Thermal Conversion of Waste Materials Into High Value Energy Products

Liquid and Gaseous Fuels, Carbon Black, Activated Carbon, Agri-Char & Electricity
Remediation Earth, Inc. (“REI”)

- Project Developer; 20 yrs modular systems approach
  - Primary focus: convert medical & mixed plastics waste
  - Secondary focus: “green” waste (biomass) to bio-diesel

- Proven commercial thermochemical conversion
  - Pyrolysis and anaerobic gasification technologies
  - Meets current emission limits; CA, US, EU & Japan

- RemEDIATE wastes; higher value energy products
  - Liquid/gaseous fuels, electricity, carbon black & agri-char

- Cost effectively integrate water treatment & pyrolysis
  - Proven chemical-free water technology; EPA registered
20 Years Modular System Experience

Skid Mounted: Intelligent Filtration System With Remote Monitoring
25 Ton per Day Continuous Pyrolysis I Unit
"Higher Value from Pre-separated Materials"

- Gasification of MSW to power - not cost effective
  - At $0.09/kWhr, $90/ton + $40 tipping = $130/ton (2009)
  - Large 500 to 1000 ton/day systems problematic
- Separated plastics - MRF; $460/ton - 3.5X revenue
  - 160 gallons/ton syn-diesel; $320/ton @ $2.00/gal (2009)
  - 200 lbs carbon black/ton (10%); $100 @ $0.50/lb (2009)
  - Tipping fee of $40/ton
- 4 smaller 50 t/d units = 200 t/d; parallel processing
  - Quickly change output products; chase market "highs"
  - Less impact from yearly scheduled maintenance

Note: MRF = material recovery facility; MSW = municipal solid waste
\( t/d = \text{tons per day} \)
REI Uses Thermal Conversion- Not Incineration

- Incineration is combustion- by many “Aliases”
  - Waste-to-energy (“WTE”), energy from waste (“EFW”)
  - Advanced thermal recovery (“ATR”), “mass burn”

- The lines are “blurred”; people are confused
  - WTE, EFW, ATR & mass burn all use stoichiometric O$_2$
  - Gasification/Pyrolysis uses little or no O$_2$- *not* combustion

- Method of treating emissions is key
  - Mass burn- can only treat *fully combusted exhaust*
  - Thermal Conversion: intermediate step for gas cleanup
  - REI’s emissions: meets both CA & worldwide standards
Our Technologies Convert All These Wastes . . .

Pyrolysis I – SynDiesel

Hybrid Pyrolysis II - “Green” Diesel

. . . Into High-Value Liquid/Gaseous Fuels and Electricity
Type & Amount; Value-Added Products
(Per Ton of Feedstock Materials)

- **Tires (100 per ton)**: 80 gallons #2 fuel oil, 640 lbs carbon black, 300 lbs scrap steel
- **Mixed Plastics (45%PP, 40%PE, 15%PS)**: 160 gallons #2 fuel oil & synthetic diesel, 160 lbs carbon black
- **Medical Waste (typical “red-bag”)**: 110 gallons “black” #2 fuel oil, syn-diesel, 120 lbs carbon black
- **e-Waste (Plastics with fire retardant)**: 80 gallons “black” diesel, 80 lbs carbon black
- **MSW (Municipal Solid Waste)**: 60 to 80 gallons (see Note), 200 lbs char/ash, depending on content

*Note: Minimum of 15% to 20% plastics (by wt) in MSW for oil production
* Deductions already made for 12% -14% oil used for parasitic needs
REI’s “Green” Diesel vs. “Black” Diesel

Green diesel properties

Compared with a commercial diesel, green diesel has higher cetane value, lower density, and narrower boiling temperature range with lower high-boiling point. In addition, green diesel has no aromatic content that is believed to be the cause of particulate matters (PM) in exhaust. Furthermore, green diesel excels in NOx reduction and contains no sulphur and thereby expedites the PM reduction effect of oxidation catalyst.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Green diesel</th>
<th>Commercial diesel*</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHV [MJ/kg]</td>
<td>43.5</td>
<td>43.5</td>
</tr>
<tr>
<td>Air-oil ratio [kg/kg]</td>
<td>14.9</td>
<td>14.6</td>
</tr>
<tr>
<td>Density [kg/m3]</td>
<td>763</td>
<td>802</td>
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<tr>
<td>Cetane number</td>
<td>78.4</td>
<td>59.9</td>
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<tr>
<td>Kinematic viscosity (at 30 C)</td>
<td>4.44</td>
<td>2.20</td>
</tr>
<tr>
<td>High-frequency reciprocating rig HFRR (µm)</td>
<td>580</td>
<td>440</td>
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<tr>
<td>Oxygen content (mass %)</td>
<td>&lt; 0.1</td>
<td>0</td>
</tr>
<tr>
<td>Carbon content (mass %)</td>
<td>84.9</td>
<td>87.5</td>
</tr>
<tr>
<td>Hydrogen content (mass %)</td>
<td>15.1</td>
<td>12.5</td>
</tr>
<tr>
<td>Sulphur content (mass %)</td>
<td>~ 0</td>
<td>&lt; 0.005</td>
</tr>
</tbody>
</table>

*Sample parameters can fluctuate
Yearly Gross profit per $million capital invested
(with tax credits)

“Product line Addition” to an existing functioning facility which is already operating and HAS EXISTING INFRASTRUCTURE

* Note: Initially, medical waste to electric with 30% grant. Switch to fuel 5 years later
Basic Flow Diagram of Hospital/Medical Waste Process
(How most medical waste processors operate)
## Profit: Medical Waste to Energy
(100 tons/day facility)

<table>
<thead>
<tr>
<th>Medical W-T-E (numbers in 000's)</th>
<th>Autoclave Only Facility (Estimate)</th>
<th>Add Pyrolysis Systems to Autoclave Facility</th>
<th>Pyrolysis Only Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Revenue</td>
<td>17,500</td>
<td>35,350</td>
<td>35,350</td>
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<tr>
<td>Operating Expenses</td>
<td>10,770</td>
<td>12,000</td>
<td>9,745</td>
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<tr>
<td>Gross Profit</td>
<td>7,030</td>
<td>23,350</td>
<td>25,605</td>
</tr>
<tr>
<td><strong>Gross Profit (%)</strong></td>
<td><strong>40.1%</strong></td>
<td><strong>66.0%</strong></td>
<td><strong>72.4%</strong></td>
</tr>
<tr>
<td>SG&amp;A Expenses</td>
<td>3,375</td>
<td>3,375</td>
<td>3,375</td>
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<tr>
<td>EBITDA</td>
<td>3,655</td>
<td>19,975</td>
<td>22,230</td>
</tr>
<tr>
<td><strong>Operating Profit (%)</strong></td>
<td><strong>20.9%</strong></td>
<td><strong>56.5%</strong></td>
<td><strong>62.9%</strong></td>
</tr>
</tbody>
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REI’s San Bernardino Facility: 4-50 ton/day Pyrolysis Plants

Remediation Earth, Inc
Thank You
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Future Site: 1250 Tippecanoe Avenue, San Bernardino, California