Community Power Corporation
The Modular Biopower Company

Emerging Small Modular Biopower Systems

May 17, 2006
NAEMI  Biomass & Business Training Workshop

Art Lilley
Chairman
Agenda

- CPC
- Modular Biopower
- BioMax Description
- FAQs
- Case Studies
CPC’s Mission

Mission:
Provide small, modular, biopower systems to the distributed generation market.

Product Development Facility
Littleton, CO
Advantages of Small Biopower

- Uses abundant local biomass residues
- Fuel flexible
- Grid quality power
- Easy to site, connect to grid
- Small footprint = high power density
- Dispatchable
- Modular, able to parallel
- Cooling, heating, power = high efficiency
- Fully automatic
- Reliable: dual fuels
- Competitive against other distributed generators
- Standard systems, ideal for mass manufacture
Biomass Fuels for Downdraft Gasifier

• **Good**
  - Wood
  - Nutshells
  - Pellets
  - Corn
  - Cubed grasses

• **Difficult**
  - Sawdust
  - Rice husks
  - Leaves
  - Corn Stover

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**BioMax Feedstocks Successfully Tested**

As of February 2006

- Pine Wood Chips
- Ground Coconut Shell
- Pine Bark Chips
- Corn Kernels
- Almond Nut Skins & Shells
- Pecan Shells
- Pelletized Switchgrass
- Pelletized Orange Skins
- Pelletized Grape Skins
- Army MRE Packaging
- Tennis Shoe Materials + Wood
- Date Seeds
- Densified MSW "Fluff"
- Juniper Wood Chips
- Russian Olive Chips
BioMax: Converts Woody Biomass to a Clean Fuel Gas for Power, Heat and Cooling

System CH&P Efficiency: >80%

FUEL
Wood Chips, Wood Pellets, Nut Shells, Etc.

20% CO
18% H₂
2% CH₄
+ CO₂, H₂O & N₂

Solid → Gas

Feeder Dryer → Gasifier → Gas Cooling & Cleaning

Start-up Fuel
Propane, Natural Gas, Diesel

Engine → Combustible Gas → HEAT

Electricity
Heat
Shaft Power
Heat
Cooling
CPC’s Renewable Fuel-Gas Generator Is A Versatile Distributed Generation Platform

RUNS:
- IC Engines
- Stirling Engines
- Fuel Cells
- Microturbines
- Driers & Chillers

Gas Production Module
EMISSIONS: BioMax Meets Current (CARB)* Standards

<table>
<thead>
<tr>
<th>Engine Exhaust Pollutant</th>
<th>CARB Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
<td>55%</td>
</tr>
<tr>
<td>CO</td>
<td>75%</td>
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<tr>
<td>THC</td>
<td>15%</td>
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</tbody>
</table>

No Water, No Smoke, No Smell, No harmful effluents

* California Air Quality Resources Board Standards for Distributed Power and Heat (CHP)
BioMax Char and Ash Residues Are Non-Hazardous

“...the waste stream [from the BioMax] neither exhibits a hazardous waste characteristic, nor is it a listed hazardous waste.”

Reference: Colorado Dept of Health and Environment; Hazardous Materials and Waste Management Division
CPC’s New BioMax 50

New Features:

- **24/6 Operation**
  - ~1.2 MWhe/day + 12 MM Btu/day
  - Greater control of gasifier
  - Automatic char & ash extraction
  - Continuous dry filtration

- **Options:**
  - Combined Heat and Power
  - Thermal

- **Being upgraded to 75 kW**

Pre-prototype Gasifier Testing
CPC’s New Thermal System

- Combusts gas directly in burner
- Dual fuel – producer gas and propane
- No need for heat exchanger or filter

300,000 Btu/hr Burner
(Same gasifier as for BM 25)
First Thermal Application: Lumber Drying

- 3,500 board foot capacity
- Primarily softwood
- Shakedown testing underway
- Host selection process ongoing

Dry Kiln
Containerized BioMax Systems

- 8’ x 20’ x 8’
  - Container
    - Contains dryer, feeder, gasifier, heat exchanger, and filter.
    - Gen-set external

Containerized BM 25
Development & Demonstration Sites

Location and Size (kW)

- Hoopa - 15
- Zuni, NM - 15
- Ruidoso, NM - 15
- Walden, CO - 15
- Starkville, MS - 15
- Philippines - 15
- San Bernadino, CA - 15
- Madison, WI - 5
- Grand Forks, ND - 15
- Truckee, CA - 15
- Natick, MA - 25
- Purdue - 25
- Mt. Shasta, CA - 25
- El Salvador - 2 x 50
- TBD - 50
- Big Bear Lake, CA - 50
- Mt. Wachusett, MA - 50

Completed Installed In-process
Frequently Asked Questions

• How much biomass is required?
  • ~2 lb will yield 1 kWhe + 2 kWh
  • 50 dry lb/hr for 25 kW BioMax

• What kind of biomass is best?
  • Woodchips (most experience to date)
  • Nut shells (easy to feed, minimal pre-processing requirement)
  • Pellets (easy to feed, no pre-processing required)

• Does system need full-time operator?
  • No
  • Part-time attendant duties:
    • Start and stop system
    • Replenish biomass
    • Inspect/maintain
    • Respond to alarms
Frequently Asked Questions

• What kind of maintenance is required?
  • Same as for any engine (filter change, oil change)
  • Clean out ash hopper once a week
  • Inspect gasifier internals once per month, remove tramp materials

• What is the footprint of the system?
  • System hardware (25 kW) – 300 sq ft max
  • Biomass storage area determined by user

• How can I use the electricity?
  • Can tie to the grid, sell excess
  • Provide transfer switch, meet on-site loads
Frequently Asked Questions

• How can I use the heat?
  • Can heat water and circulate it in hot water system, or
  • Can heat air and use it for space heating (or drying)

• Does the BioMax Consume Water?
  • No

• What does the BioMax emit as waste?
  • Dry ash with some carbon in it – non hazardous
  • Ash depends on the biomass, but wood is 1% ash
  • 100 lbs of biomass = 1 lb of ash
Frequently Asked Questions

- **What is life of BioMax?**
  - Engine life same as commercial engines
  - Heat exchanger and filter – 20 years
  - Gasifier shell – 20 years
  - Gasifier internals – undetermined, but easily serviceable

- **How much does a BioMax cost?**
  - Typical current price between $4,500 and $7,000/kW
  - Will decrease with volume
  - Depends on a host of factors best determined by a site visit

- **Is it economic at this cost?**
  - Yes, see following case studies
### Case Study 1:
**Combined Heat and Power**

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<thead>
<tr>
<th>Assumptions</th>
<th>Financial Return</th>
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<tbody>
<tr>
<td></td>
<td>Low</td>
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<tr>
<td>Capacity (kW)</td>
<td>62</td>
</tr>
<tr>
<td>Electricity (cents/kWh)</td>
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<tr>
<td>Gas Heat ($/MM Btu)</td>
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<tr>
<td>Biomass – ($/ton)</td>
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<tr>
<td>Conversion rate (lb/kWhe)</td>
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<tr>
<td>O&amp;M Cost – (cents/kWh)</td>
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<tr>
<td>Capacity Factor – (%)</td>
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<tr>
<td>Capital Cost ($/kW)</td>
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Case Study 1: Combined Heat and Power

Internal Rate of Return

• Results

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<th>Hi</th>
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<tr>
<td>0%</td>
<td>40%</td>
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Financial Return

<table>
<thead>
<tr>
<th>Assumptions</th>
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<th>Hi</th>
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<tr>
<td>Capacity (kW)</td>
<td>62</td>
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<tr>
<td>Electricity (cents/kWh)</td>
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<tr>
<td>Gas Heat ($/MM Btu)</td>
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<td>Biomass – ($/ton)</td>
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<td>Conversion rate (lb/kWhe)</td>
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<tr>
<td>O&amp;M Cost – (cents/kWh)</td>
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<td>Capacity Factor – (%)</td>
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<td>Capital Cost ($/kW)</td>
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## Case Study 2: BioMax Vs PV

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<tr>
<th>Assumptions</th>
<th>BioMax</th>
<th>PV</th>
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<tr>
<td>Annual energy (kWhe/yr)</td>
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<td>358,000</td>
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<td>Capacity Factor – (%)</td>
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<td>Gas Heat ($/MM Btu)</td>
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<td>Fuel costs – ($/ton)</td>
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<td>O&amp;M Cost – (cents/kWh)</td>
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<td>Incentives</td>
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Case Study 2: BioMax Vs PV

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<th>Factor</th>
<th>BioMax</th>
<th>PV</th>
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<tbody>
<tr>
<td>Capital Cost</td>
<td>283k</td>
<td>1,450k</td>
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<tr>
<td>Electricity savings</td>
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<td>Heat savings</td>
<td>162k</td>
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<tr>
<td>O&amp;M cost</td>
<td>172k</td>
<td>24k</td>
<td>-138k</td>
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Net NPV Savings: 1,191k

*10 yr life, 10% discount rate
Summary: Best Economics for BioMax

- Displace energy having high retail price
  - Electricity
  - Natural gas
  - Propane
- Competitive against other renewables
  - Capital cost advantage
  - Capacity factor advantage
  - Dispatchable
- Use low cost local Forest or Ag residues
  - At a natural collection point for biomass (e.g. - enterprise)
  - Avoid high disposal costs
- Use both power **and** heat
  - Year round thermal load
Community Power Corporation

www.gocpc.com
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