



Overview

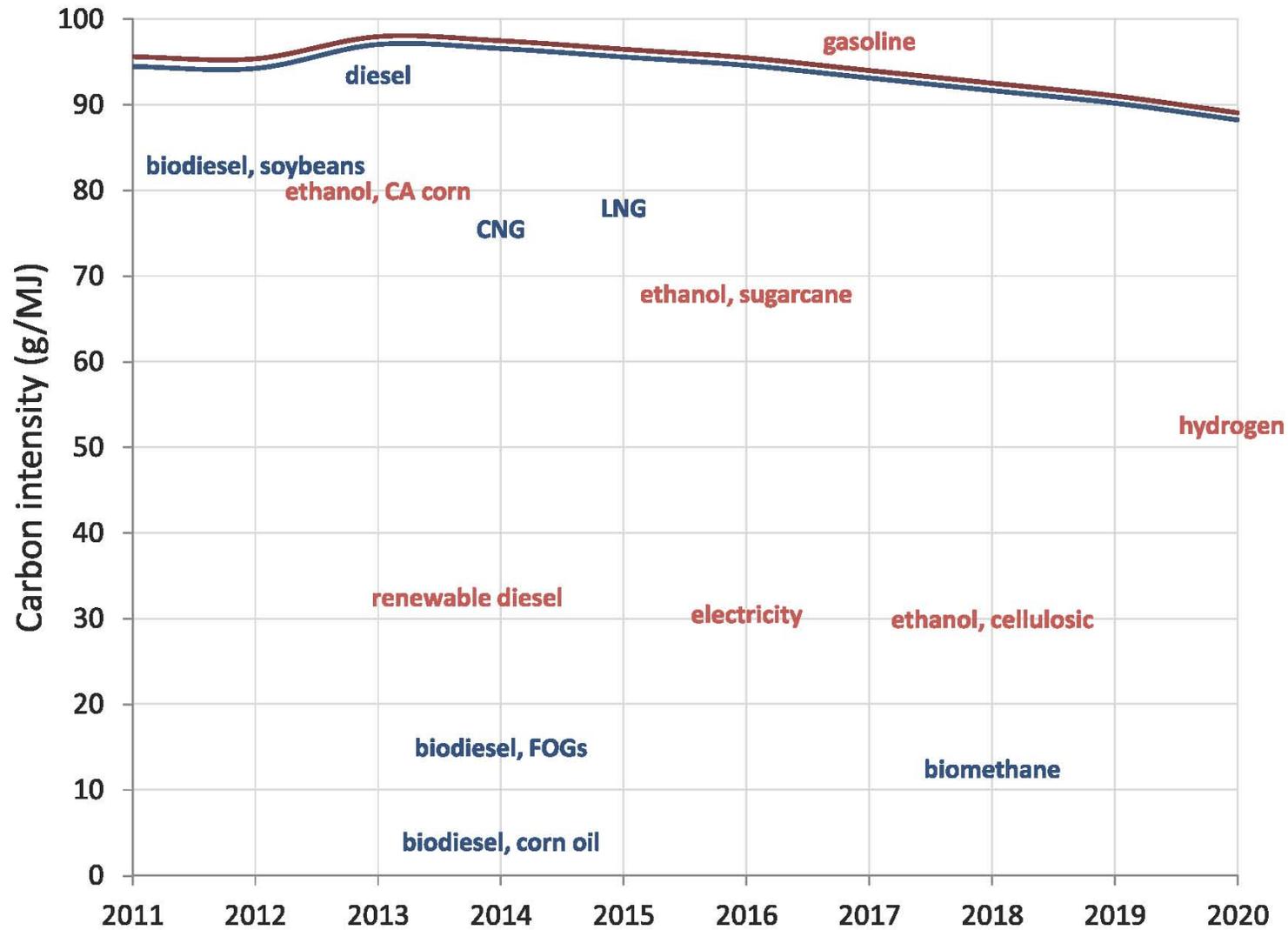
- Introduction
- Scenarios
- Market Snapshots



Introduction

Scope	<p>ICF was retained by a multi-stakeholder group to:</p> <ul style="list-style-type: none">▪ Develop Reference Case and LCFS Compliance Scenarios▪ Conduct economic modeling using REMI▪ Assess co-benefits
Methodology	<ul style="list-style-type: none">▪ ICF developed the following scenarios:<ul style="list-style-type: none">▪ Reference Scenario: As close to BAU as possible▪ Scenario 1: Increased adv vehicle technologies (NG, PEVs)▪ Scenario 2: More biofuels▪ LCFS-enhanced scenario: More optimistic penetrations of advanced vehicle technologies, biofuels, and some additional credit generating opportunities▪ Cost treatment: Costs considered include: fuel costs, vehicle costs, and infrastructure costs. Each scenario requires different investments and/or expenditures.▪ Modeling: ICF is using REMI model; a dynamic model that allows for behavior such as technological change and adaptation.▪ Co-Benefits / Positive Externalities: GHG emission reductions, criteria air pollutant reductions, energy security

Credits and Deficits



Some notes on the scope of ICF analysis



- Analysis focused on compliance in 2020 i.e., net zero of deficits and credits. This is important because it is a slightly different exercise than forecasting. Generally ICF assumed that the market, absent any major changes to LCFS, will achieve balance in 2020. However, because of uncertainty associated with post-2020, we may have under-estimated the market penetration of some alternative fuels.
- ICF assumed no shift in the carbon intensity of the crude slate in California. If the carbon intensity of the crude slate increases moving forward, then obligated parties (e.g., refiners) will generate more deficits, which will have to be offset by more credits.

Data sources



- California state agencies: California Energy Commission, Air Resources Board
- Federal: DOE/NREL, DOE/EIA, USDA
- International: OECD, USDA Foreign Agricultural Service
- Stakeholders: CalETC, National Biodiesel Board, ethanol fuel producers, California Natural Gas Vehicle Coalition

High-level observations



- Broadly speaking, compliance is achieved through biofuel blending (with both gasoline and diesel) and through the deployment of advanced vehicle technologies that use natural gas, electricity, and hydrogen. In both scenarios, the majority of LCFS compliance is achieved through blending biofuels. However, compliance in Scenario 1 depends on more aggressive forecasts for advanced vehicle technologies than Scenario 2, thereby putting less pressure on the demand for biofuels.
- Over-compliance in early years of the LCFS (through 2016, at least) is critical, and a significant number of excess credits have already been generated.
- Alternative fuels that substitute for diesel – with a focus on natural gas, biodiesel, and renewable diesel – will play a significant role in compliance.
- Alternative fuel developments are nascent, but promising and reflect disruptive potential of innovation.

SCENARIOS

Summary (and some numbers)



Scenario	Ethanol	Biodiesel / Renewable Diesel	Natural Gas	Advanced Veh (PEVs / FCVs)	Other
Scenario 1	Maintained E10 blend rate until 2018 Cellulosic/adv biofuels capped at 50% of volumes reported by E2	Limited blend percentages to 20 percent by volume of conventional diesel.	Linear increase from 2012 to 2020 to 1.2 billion gge 10% biogas	220,000 BEVs; 800,000 PHEVs; and 110,000 FCVs in 2020	Only forklifts and rail with no additional credits for displacement
Scenario 2	Maintained E10 blend rate until 2017 E15 introduced 2018-2020 Cellulosic/ advanced biofuels capped at 13% of volumes reported by E2	Limited blend percentages to 20 percent by volume of conventional diesel. Increased corn oil BD Increased RD from tallow in 2018-2020	Linear increase from 2012 to 2020 to 900 million gge, 10% biogas	ZEV Program Compliance	Only forklifts and rail with no additional credits for displacement

Summary (and some numbers, ctd)



Scenario	Ethanol	Biodiesel / Renewable Diesel	Natural Gas	Advanced Veh (PEVs / FCVs)	Other
LCFS enhanced	Maintained E10 blend rate Brazilian sugarcane capped at less than 350 MGY until 2018	Limited blend percentages to 20 percent by volume of conventional diesel.	Linear increase from 2012 to 2020 to 1.5 billion gge 10% biogas	240,000 BEVs; 960,000 PHEVs; and 110,000 FCVs in 2020	Marginal incremental calculations for forklifts and rail, no displacement when including ports, small non-truck and truck related
All Scenarios	Some E15 <ul style="list-style-type: none"> • Low CI corn at 1 BGPY • Sugarcane at 500 MGPY 			40% PHEV VMT is electric	Compliance achieved in 2011 and 2012 Assumed 1 million banked credits at end of 2012

Ethanol



- “Conventional” ethanol producers are lowering their carbon intensity.
- California ethanol is down to around 80 g/MJ; moving to 70 g/MJ. Improvements via both feedstock changes and process improvements.
- Brazilian sugarcane ethanol: RFS2 is likely the pull here; but LCFS is helping too. Early indications are that 2013 will exceed 2012 (about 90 million gallons by ship to CA, with additional volume likely from rail).
- Cellulosic ethanol: Have been some setbacks in the cellulosic ethanol industry; however, innovation in other markets e.g., renewable gasoline may offset cellulosic ethanol. There has been some good news regardless: KiOR (MS); Edeniq (CA); Zechem (OR)
- We did consider a shift to E15; introduced in 2018 in one scenario, capped based on vehicle. Maybe you don’t like E15; well, we didn’t consider much potential for E85. Key conclusion: high-level volumetric consumption is likely close.

Biodiesel



- Production: Still lots of soy biodiesel, but some shifts in the market re: feedstock.

Feedstock	Feedstock Consumption for Biodiesel (million lbs)		
	2011	2012	Change
Canola Oil	847	787	-60
Corn Oil	304	571	+267
Soybean Oil	4,153	4,023	-130
Animal Fats ^a	1,289	840	-449
Recycled Feeds ^b	666	900	+234
Total	7,259	7,291	32

a. Includes poultry, tallow, white grease, and other. b. Includes yellow grease and other.
Source: EIA

Biodiesel, ctd



- Delivery and terminal infrastructure is being deployed a bit faster than folks might have anticipated. As recently as 2010, the CEC reported that biodiesel terminal storage was severely limited.
- Today, Kinder Morgan has expanded biodiesel storage and delivery capacity at its Fresno and Colton terminals, with a reported throughput of 19 to 20 million gallons per year at each facility. Interviews with industry representatives indicate that at least 4 refiners within California have proprietary terminals at which they are or have the capacity to blend biodiesel.
- ICF research indicates that there are **at least** 230,000 barrels of biodiesel storage capacity in California today. If we assume conservatively that these storage tanks have about 75 turns per year (i.e., the number of times each tank is emptied and filled) and that biodiesel represents about 15 percent of throughput at these facilities, then we estimate a biodiesel blending capacity of around 110 million gallons annually.

Drop-in Biofuels



- Considered both **renewable gasoline** and **renewable diesel**
- Renewable gasoline numbers were about 50% of EIA projections; modified further to reflect potential delivery to CA. There are some reasons to be a bit more bullish on renewable gasoline. Some pause because of uncertainty around feedstock cost.
- Renewable diesel is here today: As many as 100 million gallons likely delivered to California in 2013. Neste Oil has been most aggressive; Diamond Green in Louisiana online in late June.
- What gives ICF pause here: biodiesel tax credit. Will LCFS be sufficient driver for delivery AND feedstock switching (e.g., palm oil to tallow) if tax credit is not extended? There are other markets for biodiesel (Southeast Asia and Europe).

Natural Gas



- Breaking news: natural gas is cheap.
- Transit agencies are the base here for the near-term future – about 85 million gge of consumption already (1/2 to 2/3 of entire market).
- Usual suspect here: Cummins Westport in the heavy-duty engine market. But, the market is changing:
 - GM introduced the bi-fuel Chevrolet Silverado and GMC Sierra 2500 HD (start around \$11,000).
 - Chrysler offering the Ram 2500 CNG to retail customers.
 - Westport Innovations WiNG technology is a conversion kit for Ford's F series of medium-duty trucks – one of the top 10 selling vehicles in California during 2012 – at a retail price of \$9,500. System has been demonstrated and deployed with success in the F-250 and F-350 models; and Westport recently announced that they are expanding the offering to the F-450 and F-550 trucks.
- LNG consumption set to increase significantly; will help penetration into the heavy-duty market (e.g., goods movement).
- Biogas: Significant potential here. Some hold-ups in the California market; but there is significant potential outside of California. Environmental attributes (RINs + LCFS credits) can make up for cost differential for fossil NG / bioNG.

Electricity, Light-duty



- PEV sales are good in California ... and there are good signs from OEMs (see below). About 35-40% of PEV sales nationwide are in California. Drivers: CVRP, HOV access, and more recently, price cuts / attractive leasing offers.
- Vehicle sales may be bolstered by decreasing battery prices. The global capacity of lithium-ion battery manufacturing is drastically over-supplied. For 2013, global production capacity is estimated to be nearly 4,000 MW; however, the demand for batteries is an order of magnitude less – around 400 MW.
- Short-term market boost for BEVs; shift to PHEVs in the mid-term.

Powertrain technologies	OEMs	Suppliers
ICE downsizing	31%	24%
Plug-in hybrid	29%	23%
Hybrid fuel systems	18%	11%
Battery (range extender)	10%	18%
Pure battery	6%	13%
Fuel cell	6%	11%

Source: KPMG Global Auto Executive Survey 2013

Electricity, HD and Off-road



- Potential in the medium-duty and heavy-duty sectors for electricity. Not considered in our analysis; conservative stance based on costs and technological advances.
- Offroad applications: Lots of potential here. In context of LCFS, fixed guideway and forklifts are the near-term consideration. More off-road electrification likely.

Questions?



Philip Sheehy
philip.sheehy@icfi.com
415-677-7139

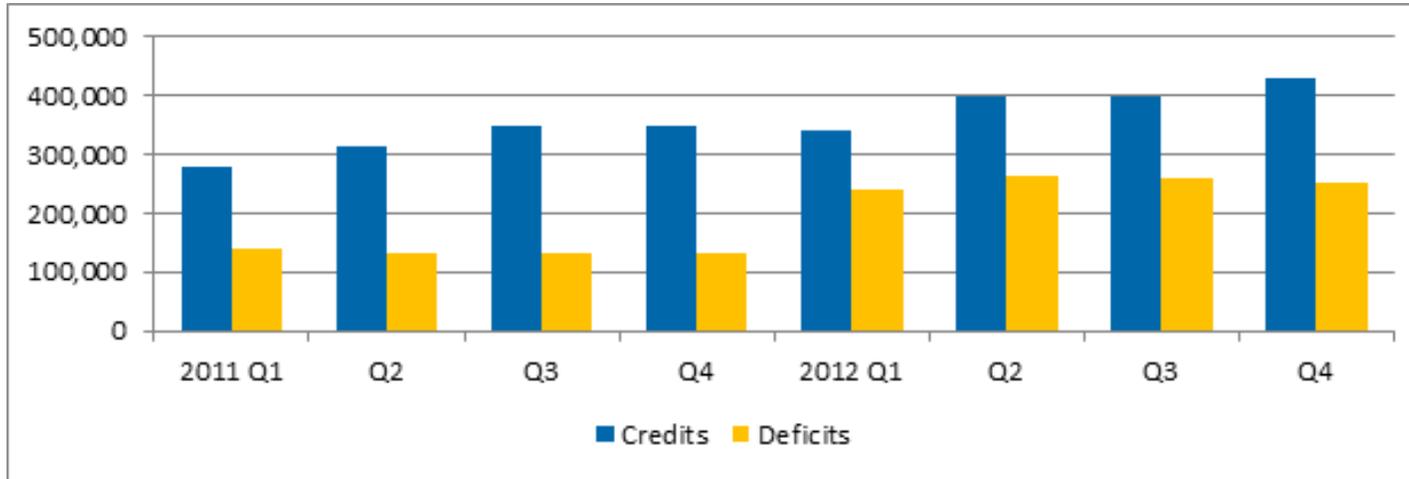
Jeff Rosenfeld
jeffrey.rosenfeld@icfi.com
408-216-2818

APPENDIX

APPENDIX



There has been significant over-compliance in the early years of LCFS



Date Range	EtOH (90<CI<95)	EtOH (85<CI<90)	EtOH (80<CI<85)	EtOH (CI<80)	Nat Gas	Biodiesel	Other
Q1 2011 Q4 2011	25%	15%	24%	16%	12%	6%	2%
Q2 2011 Q1 2012	23%	15%	24%	16%	12%	7%	3%
Q3 2011 Q2 2012	19%	14%	23%	21%	12%	8%	3%
Q4 2011 Q3 2012	17%	13%	23%	23%	12%	8%	4%
Q1 2012 Q4 2012	16%	13%	21%	28%	11%	7%	4%
Trend	↓	↓	↓	↑	—	—	↑

Source: ARB Quarterly Reporting Data