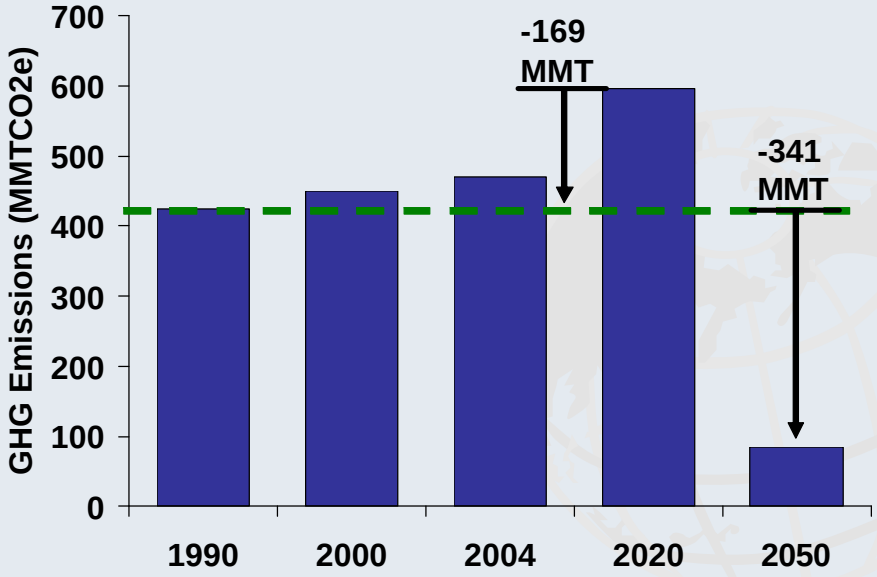
John D. Courtis
May 12, 2009

Why we need LCFS

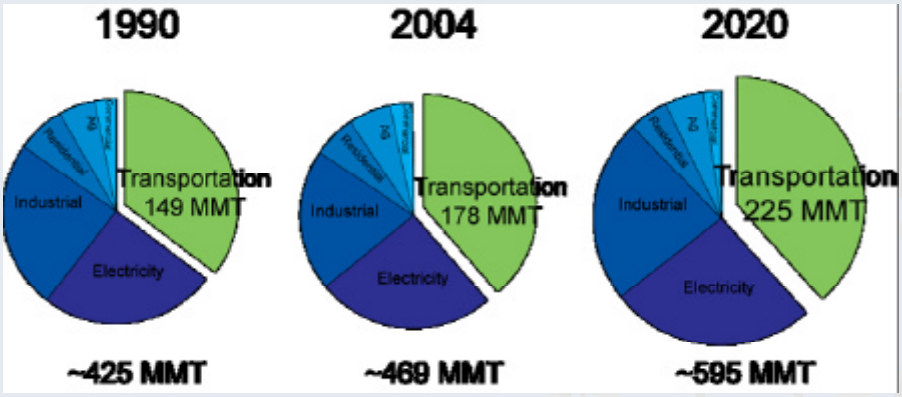
In CA Large GHG Reductions Required



Transportation Sector is Important

- **Significant reductions needed to achieve 2020 target and 2050 goal**
- **GHG emissions from transportation are large and increasing**
- **Transportation emissions affected by:**
  - **Amount and type of transportation fuels**
  - **Efficiency of motor vehicles**
  - **Number of vehicle miles traveled**

Transportation Emissions Increasing



Overview

- What are the regulatory requirements
- Importance of lifecycle analysis
- Results
- Environmental/economic impacts
- Comparison of LCFS to federal requirements
- Summary and next steps

LCFS Established by the Governor

- **Governor Schwarzenegger established the LCFS in January 2007**
- **UC completed analysis demonstrating feasibility in the spring and summer of 2007**
- **ARB identified LCFS as AB 32 discrete early action measure in June 2007**
- **Board approved LCFS on April 2009**

What are the LCFS Requirements

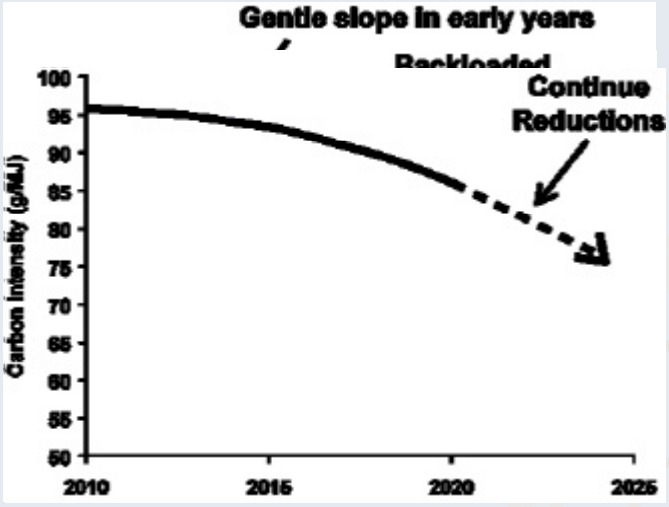
Regulated Parties?

- **Petroleum and biofuels providers are the 'regulated parties'**
- **Providers of other fuels that meet 2020 levels must 'opt in' to earn credits:**
  - **Electricity**
  - **Hydrogen**
  - **Natural Gas**

LCFS Requirements

- **Requires a 10 percent reduction in the carbon intensity(CI) by 2020; baseline 2010**
  - **Applies to (fossil fuel+biofuel) mix**
  - **Separate standards for Gasoline and Diesel**
  - **Other fuels are allowed to opt-in**
- **ARB has established CI values for some fuels and will establish CI values for other potential fuels.**

The LCFS Compliance Schedule



Compliance and Enforcement Requirements

- **ARB to provide software tools for fuel carbon reporting and credit tracking**
- **Regulated parties report quarterly and annually**
- **Enforcement includes records review, field inspections, and audits and penalties**

LCFS Flexibility: Market-Driven Compliance

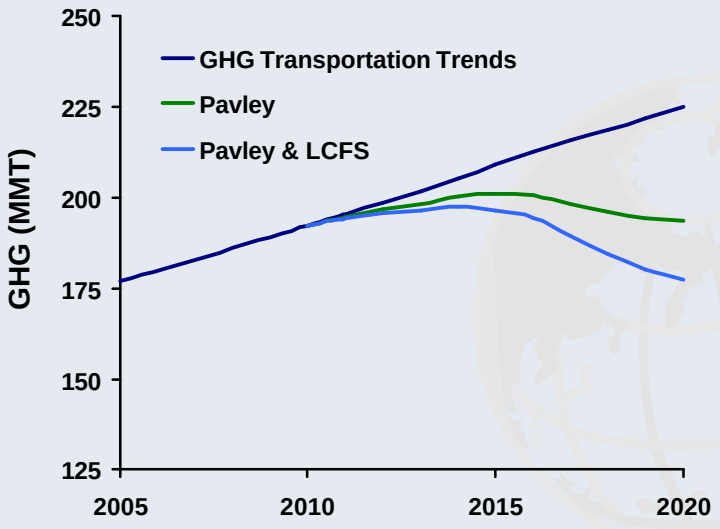
- **Supply a mix of fuels with average carbon intensity(over a year) equal to the standard**
- **Allow the use of purchased or banked credits to meet the standard**
- **Allow companies to generate their own CI values or the adjustment of CI to their specific cases**

Benefits

LCFS Benefits

- **Reduces 16 MMT GHG emissions from the transportation sector by 2020**
- **Creates durable framework for near and long term transition to low carbon fuels**
- **Encourages technology innovation**
- **Establishes a model for regional and national standards**
- **Sets stage for future reductions**

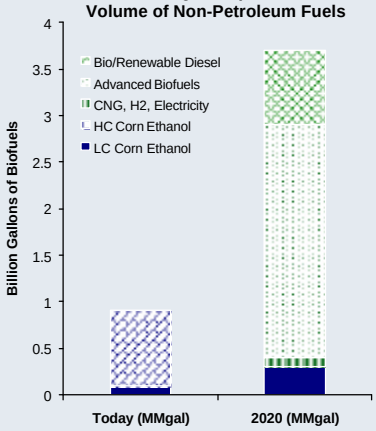
Benefits: Pavley and LCFS Reverse GHG Trend



What the LCFS Will Accomplish

LCFS Increases Demand of Biofuels and Diversity of Transportation Fuels

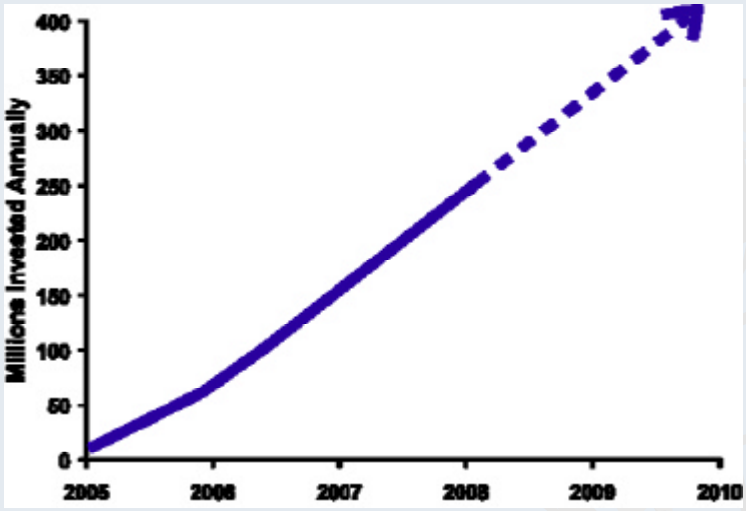
LCFS Quadruples the Volume of Non-Petroleum Fuels



LCFS Diversifies the Fuel Supply And Reduced Petroleum Consumption

Fuel	2020	
	% Difference	Volume (billion gge)
Advanced Biofuels	4800	3.3
LC Corn Ethanol	75	0.2
CNG, Electricity, FCV	N/A	0.1
HC Corn Ethanol	-100	0.0
Gasoline	-13	11.8
Diesel	-17	4.5

Benefits: LCFS Supports Investment



LCFS: Impact on Fuels

- **Increase use of:**
  - **Low carbon corn or sugarcane ethanol**
  - **Cellulosic ethanol**
  - **Renewable diesel and biodiesel**
  - **Electricity, hydrogen, natural gas**
- **And decrease the use of:**
  - **Petroleum**
  - **High carbon biofuels**

Importance of Lifecycle Analysis

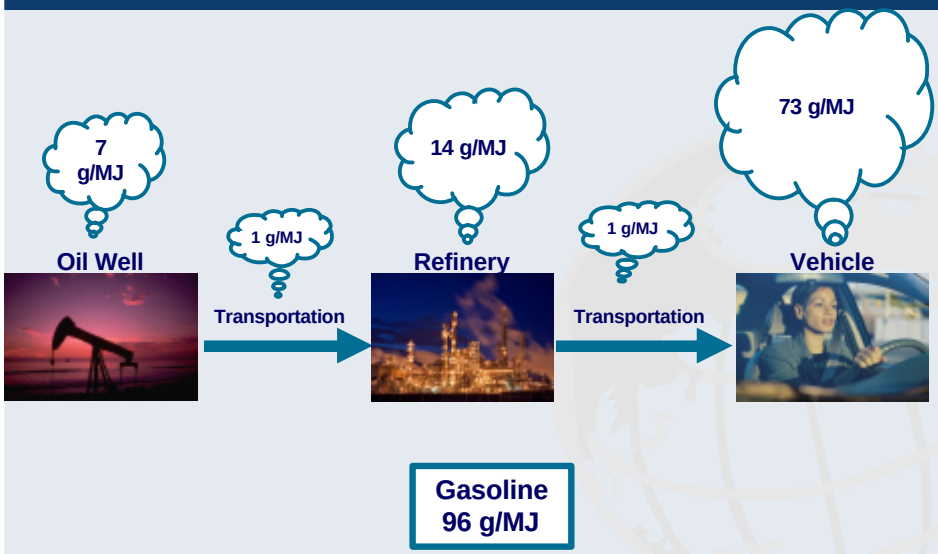
Lifecycle Analysis Basis for LCFS

- **Lifecycle analysis considers the GHG emissions from all facets of fuel production, distribution, and use**
- **Methodological approach**
  - **Direct land use effects: CA GREET**
  - **Land Use Change effects (or iLUC)**
    - **GTAP for land use change**
    - **External analysis to estimate GHG impacts**

Why GTAP for iLUC ?

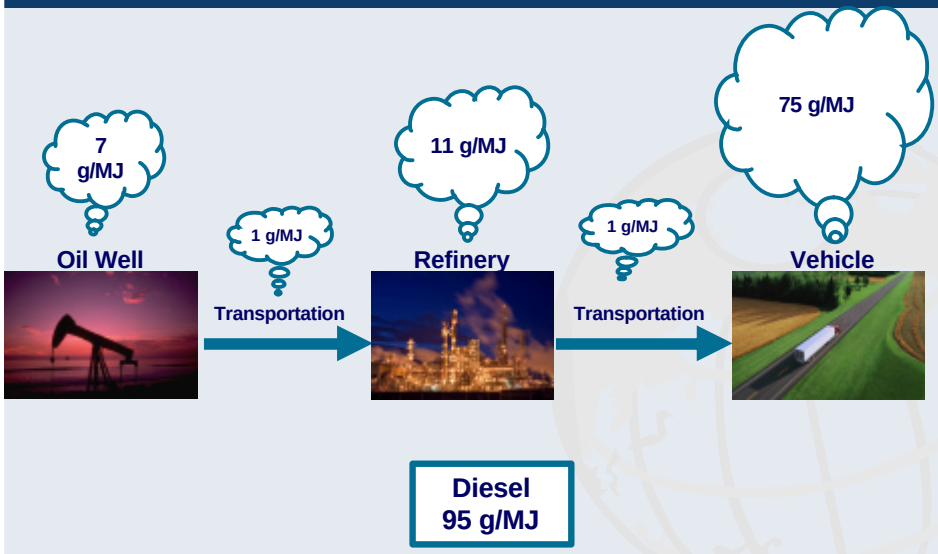
- **GTAP selected as best available model**
  - Well-established, publically available
  - Based in academia (Purdue University)
  - Thousands of GTAP applications
  - 7,500 worldwide individual contributors
  - Supported by 26 core institutions, including USDA and U.S. EPA
- **ARB worked with experts at UC and Purdue to run the model**

Direct Effects: Fuel Lifecycle – Gasoline (CA GREET)

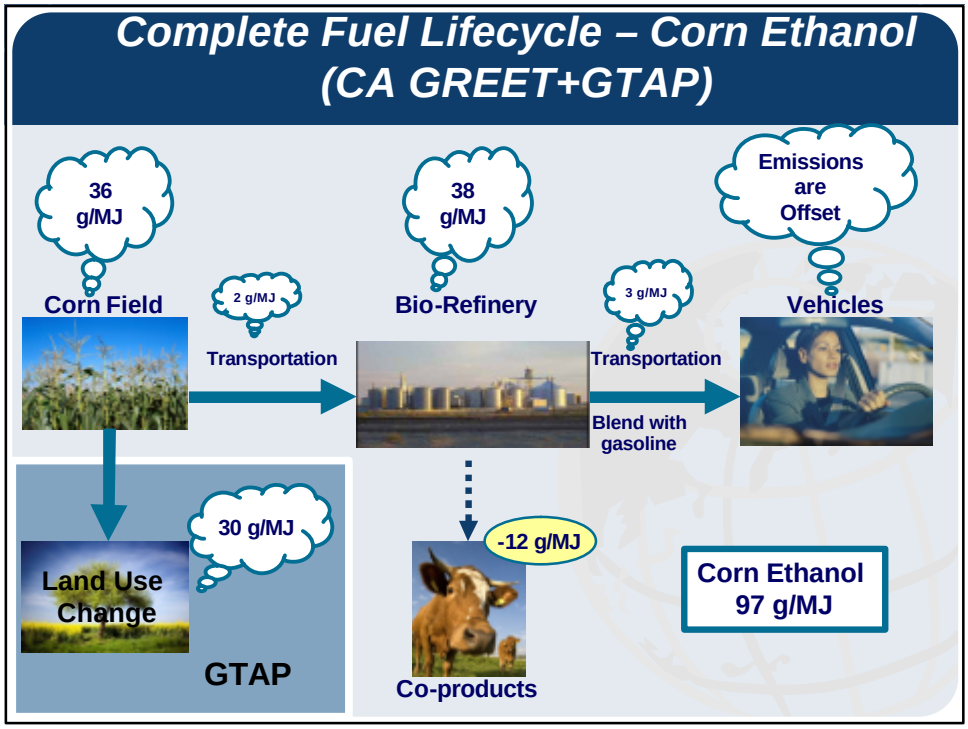


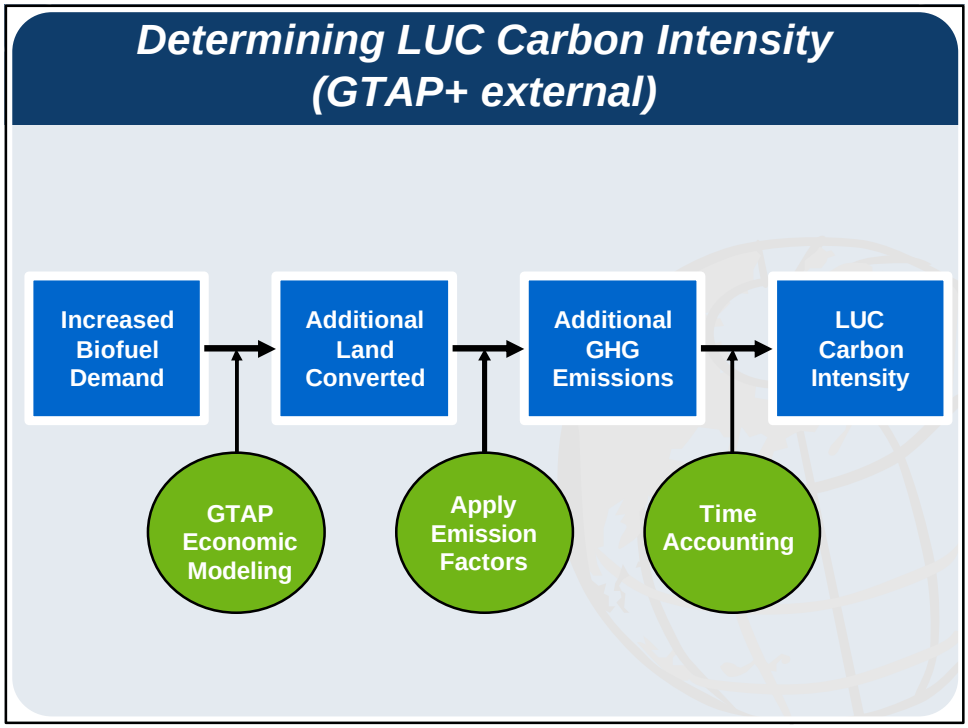
Gasoline 96 g/MJ

Direct Effects: Fuel Lifecycle – Diesel (CA GREET)



Diesel 95 g/MJ

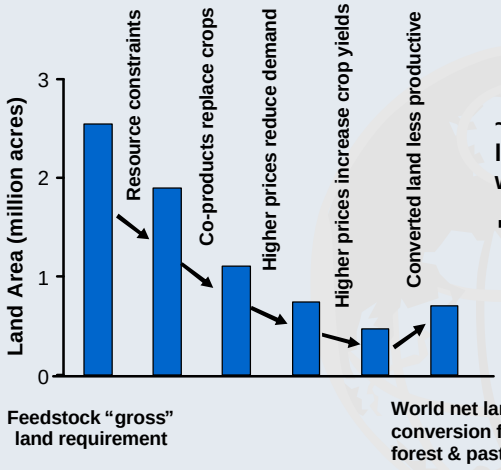

Complete Fuel Lifecycle – Corn Ethanol
(CA GREET+GTAP)
36 g/MJ
Corn Field
2 g/MJ
Transportation
38 g/MJ
Bio-Refinery
3 g/MJ
Transportation
Blend with gasoline
Emissions are Offset
Vehicles
Land Use Change
30 g/MJ
GTAP
-12 g/MJ
Co-products
Corn Ethanol
97 g/MJ


Determining LUC Carbon Intensity
(GTAP+ external)
Increased Biofuel Demand
Additional Land Converted
Additional GHG Emissions
LUC Carbon Intensity
GTAP Economic Modeling
Apply Emission Factors
Time Accounting

GTAP Adjustments: Estimating LUC

1 billion gallons of corn ethanol produced in U.S.

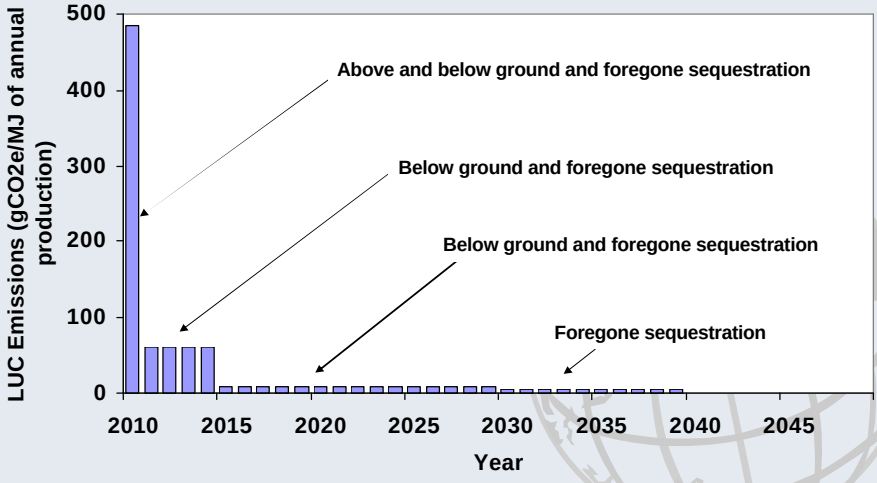
~2.5 million acres land used for corn ethanol production



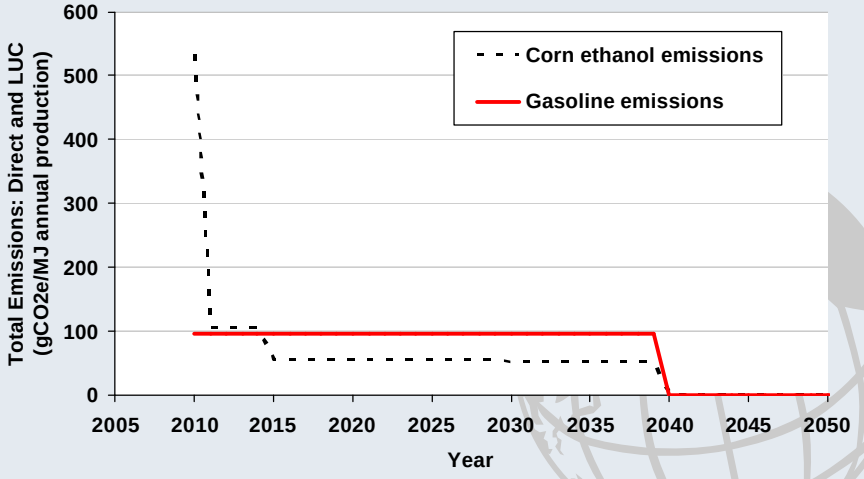
~0.7 million acres land converted worldwide

Time Accounting

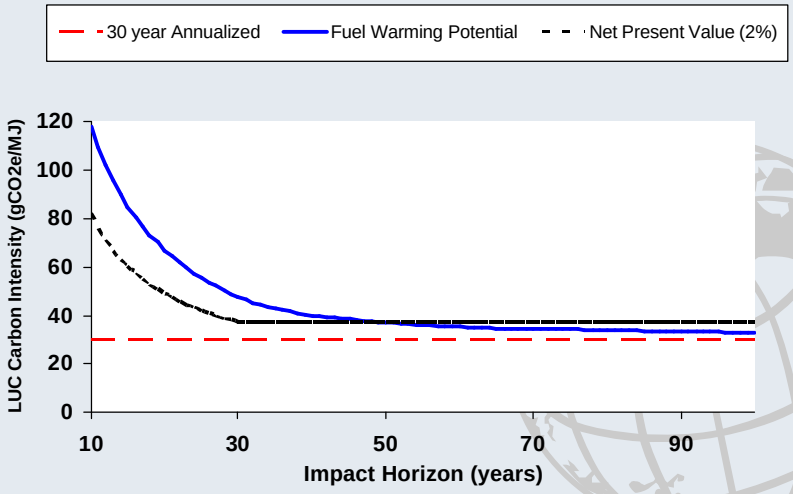
Land Conversion Emissions Profile



Comparison of Total Emissions



Comparison of Time Accounting Methods



Summary of Time Accounting Results

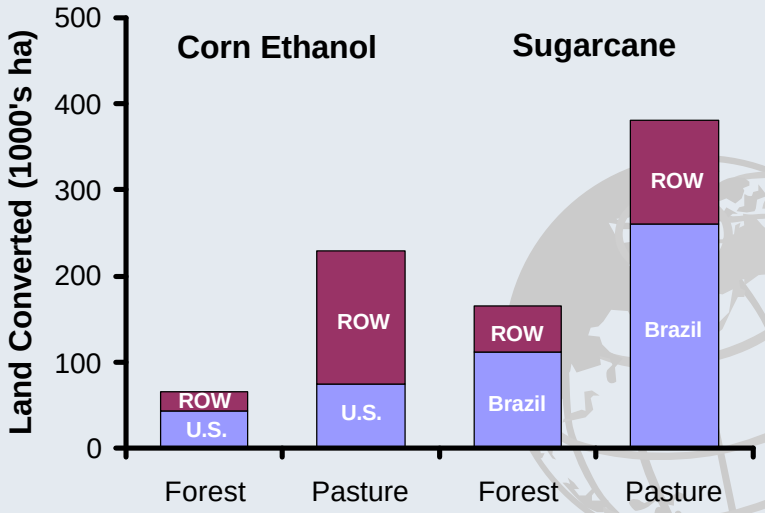
Accounting Method	Project Horizon (years)	Impact Horizon (years)	LUC CI (gCO_{2e}/MJ)
Annualized	30	N/A	30
NPV (2%)	30	30 or more	37
FWP	30	30	48
FWP	30	50	37

Results

Determining Carbon Intensities

- **Used best available data inputs**
- **Performed multiple sensitivity runs**
- **Presented results at workshops**
- **Determined amount/type of land use changes**
- **Calculated carbon intensity**

Results: Breakdown of Land Conversion (per billion gallon production increase)



LUC Results – Corn Ethanol

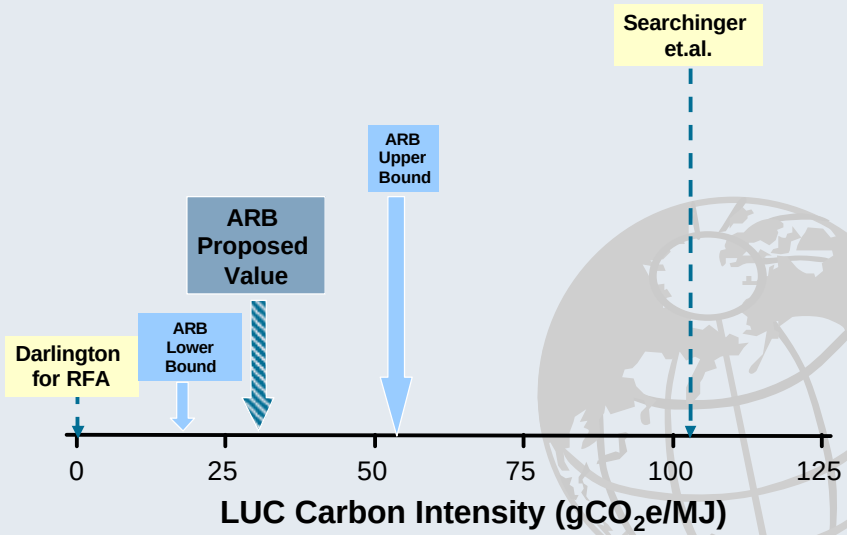
	A	B	C	D	E	F	G	Mean
Economic Inputs								
EtOH production increase (bill. gal.)	13.25	13.25	13.25	13.25	13.25	13.25	13.25	
Elasticity of crop yields wrt area expansion	0.5	0.75	0.5	0.5	0.5	0.66	0.75	
Corn yield elasticity	0.4	0.4	0.2	0.4	0.4	0.25	0.2	
Elasticity of land transformation	0.2	0.2	0.2	0.3	0.1	0.2	0.2	
Model Results								
Total land converted (million ha)	4.03	2.68	5.48	4.56	3.01	3.83	3.66	3.89
• Forest land (million ha)	1.04	0.37	1.46	0.89	1.00	0.73	0.55	0.86
• Pasture land (million ha)	3.00	2.32	4.02	3.65	2.01	3.10	3.10	3.03
U.S. land converted (million ha)	1.74	1.16	2.01	2.12	1.14	1.46	1.32	1.56
• U.S. forest land (million ha)	0.70	0.36	0.82	0.81	0.48	0.46	0.40	0.58
• U.S. pasture land (million ha)	1.04	0.79	1.19	1.31	0.66	1.00	0.92	0.99
ILUC carbon intensity (gCO_{2e}/MJ)	33.6	18.3	44.3	35.3	27.1	27.4	24.1	30.0

LUC Results – Sugarcane Ethanol

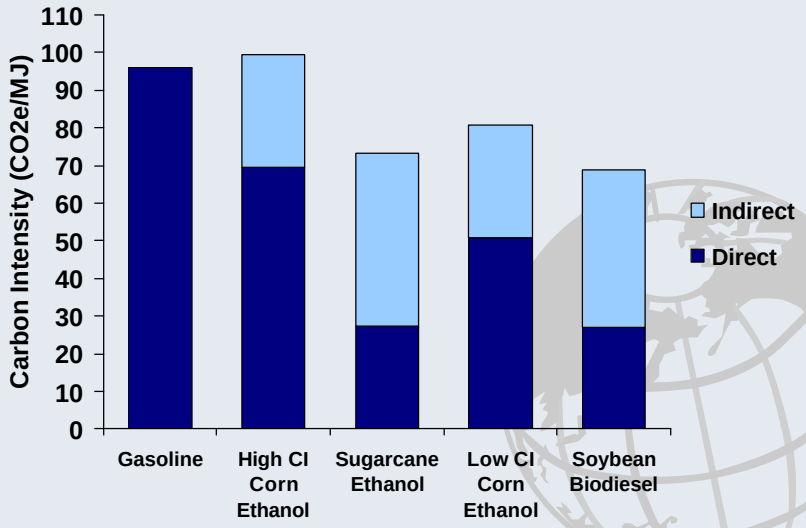
	A	B	C	D	E	Mean
Economic Inputs						
EtOH production increase (bill. gal.)	2.00	2.00	2.00	2.00	2.00	
Elasticity of crop yields wrt area expansion	0.50	0.75	0.50	0.50	*	
Sugarcane yield elasticity	0.25	0.25	0.25	0.25	0.25	
Elasticity of land transformation	0.20	0.20	0.30	0.10	0.20	
Model Results						
Total land converted (million ha)	1.28	0.85	1.46	0.94	0.94	1.09
• Forest land (million ha)	0.43	0.22	0.36	0.40	0.26	0.33
• Pasture land (million ha)	0.85	0.63	1.10	0.54	0.68	0.76
Brazil land converted (million ha)	0.89	0.59	1.06	0.60	0.55	0.74
• Brazil forest land (million ha)	0.30	0.15	0.25	0.26	0.13	0.22
• Brazil pasture land (million ha)	0.59	0.44	0.81	0.34	0.42	0.52
ILUC carbon intensity (gCO_2e/MJ)	56.7	32.3	54.5	48.3	38.3	46

* Brazil = 0.80, all other = 0.50

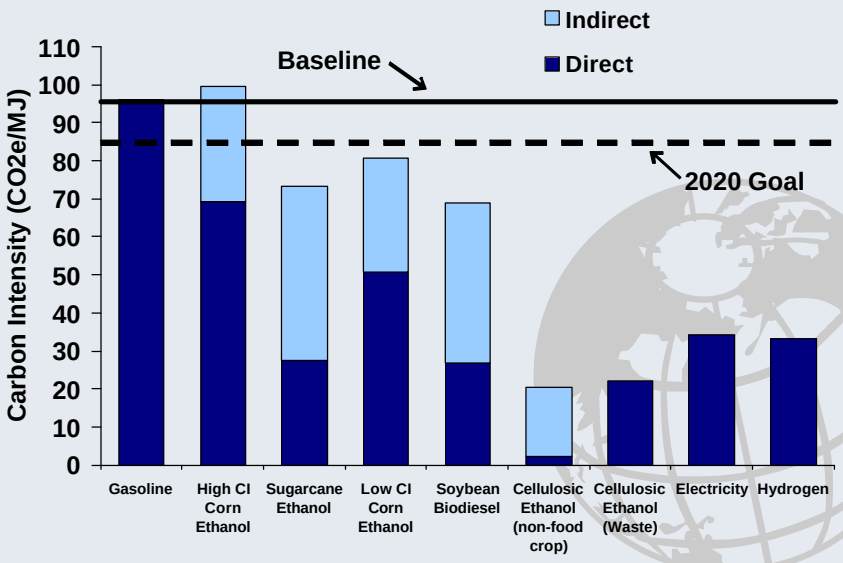
Range of LUC Carbon Intensity Values for Corn Ethanol



Carbon Intensity of Today's Fuels



Carbon Intensity of Tomorrow's Fuels



Lifecycle Analysis Summary

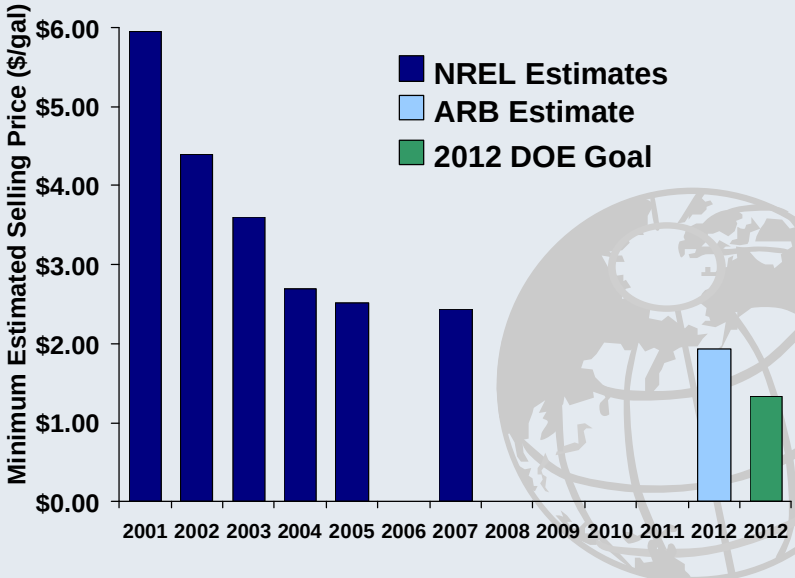
- **Key to identifying & transitioning to low carbon fuels**
- **Must include all significant effects, including land use changes**
- **GTAP uses best available science to estimate land use changes**
- **Peer reviewers generally support analysis**
- **Refine analysis through expert workgroup**

Economic and Environmental Impacts

Economic Analysis

- **Cost-of-compliance basis**
- **Overall savings estimated for 2010-2020**
- **Impact dependent on crude prices and production costs of alternative fuels**
- **Recognized uncertainties could result in slight costs**

Cellulosic Ethanol Costs



Environmental Analysis

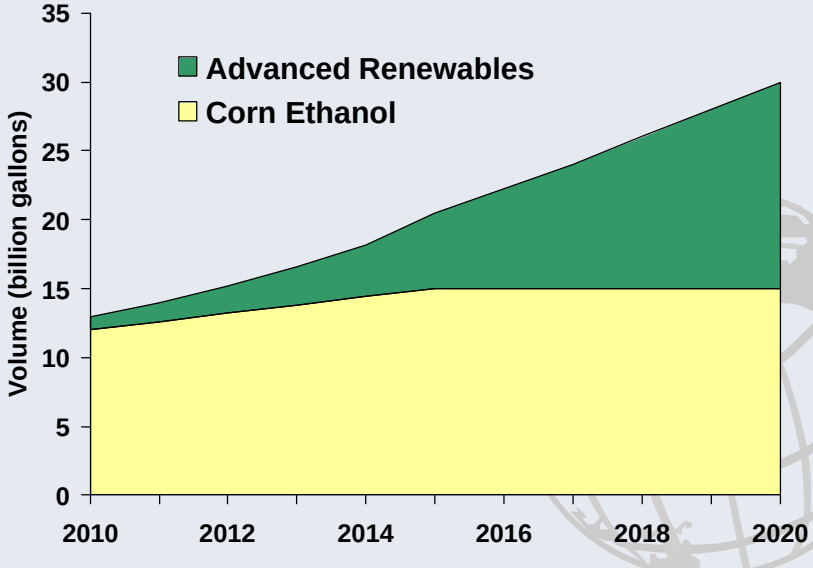
- **Reduces GHG by 16 MMT in 2020**
- **Achieves 10 percent of scoping plan target**
- **No significant adverse impacts**
- **Co-Benefits: Potential reductions in criteria pollutants with advance vehicles**

Comparison LCFS to Federal Requirements

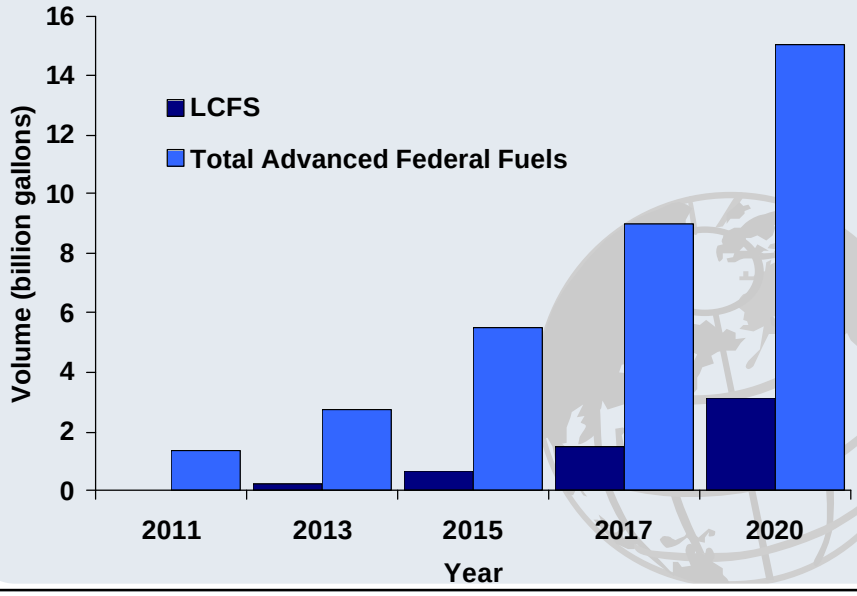
Federal Renewable Fuels Standard

- **Mandates volumes of biofuels with less focus on carbon intensity**
  - **Existing corn ethanol, no improvement**
  - **New corn facilities, 20% reduction**
  - **Other biofuels, at least 50% reduction**
  - **Cellulosic biofuels, 60% reduction**
- **Reduces GHGs nationwide by 3 percent**

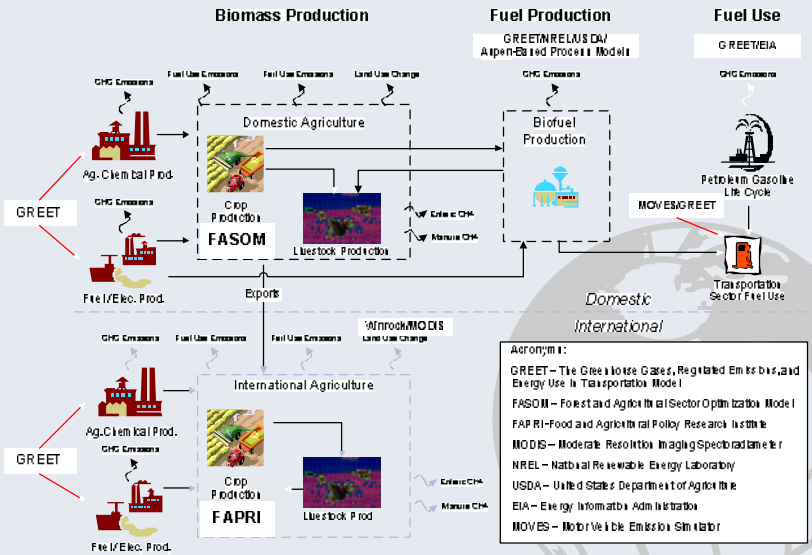
Federal Fuel Volumes



Advanced Biofuel Volumes - RFS vs. LCFS



USEPA: Key Models and Data Sources



Summary Comparison of Lifecycle Estimates

Fuel	LCFS 30 year 0% discount	RFS2 30 year 0% discount	RFS2 100 year 2% discount
Corn Ethanol (Dry Mill w/ Natural Gas)	+3%	+5%	-16%
Sugarcane Ethanol	-23%	-26%	-44%
Soy-Based Biodiesel	-28%	+4%	-22%

Percent change in emissions compared to gasoline

Summary and Next Steps

Summary

- **Reduces emissions from transportation fuels by 10% by 2020**
- **Emissions from land use changes are real, large, and positive**
- **Complements goals set forth by federal mandates**
- **Structured so program can extend beyond 2020**

Next steps

- **Review LUC by 2011, formal review by 2012 and 2015.**
- **Continue to work on additional carbon intensity values**
- **Prepare a guidance document on the evaluation process for CI**
- **Establish an experts group to evaluate issues on LUC and report to the Board by 2011**

Next Steps

- **Create a work plan to evaluate sustainability criteria (by end of 2009)**
- **Establish the details of reporting and credit trading program**
- **Coordinate with regional, national, and international groups**

Questions??

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