Role of ***Low Carbon Fuel Standards*** in Reducing (US) Transportation Emissions

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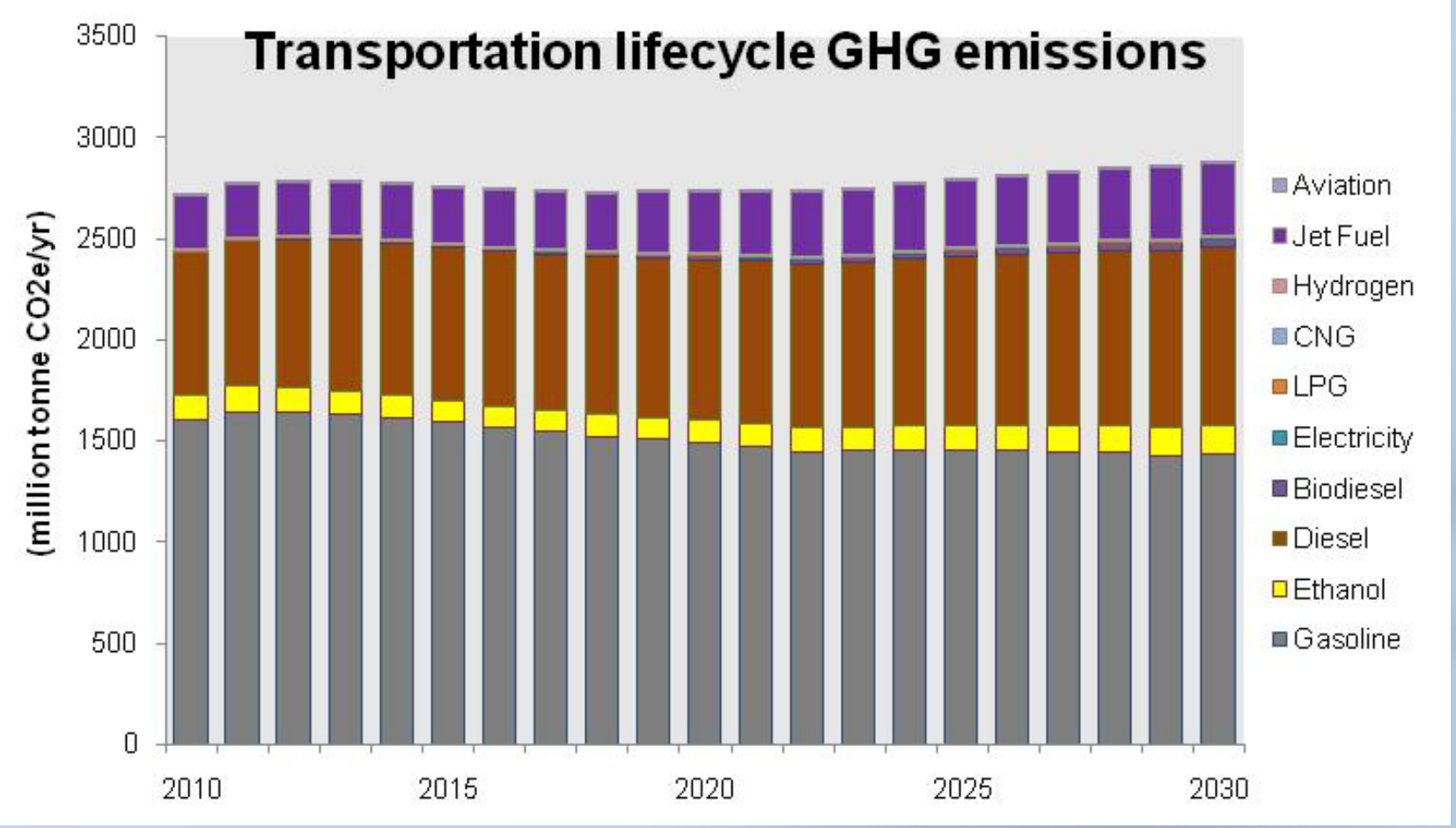
Current Policies Only Slightly Reduce Future Transportation Emissions - US



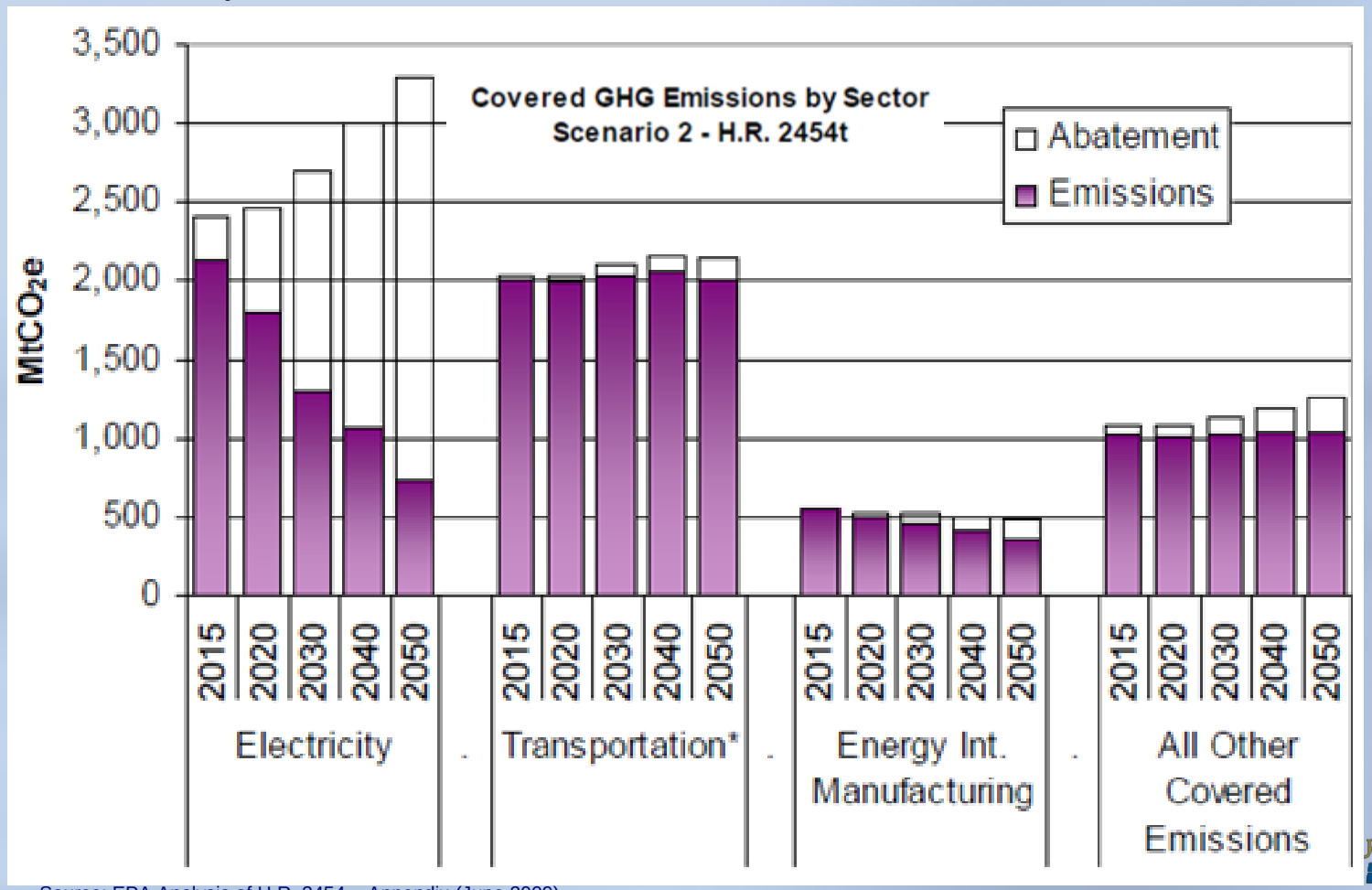
Source: AEO 2009

Many Possible Policy Approaches and Many Possible Low Carbon Fuels

- Volumetric mandates
  - e.g. US Renewable Fuel Standard
- Fuel subsidies
  - eg, corn ethanol and biodiesel
- Carbon taxes or cap and trade
- "Feebates" for fuels

Cap & Trade (and Carbon Taxes) Have Little Effect on Transport Emissions

- Analyses of proposed cap-and-trade programs suggest that only a tiny fraction of emission reduction (<5%) will come from the transport sector



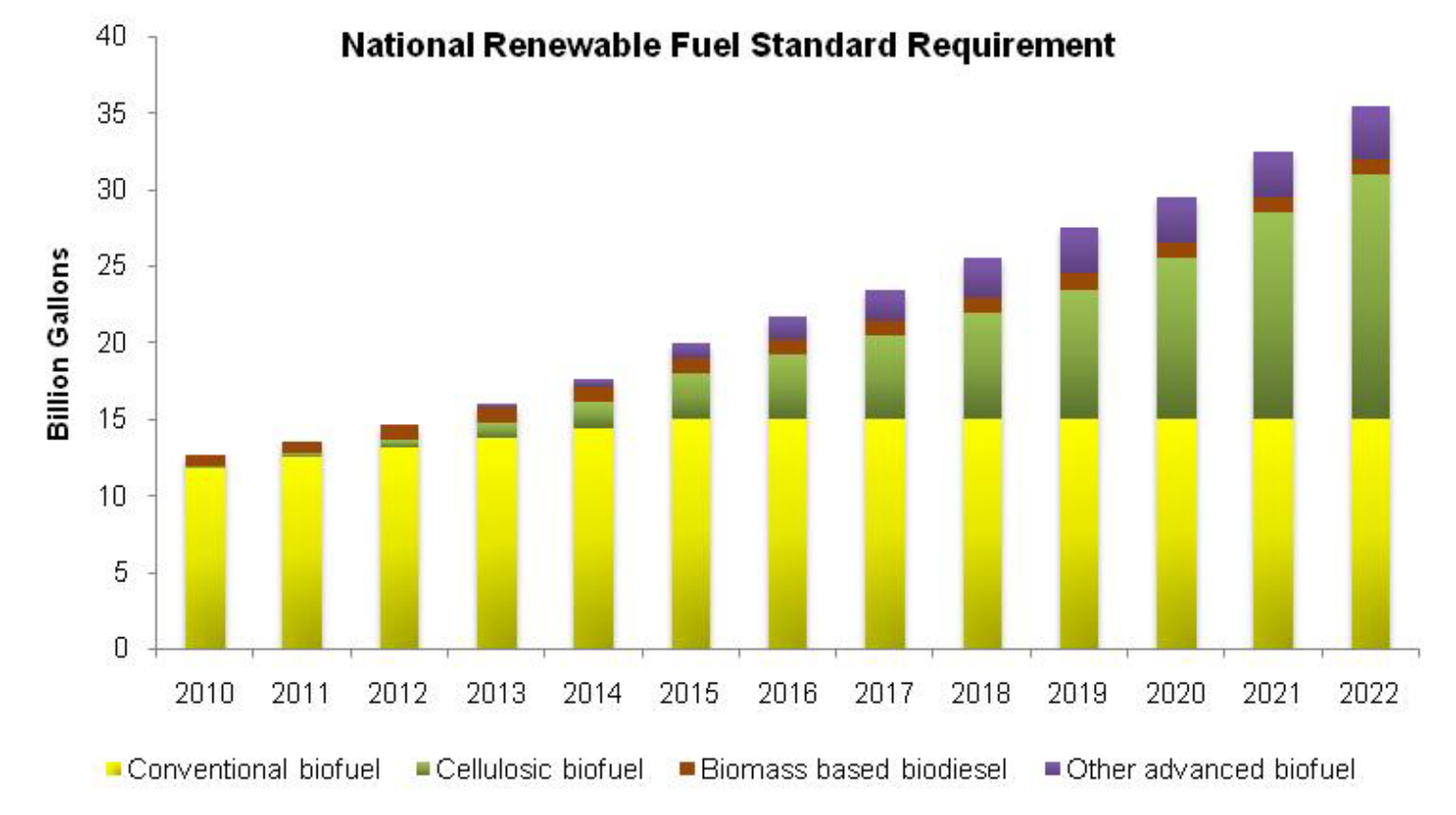
Source: EPA Analysis of H.R. 2454 – Appendix (June 2009)

Cap & Trade (and Carbon Taxes) Have Little Effect on Transport Emissions – Cont'd

- EPA estimates that cap-and-trade (Waxman-Markey) will raise gasoline price by $0.13 in 2015, $0.25 in 2030, and $0.69 in 2050
  - Not enough for inducing significant change in consumer behaviors (VMT and vehicle/fuel purchases) or low-GHG vehicle/fuel production
  - *Caveat*: transport component of EPA and other models could be improved
- Cap & trade and taxes are not effective at introducing new fuels
  - Producers just pass on the extra fuel cost to consumers
  - Too indirect to overcome a host of market barriers such as resistance by fuel suppliers and consumers
- More effective and direct policy is needed to overcome market barriers in order to gain large reductions in oil use and GHG emissions

National Renewable Fuel Standard Requirement

- Conventional ethanol - 20% fewer GHG emissions
- “Advanced” renewable fuels - 50% fewer GHG emissions
- Biodiesel -50% fewer GHG emissions
- Cellulosic biofuels: - 60% fewer GHG emissions



What is LCFS

- **Performance based**: GHG intensity reduction target for transport fuels

$$AFCI(\text{gCO2-eq/MJ}) = \frac{\sum_i^n E_i \times CI_i}{\sum_i^n E_i \times EER_i}$$

← Total GHG emission

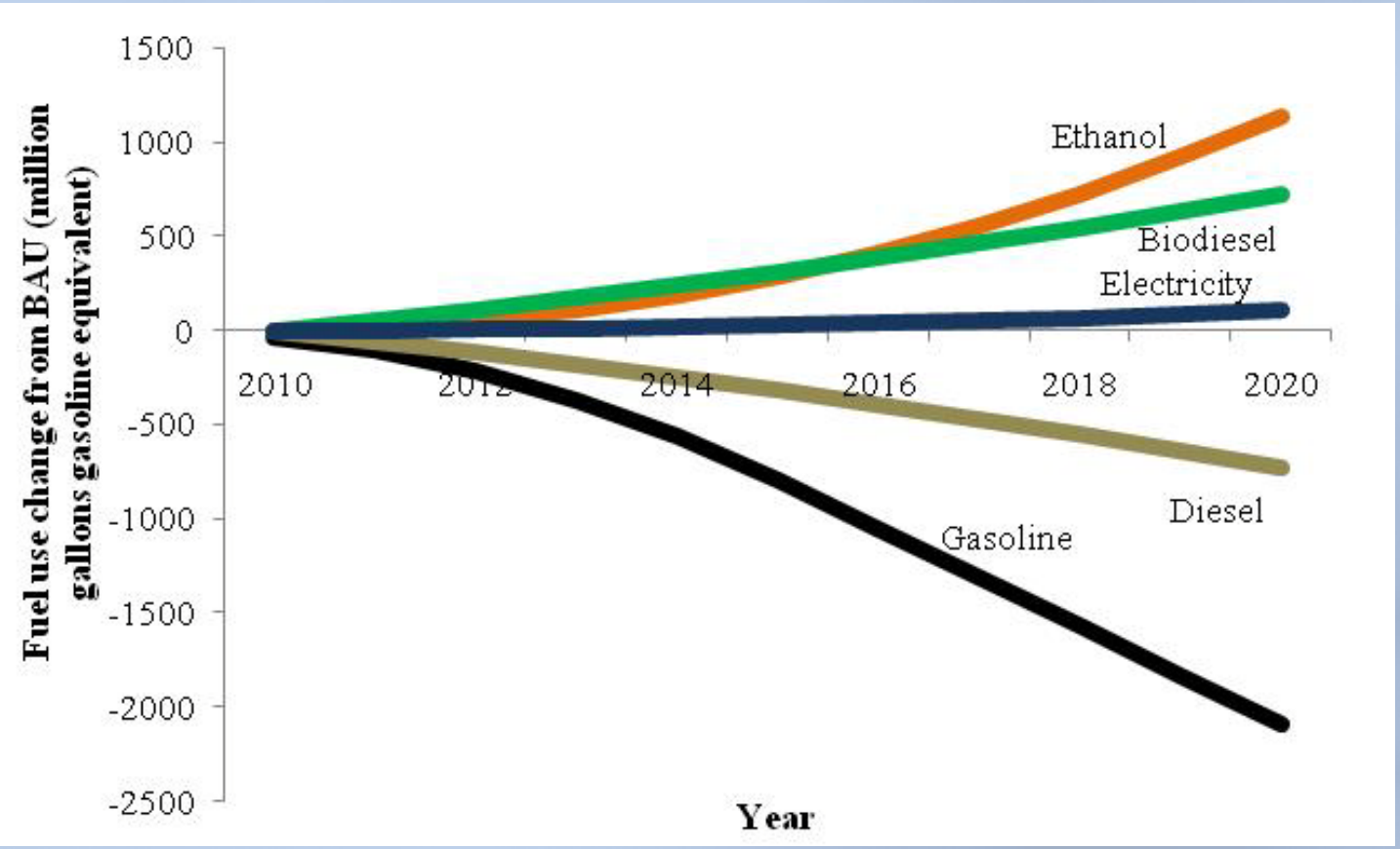
← Total transportation fuels produced/displaced

- **Lifecycle measurement** for "carbon intensity"
- Adjustment for superior efficiency of electric and fuel cell propulsion technology
- Coverage of entire fuel pool, not fuel/technology specific: Government does not pick winner/losers
- **Harnesses market forces**: Allows trading of credits among fuel suppliers, which stimulates investment and continuing innovation in low-carbon fuels

California LCFS Program and Key Features

- Adopted April 2009; takes effect Jan 2010
- Applies to on-road transport fuels (but can generate credits from low-carbon fuels used in off-road vehicles)
  - Excludes air and maritime (where California has limited authority)
- **Regulated parties are transport energy suppliers** (oil providers, plus others who want to earn credits, such as biofuel, electricity, NG and H_2 providers)
- Separate AFCI targets for gasoline and diesel (10% reduction for each)
  - Allows trading between these two targets
- Default measurements and opt-in procedure for each activity in energy chain
  - Encourages further innovation and investment in low-carbon practices

One California LCFS Scenario of Alt Fuel Use Compared to the Baseline



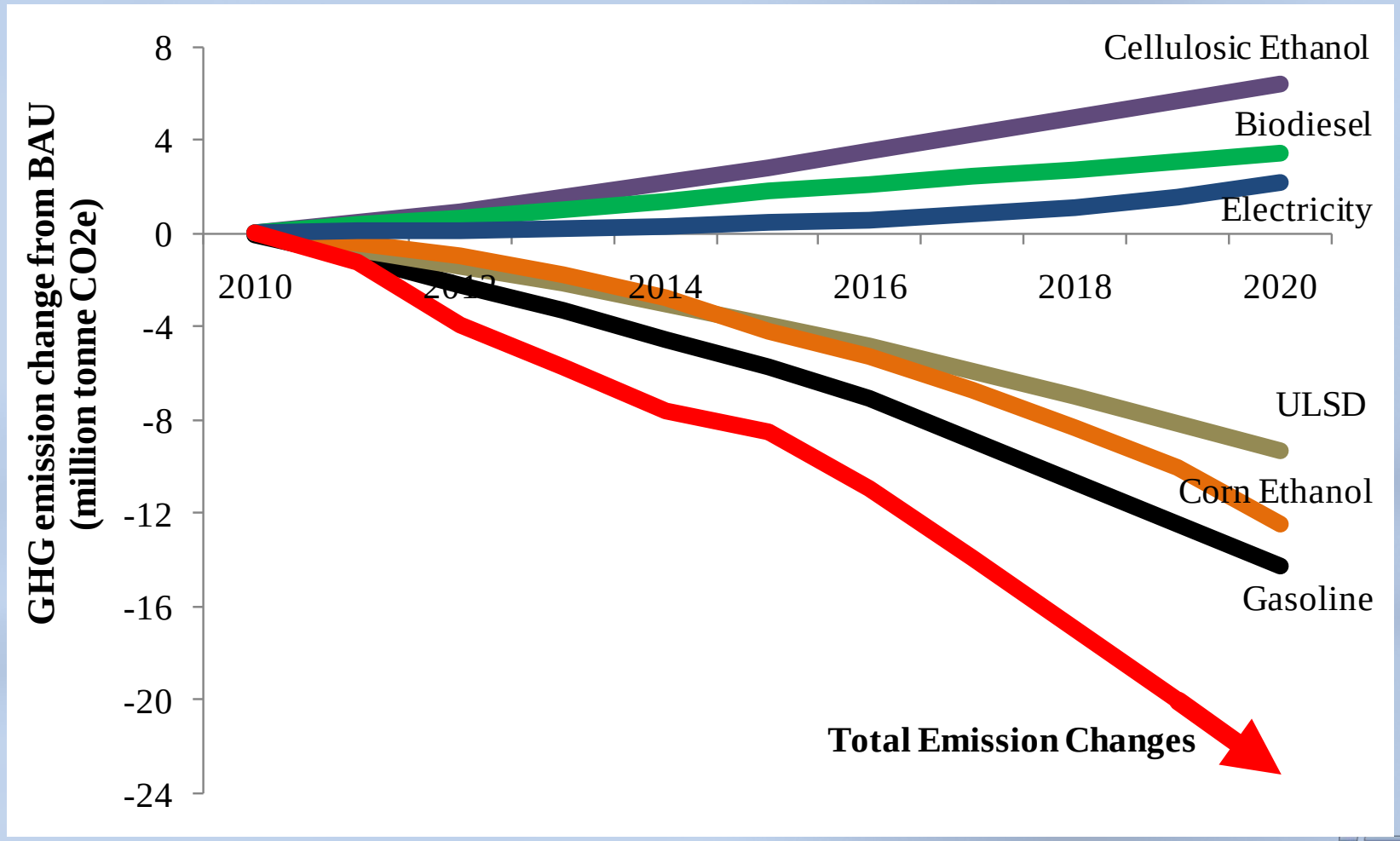
Biofuels (2020)

- 37% new car sale by 2020
- 3.7 B gallons etoh (E10=1.8 B gallons)
- 0.65 B gallons biodiesel
- ~14% of national RFS requirement

Electricity (2020)

- 0.7 million PHEVs and 60,000 BEVs
- 22,80 GWh/yr
- < 1% of 2008 CA electricity demand

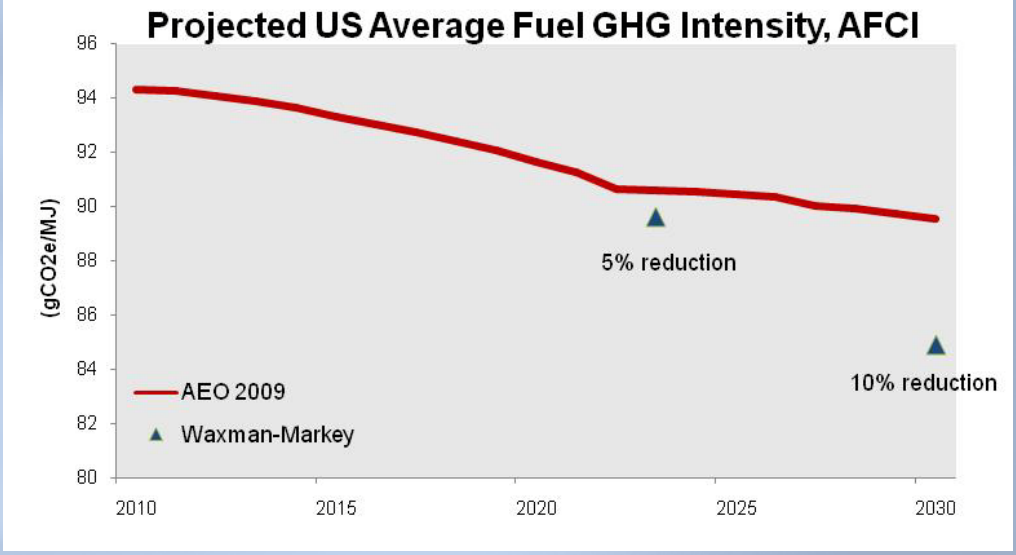
GHG Reduction with California LCFS Scenario



The figure includes emissions from the preliminary assessment of indirect land use change

LCFS is Going International

- EU moving toward an LCFS; its "Fuel Quality Directive" is very similar to California LCFS (amended Dec 2008)
- 11 northeastern and mid-Atlantic states signed a MOU in January 2009 committing to cooperate in developing a regional LCFS
- Early version of Waxman-Markey climate bill contained an LCFS



Key Challenges of an Expanded LCFS

1) Leakage and shuffling

2) Energy security

3) Indirect land use change

4) Environmental and social sustainability

The later two issues are not LCFS specific, but rather issues associated with biofuels.

Challenge 1. Leakage and Shuffling

- Concern: Regulated parties export high-carbon fuels to non-LCFS countries
  - Canada exports gasoline from oil sands to China
  - Iowa sends high-carbon ethanol to Canada
- Thus, no net benefit

Questions for discussion:

- How likely are these concerns to occur? What are the magnitude of the impacts?
- How likely are these concerns to occur *if*
  - Carbon-constraint policies implemented in EU and Canada?
  - Low oil prices (due to lowered demands)
- Is concern for leakage and shuffling a legitimate reason for rejecting an otherwise-effective GHG policy?
- What policies could reduce leakage?

Challenge 2. Energy Security

- LCFS responds to climate goals (by reducing GHGs), but there are debate about the effects on energy security
  - Encourages use of alt fuels and thus increases energy security
  - But also discourages production of fuels from oil sands, heavy oil, oil shale, and coal
- How to adjust LCFS to be responsive to energy security?
  - Reduce target
  - Other?

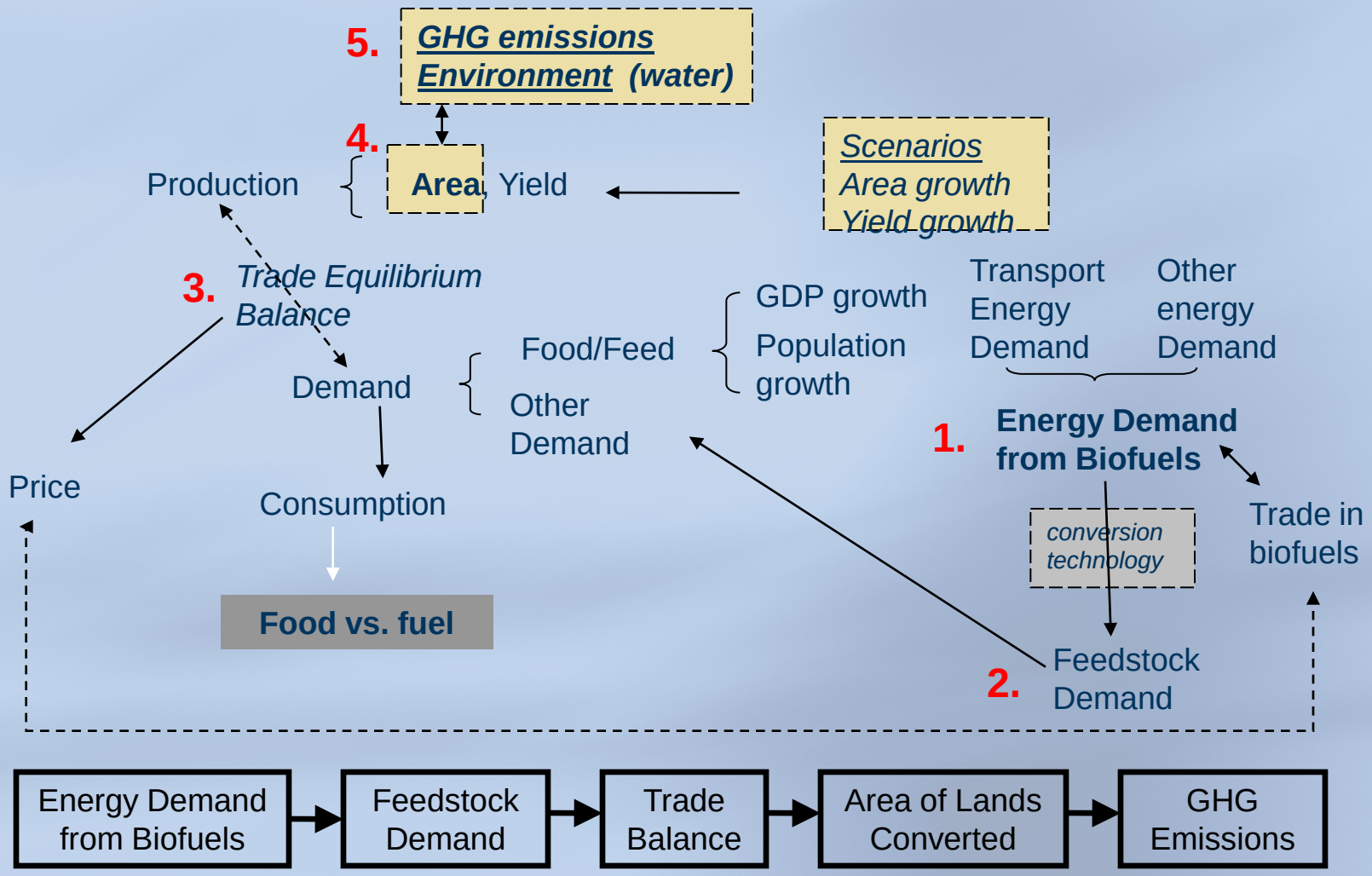
Note 1: LCFS does not ban oil sands (which is ~15% higher GHGs than gasoline from oil).

Note 2: LCFS encourages more efficient production of oil sands, and use of lower carbon process energy (nuclear energy? CCS?)

Challenge 3. Indirect Land Use Change

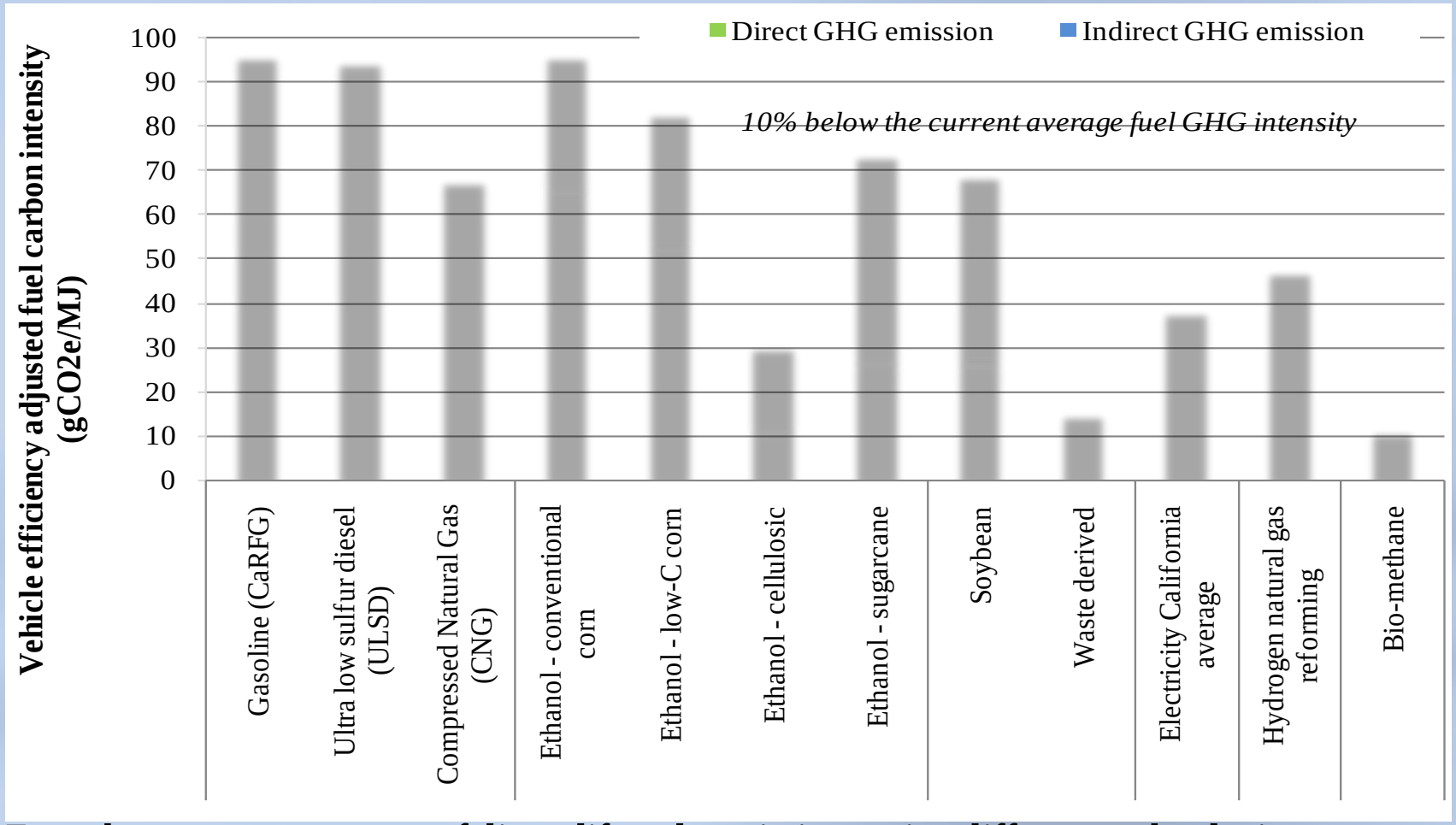
- When lands with rich soil and biomass carbon deposits are initially converted to agricultural production, a large amount of carbon is emitted.
  - This initial “carbon debt” can take years or even decades of cultivation to pay back
- Massive consumption of biofuels in the U.S. could lead to
  - Increasing inputs to increase yields: more fertilizer use
  - Expansion of cultivated land area
    - Conversion of lands to plant biofuel feedstock: **Direct LUC**
    - Conversion of lands (within and outside of the US) to replace diverted ag production due to price effect: **Indirect LUC**
      - The iLUC effects cannot be directly observed or easily measured

Flows of Estimating GHG Emissions from LUC



Source: IMPACT

Magnitude of ILUC (Preliminary)



Error bars represent range of direct lifecycle emissions using different technologies, feedstocks, and energy sources. Uncertainty of iLUC emissions are not shown, but are much larger than uncertainties of direct emissions.

Challenge 4. Concern for "Sustainability" of Fuels

- **GHG reduction**
  - Large amount of soil carbon will be released during land use conversion, both directly and indirectly, especially from natural forestlands, wetland, and peatlands.

- **Food vs fuel**: increased demand for SOME biofuel puts pressure on food prices
- **Biodiversity:** Avoid areas with high biodiversity and high conservation values
- Many (especially the EU, NGOs, and industry groups) are working on **"sustainability standards"**

How to Transform LCFS into an Ideal National Fuel GHG Policy?

- Modified California LCFS
  - Different targets
  - Include other fuels (jet fuel, maritime, home heating oil, etc)
  - Integration with Cap and Trade
  - Treatment of diesel, EVs, etc.

- RFS + LCFS
  - Phase out RFS and replace with LCFS (as proposed in early Waxman-Markey bill), but do it sooner than 2023
  - Provide additional flexibility and market incentives to encourage innovation

Integration of LCFS and Cap-and-Trade?

- Currently in California:
  - LCFS credits may be exported to cap-and-trade program but not the other way around
- How to incorporate LCFS in a cap-and-trade program?
  - Where do interactions occur?
    - Accounting of electricity use and credits
    - E.g. streamline accounting to avoid double counting of emissions from electricity, land use (domestic and international), agriculture emissions?
- When transportation section becomes sufficiently low carbon and overcome market barriers, eventually phase out LCFS (2050?) and integrate LCFS into the cap-and-trade program?

Summary

- LCFS appears to be most effective policy for orchestrating transition to low carbon fuels
  - Includes all fuels and fuel neutral
  - GHG Performance standard
  - Relies on market forces
  - Durable framework for reducing long-term GHG emissions for transport
- Transforming US RFS into a federal LCFS would provide additional flexibility and incentives for innovation
- Need to address key challenges in indirect land use change, leakage, energy security and the sustainability safeguard.