



NARA EPP Co-Product Market Opportunity: Lignin-based Activated Carbon

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INTRODUCTION

Lignin typically represents 15% - to - 40% of a biorefinery's lignocellulosic feedstock, depending on tree species, and identifying value-added market opportunities is critical to a firm's bottom line (1,2,3). Lignin-based activated carbon is a viable opportunity for a value-added product. Activated carbon (AC) is a carbon-based material utilized in hundreds of different applications across many industries (4). Biorefineries can produce mass quantities of lignin-based activated carbon from the refining processes (5).



FIGURE 1 – SCHERER COAL-FIRED POWER PLANT. IDENTIFIED AS THE WORST POLLUTING POWER PLANT IN THE US IN REGARDS TO CARBON POLLUTION.
Image source: Wikimedia

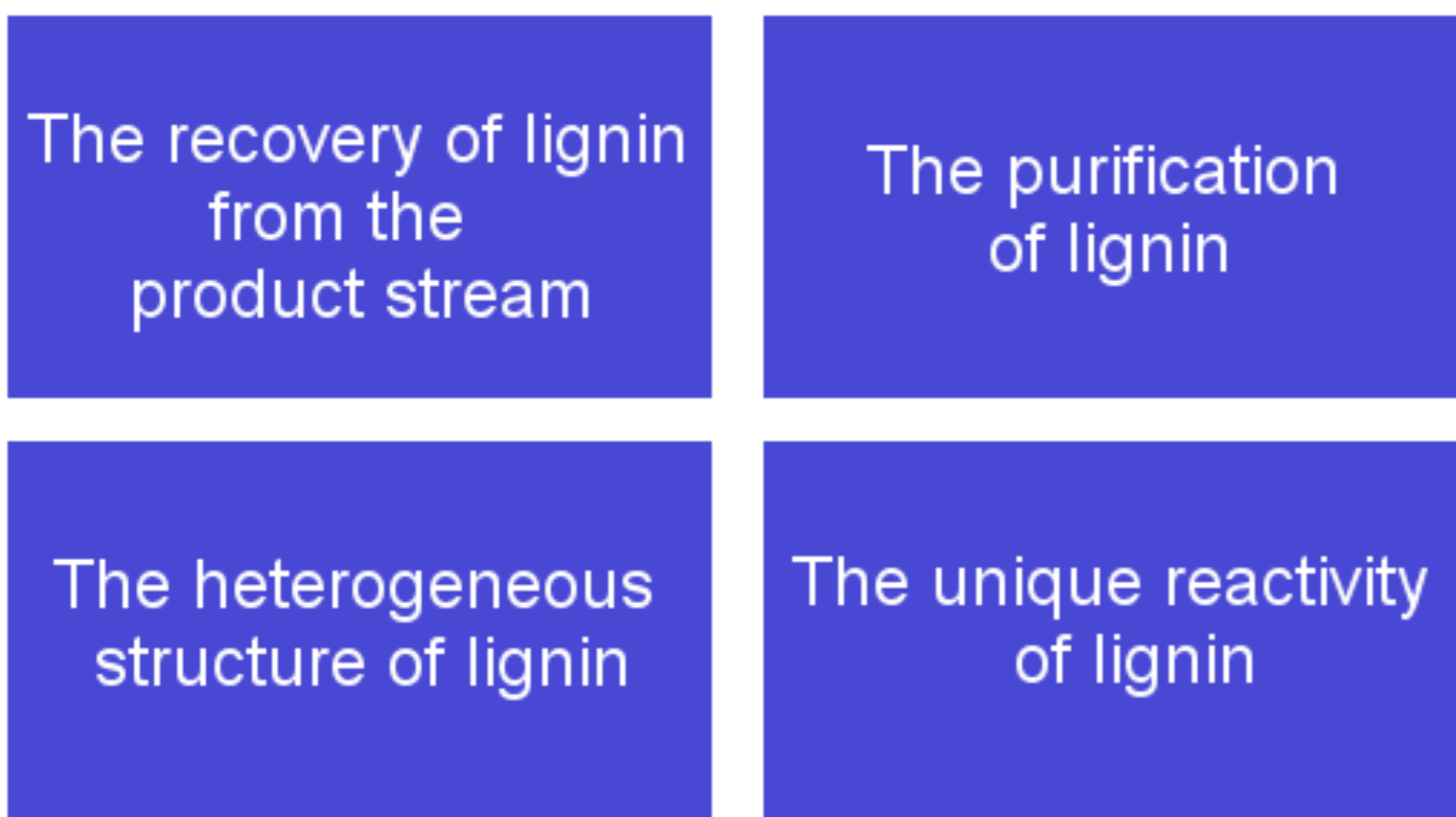
OBJECTIVE

The purpose of this research is to outline and develop a marketing research project to better understand the market opportunity for lignin-based activated carbon for the sequestration of mercury from coal-fired power plant flue gas through activated carbon injection systems.

LIGNIN

Lignin's structure and chemical composition make it an ideal feedstock for various high-value products. However, Vishtal and Kraslawski (6) outline restricting factors to developing high-value lignin products.

RESTRICTING FACTORS IN DEVELOPING HIGH-VALUE LIGNIN PRODUCTS



Lignin-based activated carbon offers a unique opportunity to use relatively low-purity lignin requiring less refining than is often required for entering other high-value lignin product markets.

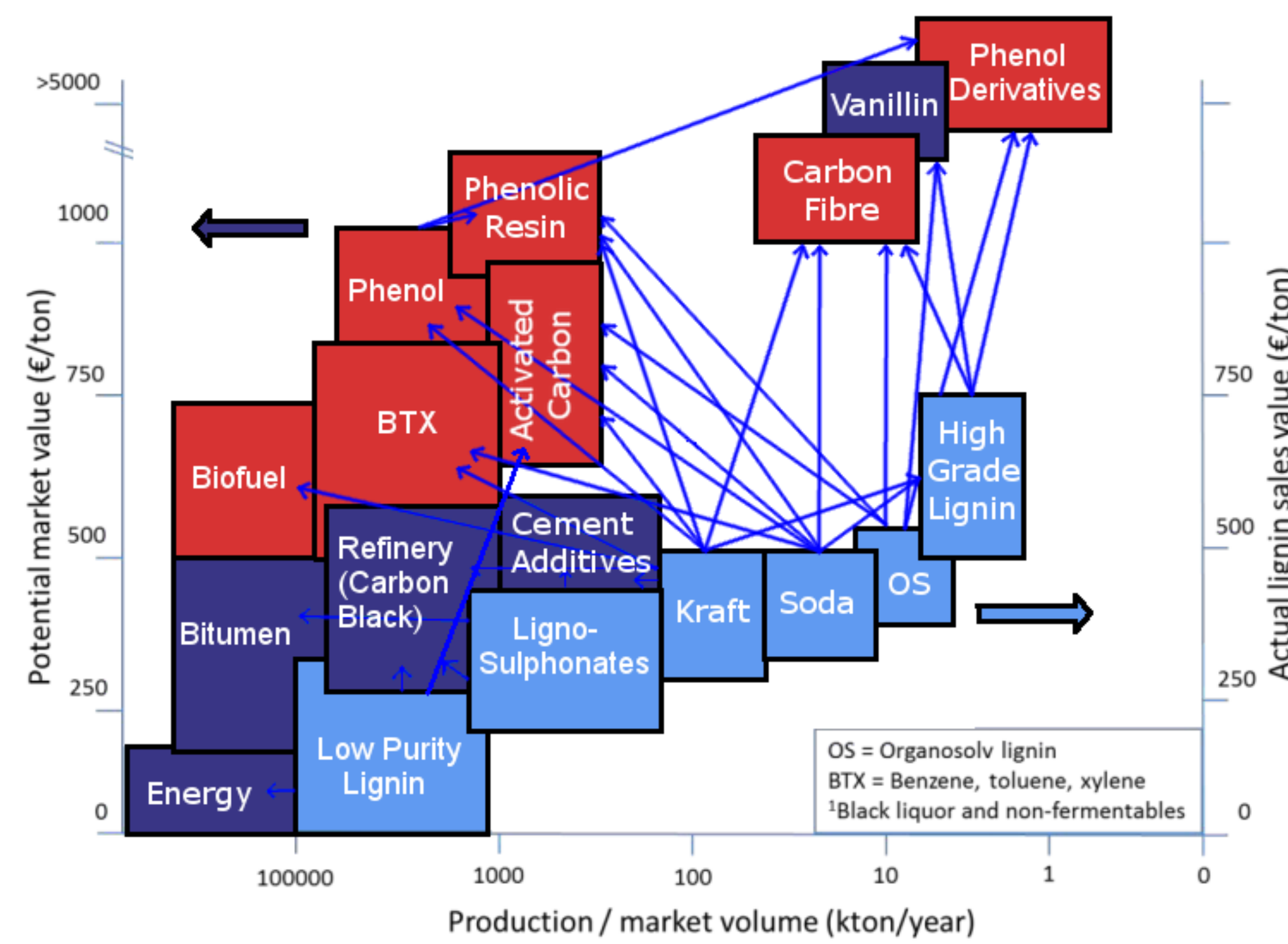


FIGURE 2 – LIGNIN-DERIVED PRODUCTS FROM LIGNIN MANUFACTURING TECHNOLOGIES BASED ON **ACTUAL AND POTENTIAL** MARKET VALUE. THE PURPLE BOXES DENOTE HIGH-VOLUME, LOW-VALUE PRODUCTS AND RED BOXES CONTAIN LOW-VOLUME, HIGH-VALUE **PENDING** PRODUCTS. LASTLY, THE LIGHT BLUE BOXES REPRESENT DIFFERENT TYPES OF LIGNIN (7,8,9,10,11).

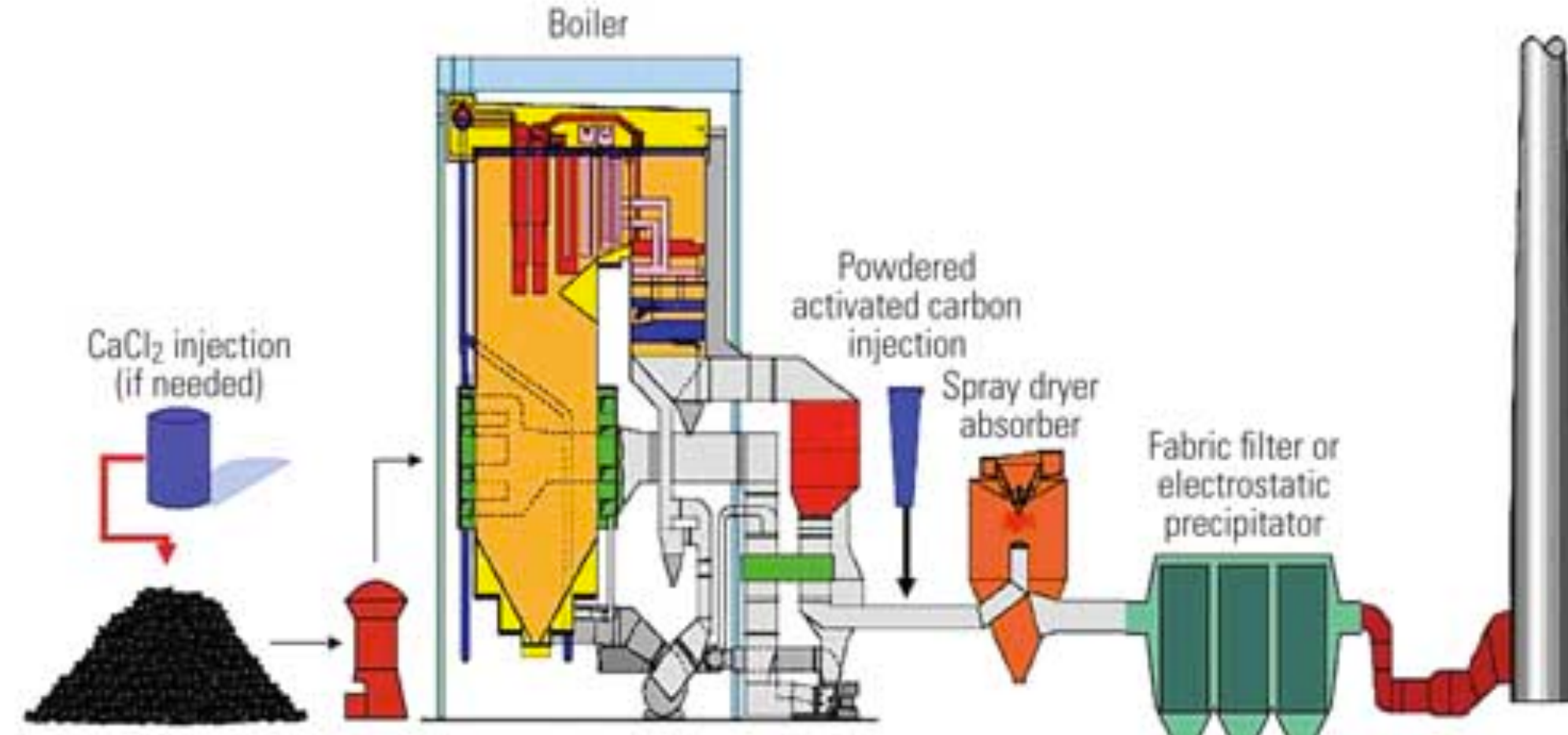


FIGURE 3 – COAL-FIRED POWER PLANT SCHEMATIC WITH ACTIVATED CARBON INJECTION AND OTHER AIR POLLUTION CONTROL DEVICES.
Image source: <http://www.powermag.com/technology-could-deliver-90-hg-reduction-from-coal/>

ACTIVATED CARBON MARKET

In 2009, the U.S. powdered activated carbon market for Air and Gas Purification was estimated at 72 thousand metric tons with projected volumes reaching 489 thousand metric tons by 2014 (13). In addition, Transparency Market Research (14) projected the powdered activated carbon market to grow at nearly 14% per year from 2013, which was valued at \$576 million to approximate \$1.3 billion in 2019 (15).

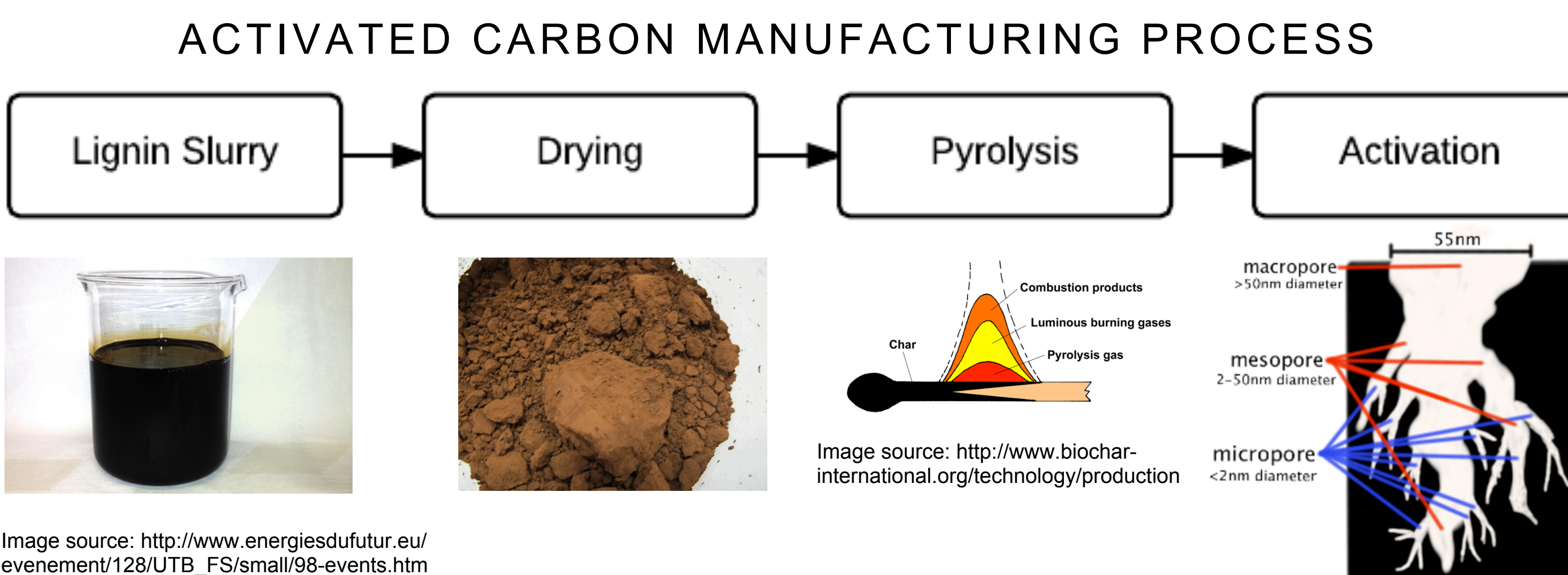


FIGURE 4 – MANUFACTURING PROCESS OF LINGIN-BASED ACTIVATED CARBON

MARKET DRIVERS

Mercury and Air Toxics Standards

- Legislation signed into effect on December 16, 2011.
- Limits coal-fired power plant emissions of several toxins
- Applies to coal-fired electric utility generating units greater than 25 MW and selling to the National Power Grid
- Power plants have until April 2015 to comply with MATS

Coal-Fired Power Plant Population

- 1,400 [electric utility generating] – approximately 1,100 existing coal-fired units and 300 oil-fired units at approximately 600 power plants (16)."
- Approximately two-thirds of U.S. electric coal-fired capacity has already complied with MATS to allow operation through 2016 (17).

2009 North American Consumption of Activated Carbon

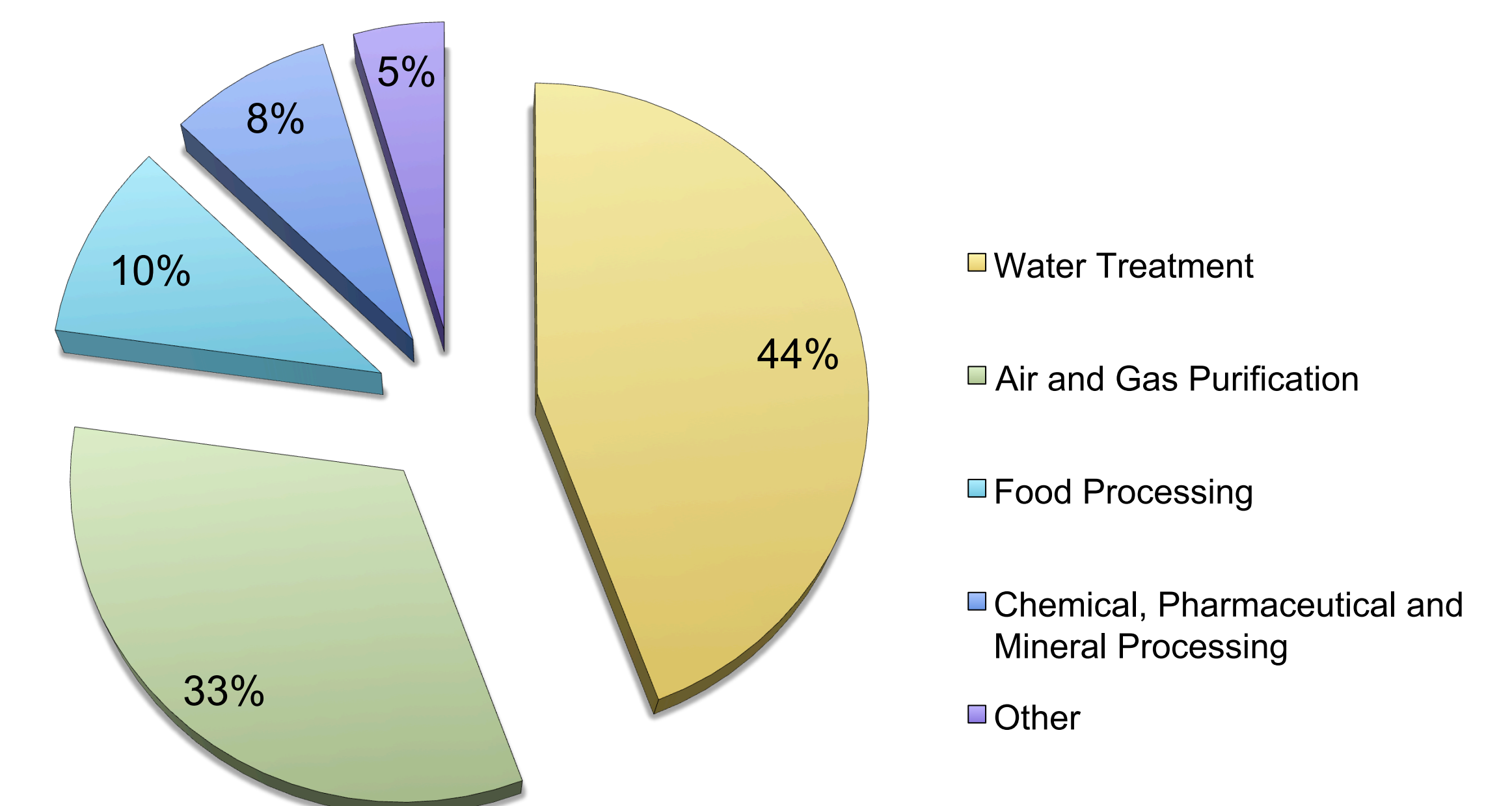


FIGURE 5 – 2009 ACTIVATED CARBON CONSUMPTION BY CATEGORY.
Source: Greiner et al. 2009

CHALLENGES

- Controversy
 - EPA
 - Coal and Power Industries
- Cost
- Job loss

CONCLUSIONS

This poster examines the market opportunity for the use of biorefinery lignin in the production of activated carbon to mitigate mercury emissions in compliance with the U.S. EPA MATS. Additional markets for low-purity lignin exist, ; however, this rapidly expanding AC opportunity offers a potential high-volume, sustainable, and viable market for biorefinery lignin.

FURTHER RESEARCH

- Continue the identification and characterization of potential candidate coal-fired electric generating power plants which may be considering ACI systems and, thus, potential demand centers for lignin-based. Parameterizing NARA biorefinery lignin outputs suitable for this market application to determine best "fit"
- Examining the value proposition of NARA biorefinery lignin-based AC as a substitute for AC in these ACI systems in terms of specification (features, advantages and benefits – including intangibles), quantities, and prices.