California Environmental Protection Agency

Air Resources Board

Low Carbon Fuel Standard Re-Adoption Indirect Land Use Change (iLUC) Analysis

November 20, 2014

Agenda

- Previous iLUC analysis
- Updates to AEZ-EF and GTAP models
- Draft Results

  Scenario analysis
- Next Steps

Previous iLUC Analysis: 2009-2014

	Board Approved (2009-2010) (g/MJ)	March 2014 (g/MJ)	September 2014 (g/MJ)	
			Approach A	Approach B
Corn Ethanol	30.0	23.2	25.0	21.6
Sugarcane Ethanol	46.0	26.5	27.9	21.3
Soy Biodiesel	62.0	30.2	30.6	26.6
Canola Biodiesel (US +EU)	n/a	41.6	40.3	35.2
Sorghum Ethanol	n/a	17.5*	14.6	13.0

* Sorghum ethanol analysis did not use all 1440 scenario runs

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iLUC: Carbon Emissions and GTAP

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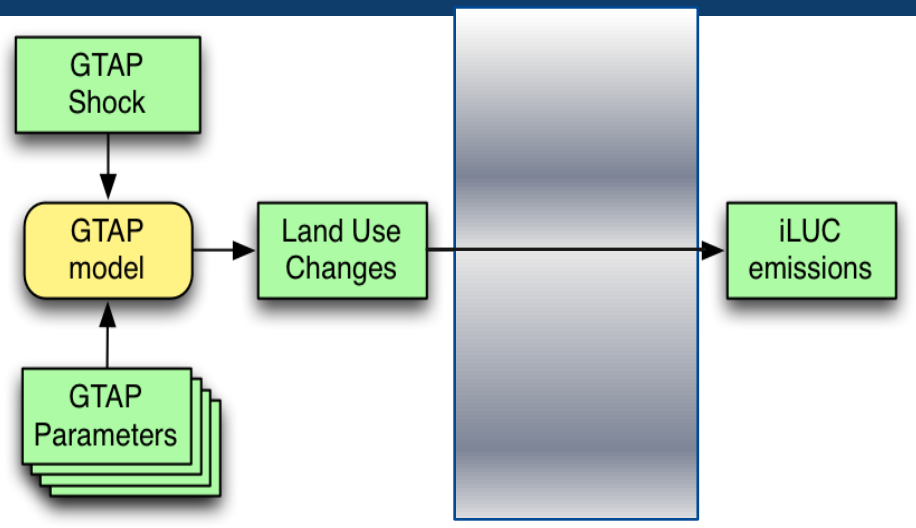
GTAP Integration with Carbon Emissions

(iLUC Estimation Methodology)



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Agro-Ecological Zone - Emissions Factor (AEZ-EF) Model

(Developed by UCB, UCD and U. of Wisconsin)

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AEZ-EF: Stakeholder Feedback

- Energy displaced by harvested wood
- Inclusion of inaccessible forests in developing forest carbon stocks
- Consider using CCLUB model for emissions
  (Emissions from cropland-pasture to cropland are ~50% of the emissions from converting pasture to cropland)
- Include CCLUB in uncertainty analysis
- AEZ-EF does not include transition of cropland-pasture to (permanent) pasture or forest

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AEZ-EF: Stakeholder Feedback (cont.)

- Root-shoot ratio for sorghum
- Emissions related to litter and deadwood
- Fraction of forest converted assigned to peatland should be higher than 33%
- F_{lu} (land use factor) different for non-tropical regions
- F_{mg} should be between 1.02 and 1.15

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AEZ-EF: Changes/Updates

Python version

- N_2O loss changed for all SOC loss (not just from top 30 cm)
- Ensured all "active" regions are used where GTAP has land-use data are included

AEZ-EF model

- In Forest and Pasture sheet, soil carbon data has been corrected to refer to appropriate data
- F_{lu} (land use factor) set to 1 for trees/perennials in all climatic zones (per stakeholder feedback)
- Fixed subtraction of litter carbon in "total C gain for cropland reversion"
- Peatland changed to 50%
- Other minor changes

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GTAP: Updates

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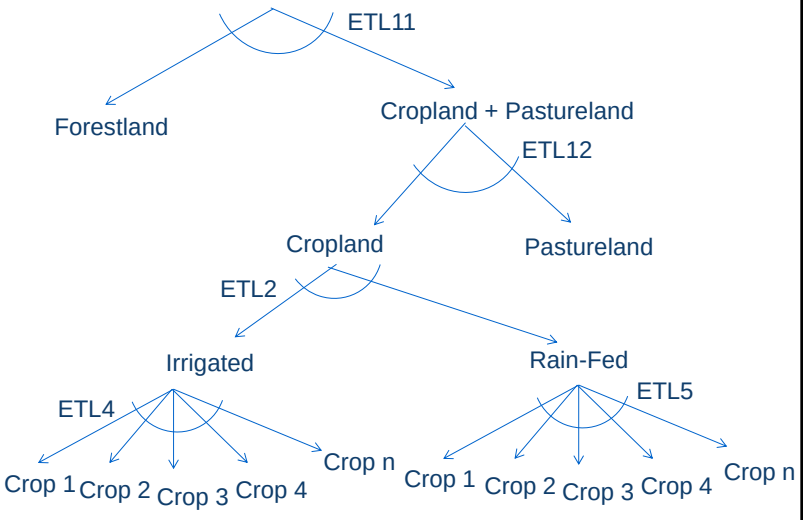
Elasticity of Land Transformation (ETL)
(a) Land Supply Structure
(b) ETL Values Used

GTAP: Stakeholder Feedback

- September workshop presented:
  - Approach A (old land transformation structure)
  - Approach B (updated land transformation structure)
- Stakeholder feedback recommending Approach B
- Staff considered feedback and will use Approach B

GTAP: Approach B



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Approach B: Separate ETL11 and ETL12

GTAP Region	ETL11	ETL12	ETL2	GTAP Region	ETL11	ETL12	ETL2
USA	-0.0182	-0.0218	-0.75	R_SE_Asia	-0.2727	-0.3273	-0.50
EU27	-0.0182	-0.0218	-0.75	R_S_Asia	-0.0909	-0.1091	-0.75
BRAZIL	-0.1905	-0.2095	-0.75	Russia	-0.0182	-0.0218	-0.75
CANADA	-0.0182	-0.0218	-0.25	Oth_CEE_CIS	-0.0182	-0.0218	-0.75
JAPAN	-0.1818	-0.2182	-0.50	Oth_Europe	-0.0182	-0.0218	-0.25
CHIHK	-0.1818	-0.2182	-0.25	MEAS_NAfr	-0.0182	-0.0218	-0.25
INDIA	-0.0909	-0.1091	-0.25	S_S_AFR	-0.2727	-0.3273	-0.25
C_C_Amer	-0.0182	-0.0218	-0.25	Oceania	-0.0182	-0.0218	-0.25
S_o_Amer	-0.0909	-0.1091	-0.50				
E_Asia	-0.1818	-0.2182	-0.50				
Mala_Indo	-0.2727	-0.3273	-0.25				

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GTAP: Yield Price Elasticity (YPE)

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YPE: Stakeholder Feedback

- Stakeholder feedback related to:
  - Consider different values for YPE
  - Use crop and region specific YPE for double cropping
- Staff evaluated feedback in relation to available studies and publications
- Preliminary analysis from UC Davis indicates no yield price trends using data from Goodwin et al. and Schlenker et al.

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YPE: Stakeholder Feedback (cont.)

- Use of crop and region specific YPEs will need supporting information and not currently available
- Will consider using crop and region specific YPE in future
- Staff proposes to use same range of YPE used in the scenario runs presented in Sept. 2014

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iLUC: Preliminary Results

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GTAP: Summary of Current Analysis

- Irrigated/rain-fed version with water scarcity
- Updated land transformation structure (Approach B)
- Same range of YPE used in September 2014 analysis
- iLUC analysis for Palm Biodiesel
- Palm oil sourced from Mala_Indo
- 400 million gallon shock for Canola, Sorghum and Palm
- For Canola, only U.S. shock used for modeling
- iLUC values for 6 biofuels (subject to revision)

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iLUC: Comparison of Previous and Current Analysis

Timeline	Details of iLUC analysis
2009/2010 analysis	Used 5-7 scenarios
March 2014 analysis	Used 1440 scenarios
September 2014 analysis	Used 30 scenarios (Approach A and Approach B)
November 2014 analysis	- 30 scenarios - Approach B - Variations of input values for YPE, ETA, and PAEL

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iLUC: Overview of Values Used in Scenario Analysis

Parameter/ Scenario	Description	Values
YPE	Yield Price elasticity	0.05, 0.125, 0.175, 0.25 and 0.35 **(5)**
PAEL	Cropland pasture elasticity	0.2 U. S. and 0.1 Brazil 0.4 U. S. and 0.2 Brazil **(2)**
ETA	Elasticity of crop yields with respect to area expansion	Baseline, 80%, and 120% of baseline **(3)**

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iLUC: Preliminary Results

Biofuel	2009 (g/MJ)	March 2014 Avg. (g/MJ)	Avg. of App. B (g/MJ)	Nov. 2014 (prelim)
Corn Ethanol	30.0	23.2	21.6	**20.0**
Sugarcane Ethanol	46.0	26.5	21.3	**19.6**
Soy Biodiesel	62.0	30.2	26.6	**27.0**
Canola Biodiesel (US only)	n/a	n/a	10.4	**14.5**
Sorghum Ethanol	n/a	n/a	13.0	**12.7**
Palm Biodiesel	n/a	n/a	n/a	**46.4**

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GTAP: Comparison of Predicted Land Conversion for Corn Ethanol

Land type	2009 work (million ha)	Current analysis (million ha)
Global (Total)	2.7 to 5.5	0.89 to 2.84
Forestland (Global)	0.4 to 1.5	0.22 to 0.95
U. S. (Total)	1.1 to 2.1	0.13 to 0.23
Forestland (U. S.)	0.4 to 0.8	0.06 to 0.12
Cropland Pasture (U. S.)		1.40 to 1.90

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Evaluation of Uncertainty

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Uncertainty: Overview

- Monte Carlo (MC) framework
- Joint model comprising GTAP and AEZ-EF
- Presented preliminary probability distributions at the March 2014 workshop
- Current distributions are expected to be similar to March workshop

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Schedule for iLUC Analysis

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iLUC: Schedule for 2014 -2015

- Current results are preliminary
- Staff reviewing both GTAP and AEZ-EF models
- Any changes/updates that impact iLUC values will be made available through 15-day change notices

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iLUC: Schedule for 2014 -2015

- Peer Review of LCFS will include iLUC review
- Proposed regulations filed with OAL in winter 2014
- Anticipated Board Hearing on LCFS and ADF in early 2015
- If Board adopts regulations, final regulations filed with OAL in 2015 to take effect January 1, 2016

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iLUC: Long-term Schedule

- Address Forestry issue in the model
- Account for Fertilizer, Livestock, and Paddy Rice emissions
- Include analysis for Cellulosic Feedstocks
- Develop and validate dynamic GTAP model

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Workshop Feedback

- Request feedback by December 5, 2014
- Submit via email to Katrina Sideco at ksideco@arb.ca.gov

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Thank you

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