

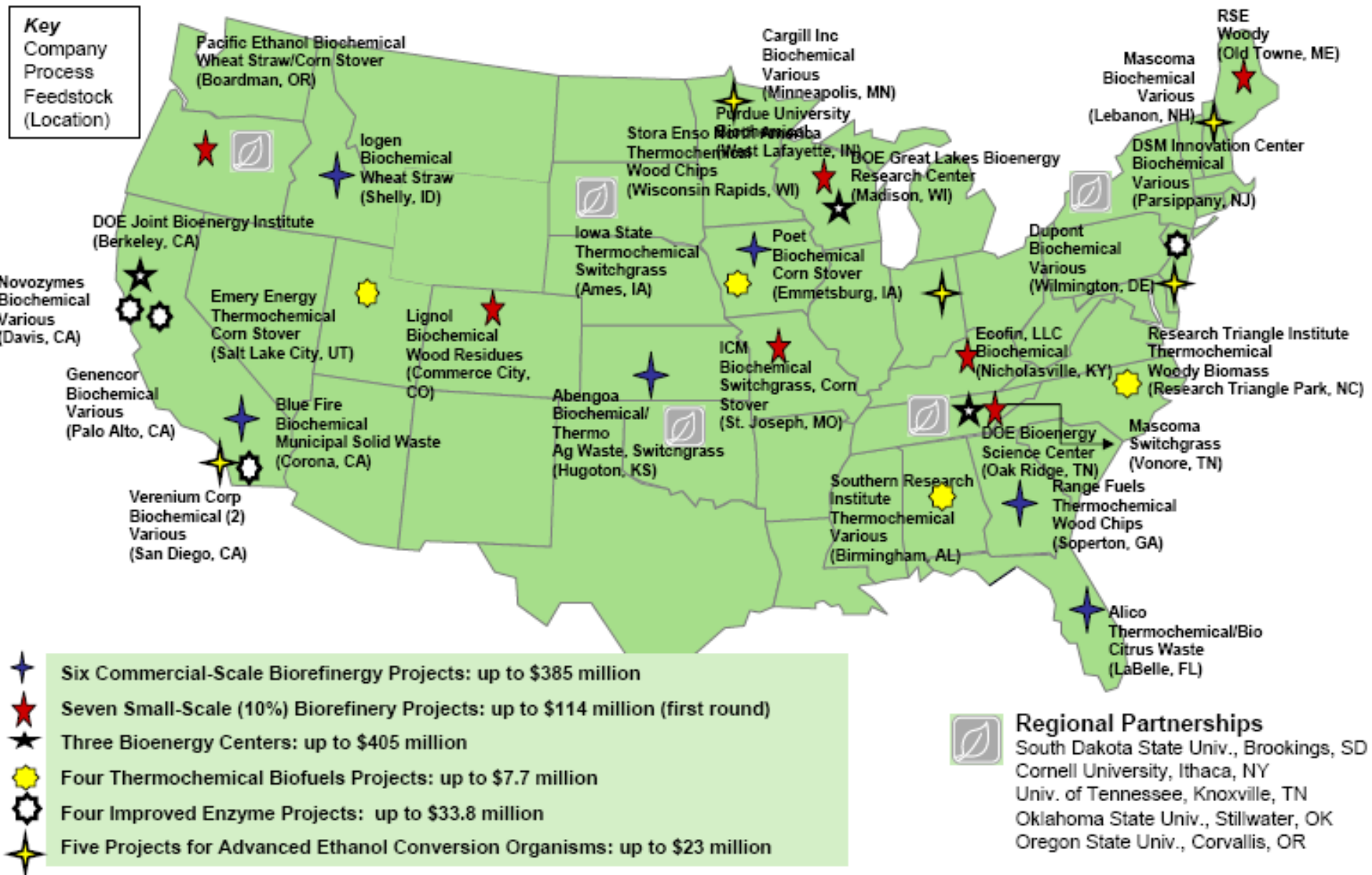
***U.S. Department of Energy
Oak Ridge National Laboratory
Growing a Robust Biofuels Economy***

***Mark Downing, Senior Scientist
and Agricultural Economist***

November 14, 2007

Major DOE Biofuels Project Locations

Geographic, Feedstock, and Technology Diversity



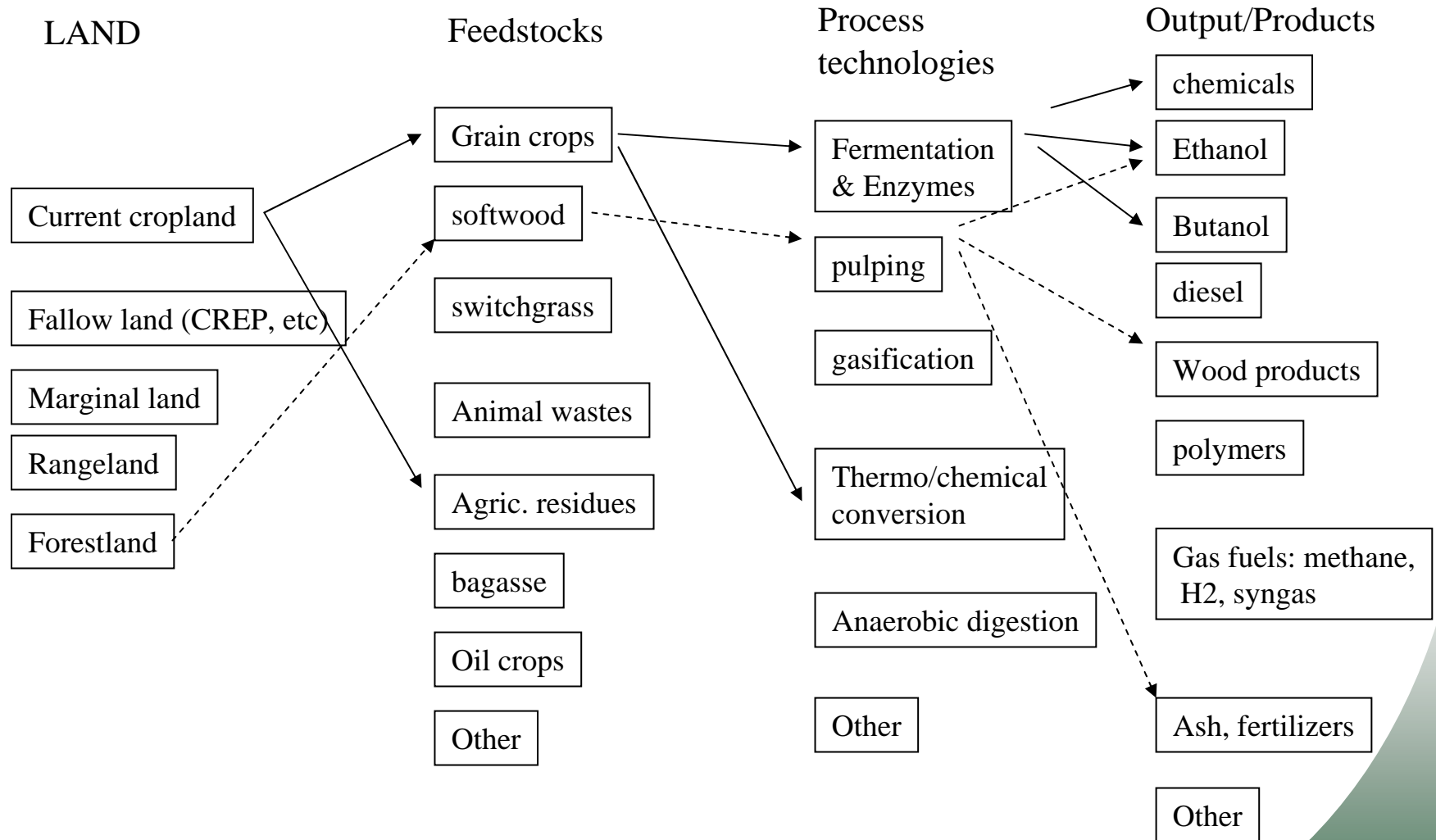
Five points to remember

- What matters is:
 - ✓ **Land use change patterns and effects**
 - ✓ **Oil displaced**
 - ✓ **Greenhouse gas emissions specie, magnitude, and direction**
- There are almost too many options to choose from
 - ✓ **Land-use, feedstocks, conversion, co-products**
- DOE and others are investing heavily in
 - ✓ **Biorefinery development**
 - ✓ **Feedstock assessment**
 - ✓ **Environmental assessment**
- Risks associated integrated biorefinery is great
 - ✓ **CAPEX \$ can range from \$4 to \$9/gal ethanol (installed)**
- Infrastructure matters
 - ✓ **Where's the biomass, and where's the biorefinery?**

Barriers to Commercialization

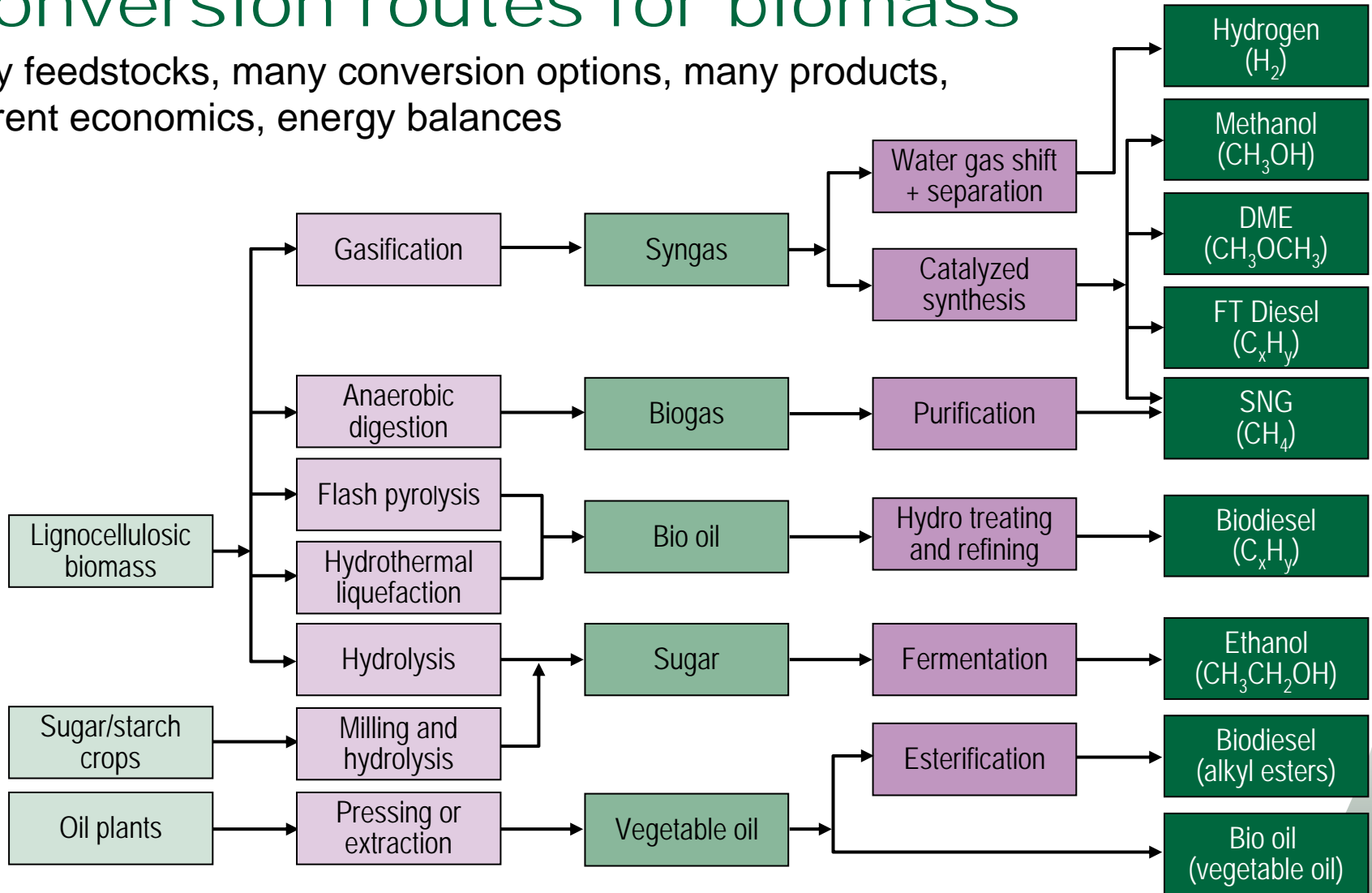
- R&D Success requires:
 - ✓ Reduce costs associated with biochemical conversion of feedstocks, specifically enzyme and fermentation costs
 - ✓ Reduce the cost associated with thermochemical conversion of feedstocks, specifically gasification, gas cleanup, and fuel synthesis
 - ✓ 2012 goal already accelerated from original 2020 goal
- Land-use assessment to meet long term requirements
 - ✓ Environmental, soil carbon, sustainability
- Immature feedstock supply systems
 - ✓ Costs range from \$5/ton for waste wood to upwards of \$50-65/ton for ag residues (depends on need to provide value to supplier)
- Risks associated with first-of-a-kind plants and high capital investment for integrated biorefineries
 - ✓ CAPEX \$ can range from \$4 to \$9/gal ethanol (installed)
- Lack of fuel distribution and vehicle infrastructures
 - ✓ Estimated 20 to 40 billion dollar capital investment required

Biomass Utilization is a multi-factorial problem (multiple choice)



Conversion routes for biomass

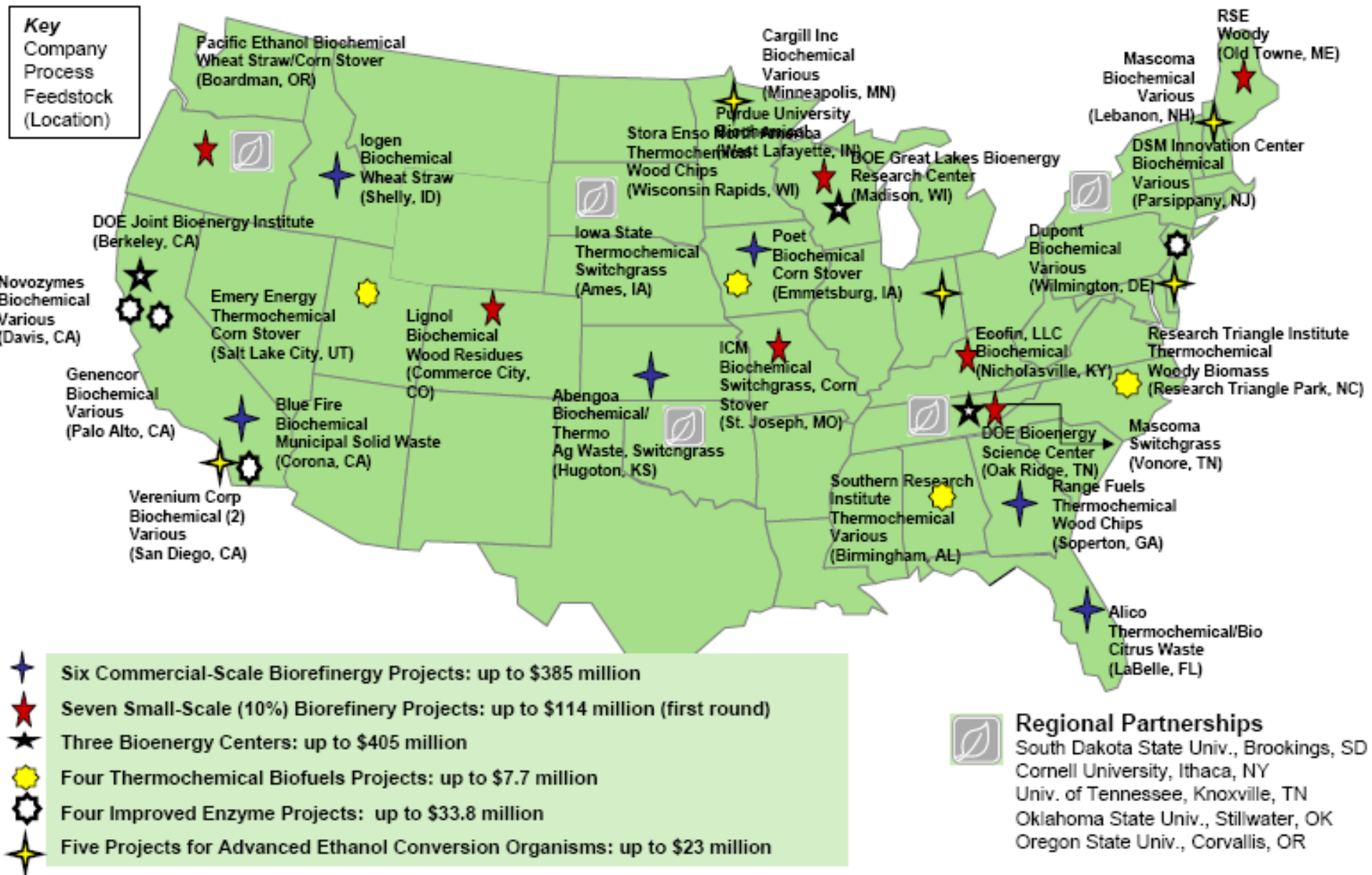
Many feedstocks, many conversion options, many products, different economics, energy balances



Source: Carlo N. Hamelinck, "Outlook for Advanced Biofuels," PhD Thesis, Utrecht University, The Netherlands, 2004

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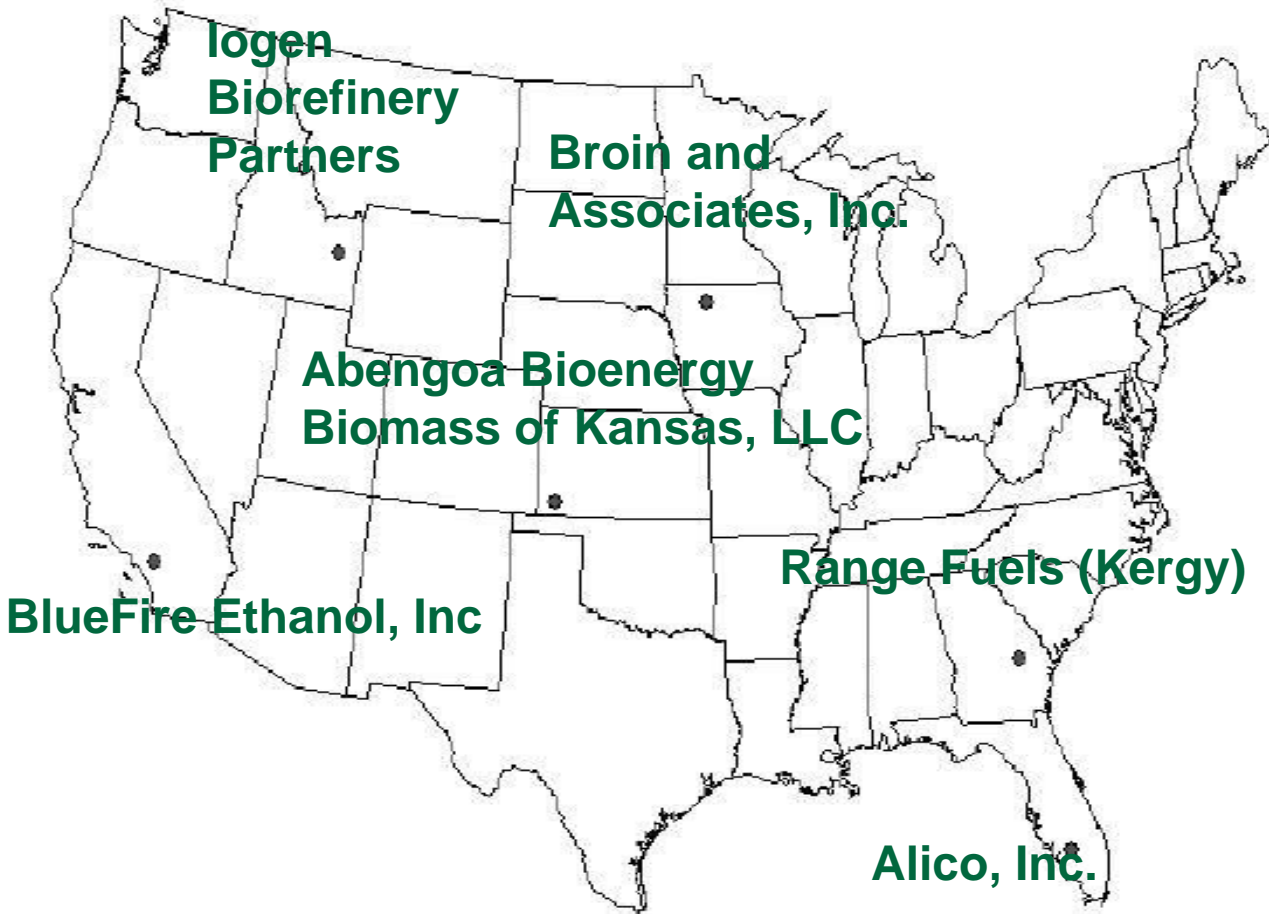
Recent Competitive Solicitations to Engage Diverse R,D,&D Partners

- **Commercial Scale Biorefineries – EPL Act 932**
- **10% Scale Biorefinery Demonstration**
- Bioenergy Science Centers
- Ethanologen Solicitation
- Thermochemical Conversion
- Enzyme Solicitation
- Joint USDA/DOE Biomass R&D Initiatives
- **NEPA and what really matters**

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Integrated Biorefinery Commercial Operations - planned



Abengoa Bioenergy Biomass of Kansas LLC
Southwestern Kansas

Alico, Inc.
LaBelle, FL

BlueFire Ethanol, Inc.
Corona, CA

Broin and Associates, Inc. (POET Energy)
Emmetsburg, IA

Iogen Biorefinery Partners, LLC
Idaho Falls, ID

Range Fuels, Inc.
Soperton, GA

- Abengoa Bioenergy Biomass of Kansas, LLC of Chesterfield, Missouri, up to \$76 million
 - **The proposed plant will be located in Hugoton, Kansas. The plant will produce 11.4 million gallons of ethanol annually and enough energy to power the facility, with any excess energy being used to power the adjacent corn dry grind mill. The plant will use 700 tons per day of corn stover, wheat straw, milo stubble, switchgrass, and other feedstocks.**
 - **Awarded a Phase 1 for project engineering and design on 9/30/07**
 - **DOE Value: \$15 million**
 - **Recipient Share: \$37.5 million**

- ALICO, Inc. of LaBelle, Florida, up to \$33 million
 - **The proposed plant will be in LaBelle (Hendry County), Florida. The plant will produce 13.9 million gallons of ethanol a year and 6,255 kilowatts of electric power, as well as 8.8 tons of hydrogen and 50 tons of ammonia per day. For feedstock, the plant will use 770 tons per day of yard, wood, and vegetative wastes and eventually energy cane.**
 - **Award under negotiation**

- BlueFire Ethanol, Inc. of Irvine, California, up to \$40 million
 - **The proposed plant will be in Southern California. The plant will be sited on an existing landfill and produce about 19 million gallons of ethanol a year. As feedstock, the plant would use 700 tons per day of sorted green waste and wood waste from landfills.**
 - **Awarded a Phase 1 for project engineering and design on 9/30/07**
 - **DOE Value: \$3.7 million**
 - **Recipient Share: \$9.2 million**

- POET (Broin) of Sioux Falls, South Dakota, up to \$80 million
 - **The plant is in Emmetsburg (Palo Alto County), Iowa, and after expansion, it will produce 125 million gallons of ethanol per year, of which roughly 25 percent will be cellulosic ethanol. For feedstock in the production of cellulosic ethanol, the plant expects to use 842 tons per day of corn fiber, cobs, and stalks.**
 - **Awarded a Phase 1 for project engineering and design on 9/30/07**
 - **DOE Value: \$3.8 million**
 - **Recipient Share: \$9.6 million**

- Iogen Biorefinery Partners, LLC, of Arlington, Virginia, up to \$80 million
 - **The proposed plant will be built in Shelley, Idaho, near Idaho Falls, and will produce 18 million gallons of ethanol annually. The plant will use 700 tons per day of agricultural residues including wheat straw, barley straw, corn stover, switchgrass, and rice straw as feedstocks.**
 - **Award under negotiation**

- Range Fuels (formerly Kergy Inc.) of Broomfield, Colorado, up to \$76 million
 - **The proposed plant will be constructed in Soperton (Treutlen County), Georgia. The plant will produce up to 100 million gallons of ethanol per year and 9 million gallons per year of methanol. As feedstock, the plant will use 2,500 tons per day of wood residues and wood based energy crops.**
 - **Awarded a Technology Investment Agreement on 11/6/07**
 - **DOE Value: \$50 million (initial with up to \$26 million to follow)**
 - **Recipient Share: \$280 million**

Company	Site	Feed	Process to ethanol
Abengoa	KS	Corn stover, ag residue	Dilute acid/enzyme/fermentation for easy sugars; then gasify the residuals to syngas and power shared with dry mill
Iogen with Shell	ID	Ag residue: wheat straw	Dilute acid/enzyme/fermentation
Range Fuels (Kergy), Merrick, CH2MHill, Khosla	GA	Wood residues	Thermochemical (gasify or pyrolysis) then catalysis to liquids (ethanol and methanol)
POET Energy (Broin) with DuPont, Novozymes, NREL	IA	Corn fiber, cobs, stalks	Dilute acid, fermentation Shared with dry mill
Alico, BRI, etc.	FL	Yard waste, citrus waste, energy cane	Gasify followed by fermentation
BlueFire with Waste Mgmt, Petrodiamond	So. CA	Yard waste, wood and green waste,	Conc. acid to sugars, then fermentation

Recent Competitive Solicitations to Engage Diverse R,D,&D Partners

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- **10% Scale Biorefinery Demonstration**
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- Joint USDA/DOE Biomass R&D Initiative
- NEPA – what really matters

ICM Incorporated of Colwich, Kansas; DOE will provide up to \$30 million

- **The proposed plant will be located in St. Joseph, Missouri, and will utilize diverse and relevant feedstocks including agricultural residues, such as corn fiber, corn stover, switchgrass and sorghum. ICM, Inc. will integrate biochemical and thermochemical processing and demonstrate energy recycling within the same facility. This project stands to broaden the company's focus from corn-based to energy crop-based ethanol production. ICM, Inc is a privately held company with the mission of sustaining agriculture through innovation, primarily through the engineering and construction of ethanol biorefinerie.**
- **ICM, Inc. is proud to recognize collaborators in this effort, including Ceres, Inc.; Edenspace; South Dakota State University; AGCO Corporation.; DOE-National Renewable Energy Laboratory (NREL); National Center for Agricultural Utilization Research (NCAUR); Novozymes , VeraSun Energy Corporation; and SunEthanol, Inc.**

Lignol Innovations Inc., of Berwyn, Pennsylvania; DOE will provide up to \$30 million

- **The proposed plant, co-located with a petroleum refinery, will be located in Commerce City, Colorado, and using biochem-organism, will convert hard and soft wood residues into ethanol and commercial products, co-located with a petroleum refinery. Lignol Innovations is a U.S.-based company with a publicly traded Canadian parent based in Vancouver, British Columbia. Lignol has acquired and since modified a solvent-based pre-treatment technology that was originally developed by a subsidiary of General Electric.**
- **Lignol Innovations participants/investors include: Suncor Energy; and Parker Messana & Associates.**

Pacific Ethanol Inc., of Sacramento, California; DOE will provide up to \$24.3 million

- **The proposed plant will be located in Boardman, Oregon, and will convert agricultural and forest product residues to ethanol using BioGasol's proprietary conversion process. Pacific Ethanol is a leading producer of low-carbon renewable fuels in the Western United States. The company is headquartered in Sacramento, California, and planning to add cellulosic conversion capability to their corn-based ethanol facility in Oregon.**
- **Pacific Ethanol's investors/participants include: Biogasol LLC; and DOE's Joint Bioenergy Institute (DOE's Lawrence Berkeley National Laboratory and Sandia National Laboratories).**

Stora Enso, North America, of Wisconsin Rapids, Wisconsin; DOE will provide up to \$30 million

- **The proposed plant will be located in Wisconsin Rapids, Wisconsin, and proposes to take wood wastes and convert it to Fischer-Tropsch diesel fuel. NewPage Corporation of Miamisburg, Ohio, recently acquired Stora Enso North America, the original applicant for this funding opportunity announcement.**
- **NewPage Corporation is the largest printing paper manufacturer in North America, based on production capacity with more than \$4.3 billion in pro-forma net sales for the last twelve months ended September 30, 2007. The company's product portfolio includes coated freesheet, coated groundwood, supercalendered and specialty papers.**
- **Stora Enso's partners include: TRI; Syntroleum; U.S. Department of Energy's Oak Ridge National Laboratory; and the Alabama Center for Paper and Bioresource Engineering at Auburn University.**

RSE Pulp & Chemical of Old Town, Maine. (DOE share: up to \$30 million.)

- **The proposed biorefinery facility will be installed in an existing pulp mill in Old Town, Maine, and will produce cellulosic ethanol from lignocellulosic (wood) extract. The project uses a proprietary process for pre-extracting hemicelluloses during the pulping process. This process has been proven on a laboratory and pilot scale, and RSE will now prove the viability of the process at the demonstration plant level. RSE Pulp & Chemical is part of the RSE renewable energy and technology-based business consortium that consists of 22 companies in the U.S. and Canada. RSE Pulp & Chemical participants/investors include: University of Maine Orono, Maine; and American Process Inc Atlanta, Georgia.**

Mascoma Corporation of Boston, Massachusetts Proposed Plant in Vonore, Tennessee. (DOE share: up to \$26 million.)

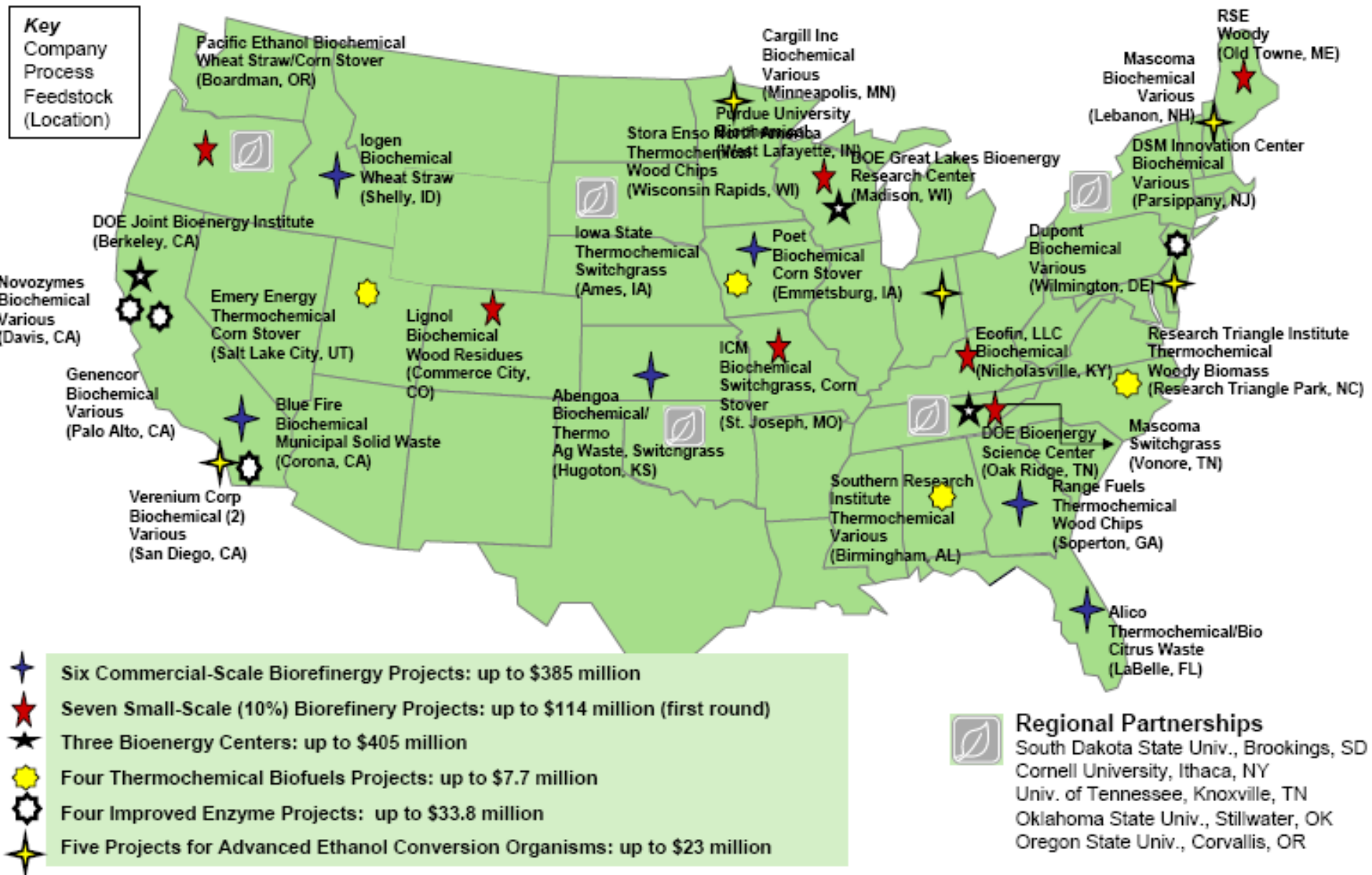
- **The proposed plant will be located in Monroe County, Tennessee, in the Niles Ferry Industrial Park. The facility is scheduled to come online in 2009 and will utilize Tennessee grown switchgrass as a primary feedstock. The plant will be the first cellulosic ethanol facility at this scale in Tennessee and will be used to demonstrate technologies and concepts that will make cellulosic ethanol an economically viable industry in the future. Mascoma was founded in early 2006 with the goal of commercializing cellulosic ethanol. Mascoma is partnering with The University of Tennessee (UT) Knoxville, TN, the UT Research Foundation and Genera Energy LLC, which was created to implement Tennessee Gov. Bredesen's Biofuels Initiative announced in 2007.**

Ecofin, LLC, of Nicholasville, Kentucky. (DOE share: up to \$30 million)

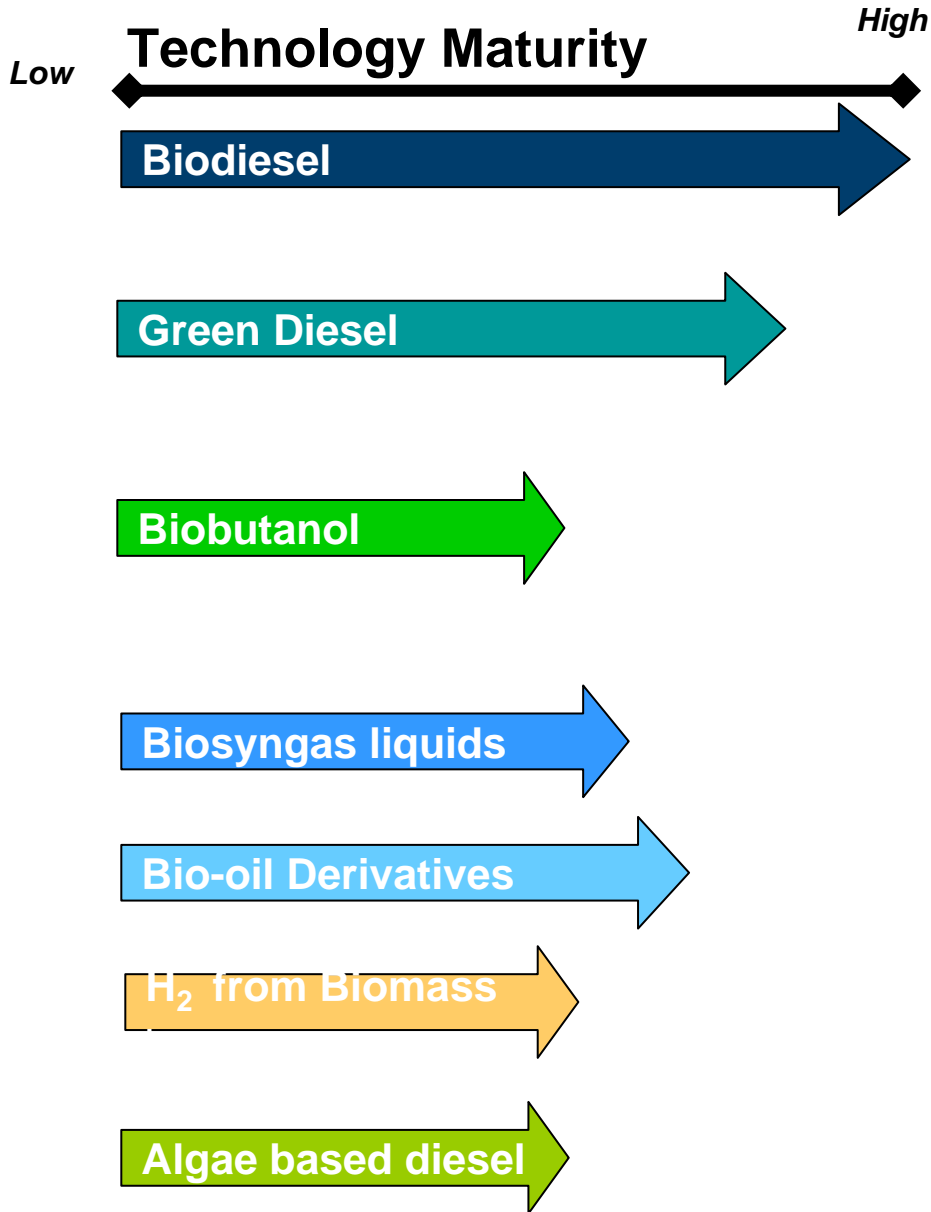
- **The proposed plant will be located in Washington County, Kentucky. The biorefinery will use novel, solid-state enzymatic complexes to convert a potentially wide range of lignocellulosic feedstocks, including corncobs, to ethanol and other nutritious feed sources, minimizing waste. Ecofin, LLC is a subsidiary to Alltech Inc.**

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Other Biofuels



Issues	Prospects
Supply of oils	Small impact on market
Supply of bio-oils	Could out compete biodiesel handily
Immature technology	Better blending than ethanol in gasoline
Costs, catalysts	Omnivorous for feedstocks
Cleanliness for applications	Good feed to green diesel
Costs	Best as co-product?
Costs, technology	Good in certain regions

NEPA Determination: Process Overview

Award II EF-1 and Associated Documentation

Update from Industries

NEPA Process Overview

NEPA Determination

NEPA Decision: FONSI, EIS or ROD

First Steps:

Proposed Action
Baseline Environmental Conditions

Alico provides Proposed Action and Baseline information to DOE. On behalf of DOE, ORNL reviews this information and makes a recommendation to DOE on the required level of NEPA review.

NEPA Analysis and Review Process:

EA or EIS **

*** DOE provides oversight to a third party NEPA Consultant who completes the documentation and analysis with input from the Applicant.*

DOE Golden Field Office NCO makes the NEPA Determination

DOE makes the final NEPA decision

Award II EF-1 Environmental Checklist

The Award II EF-1 will be submitted to the online NEPA Database. The EF-1 for Award II should include the following information:

Proposed Action Elements

- **Construction**
- **Operations**
- **Material Balance (including input, output, and waste)**
- **Logistics (transportation of input and output, including waste and required utilities, etc.)**
- **Visual Representation**
- **Major Plant Components**
- **Process Description**

Baseline Data

- **Location**
- **Aerial Photos**
- **General Physical Characteristics**
- **Air Quality and Meteorology**
- **Geology and Soils**
- **Biological Resources**
- **Water Resources**
- **Waste Management**
- **Infrastructure**
- **Cultural Resources**
- **Land Use**
- **Noise**
- **Aesthetics**
- **Socioeconomic**
- **Traffic**
- **Odor**

Thank you – and for more information:

Mark Downing downingme@ornl.gov

[http://www1.eere.energy.gov/biomass/
program_areas.html](http://www1.eere.energy.gov/biomass/program_areas.html)

<http://bioenergy.ornl.gov>

www.sungrant.org