Economics of Anaerobic Digestion

For Various Types of Food Waste, Co-collected Organics, Animal Manure and Seasonal Wastes

Digesting Urban Organics Residuals

A Forum on Technology, Economics and Permitting

By:
Tim Raibley
HDR Engineering

May 30, 2012

HDR

Overview of Presentation

- Variables in Digestion Systems
- Full Accounting of Facility
- Capital Cost Ranges
- Operations Cost Ranges
- Revenue Streams
- Summary

HDR

Variables – Types/Complexity of Feedstock

- Pre-consumer industrial/agricultural
- Post Consumer food waste
- Co-collected green/yard/food
- Fats oils and grease
- Animal manure
- Seasonal organics
- Municipal Solid Waste

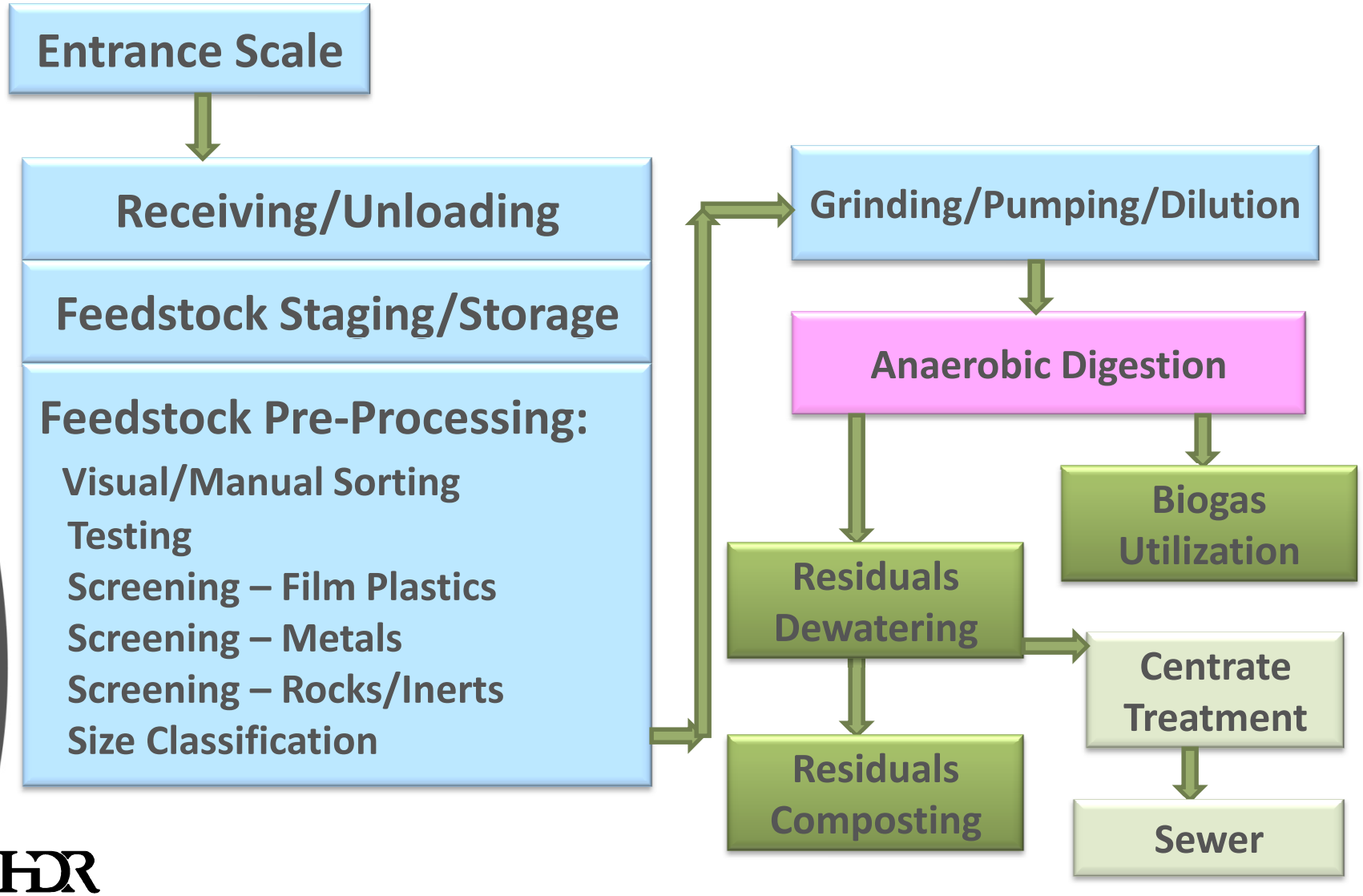
HDR

Variables - Range of Digestion Systems

- Low solids (ie: WWTP digester for biosolids)
  - Approximately 3 to 15% solids in digester
- High solids
  - Greater than about 15% solids in digester
- Lagoon with gas collection cover
  - Common for liquid wastes
- Dry fermentation/digestion (bunker type)

HDR

Example 1. University of California, Davis
Food Waste Digestion Flow Schematic



HDR

Example 1: APS - University of California, Davis

High Solids Digestion Type

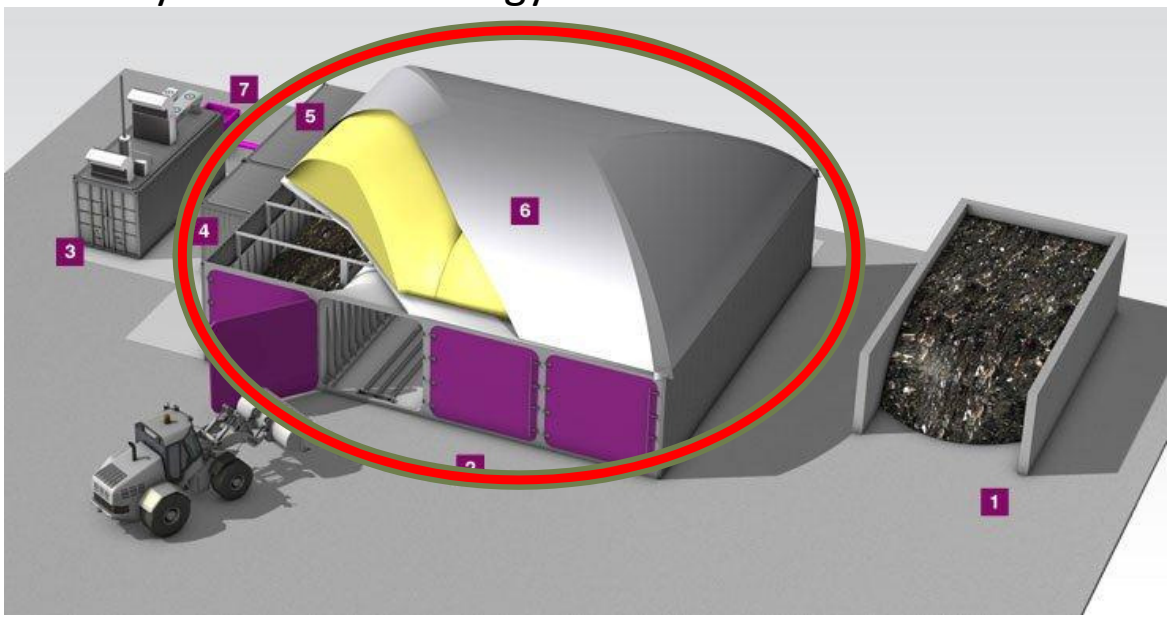
- Pretreatment required to remove inerts/contaminants
- Material pumping & conveying
- Low quantity of digestate for dewatering (compared to low-solids)
- Centrate treatment may be required

Example 2. San Jose Dry Fermentation

Less pretreatment, possibly more post treatment

- Minimal Contaminant Removal (Visual or Mechanical)
- Post process stabilization (composting)

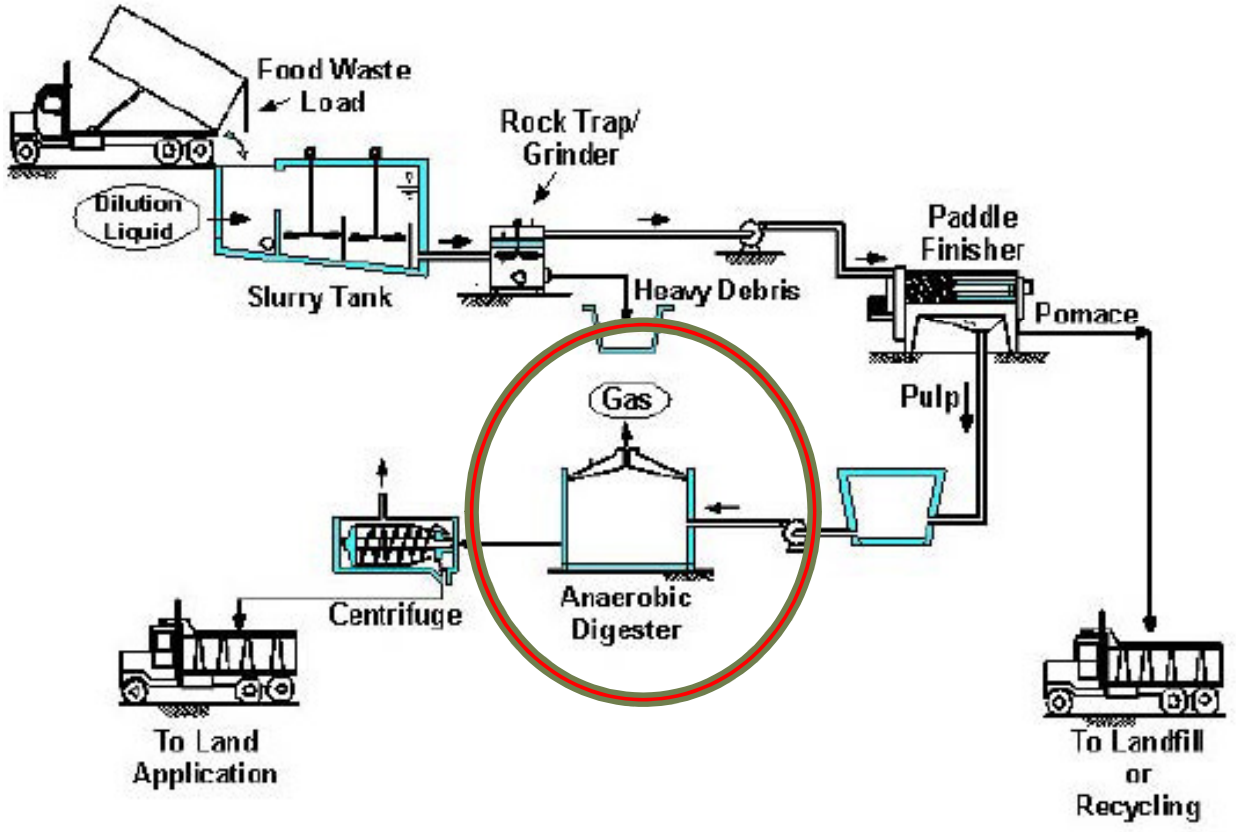
Courtesy Zero Waste Energy



Dry Fermentation Digestion Type

- Little to no pretreatment required
- Bulking agent may be required
- Pumping of “percolate” over bulk organics
- Little to no centrate

Example 3. Low Solids
East Bay Municipal Utility District



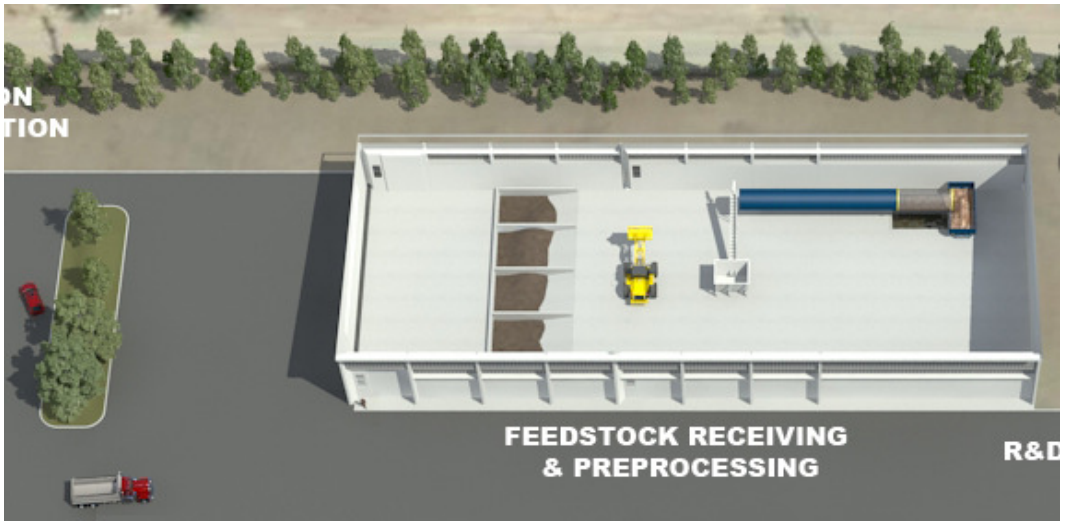
Low Solids Digestion Type

- High pretreatment required
- Feedstock dilution
- Pumping systems for liquid feed
- Larger centrate volume for treatment and discharge

Full Account of Facility – Upstream

Pre-digestion systems

- Entrance (toll, scale, etc.)
- Feedstock receipt, staging
- Pre-processing equipment/systems
- Air collection and odor control



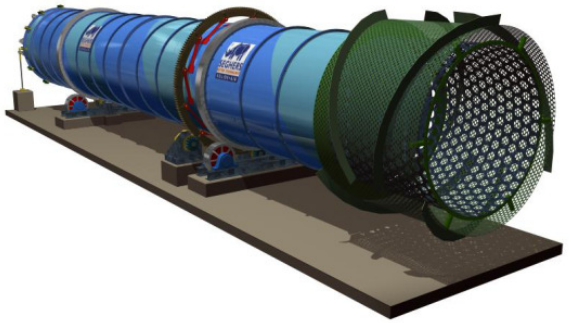
Full Account of Facility – Downstream

Post-digestion systems

- Centrate treatment
- Digestate stabilization and treatment
- Biogas cleaning
- Biogas utilization
  - Cogen
  - RNG

Ancillary Systems Cost

- Upstream and Downstream components can be significant
- Potentially 20 to 40% of total facility capital cost
- Added processes also add to O&M costs



Total System Cost

- Pre-treatment/Pre-processing
- Digestion
- Centrate treatment and discharge
- Digestate stabilization and treatment
- Biogas cleanup
- Power generation and emissions control
- Air quality/odor control

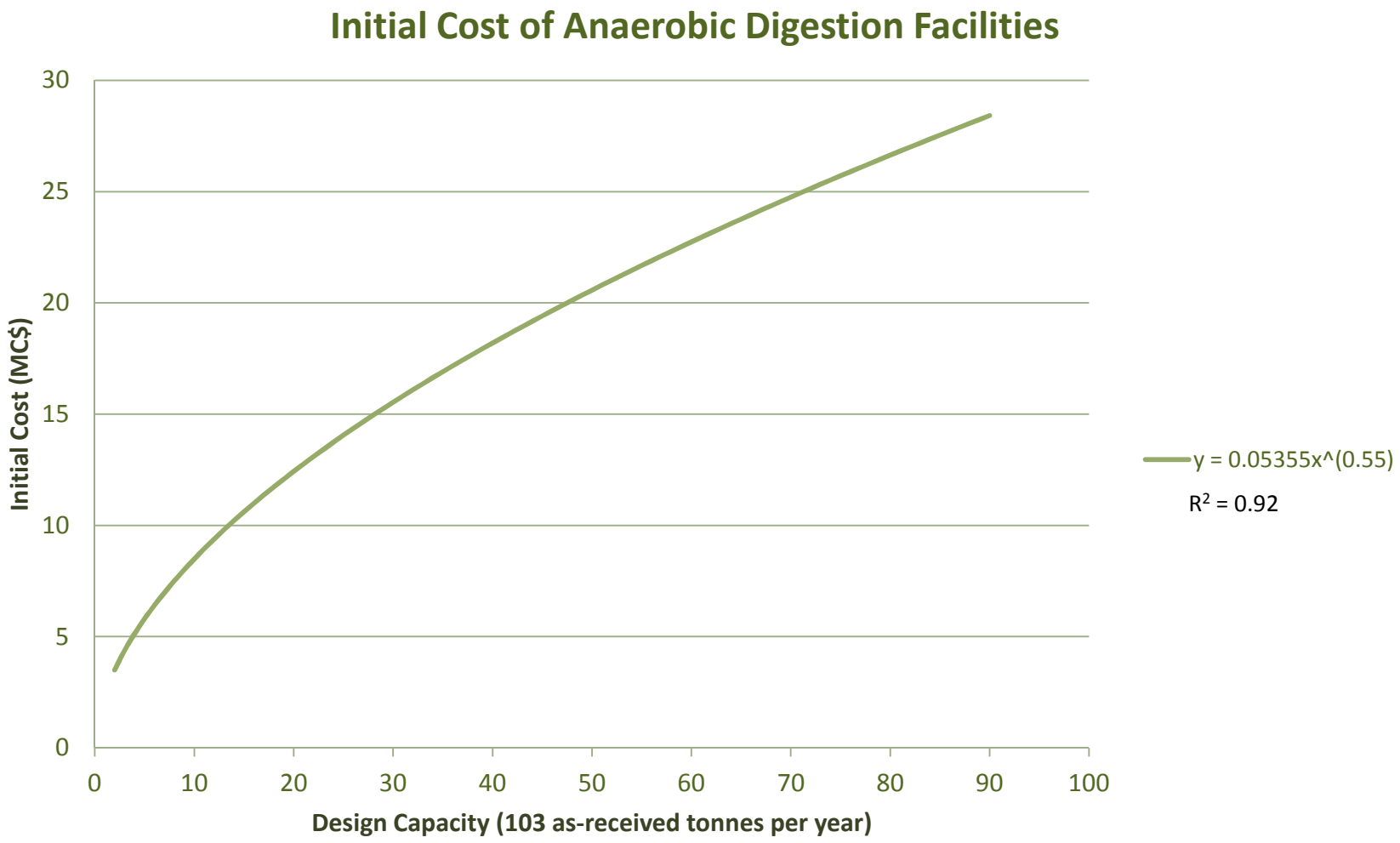
Global Factors Impacting Cost

- Magnitude/facility size
- Centrate treatment & management
- Facility location (urban vs. rural)
- Means for utilizing biogas
- Odor management (proximity to receptors, air district)

Revenue Streams

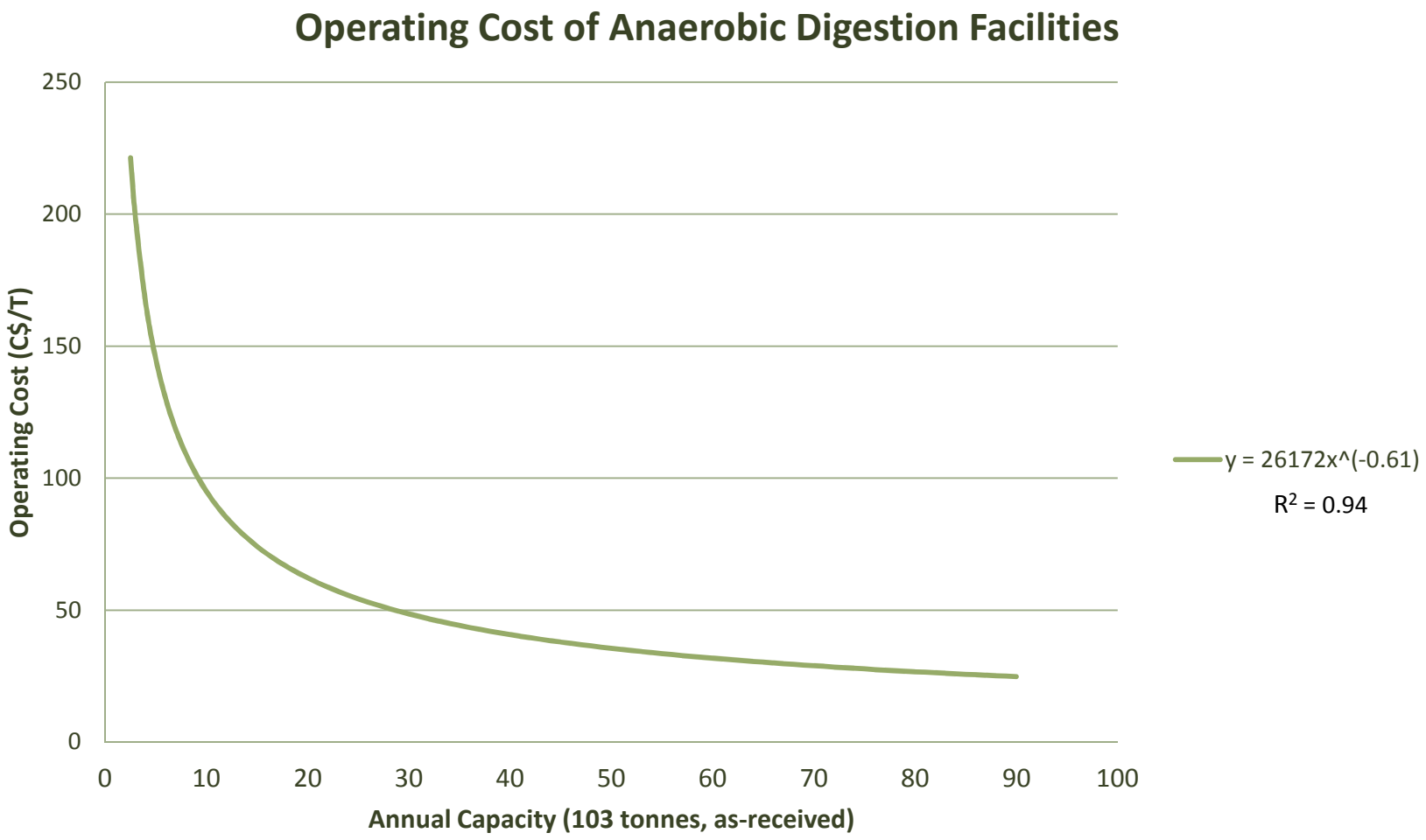
- Tip Fees
- Electrical Power Sales
- Biofuels
- By products
  - Fertilizers
  - Compost

Published Capital Cost – EU/Canada



Source: Guilford 2009 revised to Ontario based on Tsilemou 2006

Published Operating Cost – EU/Canada



Source: Guilford 2009 revised to Ontario based on Tsilemou 2006

Cost Summary

Cost Category	Low Range	High Range
Capital Cost ($M/ton-year)[1]	$250	$700
Operating Cost ($/ton)	$60	$200
Revenues ($/ton)[2]	$0	$50
Overall Tip Fee ($/ton)[3]	$70	$200

Notes:

1. Range based on variable throughput capacities and various technology types
2. Revenues limited to power sales, little to no value on compost
3. Includes amortized capital cost assuming 20 years at 6% interest and offsetting revenues

HDR

Economics of Anaerobic Digestion

For Various Types of Food Waste, Co-collected Organics, Animal Manure and Seasonal Wastes

Digesting Urban Organics Residuals

A Forum on Technology, Economics and Permitting

May 30, 2012

By:
Tim Raibley
HDR Engineering
tim.raibley@hdrinc.com
916 817 4914

HDR