Anaerobic Digestion of Municipal SSO in the City of Toronto

Seminar on Anaerobic Digestion for Organic Wastes
SWANA NY Chapter
June 20, 2012
Overview

- Overview of Toronto SWM Programs
- Background - Green Bin Organics Program
- Background - Dufferin AD Facility
- Current expansion – Disco AD Facility
- Biogas utilization
About Toronto - Statistics

- Capital of Ontario
- Population 2.5 million
- 510,000 single-family homes
- 500,000 apts., condos etc. (and growing)
- Part of Greater Toronto Area, Population ~ 8 million

Source: City of Toronto
City of Toronto Waste Statistics

In 2009, Toronto SWM Services managed (tonnes):

- Total - 933,052 MT/yr
- Diverted Waste:
  - Single-stream recyclables = 204,023
  - Organics (SSO) = 111,116 (11.9%)
  - L&YM = 95,777 (10.3%)
  - Plus White Goods, Bulky Items, HHW etc.
- Residual Waste = 522,136

* Metric tons per year
Toronto’s Green Bin Program – Facts & Figures

➢ **Quantity**
  - Single family  250 kg/hh-yr (~550 lb/hh-yr)
  - Multi-family   75 kg/unit - yr (~165 lb/unit-yr)

➢ **Current Tonnage**
  (Single-Family + commercial)
  => 110,000 MT/yr (~121,000 tons/yr)

➢ **Ultimate Tonnage**
  (include Multi-Family + schools etc.)
  => 170-180,000 MT/yr (~198,000 tons/yr)

Sources: City of Toronto
Curbside Residential Program - Three Stream Collection

**Three “Core” Streams**
- Single-stream Recycling (bi-weekly)
- Green Bin (weekly)
- Residual (bi-weekly)

**“Specialty” Streams**
- Yard + Garden Waste (seasonal; bi-weekly)
- Household Durable Goods (bi-weekly)
- White Goods – by Appointment
- Household Hazardous Waste

Source: City of Toronto
Green Bin Program
Typical Curbside Set Out

Popular with residents
Participation: ~ 90% of households have 1 or more set out per month. Consistent; 2002 – 2010.
Multi-Family Organics Collection: Deep Collection System Pilot
Toronto’s Green Bin Program – Facts & Figures

- Part of City’s “Target 70” goal (70% waste diversion from LF)
- **Objective:** maximize recovery of source separated organics (SSO) through:
  - User convenience (kitchen & green bins provided)
  - Allow use of regular plastic bagging (difficult for composting)
  - Green Bin Collection (weekly)
  - Bi-weekly residual waste collection to encourage diversion
- **NO** yard waste accepted (collected separately)

**Accepted Material:**
- fruits
- meat, shellfish, fish products
- pasta, bread, cereal
- dairy products, egg shells
- coffee grounds, filters, tea bags
- soiled paper towels, tissues
- soiled paper food packaging: fast food paper packaging, ice cream boxes, muffin paper, flour and sugar bags
- paper coffee cups, paper plates
- household plants, including soil
- diapers, sanitary products
- animal waste, bedding (e.g. from bird/hamster cages), kitty litter
- pet food

Source: City of Toronto
Toronto’s Green Bin Program - Collection

Sources: City of Toronto; CCI; AECOM
Challenge

Organic solid waste (source separated organics or the organic fraction of MSW) is inhomogeneous and contains impurities (e.g. plastic bags, textiles, cardboard, stones, grit, bones, shells, glass, metals, batteries) requiring pre-treatment prior to digestion.

Solution

Application of a "Pre- and/or Post-Treatment Process" for effective removal of contaminants & homogenization.

Source: AECOM; EPA
AD Plant Capacity of SSO and OFMSW in Europe

Source: De Beare, L.; Mattheeuws, B. (2010); adapted

>180 Plants by 2010
City of Toronto’s Green Bin Program
Dufferin AD Demonstration Plant w/ ‘wet’ BTA Process

Start-up: 2002
Capacity: 25,000 MT/yr SSO (design);
        40,000+ MT/yr (2011)
Setup: City owned; contractor operated
AD Process: “Wet” BTA
  − Complete mixed (w/digester gas)
  − Single stage, Mesophilic

* Metric tons per year

Sources: City of Toronto; CCI; BTA
The Dufferin Model

- The Dufferin model was chosen over other options because:
  - Compact size allows facilities to be located within the City
  - Wet pre-processing removes fine contaminants and plastics; allowing a Grade AA Compost to be produced
  - Challenge of Odours is minimized
  - AD achieves significant mass reduction = reduced transportation costs and carbon footprint
  - Wet digestion maximizes biogas production together combined with location close to potential points of use

Source: City of Toronto
Development of ‘Wet’ AD Technology

Pulper Technology

1986 - 1995 Garching, D
Pilot Plant

1991 Helsingør, DK

1992 Kaufbeuren, D

1995 Dietrichsdorf, D
1996 Karlsruhe, D
1996 Schwabach, D
1997 Münster
1997 Erkheim, D
(1997 München, D)
1998 Wadern-L, D

1999 Radeberg, D
1999 Fürstenwaide, D

1999 Boden, D

2000 Newmarket, CAN
2001 Mertingen, D
2001 Pulawy, PL
2002 Barramatta, AUS
2002 Toronto, CAN
2002 Verona, I
2002 Villacidro, I

2002 Barcelona, E
Ecoparque I

2003 Madrid, E

2003 Hita, JPN
2005 Lisabon, P
2005 Burgos, E
2005 Cervantes, I
2005 Salto des Negro, E

2005 Gescher, D
2005 Västeras, S
2005 Deißenlingen, D
2005 Volkonschw., D
2006 Tuceda, E

2006 Wiesels, D
2006 Lübeck, D
2006 León, E
2006 Schw. Elster, D

2006 Deiderode, D

Source: Schu, K. (2008; adapted)
The BTA Process – Hydropulper & Grit Removal System

Feed conveyor

Grit removal surge tank

Feed to digestion plant

Grit hydrocyclone

Grit collection pocket

Pulper light fraction rake

Pulper vessel

Pulper impeller

Light fraction bale

Hydraulic press

Screen wiper blade

10mm perforated plate screen

Slide valve

Heavy fraction pocket
The BTA Process at the Dufferin AD Plant

Hydropulper

Grit Removal

Inside the pulper

Organic waste slurry to be fed into the digester

Sources: BTA International; City of Toronto
The BTA Process at the Dufferin AD Plant
Pre-treatment – Removed Contaminants

Hydropulper

Grit Removal System (w/Hydrocyclone)

Stones, glass, metal...

Plastics, textiles, wood...

Tiny pieces of sand & grit

Source: BTA International
The BTA Process at the Dufferin AD Plant

Digestion – Heating and Mixing

- Complete mixed with digester gas
- Single stage
- Mesophilic (35 – 38 degC)
- Intermittent feeding (weekday only)
- Feed: 8-10% TS
- Solids Recycling
  - 15 d HRT
  - 25 d SRT

Source: BTA International
## Dufferin AD Plant - Operational Experience

<table>
<thead>
<tr>
<th>Dufferin AD Facility Performance Summary</th>
<th>2004</th>
<th>2007</th>
<th>2010</th>
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<tbody>
<tr>
<td>SSO Processed</td>
<td>23,301</td>
<td>35,881</td>
<td>43,535</td>
</tr>
<tr>
<td>Biogas Produced</td>
<td>2,875</td>
<td>3,835</td>
<td>4,151</td>
</tr>
<tr>
<td>m3/tonne</td>
<td>123</td>
<td>107</td>
<td>95</td>
</tr>
</tbody>
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Increase in Annual Processing Capacity => Trade-off between Throughput and Biogas Production

Source: City of Toronto
Intermittent AD feeding causes daily and weekly variation in biogas production

=> Solution: Addition of Buffer Tank(s)

Source: City of Toronto
70% diversion goal requires SSO program expansion

SSO tonnage to increase to ~180,000 MT/yr

110,000 MT/yr City base capacity + 70,000 MT/yr private

**Primary Sites:**
Pre-processing + AD
In-City, City-owned

**Secondary Site:**
Composting External
(public or private)

- 2007 City Council approved construction of 2 AD facilities:
  - 55,000 MT/yr at Dufferin Waste Management Facility
  - 55,000 MT/yr (75,000 MT/yr max) at Disco Rd Transfer Station
Future Expansion of Dufferin AD Facility

Phase 1:
New Digester & Biofilter

Phase 2:
Expansion of Tip Floor & Processing

Ultimate Capacity:
Up to 55,000 tonnes per year

Sources: City of Toronto; CCI-TNB
Disco Road Waste Transfer Station with New SSO Anaerobic Digestion Facility

Wet BTA Process
Plant Capacity:
- 55,000 MT/yr (base)
- 75,000 MT/yr (maximum)

Design/Build/Operate Contract
- AECOM Prime Contractor
- Construction Start - Feb 2011
- Commissioning Start - End of 2012
- Project Completion - 2nd Half of 2013

Source: City of Toronto
Toronto Disco Road SSO AD Facility
3-D Model, BTA Pre-treatment Process

Source: BTA International
Disco Road Waste Transfer Station – Before Site Preparation & Construction (Sept. 2010)

Source: AECOM
New Toronto Disco SSO AD Facility under Construction – General View (May 2012)

Source: AECOM
New Toronto Disco SSO AD Facility under Construction – *Tank Farm* (May 2012)

Source: AECOM
New Toronto Disco SSO AD Facility under Construction – *Hydropulpers & LF Presses*

Source: AECOM
New Toronto Disco SSO AD Facility under Construction – **Conveyor System** (May 2012)

Source: AECOM
New Toronto Disco SSO AD Facility under Construction – Residue Presses (May 2012)

Source: AECOM

Source: AECOM
New Toronto Disco SSO AD Facility under Construction – Grit Charge Tanks (May 2012)

Source: AECOM
Biogas Utilization Plan: Biomethane + CNG Vehicles

Primary SSO Facilities
(110,000 tonnes per year SSO)

- Biogas: 13.6M m³/yr
  - 60% CH₄

  Biogas → Biomethane Upgrading System → Biomethane into NG Grid (7.8M m³/yr)

  2.5M m³/yr → City Buildings etc.

  5.3M m³/yr → New City-owned CNG Fueling Station
  - CNG SWMS Collection Vehicles

Source: City of Toronto