Overview of California's Low Carbon Fuel Standard

Transportation Research Board
January 16, 2008
Washington, DC

Alex Farrell

Energy and Resources Group, UC Berkeley

Director, Transportation Sustainability Research Center

aef@berkeley.edu

LCFS – who?

- **Regulator – California Air Resources Board**
  - www.arb.ca.gov

- **Regulated entities – Producers, importers, and blenders of fuels**
  - Refineries
  - Blenders
  - Importers
  - Electricity providers (?)

  - *Not biofuel producers*
  - *Not retail outlets*
  - *Not consumers*
  - *Not automakers*

LCFS - what?

- **Lower the carbon intensity of transportation fuels**
  - Emissions per unit of fuel: g CO2-equivalent / MJ
  - 10% by 2020 (relative to what)
  - Contribute to overall goal – 1990 levels

- **Complements other polcies**
  - More efficient vehicles
  - Less travel demand (including transit)

LCFS – when?

- **Rulemaking**
  - Analysis underway now
  - Working Groups
  - Board decision – end 2008

- **Enforcement**
  - 2010

- **Fully in effect**
  - 2020

LCFS – where ?

- **California**
- **European Union**

- **Proposed**
  - United States (Lieberman-Warner)
  - British Columbia, Massachusetts, Minnesota and other states and provinces

LCFS – how?

Fuel	CI (gCO2e/MJ)	Adjusted* (gCO2e/MJ)	Notes
CA gasoline	92	**92**	Tailpipe – 78 (85%)
CA diesel	91	71	Based on US 2007 vehicles
FT diesel – coal	214	167	
Ethanol – coal dry mill	113	113	No indirect emissions
Ethanol – advanced corn	47	47	No indirect emissions
Ethanol - switchgrass	15	15	No indirect emissions
Electricity – CA avg.	141	20	
Hydrogen – Natural gas	102	47	Fuel cell vehicle
Credits (?)			

Notes: * Adjustment is for efficiency of drive train. Based on GREET-California reported on University of California August 2007 report

LCFS – why?

- **An economy-wide program (e.g. cap and trade) will be necessary to achieve efficient outcomes**
  - Most important in the long term as carbon emissions decline and costs increase

- **Because many market imperfections exist, an economy-wide program will be insufficient**

  (I'll come back to this)

But how does the LCFS really work ?

- **Refineries (etc.) report carbon intensity to CARB**
  - Carbon accounting for all inputs (crude oil, biofuels, etc.)
- **Compliance strategies *may* include**
  - Improve energy efficiency in refining
  - Pay suppliers different prices: Low carbon = higher price
  - Dieselization of light duty (??)
  - Electrification (buy credits)
  - Natural gas (buy credits)
  - Use carbon-free energy (nuclear-powered refinery?)
  - Sequester refinery emissions
  - Buy offsets (??)

So why do we need an LCFS?

- **Should transportation emissions be included in an economy-wide market-based GHG policy?**
- **Are complementary policies needed?**
- **Is the Low Carbon Fuel Standard a good choice as a complementary policy?**

So why do we need an LCFS?

- **Should transportation emissions be included in an economy-wide market-based GHG policy?**
  - Yes, this will help minimize the cost of GHG emission reductions.
- **Are complementary policies needed?**
  - Yes, many market failures exist.
    - Inadequate R&D (spillover)
    - Inability of government to make credible long-term commitments
    - Market power (petroleum)
    - Coordination (network effects)
    - Externalities (air pollution, energy security, etc.)
    - Uncertainties (climate thresholds)
    - Distributional effects (equity)

So why do we need an LCFS?

- **Should transportation emissions be included in an economy-wide market-based GHG policy?**
  - Yes, this will help minimize the cost of GHG emission reductions.
- **Are complementary policies needed?**
  - Yes, many market failures exist.
- **Is the Low Carbon Fuel Standard a good choice as a complementary policy?**
  - Yes, it addresses many of the market failures.
    - Inadequate R&D (spillover) – *Creates demand for innovation and learning*
    - Credible long-term commitments – *Need is reduced due to near-term goals*
    - Market power (petroleum) – *Tends to encourage fuel diversification*
    - Coordination (network effects) – *Better than supply-side R&D*
    - Externalities (air pollution, energy security, etc.) – *Unclear*
    - Uncertainties (climate thresholds) – *Unclear*
    - Distributional effects (equity) – *Less difficult than price-based policies*

Pricing GHGs at the marginal damage

- **Implications of $12.5/ton CO_2**

	Price	(wrt retail)
– Nuclear + renewable electricity	0.001 ¢/kWh	(<0.1%)
– Integrated gasification combined cycle with carbon capture and storage	0.125 ¢/kWh	(1%)
– Natural gas combined cycle	0.625 ¢/kWh	(4%)
– Pulverized coal	1.00 ¢/kWh	(8%)
– Gasoline	11 ¢/gal	(3%)
– Corn ethanol (without indirect effects)	6-12 ¢/gal	(3-6%)

- **What is the likelihood that prices like this (escalating at, say, 5% per year) will achieve climate stabilization?**
  - Maybe climate stabilization is the wrong goal, but uncertainties about climate change suggest a precautionary approach.
- **What carbon price *would* make climate stabilization likely?**

Major challenges for the LCFS

- **Subsidy for some GHG emissions**
  - Intensity target alone is not very stringent
- **Basis of competition**

Electricity	Refining	Biofuel
Rate-of-return regulation	Competitive	Consumption mandate
All emissions capped	Intensity target	Ag emissions not covered
Local monopolies	Global oligopoly	Many varied producers
"Ratepayer protection"	"Capital at risk"	"Rural development"

- **Rationalization (aka "leakage")**
  - Change in trade patterns
  - Global emissions do not change
  - Little innovation
- **Life-Cycle Analysis**
  - Uncertainties and innovation
  - Indirect land use

Global consumption: petroleum and biofuels		
California	1%	~7%
United States	25%	~45%
European Union	18%	~10%
Annex 1	58%	~55%
Annex 1 plus (Brazil, China, India, S. Korea, S. Africa)	75%	~100%

Thank you

Made possible through support from:

California Air Resources Board

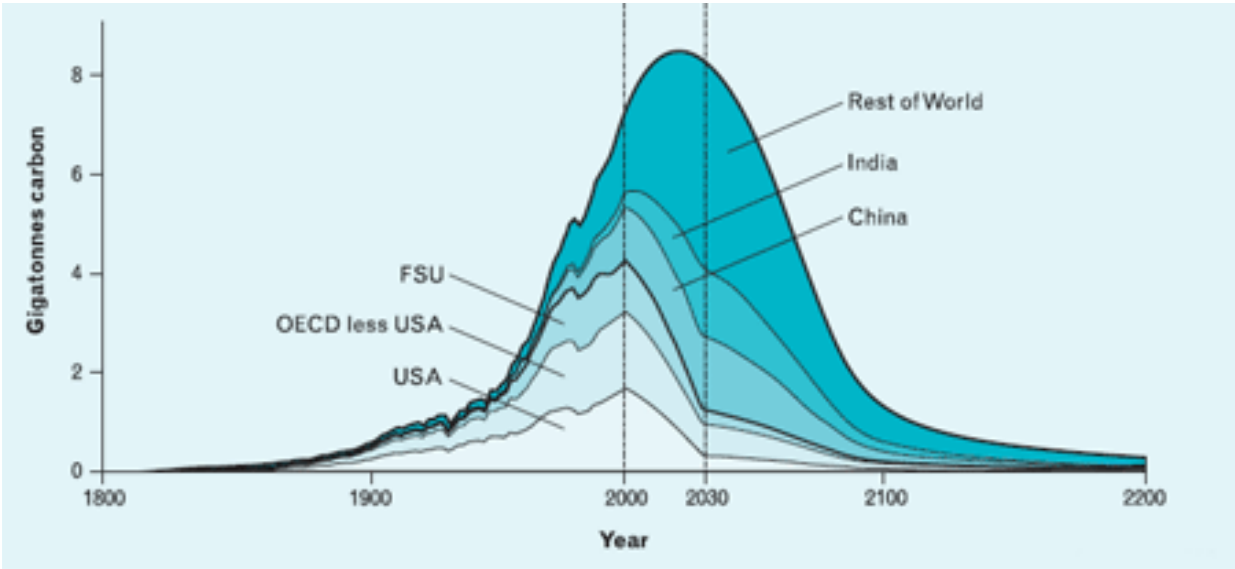
Energy Foundation

University of California Energy Institute (www.ucei.berkeley.edu)

Climate Decision Making Center at Carnegie Mellon University (http://cdmc.epp.cmu.edu).

Climate stabilization requires three overarching policy goals

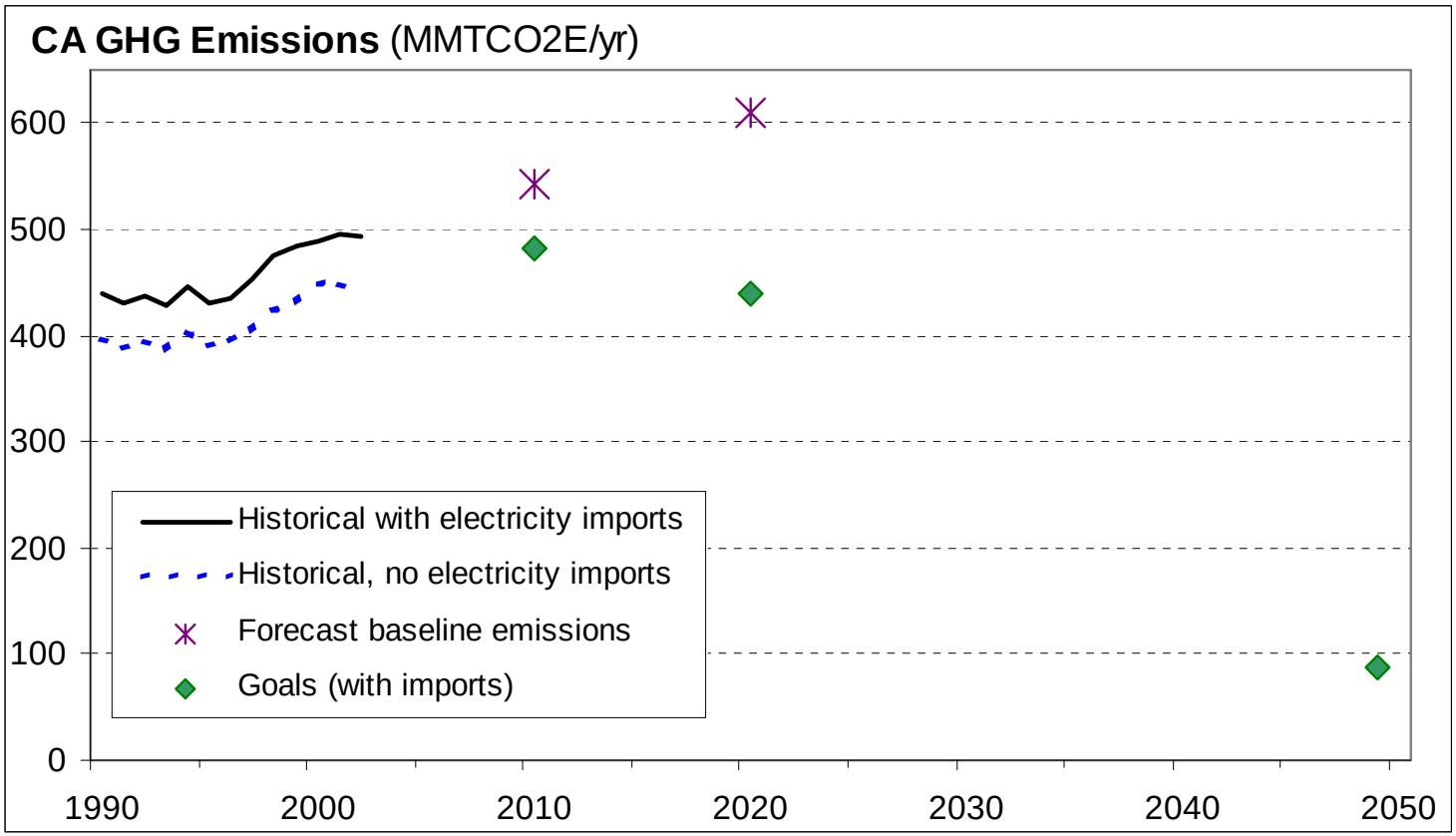
1. **Deploy near-term technologies to cut emissions by ~25% by 2020**
2. **Stimulate innovation & investment in new technologies needed to meet 2050 stabilization targets**
3. **Contribute to related objectives**
   - Air quality
   - Affordable energy prices
   - Diversity of energy sources
   - etc.



450 ppm example of per the Global Commons Initiative

www.cru.uea.ac.uk/tiempo/newswatch/comment060704.htm

Therefore, California has set ambitious targets and has designed policies to foster innovation



- Executive Order S-3-05 GHG emission reduction targets
  - –2010: maintain 2000 levels (~10% reduction from baseline)
  - –2020: return to 1990 levels (~25% reduction from baseline) → **AB32**
  - –2050: attain 80% below 1990 levels → **Climate Stabilization**

California has developed a comprehensive, sectoral strategy to cut GHG emissions

- **Overall goals**
  - Executive Order S-3-05 (2005)
  - Global Warming Solutions Act 2006 (AB 32)
  - Energy Action Plan (CEC and CPUC)
  - Bioenergy Action Plan (CARB, CEC, CPUC, etc.)
- **Energy research portfolio**
- **Buildings and appliances**
  - Energy efficiency standards (CEC)
- **Electricity other large sources**
  - Carbon Adder (CPUC)
  - Renewable portfolio standard for electricity (SB 107)
  - GHG performance standard (CPUC and SB1368)
  - GHG emissions cap (CPUC)
  - Energy efficiency targets for utility companies (AB 2021)
- **Transportation**
  - Vehicle GHG performance standard (AB 1493, CARB)
  - Low Carbon Fuel Standard (Executive Order S-1-07, CARB, CEC, etc.)
  - Reduce travel and logistics demand
- **Other policies**

AB32 Timeline (selected)

- Jan 07 - Form advisory committees and start public process, announce possible early actions
- Jan-May 2007 – Agencies begin workshops and analyses, including workshops on the AB1007 study
- June 2008 – Draft Scoping Plan for achieving 2020 targets released
- **July 2008 – CARB starts regulatory proceedings on early actions (inlcuding LCFS)**, including public workshops and notice and comment process
- July 2008 – CARB adopts mandatory reporting regulations
- November 2008 – Scoping Plan goes to Board
- **Jan 2009 – CARB adopts Scoping Plan and completes regulatory proceedings for early actions**
- **Jan 2010 – Early action regulations take effect**
- Jan 1, 2012 – All GHG regulations are legally enforceable

LCFS basics

- **Carbon intensity must be measured on a lifecycle basis**
  - Average Fuel Carbon Intensity (AFCI) measured in gCO2e/MJ
  - AFCI must decline by at least 10% by 2020
- **Stimulate technological innovation**
  - Use performance standard, with tightening over time
  - Measures desired outcome (GHGs), not a proxy (renewable)
  - Different fuels (electricity, biofuels, fossil, etc.) compete with one another, so government does not pick winners (or losers!)
- **Compliance by manufacturers or importers of fuels (mostly oil refiners)**
- **Additional to vehicle performance standards**
- **Overcompliance creates credits that can be traded in a market or banked for later use**
- **Default and opt-in approach** (Thanks to the U.K.)

Compliance through default and opt-in approach

- **Compliance is possible with many competing technologies:**
  - Lowering the carbon intensity of current fuels – e.g. refinery efficiency
  - Using new, low-carbon fuels – biofuels, electricity, hydrogen, etc.
  - Buying credits (but not or offsets from other sectors)
- **Default: all fuel inputs are assigned a carbon intensity**
  - Fuel inputs must be categorized
  - Highest value in common use is the default value
  - Encourages opt-in and focuses management attention
- **Opt-in: certified data allow lower carbon intensity values**
  - Requires protocol development and data collection
  - Certifiers are needed
  - Tends to encourage innovation

- **Example of a simple categorization:**
  - Gasoline: conventional oil, heavy oil, tar sands, coal
  - Diesel: conventional oil, heavy oil, tar sands, coal
  - Ethanol: U.S. corn, Brazilian sugar, U.S. switchgrass

Possible complementary policy choices

- **Sector-specific policies are needed**
  - Offsets lower the cost of emission reductions but delay innovation
- **Innovation supply:**
  - Government R&D and support for R&D
  - Tax credits/demonstration plants/loan guarantees
- **Innovation demand:**
  - Technology requirements (command and control)
  - Performance standards (market-based)
  - Quantity (carbon cap)
    - Limit GHG emissions to achieve desired atmosphere
    - Information needed: climate science
  - Price (carbon tax)
    - Price GHG emissions to achieve desired atmosphere
    - Information needed: climate science, technology and market forecasts
    - *Or*, price GHGs at the marginal damage ($10-$15/ton)

A Low-Carbon Fuel Standard for California

August 2007

Project Directors

Alexander E. Farrell, UC Berkeley
www.its.berkeley.edu/sustainabilitycenter

Daniel Sperling, UC Davis
www.its.ucdavis.edu

Contributors

S.M. Arons, A.R. Brandt, M.A. Delucchi, A. Eggert, A.E. Farrell, B.K. Haya, J. Hughes, B.M. Jenkins, A.D. Jones, D.M. Kammen, S.R. Kaffka, C.R. Knittel, D.M. Lemoine, E.W. Martin, M.W. Melaina, J.M. Ogden, R.J. Plevin, D. Sperling, B.T. Turner, R.B. Williams, C. Yang

www.its.berkeley.edu/sustainabilitycenter/lowcarbonfuelstandards.html

Regulatory implementation requires a new approach to Life Cycle Analysis

- **Plant-specific analysis is required**
  - May be proprietary and thus must be protected by government
  - Mechanisms for certifying data are needed
- **Key assumptions must be agreed-upon by all users**, else the model produces any answer you want (e.g. forecasts)
- **Uncertainties** must be calculated and evaluated.
- **Factors that cannot be represented in a LCA need to be added**
  - **Land use change**
- Must be **usable** by regulated entities, **resistant** to fraud, and easy to **verify**.

What does the LCFS mean to biofuel producers?

- **Accept default or obtain certified information** that allows for a lower, more accurate opt-in value.
- Value for product will be reflected in **prices** that the regulated entities (e.g. refiners) have will pay
- **Incentives to lower GHG emissions** (efficiency, fuel switching, process changes, etc.)
- **Incentives to use waste and residue feedstocks** that require little or no inputs because these have low GHG emissions and so obtain a high price.
- **Feedstock production on newly-cleared land is likely to have a low price** (due to high GHG emissions, direct and indirect)