U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

U.S. Department of Energy (DOE)
Bioenergy Technologies Office (BETO)
2017 Project Peer Review

2019 Project Peer Review

1.2.2.2 Potential Biomass Supply Chain Risk Standards (BSCRS)

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Feedstock Logistics

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Goal Statement

- **Goal**
  - Provide a solution to the problem of high debt costs and slow development of bio-projects, which is linked to the lack of a systematic and verified assessment and comparison protocol for determining biomass supply chain risk, through the development of potential Biomass Supply Chain Risk Standards (BSCRS).
- **Outcome**
  - Demonstrate the utility of the Potential BSCRS, which will cover > 90% of recognized risk factors, in accordance with project industry advisors, to (1) more accurately quantify biomass feedstock supply chain risk and (2) verify the degree to which the standardized approach can decrease the debt costs of bio-projects based on real before/after investment data from actual bioenergy projects that require financing.
- **Relevance To Bioenergy Industry**
  - Success of bio-economy depends on low cost of capital, which is currently high because of poor understanding and inconsistent assessment of risks in the biomass supply chain. Potential BSCRS will provide a consistent framework and knowledge base to estimate these risks and lower the cost of capital of bioenergy projects.

Quad Chart Overview

Timeline

- Project start date: 10/1/2017
- Project end date: 9/30/2021
- Percent complete: 40%

	Total Costs Pre FY17	FY 17 Costs	FY 18 Costs	Total Planned Funding (FY 19-Project End Date)
DOE Funded		$752K	$1,011K	$1,011K (FY19) $1,018K (FY20) $1,018K (FY21)

Partners:

Sub Contractor(s)-INL

•Ecostrat, Inc. (20%)

•South Dakota State University (3%)

Industry Partners

•Industry Stakeholders Group (>100 members)

Barriers addressed

- Ot-C: Risk of Financing Large-Scale Biorefineries
- ADO-C: Codes, Standards, and Approvals for Use
- Ot-A: Availability of Quality Feedstock
- Ot-B: Cost of Production
- Ct-A: Defining Metrics Around Feedstock Quality

Objective

Develop potential BSCRS addressing industry verified risk factors associated with biomass supply chain risk to accelerate take-off of bioenergy projects and potentially improve risk ratings of bioenergy projects.

End of Project Goal

Apply the developed potential BSCRS and Risk Rating methodologies using a case study to demonstrate a reduction in project risk score of ≥ 50%.

1 - Project Overview

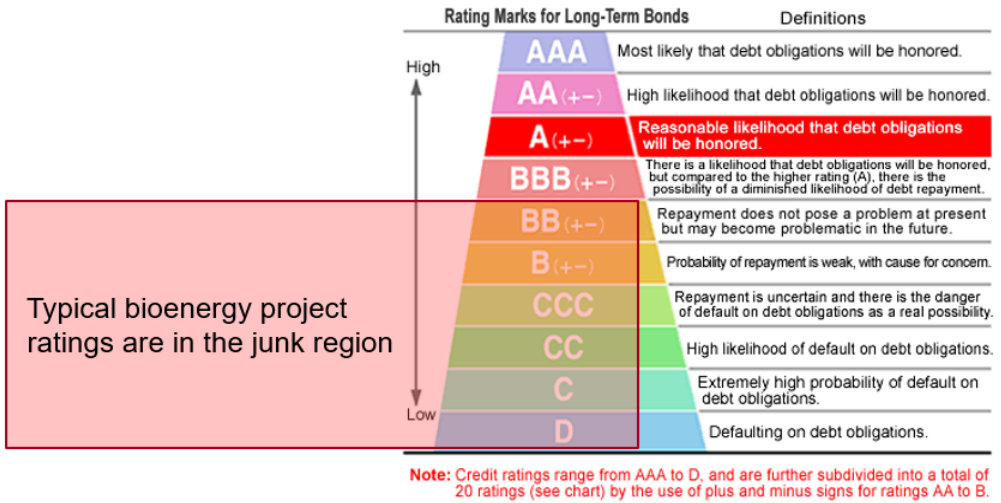
- **History**
  - Project is a combination of two past complementary efforts
    - FY17 task within project 4.1.2.20 (Economic Analysis of Risk) based on Subcontractor's (Ecostrat) interest in developing standardized framework to capture and assess biomass supply chain risks.
    - FY08 Bioenergy Feedstock Library project focused on creating a central repository database for sample and data management and data interrogation tools representing biomass and feedstocks throughout the supply chain through conversion.
- **Objectives**
  - Develop a comprehensive potential BSCRS Framework
    - Known and perceived risk indicators that can be practically assessed and evaluated
    - Resources and guidance for understanding and mitigating risk
    - Methodology for risk assessment and scoring
  - Verify efficacy of framework for lowering risk.
  - Certify potential BSCRS framework for industry adoption.

1 - Project Overview

Why Create Standards for Biomass Supply Chain Risk?

- Risks associated with biomass supply chains are not well understood.
- No established protocols, standards, or recognized industry best-practices to rely upon to empirically quantify supply chain risks.
- Developers, investors, commercial lenders, insurance companies, and rating agencies independently use inconsistent approaches and evaluation criteria.
  - Leads to unreliable assessment of project risks.
- There are many reasons for low ratings, but a key reason is confusion about the degree of long-term supply chain risk.

Most Bioenergy Projects Carry a BB Rating or less (~Junk)

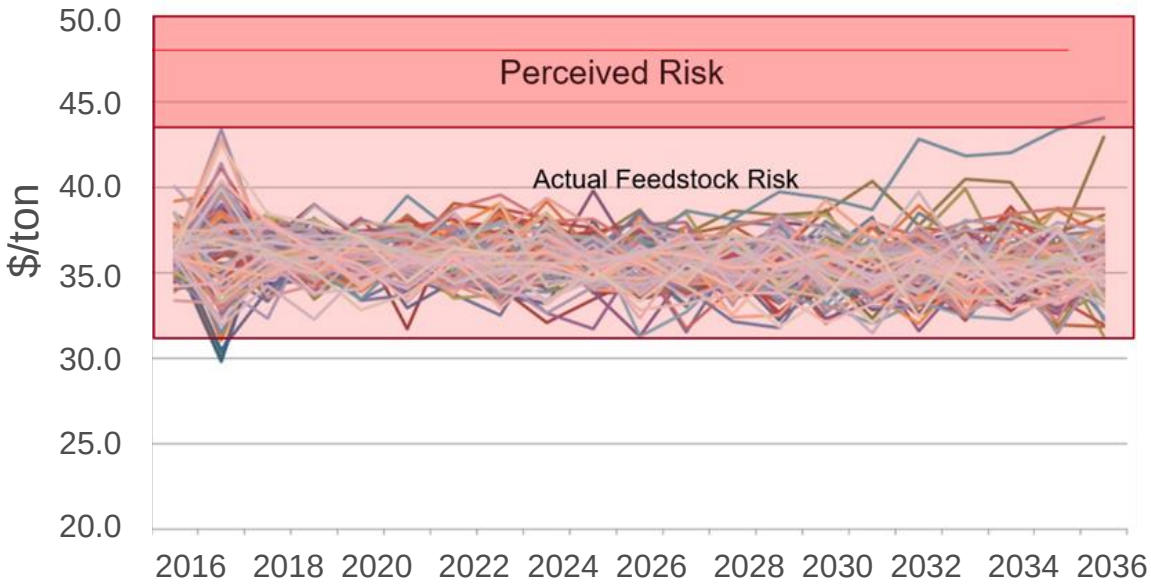


"Lack of BSCR Standards is a material barrier to bio-project finance."

AGF, Stern Brothers, Raymond James, Jefferies Investment Banking

1 - Project Overview

Actual versus Perceived Bioenergy Feedstock Cost



Better understanding and pricing of risk will lead to easier capital flow to bioenergy projects and accelerate growth of the bio industry.

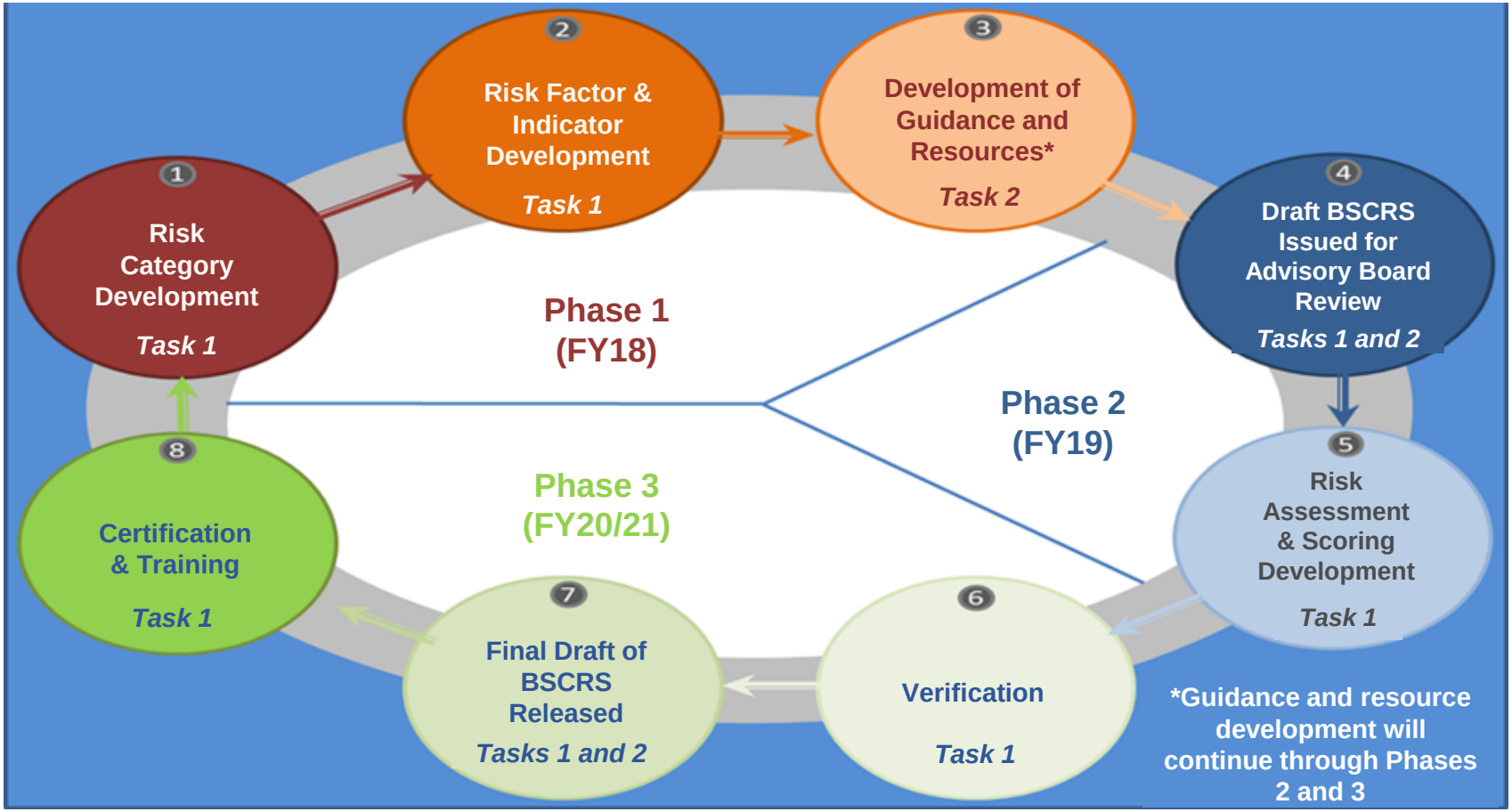
- Impact of confusion in Capital Markets
  - When Capital Markets are unclear about impact of long-term feedstock risk, the perceived risk can be greater than actual risk.
  - Bio-projects are burdened with financing and debt costs 150-250 basis points higher than might otherwise have been required.
- Better understanding of risk for Capital Markets
  - An established protocol or set of standards gives rating agencies, commercial lenders and investors a common approach to pricing feedstock risk.

2 – Approach (Management)

- **Task 1:** BSCRS Framework and Risk Scoring Development
  - **Objective(s)**: (1) Develop potential BSCRS framework, (2) Develop methodology to assess and score risk, (3) Provide verification of the utility of the potential BSCRS and scoring, (4) Certify and train for adoption of potential BSCRS.
  - **Team:** INL, Ecostrat, Advisory Board, and 100+ member of Industry Stakeholder Group
- **Task 2:** Guidance and Data Resources Development
  - **Objective(s)**: Develop guidance for potential BSCRS framework for understanding and mitigating risk through identification, aggregation, and/or generation of data and knowledge for specific risk indicators.
  - **Team:** INL, South Dakota State University, Knowledge Discovery Framework-ORNL

2 – Approach (Technical)

Development of Biomass Supply Chain Risk Standards Framework



- Each phase requires continuous industry input and buy-in:
  - 100+ Industry Stakeholders Groups (ISG)
  - Advisory Board

2 – Approach (Technical cont.)

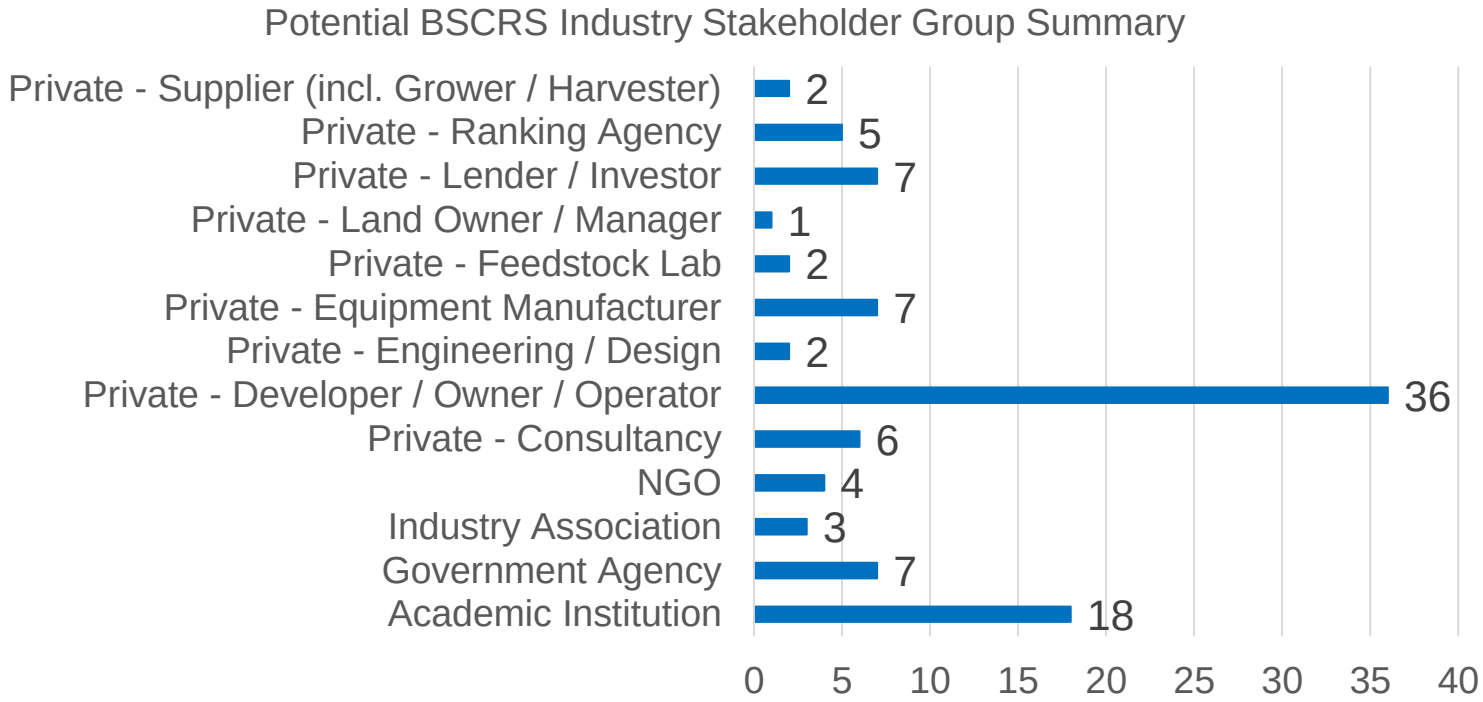
- **Phase 1:** Develop a Potential BSCRS Framework
  - Document and organize all identified sources of risk.
  - Provide guidance to understand and mitigate risk .
    - Guidance development will continue to build and improve throughout all phases .
  - **Milestone (FY18):** Draft initial potential BSCRS framework with all identified risk indicators and initial guidance for formal review by the Advisory Board.
- **Phase 2:** Risk Scoring Methods
  - Develop risk scoring and rating methodology including scoring system guidance documentation.
  - Develop example risk scoring and rating using case studies.
  - **Milestone (FY19)**: Complete potential BSCRS development with fully defined Risk Categories, Factors, Indicators, risk assessment and mitigation guidance and tools, scoring methodology, and reporting requirements; demonstrate decrease in perceived supply chain risk of 15%.
- **Phase 3:** Verification and Certification
  - **Go/No Go (FY20):** Develop case study to test application of potential BSCRS and Scoring Methodology. **Go:** demonstrate decrease in perceived supply chain project risk score of 20%.
  - **Milestone (FY21):** Apply the research and potential BSCRS to show via a case study a reduction in project risk score of 50%.

2 – Approach (Technical cont.)

- **Success Factors**
  - **Industry buy-in and widespread use**
    - ISG and Advisory Board formed for industry input and feedback.
    - Adoption of methods used in the industry.
    - Example case studies.
    - Vetting through repeated applications.
  - **Risk scoring and rating methods consistent with investment industry practices and easy to implement**
    - Patterned after Moody's Risk Scoring and Rating methodology.
    - Clear criteria being developed for scoring.
  - **Repeatable results,** i.e., not dependent on the scorer but on data
    - Show, through case studies, a reduction in capital cost when the potential BSCRS is implemented.
  - **Deployable framework**
    - Available as online database and easily exported/imported in Word format.
- **Challenges**
  - Development of realistic case studies.
  - Ensure stakeholders find the potential BSCRS and scoring system easily implementable.
  - Obtaining buy-ins and adequate vetting by industry and investment community.

3 – Technical Accomplishments

Industry Stakeholder Group (100+) and Advisory Board



- Each organization provided extensive input into the potential BSCRS framework through a phone interview and/or direct comments to the draft.
- **Objective:** 100 members of Industry Stakeholder Group by Sep 30, 2018

- **Advisory Board Members**: 10 members ranging from consultants from the financial and lending sectors, national lab bioenergy experts, academic bioenergy experts, and industry.

3 – Technical Accomplishments Cont.

Industry Stakeholder Group Key Players

3 – Technical Accomplishments Cont.

Potential BSCRS Framework

Risk Category	Number of Risk Factors	Number of Risk Indicators
1: Supplier Risk	18	54
2: Competitor Risk	8	19
3: Supply Chain Risk	37	141
4: Feedstock Quality Risk	5	20
5: Feedstock Scale-Up Risk	6	8
6: Internal Organizational Risk	11	39
Total	85	281

A framework of to allow bio-projects to clearly demonstrate feedstock supply risk to financing sector.

- Risk Categories (6) ➔ Risk Factors ➔ Risk Indicators
  - Rationale and initial guidance gathered based on:
    - Inputs from Advisory Board and ISG members
    - Literature (321 peer reviewed papers/databases reviewed)

https://bioenergylibrary.inl.gov/BSCR/RiskStandards.aspx

Reference Number	Indicator	Indicator Rationale	Indicator Source	Guidance	Guidance Source	Risk Assessment Methodology
1.3.1 **Category:** Supplier Risk **Factor:** Long-Term Risk of Supply Disruption	Supplier has long-term relationship or vested interest with a competitor and/or a history of favoring that competitor over other buyers.	Suppliers may have a preference to supply to specific competitors for biomass feedstock. This preference may be due to historical, long-term or personal relationship between the supplier and competitor, less stringent demands in terms of feedstock quality, operating hours etc. Despite contract terms, such suppliers may still have a preference for existing markets. During periods of feedstock shortage these suppliers may be more likely to allocate the scarce supply to the competitor and cause supply disruption for the project.	Hladik 2017 (comment)	Typically, if there exists a ready market for biomass feedstock in a region the relationship of the bio project to the competitor and dynamics which may affect feedstock available and cost should be clearly understood. - Constantly monitor the supplier's and competitor's actions. If it looks like a supplier is close to breaching contract, take necessary steps to convince him otherwise.	Hladik 2017 (comment)	Qualitative

3 – Technical Accomplishments Cont.

Potential BSCRS Framework Accessibility and Advisory Board Review

Comments from advisory board and ISG tracked and resolved in BSCRS framework

BSCR Online Risk Standards Document Comments Summary:

There are a total of 33 comments, 22 of which are not resolved.

	Reference Number	# Comments	# Unresolved Comments	Indicator
Goto Edit	5.6.1	2	0	High infrastructure or scale-up costs required to produce feedstock.

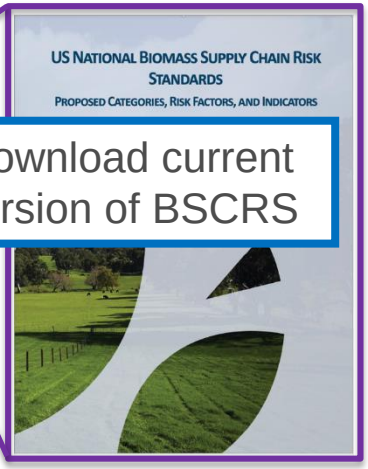
User Name	Comment Text	Comment Date	Resolved By User	Resolution Text	Resolution Date
Quang Nguyen	Larger scale operation runs higher risk of higher cost of feedstock delivery because of potential shortage of trucks and drivers, higher cost of satellite storage and multiple handling steps.	8/30/2018 2:14:09 PM	Shyam Nair	This comment has been added to the guidance.	9/12/2018 9:58:11 AM

BSCR Standards Database:

Create Full Document

Create Category Document

Create Risk Factor Document



Download current version of BSCRS

Advisory Board and ISG Feedback

Positive

- "Feedstock supply risk analysis is the single most important thing banks want to see" – *Rajdeep Golecha, formerly BP*
- "Lenders need security [and] would like to see something like this" – *Brian Reed, Highland Pellets*

Constructive Criticism

- Document complexity and redundancy
  - Aggregate guidance and indicators
  - Focus on concise representation
- Categories of feedstock have different risk profiles and should be treated separately
  - Update framework to account for differences in risk for 3 profiles:
    - forestry-derived
    - agricultural residues
    - energy crops

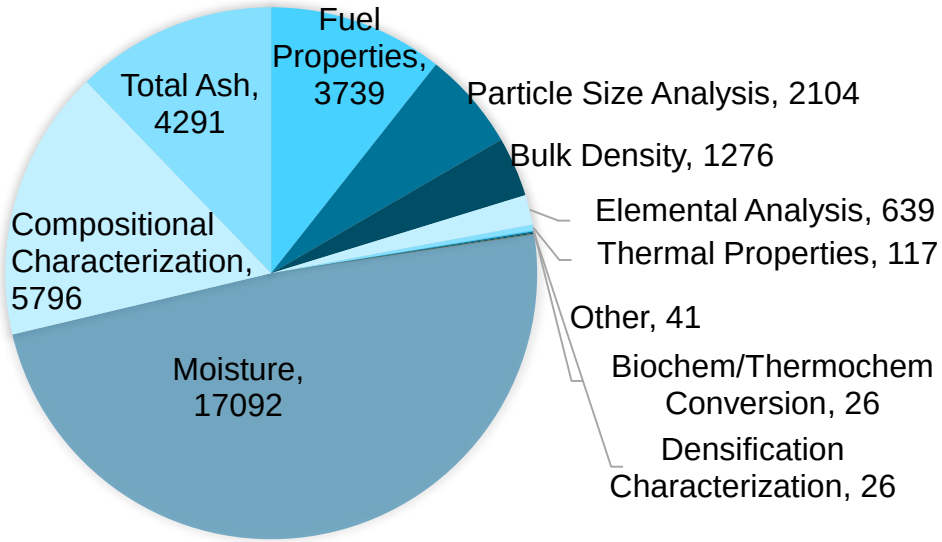
Prompt incorporation of feedback is necessary to accomplish goals of industry buy-in and widespread use

3 – Technical Accomplishments Cont.

Development of Guidance and Resources

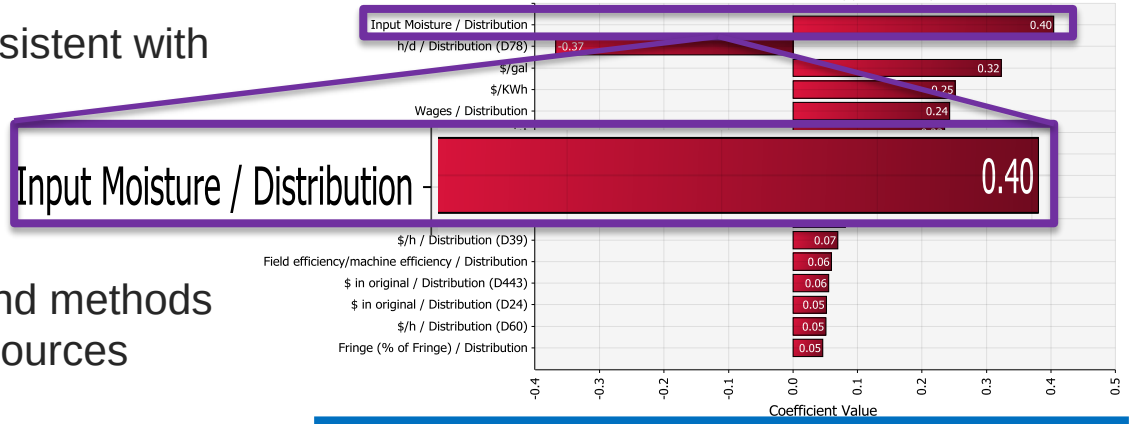
Feedstock Quality Risk (Category 4)

- **4.1**. Feedstock Requirements Inconsistent with Availability
- **4.2** Feedstock Flexibility
- **4.3** Degradation During Storage
- **4.4** Variability in Feedstock Quality
  - Appropriate measuring tools and methods
  - Variability caused by multiple sources
  - Variability in properties
    - moisture, ash, particle size, and chemical
  - Ranges in variability
- **4.5** High Feedstock Density



Total cost per DM ton

Correlation Coefficients



Moisture had largest impact on cost in stylized cost risk model applied to 2013 SOT Herbaceous case

https://bioenergylibrary.inl.gov/Home/Home.aspx

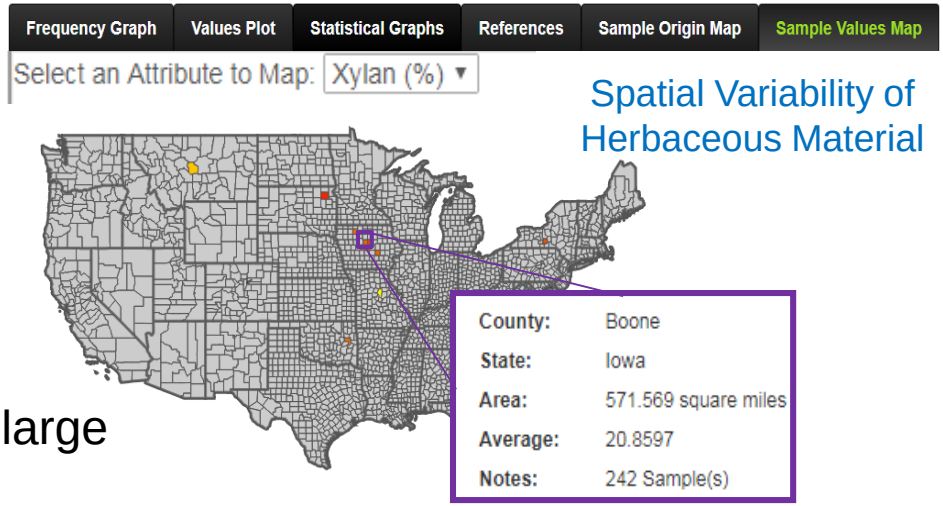
Analytical and metadata for over 70,000 samples across the U.S.

3 – Technical Accomplishments Cont.

Bioenergy Feedstock Library Database Functions

Visualization of Biomass Characteristics

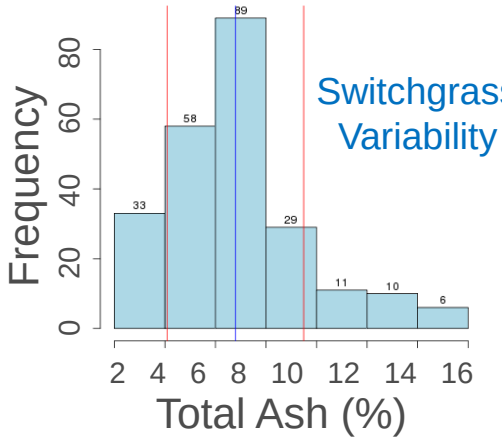
- Spatial variability of specified biomass characteristics
- Distributions of variability



Spatial Variability of Herbaceous Material

Export Data and Reports

- Summarized report for quick overview of large selected datasets
- Sample information (>280 metadata elements)
  - Biomass type, location, harvest, field, equipment
- Analysis Data (>16 analysis categories)
  - Chemical, ash, physical, conversion
- Sample Hierarchy
  - History of sample



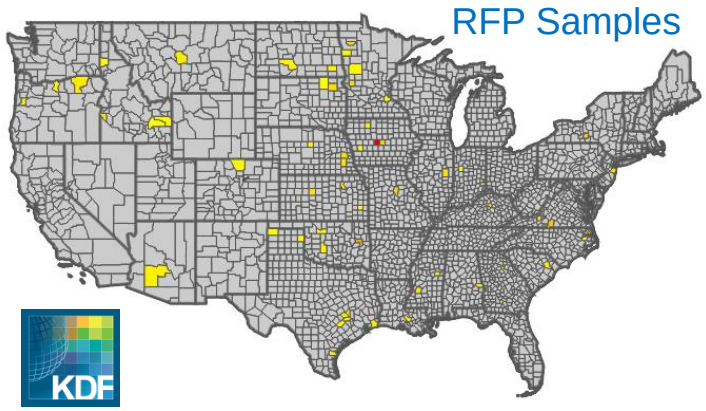
Switchgrass Variability

BFL data available to provide understanding for project risks and mitigation strategies associated with biomass quality.

3 – Technical Accomplishments Cont.

Regional Feedstock Partnership Dataset

Biomass Type	Exp. Design	Sites	Years	# Samples w/ Analytical Data
CRP Mixed Grasses	Nitrogen Trt., Harvest timing	6	6	518
Miscanthus	Nitrogen Trt.	6	7	512
Switchgrass	Nitrogen Trt.	6	7	747
Energycane	Genotype	8	7	538
Sorghum	Genotype	7	5	543



Owens VN. Sun Grant/DOE Regional Feedstock Partnership: Final Technical Report. US; 2018. 10.2172/1463330

Objectives:

- Bring together all data (metadata, yield, analytical)
  - Create link between RFP data in BFL/KDF
- Analysis of impact agronomic and environment factors on chemical properties.
  - Nitrogen treatments, genotypes
  - Weather (precip., temp., drought indicators), soil attributes

Outcomes:

- Workshop with RFP partners
- Quality-based Summary Report and peer-reviewed publications

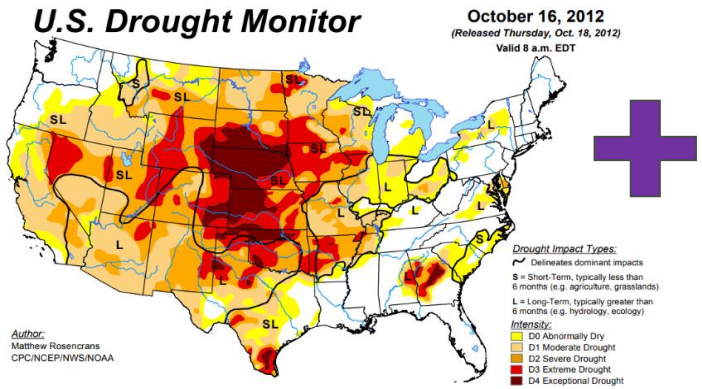
Datasets and reports provide multiple resources for biomass variability risks based on impacts of sources of variability on biomass yields and quality.

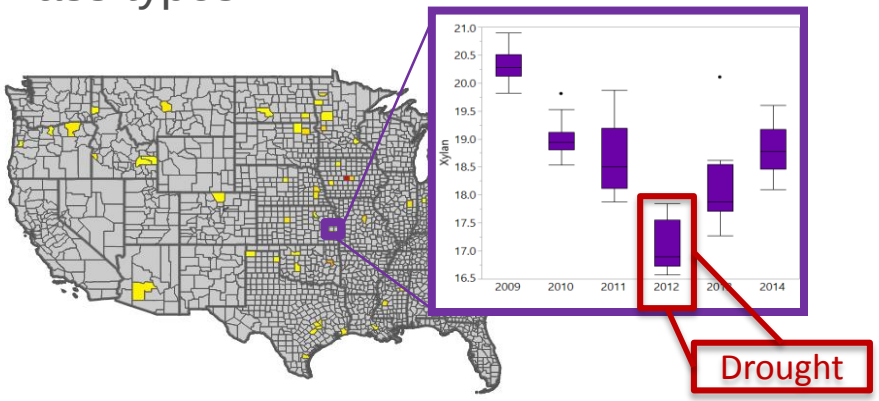
3 – Technical Accomplishments Cont.

Analysis of RFP Data: Agronomic and Environmental Impacts

Agronomic Impacts

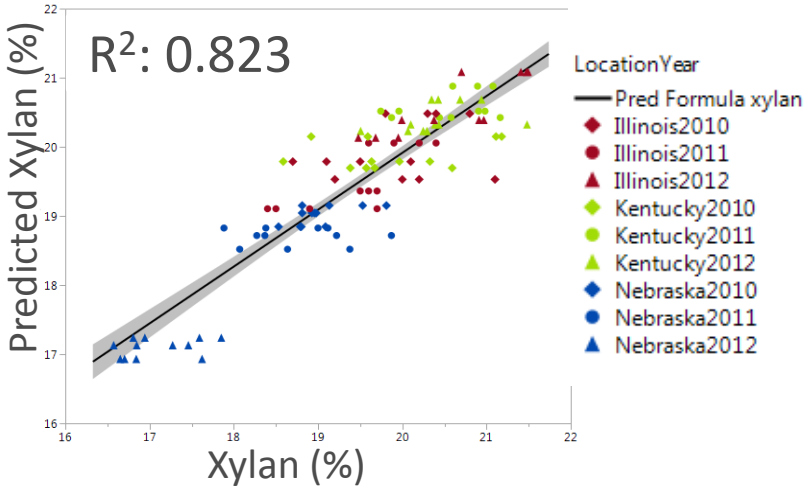
- ANOVA results show that agronomic factors significantly ($p<0.05$) impact chemical characteristics for specific biomass types





Environmental Impacts

- Preliminary correlations show significant effects ($p<0.05$) using drought indicators



- Agronomic practices are necessary to consider when assessing risk associated with variability in biomass quality.
- Use drought to "predict" variability in feedstock quality demonstrating potential for quality maps.

4 – Relevance

- **Outputs**
  - Standards-based risk mitigation, combined with consistent and investment-industry-patterned approach to risk scoring and rating will facilitate quicker and lower cost of capital.
  - Verified, well-documented standards, including a set of extensive resources for understanding and mitigating risk, will pave way for certification and formation of an Institute for Biomass Supply Chain Risk Standards managed by industry stakeholders.
- **Stakeholders**
  - **Land managers –** support for precision agronomics and reduced risk.
  - **Researchers –** address high-level biomass availability and row-crop depletion concerns.
  - **Industry –** information on biomass supply and competition, economic opportunities, and good understanding of risk, will allow for a quick means to evaluate cost of capital.
  - **Policy makers –** clear understanding of risks and risk mitigation measures provided through development of guidance and resources.
- **Impacts**
  - Allows supply chain practitioners and the investment community to understand and evaluate risks in a comprehensive and consistent manner.
  - Builds knowledge regarding biomass/feedstocks and sources of variability that can be leveraged by other projects (e.g. FCIC).

5 – Future Work

- **FY19**
  - Develop and Test Scoring and Rating Methodologies for Potential BSCRS.
    - Methodologies patterned after Moody's ratings approach.

		Sub-Factor Rating					
Risk Factor 3.1	**Factor Weight**	**Aaa**	**A**	**Baa**	**Ba**	**B**	**C**
Feedstock Availability	xx%	The Biomass Availability Multiple (BAM) is equal or larger than the minimum required BAM. **AND** Increased feedstock utilization models indicate high BAM under all realistic	The Biomass Availability Multiple (BAM) is equal or larger than the minimum required BAM. **AND** Increased feedstock utilization models indicate high BAM under	The Biomass Availability Multiple (BAM) is equal or larger than the minimum required BAM. **AND** Increased feedstock utilization models indicate high BAM under most	The Biomass Availability Multiple (BAM) is equal or larger than the minimum required BAM. **AND** Increased feedstock utilization models indicate medium-to-high	The Biomass Availability Multiple (BAM) is equal or larger than the minimum required BAM. **AND** Increased feedstock utilization models indicate high-to-medium	The Biomass Availability Multiple (BAM) is lower than minimum required BAM. **AND** Increased feedstock utilization models indicate lower than required BAM

    - Demonstrate reduction in capital cost for an example test case.
- **Beyond FY19**
  - Strengthen potential BSCRS risk understanding and mitigation.
    - Knowledge gained through available BFL data and beyond.
    - Inclusion of new models and methodologies based on INL and external research associated with the biomass supply chain.
  - Develop test cases to apply and verify the methodology before and after application of potential BSCRS.
- **Go/No Go (Mar 2020)**
  - Develop case study to test application of potential BSCRS and Scoring Methodology.
    - **Go:** demonstrate decrease in perceived supply chain risk of 20%.

Summary

- **Overview**
  - Develop a consistent framework and knowledge base to estimate risks and lower the cost of capital of bioenergy projects.
- **Approach**
  - 3-Phase approach to create comprehensive documentation of all identified risks, including guidance for risk mitigation and understanding, develop a scoring system to quantify and assess risks, and verify/certify proposed potential BSCRS framework.
  - Continuous input from industry.
- **Progress & Results**
  - Risk Categories, Risk Factors, and Risk Indicators along with Rationale and Risk Mitigation Guidance developed for each Risk Indicator
  - Available and accessible potential BSCRS framework through INL's BFL
  - Development of guidance and resources through RFP data regarding understanding and predicting variability in biomass resources
- **Relevance**
  - Standards-based risk framework, combined with investment-industry-patterned approach to risk scoring to facilitate lower cost of capital
- **Future Work**
  - Develop and test scoring and rating methodologies for potential BSCRS

Questions

???

Additional Slides

Potential BSCR Framework Development

- Deploy risk standards and certification framework into the marketplace (*outreach to key stakeholders will provide more confidence of the path to success*).
  - Industry stakeholders group formed with >100 members.
  - Outreach and communication key part of FY20 and 21 tasks after completion of potential BSCRS Framework.
- Extend risk standards and certification framework beyond feedstocks into conversion.
  - Variability in feedstock quality and price is a major cause of high conversion costs.
  - Through standardization of supply chain processes, potential BSCRS aims to reduce the supply chain risks.
- Project needs to understand asymmetry of information, uncertain market structure and risk distribution.
  - The very purpose of standardization is to reduce uncertainty and asymmetry in information across stakeholders.

2017 Peer Review Comments

Bioenergy Feedstock Library

- "…It is a waste of time and resources to not have the library integrated with KDF!!!"
  - BFL developers have made considerable efforts to create collaborative and synergistic connections with other relevant databases, including KDF.
- "…The scope is very ambitious with many customers, objectives and functions."
  - The combination of potential BSCRS development and BFL data and resources has provided a distinct customer and tangible goals to focus near term objectives for data and analysis capabilities.
- "The biggest challenge this project needs to address is increasing public awareness of this incredible resource, as this reviewer for example was previously unaware of the extent and availability of this database."
  - The potential BSCRS framework is currently housed within the BFL and will be populated with guidance based references to the BFL data. As potential BSCR development requires continuous review from >100 member industry stakeholder group, the BFL will naturally benefit from a large number of views.

Risk Factors-Supplier Risk (Category 1)

1.1	Credit-Worthiness or Problematic Future Solvency of Suppliers	1.10	Supplier Harvesting/Collection/Processing Capacity Inadequate or Not Understood
1.2	Supplier Contracts	1.11	Market Drivers for Supplier's Primary Products not Understood
1.3	Long-Term Risk of Supply Disruption	1.12	Suppliers Without Vested Interest
1.4	Supplier Capacity	1.13	Suppliers Store Feedstock Outdoors
1.5	Lack of Early Supplier Involvement	1.14	Competitor as Supplier
1.6	Supplier Lacks Control Over Transportation, Harvest or Means of Production	1.15	Supplier's Lack of Planning
1.7	Supplier's Distance from the Project	1.16	Supplier's Lack of Experience with Biomass Cultivation and/or Harvesting
1.8	No or Little History of Supplying Feedstock	1.17	Intermediary Risk
1.9	History of Feedstock Quantity, Quality or Delivery Issues	1.18	Supplier's Insurance Policy

Risk Factors-Competitor Risk (Category 2)

2.1	Utilization of Feedstock by Competition
2.1	Price Control by Competitor
2.3	Supplier Control by Competitor
2.4	Impacts of Future/Additional Competition on Feedstock Availability and Price
2.5	Distrust in the Industry Due to a Competitor
2.6	Competitor’s Logistical Advantage
2.7	Lack of Relationships with Competitors
2.8	Lack of Understanding of Competitor's Business

Risk Factors-Supply Chain Risk (Category 3)

3.1	Feedstock Availability/Increased Utilization	3.20	Supply Chain Computer Modeling
3.2	Political and Legislative Risk	3.21	Feedstock Sustainability
3.3	Environmental Risk	3.22	Land Ownership, Harvest rights, Tenure
3.4	Inadequate Infrastructure	3.23	Scale of Feedstock Analysis
3.5	Low Historical Demand for Feedstock	3.24	Self-impact Risks & Supplier Collusion Risks
3.6	Seasonal Weather and Weather Events	3.25	Feedstock Production Economics
3.7	Different Harvesting, Collection Equipment among Suppliers	3.26	Feedstock Yield Variability
3.8	New Feedstock Risks	3.27	Infestation
3.9	Transportation Risk	3.28	Impact on Suppliers' Land.
3.10	Impact of Diesel and CPI/PPI	3.29	Worker Safety
3.11	Historical Price Trends	3.30	Feedstock Crop Establishment
3.12	Future Feedstock Cost Risks	3.31	Greenhouse Gas Emissions Accounting Systems
3.13	Feedstock Production Seasonality	3.32	Lack of Existing Biomass Supply Chain
3.14	Low Resiliency Factor	3.33	Decentralized Storage
3.15	Physical Accessibility Risks	3.34	Feedstock is a By-Product / Secondary Product
3.16	Supplier Ratio Risks	3.35	Social Acceptability Risk
3.17	Risk Related to Spatial Distribution of Suppliers	3.36	Alternative Markets for Feedstock
3.18	Harvest Schedules	3.37	Investment Risk
3.19	Availability of Labor		

Risk Factors-Feedstock Quality Risk (Category 4)

4.1	Feedstock Requirements Inconsistent with Availability
4.2	Lack of Feedstock Flexibility
4.3	Degradation During Storage
4.4	Variability in Feedstock Quality
4.5	High Feedstock Density

Risk Factors-Feedstock Scale-Up Risk (Category 5)

5.1	Scale of Plant
5.2	Readiness of Full-Scale Design – Lab-Scale Tests
5.3	Readiness of Full-Scale Design – Pilot-Scale Tests
5.4	Readiness of Full-Scale Design – Field-Scale Tests
5.5	Quality of Pilot Facility Feedstock is not Reflective of Actual Feedstock
5.6	Feedstock Production and Delivery Infrastructure Scale-up

Risk Factors-Internal Organization Risk (Category 6)

6.1	Inventory and Inventory Management Plan
6.2	Level of Trust with Suppliers
6.3	Risk Infrastructure System
6.4	Inadequate Data Processes
6.5	Feedstock Quality Testing Procedures
6.6	Feedstock Yard Operations
6.7	Feedstock Yard Equipment
6.8	Delayed Start-Up
6.9	Personnel Experience and Training
6.10	Equipment Ownership
6.11	Lack of Feedstock Supply Insurance Policy