Advanced Gasification
Maximizing Resources : Minimizing Waste
SWANA Nova Scotia

White Castle, Louisiana : ≈48 Tonnes/day
Commenced operations : 2014

“Advanced Gasification ... converts waste into usable products at high temperatures, without combustion or oxygen.”
Community Waste Handling Example

Experience: very high rate of public acceptance

Before

Landfill ≈ 55%

Sorting, Pre-Process

Advanced Gasification

Energy Loop

District Heating

District Cooling

Power Unit

Fertilizer

After

Landfill ≈ 10%

=90% Diversion

Waste → Gasification → Outputs → Convention → Usable resource

Nova Scotia's Waste-to-Energy Direction

Solution: Advanced Gasification's Multi-Fuel, Polygeneration

MSW Diversion Comparison

Traditional Diversion

Advanced Gasification

Max. 97% recycled

37% Landfilled

63% recycled

Blue Box → Re-use → Recycle → Landfill
Nova Scotia’s Waste-to-Energy Direction

**Solution**: Advanced Gasification’s Multi-Fuel, Polygeneration

### Type

<table>
<thead>
<tr>
<th></th>
<th>Tonnes</th>
<th>%</th>
<th>Dry</th>
<th>Tonnes</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibre</td>
<td>38,528</td>
<td>13.6%</td>
<td>25,043</td>
<td>16.3%</td>
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<tr>
<td>Organics</td>
<td>68,627</td>
<td>24.1%</td>
<td>53,333</td>
<td>37.4%</td>
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<tr>
<td>Plastics</td>
<td>59,258</td>
<td>20.9%</td>
<td>14,095</td>
<td>9.2%</td>
<td></td>
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<tr>
<td>Textiles</td>
<td>25,170</td>
<td>8.9%</td>
<td>14,095</td>
<td>9.2%</td>
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</tr>
<tr>
<td>C&amp;D</td>
<td>26,824</td>
<td>9.4%</td>
<td>10,730</td>
<td>7.0%</td>
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<tr>
<td>SCW</td>
<td>26,854</td>
<td>9.4%</td>
<td>10,742</td>
<td>7.0%</td>
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</tr>
<tr>
<td>Other</td>
<td>38,910</td>
<td>13.7%</td>
<td>15,564</td>
<td>10.1%</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td>284,172</td>
<td></td>
<td>153,526</td>
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</tr>
</tbody>
</table>

**Water**: ~130,000 tonnes ~46% of measured waste

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**W2E**: Not the Only Consideration

<table>
<thead>
<tr>
<th>Technology</th>
<th>mWe to grid</th>
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</thead>
<tbody>
<tr>
<td>Pyrolysis</td>
<td>629 kWh / tonne MSW</td>
</tr>
<tr>
<td>Pyrolysis/gasification</td>
<td>755 kWh / tonne MSW</td>
</tr>
<tr>
<td>Conventional gasification</td>
<td>755 kWh / tonne MSW</td>
</tr>
<tr>
<td>RotoGasifier</td>
<td>755 kWh / tonne MSW</td>
</tr>
<tr>
<td>Fluidised bed</td>
<td>1,170 kWh / tonne MSW</td>
</tr>
</tbody>
</table>

**The price for biochar has averaged $1,200 - $1,500 per ton over the last several years (Inkwood, 2017) (International Biochar Initiative, 2015)**

W2E : RNG/SNG Challenge
Rising Demand : Questionable Focus

- Fluidized Bed AG
- Existing plant
- Operating since 2014
- Actual $$$, scaled

- Anaerobic digestion
- Planned project
- Based on actual plant
- Winning bid $$$, scaled

- RotoGasifier AG
- Planned project
- Guaranteed contract
- Contractor $$, scaled

BUT: Only ≈15% of waste volume suitable for RNG in Nova Scotia

Total life cycle cost, 25 yrs, 2018 $$

- C$456m
- C$245m
- C$87m
- C$500m
- C$400m
- C$300m
- C$200m
- C$100m
- C$0m

RNG/SNG : Life Cycle Comparison, ≈300GJ RNG Plant

Preliminary estimate based on BC model & analysis. Actual results will vary by application and province.
Example: Güssing Austria
Problems ► Solution: Advanced Gasification

- 50 years alongside the iron curtain to Hungary
- Small structured agriculture, no industry
- Poor transportation infrastructure
- High unemployment rate: 70% commuters
- High rate of migration: declining population

Benefit

Project cost: ≈C$19.6m

Energy benefit
- Before: -C$9.3m buying energy
- After: +C$20.4m energy sales
- Net difference: +C$29.7m
- 45% self sufficient on energy
- If 100% self sufficiency: C$55.5m

BUT other benefits more valuable
- More than 50 new companies
- More than 1,500 new jobs netting C$13.5m a year
- NB: Europe’s far higher energy FIT
  - Lesson: Always do site-specific analysis
Waycross, Georgia – ≈1,000 tonnes/day
World’s largest biomass pellet plant
Pyrolysis-phase project, operating since 2011

Demonstration unit, California ≈240kg/day
Physically test & prove that wastes will work before major $$$ commitment
The Potential: Nova Scotia

Nova Scotia tonnage/yr, wet:
- 284,172 tonnes
- Dry @ >54%: 153,453 tonnes
- Gasification suitable, @ max 87%: 133,504 tonnes
- Char suitable: 86,778 tonnes

Yield per annum:
- Electrical: 100,796 mwh
- Thermal: 431,218 mwh
- Char: 26,033 tonnes

Face generating capacity:
- Electrical: 11.5mw
- Thermal: 49.2mw

Estimates based on available information.

Louisiana Gasifier in operation
Note: small plant size

Landfill GHG Curve

Annual methane emissions, by year of waste deposition in the landfill

E.g., this is the methane emitted each year from the decomposition of the waste deposited in 2044 (25th year of the project)
Summary

- **Technology**
  - Fluidized Bed – typically ≈4.8 mwt/tonne
    - Mainly biofuel projects
  - Roto-Gasifier - typically ≈3.23 mwt/tonne
    - Flexible feedstocks, highly scalable
  - Both near-silent, no odour; emissions ≈natural gas

- **Implementation steps**
  - Initial evaluation & estimate
  - Test & prove feedstocks and operation
  - Contract, guarantee & implement

- **Procurement**
  - Currently the largest challenge

Management & Strategic Partners

- **Main strategic partners**
  - TSI Corp., West Biofuels & Pivotal IRM
  - University of California at San Diego & Davis
  - Technical University of Vienna

- **Plus:** European experience, plants & partners