Incorporating Bioenergy into Sustainable Landscape Designs

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U.S. DEPARTMENT OF ENERGY

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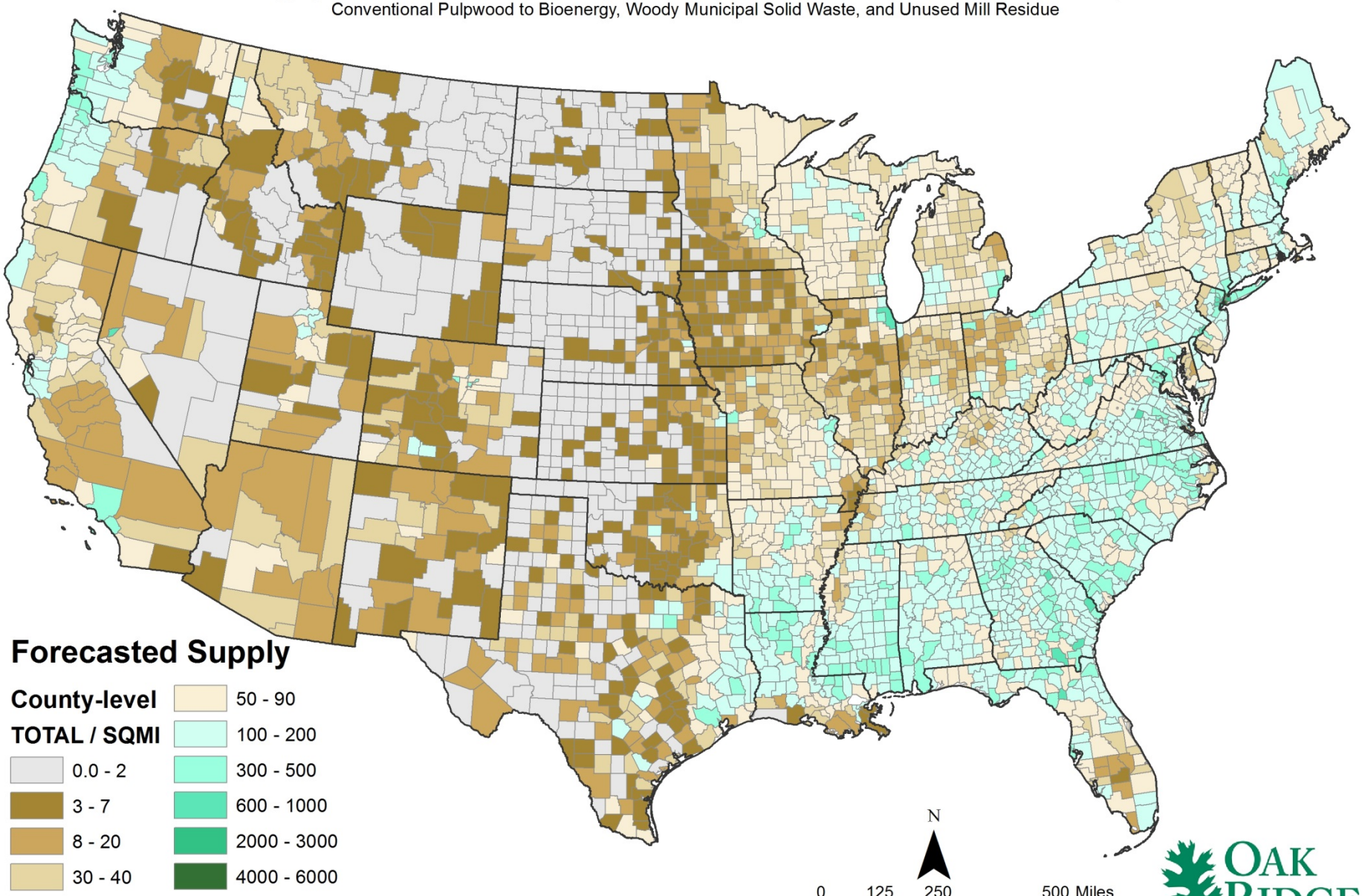
Consider bioenergy within system as an opportunity to <u>design landscapes</u> that add value

Potential Forestry Biomass Resources, 2012

Includes all potential primary and secondary resources excluding Federal Lands (when available) at $80 per dry ton or less:
Logging Residues, Simulated Forest Thinnings, Other Removal Residue, Treatment Thinnings (other forestland),
Conventional Pulpwood to Bioenergy, Woody Municipal Solid Waste, and Unused Mill Residue



Source: U.S. Department of Energy. 2011. U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry. R.D. Perlack and B.J. Stokes (Leads), ORNL/TM-2011/224. Oak Ridge National Laboratory, Oak Ridge, TN. 227p.

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Landscape design is a plan for resource allocation.

- Suggest a way to manage for more sustainable provisions of bioenergy and other services
- Takes context, trends and current conditions into consideration

Negative impacts of bioenergy can be avoided or reduced by attention to three principles:

1. Conserve priority ecosystem and social services
2. Consider local context
3. Monitor effects of concern and adjust plans to improve performance over time

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Landscape design approach for bioenergy should be applied via five steps:

- Set goals
  - Involve key stakeholders
  - Develop consensus approach
- Consider constraints
- Address wastes
- Evaluate and apply solutions
- Monitor for adaptive management

Pressures and incentives for landscape design

- Legal demands or regulations
- Customer requirements or specifications
- Stakeholder concerns
- Competitive advantage
- Environmental and social pressure groups
- Reputation loss

[Building from Seuring and Muller (2008) Journal of Cleaner Production 16:1699-1710]

Obstacles to developing and deploying landscape design

- Landowner rights
- Traditional practices
- Up front planning required
- Coordination complexity/effort
- Higher costs

[Building from Seuring and Muller (2008) Journal of Cleaner Production 16:1699-1710]

What enables landscape designs?

- Communication across the supply chain
- Management systems (e.g., ISO 14001)
- Training and education
- Integration into corporate policy
- Regulations and standards

[Building from Seuring and Muller (2008) Journal of Cleaner Production 16:1699-1710]

Recommended practices

- Stakeholder engagement throughout process
- Consider management options within the broader context
- Attention to site selection and environmental effects in the
  - location and selection of the feedstock
  - transport of feedstock to the refinery
  - refinery processing
  - final transport and dissemination of bioenergy.
- Monitoring and reporting of key measures of sustainability
- Attention to what is “doable”

By–products of tree harvest for saw timber and pulp in southeast US are used for bioenergy

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Trees are cut and sorted by size.

- Harvest meets standards – for example, Forest Sustainability Initiative (FSI)
- Branches returned to forest
- Protection of places providing ecosystem service

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Chain of custody needs to be followed

Plum Creek
Ticket #
3540124514
LOGISTICS

Logger Name: Southeast Logging Inc
County: Liberty State: GA
Harvest Unit: 110H-CB JONES-2THIN

Front Log Count: 42 Avg. Length: 19.6
Back Log Count: 44 Avg. Length: 13

Created Time: 10:13 AM Created Date: 10/23/13
Product: PST Cut to Length
Destination: East Coast Terminal
Hauler Name: Wall Timber Products Inc
j2799 Truck #: Robbie Finch
Authorization:
Contractor Signature:

Time: 10/24/13 07:45 AM
Location:
Latitude: 31.71831
Longitude: -81.45925
Contract: 350F6502

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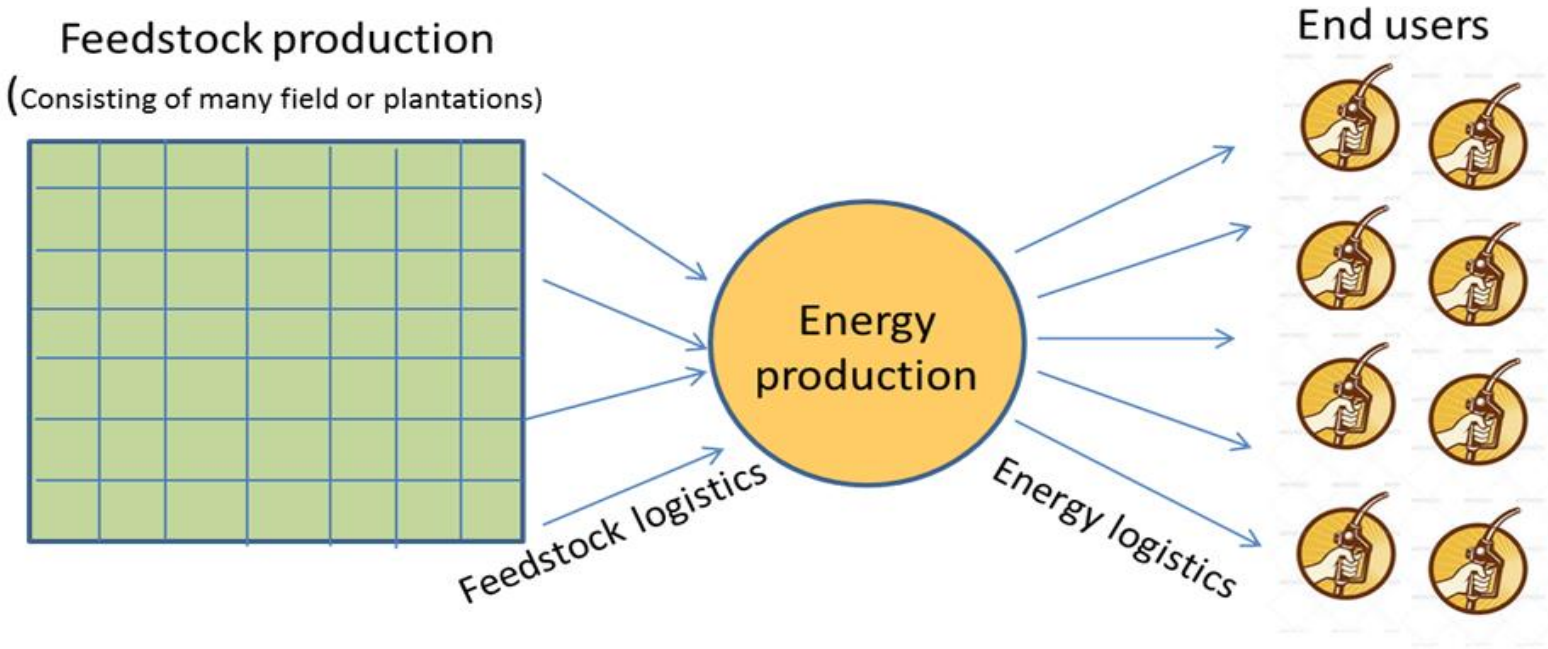
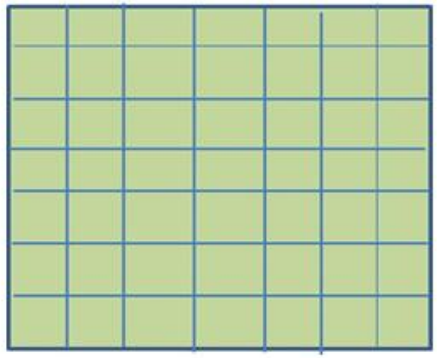
The scale of the bioenergy production system may be

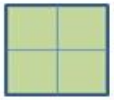
(A) The entire supply system



(B) Just one part of the supply system: e.g., feedstock production



(C) A set from one part of the supply system: e.g., a few fields where energy crops are produced or residues are collected



DOE Approach to Assessing Bioenergy Sustainability

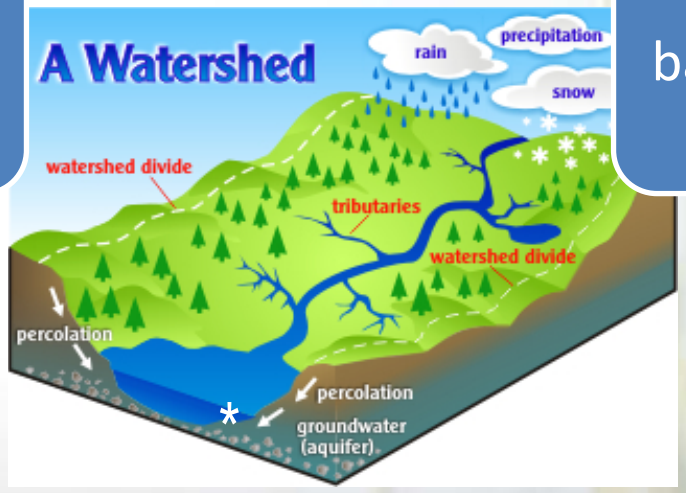
✔ Select Indicators

Establish baselines and targets

Evaluate indicator values

Identify trends and tradeoffs

Develop and test best practices



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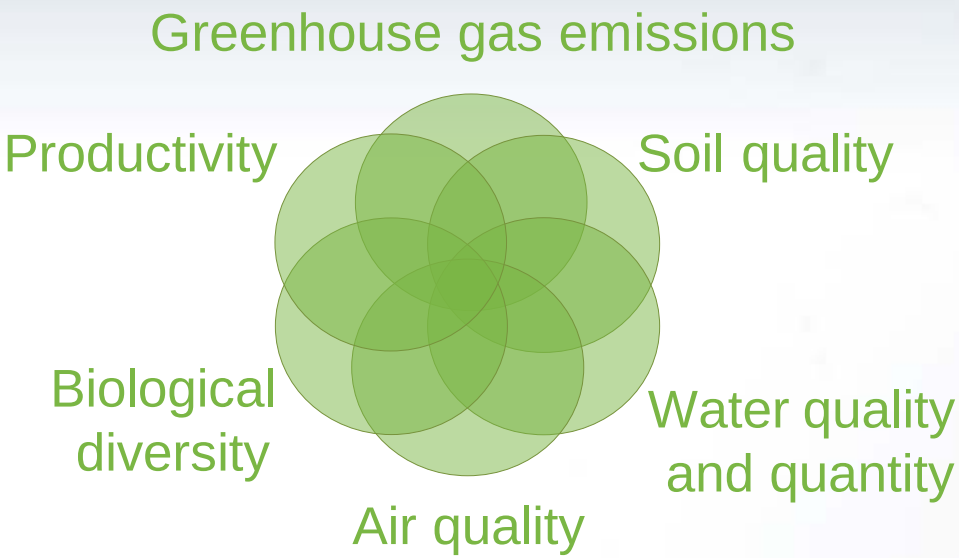
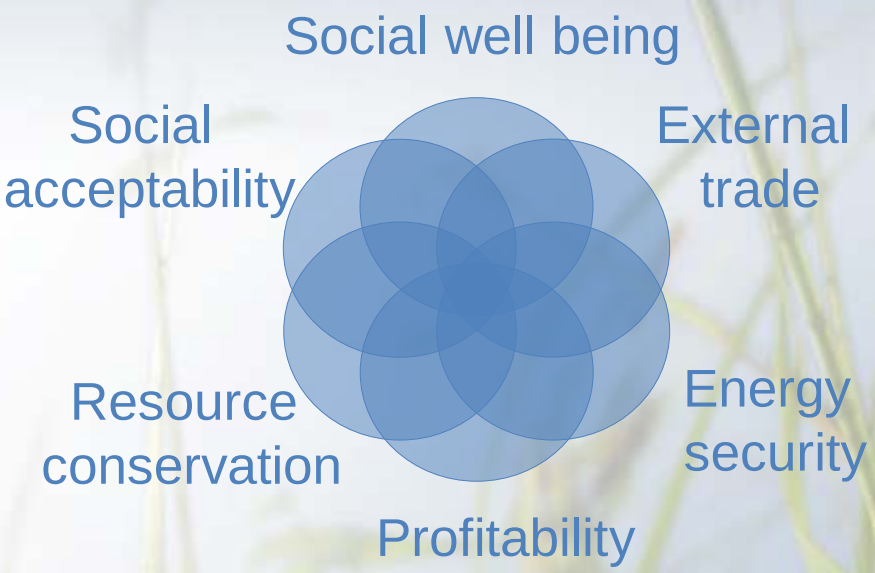
Categories for indicators of environmental and socioeconomic sustainability



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



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

Recognize that measures and interpretations are <u>context</u> specific

Efroymson et al. (2013) *Environmental Management* 51:291-306.

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Categories of environmental sustainability indicators

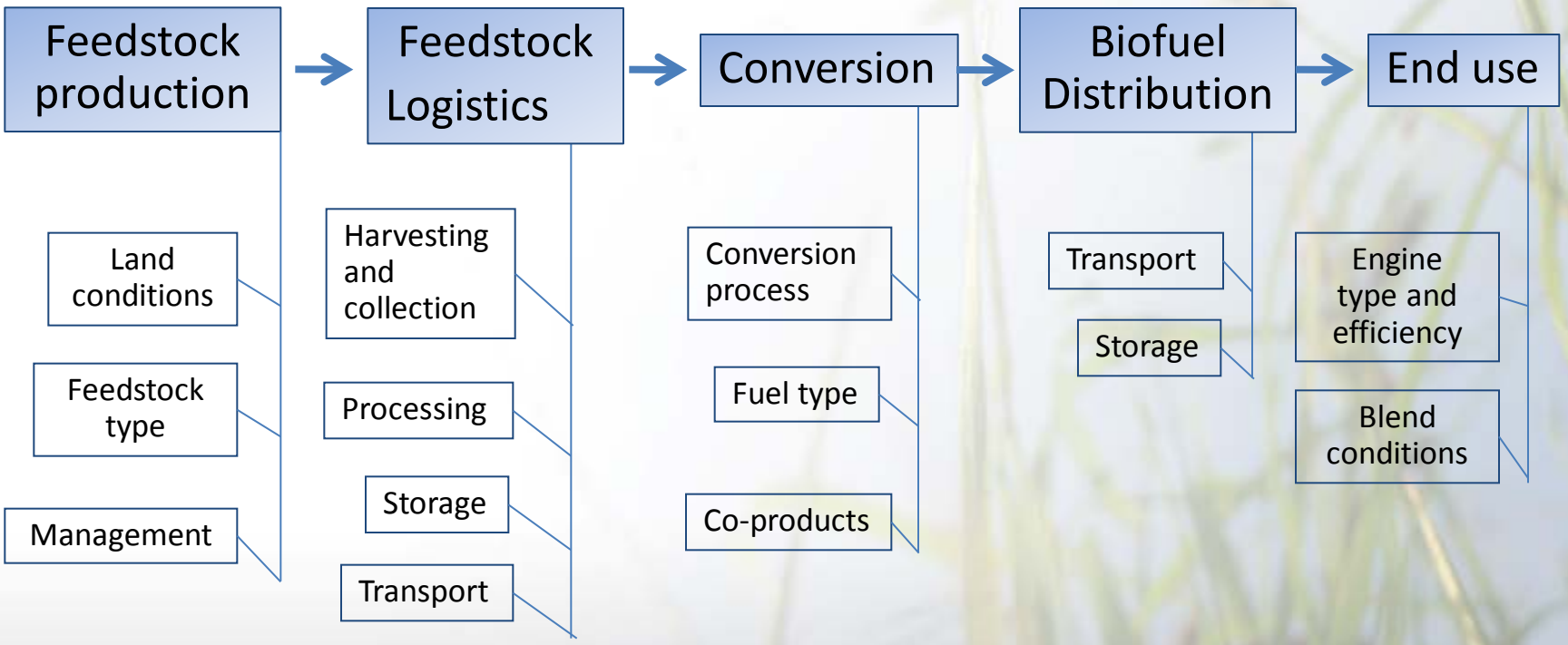
Environment	Indicator	Units
Soil quality	1. Total organic carbon (TOC)	Mg/ha
	2. Total nitrogen (N)	Mg/ha
	3. Extractable phosphorus (P)	Mg/ha
	4. Bulk density	g/cm^3
Water quality and quantity	5. Nitrate concentration in streams (and export)	concentration: mg/L; export: kg/ha/yr
	6. Total phosphorus (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

Sustainability Should Apply to

- Entire supply chain
- Diverse feedstocks
- All conversion pathways



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

Dale et al. 2013. *Environmental Management* 51(2): 279-290.

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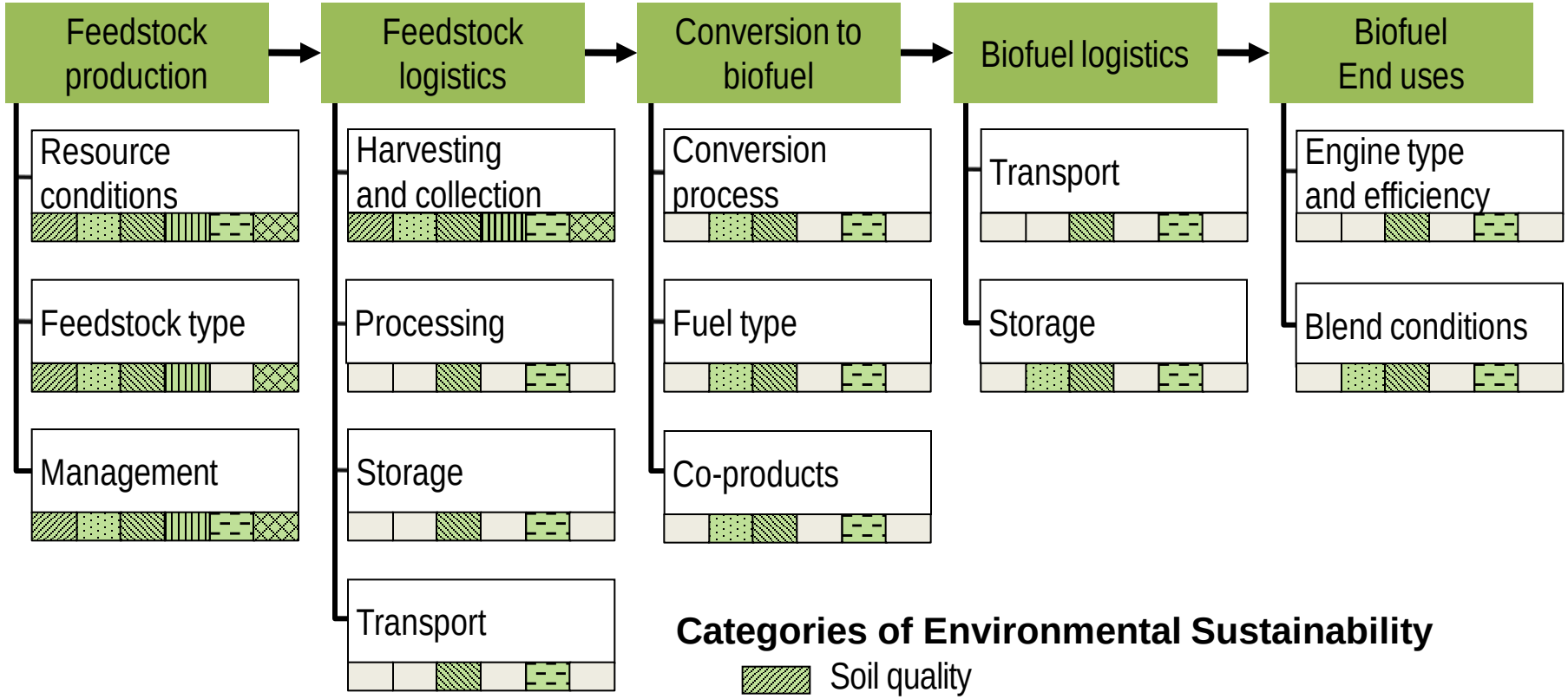
Looking at the biofuel supply chain in terms of environmental sustainability indicators

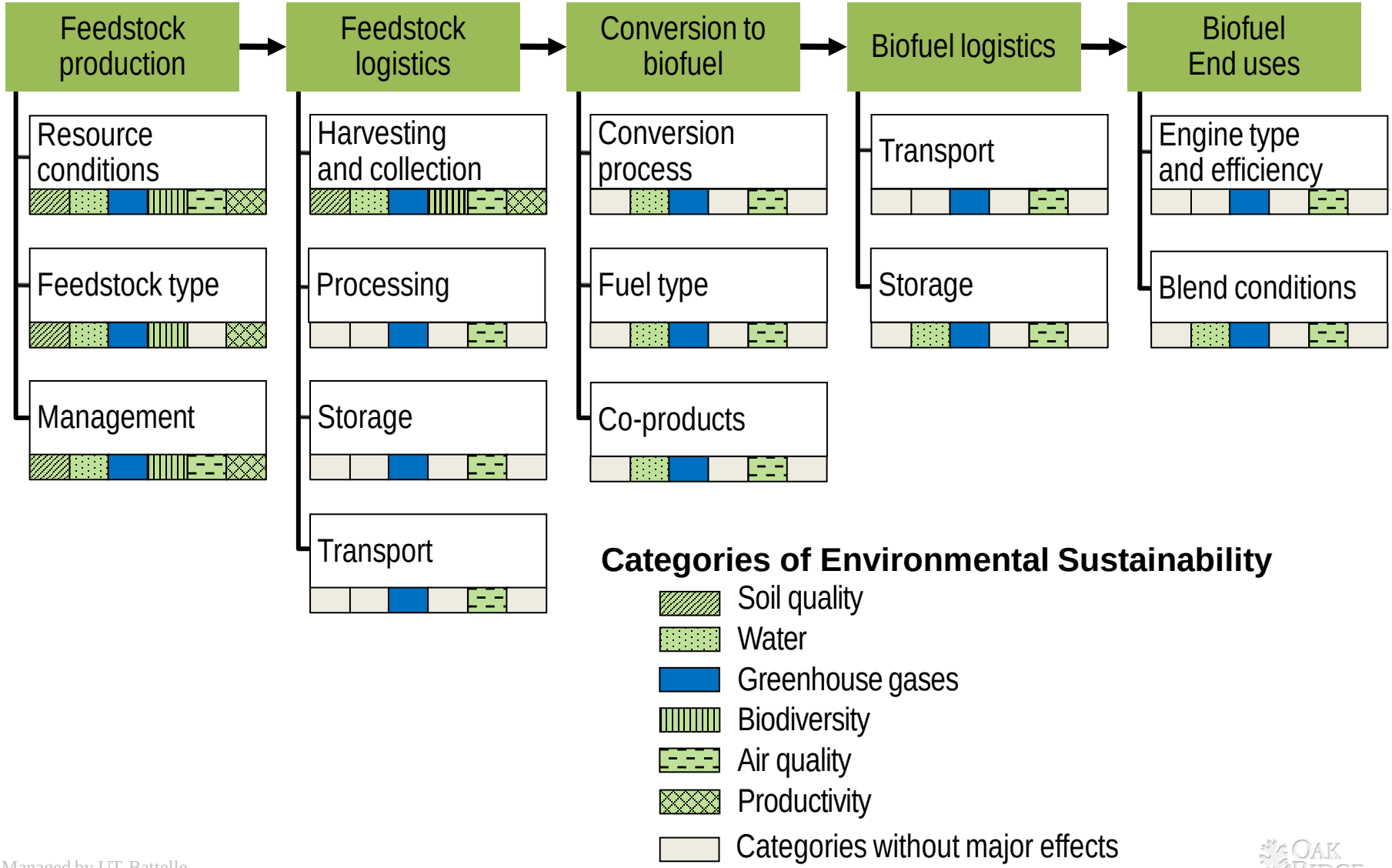


Categories of Environmental Sustainability

- Soil quality
- Water
- Greenhouse gases
- Biodiversity
- Air quality
- Productivity
- Categories without major effects

Efroymson et al. (2013) *Environmental Management* 51:291-306.

Greenhouse gas effects occur at all steps and substeps of the supply chain



Categories of socioeconomic sustainability indicators

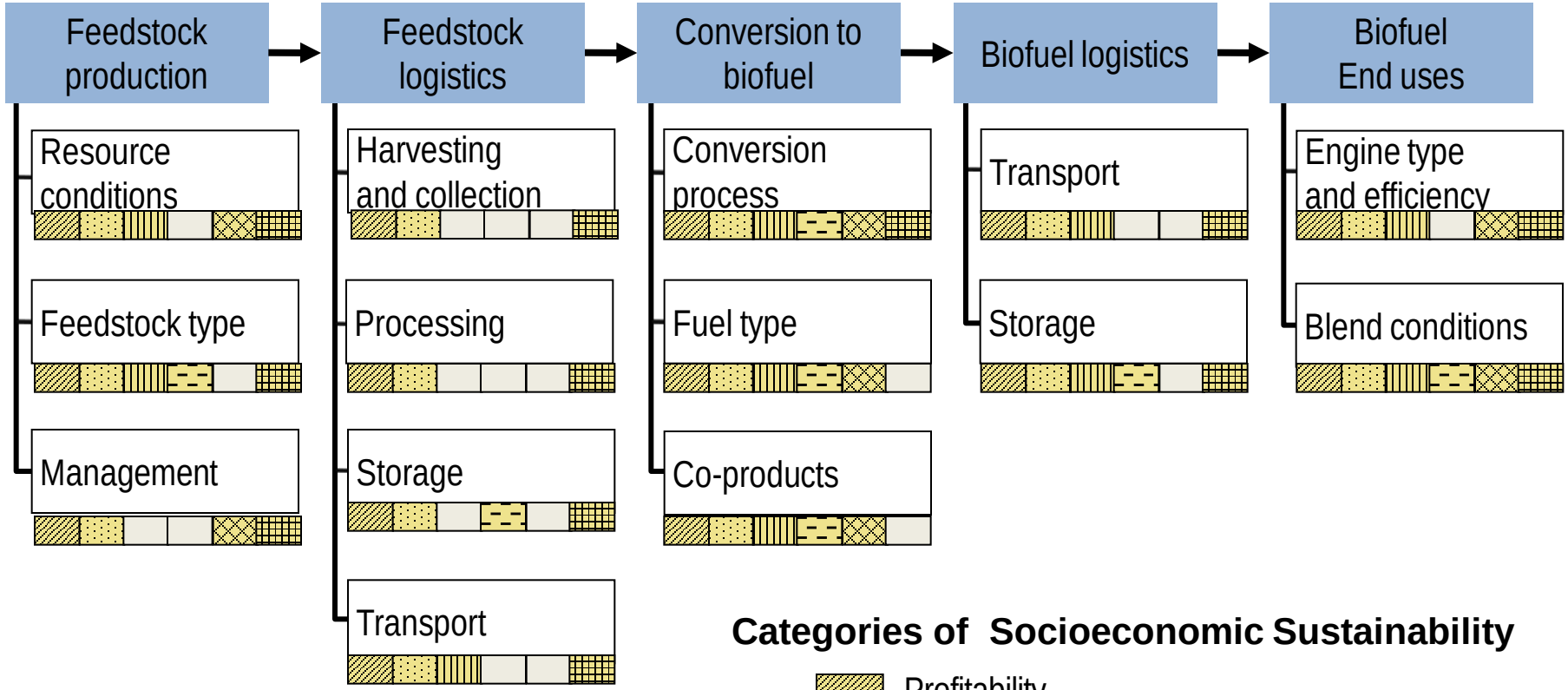
Ten minimum practical measures

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 outputt
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) *Ecological Indicators* 26:87-102.

Looking at the biofuel supply chain in terms of socioeconomic sustainability indicators



Categories of Socioeconomic Sustainability

- Profitability
- Social well being
- External trade
- Energy security
- Resource conservation
- Social acceptability
- Categories without major effects

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

Adapting Suite to Particular Contexts

- **Indicator set is a starting point for sake of efficiency and standardization**
  - Particular systems may require addition of other indicators
  - Budget may require subtraction of some indicators
  - Some indicators more important for different supply chain steps
- **Protocols must be context-specific**

Thank you!

CBES

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