Energy Recovery
A Viable Resource Management Option

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Terminology Matters

‘Waste’ Management vs Resource Management

Energy from ‘Waste’ (EFW) vs Energy Recovery

‘Waste’
“something rejected, worthless, of no value”

‘Post-consumer Packaging’
A previously used resource which still has value

Packaging is not a waste
Packaging is a valuable resource

Extends shelf life
  • Prevents food spoilage
  • So less people go hungry
  • So we ship less frequently
  • Consume less resources
  • Generate less emissions
  • Reduce impact of climate change

Protects against product theft and damage

Fosters a safer and healthier society

Facilitates economic development
Landfills are Not the Answer

- Wasting Valuable Energy
- Water table Contamination
- Chemical Instability
- Methane Emissions
- Visual Pollution
  - High $ Costs
  - Tipping Fees
  - Shipping
- Limited Space

Number of Landfills in U.S. 1988-2007

78% Reduction in 19 yrs
(-6,170 landfills)
Mechanical Recycling is a Major Part of the Solution - But has Limitations

Technical
- Foodservice ware
- Multi-layer packaging
- Difficult to show material codes on all materials

Unrealistic to expect mechanical recycling alone will meet the required diversion goals

Costs
- Collection, Sorting, Cleaning

Lack of infrastructure
- Inconsistent national approach
  - Curbside vs Deposits vs Depots vs Retail stores
  - Not compatible with collection and recycling needs of flexible packaging
- End markets are not being supported
Why do We Recycle?

To reduce “waste” - To prevent physical materials from being buried in a landfill when they are still a valuable resource

To reduce extraction of the earth’s limited natural resources (minerals & fossil energy)

To reduce energy consumption, particularly fossil energy

To reduce greenhouse gas emissions & other pollution

Note: Not all types of recycling accomplish all of these goals!
Must Utilize All EOL Resource Mgt Options

U.S. EPA’s Integrated Solid ‘Waste’ Management Hierarchy

- Most desirable
  - Reduce.
  - Reuse.
  - Recycle/Compost.
  - Energy Recovery
  - Dispose/Landfill.

- Least desirable

All options are needed to minimize disposal in landfills. Resource conservation is key.

Source: U.S. Environmental Protection Agency
Energy Recovery: Common Misconceptions

**MYTH #1**: Emits massive amounts of GHGs

**FACT**:  
- One of the cleanest forms of energy generation available today  
- Operates within strict emission standards (US EPA - Maximum Control Technology (MACT) Standards; European Union, Canadian - A-7 Guidelines)  
- Cleaner than coal utilities

**MYTH #2**: Reduces mechanical recycling rates

**FACT**:  
- Does not compete with recycling, rather complements it  
- Locations with E.R. experience recycling rate 4%-5% > national average

**MYTH #3**: Economically uncompetitive

**FACT**:  
- Combustion: High capital costs but competitive pay-backs (B.C. facility 8 years break-even)  
- Emerging Technologies: Lower upfront costs.

**MYTH #4**: Low public acceptance - N.I.M.B.Y.

**FACT**:  
- Canadian study shows 83 % public support E.R. technologies (~ 24% increase last 4 yrs)  
- 10 of 15 ‘Most Livable Cities in the World’ have Energy Recovery facilities  
  (Vienna, Zurich, Geneva, Vancouver, Dusseldorf, Munich, Frankfurt, Bern, Toronto, Helsinki)

Sources: Canadian EFW Coalition, 2009 / Mercer’s ‘Quality of Living Survey’, 2009 / The Economists ‘World’s Most Livable Cities’, 2009

MSW Generation (Million Tons)

- 1960: 88
- 1970: 121
- 1980: 152
- 1990: 205
- 2000: 239
- 2005: 250
- 2007: 254

*MSW grown 3X last 47 yrs*

- Recycling (incl compost)
- Energy Recovery
- Discards to Landfill

Source: US EPA
Energy Recovery Facilities

Modern Energy Recovery Facilities

Outdated Energy Recovery Facilities
## Energy Recovery Facilities Globally

<table>
<thead>
<tr>
<th>Region</th>
<th># Facilities</th>
<th>MSW Processed Annually</th>
<th>% Total MSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.A.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.A.</td>
<td>89</td>
<td>30 million tonnes</td>
<td>13%</td>
</tr>
<tr>
<td>Canada</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asia</td>
<td>301</td>
<td>70 million tonnes</td>
<td>75%</td>
</tr>
<tr>
<td>Japan accounts for 83%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total:</td>
<td>785</td>
<td>160 million tonnes</td>
<td>29%</td>
</tr>
</tbody>
</table>

Energy Recovery - USA

89 facilities operating in 29 States
- Down 12% since 2000
- 75% use mass burn technology
- > 6,000 workers

Dispose of 94,721 tons of material per day
- Generates 2,700 MW of electricity (2.3 Million households)
- Saves about 30 Million barrels of oil per year

According to US DOE, prevents the annual release of:
- 40 million tons of GHG as CO2 equivalents
- 25,000 tons of nitrogen oxides
- 2.6 million tons of volatile organic compounds

Energy Recovery Can Play a Major Role in ‘Waste’ Diversion

- Mech. Recycling* (All Mtls) Avg. 17%
- Mech. Recycling (Plastics) Avg. 24%
- Energy Recovery (All Mtls) Avg. 57%
- Energy Recovery (Plastics) Avg. 67%

Sources: European Environmental Agency / Plastics Europe / U.S. EPA / CPIA / Covanta Energy

* USA & Cda includes composting
Yet we tend to mine coal and bury plastics.

Source: CPIA
Municipal Solid Waste (MSW) and the Environment

MSW contains thousands of chemicals, including chlorine, particulate matter, metals, and microorganisms.

All ‘waste’ management options involve the destruction of some chemicals and the creation of others.
   — None of these chemicals are unique to waste management.

Hazard vs Risk (exposure)

Need to manage MSW effectively to minimize risks to human health and environment.

Source: Professor James Bridges, Chair of European Unions Science Committee, University of Surrey
<table>
<thead>
<tr>
<th></th>
<th>Average WTE (mg/Nm³)</th>
<th>EU Standard (mg/Nm³)</th>
<th>US EPA Standard (mg/Nm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Particulates (PM)</strong></td>
<td>3.1</td>
<td>&lt; 10</td>
<td>11</td>
</tr>
<tr>
<td><strong>Hydrogen Chloride (HCl)</strong></td>
<td>8.5</td>
<td>&lt; 10</td>
<td>29</td>
</tr>
<tr>
<td><strong>Sulphur Oxides (SOx)</strong></td>
<td>3</td>
<td>&lt; 50</td>
<td>63</td>
</tr>
<tr>
<td><strong>Nirogen Oxides (NOx)</strong></td>
<td>112</td>
<td>&lt; 200</td>
<td>264</td>
</tr>
<tr>
<td><strong>Mercury (Hg)</strong></td>
<td>0.01</td>
<td>&lt; 0.05</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>Carbon Monoxide (CO)</strong></td>
<td>24</td>
<td>&lt; 50</td>
<td>45</td>
</tr>
<tr>
<td><strong>Total Organic Carbon</strong></td>
<td>1.02</td>
<td>&lt; 10</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Dioxins</strong></td>
<td>0.02</td>
<td>&lt; 0.10</td>
<td>0.14</td>
</tr>
</tbody>
</table>

All well within EU and U.S. Standards

Source: Gershman, Brinkner & Bratton, Inc., Waste to Energy Research & Technology, Columbia University
Dioxins

All combustion generates dioxins

Dioxins are hazardous – cancer, nervous systems, reproduction

Dioxins are persistent in the environment and come from a variety of sources
  – Only 1% of dioxins in U.S. come from Energy Recovery

Main source of exposure is not via air emission but through diet (fish)

Source: Professor James Bridges, Chair of European Unions Science Committee, University of Surrey
Maintaining Perspective – Dioxin Exposure

1. The 15 minutes London Millennium fireworks display produced emissions equivalent to 120 years from a single Energy Recovery facility

2. BBQ for 2 hours results in higher dioxin exposure than residing beside an energy recovery facility for 10 years

Source: Professor James Bridges, Chair of European Unions Science Committee, University of Surrey
APSWG briefing on Energy from Waste; UK Environment Agency 2000
Magnus Schonning, Embassy of Sweden; Carl Lilliehöök, Waste & Recycling, Tekniska Verken AB, Linköping Sweden
## Coal vs Energy Recovery

<table>
<thead>
<tr>
<th></th>
<th>Coal</th>
<th>Energy Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Emissions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dioxin²</td>
<td>60</td>
<td>12 ✓</td>
</tr>
<tr>
<td>CO₂³</td>
<td>2,249</td>
<td>837 ✓</td>
</tr>
<tr>
<td>SO₂³</td>
<td>13</td>
<td>1.3 ✓</td>
</tr>
<tr>
<td>NOₓ³</td>
<td>6</td>
<td>5 ✓</td>
</tr>
<tr>
<td>Mercury⁴</td>
<td>41</td>
<td>2 ✓</td>
</tr>
<tr>
<td><strong>Calorific Value¹</strong></td>
<td>26</td>
<td>45 (Plastics) ✓</td>
</tr>
<tr>
<td><strong>Current Source of Energy</strong></td>
<td>48%</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>

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Units: ¹ MJ/Kg ² g TEQdf-HW098/Yr ³ Comparative units used ⁴ Tonnes/Yr

Source: WTE Research and Technology Council, Columbia University, New York
Recycling **AND** Energy Recovery

**Mechanical Recycling** is important but will not solve ‘waste’ and ‘energy’ issues on its own

**Energy Recovery ...**

– Safe and technically proven
– Compatible with recycling
– Environmentally sustainable
  • Generates clean renewable energy
  • Reduces GHG emissions (vs coal & land-filling)
– Promotes energy independence
– ‘Green’ jobs
Energy Conversion Technologies

Thermal/Chemical
- Combustion / Mass Burn
- Acid Catalysis & Distillation
- Gasification / Pyrolysis
- Microwave Processes
- Plasma Arc
- Thermal Decomposition

Biological
- Aerobic Composting
- Anaerobic Digestion
- Biodiesel
- Bio-ethanol
- Biological Pretreatment
- Vermicomposting

Processing
- Fiberboard & Construction Composites
- Refuse Derived Fuels (RDF)

- Most common in U.S.
- Proven technology
- Creates electricity from steam

- O2 free ‘burn’.
- Produces syngas (CO + H2)
- Used to create fuel and chemical feedstock
- Smaller scale than mass burn
- Practiced widely in Japan

- Proven technology
- Solid Recovery Fuel (SRF)

- Break down of organics in the absence of oxygen.
- A composting system with energy as bi-product.
Potential Products

Ethanol
Chemical feedstocks
Diesel fuel
Steam
Electricity

Note: Different conversion processes have different potential products; not all products can be made by all processes
‘100% of Packaging into the Recycle Bin’

1. Used Packaging
2. Food and Lawn Waste

- High Energy Content
  - Large Volume Mono Materials
    - Mechanical Recycling
  - Low Volume and Mixed Materials
    - Energy Recovery
      - Chemicals
      - Fuels

- Low Energy Content
  - Compost Facilities
  - Landfill: Non-compostable Materials

3. ‘100% of Packaging into the Recycle Bin’
Why ‘100% of Packaging into the Recycle Bin’¹?

Makes it easy for consumers

– Eliminates confusion
– No sorting at home
– Able to participate more easily

Increases collection and reduces packaging going to landfills

Captures energy value of hard to mechanically recycle packaging

– Eg. Flexible packaging, mixed materials

Improves image of packaging from ‘waste’ to something of value

Provides a sustainable energy source & reduces need for foreign oil

¹ 100% of Packaging into the Recycle Bin = mechanical recycling + composting + energy recovery + chemical transformation
Marketing the Concept: Plastics Packaging

Value Multiplier: > 15

Oil
Coal
Natural Gas

Plastics Packaging

~ 80%

Value Multiplier: 1

Transportation
Heating & Cooling
Power

PE retains 2/3 of its original energy content - so let’s not waste it

Stop burying oil - instead extend the life of this valuable resource!

Sources: American Chemistry Council; U.S. Energy Information Administration; Canadian Plastics Industry Association.
Chemical Transformation

Used Packaging

Steam
Boiler
Gas 30% (vapor)

Hydrocarbon cracker

Liquids 65%

Bio-diesel

Semi-Solid 5% or less

C2

PE

Pyrolysis Unit

Artwork for illustrative purposes only
How Much Energy is in Used Packaging?

All household packaging waste (non-recycled plastic & paper of all types) contains the energy equivalent of 90 days supply of household electricity.

If processed in a recycle-to-energy facility, the packaging waste (all non-recycled paper & plastic) for a typical household would generate enough electricity to supply the home-use requirements for that household for about 30 days.

The non-recycled plastic packaging waste generated by a typical household contains the energy equivalent of 30 days supply of electricity and would generate enough electricity in a recycle-to-energy facility to provide power to that household for 10 days.

A year’s supply of plastic packaging uses about 3-days supply of the per-capita energy (all types) used in North America.

To advance;

– acceptance and use of energy recovery and chemical transformation as a recognized part of the resource management hierarchy
– perception of paper and plastic packaging as;
  • captured energy
  • a valuable resource even after its original use
  • a contributor to a national energy solution
– education & communication with key stakeholders and decision-makers
  • Case Studies, consistent messaging, joint advocacy
– change
  • Drive change ourselves before change is forced upon us
    – Mandated discriminatory legislation & regulations
Let’s Seize the Opportunity

• Packaging helps ‘people, planet, and profit’
• Industry needs to;
  - communicate the benefits of sustainable packaging and positive role of Energy Recovery
  - educate key stakeholders and decision-makers
  - change perceptions
• Pursue “100% recycling” goals
• Coordination and collaboration
Thank You

For more information:
http://www.AmericanChemistry.com/plastics/
http://www.CPIA.ca/epic/