Glass Clean-up Systems in MRFs

NOVEMBER 8, 2017 | NYSAR3
We invest in businesses, municipalities and technologies that optimize product supply chains and build the circular economy.

PROJECT FINANCE

CLOSED Loop fund
Invest in large scale recycling and circular economy infrastructure.

Investors Include:
- Coca-Cola
- PEPSICO
- Nestle
- Procter & Gamble
- Wal-Mart
- Unilever
- Keurig Green Mountain
- 3M
- Dr Pepper Snapple
- Johnson & Johnson
- Colgate-Palmolive

GROWTH EQUITY

CLOSED Loop ventures
Invest in growth of leading companies that can catalyze circular supply chain solutions in apparel, food, electronics, and materials.

Investors Include:
- Family offices
- Institutions
- Individuals interested in strong financial returns and measurable social impact.

RESEARCH & DEVELOPMENT

CLOSED Loop foundation
Identify and incubate early stage solutions, builds the investment field.

Partners Include:
- Goldman Sachs
- Wal-Mart Foundation
- Johnson
- Heineken
- New Belgium Foundation
- The Barry and Jane Fall Foundation
The Fund’s First Investments: From Collections to Manufacturing

Impact to date:

- 1.5 million households represented
- 250,000 tons diverted
- 600,000 MTs of CO2E reduced
- $4.3 million in direct economic benefit to municipalities
- $90 million in co-investment

Export markets (e.g., Canada)
Glass in our portfolio

- Escambia County, FL
- New MRF serving 250K hh
- 50,000 tons per year

- Denver, CO
- New glass processor – only one in CO
- Marketing to bottler, abrasives, fiberglass
- 75,000 tons per year

- Eddystone, PA
- New manufacturer of foamed glass aggregate
- Marketing to construction (e.g., PENNDOT)
- 35,000 tons per year
Is there a productive and cost-effective way to increase the reuse of glass from material recovery facilities (MRFs)?
• 9M tons of glass containers generated as MSW each year

• <3M tons (33%) recovered for reuse, largely as a result of residential single stream recycling programs

• 6M (67%) tons go to landfill

• Up to 95% could be reused in containers

• The infrastructure and need exists to reuse substantially more glass

Additional yield data available from Glass Recycling Coalition, RRS: http://www.glassrecycles.org/glassrecyclingbenefits
Costs

- Poor glass quality has limited the options for MRFs. Many are utilizing outlets with a lower quality standard, such as landfill cover or even disposal.

Financial costs to the system are more than $150M per year

MRFs pay disposal and transportation costs

Municipalities pay processing and disposal costs
The ROI on improving glass clean-up (1)

15,000+ TPY of SS glass
- Installed Cost of Clean-up System: $350K - $1M (2)
- System: adjustable sizing screens, closed air separation
- Design: glass removed at presort, NGR reintroduced to main line, protected storage bunkers

MRF savings: + $25/ton
- 75+% yield for higher value glass cullet
- Marketable NGR commodities (1+%)  
- Less fines (< 10%), residue (< 15%)

Higher quality feedstock
- 7-8% energy savings and GHG emissions reductions
- Less contamination

Disposal: - $35/ton
- Discounted landfill tip fees
- Transportation

More glass is recycled

More end markets
- Additional opportunities to create value in established and emerging markets

(1) Actual results will vary depending on MRF and local market. (2) Does not include cost of downtime at MRF to install new equipment
### Benefits

**For Single Stream MRFs**
- Revenue from glass stream
- More volume
- Marketing advantage
- Secure markets for material
- Transportation (T&D) savings

**For Municipalities**
*In addition to potential MRF benefits…*
- Sustainable home for a key commodity
- Supports zero waste goals
- Convenience for residents

**For Processors**
- Lower capex, operating costs
- Increased productivity
- Lower disposal costs

**For End Markets**
- Lower capex, operating cost to get/use higher quality feedstock
- More secure and sustainable supply
- Greater yield from feedstock – competes better with virgin material
Example #1 – MRF in the Northeast

Before:

• A large single stream MRF generating over 40,000 tpy of glass, paying for glass to go to glass processor at a significant cost
• First generation clean-up system from 2008

After:

• A $600,000 total investment – vibratory double screen deck, zig-zag air separation, conveyors, platforms, controls, etc.
• Installed in 2016
• Glass going to same processor (< 50 miles)
• Fines going to alternative aggregate use
• NGR (paper, bottles, cans) going back to system for recovery and commodity value
• MRF saw an increase in cullet pricing; **payback period of less than 2 years**
## Example #2 – Results

### Composition of the clean glass stream:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass (¼” – 2”)</td>
<td>93.3%</td>
<td></td>
</tr>
<tr>
<td>Fines (&lt; ¼”)</td>
<td>0.9%</td>
<td></td>
</tr>
<tr>
<td>NGR</td>
<td>5.8%</td>
<td>Non glass residue</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

### Composition of the NGR:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSP</td>
<td>3.2%</td>
<td>Ceramic, stone, porcelain</td>
</tr>
<tr>
<td>Organics</td>
<td>1.1%</td>
<td></td>
</tr>
<tr>
<td>Metals</td>
<td>1.0%</td>
<td></td>
</tr>
<tr>
<td>Residue</td>
<td>0.6%</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5.8%</td>
<td>Of the total stream</td>
</tr>
</tbody>
</table>

Note: Results from audit conducted in mid-2016 reflect standard specifications (“Fines = ¼” or less”) prior to recent update from ISRI (Nov 2016)
Economic Analysis – Key Drivers

1. Volumes
2. Operations
3. Markets
4. Transportation
5. Financing Terms

Refer to Calculator Tool for details
Sample Economic Analysis

### Before

Average size MRF (60,000 TPY) sorts **15,000 TPY of SS glass** using minimal/outdated equipment. Glass goes to local landfill for use as alternative daily cover.

<table>
<thead>
<tr>
<th>Description</th>
<th>Tons</th>
<th>$/ton</th>
<th>Total/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposal</td>
<td>15,000</td>
<td>($22.00)</td>
<td>($330,000)</td>
</tr>
<tr>
<td>Transportation</td>
<td></td>
<td>($10.00)</td>
<td>($150,000)</td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td>($3.00)</td>
<td>($45,000)</td>
</tr>
<tr>
<td><strong>Total annual cost</strong></td>
<td><strong>($35.00)</strong></td>
<td><strong>($525,000)</strong></td>
<td></td>
</tr>
</tbody>
</table>

### After (1)

MRF upgrades to **new glass clean-up system**. Same volume of glass is marketed to local processor, generating revenue from glass and NGR commodities.

<table>
<thead>
<tr>
<th>Description</th>
<th>Tons</th>
<th>$/ton</th>
<th>Total/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketable glass (2)</td>
<td>11,250</td>
<td>$12.40</td>
<td>$156,240</td>
</tr>
<tr>
<td>Fines (3)</td>
<td>1,350</td>
<td>-0-</td>
<td>-0-</td>
</tr>
<tr>
<td>NGR commodities</td>
<td>150</td>
<td>$150.00</td>
<td>$22,500</td>
</tr>
<tr>
<td>Residue disposal</td>
<td>2,250</td>
<td>($37.00)</td>
<td>($83,250)</td>
</tr>
<tr>
<td>Transportation</td>
<td>15,000</td>
<td>($10.00)</td>
<td>($150,000)</td>
</tr>
<tr>
<td>Maintenance (4)</td>
<td></td>
<td>($4.00)</td>
<td>($60,000)</td>
</tr>
<tr>
<td><strong>Total cost (before financing)</strong></td>
<td><strong>($7.63)</strong></td>
<td><strong>($114,510)</strong></td>
<td></td>
</tr>
</tbody>
</table>

**NET SAVINGS**

$27.37

$411,510

(1) Scenario assumes no significant change in inbound materials or overall MRF operations; scenario does not include one-time costs, such as downtime during installation of a new glass clean-up system. (2) Assumes 75% glass yield (incl. 5% NGR, 9% undersize), 1% marketable NGR, 15% residue; actual price/ton may vary. (3) Additional savings could be gained by marketing fines; (4) based on MRF interviews
Other Levers and Success Drivers

New equipment alone will not ensure benefits to MRFs and municipalities

- Municipalities and MRFs must continue to accept glass
- Municipalities and MRFs should negotiate fair contracts that reflect true costs/value of glass and minimize volatility
- Processors and manufacturers must be willing to pay for higher quality cullet in established markets (i.e., move up the price matrix)
- MRFs need access to alternative end markets (e.g., abrasives, aggregates) that are willing to pay for cullet and fines, and will scale over time
Glass Study Calculator

To enter your own data into the tool, download a copy and save on your desktop.

Current single stream MRF glass scenario:

<table>
<thead>
<tr>
<th></th>
<th>%</th>
<th>Total Per Year</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VOLUME</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inbound tons per year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass stream % by weight</td>
<td>25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total volume, glass stream</td>
<td>15,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OPERATIONS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual maintenance cost</td>
<td>$ (3.00)</td>
<td>$ (45,000)</td>
<td>Incremental cost for glass processing only</td>
</tr>
<tr>
<td><strong>MARKETS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue (Disposal cost)</td>
<td>$ (22.00)</td>
<td>$ (330,000)</td>
<td>Assumes discounted tip fee at landfill bhrn - $20-$25/bhr, or “low quality” cullet (25% underestimate 30% NGR)</td>
</tr>
<tr>
<td><strong>TRANSPORTATION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance traveled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freight cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$ (10.00)</td>
<td>$ (150,000)</td>
<td></td>
</tr>
<tr>
<td><strong>NET TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (cost) / revenue per year</td>
<td>$ (35.00)</td>
<td>$ (525,000)</td>
<td></td>
</tr>
</tbody>
</table>
Appendix
Clean Up Process

Feeding of material from wherever glass is removed via trommel, disc screen, glass breaker etc.

Size separation
Using a vibratory deck or trommel screen

Density separation
Using air vacuum and / or blower

2”+ Paper, bottles, cans, etc.

Heavies

2” to $\frac{1}{4} - \frac{1}{8}$” (1)

Fines, small shredded paper

2” to $\frac{1}{4} - \frac{1}{8}$” (1)

Lights

$\frac{1}{4} - \frac{1}{8}$” minus

Glass pieces, ceramic, stone etc.

The best-performing systems:
1. Can be adjusted to differing conditions of glass material
2. Are designed to allow for a longer retention time of the material in the air separation stream

(1) Typical minimum size today is $\frac{1}{4}”$. ISRI 3-mix standard specifications define fines as smaller than $1/8”$, which may change minimum size over time.

Clean-Up Systems

- Both of these recent installations use similar principles
- Both systems have significantly improved the glass quality enabling MRF’s to utilize alternative, more cost-effective, outlets
- For mid-sized MRFs, capital costs can run between $350,000 to $1M for new equipment installed; costs will depend on capacity and support equipment

Note: Closed Loop Foundation and Closed Loop Fund do not endorse any specific equipment manufacturer. The study reviewed equipment based on performance, with the aim of improving quality and increasing value at market. Although we gave our best effort to consider latest designs and technology available, not every manufacturers’ product was reviewed.