CITY OF ames™

Gasification Financial Modeling

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City of Ames – Study Basis

- Facility sizing 300 tpd
- RDF to Gasification
  - 85% of processed MSW (i.e. 43,800 tpy in 2012)
  - 15% ash residue/char (estimated wet basis)
  - Syngas energy content 65% of RDF heating value
- MSW to Mass-Burn
  - 56,000 tpy MSW available + yard waste
  - Post-combustion recovery of ferrous/non-ferrous
  - 28% ash residue (wet basis)

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Gasification Scenarios

- Scenario 1 – gasification of RDF and combustion of the syngas in the City's existing coal-fired boilers. Syngas conditioning would include cooling the syngas.
- Scenario 2 – gasification of RDF to produce syngas and inject the syngas as a supplemental fuel into each of the City's existing boilers which are presumed in this scenario to have been converted to natural gas-fired. Syngas conditioning would include cooling the syngas.

Gasification Scenarios

- Scenario 3 – gasification of RDF to produce syngas and inject syngas as a supplemental fuel in a natural gas-fired combustion turbine generator set connected to electrical distribution grid. Syngas conditioning will include cooling, acid gas removal and particulate control.
- Scenario 4 – gasification of RDF to produce syngas and combustion of syngas in a dedicated internal combustion generator set connected to electrical distribution grid. Syngas conditioning will include cooling, acid gas removal and particulate control.

Gasification Scenarios

- Scenario 5 – gasification of RDF to produce syngas and combustion of syngas in a dedicated package boiler with associated generator set connected to electrical distribution grid. Owing to the direct combustion of the syngas, no conditioning equipment will be required.

Mass Burn Waste-to-Energy Scenarios

- Scenario 6a – construction and operation of a mass burn electrical generation plant using raw MSW.
- Scenario 6b – construction and operation of a mass burn electrical generation plant using shredded MSW.

Permitting Review

- Small power production facility exemption – not qualify due to co-location with existing EGP
- Prevention of Significant Deterioration (PSD) pre-construction permitting program
- All scenarios require construction permits
- Greenhouse gases emission reductions

Expected Performance by Scenario

- 1 – 65% of RDF Energy in Syngas
- 2 – 65% of RDF Energy in Syngas
- 3 – Varies from 431 to 471 kWh/ton of RDF
- 4 – Varies from 555 to 599 kWh/ton of RDF
- 5 – 500 kWh/ton of RDF
- 6a – 600 kWh/ton of MSW
- 6b – 590 kWh/ton of MSW

Probable Capital Costs

- Site work
- Site improvements
- Gasification equipment
- Buildings
- Power block equipment
- Permitting
- Design/engineering
- 20% contingency

Scenarios	Capital Cost (2012$)
Gasification Systems	
1	$34,500,000
2	$33,800,000
3	$59,200,000
4	$77,300,000
5	$79,100,000
Mass-Burn Facilities	
6a	$80,500,000
6b	$85,300,000

Annual O&M Cost Components

Gasification Systems

- Purchase of RDF
- RDF storage bins O&M
- Labor
- Routine maintenance/ equipment replacement
- Utilities
- Emissions control (chemicals)
- Ash residue disposal
- Misc. supplies, G&A, etc.
- Insurance
- 10% contingency

Mass Burn Waste-to-Energy

- Labor
- Routine maintenance/ equipment replacement
- Fuel costs (mobile equip)
- Utilities
- Emissions control (chemicals)
- Ash residue disposal
- Bypass/non-processible waste disposal
- Annual stack testing
- Misc. supplies, G&A, etc.
- Insurance
- 10% contingency

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Revenues and Avoided Cost Components

- Avoided Costs
  - Reduced RDF landfill haul & disposal costs (Scenarios 1-5)
  - Yard waste management costs (Scenarios 6a/6b)
  - EGP: RDF ash removal & disposal costs
  - EGP: RDF storage bins O&M
  - EGP: Boiler maintenance costs
  - EGP: Extra cost of power to burn RDF
- Energy Revenue (syngas or electric sales)
- Metals Recovery Revenue (Scenarios 6a/6b)
- Tipping Fee & Per Capita Revenue (Scenarios 6a/6b)
- No renewable energy credits or carbon credits included in Base Case

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Business Case Analysis

- Implementation Schedule
- Financing/Debt Service
  - Tax-exempt revenue bonds: 6% gasification scenarios, 5% mass burn scenarios
  - Bond issuance fees 4%
  - Reinvestment rates 2%
  - Annual escalation capital costs 4%
  - One-year debt service reserve
- 20-year Pro Formas

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Capital and O&M Costs Summary

Scenarios	Tonnage Throughput[2]		Capital Cost[4] (2012$)	Annual Net Debt Service	Annual O&M[5] (2012$)
	TPY	TPD[3]			
Gasification Systems					
1	46,000	148	$34,500,000	$3,940,000	$3,350,000
2	46,000	148	$33,800,000	$3,860,000	$3,350,000
3	46,000	148	$59,200,000	$6,980,000	$4,970,000
4	46,000	148	$77,300,000	$9,120,000	$4,730,000
5	46,000	148	$79,100,000	$9,650,000	$6,090,000
Mass-Burn Facilities					
6a	63,000	203	$80,500,000	$9,380,000	$7,110,000
6b	63,000	203	$85,300,000	$9,940,000	$7,340,000

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Revenues Summary: Scenarios 1 - 5

Scenarios	Net Energy Generation		Avoided Costs[2] (2012$)	Annual Energy Revenues[3] (2012$)	Net Revenues/(Expenses)[4]	
	Syngas MMBtu/ ton RDF	kWh/ ton RDF			Net w/out Avoided Costs	Net w/ RRP & EGP Avoided Costs
1	6.7		$3,080,000	$1,050,000	($6,210,000)	($3,040,000)
2	6.7		$3,080,000	$1,050,000	($6,140,000)	($2,960,000)
3		431	$5,920,000	$1,340,000	($10,530,000)	($4,810,000)
4		555	$5,920,000	$1,220,000	($12,420,000)	($6,710,000)
5		500	$5,920,000	$1,100,000	($14,490,000)	($8,770,000)

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Revenues Summary: Scenarios 6a/6b

Scenarios	Net Energy Generation		Avoided Costs[3] (2012$)	Annual Energy Revenues[4] (2012$)	Tip Fee & Per Capita Revenues[5] (2012$)	Add'l Net Revenues/(Expenses)[6]	
	Annual kWh/yr[2]	kWh/ ton MSW				Net w/out Avoided Costs	Net w/ Avoided Costs
6a	35,280,000	600	$5,410,000	$1,760,000	$4,040,000	($10,160,000)	($5,080,000)
6b	34,692,000	590	$5,410,000	$1,730,000	$4,040,000	($10,960,000)	($5,870,000)

Findings/Conclusions

- Current MSW deliveries 56,000 tpy
  - Approx. 180 tpd
  - Supplemental waste needed to maximize capacity; may or may not provide more revenues depending on scenario
- Scenarios 1 and 2 least cost options for RDF gasification
- Avoided costs are reinvested as revenues rather than realized as actual budget savings
- Additional revenues required for all Scenarios

QUESTIONS?