



# **NRRI Biochar**

## **Research Development & Demonstration**

**Natural Resources  
Research Institute**

UNIVERSITY OF MINNESOTA DULUTH

*Driven to Discover*

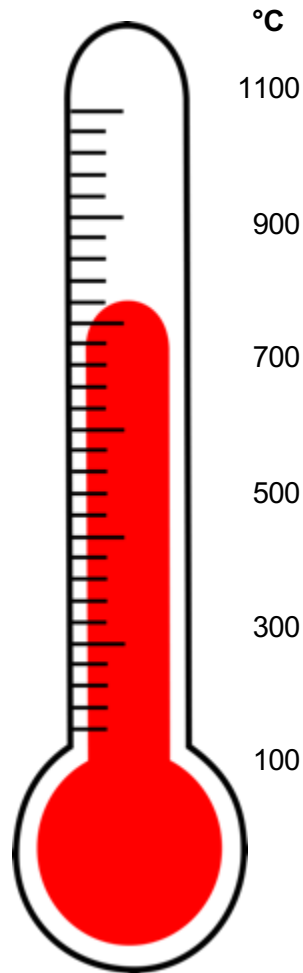
**Innovative Research. Minnesota Value. Global Relevance.**

# Minnesota Challenges



- Declining markets for forest products
- Forest fuel loading concerns
- Unused biomass resources (ag, forest, mill residuals, water treatment biosolids)
- Animal waste management
- Pest-killed trees
- Water contamination (nutrients, pollutants)
- Meeting carbon reduction goals
- New industry to create jobs

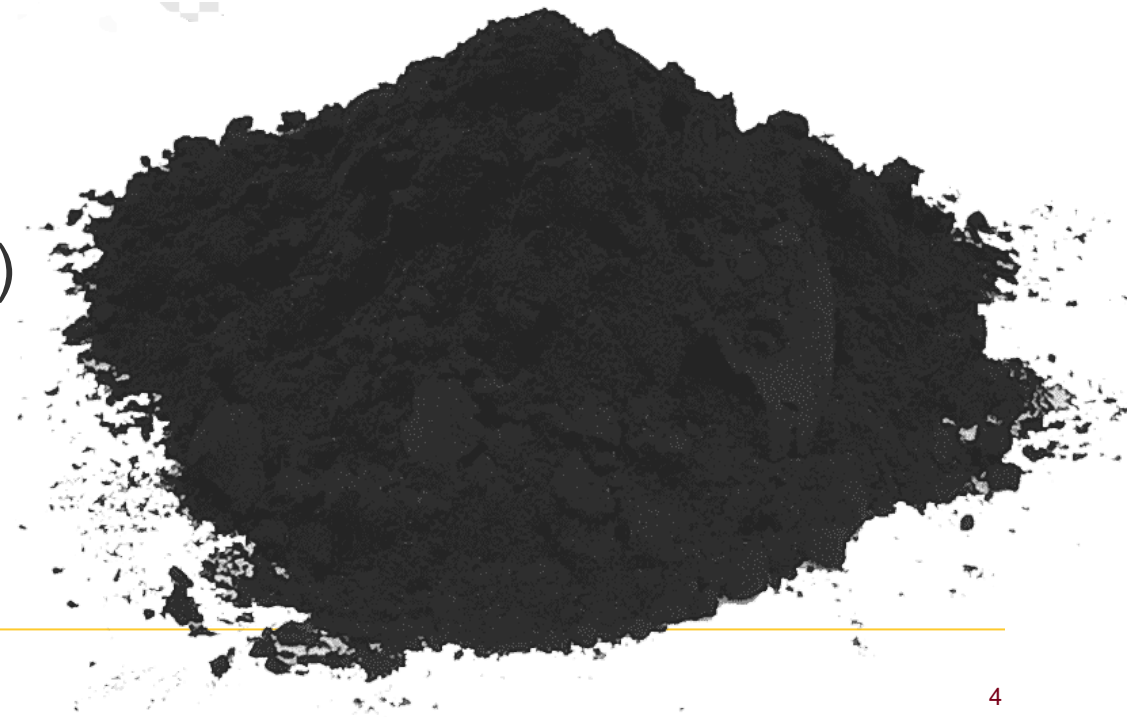
# Biomass Thermal Processing



Product	Appearance	Properties	Markets
<b>Biochar</b>	Black chips or dust; odorless	Adsorption Surface area Exchange Recalcitrance	<u>Materials</u> Activated carbon Water/air filter Soil amendment Composite filler
<b>Torrified Wood</b>	Dark brown/black chips, pellets, briquettes; campfire odor	Energy density Stability Brittleness	<u>Energy &amp; Chemical</u> Power generation Pellets & Briquettes Syngas production
<b>Thermally Modified Timber</b>	Boards, lumber, trim, siding; slight vinegar or smoke odor	Dimensional stability Decay resistance Appearance	<u>Construction</u> Outdoor lumber Decking & Cladding Windows & Trim Flooring

# Biochar Defined

- Nearly pure carbon in the form of *amorphous graphite*
- *Was* biomass but now has charcoal-like properties
- Beneficial habitat for soil microbes
- High porosity
- Recalcitrant carbon
  
- NOT carbon from decomposing biomass
- NOT fossil carbon (coal, oil, or natural gas)

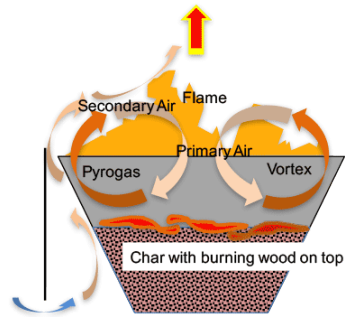


# Biochar Production



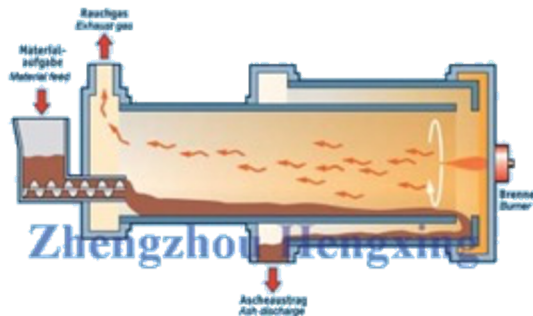
## Incidental (e.g., Forest fire)

Process control: none  
Product quality: variable  
Emissions: Very high, uncontrolled  
Co-products: None



## Retort (e.g., batch kiln, V kiln)

Process control: low  
Product quality: constant  
Emissions: Very high, uncontrolled  
Co-products: None



## Indirect kiln (e.g., rotating kiln)

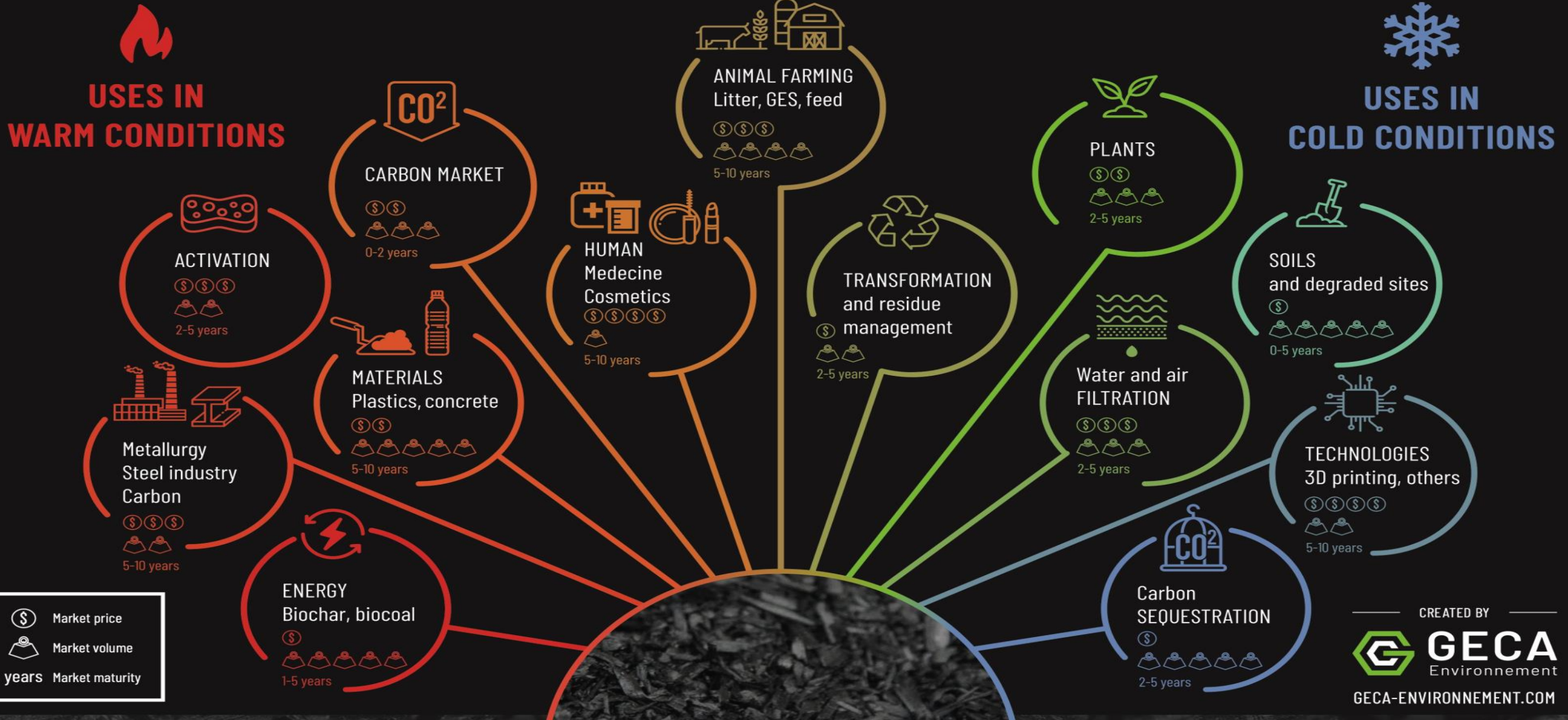
Process control: high  
Product quality: constant and controllable  
Emissions: Controlled  
Co-products: Thermal energy, steam, electricity, pyrolysis oils, wood vinegar, etc.

# Pilot Kiln for Char Production

Designed for flexible production of multi-ton product quantities for real-world evaluation



## BIOCHAR MARKETS



# Research Development & Demonstration

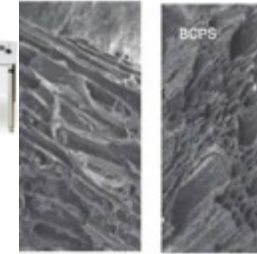
## Process Development & Production

Consistent  
Controlled  
Predictive  
Modification



## Material Characterization

Elemental analysis  
Structural analysis  
Surface chemistry  
Porosity  
(New methods)



# MINNESOTA OPPORTUNITY

## Biomass Sourcing

Bug kill & unmerchantable  
Residuals  
Management  
Logistics



## Market Opportunity

Demonstration  
Value proposition  
VOC collection  
Logistics evaluation  
Price:Performance



## Performance Evaluation

Lab studies  
Field trials



## Application Development

Structure-function relationship  
Formulations



# Biochar RD&D Programs

- Pilot-scale production  
Biomass Conversion Lab
- Characterization  
Materials Lab
- *E coli* contamination reduction  
Water Research Group
- Erosion control socks  
Water Research Group
- Forest Soils  
MN Forest Resources Council
- Urban Infrastructure  
City of Minneapolis



# Future RD&D Interests

- Co-production of energy and biochar & landfill capping
  - *Proposal to USFS*
- Develop PFAS remediation technology
  - *Pre-proposal to EREF*
- Demonstrations in conventional agriculture
- Demonstrations in infrastructure (roadsides, parks, boulevards, parks)
- Definition of carbon market opportunity
- Develop water and air treatment media
- Mineland restoration
- Applications in mineral processing
- Engineered materials

# Thank You

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