

# Automotive Engine Powered Generators for Landfill Gas Fueled Generation

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# Stan background

- Mennonite Dairy Farm In Indiana
- Purdue University – BS Conservation of Natural Resources 1973
- 34 Years USDA
- Blue Ridge RC&D – LFG, EnergyXchange
- 10 Years Appalachian State University Energy Center

# Conservation Ethic

Ivan Steury – “...the farmer learns to appreciate nature and the handiwork of God.”

Nigerian Chieftan – “I conceive that land (natural resources) belong to a vast multitude, of which many are dead, few are living, and countless numbers are yet unborn.”



# Goals of Presentation

- Encourage Use Of Landfill Gas To Meet **Local** Energy Needs and to Promote Social Benefits
- Document Successful Use Of Automotive Engines For Landfill Gas Fueled Generation
- Identify Situations Where These Small Generators Work



- 1999-2017
- 6 acre landfill
- 40 scfm gas

## EnergyXchange Renewable Energy Center

# POTTERY STUDIOS

A woman with short brown hair, wearing a light blue long-sleeved shirt, is seated at a pottery wheel in a studio. She is focused on shaping a piece of light-colored clay. The studio has a window with white blinds on the right, through which bright light is streaming. On the wall behind her, there is a wooden lattice hanging and a wooden mallet. A vase with red and white flowers sits on a wooden shelf behind her. The overall atmosphere is calm and creative.

- First LFG Ceramic Kiln
- 4 resident artists
- 10 scfm – Occassional

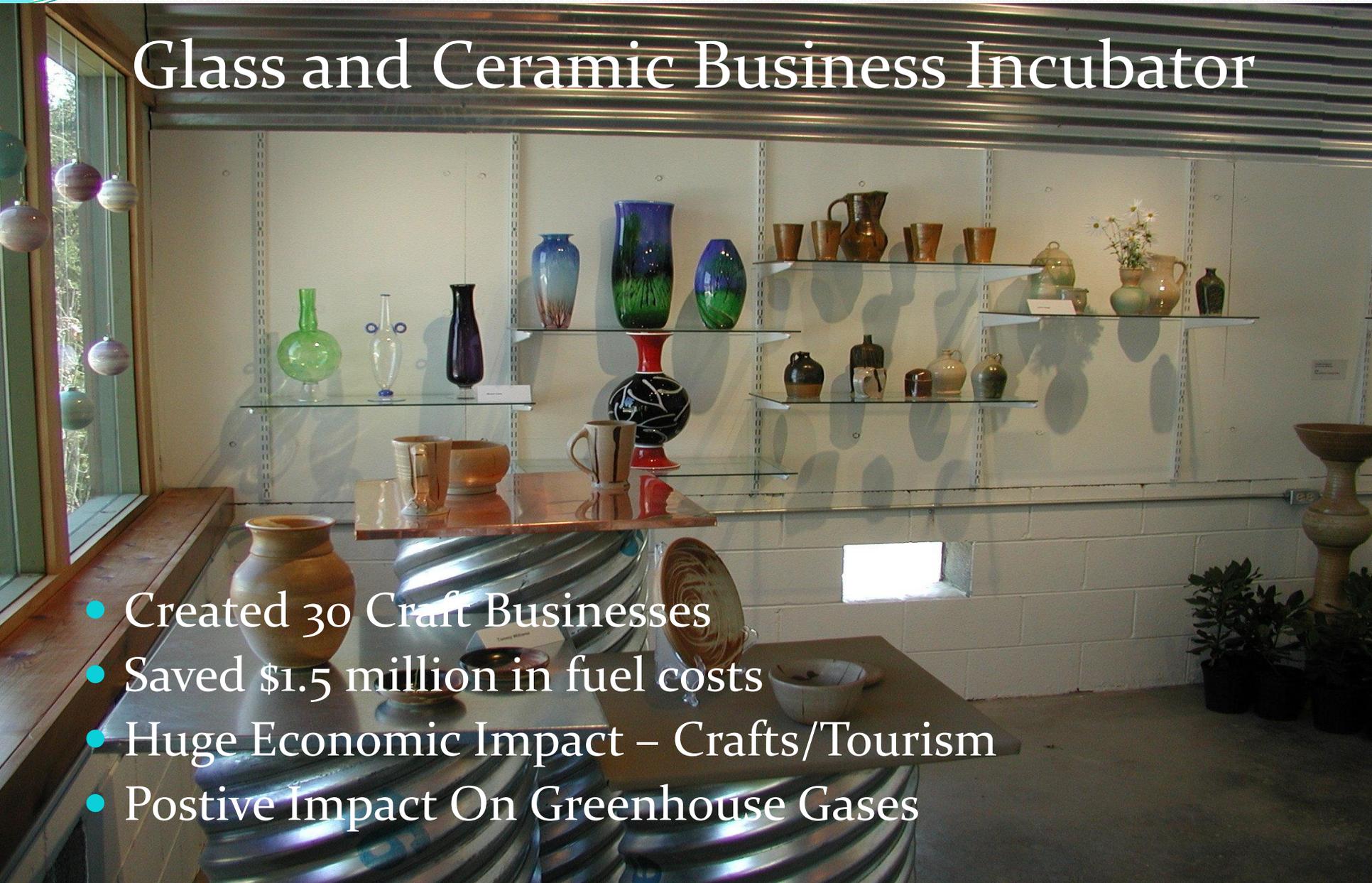
# Glass Studio

- First LFG Glass Furnaces
- 2300 F 24/365
- 15-20 scfm continuous



# Glass and Ceramic Business Incubator

- Created 30 Craft Businesses
- Saved \$1.5 million in fuel costs
- Huge Economic Impact – Crafts/Tourism
- Postive Impact On Greenhouse Gases



# Project Branch Out



- LFG Heated Greenhouses
- Provide Seed Stock of Native Azaleas and Rhododendrons For Local Growers
- Reduce Poaching of Rare Plants
- Expand Local Horticulture/Nursery Industry with Native Shrubbery



- New Cash Crops
- Internships
- Aquaponics
- Greenhouse Floral



# Other Renewable Energy



# Accomplishments

- First Use of LFG for Glass Furnaces & Pottery Kilns
- Jobs At Site
- Incubated New Craft Business (30)
- 27 Expanded or New Native Plants Businesses In Nursery Industry
- Reduced Poaching and Wild Harvest of Rare Plants
- Decreased Greenhouse Gas Emissions
- Use of Previously Wasted Fuel
- 15 Years of Fuel
- Pilot for other Community-based LFG Projects

# Appalachian State University

- Boone, North Carolina
- 18,295 Students
- Well known for
  - Education
  - Business Administration
  - Renewable Energy
  - Sustainability
  - Economics
  - International Education
  - Geography and Planning



# Appalachian State University Energy Center (Est. 2001)

- Mission - Committed to research, development, policy analysis and demonstrations in all areas of energy, including...
  - Energy efficiency
  - Wind
  - Small hydro
  - Bio-fuels
  - Solar
  - Biogas and landfill gas



# Community TIES

- Duplicate Success of EnergyXchange
- Community-based, Small to Medium Sized Landfills
- Initial Funding by Two Foundations
- 8 Targeted Counties Initially
  - Economically Challenged, Tobacco Dependent
  - Bertie, Robeson, Columbus, Scotland, Haywood, Cleveland, Rockingham, Rutherford
- 13 Counties Assisted
- 7 Counties with Operational Projects

# Small to Medium Sized Landfills

- Commercial Developers Not Interested
- Still Enough Gas For A Community-based Project
- Smaller Landfills Usually Owned By Limited Resource Counties
- Projects With Social Benefits

# Direct Thermal vs Generation

- Direct
  - Jobs
  - Economic Development
  - Interesting
  - Users Remote From Site
- Generation
  - Relatively Easy
  - Few Jobs
  - Mature Technology/Bigger Sites

# Generators For Small Sites

- Micro-turbines
- European Biogas Engines
- High Cost
- Difficult Maintenance
- Alex Hobbs – Automotive Engines

# Concerns

- Durability
- Won't start/run on Methane
- Low production
- 1<sup>st</sup> Generation – Lack of Automation
- Lack of history on biogas
- Automotive gensets usually for standby & peaking
- Throw away engines?

# KSD Enterprises

- Exhausters for Coal Mines Since 1991
- Exhausters Run On Gas They Exhaust
- Highly Variable Methane – CH<sub>4</sub> as low as 10% reported, 30% verified
- Engine Repair & Overhaul
- Remote Sites
- No Electricity At Many Sites



# KSD Two Gas System

- Start on Propane
- Switch to LFG After Warm-up
- Manual Gas Controls – One Propane Two LFG
- Moto-viewer Program for Gas Mixture Control
- Not automated
- Kicked Off Grid Engine Runs Too Rich, Shuts Down



# Controls/Switchgear



# Research & Development Plan

- Watauga County Pilot
- Fine Tune Operation
- ASU/Watauga Small Generator Testing Center
- Link Control and Switchgear Partner
- Ready for Other Applications



# Stimulus Spoiled Plan

- Great Recession
- Success of Community Ties Led To 11 Shovel Ready Projects
- Good Working Relationship with NC State Energy Office Led to 6 Million In Funding
- 11 Projects Funded, 9 Projects Developed
- ALL wanted Direct Thermal Projects. Generation was Second Choice.
- 5 Counties with 7 Automotive Engines Went In At Once

# Performance

- Runs on low quality gas – 40% documented  
30% likely
- Continuous duty rating About 85 kw for 8.1 L
- Actual performance on 50% CH<sub>4</sub> LFG about 75 kw
- 34-35 scfm required at full capacity
- Oil less than 1 quart per 24 hours with quality block – compares to Jenbacher
- 12,000 -15,000 hours to overhaul with a quality block – compares to Jenbacher
- Actual Wilkes 14,272 hrs Watauga over 20,000 hrs
- Equal to 1,000,000 road miles at 70 mph, 80% throttle?

# Performance Continued

- Catalytic converters plugged at 400 hrs
- Starters on 8.0L replacement regular
- Spark plugs and plug wires replaced monthly or 700 hours
- Several months 100 % uptime
- 1 million kwh Wilkes genset
- 1.5 million kwh Watauga genset
- Heat damage to ignition system biggest issue

# Track Record Automotive

- 5 Counties with automotive engine generators with 7 generators
- Shaky local resources and will
- Political football
- Today 2 counties, 3 gensets
- Reason 3 counties not running today – No Passion For Project
- **YOU CAN RELY ON THE TECHNOLOGY, THE PEOPLE NOT SO MUCH!!**

# What Did We Find

- Affordable –  $\frac{1}{4}$  cost of micro-turbines,  $\frac{1}{2}$  cost of biogas engines
- Durability – Quality block very durable
- Can meet air quality standards w/o catalyst
- Maintenance and repair of engine easy
- Local mechanics, parts at local NAPA, Advance Auto, etc
- Most technical problems where systems merge
- Failures due to people problems
- Not enough \$ to attract commercial developers

# What Did We Find Continued

- We made our biggest mistake picking engine on basis of capacity rather than past performance
- Picked unproven 8.1/8.0L Rather than Well Proven 4.3L or 5.7L
- Runs on low quality gas – 40% document, maybe 30%
- Technicians not readily available
- Not enough profit to justify commercial
- Need packager – Engine, generator, controls/switchgear

# Where Will They Work

- LFG/Biogas
- Low CH<sub>4</sub>
- Use own electricity, micro-grid
- Passionate/competent local operator
- Small closed landfill or new small growing landfill
- Add-on to commercial project

# What Would We Do Differently

- Use most proven block OR one operators familiar with
- One county at a time
- Find a company willing to package
- Make sure blocks are well sourced and proven

# Carbon Offsets Wilkes/ASU

- REI
- Carbon Neutral Commuter
  - Sterling Planet – Offsets somewhere else
- Carbon Offsets For Travel
- Locally Sourced And Verified Carbon Credits
- Wilkes Break Even to Plus

# Maracanaú, Ceará, Brazil







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