Low Carbon Fuel Standard Life Cycle Analysis (LCA) Working Group 1 Meeting

November 16, 2007

California Environmental Protection Agency

Air Resources Board

Agenda

- Introductions
- GREET Training
- Specific issued to be discussed at this meeting
- Discussion how to resolve these issues
- Stakeholder comments
- Stakeholder presentations
- Other items to be discussed
- Topic of focus for next meeting
- Proposed meeting date(s)

GREET Training

- GREET Training for stakeholders on December 18, 2007 at the California Energy Commission
  - 14 people have expressed interest to attend

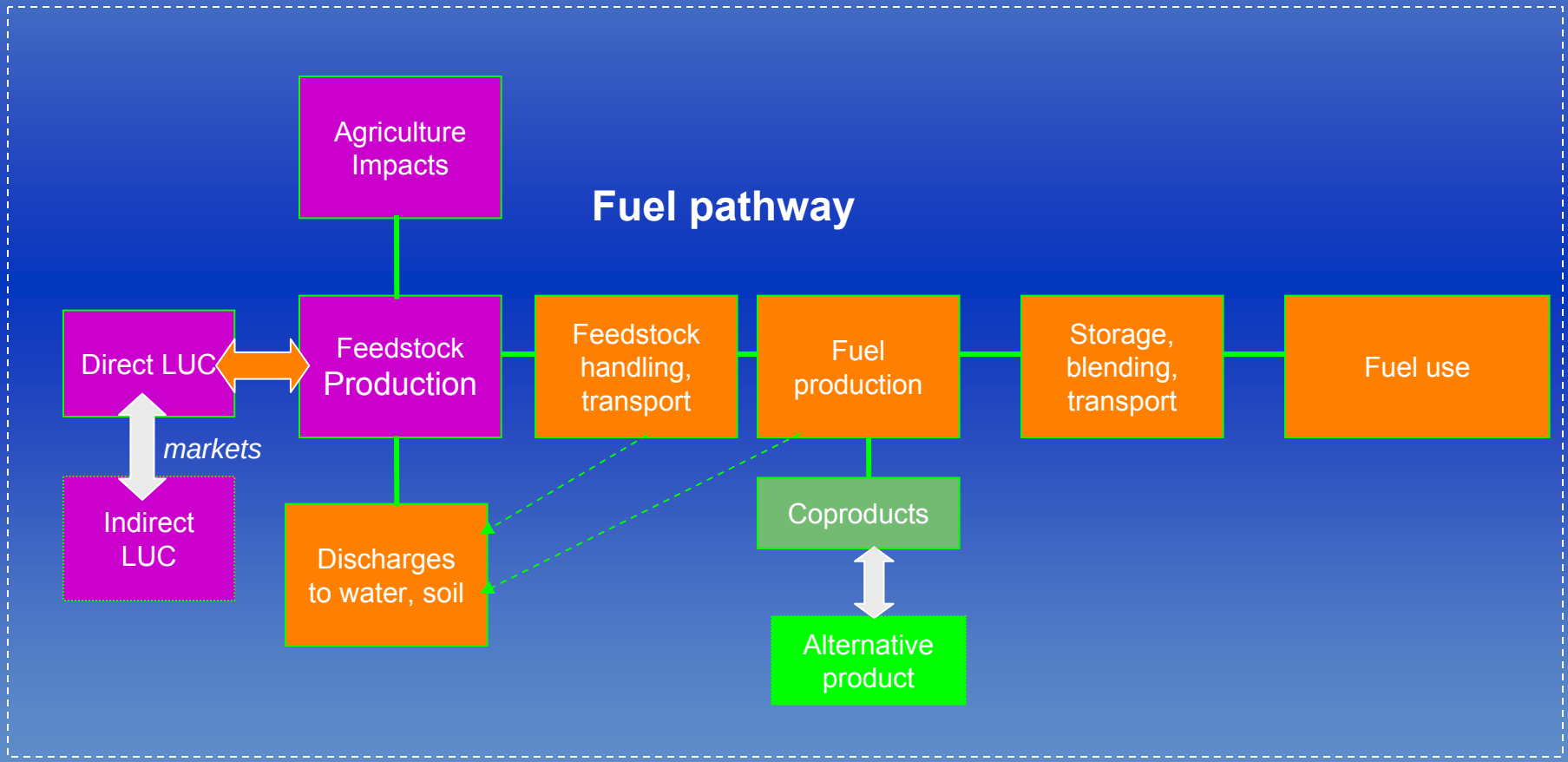
LCA Oveview

- Model Review and Modifications
  - Co-products: Methodology (discussed earlier and 11/16/07)
  - Agricultural and Land Use Change Impacts: Methodology (11/16/07)
  - Defaults and Assumptions (12/20/2007)
  - Fuels, Pathways, and Fuel Boundaries (12/20/2007)
  - VISION Model (01/2008)
  - Uncertainty/ Sensitivity (01/2008)
- Scenarios and Scenario Analysis (01/2008)

Specific Issues to be Discussed

- Co-product issues
- Agricultural and Land use change impacts

System Boundary for Lifecycle Analysis



Co-product Credit Methodologies

- Displacement/Substitution
- Allocation by attribute

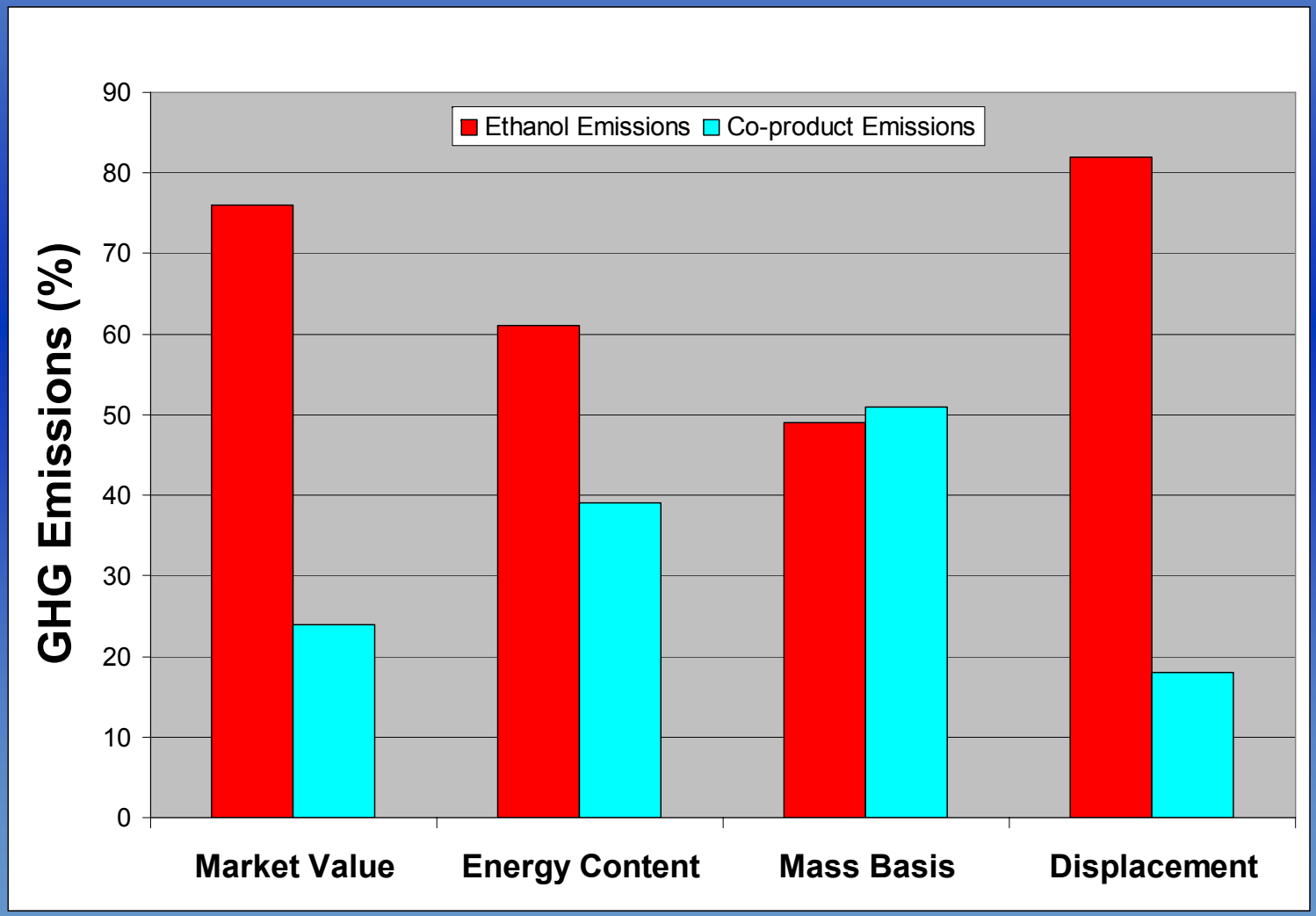
Co-product Methodology: Displacement

- Displacement/Substitution: co-products substitute for some quantity of another product
- Co-product credit is based on the life cycle GHGs associated with the avoided product.
- Example: electricity exported from a cellulosic ethanol plant would be credited with the avoided emissions for producing the same quantity of electricity in the local grid.

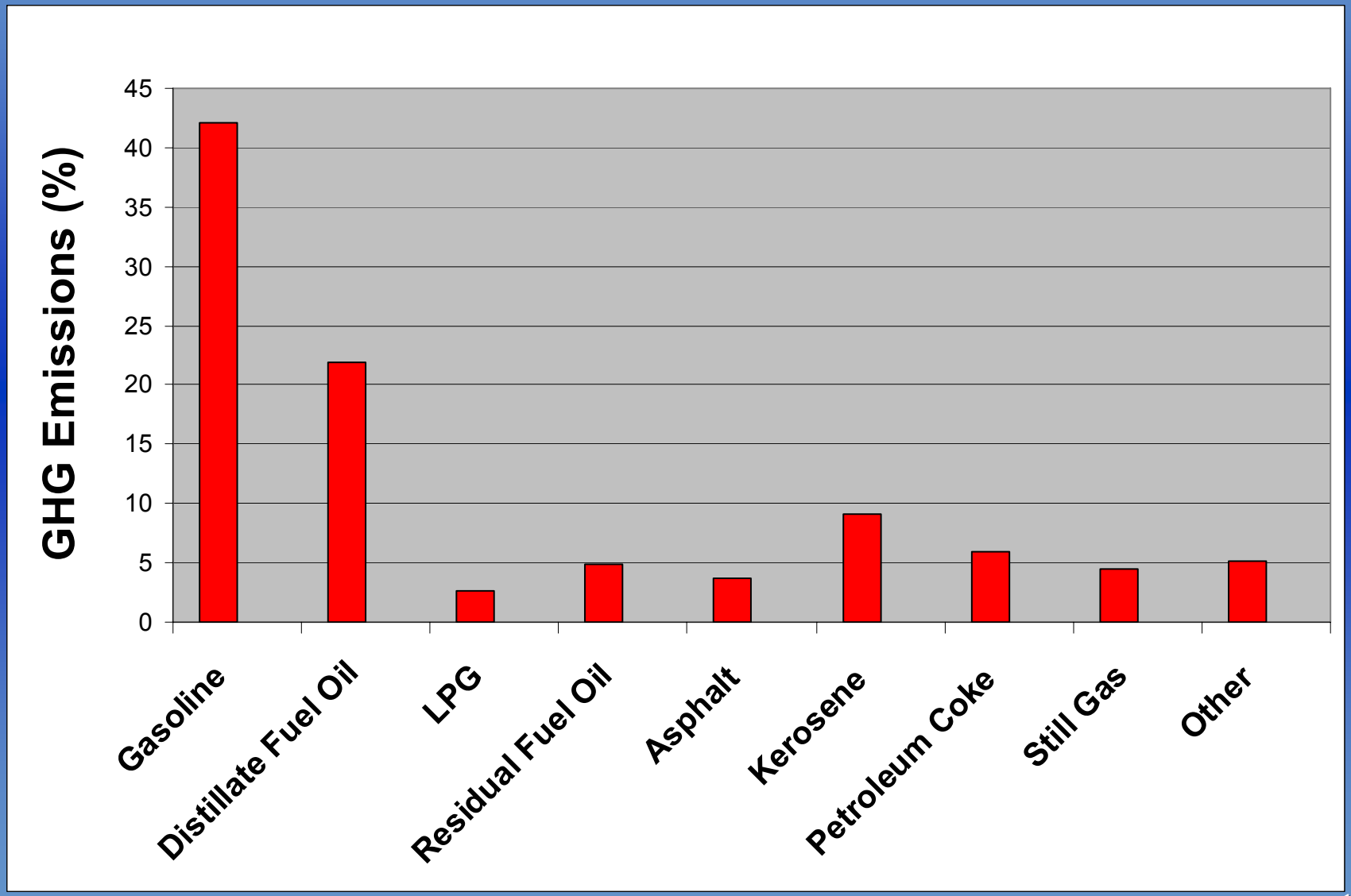
Co-product Methodology: Allocation

- Allocation by attribute:
  - GHG emissions are allocated to products proportionally to:
    - Mass or
    - Economic value or
    - Energy content
- Example: for corn ethanol, GHG allocations proportioned by dollar value of each product. GHG credit for DGS would then be calculated based on dollar value of ethanol produced.

Example: Comparison of GHG Results (Corn Ethanol from Dry Milling)



Example: Comparison of GHG Results (Refinery- Allocation method)



Co-Product Methods from Other Studies

- ISO 14040
  - For LCA recommends "substitution' method
- U. S. EPA, CONCAWE, U. K. RTFO, and the Cramer Commission
  - Recommend the substitution/displacement approach
- GREET, AB 1007
  - Used hybrid methodologies in certain cases
- Staff Recommendation
  - Substitution/displacement but allocation necessary for certain pathways

Recommendation for Criteria for Co-product Credit

- Credit will be given for
  - Animal feed*
  - Electricity
  - Glycerin
  - Refinery products (e.g. LPG by allocation)
- No Credit
  - No demonstrated 'benefit'
  - If given credit elsewhere (no double-credited)
  - No methodology to estimate impacts; questions on co-product use

* May need to be adjusted by addressing economic impacts of animal feed demand and availability

Co-products: Recommended Methodologies

Primary Fuel	Co-product	Recommended Methodology
CARBOB	Residual oil, LPG, Kerosene, Coke, Pentanes, Butanes	Allocation
ULSD	Residual oil, LPG, Diesel, Kerosene, Coke	Allocation
Natural Gas (CNG)	LPG, CO_2	Allocation
Natural Gas (LNG)	LPG, CO_2	Allocation
Other Fossil	To be determined	Allocation

Staff Recommendations: Co-product Methodologies (cont.)

Primary Fuel	Co-product	Recommended Methodology
Corn Ethanol (dry milling)	Wet or dry DGS	Displacement
Corn Ethanol (wet milling)	Corn oil, Corn gluten meal, and feed	Displacement
Sugarcane Ethanol	Fermentation solids, electricity	Displacement
BioEthanol (biochemical)	Fermentation solids, electricity	Displacement
BioEthanol (thermochemical)	Electricity	Displacement

Staff Recommendations: Co-product Methodologies (cont.)

Primary Fuel	Co-product	Recommended Methodology
Soy Biodiesel	Soybean meal, Glycerin	Displacement
Palm Oil Biodiesel	To be evaluated	Displacement
Renewable Diesel	LPG	Displacement
Other Biofuels	To be evaluated	Displacement

Staff Recommendation for co-product credits

	Corn Ethanol (U. S.)	Stover to Ethanol (U. S.)	Sugarcane Ethanol (Brazil)	Soy Biodiesel (U. S.)	CARBOB	ULSD
Animal Feed	√			√		
Electricity	√	√	√			
Glycerin				√		
Refinery Products					√	√

√ Data Available (IPCC, LEM, GREET, etc.)

Values for Co-products

- GREET, LEM, and other studies have assigned unique values or provided range of values for co-product credits
- ARB will provide by December 7, 2007 a list detailing all values for co-products indicated in the previous slide
- Stakeholders are requested to provide suggestions and comments on this list before the next working group meeting

* May need to be adjusted by addressing economic impacts of animal feed demand and availability

Agricultural and Land Use Change (LUC) Impacts

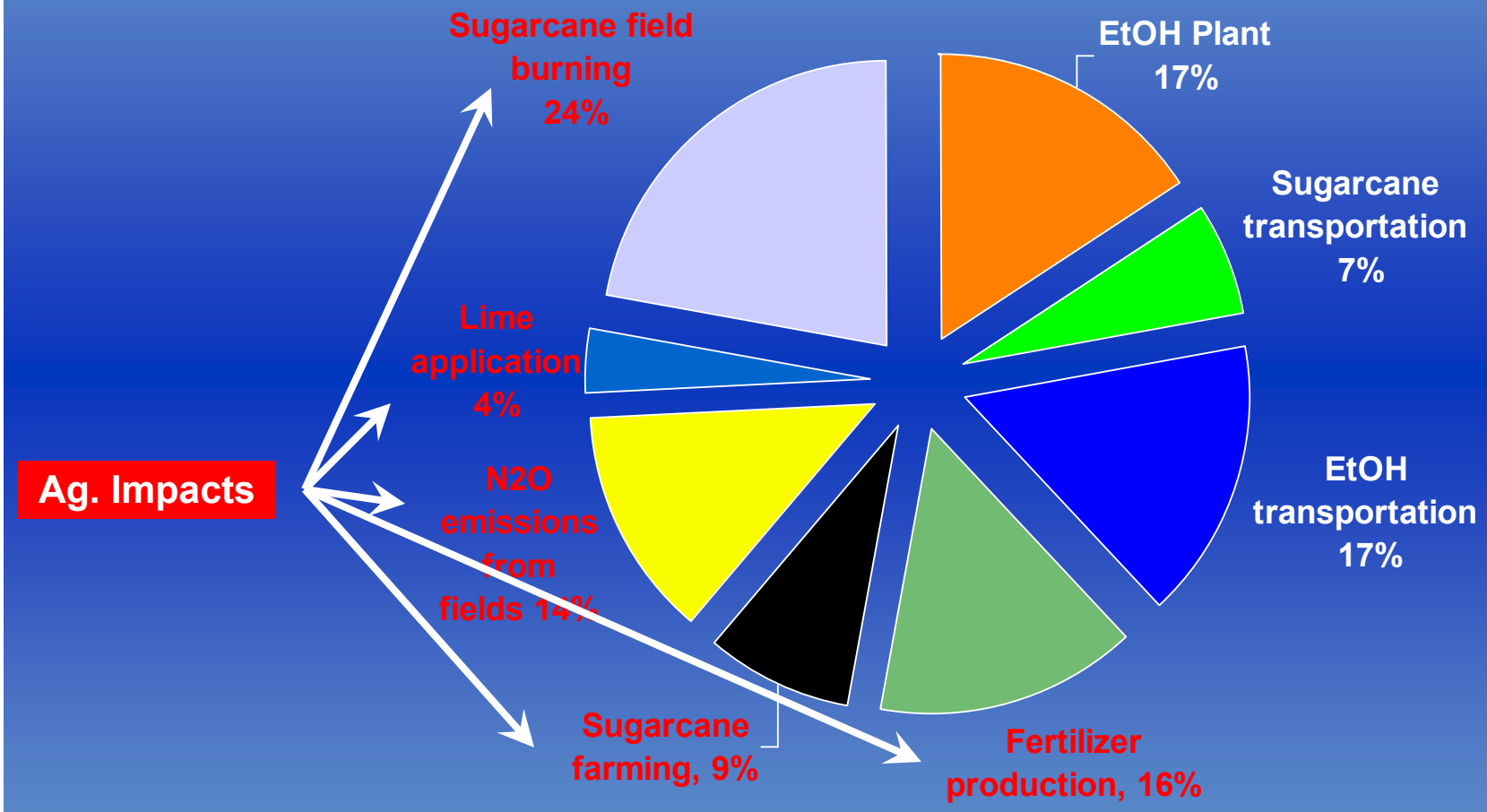
Agricultural And LUC Impacts

- Agricultural Impacts
  - Fertilizer production and use
  - Pesticide production and use
  - Lime production and use
  - Farm equipment use
  - Other activities (i.e. seed production)
- Land Use Change
  - Direct LUC Impacts
  - Indirect LUC Impacts
- Outside of GREET
  - Eutrophication
  - Soil Erosion
  - Water Impacts
  - Sustainability
  - Biodiversity
  - Other issues

Agricultural Impacts

- Impact from production and use of fertilizer
  - GREET has values for GHG impacts and other data is also available
- Impact from production and use of pesticide
  - GREET has values for GHG impacts and other data is also available
- Impact from production and use of lime
  - GREET has values for GHG impacts and other data is also available
- Farm equipment use
  - GREET has values for GHG impacts and other data is also available

Example: Sugar Cane Ethanol
(Relative contribution to GHG emissions)



Source: Michael Wang – Argonne National Lab

Staff Recommendation for considering Agricultural Impacts in modified GREET

	Corn Ethanol (U. S.)	Stover to Ethanol (U. S.)	Switchgrass to Ethanol (U. S.)	Sugarcane Ethanol (Brazil)	Soy Biodiesel (U. S.)	Palm Oil Biodiesel (S. E.Asia)
Impact of Fertilizer	√	√	√	√	√	X
Impact of Pesticide (herbicides and insecticides)	√	√	√	√	√	X
Lime use	√	√	√	√	√	X
Farm equipment use	√	√	√	√	√	X

√ Data Available X Need to find data

Values for Agricultural Impacts

- GREET, LEM, IPCC, and other studies have provided unique values or estimates for agricultural impacts
- ARB will provide by December 7, 2007 a list detailing all values for agricultural impacts discussed in the prior slide
- Stakeholders are requested to provide suggestions and comments on this list before the next working group meeting

Direct Land Use Change

- Direct Land Use Change (LUC):

  - Biofuel crop grown on land that was previously used for another crop and its associated agriculture impacts.
    - Change from current use to biofuel crop
    - Change from uncropped (eg. forest) to crop growing
    - Draining of wetlands for agriculture

Indirect Land Use Change

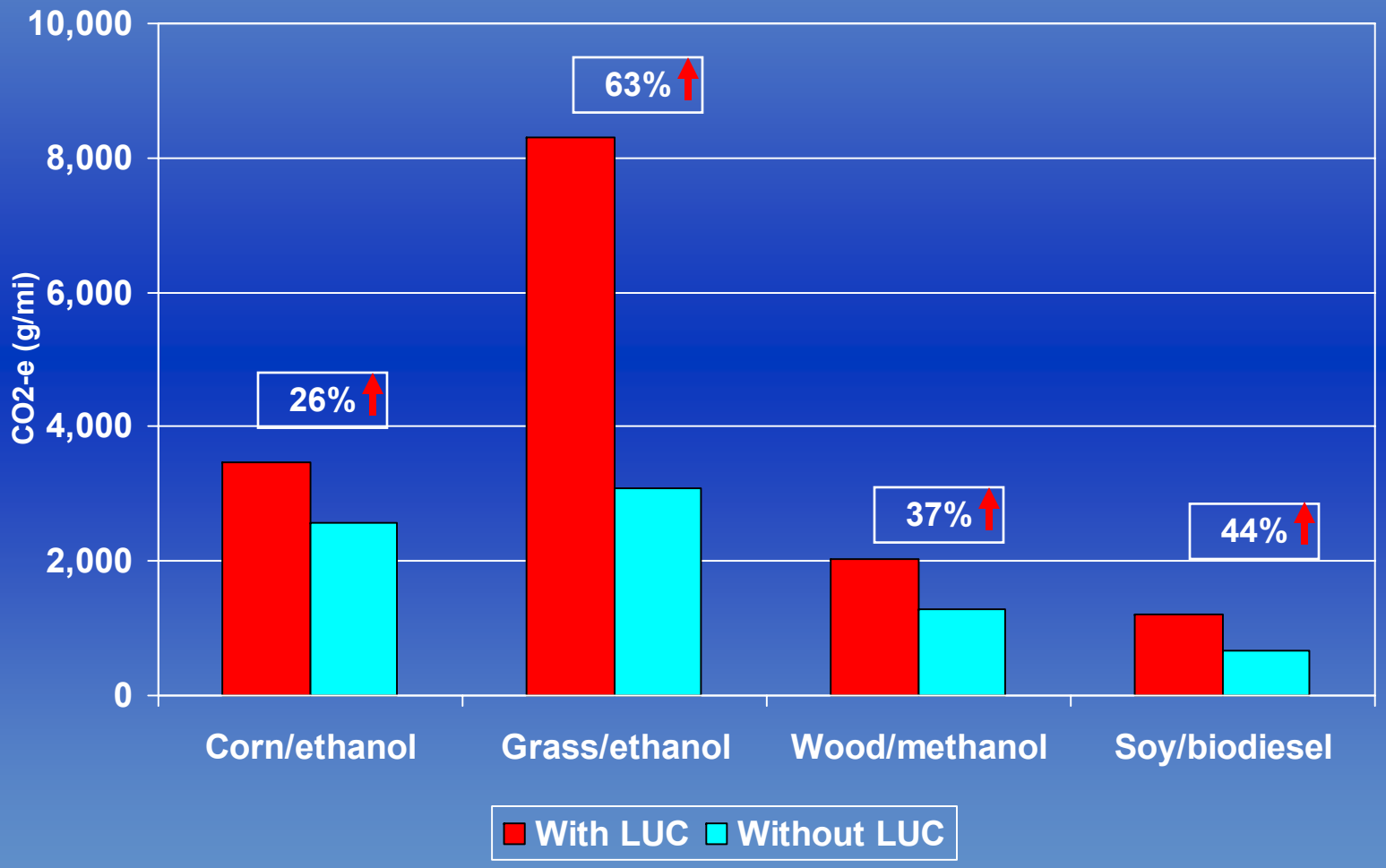
- Indirect LUC:

  - Convert uncropped or different crop land to replace crops that are triggered by direct LUC somewhere else and its associated agriculture impacts.

    - e.g.: native grasslands converted to soybean farming due to increased demand arising from soybean cultivation being replaced by corn cultivation
    - Draining of wetlands to grow palm oil for food to replace palm oil used as fuel feedstock

Impacts of Land Use Change on LCA

Source: Mark Delucchi (2003) **LEM MAIN REPORT** p.197



Staff Recommendations for considering Land Use Impacts

		Corn Ethanol (U. S.)	Stover to Ethanol (U. S.)	Sugarcane Ethanol (Brazil)	Soy Biodiesel (U. S.)	Palm Oil Biodiesel (S. E.Asia)
Direct LUC Impacts	Change of land from current to biofuel crop	√	√	X	√	X
	Change from forest or permanent grassland to crop growing	√	√	X	√	X
	Draining of land for agriculture	√	√	X	√	X
Indirect LUC Impacts	Change of land from current to biofuel crop	√	X	X	√	X
	Change from forest or permanent grassland to crop growing	√	X	X	√	X
	Draining of land for agriculture	√	X	X	√	X

√: Data Available X Sources being researched

Values for LUC Impacts

- GREET, LEM, IPCC, Iowa Ag. Center and other studies have provided unique values or estimates for land use impacts
- ARB will provide by December 7, 2007 a list detailing all values for land use impacts discussed in prior slides
- For unavailable data, ARB will attempt to provide recommendations
- Stakeholders are requested to provide suggestions and comments on this list before the next working group meeting

Stakeholder Presentations

- Shell Presentation on Co-products
- Other Presentations?

Next Meeting Date and Topic

- Focus for next meeting of WG1
  - Values and Assumptions necessary for modified GREET
  - Default values
- Next Meeting: December 20, 2007 at ARB HQ from 1:30 to 4:30 PM

For More Information

- Contact us:

  Anil Prabhu, Ph.D.
  (916) 327-1501; aprabhu@arb.ca.gov
  Chan Pham
  (916) 323-1069 ; cpham@arb.ca.gov

- Visit our website at:

  http://www.arb.ca.gov/fuels/lcfs/lcfs.htm

Open for Discussion