Low Carbon Fuel Standard Analysis

Transportation Committee Workshop on Transportation Energy Demand and Fuel Infrastructure Issues

Transportation Committee Workshop

September 9, 2011

Gordon Schremp
Fuels and Transportation Division
California Energy Commission
gschremp@energy.state.ca.us

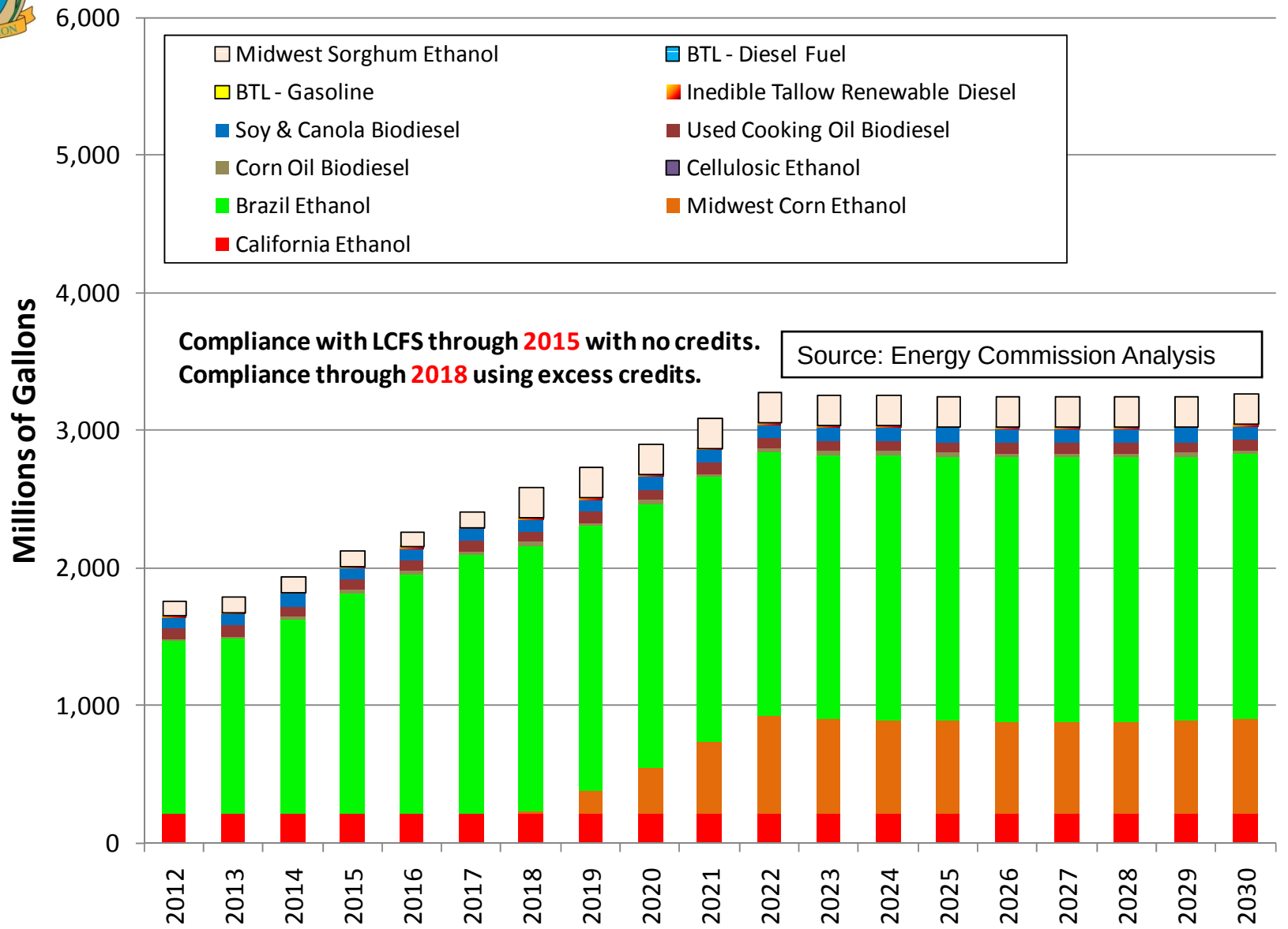
LCFS Compliance Analysis

- Primary intent of this initial analysis is to evaluate compliance feasibility using various types of biofuels
  - This scenario analysis should not be considered a forecast
- Four cases with varying assumptions
  - Availability of low carbon intensity fuels increased with each case
  - Most biofuels are currently available in commercial quantities
  - Only exceptions cellulosic biofuels, especially BTL gasoline
- Adjustment for biodiesel NO_x mitigation
  - Biodiesel use does not exceed 5 percent in any of the cases
  - This represents a change from the assumptions in the draft report
- No adjustment for higher-cost biofuels
  - Brazilian ethanol $1.50 more per gallon compared to corn ethanol
  - Biodiesel at nearly $3.00 more than diesel fuel
- Primary concern is plausibility of the assumptions

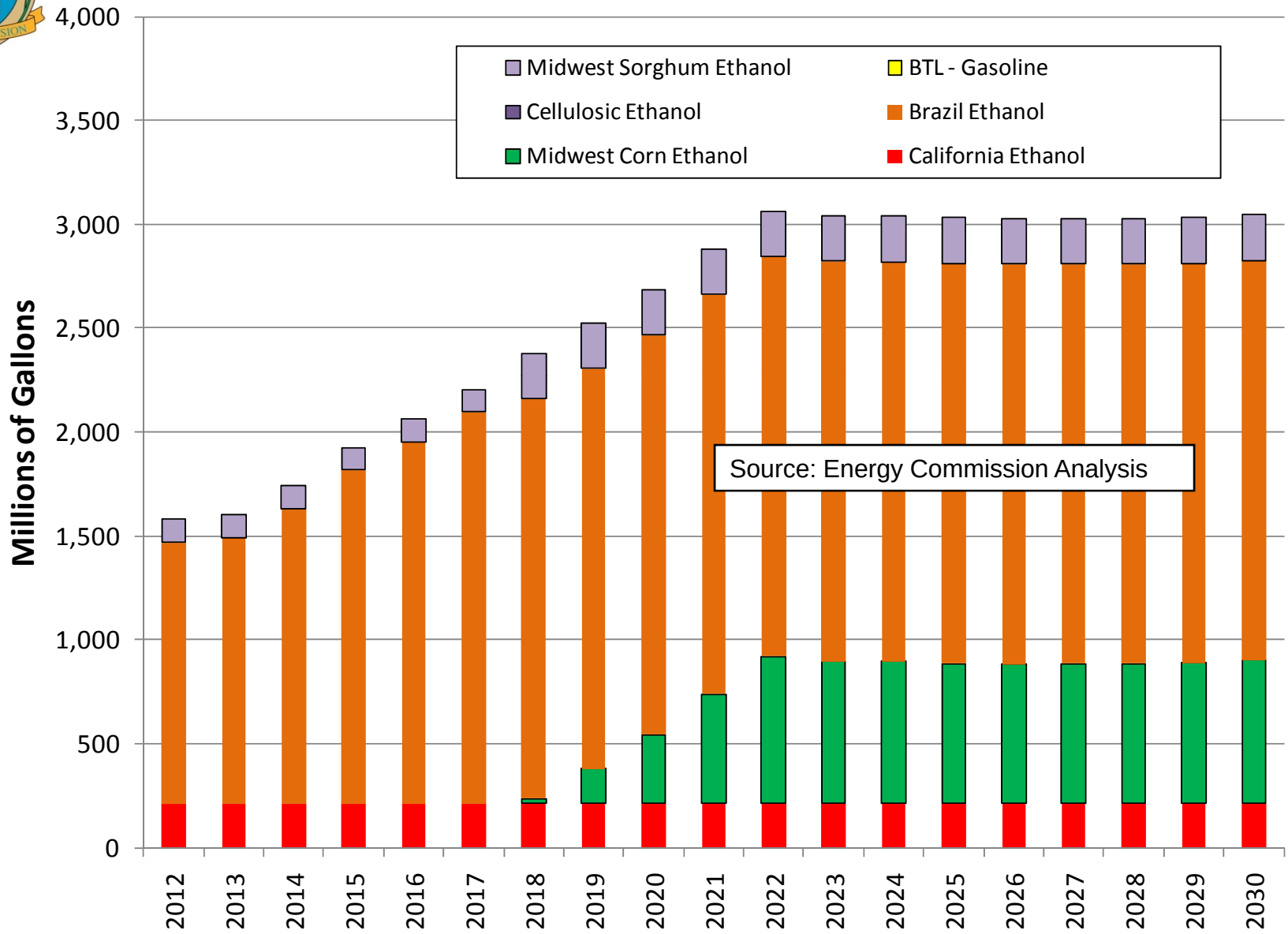
LCFS Analysis – Case 1 Assumptions

- Biofuel supply availability limited to the production capacity for all facilities that have either completed or have pending registration approval
- No use of cellulosic fuels
- No adjustment for more expensive biofuels
- Biofuels with lowest carbon intensity selected first
  - Except for preferential use of California biofuels
- High transportation fuel demand forecast
- Credits from electricity demand use for transportation sector (both light and heavy duty) are counted, even though a portion of these credits may not ultimately be identified in the reporting system
- Same for natural gas use for transportation purposes

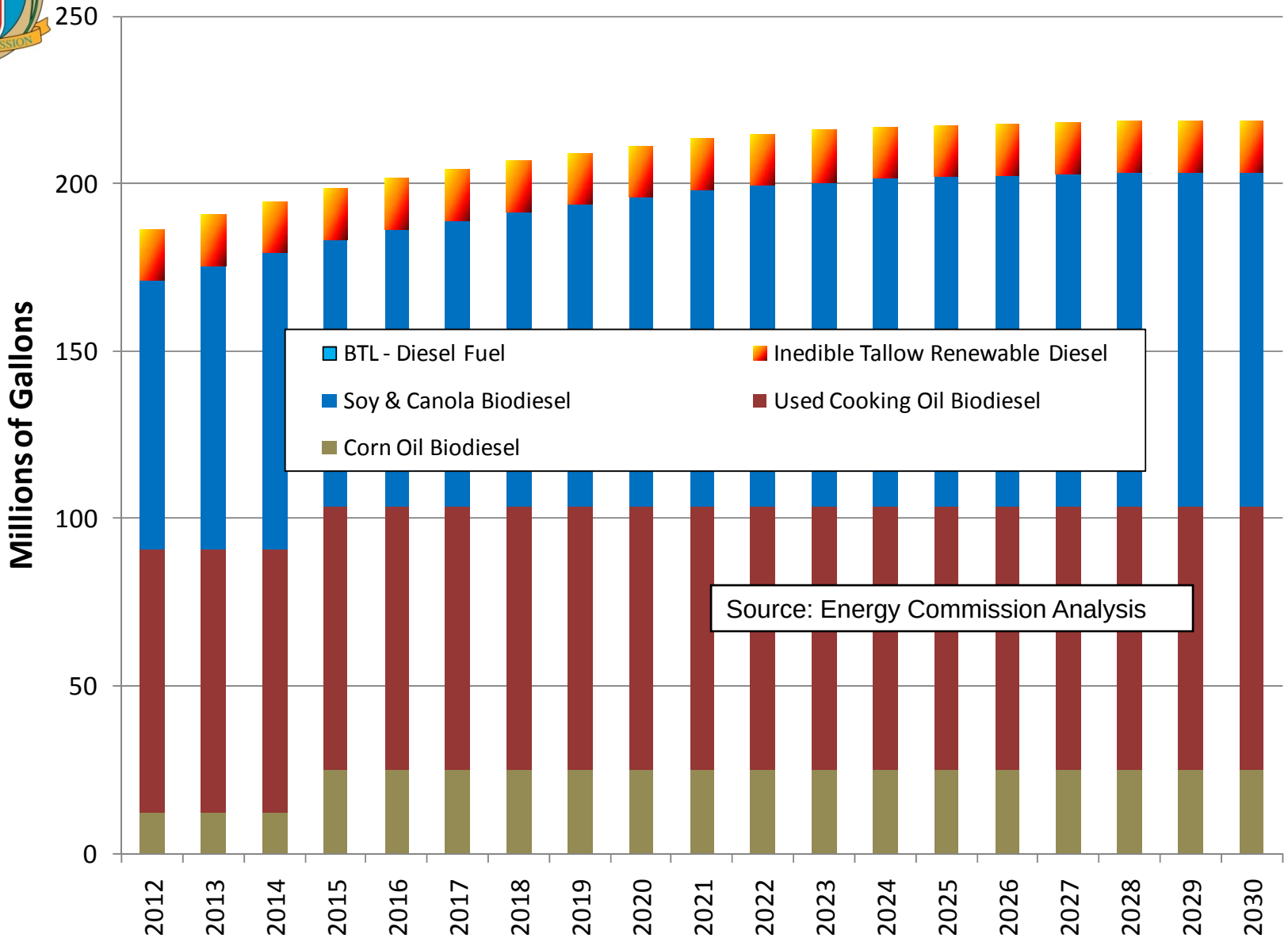
Case 1 Preliminary Results – All Fuels



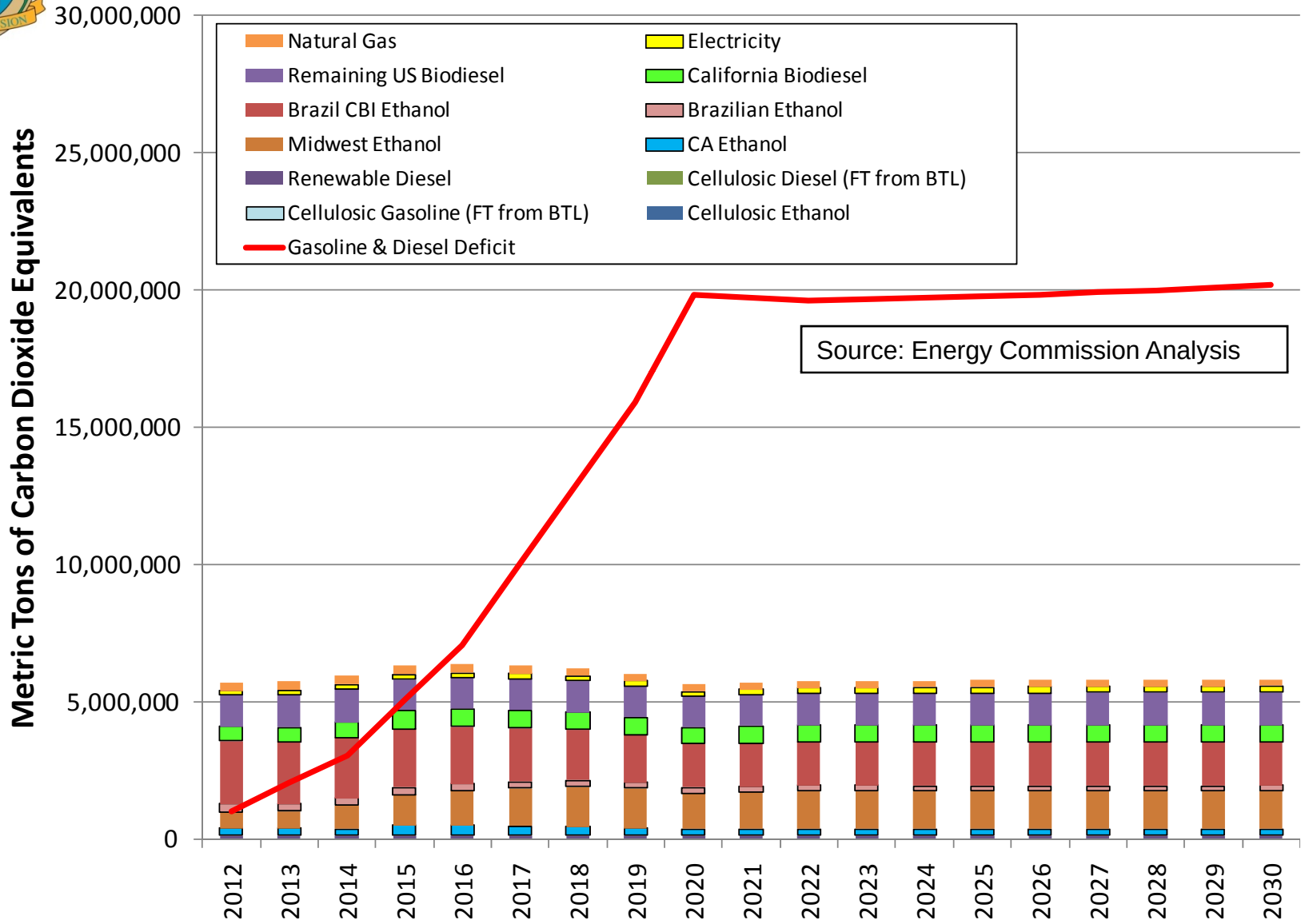
Case 1 – Gasoline Blend Fuels



Case 1 – Diesel Blend Fuels



Case 1 Results – Credits vs. Deficit



Case 1 Observations

- Compliance through first half of LCFS program (2015) possible through use of commercially available biofuels
- Excess credits can extend compliance through 2018
- Compliance through the forecast period (2030) would require generation of additional credits from:
  - Increased production capacity for certain low CI biofuels
    - Renewable diesel fuel
    - Biodiesel from corn oil & used cooking oil
  - Use of other biofuels with low CI values
    - Cellulosic ethanol
  - Displacement of gasoline and diesel fuel with drop-in biofuels
    - Biomass-to-liquids (BTL) gasoline and diesel
- Midwest corn ethanol in early years not selected due to higher CI value
  - Use is still feasible – excess credits would be less

Case 1 Concerns

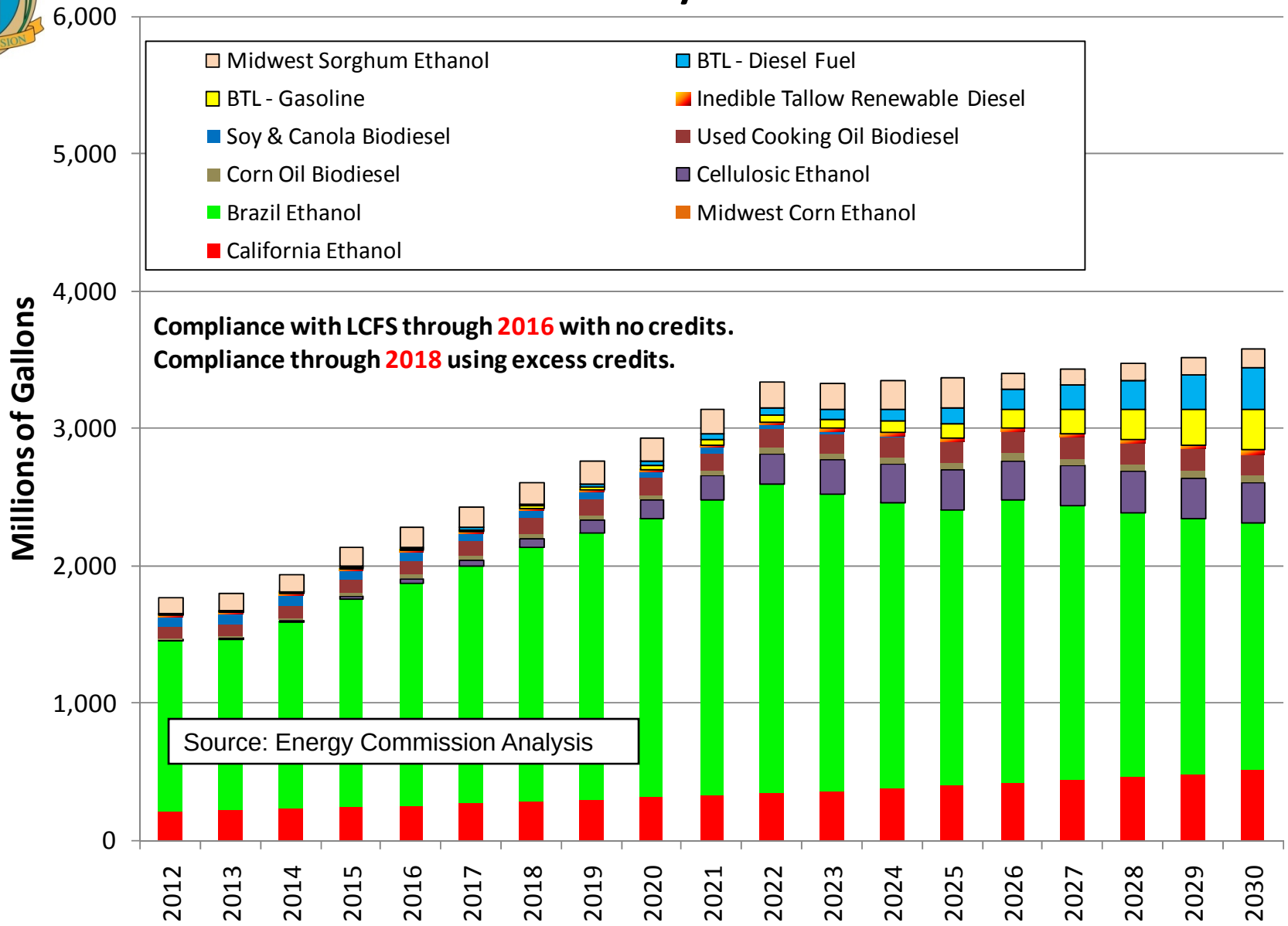
- Heavy dependence on Brazilian ethanol
  - Use of Brazilian ethanol by 2012 is 2.7 times greater than the record exports to the United States during 2006
  - Use of Brazilian ethanol by 2014 exceeds the record for Brazilian exports to the world during 2008 of 1.35 billion gallons
  - Infrastructure to receive imports of Brazilian ethanol would need to be completed in Houston to ensure sufficient capacity
  - Ethanol “shuffling” may be necessary to ensure access to imports
- Biodiesel use would need to rapidly increase to B5
  - Use of biodiesel by 2012 (170 million gallons) is nearly equivalent to 50 percent of the record consumption of biodiesel (358 million gallons) for the entire United States during 2007
  - California distribution terminals would need to be upgraded to enable the receipt, storage and blending of B100 to achieve statewide B5 levels

LCFS Analysis – Case 2 Assumptions

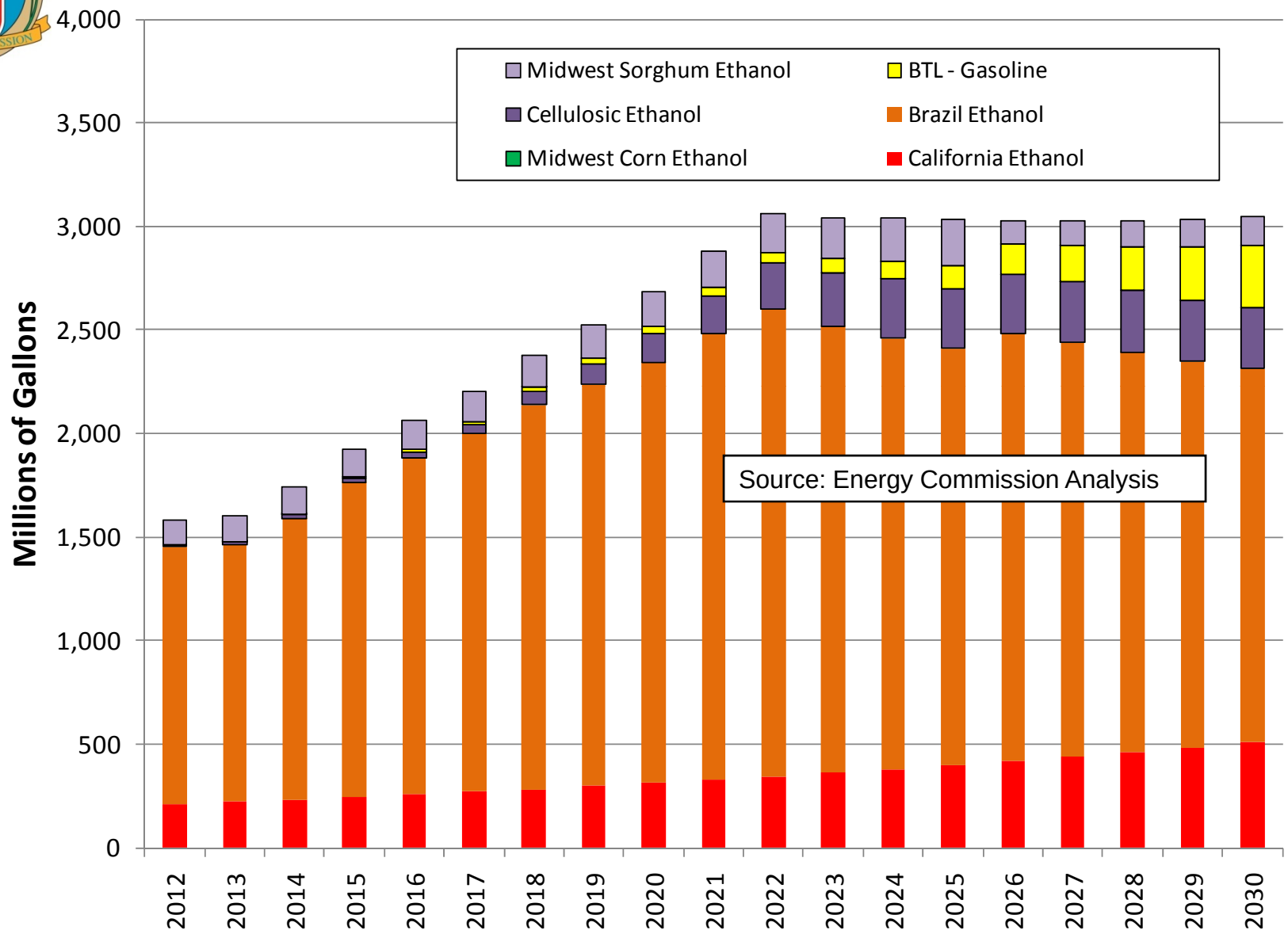
Additional Assumptions

- Cellulosic fuels used – California's proportional share of RFS2
  - Uses EIA's cellulosic fuels supply forecast, not higher RFS2 targets
- Brazilian ethanol with cogeneration assumed to convert to mechanized harvesting and the lower CI of 58.2 gCO2e/MJ
  - Up to 610 million gallons by 2012

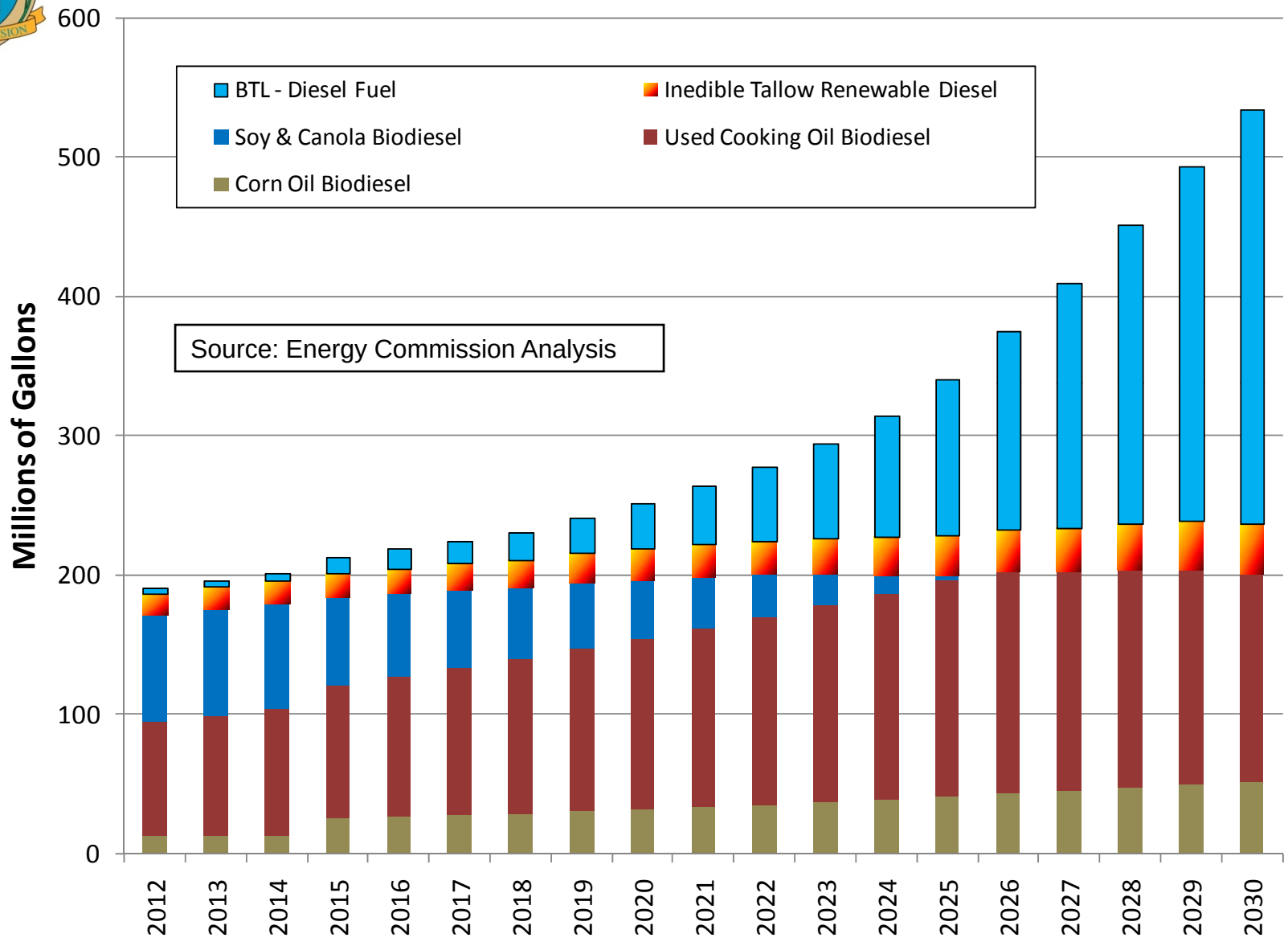
Case 2 Preliminary Results – All Fuels



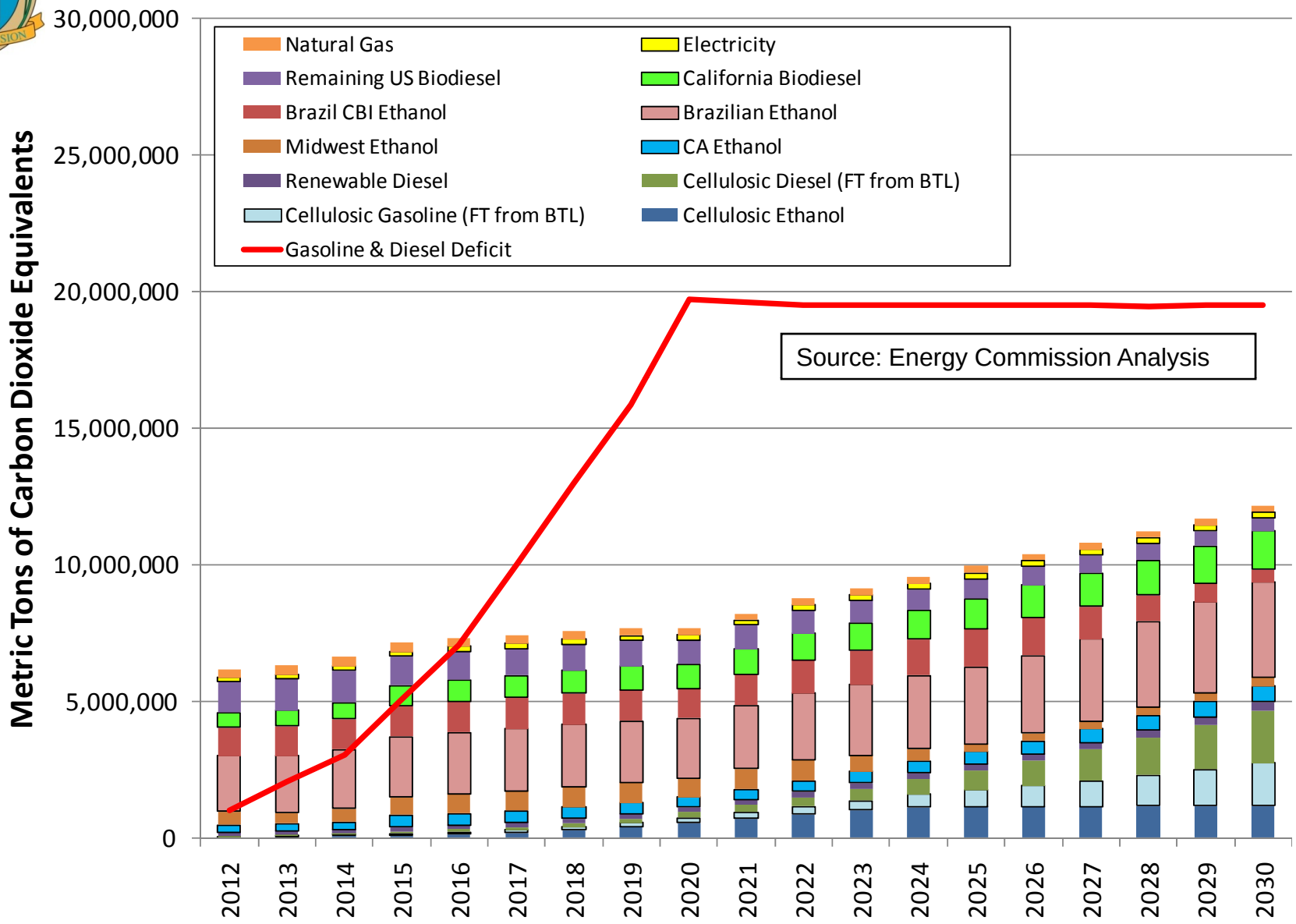
Case 2 – Gasoline Blend Fuels



Case 2 – Diesel Blend Fuels



Case 2 Results – Credits vs. Deficit



Case 2 Observations

- Compliance period extended an additional year (2016) through the use of cellulosic fuels and lower CI Brazilian ethanol
- Excess credits can extend compliance two additional years
- Compliance through the forecast period (2030) would require generation of additional credits from:
  - Increased production capacity for certain low CI biofuels
    - Renewable diesel fuel
    - Biodiesel from corn oil & used cooking oil
  - Use of additional quantities of biofuels with low CI values
    - Cellulosic ethanol
  - Use of additional quantities of drop-in biofuels
    - Biomass-to-liquids (BTL) gasoline and diesel
- Midwest corn ethanol in early years not selected due to higher CI value
  - Use is still feasible – excess credits would be less

Case 2 – Additional Concerns

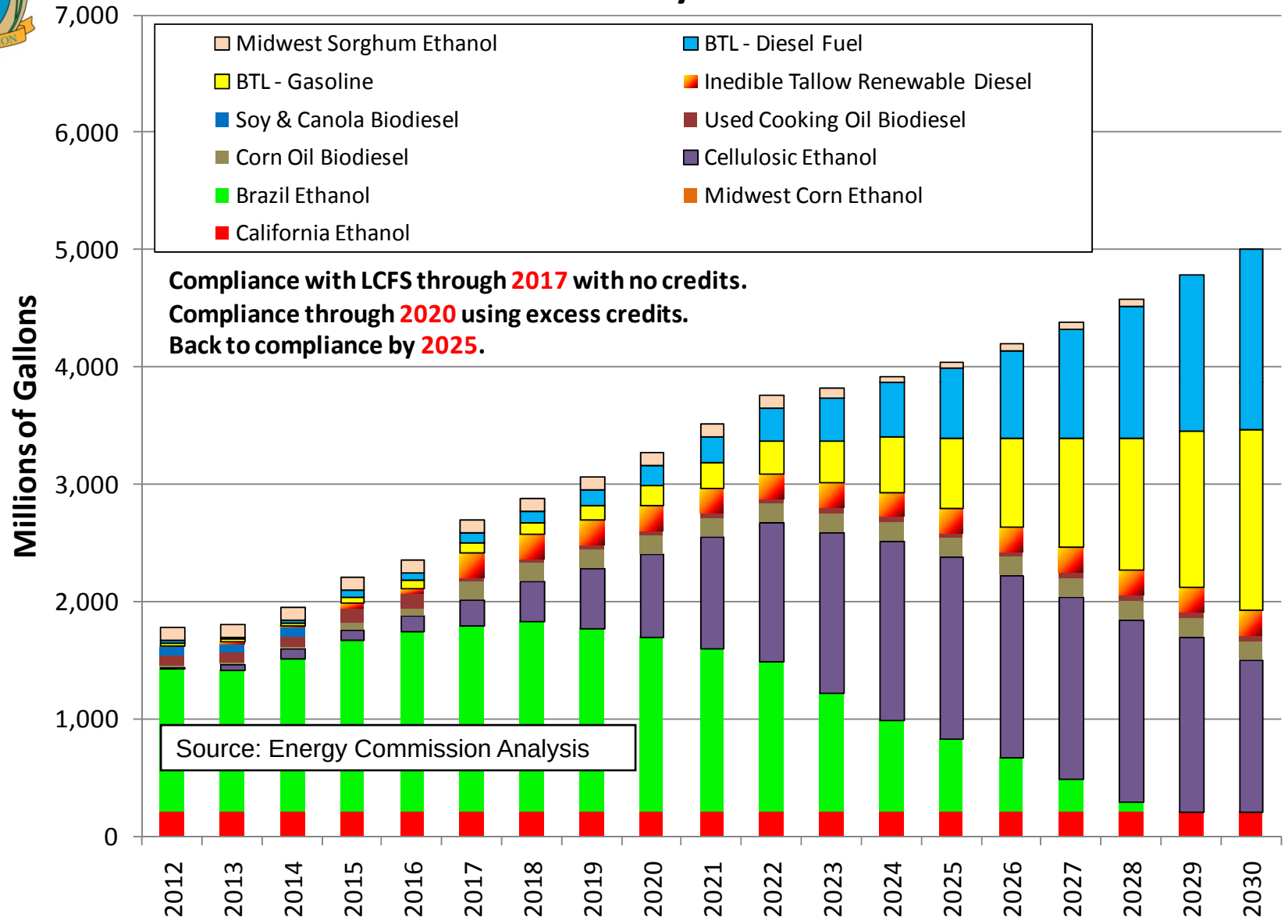
- Heavy dependence on Brazilian ethanol continues
  - Entire production capacity of ethanol facilities using cogeneration assumed to be capable of switching to mechanized harvesting by 2012
    - May not be possible for all of these facilities due to steepness of sugarcane fields
  - Infrastructure to receive imports of Brazilian ethanol would need to be completed in Houston to ensure sufficient capacity
  - Ethanol “shuffling” may be necessary to ensure access to imports
- Biodiesel use would need to rapidly increase to B5
  - Similar to Case 1
- Use of cellulosic fuels begins
  - Quantity used next year (11.8 million gallons) is nearly equal to the maximum available U.S. supply estimated by EPA for 2012 (12.6 million gallons)

LCFS Analysis – Case 3 Assumptions

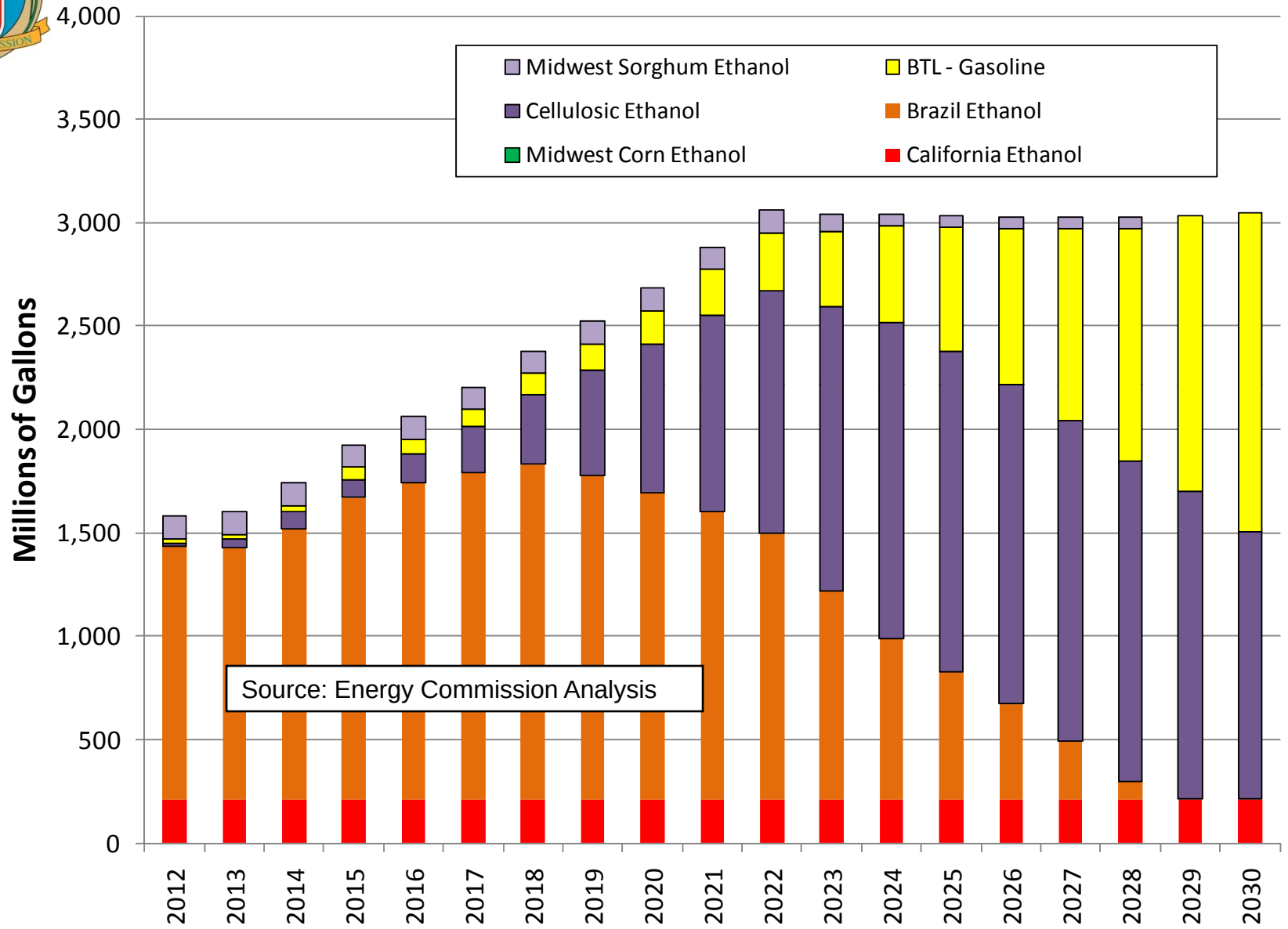
Additional Assumptions

- Cellulosic fuel availability increased to 50 percent of U.S. supply
- Brazilian ethanol supply availability increased to 1.5 billion gallons beginning in 2014 – lowest CI type
- Renewable diesel fuel supply availability
  - Raised to 50 percent of U.S. supply by 2017 – 219 million gallons
  - Carbon intensity of 19.65 gCO2e/MJ
- Biodiesel from corn oil
  - Raised to 50 percent of U.S. supply by 2017 – 160 million gallons
  - Carbon intensity of 5.90 gCO2e/MJ
- Biodiesel from used cooking oil
  - Raised to 200 percent of registered facilities by 2017 – 155 million gallons
  - Carbon intensity of 11.76 gCO2e/MJ

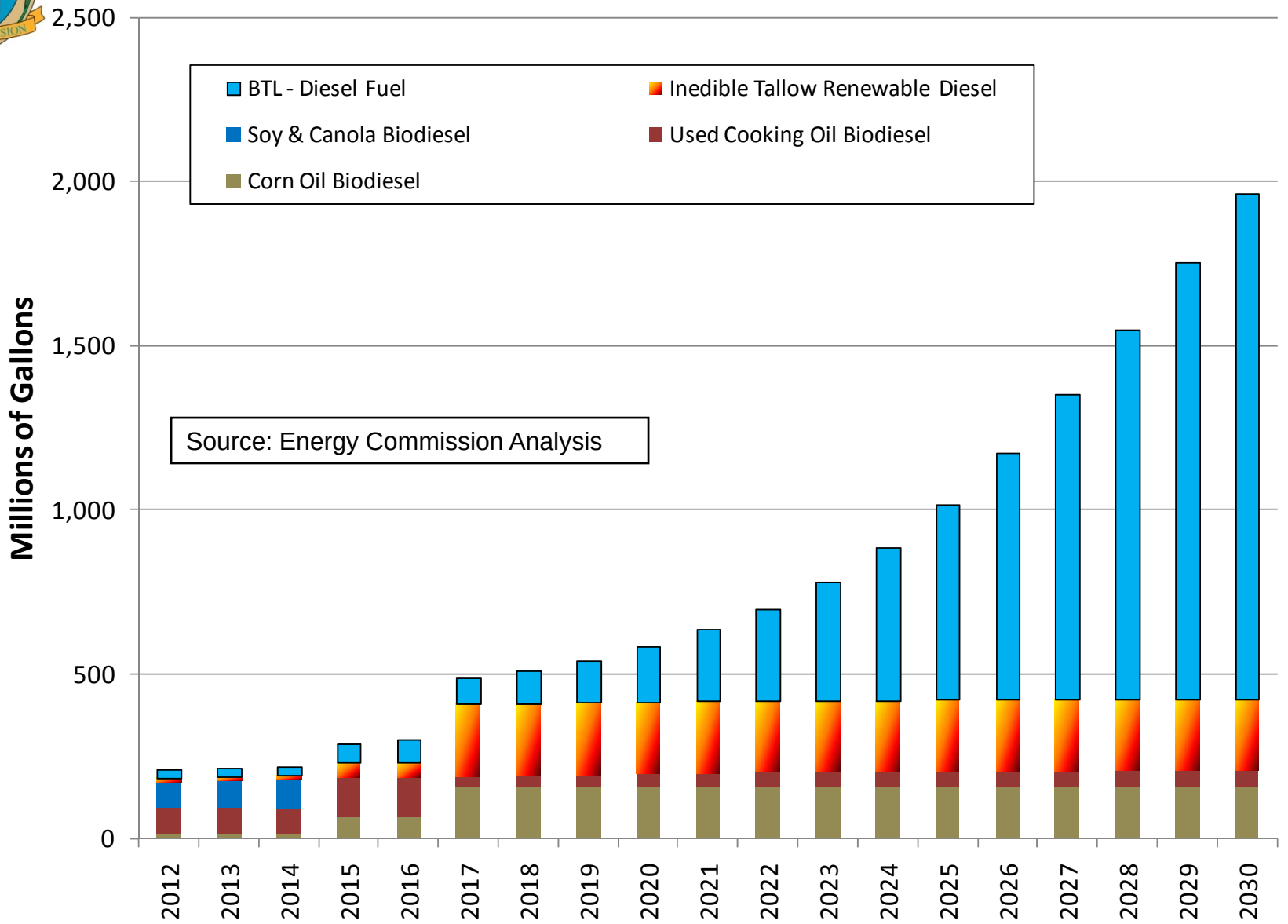
Case 3 Preliminary Results – All Fuels



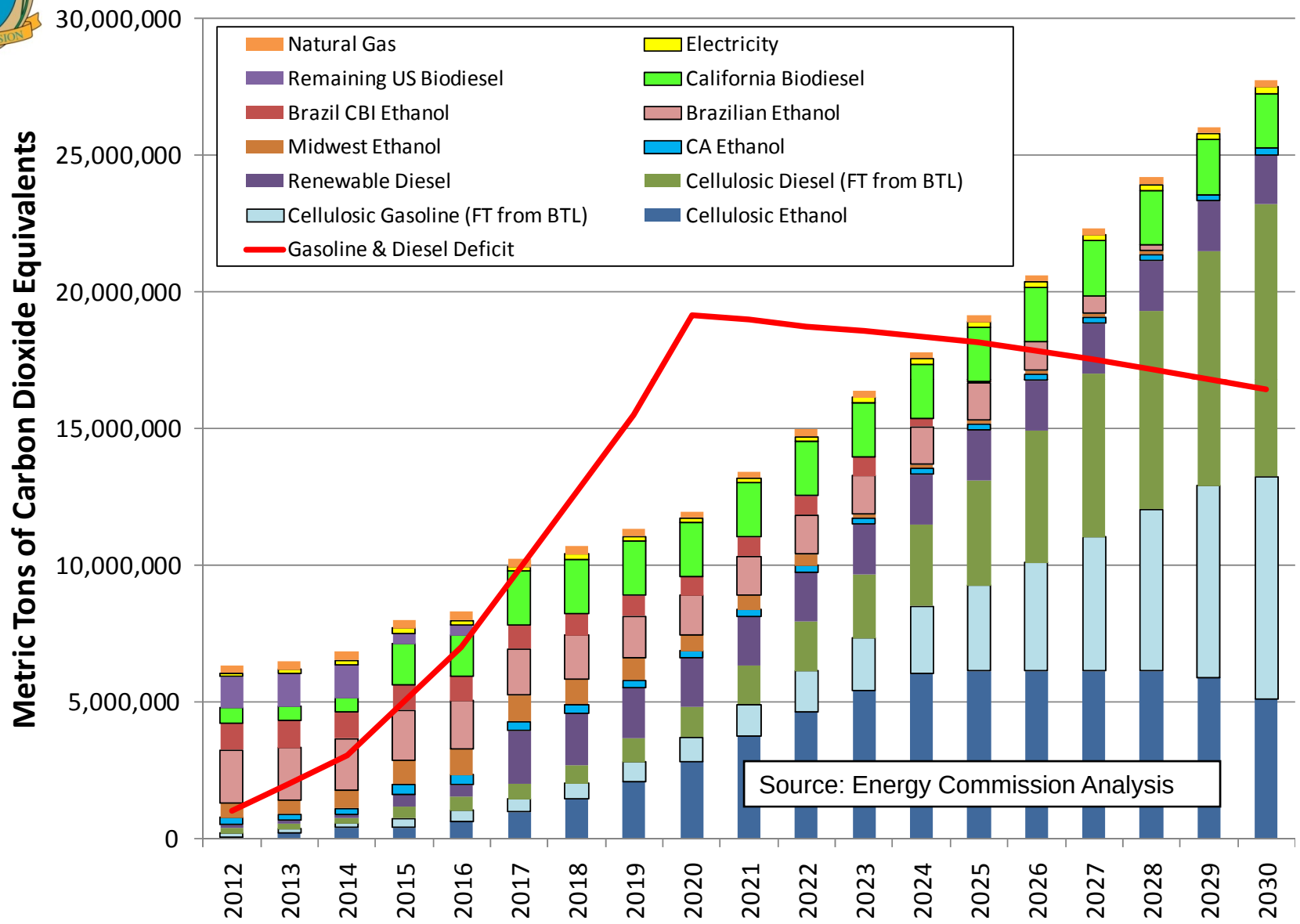
Case 3 – Gasoline Blend Fuels



Case 3 – Diesel Blend Fuels



Case 3 Results – Credits vs. Deficit



Case 3 Observations

- Compliance period extended an additional year (2017) through increased use of cellulosic fuels
- Excess credits can extend compliance three additional years (2020)
  - Due to increased supply of renewable diesel and corn oil biodiesel
- Compliance through the forecast period (2030) would require generation of additional credits from:
  - Use of additional quantities of biofuels with low CI values
    - Cellulosic ethanol
  - Use of additional quantities of drop-in biofuels
    - Biomass-to-liquids (BTL) gasoline and diesel

Case 3 – Additional Concerns

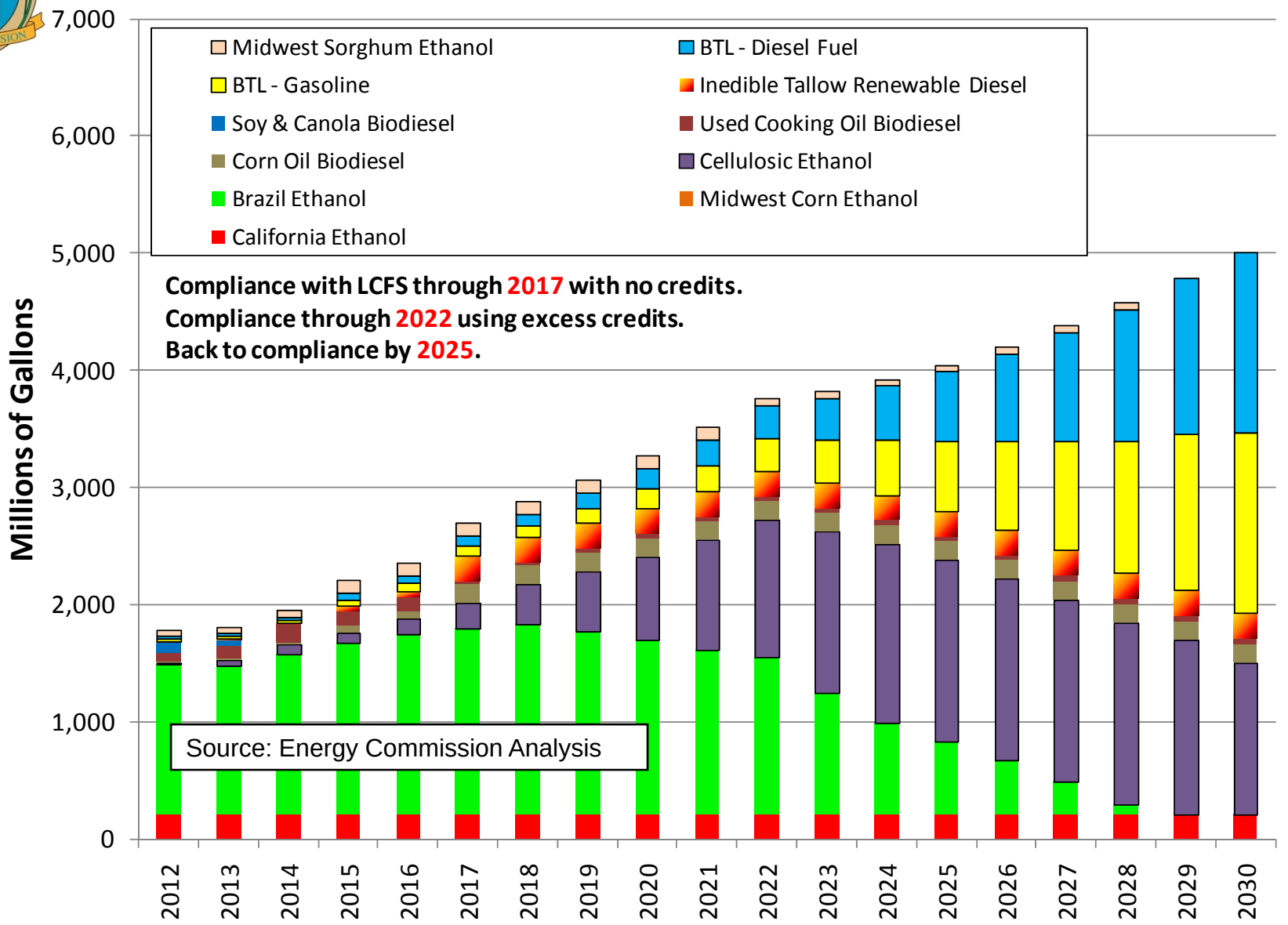
- Heavy dependence on Brazilian ethanol lessens somewhat
  - Similar to previous cases
- Biodiesel use would need to rapidly increase to B5
  - Similar to previous cases
  - Feasibility of corn oil biodiesel supply increase in 2017 uncertain
- Use of renewable diesel significantly increased
  - Feasibility of supply increase to 219 million gallons in 2017 uncertain
- Use of cellulosic fuels significantly increased
  - Quantity used next year (56 million gallons) is nearly 4.5 times greater than the maximum available U.S. supply estimated by EPA for 2012 (12.6 million gallons)
  - Feasibility of using half of the U.S. cellulosic fuel supply questionable, even if the volumes forecast by EIA actually become available

LCFS Analysis – Case 4 Assumptions

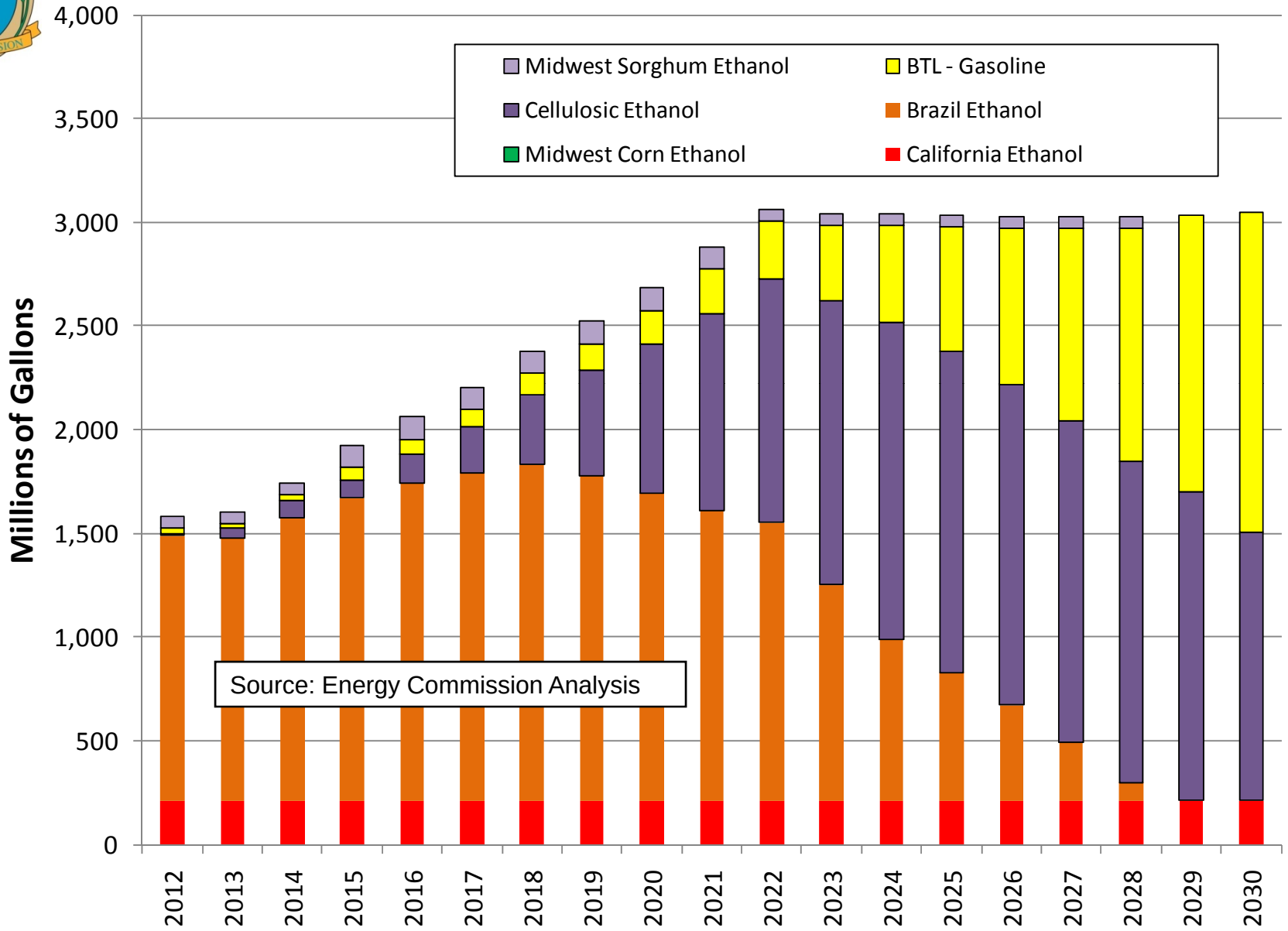
Additional Assumptions

- Brazilian ethanol supply availability increased to 1.0 billion gallons beginning in 2012 – lowest CI type
- Biodiesel from used cooking oil
  - Raised to 155 million gallons by 2014
  - Raised to 310 million gallons by 2015
  - Raised to 750 million gallons by 2017
  - Carbon intensity of 11.76 gCO2e/MJ

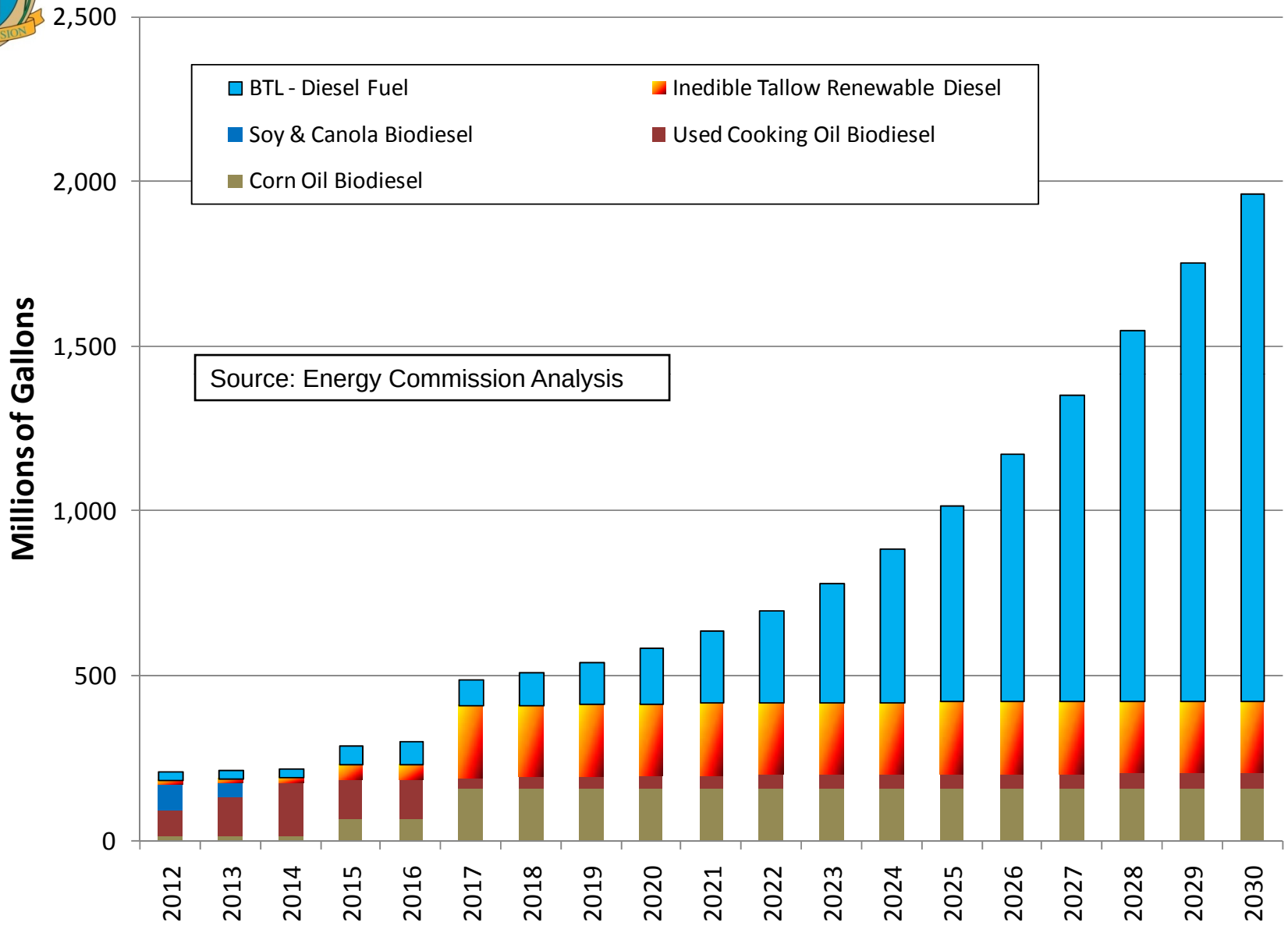
Case 4 Preliminary Results – All Fuels



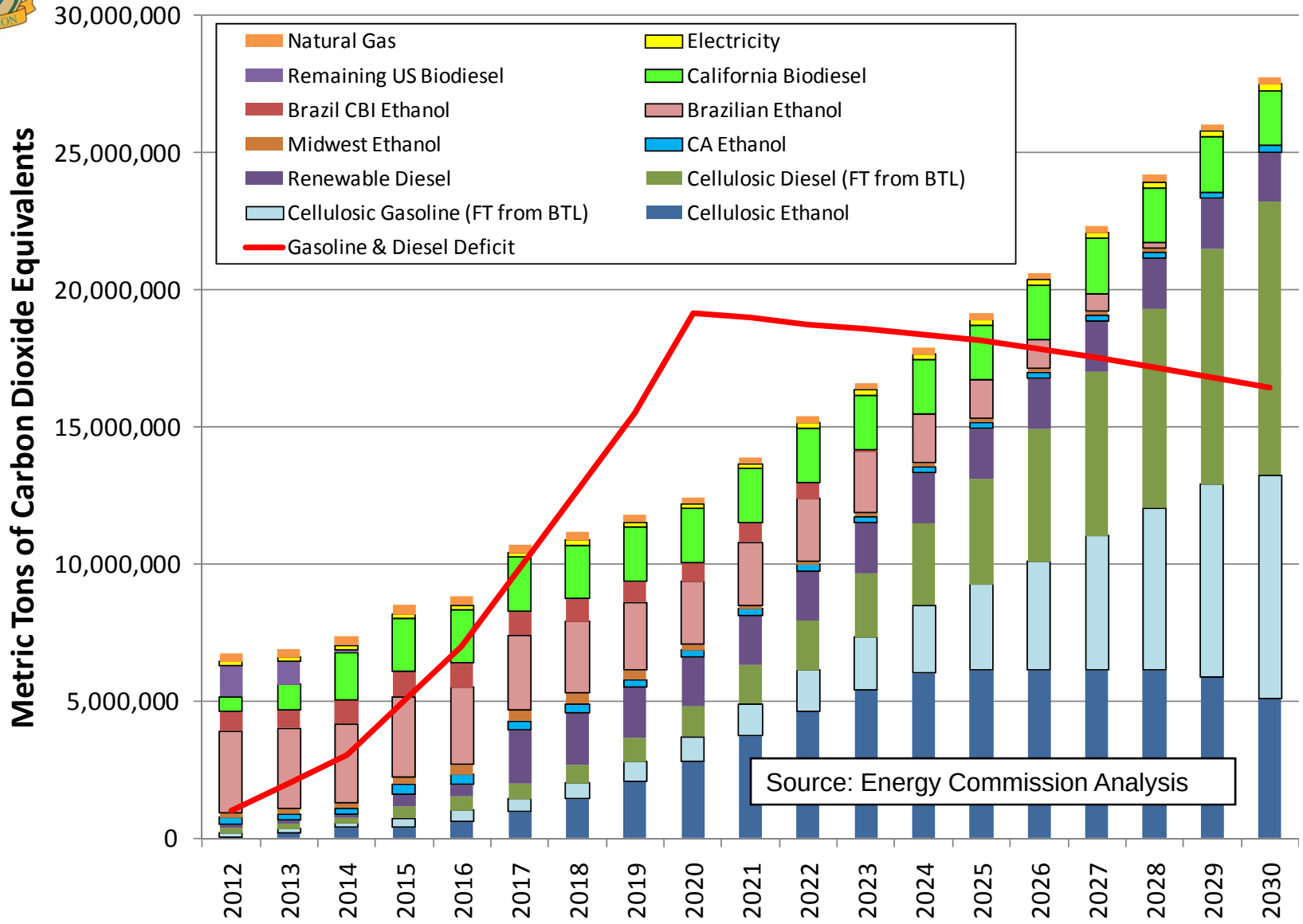
Case 4 – Gasoline Blend Fuels



Case 4 – Diesel Blend Fuels



Case 4 Results – Credits vs. Deficit



Case 4 Observations

- Compliance period not extended past (2017) through increased availability of UCO biodiesel and lowest CI Brazilian ethanol
- Excess credits can extend compliance five additional years (2022)
  - Due to increased supply of lowest CI Brazilian ethanol
- Compliance through the forecast period (2030) would require generation of additional credits from:
  - Use of additional quantities of drop-in biofuels
    - Biomass-to-liquids (BTL) gasoline and diesel
- Increased availability of used cooking oil biodiesel has little to no impact on case results
  - Use of this fuel could be more beneficial if biodiesel concentration were raised above the current assumed limit of B5

Case 4 – Additional Concerns

- Heavy dependence on Brazilian ethanol lessens somewhat
  - Similar to previous cases
- Biodiesel use would need to rapidly increase to B5
  - Similar to previous cases
- Use of renewable diesel significantly increased
  - Similar to previous case
- Use of cellulosic fuels significantly increased
  - Similar to previous cases

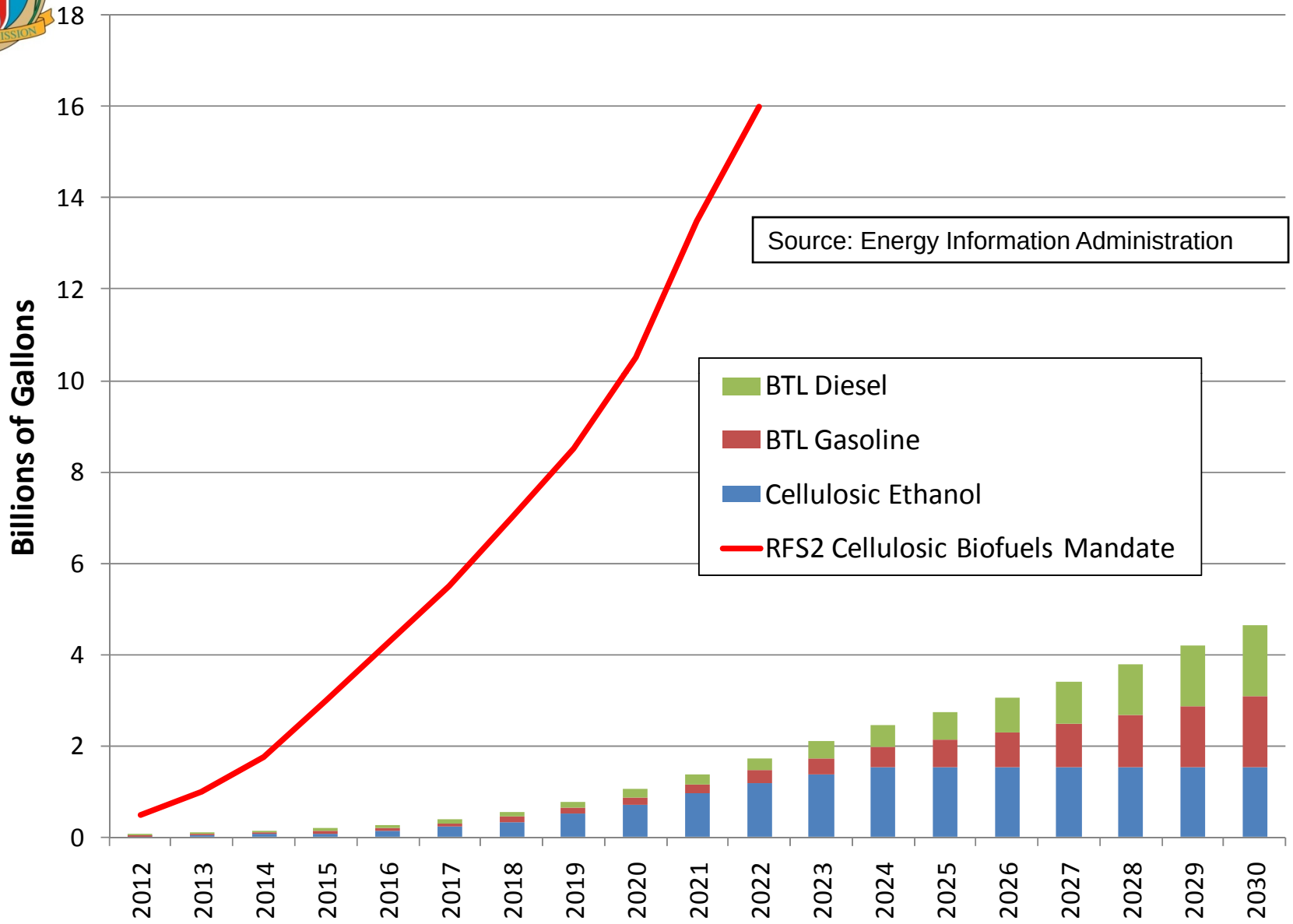
Cellulosic Fuels – Lack of Progress

- Production capacity for cellulosic biofuels has not made sufficient progress over the last several years to fulfill minimum mandate volumes established under the Renewable Fuels Standard 2 (RFS2)
- U.S. EPA has adjusted downward the cellulosic biofuels requirement for 2010 through 2012

Year	Total Renewable Fuel Requirement Bil. Gallons	Starch Derived Biofuel Bil. Gallons	Advanced Biofuels			
			Cellulosic Biofuels Bil. Gallons	Other Advanced Biofuels Bil. Gallons	Biomass Based Diesel Bil. Gallons	Total Advanced Biofuels Bil. Gallons
2008	9.00	9.00				0.00
2009	11.10	10.50		0.10	0.50	0.60
2010	12.95	12.00	~~0.10~~ **0.0065**	~~0.20~~ **0.294**	~~0.65~~ **1.15**	0.95
2011	13.95	12.60	~~0.25~~ **0.0066**	~~0.30~~ **0.543**	0.80	1.35
2012	15.20	13.20	~~0.50~~ **0.0035 - 0.0126**	~~0.50~~ **0.987 - 0.997**	1.00	2.00
2013	16.55	13.80	1.00	0.75	~~1.00~~ **1.28**	2.75

- Staff elected to use EIA's forecasted supply outlook

Cellulosic Biofuels – EIA Forecast



Supply Availability for Biofuels

- Staff has estimated upper limits for potential supply for specific types of biofuels that have low carbon intensities
  - Biodiesel from corn oil – 319 million gallons
  - Biodiesel from used cooking oil – 750 million gallons
  - Renewable diesel from inedible tallow – 439 million gallons
- Are the limits discussed in the draft report reasonable, too high, or too low?
- Are there other issues that could constrain these upper limits?
- Could these upper limits be higher? If so, under what conditions or projections?

More Expensive Biofuels

- Case results show large volumes of lower CI biofuels being used to comply with the LCFS – but these fuels are currently expensive
- Staff proposing to estimate costs for biofuels based on:
  - Near-term pricing information
    - Brazilian ethanol as one example
  - Federal RFS2 RIN values during 2011
    - Biodiesel
    - Cellulosic ethanol
  - A premium for each gram of carbon intensity differential
    - Based on 2011 average value of nearly 0.2 cents per gram as calculated from the prices posted by the Oil Price Information Service (OPIS)
    - Will consider using a range that uses a higher average per gram value based on the fact that this market is very early in the process and is based on two types of Midwest corn ethanol

More Expensive Biofuels

- Brazilian sugarcane ethanol
  - $1.04 per gallon greater compared to ethanol delivered to California from the Midwest during 2010
  - $1.75 per gallon greater compared to ethanol delivered to California from the Midwest during the first six months of 2011
  - Ethanol from CBI countries could be less expensive compared to Brazilian anhydrous ethanol by approximately the value of the tariff
- Staff proposes to use an incremental cost of $1.50 per gallon for compared to corn-based ethanol – average type
  - Lower CI types of Brazilian ethanol would be increased by approximately 0.2 cents per gram differential in carbon intensity

More Expensive Biofuels

- Biodiesel
  - Up to $3.00 per gallon greater compared to petroleum-based diesel fuel
  - Incremental cost based on Renewable Identification Number (RIN) values and the $1.00 per gallon blenders credit
- Is the RIN price a reasonable reference to use or is there a better alternative?
- If incremental prices for biodiesel made from soy oil are this high, should an additional premium be placed on other types of biodiesel that have significantly lower CI values
  - Biodiesel from corn oil?
  - Biodiesel from used cooking oil?
- If so, which analytical approach might be optimal to differentiate types of biodiesel that will be in greater demand under the LCFS?

More Expensive Biofuels

- Cellulosic ethanol
  - RIN values for cellulosic ethanol have averaged 104 cents per gallon between January and August 2011
  - Is this value a reasonable benchmark to use for calculating an incremental cost for cellulosic ethanol?
- Biomass-to-liquid gasoline and diesel fuel
  - Should staff use an incremental cost for these biofuels that is similar to cellulosic ethanol?
- Renewable diesel fuel from inedible tallow
  - Similar value as biodiesel?
  - Increased premium to account for lower CI?

Continuing Efforts

- Energy Commission staff will continue to analyze LCFS compliance cases:
  - Including an additional constraint of higher costs for certain biofuels
  - Actual range of costs will be determined, in part, by information provided as part of these proceedings
- Comparison will be LCFS compliance cost versus RFS2 proportional share cost
  - Proportional share of RFS2 obligations are anticipated to incur higher costs for gasoline and diesel fuel
  - These incremental costs should not be attributed to the LCFS program
  - Estimates of potential LCFS compliance costs will include the incremental biofuels used in excess of the proportional RFS2 volumes
- This additional LCFS analysis will be published in the Final Staff Report

RFS2 Proportional Share

- Staff proposes to continue using the EIA cellulosic biofuels supply forecast as the national target for this type of biofuel, rather than the higher volumes set forth in the RFS2 regulations
- Since these numbers will be significantly lower, should another category of biofuels be increased to compensate to retain the original totals for each year?
  - Consequence – "other advanced" biofuel target volumes could rise by over 10 billion gallons. Is that a reasonable or plausible assumption?
- Or should the target volumes in the other biofuel categories remain unchanged?
  - Consequence – total biofuel volumes would be much lower than the RFS2 original target by as much as 10 billion gallons. Is that a more reasonable or plausible assumption?
- If not, is there a better alternative?

LCFS Outside of California

- 22 other states are developing or considering adoption of LCFS programs similar to California
- The incremental demand for the same type of biofuels used to comply with California's LCFS program that would result if any other region of the United States carried out implementation of an LCFS-like program would, at a minimum, increase competition and raise the market-clearing prices of these biofuels
- States considering implementation of LCFS-like regulations equate to 3.7 times the quantity of gasoline consumed in California and 7.2 times the quantity of diesel fuel consumed in California during 2009