenarios, companies rely more heavily on innovative business models to close resource loops post consumption, such as products as services, product life extension through e.g. reuse, and collaborative consumption i.e. product sharing [17, 18]. Moreover, there would be more demand for improved recycling technology to process all waste arisings.

3.1.3 Enabling innovations

The third theme referred to enabling innovations: digitisation, material and product design, and business model innovation. Digitisation offers opportunities in terms of enabling recycling, especially in combination with the internet, for example through data collection and sharing on waste flows, Raw Materials Information Systems, and sharing scientific results via online databases. Conversely, digitisation is associated with increasingly complex e-wastes. Material and product design can enable recycling by designing in end-of-life options for products including electronics, packaging, etc. Such improved design of materials, components and products requires both regulatory support to prevent designed obsolescence and, instead, build-in reparability and recyclability, for example disincentivising rapid turnover products that generate large quantities of difficult to recycle wastes. Co-polymer designs of bottles with different plastic tops and bodies were widely cited as an example (for an overview of resource recovery from plastics see [19]). The general consensus was that

[3] https://www.gov.uk/topic/business-tax/aggregates-levy

improved recycling technologies and product designs would need to be combined with innovative business models to enable the circular economy (as discussed above).

3.1.4 Whole system approach identifying key intervention points

The fourth theme focused on the need for whole system approaches that identify key intervention points. One way to identify such points is a sectoral approach, focusing attention on priority sectors such as food waste, plastics, construction and demolition, etc. Sectors or materials could be prioritised by value and environmental impact. Further intervention points could be defined by assessing risks along whole (circular) value chains to identify hotspots.

Alternatively, three cross-sectoral areas for intervention were suggested, focusing on:

1. Higher end of the waste hierarchy: All participants were coherent in suggesting a move away from end-of-pipe approaches towards an accelerated focus on the top of the waste hierarchy i.e. more waste reduction, reuse and recycling. However, the ways in which this needs to be realised varied between regulating/ charging and incentivising (further discussed in next section).
2. Carbon benefits of improved waste and resource management: Carbon emissions were associated with waste and resource management [8]. With regard to the embodied carbon in materials, components and products, i.e. the energy used to extract/grow and process the resources into its current functional form, recycling/reuse may deliver carbon savings when compared to processing virgin materials. In energy intensive industries, waste and resource management are increasingly important for decarbonisation now that savings through energy efficiency measures are reaching thermodynamic limits. Waste infrastructure such as biogas and energy-from-waste also play a direct role in decarbonisation of the energy sector. Finally, the ways in which carbon emissions have climbed government and industry agendas could serve as an example for waste management.
3. Waste/ circular economy infrastructure: Enabling the circular economy requires a better understanding of existing waste infrastructure including location and capacity [20]. Arguably, a decentralised waste infrastructure would benefit the circular economy, allowing segregation of waste streams to realise resources and value as close to the point of discard as possible, whilst offering the best opportunity to stimulate regional economies. However, the feasibility of regional waste treatment will depend on the materials concerned (also see [21]); increasingly complex materials are expected to pose new technological challenges for the waste industry. Nevertheless, exporting wastes as RDF/SRF was generally perceived as a missed opportunity to generate value from material recovery for the UK economy. Re-imagined waste infrastructure and procurement systems in the UK could improve these outcomes.

3.2 Policy and regulatory approaches

3.2.1 Key policy directions

To realise the vision and work on the key themes outlined above, interviewees discussed various policy and regulatory approaches. Five focal areas for policy development were indicated:

1. Longer term policies that are stable and predictable. Such policies would enable investment and business model innovation.
2. The vision focusing on the higher levels of the waste hierarchy was reflected in the suggestion to focus policies on resources and resource efficiency rather than waste and waste reduction.
3. Build on the EU Circular Economy Strategy to maintain integrity with EU resource, waste and circular economy policies.
4. Prioritise reduction of single use and superfluous products/packaging as well as the use of hazardous materials in products when it poses barriers to recycling.
5. Develop circular economy infrastructure in support of decarbonisation agenda.

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Overall, policies should strive to make the concept of waste redundant[4]. Whilst recognising that there may always be wastes currently considered as "unavoidable", it should still remain the ultimate objective of all policy efforts.

3.2.2 Regulation and incentives

Turning to regulatory approaches, a combination of incentives and regulations were suggested to focus efforts on the higher levels of the waste hierarchy. The overriding idea is that each level of the waste hierarchy needs its own mix of incentives and regulations, with more 'carrot' or 'save as you recycle' approaches towards the higher levels and more use of regulatory 'sticks' or taxation to prevent resources moving down the hierarchy (Figure 3). However, across government there were pertinent differences as to whether incentives should be preferred over regulation, although evidence suggests that regulating i.e. legal obligations motivate more change than incentives [22]. Further diversification of regulatory approaches may be required for different sectors, as sectors are subject to varying sets of technological and market constraints and opportunities.

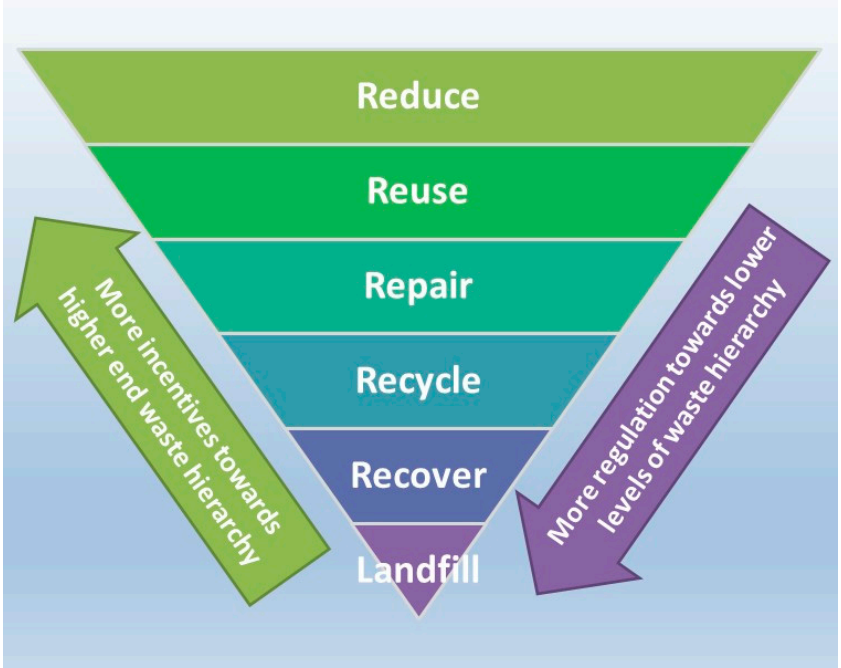

Figure 3: The transition towards a circular economy can be motivated through a combination of regulation and incentives.

Six groups of regulatory instruments were discussed:

1. Taxation and tax breaks – To promote reuse and repair in addition to recycling. Taxation could motivate technological change, potentially further mechanisation, and a transition from labour-focussed to resource-focussed processes. Taxation could also play a role in internalising elements of resource value that are currently largely externalised, such as the end-of-life impacts. Such tax approaches would enable prioritising resource use by value of the products, components and materials being produced; however, it requires new frameworks and tools to measure, categorise and prioritise resource use by application.

[4] This could also help combatting waste crime which poses an expensive issue for businesses and local authorities alike in the UK. If wastes are perceived as a resource, then higher value applications will be more attractive than dumping wastes illegally. The government could fund more industry initiatives to drive such change in perception, such as previously the National Industrial Symbiosis Programme http://www.nispnetwork.com/.

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2. Reporting – It is necessary to identify and understand resource flows especially at higher levels of the waste hierarchy such as reuse [23]. Reporting could be incentivised by tax breaks in reuse and repair. Nevertheless, motivating reuse and repair should not create perverse incentives that make waste prevention and reducing resource use relatively less attractive. In this respect extended producer and consumer responsibility can play an important role.
3. Extended producer *and* consumer responsibility – Extended producer responsibility (EPR) can help targeting specific waste/ resource streams, supporting schemes to make polluters pay and motivate designing wastes out of the system. EPR should be combined with increasing emphasis on consumer responsibility, to improve the quality and quantity of wastes feeding into the waste management industry, for example through deposit refund schemes on items that are difficult to recycle (low energy light bulbs, batteries, etc.). The value of EPR would be greatly enhanced by better understanding the roles and responsibilities of consumers.
4. Product bans or product standards – Connected to EPR, product bans could offer a strong instrument to intervene. However, such bans were contentious and, alternatively, products standards and inclusion of externalities in economic value were proposed.
5. Mandatory recycling regimes – In support of extended producer and consumer responsibility, markets could be further directed by mandating recycling regimes. Such mandates are expected to improve the quality of recycled resources, which is an essential requirement to realise the circular economy.
6. Waste Prevention Act – Waste and resource management can play an important role in carbon reductions as supported by the Climate Change Act. Waste prevention was perceived of such importance that it should not be voluntary and, instead, should be embedded in a Waste Prevention Act.

3.2.3 Reviewing the policy and regulatory framework

When introducing the newly proposed regulatory approaches above, participants considered that reconsideration of the existing policy and regulatory framework would also be necessary. First, regulatory barriers to closing resource loops need to be addressed – for example, the end-of-waste[5] pathway needs to be more transparent and easier to achieve. The regulatory system should become less centred on waste and focus more on valuing resources and prioritising risks within the whole cycle of production and consumption. Second, it is necessary to realign support for competing incentivised supply chains. Linked to realigning incentives, regulatory efforts should focus on those who can actually (pay for) change in waste and resource management. For example, local councils carry responsibility for recycling but austerity measures cause difficulty in achieving obligations [24, 25]. Similarly, various energy intensive industries are reaching their boundaries for resource and energy efficiency; hence sectoral differentiation in policy and regulation may be required to only target sectors where significant improvements are feasible.

3.2.4 Education for circular economy transition

Building on the argument that regulatory approaches should focus on those who can change practices, education and support play an important role. Local councils play a key role in realising waste infrastructure and cultural change. The Local Government Association (LGA) is well positioned to provide information to local councils about circular economy and best practice. Such knowledge is also crucial for government in general but especially those in power to lead on waste and resource management. Other than government actors, it is also important to educate households and businesses. Business needs to be enabled to understand what the circular economy is and what opportunities exist for example in terms of reducing costs, increasing profits and/or long-term business viability, and reducing risks around material supplies [26] (further developed in the next step of the RRfW co-creation process explained in Section 2). Education, tied into the sectoral differentiations introduced above, should focus on general concepts, business planning, support to

[5] https://www.gov.uk/guidance/turn-your-waste-into-a-new-non-waste-product-or-material

adopt circular economy approaches and championing successful cases, and disseminating good practices between local authorities and businesses. Academia is well placed to provide consistent, credible and impartial materials for all areas of education and behaviour change.

3.3 Effective collaboration between academia and government

In what ways could academics best collaborate with governmental partners developing the policies and regulations discussed above? This section presents recommendations from governmental partners for academics on potential engagement methods, organisations, government processes, and positioning and generation of research outcomes.

Participants felt that academics should engage governmental organisations from the start of research projects. This early engagement should be followed up by regular contact throughout the project. Such regular contact also helps to stay up-to-date with relevant policy processes (further discussed below), offering opportunities for participation and uptake. Participation of government partners at multiple levels was seen as crucial in the transition process towards more sustainable waste and resource management. Far-reaching changes are needed at all levels of government, and throughout society, hence to bring about such systemic change "taking everyone with us" is important. Only with such broad engagement approach can academics capture and integrate all relevant perspectives, educate key actors, and present a shared pathway towards a sustainable circular economy.

Government partners at all levels need to be engaged, from politicians to departmental policy and technical teams, and parliamentary groups and committees. Involvement of politicians such as MPs, MSPs, AMs and MLAs[6] is important in order to build up credibility in the political arena. Important departments to engage about waste and resource management are DEFRA, BEIS and the Treasury in England, and equivalent departments in the devolved administrations, which are in crucial positions for waste and resource management policy and regulation, industrial strategy and waste infrastructure. MHCLG and the equivalent departments in the devolved administrations are also of key importance as they regulate the budgets available for local councils responsible for municipal solid waste. Engagement should include both technical officers as well as policy makers. Membership of various parliamentary groups and committees is another way of channelling engagement and impact. The All-Party Parliamentary Sustainable Resource Group is a good conduit for influencing in England, as is the Environmental Audit Committee. Additionally, timely engagement of regulators and regional governments is crucial for the implementation of sustainable waste and resource management strategies and measures [25].

It is important to engage the governmental actors mentioned above, because they are closely involved themselves or indeed coordinating various relevant activities to which academics could contribute. For example, in departments such as DEFRA, BEIS and the Treasury, engagement could take the form of direct and regular meetings to exchange knowledge or through contributions to consultations such as for the industrial strategy, bioeconomy strategy and approaches to support the circular economy. Contributions to standards, for example BREFs (BAT, Best available techniques, REFerence documents) and the recycling protocol for demolition and construction waste, are another option. To make results more accessible for government partners, academics could also contribute to POST (Parliamentary Office of Science and Technology) notes and the Raw Materials Information System. Furthermore, organising research results and data in existing, or newly launched, online databases would make research results on waste and resource management more accessible. Finally, organising events in Westminster and the devolved parliaments/assemblies offer another platform to engage politicians and other government actors.

Two interlinked approaches to position research outcomes were brought forward. The first pertains to whole system approaches. The ability of maintaining the bigger picture of whole systems is a core strength of academia. However, government changes holistic systems through key intervention points. Moreover, they only have limited resources to intervene and hence need to

[6] https://www.parliament.uk/about/mps-and-lords/members/

maximise the effects with minimum resources. Therefore it is recommended that academics provide specific measures targeted at sectors and materials, within the context of the whole system. In other words, academics should present whole system models but with more practical recommendations.

Another key approach in presenting research outcomes revolves around integration. Building on the observation above that actors throughout society need to change, at all levels of government as well as industry and general public; academic work should integrate the diverse stakeholder perspectives. Priority should be given to integration of strategies for the circular economy with the wider agenda for economic development and protection of the environment. Practical advice to support such integrated, cross-government, approach is in demand. Recommendations in the form of new metrics to integrate into economic development models would be valuable, for example circular economy metrics or sets of metrics that include environmental and social indicators of progress in addition to economic metrics. Data associated with such new as well as existing metrics to understand whole systems, in addition to data covering gaps in models used by the government, would also help governmental partners better understand whole systems. Academia should support a more integrated understanding of promoting sustainable waste and resource management by joining up the elements of the circular economy. While government interventions tend to focus on sectors and materials, and academics should translate recommendations into such terms, academia should also clarify how resources can circulate through the economy through interconnected sectors. In other words, academics should identify where joined up interventions for two or more sectors are necessary to support the emerging circular economy. Finally, it is strategically important to integrate perspectives within academia. Too widely differing academic perspectives are open to misuse by transition sceptics looking for reasons not to use the provided evidence and change any practices.

Turning towards the research activities supporting effective collaboration with government partners, three activities are suggested – but many more are possible:

1. Identify policies and regulations linked to the research project.
2. Carry out a situational analysis to understand if, and in what way, a new approach or technology could be realised within the policy and regulatory context.
3. Connect solutions and recommendations explicitly to policies and regulations in a specific region.

4. Discussion: Reflections on RRfW vision and existing government strategies

4.1 Comparing the academic and governmental narratives

Comparison of the "governmental" narrative outlined above to the opening narrative of the Resource Recovery from Waste programme [8] shows that both perspectives largely align. Importantly, government and academic perspectives agree on the necessity to transition towards a circular economy, moving away from end-of-pipe solutions and increasingly focusing on upstream supply chain changes to bring materials, components and products to market that can easily be reused, dismantled and recycled. This is especially the case for new complex materials and e-wastes. The need for new economic theory and practice was recognised, including the ability to assess the true costs of processes in terms of economic, social and environmental values throughout whole supply chains – note that technical value was not discussed by government partners. The circular economy, and associated increased need for innovation, was perceived as an opportunity for the British economy. However, reaping the benefits will depend on understanding and realising the required waste and resource management infrastructure in support of a CE.

The government and academic narrative agreed on the necessity for more action supporting sustainable waste and resource management from actors throughout society. Everyone needs to be involved in the transition process. Academia is particularly well-placed to keep an overview of the bigger picture, suggesting alternative economic development pathways and identifying key intervention points. The need for continuous engagement of non-academic stakeholders in academic research and formulating practical recommendations were a shared concern.

Differences between the academic and governmental narrative were relatively diffuse. The discussion with partners in governmental organisations did not reach as widely as the academic narrative – for example the dependency of economy on society and environment was less pronounced. However, such dependencies were not directly questioned either by governmental contacts engaged for the narrative presented herein. Similarly, linkages between waste management, overexploitation of resources and quality of life *in the UK* were less clear. Governmental and academic narratives diverged on the questions whether changing consumer behaviour is a necessity before marketing products that are more amenable to recycling, and whether internalising environmental and social values into financial cost-benefit analysis will really support a transition towards a circular economy. Finally, while clear agreement emerged on the issue of data deficiencies, the governmental response was centred on increasing efforts for data acquisition and digitisation opportunities while academia may focus more on developing tools to deal with imperfect data and/or data that is difficult to combine. These two approaches could be complementary if correctly designed.

4.2 Reflecting upon government strategies in England, Scotland, Wales and Northern Ireland

This article has presented the personal views of those working in governmental organisations and this section complements those perspectives with the formal government positions. As waste is a devolved matter in the UK, the key themes identified in this article are compared to the aspirations presented in visions, strategies and plans for the promotion of a CE, resource recovery and waste management (as far as they are available) in England, Wales, Northern Ireland and Scotland.

4.2.1 Wales

In Wales the circular economy is promoted through the national waste strategy "Towards Zero Waste" [27] under the leadership of the Cabinet Secretary for Environment and Rural Affairs. The strategy was introduced in 2010 and is due for an update in 2018, for which consultation is currently on-going. It integrates waste management with other policy areas, including the Well-being of Future Generations (Wales) Act 2015 and Environment (Wales) Act 2016, striving to achieve the One Wales: One Planet goal sustainable development scheme [28]. The national waste strategy is implemented through a series of sector plans and a programme of government initiatives including e.g. the statutory recycling targets and investment in WRAP Cymru[7], and, more recently, a Circular Economy Investment Fund for SMEs[8].

Recently the Welsh government published the Natural Resource Policy [29]. This policy recognises natural resources as the backbone of the economy and society, adopting an ecosystem stewardship approach (such as discussed in the Resource Recovery from Waste vision in [8]). Clearly, this policy takes a next step in Wales' transition towards an economy that is sustainable by design, putting the environment and human well-being up-front whilst promoting sustainable growth through renewable energy, resource efficiency and the circular economy as expressed in this quote: *"The evidence shows that the inefficient use of natural resources is affecting the availability of primary resources and materials now and in the future. In addition the use of these resources places significant pressures on our natural resources and ecosystems in the form of damaging pollution and climate change. To reduce these pressures, we need to increase waste prevention and promote reuse, recycling and recovery."*[29] (p11).

Similar to the zero waste strategy, the natural resource policy is integrated with the Well-being of Future Generations[9] and Environment Act[10], while strongly linking to the international agreements in the UNFCCC, CBD, and UN SDGs. Finally, the national strategy "Prosperity for All"

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[7] Written statement - Achieving a more circular economy for Wales http://gov.wales/about/cabinet/cabinetstatements/previous-administration/2016/circulareconomy/?lang=en

[8] http://gov.wales/newsroom/environmentandcountryside/2017/170310-cabinet-secretary-confirms-6m-circular-economy-fund/?lang=en

[9] http://gov.wales/topics/people-and-communities/people/future-generations-act/?skip=1&lang=en

[10] http://gov.wales/topics/environmentcountryside/consmanagement/natural-resources-management/environment-act/?lang=en

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links into this framework of strategies, policies and agreements too [30]. However, realising these plans will require considerable regulatory reform and this appears to be still in its early stages.

When comparing the Towards Zero Waste strategy and the Natural Resources Policy to the themes identified in this research, it is clear that they not only already have integrated all aspects (Table 1) but also added further themes such as:

- Ecosystem stewardship and biodiversity
- Integrated governance
- Investment support for CE and resource efficient public procurement

4.2.2 Scotland

Scotland has a longer history of working towards a CE, stemming from the Zero Waste Plan [31]. The focus on waste minimisation has grown to include resource efficiency and CE, connected to the decarbonisation of the economy. The EU CE Package[11] is seen as leading the uptake of circular practices, providing a strong basis for the detailed strategy "Making Things Last" for the Scottish CE [32]. The CE strategy integrates objectives of the Zero Waste Plan [31] and waste prevention strategy "Safeguarding Scotland's Resources" [33], and is linked to "A Manufacturing Future for Scotland" strategy [34] in which CE takes centre stage in the first key action to *"Deliver concrete initiatives to boost productivity including leadership, employee engagement and skills, energy efficiency and the adoption of circular economy approaches across the manufacturing sector"*. In Scotland, CE is explicitly linked to zero waste and resource efficiency; resource efficiency in its turn has been integrated with decarbonisation and preservation of natural capital as part of investment priorities set out in the economic strategy [35].

The Scottish CE strategy strongly embraces the waste hierarchy, with plans and priorities to promote circularity via every level of the hierarchy. It envisions the decoupling of economic growth from resource use, through increased resource productivity [36], as formulated in this quote: *"All of the priorities in chapters covering loops of the circular economy (design, reuse, repair and remanufacture) will also contribute to waste prevention, helping to decouple resource use from economic growth."* [32](p11).

Despite the clear plans for decoupling, compared to the themes identified in this research the overall strategy seems less radical and integrative in terms of social changes and reforming perceptions of economic progress and associated values (Table 1). While environmental and economic objectives are well-integrated, the social interests appear to be more in the background. This is for example reflected in the way that progress is defined with social factors such as skills, jobs and social enterprises, but less about the bigger picture of welfare and viable communities; while the proposed metrics framework, which appears to be in its early stages of development, entirely focuses on 'classic' indicators such as reducing carbon emissions and wastes. Moreover, the strategy aims for lower costs and economic growth for Scotland. Environmental limits, and particularly resource scarcity, appear to be the key driver for Scotland, as framed in "Safeguarding Scotland's Resources" [33] (p6): *"The overall aim of this programme is to prevent waste, increase resource efficiency and enable a shift towards a more circular economy."* This confirms the predominantly environmental and economic basis for the Scottish CE, from a materials' management perspective. Overall, focus does not seem to be as much on reduction of consumption and promotion of 'sufficiency' such as in Wales, indicating perhaps a less radical view on societal change. That said, the resource management blueprint does include ideas for a culture change regarding resource efficiency [33]. While the envisioned changes for Scotland may be less radical in nature, the strategies and plans are coherent and are operationalised with detailed actions.

4.2.3 Northern Ireland

Northern Ireland does not have a CE strategy yet [37]. Circular economy does get mentioned in the waste management strategy for Northern Ireland "Delivering Resource Efficiency" [38]; linking

[11] http://ec.europa.eu/environment/circular-economy/index_en.htm

waste management and resource efficiency to the low-carbon and circular economy. The strategy defines resource efficiency as *"using resources in the most efficient way while minimising the impact of their use on the environment"* (p6). While it recognises that waste should be treated as a resource with a value, it remains viewed mostly as a risk to environment and people rather than recognising it as an opportunity to transform the economy. Recycling targets are integrated to deliver objectives on protecting people, environment and creating safer communities. Nevertheless, waste management is recognised as part of the green economy, and relations are established to sustainable development too.

The Northern Irish sustainable development strategy "Everyone's involved" [39] presents ambitious plans around four key themes: economic prosperity, social cohesion, environmental protection and meeting national and international responsibilities. The strategy strongly centres on climate change, reducing carbon emission, and energy generation. While the strategic objectives do mention resource efficiency, the translation into actions is limited to increasing resource efficiency of businesses and reducing landfill. No specific investments into waste, resource recovery or circular economy infrastructure are included. Looking into the details of investment in infrastructure, the Strategic Waste Infrastructure Programme launched in 2008 was designed to deliver landfill reduction targets[12]. Initially, the programme was designed to be delivered through three projects, striving to deliver waste infrastructure including Mechanical- and Biological Treatment- and Energy-from-Waste facilities[13]. However, delivery was protracted and eventually two of the three projects were abandoned due to procurement challenges and the success of the waste prevention measures, driving down demand for this type of facilities.

Waste prevention was supported by the EU Waste Framework Directive, obliging all member states to prepare a waste prevention plan. In Northern Ireland, the introduction of the new waste management strategy (discussed above) and the Waste Prevention Programme increase efforts to *"drive waste up the waste hierarchy; to deliver resource efficiency"* [40] (p6). The waste prevention strategy strives to continuously reduce waste arisings in Northern Ireland, delivering objectives on decoupling, encouraging people to increase resource efficiency and produce less waste, and integrating resource efficiency and waste prevention into business management and project planning.

Comparing the Northern Irish context to the key themes in Table 1, it is recognised that progress should be redefined to include environmental and social- in addition to economic factors. However, for waste and resource management this has not translated yet into values and metrics to progress in such integrated manner, transforming the economy to become more circular. Old perspectives on waste management appear to prevail in government, with a bias towards environmental- and health risks and EfW and little action beyond achieving landfill reduction targets. It can be concluded that a good start has been made in preparing the government strategic context for waste and resource management integrated into sustainable development and set for radical economic and societal change, however, this has not crystallised yet into substantial, concrete progress in line with this framework.

4.2.4 England

Similar to Northern Ireland, England does not have a CE strategy. The waste review 2011, initiated by the previous coalition government, set out a comprehensive view to move towards a green, zero waste economy delivering economic and environmental benefits [41]. However, the waste management plan [42] and associated post-adoption statement [43] indicate a step backwards from the radical economic and societal reforms required for sustainable waste and resource management. The plans voice the ambition to achieve zero waste as part of the transition towards a sustainable economy, however, also accept waste as unavoidable. Framed according to the waste hierarchy, it delivers the minimum requirement for the revised Waste Framework Directive aim *"to protect the*

[12] https://www.daera-ni.gov.uk/articles/waste-infrastructure-and-secretariat-office#toc-0

[13] http://www.agendani.com/waste-infrastructure/

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environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use" (p34).

The waste management plan is complemented by the waste prevention programme for England [44] and a quality action plan [45]; both making positive statements about the environmental and economic values that can be created by driving waste management higher up the waste hierarchy. However, the overall picture of waste strategies and plans appears somewhat ambivalent, with contradictory statements such as a indicated above around zero waste yet readily accepting unavoidability, willingness to support secondary resource markets in the UK yet justifying large-scale exports, incorporating the waste hierarchy including the requirement for a diverse waste and reprocessing infrastructure yet directing public investment nearly solely to energy recovery (also see [20]), and setting out collective responsibilities yet delegating responsibility to deliver to local authorities and the EA with diminishing budgets. Hence in the comparison with the key themes in Table 1, England appears the least green in terms of waste and resource management.

Perhaps the picture in England is constrained by the political complexity and available capacity in ministries who are, unlike their devolved counterparts, not only responsible for England but the whole UK. For the UK as a whole there is no CE strategy. However, the CE has been incorporated into the new industrial strategy "Building a Britain fit for the future" [46]. Circular economy, resource efficiency and resource productivity are recognised in achieving clean growth i.e. increased economic growth while decreasing carbon emissions [47]. These strategies are supported by the 25 year Environmental Plan [48] and forthcoming Resource and Waste Strategy aiming to make the UK a world leader in competitiveness, resource productivity and resource efficiency.

Government action now needs to follow this positive curve. While the benefits and feasibility of measures increasing resource efficiency are long known (e.g. [49]), in practice government action focuses on energy efficiency rather than material efficiency which is perceived as more of a future challenge [47]. Similarly, the National Infrastructure Delivery Plan 2016-2021 [50] shows a relatively limited investment in waste management, justified with the fact that capacity is sufficient to meet EU landfill diversion targets. Investments that are scheduled are for ca. 80% in EfW. The government should invest in diversifying waste infrastructure to include material reuse, recycling and recovery in line with its ambition to have the infrastructure in place and move towards a high-value CE in the UK [20].

Comparing the analysis from the four nations in Table 1 confirms that changing practices presents the most challenges. While governments generally recognised that progress includes environmental and economic factors, social benefits and impacts tend to be underrepresented across the UK. Moreover, the translation of these new visions around progress into actual values and metrics lags behind and this is where governments can strengthen their strategies and plans. Personal- and formal government perspectives were relatively aligned regarding the promotion of secondary resource markets and enabling innovation (Table 1). Within the theme of "whole system approaches identifying key intervention points" contrasts were particularly stark around the enabling of a CE through (decentralised) infrastructure. Overall comparison of themes in Table 1 reveals that there are strong regional differences within the UK. This raises the question to what extent context-specific approaches are required and how this could be balanced within strategies and plans for the whole UK to move all nations forward to a more CE.

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Table 1: Comparative analysis of key themes distilled from government specialists' personal views and formal government visions, strategies and plans for CE, resource recovery and/or waste management for as far as these documents were published by the devolved administrations within the UK.

	Country			
Themes	**Wales**	**Northern Ireland**	**Scotland**	**England**
INTEGRATING ECONOMIC WITH SOCIAL AND ENVIRONMENTAL VALUES				
Radical change in economic theory and practice	Yes	Partly	Partly	No
Progress redefined to include social and environmental factors	Yes	Yes	Partly	Partly
Maximise environmental, social and economic value created from resources	Yes	No	Partly	No
Internalise or integrate environmental, social and economic metrics	Partly	No	Partly	No
SUPPORTING SECONDARY RESOURCE MARKETS				
Decoupling: consumption from economic growth; environmental, social and economic metrics	Yes	Yes	Yes	No
Keep materials in economy as long as possible	Yes	Partly	Yes	Partly
Incentivise/ regulate emerging secondary resource markets	Yes	Yes	Yes	Yes
From supplier-led to demand-led markets	Yes	Partly	No	No
ENABLING INNOVATIONS				
Business model innovation vs. business as usual with improved recycling technology	Yes	Partly	Yes	Partly
Material and product design including end-of-life options	Yes	Yes	Yes	Yes
Digitisation enabling recycling, but growing e-waste	Partly	No	Yes	Partly
WHOLE SYSTEM APPROACH IDENTIFYING KEY INTERVENTION POINTS				
Move away from end-of-pipe approaches and higher up the waste hierarchy	Yes	Partly	Yes	Partly
Decarbonisation+ has to include waste and resource management	Yes	Partly	Yes	Partly
Enable CE through (decentralised) waste infrastructure	Yes	No	Yes	No
Whole system approach but identify key intervention points for targeted action	Yes	Yes	Yes	Partly
REALISE RADICAL CHANGE THROUGH ENGAGEMENT OF GOVERNMENT, INDUSTRY, ACADEMIA AND GENERAL PUBLIC	Yes	Partly	Partly	Partly

5. Conclusions and Recommendations

This article shed light on the undercurrent of perspectives within governmental organisations that drive resource recovery and CE. Experts in waste and resource management in British governmental organisations broadly agreed on a vision of a circular economy that focuses on maximizing the value created from materials whilst keeping them in the economy for as long as possible. They also agreed that a move away from end-of-pipe approaches and instead designing durability and recyclability into the economy was necessary. A practical circular economy strategy was seen to require:

1. Integration of economic with social and environmental values, metrics and models; this applied to all government departments and especially the Treasury;
2. Support for secondary resource markets, for example under the guidance of the Department for Business, Energy and Industrial Strategy and the Department for Environment, Food and Rural Affairs and their devolved counterparts;
3. Policy interventions that enable innovation not just in waste processing technology but also in business models, product design, and data collection and analysis through the work of UK Research and Innovation; many of which will rely on increased exploitation of digital and data

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technologies analogous to those in construction (e.g. CAD, BIM) or financial technology (e.g. blockchain);

4. Adoption of a whole-systems approach to analysis (aided by academics) but a recognition that Government operates in departments, and thus translation of whole-system recommendations into specific actions that can be steered through key intervention points, under the leadership of the Cabinet and their devolved counterparts supported by a new Office for Resource Stewardship [20, 25].

To deliver such a circular economy, government needs to collaborate with partners from across society to integrate scientific research, policies and regulations. The government must adopt a long-term and predictable policy framework focused on resource efficiency and building on the EU circular economy package in line with the decarbonisation agenda. This should be allied to a clear pipeline of forthcoming projects and interventions similar to that adopted by the National Infrastructure Plan to reduce uncertainty and investment risk, unlocking new finance and business models. A mix of supporting regulatory approaches needs to be developed, including a) taxation, b) reporting, c) extended producer- and consumer responsibility, d) product bans or standards, e) mandatory recycling regimes, and f) a new Waste Prevention Act.

Comparison of the personal expert views to the formal government positions shows that a part of the proposed vision and approach has already perpetuated into strategies and plans. However, differences in policy and regulation across the four nations in the UK are large and any existing coherence appears to be driven by a desire to comply with EU directives. Clearly the UK's current intention to drastically change its relationship with the EU, and thus the degree to which the UK as a whole and individual nations continue to implement e.g. the EU Circular Economy Package, will disrupt this coherence unless concerted policy action is taken soon. Comparing the government views to RRfW's perspective (see [8]), attention for the social impacts (such as air quality) and benefits (for example high quality jobs) is generally lower in government; we note that relations between waste and resource management and "social" aspects, well-being and human rights in the UK needs more research and communication and this could in part be delivered via academic research. Moreover, further action is needed to maintain the technical qualities of materials (and thus their ability to contribute to industrial productivity i.e. the status as resources, not wastes) rather than losing them through for example disproportionate reliance on energy-from-waste and export; this will require a change in investment profile of the Infrastructure and Projects Authority.

The promising and increasingly coherent strategies of the British government now need to be translated into practice. This will require inclusion of more diverse values and metrics in government plans and models that measure technical, social and environmental costs and benefits as well as economic; it is likely to require a step-change in the way resource and waste flow data is collected and analysed. It will also require alignment of public investment with the ambitions for a growing, low-carbon and zero avoidable waste economy that increases resource productivity and creates jobs in all regions of the UK as the Government envisions.

Academia should contribute to government processes by keeping a watchful eye on the 'bigger picture' whole-systems research but also translate this into communications to government departments that explain how their various, specific decisions interact with- and impact on the growing circular economy. Academics should recommend to government how greater coherency in governance as well as policies and regulations can achieved. Regular contact with governmental organisations enables the provision of the timely and concrete recommendations needed in the governance process. Research programmes such as those funded via UK Research and Innovation must be designed to enable such collaboration with government and other relevant organisations [8]. RRfW will continue to collaborate with governmental organisations and translate project outcomes into concrete recommendations for specific government bodies. Moreover, the programme will continue to bring together the relevant actors in government, industry and academia with the aim to actively contribute to the transition to a circular economy.

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