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Carbon Efficiency in Energy and Waste

Presentation to Sydney Branch on 6 April 2009 and to Melbourne Branch on 20 April 2009, by Peter Jones OBE, strategic advisor on waste, carbon and materials efficiency.

Until May 2008, Peter was a Director of Biffa Waste Services Limited, a key participant in the United Kingdom's 'mass balance' project (www.massbalance.org). This article is taken from the presentations and related material on the potential to convert waste to energy in the United Kingdom.

The mass balance concept is based on the fundamental physical principle that matter can neither be created nor destroyed. Therefore, the mass of inputs to a process, industry or region balances the mass of outputs as products, emissions and wastes, plus any change in stocks, hence the term 'mass balance' is used to describe this type of analysis. When applied in a systematic manner this simple and straightforward concept of balancing resource use with outputs can provide a robust methodology for analysing resource flows.

Waste strategies are often predicated on the assumption that we have a problem, and we ask "Where can we get rid of it?" and "What technology is likely to offer the line of least resistance?" In effect, we react to waste. There is an alternative approach based on establishing a consensus of probability around known economic, technological and socio-political interactions in the five-to-10-year horizon for markets in waste disposal, resources (as recyclate, electricity, heat, transport fuels or soils) coupled to regionally specific extant or predicted 'sinks' or markets for different materials in these applications.

In moving from 'end' to 'front' of pipe thinking, of particular importance is the presumption that the energy, agricultural and waste resource markets are subject to distinct, often unconnected supply and demand side influences on costs and prices. Yet the movement of resources between them is inextricably intertwined by the reality that they all 'modify' carbon in different ways to achieve an economic return on investment from different market participants. As such they will increasingly cross-compete for that carbon feedstock in ways which, to individual operators in each market, will appear erratic, illogical and unpredictable due to their lack of knowledge of these underlying price determinants outside their own 'chimney' of knowledge. Those interactions will accelerate due (mainly) to:

- probable underlying significant real price increases in the price of carbon as a fossil resource;
- nationally driven taxation and/or traded pollution permit regimes applied to carbon and resources to improve resource efficiency; and
- continued escalation in the landfill tax which will render obsolete the technology which currently acts as the major carbon reprocessor in the United Kingdom.

The approach has five stages:

Stage I

Mapping the tonnages and financials of scrap carbon, including municipal controlled waste, commercial and industrial waste, sewage and organic effluents, agricultural arisings of biomass, and forestry residues – whether these materials are left in situ or otherwise disposed. This biomass resource can then be analysed or credibly extrapolated utilising identified factual or academic assessments by sector, area, calorific value, mass, volume or other relevant parameters. Translate these inputs of scrap carbon data in 'financial equivalence' utilising current and predicted values per tonne for 2008 and (say) 2012, 2015, and 2020. This will produce a market value map by type of scrap carbon and the parameters selected. Undertake a similar exercise but this time looking at the output markets for fossil and renewable carbon-based material on current and predicted patterns.

Stage II

Mapping and matching virgin carbon market tonnages and values to produce an economic market map of financial values for required carbon demand sinks/users. As a consequence there will become apparent an understanding of carbon scale relativity in terms of tonnage, calorific equivalence and volume. This will then identify where technological shifts may be required to connect spatially the existing site 'sinks' to exploit available carbon from an adjacent 'scrap' source not currently utilised. New investment could provide an economic return in response to changing upward costs of existing carbon feedstocks to substitute cheaper sources from waste.

In the energy context such mapping would need to take account of additional investment to remove known blockages in the existing infrastructure (eg in the centralised grid distribution network of wires or pipes where bottlenecks are predicted due to demographic changes or localised increases in energy intensity). While the economic analysis will start with revenue/cost comparisons, consideration of investment decisions will need to model tradeoffs in terms of investment cost per unit of avoided carbon/MWh output/Gigajoule saved or similar measures.

This involves moving to the next level of detail in terms of defining specific sites where 'carbon processing' is occurring and evaluating them in a spatial modelling exercise to reduce overall carbon footprint matching supply and demand. Thus this stage will map all locations with a significant energy/carbon load, assessed in terms of suitability based on available space, connectivity to the relevant energy grid, motorways, rail and/or navigable waterways, brownfield status, adjacency of housing and other parameters identified.

Stage III

This requires the assessment of the narrowed down list of sites deemed suitable on current or forecast economic, spatial and social grounds. These shortlisted locations should thus represent the best possible (ie least risk) means to establish integrated carbon resource reprocessing activities. Ideally such locations would be co-located with extant or proposed electrical, gas, heat or road fuel using sites insofar as the cost of new pipes or cables usually exceeds £1 million (A$2 million) per kilometre. Additionally they should have sufficient extra space for aerobic composting, recycling and recyclate material reprocessing activities co-located to permit the movement of materials between different exit routes on a weekly, seasonal or structural basis as market conditions move. Such sites may be owned by single investors, energy supply companies, or multiple independent participants acting as shared tenants.

Electricity and combined heat and power (CHP) is presumed to be the strongest economic driver. Such CHP locations are most likely to present economically attractive investment routes to the private sector and will become the highest probability 'anchor' sites for waste carbon management. Bear in mind however that across the United Kingdom, the available energy from waste from municipal, commercial and industrial sources is unlikely to produce more than six or seven GW electrical (8% current baseload demand) or 15 GW electrical plus heat (based on estimates by the Institution of Civil Engineers). This is after withdrawal of economically viable routing of other biomass to composting or recycling due to reasons of end market value or location.

Stage IV

Once the market-driven probability profile is established (Stage II), it should be easier to define the reverse logistics infrastructure in terms of intermediate feedstock processing centres (material recovery facilities, transfer stations, etc). Stage II sites would ideally incorporate these activities for their immediate area anyway. Beyond that it will be possible to backcast into decisions on how to collect material at source and re-engineer the vehicle fleet. Common sense suggests that separation at source is likely to be more economic on the basis that it is cheaper to blend or integrate separated material for a variable series of exit routes than it is to separate collected mixed materials to a required specification of moisture, calorific value, or chlorine content, or cleanliness.

Stage V

Regional or sub-regional groupings should be in a position to make recommendations to political bodies (based on sound science) in terms of carbon impact and internality economics (and the collateral risk assessment of how these might move in the coming decade). Thereafter those suggestions need to be templated against the opportunities/threats issues in relation to employment, job creation, fuel poverty strategies and the whole debate around public acceptance.

As the capacity of plants extends beyond available supply of scrap, carbon waste disposal gate fees will begin to weaken and fall much as they did as German incineration capacity outstripped the supply of waste in the years from 2000.This will make 30-year Public Finance Initiative contracts with price indexation look increasingly foolhardy – particularly if the process technology and/or the backup logistics supply infrastructure is also carbon dioxide intensive relative to other options that might be forthcoming.

Zero carbon waste

In the United Kingdom, the carbon-based waste disposal industry's annual turnover is around £7 billion, while the fossil carbon energy sector across all fuel formats is around £100 billion. Adopting a 'zero carbon waste approach' will increasingly offer greater added value to the conventional throwaway approach to waste and at the same time position the United Kingdom to serve a growing global demand for industrial technologies and services allied to higher resource efficiency. Managing that transition is a complex and investment-intensive process but it will undeniably result in lowered whole-life impacts from waste management. Policy, fiscal, regulatory and research initiatives need to be integrated if the correct signals are to be given to unleash the scale of financial commitment needed.