

California Environmental Protection Agency



**Air Resources Board**

***The California  
Low Carbon Fuel Standard***



**April 23, 2009**

# *Overview*

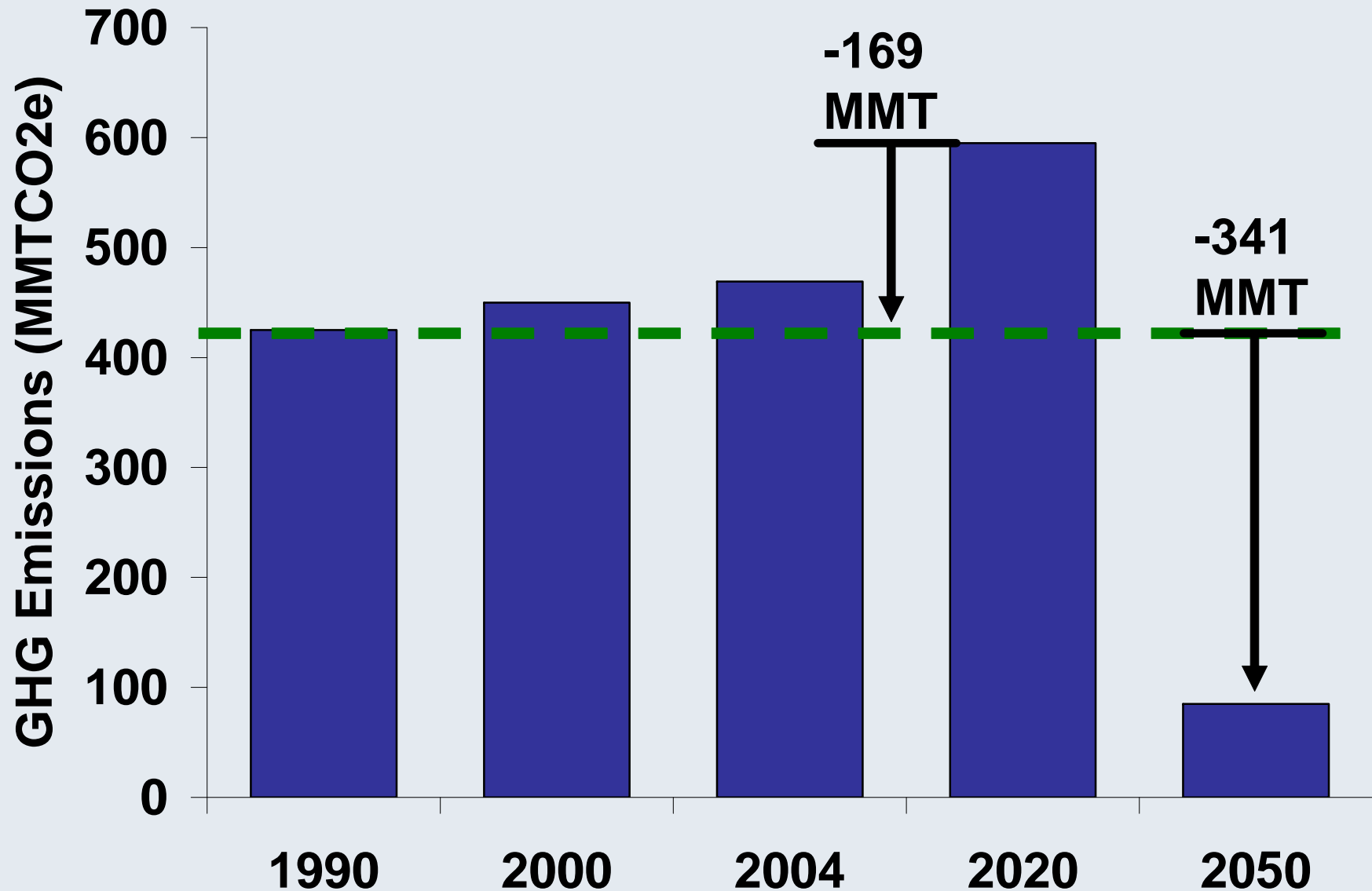
- **What the program accomplishes**
- **How the program works**
- **Importance of lifecycle analysis**
- **Environmental/economic impacts**
- **Comparison of LCFS to federal requirements**
- **Proposed changes and next steps**
- **Summary and Recommendation**

# **What the Program Accomplishes**

# *Transportation Sector Important*

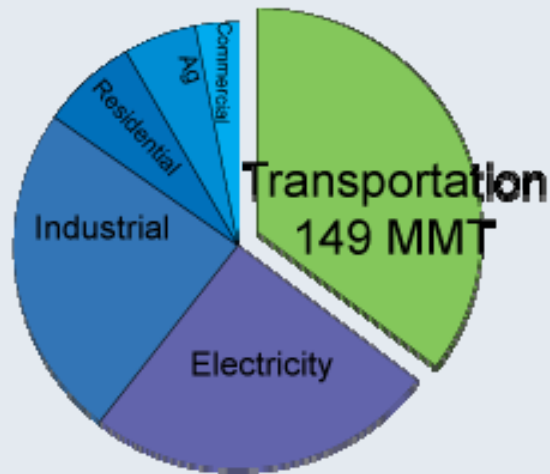
- **Significant reductions needed to achieve 2020 target and 2050 goal**
- **GHG emissions from transportation are large and increasing**
- **Transportation emissions affected by:**
  - Amount and type of transportation fuels
  - Efficiency of motor vehicles
  - Number of vehicle miles traveled

# Large GHG Reductions Required



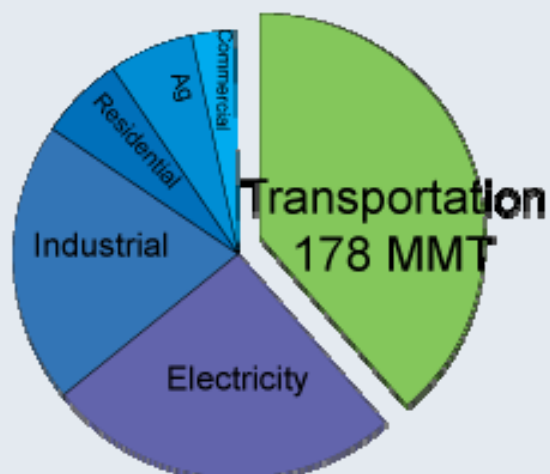
# Transportation Emissions Increasing

1990



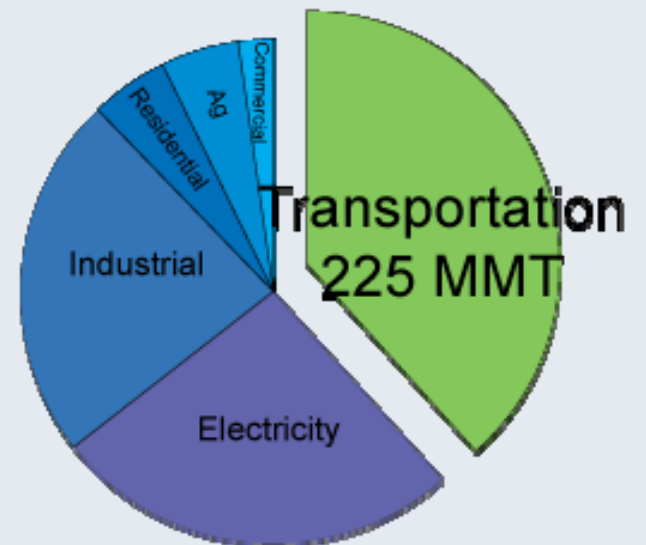
~425 MMT

2004



~469 MMT

2020



~595 MMT

## ***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**
- **Staff issued proposal in March 2009**

# ***Framework for Low Carbon Fuels***

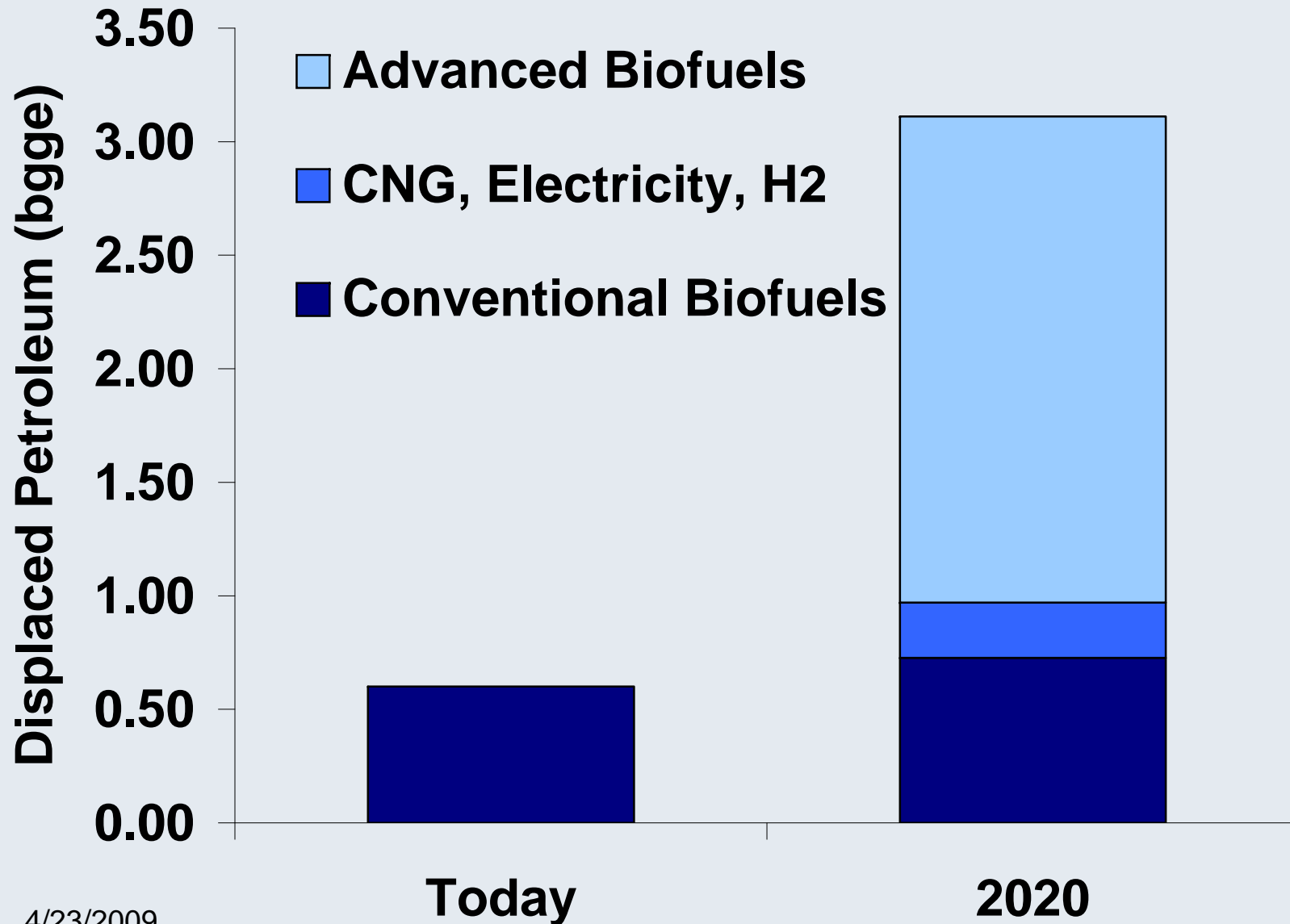
- **Creates durable framework for near and long term transition to low carbon fuels**
- **Encourages technology innovation**
- **Establishes a model for regional and national standards**
- **Sets stage for future reductions**



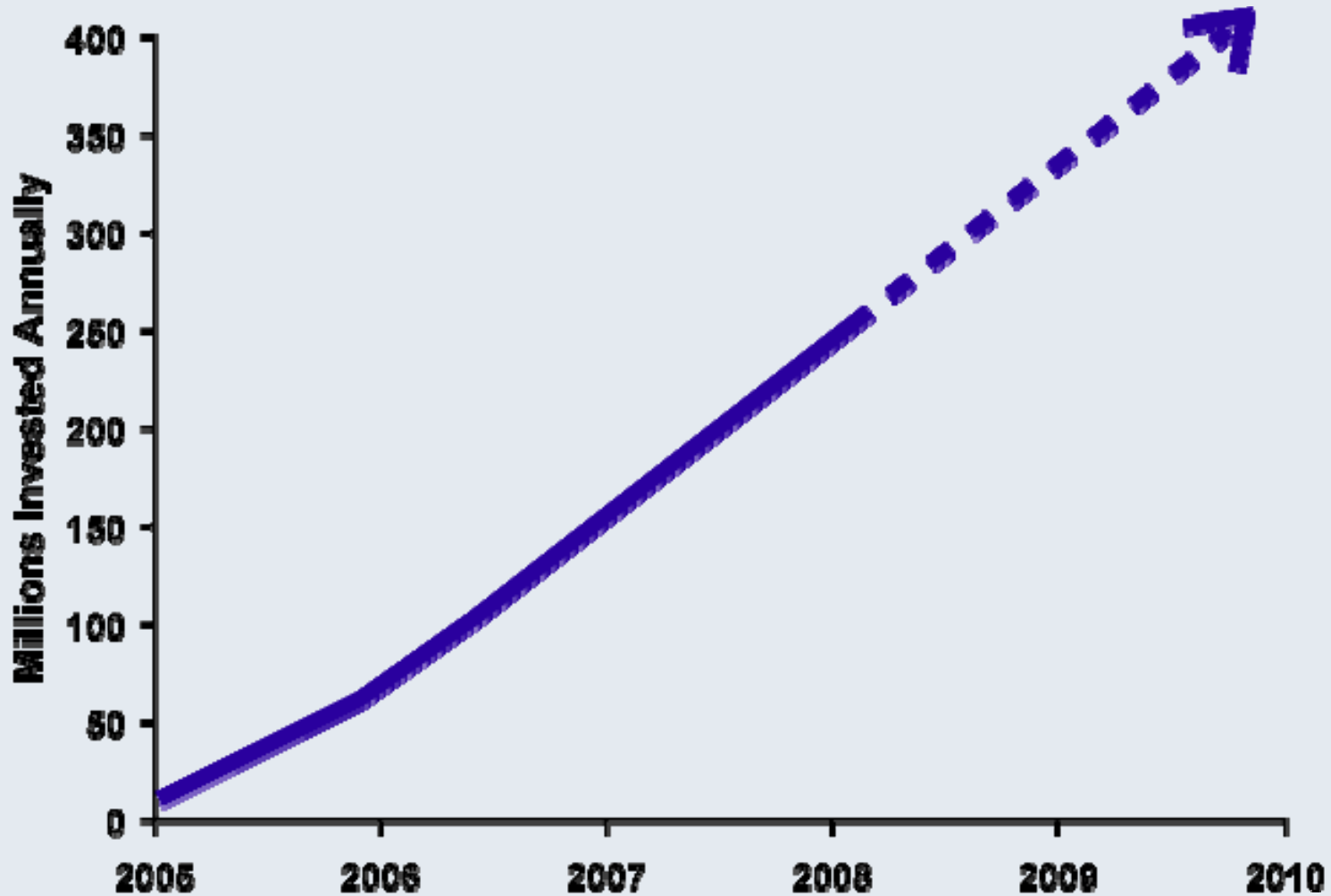
## ***LCFS Reduces GHG Emissions***

- **Results in a 10 percent reduction in the carbon intensity by 2020**
- **Reduces 16 MMT GHG emissions from the transportation sector by 2020**
- **Achieves about 10 percent of the total emission reductions required to meet the AB 32 target**

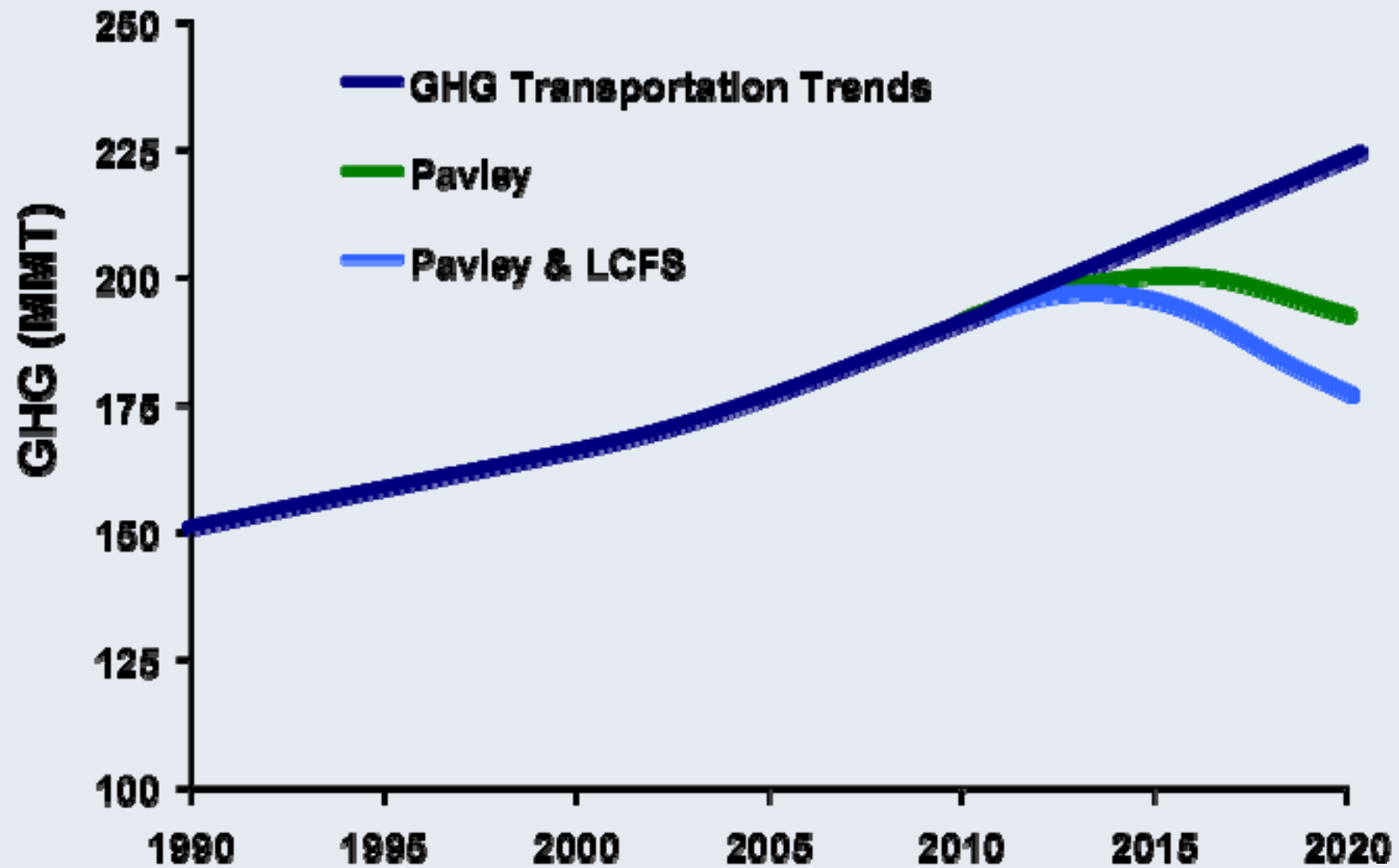
# *LCFS Displaces Petroleum*



# *LCFS Supports Investment Trends*



# *Pavley and LCFS Reverse GHG Trend*

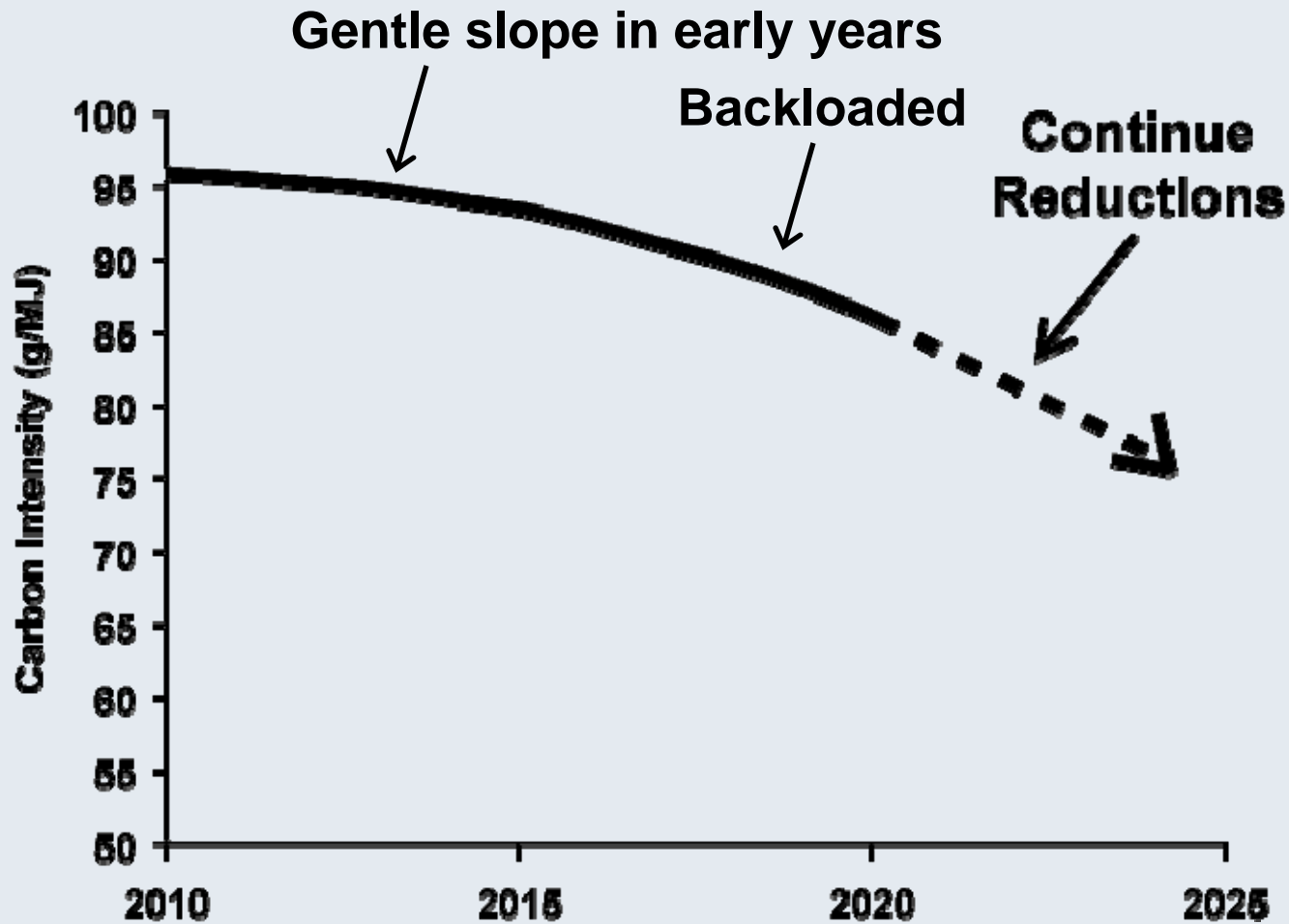


# **How the LCFS Works**

## ***LCFS Mechanics***

- **Baseline fuel carbon “intensity” is that of 2010 gasoline and diesel fuel**
- **Carbon intensity represents the GHG emissions per unit of energy**
- **Fuel producers achieve 10 percent reduction by 2020**
- **Reduction is gradual and weighted toward later compliance years**

# The LCFS Compliance Schedule



## *Who is Regulated?*

- **Providers of most petroleum and biofuels are ‘regulated parties’**
- **Providers of fuels that meet 2020 levels must ‘opt in’ to earn credits:**
  - **Electricity**
  - **Hydrogen**
  - **Natural Gas**



## ***Flexible/Market-Driven Compliance***

- **Supply a mix of fuels with carbon intensity equal to the standard**
- **Provide fuels that have lower carbon intensity than the standard**
- **Use purchased or banked credits to meet the standard**

## *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**

# ***Compliance and Enforcement***

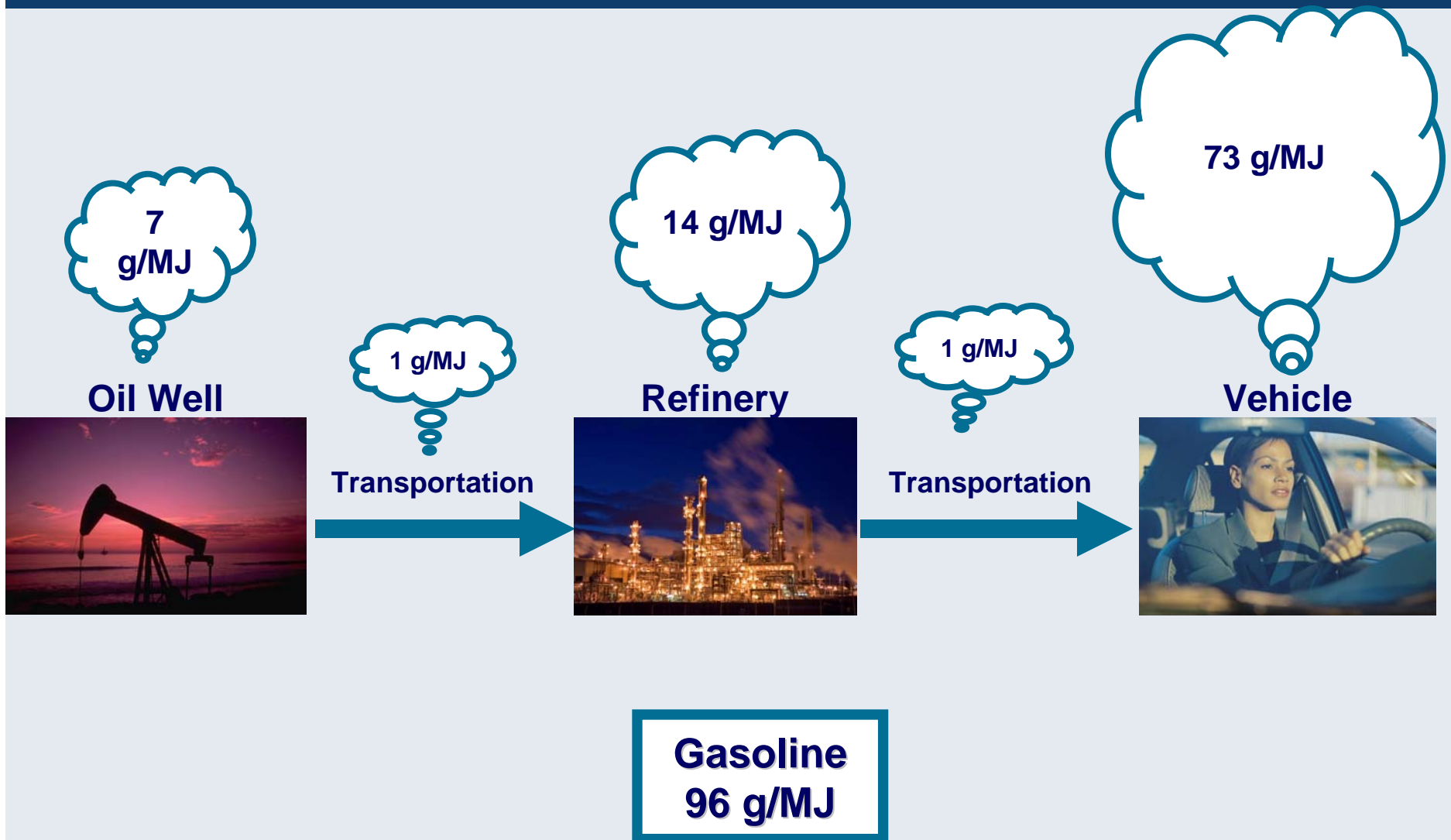
- **ARB to provide software tools for fuel carbon reporting and credit tracking**
- **Regulated parties report quarterly and annually**
- **Enforcement includes records review, field inspections, and audits and penalties**

# **Importance of Lifecycle Analysis**

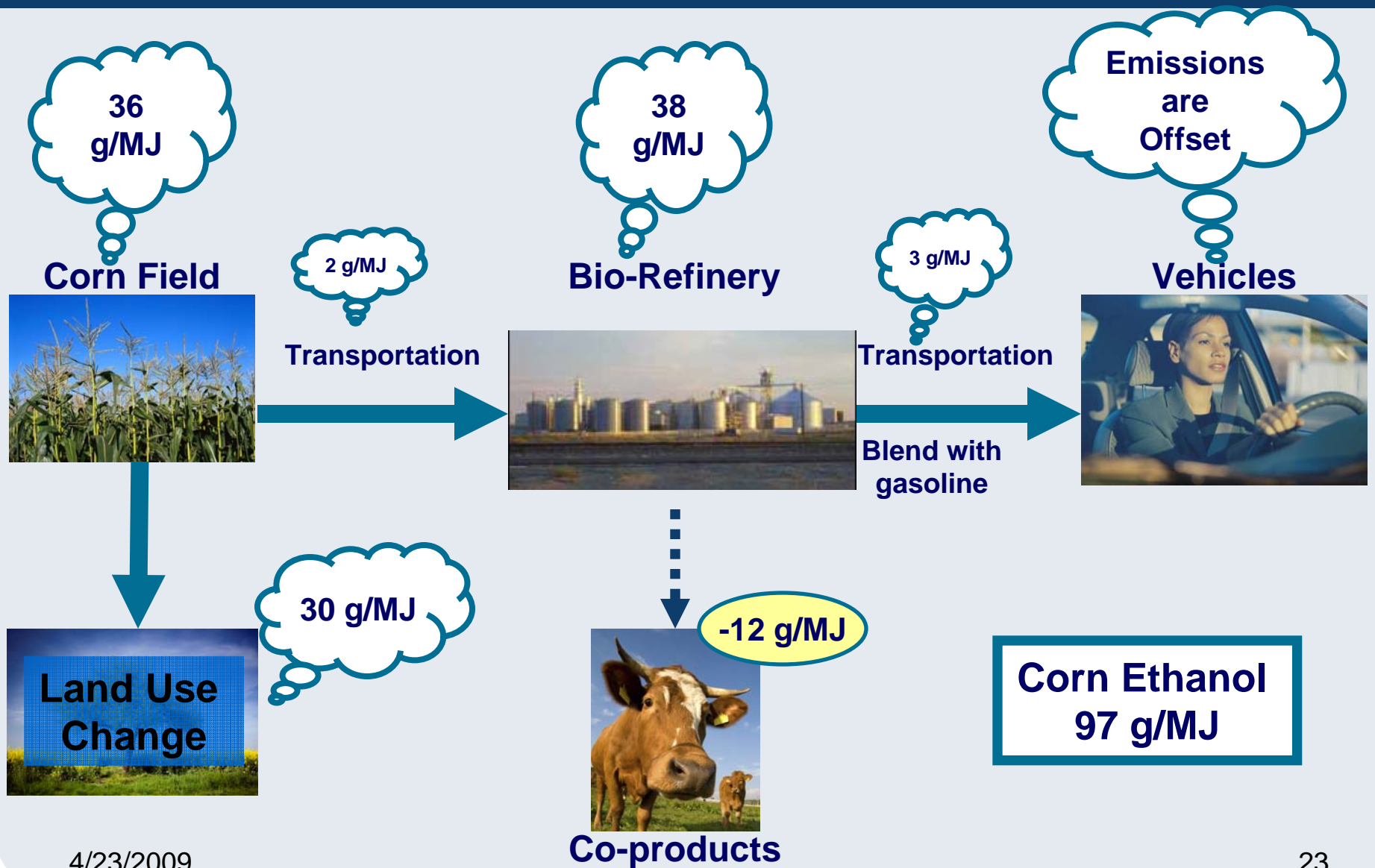
# ***Lifecycle Analysis Basis for LCFS***

- **Lifecycle analysis considers the GHG emissions from all facets of fuel production, distribution, and use**
- **Governor's EO directed that ARB consider lifecycle analysis**
- **UC reports confirmed that LCFS needs to be based on lifecycle analysis**

# Fuel Lifecycle – Gasoline



# Fuel Lifecycle – Corn Ethanol

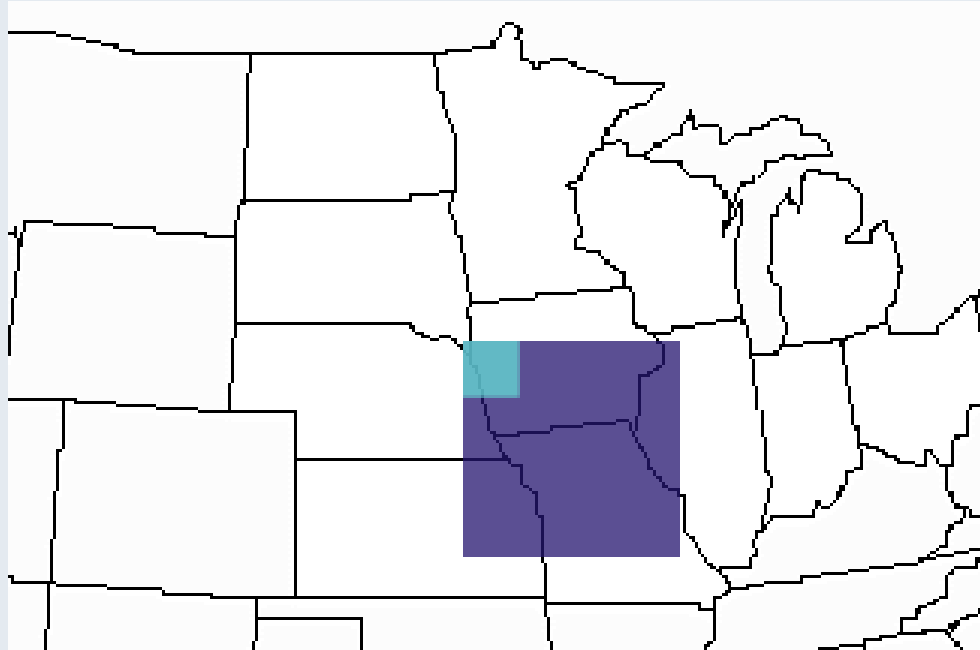


# *Crop-Based Fuels Require Land*

**Using crops for fuel leads to changes in land use**

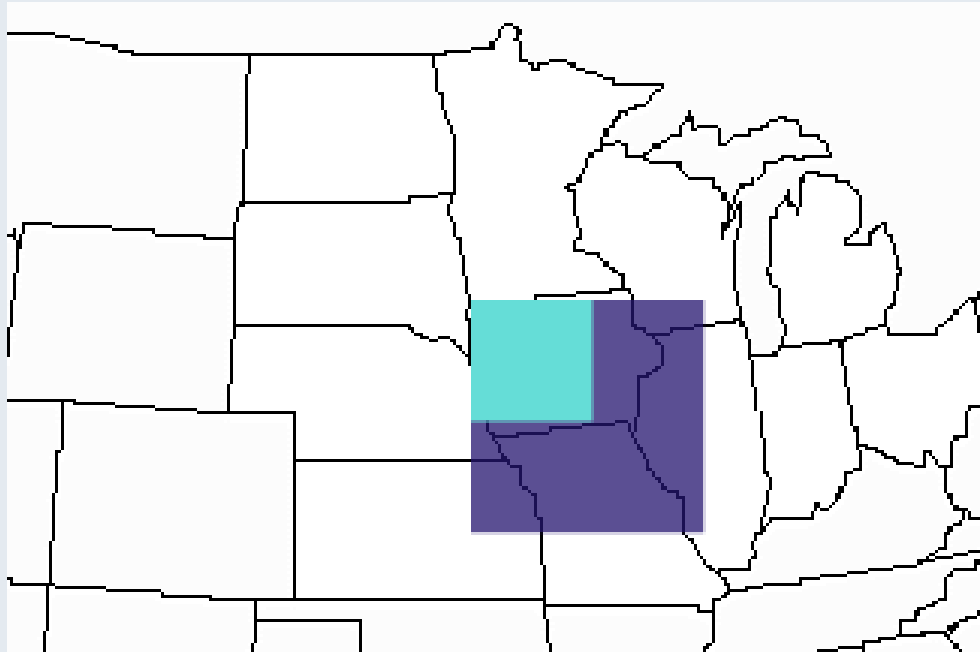


## *Ethanol Land Requirements - 2001*



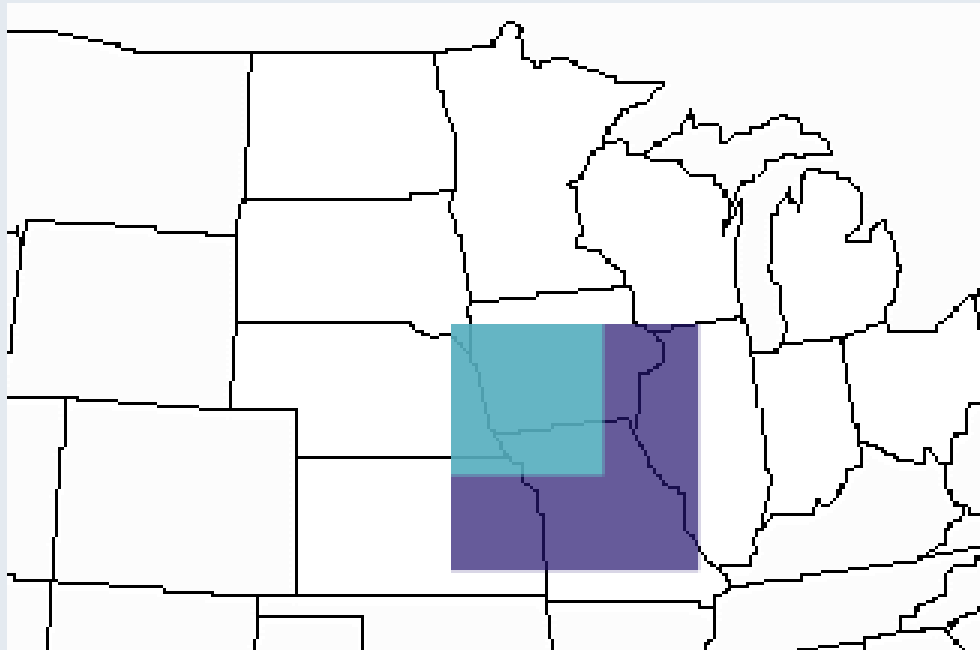
**In 2001, the corn dedicated to ethanol production would have covered about 6% of this area**

## *Ethanol Land Requirements - 2008*



**In 2008, the corn dedicated to ethanol production would have covered about 27% of this area**

# *Ethanol Land Requirements - 2015*

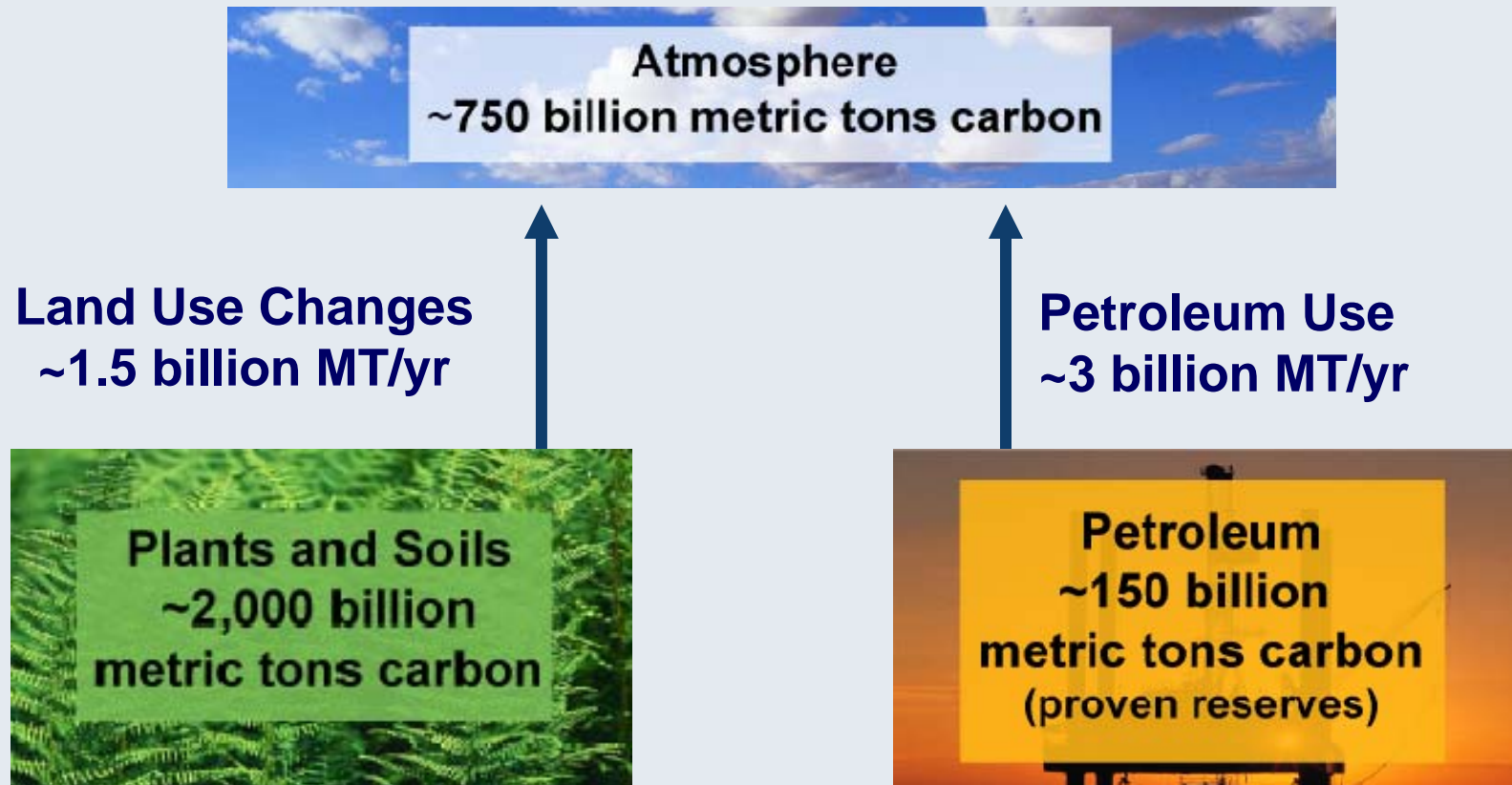


**In 2015, the corn dedicated to ethanol production will cover about 37% of this area**

## *Land Conversions Release Carbon*

**Plants and soil store large amounts of carbon which is released during land conversion**

# Carbon Storage and Emissions

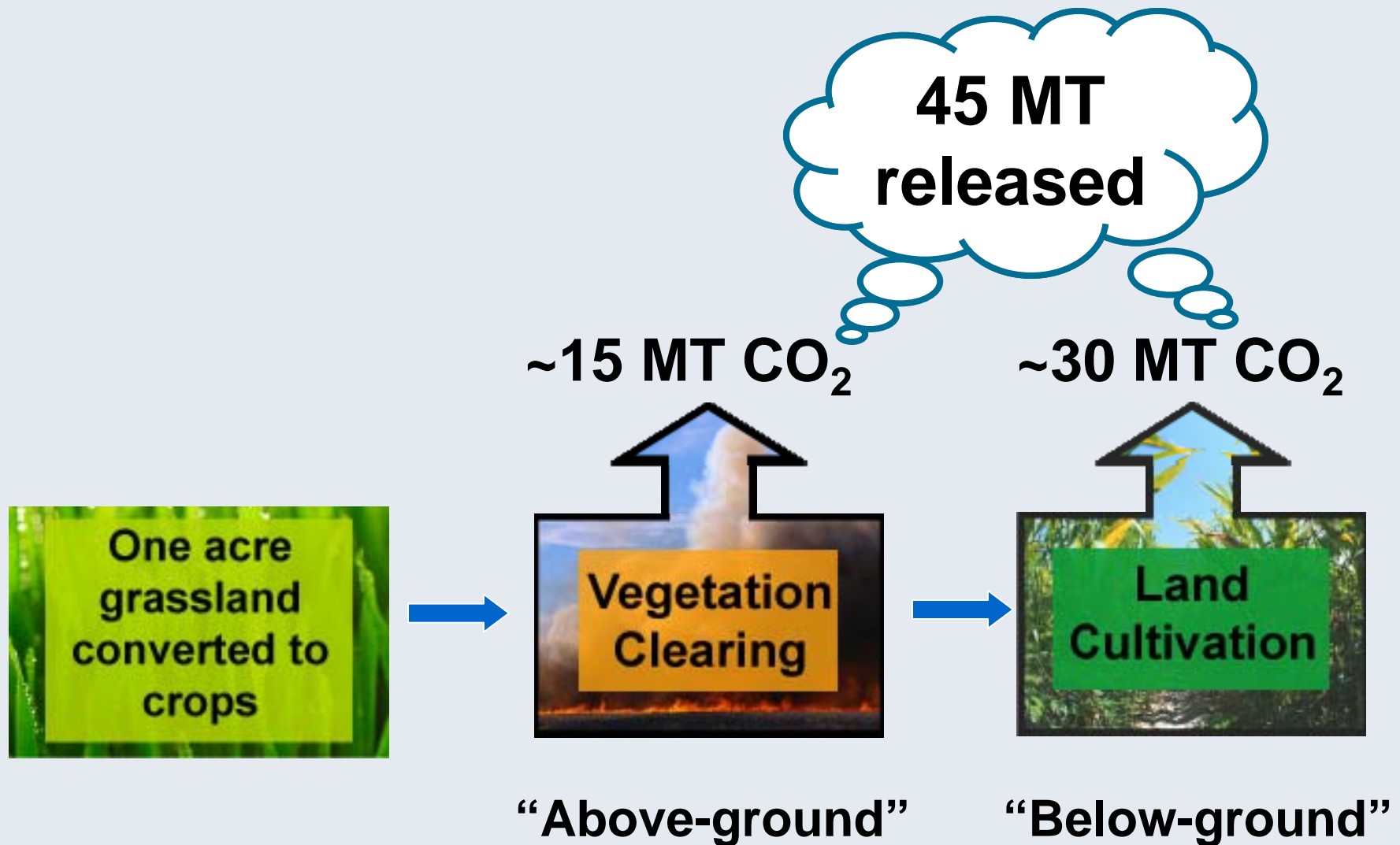


Plants and soils contain approximately 15 times the carbon in proven oil reserves.

# ***Biofuels Affect the Carbon Cycle***

**Carbon is stored above and  
below ground**

# Grassland Conversion Emissions



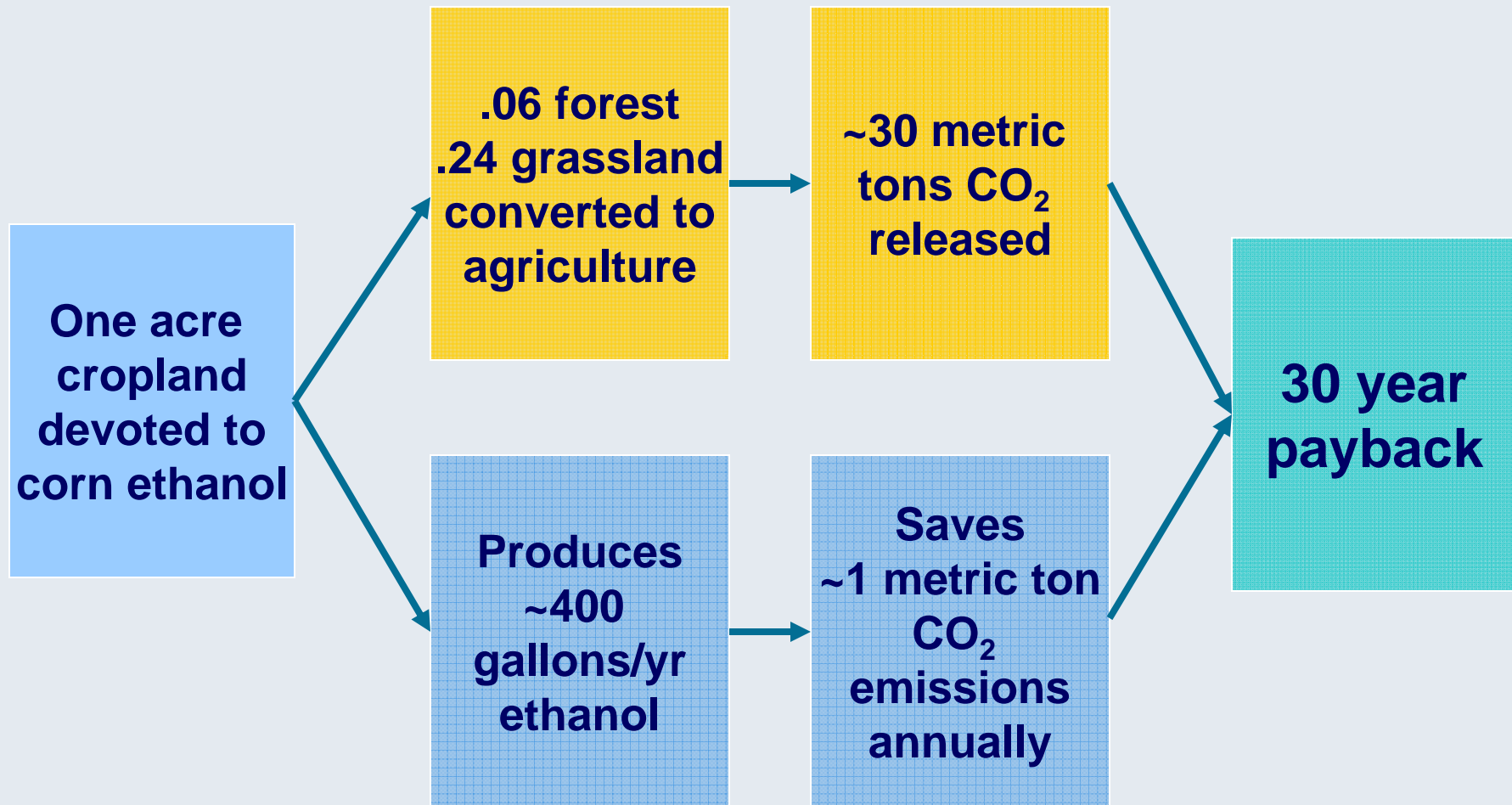
# *Biofuels Affect the Carbon Cycle*

**Current biofuels take decades before there is a net GHG benefit**



# *Time to Payback*

## *Land Use Change Emissions*



# ***GTAP Used For Analysis***

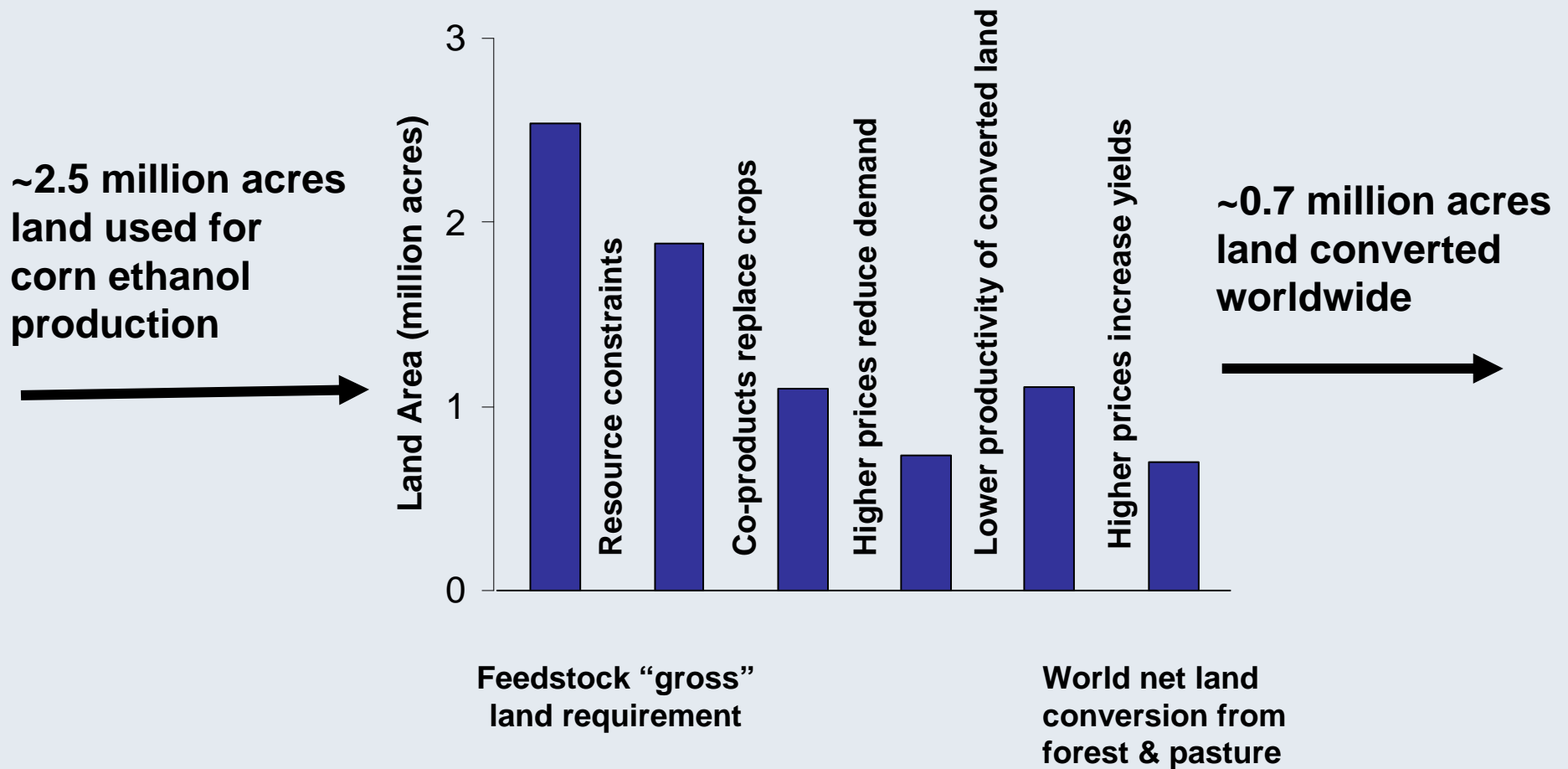
- **GTAP selected as best available model**
  - Well-established, publically available
  - Based in academia (Purdue University)
  - Thousands of GTAP applications
  - 7,500 worldwide individual contributors
  - Supported by 26 core institutions, including USDA and U.S. EPA
- **ARB worked with experts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

# *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**

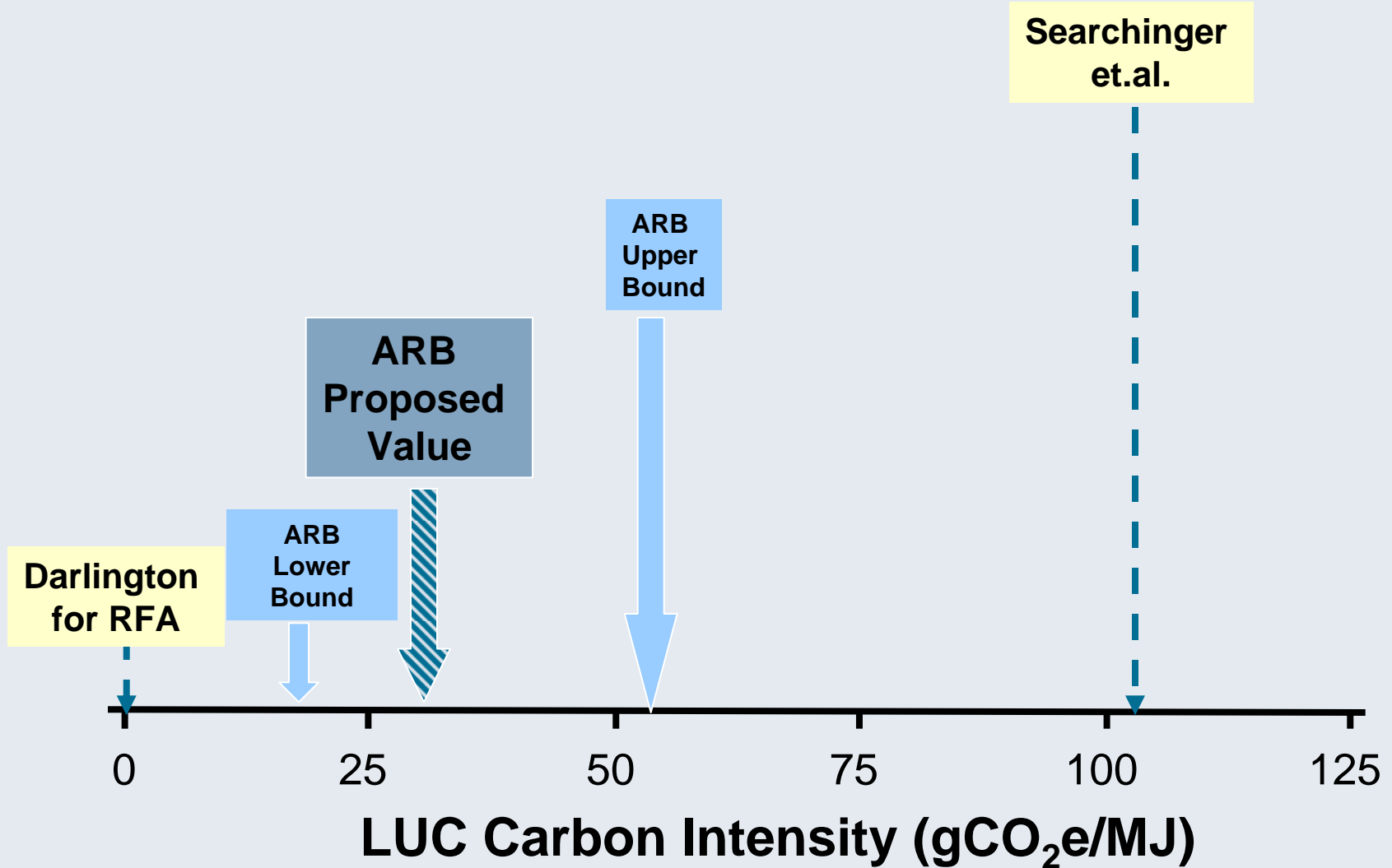
# Using GTAP to Estimate LUC

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

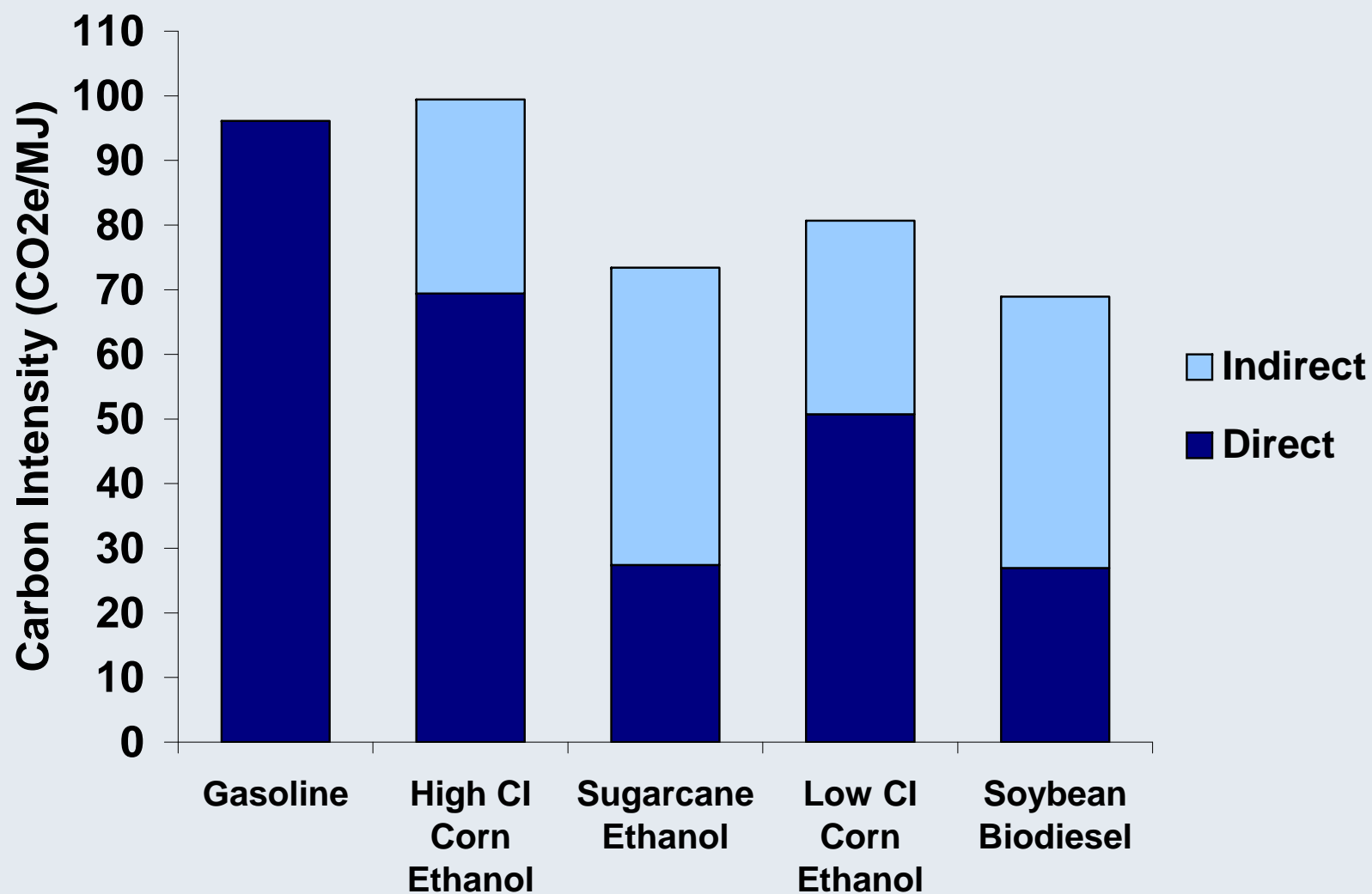


GTAP Model

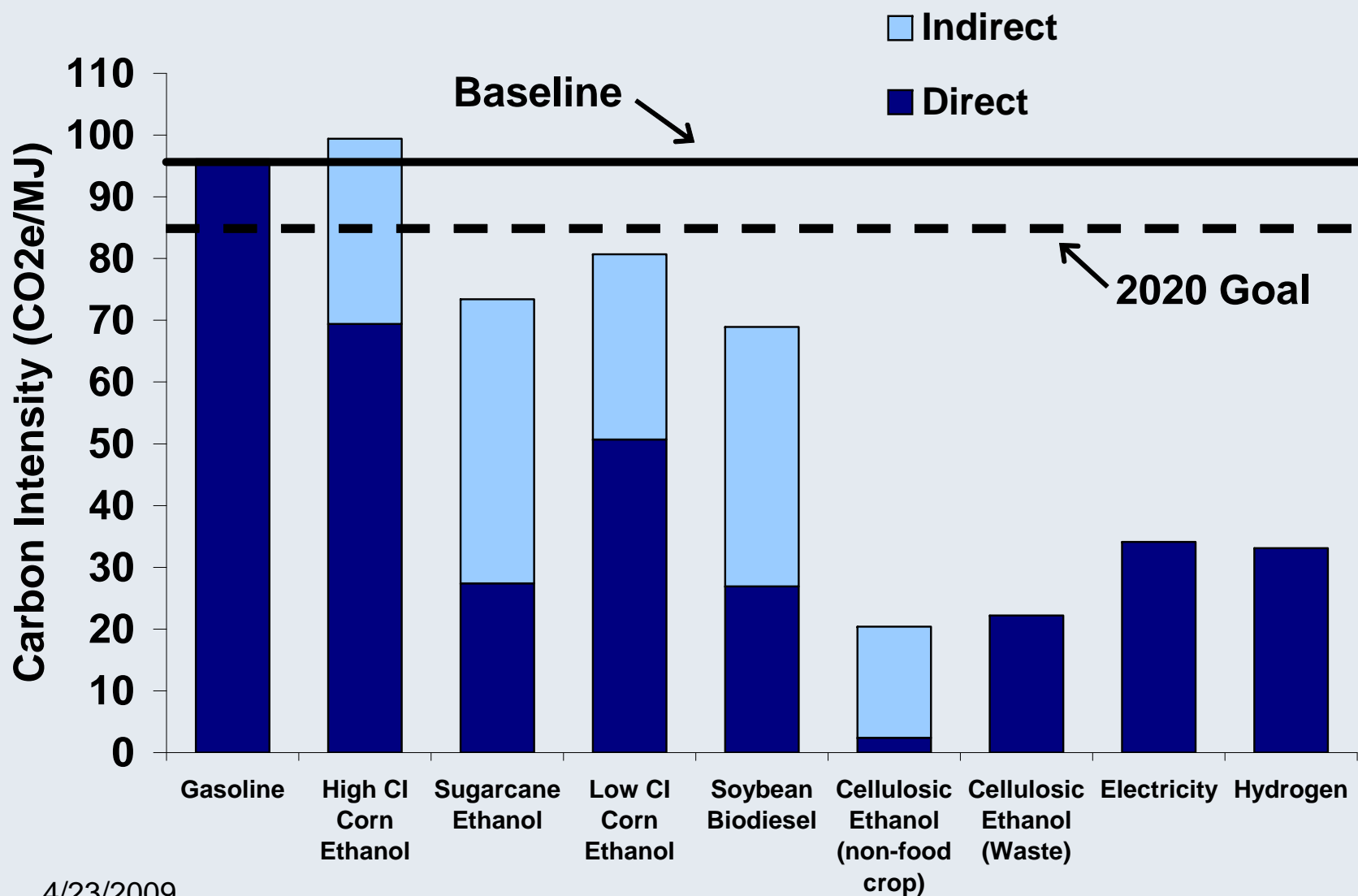
# Range of LUC Carbon Intensity Values for Corn Ethanol



# Carbon Intensity of Today's Fuels



# Carbon Intensity of Tomorrow's Fuels



## ***LCFS Treats All Fuels Fairly***

- **Land use change contributes to carbon intensity of certain biofuels**
- **Staff have not identified any significant indirect effects from non-biofuels, though research is ongoing**
- **Open process; results and assumptions shared with stakeholders**



# *Lifecycle Analysis Summary*

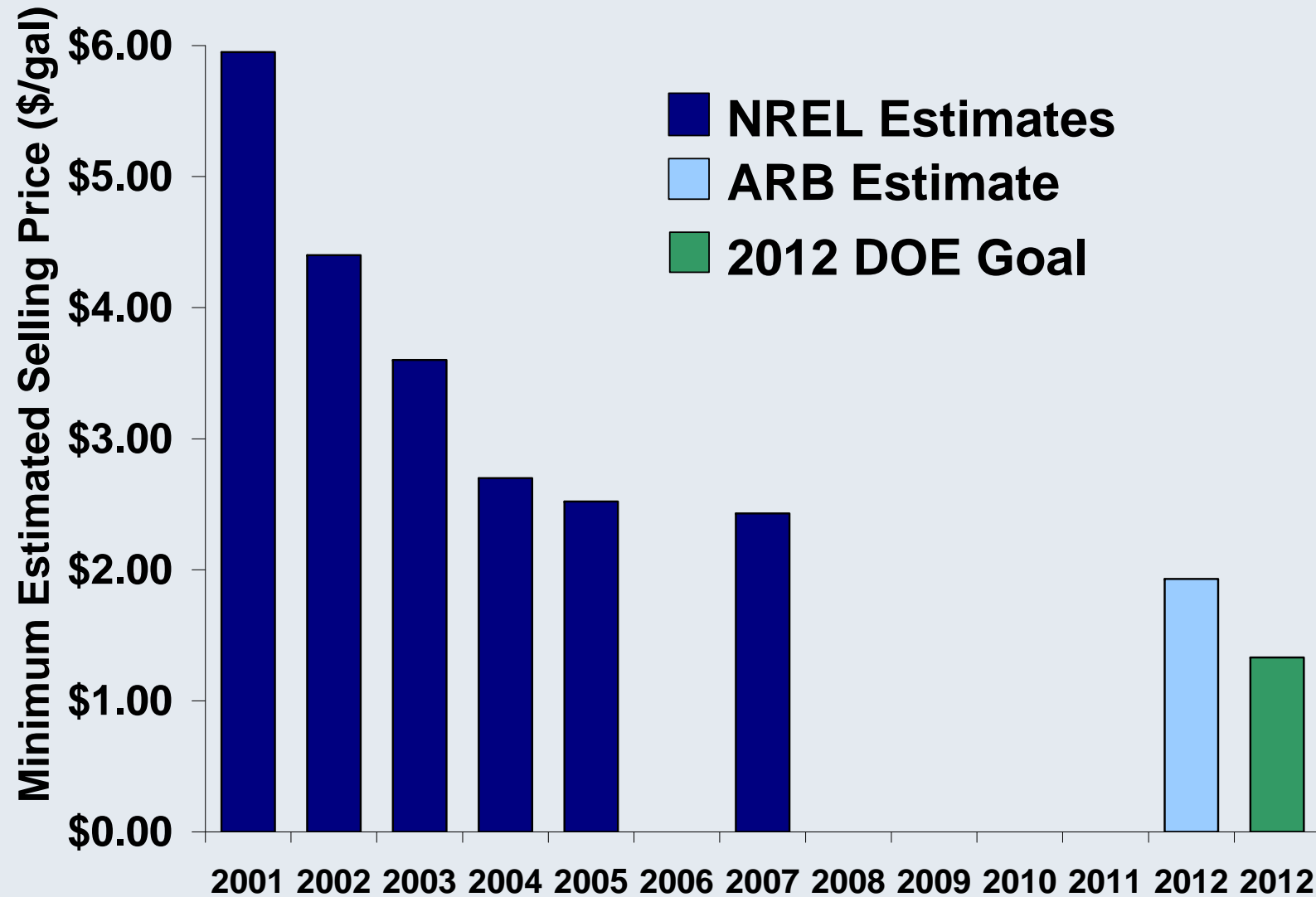
- **Key to identifying & transitioning to low carbon fuels**
- **Must include all significant effects, including land use changes**
- **GTAP uses best available science to estimate land use changes**
- **Peer reviewers generally support analysis**
- **Refine analysis through expert workgroup**

# **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**
- **Potential reductions in criteria pollutants with advance vehicles**

## ***Continuing Efforts***

- **Best practices siting guidelines (Dec. 2009)**
- **Sustainability guidelines:**
  - **Development workplan (Dec. 2009)**
  - **Recommendations to Board (Dec. 2011)**

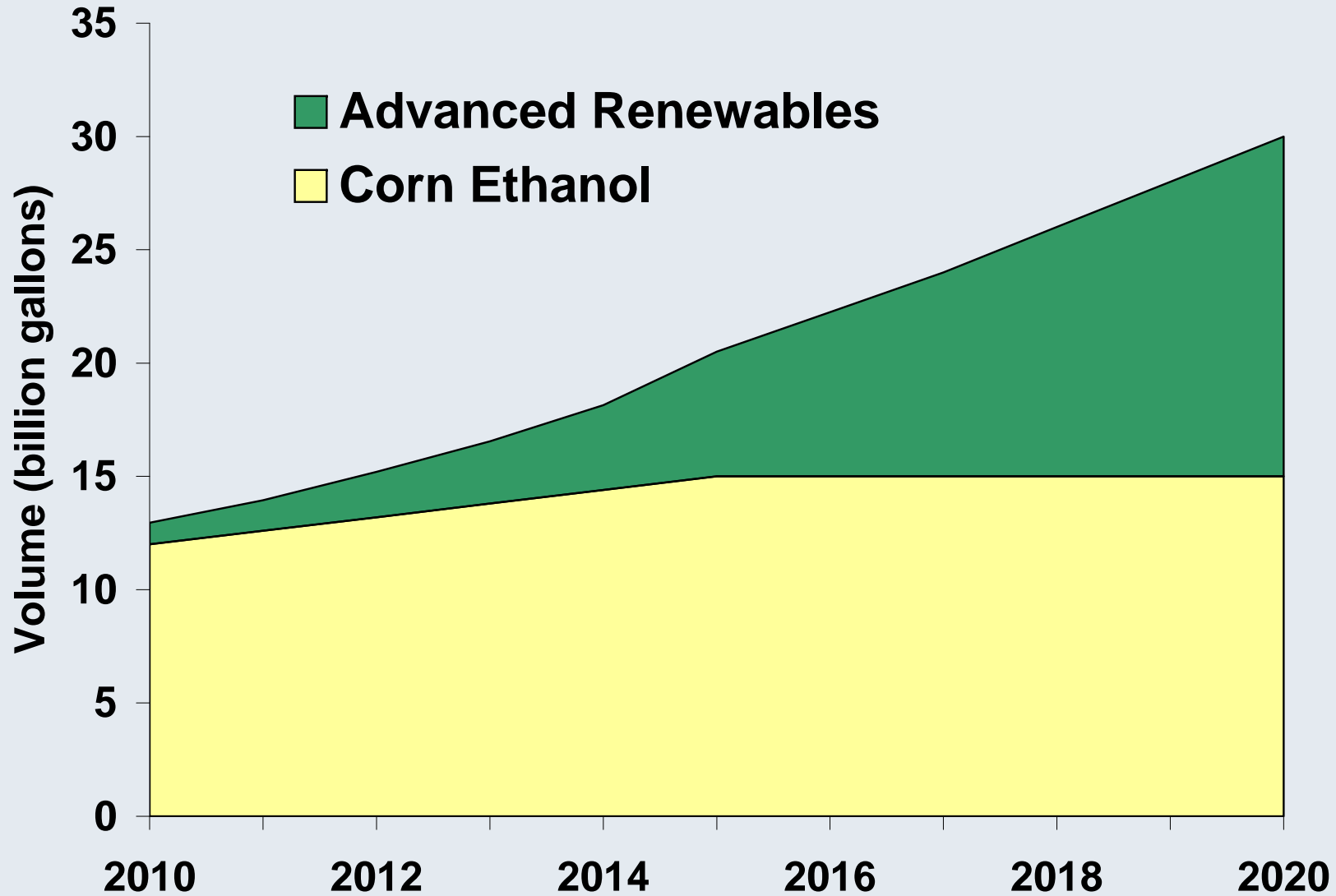
# **Comparison LCFS to Federal Requirements**

# ***Federal Renewable Fuels Standard***

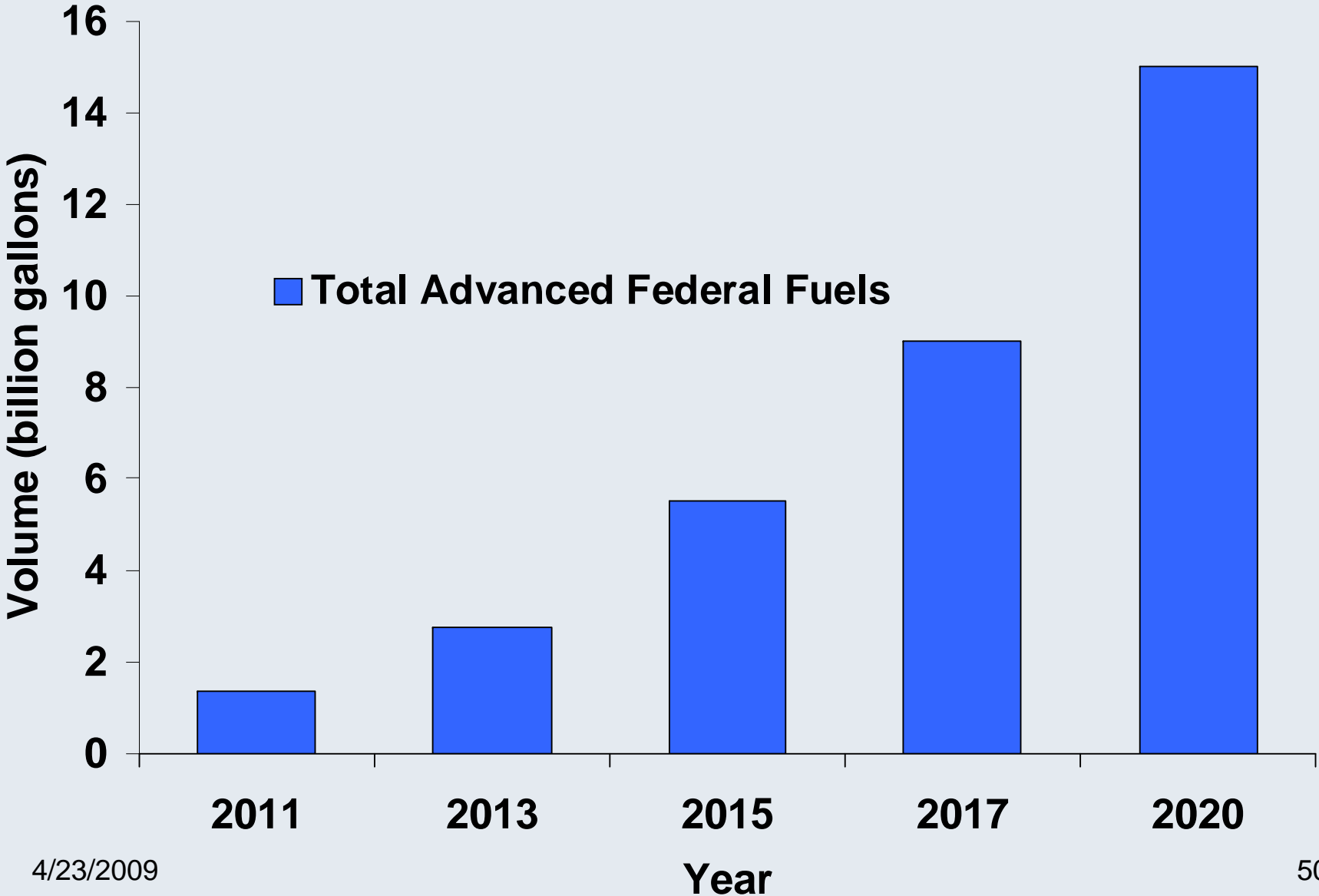
- **Mandates volumes of biofuels with less focus on carbon intensity**
  - **Existing corn ethanol, no improvement**
  - **New corn facilities, 20% reduction**
  - **Other biofuels, at least 50% reduction**
  - **Cellulosic biofuels, 60% reduction**
- **Reduces GHGs nationwide by 3 percent**



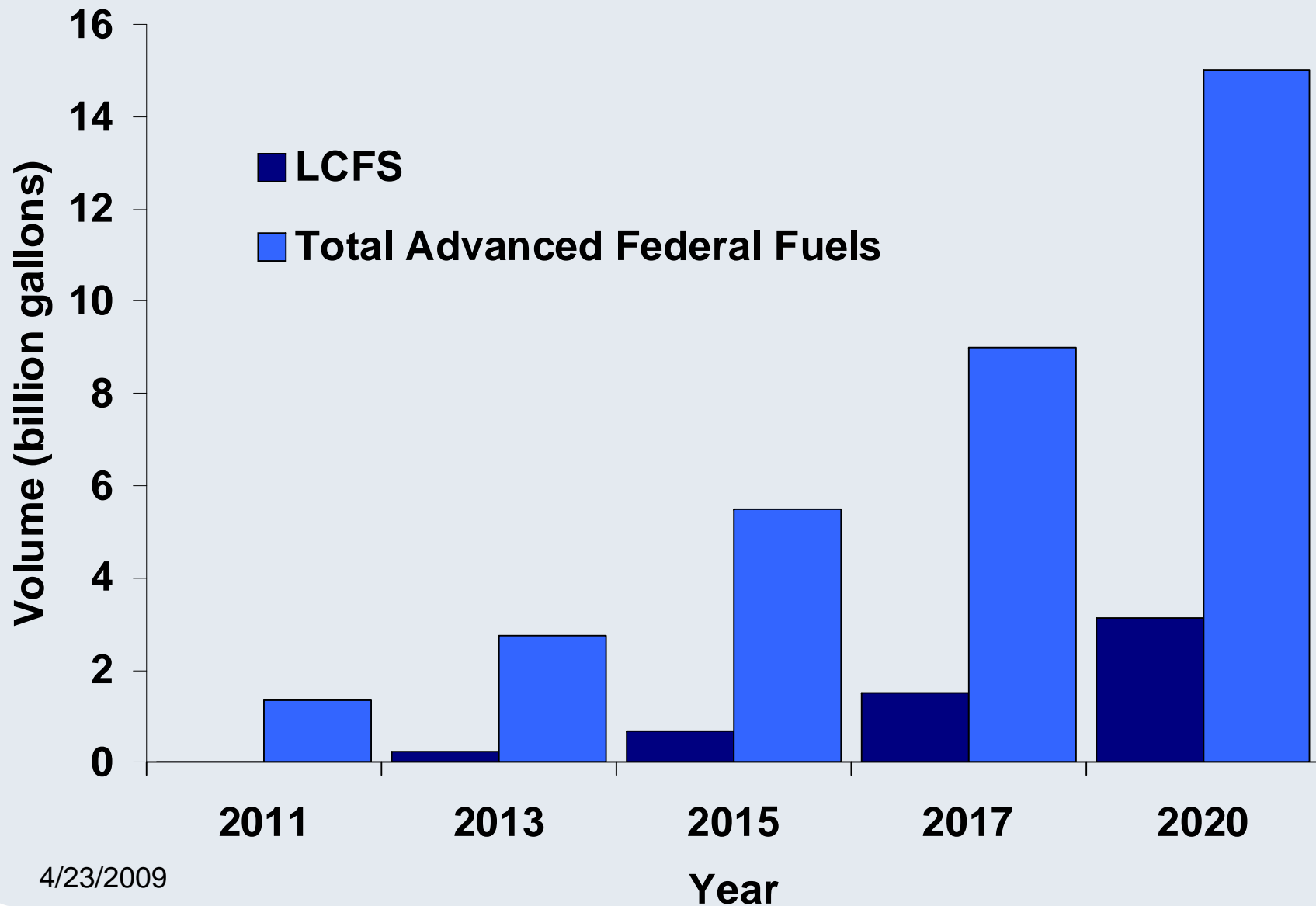
# Federal Fuel Volumes



# *RFS Advanced Biofuel Volumes*



# Advanced Biofuel Volumes - RFS vs. LCFS



## ***Builds Upon and Improves the RFS***

- **All fuels treated the same; no exemptions for existing corn ethanol**
- **Performance-based vs. volume mandates**
- **More market incentives**
- **Includes non-liquid fuels**
- **Provides 3 times the GHG reduction benefits**

# **Proposed Changes and Next Steps**

## ***Staff Proposed 15 Day Changes***

- **Formal review by 2015; identify scope**
- **Add several carbon intensity values**
- **Minor technical amendments**

## *Next Steps*

- **Establish credit trading program**
- **Continue work on carbon intensities**
- **Coordinate with regional, national, and international groups**

# **Summary and Recommendation**



## *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**

# *Recommendation*

**Adopt the proposal with  
staff's suggestion modifications**

**Presentation by  
Dr. Tom Hertel  
Purdue University**