Exploiting Biogas for Cost Savings

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Biogas Conversion to Electricity Allows Two Major Wastewater Utilities In Texas to Meet State Mandated Energy Measures and Reduce Their Grid Derived Electricity Costs

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In Cooperation with:
Dallas Water Utilities
San Antonio Water System

Outline

◆ Background information
  ◆ Texas Senate Bill 5
  ◆ Texas Senate Bill 7
◆ Leveraging these bills for cost savings
◆ What is biogas?
◆ What is the value of a city’s biogas?
◆ The Southside and Dos Rios WWTP Biogas Capitalization Projects
Texas Senate Bill 5 (2001) - Background

- Federal Clean Air Act Amended - 1990
  - Requires State Implementation Plans (SIPS)
  - Grants Enforcement Power to US EPA
- US EPA Establishes National Air Quality Standards
  - DFW Classified “Moderate” Ozone Non-Attainment Area – 1990
  - DFW Reclassified “Serious” Ozone Non-Attainment Area – 1998
  - San Antonio Classified “Near” Ozone Non-Attainment Area
- TNRCC (Now TCEQ) Adopts SIP Revisions to Address Ozone Non-Attainment Areas
  - Includes Numerous Control Strategies to Reduce Emissions from Electricity Generating Facilities (EGFs)
- SB 5 Legislated to Provide Tools to Assist the TNRCC in Reducing EGF Emissions - 2001
  - Includes Legislation for the Mandatory Reduction of Energy Use by Political Subdivisions of the State

Cost Saving Opportunities

Texas Senate Bill 7 (1999) - Background

  - Promote Greater Competition in Bulk Power Markets
  - Ensure Wholesale Purchaser Access to Alternative Power Supplies
- Wholesale Electricity Market Deregulated - 1996
  - Provided for the Open Access and Use of Privately Developed Transmission Systems
  - Established the Rules for Wholesale Wheeling of Electricity
- SB 7 Legislated to Deregulate the Retail Electricity Market - 1999
  - Prevent Domination of Electrical Markets
  - Set Goals for Electricity Generation From Renewable Energy Resources
  - Require Older Plants to Reduce Air Pollution
  - Ensure Reliability and Protect Consumers
- Texas PUC Issues Rules for Buying & Selling Renewable Energy Credits (REC) - 2000
  - Establishes Renewable Resource Requirements for All REPs
  - Defines Penalties for Non-Compliance

Cost Saving Opportunities
Leveraging the Features of Both Bills for Cost Savings

**TEXAS SENATE BILL 5 REQUIRES:**

Political Subdivisions of the State to:
1. Undertake All Cost Effective Energy Efficiency Projects on Existing Facilities that will Result in a Reduction in the Use of Electricity
2. Adopt a Goal to Reduce Electricity Use by 5% Per Year for Five Years Beginning in 2002
3. Report the Results of their Progress in Meeting this Goal on a Yearly Basis

**TEXAS SENATE BILL 7 ALLOWS:**

Energy Produced by a Renewable Resource to be Bought and Sold in the Texas Wholesale Market or to Retail Customers in Texas and Marketed as Renewable Energy if it is Generated From a Qualifying Resource

**Cost Savings By Capitalizing on the Energy Value of Biogas**

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**What Is Biogas?**

- Screensings Removal
- Grit Removal
- Primary Clarification
- Aeration
- Secondary Clarification
- Filtration
- Treated Effluent
- Gas Flaring
- Gas Compression
- Storage
- Hot Water Supply
- Hot Water Return
- Digester
- Landfill

Biogas 60% CH₄ 40% CO₂ ≈ 500 BTUs
Biogas 50% CH₄ 50% CO₂ ≈ 350 BTUs
Gas Production / Heating Value Relationships

**Dallas’ Southside WWTP**

<table>
<thead>
<tr>
<th>Fraction of Biosolids that are Volatile (%)</th>
<th>Volatile Fraction Destroyed Through Digestion (%)</th>
<th>Biogas Production Rate (ft³ gas/lb Volatile Solids Destroyed)</th>
<th>Calorific Value of Biogas (Btu per ft³)</th>
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<tbody>
<tr>
<td>70</td>
<td>55</td>
<td>15</td>
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**San Antonio’s Dos Rios WRC**

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Southside WWTP Energy Balance - Year 2005 Probable Electricity and Waste Heat Production

- **Gas Engine Generator (35% Efficient)**
  - Biogas 1000 MMbtu/d
  - Electricity 4.2 MW

- **Heat Recovery System**
  - Radiant Heat
  - Radiant Heat and Exhaust Heat
  - Recovered Waste Heat 450 MMbtu/d

- **Other Heating Needs**
  - Recovered Waste Heat 300 MMbtu/d
  - Unrecoverable Waste Heat 200 MMbtu/d
  - Radiant Heat
  - Radiant Heat and Exhaust Heat

**NOTE**

1 MMbtu = 1 Million Btu
As a Renewable Energy, DWU's Biogas has a Potential Value Over $2,800,000/Year

Recoverable Mechanical Energy (as Electricity)
350 MMBtu/Day ($2.4 Million/Year @ $0.065/kWh)

Unrecoverable Waste Heat
(200 MMBtu/Day)

Recoverable Waste Heat
450 MMBtu/Day

PLUS
37,000 RECs
($426,000/Year @ $11.50/MWh)

As a Fuel to Generate Electricity, DWU’s Biogas has the Potential to Reduce the City’s Aggregate Electricity Consumption by More Than 5% (1 Year of Senate Bill 5 Compliance)

56% Reduction
(36,800,000 kWh/Year)

9% Reduction
(430,000,000 kWh/Year)

5% Reduction
(790,000,000 kWh/Year)

9% Reduction
(36,800,000 kWh/Year)

430,000,000 kWh/Year

790,000,000 kWh/Year

CITY

SOUTHSIDE WWTP

DWU
Dos Rios WRC Energy Balance - Year 2005
Probable Electricity and Waste Heat Production

- **Radiant Heat**
- **Digesters**
- **Unrecoverable Waste Heat**: 180 MMBtu/d
- **Jacket and Exhaust Heat**
- **Biogas**
  - 900 MMBtu/d
  - Electricity: 3.8 MW
- **Diverter Valve**
- **Value**: 35% 20% 45%
- **Unrecoverable Waste Heat**: 180 MMBtu/Day
- **Recovered Waste Heat**: 405 MMBtu/Day
- **Recoverable Mechanical Energy (as Electricity)**: 315 MMBtu/Day ($1.5 Million/Year @ $0.046/kWh)
- **PLUS**: 33,000 RECs ($380,000/Year @ $11.50/MWh)

As a Renewable Energy, SAWS' Biogas has a Potential Value Over $1,800,000/Year

- Gas Engine Generator (35% Efficient)
- Radiant Heat and Exhaust Heat
- Recovered Waste Heat
- 1 MMBtu = 1 Million Btu
- Other Heating Needs: 235 MMBtu/d
- Gas Engine or Turbine (35% Efficient)

Image courtesy of Solar Turbines – A Caterpillar Company
As a Fuel to Generate Electricity, SAWS Biogas has the Potential to Reduce the Utility’s Aggregate Electricity Consumption by Nearly 13%, (More Than Two Years of Senate Bill 5 Compliance)

- **DOS RIOS WRC**: 36,000,000 kWh/Year
  - 93% Reduction (33,300,000 kWh / Year)

- **SAWS**: 260,000,000 kWh/Year
  - 12.8% Reduction (33,300,000 kWh / Year)

SB7 Establishes a Goal of 2000 Additional Megawatts of Renewable Electricity Generating Capacity in Texas by 2009

- **1999**: 880 MW
- **2000**: 1512 MW – Actual to Date
- **2001**: 1730 MW
- **2002**: 1280 MW
- **2003**: 880 MW
- **2004**:
- **2005**: +450 MW
- **2006**: +300 MW
- **2007**: +50 MW
- **2009**: +650 MW
More on RECs

- The PUCT requires all REPs, as part of their licensing, to have a percentage of their generating capacity derived from renewable energy sources.
- This percentage is in proportion to the REPs load share (e.g. if REP “X” serves 10% of the total Texas generating load in 2003, they need to have 0.10 x 1280 MW or 128 MW of renewable energy derived electricity generating capacity for that year in their portfolio.
- The ERCOT administered REC trading program allows REPs to buy RECs from third party renewable energy generators and “bank” them to their individual REC accounts.
- After registering with the PUC, owners or operators of renewable energy generation facilities can create their own REC accounts from which ERCOT accounted REC trades can be transacted.

TDSP Incentives Provide “Seed” Money for Energy and Demand Reduction Projects

**SOUTHSIDE WWTP COGENERATION PROJECT**
- Demand Reduction = 4.2 MW @ $189/kW
- Energy Reduction = 36,800 MWh/Year @ $0.065
- MAXIMUM INCENTIVE FROM TXU ELECTRIC DELIVERY = $3.2 MILLION

**SOUTHSIDE WWTP DIFFUSED AERATION PROJECT**
- Demand Reduction = 2.3 MW @ $189/kW
- Energy Reduction 20,100 MWh/Year @ $0.065
- MAXIMUM INCENTIVE FROM TXU ELECTRIC DELIVERY = $1.7 MILLION
The Southside WWTP Cogeneration Project

<table>
<thead>
<tr>
<th>DWU RESPONSIBILITY</th>
<th>CONTRACT OPERATOR RESPONSIBILITY</th>
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<td></td>
<td>Condensate Pumping</td>
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<td>Digesters</td>
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<td>Gas Compression</td>
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<td>Gas Storage</td>
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<td>Make-up Water from Utility</td>
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<td>Southside WWTP Main Substation</td>
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<td>To WWTP Leads</td>
<td>Electricity from REP</td>
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<td>Electricity</td>
<td>Biogas Natural Gas</td>
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<tr>
<td>Natural Gas</td>
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**DWU RESPONSIBILITIES**
- Own Cogeneration Facility/Equipment
- Produce Guaranteed Quantity and Quality of Biogas

**CONTRACT OPERATOR RESPONSIBILITIES**
- Operate/Maintain Cogeneration Facility
- Generate/Delivery Electricity
- Generate/Deliver Steam
- Permit Facility
- Broker RECs
- Arrange for Own Utility Needs

The Dos Rios WRC Combined Heat and Power Production Project

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<tr>
<th>SAWS RESPONSIBILITY</th>
<th>ENERGY CONVERSION CONTRACTOR RESPONSIBILITY</th>
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<tr>
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<td>Biogas / Propane / Natural Gas</td>
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<td>Hot Water Supply</td>
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<td>Hot Water Return</td>
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**SAWS RESPONSIBILITIES**
- Allocate a Pad Site for Development
- Route Necessary Utilities to Pad Site for Hook-Up
- Produce Guaranteed Quantity and Quality of Biogas

**ENERGY CONVERSION CONTRACTOR RESPONSIBILITIES**
- Provide/Operate Maintain Cogeneration Facility
- Generate/Delivery Electricity
- Generate/Deliver Hot Water
- Permit Facility
- Broker RECs
**Framework of Southside WWTP Biogas Cogeneration Project Award**

- Contract operator submitting the lowest rate for biogas produced electricity (a 4.2 MW facility should be operable with a reasonable profit at $640,000 per year or $0.017/kWh assuming no fuel costs, no capital costs and no consideration to leveraged income from REC sales)
- Contract operator submitting the best value operations and maintenance plan (flexibility, PM, reporting, uptime response, etc.)
- Contract operator submitting the least exceptions to required commercial terms (indemnification, insurance, bonds, force majeure, etc.)
- 8-12 year term to allow at least two major overhauls to be performed on each machine

**Economics of Southside Cogeneration Project**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>Current Grid Derived Electricity Use</td>
<td>66,000,000 kWh/Year OR $4,290,000/Year (A) @ $0.065/kWh</td>
</tr>
<tr>
<td>Offset Grid Derived Electricity Use as Result of Cogen Project</td>
<td>36,800,000 kWh/Year</td>
</tr>
<tr>
<td>Post Cogen Project Grid Derived Electricity Use</td>
<td>29,200,000 kWh/Year OR $1,898,000/Year (B) @ $0.065/kWh</td>
</tr>
<tr>
<td>Gross Annual Savings Available for Cogen Project Investment</td>
<td>(A) —— (B) = $2,400,000/Year</td>
</tr>
<tr>
<td>Estimated Capital Cost of 4.2 MW Cogeneration Project</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>DTSP Incentive</td>
<td>$3,200,000</td>
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<tr>
<td>Net Capital Cost for Payback Analysis Purposes</td>
<td>$7,300,000</td>
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<tr>
<td>Gross Annual Savings Available for Cogen Project Investment</td>
<td>$2,400,000/Year</td>
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<tr>
<td>Estimated Annual O&amp;M Cost of Cogen Facility (Assuming No Fuel and Capital Costs)</td>
<td>$640,000/Year @ $0.017/kWh</td>
</tr>
<tr>
<td>REC Income (Assuming 50/50 Split With Cogen Operator)</td>
<td>$210,000/Year</td>
</tr>
<tr>
<td>Total Adjusted Annual Savings Available for Net Cost Payback</td>
<td>$1,970,000/Year</td>
</tr>
<tr>
<td>PAYBACK ON NET CAPITAL COST</td>
<td>$7,300,000 = 3.7 YEARS</td>
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Framework of Dos Rios WRC Cogeneration Project Award

- Energy conversion contractor submitting the lowest rate for biogas produced electricity (a 3.8 MW facility should be operable with a reasonable profit at $440,000 per year or $0.013/kWh assuming no fuel costs, and no leveraged income from REC sales; a 3.8 MW facility should be constructible and operable with a reasonable profit over a 15 year term for $0.039/kWh under the same assumptions)
- Energy conversion contractor submitting the best value operations and maintenance plan (flexibility, PM, reporting, uptime response, etc.)
- Energy conversion contractor submitting the least exceptions to required commercial terms (indemnification, insurance, bonds, force majeure, etc.)
- 15 + year term to allow for capital investment retirement

Economics of Dos Rios Cogeneration Project

- Current Grid Derived Electricity Use = 36,000,000 kWh/Year OR $1,660,000/Year (A) @ $0.046/kWh
- Offset Grid Derived Electricity Use as a Result of Cogen Project = 33,300,000 kWh/Year
- Post Cogen Project Grid Derived Electricity Use = 2,700,000 kWh/Year OR $124,000/Year (B) @ $0.046/kWh
- Gross Annual Savings Available for Cogen Project Investment = (A) —— (B) = $1,540,000/Year (C)

- Estimated Annual O&M Cost of Cogen Facility (Assuming No Fuel Costs) = $440,000/Year OR $0.013/kWh
- Estimated Annual REC Income (Assuming 50/50 REC Sales Split) = $130,000/Year OR $0.005/kWh
- Adjusted Annual O&M Cost of Cogen Facility = $250,000/Year (D) OR $0.008/kWh
- Adjusted Annual Savings Available For Capital Investment Retirement = (C) —— (D) = $1,290,000/Year (E)

- Estimated Annual Debt Service Costs on $9,400,000 of Capital Investment @ 6% Interest, 15 Year Term, and 10% Salvage Value = $370,000/Year (F) OR $0.026/kWh
- Net Annual Savings Resulting from Cogen Project = (E) —— (F) = $420,000 OR $0.013/kWh

- Post Cogen Project Grid Derived Electricity Cost = 2,700,000 kWh/Year @ $0.046/kWh = $124,000/Year
- Cogen Project Electricity Cost = 33,300,000 kWh/Year @ $0.034/kWh = $1,136,000/Year
- Post Cogen Project Total Electricity Cost = 36,000,000 kWh/Year @ $0.035/kWh = $1,260,000/Year
Questions and Answers