Cooperation on Sustainability Standards

Center for BioEnergy Sustainability

Climate Change Science Institute

USDOE Biomass Program webinar “Global Solutions for Global Challenges: International Collaborations to Advance Bioenergy Research”

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In collaboration with ORNL staff, ISO PC248 membership and others (see references)

http://www.ornl.gov/sci/ees/cbes/

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Summary

- Bioenergy and climate change are global challenges that are best addressed in processes that include international cooperation
- International cooperation is more effective when it can
  - build on existing projects, agreements, and frameworks
  - respond to mutually perceived priorities
  - respond to windows of opportunity that influence strategic decisions, policies and programs, and
  - expand and solidify a sense of teamwork.
- International standard development offers a transparent platform for building consensus around global clean energy deployment
- Many challenges remain. We lack
  - accurate representations of local LUC dynamics and causal models validated at multiple scales
  - effective incentives for compliance and continual improvement
  - adequate empirical data to test models and hypotheses
  - multi-disciplinary, multi-institutional problem-solving mechanisms
  - lower transaction costs and higher value-added

Topics

- Definitions
  - Sustainability
  - Standards
  - Indicators
  - System boundaries…
- Collaboration benefits
- Examples
- Questions and discussion

Sustainability has been an explicit global concern for decades:

- Brundtland Commission Report (1983-1987)
- UN Conference on Environment and Development in Rio (1992)
- Earth Summit on Sustainable Development, Johannesburg (2002,“Rio+10”) and “Rio+20” (2012)
- US NAS: *Our Common Journey – A Transition to Sustainability* (NRC 1999)
- Evolving “sustainability science” at university centers - Arizona State and Harvard (see Kates et al., <u>Science</u>, 2001 and *Readings in Sustainability Science and Technology 2010)*

WHAT IS TO BE SUSTAINED:	FOR HOW LONG? 25 years "Now and in the Future" Forever	WHAT IS TO BE DEVELOPED:
NATURE Earth Biodiversity Ecosystems		PEOPLE Child Survival Life Expectancy Education Equity Equal Opportunity
LIFE SUPPORT Ecosystem Services Resources Environment	LINKED BY: Only Mostly But And Or	ECONOMY Wealth Production Sectors Consumption
COMMUNITY Cultures Groups Places		SOCIETY Institutions Social Capital States Regions

Slide adapted from T Wilbanks presentations to KSS workshop, ORNL 2012

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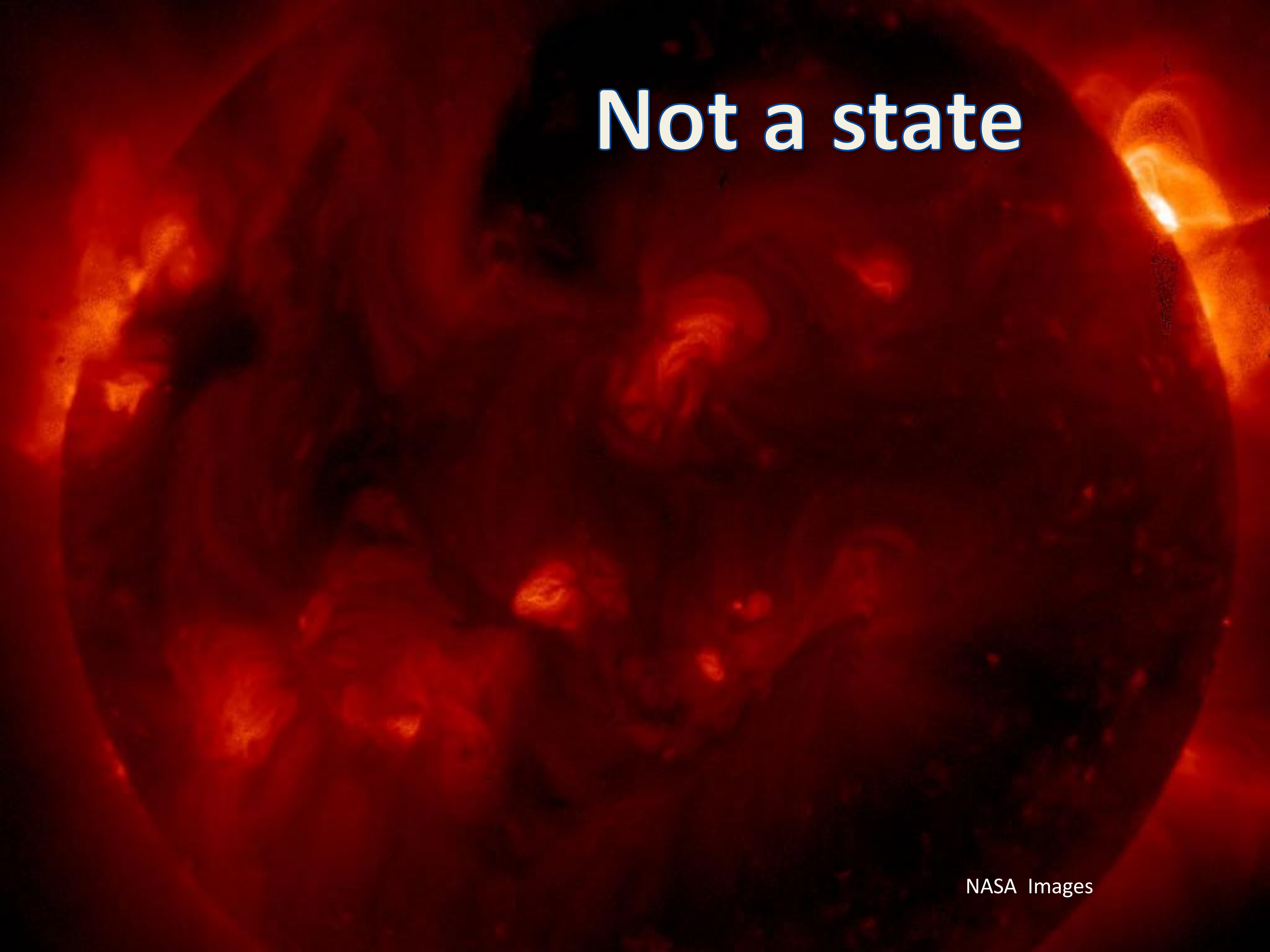
But what is *sustainability*?

NASA Images

Not a state



NASA Images


A trajectory…
NASA Images

Relative to other possible trajectories

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Scale matters

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Perspective matters
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How we define and measure is fundamental to understanding

Measurement is challenging…

"Not everything that can be counted counts, and not everything that counts can be counted."

-William Bruce Cameron

NASA Images

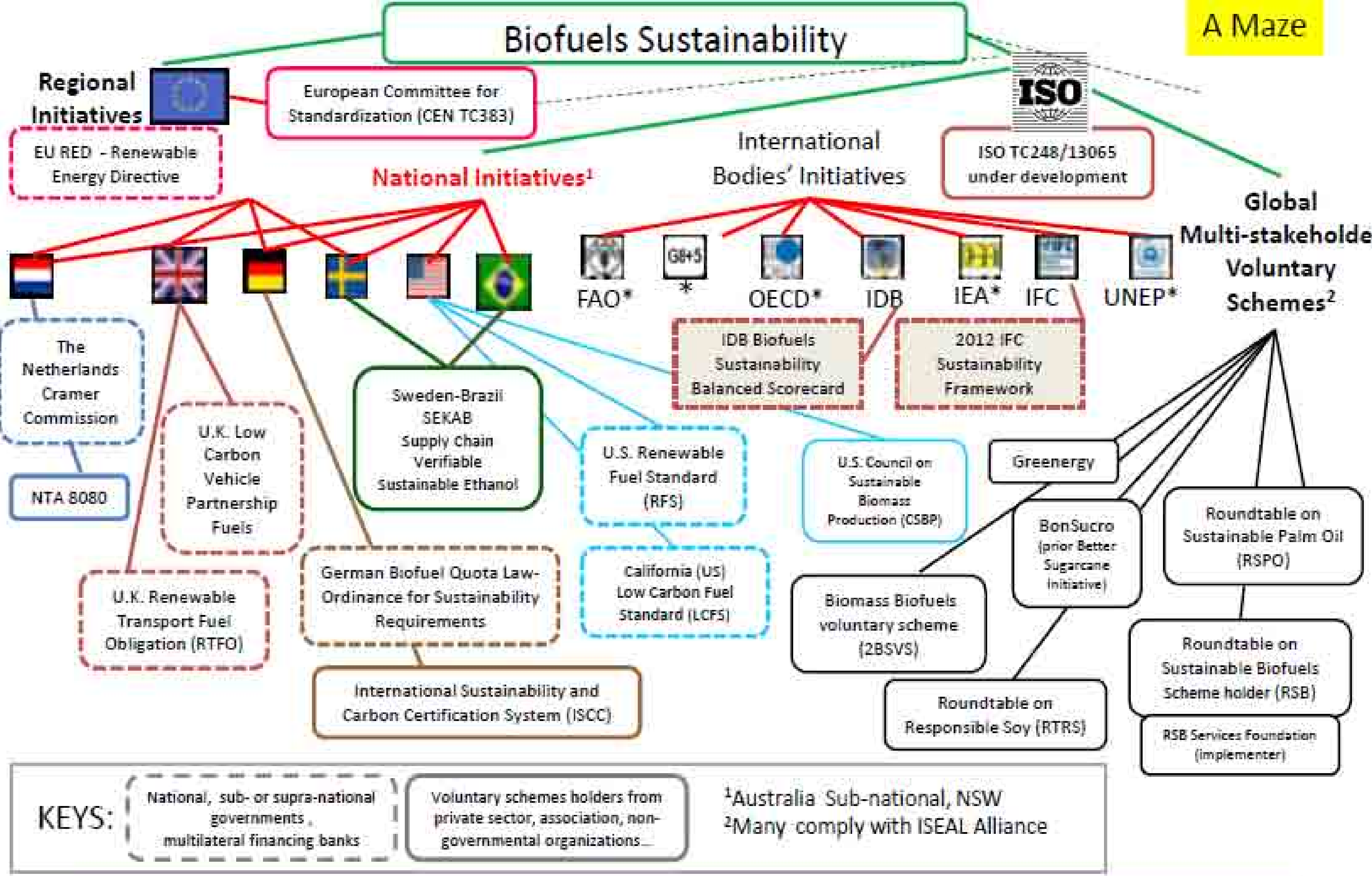
The performance paradox:
You can’t manage
what you can’t (or don’t) measure.

NASA Images

“Sustainability” An overused term

The capacity of an activity to continue while maintaining options for future generations and considering environmental, social and economic dimensions

- Measurement and interpretation always “depend”
- Priorities vary with place and time (system boundaries)
- Compared to what? Reference case scenarios can pre-determine outcomes
- Trade-offs and choices are ever present
- Analysis to support informed decisions



***Enabling entities: IEA** Bioenergy tasks (multiple countries) LCA methodologies and sustainability expertise; Global Bioenergy Partnership (**GBEP**) 2011: Sustainability themes and indicators; **FAO**- Germany: 2012 Bioenergy and Food Security Criteria and Indicators (**BEFSCI**) tools

Source: NREL (Chum, Warner), UNICA

International Standards

What is a standard?

- A standard is a document that
  - Provides requirements, specifications
  - Sets forth guidelines
  - Can be used to ensure consistent and appropriate
    - Materials,
    - Products
    - Processes
    - Services
- ISO has published over 19000 International Standards

What are benefits?

- Help ensure products and services are fit for their purpose
- Reduce costs by minimizing waste and errors and increasing productivity
- Facilitate free and fair global trade
  - Access to new markets
  - Level the playing field for developing countries

Source: adapted from www.ios.org

International cooperation on standards can:

- Accelerate research and development results
- Accelerate deployment of new energy technologies
- Reduce global greenhouse gas emissions/global climate forcing
- Create confidence among parties
- Accelerate growth of export markets for clean energy products and technologies

Slide adapted from KL Kline presentation to 2011 DOE OBP External Peer Review. See report on OBP website.

For example:

- To develop secure, sustainable energy sources, key barriers to bioenergy market growth must be addressed.
- Key barriers to acceptance of bioenergy are related to concerns (such as LUC and food security) that cannot be effectively addressed in the absence of consensus on:
  - definitions
  - criteria and methods
  - modeling for land-use and sustainability
- Research that improves understanding of sustainable bioenergy production and of the conceptual relationships required for more reliable modeling, can help address these threats.
- This research requires international collaboration to resolve contentious issues and effectively communicate results.

Graphic: www.ios.org

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Toward Strategies for Multiscale Collaboration and Transformative Change:

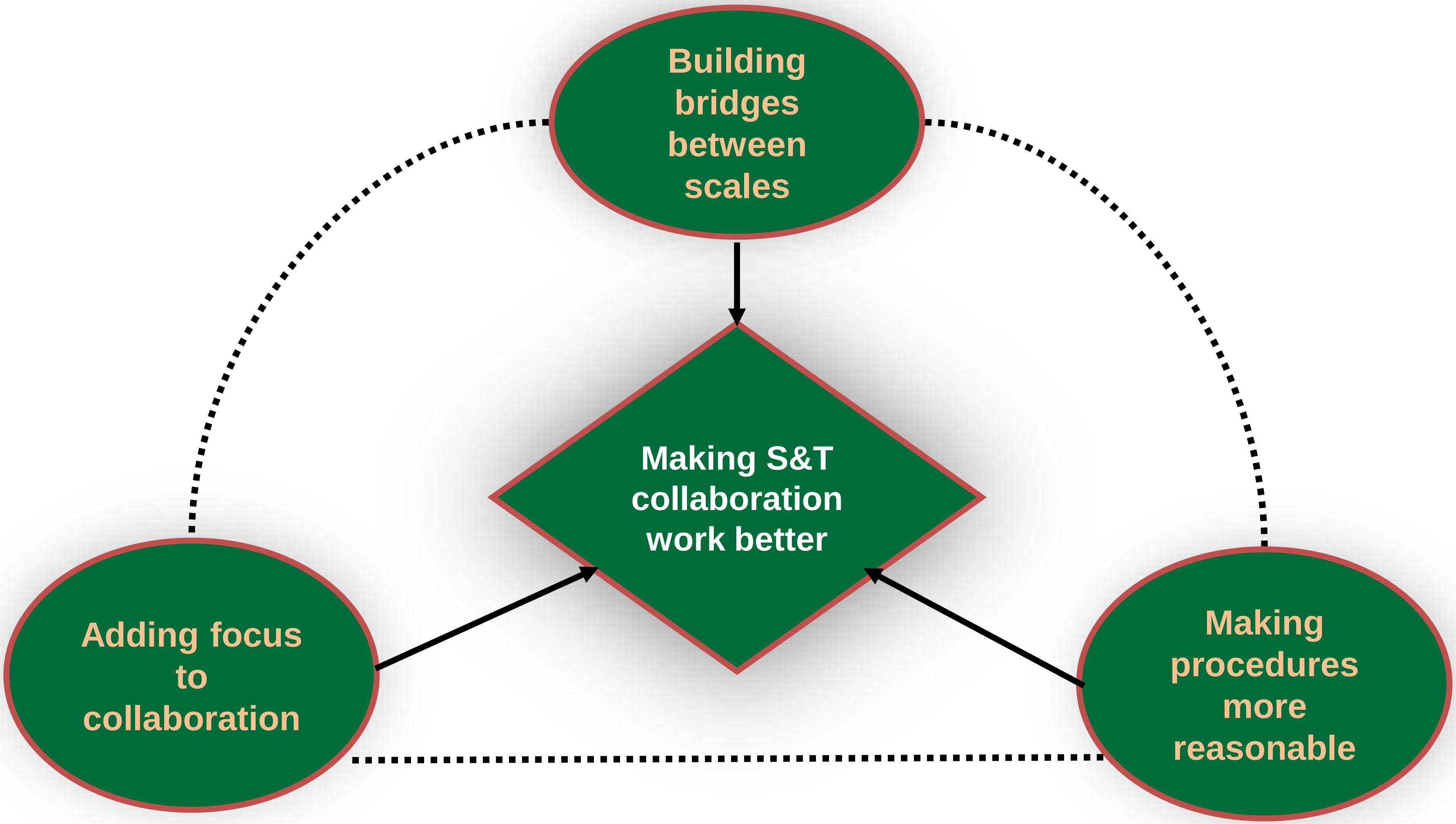


FIG. Source: Wilbanks T. 2011. Perspectives from Sustainability Science about Energy. CBES Forum: http://www.ornl.gov/sci/besd/cbes/

For example:

- Participation in processes to establish international standards helps ensure the processes are compatible with policy objectives.
- Building consensus and developing standards facilitate trade and reduce barriers to biofuel market development.
- ***An effective ISO Standard will reduce transaction costs while advancing the technical and market readiness of more sustainable bioenergy production.***
- Even in the absence of an ISO Standard, participation in the process can be productive and influential.
- Scientific exchange among key countries and international organizations helps accelerate deployment of more sustainable, clean, renewable bioenergy supplies.

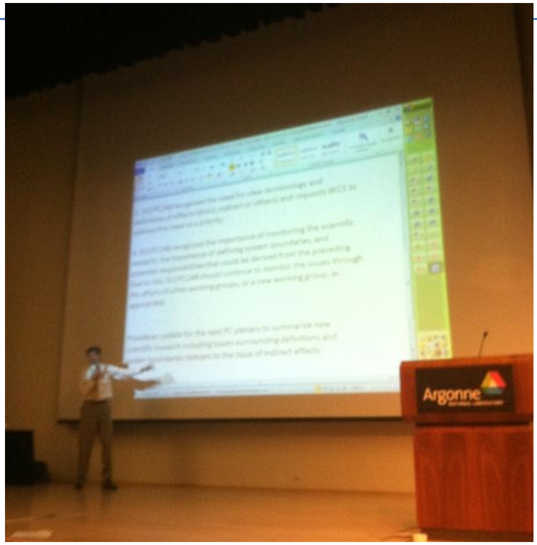
DOE supports science-based approaches

Examples of contributions stemming from international cooperation include:

- Scientific publications addressing key concerns
- Reviews of international sustainability documents/proposals
- Interactions with 15 international organizations and dozens of bilateral partner agencies and universities
- Building fruitful linkages among international public-private sector partners…

ISO
GBEP Global Bioenergy Partnership
Roundtable on Sustainable Biofuels
EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
NREL
CTBE Brazilian Bioethanol Science and Technology Laboratory
ICONE Institute for International Trade Negotiations
GSB
CONSERVATION INTERNATIONAL
IDB Sustainable Energy and Climate Change Initiative
novozymes Rethink Tomorrow
CBES Center for BioEnergy Sustainability

INTERNATIONAL STANDARDS AND GLOBAL ISSUES AFFECTING SUSTAINABILITY OF BIOFUELS



ORNL Approach

- Contribute to scientific research and consensus building to address key barriers to growth of bioenergy markets
- Strategic engagement in international processes
- Build and sustain relationships with international partners and governments
- Provide expertise for development of effective criteria and indicators
- Assist with requested reviews and presentations
- Private-public, cross-agency partnerships

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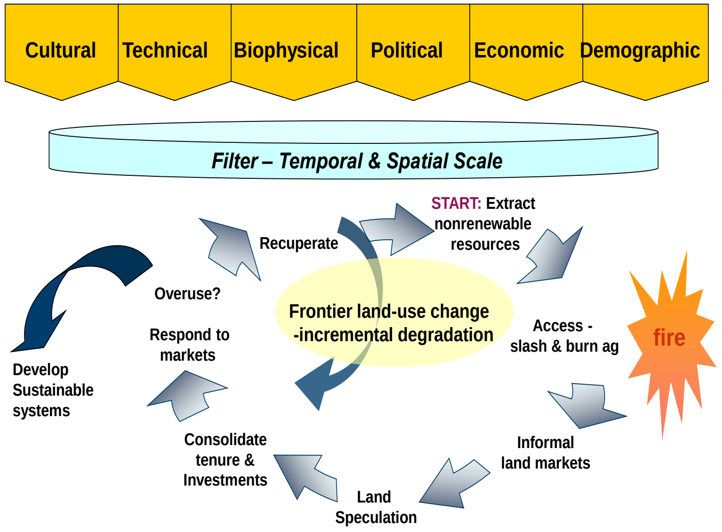
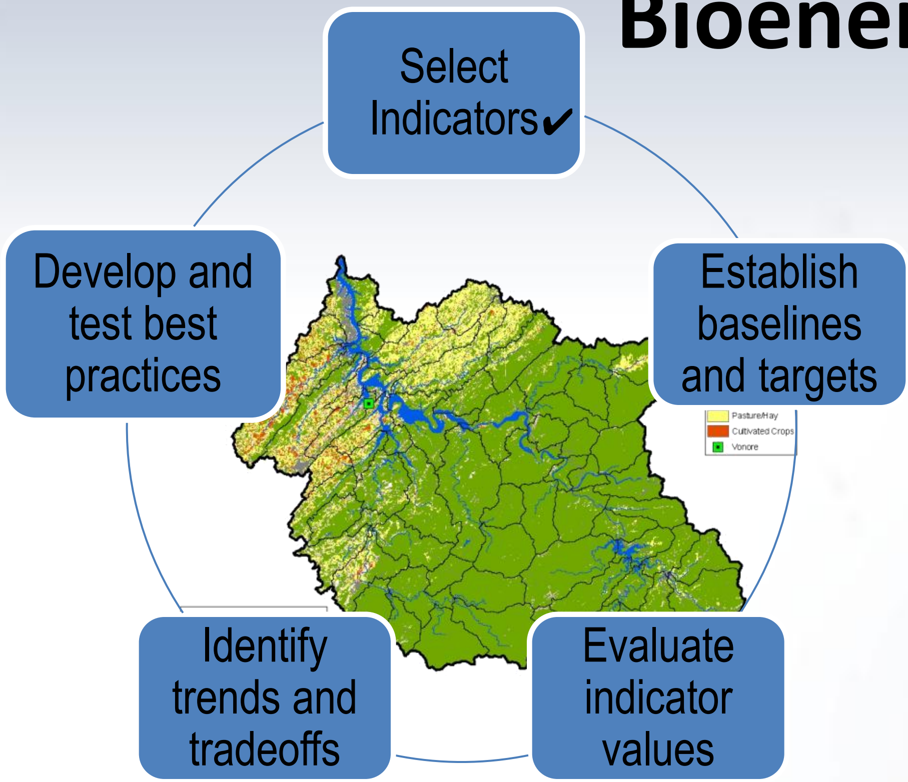
INTERNATIONAL STANDARDS AND GLOBAL ISSUES AFFECTING SUSTAINABILITY OF BIOFUELS



Specific examples (FY12-13)

- ISO committee reports on food security and indirect effects
- Draft ISO 13065: Sustainability Criteria for Bioenergy
- Comments and reviews for:
  - International Energy Agency (IEA)
  - Roundtable for Sustainable Bioenergy (RSB)
  - Global Bio-Energy Partnership (GBEP)
  - Global Sustainable Bioenergy Project (GSB)
  - Input to several others (NRC, National Assessment, IPCC, EPA…)

Bioenergy Sustainability

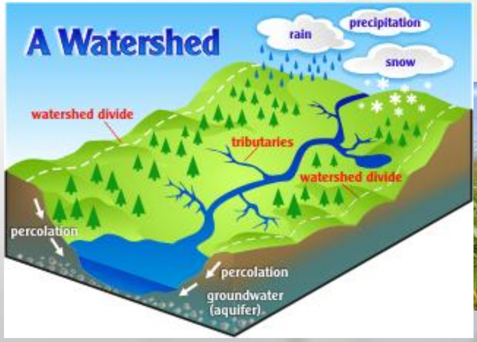


Facilitating establishment of sustainable industry

- Establishing indicators of sustainability
  - Defining indicators – what are critical few?
  - Determining existing baseline conditions and sustainable targets
  - Testing indicators of sustainability in specific contexts
- Evaluating trends and effects of tradeoffs for several aspects of sustainability

Collaborators include:

- Other DOE Labs (5)
- Other federal agencies
- Bioenergy teams (3)
- Certification efforts (4)
- Universities (7)
- Industry (7)



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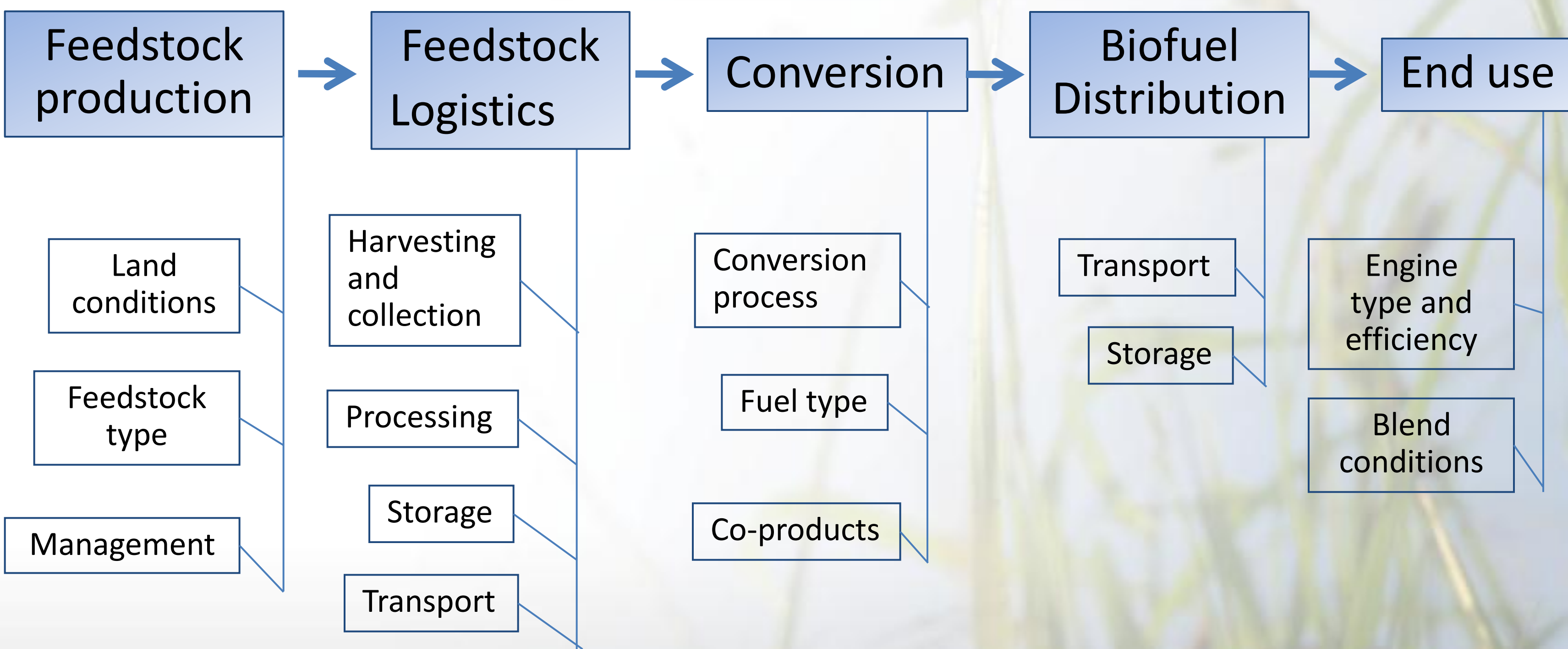
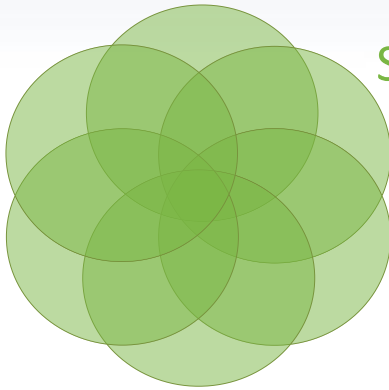
Sustainability Should Apply to

- Entire supply chain
- Diverse feedstocks
- All conversion pathways



(Example shown is biofuel, but concepts are applicable to bioenergy as well)

Categories for indicators of environmental and socioeconomic sustainability



McBride et al. (2011) *Ecological Indicators* 11:1277-1289

Dale et al. (2013) *Ecological Indicators 26:87-102.*

Recognize that measures and interpretations are context specific

Efroymson et al. (2013) *Environmental Management*

Categories of environmental sustainability indicators

Environment	Indicator	Units
Soil quality	1. Total organic carbon (TOC)	Mg/ha
	2. Total nitrogen (N)	Mg/ha
	3. Extractable phosphorus (P)	Mg/ha
	4. Bulk density	g/cm^3
Water quality and quantity	5. Nitrate concentration in streams (and export)	concentration: mg/L; export: kg/ha/yr
	6. Total phosphorus (P) concentration in streams (and export)	concentration: mg/L; export: kg/ha/yr
	7. Suspended sediment concentration in streams (and export)	concentration: mg/L; export: kg/ha/yr
	8. Herbicide concentration in streams (and export)	concentration: mg/L; export: kg/ha/yr
	9. storm flow	L/s
	10. Minimum base flow	L/s
	11. Consumptive water use (incorporates base flow)	feedstock production: m^3/ha/day; biorefinery: m^3/day

Environment	Indicator	Units
Greenhouse gases	12. CO_2 equivalent emissions (CO_2 and N_2O)	kgC_{eq}/GJ
Biodiversity	13. Presence of taxa of special concern	Presence
	14. Habitat area of taxa of special concern	ha
Air quality	15. Tropospheric ozone	ppb
	16. Carbon monoxide	ppm
	17. Total particulate matter less than 2.5µm diameter ($PM_{2.5}$)	$\mu g/m^3$
	18. Total particulate matter less than 10µm diameter (PM_{10})	$\mu g/m^3$
Productivity	19. Aboveground net primary productivity (ANPP) / Yield	gC/m^2/year

McBride et al. (2011)
Ecological Indicators
11:1277-1289

Categories of socioeconomic sustainability indicators

Ten minimum practical measures

Category	Indicator	Units
Social well-being	Employment	Number of full time equivalent (FTE) jobs
	Household income	Dollars per day
	Work days lost due to injury	Average number of work days lost per worker per year
	Food security	Percent change in food price volatility
Energy security	Energy security premium	Dollars /gallon biofuel
	Fuel price volatility	Standard deviation of monthly percentage price changes over one year
External trade	Terms of trade	Ratio (price of exports/price of imports)
	Trade volume	Dollars (net exports or balance of payments)
Profitability	Return on investment (ROI)	Percent (net investment/ initial investment)
	Net present value (NPV)[2]	Dollars (present value of benefits minus present value of costs)

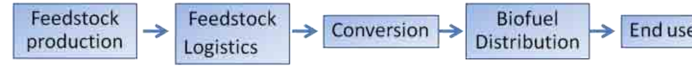
Category	Indicator	Units
Resource conservation	Depletion of non-renewable energy resources	MT (amount of petroleum extracted per year)
	Fossil Energy Return on Investment (fossil EROI)	MJ (ratio of amount of fossil energy inputs to amount of useful energy output
Social acceptability	Public opinion	Percent favorable opinion
	Transparency	Percent of indicators for which timely and relevant performance data are reported
	Effective stakeholder participation	Number of documented responses to stakeholder concerns and suggestions reported on an annual basis
	Risk of catastrophe	Annual probability of catastrophic event

Dale et al. (2013)

Impetus

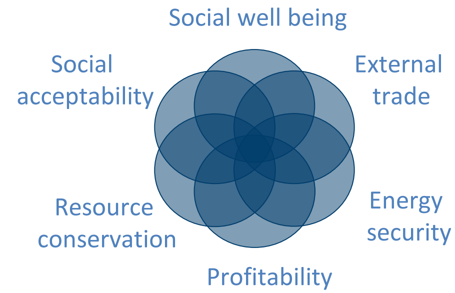
Sustainability

Apply across supply chain

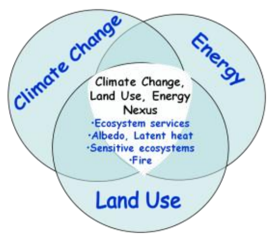


Definition

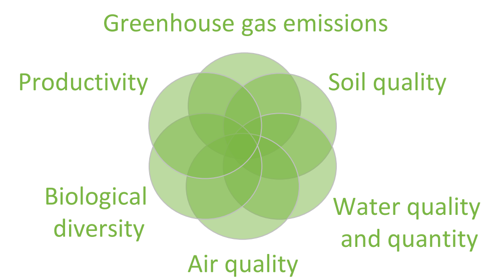
Indicators



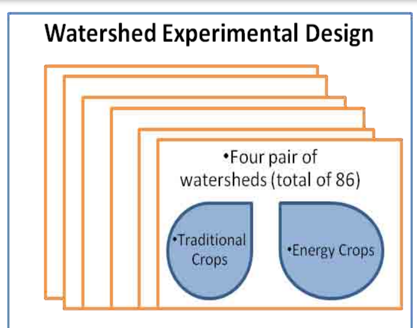
Sharing Information



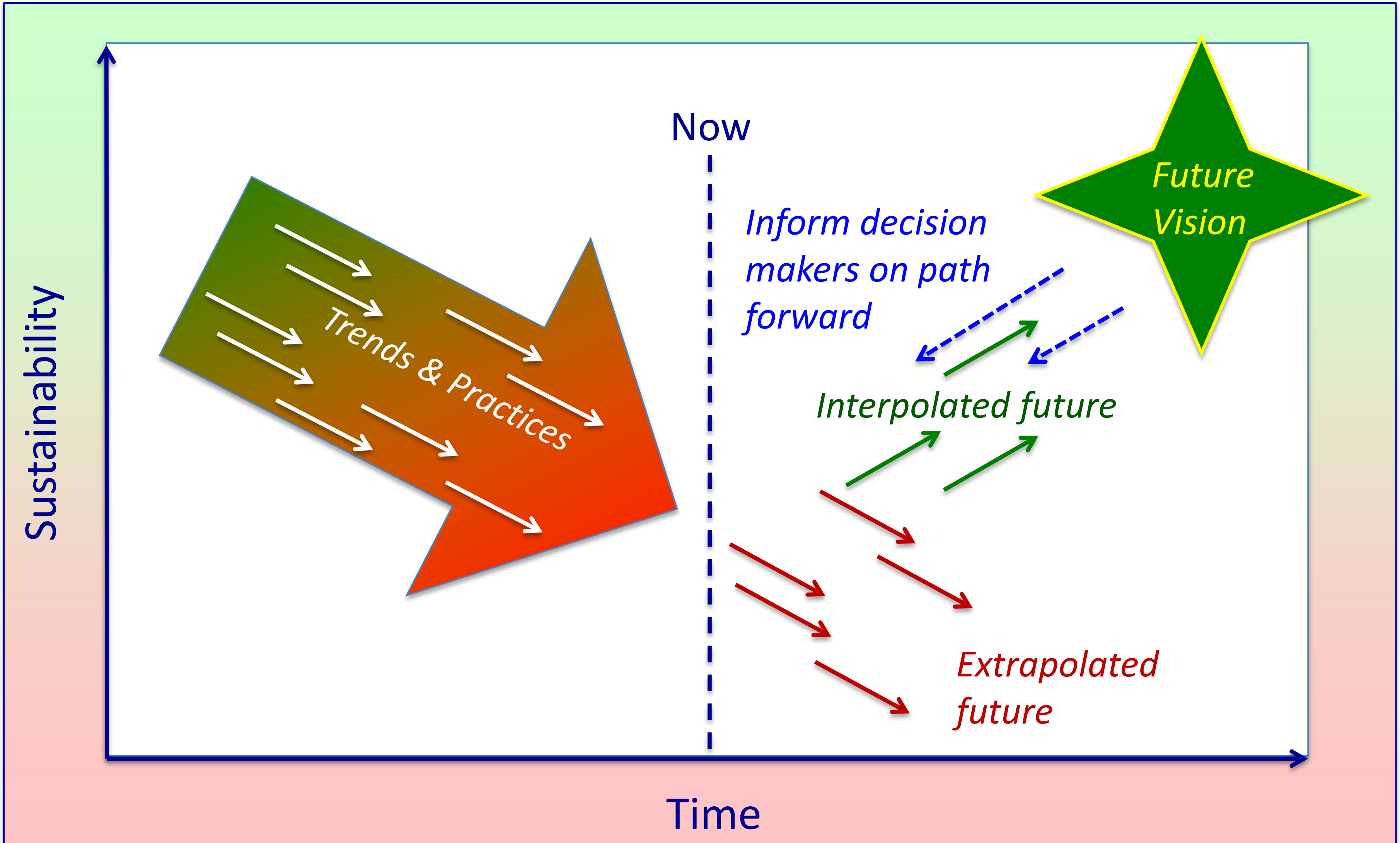
Workshops, CBES forums, conferences, calls, monthly summary, publications, etc.



Quantification



Relevance and outcomes: international cooperation is key to developing pathways toward more sustainable global energy futures



Source: GSB Project

Conclusion: Benefits, Expected Outcomes

Impact on commercial viability of biofuels:

- Internationally recognized standards for sustainable bioenergy (ISO, RSB, etc.) facilitate trade and market development
- International forums facilitate dialogue and consensus on key constraints (land-use, food and fuel security)
- Project insights, shared across global partners and scientific community, inform supportive legislation and regulations

Impact on environmental performance of bioenergy:

- Research helps define methods and metrics essential to measure performance and sustainability for feedstock supplies
- Cooperation stimulates distributed discovery, innovation and communications
  - Ingredients for transformational change
  - Accelerate development of better practices and technologies for sustainable bioenergy production

Collaborative networks that share knowledge and support consensus on sustainability, speed global deployment of clean technologies and GHG emission reductions

Thank you

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http://www.ornl.gov/sci/ees/cbes/

See the website for

- **Reports**
- **Forums**
- **Other presentations**
- **Recent publications**

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The views in this presentation are those of the author, Keith L. Kline, who is responsible for any errors or omissions.

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Selected References

- Dale VH, SC Beyeler 2001. Challenges in the development and use of ecological indicators. Ecological Indicators 1: 3-10.
- Dale VH, R Lowrance, P Mulholland, P Robertson. 2010. Bioenergy sustainability at the regional-scale. Ecology and Society 15(4): 23. [online] URL: *http://www.ecologyandsociety.org/vol15/iss4/art23/*
- Dale VH, KL Kline, LL Wright, RD Perlack, M Downing, RL Graham. 2011. Interactions among bioenergy feedstock choices, landscape dynamics and land use. *Ecological Applications* 21(4):1039-1054.
- Dale, VH, RA Efroymson, KL Kline, MH Langholtz, PN Leiby, GA Oladosu, MR Davis, ME Downing, LM Eaton, MR Hilliard (2012). Indicators to support assessment of socioeconomic sustainability of bioenergy systems. Ecological Indicators (available on line) .
- Efroymson, R. A., V. H. Dale, K. L. Kline, A. C. McBride, J. M. Bielicki, R. L. Smith, E. S. Parish, P. E. Schweizer, D. M. Shaw. 2013. Environmental indicators of biofuel sustainability: What about context? Environmental Management DOI 10.1007/s00267-012-9907-5
- Giglio L., J. T. Randerson, G. R. van derWerf, P. S. Kasibhatla, G. J. Collatz, D. C. Morton, and R. S. DeFries. Assessing variability and long-term trends in burned area by merging multiple satellite fire products. Biogeosciences, 7, 1171–1186, 2010.
- McBride A, VH Dale, L Baskaran, M Downing, L Eaton, RA Efroymson, C Garten, KL Kline, H Jager, P Mulholland, E Parish, P Schweizer, and J Storey. 2011. Indicators to support environmental sustainability of bioenergy systems. *Ecological Indicators* 11(5) 1277-1289.
- Parish ES, M Hilliard, LM Baskaran, VH Dale, NA Griffiths, PJ Mulholland, A Sorokine, NA Thomas, ME Downing, R Middleton. 2012. Multimetric spatial optimization of switchgrass plantings across a watershed. *Biofuels, Bioprod. Bioref*. 6(1):58-72.

Related publications (see CBES web site)

- Dale VH, Efroymson RA and Kline KL. 2011. The land use – climate change – energy nexus. *Landscape Ecology* 26(6):755-773.
- Dale VH, Kline KL, Wiens J, Fargione J. January 2010. Biofuels: Implications for Land Use and Biodiversity. Ecological Society of America special report: http://www.esa.org/biofuelsreports
- Hecht, AD, D Shaw, R Bruins, V Dale, K Kline, A Chen. 2009. Good policy follows good science: Using criteria and indicators for assessing sustainable biofuels production. Ecotoxicology 18(1)
- Kline KL, Dale VH, Grainger A. 2010. Challenges for Bioenergy Emission Accounting. *Science e-letter.* (2 March 2010)
- Kline, KL and Dale, VH. 2008. Biofuels, causes of land-use change, and the role of fire in greenhouse gas emissions. Science 321:199 http://www.sciencemag.org/cgi/reprint/321/5886/199.pdf
- Kline KL, et al. 2011. Scientific analysis is essential to assess biofuel policy effects [published as a peer-reviewed article] in response to the paper by Kim and Dale on "Indirect land use change for biofuels: Testing predictions and improving analytical methodologies."] *Biomass and Bioenergy*;
- Kline KL, VH Dale, R Lee, and P. Leiby. 2009. In Defense of Biofuels, Done Right. Issues in Science and Technology 25(3): 75-84
- Kline KL, Dale VH, Efroymson RA, Haq Z, Goss-Eng A. 2010. Land-Use Change and Bioenergy: ORNL/CBES-001, U.S. Department of Energy and ORNL. http://www.ornl.gov/sci/besd/cbes.shtml
- Oladosu G and K Kline.2010. The Role of Modeling Assumptions and Policy Instruments in Evaluating the Global Implications of U.S. Biofuel Policies. Proceedings of the 33rd IAEE International Conference "The Future of Energy: Global Challenges, Diverse Solutions" Rio de Janeiro, Brazil, June 6-9, 2010.
- Oladosu G., K. Kline, R. Martinez and L. Eaton. 2011. Sources of Corn for Ethanol Production in the United States: A Review and Decomposition Analysis of the Empirical Data. *Biofuels, Bioprod. Bioref*. DOI: 10.1002/bbb.305