



ICM Gasification Technology

USDA-ARS Presentation

February 8, 2011



ICM Engineering, Manufacturing, Construction and Management

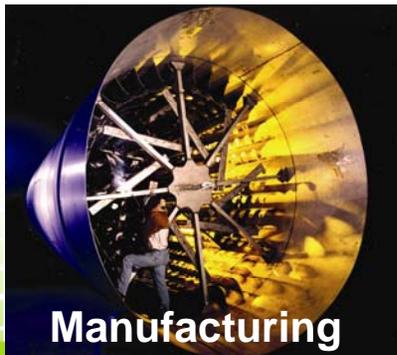
Construction Management



Rotary Drying Equipment



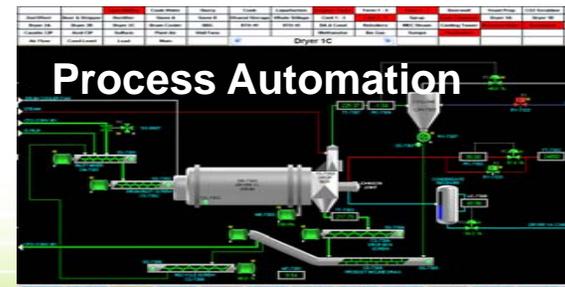
Installation Services



Manufacturing



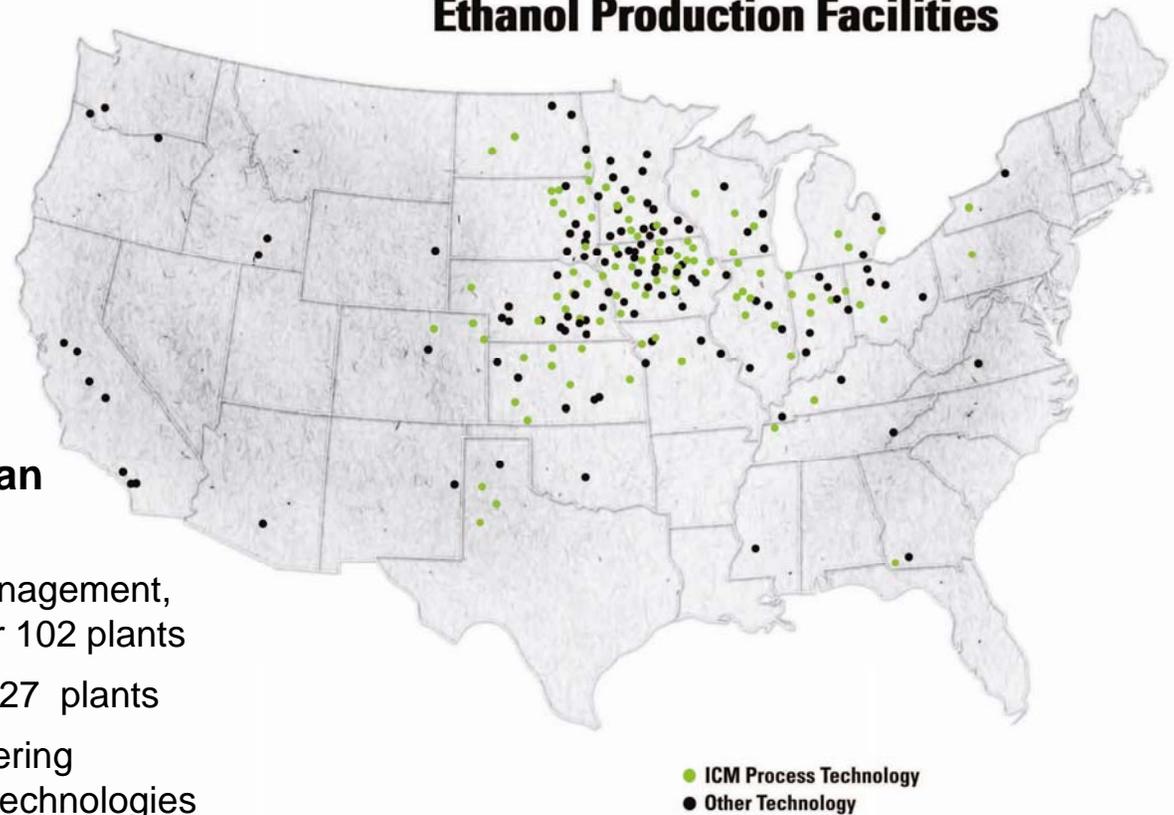
Process Engineering



Process Automation

ICM Technology: 102 Facilities across North America

United States Ethanol Production Facilities

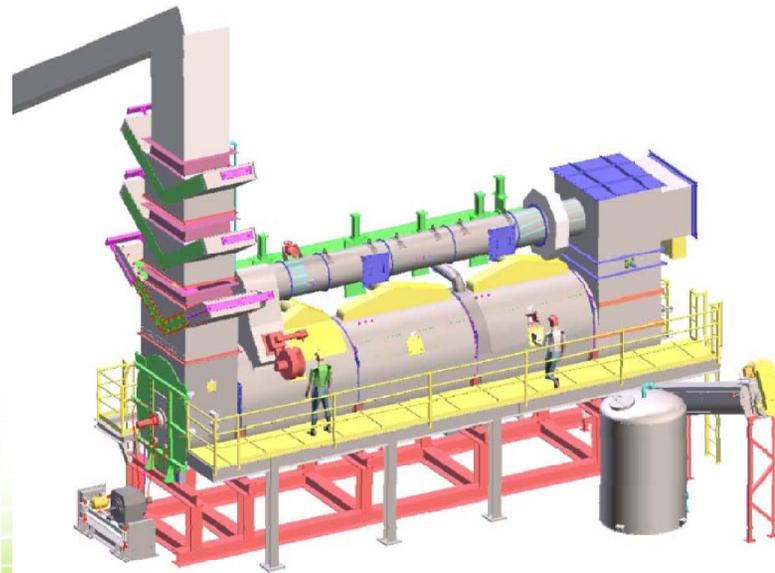


Serving the U.S. and Canadian Ethanol Industries

- Process engineering, project management, training, and start-up services for 102 plants
- General contracting services for 27 plants
- Retrofits, operations and engineering assistance to other fuel ethanol technologies

ICM's Auger Gasification Technology

- **Successfully developed in the late '70s early '80s**
 - Tested 250 TPD using MSW and wood wastes
 - Supported by DOE and Boeing
- **After extensive technology review and installation of another gasification technology ...**
 - Licensed technology
 - Fuel flexible
 - Greater control
 - BioChar capable
 - Shop fabricated



Reducing Ethanol's Carbon Footprint

- **Provide a proven, robust gasification technology**
 - Reduce the Ethanol Industry's dependence on natural gas
- **Gasification technology that is fuel flexible**
 - Fiber from the dry fractionation of corn
 - Separation of starch from food grade corn oil and proteins
 - Local corn stover, wood chips, other biomass/energy crops
 - Municipal solid wastes and sludge
- **Promote sustainable agriculture through co-production of BioChar**

ICM's Commercial Demonstration Gasifier

- Located in Newton, Kansas
- 150 - 200 ton/day capacity



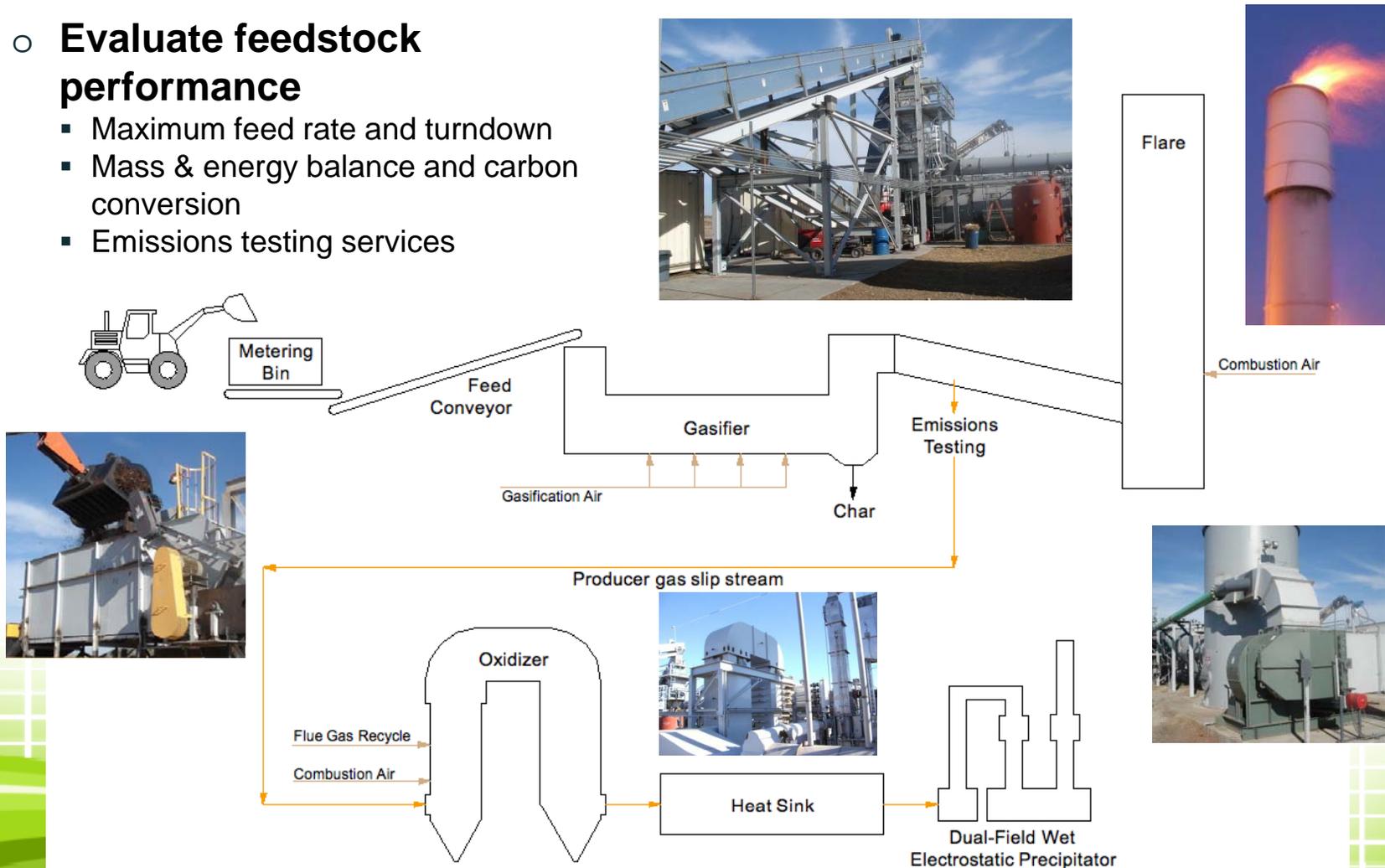
ICM

e ethanol

ICM's Commercial Demonstration Gasifier

- Evaluate feedstock performance

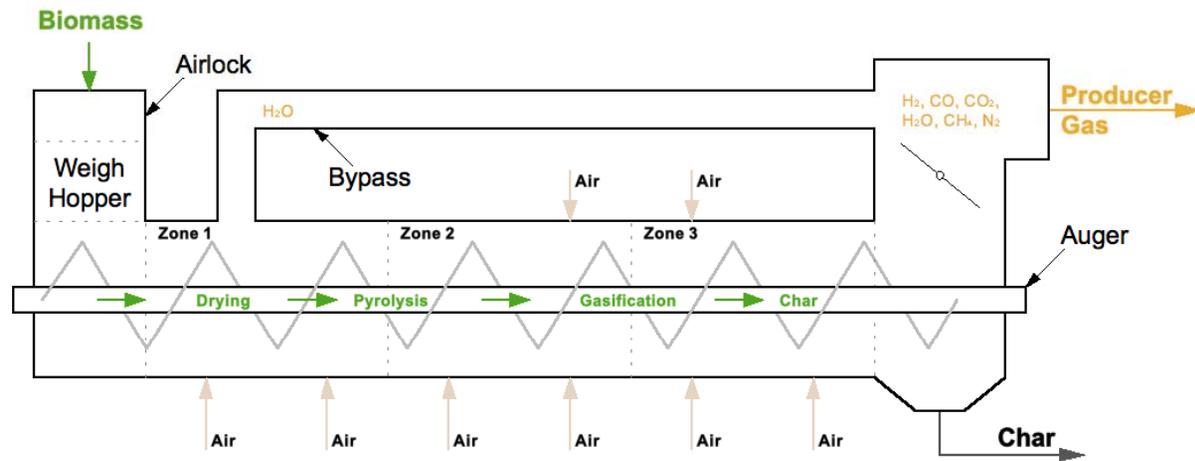
- Maximum feed rate and turndown
- Mass & energy balance and carbon conversion
- Emissions testing services



ICM Gasifier

○ Better Control

- Mass input
- Low rpm auger
 - Retention time
- Wet gas bypass
 - 10% - 50% mc
- Zoned air input



○ Robust Design



○ Small footprint

- 8 ft x 40 ft = 150 ton/day

○ Low energy

- Minimal size reduction
- < 5 hp for auger
- < 15 hp air fan
- Fluid bed >>hp



Gasifier Operations: March 2009 – Nov. 2010

- **6,850tons** gasified
- **20 months** in operation, 2100 hrs
- **Two 100 hour continuous runs**
 - 100 hours on corn stover
 - 100 hours on wood chips
- **35 day continuous run**
 - Wood chips, stover and straw
 - Independent engineer's review

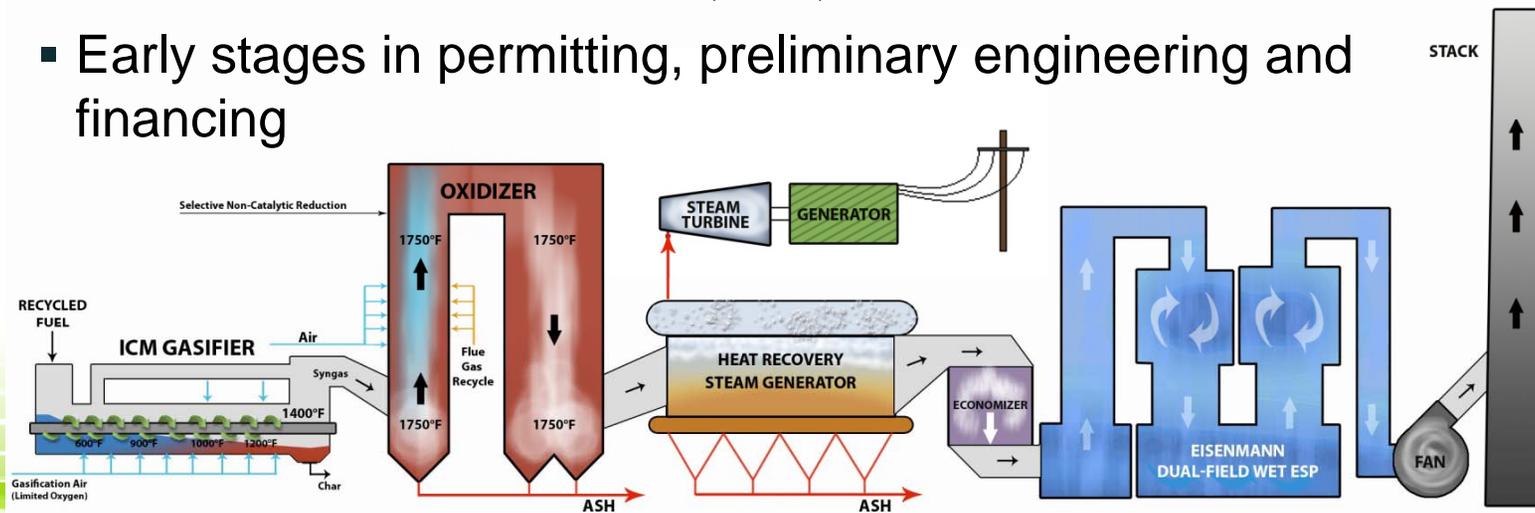
- **Wood Chips** 4,000 tons
- **Corn Stover** 1,000 tons
- **Wheat Straw** 400 tons
- **Sorghum Stalks** 400 tons
- **C & D** 200 tons
- **Paper Pulp + Plastics** 100 tons
- **Switchgrass** 50 tons
- **Corn Bran + Syrup** 50 tons
- **Auto Shredder Res.** 50 tons

- **MSW (RDF) + Tires** 350 tons
- **Chicken Litter** 200 tons
- **Dairy Manure** 50 tons
- **Manure + Woodchips** 50 tons



Applications

- **1st OPPORTUNITIES: Steam & Power, 10-60 MWe**
 - RDF, RDF+TDF, Wood chips
 - ICM also providing startup and long-term O&M services
- **Domestic and International**
 - 20 MWe WTE for Charlotte, NC, etc.
 - Early stages in permitting, preliminary engineering and financing

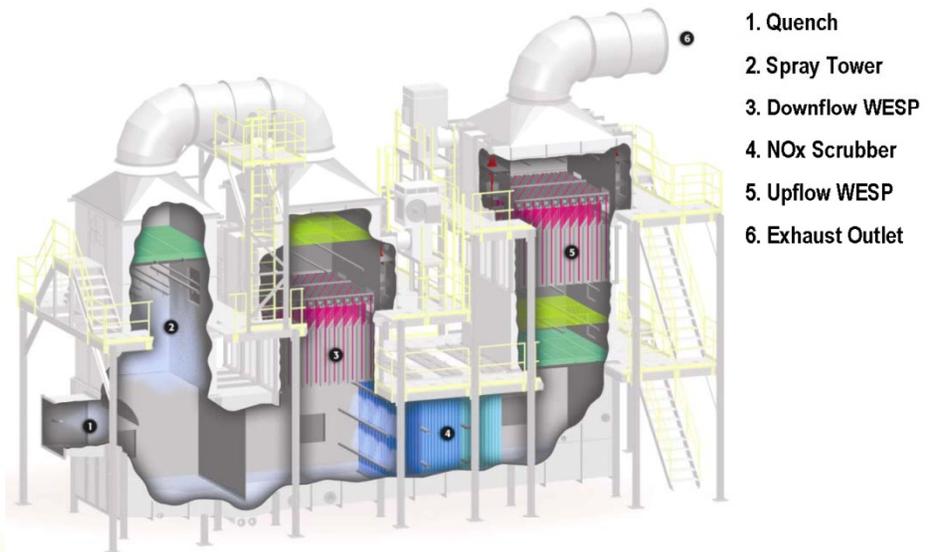


More Applications

- **In DEVELOPMENT: IC engine to Power, 5-20 MWe**
 - Gasifier ⇒ ⇒ Gas Cleanup ⇒ ⇒ IC Engines & CHP
 - RDF, RDF+TDF, Wood chips
 - Harvey County Kansas
- **Targeting smaller municipalities**
 - Lower capital requirements
 - No high pressure steam, boiler certifications, etc.
- **Other Opportunities**
 - Industrial applications – waste disposal
 - Process residuals

Flue Gas Emissions Control

- **Particulate removal**
- **Staged injection of air & flue gas recycle**
- **NOx - Selective non-catalytic reduction**
- **Dry sorbent injection**
- **Dual-field Wet ESP**
 - Strategic alliance with EISENMANN Corp.
 - IC Engine gas cleanup



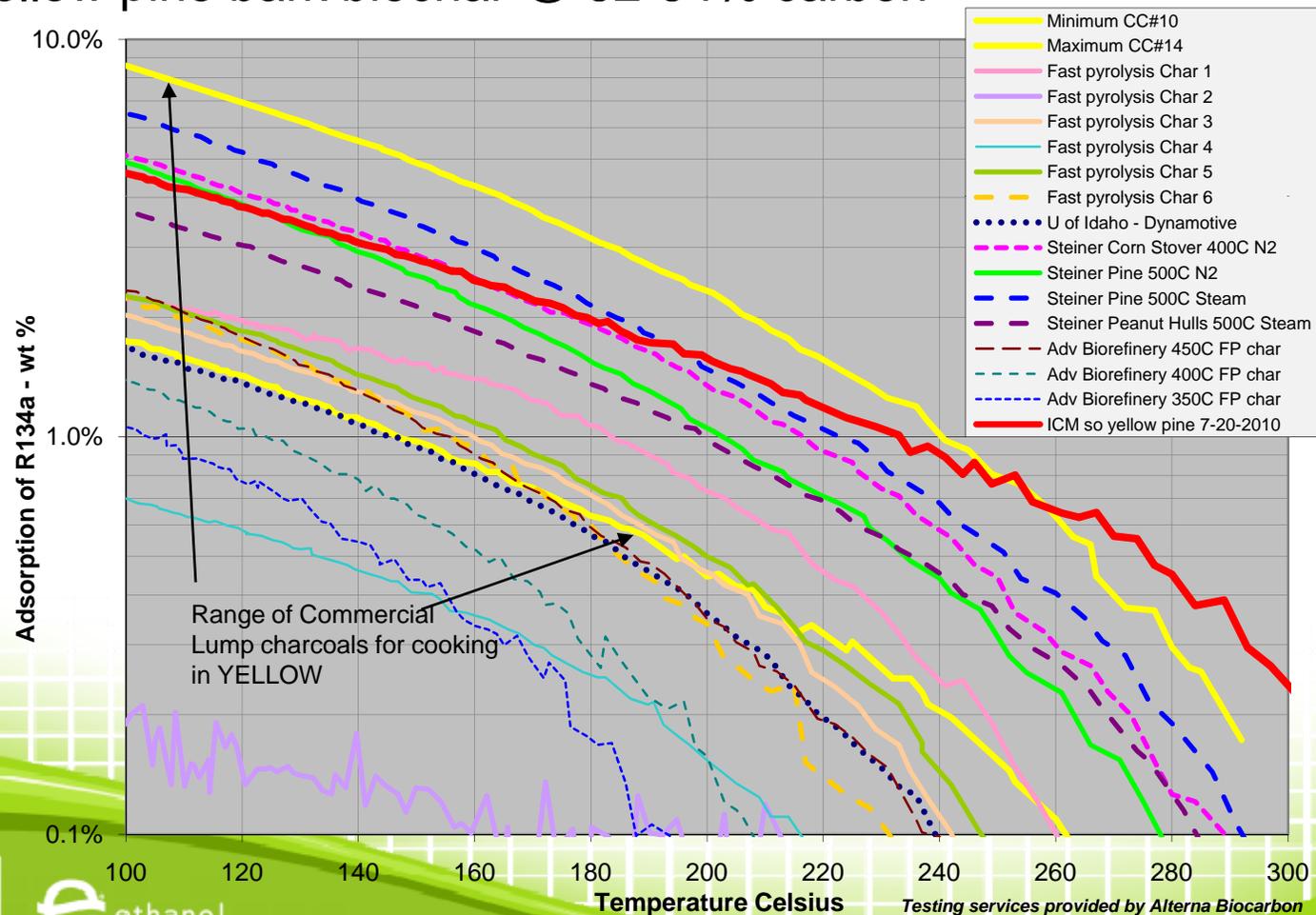
BioChar Co-Production

Research and Development

- **Can the ICM gasifier produce high quality biochar?**
 - Pyrolysis is not the only path to biochar
- **To date - supplied over 100 tons Biochar to ...**
 - Research institutions
 - Community organization
 - Private entrepreneurs
- **Continued interest in promoting biochar and sustainable agriculture**

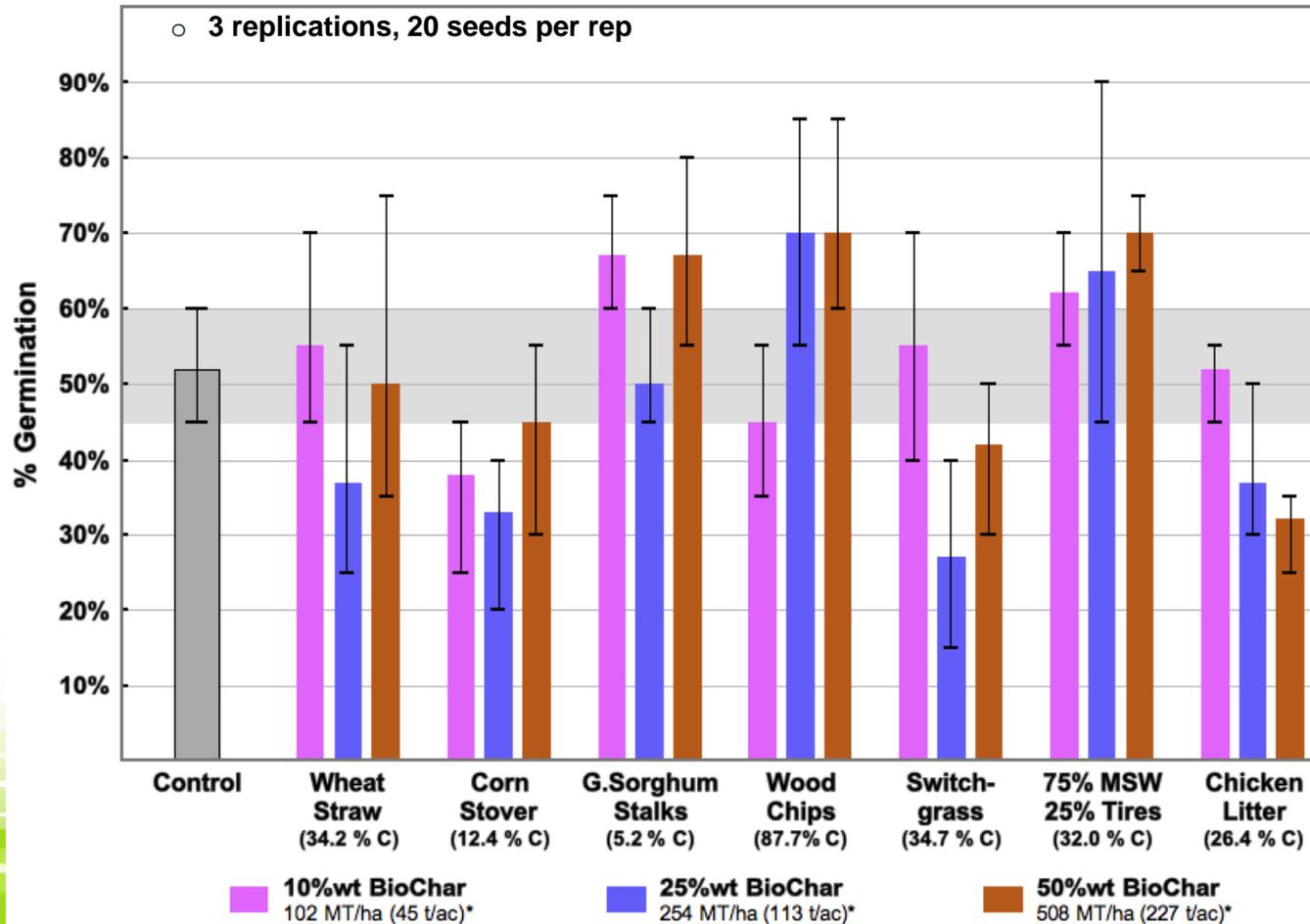
High Adsorption, High Carbon BioChar

- High quality biomass, low gasification temperatures
 - S. yellow pine bark biochar @ 92-94% carbon



Germination Testing on High and Low Carbon BioChars

Lettuce Seed Germination Tests



* First 10 cm (4") of top soil; soil bulk density: 1.0 g/cm³ (62 lb/cf)

Bed Temps.

- Wheat Straw
 - 540-600°C
- Wood chips
 - 600-700°C
- MSW & Tires
 - 750-820°C

High and Low Carbon BioChar

Feedstock	Feedstock Input		Carbon Conversion	Biochar Production	
	%ash, db	%C, db	%C to syngas	%C	% Yield, db
S. Yellow Pine Bark	1.8%	52.6%	44.5%	94.1%	31.0%
	1.8%	52.6%	59.7%	92.1%	23.0%
	1.8%	52.6%	93.5%	65.0%	5.2%
Urban Wood Waste	2.8%	50.2%	43.0%	91.0%	31.4%
	2.8%	50.2%	59.8%	87.7%	23.0%
	2.8%	50.2%	91.5%	60.0%	7.1%
Wheat Straw	6.4%	47.0%	69.7%	69.0%	20.6%
	6.4%	47.0%	79.6%	60.0%	16.0%
	6.4%	47.0%	92.9%	34.2%	9.7%
	6.4%	47.0%	98.5%	10.0%	7.1%
Corn Stover	8.4%	46.9%	86.0%	44.0%	15.0%
	8.4%	46.9%	97.5%	12.4%	9.6%
	8.4%	46.9%	98.9%	6.0%	8.9%
Chicken Litter	21.2%	38.7%	70.9%	34.7%	32.4%
Switchgrass	6.0%	50.0%	93.6%	34.7%	9.2%

Co-Production of Power and BioChar

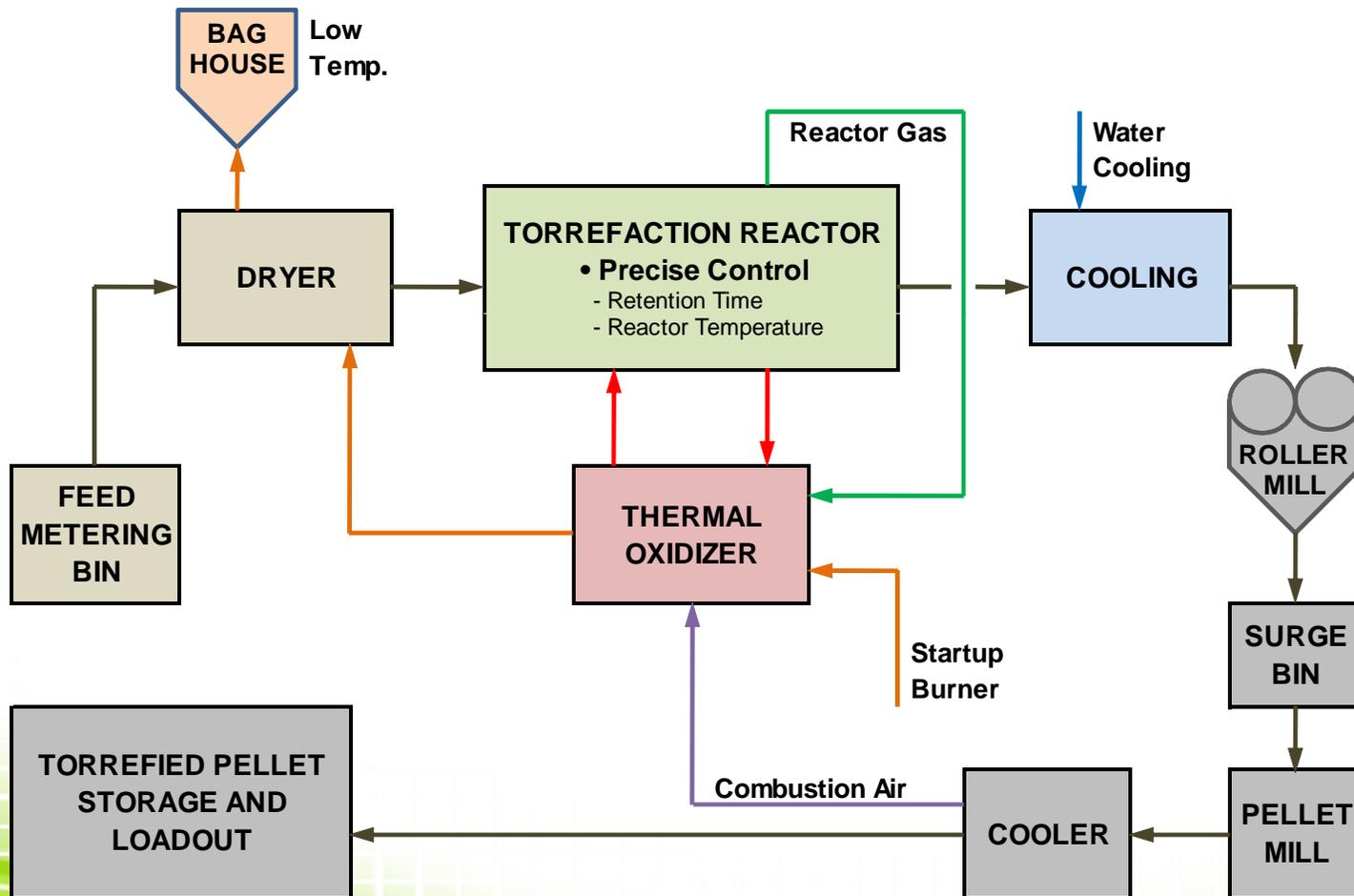
- **Three commercial gasifiers**
 - **4.5 MW** - 136 MT/day (150 TPD)
 - Same scale as demonstration facility; footprint: 2.0m x 12m (6.0' x 39')
 - **9.0 MW** - 272 MT/day (300 TPD)
 - Same scale as original DOE demonstration footprint: 2.6m x 12m (8.5' x 39')
 - **13.5 MW** - 408 MT/day (450 TPD)
 - 1.5x original DOE demonstration; footprint: 3.0m x 12m (11' x 39')
- **Example: wood chips and corn stover**
 - **Yellow Pine** 1.3% ash db 25% mc 90% carbon conversion to syngas
 - BioChar with 80% carbon content (6.5% biomass db)
 - **4.5 MW** – 7.3 MT/day 2,560 MT/y
 - **9.0 MW** – 14.6 MT/day 5,120 MT/y
 - **13.5 MW** – 21.9 MT/day 7,680 MT/y
 - **Corn Stover** 8.3% ash db 18% mc 90% carbon conversion to syngas
 - BioChar with 36% carbon content (13% biomass db)
 - **4 MW** – 16.0 MT/day 5,600 MT/y
 - **8 MW** – 31.9 MT/day 11,200 MT/y
 - **12 MW** – 47.9 MT/day 16,750 MT/y

BioChar Currently Available

- **2+ ton of S. yellow pine bark BioChar**
 - 92-94% carbon content
 - Free ... just pay shipping costs
 - 80-100lb bags
- **200+ ton from woodchips for Apr-May 2011**
 - >90% carbon content
 - Most going to academic institutions
 - Some may be available @ \$250/ton + shipping

ICM Torrefaction Technology

100-150k TPY Demonstration Facility



Questions?

Albert S. “Bert” Bennett, Ph.D.
Senior Engineer and Principal Scientist
Direct: 316-977-6671
albert.bennett@icminc.com