Supporting Waste Biomass Fuels: Opportunities and Limits of Existing Policy

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CA Climate Summit

Waste Based Biofuels

- Typically have favorable sustainability characteristics and carbon intensity
- Many so-called "wastes" actually have a valuable use.
  - Used cooking oil often added to animal feed
  - Straw used for animal feed or bedding
  - Agricultural residues plowed back into field provide soil conditioning, nutrients, and soil carbon maintenance
- If something would otherwise be burned, landfilled, or left to decompose it's pretty clearly a waste
  - E.g. Forest fuel reduction biomass and some agricultural residue
  - These are the low-hanging fruit for biofuels/bioenergy
- You can get useful, low-carbon fuels or energy from non-waste feedstocks but need case-by-case assessment of GHGs

Scale of Potential Woody Waste Biomass

- From Elizabeth's presentation: 7.7 million tonnes of forest biomass annually from fire management and another 1 million tonnes from orchard waste that would otherwise have been burned.
- Assume very rough conversion rate of 62 gasoline-equivalent gallons of fuel per dry tonne of input.
- This yields around 540 million gasoline-equivalent gallons of fuel.
- California 2023 consumption (LCFS data):
  - Petroleum gasoline: 12.1 billion gallons
  - Petroleum diesel: 1.4 billion gallons
  - Ethanol: 1.4 billion gallons ethanol
  - Biomass-based diesel: 2.2 billion gallons biomass-based diesel

LCFS, Biofuels, and CDR

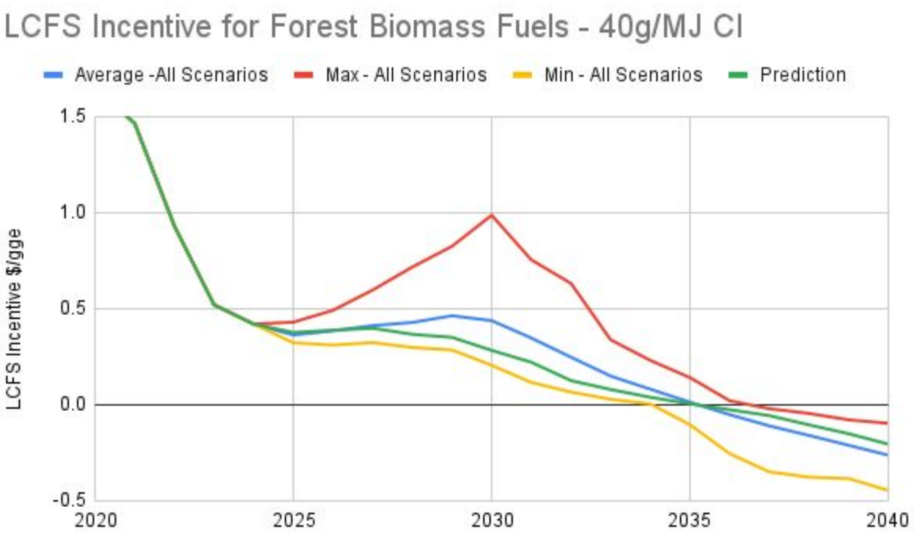
Good News:

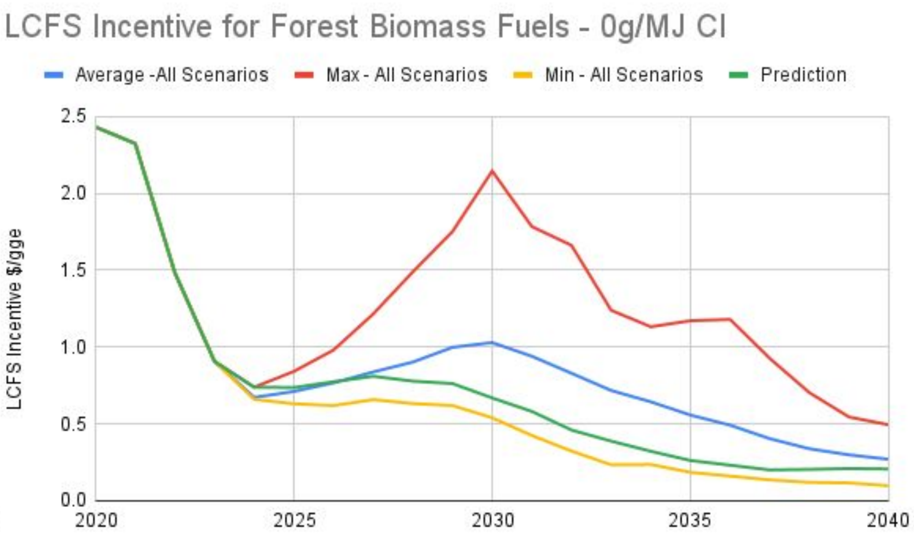
- LCFS focus on life-cycle assessment and history w/ biofuels suggests it can help waste-based biofuel/ bioenergy systems with CDR
- Revenue from LCFS is relatively secure
- LCFS was first regulatory program to offer CCS incentive
- Biomass+CDR systems likely to have more staying power in market than many current-gen biofuels due to lower potential carbon intensity

Bad News:

- Only applies to transportation fuels
- LCFS incentive is limited, esp. while credit prices remain low.
  - ITS-Davis modeling suggests they're likely to remain low.
- Effective credit quantification requires new modeling tools
- Current forest conditions present challenge for GHG focused policy
- Many benefits of better organic waste management are unrelated to GHGs

Impact of LCFS on Wood Waste Biofuels





- Per-gallon LCFS incentive estimates based on analysis of 30 plausible LCFS credit prices & target scenarios. Prediction scenario is based on my own judgment. Highly variable and uncertain!
- 40 g/MJ fuel is roughly representative of current cellulosic production technology.

Need for Modeling Tools

- Life-cycle GHG policies need effective models, otherwise incentive will not align with GHG benefit
- There's more potential waste/residue biomass beyond planned forest fuel management and orchard waste, but understanding its GHG impacts is complicated
  - Removing wood from forests impacts carbon dynamics in complex ways that must be accounted for to understand GHG impact.
    - C-BREC Calculator, developed by Dr. Kevin Fingerman of CSU Humboldt can help
  - Reducing catastrophic wildfire risk has GHG impacts, but models to estimate this are still immature
  - We need to know the alternative fate of agricultural residue to effectively quantify GHG impacts of use
  - Soil carbon models need robust region/soil/climate data for calibration

The Problem of Forest Management

- Manual fuel reduction treatments are very energy-intensive due to the remote and inaccessible terrain they often occur in
  - May lead to poor GHG or net-energy outcomes
- Wildfire risk is often due to excessive accumulation of highly flammable carbon
- Forests may be healthier and more resilient after fuel reduction treatment, but the total amount of carbon per acre is lower, and life cycle assessment for GHG policy can't just ignore this
- Need a framework that defines the "right" amount of carbon for a given forest, using objective criteria, to allow this to happen without penalizing fuel producer

Summary

- Turning biomass that would otherwise be burned, landfilled, or left to decompose into bioenergy or biofuels usually has good life cycle GHG impacts
- The LCFS can offer some support for this but:
  - Only for transportation fuels
  - Probably not enough to make these pencil out on its own
  - Need additional tools for life cycle GHG assessment
  - Many benefits are unrelated to GHGs
- Forest biomass from fuel reduction treatments has some unique challenges

Questions and discussion welcome!

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Additional Resources

- Lowcarbonfuel.ucdavis.edu (UCD LCFS Research Group site)
- LCFS Web Data Explorer
- Driving California's Transportation Emissions to Zero by 2045
- Fuel Policy Scenario Modeling (FPSM) of Low Carbon Fuel Standard Targets for 2030 and Beyond
- Updated Fuel Portfolio Scenario Modeling to Inform 2024 Low Carbon Fuel Standard Rulemaking
- Multijurisdictional Status Review of Low Carbon Fuel Standards, 2010–2020 Q2: California, Oregon, and British Columbia
- Improving Credit Quantification Under the LCFS: The Case for a Fractional Displacement Approach
- Modeling expected air quality impacts of Oregon's proposed expanded clean fuels program - ScienceDirect
- Current Methods for Life Cycle Analyses of Low-Carbon Transportation Fuels in the United States (National Academies report)
- Making Policy in the Absence of Certainty: Risk-Aware Consideration of Indirect Land Use Change (ILUC) Estimates for Biofuels

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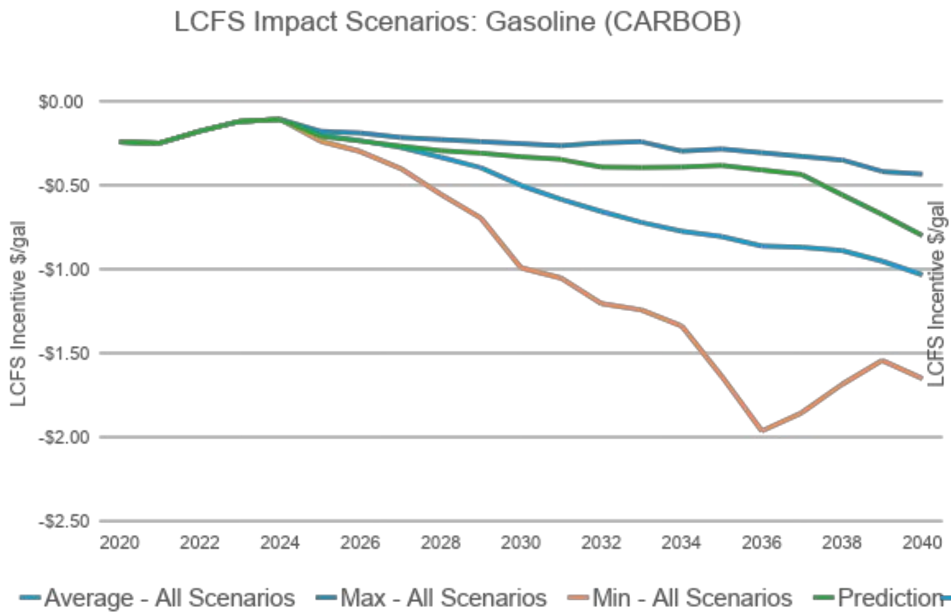
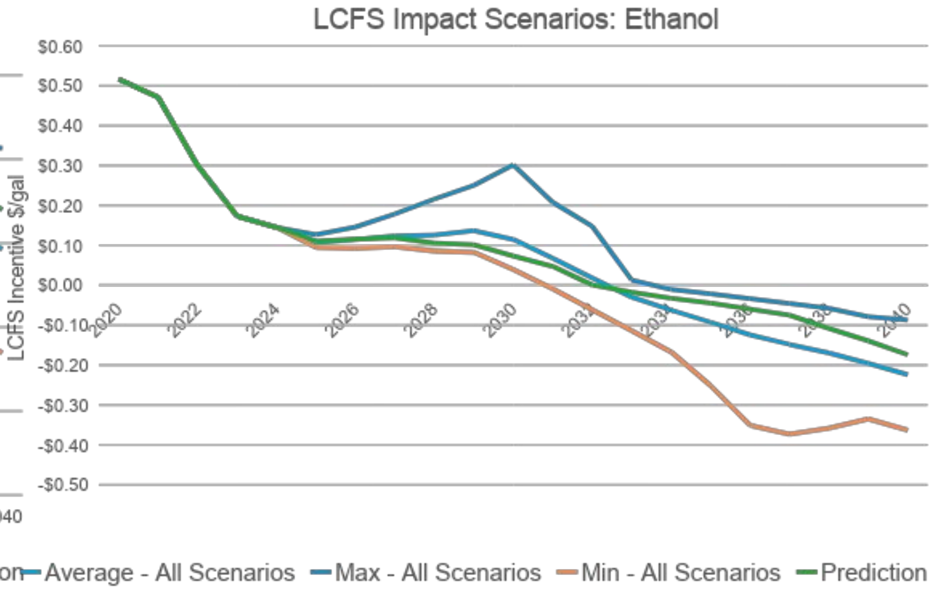
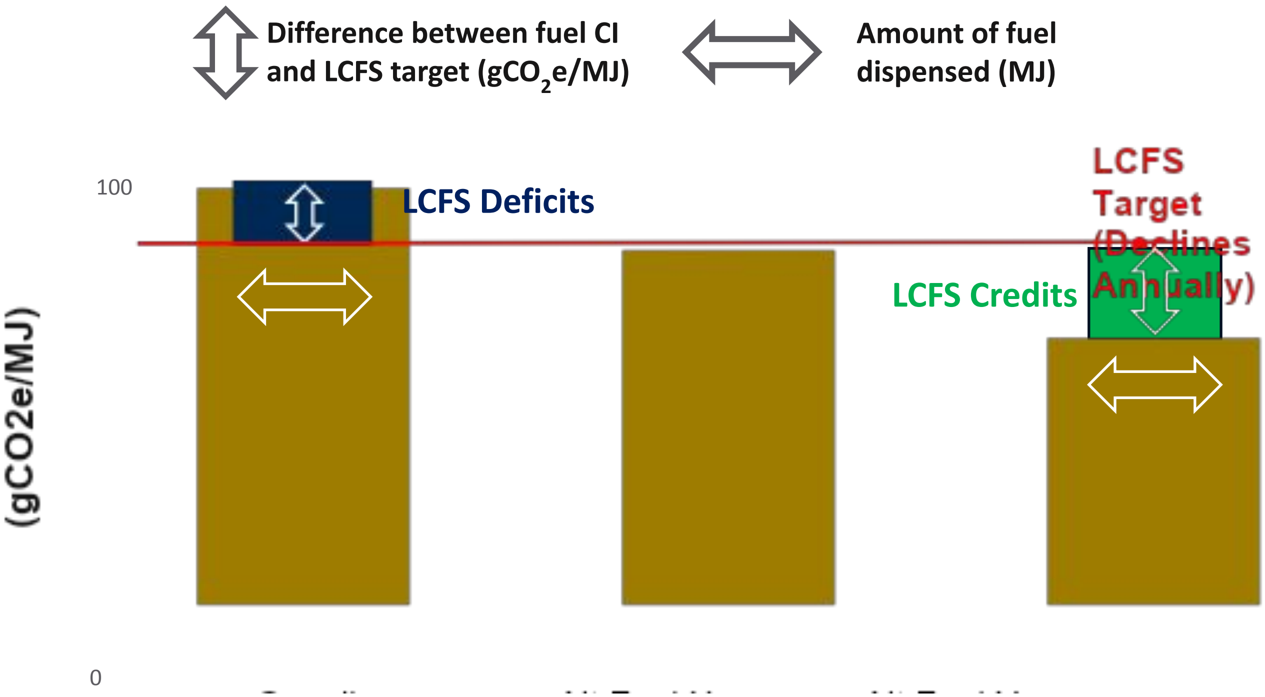
Impact of LCFS on Gasoline & Ethanol Costs





LCFS, Fuel Carbon Intensity, and Credits



Credits (tonnes) = ⇕ x ⇔ x 10^{-6}

Credit revenue = Credits *x* Credit Price ($/tonne)

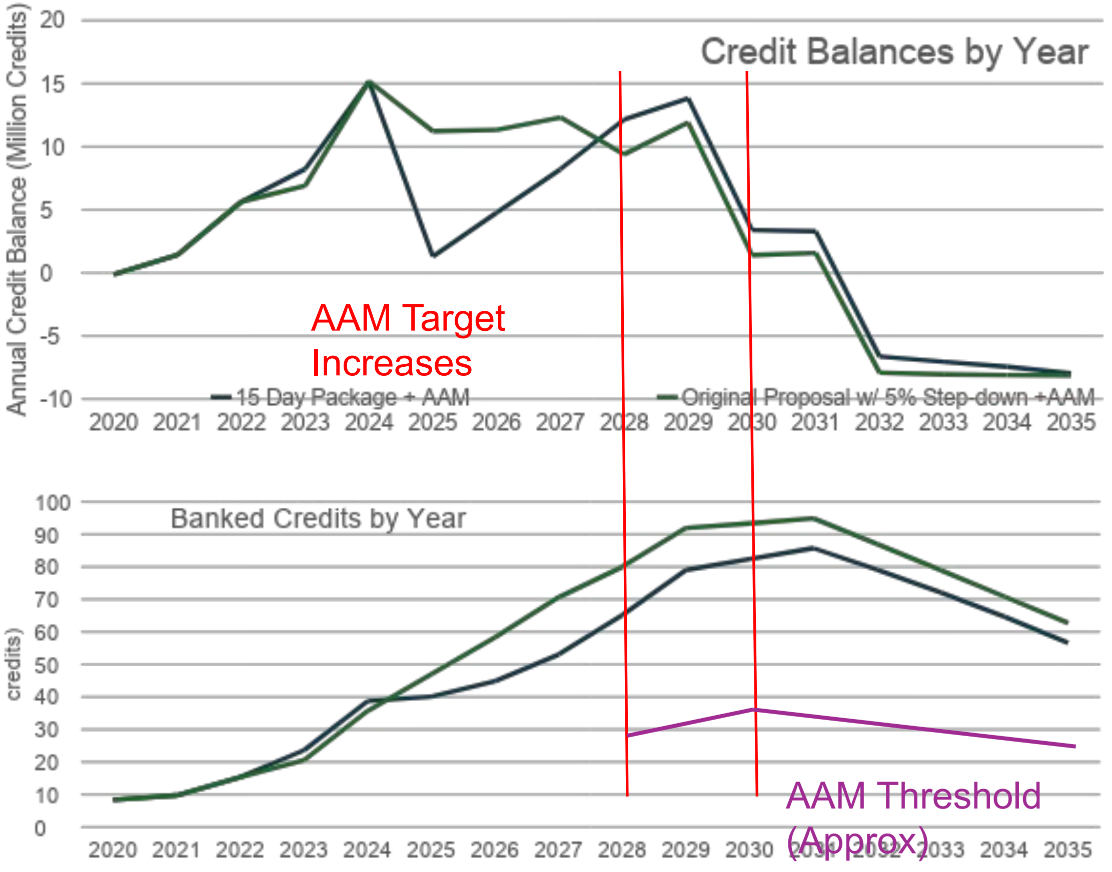
LCFS Cost Impact Scenario Modeling

- Following slides present estimated cost impacts from LCFS.
- LCFS cost impacts are a function of the target level, the carbon intensity of the fuel, and LCFS credit price.
  - Auto-Acceleration mechanism means future targets are not certain
  - Credit market means price projections are not certain
  - Carbon intensity (CI) of fuels changes over time, usually showing gradual improvement, but fluctuations up and down have regularly been observed.
- We created a slate of 3 target scenarios (zero, one and two AAM triggering events) and 10 credit price scenarios to show the range of possible outcomes
  - Credit price scenarios reflect various trajectories based on historical behavior picked by ITS-Davis researchers.
  - Averages assume all outcomes are equally likely
  - “Prediction” is credit price trajectory based on Dr. Murphy’s prognosticative judgment
- Positive values indicate incentive, negative indicate a charge

LCFS Long-Term Outlook

<u>If current market trends hold:</u>

- We expect 1-2 years of approximate balance between supply and demand.
  - Possible credit price recovery during this period.
- Continued RD growth & rapidly growing EV credits projected to return market to oversupply by 2027, likely to trigger AAM.
- TL;DR: If current market trends hold, credit price is likely to remain low.



Federal Fuel Policy

- Federal fuel policy includes Renewable Fuel Standard and section 45(Z) tax credits.
- Section 45(Z) would replace previous bio/renewable diesel blender's tax credit with GHG-indexed incentive, higher for aviation fuels than on-road.
- 45(Z) on hold. Trump has pledged to repeal most or all of Inflation Reduction Act, which was its authorizing legislation.
    - Many business stakeholders have made large investments in anticipation of 45(Z)
- EPA Secretary Lee Zeldin has opposed RFS support for biofuels in the past.
- 1st Trump administration did not clearly indicate a strategy related to alt fuels.
- Federal policy can massively impact fuel costs in CA, as well as LCFS credit price.
- Ultimately: Hard to tell how new administration will impact alternative fuels but impacts on LCFS are somewhat more likely to provide upward pressure on LCFS credit prices than downward.

Conclusion

- LCFS creates incentive for lower-carbon fuels, based on charges applied to higher-carbon ones.
  - Declining target means fuels have to reduce CI to maintain incentive
  - Crop-based biofuels likely to become deficit generators in mid-2030's
  - Actual cost impacts to fuel producers likely lower than estimates presented here
  - Fuel prices are set by fuel sellers, and do not always reflect actual costs of regulation
- Charges on high-carbon fuels, like petroleum, will rise over time.
  - Petro-diesel cost impacts projected to rise from ~$0.25/gal (2025) to $0.50-0.60/gal (2030).
  - But 80% of diesel today is biofuel, which does not accrue charges.
- Biodiesel/renewable diesel incentives ($0.36 in 2025) projected to rise only a few cents/gal unless low CI-feedstock becomes more available
- HD EV incentive projected to rise from 9 cents/kWh (2025) to 13 cents/kWh (2030).
  - HD Hydrogen incentive -currently $0.97/dge – may rise a bit, depending on CI
- If current market trends hold, credit price is unlikely to rise by much.
  - Changes in Federal fuel policy could radically reshape current market.