Approaches to selecting food waste processing technologies

Daryl McCartney, Ph. D., P.Eng.
Edmonton Waste Management Centre of Excellence
University of Alberta

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Background
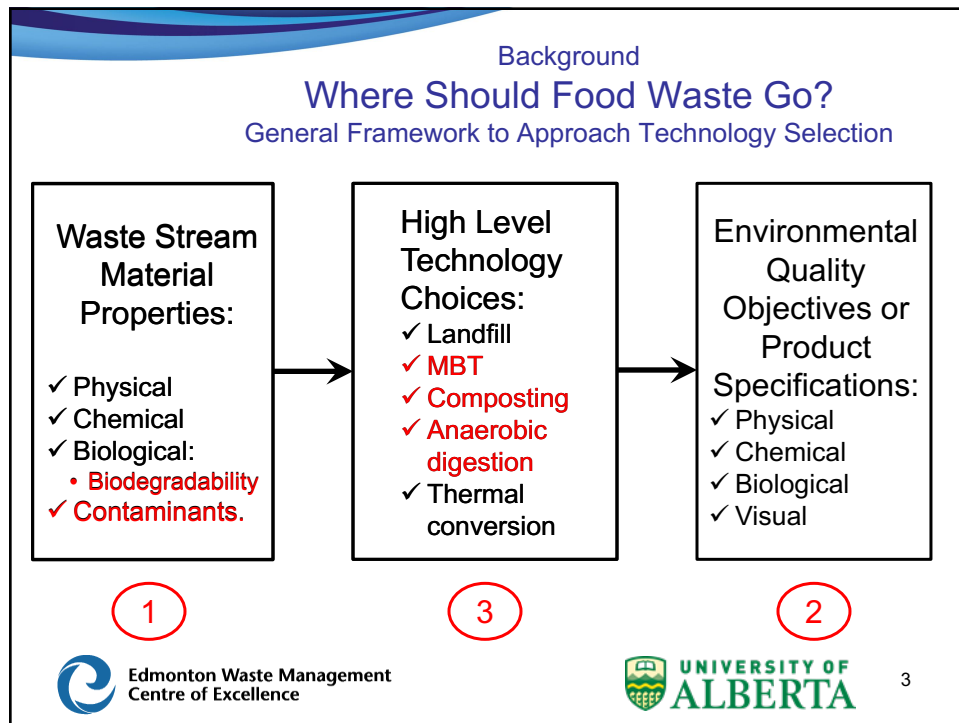# City of Edmonton

- Population: 932,500 (2016).
- Material streams available:
  - Residential:
    - curbside & multi-family.
  - ICI sectors.
- Technology available:
  - Composting:
    - Windrow (Leaf & YW).
    - Covered aerated static pile (biosolids & woodchips).
    - In-vessel basin (OFMSW).
  - Anaerobic digestion (dry).
  - Gasification to biofuels.
- Match streams to best technology.

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2

Slide 1

Background
Where Should Food Waste Go?
General Framework to Approach Technology Selection

Waste Stream Material Properties:

✓ Physical
✓ Chemical
✓ Biological:
  • Biodegradability
✓ Contaminants.

→

High Level Technology Choices:
✓ Landfill
✓ MBT
✓ Composting
✓ Anaerobic digestion
✓ Thermal conversion

→

Environmental Quality Objectives or Product Specifications:
✓ Physical
✓ Chemical
✓ Biological
✓ Visual

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3

Slide 2

Background
Food Waste Technology Selection
Physical Contamination & BMP

Technology	Key Feedstock Parameters
Bioreactor Landfill	MC; BMP
MBT to Landfill	MC; C:N; BMP
Composting	Physical contamination; MC; C:N
Anaerobic Digestion	Physical contamination; BMP; C:N:S; MC
Thermal Conversion	Physical contamination; MC; energy yield

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4

Background
Objectives For Today

- Understand impacts of material source on:
  - Contaminants &
  - Biodegradability (BMP).

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Source of Food Waste Material
Impact of Collection Method on Feedstock
(Cecchi et al. 2003)

- Three general methods to separate organics from MSW:
  1. Separate collection (SC):
     e.g. pure waste streams from ICI sector.
  2. Source separation (SS):
     e.g. household separation of residential waste also know as BioWaste.
  3. Mechanical separation (MS) at central facility:
     - co-mingled collection and then treatment, e.g. MBT in Europe and Edmonton Compost Facility.

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Source of Food Waste Material
Percent Contamination by Source Type

Separate Collection (as received)	Source Separation (as received)	Mechanical Separation (~3" screen)
ICI 0.3[a] to 2.2[a]	R 1.8[b] to 20.0[c]	MBT 22.8[d] to 36.8[e]
	3.0[g] to 14.0[g]	Edm 6.8[f] to 16.4[f]

a Cecchi et al. 1997   f Rajabpour & McCartney 2015
b Seattle 2012   g Yan & McCartney 2014
c Levis et al. 2010
d Montejo et al. 2010
e Montejo et al. 2015

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Source of Food Waste material
Monthly Variable of Residential
(Seattle 2012)

Material	Curbside (%)	Multi-family (%)
Yard waste	66.2 (27.4 - 88.0)	35.4 (34.8 - 53.0)
Food waste	26.2 (8.9 - 57.1)	43.4 (34.4 - 51.8)
Compostable paper	5.0 (1.9 - 11.5)	7.8 (6.9 - 10.3)
Contaminants	1.8 (0.5 - 4.3)	4.0 (3.0 - 5.9)

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Source of Food Waste Material

ICI Sector: Pre- versus Post-Consumer
(Yan & McCartney 2014, 2017)

Sample Level	Source	Contamination % (min to max)	Recovery, % (min to max)
Between Buildings	Pre-consumer	3 (0 to 7)	NA
	Post-consumer	14 (2 to 19)	NA
Between Buildings	Buildings with Significant Food Services	5 (0 to 10)	25 (0 to 69)

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Food Waste Risk & Reward
Reward - Substrate Biodegradability

- Most important design & operation factor for:
  - Composting.
  - Anaerobic digestion.
- Used to determine:
  - oxygen demand;
  - air demand to remove heat;
  - biomethane potential; and
  - final product mass.

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Food Waste Reward - Biodegradability
Relative to Other Organic Waste Feedstock

- Biodegradability function of macromolecules.
- Relative biodegradability:
  - carbohydrates/sugar > protein > lipids/fats > > cellulose/hemicellulose >> lignin
- Food waste highly degradable plant and animal material:
  - Manures once digested.
  - Biosolids twice digested.
  - Leaf & yardwaste less biodegradable.

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Food Waste - Biodegradability

Methane Yield Based on Source of OFMSW

(Cecchi et al. 2003)

Source $\text{Methane Yield (m}^3 \text{ CH}_4 \text{ per tonne VS)}$		
Separate Collection	Source Separated	Mechanically Separated
450 to 490	370 to 400	160 to 370

Lower methane potential from MS material.

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Food Waste - Biodegradability

Methane Yield Based on Source of OFMSW

(Lopez et al. 2016)

		Residential	ICI Sector
Literature Review	$\text{m}^3 \text{ CH}_4$ per tonne VS	n = 7 298 (225 to 349)	n = 9 447 (281 to 630)
Lopez Data	$\text{m}^3 \text{ CH}_4$ per tonne VS	NA	n = 8 421 (342 to 496)

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14

Slide 15

Food Waste Composting Risk
Risk - Food Waste Can Also Be Very Wet
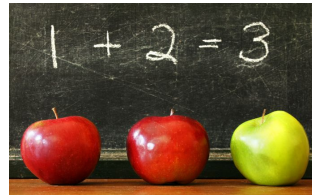Prince George's County, Maryland Composting Facility

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15

Slide 16

Summary & Conclusions

- Understand impacts of material source on food waste contamination & BMP.
- Feedstock source significant impact on contamination & BMP:
  1. Separate Collection – ICI
  2. Source Separated
  3. Mechanical Separation

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16

Questions?

Daryl.McCartney@ualberta.ca

False Killer Whale, Maui
McCartney 2017

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