



**engenuity**  
worldwide



# Today's Presentation



**Introduction and Background**

**USDA Investment**

**Our Value Proposition**

**Bioeconomy Potential**

**Comments to the Committee**

# Home-Grown Technology



## Nancy – Owner, Strategy & Commercialization

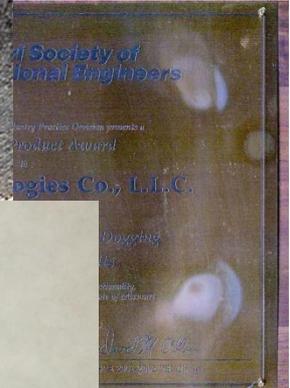
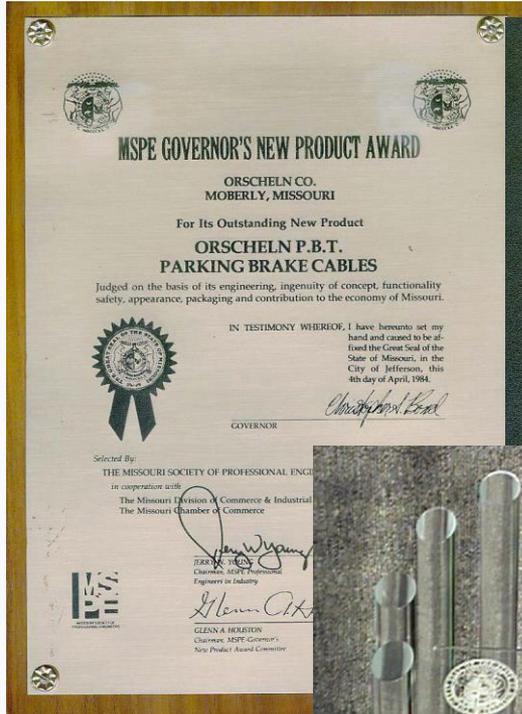
15 years of license in and license out  
Technology transfer to/from Fortune 100  
Sustainable Strategy

## Bob – Lead Inventor

60+ patents in materials engineering  
Inventions on passenger car brake cables  
Inventions on US Navy door latches and wire rope  
Inventions on oil and gas pipeline coatings



# New Product Awards



# From a Garage to the World ...

**enginuity**<sup>™</sup>  
worldwide

Novel Non-Woody Biomass Conversion Technology Method Deploying Low Energy Roasting & Binder to Produce a Weatherable/High BTU Power Cube<sup>™</sup>



**Conservation of Energy without Fossil Fuels -**  
*What took nature 100 million years, we can now do in 90 days.*



### Binder

The Enginuity novel, low-cost organic/inorganic binder system provides both improved weatherability and superior durability qualities to non-woody biomass power cubes.



### Power Cube<sup>™</sup>

The patented, stylized corn kernel neither binds nor bridges throughout transportation or material handling. It is important for materials to flow through already existent material handling processes to reduce the barriers for usage of renewable fuels in existing coal fired power plants.



### Roaster

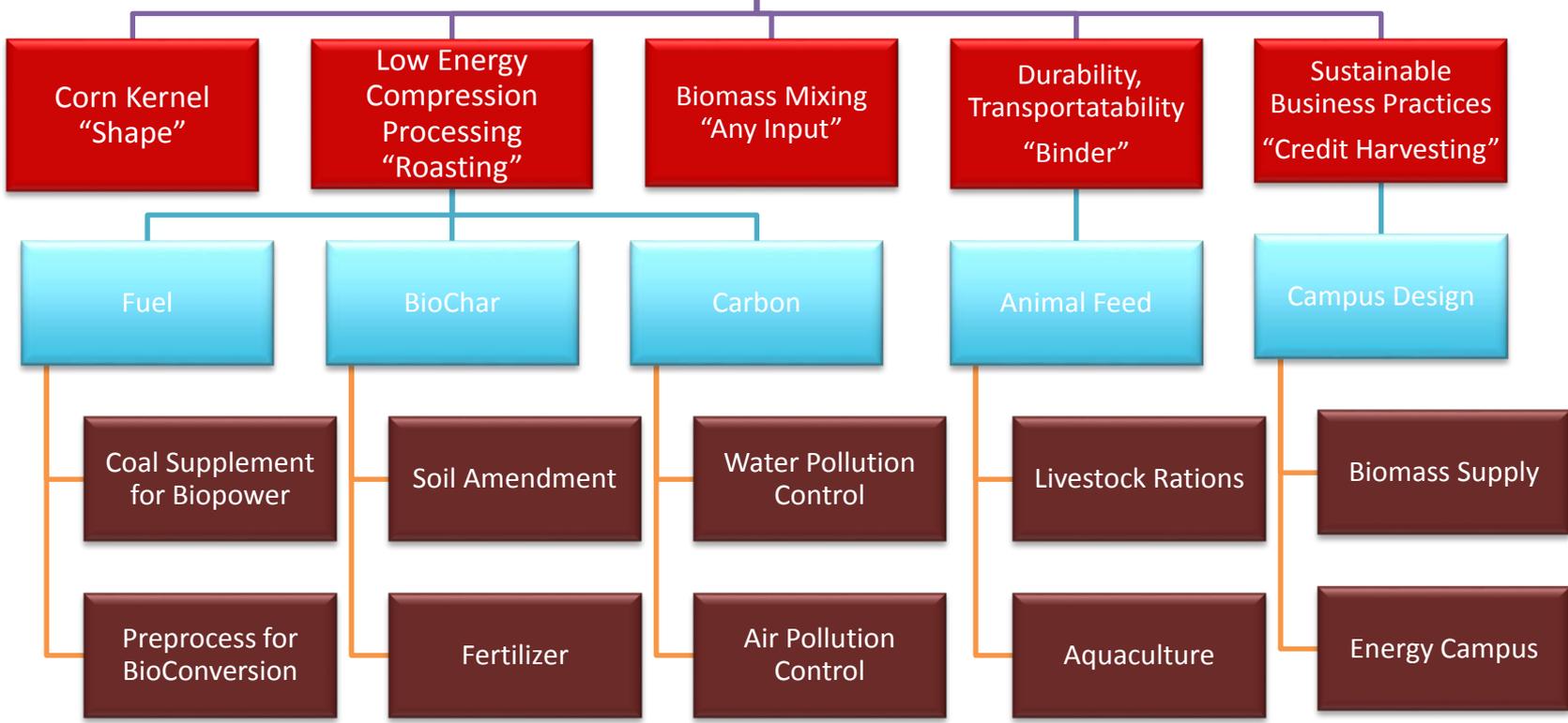
The rotary biomass dryer is based on a novel barrel/screw design that compresses material. The heat of compression causes both unbound and bound water to turn to steam, effectively steam drying within the barrel. No energy sources required other than a motor to rotate the rotary biomass screw. Roasting biomass improves energy/content as well as weatherability.

# engenuity



- Patent Portfolio in Engineered Biomass Products
- Fully Funded Technology Development Team
  - USDA REAP Grant – \$500,000
  - USDA B&I Loan Guarantee – \$2,000,000
- HQ at Missouri Plant Science Center
  - World Class Lab and Test Quantity Production Facility
- Scale-Up on Multiple Products

# Abundant Biomass Resources



Answers

Products

Markets

Sustainable Regional Biomass Supply

# engenuity Fuel Value Proposition

- Our process uses non-woody, annually renewable agricultural materials like corn stover, grass, and energy crops to create engineered solid fuel that can be burned in coal fired boilers without modification to the feed and boiler systems of power plants
- The fuel then supplements coal and enables plants to meet emissions requirements without expensive expenditures i.e. new boilers



## Binder

The Engenuity novel, low-cost organic/inorganic binder system provides both improved weatherability and superior durability qualities to non-woody biomass power cubes.



The Lowest Cost Alternative to Meet  
Greenhouse Gas Directives

(non-natural gas)

# Lowest Cost Alternatives

Technology	Assumptions	Cents/kw-hr	Expected Prices	Capital Included?
Coal	\$2.5/MMBTU, 10 Heat Rate	2.5 cents	Lower	Yes
Natural Gas	Heat Rate 8, fuel cost \$2 and \$4 (\$6)	1.6 cents - 3.2 cents (4.8 cents)	Volatile	No--\$1.0 mil/MW
Coal With Carbon Credits	1 MW-hr coal emission is 1.8 tons/CO2 Equiv, \$14/ton credit	5.0 cents	Higher	N/A
Coal with Sequestration	Heat Rate de-rated by 20% on 10 Heat Rate Plant	6.2 to 7.7 cents	Stable	Yes
Wood Chips/Pellets	10 Heat Rate Plant	5.0 to 7.0 cents	Site specific	No--\$1.5-2.0 mil/MW
Torrifaction	10 Heat Rate Plant	10.0 to 12.0 cents	Stable	Yes
Low Cost Model for Enginuity	Heat Rate 10, Integrated Raw Supply or \$45/ton	2.72 cents for captive feedstock 4.99 cents for merchant feedstock	Stable	Yes
Full Cost Model for Enginuity	3 <sup>rd</sup> Party Supply \$45/ton	6.0 cents	Stable	Yes

# Cost Effective Drying/Torrefaction



## Roaster

The rotary biomass dryer is based on a novel barrel/screw design that compresses material. The heat of compression causes both unbound and bound water to turn to steam, effectively steam drying within the barrel. No energy sources required other than a motor to rotate the rotary biomass screw. Roasting biomass improves energy/content as well as weatherability.

- 1<sup>st</sup> Law of Thermodynamics
  - Work = Heat
- Rotary Biomass Dryer
  - Uses Compression and Friction to Produce Steam Drying
- No External Fuel Input
- Engineered to be Economic

## Future Products for Pulverized Coal Supplement



- Destructive Drying to Achieve Granulated
- Rotary Biomass Dryer
  - Uses Compression and Friction
- No External Heat Input
- Engineered to be Economic.



Pulverized Coal Supplement

# Agricultural Products to Supplement Coal Without Modification to the Power Generation Plant



- Uses diverse biomass streams.
  - Ag Residues (Corn Stover & Grass)
  - Energy Crops



Power Plant

Engineered Fuel Production

- Complies with APPA Engineering Spec.

BTU – 8,400 BTU / pound

Moisture < 10%

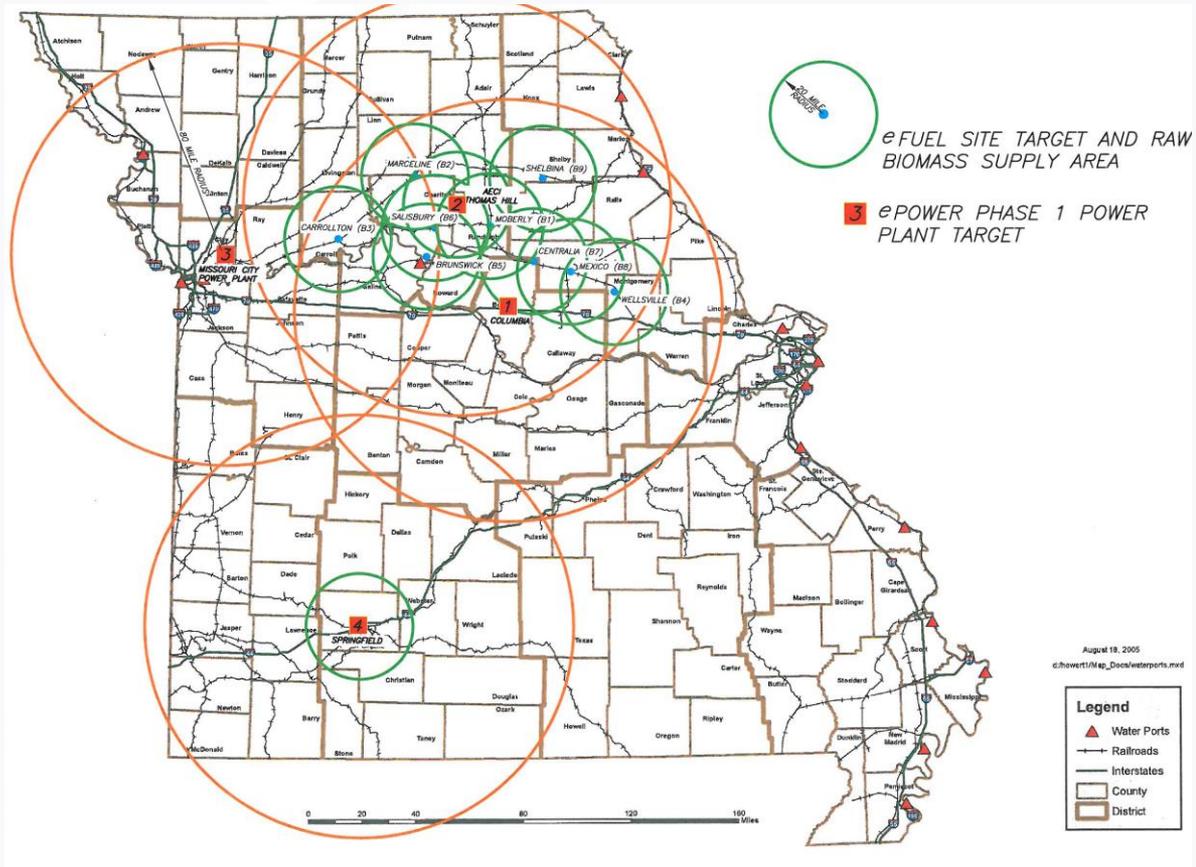
PDI ~ 98%

# Hub Supply Development Approach



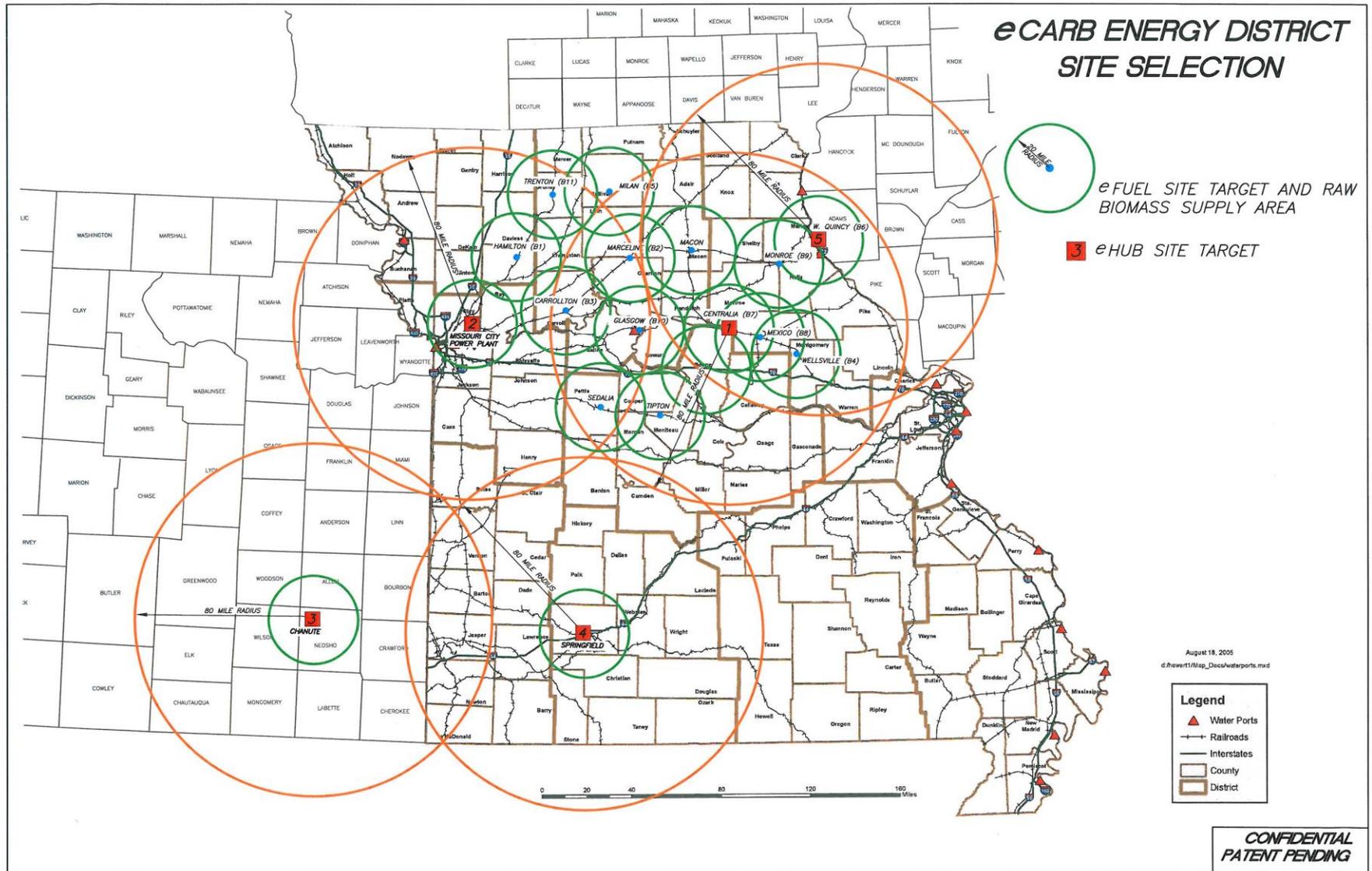
## Supply Area #1 – Missouri

- Multiple utilities
- Initial area has potential for 500,000 – 1,000,000 tons per year in multi-year contracts.
- Engenuity technology enables transport via truck, rail, barge, container or bulk



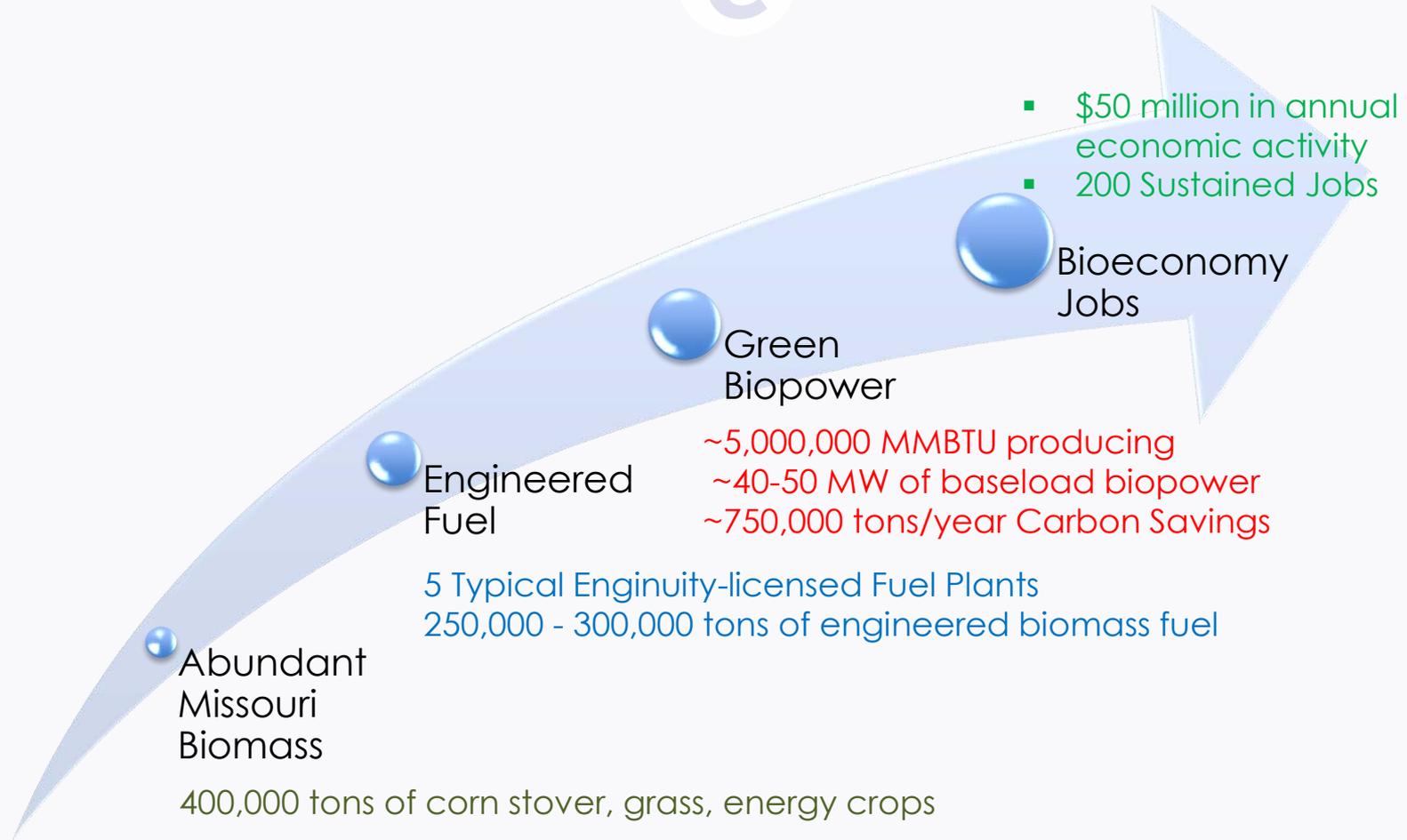
# engnity worldwide

## Initial Deployment



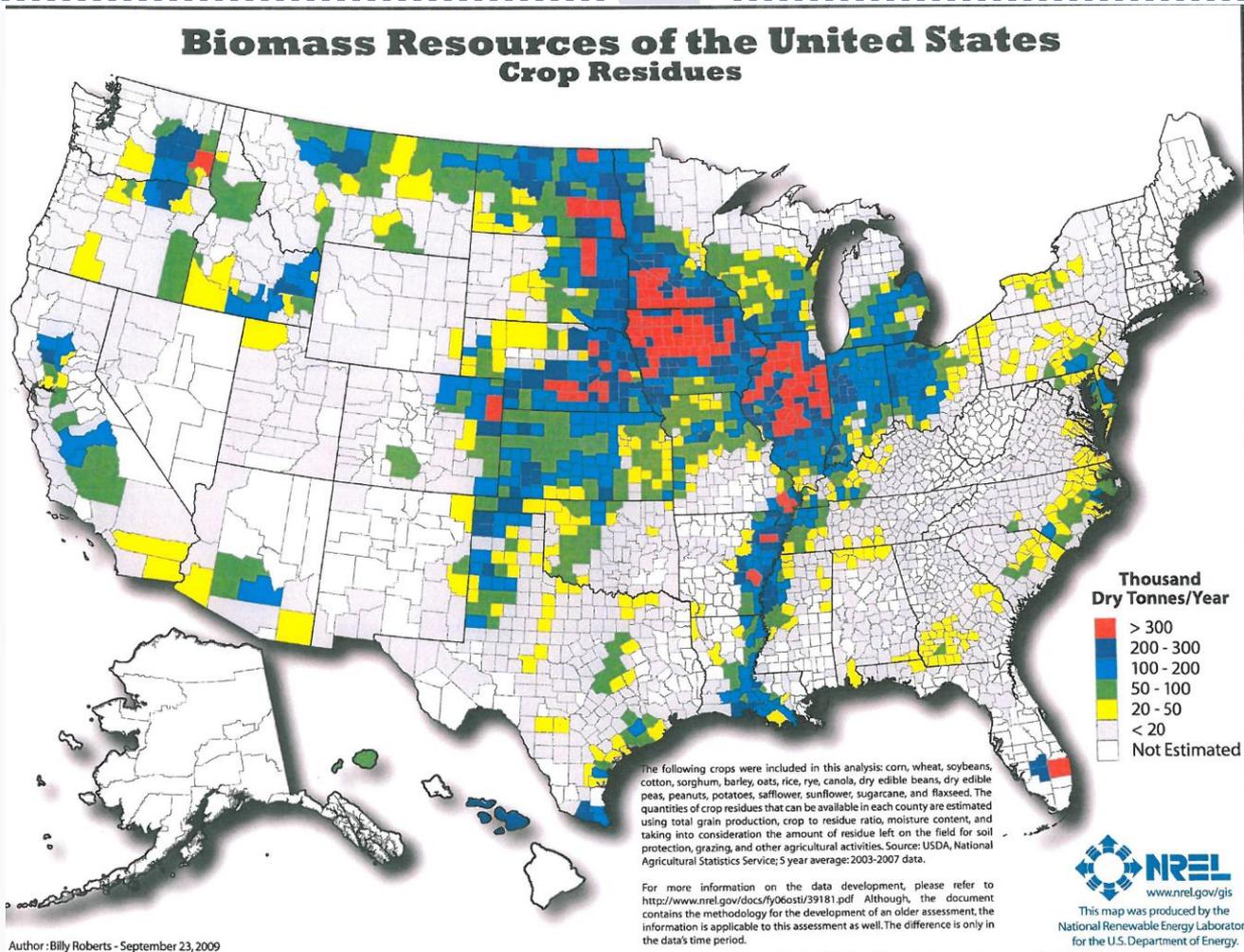
# Regional Impact of HomeGrown Fuel

## Example in Missouri

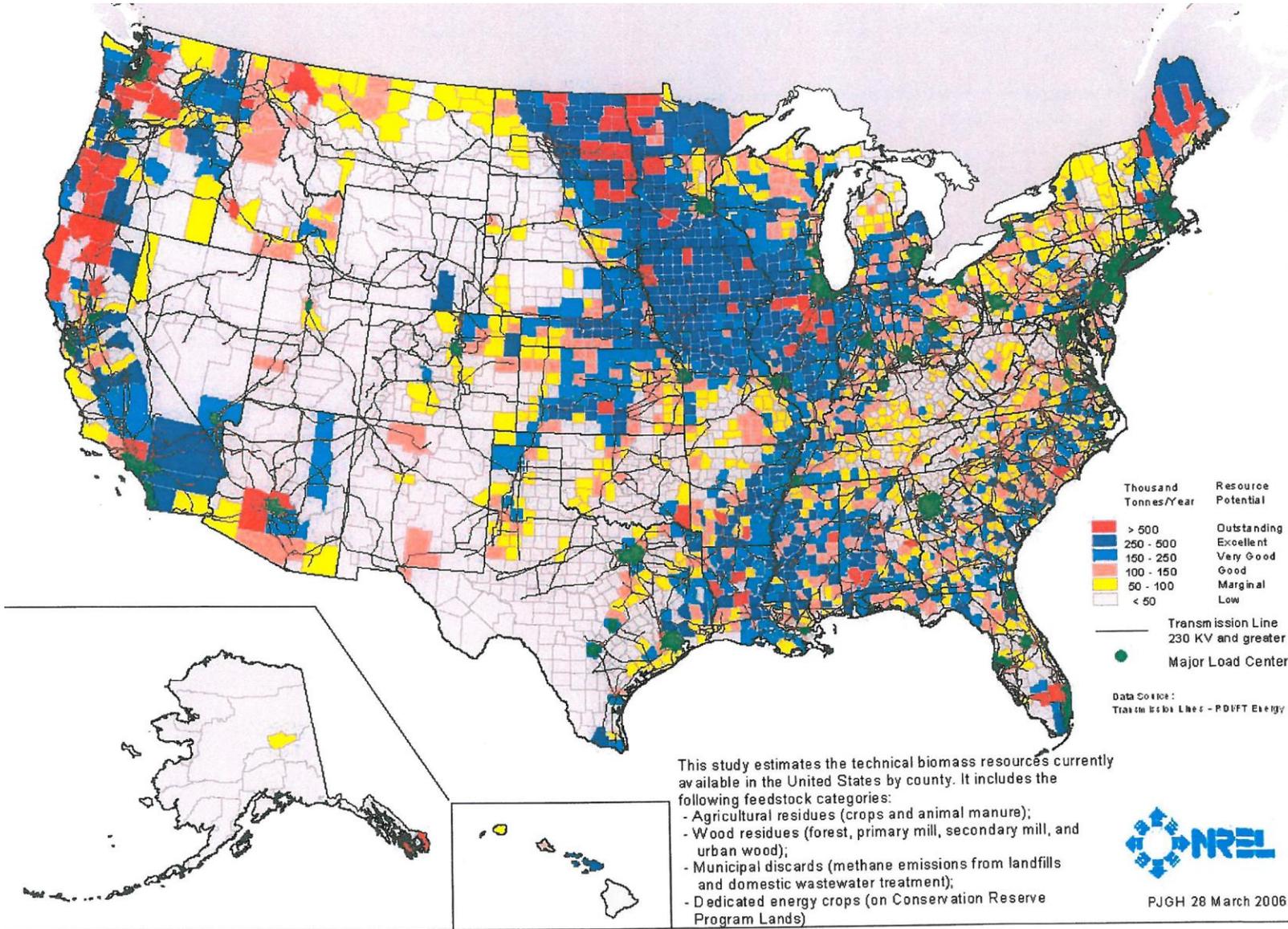


REFERENCE: University of Missouri Extension - Commercial Agriculture Program

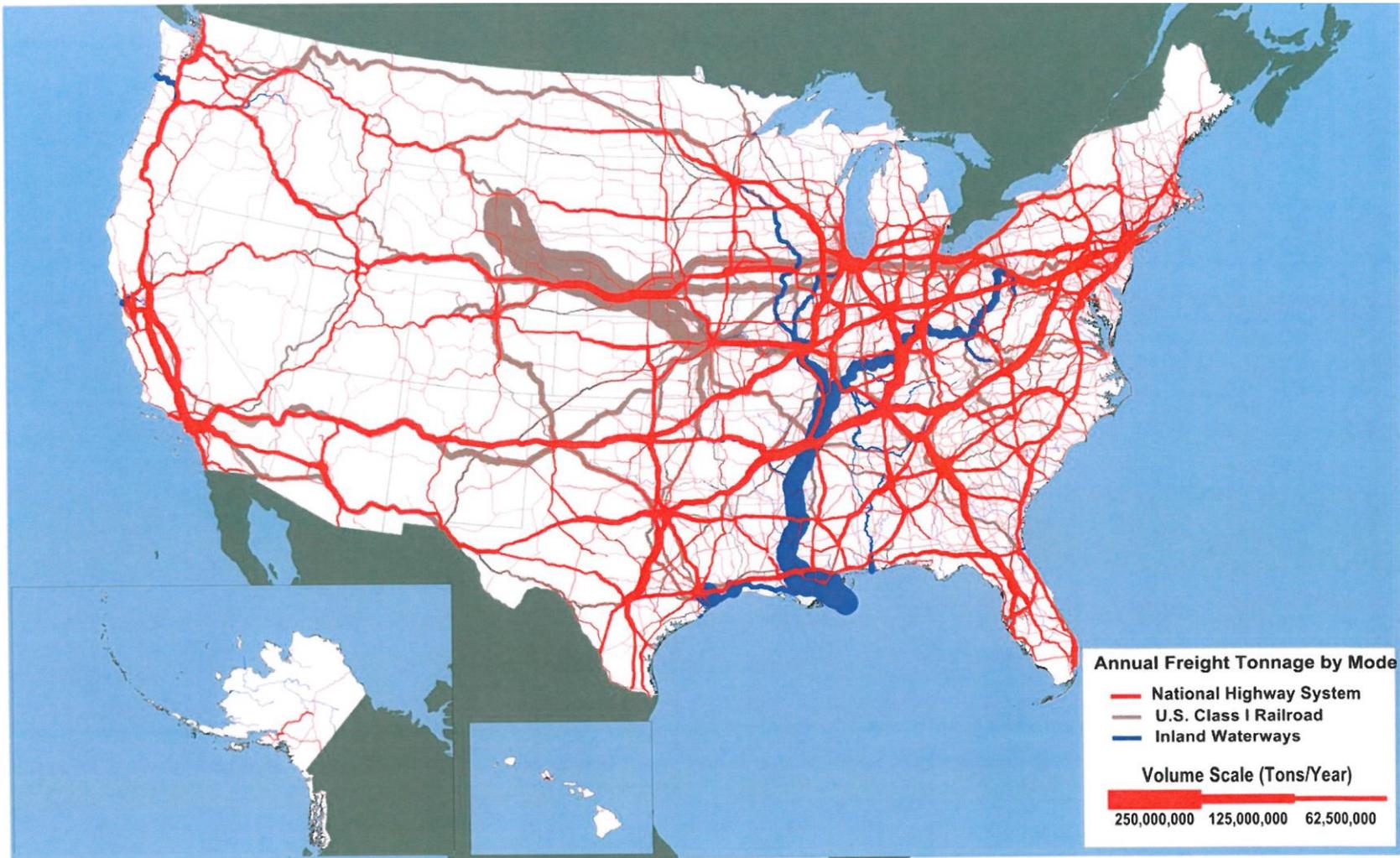
# Bioeconomy Corridor Approach



# Bioeconomy Corridor Approach



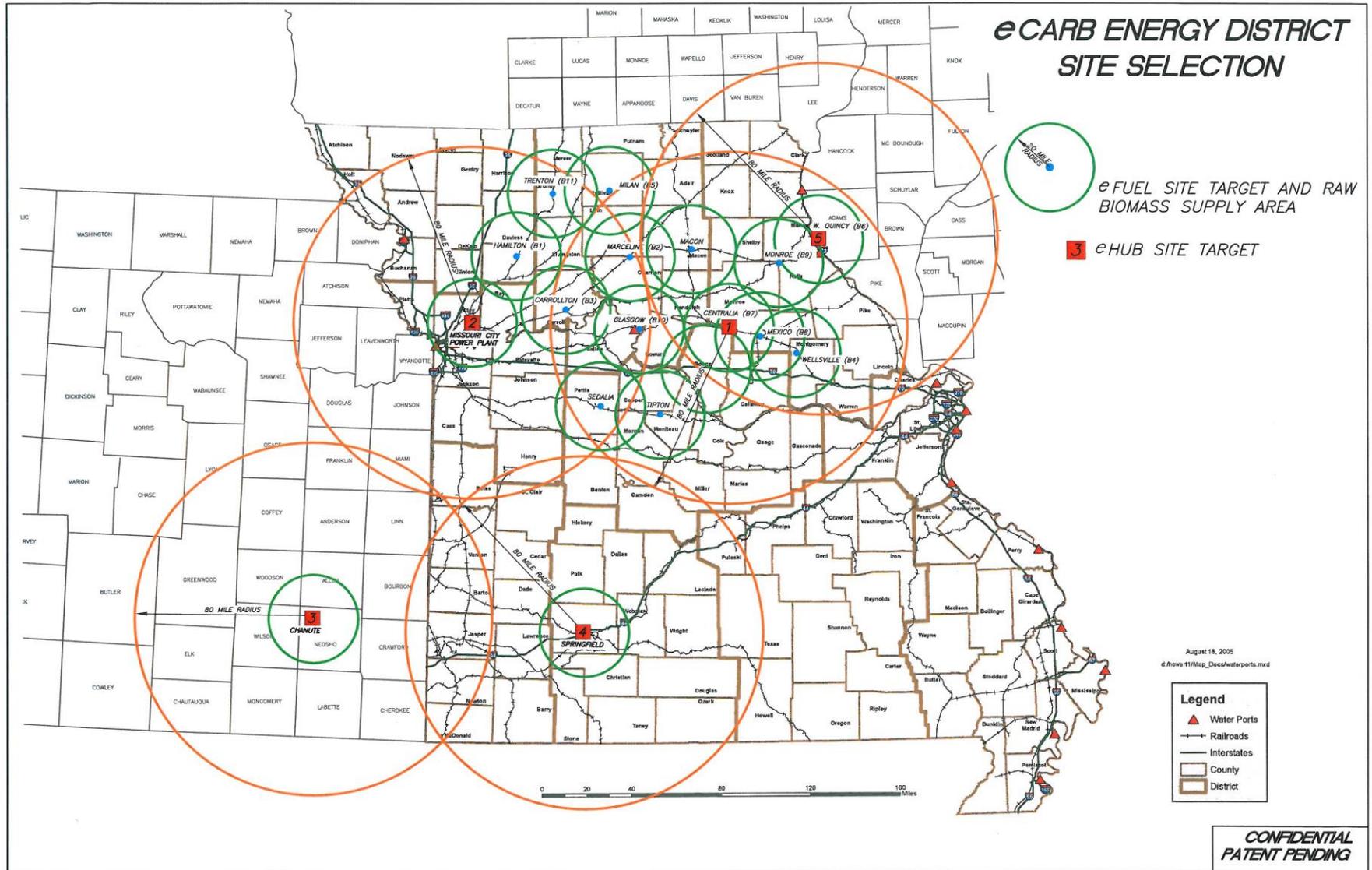
# Bioeconomy Corridor Approach



Sources: Highways: U.S. Department of Transportation, Federal Highway Administration, Freight Analysis Framework, Version 3.4, 2012. Rail: Based on Surface Transportation Board, Annual Carload Waybill Sample and rail freight flow assignments done by Oak Ridge National Laboratory. Inland Waterways: U.S. Army Corps of Engineers (USACE), Annual Vessel Operating Activity and Lock Performance Monitoring System data, as processed for USACE by the Tennessee Valley Authority; and USACE, Institute for Water Resources, Waterborne Foreign Trade Data, Water flow assignments done by Oak Ridge National Laboratory.

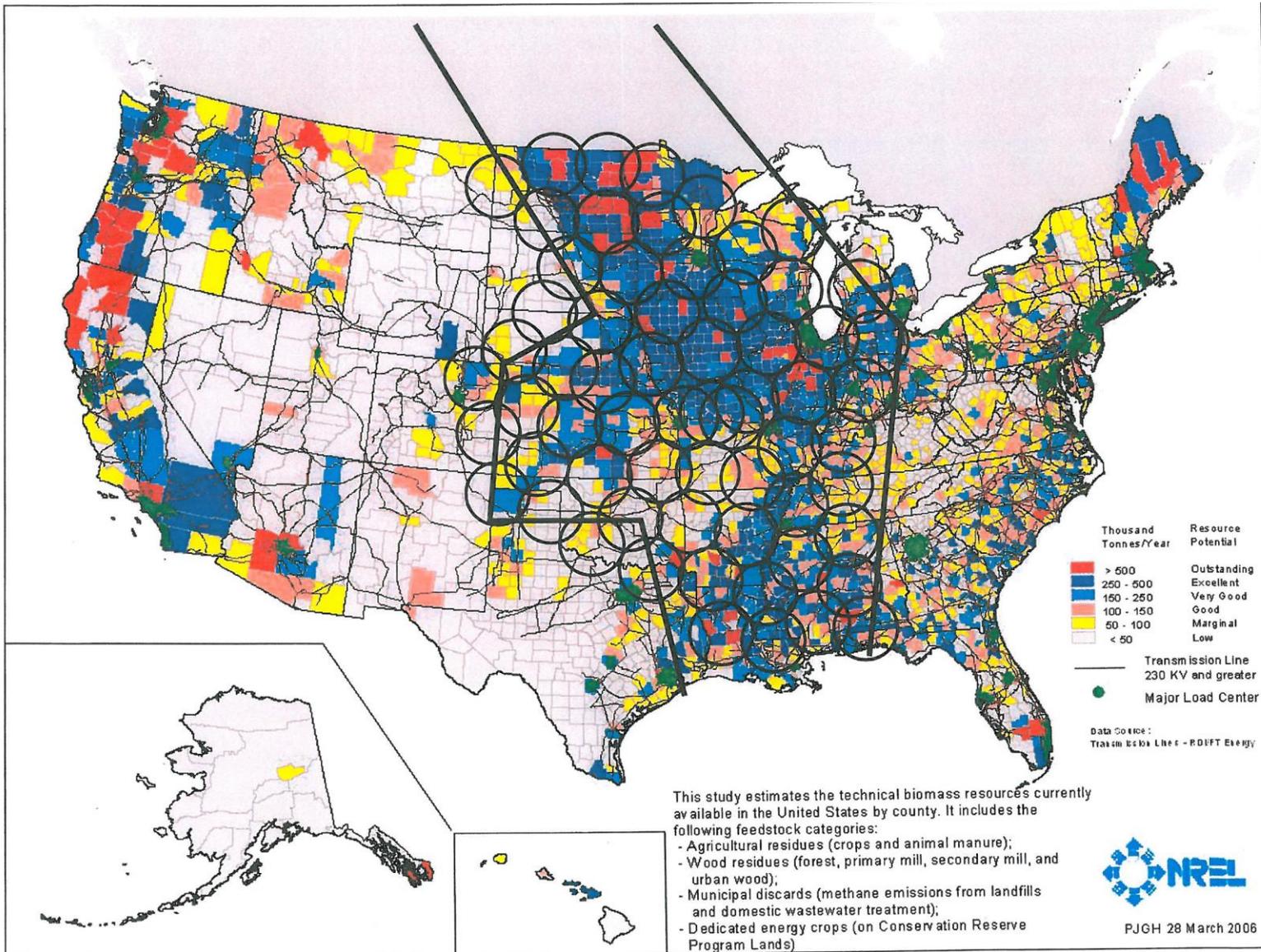
# engenuity worldwide

## Beach Head in Missouri



# engnuity worldwide

## Bioeconomy Corridor Vision



# Comments to the Committee



**Encourage Continued Vision to Include  
Solid Fuels, Biopower, GHG and LCA.**

**Your Work is More Important than Ever**

**Cost, Cost, & Cost**