ASSESSMENT OF WASTE TO ENERGY AS A RESOURCE RECOVERY INTERVENTION USING SYSTEM DYNAMICS: A CASE STUDY OF NEW SOUTH WALES, AUSTRALIA

Ben Madden, Institute for Sustainable Futures, University of Technology Sydney
Benjamin.madden@uts.edu.au
Nick Florin, Institute for Sustainable Futures, University of Technology Sydney
Damien Giurco , Institute for Sustainable Futures, University of Technology Sydney

Key Words: System dynamics, waste to energy, resource recovery, waste management.

Driven by an increasing population, affluence and economic activity, waste—an almost inevitable by-product of modern production and consumption—is being generated at a rate that is growing exponentially with time in Australia. Despite the global maturity of waste to energy technology as a waste valorisation process, it is yet to be applied at scale in Australia, which has traditionally relied on landfill disposal, and more recently recycling, for the management of waste. Recent policy frameworks implemented have enabled the uptake of waste to energy in parts of Australia to divert waste from landfill, while offsetting non-renewable energy sources in the transition to a low-carbon energy landscape. However, recent policy dictates that higher order waste valorisation processes such as re-use and recycling, must not be undermined by energy recovery processes.

In this paper, we present initial findings from a system dynamics model, developed to assess interventions to improve resource recovery in a multi-stream (municipal, construction and commercial) waste system specific to New South Wales. The system under investigation is characterised by causal feedback processes between waste generation, valorisation processes, and waste management policies, making it ideal for study using a system dynamics approach, and offers benefits in terms of greater understanding of the system processes over more typical mechanistic approaches [1]. System dynamics modelling has been used in the study of sustainable waste management, and waste management planning (see [2], [3], and [4]), and has yet to be applied in the context of waste to energy in Australia. Using socioeconomic and waste management data as inputs, projected waste generation and recycling rates under reference conditions are compared to scenarios with waste to energy intervention, to estimate the potential of energy recovery in achieving local waste management targets. Several scenarios are modelled with variation in allowable feedstock criteria, fleet efficiency, and feedstock pre-treatment. Insights into the potential impacts of waste to energy on other valorisation processes are gained, and assessed against dynamic objective functions to determine an optimal waste to energy scenario. The modelling shows that waste to energy would have minimal perverse outcomes on other resource recovery efforts under current feedstock criteria.

This innovative approach is demonstrated for the case of New South Wales, Australia's largest state and biggest producer of waste. A new policy framework, the Energy From Waste Policy Statement, has recently been released, mandating allowable feedstock for energy recovery processes. New South Wales also has a set of targets specified in its Waste Avoidance and Resource Recovery strategy, describing state-wide recovery targets across the waste stream. These targets are defined as the proportion of total waste generated used in a recovery process, and not sent to landfill. Waste to energy is such a process, envisioned as part of an integrated sustainable waste management system. However there are competing effects between waste to energy, materials recycling, and waste avoidance on the efficacy of the different intervention types in meeting recovery targets. Finding the tipping point, where waste to energy in a system can be optimised for reduced carbon emissions, waste volume reduction and landfill diversion for example, without sacrificing performance in other high-valued waste valorisation processes is valuable information for waste management planners, which the developed model addresses.

References:
[1] Forrester, J. (1969). *Urban Dynamics*, MIT Press, Cambridge, Massachusetts
[2] Inghels, D. and Dullaert, W. (2011). 'An analysis of household waste management policy using system dynamics modelling', *Waste Management & Research*, Vol. 29, No. 4, pp. 351-370
[3] Sufian, M. and Bala, B. (2006). 'Modelling of electrical energy recovery from urban solid waste system: The case of Dhaka city', *Renewable Energy,* Vol. 31, No. 10, pp. 1573-1580
[4] Dyson, B. and Chang, N. (2005). 'Forecasting municipal solid waste generation in a fast-growing urban region with system dynamics modeling', *Waste Management*, Vol. 25, No. 7, pp. 669-679