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Canada

R-NET

Canadian Association of Recycling Industries

RECYCLING TECHNOLOGY NEWSLETTER

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Currently, only twenty four percent of Canada's post-consumer and post-industrial non-hazardous materials are recovered. Approximately twenty three megatonnes of materials were relegated to landfills and incinerators in 2000. Canadian residential sources accounted for more than 8 megatonnes while industrial, commercial and institutional (IC&I) and construction and demolition (C&D) sources accounted for 12 and 3 megatonnes of disposed materials, respectively. Because waste generation is expected to follow the same trend as population and economic growth, Canadians will see disposal tonnages increase unless the recovery of these undervalued resources is made a national priority.

In 2000, Canada's greenhouse gas (GHG) emissions totalled approximately 726 megatonnes of carbon dioxide equivalent. Recovering our "wasted" resources through recycling or energy recovery can directly lower GHG emissions by displacing both virgin resources in the manufacture of new products and energy derived from GHG intensive fuels.

Developing a robust and sustainable framework for the recovery of valuable materials will require collaborative partnerships between all levels of government, industry associations, environmental groups, communities and businesses engaged in activities that will foster a shift in the paradigm of "waste" to "resource". Such activities include: developing technology, infrastructure, fiscal and regulatory environments, education and awareness programs that advantage recovery practices. Besides substantial contributions to Canada's Kyoto Protocol commitments, long-term sustainable resource recovery will benefit Canadians by:

- Conserving natural resources and reducing outputs of waste to the environment
- Increasing competitiveness through the development of globally marketable products, processes and expertise
- Strengthening communities via social engagement and connectivity
- Enhancing business and employment opportunities

This issue of R-NET will examine the benefits of recycling with particular emphasis on the issue of climate change.

Michael Clapham
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The R-NET team has received numerous requests for copies of the papers we abstracted. We cannot, however, supply copies of the full articles since their reproduction is strictly prohibited through copyright. If you cannot access these articles through your library, please contact the Canadian Institute for Scientific and Technical Information (CISTI) at the National Research Council Canada. More information about CISTI services can be found on the Internet at **http://www.nrc.ca/cisti/**

Please keep writing to us with your ideas and suggestions. Share your success stories with us, do not forget to tell us about meetings and conferences that you are organizing, and be sure to let us know if you mention us in any of your publications.

Également disponible en français sous le titre R-NET... Bulletin d'information sur la technologie du recyclage.

ACTION PLAN 2000 ON CLIMATE CHANGE: MINERALS AND METALS

ENHANCED RECYCLING

Between 1990 and 2000, Canada's greenhouse gas (GHG) emissions had risen from 607 megatonnes of carbon dioxide equivalent (Mt eCO_2)/year to 726 Mt eCO_2/year. To reach Canada's Kyoto target of 571 megatonnes eCO_2/year by 2010 will require a 29% or 238 Mt reduction from the projected "business as usual" emissions of 809 Mt eCO_2/year. As part of the Government of Canada's *Action Plan 2000 on Climate Change*: *Minerals and Metals* Natural Resources Canada (NRCan) oversees a 5 year Climate Change Program that aims to contribute an overall reduction of 1.65 Mt eCO_2/year by 2010 with work in the following areas: *Supplementary Cementing Materials*, *Concrete Roads*, *Studies to Develop Options for GHG Reduction* and *Enhanced Recycling*. This article highlights the *Enhanced Recycling* segment of the aforementioned program.

The objective of *Enhanced Recycling* is to reduce annual GHG emissions by 700,000 tonnes eCO_2 by 2010 through increasing aluminum and steel recycling by 100,000 tonnes/year and 200,000 tonnes/year, respectively. Steel and aluminum are already recycled within Canada to a large extent, however because of the high GHG emissions associated with the primary production of these materials, every opportunity to increase recycling rates and fine-tune recycling and recovery infrastructure should be explored. *Enhanced Recycling* brings together experts from municipalities, provinces, recycling organizations, industry and consumer associations to address major issues, identify gaps in knowledge, communication and current approaches and transfer information and technology.

There are many impediments to increased recycling including unavailability of consistent and meaningful statistics on which to base decisions and the lack of uniform approaches for collecting, sorting and processing materials. As well, many manufacturing specifications restrict the use of recycled materials. Evaluation of these specifications, including testing the quality, durability and safeness of products made with recycled materials is required to increase consumer confidence in recycled products, thereby increasing demand and generating sustainable markets. For example, mandating minimum recycled content in Canadian goods would ensure a market demand for secondary materials.

The main activities associated with *Enhanced Recycling* include:

- Identification of regulatory and economic factors that may impede or promote metals recycling, both nationally and internationally
- Development of life-cycle analyses for specific material streams to understand recycling costs and benefits
- Formation of a multi-stakeholder (metal producers, fabricators, government represen tatives, environmental non-governmental organizations and recycling associations) National Recycling Council to develop communication networks and facilitate the transfer of knowledge and technology
- Compilation of comprehensive recycling statistics as well as supply and demand data for Canadian minerals and metals
- Evaluation of the environmental and economic soundness of various recovery approach es

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Strategies to meet *Enhanced Recycling* objectives are already well underway. During the fiscal year 2001/2002 two meetings of a multi-stakeholder advisory group resulted in the approval of a number of undertakings, such as:

- A series of discussion forums/consultations sessions across Canada in the spring of 2002 identified regionally specific resource recovery issues and viable resource recovery initiatives. Sessions in Vancouver, Yellowknife, Edmonton, Toronto, Halifax, Montreal and Iqaluit included participants from industry, non-governmental organizations, academia and municipal, provincial/territorial and federal governments. Comprehensive reports for each session are available, in English and French, on NRCan's *Recycling in Canada* website at http://www.recycle.nrcan.gc.ca/ The consultations are described in the next article.
- Two-day workshops on Canada/USA regulatory systems, designed by NRCan, will be held across Canada in conjunction with regional partners. The workshops will expand awareness and build capacity for the implementation of sustainable development tools among small and medium sized enterprises.
- A collection of electronic fact sheets on the environmental benefits of mineral and metal recycling, including GHG emissions and energy savings, will be developed by the Recycling Council of Ontario. When completed it will be available on a forthcoming waste minimization website.
- The Recycling Council of Alberta will generate a comprehensive list of Canadian mineral and metal recycling programs as well as examine the success of these programs and their potential impacts on GHG emissions.
- The Information Technology Association of Canada and Environment Canada have developed a national action plan for end-of-life IT and Telecom equipment.
- The Federation of Canadian Municipalities and Environment Canada are developing a guidance document for community leaders that will aid in decisions about waste management options. The guide will examine current solid waste management policies and discuss their limitations and success with respect to diversion rates, potential revenues, implementation costs and environmental impacts.
- NRCan's Mineral and Metal Policy Branch has completed a review of Canada/U.S. computer recycling regulations to support the possible development of a producer responsibility program in Canada.
- CANMET (NRCan) is conducting a study of major recycling and refining technologies used in the steel, magnesium and aluminum industries. Various approaches will be assessed in terms of climate change impacts and energy efficiency and the findings will be transferred to Canadian companies.
- Hatch Associates is preparing an evaluation tool that can be used to assess the potential for Canadian industry to establish innovative approaches such as by-product synergies.

This collection of projects will serve to enable Canada's mineral and metal recovery capabilities and leverage long-term sustainability in industry.

Recycling Steel and Aluminum

When a material is landfilled, the equivalent amount must be produced from either primary or recycled materials to replace this "lost resource". According to the Environment and Plastics Industry Council (EPIC), Canadians landfill about 180 kt of aluminum and steel cans every year.

Aluminum: The majority of Canada's GHG emissions come from the production and use of energy, therefore dramatic emission reductions can be achieved by developing strategies

Cloudy Skies: Assessing Public Understanding of Global Warming
J. D. Sterman, L. Booth Sweeney
http://web.mit.edu/jsterman/www/cloudy_skies.html
This is a thought-provoking article about global climate change and the misconceptions held by well-educated individuals about the topic. The authors tested people's intuitive understanding of the most basic stock and flow structures governing the climate. Their subjects were graduate students from Massachusetts Institute of Technology (MIT) and Harvard enrolled in the introductory system dynamics course at the MIT Sloan School of Management and students at the Graduate School of Business at the University of Chicago. Students were asked to predict the response of the climate system to various scenarios of CO_2 emissions or concentrations. Overall performance was poor: a warning that the errors and misconceptions exhibited by highly educated adults constitute a serious challenge to informed debate over climate change policy.

The common misconceptions support "wait and see" attitudes ("if warming turns out to be greater and more harmful than expected, policies to mitigate it can then be implemented…"). "If people don't recognize the existence of important feedbacks, time delays, and stock and flow structures in the climate system, or if they are unable to relate these structures to the dynamics of the climate, they are likely to draw erroneous inferences about the response of the climate to human activity." The authors note that the policy debate has become a fight to stabilize the emission ***rate***, not the stocks of greenhouse gases that drive the climate.

The authors give a comprehensive, easy to follow summary of climate change dynamics and support their arguments with information from the

Intergovernmental Panel on Climate Change (IPCC). The IPCC reports that anthropogenic GHG addition rates currently exceed removal rates by a factor of two, meaning that humanity is injecting CO_2 into the atmosphere at about twice the rate it is drained out. Therefore, to stabilize atmospheric GHGs at present record levels, current GHG emissions would have to be reduced by 50%. Such reductions greatly exceed the Kyoto targets.

Sterman and Booth Sweeney maintain that actions to halt warming must be taken now, before the extent and consequences of warming are known. Unless the population is equipped with opinions substantiated by their own deductive reasoning of climate system relationships, they will be ill equipped to support these actions. This, in turn, will result in the perpetuation of complacency and misinformation within society.

ADDITIONAL READING:

1. **Bathtub Dynamics: Initial Results of a Systems Thinking Inventory**
L. Booth Sweeney, J.D. Sterman
http://web.mit.edu/jsterman/www/Bathtub.html

2. The Intergovernmental Panel on Climate Change (IPCC), established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation can be found on the Internet at ***http://www.ipcc.ch/***. IPCC was instrumental in establishing the Intergovernmental Negotiating Committee for a UN Framework Convention on Climate Change (UNFCCC) by the UN General Assembly, which was adopted in 1992 and entered into force in 1994. The Second Assessment Report, *Climate Change 1995*, provided key input to the negotiations, which led to the adoption of the Kyoto Protocol in 1997. The Third Assessment Report, *Climate Change*

that target energy consumptive processes. Have you ever considered the energy it took to produce the aluminum can you just threw in the trash? When aluminum is recycled, the substantial GHG emissions associated with bauxite mining, refining (to aluminum oxide) and smelting (to aluminum) are eliminated. In fact, recycling aluminum requires only 5% of the energy required to produce primary aluminum. While primary aluminum production may use predominantly "clean" (hydroelectric) energy in Canada, recycling still represents energy savings: energy that could be applied to other purposes. According to the International Aluminium Institute, world recycling of aluminum saves about 84 Mt eCO_2/year. About 30% of Canadian use of aluminum comes from recycled materials.

Besides energy emissions, primary metal production is associated with significant *process emissions* (GHG emissions arising as a direct by-product from an industrial process). Aluminum electrolysis (reduction of aluminum oxide to aluminum) generates potent GHGs called perfluorocarbons (PFCs) during brief upset conditions known as "anode effects". An anode effect is basically a short circuit that occurs when alumina (aluminum oxide) levels become too low. The PFCs: CF_4 and C_2F_6, have global warming potentials of 6500 and 9200, respectively and therefore even small emissions of these gases are significant. According to *Canada's Greenhouse Gas Inventory 1990-2000*, average PFC emission rates range from 0.3 to 1.1 g of CF_4 and 0.02 to 0.1 g C_2F_6 for every kilogram of primary aluminum, depending on the type of reduction technology used.

Electrolysis also produces CO_2 directly when carbon anodes are consumed by oxygen. *Canada's Greenhouse Gas Inventory 1990-2000* estimates CO_2 production to be between 1.54 and 1.83 kg for every kilogram of primary aluminum. According to the Aluminium Association of Canada (AAC), the intensity of CO_2 emissions from primary aluminum production has decreased from 5.59 tonnes CO_2/tonne aluminum in 1990 to 3.94 tonnes CO_2/tonne aluminum in 2000, owing mainly to improvements in process control. The industry is currently at work trying to development non-consuming or inert anodes that will not produce CO_2.

Steel: According to Industry Canada, emissions rates (per tonne of steel shipped) are roughly 3 times greater for integrated plants (primary inputs) compared to Electric Arc Furnace plants (already smelted scrap inputs). The GHG savings associated with recycling steel (versus primary production) may seem small (approximately 0.9 tonnes CO_2/tonne steel) compared to aluminum recycling. When applied to the 15 Mt of steel that are produced in Canada each year, however, these savings represent an opportunity for large emissions reductions. Although the recycling rate of steel in Canada is already quite high, at approximately 65%, it could be improved. According to the Integrated Waste Management Tool (EPIC and CSR: Corporations Supporting Recycling), 1 tonne of steel cans collected at the curbside represents a potential energy savings of 17.5 GJ if recycled.

Environment Canada reports that primary steel production consumes 22.8 GJ of energy derived from coal (69%) and natural gas (24%) while recycled steel consumes 9.3 GJ of energy derived from electricity (39%) and natural gas (59%). Because coal combustion produces 20 to 35 times more CO_2 than natural gas, every opportunity to recycle steel should be promoted.

For more information contact Linda Wilson, Manager, Climate Change, MMS/MTB/MMSL, Natural Resources Canada, Phone: (613) 995-4133, Fax: (613) 947-1200, Email: lwilson@NRCan.gc.ca

Canadian Resource Recovery Strategy

Resource recovery promotes environmental and economic sustainability by reinputting used materials and energy back into the economy. The development of the Canadian Resource Recovery Strategy (CRRS) evolved from an identified need for coordinated actions towards removing barriers for the effective recovery of these secondary resources. There is no current federal program that focuses on resource recovery and many opportunities to save natural resources and reduce releases to the environment, including greenhouse gas emissions, are not being realized.

To define national resource recovery needs and priorities and gauge support for the CRRS, Natural Resources Canada held a series of consultation sessions across Canada, in the spring of 2002. Participants at sessions in Vancouver, Yellowknife, Edmonton, Toronto, Halifax, Montreal and Iqaluit represented resource recovery stakeholders from industry, non-governmental organizations, academia and municipal, provincial/territorial and federal governments.

Most importantly, the consultation sessions served as a platform to informally gather over 200 proposals for feasible resource recovery projects. The proposals indicate the nature and range of needs across the country and include innovative approaches to overcoming the barriers associated with successful resource recovery in industrial, post-consumer and institutional sectors. The scope of the proposals ranged from preliminary concepts to well-defined projects with identified funding and partners, including:

- Demonstration projects that would evaluate the technological and economic feasibili ty of small-scale mobile technologies and shared specialized facilities, as well as energy recovery and composting techniques
- Communication projects that would include public education and awareness cam paigns, the mapping and inventory of secondary material flows through different sectors and the development of knowledge exchange networks for producers and consumers of secondary materials
- Policy and regulatory studies that would harmonize product and industry standards with resource recovery efforts and ensure Canada's regulatory and fiscal mechanisms for secondary resources are internationally progressive and competitive
- Infrastructure support projects that would promote cross-sectoral by-product syner gies and encourage self-sustaining, small-scale initiatives in northern and rural communities

The most important barriers to resource recovery are not deficiencies in knowledge or technology but attitudes, economic factors, existing regulatory frameworks and lack of information. The consultation sessions were invaluable in defining the scope of stakeholder responsibilities in addressing these barriers. First and foremost, it is important for political leaders to speak strongly in support of resource recovery and to aid in setting a national goal to guide collective action. The federal government, in particular, can be instrumental in establishing and sustaining markets for secondary materials. Specific suggestions for government included:

- Establishing incentive programs for industry and business that focus on rewards for progressive resource recovery
- Reinvesting revenues gained from resource recovery fees, taxes, and deposit schemes back into resource recovery
- Leading by example through their own procurement policies and internal operations

2001, is available online at IPCC web site. The full report is available in English. Parts of the report (*Summery for Policymakers* and *Technical Summary*) are available in French and Russian.

Recycling Automotive Magnesium Scrap

G. Hanko, H. Antrekowitsch, P. Ebner

Journal of Metallurgy ***2002****, 54(2), 51-54 (Eng)*

Magnesium alloys are becoming widely used in the automotive industry for light parts. The diversity of these alloys poses recycling challenges. The European guideline for disposing of old automobiles requires that by January 2006, 85% of vehicle weight must be recovered and at least 80% of vehicle weight must be reused. The authors present a comprehensive discussion of the economics of magnesium recycling, scrap categories and the current technologies used to recycle magnesium scrap from automotive components. Because the quality of a recycled magnesium product is ultimately dependant upon the quality of the scrap, this article details the many factors involved in recovering and refining diverse magnesium products including removing impurities, coatings and contaminants.

Impact of the European Union Vehicle Waste Directive on End-Of-Life Options for Polymer Electrolyte Fuel Cells

C. Handley, N.P. Brandon, R. van der Vorst

Journal of Power Sources ***2002****, 106, 344-352 (Eng)*

The number of fuel cell passenger cars is expected to reach 2.1 million by the year 2010. Over the years that follow, millions of fuel cells will reach their end-of-life. This emerging market, coupled with the European Union vehicle waste directive that imposes strict recycling targets on vehicle manufacturers, necessitates a study of the end-of-life options for fuel cells. The authors have used a life cycle assessment (LCA) to determine the optimum management strategy for the polymer electrolyte membrane fuel cell (PEMFC) stack. Each element of the stack (the electrolyte, platinum/ruthenium electrocatalysts, bipolar plates and ancillary components) has been evaluated in terms of environmentally and economically feasible recycling methods and ease of disassembly. Recycling of both the fluorinated membranes and the bipolar plates imposes specific design problems and requires specialized processes. Incineration of the bipolar plates for energy recovery is discussed, as is the solvent extraction process for the recovery of platinum and ruthenium. Techniques and infrastructure are readily available for recycling ancillary steel and aluminum components. Based on the results of the LCA, the authors propose an end-of-life management strategy for the fuel cell stack and discuss the future impacts that the EU vehicle waste directive will have on this technology.

The Recycle of Wrought Aluminum Alloys in Europe
V. Kevorkijan
Journal of Metallurgy ***2002****, 54(2), 38-41 (Eng)*
In the European community, increasingly high demands for aluminum based products have increased concerns for the future of this resource. To be competitive in this marketplace, producers must keep production costs low while maintaining a quality product. Because producing wrought aluminum alloys from scrap consumes 15 times less energy than producing alloys from the raw material, the availability of scrap in a region directly affects its production rates and costs. This comprehensive article addresses the problems encountered by European producers outside of the European Union that have lower aluminum consumption rates and consequently are at a distinct disadvantage obtaining well-priced scrap in sufficient quantities. Also discussed are the various types of aluminum scrap, the many diverse uses of aluminum, and the quality control and logistics of scrap remelting. The future of the industry will require a market that balances primary aluminum production with old scrap recycling to meet the demands of the global economy.

- Internalizing social and environmental costs into the prices of waste disposal, energy use and virgin resources

While government should develop policies and regulations that favour resource recovery, legislative and fiscal mechanisms aimed at increasing resource recovery must consider regional distinctiveness and address the unique challenges posed by Canada's geography, population distribution and climate. Participants particularly emphasized the unique requirements of rural and northern communities.

The role of industry stakeholders was discussed in terms of extending producer responsibility to the entire lifecycle of their products and services. Because of the global aspects of trade in Canada, it is difficult to impose legislation with respect to product design and manufacturer responsibilities that will be fair to small businesses and not jeopardize the competitiveness of Canadian producers.

The concept of by-product synergies, where one industry's waste becomes another industry's feedstock, was brought up in numerous sessions. The existence of viable markets for post-industrial materials would promote by-product synergies and industry would be motivated to design their waste streams to fulfil particular market niches. When the end-of-life fate of residual materials and energy can be profitable, there is greater incentive to invest in strategies that eliminate unrecoverable wastes.

Specific barriers to resource recovery:

- Perceptions that used products are inferior
- Lack of education and awareness about the benefits of resource recovery
- For sparsely populated, rural and northern communities, inadequate economies of scale and large distances to markets make resource recovery too costly
- Supply of secondary materials is often independent of demand contributing to unstable markets
- Low costs of virgin materials, waste disposal and energy encourage wasteful practices
- Lack of existing infrastructure for collection, storage and distribution of secondary materials
- Lack of financial resources to invest in new infrastructure and resource recovery initiatives
- Lack of communication between producers and consumers of secondary materials (what is available, who needs what) inhibits their mutually beneficial exchanges
- Policies and regulations that hinder economic recovery of secondary materials

There is a need to develop a national inventory of secondary materials and map the flows of these materials between producers and potential consumers. Important by-product streams that should be targeted were identified, including: energy from industrial and post-consumer activities; marketable materials like paper products, metals and plastics; obsolete electronics; and compostable organic food and yard wastes. A Virtual Centre of Excellence in Resource Recovery could serve as a portal for knowledge exchange to link stakeholders in all sectors, encourage collaboration, and eliminate the duplication of efforts.

A national strategy would endeavour to strengthen existing resource recovery initiatives. The CRRS would not attempt to 'reinvent the wheel' and would support initiatives that are already working at community and national levels: initiatives that improve the value of by-products, provide social and environmental benefits and are economically and technically feasible. The publicity and educational value of existing and future initiatives should be maximized to generate enthusiasm for resource recovery. The next step for the proponents of CRRS will be to present a business case to parliament for federal approval and funding. A formal process for inviting project proposals would follow.

Comprehensive reports have been compiled from each session and the key points of all sessions have been summarized in a Final Report entitled *Consultations on a Canadian Resource Recovery Strategy*, now available at (www.recycle.nrcan.gc.ca/ or www.recyclage.rncan.gc.ca/).

Recognizing Greenhouse Gas Emissions in Waste Management

The way a product is managed at the end of its useful life can directly affect greenhouse gas (GHG) emissions by having significant impacts upon energy consumption, process emissions (when GHGs are produced as a direct by-product of manufacturing), methane emissions and carbon sequestration. The United States Environmental Protection Agency's Office of Solid Waste (EPA/OSW), in their 1998 publication *Greenhouse Gas Emissions from Management of Selected Materials in Municipal Solid Waste*, has adopted a comprehensive life-cycle methodology to develop emission factors for source reduction, recycling, composting, combustion and landfilling of the most prevalent materials found in municipal solid waste.

The emission factors represent the net effect on GHG emissions, when direct emissions of the waste management practice, avoided emissions due to virgin material or energy displacement, and changes in carbon stocks are considered. For example, the practice of landfilling organic materials releases methane gas - a potent GHG with 21 times more global warming potential than carbon dioxide. However, the methane gas, if collected and used as an energy source, can potentially displace GHGs from the utility sector. Recycling eliminates the emissions associated with raw materials extraction and processing, and also, in the case of paper, conserves forests and thereby increases stored carbon. The EPA has made available a Waste Reduction Model (WARM) spreadsheet tool (http://yosemite.epa.gov/oar/globalwarming.nsf/content/ActionsWasteWARM.html) that incorporates these emission factors and allows users to compare the GHG impacts of altering their current waste management practices.

In their report *Opportunities for Reducing Greenhouse Gas Emissions through Residential Waste Management* (March 2002), the Environment and Plastics Industry Council (EPIC) has supplemented the EPA/OSW information with representative Canadian waste generation data to provide a thorough commentary on the implications of different methods of waste management. Canadian waste management professionals will find this article a useful reference when designing integrated waste management strategies that minimize GHG emissions. A Technical Report Summary of this document, entitled *Cutting Greenhouse Gases Through Waste Wise Management*, is also available on the EPIC website at http://www.cpia.ca/StaticContent/StaticPages/epic/ (in *Publications*, under *Reports and Technical Materials*).

In addition, EPIC and Corporations Supporting Recycling (CSR) have commissioned the development of an *Integrated Waste Management Model for Municipalities*; a tool that aids waste management professionals in determining both the environmental and economic per-

Et cetera...

FROM OUR MAIL FOLDER

R-NET contacted the City of Iqaluit to find out about northern/remote communities approaches to the management of wastes and surplus materials. We were pleased to receive the following response:

A GREAT DEAL OF WORK has been done on our [Iqaluit's] waste management program since August 2001. In December the first household recycling program was launched. The goal of the program is to divert as much waste from the landfill as possible. We have traditionally burned our garbage and burning plastics has been declared unacceptable by our residents. The recycling program is successfully diverting a large amount of household plastics and metals. A baler was purchased and shipped up in the summer. The first separation (of recyclables collected in blue bags) effort took place at the end of August. Several containers are currently on their way to recycling depots in Quebec.

Short Term Plan

It was decided in February of this year [2002] to implement landfilling at the current waste site to replace burning as the primary disposal method. To this end several large purchases have been made. A compactor, a loader, and a structure to house the equipment (and continue separation and baling of materials), have all been sourced. A large amount of granular material has been transported to the landfill site to be used as the daily cover of waste. Training of staff and rewriting operation and maintenance manuals is ongoing at this moment. We will soon be able to extinguish the fire for good.

Medium Term Plan

It has been recognized that the current waste site can only be used for a few more years. To quantify its longevity we commissioned a waste audit. We will soon have up to date projections of waste composition and volume for a twenty year horizon. With this information we will be able to better target and expand our waste diversion initiatives. We will also be able to redevelop the current site to accommodate the expected waste. This work is considered the 'medium term plan' and will be worked on throughout 2003.

Long Term Plan

It is expected that, within 5 years, the current site will no longer be able to be manipulated and redeveloped to meet our waste disposal needs. Planning for a new site will begin in earnest late next year [2003] and throughout 2004. This task is expected to be very difficult as the availability of easily accessible land is very low. Community concern over the placement of a new landfill will be a prominent issue in the discussions.

Barriers to Waste Management

Financing is always the greatest barrier to developing an environmentally friendly and complete waste management program. Only a year ago our organization was considering the installation of an incinerator. Incinerators are used throughout Greenland (a similar climate to us) to dispose of waste and produce heat for homes. It became clear to us that we would not be able to raise the $12M in capital required - a great deal of money for a town of 6000. As such we have opted to make very gradual changes to our waste program and attempt to meet some important milestones such as ceasing the burn. Financing will continue to be a concern as we plan for a new site. Distance and weather are also barriers in the Arctic. Note above that we sourced items and worked on the landfill site in the summer. This is the only time we are able to make major changes to our program as the ground thaws in June and the boats arrive in July. We have about 5 months to work. This requires advanced planning - a difficult thing when budgets are not always known until March at the earliest. Distance has also been a barrier to rapidly expanding our waste diversion program. We either have to ship the recyclables in the summer or beg the airlines to take the materials as ballast. Then we may or may not be able to convince someone in the South to accept our materials. This is an added burden to being environmentally friendly in Iqaluit.

Matthew Hough
Director of Engineering, City of Iqaluit
October 30, 2002

formance of different waste management practices applied to various materials. Not only are GHG emissions calculated, but the tool has also been extended to include other impacts to land, air and soil including smog precursors, heavy metals and acid gases. The Excel model with a Visual Basic interface allows users to enter their own regionally specific data, including: the composition and quantity of different materials collected by the region; how much and what is recycled, landfilled, composted, or converted to energy; the electricity mix in use by the region; collection and transportation data; sorting facility distance to reprocessors of waste materials; energy use at the sorting facility; and details about landfill gas and/or energy recovery. The model is an example of how valuable life-cycle analyses are to real-life decision-making. Check out http://www.iwm-model.uwaterloo.ca/ for a detailed description of this project.

There is a vast amount of information available today about the climate change impacts of various practices (i.e., manufacturing, waste management etc.) for different materials. It is important to scrutinize any data carefully e.g.,- does this emission factor include process emissions, raw material extraction emissions, transportation emissions?, before effective comparisons can be made.

Industrial Ecology

INTERFACING INDUSTRY WITH THE ENVIRONMENT FOR SUSTAINABLE DEVELOPMENT

What is industrial ecology?

Just as natural ecosystems transform energy in a continual flux of birth, growth, death and regeneration, humans transform energy derived from nature to produce commodities in industrial processes. While energy transformations and exchanges in ecosystems are cyclical and 100% efficient (every product becomes a resource for use in another process) industry is characterized by linear systems. This one-way depletion of resources and build-up of wastes, coupled with the exponentially increasing demands of a growing world population, is not sustainable.

Industrial hierarchies include:

- Internal systems (manufacturing processes and product lifecycles)
- External systems (commodities markets, and the relationships between industries in the same sector or region)

The term *industrial ecology* applies to the broad study of material and energy flows in human industrial processes and how these processes can be interfaced harmlessly with the natural world. By considering the environmental impacts at every stage of a product or process lifecycle, industrial ecology acknowledges that the industrial and natural world are not discrete entities; they overlap, intermingle and are intimating connected. Industrial ecologists use a systems approach to examine the efficiency of exchanges among the organizational hierarchies of industry and society with the aim of modelling these human systems to mimic nature's wasteless material and energy exchanges.

The consequence of present day industrial practices

When a human process yields residuals in the form of energy and material, there are two options for its fate: either these residuals are re-inputted into another production process or they are outputted to the environment. In the environment, they may be incinerated, landfilled, or stockpiled, or they may enter the air, water or soil to ultimately alter the dynamic equilibrium of a natural pathway. Not all anthropogenic additions to natural pathways need be harmful: ecosystems have a tremendous ability to adapt and shift their equilibrium, but there are limits to nature's capacity to absorb waste.

Consider the 30% increase in atmospheric carbon dioxide concentration since the beginning of the industrial revolution. Carbon has been cycled for millions of years between organisms and their environment through the processes of respiration, photosynthesis, growth and decay. Deforestation and increased land cultivation have decreased carbon sinks while burning fossil fuels has increased the carbon sources. As a result, the carbon cycle is faltering and leading to concerns about climate change.

Industrial symbiosis

'Closing the loop' on industrial systems refers to designing cyclical and self-sustaining processes like those observed in nature from today's linear and consumptive processes. 'Closing the loop' can be applied externally to groups of industries by creating eco-industrial parks or internally by streamlining product lifecycles and manufacturing processes to eliminate waste. The most famous eco-industrial park is in Kalundborg, Denmark. Kalundborg is an example of industrial symbiosis or by-product synergy: a process whereby a waste product from one industry can be marketed as a resource to a neighbouring industry, to the mutual benefit of both industries and to the environment. The success of this concept mirrors nature's limited ability to absorb human outputs, in that the demand for residuals must be equal to the amount of materials and energy discharged. The success of this type of industrial relationship requires products and processes to be designed so that unrecoverable wastes are eliminated.

Typical product lifecycle stages include:
- Pre-production (raw materials acquisition)
- Manufacturing, shipping and distribution
- Use by consumers
- Fate after use (disposal, reuse or recycling)

A tool of industrial ecology

A lifecycle assessment (LCA) is a good example of how individual companies can use a systems approach to develop environmentally friendly products and sustainable processes. An LCA traces material and energy throughputs at every product lifecycle stage using material flow diagrams. A material flow diagram can also be used to trace the flow of a particular commodity through entire industrial systems.

By characterizing all material and energy transformations with an inventory analysis, an impact assessment can evaluate each transformation according to its theoretical or observed effect on human and ecosystem health, stock of resources, or social welfare. These types of assessments are very complex and require the collaboration of experts in the fields of politics, toxicology and natural resource management, to name a few.

Because impact assessments require enormous investments of time and money they are not feasible for every product that passes through the cycle of human industry. Large corporations find them useful for redesigning processes and products to meet emission and efficiency targets while governments use them to devise standards and controls for industry.

Events

COM 2003: The Conference of Metallurgists

August 24-27, 2003
Vancouver, British Columbia, Canada
Contact: MetSoc of CIM
Phone: (514) 939-2710, ext. 317
Email: metsoc@cim.org
Web: www.metsoc.org/

22nd Annual Congress and Exposition: Charting a New Course for Recycling

National Recycling Coalition
September 14-17, 2003
Baltimore, Maryland, USA
Phone: (202) 347-0450
Web: www.nrc-recycle.org/congress/

European Metallurgical Conference 2003

September 16-19, 2003
Hannover, Germany
Phone: +49 5323 93790
Email: EMC@GDMB.de
Web: www.emc.gdmb.de/

Combustion Canada Conference 2003

September 22-24, 2003
Vancouver, British Columbia, Canada
Phone: (613) 947-5190
Fax: (613) 995-9584
Email: nicole.miljour@nrcan.gc.ca
Web: www.combustioncanada.ca/

ENTSORGA 2003

September 23-27, 2003
Cologne, Germany
Phone: +49/(0)221/934700-90
Email: entsorga@koelnmesse.de

Composting Council of Canada 13th Annual National Conference, Exhibits and General Meeting

September 24-26, 2003
London, Ontario, Canada
Phone: (416) 535-0240
Fax: (416) 536-9892
Email: ccc@compost.org
Web: www.compost.org/

2003 Recycling Council of Alberta Fall Conference and AGM

September 24-26, 2003
Calgary, Alberta, Canada
Phone: (403) 834-6563
Email: info@recycle.ab.ca

The 22nd International Mineral Processing Congress

September 28 to October 3, 2003
Cape Town, South Africa
Email: impc@chemeng.uct.ac.za
Web: www.impc2003.org.za/

WASTECON® 2003

Solid Waste Association of North America (SWANA)
October 14-16, 2003
St. Louis, Missouri, USA
Contact: Denise James
Phone: (800) GO-SWANA (467-9262)
Email: wastecon@swana.org
Web: www.wastecon.org/

Environmental Law & Regulation in Ontario, New Enforcement Priorities - New Regulatory Developments

October 15, 2003
Toronto, Ontario, Canada
Phone: (416) 927-7936
Phone (toll free): (877) 927-1563
Fax: (416) 927-1563
Web: www.canadianinstitute.com/

Cleaner Cities - Cleaner Environment From Littering to Producer Responsibility

October 20-23, 2003
Vienna, Austria
Phone: +43 1 866320
Fax: +43 1 86632-33
Email: office@gutwinski.at
Web: www.gutwinski.at/

1st World Summit on Ethanol for Transportation

November 2-4, 2003
Québec City, Québec, Canada
Phone: (719) 942-4353
Email: conferences@bbiethanol.com
Web: www.bbiethanol.com/worldsummit/index.html

The final step is an improvement analysis, whereby steps are taken to mitigate any negative impacts determined in the previous stages. Examples of improvements could be:

- Downcycling former outputs back into production processes and using recycled materi als and energy
- Investing in cleaner, more efficient technologies
- Reducing emissions to water, air and soils with abatement technologies
- Forming partnerships with other industries to create markets for used materials and energy
- Designing products that use benign materials, have a planned fate at the post-consumer stage, and are easy to repair and disassemble

Challenges to achieving sustainability

Often, health, happiness, and sustainability are overlooked when a society examines its prosperity. These abstract concepts of well-being cannot be quantified and, as a result, success is equated with present day profits in dollars. To conserve the environment for future generations, society must redefine its economic systems to reflect true measures of wealth. Partnerships between government and industry can shift market demands from virgin to recycled resources. Businesses will undoubtedly see increases in profits when wasteful processes are defined and eliminated through the LCA approach and environmental planning. Industries can benefit by sharing and trading residual energy and materials with reduced waste disposal costs and increased revenue from recovered resources.

The term industrial ecology is meant to provide a framework within which human interactions with the biosphere can be examined and redesigned to ensure sustainable development. Sustainability is not just the ability to endure. It is about living and developing in a way that provides economic, social and environmental well-being to present and future generations. By closing the loop of consumption and production cycles, industrial systems can help society evolve towards sustainability by:

- Reducing the net flow of virgin materials and energy through industrial processes
- Promoting a service and flow economy where more value is placed on quality and useful services than the production and ownership of goods
- Reducing amounts of garbage
- Lowering human exposures to hazardous materials
- Conserving resources and ecosystem health

Canadian Association of Recycling Industries

Closing the Loop

By Leonard Shaw

Recycling is often thought to consist of only discarding, collecting, sorting, separating, compacting or other processing of materials for delivery to a primary or secondary material producer. For this reason the existence of blue boxes in homes, offices, schools, and shopping centres is seen to demonstrate a strong recycling society. In fact, governments and industries that have attempted to support recycling have concentrated their efforts on the collection of materials. However, if every piece of recyclable material was collected and processed for return to the economy, it would in no way guarantee recycling.

Recycling certainly requires all of the supply side activities mentioned above. However, to truly recycle requires a continuum, a closed loop. Real recycling means taking products at the end of their useful lives, or by-products or other process residues, sorting and processing them to produce resource materials that are subsequently used in the production of new goods, which are, in turn purchased and used by consumers.

These last two additional stages are demand components to close the recycling loop. Fortunately this demand can be created, particularly through these four activities: procurement policies, education, information and innovative product design.

The greatest single element that leads to an increase in demand is that of "green procurement". The federal government is the largest buyer of goods and services in the country. It purchases more than 10 billion dollars of goods alone each year. Likewise provincial governments and collectively the municipal governments wield very large procurement sticks. All governments need to show leadership by developing and implementing green procurement policies that offer a preference for recycled products. Such leadership will result in corporations and individuals following their lead and manufacturers changing their product mixes and listing the level of recycled content in products.

Education is equally lacking. Buyers, whether private or corporate, must think past the particular use of an article to be purchased to the end of its life and final destiny. Additionally many think that a product with recycled content is inferior in quality, has already been used or contains materials that could lead to health concerns. Even fewer understand the recyclablity of a product. Not all products are equally recyclable even if they contain a high degree of recycled content. When making a "green procurement" choice, both the recyclability and recycled content of products must be considered. Are tenders written in such a way, that procurement specifications encourage recycled products and don't exclude them?

But even educated consumers cannot know the differences between products without being told. They need information. Eventually manufacturers will list the level of recycled content and recyclability of products, as consumers' demand for these goods increases. In the interim, governments could promote the listing of recycled content, either directly on products or on their packaging, to provide the consumer with the information necessary to make an informed choice.

With increased demand for "recycled products" manufacturing companies will have to become innovative. Some manufacturers like Nortel, Xerox and the automotive manufacturers are already addressing product design, but usually not because of consumer demand. A supply of innovative products will, in turn, increase demand.

In essence, increasing demand will close the recycling loop. Closing the loop will ensure that the real benefits of recycling are attained.

For further information regarding the above article, or for information on CARI's activities and membership, please contact Dr. Leonard Shaw. He may be reached by Phone (613) 256-8533, Fax: (613) 256-8534, Email: len.shaw-cari@on.aibn.com

ISWA World Congress 2003: Sustainability in a New World

International Solid Waste Association
November 9-14, 2003
Melbourne, Australia
Email: quitz@bigpond.net.au
Web: www.iswa2003.net/

EnviroSeries2003 - Waste Management & Recycling

November 27, 2003
Hong Kong
Phone: +852 2784 3900
Fax: +852 2784 6699
Email: info@enviroseries.com
Web: www.enviroseries.com/2003/wm/

Copper 2003/Cobre 2003

November 30 to December 3, 2003
Santiago, Chile
Contact: Dr. Gustavo Lagos
Email: info@cu2003.cl
Web: www.cu2003.cl/

Pollutec 2003

December 2-5, 2003
Paris, France
Phone: +33 (0)1 47 56 21 24
Fax: +33 (0)1 47 56 21 20
Email: ilse_dapper@reedexpo.fr
Web: www.pollutec.com/

Canadian Waste and Recycling Expo

December 3-4, 2003
Toronto, Ontario, Canada
Contact: Stuart Galloway
Phone: (800) 787-9328
Email: stuart@exposition.com
Web: www.exposition.com/events/

International Electronics Recycling Congress

January 14-16, 2004
Basel, Switzerland
Phone: +41 56 664 72 50;
Fax: +41 56 664 72 52
Email: info@icm.ch
Web: www.icm.ch/

International Automobile Recycling Congress

March 10-12, 2004
Geneva, Switzerland
Phone: +41 56 664 72 50
Fax: +41 56 664 72 52

Email: info@icm.ch
Web: www.icm.ch/

GLOBE 2004

March 31 - April 2, 2004
Vancouver, British Columbia, Canada
Phone toll free: (800) 274-6097
Phone: (604) 775-7300
Fax: (604) 666-8123
Email: info@globe.ca
Web: www.globe.ca/

SWANA's 12th Annual North American Waste to Energy Conference (NAWTEC)

May 17-19, 2004
Savannah, Georgia, USA
Phone: (240) 494-2257
Phone toll free: (800) 467-9262
Fax: (301) 589-7068
Email: kdrinker@swana.org
Web: http://www.swana.com/

SWEMP 2004: 8th International Symposium on Environmental Issues and Waste Management in Energy and Mineral Production

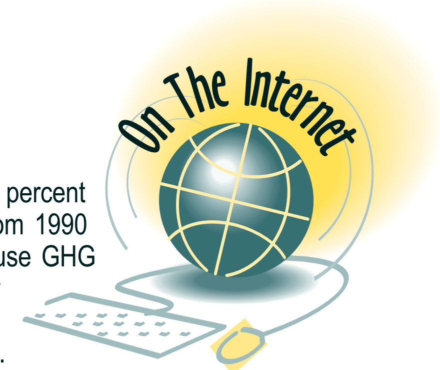
May 17-20, 2004
Antalya, Turkey
Email: terbay@atilim.edu.tr
Web: swemp.atilim.edu.tr/

Greenhouse Gases in the Metallurgical Industries, Policies, Abatement and Treatment

August 22-25, 2004
Hamilton, Ontario, Canada
Contact: Prof. Chris Pickles
Phone: (613) 533-2759
Fax: (613) 533-6597
Web: www.metsoc.org/

International Conference on the Use of Pressure Vessels for Metals Extraction and Recovery

October 23-27, 2004
Banff, Alberta, Canada
Phone: (514) 939-2710, ext.1329
Fax: (514) 939-9160
Email: gjazzar@cim.org
Web:
www.metsoc.org/conferences/hydro2004/



As party to the Kyoto Protocol, Canada has set a 6 percent greenhouse gas (GHG) emission reduction target from 1990 levels over the 5-year span of 2008 to 2012. Because GHG emission levels have risen between 1 and 3% a year since 1990, this target translates to substantial reductions from the projected "business as usual" emissions. What are the environmental and economic implications of reaching this target and how will Canadian businesses and individuals be affected?

For a global understanding of climate change, few sites can compare to *Climate Compendium* on the *Climate Change Knowledge Network* site at ***http://www.cckn.net/compendium/*** Hundreds of publications are at your fingertips, making this site ideal for anyone interested in the finer points of the ongoing international climate change negotiations.

For a Canadian perspective, try the *Government of Canada Climate Change web site* at ***http://www.climatechange.gc.ca/*** This site abounds with up-to-date information and includes links to pertinent international, federal, provincial and regional climate change issues and resources. The site is closely associated with the pages of Natural Resources Canada's (NRCan) (***http://www.climatechange.nrcan.gc.ca/***) and Environment Canada's (EC) (***http://www.ec.gc.ca/climate/***) climate change sites. The best way to explore these sites and be sure you aren't missing anything is to start your navigation from the site map.

From here you can learn about:

- The Government of Canada's Action Plan 2000 on Climate Change
- Specific climate change impacts and adaptations experienced by communities, environments and businesses in publications such as the Canada Country Study (***http://www.ec.gc.ca/climate/ccs/***) and Climate Change in Canada (***http://www.adaptation.nrcan.gc.ca/posters/***)
- Important climate change initiatives, including Action by Canadians (ABC), an Energy Council of Canada program providing climate change workshops that challenge people to set targets for reducing their personal GHG emissions
- The Kyoto Protocol (***http://www.ec.gc.ca/climate/kyoto.htm***)

The Greenhouse Gas Division of Environment Canada has launched *Greenhouse Gas Emissions*, at ***http://www.ec.gc.ca/pdb/ghg/*** From here you can download the latest issue of Canada's official GHG inventory: an annually required report to the United Nations Framework Convention on Climate Change.

A couple of other great sites (available in English only) are:

- Global Warming: Early Warning Signs (***http://www.climatehotmap.org/***) Clicking on a particular region of an interactive world map displays either footprints ("direct mani festations of a widespread and long-term trend toward warmer global temperatures") or harbingers ("events that foreshadow the types of impacts likely to become more fre quent and widespread with continued warming") of climate change reported from sci entific journal articles, magazines, newspapers, etc.
- The David Suzuki Foundation (***http://www.davidsuzuki.org/***) Among other things, this site features a comprehensive section devoted to the Intergovernmental Panel on Climate Change (IPCC) and its *Third Assessment Report* (2001) on climate change. The IPCC is recognized as the world's most authoritative scientific voice on climate change.