

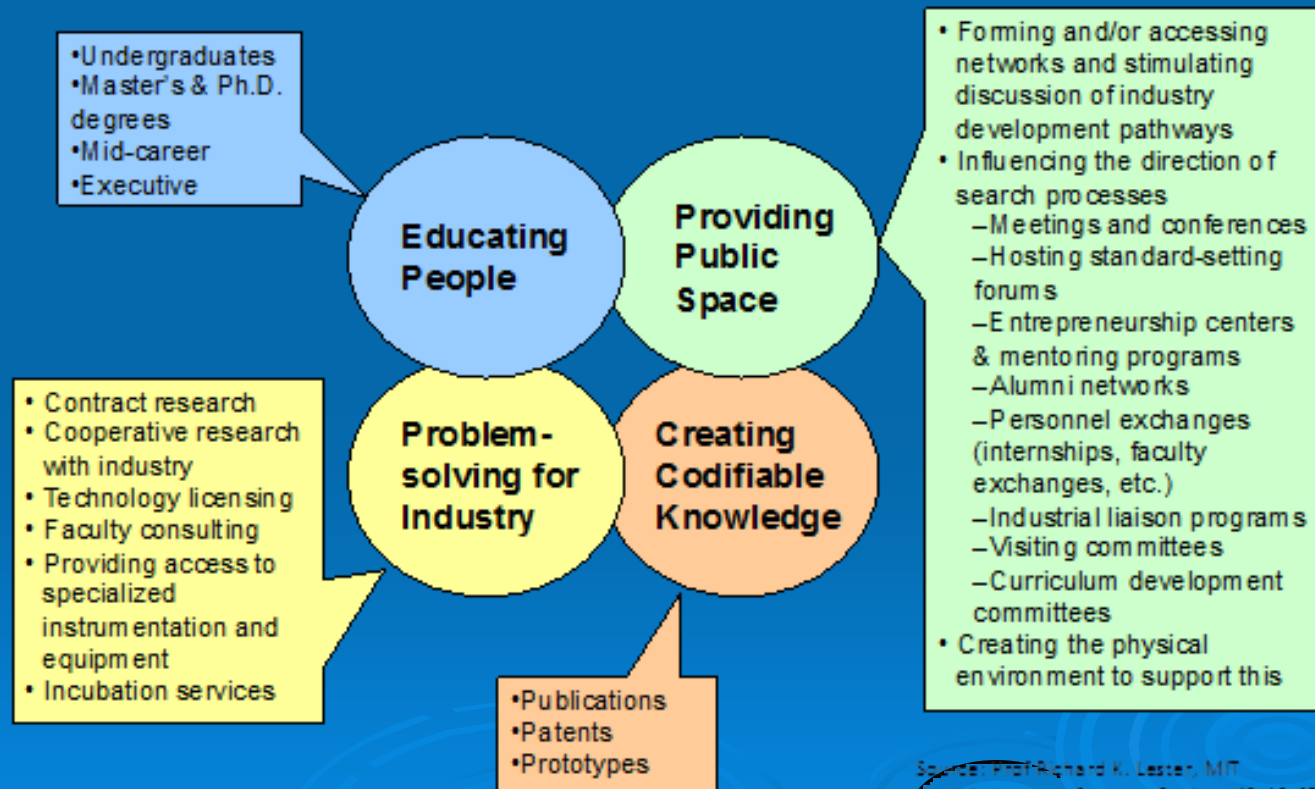


Mapping the Midwest Future

Kevin D. Kephart
Vice President for Research & Economic Development
South Dakota State University

Economic Roles of Universities

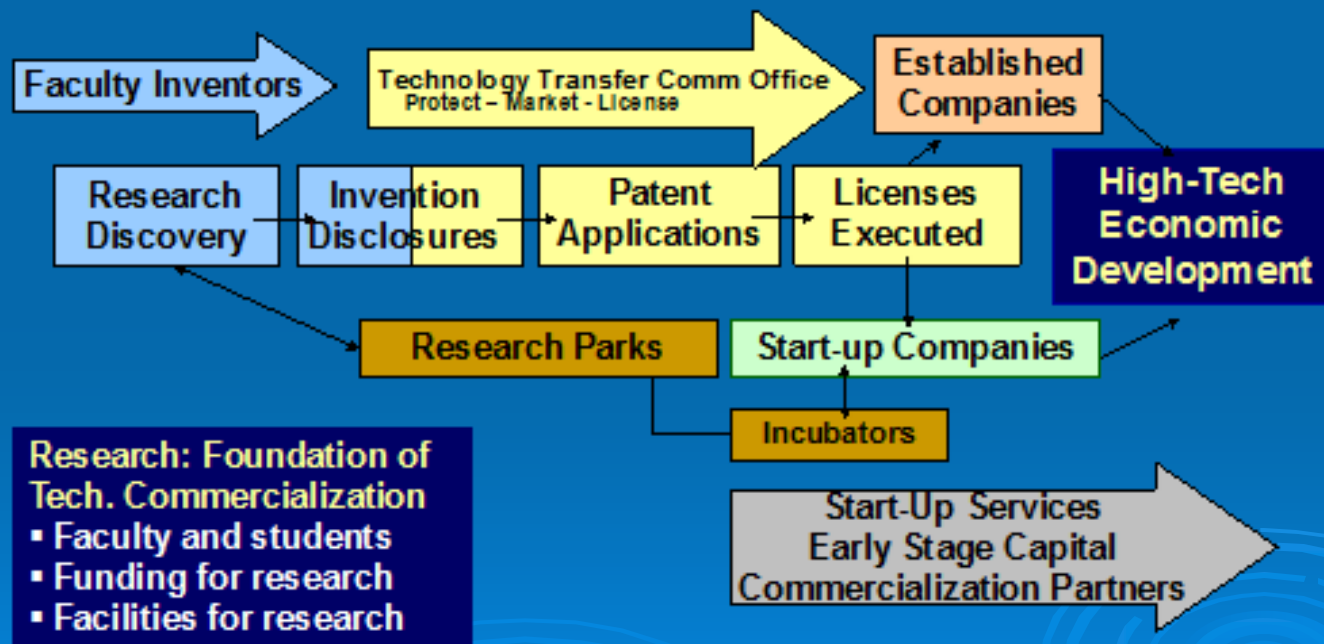

Multiple University Roles in the Regional Economy



Pathway to Commercialization

Faculty
Research
Discovery

Pathway from Discovery to Technology Commercialization





tran^zderm
solutions

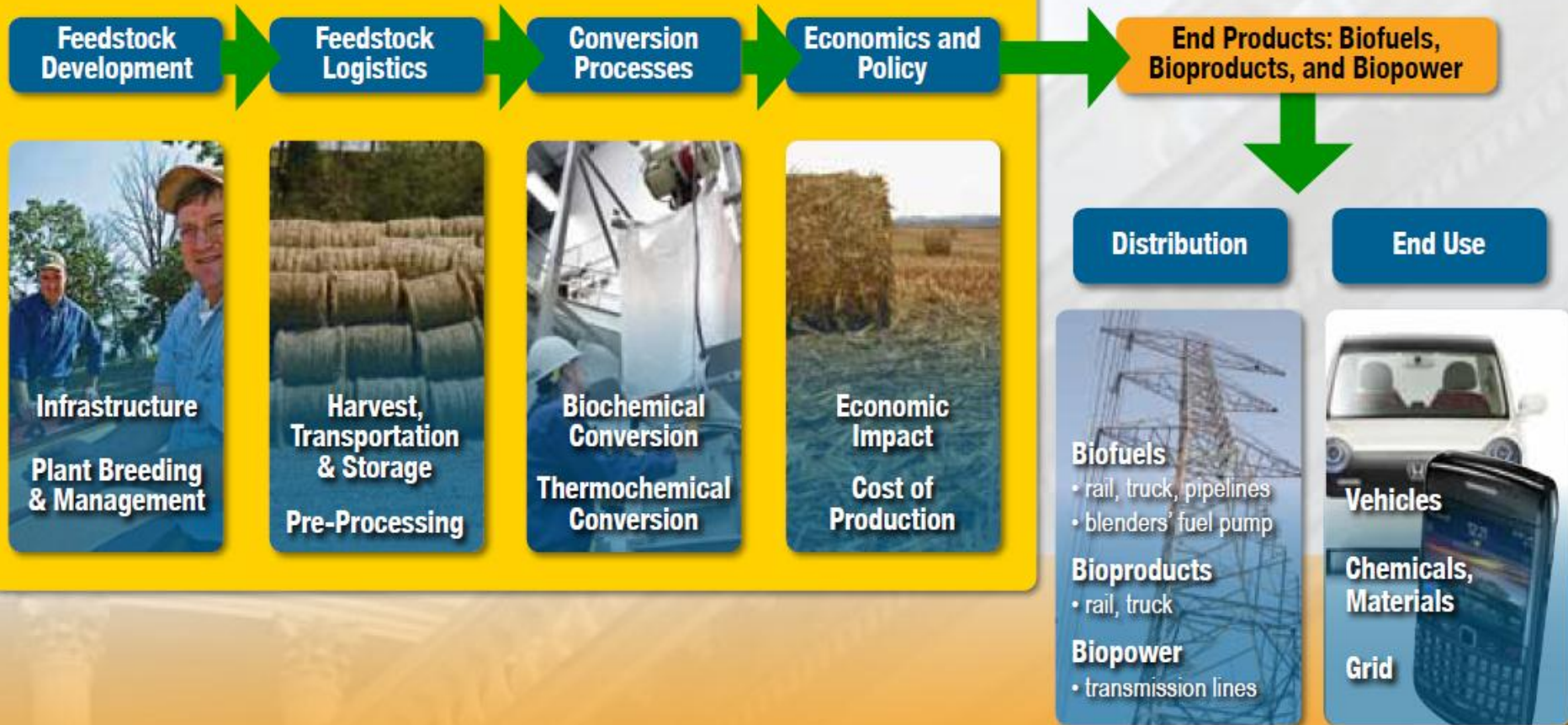


• SOUTH DAKOTA •
INNOVATION PARTNERS

- Five Regional University Centers

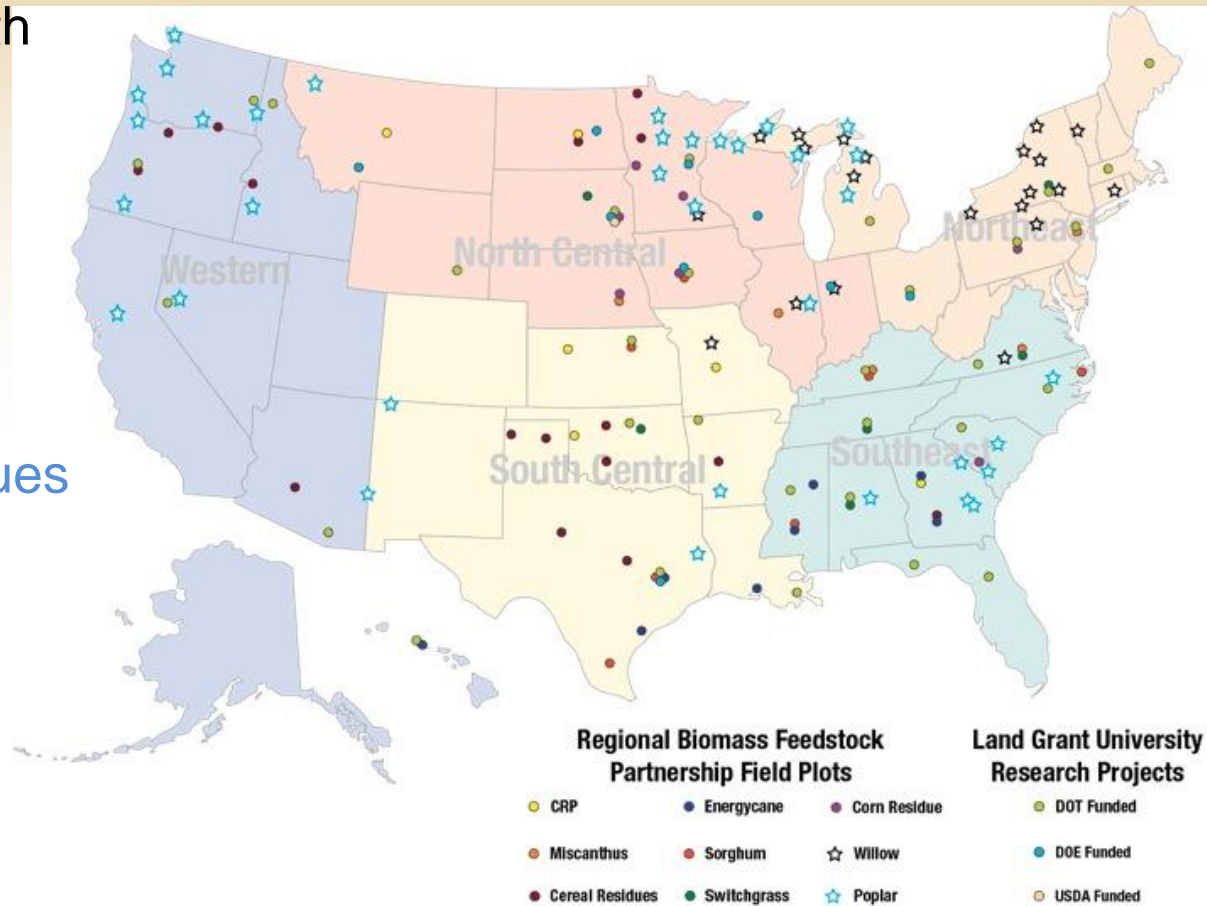


Sun Grant Initiative



SUSTAINABILITY

- More than 200 projects with collaborators in 42 states
- Feedstocks include:
 - Switchgrass
 - Miscanthus
 - Energycane
 - Corn and cereal residues
 - CRP
 - Willow
 - Poplar
 - Prairie cordgrass
 - Others
- Sustainability measurements



Matthew Darr—Iowa State Univ.
\$699,557—North Central SG

- Experimental models for rapid in-field densification
- Stover harvest scenarios and economics
- Storage effects
- Industry partners included DuPont and AGCO
- Project associated with 4 MS and 2 Ph.D. students, 10 undergraduates, 10 peer reviewed articles, 5 presentations



Catalytic Fast Pyrolysis Conversion of Corn Stover to Transportation Fuels



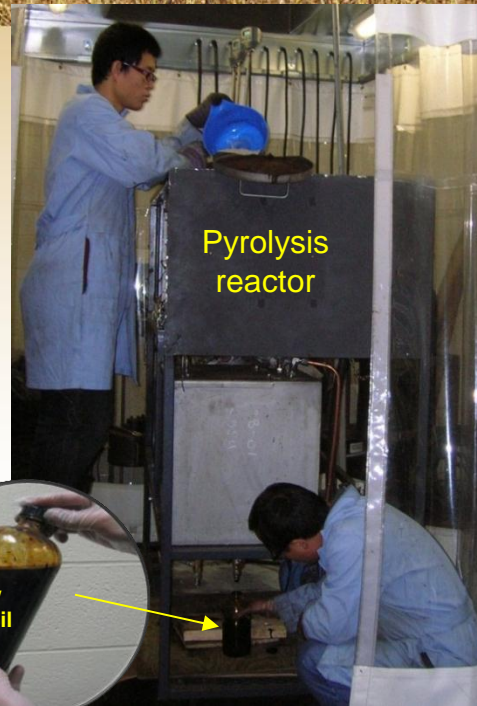
Forest residues



Corn stover

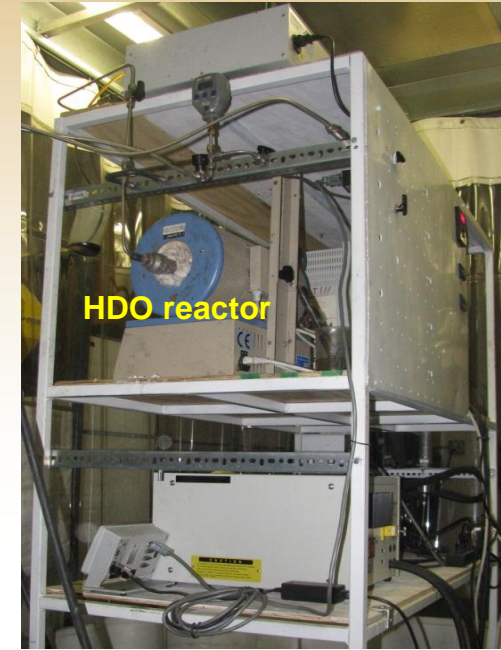


Switchgrass



Pyrolysis reactor

Raw bio-oil

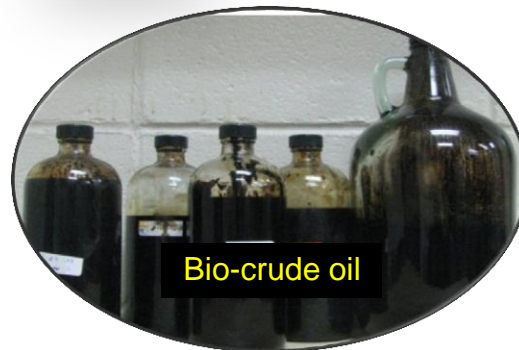


HDO reactor



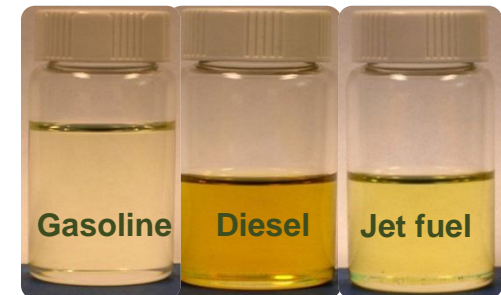
Corn stover

Pyrolysis



Bio-crude oil

HDO upgrading



Gasoline

Diesel

Jet fuel

- Brings the gasifier to the biomass
- SDL Citadel Global (Dallas, TX) has licensed the TAMU gasifier technology utilizing municipal solid waste for power generation
- Project associated with 4 MS and 1 Ph.D. student, 11 new associated grants, 5 peer reviewed articles, 11 presentations, 2 books and 3 outreach publications
- 4 IP disclosures, 2 patents, 1 license executed, and 1 start-up job

Sergio Capareda—Texas A&M
\$279,380—South Central SG





Biomass Research & Development
Technical Advisory Committee
2013 Recommendations

Dr. Kevin Kephart
Committee Co-Chair
February 19, 2014

Problem Statement

- The primary obstacle to producing advanced biofuels and bio-products from cellulosic feedstocks is the lack of cost competitiveness when compared with petroleum's cost of production.
 - This lack of cost competitiveness is the main reason for the lack of adoption.

Consistent with Past Committee Recommendation

- Problem Statement: There are currently more stringent constraints for biofuels than competing types of transportation fuels.
- Recommendation: Perform analyses on indirect effects across all fuel types including petroleum. These analyses should include current and future fuel sources including fossil fuels (e.g. tar sands, deep sea oil).

The Grand Challenge

Replace fossil carbon with renewable transportation fuels and related products:

- Rapidly expand the emerging biofuels and bioproducts industries achieving 30% penetration of biomass carbon into the U.S. transportation market by 2030 in a sustainable and cost-effective manner to create jobs, reduce greenhouse gas impacts, and enhance national security.

Additional Outcomes:

- Enhanced economic development by increasing direct and indirect jobs from 152,000 in 2012 (Bio-ERA Report) to more than 1 million by 2022. By 2030, with 45 billion gallons of fuel made with renewable carbon introduced into the biofuel industry, the direct and indirect economic impact should exceed 5 million jobs. Incentives need to guide such developments to provide opportunities for disadvantaged and minority populations.
- A cost-effective energy supply that is synergistic with existing fossil-based markets.
- Enhanced economic, environment, and social sustainability.
- Improved national energy security and decreased dependence of national defense on foreign energy supplies.

List of Action Items from 2013



	Near Term	Mid Term	Long Term
Policy	<ul style="list-style-type: none"> • Create a floor price for biofuels • RFS goals must encourage use of renewable materials 		
Feedstocks	<p>During the next five years, access 200 million tons of aggregated low-cost feedstocks. Examples include MSW, woody residues, industry wastes, manures, etc.</p> <ul style="list-style-type: none"> • Determine technology readiness levels for low-cost feedstocks and develop strategies • Early use of non-conventional feedstocks • Leverage first-generation production for second-generation systems • Expand acreage and seed development of novel crops • Develop agricultural system models and analytics that provide for decision support on societal issues 	<p>During the next 5–10 years, access 600 million tons of feedstocks. Bring ag-derived feedstock online through new farming systems technologies and intensify feedstock production</p> <ul style="list-style-type: none"> • Optimize existing production acreage, or “added virtual acres” • Implement broad-based crop rotations that are synergistic with food crop production • Access mature agricultural residues and processing wastes • Access silviculture production resources 	<p>Beyond the next 10 years, access 1 billion tons of feedstocks annually</p> <ul style="list-style-type: none"> • Access purpose-grown feedstock crops resulting from modern plant breeding and genetics R&D • Link feedstock resources to the correct conversion process, including biobased products and biochemicals • Implement algae-based production systems
Conversion	<p>Capture the successes of previously funded R&D projects</p> <ul style="list-style-type: none"> • Ensure that current integrated biorefineries are completed and begin production • Capture lessons learned from terminated integrated biorefineries in order to provide insight and keep future paths moving toward technical breakthroughs and commercialization goals • Ensure that knowledge is shared among federal agencies and transferred to industry • Enable more demonstrations and pilot projects through science-based competitive processes • Establish policy to provide a “floor” for stability in biofuels prices compared to petroleum • Support research on specialty and high-value co-products derived from biomass to enable the production of fuels • Support research on novel separations technology to help lower capital costs 	<p>Commence a national effort on next-generation biofuels</p> <ul style="list-style-type: none"> • Develop new technologies that focus on enabling new molecules; conversion technologies focused on hydrocarbons, such as biobased diesel and jet fuel. Refine thermochemical catalysis, metabolic engineering/synthetic biology, and separations technologies. Develop fuels that are compatible with the existing delivery infrastructure • Facilitate research on separations and other core processes that would reach several technologies, have a significant impact on the industry, and improve yields • Optimize the loan guarantee process to realistically recognize risk of new biofuels/bioproducts plants • Support implementation of distributed facilities to perform preliminary processing with final conversion conducted at larger, more centralized refining facilities. This should reduce both capital and operating costs 	
Infrastructure/ Logistics	<p>Establish industry standards for feedstock characterization</p> <ul style="list-style-type: none"> • Review existing relevant research and specification limits of existing supply chains • Implement systems R&D programs to optimize the mass and energy balances of the complete supply chain while capturing maximum efficiencies throughout; <i>replacing the whole barrel while using the whole plant</i> • Conduct feasibility analyses between large centralized biorefineries and distributed pretreatment facilities 	<p>Demonstrate numerous feedstock supply chains that correspond to feedstock development goals</p> <ul style="list-style-type: none"> • Solicit proposals to integrate biomass producers, communities, facility operators, equipment manufacturers, transporters, and end users. Establish multiple examples of functioning supply chains, which represent real-world examples of collecting, preprocessing, and shipping biomass to the various end users that facilitate the nation in meeting the Grand Challenge 	<p>Aggregate, process, blend, and store feedstocks in order to “Use the Whole Plant”</p> <ul style="list-style-type: none"> • Establish processes to efficiently deconstruct, increase energy density, remove oxygen, improve handling, and stabilize during storage • Develop processes to improve handling and storage at the refinery • Demonstrate improved separation processes in order to “Replace the Whole Barrel” • Demonstrate improved distribution logistics of conversion products and co-products, including distribution of drop-in fuels that consist of molecules similar to petroleum-derived fuels, as well as products that do not have petroleum counterparts

Public Sector Support

- Policy
- Infrastructure
- Market development
 - Risk mitigation

Thank You

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Challenge #1: *Reduce Feedstock Costs*

Widespread, sustainable, affordable, commercial-scale biomass feedstocks is our first key enabler to achieving significant bioenergy and bioproducts production for the U.S. “all-of-the-above” energy strategy and supports the “National Bioeconomy Blueprint.”

Barriers:

- Concerns around sustainable (environmental, social, and economic) development.
- Matching supply and demand of both feedstock and bio-based products in a nascent industry requires robust and cost effective conversion technologies.
- Adoption in the farming community and response to economic opportunities.

Potential Solutions:

- During the next 5 years, access 200 million tons of aggregated low-cost feedstocks; Next 5 to 10 years, access 600 million tons of feedstocks; Beyond 10 years, access 1 billion tons of feedstocks annually.
- Early use of non-conventional feedstocks (waste streams).
- Add productivity to existing production acreage.
- Link feedstock resources to the correct conversion process.
- Implement algae-based production systems.

Challenge #2: *Develop Highly Productive Conversion Technologies that Demonstrate Investment Economics*



Focus should be on technologies investments that can significantly reduce the capital and operating costs of advanced biofuels and biochemicals.

Barriers:

- Feedstock transportation costs often render *pro-forma* estimates as non-feasible
- High capital costs increase perceived project risk and reduce the likelihood of obtaining investment funding.

Potential Solutions:

- Ensure that current IBR are completed and begin production and lessons from terminated IBRs should be objectively captured.
- More demonstrations and pilot projects through science-based competitive processes.
- Establish policy to provide a “floor” for biofuels prices compared to petroleum.
- Support research on specialty and high value co-products derived from biomass to enable the production of fuels.
- Support research on novel separations technology to help lower capital costs.

Challenge #3: *Improve Distribution*

Infrastructure, Consumer Adoption, and Market Incentives

Fuel prices are based on the market price of petroleum; however, petroleum production costs are relatively low. The result is a volatile market dynamic for biofuels that renders the new industry uncompetitive.

Barriers:

- Absence of a reliable and sufficient market price for the fuel products.
- Integrating unit operations is a challenge especially since the scaling factor of one unit is substantial different.
- Create value for both the upstream feedstock elements and the downstream conversion sector.

Potential Solutions:

- Conduct feasibility analyses between large centralized biorefineries and distributed pre-treatment facilities.
- Solicit proposals to establish multiple examples of functioning supply chains, which represent real-world examples of collecting, preprocessing, and shipping biomass to the various end users that facilitate the nation meeting the grand challenge.
- Demonstrate improved distribution logistics of conversion products and co-products, including distribution of drop-in fuels that consist of molecules similar to petroleum derived fuels as well as products that do not have petroleum counterparts.