

QuestAir



Optimizing PSA Design for Biogas Upgrading Systems

Biogaz Quebec/AWMA Conference

14 May 2009

Agenda

1. QuestAir Overview & Biogas Project Experience
2. Energy integration opportunities for Municipal digesters
3. Worked example – Economics
4. Conclusions



QuestAir Technologies Inc.

Gas purification technology

- Proprietary PSA technology
- Compact, modular, scalable products
- Low cost of ownership

Markets

- Biogas upgrading
- Industrial hydrogen
- Gas processing (offshore)

Biogas Projects

- Equipment supplied to 12 projects
- Europe (6), US (5), Asia (1)
- Upgrading for Pipeline Injection, CNG vehicle fuel & Power Generation

QuestAir's Gas Purification Technology



Conventional PSA:

- Slow cycle speed
- Large vessels
- High cost of ownership

QuestAir PSA:

- Faster cycle speed
- Compact, modular
- Low cost of ownership

Merger with Xebec Adsorption Inc.

- Announced merger transaction with Xebec Adsorption Inc.:
 - Closing ~May 29th
- Xebec Adsorption:
 - Montreal based company
 - Manufacturer of Natural Gas & Air dryers
 - Manufacturing facilities in Montreal & Shanghai
- Vision – global leader in natural gas infrastructure & biogas:
 - Global reach
 - Proprietary gas purification technology
 - Positioned for convergence of biogas and CNG

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Biogas-to-Energy



Agricultural Waste



Landfill



Wastewater



Source Separated Organics

Biogas



**Heat
OR
Steam**



**Renewable
Power
&
Heat**



**Biomethane
OR
CNG vehicle
fuel**

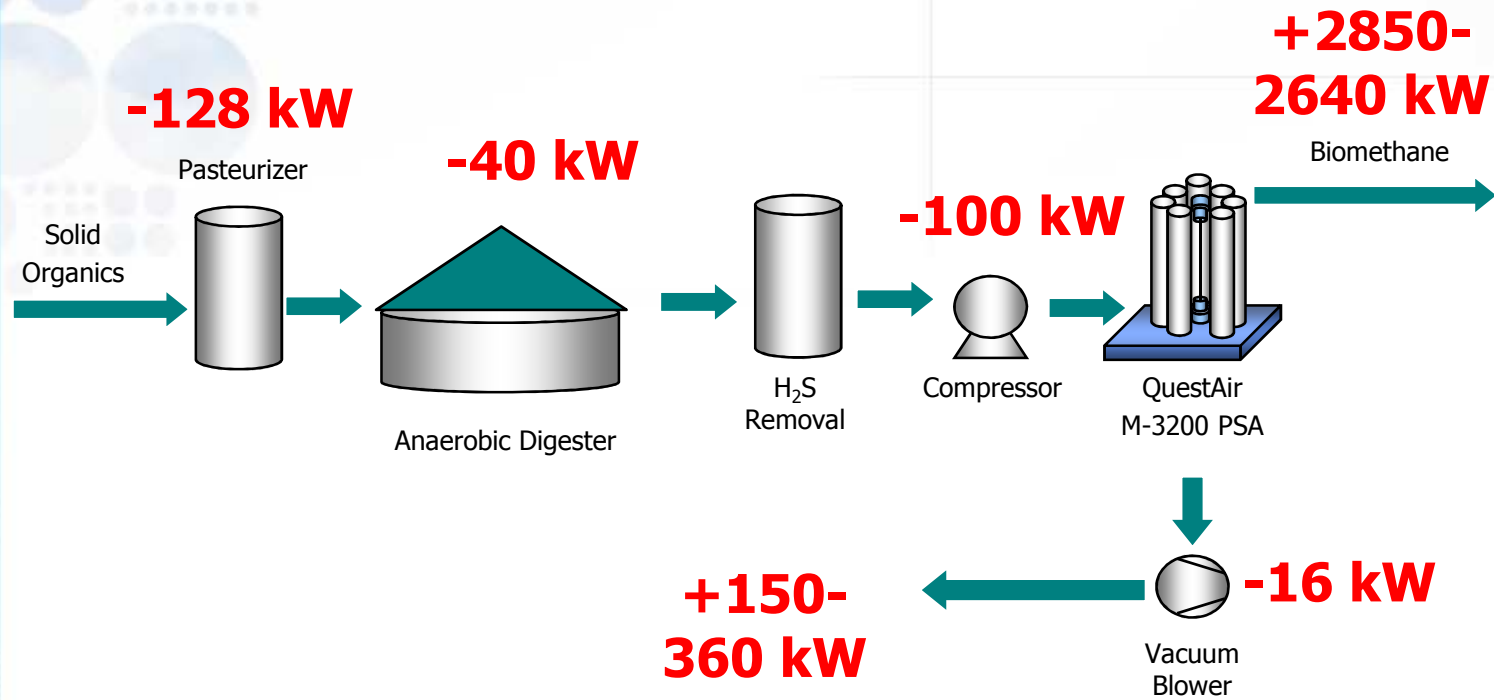
Purifying Biogas from SSO – Energy Integration

- Features of biogas upgrading technology:
 - Installed Capital Costs
 - Operating costs (kWh/Nm³ feed gas)
 - Methane recovery
 - Simplicity/operability
- Digestion of SSO, food waste, slaughter house waste:
 - Pasteurization of feed material typically required
 - Energy integration needs to be assessed in system design
 - Integrated approach required

Energy Integration – Worked Example

- 48 tons per day source separated organics
- Feed pasteurization @ 70°C
- Thermophilic Digester operating @ 55°C, with average heat loss for cold climate
- Raw biogas:
 - ~500 NCMH of raw digester gas
 - Assumed composition of 60% CH₄, 40% CO₂
- Product Biomethane
 - <2% CO₂
 - Pipeline injection @ 130 PSIG

SSO Digester & Biogas Upgrading



Energy Requirements

- Feed Pasteurizer
- Digester (thermophilic)
- Biogas Feed Compressor
- Other equipment

Energy Sources

- Waste gas from gas upgrading
- Product Biomethane
- Purchased Energy



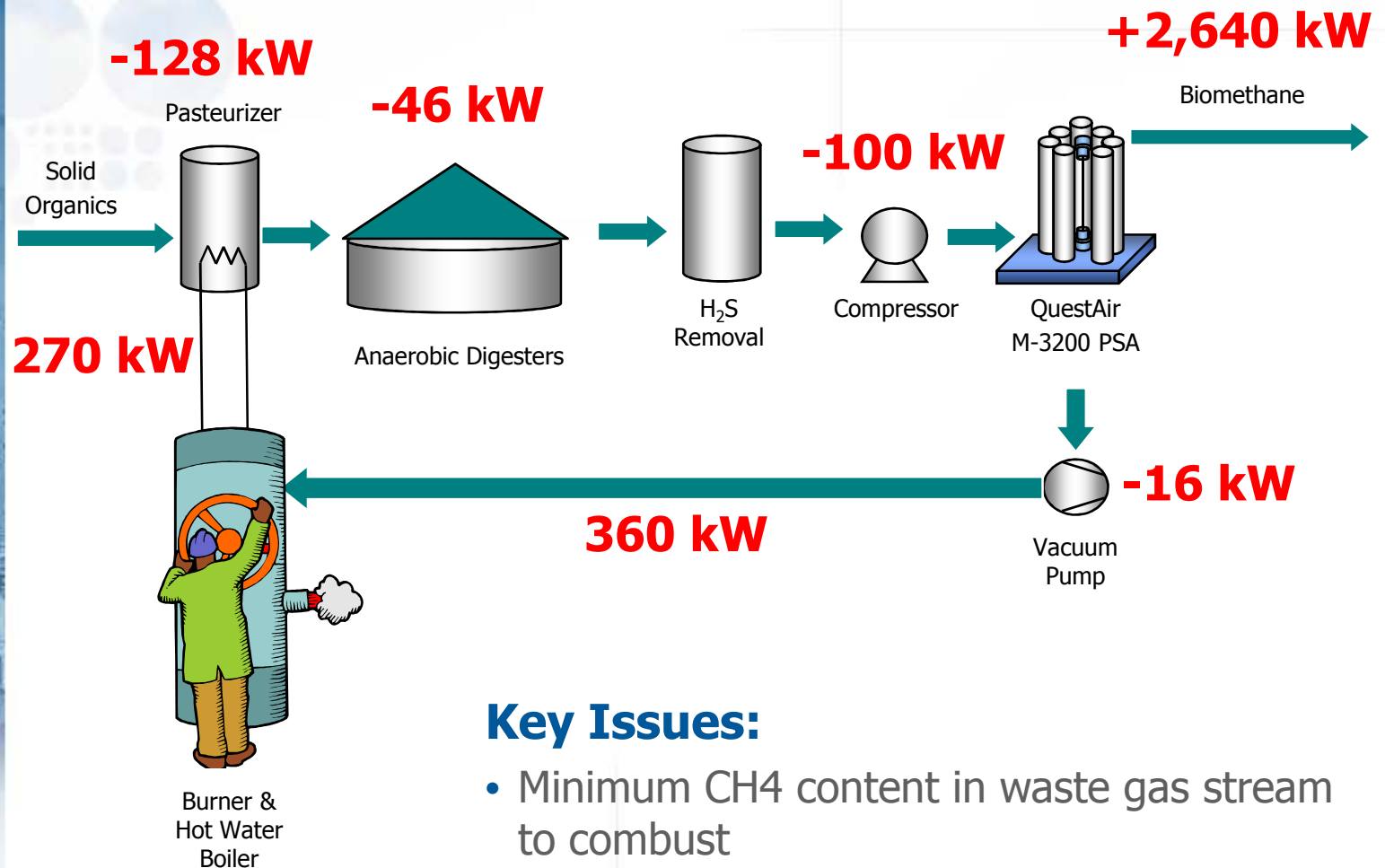
Options for Energy Integration

- A. Heat recovery from Gas Upgrading Waste Gas:
 - Operate gas upgrading system at 'optimized' recovery
 - Combust waste gas to provide heat

- B. Power Generation from Gas Upgrading Waste Gas:
 - Generate electricity from waste gas
 - Use power to offset part of plant energy requirements

- C. No Energy Integration:
 - Maximum CH₄ recovery to sales gas (95-98%)
 - Purchase all energy for process

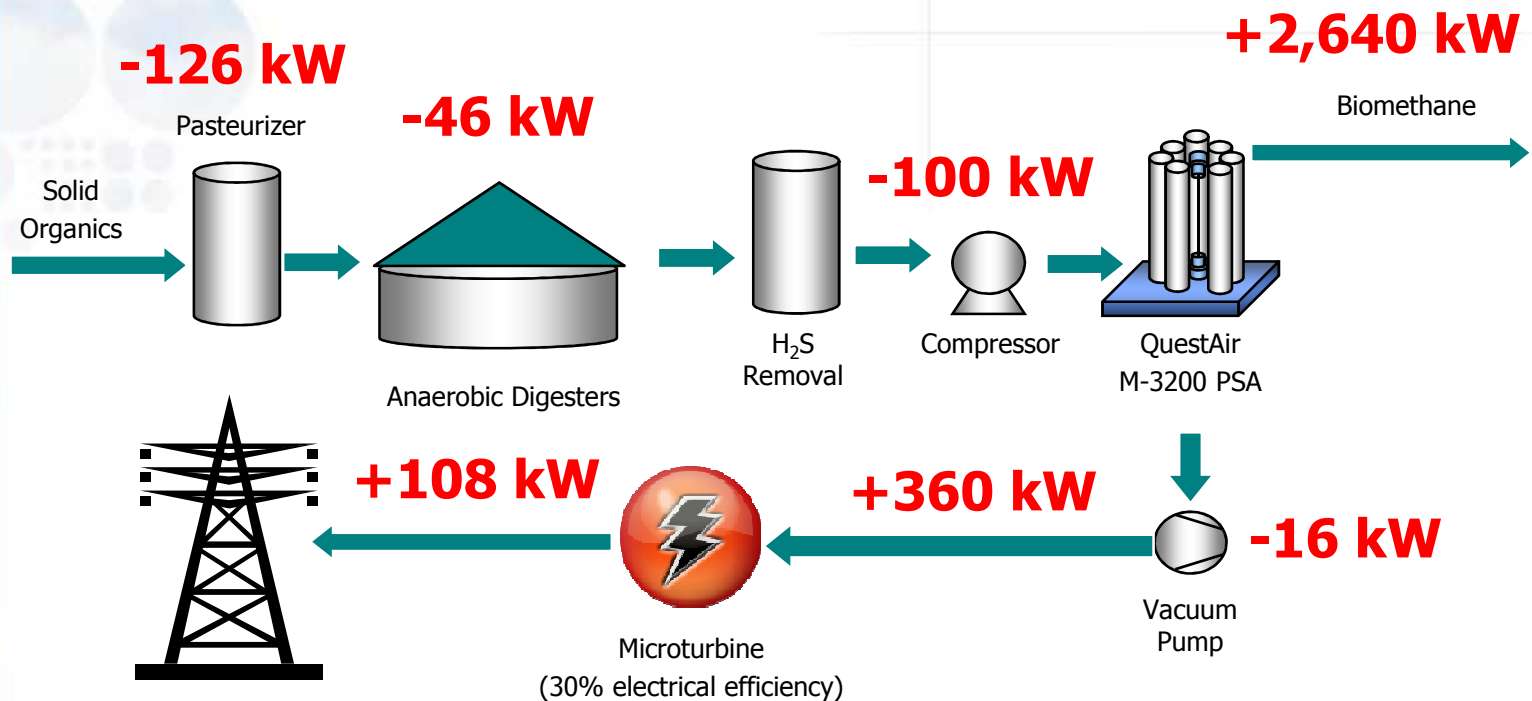
Option A: Energy Recovery to Pasteurizer



Key Issues:

- Minimum CH₄ content in waste gas stream to combust
- Burner design

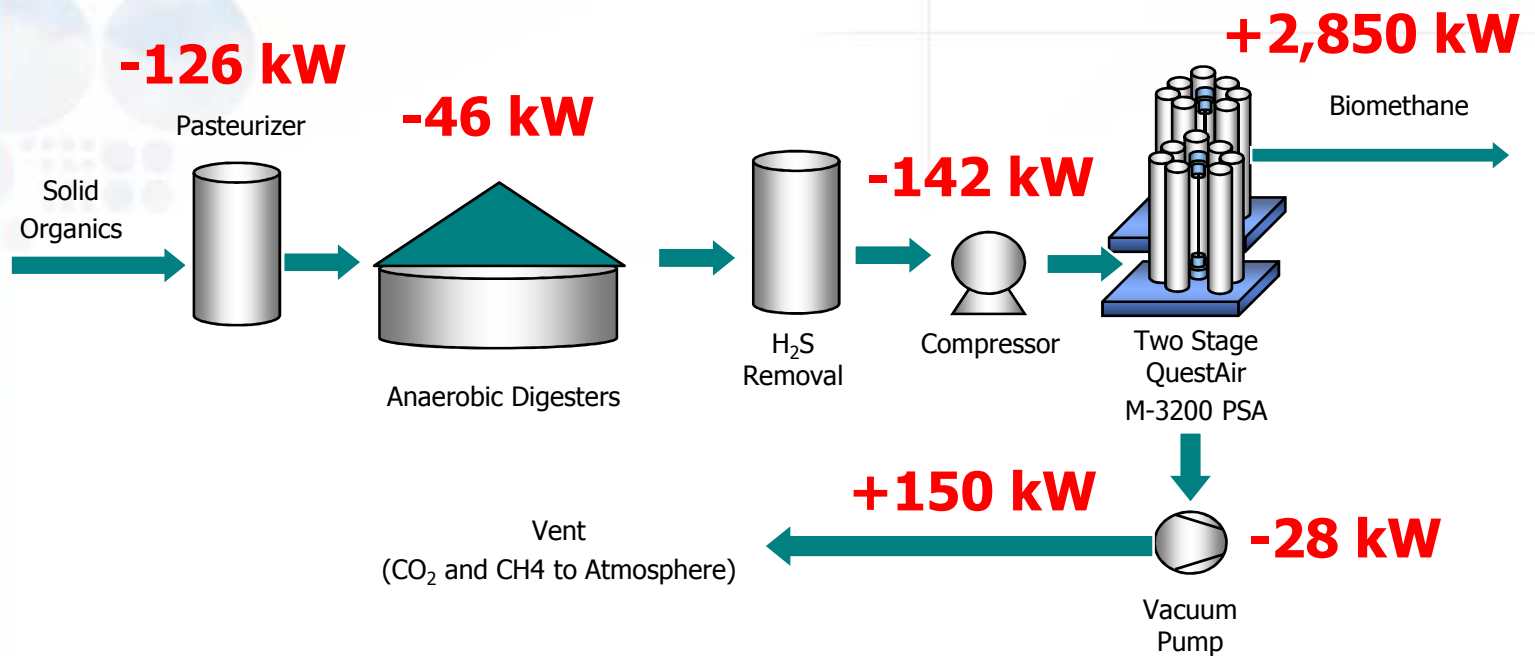
Option B: Energy Recovery by Power Gen



Key Issues

- Minimum CH₄ content in waste gas for stable microturbine operation

Option C: Maximize Biomethane Production



Key Issues

- Unable to combust waste gas with low CH₄ content
- CH₄ emissions to atmosphere

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Project Economics: Quebec Installation

Location:	Quebec, Canada
Assumed Pipeline Gas Sales Price:	\$4.00/mmBTU
Electricity Cost:	\$0.03/kWh

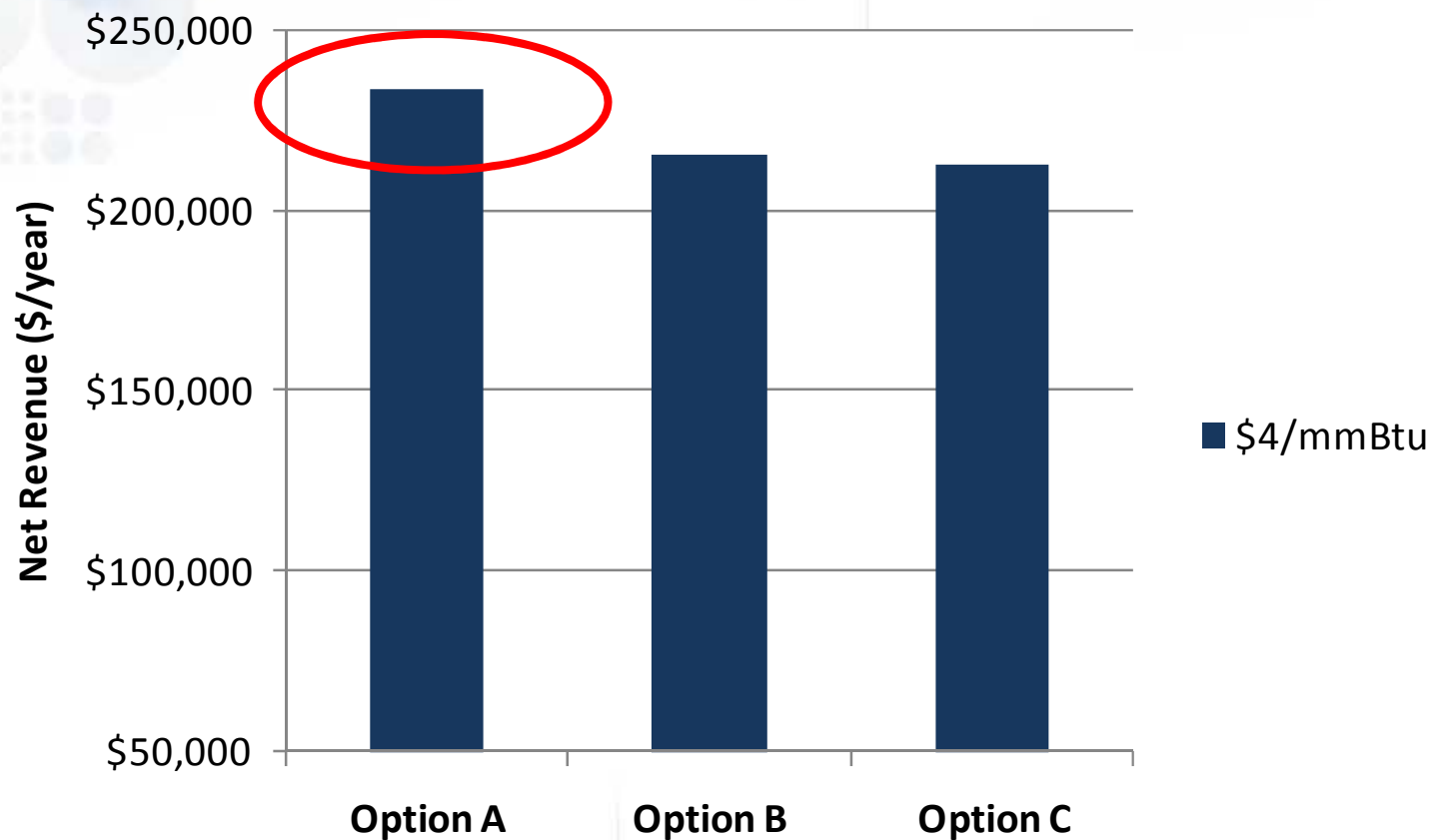
(\$/year)	Option A	Option B	Option C
Gas Sales Revenue	\$265,000	\$265,000	\$303,000
Electrical Power Costs	\$31,000	\$48,000	\$90,000
Net Earnings	\$234,000	\$217,000	\$213,000

Project Economics: California Installation

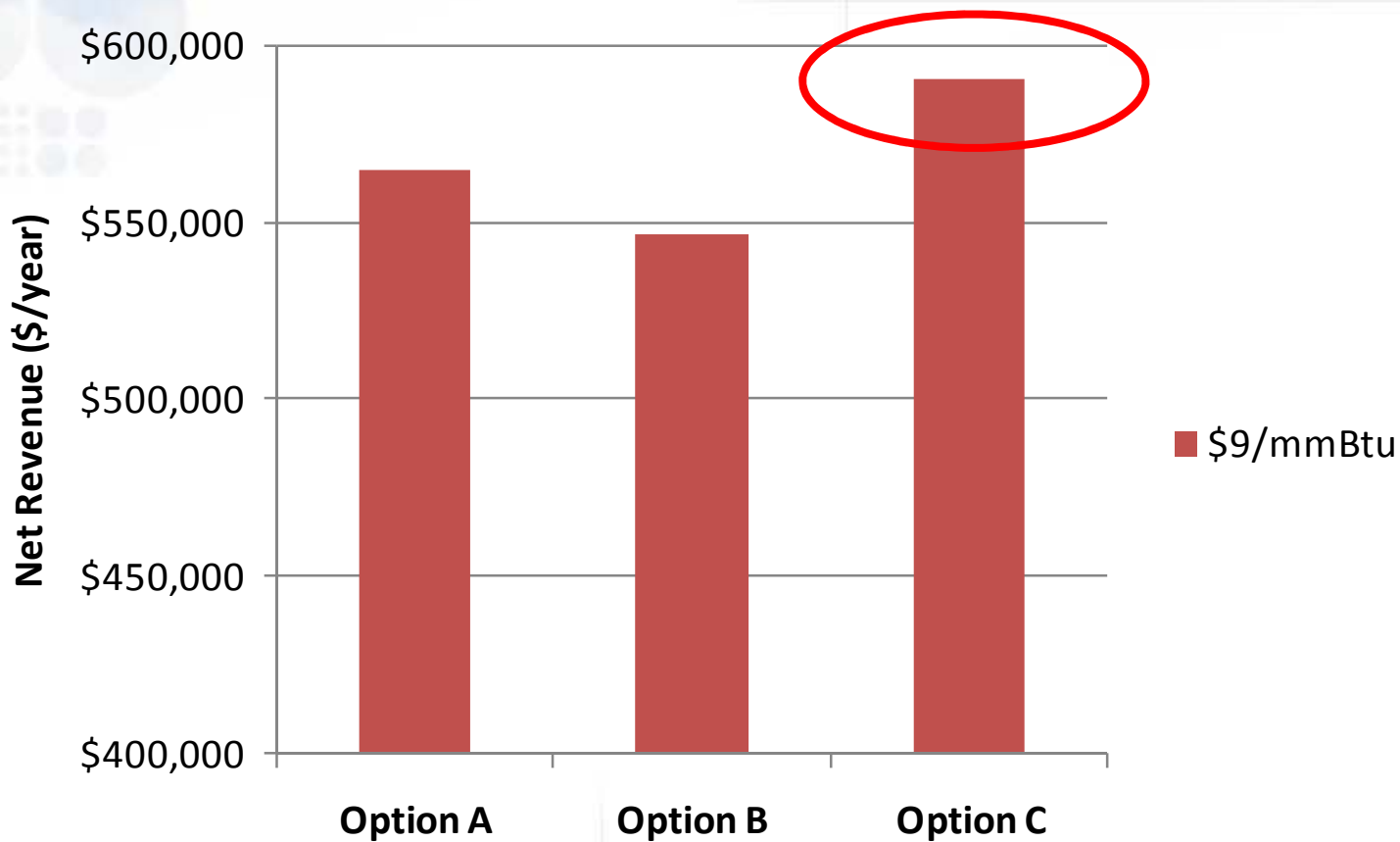
Location:	California, USA
Assumed Pipeline Gas Sales Price:	\$4.00/mmBTU
Electricity Cost:	\$0.10/kWh

(\$/year)	Option A	Option B	Option C
Gas Sales Revenue	\$265,000	\$265,000	\$303,000
Electrical Power Costs	\$102,000	\$160,000	\$301,000
Net Earnings	\$163,000	\$105,000	\$2,000

Project Economics: Impact of Gas Sales Price



Project Economics: Impact of Gas Sales Price



QuestAir Product Offering

- Product offering to cover all scenario's:
 - Energy integration \Rightarrow 'optimized' recovery, low operating costs
 - No energy integration \Rightarrow maximize CH₄ recovery

	Single Stage PSA	Two Stage PSA	New Product under Development
Application	Option A	Option C	Option C
CH ₄ Recovery	83-85%	93-95%	96%+
Power Consumption (kWh/Nm ³)	0.23	0.33	0.25
Availability	Commercial (10 installations)	Commercial (2 installations)	Early 2010

Conclusions

1. Anaerobic digestion with feed pasteurization:
 - Energy integration & optimization needs to be assessed
2. Options for energy integration:
 - Heat recovery from gas upgrading waste stream
OR
 - No Integration, maximize methane recovery
3. Optimal Economics:
 - Depend on relative natural gas & electricity costs
 - Case-by-case analysis required
4. QuestAir/Xebec Product Offering:
 - Gas upgrading solutions for range of scenario's
 - Work closely with project developers to offer best solution