

A Low-Carbon Fuel Standard for California

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NOTE: These recommendations are our own views based on currently available data. The California Air Resources Board will adopt rules and protocol in accordance with AB32.

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This is hugely important

This is the most important policy initiative in transportation fuels, perhaps ever! It is a durable framework for guiding investments and the transition to alternative fuels. It could be the principal mechanism for implementing the AB1007 plan.

Two Background Notes

Note 1: LCFS is not the only strategy to reduce GHG emissions from transport:

- i) Complementary efforts to introduce low carbon fuels (and improve “sustainability”)
- ii) More efficient vehicles (CAFE, California’s GHG vehicle standards, other)
- iii) less vehicle travel

Note 2: Our recommendations are result of extensive consultation with oil companies, electric and natural gas utilities, biofuel companies, environmental groups, and ARB and CEC, as well as others such as PUC and car companies. We held over 30 major meetings, most lasting 2-3 hours. Most were attended by 3-7 individuals from the respective organizations.

Principles underlying LCFS

- Provide durable framework for orchestrating near and long term transition to low-carbon alternative fuels
 - Send consistent signals to industry and consumers to reduce GHGs
 - Synergistic with vehicle GHG standards in AB1493 (Pavley)
- Stimulate technological innovation
- Use performance standard, with tightening over time (after 2020)
- Government does not pick winners (or losers!)
 - Provide industry with flexibility in how they respond
- Use lifecycle approach
- Rely on measurable data as much as possible
- Be consistent/compatible with other states, US, EU, others
 - E.g. use federal Renewable Identification Number, UK protocol
- Start with baby steps (allow for institution learning)
- Limit periodic reviews to protocol and methods (but not targets)

Part 1: Is the 10% target technically feasible and cost effective?

Part 2: What are the key policy choices?

Ways to meet LCFS

- Blend low-carbon fuels (biofuels) with gasoline and diesel
- Introduce low-GHG alternative fuels (eg, electricity, natural gas, hydrogen)
- Buy credits from low-GHG fuel suppliers
- *[Reduce emissions from energy production operations]*

Point of regulation

- **Refiners, blenders, and importers**
 - These organizations either manufacture or import finished transportation fuels
 - Existing point of regulation for fuel formulation and emissions

- **Alternative points of regulation (not recommended):**
 - Fuel distributors (possible)
 - Retail stations (too numerous and too difficult administratively)
 - Households and individuals (only academics and economists would recommend this)

All gasoline and diesel in regulated pool?!

Recommendation:

1. Apply the standard to all gasoline and diesel fuel, including off-road
 - Jet fuel and marine fuels not included (State lacks jurisdiction)
 - But allow (opt-in) credits for substitution of low carbon fuels for jet and marine fuels
2. Allow all low-carbon alternative fuels to generate credits
 - Biofuels (ethanol, biobutanol, other); natural gas; electricity; hydrogen

Is the 10% target feasible?

Constructing scenarios (of different combinations of innovation and investment)

- Fuels
 - Current ethanol – average of current technologies
 - Mid-GHG biofuels – best current technologies
 - Low-GHG biofuels – in development and pilots
 - (Advanced fuels discussed later today are *not* include)
- Vehicles
 - Conventional
 - Flex-fuel
 - Diesel
 - Hybrid
 - Plug-in hybrid
 - Battery electric
 - Hydrogen

Calculation of “carbon intensity” (AFCI)

- Global Warming Intensity
 - Total effect on climate change
 - Greenhouse gas emissions (CO₂, N₂O, black carbon, etc.)
 - Other effects due to land use change
 - Some effects are uncertain and variable (more research is needed!)
 - Unit is grams of carbon dioxide equivalent per mega-joule of energy in the fuel (**gCO₂e/MJ**)
- Adjusted for inherent drivetrain differences
 - Gasoline = 1.0 by definition
 - Diesel = 0.78
 - Electricity = 0.20
 - Hydrogen (FC) = 0.48

Representative lifecycle values used for scenarios

Fuel type	Description	GWI gCO₂e/MJ
Gasoline	California average	92.8
Diesel	California average	71*
Average Midwest corn ethanol	Approximate national average	76
Mid-GHG ethanol	Corn feedstock, modern dry mills Natural gas, natural gas (wet DGs), stover	58
Low-GHG ethanol	Poplar, switchgrass, prairie grasses Cellulosic production	4
Mid-GHG biodiesel	Typical soy fatty acid methyl ester	32*
Low-GHG renewable diesel	Waste oils, California poplar Hydrogenation, Fischer-Tropsch	9
Natural gas	California average (compressed)	68
Electricity	California average	24*
Hydrogen	Steam methane reforming	52*

* Adjusted to account for inherent drivetrain differences (see table 5-2 of Part I)

These values are taken from the version of GREET used in the AB1007 study, but subject to wide variability and need to be updated by ARB with more research and stakeholder input.

We used the VISION-CA model

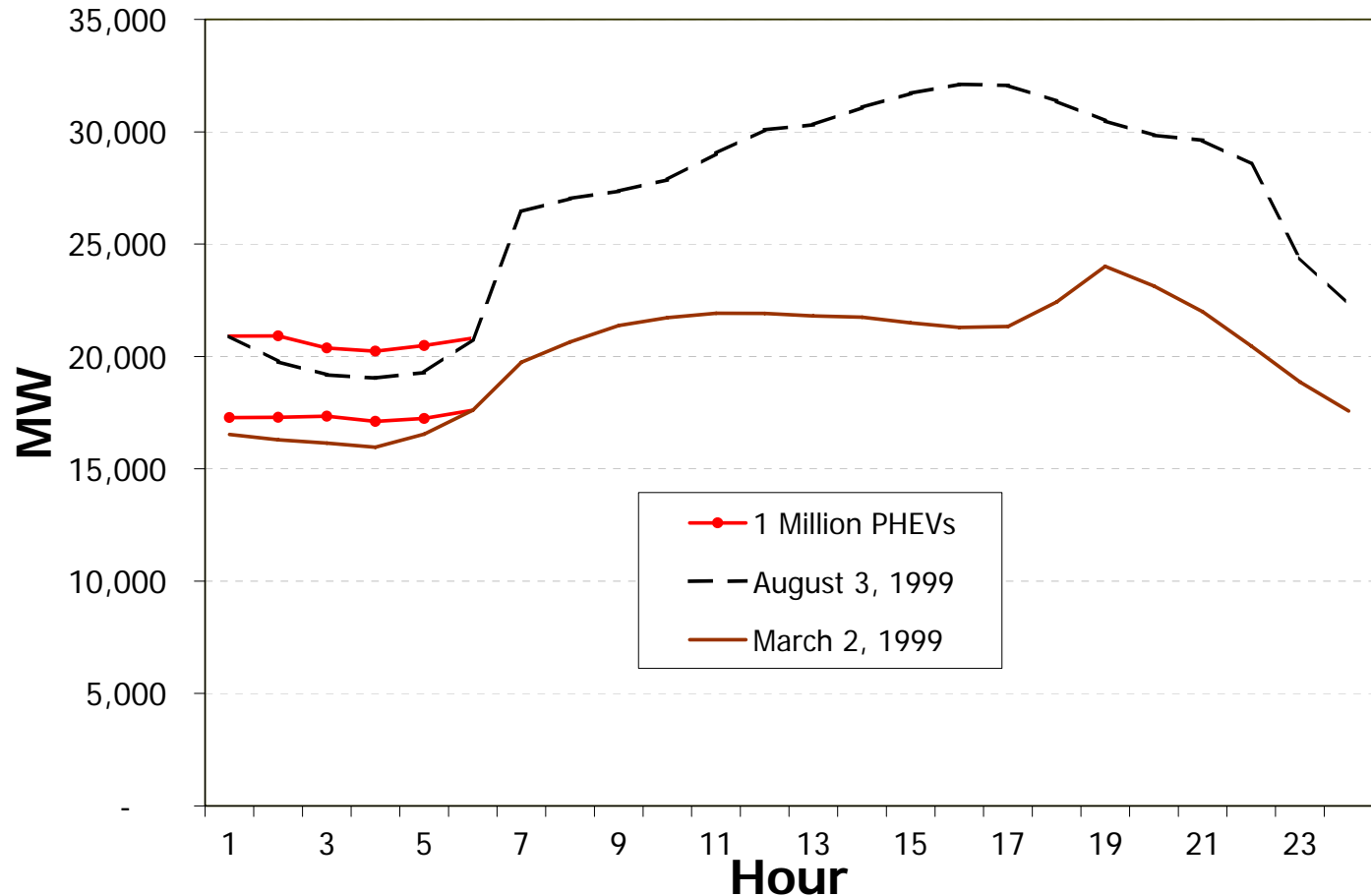
- Available next week on our websites
- Based on a Argonne National Laboratory model
 - Calibrated to California data
 - Population and economic growth
 - Vehicle stock turnover
 - Existing technological change: AB1493 (Pavley), diesels, etc.
- Smooth transitions in light duty vehicles and fuels
 - Example: Transition from current ethanol to low-GHG ethanol
 - Example: Introduction of plug-in hybrid electric vehicles
- Scenarios are created with combinations of fuel and vehicle introduction rates
- Results
 - Estimates vehicle and fuel market size, and AFCI
 - Unit: billions of gallons of gasoline equivalent (BGGE)

Scenarios (of combinations of light duty vehicles and fuels) to achieve GHG reductions

Name	Description (beyond Business As Usual)	% reduction (AFCI)
Business As Usual		
Electric Drive	Battery, plug-in hybrid, and hydrogen vehicles California average electricity	-5%
Existing Vehicles and Improved Biofuels	Diesel vehicles Low-GHG ethanol, low-GHG diesel	-5%, -10%
Evolving Biofuels and Improved Batteries	Battery, plug-in hybrid vehicles and FFVs Mid-GHG ethanol, mid-GHG diesel, Electricity	-5%, -10%
Biofuel Intensive	Diesel, flex-fuel, flex-fuel hybrid vehicles Mid- and low-GHG ethanol, mid- and low-GHG diesel	-5%, -10%, -15%
Multiple Vehicles and Fuels	CNG, plug-in hybrid, battery, fuel cell, flex-fuel, diesel Low-GHG ethanol & diesel, CNG, electricity, hydrogen	-5%, -10%, -15%

California has more than enough electrical capacity to help meet the LCFS goals

Hourly demand curves for the California Independent System Operator (1999)



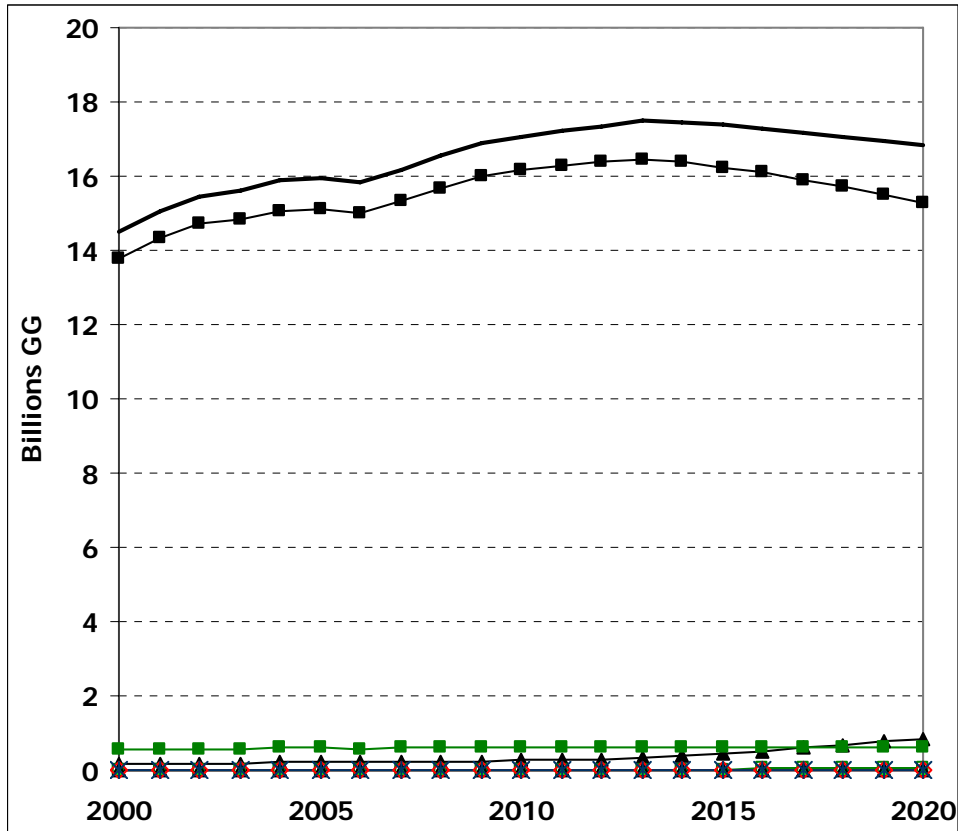
1. Vehicle buyers are incentivized to buy electric vehicles.
2. Charging is incentivized or controlled so it occurs at night.

Several options exist for heavy duty vehicles.

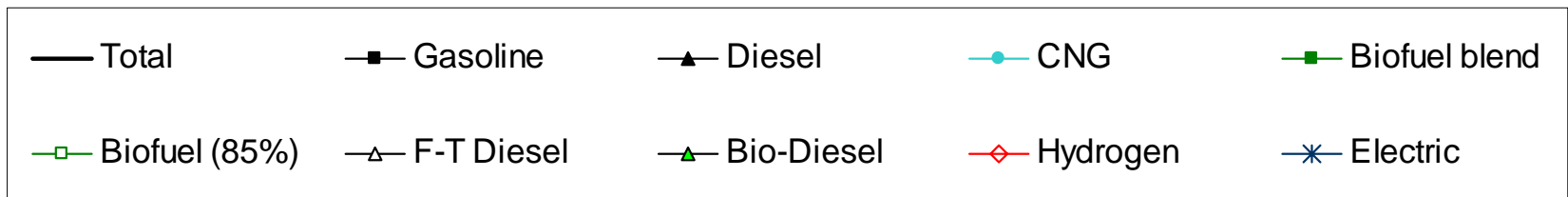
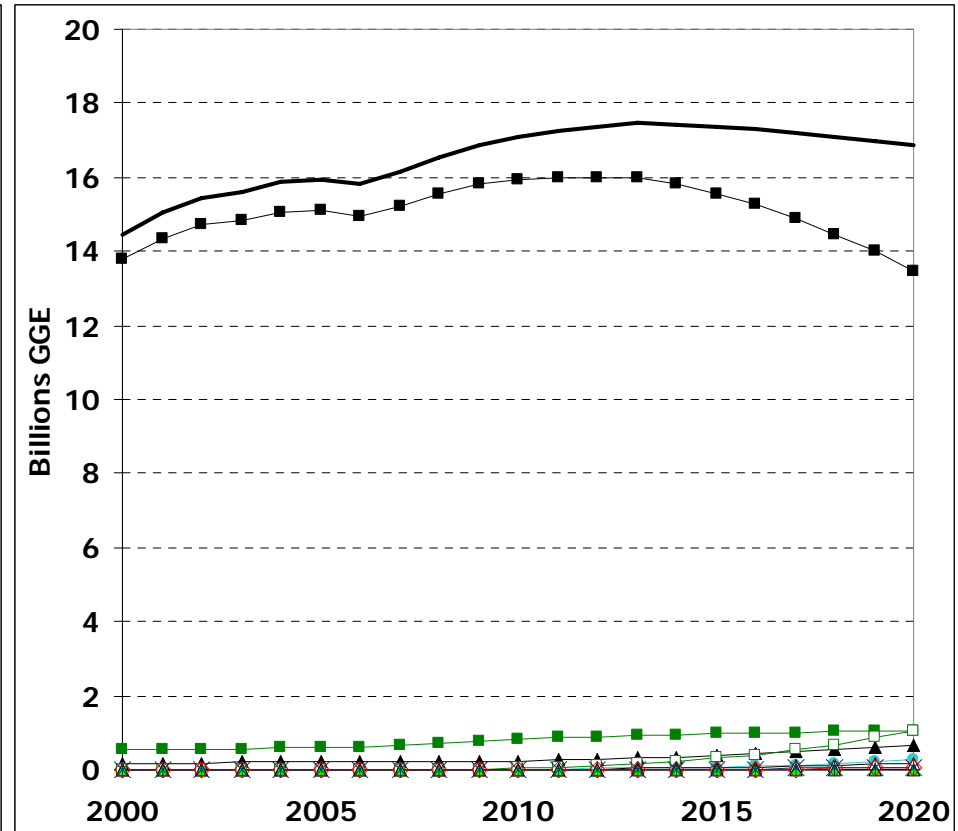
- Low-GHG diesel
- Electrification
 - Truckstops
 - Ports
 - Freight (cranes, forklifts, etc.)
- Natural gas

Fuel consumption changes in the scenarios

Business As Usual



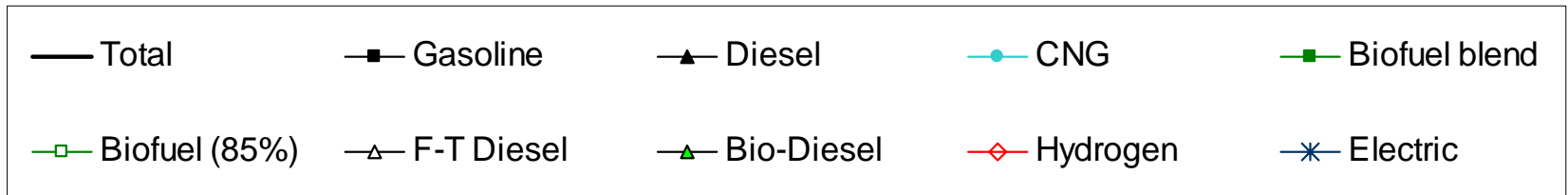
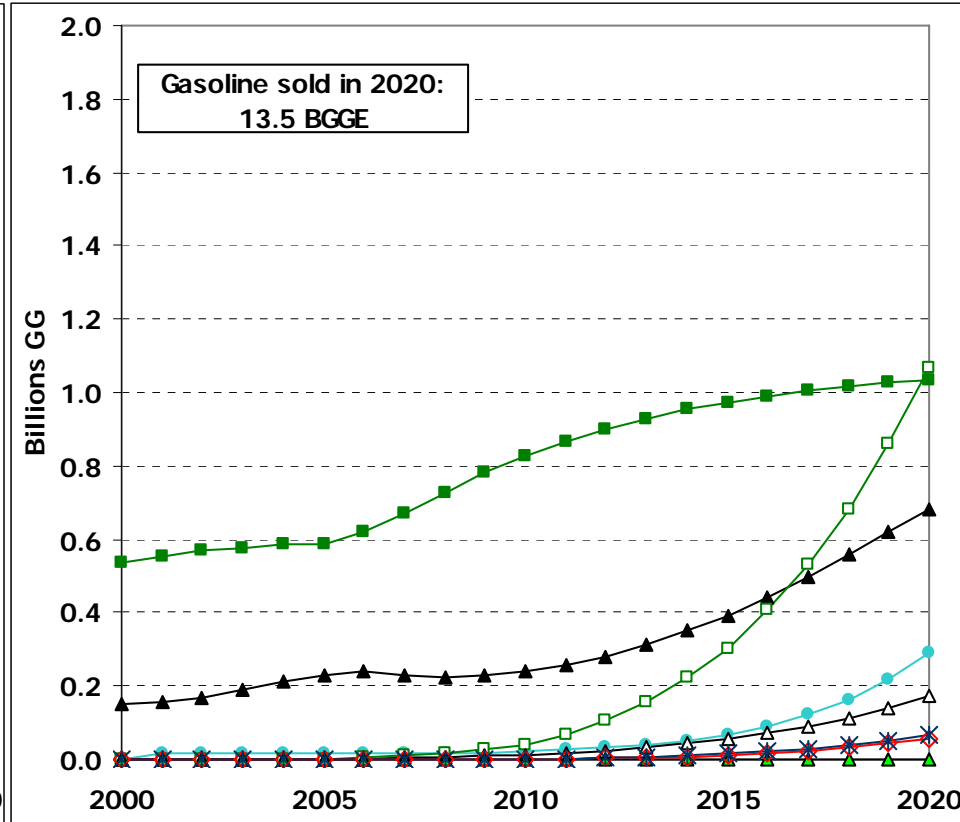
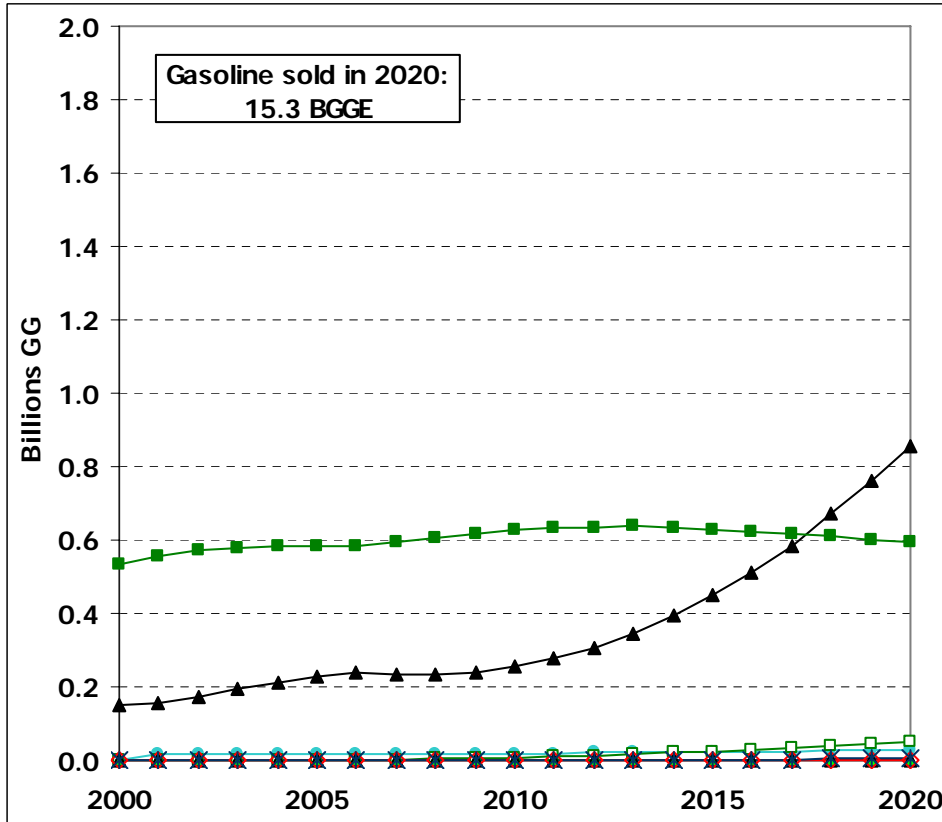
Multiple Vehicles and Fuels



Alternative fuel consumption increases

Business As Usual

Multiple Vehicles and Fuels*



* Biofuels are getting *better* as well as increasing in volume.

Cost-effectiveness

- The LCFS will stimulate technological innovation and investment
 - Current technologies were not developed with low carbon intensity in mind
- Numerous technologies will compete to lower costs
 - I haven't even mentioned: biocrude, direct methanol fuel cells, biobutanol, compressed air, algae, etc.
 - Fuel providers choose solutions that work for them and for their customers
- Credit trading within the fuels sector minimizes costs.
 - Experience shows that well-designed market based regulations achieve results at lower costs

Study team finding

The 10% target seems reasonable

- **Current technologies can meet the standard, but are not optimal for the job**
- **Resources for low-carbon fuels (e.g. electricity and biofuels) are adequate**
- **LCFS will direct innovation to improve technology**

How it works

Default values for fuels

Recommendations:

1. Assign a lifecycle GHG default value to all fuel paths (similar to UK system)
 - Default value is conservative (but better than worst case)
 - ARB will define defaults in LCFS Protocol
2. Provide additional credits to fuel suppliers that beat the default value
 - LCFS Protocol will contain methods to determine values for better production processes for each fuel
 - Requests for additional credits (beyond default value) will be subject to 3rd-party certification

Credit trading among fuel providers

Recommendation: Allow trading and banking among all transport fuel providers

How?

- Overachievers generate credits that can be sold to underachievers
 - Not a cap, no allowances to allocate
 - Note: total fuel emissions could increase (because of greater fuel use)

Why?

- Trading provides flexibility that allows companies to innovate and develop low-cost strategies
- Trading creates competition which speeds innovation and lowers costs
- Emissions trading has largely successful track record
 - Lead phase-out from gasoline
 - SO_x from coal-fired powerplants
 - Criteria pollutants under the Clean Air Act (bubbles, banking)

Trading Beyond Fuel Providers?

YES: Allow opt-in in aviation, bunker fuels and off-road diesel/gasoline fuel use

EVENTUALLY? Allow trading between fuel providers and automakers

NO

- Prohibit purchasing of credits (“offsets”) from outside California (but others can purchase credits from California energy producers)
- Prohibit purchasing of credits (“offsets”) from other industries

Goal is to stimulate technological innovation in the transportation sector

Need tailored sector-specific program because of unique aspects of transport sector ... low price elasticity, large co-benefits.

How to interface with AB32 caps on oil refineries and electricity generation??

- Lifecycle nature of LCFS means there will be regulatory overlaps with AB32 caps on oil refineries, electric utilities, and oil production
- Possible protocol/approaches:
 - LCFS supercedes all other caps (emissions associated with LCFS at refineries, utilities and oil production are deducted from caps)
 - Apply fixed emission factor value for conventional oil production and refineries for purposes of LCFS compliance
 - Oil companies and electric utilities are regulated twice
- Caps and LCFS targets can be adjusted based on which approach is used

Still under discussion

Electricity (and NG) Issues

- Options to measure electricity used in vehicles
 - Meters in house or vehicle
 - Analytically determine number of vehicles in electricity supply territory and average usage and efficiency characteristics
- Need special attention to PHEVs which are bi-fuel (and not commercialized yet)

Recommendations

1. Allow credits for electricity substituted for off-road diesel applications (airports, construction, forklifts, etc)
2. Develop protocol to handle “fuel electricity” interface with AB32 caps on electric utilities (either double crediting for LCFS and AB32 cap, or keep separate)

Land Use Change and Biofuels

- GHG emissions associated with land use changes can be large with biofuels -- but they are uncertain and not well understood

Tentative Recommendations

1. Exclude land-related emissions during first 5 year period (2010-2015), but protect sensitive lands
2. Over next 6 years (2008-2013), conduct intensive research on land effects and incorporate into models and rules (rules taking effective in 2016).

Energy suppliers should be on notice that the calculated global warming emissions for many biofuels will likely increase sharply in next phase.

Related Environmental Justice & Sustainability Issues

- Air quality
- Siting of facilities (environmental justice)
- Soil erosion
- Habitat loss and biodiversity
- Job opportunities and working conditions
- *But doesn't kill 3 billion people, as claimed by Fidel Castro in today's SF Chronicle*

Recommendations:

Require report by regulated entities (similar to UK)

Continuing need for research

- To develop new, lower-carbon fuels (by industry)
- To better measure the global warming intensity of fuels and create a modeling framework for lifecycle emissions
 - We recommend research over the next 12-15 months to improve the GREET model, which should then be used to develop the refined LCFS Protocol for the first compliance period (2010-2015)
 - Conduct research to develop a better framework for analysis with which to refine the LCFS Protocol for second compliance period.
- To develop compatible international standards and rules
- To design and evaluate trading mechanisms

Coordinating With Others

- **Other States:** Proposals in BC, WA, OR, AZ, NM, MN, and...IL?
- **United States:** Bills by Boxer (D-CA), Feinstein (D-CA), Obama (D-IL) Inslee (D-WA)
- **Other countries**
 - **United Kingdom:** Renewable Transportation Fuel Obligation being implemented
 - **Germany and other European countries:** various proposals
 - **European Union:** monitoring and rules under development

Next

Research, rule-making, model refinement and protocols

- **2007** – LCFS inserted into CEC/CARB Alternative Fuel Plan (AB1007); Adopted by CARB as AB32 “early action”; CARB rulemaking begins
- **January 2010** – LCFS regulations take effect
- **2013** – We recommend 5 year review of models and methods (but not targets)
- **2018** – Initiate tightening of LCFS targets

CONCLUSION: This is Hugely Important

Yes, there is uncertainty.

Yes, there are challenges.

Yes, more research is needed.

But... this is the most important policy initiative in transportation fuels, perhaps ever!

It is a durable and flexible framework for guiding investments and the transition to alternative fuels. We need to make this work.

Thank You

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- Stakeholders
- CARB and CEC staff
- Energy Foundation for funding the UC study team

Biofuel market size (-10% AFCI)

Scenario name	Million GGE/yr
Business as Usual	Gasoline: 15,300 Diesel: 850 Average ethanol: 650
Existing Vehicles and Improved Biofuels	Low-GHG ethanol: 957 Low-GHG diesel: 709
Biofuel Intensive	Mid-GHG ethanol: 3,293 Mid-GHG diesel: 423
Multiple Vehicles and Fuels	Low-GHG ethanol: 1,262 Low-GHG diesel: 171 CNG: 289 Electricity: 69 Hydrogen: 59

Biofuel consumption
(Millions GGE/yr)

BAU: 650

Meet 2020 target with
Mid-GHG: 3,700

Meet 2020 target with
Low-GHG: 1,400-1,700

Note: Scenarios with improved electric vehicle technologies require less biofuels

Existing and planned biofuel production in the U.S. can supply California's needs in 2012

Forecasted 2012 nationwide production capacity of existing and planned facilities	Potential (Million GGE / yr)
National mid-GHG ethanol	776 to 969
National mid-GHG diesel	1,400
National low-GHG ethanol	288
National low-GHG diesel	175

1. Little new innovation or investment may be needed to meet the LCFS through 2012
 - Existing and planned low-GHG biofuels are shipped to California
2. Little need for additional biofuel volume up through 2012
3. Little or no need to expand land use for biofuels up through 2012

Innovation is key to the 2020 outcome

In-state feedstocks for mid-GHG biofuels	Potential (million GGE / yr)
California starch and sugar crops	360 to 1,250
Imported corn for animal feed	130 to 300
In-state feedstocks for low-GHG biofuels	
Potential (million GGE / yr)	
California cellulosic agricultural residues	188
California forest thinnings	660
California waste otherwise sent to landfills	360
Cellulosic energy crops on 1.5 million acres in California	2,400 to 3,200

1. With current technologies, California will have to rely on imports to meet the 2020 target, and must increase biofuel consumption.
2. With innovation and investment in fuel technologies, California may be able to meet the 2020 target without significant imports or land use expansion.