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## **Commercial-Scale Production of Biochar and Energy**

**Presented by:  
Jon Orr | Bert Bennett  
Gasification Technology Team**



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310 North First Street | PO Box 397 | Colwich, KS 67030  
O: 316.796.0900 | F: 316.796.0570 | [icminc.com](http://icminc.com)



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# PRESENTATION TOPICS

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- **ICM's Biochar Production Technology**
- **Projects**
- **Demonstration Results**



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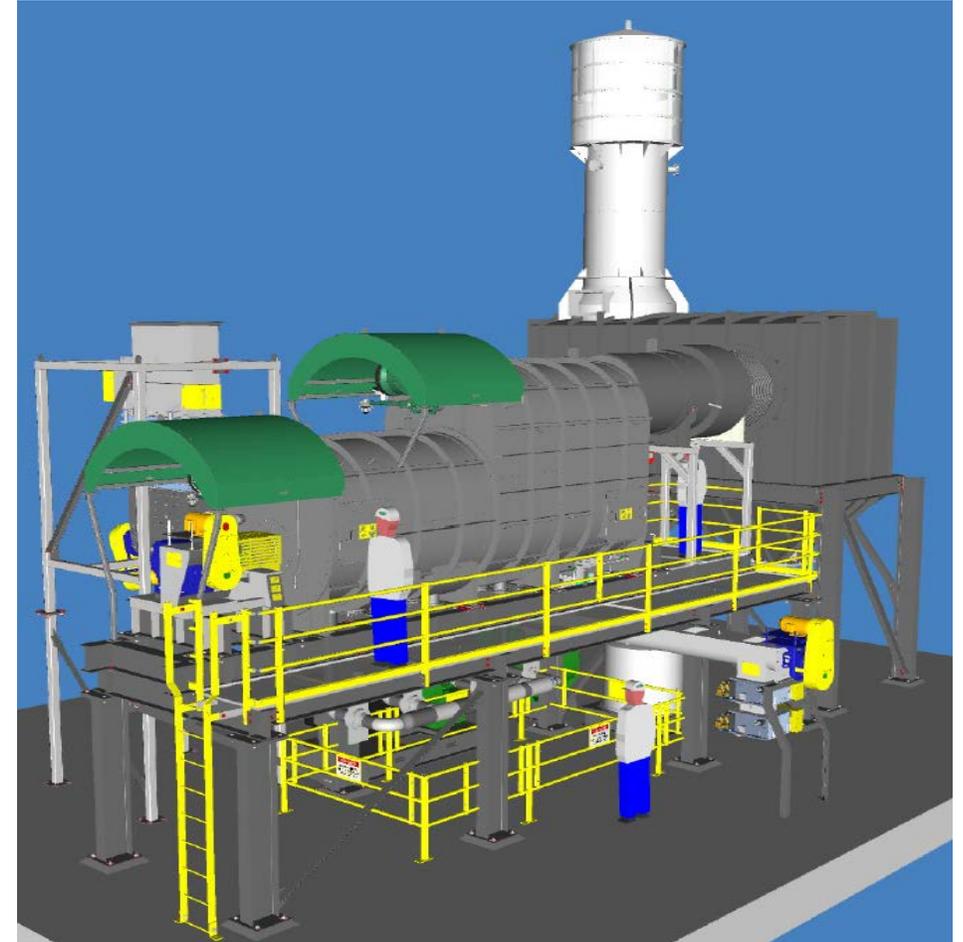
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# ICM'S BIOCHAR PRODUCTION TECHNOLOGY

## • Key Features

- Internally-augured, air blown gasifier
- Feedstock flexibility
- Produces high quality biochar
- Low process temperatures
- No additional thermal energy needed
- Variety of uses for recovered heat



# ICM'S BIOCHAR PRODUCTION TECHNOLOGY

- **Better Control**

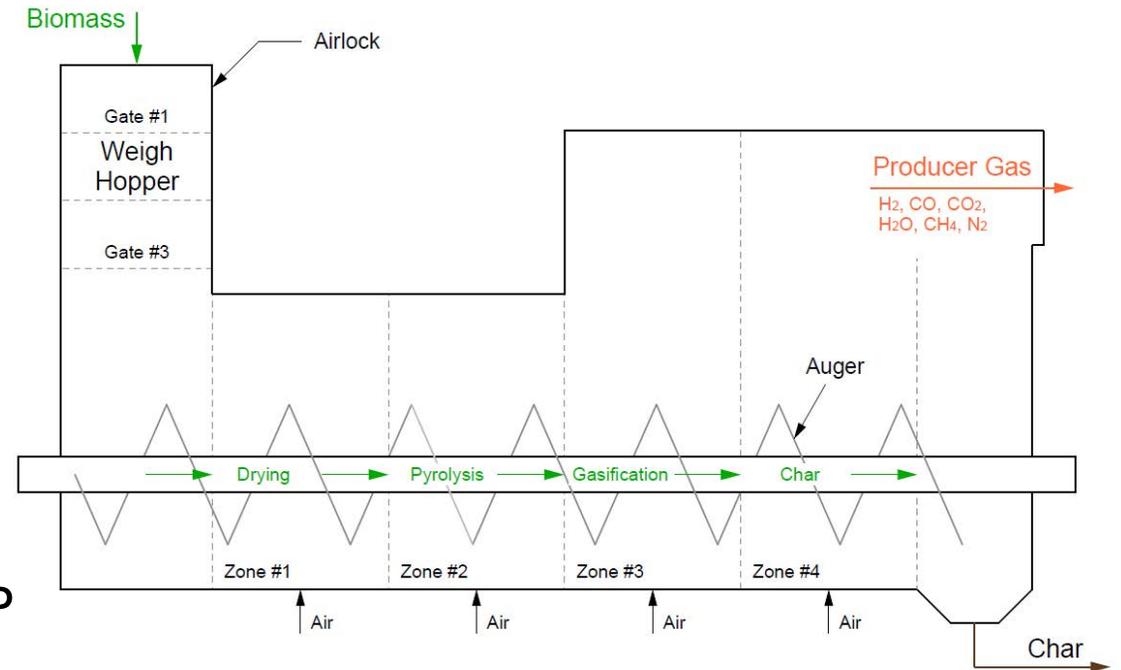
- Mass input
- Low rpm auger
- Retention time
- 10 - 40+ % mc
- Zoned air input
- Wide turndown range

- **Lower Energy to Operate**

- Primary Drivers - Auger & Fans Low HP
- After Start, No Additional Fuel
- Lower Bed Temperatures

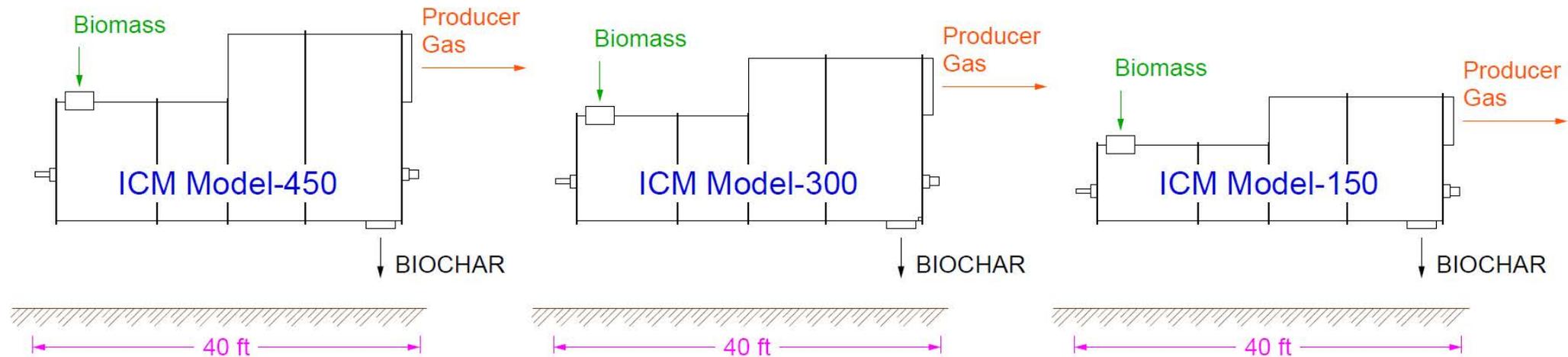
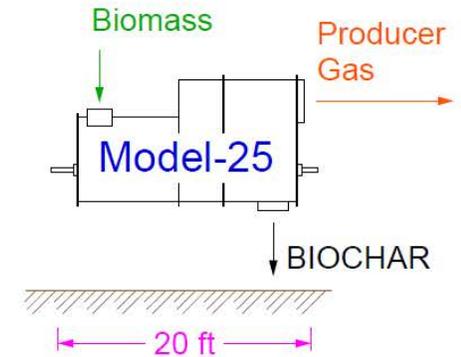
- **Optimize for Biochar or Energy**

- **Small Footprint**



# ICM'S BIOCHAR PRODUCTION TECHNOLOGY

- ICM Models 25, 150, 300 and 450 (based on feedstock input)
- It can produce 3 to 85+ (\*) tpd of biochar
- Units built or under construction on 25, 150 and 300 tpd sizes
- NOTE (\*) based on 20% dry basis biochar yield (90+% C), from softwood at <15% mc, <1.5% ash, db



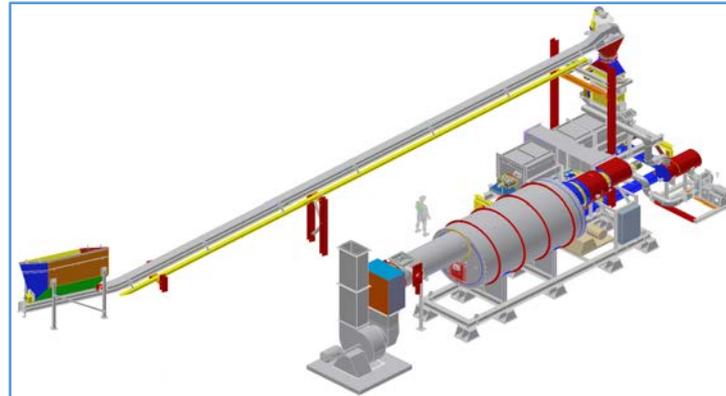
# ICM'S LARGE SCALE DEMONSTRATION GASIFIER – NEWTON, KANSAS

- Feedstock conversion from 50 to 200+ tons/day
- Biochar yields up to 20 tons/day
- Operated from March 2009 to June 2012



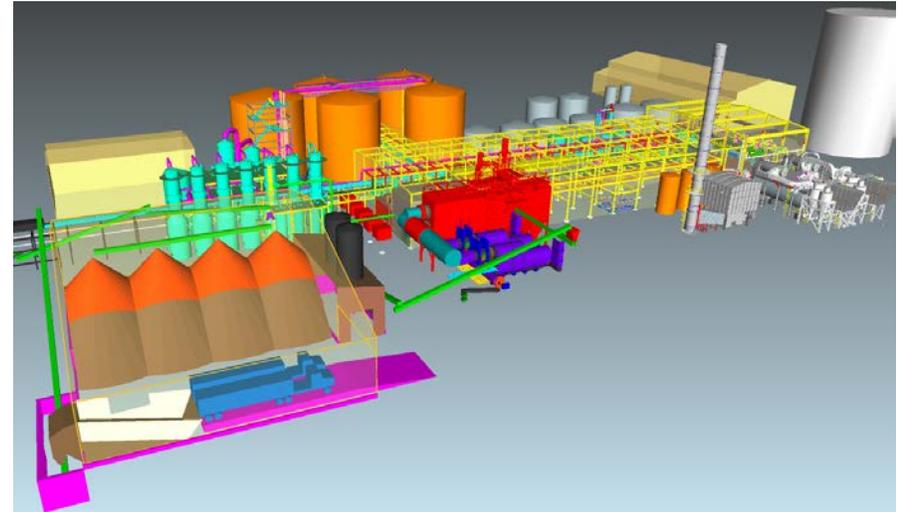
# ICM'S SMALLER SCALE DEMONSTRATION GASIFIER – NEWTON, KANSAS

- Feedstock capacity 5 to 20+ tons/day
- Biochar yields up to 3+ tons/day
- Mobilized
- Enhancements
- In service April 2016
- Demonstrated yields of 15 to 20+%(from DS)
- Total carbon in 89 to 92% (per IBI methods)



# PROJECTS – ELEMENT, LLC in COLWICH, KS

- ELEMENT™ will produce ethanol biofuels and feed products, which is expected to have the lowest carbon footprint in US
- Will recover energy from gasifier(s), to be used to produce steam and power
- Will provide operating energy up to 70 MMGPY ethanol
- Will reduce Greenhouse Gases
- **Will produce Biochar**



# PROJECTS – PROJECT X

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- Project: (not announced)
  - In detailed design phase
  - Based on single 25 tpd gasifier
  - Using chipped forest maintenance material
  - Mitigate forest fires
  - Produce 3 to 4.5 tpd of high quality biochar
  - Use recovered heat to pre-dry feedstock to < 15 wt% moisture



# DEMONSTRATION RESULTS

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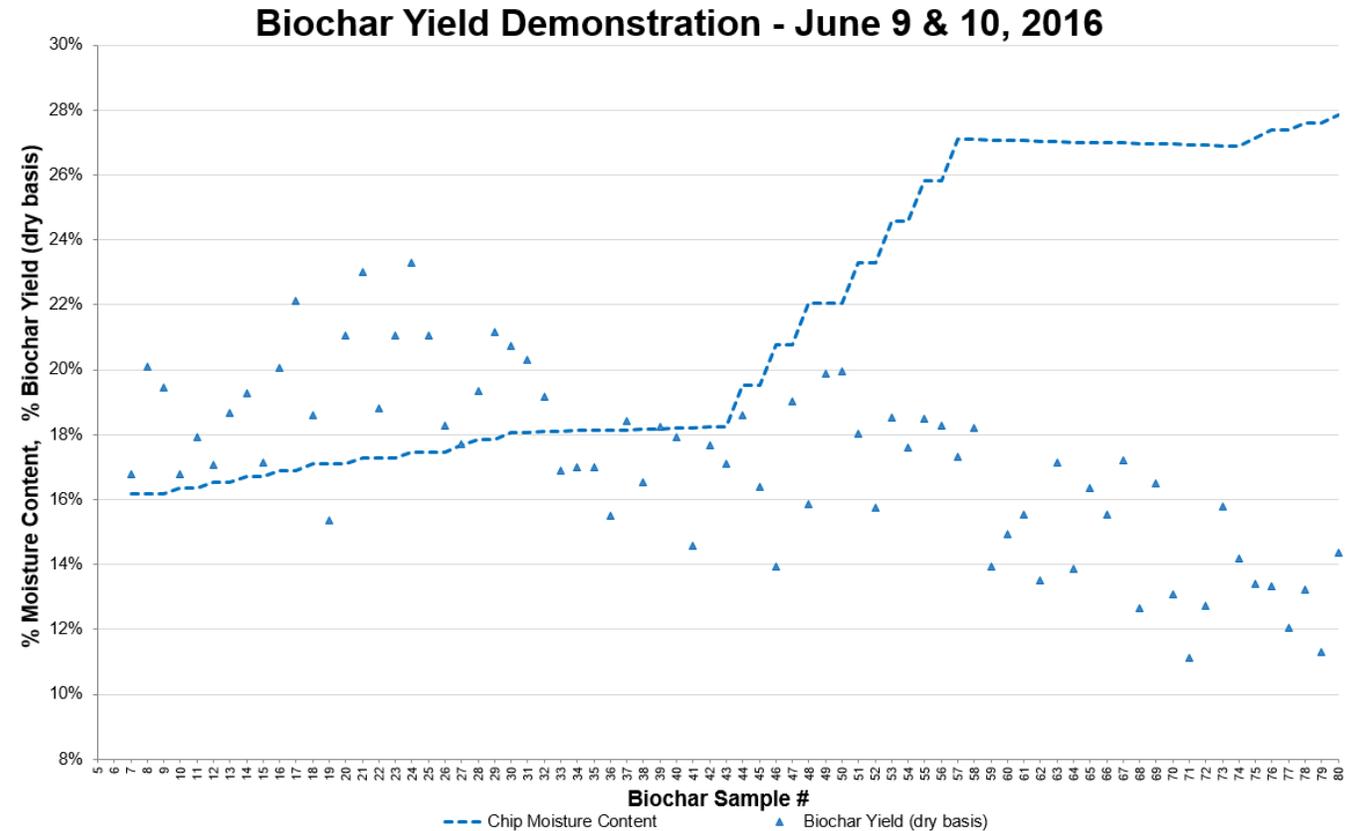
- **Continuous Development Path Since 2007**
  - Approx 9000 tons of various materials tested on two demo units
    - Successful demonstrations using Woody Biomass, Ag Residuals, Chicken Litters and Dairy Manures, and Refused Derived Fuels (MSW and tires)
  - Numerous continuous demonstration 2007-2018
    - 24h, 100h to 800+ h runs
  - Recent biochar demonstrations



# DEMONSTRATION RESULTS – Yield vs Moisture Content

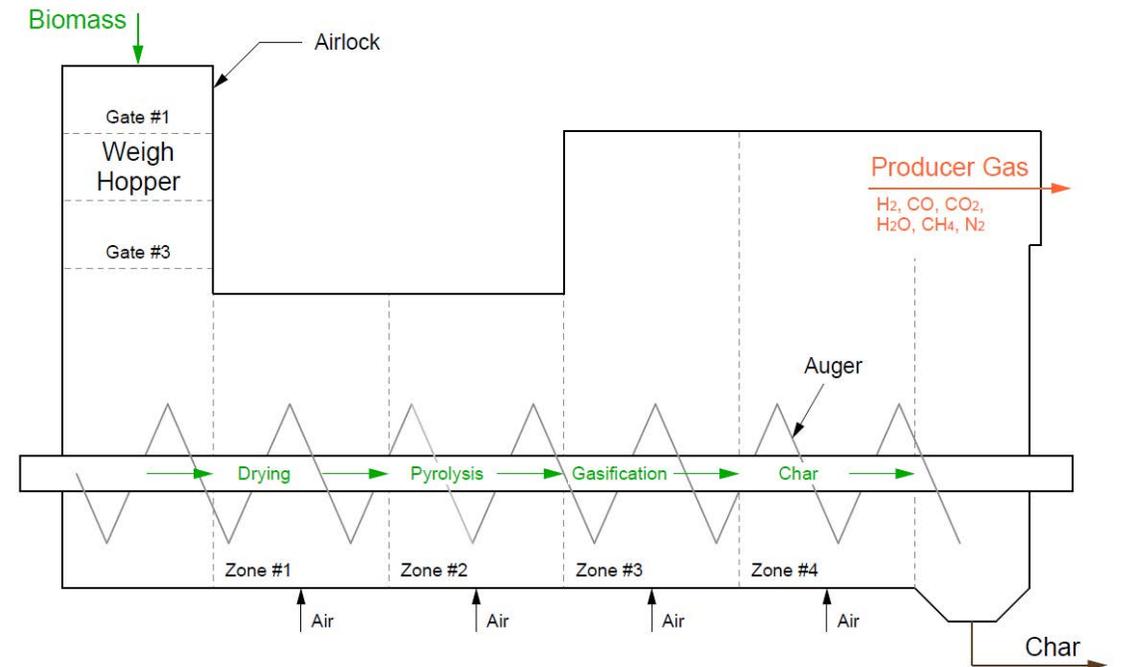
- **Biochar Yield and Optimization**

- June 2016, Newton KS
- 24 hour continuous yield demonstration
- Gradual increase in feedstock moisture content (15 to 28%)
- On-the-fly control parameters adjusted to optimize yield
- Demonstrated yields up to 20+ % dry basis
- Total carbon in 89 to 92% (per IBI methods)



# INDUSTRIAL-SCALE CO-PRODUCTION OF BIOCHAR AND ENERGY

- **Opportunities for Heat Recovery**
  - Biomass dryers
  - Steam heating applications
  - CHP using steam or ORC turbine
- **Biochar & Energy – 150 ton/day**
  - Pine: 15% mc, 1.5%ash db, 7280 Btu/lb HHV
  - Max Biochar 90+% C (25.5 ton/day)
    - Dry 50% to 15% (800 to 450 TPD, **OR**
    - Dry 255 to 150 TPD, plus 30,000 lb/h Steam
  - Max Energy and Low-C Biochar
    - CHP with steam letdown turbine
      - 3 MW power generation
      - dry 255 to 150 TPD
      - 30 MMBtu/h district heating



# LETTUCE SEED GERMINATION TESTS HIGH AND LOW CARBON BIOCHAR

- **Bed Temperatures**

- **Wood chips**

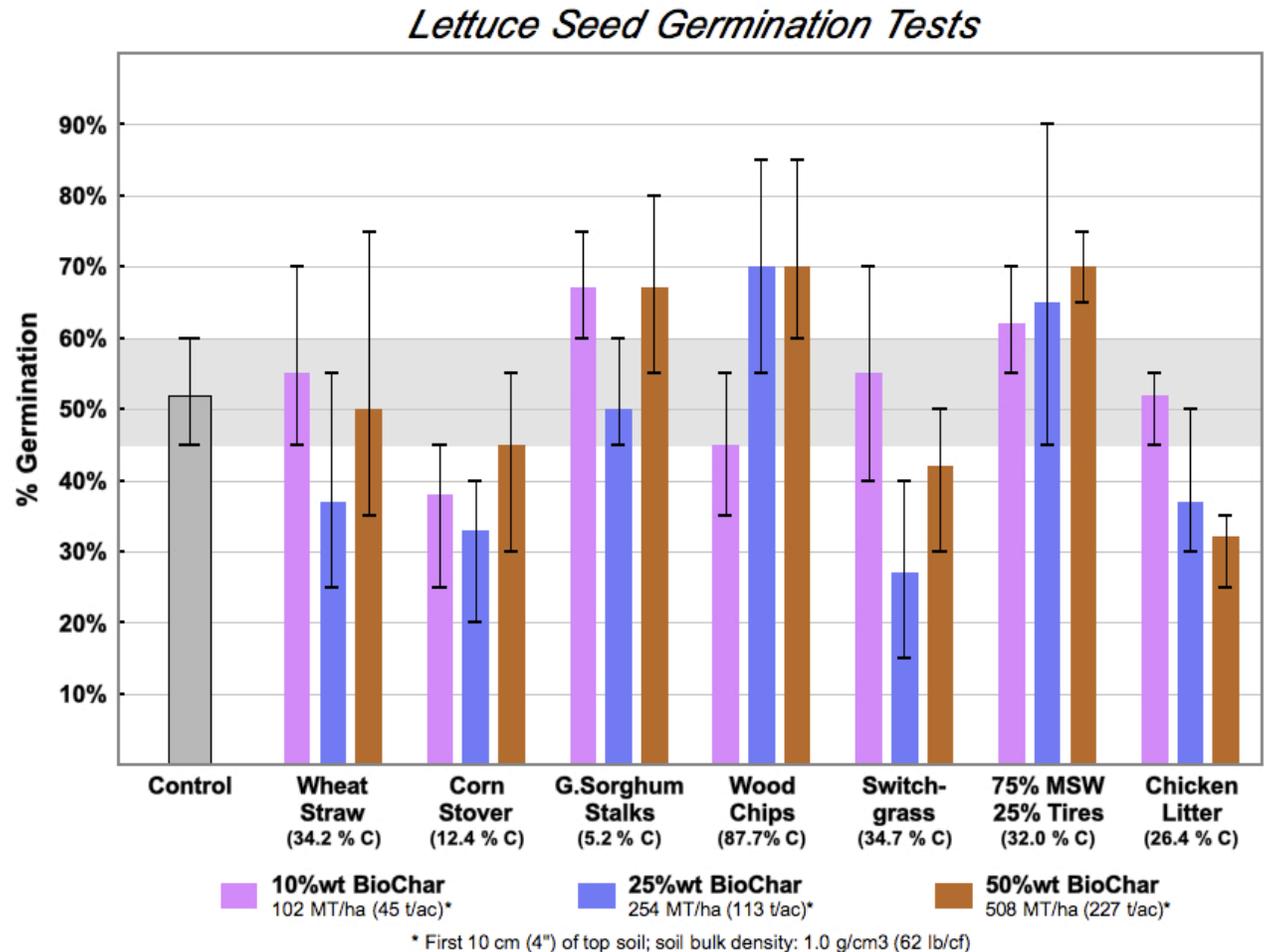
- 480 - 540°C
- 900 -1000°F

- **Wheat Straw**

- 480 - 540°C
- 900 -1000°F

- **MSW and MSW + Tires**

- 540 - 650°C
- 1000 -1200°F



# SUMMARY

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- **Active Development Since 2007**
- **First Industrial-Scale Commercial Plant being Constructed**
- **Quality Biochars**
- **Platform Flexibility: Feedstocks, Biochar and Energy, including pathways to activation**



# Thank You!

## Jon Orr

Capital Sales Manager, Gasification

310 N. First St.  
Colwich, KS 67030  
Direct Line: +1.316.977.6834  
[Jon.Orr@icminc.com](mailto:Jon.Orr@icminc.com)

## Bert Bennett, Ph.D.

Senior Engineer / Principal Scientist

310 N. First St.  
Colwich, KS 67030  
Direct Line: +1.316.977.6671  
[Albert.Bennett@icminc.com](mailto:Albert.Bennett@icminc.com)



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