Small Modular and Distributed Biopower Systems:
Applications and Demonstration in California

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Engineered Properties and Structures (FS-FPL-4714)
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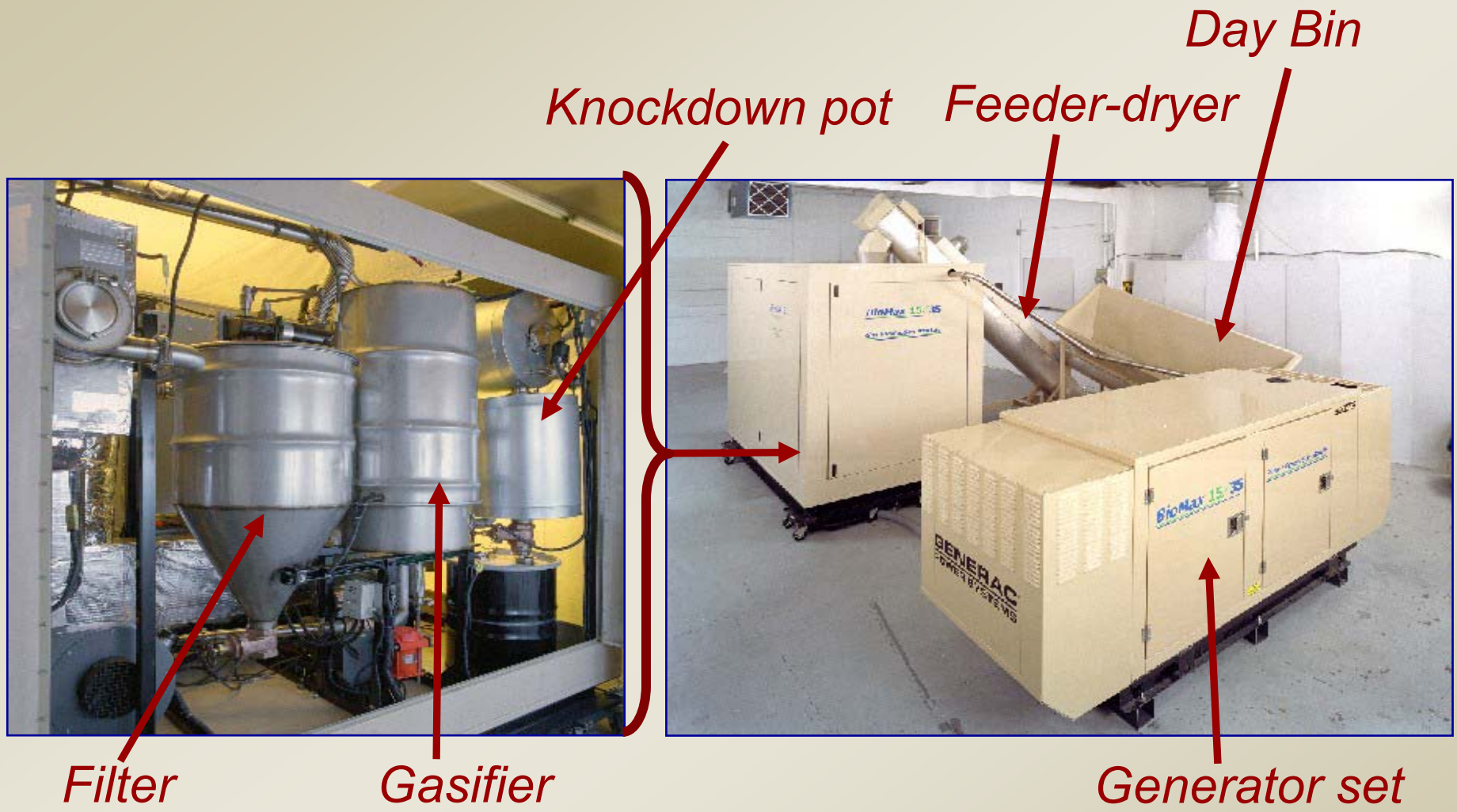
Small Modular Biopower System (SMBS)

- Background
  - National Fire Plan objective
  - Pre-commercial technology (wood gasification)
  - Small scale (5,15, & 50 kW_e)
  - Cogeneration (air drying feedstock if needed)
- 2-year demonstration on-site
- Joint government/industry project
  - National Renewable Energy Laboratory (NREL)
  - Community Power Corporation (CPC)



BioMax 15 (15 kW_e)

Suitable for small businesses, farms, & greenhouses

BioMax 15: Walden, CO

- Host: North Park School
- Contact: Phillip Anderson
- Wood residue: Wood chips from thinning operation
- Use: Greenhouse
- Status Update

BioMax 15: Glencoe, NM

- Host: SBS Wood Shavings
- Contact: Glen & Sherry Barrow
- Wood residue: Wood chips from thinning operation (unusable)
- Use: Overhead lights (~7.5 kW_e)
- Status: Idle, in process of selecting new site

BioMax 15: Zuni, NM

- Host: Zuni Furniture Enterprise
- Contact: Stirling Tipton
- Wood residue: Wood chips from thinning operation and wood residue generated in-house
- Use: Heaters, lights, and small tools (~7.5 kW_e)
- Status Update

BioMax 15: Truckee, CA

- Host: McNeil Technology
- Contact: Scott Haase
- Wood residue: Wood chips
- Use: grid electricity & heat for office building
- Status Update: not installed

BioMax 5 (5 kW_e)

Suitable for Houses

BioMax 5: Madison, WI

- Host: Forest Products Laboratory
- Contact: Rick Bergman
- Wood residue: Urban wood waste/wood pellets
- Use: Heat & power for house

"First choice was my house!"

"The Real Deal"

Research Demonstration House located at the Forest Products Laboratory in Madison, WI

Expected Fuel Usage

- **BioMax 15** (10-hour shift) @ 100% power
  - ~ 3.5 pounds of wood residue per hour per kilowatt @6,500 Btu/lb (air dry)
  - 15 kW_e x 10 hours per day x 3.5 lbs = 525 lbs per day
  - $30 per green ton (good quality chip)
- **BioMax 5** (24/7 operation)
  - ~100 pounds per day of wood pellets
  - ~4 pounds of wood pellets per hour per kilowatt
  - 25 kilowatts needed daily for an average household
  - $3.00 per 40# bag *(Menard's–11/16/03)*
  - $7.50 per day for wood fuel costs

Expected Fuel Usage

- **BioMax 50** (24/7) @ 100% power
  - ~ 1.6 pounds of wood chips per kilowatt-hour
  - 50 kW_e x 24 hours per day x 1.6 lbs = 2,000 lbs per day of (12-15% MC) chips
  - 15-20% fines, 2” minus chips
  - Produces 135 cubic meters of producer gas per hour

Efficiencies – BioMax 50

- Efficiency of converting energy in producer gas to electricity – **28%**
- Gasifier energy efficiency – **87%**
- Overall efficiency (energy conversion of dry wood to electricity) – **24%** (vs 15% for the BioMax 15)

BioMax 50

- Under development
  - Prototype built
  - Grid interconnection
  - 24/6 operation
- 3 sites already selected for installation
  - San Bernardino National Forest – Big Bear Discovery Center
  - Mount Shasta - Siskiyou Opportunity Center
  - Mount Wachusett Community College (MA)

Feedback on Operation

- Requires expertise in operating => unit requires simplification
- Heat exchanger failures => better design
- Requires operator's intervention => continuous upgrades
- **Wood fuel issues** => oversize chips require removal or resizing (smaller the gasifier, greater the need for consistent size)

Feedback on Operation

- High school students capable of running unit with minimal oversight
  - Learning potential of renewable energy
  - Bucket brigade – wood chip handling
- For BioMax 15, net metering economics
  - 10 kWe used internally (Walden, CO)
  - 5 kWe * 8 hrs per day * 20 operating days per month* $0.10 ($0.06) per kW-hr = $80 ($48)
  - $7,000 for net metering switch

Feedback on Siting Units

- Requires persistence and flexibility by all collaborators
- Need particulate emissions data – environmental concerns (Truckee, CA)
- Ensure proposed site is fully aware of the needed commitment
- Be prepared for setbacks in time tables

Improvements

- Upgrading air code
- Continual reduction in tar and particulate – very low tar levels
- Char not listed as hazardous waste (CO)
- Gasifier may use wood chips with 5% to 25% moisture – drying from 15% to 50% (green) moisture is possible
- Use engine exhaust to preheat unit faster during startup – BioMax 5

More Improvements

- Installation of automotive catalytic converter – reduces CO and NOx
- Using wood fuel with ~50% fines – requires more cleaning
- Addition of supercharger – BioMax 50
  - Densifying the fuel-air mixture
  - 80 kVA generator (75 Kwe)
- Better wood chip sorter – BioMax 50

Closing Remarks

- Questions & answers
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