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The use of metrics in guiding transformation in resource recovery systems

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The need for systemic changes, identified from our understanding of the technical, environmental, economic and social aspects that make up our resource management systems, is important for making the transition to a resourceful future. The nature and effect of these changes is difficult to gauge mostly due to the hidden impacts that many resource recovery systems have, which have to be taken into account. For instance, studies have shown that much of our plastic waste is exported to the Far East, where it is reprocessed by workers in unhealthy conditions paid very poor wages; a hidden social and health impact (Velis, 2014; Velis, 2015). Until we have a method for weighing up all these factors, poor decisions will continue to be made.

Today, although there is a vast array of metrics for measuring environmental, economic, social and technical aspects, these are often selected based on the application and/or context in which they are commonly used, or are constraint within the limits of a method (e.g. life cycle assessment (LCA), input/output (I/O) analysis, eco-efficiency analysis, etc.) (Ingwersen et al., 2014). However, in assessing a resource management system's performance we need metrics that are useful, robust and informative, and can be measured throughout the supply chain system (Atlee and Kirchain, 2006). This holistic approach can facilitate a transparent assessment process and allow for comparisons between different scenarios of recovering resource to be made. To realise this, scientific and engineering methods that measure flows are combined with metrics that measure environmental, economic, social as well as technical benefits and impacts in order to achieve complex-value optimisation for resource recovery (CVORR). The overarching aim of CVORR is to enable robust decision-making, goal setting and adoption of sustainable practices by decision-makers, businesses, organisations, government, and the general public in a consistent, meaningful and holistic manner.

This study reviews the wide array of existing metrics used in environmental, economic, social and technical assessment of upstream (before a resource becomes waste) and downstream (when a resource becomes waste) parts of the supply chain to aid the selection of key metrics for evaluating resource recovery system's performance. It is demonstrated that metrics that combine too many indicators are less versatile and useful in making comparisons across products and industries. On the contrary, simple, broadly applicable and informative metrics are found to be more likely to be understood, used and accepted by the various actors involved in the supply chain. These simple metrics are often used in many tools and methodologies; an indication of their robustness and usefulness as well as their acceptability by the various stakeholders involved in the supply chain. For example, carbon emissions (kg CO_2 equivalent) is common in methods including LCA, eco-efficiency analysis, I/O analysis, eco-design, sustainability analysis and green design, and material cost (£/tonne) is frequently used in cost-benefit analysis (CBA), life cycle costing (LCC), eco-efficiency analysis, green design and sustainability analysis. This metrics overlap between different methods is considered to be beneficial for the selection of metrics that are universally pertinent and commonly accepted. Mapping of the environmental, economic, social and technical metrics overlaps identified between different tools and methods was carried out, and a tailored list of analytically sound metrics for incorporation into CVORR was developed. Further analysis is required to showcase the potential of these metrics in guiding transformation in resource recovery systems.

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