

WADE DistribuGen Conference and Trade
Show For Cogeneration/CHP 2015

Turning Problems into Energy

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About the Presenter

- 43 years in the Power Generation Business
- Rudd Asset Management
- Renewable Biomass Power generation
- Power Project Consulting business
- Power Project Risk Management services
- See bio sheet provided to WADE



Power Plants That Make Cents

- RAM projects are designed as solid power plant designs, first and foremost
- Not just a simple subsidy play
- Cautious about using unproven technology
- Focus on Distributed Energy (DE) & Combined Heat & Power (CHP)
- Typical designs use biomass gasification and reciprocating engine gensets



Creating Value - Fuels

- Natural gas currently advantaged
- Biomass fuels
- Waste/Opportunity fuels
- Agricultural by products
- Green Power premiums



Engineering Additional Revenues

- Focus on CHP benefits
- Power quality improvement of DE
- Focus on high LMP areas
- Focus on power quality and voltage problem areas
- Adapt generation to meet local needs



Potential Applications

- United States or similar developed utility grids that have problem areas
- Evolving economies that are unable to add generation quickly enough while new generation and T&D is built
- Developing countries that lack sufficient electrical energy and seek a rapid solution



USA/Developed Grid Opportunities

- Potential for renewable biomass generation every 50 miles
- Dispatch able power
- Ancillary services for the grid (VAR support, spinning reserve, black start)



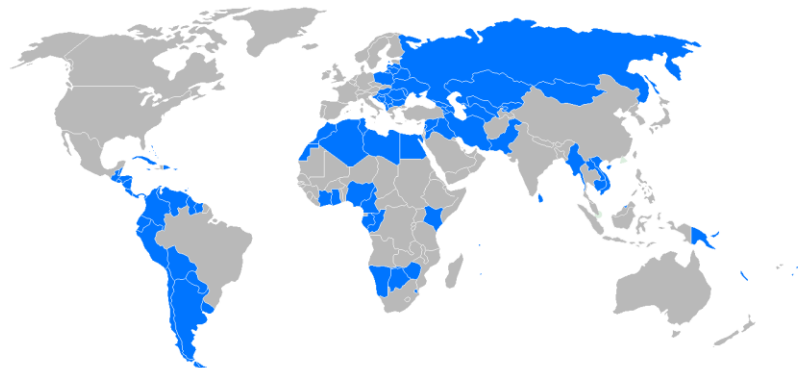
Developing Countries

- Relatively quick supply of electrical & thermal energy
- Modular & flexible sizing
- Easily expandable to meet load growth
- Ability to use agricultural product waste to provide additional revenue and jobs
- Easily connected to the grid once T&D sources become available



Developing Country Guidelines

- Identify indigenous local fuel options
- Identify locations for electric power and thermal energy
- Size electrical generation to match stable thermal load
- Review fuel handling and processing options



Sorghum 1- 5 MWe Project Example

- For an example, a 1 – 5 MWe power need with high thermal load
- Identify thermal energy use (food processing, industrial, commercial, etc.)
- Sorghum food product source of biomass residual



Advantages of Sorghum

- Commonly used global food source
- Minimal agricultural requirements (water, labor, minimal fertilizer, well understood)
- Relatively high quantity of biomass by product
- Potential for “green energy” with lower environmental emissions
- Potential for “carbon neutral” generation



Biomass Additional Economic Benefits

- Farmer has an additional revenue source for the sorghum plant residual
- Bottom ash product potential use as fertilizer
- Job creation:
 - Transport the biomass to the food processor
 - Transport the residual biomass to the power plant
 - Handling and processing of the biomass at the power plant
 - Stable long term jobs for power plant operators



Biomass Generation Benefits Summary

- Relatively low capital costs
- Renewable fuel
- Additional crop revenue to the community
- Additional jobs to the community
- Use of proven, well understood equipment
- Modular design that is easily expandable
- Low economic “barriers of entry” and “exit costs”



Evaluating projects

- RAM uses a quick, but thorough project “screener”
- Consistently review power projects like any other investment
- Provides 5 year Discounted Cash Flow analysis with Monte Carlo simulations
- Provides project optimization
- Provides Risk Management review



Review of RAM Project Screener

- Project equipment review
- Performance assumptions
- Financial assumptions
- Project fees review
- Investment results (EBITDA, NPV, IRR, DCR)
- Monte Carlo simulation of results
- Confidence Interval & Confidence Level results
- “Tornado Diagram” review
- Project Optimization discussion



RAM Project "Screener" page 1/4

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Presentation: Turning Problems into Energy

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Appendix

Conceptual Review of Renewable CHP Power Plant

Note:

This spreadsheet is used as a template that shows project design, heat rate, efficiency estimates, fuel price, and energy content. It does a quick assessment of a project's potential profitability. It is intended to serve as a project viability screener ONLY. If the results are acceptable, a full project analysis would then be done by RAM using project specific data.

	Values	Explanation	
Fuel Type	composite fuel	sorghum, miscanthus, etc.	
Fuel Feed Stock Energy Content	8,600	Btu/lb	assumes 12 - 15 % moisture
Cost of feed stock (fuel) to gasifier	\$ -	per ton	waste disposal fee
Fuel Processing Revenue	\$ -		Tipping fee paid for disposal
Gaseous fuel energy content	150	Approximate Btu/cubic foot of gaseous fuel (@ STP)	
Feed Stock Consumption per year	24,803	tons/yr	
Value of gasifier bottom ash	\$ -	per ton	potential use as fertilizer
Cost of gaseous fuel to engine (\$/million Btu)	\$ -	per million Btu	
Engines			
# of engines	1		
Rated power/engine	1,800	KWe	4,000 with natural gas
Engine Gross Generation	1,800	KWe	
Plant Net Generation	1,700	KWe	
Estimated Engine heat rate	10,000	Btu/kWh	
Estimated price for engine	\$ 1,438,800		
Fixed Maintenance Costs	\$ 311,429	Sinking fund	
Variable O&M Costs	\$ 17.42	\$/mWh	
Fixed labor for engines	\$ 160,000		
Estimated Engines Aux Load	50	kWe	
Estimated Availability	90%	Estimated @ 90 % +	
Gasifier			
Estimate price for gasifier	\$ 2,158,200	total installed cost	
Estimated Gas Clean Up Cost	\$ 500,000	total installed cost	
Fuel Handling Equipment	\$ 452,000	To handle fuel (front end loader, storage, etc.)	MSR estimate
Fuel Pelletizer	\$ 126,750		
Maintenance & annual repairs	\$ 100,000		
Labor for fuel handling & gasifier	\$ 160,000		
Est. gasifier auxiliary load	50	KWe	
Bottom ash revenue/disposal	\$ -	\$ 0 per ton	Sible 011410 discussion
Biomass Fuel processing steam		million lbs/hr.	project specific
Financial Information			
Wholesale power price (cents/kWh)	\$ 0.1100	location dependent	
Green Power premium (\$/kwh)	\$ -	location dependent	
RECs & carbon credits value (\$/kwh)	\$ -		
Annual Revenue increase	0%		
Annual Expense increase	3%		
Gasifier bottom ash production percentage	6.5%	5 - 8 % of fuel supply	
Assumed Plant Equivalent Availability	90%		
Loan % interest rate	7.50%		
Owner Equity %	30%		
Debt %	70%		
Federal MTB assumed	35%		
State MTB assumed	7%		
ITC (\$/kwh)			project specific
PTC (%/kwh)			project specific
Treasury option	30%	30 % Treasury Grant Option	project specific
Revenue from CHP thermal energy	\$ 1,419,120		project specific
Tipping Fee Income	\$ -	per year	project specific
Project Summary			
Annual Fees			
A&G - annual expense	\$ 36,000	\$/yr	project specific
Annual Administrative Project Expenses	\$ -	O&M trending/monitoring	project specific
Annual Security Monitoring Expense	\$ 12,000		project specific



RAM Project "Screener" page 2/4

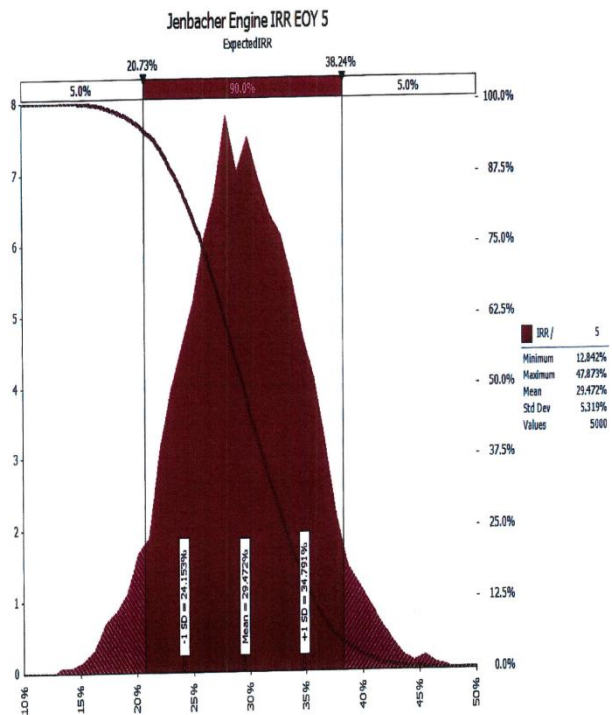
<u>Capital Expenses</u>				
Estimated Interconnection Expenses	\$	250,000		project specific
Long Term Service Agreement development				project specific
Biomass Fuel Handling	\$	452,000	Blidg., loader, conveyor, etc.	project specific
Site real estate cost	\$	40,000		project specific
Plant Buildings (2) (Gasifiers, Generation)	\$	224,000		project specific
Building/Noise Abatement	\$	50,000		project specific
Building crane hoist installation (2)	\$	50,000	one hoist in each Building	project specific
Switch Yard and wires	\$	200,000		project specific
Fire Protection system	\$	225,000		project specific
Estimated Site Security Capital Expense	\$	40,000		project specific
Infrastructure - Building fencing, roadway, gates	\$	67,800		project specific
Thermal Energy System	\$	278,000		project specific
Interconnection study, Permits, Design & Construction	\$	416,500	see RAM Business Plan	project specific
Construction management	\$	60,000		project specific
OEM Construction, Start Up & Training Support	\$	49,000		project specific
Estimate total price for installed engines	\$	1,438,800		project specific
Estimate price for installed gasifiers	\$	2,158,200		project specific
Estimate price for installed gas clean up	\$	500,000		project specific
Initial OEM Spare Parts	\$	1,090,000		project specific
Total Plant Capital Costs	\$	7,589,300		
Overall Installed Cost Review (\$/kWe)	\$		\$ 1,897 per KWe installed	
Annual Property Taxes	\$	-		project specific

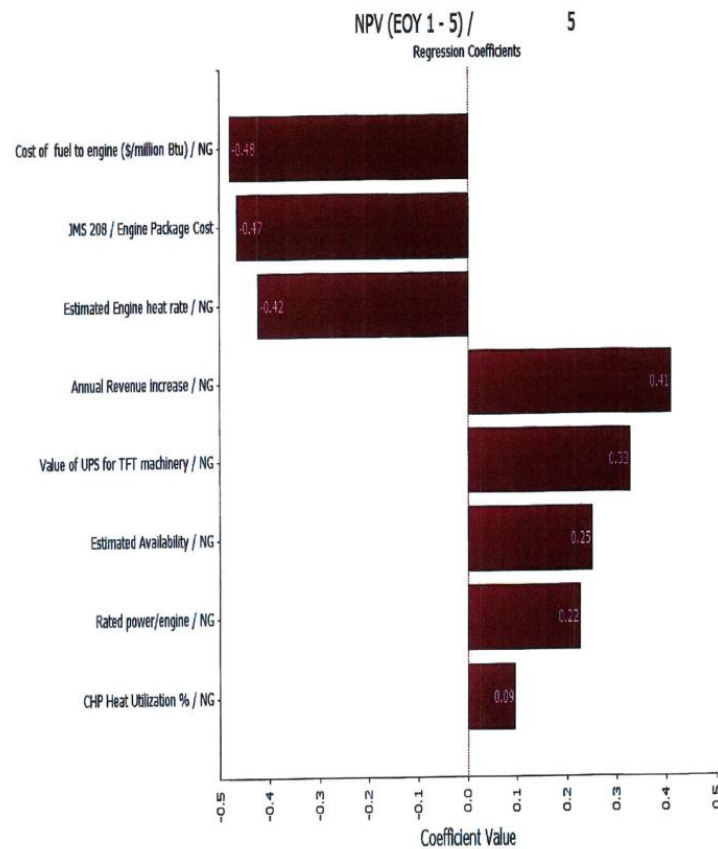
Investment Analysis

(see "Financial Analysis" worksheet for details and assumptions)

Investment BOY1	\$	2,276,790					
			Year	Year	Year	Year	Year
Year	BOY		1	2	3	4	5
Cash Flow	\$	(2,276,790)	816,909	796,588	775,658	754,099	731,894
EBITDA	\$		1,725,556	1,690,520	1,654,433	1,617,263	1,578,978
NPV (EOY 1 - 5)			(\$1,411,046)	(\$769,823)	(\$189,010)	\$336,264	\$810,503
IRR							21%
Discount Rate =	7.50%						
DCR			2.38	2.35	2.31	2.28	2.24









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