



WOOD POWER!



**OFEE Environmental Symposium West
June 08
Ms. Manette Messenger
US Army IMCOM Southeast**



Demonstration Project



- ▶ **Partnership between Army, academia, industry to:**
 - **Determine the technical, economic, and environmental performance of a prototype fast pyrolysis plant that converts woody materials into BioOil**
 - **Evaluate various fiber wastes and their impact on the resulting BioOil composition and quality**
 - **Evaluate the performance of the BioOil and char as boiler and steam generator fuels**
- ▶ **The demonstration will take place during 2008/2009**

Funding Organization



Dr. Bob Rummer



Mr. Phillip Badger



Ms. Manette
Messenger



Dr. Timothy
McDonald

-C-S-S

Center for Sustainable Solutions

Mr. Mike LaDuc

Performers

FORT BRAGG

Home of the
Paratroopers
and
Special Operations

Dr. Christine Hull
Dr. Gay Kendall
Ms. Jennifer McKenzie





Problems we're trying to solve



- ▶ Energy production from fossil fuels results in air pollution and greenhouse gas emissions – the BioOil technology greatly reduces both.
- ▶ Landfilling waste wood consumes land, threatens groundwater resources, requires transportation which increases air pollution, and wastes the inherent value of the wood
- ▶ Operational costs for solid waste disposal and energy are increasing and *unpredictable*





Technology Description



Renewable Oil International® LLC
5 dry ton per day plant in NW Alabama



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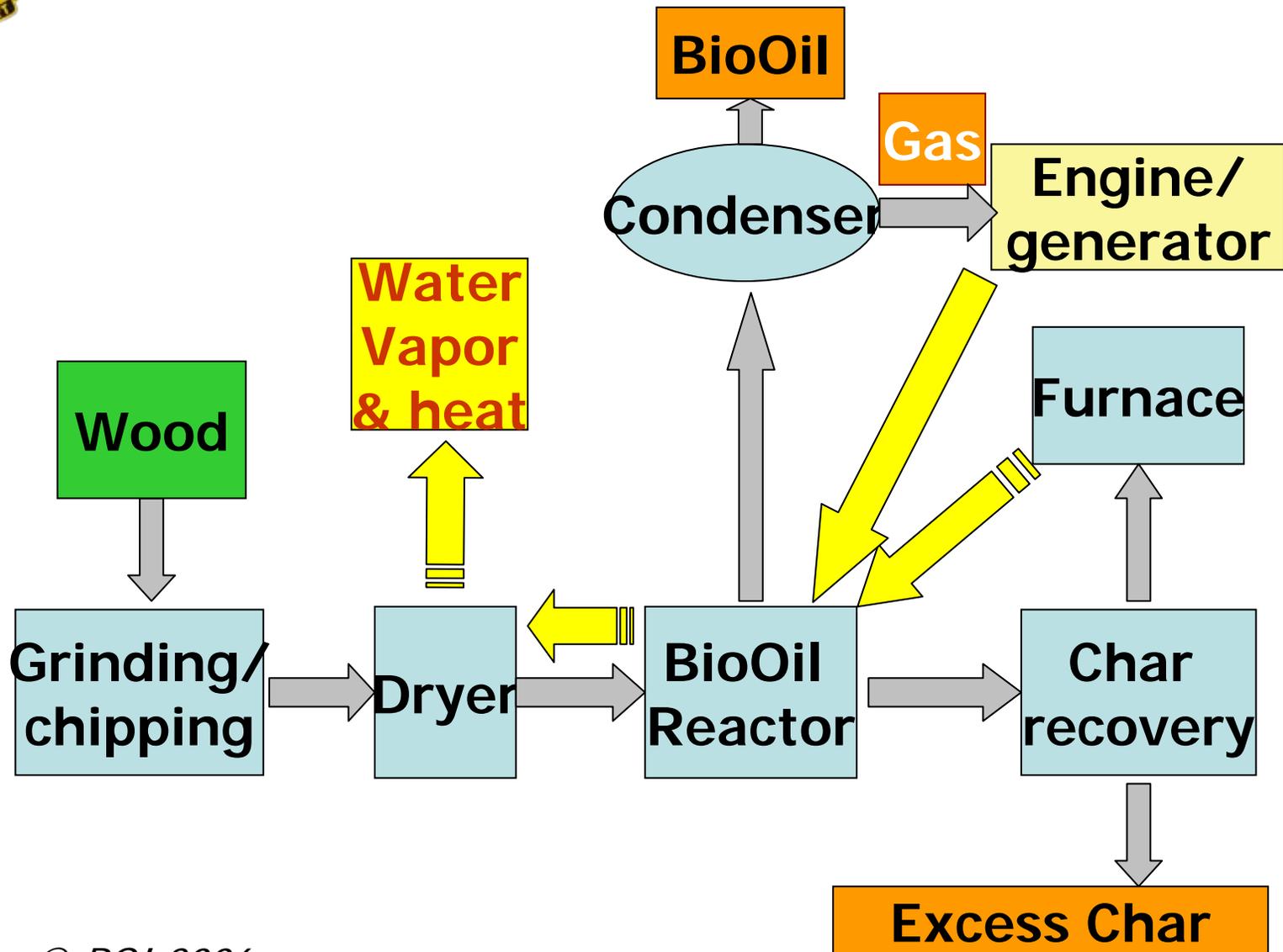
Technology Description



- ▶ **The fast pyrolysis technology rapidly heats biomass under airless conditions, yielding roughly 120 gallons of liquid BioOil (1200 lb), 500 lb of charcoal, and 300 lb of combustible gas per ton of dry wood.**
- ▶ **BioOil is similar to fuel oil #6.**
- ▶ **The ROI process injects biomass and steel shot that has been heated to 1,000 F into an enclosed vessel to decompose the biomass. The shot and biomass are mechanically mixed in a moving bed.**
- ▶ **Current commercial fast pyrolysis processes use circulating sand fluid beds, which are very energy intensive, difficult to scale up, and expensive to construct and operate.**



Technology Description



Technology Description



Advantages of the process over commercial fast pyrolysis units:

- ▶ ROI's simplified design reduces capital costs by one-third and O&M costs by 5 to 10 times.
- ▶ Scale-up is simplified because it is only necessary to keep the ratio of heat carrier and biomass constant during scale-up.
- ▶ The steel shot is a more efficient heat carrier than sand and mechanical mixing is less energy intensive than the fixed sand bed systems with gas recirculation.
- ▶ The gas and charcoal can be combusted to provide energy for the process, making an ROI plant potentially energy self-sufficient.
- ▶ The ROI process does not require process water, which simplifies plant construction and operations, decreases regulatory oversight, makes for safer plant operations, and conserves water.
- ▶ ROI plants can be cost effective at a relatively small scale and constructed in modules that allow the plants to be transportable and factory fabricated. Factory fabrication reduces capital costs and simplifies and speeds up field installation.
- ▶ Once validated for military use, the transportability may have tactical application



Feedstocks



- ▶ **Ft. Bragg potential feedstocks:**
 - 9000 tons/year waste wood from site clearing and packaging
 - 224 tons/year “powdered” paper from classified document destruction @ tipping fee of \$250k/year
 - Pine straw
 - Paper and cardboard
- ▶ **Ft Bragg will process feedstocks to reduce their size and remove metals using existing industrial grinder**



Plant Performance Measures



- ▶ **Feedstock physical and chemical characteristics**
- ▶ **BioOil physical and chemical characteristics from different feedstocks**
- ▶ **Char physical and chemical characteristics from different feedstocks,**
- ▶ **Syngas physical and chemical characteristics from different feedstocks,**
- ▶ **Material and energy balances for the plant, dryer, and furnace**
- ▶ **Emissions from processing system**
- ▶ **Labor requirements**
- ▶ **Maintenance requirements**
- ▶ **Cost effectiveness**

Boiler Performance Measures



▶ Boiler performance measurement vs. present fossil fuel used:

- Fuel-to-steam efficiency (amount of fuel in and amount of steam generated)
- Regulated stack emissions (types and amounts)
- Retrofit costs
- O&M performance:
 - Fuel savings
 - Operating costs
 - Operational problems



Cost/Benefit of Technology



▶ Cost Benefit

- The Internal Rate of Return for a 15-dtpd plant is 24%; the Internal Rate of Return for a 50-dtpd plant is 84%
- BioOil cost: \$5/MBTU Southeast Fuel Oil cost: \$13.4/MBTU

▶ Energy value

- BioOil process produces 9.6 MBTU/dry ton wood
- Bragg potential energy value: 86,400 MBTU = \$1.2M
- DoD potential energy value: 1.1M tons waste wood = 10.6 million MBTU = \$142 million

▶ Disposal cost avoidance - average \$82/ton

- Bragg potential cost avoidance, 9000 tons/year wood waste: \$738k/year
- DoD potential cost avoidance, 1.1M tons/year wood waste: \$90M/year



Intangible Benefits



- ▶ Reduce fossil fuel demand
- ▶ Reduce emission of greenhouse gases: 120lbs of CO₂ per MBTU of natural gas replaced by BioOil.
- ▶ Potential to return land to mission use: smaller C/D landfills and potential for “mining” old C/D landfills
- ▶ Provide fuel at a fixed, known cost
- ▶ Provide potential for “growing” all energy needs on installation
- ▶ Potential use in deployed operations
- ▶ Helps base meet federal mandates on renewable energy and base security
- ▶ Expands overall scientific knowledge base



How you can play



- ▶ **ESTCP requires extensive “technology transfer”**
- ▶ **We’ll be holding two Demonstration Days at Ft Bragg to provide “hands-on” operational demonstration to potential users**
- ▶ **YOU’RE invited!**





QUESTIONS?



Pallets at the Pitt County, NC Landfill

Assets???

Liabilities????



BACK UPS



Technical Approach



- ▶ **Task 1: Project Management** – Overall project planning and coordination.
- ▶ **Task 2: Test Site Identification** – Fort Bragg NC



Potential Bragg feedstocks

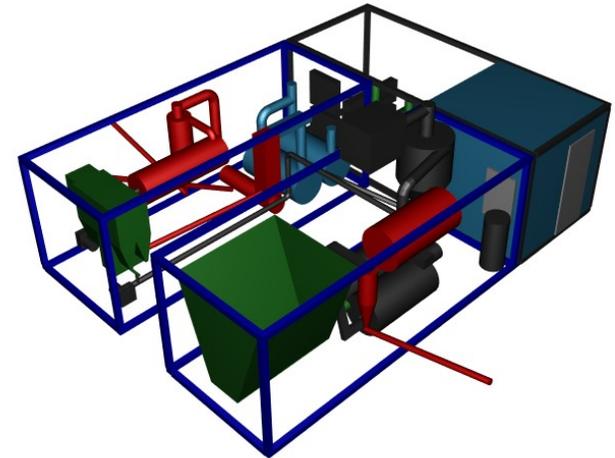
- ▶ 9000 tons/year waste wood
- ▶ 450 railroad ties
- ▶ 224 tons/year “powdered” paper from classified document destruction @ tipping fee of \$250k/year



Technical Approach



- ▶ **Task 3 Technology Demonstration Plan**
- ▶ **Task 4. Design, Fabrication, Shakedown, and Shipping of 15 dtpd Plant**
- ▶ **Task 5. Site Prep, Permits, Utilities**



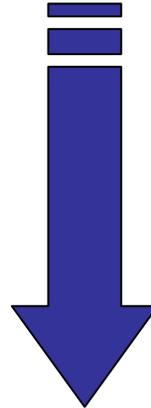
**CAD drawing
of 15 dtpd unit**



Technical Approach



- ▶ **Task 6. Feedstock Evaluation**
- ▶ **Task 7. Install Pyrolysis Plant at Ft. Bragg**
- ▶ **Task 8. Boiler Preparation and Testing**



- ▶ **Task 9. Test Performance!**
 - 3 month field test and operation
 - Evaluation of feedstock, BioOil, char, syngas, and emissions



Technical Approach



- ▶ **Task 10. Technology Transfer.**
 - **Our technology transfer efforts span the whole period of performance, and include direct outreach to key DoD players, as well as required ESTCP reports**
 - **We will boldly go where no man has gone before and tirelessly mind-meld the good news!**





Technical Approach



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Technology Maturity



- ▶ The ROI technology has three pending patents.
- ▶ The ROI process has been tested at the bench and 5-dtpd level and a 15-dtpd plant has been designed and fabricated.
- ▶ ROI and the University of Massachusetts have received a \$100,000 SBIR grant from DOE to research the upgrading of BioOil into transportation fuel
- ▶ DOE's Pacific Northwest National Laboratory (PNNL) found ROI's BioOil to be of equal or better quality than commercial
- ▶ Investors to date:
 - Natural Resources Canada \$800k
 - Farm Pilot Project \$450k
 - Mass. Technology Collaborative \$550k
 - US Forest Service \$106k
 - NY Watershed Ag. Council \$50k
 - ROI \$350k



Technical Risks



- ▶ Permitting new air emissions is a factor since we have only estimated air emissions. Fort Bragg's relationship with the regulators, the low estimated emissions, and the short testing duration (3 months) lessen this risk.
- ▶ A few parts of the plant have not yet been thoroughly tested (e.g., the ROI BioOil system has not yet been integrated with a commercial boiler).
- ▶ BioOil stability may be an issue depending on storage time; however, if necessary, there are additives for stabilizing BioOil.

Schedule of Milestones



Tasks	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
1. Project Management	█	█	█	█	█	█	█	█
2. Site ID	█							
3. Demo Plan	█	█	█					
4. Fab Plant		█	█	█				
5. Site Prep	█	█	█	█				
6. Fuel Eval		█	█	█	█			
7. Install Plant					█			
8. Boiler Prep			█	█	█	█		
9. Testing						█		
10 Tech Transfer		█	█	█	█	█	█	█
			DP				FR	C&PR



Transition Plan



- ▶ Provide Ft Bragg w/ a successful Fast Pyrolysis capability to generate critical fuels through a self-sufficient system which turns fiber waste into useable energy sources
- ▶ Provide updated design and field operating manuals.
- ▶ Document complete process for implementation, to include acquisition of system, site selection, installation, environmental compliance & permitting (State & Federal regulatory partners will be engaged), operations, and lessons learned.
- ▶ Publish as Army Tech Report & distribute to all facility operators at DoD installations & depots; post on IMCOM, Bragg & ESTCP websites
- ▶ Hold two “Demonstration Days” at Ft Bragg to provide “hands-on” operational demonstration to potential users throughout DoD



Transition Plan, continued



- ▶ Publish results in papers submitted to DoD, DoE & technical journals, and present at DoD, DoE, academic and industry-sponsored meetings & conferences.
- ▶ Provide project status updates will be provided to RDECOM's Power & Energy IPT for SA and expert input to project.
- ▶ Develop a decision tool to assist in determining feasibility & benefits of Fast Pyrolysis implementation at other facilities.
- ▶ Use lessons learned to directly influence ROI's next-generation design of Fast Pyrolysis systems.



Cost Estimate



TOTAL ESTCP funds requested: \$1.05 million over two years

Performer	CY08	CY09
IMCOM-SE/Bragg	25	25
ROI	749	123
Auburn University	46	34
US Forest Service	3	3
Center for Sustainable Solutions	20	20
TOTAL	843	205



Partner Contributions



Leveraged funds to be provided by the partners:

- **IMCOM-SE: \$200k for labor**
 - **Auburn University: \$44k staff labor**
 - **US Forest Service: \$32k staff labor**
 - **ROI: \$52k labor**
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- **Total partner contribution: \$328k**