IEA Bioenergy

Conceptual and analytical frameworks for evaluation and reporting of the bioenergy impacts - The challenge of applying LCA for water

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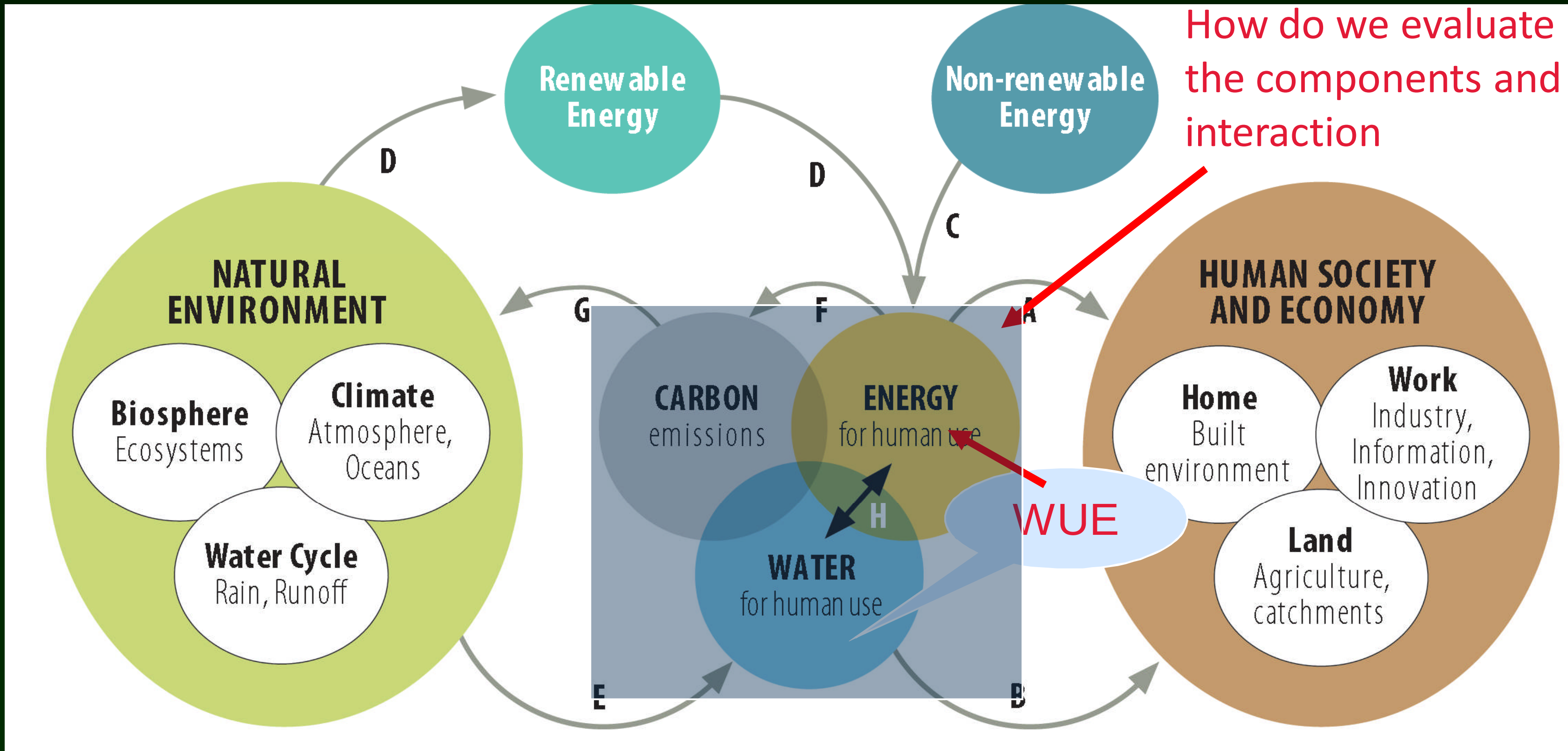
B.H. George, November 2011; Bioenergy Australia, Sunshine Coast

Water – bioenergy workshop

- Water aspects of bioenergy
  - Global – covered by Berndes
  - Australian issues – McGrath, George
  - Specific examples – Kunz, Neary, Wani
  - Economics (Abadi) + governance (Martin)
- This talk
  - LCA methodology
  - Understanding hydrology
  - Existing work – define some of the parameters
  - Lead to detailed advanced assessment (Fingerman)
- Linkages to bring together – workshop discussion

Carbon – energy – water



- Balance between society, economic and environment
- Interplay between water-energy and role for renewable energy

PMSEIC, 2010. Challenges at energy-water-carbon intersections. Prime Minister's Science, Engineering and Innovation Council, Canberra, Australia, p. 88.

Life Cycle Assessment (LCA)

- Widely used (systems analysis) tool developed for:
  - measuring the environmental (issues and) outcomes of the (feedstock supply), production, use and disposal of products and services.
  - Based on input-output modelling.
  - Used widely for building systems.
  - Heavily used in **GHG** and contributing to accounting, and especially energy transformation.
  - (not discussing other application or development such as allocations, system expansion)

LCA (recognition of water)

- Goal & scope
  - Identify, define and understand importance of water in production system
  - Water included in the functional unit & impact assessment
- Inventory
  - Identify specific input parameters
    - e.g., output ex-hydrology-based systems/models
- Analysis/impact assessment
  - Integration and assessment of water as an impact category
- Interpretation – recognition of water and implications

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Adapting LCA

- Limitations – C is C but water 'aint water
  - Spatial context
  - Temporal (short timescales)
- History of water in assessment
  - Recognition – of blue and green; footprint (+limitations)
- Specific approaches & US case study discussed by Kevin Fingerman following

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LCA + Hydrology

- What are linkages between LCA and hydrology?
  - Previously (ignore* or part recognition# of water in the biomass production system)
    - Many LCA studies focus on the processing components of water use
- Hydrology in space and time – significant field of research – Zhang *et al.*, growth studies in ag & forestry, upcoming CSIRO DAFF report….
- Understanding and recognising the components of water, *viz*. 'blue', 'green' and 'grey'

* - e.g., Harto *et al.* (2010). Life cycle water use of low-carbon transport fuels. Energy Policy 38, 4933-4944.

- e.g., Bayart *et al.* (2010). A framework for assessing off-stream freshwater use in LCA. International Journal of Life Cycle Assessment 15, 439-453.

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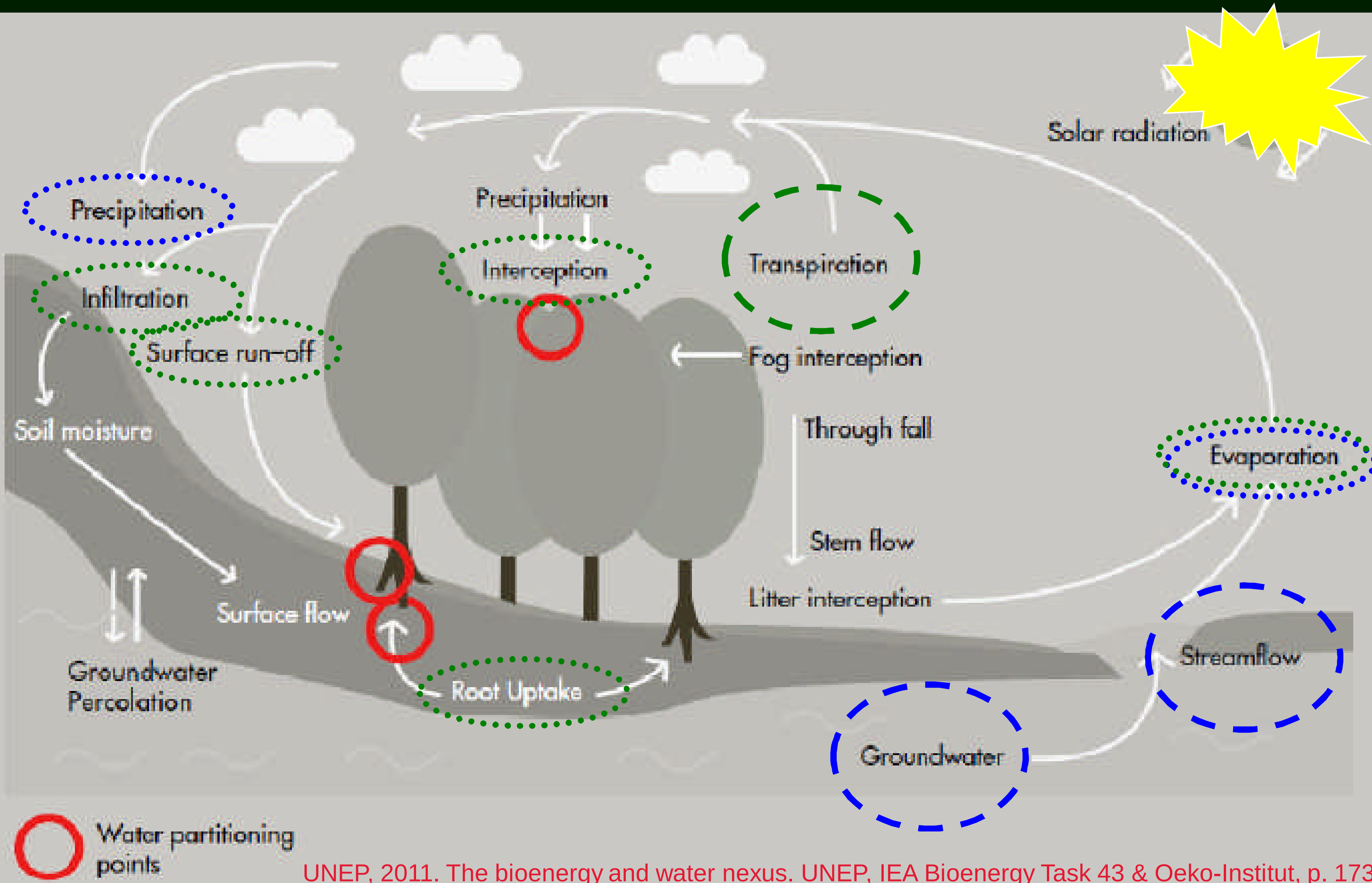
Hydrology – green and blue



UNEP, 2011. The bioenergy and water nexus. UNEP, IEA Bioenergy Task 43 & Oeko-Institut, p. 173.

What colour is that water?

- Blue – water in rivers, lakes, wetlands & aquifers which can be utilised for human use (e.g., irrigation)
- Green – soil water in the unsaturated zone (from precipitation) that is available to plants
- Grey – water that is ‘contaminated’ during a production process

Production and water use

	Consumptive uses	Non-consumptive uses
Productive evaporation use	• Crop ETc • Water harvested with crop	• Deep percolation for salt leaching • Frost control
Non-productive evaporation use	• Evaporation from soil surface, open ditches, conveyance channels, and crop canopy, etc. • Sprinkler evap. • Reservoir evap.	• Excess run-off and seepage looses • Excess deep percolation

- Consumptive water use - water is considered consumed when it is removed from the usable resource base for the remainder of one hydrologic cycle (e.g., ET).
- Competition for water use

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The Water Footprint - WF

- Factors determining the water footprint of a country are:
  - volume of consumption (related to the GNI);
  - consumption pattern (e.g., meat consumption);
  - climate;
  - agricultural practice (e.g., WUE)
- Freshwater (+ pollution) consumption per unit output

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Hoekstra, A., Chapagain, A., 2007. Water footprints of nations: Water use by people as a function of their consumption pattern. Water Resources Management 21, 35-48.

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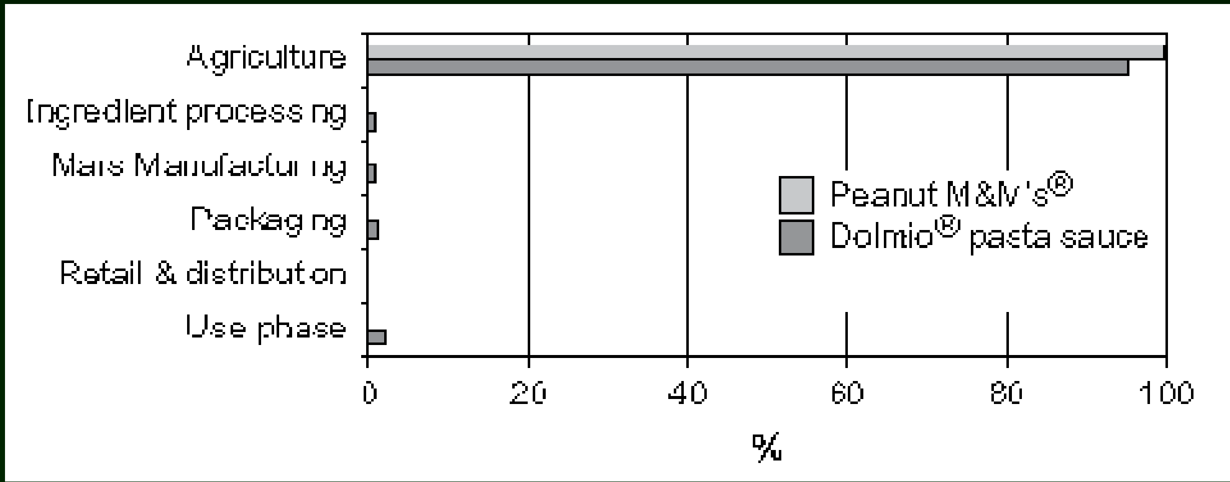
Water footprint



1153 L per 250g packet
202 L per 575g jar

- ‘Abstract’ example
- Authors identified limitations in the ‘water footprint’ approach
  - What does it mean in recognition of alternative water uses?
  - How much water is there? Is 1153 L a lot?

Ridoutt et al., (2009). Water footprinting at the product brand level: case study and future challenges. Journal of Cleaner Production 17, 1228-1235.

Water footprint - WF

- Water footprint
  - Combines the blue, green & grey water
  - Simplification that does not give ‘context’ to output (e.g., 1ML has different ‘value’ in different catchments)
- ‘Shoesize’ v WF (Pfister & Hellweg, 2009)
  - Water Stress Index as a weighting function
  - Attempt to normalise results across basins (to Colorado)

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Water scarcity

- ‘The point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully…’
- Water scarcity index - the water scarcity index is often expressed as the ratio between gross water abstraction and total renewable water resources.

UN Water Thematic Initiative, 2006. Coping with water scarcity.

A scarce resource

- Water scarcity:
  - 1 700+ m^3 $capita^{-1}$ yr^{-1} (water shortage irregularly or locally)
  - <1 700+ m^3 $capita^{-1}$ yr^{-1} stress appears regularly
  - < 1 000+ m^3 $capita^{-1}$ yr^{-1} below water scarcity is a limitation to economic development and human health and well being
  - <500+ m^3 $capita^{-1}$ yr^{-1} water availability is a main constraint to life

Upcoming 'discussion' regarding the Murray-Darling Basin plan

Falkemark water stress indicator, UNEP 2011

Developing a standard approach

- ISO 14046 (prelim work item)
  - *Water footprint – Requirements and guidelines*
  - ISO/TC 207 subcommittee SC 5, *Life cycle assessment* – through WG 8
  - Define how the different types of water sources (e.g., ground water) and water releases (e.g., grey water) should be considered
  - Determine how local environmental and socio-economic conditions addressed
- The standard should *not* offer a methodology for calculating offsets or compensation

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http://www.iso.org/iso/isofocusplus_bonus_water-footprint

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Working example - Australia

- Significant science of hydrology, water use efficiency and implications (ongoing)
  – Water use studies associated with MDB
- Developing expertise in LCA – GHG, materials, buildings, agriculture
  – being considered for water

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A game of catch up?

- Carbon Farming Initiative (CFI)
  - Fits within the *Clean Energy Future* ‘package’
  - GHG outcomes
  - Biodiversity a big component
- Preference for non-harvested biomass
  - (Different discussion)
- Water limitations

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Carbon Farming Initiative

- National Water Initiative (NWI)
  - Intergovernmental agreement (COAG)
  - Particularly relevant to the MDB – Qld, NSW, Vic & SA

CFI regulations

Land use change (not changed management)

Plantation & Reafforestation Act (NSW)

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National Water Initiative

- The Parties recognise that a number of land use change activities have potential to intercept significant volumes of surface and/or ground water now and in the future. Examples of such activities that are of concern, many of which are currently undertaken without a water access entitlement, include:
  - i) farm dams and bores;
  - ii) intercepting and storing of overland flows; and
  - iii) **large-scale plantation forestry**.

(Clause 55)

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Carbon farming initiative

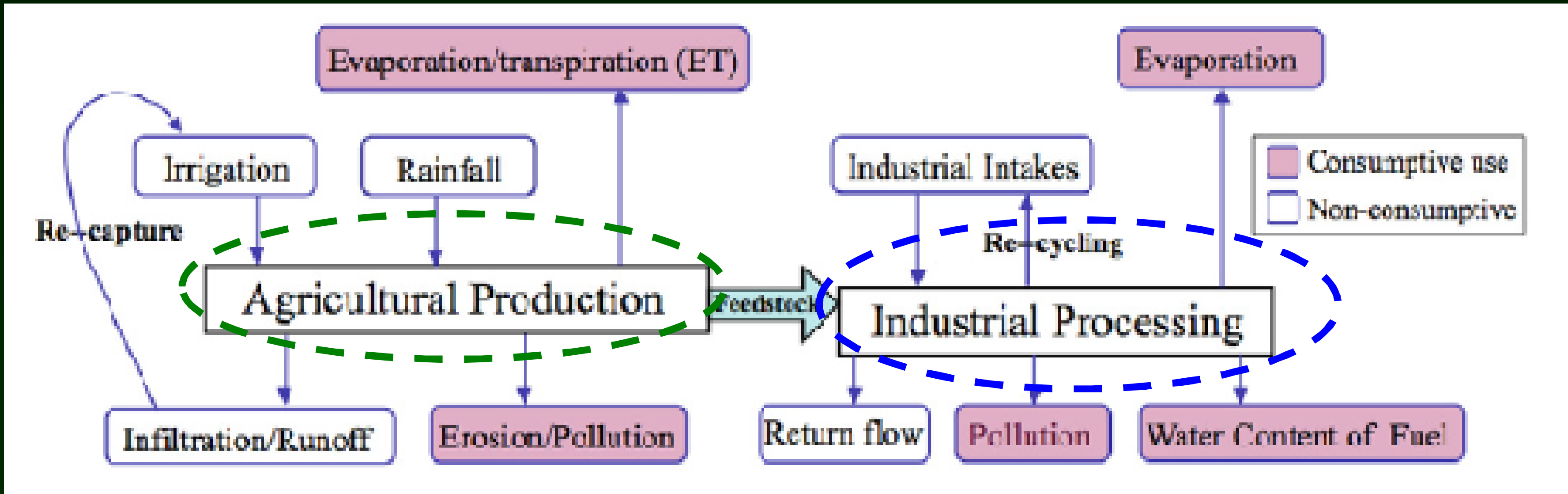
- **Carbon Credits (Carbon Farming Initiative) Regulations 2011**
  – Links to the National Water Initiative

Table 1

Long-term average annual rainfall	Volume of water offset entitlements required per hectare per year for the life of the project
600 – 700mm	0.9ML
700 – 800mm	1.2ML
800 – 900mm	1.5ML
900 – 1000mm	1.8ML
greater than 1000mm	2.1ML

http://www.climatechange.gov.au/government/submissions/~/media/publications/carbon-farming-initative/draft-regulations-positivenegative.pdf

How does it fit for bioenergy?



- Develop procedures and metrics to link water and LCA will be one option
- Don't forget the 90+% ('green' water)

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Fingerman, K.R., Torn, M.S., O'Hare, M.H., Kammen, D.M., 2010. Accounting for the water impacts of ethanol production. Environmental Research Letters 5, 8.

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Water – bioenergy workshop

- Objective is to facilitate:
  - – the discussion regarding bioenergy production systems
  - – water as a limiting environmental parameter
  - – The use of existing tools (e.g., LCA, economics) to quantify impacts
  - – potential implications for policy development to facilitate

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