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

3.1.3.2
Codes and Standards in IBRs

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Demonstration and Market Transformation

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Goal Statement

We lead industry-government consortiums to address scale-up barriers with development of evidence-based codes and standards for:

Reducing fire risk in biomass storage/handling

- **Ensure the safety of people and assets**
- **Reduce risk and improve insurability**

Decreasing costs and promoting fair comparisons in sustainability assessments

- **Clarify market expectations**
- **Support trade involving energy or chemicals from biomass**

Quad Chart Overview

Timeline

- 10/1/2014
- 9/30/2017
- 70%

Barriers

- Im-E - Lack of or inconsistent industry standards and regulations
- St-A - Scientific consensus on bioenergy sustainability
- Im-C - Lack of understanding of environmental/energy tradeoffs

Budget

	FY 15 Costs	FY 16 Costs	Total Planned Funding (FY 17-Project End Date)
DOE Funded	$660K	$780K	$440K
Cost Share	Informal cost share estimate - $390K *Estimate includes industry staff time, travel, and biomass material*		

Partners

- Collaborations
  - Antares
  - Genera Energy, LLC
  - Abengoa
  - POET
  - DuPont
  - Idaho National Laboratory
  - American Society of Agricultural & Biological Engineers
  - ADM
- Subcontractors
  - Vista Consulting/Davidson Code Concepts
  - UL

1 - Project Overview

Facilitate development and deployment of evidence-based fire codes/standards

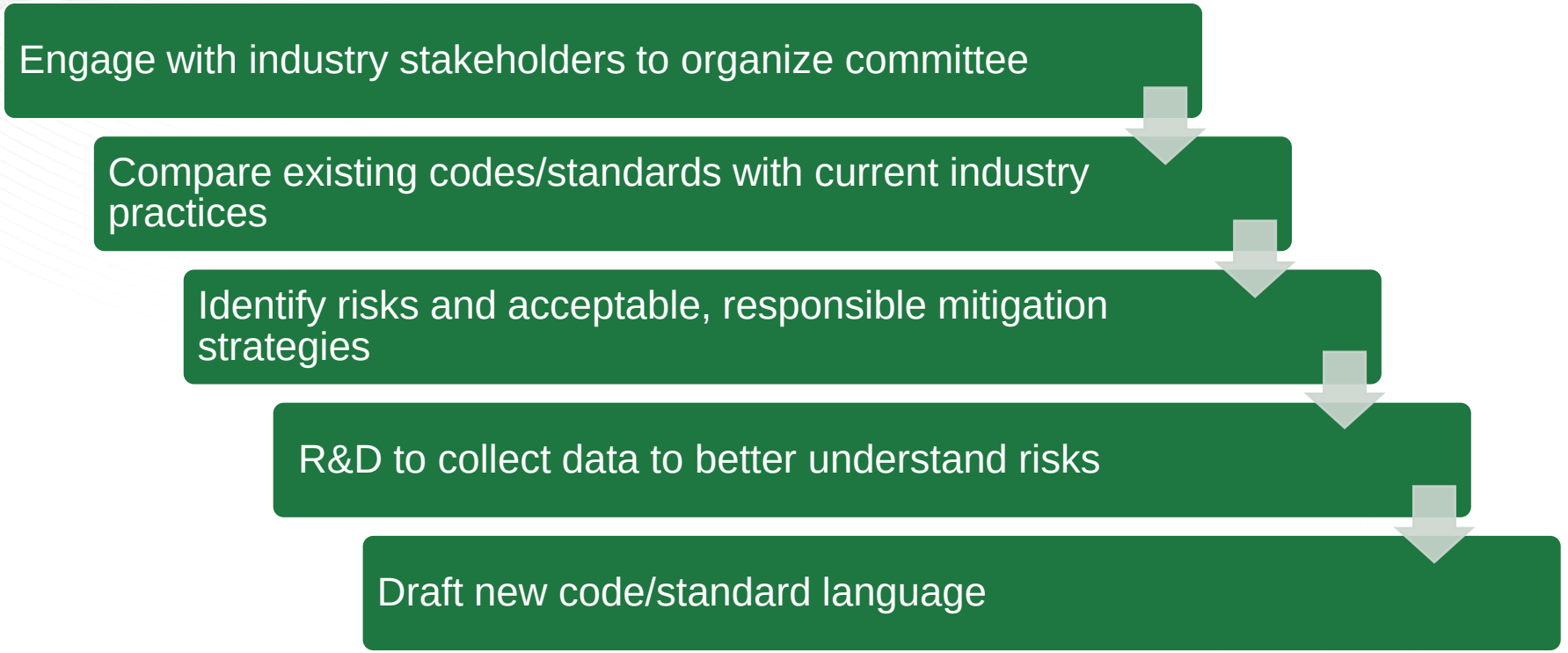
- Add herbaceous feedstocks to NFPA sprinkler standard
- New storage guidelines
- Guideline Document for engineers and code reviewers

Develop and test ASTM International “Standard Practice for Assessment of Relative Sustainability”

- Provide a clear process to help users assess, compare, and rank options
- Focus on practical indicators with quantitative / measured values

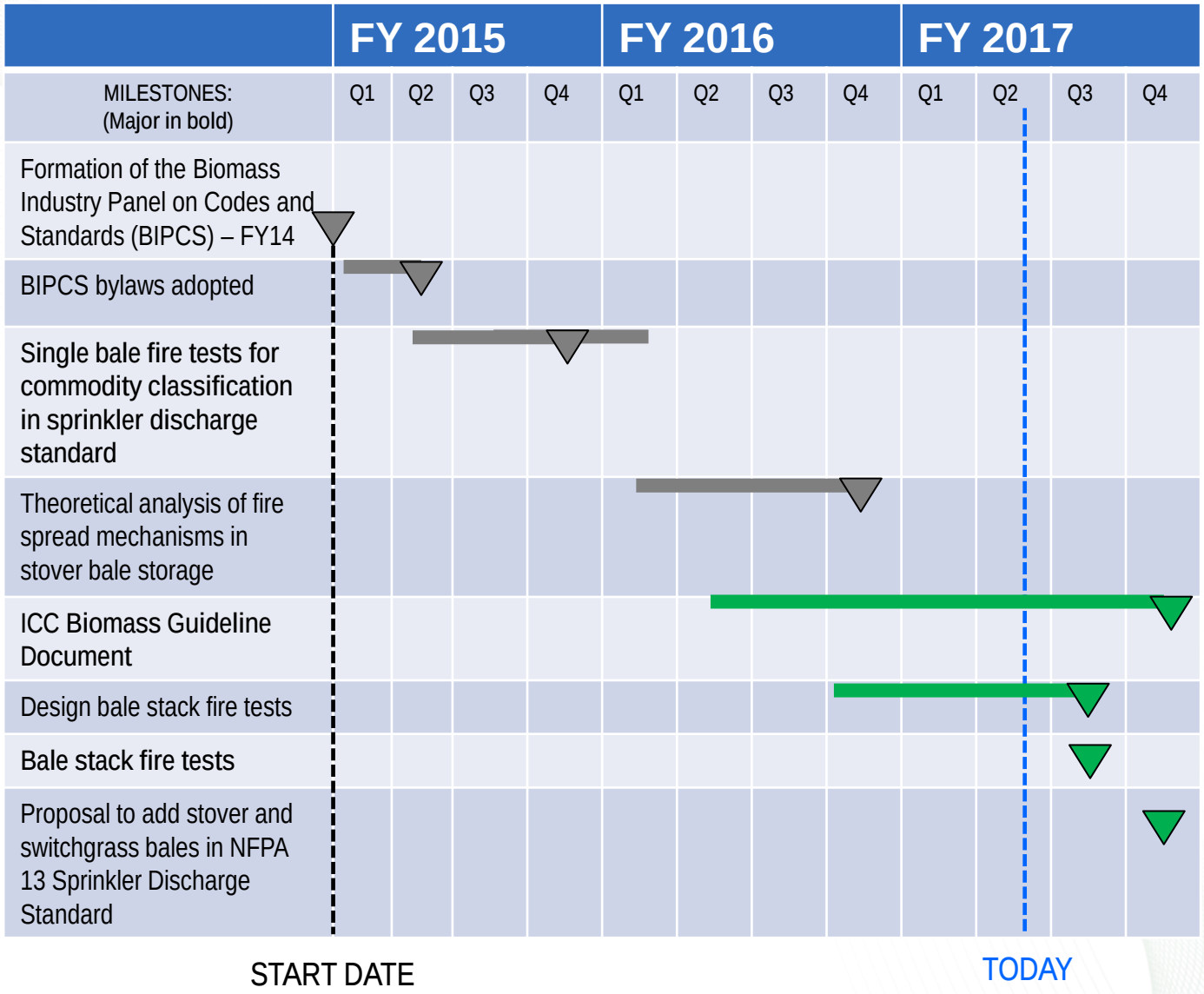
2 – Approach (Technical)

Objective: Standardization to support trade, limit risk, reduce costs

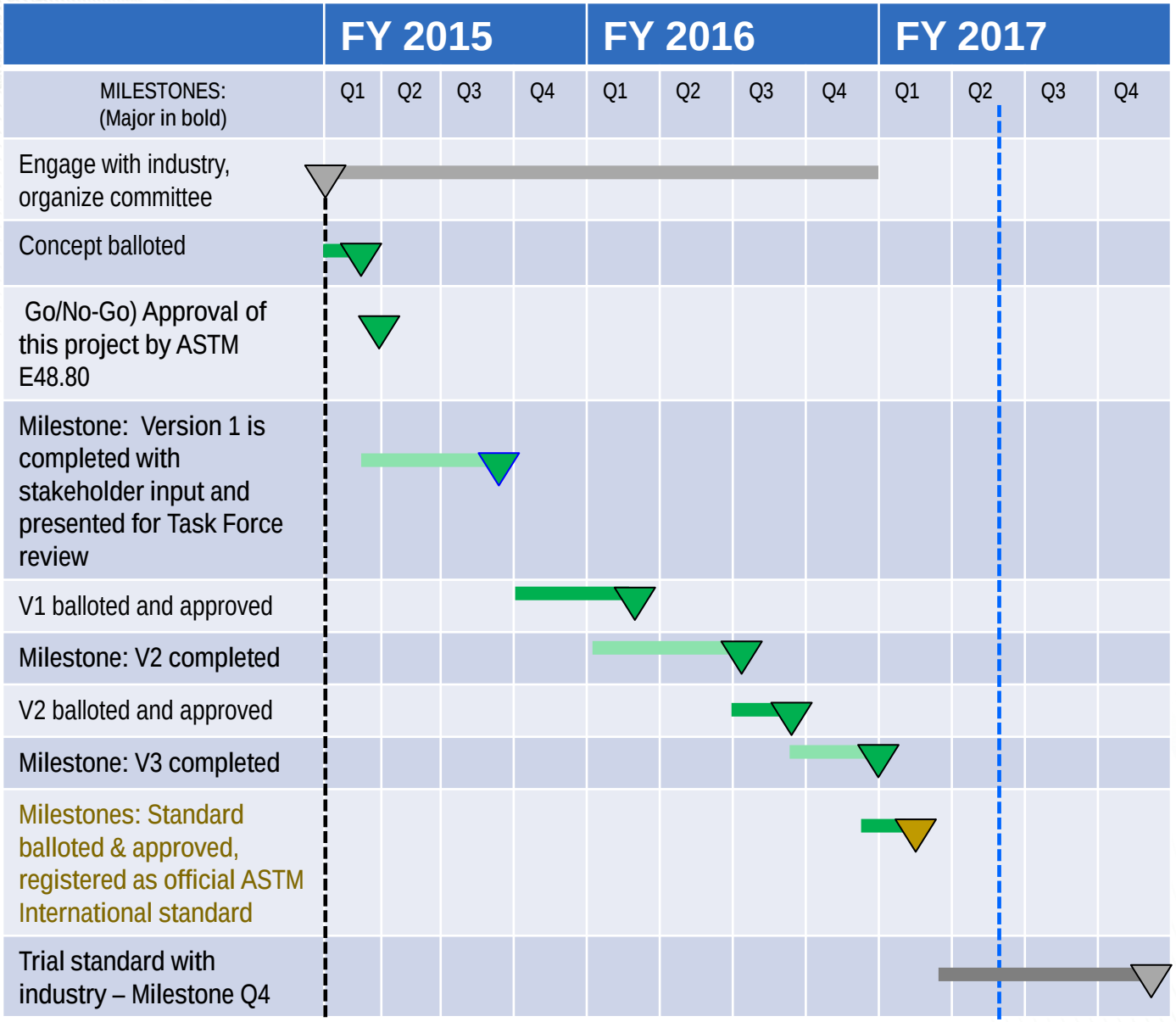


Challenge	Strategy
Industry scale-up hindered by unclear expectations and risk	Codes and standards enable companies to streamline processes and improve efficiency across the industry
Some industry codes/standards based on empirical evidence or observations only	Conducting experiments and trials for gathering data to inform standards development and application
Some standards are overly burdensome for industry	Engaging stakeholders early in process for feedback on experimental plans and document preparation

2 – Approach (Management) – Fire Codes



2 – Approach (Management) – ASTM Standard



Risk: Approval required for proposed standard (go/no-go); failure during one of three rounds of balloting possible.

Risk manageable: could have required draft iterations to address all stake-holder concerns.

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2 – Approach (Management)

- Principal Investigator: Erin Webb
- Fire Codes and Standards
  - ORNL (Erin Webb)
    - Lead development of R&D objectives and experimental planning
    - Manage Industry Panel communications, activities, dissemination of results
    - Contribute to proposal and document writing
  - Vista Consulting/Davidson Code Concepts
    - Lead development of code/standard change proposals
    - Lead writing of Biomass Technical Guideline
    - Monitor proposals to ICC and NFPA that could impact biomass industries
  - Industry collaborators
    - Advise on development of code proposals, presentations and other documents, and experimental plans
    - Provide biomass for experimental testing
- ASTM Sustainability Standard
  - ORNL (Keith Kline and Maggie Davis)
    - Conceptual design for Standard by ORNL,
    - Principal contributions on organization of standard and response to comments

Risk Registry Table

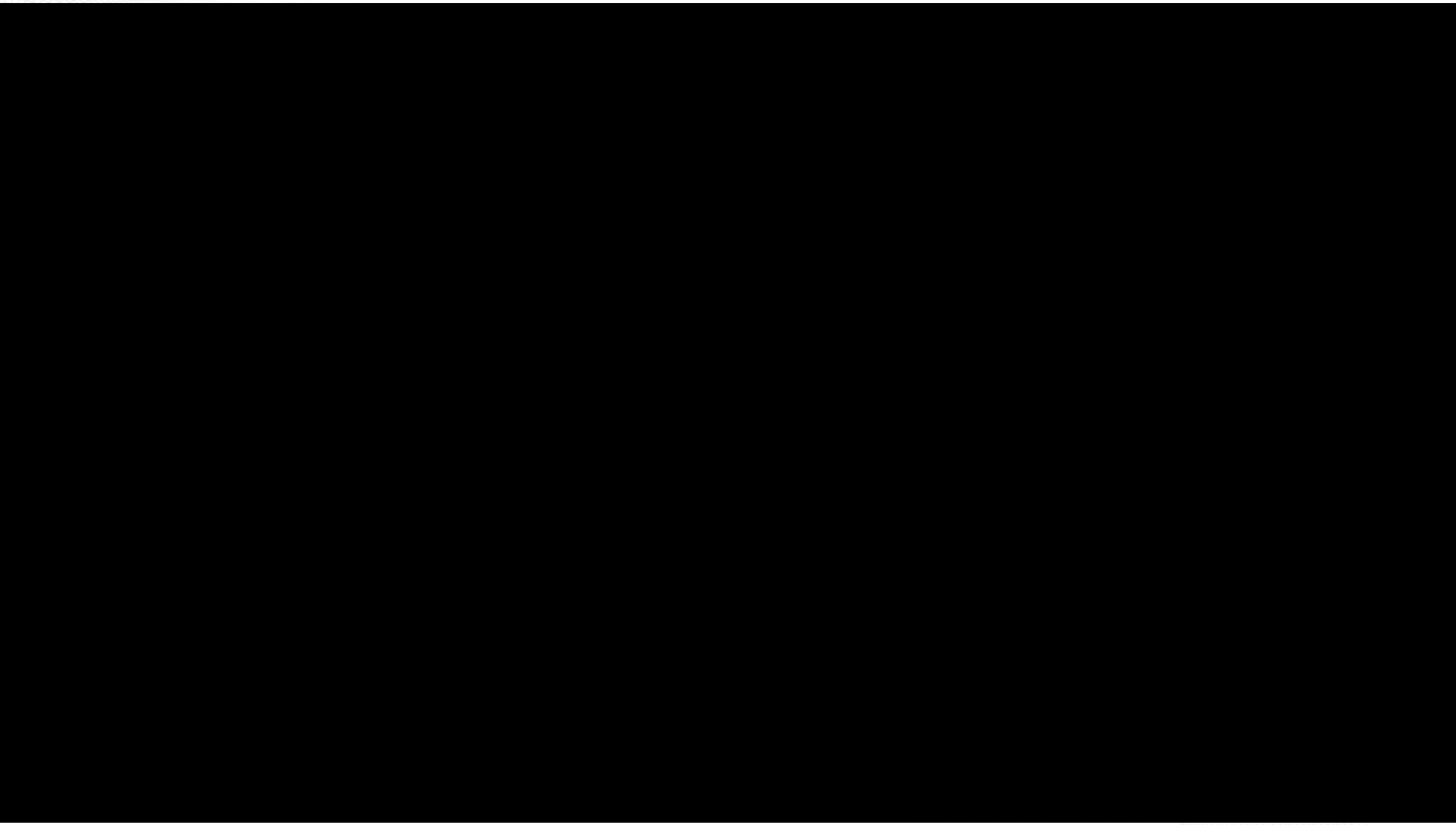
	Risk Identified		Mitigation Strategy		Current Status
Risk ID	Risk Description	Severity (High/ Med/Low)	Mitigation Response	Planned Action Date	Active/ Closed
1	Lack of industry support for fire codes and standards	Low	Convened a 1-day interest meeting. Strong participation an indication that industry will support the effort	July 2014	Closed
2	Lack of industry support for proposed new draft of ASTM standard	Low	FY15 Go/No-go decision point mitigated most risk. If committee supports proposal, it is very likely to continue to support development needed to overcome hurdles along the way	FY15 Q2	Closed

3 – Technical Accomplishments/ Progress/Results

Biomass Industry Panel on Codes & Standards

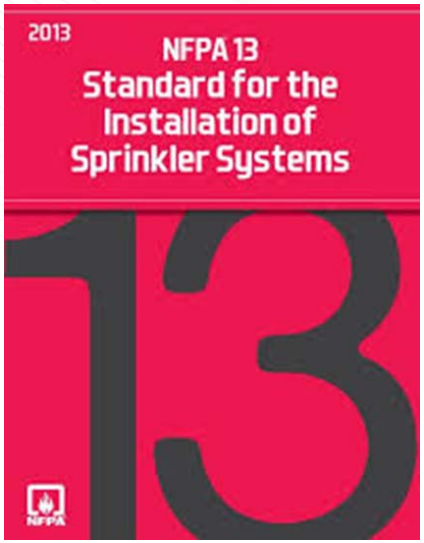
Objectives

- Currently meets monthly by phone and in-person 1-2 times annually
- Industry partners provide feedback on code proposals, presentations and other documents, and development of experimental plans
- Biomass for fire experiments provided by industry partners
  - Including additional time to prepare bales for standard test configurations



3 – Technical Accomplishments/ Progress/Results

Commodity classification testing of herbaceous feedstocks



- Goal: Add herbaceous biomass feedstocks to the National Fire Protection Association *Standard for the Installation of Sprinkler Systems* (NFPA 13)
- Why? To streamline sprinkler design for biomass-handling facilities and reduce design and development costs
- NFPA 13 technical subcommittee requires commodity classification tests performed at a certified laboratory

Tests performed in July 2015

- Corn stover (rectangular bales)
- Corn stover (round bales)
- Switchgrass (rectangular bales)

3 – Technical Accomplishments/ Progress/Results

Feedstock type and bale shape significantly impact fire growth

Stover rectangular bales

Switchgrass rectangular bales

Stover round bales

Photos courtesy of Bob Davidson, Davidson Code Concepts

Observations

- Switchgrass burns much better than stover
- Lower density of round bales enabled fire more access to oxygen
- After netwrap was burned away, outer layers of round bales fell away exposing fresh material to fire

Proposal to add bales stover and switchgrass to sprinkler discharge standard is in development

Round stover bales	Class IV
Rectangular stover bales	Class III
Rectangular switchgrass bales	Product rank exceeds that of cartons unexpanded group A plastics

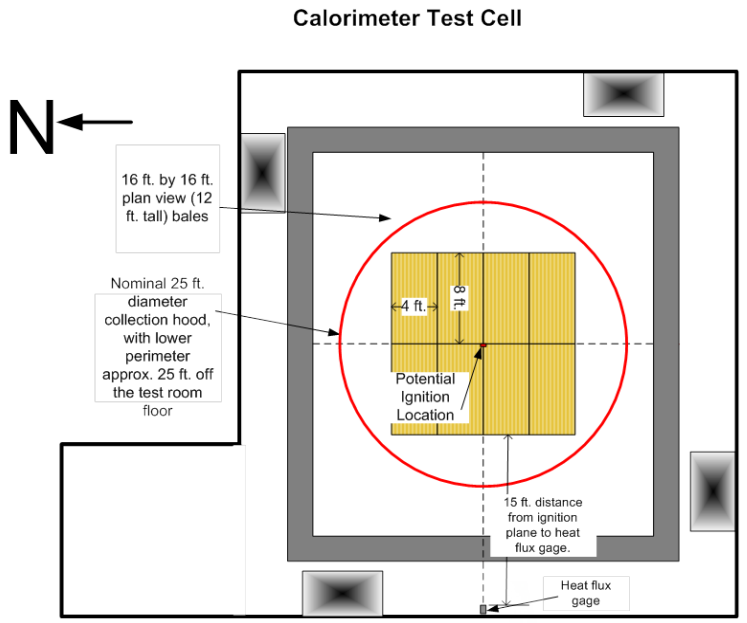
3 – Technical Accomplishments/ Progress/Results

Assessing fire risk in outdoor biomass storage

Developed R&D plan to design safer bale storage yards

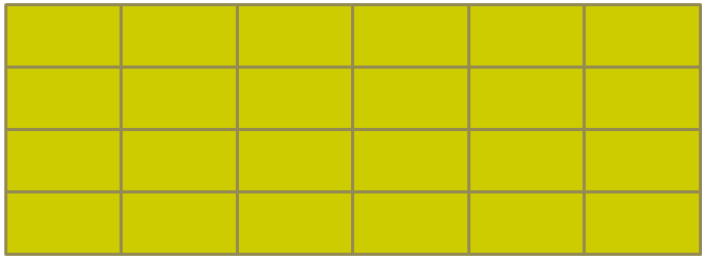
Experiment 1 (Spring 2017)

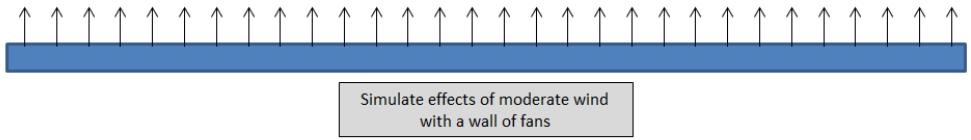
- ~ 15-20 bales
- Measure heat release rate
- Smoke generation
- Observe fire growth and dynamics in bale stack



Experiment 2 (July 2017)

- Full-scale bale stack
- Radiant heat flux at varying distances
- Ember generation and transport
- Performance of fire retardants





3 – Technical Accomplishments/ Progress/Results

ASTM E3066 “Standard Practice for Evaluating Relative Sustainability Involving Energy or Chemicals from Biomass” Q1 FY17 received unanimous approval

Final publication anticipated by end of Q2

Foundation for success: FY15-FY16 ORNL helped generate three iterations of draft standard that were balloted with the committee.

3 – Technical Accomplishments/ Progress/Results

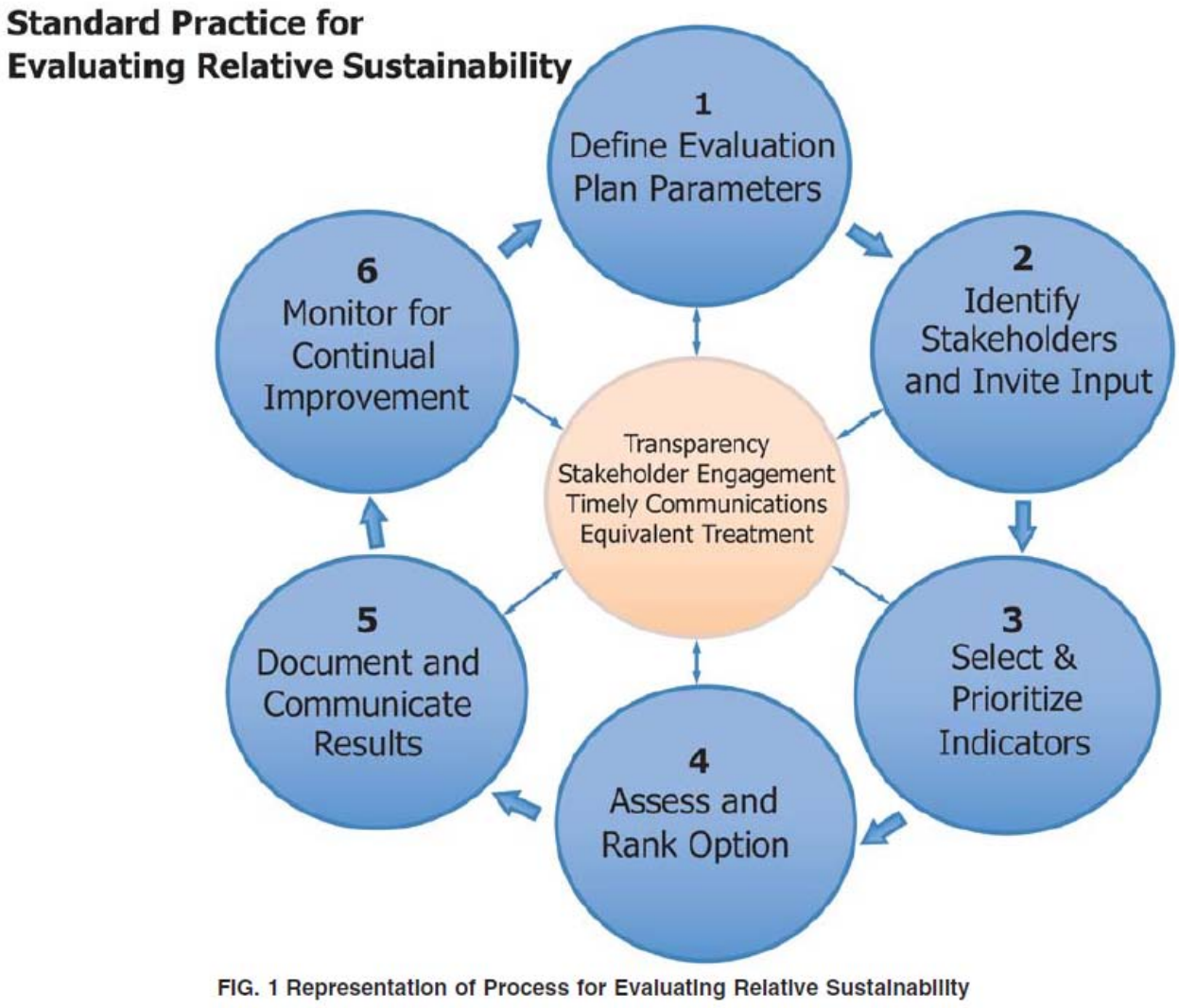


FIG. 1 Representation of Process for Evaluating Relative Sustainability

Excerpts: "*indicator, n* – Specific, science-based observable and measurable characteristic"

"Sustainability does not imply a steady state or an absolute value"

Progress: Unanimous approval of novel standard for assessments of *relative* sustainability with science-based indicators required.

Example application of ASTM Standard Practice:

POET clean cookstoves trial application
first step: Haitian charcoal (local fuel) & ethanol
next step: Uganda ethanol (local fuel) & POET ethanol

Follow standard practice, science-based methods
- Context specific goals & indicators

Support continual improvement of both systems

POET

HUMAN + NATURE

ABOUT PRODUCTS TECHNOLOGY SUSTAINABILITY

POET PARTNERS TO FIGHT POLLUTION, DEFORESTATION IN HAITI

PROJECT GAIA REPLACES WOOD-BURNING STOVES WITH ETHANOL STOVES

Wednesday, January 28, 2015

POET is fighting pollution and deforestation in Haiti through a new partnership with Project Gaia to replace wood-burning stoves with clean, ethanol-fueled cook stoves.

4 – Relevance

Engage industry in proactively addressing fire risks while not overburdening industry

Risks of fires (real and perceived) for commercial-scale biomass-handling facilities has emerged as a barrier to the developing bioenergy industry

Science-based codes and standards developed in this project will reduce risk to people and assets and improve insurability of biomass facilities

Decreasing costs and promoting fair comparisons in sustainability assessments

- ASTM E3066:
  - increases confidence and decreases costs of assessments
  - fills a gap that threatens US export markets
  - incentives for growth using best practices
  - applicable to the entire supply chain
  - any product (energy or chemical) from biomass

Industry engaged and eager to trial standard; reduces costs; applicable to entire supply chain, any biomass product (energy or chemical).

5 – Future Work
Fire Codes & Standards

- **NFPA 13 Sprinkler Standard**
  - Using data from UL tests, develop proposal to include herbaceous bioenergy feedstocks into NFPA 13 commodity classification tables for sprinkler design
- **Complete ICC Biomass Technical Document**
  - Will guide engineers and code reviewers in applying codes from the International Code Council for biomass-handling facilities
- **Best practices to reduce risk of fire spread in outdoor biomass bale storage yards**
  - Conduct experiments to measure heat release rate, radiant heat flux, smoke generation from bale stack fires
    - Safe separation distances
    - DuPont plans to use smoke generation rate data in dispersion modeling for siting bale yards to reduce impacts of smoke on nearby communities

5 – Future Work
Fire Codes & Standards

- **Engage stakeholders from other industries utilizing other feedstocks**
  - Woody biomass
  - Pellets and other advanced feedstocks
- **Biomass Industry Panel on Codes and Standards (BIPCS) as a model for future codes and standards development for other industry needs**
  - Biomass quality specifications (per industry requests)

5 – Future Work

Requested by industry partners, ORNL will help trial the new ASTM standard to at least one of the following options:

- Clean cookstoves (Uganda and/or Haiti)
- Bio-based plastics
- Industrial pellets

Results and draft manuscripts expected 2017

Summary, Fire Codes and Standards

Overview: Improve codes/standards to better reflect current knowledge of biomass fire risk and industry practices

Approach: Work with industry collaborators to develop evidence-based codes and standards

Accomplishments: Completed experiments for classifying stover and switchgrass for sprinkler design. Working on a biomass code guide and experiments for designing safer outdoor storage

Relevance: Engage industry in proactively addressing fire risks while not overburdening industry

Summary, ASTM Standard

Overview: Develop and trial ASTM International “Standard Practice for Assessment of Relative Sustainability” (E3066)

Approach: Approach: Standardization to support trade, limit risk, reduce costs.

Accomplishments: Unanimous approval of novel standard for assessments of relative sustainability with science-based indicators required.

Relevance: Industry engaged and eager to trial standard; reduces costs; applicable to entire supply chain, any biomass product (energy or chemical).

Additional Slides

Responses to Previous Reviewers' Comments

Overall Impressions

- This is an excellent project where DOE is partnering with the industry to help solve an immediate challenge.
- This project is targeted exclusively on market transformation and is not typical of previous grants from the Demonstration and Market Transformation (DMT) Program. It represents an area that has historically been underfunded or ignored, but represents valuable work in the area of industry standards that needs to be addressed as an integral part of enabling the emerging biorefinery industry, especially in the area of feedstock storage requirements to meet the requirements of insurance providers. DMT should remain open to other such programs and grants in other enabling areas, such as certification of biofuels, and supply chain issues for other bioenergy technologies, such as bio-heat, infrastructure certifications.
- This is very good work and a presentation on an area definitely needed for the industry.
- The project team has done an excellent job in preparing for the upcoming challenges that are involved with handling large quantities of biomass, while still maintaining adherence to relevant codes and regulations. Working to modify the relevant codes in advance of a new technology's introduction is a far-thinking approach, and warrants further support.
- This is important work since biomass refining on a large industrial scale introduces new standards and code issues. The project showed effective use of industry stakeholders in developing standards. Good progress was made in modifying existing fire codes.

PI Response to Reviewer Comments:

- We sincerely appreciate the encouraging comments from the reviewers. This project, focused on development and harmonization of codes and standards for the biomass industry, is a relatively new effort and, as noted by the reviewers, the structure and deliverables of this project are different than many BETO-funded projects. We hope that this BETO work can be a model, even beyond the bioenergy industry, for how government and industry can work together to proactively address safety and market barriers to enable industry growth while protecting personnel and assets.

Publications, Patents, Presentations, Awards, and Commercialization

Presentations

1. Webb, E. 2016. Addressing fire risk in biomass handling and storage. DOE Bioenergy Technologies Office Biorefinery Optimization Workshop; October 2016, Rosemont, IL.
2. *Morris, M. and E. Webb. 2016. Modeling Fire Risk in Biomass Storage Yards. ASABE Annual Meeting, Orlando, FL, July 17-20, 2016.
3. *Morris, M. and E. Webb. 2016. Modeling Fire Risk in Biomass Storage Yards. IBSS Annual Meeting, Oak Ridge, TN July 27-28, 2016.
4. Steppan, D. L. and E. G. Webb. 2016. *Biomass Commodity Classification Testing.* 2016 NFPA SupDet (Suppression and Detection) Symposium, San Antonio, TX. Presentations are available at: http://www.nfpa.org/2016supdetpapers
5. Webb, E. 2016. Addressing biomass fire risk. Industry Outlook into BioMass and Overcoming the Handling Difficulties. International Powder & Bulk Solids Conference, May 3-5, 2016 (Invited).
6. Webb, E. 2015. Addressing fire risk in biomass handling and storage. American Society of Agricultural and Biological Engineers Annual International Meeting; July 2015, New Orleans, LA.
7. Kline, KL. 2015 “Thirty years later: Reflections on the past and future of biomass utilization,” invited presentation to the ASTM International Committee E48. Fort Lauderdale, FL.
8. Kline, KL. 2016. “ASTM E-48 Celebrating thirty-one years: Biomass past and future” Invited presentation titled, for the ASTM International Meeting, Committee E-48, session on Sustainability Standards. Lake Buena Vista, Florida

** Student advisee*