

**Acceptance of Waste-to-Energy as Part of an Integrated
Approach to Waste Management is Better for the Environment
and Could Reduce Community Waste Management Costs**

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INTRODUCTION

Many countries have set targets for reducing the quantity of waste that ends up in landfill. Early waste management strategies were often based on assumptions of an impending landfill shortage or a desire to reduce the environmental impact of landfill itself, although this can be most economically achieved through landfill design and engineering. In recent years the emphasis has shifted to the recovery of resources that were perceived to be wasted by landfilled materials and this has resulted in the setting up of thousands of kerbside recycling programs aimed at recovering paper and packaging, increasingly complemented by green or yard waste programs.

Since a recycling based approach has limitations, the concept of 'integrated waste management' emerged. To many this means using a variety of treatment options including material recycling, composting and waste-to-energy (wte) to handle waste and landfilling the left-overs. Unfortunately wte tends to be dropped out of the mix for a variety of reasons and communities make do with the remaining options. Also waste policy makers, even if committed to integrated waste management, often fail to integrate waste policy with other policies which aim to reduce our overall impact on the environment, those relating to greenhouse reduction, renewable energy, resource optimisation and, ultimately, sustainability. The latter implies reducing our impact on the environment in a manner which meets social and economic objectives as well as environmental ones.

The reason wte is left out of the equation is in many cases based on the perception that it is more polluting than other means of managing waste and that, rather than recovering resources, it destroys them.

Complicating the development of appropriate waste strategies is the concept of a 'waste hierarchy' which assigns a higher place to methods of handling waste which recover materials than those which recover energy.

This paper examines the benefit of addressing these perceptions and how the use of wte in a fully integrated waste strategy can help communities to meet resource recovery and environmental impact reduction objectives cost-effectively.

PUBLIC PERCEPTION AS POLICY DRIVER

Many who live in a highly urbanised environment would regard a weekend away in a rural retreat with evenings in front of an open fire as the ideal break. They would be happy to burn timber in the fireplace but would object to the burning of organic material or wood derivatives such as paper in a wte plant. They would happily burn several tankfuls of fuel getting there and back but would be concerned about the burning of petroleum derivatives such as plastics to recover the energy content. They would object to the pollution potential of a wte plant without realising that both the open fire and the automobile were more polluting and whilst they would understand that in both cases the

'destruction' of the resource derived an energy benefit they would be less likely to see the same benefit being derived from a wte facility. Physical, material based, recycling is so much easier to visualise.

Community, state and national policies are based on similar perceptions. For example the city of Seattle chose to exclude wte from its waste strategy on the basis of public opinion.

We should also remember that politicians too are members of the public and are likely to share the same perceptions. This point was made by researchers at the Energy Systems Division of Argonne Laboratory conducting a study for the US Department of Energy into the impact of mandated recycling rates on energy consumption. The Argonne study suggests:

“Congress specifically excluded combustion for energy recovery from counting towards the recovery goals, probably because combustion is viewed as a form of disposal and therefore is assumed to waste resources and have negative environmental impacts. However, cocombustion in coal fired plants or combustion in appropriately pollution controlled waste-to-energy plants is safe, avoids landfill costs. And can displace fossil fuels - in some cases more fossil fuels than by recycling. Therefore the objectives of the proposed legislation must be examined to see if they can most effectively be met by recycling at the mandated rates or by other methods of disposition.”¹

This approach is interesting as the US government had previously adopted policies which encouraged the development of wte facilities.

German policy on packaging waste provides another example of how wte is seen as a less than optimum means of recovering resources. Although the German Packaging Ordinance sets high recovery and recycling targets for packaging and insists that all types of packaging are recovered it prohibits the use of wte as a recovery option, insisting on recovery methods not based on combustion. The measure has resulted in real problems for the plastics industry because the volume of material recovered far exceeds the reprocessing capacity and, in some cases, the available technology. This has led to a number of creative solutions including the use of plastic waste as a reducing agent in steel blast furnaces. This is not categorised as combustion because the oxygen comes from the iron ore and not the atmosphere.

The legislation is about to be changed to allow some use to be made of energy recovery under defined conditions relating to the proportion of the total energy recovered.

Germany's insistence on material recovery in preference to energy recovery has resulted in increased community costs with the cost of recovering plastics calculated at thousands of dollars a tonne.

France on the other hand allows both the recovery of materials and energy from waste and this has resulted in reduced community costs. The Netherlands government negotiated a 'Packaging Covenant' with industry which agreed to eliminate packaging waste from landfill by the year 2000 using a combination of approaches including wte. Although this objective was reached ahead of schedule it now appears that the covenant will need to be renegotiated to include minimum rates of recycling for each material type so that the Dutch scheme meets the requirements of the European Packaging and Packaging Waste Directive which insists that at least 15% of each material group is recovered through physical recycling means, although the directive itself recognises energy recovery as an equivalent means of resource recovery.

The debate in Europe is now centred on whether wte should be demoted in accordance with the 'waste hierarchy' with the result that the Directive will state a distinct preference for material recycling. Again it is felt by some that wte does less than a complete job of resource recovery.

RECYCLING AND RESOURCE RECOVERY

When householders put out an item for collection each week they see the whole item disappear and therefore it is easy to assume that in each case it is fully recovered. The high resource recovery assumption is further strengthened by pictures of bales and bales of recovered materials. So in the consumer's mind a glass bottle becomes a new glass bottle (never mind about the cap and the label) and an aluminium can becomes a new can - which needs a new lining as the old one wasn't recovered.

Recycling rates are reported on the basis of the volume of material collected rather than the amount recovered at the end of the process. It is not generally recognised that recycling is an industrial process which consumes further resources and generates wastes and impacts and that material losses occur during collection, sorting and processing. i.e. no material is 100% recyclable. Rarely is the reported waste saving discounted by the waste generated in the recycling process.

Several studies have looked at the comparative benefit of using secondary rather than virgin resources which is one way of judging the merit of recycling. A study for the US Department of Energy² into glass recycling concludes "the maximum energy saved is only about 13%" and recycling saves no energy if the glass has to travel more than 100 miles further than the distance to the landfill. The study concludes "Recycling of glass does not save much energy or valuable raw material and does not reduce air or water pollution significantly. The most important impacts are small reductions of waste sent to landfill...." (but of course glass is inert in landfill)

A similar conclusion was reached by the Tellus Packaging Study³ which aimed to put packaging policy on a scientific base. It suggested a 23% saving in overall impact for glass, ignoring all transport impacts which in the case of glass are significant. The manufacture of steel containers had an impact similar to that of glass on a volume

packed basis and this was not reduced by recycling it. Aluminium starts off with a higher per ounce packed impact but it is the only pack where impact is significantly reduced by recycling "cans made from recycled aluminium have impacts below 40% of the recycled glass level as do (unrecycled) aseptic packages (juice boxes) paperboard and HDPE juice containers"

The study also makes the point that the major portion of the environmental impact associated with packaging relates to its manufacture not its disposal with the environmental impact of disposal typically less than 1% of overall impact.

A similar theme is followed by T Kingsbury in a yet unpublished study⁴ comparing the benefits of source reduction with those of recycling. In his paper he lists energy savings by material type gleaned from a number of sources. Savings range from 75,000 Btu/pound for aluminium against a virgin material production energy of 97,500 Btu/pound down to 1000Btu/pound for glass whose virgin material production energy is 8,500 Btu/pound (Given the different pack weights for these materials it would be interesting to compare per pack savings) Plastic bottles come in at 22,000 Btu/pound saving, paperboard at 13,500 and steel cans at 5,500. Again transport impacts are excluded. In percentage terms the savings incurred range from 75% for aluminium down to 12% for glass. Plastic, paperboard and steel come in at 57%, 44% and 20% respectively.

There is no suggestion here that recycling leads to full recovery of resources whereas there is a tendency to criticise wte because not all of the energy in a material is recovered in a wte plant.

Kingsbury goes on to suggest that higher energy gains result from an emphasis on source reduction, reducing pack weight, a conclusion shared by the Tellus study.

WTE AND RECYCLING COMPARED

Several studies have compared the resource recovery potential of wte with that of recycling and have concluded that they are comparable for most combustible materials. The Argonne study into mandated recycling rates referred to above concluded that for kraft paper wte was comparable to recycling whilst a Swedish study⁵ suggests that for paper an optimised mix of recycling, where it is cost-efficient, and wte is the best solution since recycling can reduce the use of certain resources and wte can be used to conserve fossil fuel.

A collaborative study⁶ conducted in Germany recently comparing the mechanical recycling of plastics with a range of energy recovery based technologies showed that in the case of a plastic detergent bottle mechanical recycling was superior to energy recovery only when recycled plastic could be substituted for virgin plastic on a 1:1 basis (i.e. there was no reduction in function or efficiency through the use of recycled materials) In energy recovery terms, greenhouse benefit terms and renewable energy

terms the use of recovered plastic in, say, a blast furnace achieved 92-94% of the benefit of mechanical recycling. Given the high cost of recovery of plastic waste for recycling in Germany, a case could be made for sending it unsorted to a wte plant with other non-recyclable household waste.

LIMITS TO SUSTAINABLE RECYCLING

It would be easy to conclude that if recycling is good for the environment, more recycling would be even better. There is a tendency amongst waste policy makers to set and increase recycling targets on just that assumption.

Given the task of reviewing the European approach to recycling recently, the Institute for Prospective Technological Studies based in Seville, Spain reported back to the European Parliament as follows:

“Recycling is not always necessarily the preferable waste management solution since it is limited by the Second Law of Thermodynamics and obeys the law of diminishing returns. Other options such as prevention, reuse and recovery of energy can offer ecological or economic advantages over recycling according to the application area. In this light, the growth of the recycling industry is not a necessarily desirable policy target. The point is to perform recycling at its optimum rate both on an economic and environmental point of view. This optimum can vary widely according to material, location, available infrastructure, application, scientific and technological state of the art. etc.

The desirability for increasing recycling depends on its relative merits compared to the other waste management options in a given geographic area.”⁷

So what are the limits to sustainability for recycling? Obviously they vary by material and situation. Juha Kaila of Finland presented a paper on glass recycling⁸ to the ISWA workshop held as part of the R'97 Conference in Geneva in February of this year in which he suggests that if the impact of the collection vehicle is taken into account, fossil fuel use considerations would dictate a glass collection rate of between 40 and 60% and if the truck's emissions were to be the deciding factor a collection rate of between 10 and 30% was sustainable.

FRAGMENTATION OF THE WASTE STREAM

One of the consequences of the 'Integrated Waste Management' approach to waste is that it results in a multiplicity of waste streams - a stream for each 'solution'. This can result in the duplication or multiplication of waste collection systems putting more resources behind collection and sorting at increased community cost. Whereas in the old days one truck used to come past to pick up all the trash, now there can be two, three or even four separate fractions requiring collection.

Again Germany supplies an example of a trend. On top of its controversial approach to the recovery of packaging waste the German government has passed legislation to control the recovery of other materials. Called the Closed Substance Cycle and Waste Management Act it seeks to make all industry waste materials part of 'substance loops' with the producer taking the responsibility for the establishment of loops for products produced. The recovery of waste therefore becomes the responsibility of every original owner or producer of wastes or products that eventually become waste. Waste is, however, not excluded as a recovery option but restricted to materials with an inherent calorific value of 11MJ per Kg going through a plant that recovers a minimum of 75% of this energy.

The legislation targets certain industry sectors, e.g. electronics, white goods, automobiles, and will lead to the development of a multiplicity of waste streams as recovery options tend to be based on what the material recovered is (and who is notionally responsible for it) rather than what it is made of and therefore what resource recovery option best suits.

Further complicating the material recovery task is the ever increasing range and complexity of products, ones which defy disassembly. Some say products should be designed for recycling, but that too is debatable.

Dealing with the waste fraction already commonly targeted for recovery we see three continuing trends. The first is towards lighter packaging, the second is a greater variety of pack types and the third is the increased use of multi-material or multi-layer which although more efficient make mechanical recycling difficult, if not impossible. The packaging industry is doing its bit for the dematerialisation of consumption - doing more with less. Each of these trends will make recycling more expensive as a resource recovery option. To get an appreciation of the impact of these trends have a look at the packaging currently on supermarket shelves that is not being recycled. It is mostly efficient, lightweight packaging that, whilst not being recyclable can easily and safely be used as a source of energy.

THE NEED FOR RE-INTEGRATION

The tendency in recent years has been to find different things to do with different parts of the waste stream. Much of waste policy has been based on the landfill diversion imperative rather than any genuine consideration of the relative environmental merits of available alternatives or the need to base strategies on the reduction of overall environmental impact rather than the reduction of solid waste. In many cases the recovery of material resources has been pursued at the expense of energy and other resource use and the generation of a range of other impacts.

The result is a multiplicity of approaches and programs each coming at significant community cost. Again taking kerbside recycling as an example there have been a number of studies which have sought to allocate the collection cost to each of the

materials being collected. Whilst it is possible to get close to breaking even on some materials, especially in areas where landfill costs are high, plastic bottles, PET and HDPE are typically collected at a significant cost - studies show collection costs approaching \$1000 in excess of their market value. The cost of collecting and reprocessing the variety of lightweight packaging collected by the German DSD system is substantially higher. As these materials are a good source of energy it would make sense to allow them to go with the residual waste to a wte plant rather than to persist with their collection.

The disproportionately high recovery cost for some materials is largely the result of persisting with policies and strategies on prevailing perceptions rather than on substantive fact based analysis of what can be achieved in the way of impact reduction at optimum cost. The starting point of such an analysis should be the realisation that in many ways energy is the common denominator to the question of resource optimisation and impact reduction. A re-examination of options that focus on energy rather than material optimisation would show that wte has a role to play in both resource recovery and environmental impact reduction.

There is also a need to re-examine waste policy to try to bring together the divergent waste streams and treatment options as reducing their number can increase overall efficiency and cost-effectiveness.

Including wte in the range of treatment options allows the waste manager to recover resources in the form of energy from those materials currently not recyclable, materials for which there are no markets and materials which present a risk to community or worker health and wte can do so with a relatively low overall environmental impact.

If we were to take the concept of policy integration further and consider the need to take into account greenhouse issues, renewable energy, air and water impacts, inter-generational equity and sustainability in the development of a responsible waste management strategy, again wte would be the centrepiece or unifying theme.

The role of wte is recognised by many governments. It forms the focus of waste strategies for the Danish and Swiss government who have a 'here and now' approach to waste - solve the waste problem where it is generated and in the current generation. Singapore burns 85% of its waste in three modern wte plants which supplement the local coal fired power stations. Yes, Singapore does recycle paper, and aluminium for which it can find markets and has an impressive record in building and construction waste recycling.

Japan has close to 2000 plants each servicing a local community but has recently caught the recycling bug, passing legislation to increase the recovery of household recyclables. Japan's latest facility, due to come on stream this year, is part of the Tokyo Harbour Sub Centre, a new development built on reclaimed land in Tokyo Bay (an old landfill site) designed to house 60,000 people and accommodate a further 150,000 office workers

during the day. The waste generated by this community goes through underground pipes directly into the wte plant. This provides district heating, hot water and air conditioning to its host community and generates a portion of its electrical energy. Local use of the energy recovered optimises the environmental benefits.

We should continue to encourage the community to see waste as a resource but as a source of energy as well as secondary materials. A greater emphasis on energy recovery will result in opportunities to consolidate waste streams and reduce overall costs. The environment benefits from a more complete recovery of resources in a manner that has a relatively low impact and yield other benefits such as greenhouse gas reduction.

¹ Mandated Recycling Rates: Impacts on Energy Consumption and Municipal Solid Waste Volume Energy Systems Division Argonne National Laboratory, December 1993

² L.L. Gaines et al Energy Implications of Glass Container Recycling Energy Systems Division Argonne National Laboratory and National Renewable Energy Laboratory, March 1994

³ F. Ackerman et al CSG/Tellus Packaging Study for the Council of State Governments and the US EPA, Tellus Institute, May 1992

⁴ T Kingsbury Source Reduction in Recycling Terms Unpublished draft, Jan 1997

⁵ Environmental Impacts of Waste Paper Recycling International Institute for Applied Systems Analysis, Sweden

⁶ Life Cycle Analysis of Recycling and Recovery of Households Plastics Waste Packaging Materials, Fraunhofer Institute, Munchen, Technical University of Berlin and University Kaiserlautern

⁷ L Bontoux et al The Recycling Industry in the European Union: Impediments and Prospects Institute for Prospective Technological Studies, Seville, Spain, December 1996

⁸ J. Kiala Limits to Sustainable Recycling - A Case Study on Glass Recycling ISWA Workshop on Sustainability R'97, Geneva, February 1997