

Institution: Glasgow Caledonian University
Unit of Assessment: 16
Title of case study: Driving Sustainable Waste Management Practices in Scotland
<p>1. Summary of the impact (indicative maximum 100 words)</p> <p>The impact of the research by the Caledonian Environment Centre can be demonstrated by the shift in Scotland's recycling rates from 4% in 1998 when the Centre was established, to 40% in 2011. The Centre's research methods were embedded in assessment tools which led to Scottish Councils being provided with £64m of additional annual funding. The Remade Scotland programme, hosted and developed by the Centre, between 2000 and 2010, delivered change as the first recyclate UK market development programme, and was further developed across the UK: two years later leading to the establishment of Waste Resources Action Programme (WRAP).</p>
<p>2. Underpinning research (indicative maximum 500 words)</p> <p>In partnership with Scottish and Newcastle plc, the University established a Chair of Environment in 1994 to support newly established postgraduate courses in energy and environmental technology. As Chair, Professor Jim Baird established a research centre to complement the environmental teaching programmes launched by the University in 1993.</p> <p>In the 1990's the Scottish Executive brought forward waste policies and legislation, where waste was not for disposal to landfill, but as a resource to be minimised, recovered and used within a circular economy. Interest in an early LIFE proposal by Professor Baird around the concept of integrated waste management, led to the formation of the Caledonian Shanks Centre for Waste. The research centre attracted funding to address the challenges facing the waste sector in Scotland (£550k to support an EcoSchools resource programme, and 25 postgraduate and PhD bursaries).</p> <p>In 1999 a number of public agencies including the Scottish Government, the Scottish Environment Protection Agency and Scottish Enterprise, recognised a requirement for a structured market intervention programme to promote and develop recycling in Scotland. These agencies recognised the early achievements of the Centre, and provided £1.1m of funding to support a three year development programme, REMADE Scotland (Recyclate Market Development programme). The programme's success led to Scottish Government providing a further £4.5m of funding between 2002 and 2010.</p> <p>With 15 staff the Centre also worked with other academic colleagues to develop organic waste research around the co-digestion of sewage sludge, and the bioavailability of pharmaceutical compounds in waste and wastewaters (1,2). These projects led to an EU Programme with six European partners (www.batfarm.eu).</p> <p>In 2008, a paper produced by Prof Baird and colleagues was awarded the Chartered Institution of Wastes Management (CIWM) James Jackson award for the best published paper on waste research. Prof Baird was also invited by Scottish Ministers in 2009 to be a member of Scotland's Zero Waste Think Tank. In 2013, he was elected to Junior Vice President of the CIWM.</p> <p>Some of the key research themes are:</p> <ol style="list-style-type: none"> 1. Assessment of recyclates into specific markets – the evaluation of glass as an industrial abrasive, the environmental impact of baled tyres for use in construction, land restoration using PAS100 compost, and suitability of biowaste for land reclamation, the insulation properties of shredded carpet waste, and recycling reconstituted wood. 2. Economic evaluation of market opportunities and material flows –the impact of recycling activities, treatment capacity requirements for Material Recovery Facilities, and material flows through the Scottish and UK economy, including domestic and export markets for paper and glass (3,4). 3. Evaluation of recycling performance and optimisation – Establishing key factors which affect the performance of recycling programmes. Statistical analysis of the three key factors explain 80% of the variability in the overall performance of kerbside recycling. Further research included the development of predictive methods in the economics of recycling performance including electronic waste from local authority household waste centres (5,6).

Impact case study (REF3b)

3. References to the research (indicative maximum of six references)

Details of the Centre's Research in the three themed areas are given below:

Technical Assessment of the performance of recycled materials into specific markets:

1. The Use of Stabilised Biowaste in the Restoration of former Landfill Sites, Baird J, Hipkin A, Hutton M, Savage A, Technical Report on Scottish Government website <http://www.scotland.gov.uk/Publications/2005/06/1483953/39542>
2. Pahl O, Firth A, MacLeod I, Baird J, 2008. Anaerobic co-digestion of mechanically biologically treated municipal waste with primary sewage sludge – A feasibility study. *Bioresource Technology*, 99(9), pp.3354–3364.

Economic evaluation of market opportunities

3. Assessment of the qualities of Waste Electronic and Electrical Equipment (WEEE) in Scotland, Feszty K, Murchison C, Baird J, Jamnejad G , 2003. Assessment of the quantities of Waste Electrical and Electronic Equipment (WEEE) in Scotland. *Waste Management & Research*, 21(3), pp.207–217.
4. An Assessment of the Economic and Job Opportunities Arising in Scotland in Relation to the Growth in Solid Wastes Management, 2008, Remade Scotland report commissioned by Scottish Government

Evaluation of recycling performance and optimisation

5. Model for developing Local Authority Management Strategies – produced for Scottish Government and submitted as an output in REF2.
6. Development and application of a multiple linear regression model to consider the impact of weekly waste container capacity on the yield from kerbside recycling programmes, Baird J, Reid T, Curry R, submitted and accepted, *Waste Management Research*, ISWA Journal 2013

4. Details of the impact (indicative maximum 750 words)

The research undertaken by the Centre has had a significant impact on the journey Scotland has taken in relation to sustainable waste management practices, in particular in relation to the increase in recycling. With REMADE Scotland as a major programme to provide evidential research to help formulate waste policy in Scotland, the country has moved from 4% recycling in 1998 to over 40% of household waste being recycled in 2011. The impact on the Scottish economy is significant. The REMADE Scotland programme showed that:

- 4,500 new jobs in the waste sector had been created and sustained;
- The number of waste related businesses has doubled in Scotland
- In 2012 the Scottish waste sector is estimated to have earned £1.2bn.

This represents a significant impact on the Scottish economy over the period. The evidential research produced by REMADE Scotland provided much of the intervention and support to Scottish agencies to deliver the shift towards greater resource recovery.

Two areas of intervention where the Centre's work had significant impact are given as follows:

- **Finding feedstock and markets for organic wastes material** – one of the consequences of early legislative changes which introduce limits on the amount of organic waste going to landfill, was the construction of mechanical biological treatment (MBT) facilities, several were constructed in Scotland through Private Finance Initiatives and standard procurement routes. These MBT facilities were viewed as alternatives to incineration. The consequence was the production of a biowaste output, which under Waste Framework Directive would still need to be treated as waste and in accordance with a waste permit. Our research published in 2005 resulted in guidance being produced for the Scottish Government (and found on Scottish Government website - <http://www.scotland.gov.uk/Publications/2005/06/1483953/39542>) which set out the main criteria for using the stabilised biowaste material on the restoration of old landfill sites. This work continues to provide a methodology for considering how organic waste can be safely applied to land.

Since 2010 Government interest has moved to the treatment of organic material by anaerobic digestion (AD). The west of Scotland alone has 3 recently built AD plants each capable of processing 60kt of waste per year. All three facilities were advised by the Centre on the amounts and locations of potential feedstock in support of their operations. Our research also included a

national survey of wastes arising in the hotel and restaurant sectors, the evidence of which has supported a new national voluntary initiative for the hotel sector on waste reduction.

- Assessment of recycling performance of Local authorities**– Scottish Government targets have focussed on local authorities, with all 32 Scottish local authorities being given recycling targets over the past 12 years and as such, have had to reconfigure their waste collection infrastructure. One outcome from REMADE Scotland programme was individual service level agreements with 20 authorities, valued at £250k per year over a three year period to provide bespoke support. Advice was provided on alternating weekly collection of residual and recyclable wastes, shifts in working patterns, collection crew and vehicle requirements, the development of Material Recovery Facilities, recycling centres and points. At the same time the Scottish Government established a Strategic Waste Fund, which relied on performance modelling tools developed by the Centre in appraising bids from 29 of the 32 Scottish local authorities. In effect these tools were used in the determination and approval of £65m per year of Government funding into these Scottish local authorities. The tools helped ensure value for money and maximum recycling performance was achieved. The Centre also undertook annual reviews of recycling performance across all 32 councils, presenting evidence on best practice. This led to a reduction in the number of different services being provided by Councils, to ensure maximum recycling performance and best value

Perhaps of most significance is that the Remade Scotland programme was the first waste research and market intervention programme in the UK. A similar model was later adopted by Clean Merseyside Centre, Remade Essex, Urban Mines in Yorkshire, London Remade. The Waste and Resources Action Programme was launched two years after, using the same model, and with over £250m funding, has become the UK Government's principal agency in support of a material efficient economy.

5. Sources to corroborate the impact (indicative maximum of 10 references)

Finding markets for biowaste material

The Use of Stablised Biowaste in the Restoration of former Landfill Sites

<http://www.scotland.gov.uk/Publications/2005/06/1483953/39542> This

Testimonial from Gordon Jackson, Scottish Government

“local authority recycling performance increased from an average of 8% to over 32% and this was achieved by all 32 local authorities implementing recycling waste collection and treatment services funded through the Strategic Waste Fund. In determining eligibility for grant funding it was necessary for the assessment team to determine value for money and the Scottish Government was greatly assisted in the complex process of assessing bids by a model that was developed by the Environment Centre's ReMaDe programme. The model helped Scottish Government assess disparate bids on a like for like basis and presented outputs in a clear and understandable cost per tonne basis, which took account of the time value of money. In addition to assisting the Scottish Government undertake robust value for money checks on grant applications submitted by local authorities, the model electronic input forms developed by ReMaDe increased the efficiency of the funding bid development process and aided consistency of approach between local authorities”.

Details of Other Government Reports: An Examination of the Factors Affecting the Prices Obtained by Scottish Local Authorities for Recyclable Materials, 2008, Remade Scotland for Scottish Government; Market Development for “Difficult” Materials and Non-core Recyclates in the Community Sector, 2008, Remade Scotland for Scottish Government; Scottish Food Waste Collection Trials - performance and Evaluation, 2009, for Zero Waste Scotland; An Assessment of the Economic and Job Opportunities Arising in Scotland in Relation to the Growth in Solid Wastes Management, 2008, Remade Scotland for Scottish Government; Treatment Capacity Requirements for Material Recycling Facilities in Scotland, 2009 Remade Scotland, for Scottish Government; Assessment of the Potential Landbank for PAS 100 Compost, 2009 Remade Scotland, for Scottish Government; and, Anaerobic Digestate Quality in the EU, 2010 Remade Scotland, for Scottish Government
 Scotland's Infrastructure requirements to meet 2025 targets, 2010, Remade Scotland