

Global Sustainable Bioenergy: Feasibility & Implementation Paths “GSB Project”

Project initiated (June, 2009)

- International Organizing Committee formed
- Joint statement in *Issues in Science and Technology*
- Web site launched

Working hypothesis (slightly reworded):

It is physically possible to gracefully reconcile large-scale bioenergy production ($\geq 25\%$ of global mobility or equivalent) with feeding humanity, meeting other needs from managed lands, and preserving wildlife habitat and environmental quality.



Motivation

- Could we?
 - Working hypothesis
- Must we?
 - Sustainable Mobility (aviation, heavy duty)?
 - Sustainable Electricity (base load)?
 - Sustainable Rural Development?
 - Sustainable Land Management?



Dimensions of Innovation & Change Impacting Biofuel Feedstock Availability

I.A. Integrate feedstock production into managed lands

- Double crops
- Coproduce feed and feedstocks - e.g. early-cut grass in lieu of soy, perhaps other strategies
- Increase harvest from underutilized pasture, range, and/or CRP land
- Sustainably harvest ag. residues, perhaps enhanced by new crop rotations
- Develop crop varieties with increased yields of non-nutritive cellulosic biomass (more residues)
- Sustainably harvest forest residues and thinnings
- On abandoned, degraded, steep cropland

I.B. Produce food more land-efficiently

- Change animal feeding practices, e.g. pasture intensification, forage pretreatment
- Increase crop productivity, especially feed crops

I.C. Change diet

- Amount & kind of animal products

I.D. Decrease fuel demand

- Energy efficient cars
- Public transportation
- Increased use of rail & shipping
- Smart growth

II.A. Mature biomass production

- High productivity
- Broad site range
- Low inputs
- High digestibility

II.B. Mature conversion technology

- Advanced pretreatment
- Consolidated BioProcessing (CBP)
- Advanced thermochemical routes

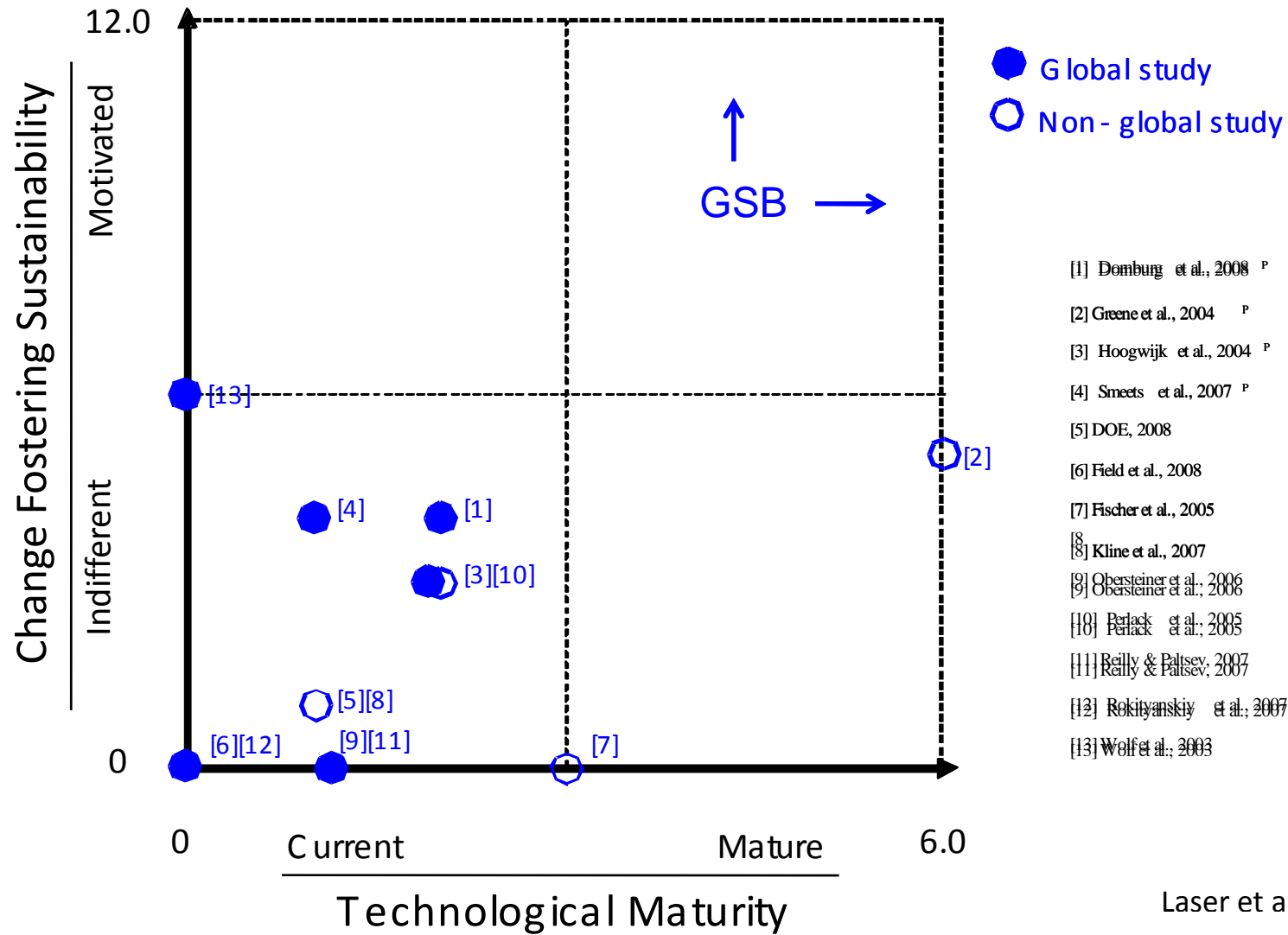
Consideration of Innovation & Change in Recent Studies Examining Biofuel Feasibility

STUDY	I. CHANGE TO ACHIEVE SUSTAINABILITY				Total	II. TECHNOLOGY		Total
	I.A. Feedstock integration	I.B. Food production efficiency	I.C. Changing diet	I.D. Lower fuel demand		II.A. Mature feedstock production	II.B. Mature cellulosic conversion	
Dornburg et al., 2008	1	2	0	1	4	2	0	2
Greene et al., 2004	2	0	0	3	5	3	3	6
Hoogwijk et al., 2004	1	0	1	1	3	2	0	2
Smeets et al., 2007	1	3	0	0	4	1	0	1
Leite et al., 2008	0	0	0	0	0	1	0	1
DOE, 2008	1	0	0	0	1	1	0	1
Field et al., 2008	0	0	0	0	0	0	0	0
Fischer et al., 2005	0	0	0	0	0	3	0	3
Fischer & Schratzenholzer, 2001	1	1	0	0	2	1	0	1
Kline et al., 2007	1	0	0	0	1	1	0	1
Moreira, 2006	1	0	0	0	1	0	0	0
Obersteiner et al., 2006	0	0	0	0	0	1	0	1
Perlack et al., 2005	1	2	0	0	3	2	0	2
Reilly & Paltsev, 2007	0	0	0	0	0	1	0	1
Rokityanskiy et al., 2007	0	0	0	0	0	0	0	0
Wolf et al., 2003	0	3	3	0	6	0	0	0

- 3 Extensive consideration
- 2 Moderate consideration
- 1 Minimal consideration
- 0 Not considered

Laser et al., in preparation

Consideration of Innovation & Change in Recent Studies Examining Biofuel Feasibility



Laser et al., in preparation

Staged structure

Stage 1. Five Continental Conventions

- Gather input on framing stages 2 and 3
- Continental and common resolutions
- Recruit participants & funds

Stage 2.

Address working hypothesis,
unconstrained by current realities.

Stage 3.

Analyze implementation paths,
recommend policies



GSB Project: Stage 1 Continental Conventions

Representation	Host Institutions, Location	Meeting Chairs, also Members of the GSB Organizing Committee	Dates
Europe	Kluyver Center for Genomics of Industrial Fermentations, Delft, The Netherlands	<ul style="list-style-type: none"> • Andre Faaij, Utrecht University • Patricia Osseweijer, Delft University of Technology 	February, 24-26, 2010
Africa	University of Sellenbosch, Stellenbosch, South Africa	<ul style="list-style-type: none"> • Emile van Zyl, University of Stellenbosch • Miyuki Iiyama, World Agroforestry Centre, Nairobi 	March, 17-19, 2010
South America	University of São Paulo, São Paulo, Brazil	<ul style="list-style-type: none"> • José Goldemberg, University of São Paulo • Carlos Henrique de Brito Cruz, FAPESP, São Paulo 	March, 23-25, 2010
Asia, Oceania	Kuala Lumpur, Malaysia	<ul style="list-style-type: none"> • Ramlan Abdul Aziz, Universiti Teknologi Malaysia • Reinhold Mann, Battelle Science and Technology, Malaysia 	June 14-16, 2010
North America	University of Minnesota, Minneapolis/St. Paul, USA	<ul style="list-style-type: none"> • John Foley and John Sheehan, University of Minnesota 	September, 14-16, 2010

Steering Committee (expansion anticipated): Lee Lynd (Chair), Dartmouth, Mascoma Corp.
 Nathanael Greene, Natural Resources Defense Council
 Tom Richard, Pennsylvania State University

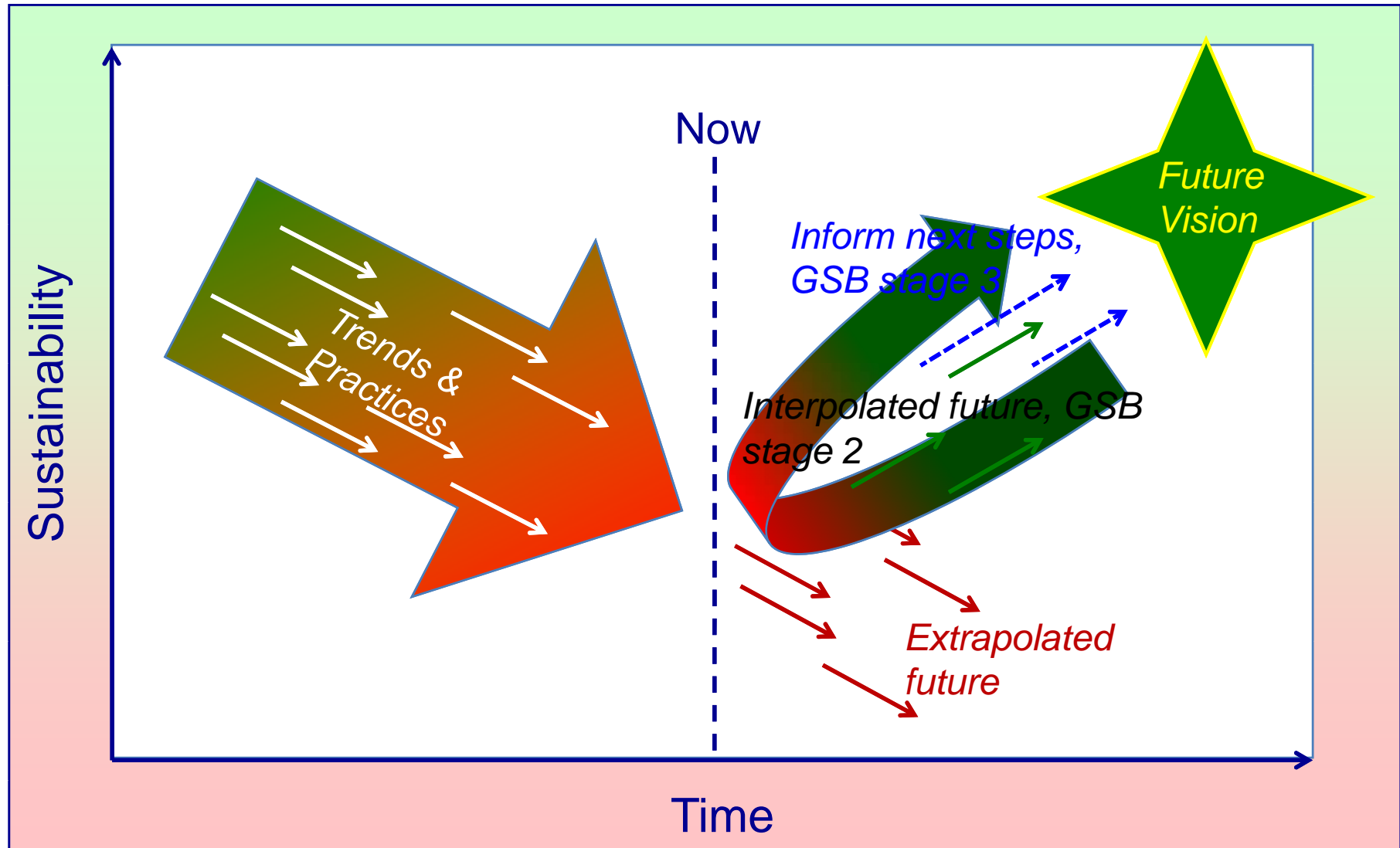
GSB Project: Approach and Differentiation

	Most Bioenergy Projects & Analyses	GSB Project
Focus	Most probable	Most desirable
Expert opinion	Reflected, often sharply divided	Informed, seek new understanding & consensus
Point of reference	Current reality	Future vision
Value	✓	✓

While there is a natural reluctance to consider change, we must do so since humanity cannot expect to achieve a sustainable and secure future by continuing the practices that have resulted in the unsustainable and insecure present.

Statement made on behalf of the GSB Stage 1 Organizing Committee, Issues in Science and Technology, Summer, 2009

Future Vision Point of Reference: Extrapolated and Interpolated Resource Futures



Some things we learned at the European GSB Convention...

Endorsement of many aspects of the GSB framework

People came! 65 attendees, 10 European countries, 5 continents

Participatory format, including ratifying a European resolution

3-stage GSB process

Community building

Attendees believe that Europe can produce a great deal of its primary energy (e.g. 30%) from biomass, much of this from eastern Europe

Strong endorsement for needs and benefits of integrating bioenergy from 2nd generation feedstocks into the European landscape

Some things we learned at the European GSB Convention...

...but not all

Many attendees are satisfied that the answer to the “Can we?” question is “Yes”. Are we preaching to the choir?

Rethink definition of large-scale – *“e.g. 25% of global mobility or equivalent”*

Good to define in terms of need as well as “big enough to matter”

If we got everything we could from sustainable sources other than bioenergy, what fraction of energy supply would we still look to bioenergy to provide?

Current definition perhaps too narrow, should not be restricted to transport

Changes will be considered by the GSB Organizing Committee

GSB website:

“We are open to refining wording based on input received during stage 1.”

“During stage 1, consideration will be given to the relative emphasis on fuels and electricity”

Two Audiences

Value of GSB Analysis

**Position on GSB
Stage 2 Hypothesis**

**Answer to “Can we?”
question**

**Illumination of
multiple paths**

In doubt

Key focus

*GSB goal: Most comprehensive
analysis to date*

- Informed by stage 1 meetings
- Less constrained by current trends & practices
- Distributed geographical data

**Of interest if/as
hypothesis accepted**

Convinced

**Of interest to convince
others**

Key focus

*GSB Goal: Most forward-
looking analysis to date*

- Less constrained by current trends & practices
- Broader range of alternatives considered
- Maximization of benefits, synergies

The GSB Project is focused on

Resource issues, in hopes of providing a more definitive answer to the physical possibility of producing bioenergy on a much larger scale, consistent with the GSB stage 2 working hypothesis

Analysis addressing not only **if** the stage 2 working hypothesis can be confirmed, but also **how**
– anticipating that there may be multiple paths

Consideration of transition paths and policy informed by stage 2 analysis

The GSB Project is not focused on

Processing technology

Advocacy



Global Sustainable Bioenergy Project: Continental Convention Outcomes

Input on structuring stages 2 and 3

To be gathered during breakout and plenary sessions Friday morning, compiled in stage 1 report

Continental resolutions

Drafted by a committee consisting of one delegate from each working group to be elected at the end of Thursday, assisted by a representative of the GSB steering committee

Draft ratified on Friday morning, to be circulated more widely before finalized

Compiled in the stage 1 report

Framework – continent-specific perspectives on

- Needs and priorities
- Regional diversity within the continent
- Constraints
- Bioenergy solutions and opportunities
- Bioenergy vision for Africa

Common resolution

Drafted by a committee consisting of five organizing committee members, one from each continent, and a delegate from each continental convention to be elected on Friday

Dialogue, mutual understanding, and interest in stages 2 and 3...

Chesapeake Bay: Biofuels and Water Quality

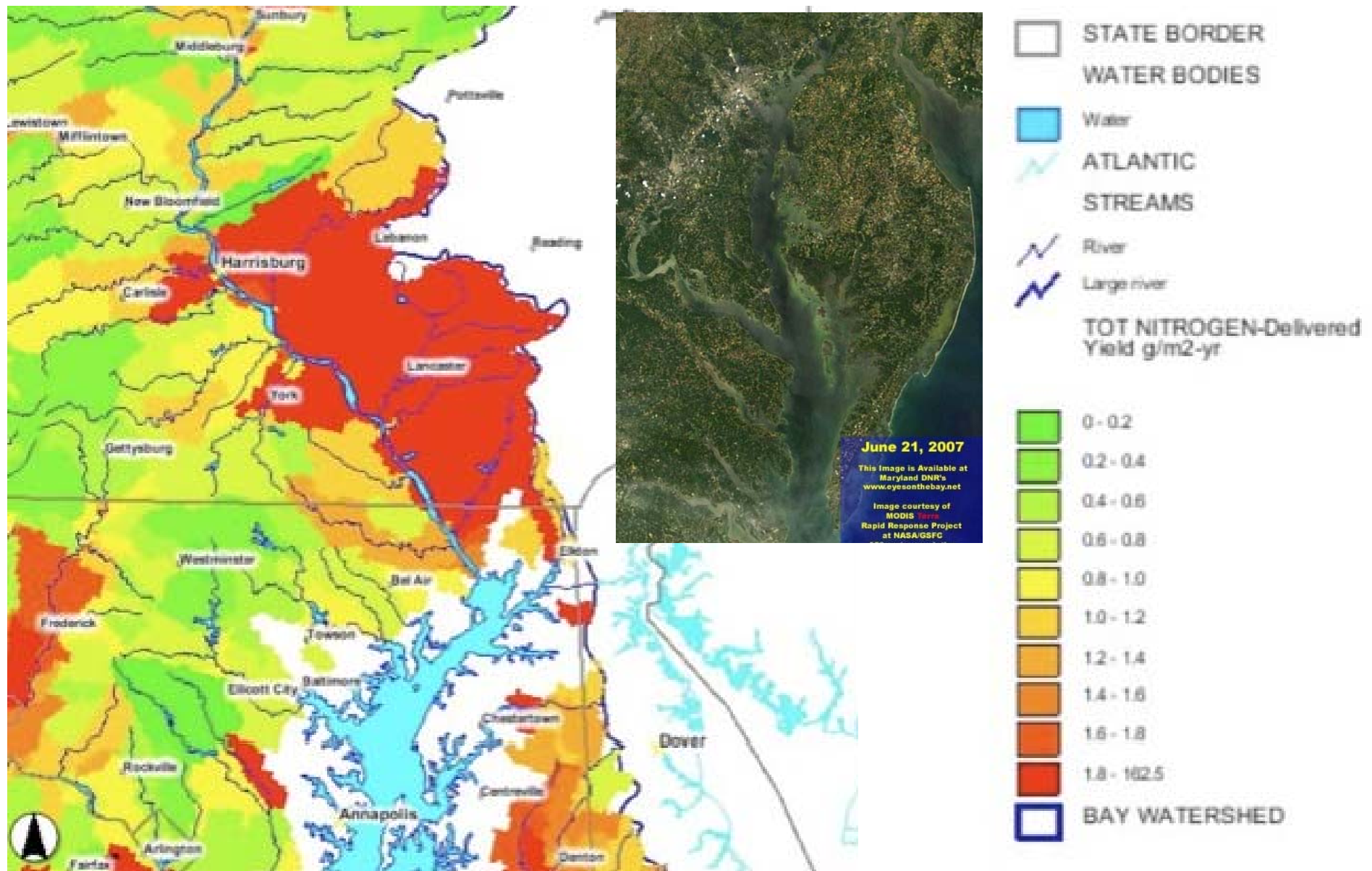
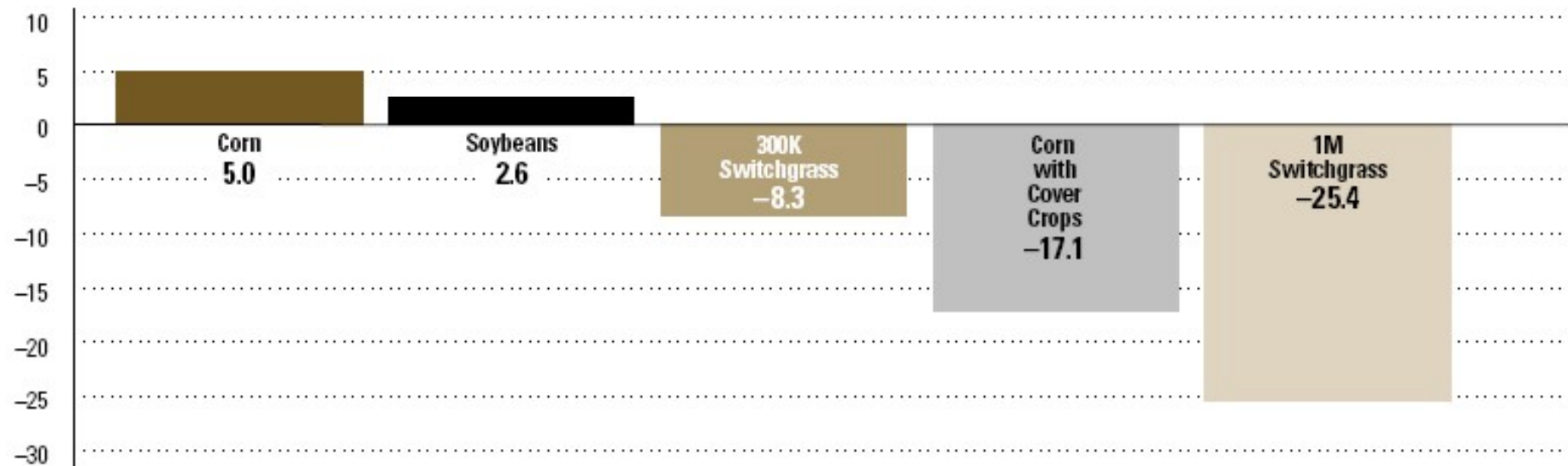


FIGURE 5
Maximum Nitrogen Load Changes for Biofuels

Millions of pounds per year of nitrogen delivered from the Chesapeake Bay watershed to the Bay under five modeling scenarios.



Assumptions for Alternative Scenarios:

- **Corn:** 300,000 additional acres of corn with typical levels of management practices
- **Soybeans:** 300,000 additional acres of soybeans with typical levels of management practices
- **300K Switchgrass:** 300,000 acres of switchgrass, converted primarily from hay and pastureland, with no fertilization
- **Corn with Cover Crops:** Cover crops on all existing and new (additional 300,000) corn acres and one quarter of all other row crops, watershed-wide.
- **1M Switchgrass:** 1 million acres of switchgrass, converted primarily from hay and pastureland, with no fertilization

SOURCE: U.S. EPA CHESAPEAKE BAY PROGRAM OFFICE

Chesapeake Bay Commission (CBC): Progress to Date

- ❑ 2007 – Biofuels and the Bay Report –
 - ✓ Estimates biofuels potential and impacts

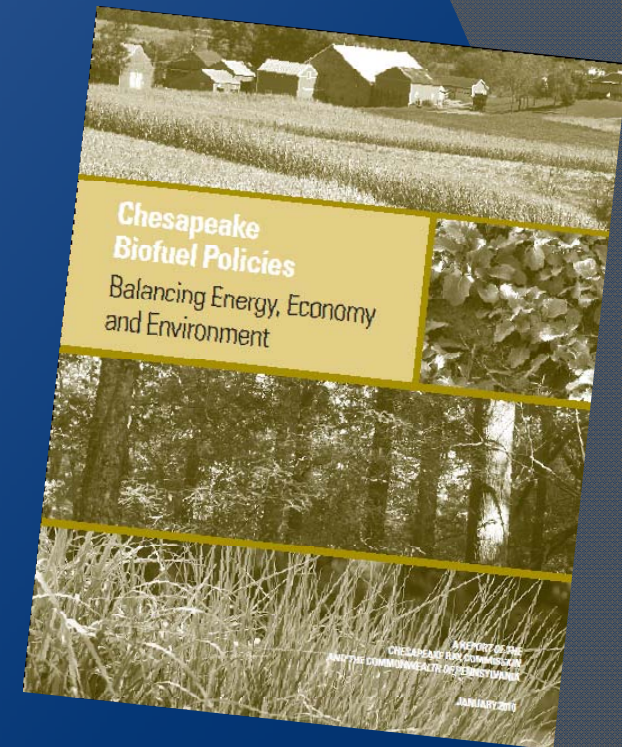
- ❑ 2007 Chesapeake Bay Executive Council Meeting
 - ✓ Accepts Report Recommendations, including leading the Nation in move to next-generation biofuels
 - ✓ Pennsylvania joins CBC as co-champion
 - ✓ Agreement to form Biofuels Advisory Panel

Progress to Date (continued)

- ❑ September, 2008: Biofuels Summit
 - ✓ Panel presents Next Generation Biofuels Report with 10 state and 10 regional recs.
- ❑ December, 2008: Executive Council Directive
 - ✓ Accepts Recommendations
 - ✓ Asks Panel to help set state and regional production goals, and provide strategic advice.
- ❑ Legislative Action in 2009 sessions in all three states.

Chesapeake Biofuel Policies: *Balancing Energy, Economy and Environment*

- ❑ Report Findings:
 - ✓ 500 Million gallons annually
 - ✓ Over 18,000 jobs created by 2022
 - ✓ X lbs. of Nitrogen runoff reduced
- ❑ Near-Term Policy Priorities:
 - ✓ Guidelines for residuals harvest
 - ✓ Encouragement of winter biofuel crops
 - ✓ Protocol on invasive feedstock species
- ❑ Regional Council for Bioenergy Development



Establish an Interstate Council

- ❑ Ongoing need to coordinate among six states the implementation of the 20 Panel recommendations – set up w/ MOA.
- ❑ Focus should be on water quality and other environmental consequences of bio-energy development.
- ❑ Engage state energy, environment, agriculture and development agencies.
- ❑ Chesapeake Bay Commission to represent legislative arm.

Local Motivation

- ❑ Bioenergy as a market-based tool for water quality improvement.
- ❑ Reinforce existing agriculture/forestry and expand rural economic opportunity.
- ❑ Diversify our energy sources and keep them close to home.



Motivation

- Could we?
 - Working hypothesis...
- Must we?
 - Sustainable Mobility (long haul, heavy duty)?
 - Sustainable Electricity (base load)?
 - Sustainable Rural Development?
 - Sustainable Land Management?
- Process, Partners, Progress

