

DOE Bioenergy Technologies Office (BETO) 2021 Project Peer Review

WBS 4.2.1.42

Scientific methods for biomass reference scenarios

23 March 2021

System Development and Integration

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ORNL is managed by UT-Battelle, LLC for the US Department of Energy



Project Overview --

- Concluded Sept 30, 2020. Achieved goals → Develop & test a “Protocol for Reference Scenarios involving Bio-based Systems”
 - Protocol (n): a defined set of rules and procedures (see abstract)
- **What were aims?**
 - Provide science-based approach for reference scenarios
 - Facilitate consistent & transparent communication of input values, assumptions, & implications
- **How is it done?**
 - Draft, revise, publish, & apply a standard protocol with inter-disciplinary contributions.
 - Partner with ASTM International to develop and publish results in an International Standard
- **Why is it important?**
 - Standards are needed for science-based, replicable, and useful assessments.
 - Project improves state-of-art which generates widely divergent results.
 - Explains key source of uncertainties, especially related to “land-use change” and forest ecosystems.



1 – Management plan

- **Management strategy: facilitate & develop products with shared ownership**
 - International participation via webinars include constructive suggestions from EU and international standards initiatives
 - Significant private sector engagement
- **Leadership: Kline (PI) & Efroymsen (ORNL)**
 - Organize & host webinars, conference calls, meetings (pre-COVID)
- **Communicate and collaborate with related projects**
 - Early-stage AOP planning to coordinate work with other BETO projects
 - Other labs invited to quarterly reviews with BETO (NREL often accepted)
- **Organize and lead work groups as required to**
 - Receive feedback from stakeholders
 - Engage with diverse perspectives
 - Discuss issues in context of a living document

Management: ORNL and stakeholder participants (examples)



**PI,
Stakeholder
Engagement**

Keith Kline
> 30 years
experience with
sustainable
development
projects involving
renewable energy
and stakeholder
engagement.

Roles: ORNL coordination and leadership: Identify and propose resources, develop initial draft materials for comment when necessary

Work Groups: planning, drafting, internal reviews, participation in calls, webinars (>60 total participants)

Stakeholder participation in stretch goal drafting team

- 7 representatives from industry, private sector
- 5 representatives from universities, research centers
- 10 from National Labs



**Leads
webinars &
tech reviews**

**Rebecca
Efroymsen**
Risk analysis,
30 years
studying
environmental
effects of energy
technologies;
Lead author of
Billion-Ton 2016
Volume 2

Advisory group role: comment on plans & draft products

- Academia
- Environmental NGOs
- Industry
- Other agencies
 - USDA Bio Preferred; USDA Forest Service
 - EPA
- DOE, ORNL sponsors & managers

Management plan efficiently achieved goals with stakeholder inputs.

1 – Management adapted to participatory approach involves Risks & mitigations

- **Success Factors**
 - Stakeholder participation in each step
 - Relevance, dissemination & adoption by others
- **Risks:** duplication of effort, lack of relevance, lack of input or adoption
- **Mitigations**
 - *Literature reviews (2)* to avoid duplication
 - *Maintain regular communications* and facilitate diversity of inputs
 - *Monitor, & engage* in similar or parallel processes when appropriate
 - Diverse stakeholders participate in drafting teams, webinars, meetings & regular calls (bi-weekly) to assure relevance and future use
- **Project management**
 - Weekly check-ins with ORNL's Bioresource & Engineering Group
 - Monthly BETO A&S calls, financial and progress reviews with sponsors /managers, quarterly progress reports, quarterly milestone reports...
- **Kline (PI) & Efroymsen (ORNL) facilitation role**
 - Propose information resources, encourage inputs
 - Develop initial draft materials for comment when necessary



2 – Approach: Detailed 3-Year plan & milestones *updated with each AOP per stakeholder feedback*

1. Conduct outreach, internal plans
2. Form inter-disciplinary teams; review procedures & assign roles
3. Develop a joint research plan
4. Conduct literature reviews & begin iterative drafting

FY 2018

5. Team Action Plan: review and approve by members
6. Draft text, lead webinars for participatory reviews
7. Test ideas with stakeholders
8. Solicit feedback → revise iteratively

FY 2019

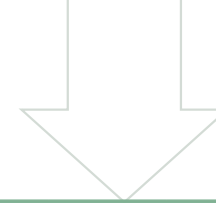
9. Support ballots, publish ASTM standard
10. Stretch goal: Apply protocol in test case (US- no biofuels)
11. Invite stakeholders, define scope, apply steps in protocol
12. Document lessons, share & promote adoption
14. Publish findings and outreach (ongoing)

FY 2020

Approach: Detailed 3-Year plan & milestones final two years addressed in this Peer Review

1. Conduct outreach, internal plans
2. Form inter-disciplinary teams; review procedures & assign roles
3. Develop a joint research plan
4. Conduct literature reviews & begin iterative drafting

FY 2018



5. Team Action Plan: review and approve by members
6. Draft text, lead webinars, participatory review & revision
7. Test ideas with stakeholders
8. Solicit feedback → revise plans & text iteratively

FY 2019



9. Support ballots, publish ASTM standard (iterative process)
10. Stretch goal: Apply protocol in test case (US- no biofuels)
11. Invite stakeholders, define scope, collect data &
12. apply protocol steps
13. Document lessons, share & promote adoption
14. Publish findings and outreach (ongoing)

FY 2020

2 – Approach – example of participants in stretch goal FY20

Work group		Reviewers and other interested parties	
Federal	Oak Ridge National Lab (5)	Federal	Oak Ridge National Lab (1US)
	Argonne National Lab (1)		Argonne National Lab (1)
	National Renewable Energy Lab (1)		US Dept of Energy (2)
	Idaho National Lab (2)		US Environ Protection Agency (3)
	US Environmental Protection Agency (1)		US Dept of Agriculture (1)
Industry	National Council for Air and Stream Improvement (1)	Industry	Environmental Health & Engineering (2)
	Kemin Industries (1)		NCASI (1)
	National Biodiesel Board (1)		SCS Global (1)
	Net Gain Ecological Services (1)		POET (1)
	POET (1)	NGO	National Wildlife Federation (1)
	Union of Concerned Scientists (1)		
Academia	U Wisconsin (1)	Academia	Iowa State (1)
	Penn State (2)		Colorado State (3)
	Purdue (1)		University of Illinois (1)
Consulting	Corr Consulting (1)		Penn State (1)
	Biofuels Consulting (1)		

2 – Approach: *develop plans and products with stakeholders to advance state of art*

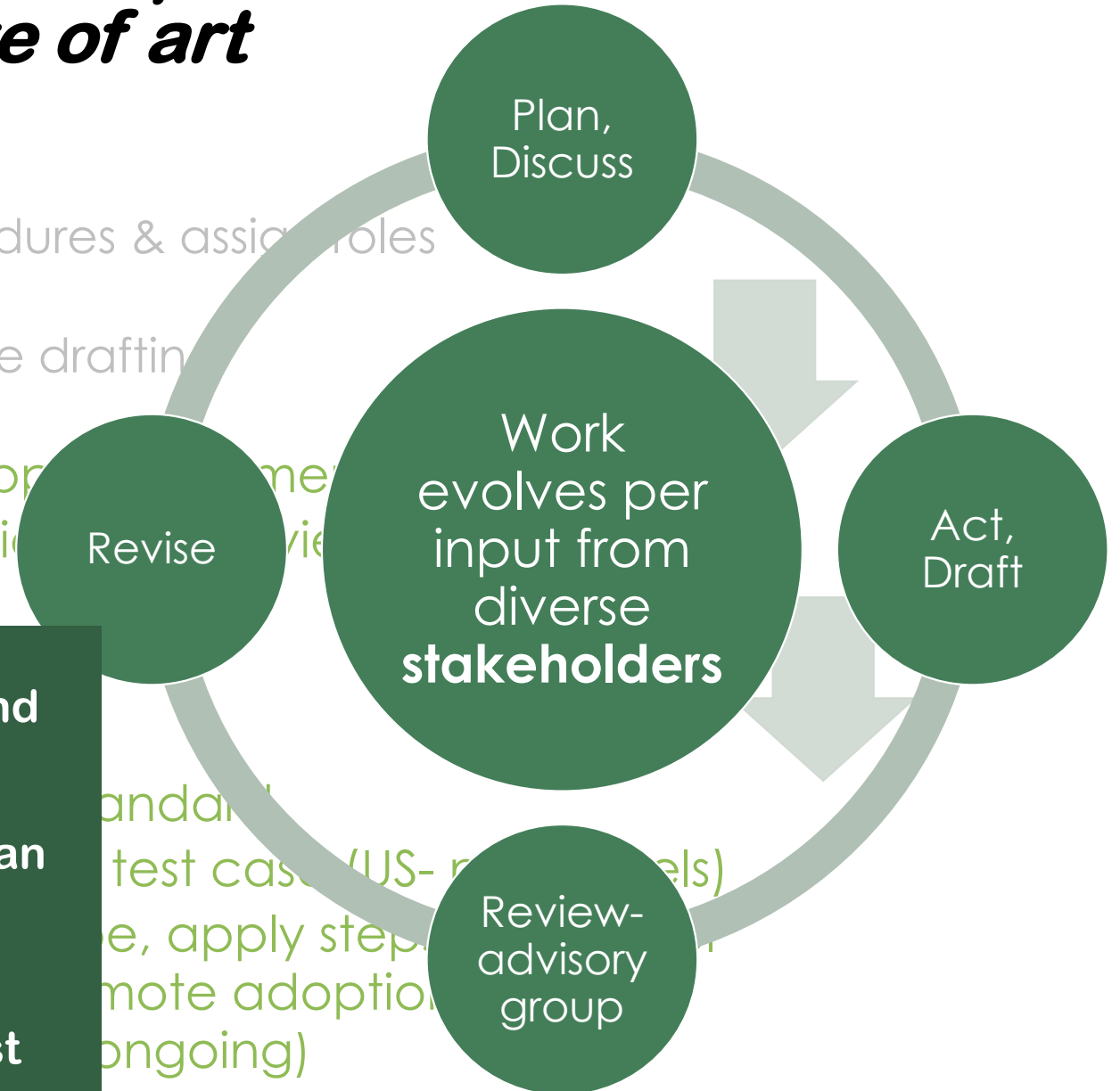
Challenges:

- Unforeseen difficulties with factual data sets
- Limited time and input from volunteers
- Defining “consensus” with variable participation

1. Co
2. For
3. De
4. Co

5. Team Action Plan: review and approval
6. Draft text, lead webinars for participation
7. Test ideas with stakeholders
8. Approach addresses BETO goals:

- At-E - Quantification of Benefits and Costs of options: A reference scenario is essential to measure impacts & inform how synergies can be enhanced and trade-offs minimized.
- ADO-C - regulations set minimum requirements for biofuels that must be documented.



3 – Impact – Developing standards for reference scenarios

State of the art: Variable assessment results are often attributable to different reference scenario assumptions.

- **Fill critical void:** Lack of standard procedures
 - constrain fair analysis
 - confuse public
 - undermine clear communications and trust among stakeholders

“an analysis that begins with a clear set of simple assumptions about a pellet mill can lead to a wide range of projected impacts depending on the scenario(s) selected for comparison.”

- Parish et al., 2017

- **Who decides:** What is an appropriate reference scenario when conducting assessments of the effects of biomass-based production systems?
- **Transparency:** In absence of standards, many analyses provide insufficient reference scenario data, leading to misinterpretations.



Effects of biomass harvest depend on what is assumed would happen in absence of harvest

3 – Impacts: Enabling fair comparisons is critical to identify innovative solutions and assess impacts

Figure: What would happen in absence of a bioenergy option? There are many potential answers to such questions. This project provides guidelines for identifying an appropriate reference scenario.



3 – Impact significance

Who cares?

- The Coordinating Research Council (CRC) for renewable transport fuels – special session topic
- NGOs, parties interested in climate-smart energy options
- Government agencies - USDA BioPreferred, USDA Forest Service, DOE, EPA
- International Standards organizations including ASTM International
- Industry representatives... *any stakeholder trying to assess effects of current or future biofuels and bioeconomy options*

Dissemination and application of results


Achieved goals: *protocol is published, accessible, and citable as adopted and published by ASTM International*

- Guide for documenting input values and assumptions
- Applied to at least 4 cases
- Generates more consistent quantification of trade-offs and opportunities to guide decision-making.

Program

**CRC WORKSHOP ON LIFE CYCLE ANALYSIS
OF TRANSPORTATION FUELS**

Argonne National Laboratory
Lemont, IL
October 15-17, 2019



WORKSHOP SPONSORS

API Argonne National Laboratory California Air Resources Board Canadian Fuels Association Concawe Neste	National Biodiesel Board Renewable Fuels Association U.S. Department of Agriculture U.S. Department of Energy - BETO Union of Concerned Scientists U.S. Environmental Protection Agency
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Session 3 Biofuels: "Compared to What?" Of Baselines, Reference Scenarios and Counterfactuals <i>Chairpersons: Keith Kine and Jeongwoo Han</i>			
1:00 PM	Estimating Displacement Emissions from By-Product, Waste, and Residue Biofuel Feedstocks	Nikita Pavlenko	International Council on Clean Transportation
1:20 PM	Developing Counterfactual and Comparison Scenarios to Evaluate the RFS	Tyler Lark	Wisconsin University
1:40 PM	The Need for a Standard for Reference Scenarios: The Development of a New ASTM Standard	Chuck Corr	Archer-Daniels Midland

3 – Impacts: Enabling fair comparisons is critical for quantifying effects and optimizing benefits

Reference scenario benchmarks are often lacking for bioenergy projects – in part due to limited data, complexities of interacting human and biological systems, and costs of comprehensive analysis.



Application of standard guidance

- **Increases confidence in results**
- **Provides incentives for using best practices**
- **Is broadly applicable to products from biomass**
- **Reduces complications & costs that arise if assessments undermine access for US bio-based products based on biased reference scenario assumptions**

4- Progress: Review of planned milestones FY19-20

Q	Milestones: See prior peer review for FY 18
1	Develop action plan to address comments received from stakeholders on draft protocol...
2	Test draft via application: prepare options and recommendations for reference scenario for the NREL project BEIOM Input/ Output (I/O) environmental impact framework.
3	Complete revisions for protocol v2; work group and ORNL team address all stakeholder comments received (per Action Plan).
4	Test revised draft protocol in 2 nd test case: document reference scenario options for the landscape design project in Iowa.
1	Update literature review to verify need and rationale for a science-based reference scenario protocol.
2	Form new work group, multi-sector stakeholders, to develop scope and objectives for a US Biofuels Reference Case scenario (FY20 stretch goal per FY19 Peer Review)
3	Support ASTM committee E-48 to complete balloting and approval of new International Standard based on the protocol, increasing community awareness.
4	Stretch goal: Coordinate work groups to apply protocol to priority case: USA without biofuels 2000-present.
EOP	Share lessons learned via publications and outreach.

4 - Progress: Status of milestones (examples)

Q2 FY 19	Test draft protocol via application to NREL project	Options and recommendations for reference scenario for the NREL BEIOM, Input/ Output (I/O) environmental impact matrix and supporting Excel Tables, sent to NREL March 15, 2019	✓
Q3	Complete revisions to the draft protocol	Work group and ORNL team addressed all stakeholder comments; documented changes & next steps in report to BETO.	✓
Q4	Test new draft protocol in 2 nd test case	Consensus document for set of 4 scenarios supporting multiple BETO projects linked to the Antares Group-led Integrated Landscape Design Project (next slide)	✓
Q1	Update literature review	Updated Dec 2019; verified that there is still a clear need for a science-based reference scenario protocol.	✓
Q2 FY 20	Form new multi-sector stakeholder work group to develop scope and objectives for a US Biofuels Reference Case scenario	['Stretch goal' added in response to FY19 Peer Review comments] Kick-off workshop Feb 2020; 40 people expressed interest to contribute including 20 from federal agencies and research centers, 9 representatives from industry, and 14 representatives from NGO, academia, or private consulting. Draft scope and objectives shared for team comment	✓

Progress – examples of test applications of the protocol supporting BETO projects

- Bioeconomy Scenario Modeling and Analysis and Integrated Life Cycle Sustainability Analysis (NREL)
- Antares Group-USDA Landscape Design Project (ANL, INL, PNNL, ORNL)
- Attribution Analyses & Inter-Agency Collaborations (ORNL)
- Triennial Report to Congress led by EPA, with multiple other agencies and laboratories
- Visualizing Ecosystem Service Portfolios of Agricultural and Forested Biomass Production (ORNL – next slide)

BEIOM

National-level
+ sectoral detail
+ regional detail
+ temporal detail

TRACI: EPA Tool for the Reduction and Assessment of Chemical and Environmental Impacts

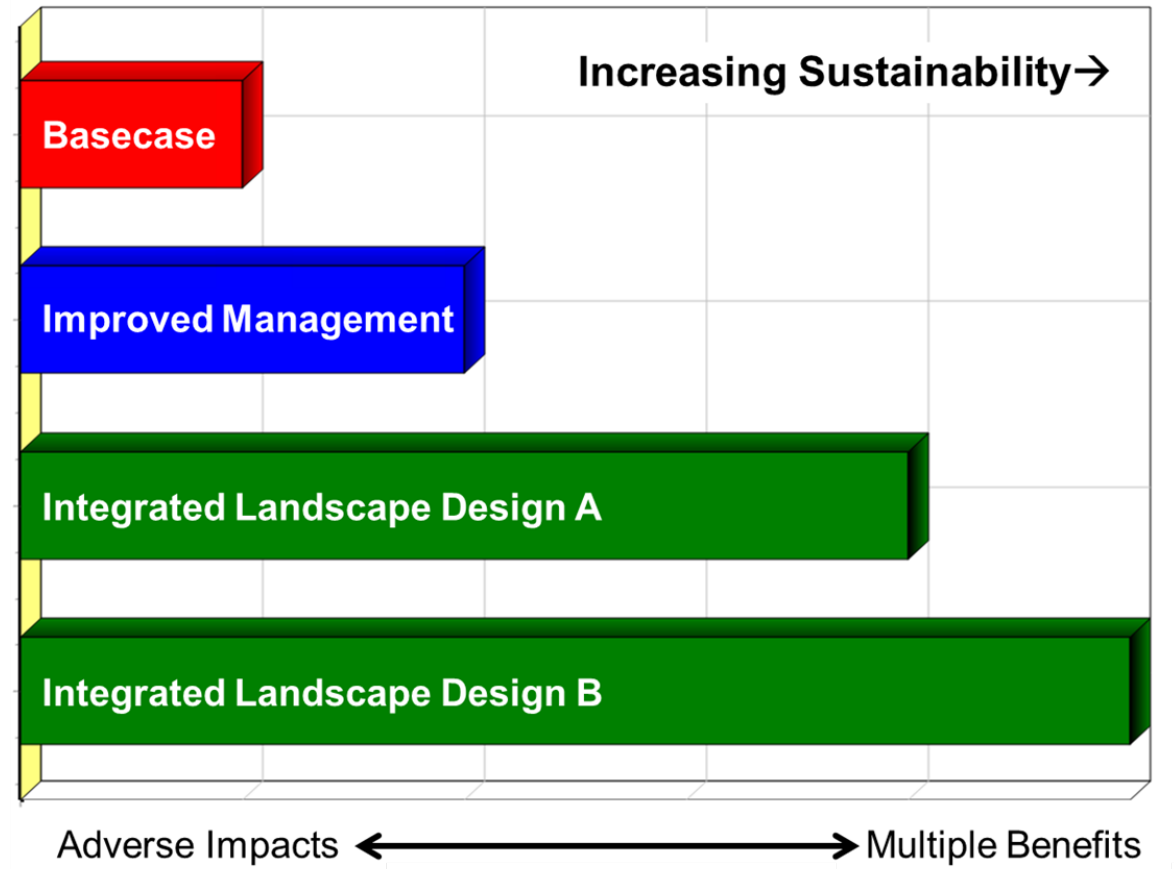
**Bioeconomy
Environmentally-
extended Input-Output
Model (BEIOM) NREL &
EPA**

Progress example: One of several test applications of the protocol

Protocol guidance applied with team working on visualization of effects under the Iowa Landscape Design Project (large, multi-lab, multi-donor, multi-institutional, initiative).

Applying protocol, 4 scenarios were developed with input from diverse team, enabling comparison of effects of different interventions based on a common base case (reference scenario) and standard data sets.

Results for the Nevada fuelshed in central Iowa



Clearly defined scenarios permit comparisons and quantified effects of four alternative landscape design scenarios (Nevada Fuelshed, Iowa). See BETO Projects 4.2.2.63; and 4.2.240

4 – Progress and Outcomes

Drafting team-work continues:
“Systematic approach to defining reference scenarios when assessing effects of land management -- Lessons learned” for submission to *Nature Sustainability*

Reference scenario selection process

Key steps and implementation challenges






Figures prepared by V. Vazhnik, co-author, project drafting team, summarize steps, challenges encountered, and analysis of data sets (paper in prep. 2021)

Dataset selection

	NRI	USDA Census of Agriculture
US geographic extent	✓	✓
Citability	✓	✓
20-year temporal extent	✓	✓
Annual temporal resolution	✗	✗
Thematic classes include major crops and land cover transitions	✓	✗
Can be aggregated or downscaled to different resolutions	✗	✗

4 - Progress: Status of milestones (examples)

<p>Q3 FY 20</p>	<p>Support ASTM committee E-48 to complete balloting and approval of new International Standard based on the protocol, increasing community awareness.</p>	<p>Industry engagement succeeded in developing and approving a new standard. (see next slide)</p>	
<p>Q4 FY 20</p>	<p>Stretch goal: Coordinate work group to apply final protocol to priority case: USA without biofuels 2000-present.</p>	<p>The work group applied the protocol to the challenging case of the US without biofuel development 2000-present. Did not reach conclusion as the group, confirmed that it is difficult to document and justify a reference scenario when there is not full agreement on the historical “factual” case.</p>	
<p>EOP FY 20</p>	<p>Lessons learned are shared, publications & outreach.</p>	<p>See attached list of 8 publications and 5 presentations. Two additional publications advancing but may need some support to complete process.</p>	

STANDARDIZATION NEWS

Featured January/February 2021

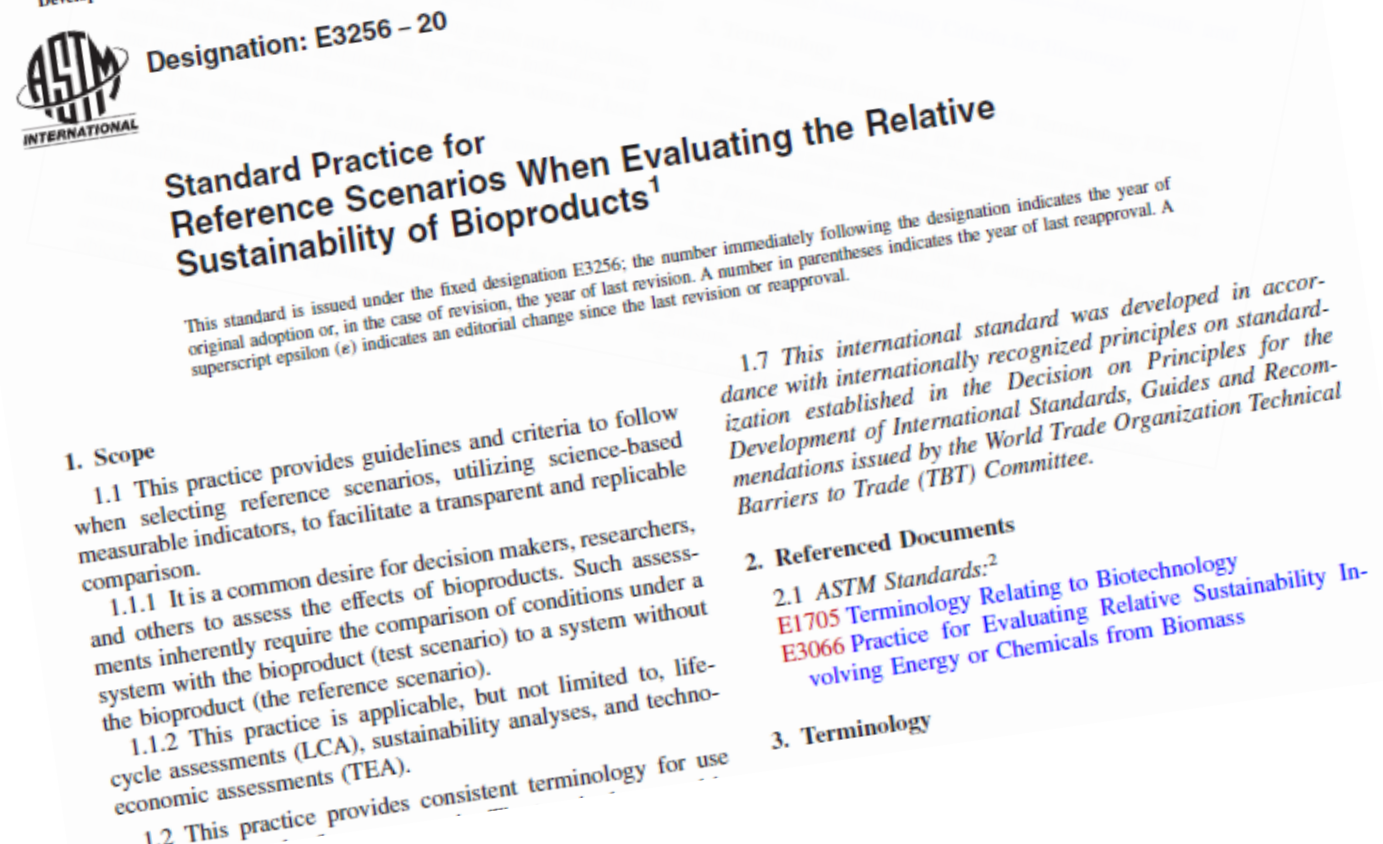
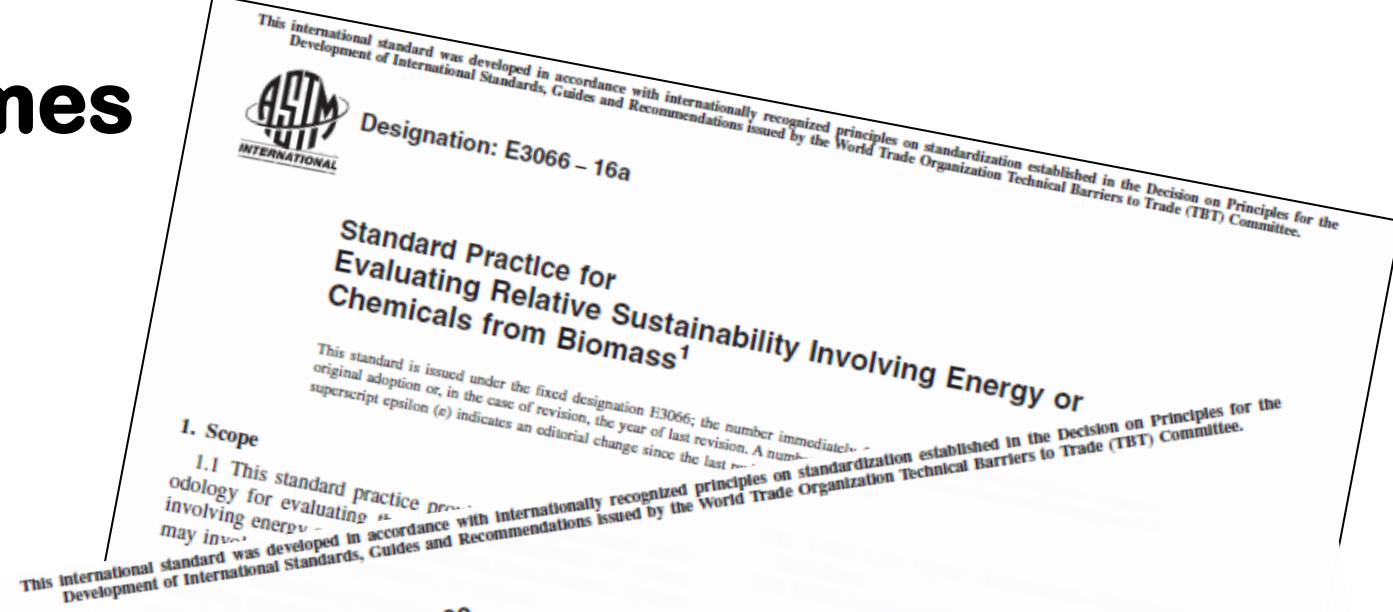
E48/Bioenergy and Industry
Chemicals from Biomass

Sustainability Evaluation Scenarios

Evaluating the relative sustainability of bioproducts using reference scenarios is the topic of a new standard. ASTM’s committee on bioenergy and industry chemicals from biomass (E48) developed the new standard, which fills a current need for a guide for developing reference scenarios and conditions

4 – Progress and Outcomes

- **New: ASTM International Standard Practice for Reference Scenarios (published 2020) ASTM E3256-20** based on protocol
- **Presentations, test cases, and publications** to get the word out
- **Bonus: Updated “Standard Practice for Evaluating Relative Sustainability” (ASTM E3066-20)**
 - Alignment with new Reference Scenario standard
 - Revisions based on reference scenario work group lessons
 - Improved, balloted, approved and **published (2020)**



Summary:

- Two ASTM International Standards published
- Stakeholders engaged to apply improved practices in BETO projects

So what?

- Well-documented reference scenario is essential for transparent, equitable assessments of bio-based production systems and renewable energy sources.
- Citable guidance now supports more consistent & comparable assessments of bio-based options.
- Lessons learned and progress made on stretch goal: to define US Reference Scenario data sets
- Society of American Foresters policy update on woody biomass (2019)

Value to BETO:

- Applicable to most supply chain analyses & assessments
- Applied to develop consensus around standard scenarios required for final reports of flagship Landscape Design Project (Antares Group, USDA, & 16 partners)
- Multiple labs & agencies developing 3rd Triennial Report to Congress with EPA, USDA



Quad Chart Overview

- Start: FY18 (Oct 2017)
- End: Sept 2020

	FY20	Project
DOE Funds	\$0 FY20 (\$190,000 forward funded in FY19)	\$710,000 3-yr life of project

Partners – over 60 stakeholders from diverse agencies, academia, private sector, consultants, DOE labs, NGOs, other research centers

Barriers addressed

Codes & Standards: Federal, state, & regional regulations set minimum requirements for biofuels that must be documented.

Quantification of Benefits and Costs: A reference scenario is essential to measure impacts & inform how synergies can be enhanced and trade-offs minimized

Objective: Develop a “Protocol for Reference Scenarios involving Bio-based Systems.

Stretch goal (added in final year): Apply protocol to US case.

Go/No-Go: Memo approved by BETO for “Go” (May/2019)

End of Project Milestones:

Final Protocol is published as an International Standard [*two standards were produced*].

Lessons learned are shared via publications, presentations, web sites [*see final slides*].

FY20 stretch: Apply to develop a consensus-based data set for US lands (crops, pasture, forestry, other) as basis for US biofuel reference scenario.

Funding Mechanism: AOP

Additional Slides

Go / No-go review memo

- Research team will assemble and review all comments received from stakeholder reviewers of the first draft protocol and will describe how each issue will be addressed in the next iteration of the protocol.
- Criteria:
 - Decision = *No-go* if >50% of comments received on the draft protocol are unfavorable, or if >50% of the comments received cannot be addressed by the team.
 - Decision = *Go* if majority of comments are constructive AND the team is able to describe how majority of comments will be constructively addressed in the next iteration of the protocol.
- Accomplishment: Report submitted to BETO provided spreadsheet with all comments received and responses from work group. All comments were constructive. Many reviewers offered thanks for undertaking this work.
- Approved as “go” by BETO – email May 2019.

Prior peer review comments and → responses from 2019

- “Relevant project... What will be the tangible results?”
 - Planned results include: (a) consensus-based journal publication with definitions of key terms and best practices; (b) an ASTM International Standard; (c) clear guidance to improve comparability and transparency of input values and assumptions used in assessments of effects of bio-based products; (d) Apply the protocol in two case studies.
- “There is no single, definitive reference case.”
 - We agree! Indeed, the draft protocol noted that there are an infinite number of potential reference scenarios and the best choice might be to use more than one to frame the results within a reasonable range.
- “What gives BETO authority to be final arbiter” in defining reference scenarios or standards?
 - We do not assume or imply any such authority. To contrary, we facilitate a process and support established procedures for voluntary standard-setting bodies such as ISO and ASTM.
 - The product is guidance and application of the standard is voluntary.
- “What is role of civil society?... What stakeholders are consulted?”
 - Civil society was encouraged to contribute through multiple outreach mechanisms and announcements. Project included representatives from: seven universities (e.g., UGA, NCSU, UC Davis, Leeds); eight NGOs including the Pinchot Society, Union of Concerned Scientists, and the NSF Standards Foundation; seven industries involved in biofuels, bioplastics and biochemicals production (e.g., POET, Cargill, Enviva); eleven international organizations (e.g., FAO Rome and International Standards bodies); four National Labs; USDA, EPA, DOE, state government...

Publications since last peer review

1. ASTM Standard E-3256-20. “Standard Practice for Reference Scenarios when Evaluating the Relative Sustainability of Bioproducts.” ASTM International, West Conshohocken, PA. <https://www.astm.org/Standards/E3256.htm> The new International Standard for science-based reference scenarios was developed based on the BETO-sponsored protocol drafted under this project. Published in Q3, FY20.
2. ASTM Standard E-3066-20 Standard Practice for Evaluating Relative Sustainability Involving Energy or Chemicals from Biomass. www.astm.org/Standards/E3066.htm This international standard approach for assessing sustainability was improved and updated based on recommendations submitted by the PI (Kline), synthesizing experiences gained under the Reference Scenario project.
3. Kline KL, Parish ES and Dale VH. The importance of reference conditions in assessing effects of bioenergy wood pellets produced in the southeastern United States. *World Biomass 2018-2019*; p 82-86. DCM Productions, United Kingdom. <http://www.dcm-productions.co.uk>
4. Society of American Foresters (SAF) Committee on Forest Policy -- revised position statement on Utilization of Woody Biomass for Energy developed with contributions from ORNL team per protocol guidance (M. Davis July 2019)
5. Systematic approach to reference scenarios when assessing effects of land management – Lessons learned (drafting team is preparing manuscript for submission as Brief Communication to *Nature Sustainability* --in prep).
6. (Corr and Kline, Jan 2021). New standard guidance for more consistent & comparable sustainability assessments of bio-based options – Description of the new ASTM standard, potential applications and impacts. Published in *ASTM Standardization News*, pg. 11-12.
7. Dale VH, Kline KL, Parish ES, Eichler SE. 2019. Engaging stakeholders to assess landscape sustainability. *Landscape Ecology*. DOI: 10.1007/s10980-019-00848-1. <http://link.springer.com/article/10.1007/s10980-019-00848-1>
8. Junginger M, Fritsche U, Mai-Moulin T, Thrän D, Thiffault E, Kline KL, Dale VH. 2019. Measuring, governing and gaining support for sustainable bioenergy supply chains: Summary of Objective 3: Understanding positions and underlying motivations of stakeholder groups relative to their perceptions of bioenergy (21 pages). IEA Bioenergy Inter-Task Report. Published by IEA Bioenergy, IEA Energy Technology Network www.ieabioenergy.com
9. ASTM Int'l WK 68950 (Multiple iterations of draft Standard Practice for Selecting Reference Scenarios) for ballot (06Nov2019).

Presentations since last peer review

1. Presentation for CRC, “Biofuels Compared to What? Of baselines, reference scenarios and counterfactuals” (Oct 2019, Coordinating Research Council, Argonne National Lab) -- Organized and chaired session for the LCA Workshop Oct 16-17.
2. Poster and Presentation, “On the importance of a well-documented reference scenario for assessing progress toward sustainability” for the AIChE Institute for Sustainability and NSF Conference on Bioenergy Sustainability (Nashville, Oct 2019).
3. Presentation for 2019 Annual Meeting of the Landscape Design Team, Clive Iowa (Dec 2019), “Quantifying & Visualizing Progress Toward Sustainability –Standard Scenarios.”
4. Co-chaired and organized AIChE workshop on bioenergy sustainability, Nashville, TN, which included ORNL presentation on reference scenarios, inviting comments and stakeholder participation.
5. Proposed scope and goals presentation (20 Feb, 2020) for kick-off webinar for multi-sector stakeholder group. (See Q2 Milestone Report Attachment B)

Other Reports since last peer review

1. GBEP Attribution Guidelines (contributions to incorporate appropriate reference scenario considerations; Jan 2020).
2. Draft Report on Recommended Reference Scenario and supporting Excel Tables (sent to NREL March 15, 2019). And revised Report on Recommended Reference Scenario (sent to BETO and NREL, April 1, 2019).
3. Reference Scenario Protocol for Assessing Bio-Based Systems V₃ distributed June 30 2019 after incorporating comments.
4. July 2020: 4.2.2.40 Sustainability Project (Parish) and Landscape Design Project (Antares Group), a set of common reference scenarios were finally endorsed and posted on the project team share-site. (also, FY19Q4 Milestone Completion Rpt appendices).
5. Singh N. (with Kline) 24 June 2020. “National Resources Inventory (NRI) Data – summary of historic trends in land cover and use.” Set of Figures to support dataset review, after stakeholder identified NRI as the best source for US (factual scenario) data.
6. Report (19 March 2020): Data Sets for a US Reference Scenario – Work plan, schedule and outline for the multi-institutional Work Group developing data sets and documentation. Submitted to BETO, Attachment B to the Q2 Milestone Report.
7. “Suggestions for improving the ASTM draft reference scenario standard” submitted by Kline email (20 March) to ASTM Task Force leader, for review and consideration by ASTM sub committee.