Biofuels and greenhouse gases: A view from California

Global Bio-Energy Partnership
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Climate stabilization requires three overarching policy goals

1. **Deploy near-term technologies to cut emissions by ~29% by 2020**

2. **Stimulate innovation & investment in new technologies needed to meet 2050 climate stabilization targets**

3. **Contribute to related objectives**
   - Clean air
   - Affordable energy
   - Diverse energy sources
   - Job growth
   - etc.

California's strategy to fight global warming

Overall goals	Executive Order S-3-05 AB 32 Global Warming Solutions Act
Research portfolio	CEC Public Interest Energy Research California Institute for Climate Solutions
Buildings & appliances	Efficiency standards
Electricity generation	Efficiency targets, Renewable Portfolio Standard, Carbon Performance Standard, Carbon Adder, GHG Cap + Trade
Industrial sources	Commercial refrigeration standards, Blended cement, Combined Heat and Power, GHG Cap + Trade
Transportation	Better vehicles (Pavley, etc.) Better fuels (Low Carbon Fuel Standard) Better transportation systems (Infrastructure, etc.) Economy wide policy (Cap + Trade ??)
Other policies	Electrification of ports and truckstops and agricultural motors, Soil carbon management (offsets), Manure management (offsets), Afforestation (offsets), etc.

Low Carbon Fuel Standard - what?

- **Lower the carbon intensity of transportation fuels**
  - Emissions per unit of fuel: g CO2-equivalent / energy
    - CO2e/MJ, CO2e/Btu, CO2e/gallon gasoline equivalent
  - Lower by 10% by 2020
  - Contribute to overall goal – return to 1990 levels by 2020

- **The California Air Resources Board has many decisions to make on the details**
  - Which fuels? (Gasoline? On-road? All?)
  - How to treat light duty dieselization?
  - How to treat electric vehicles?
  - Multimedia and sustainability?
  - Etc.

Low Carbon Fuel Standard – when?

- **Rulemaking**
  - Analysis underway now
  - Working Groups are meeting
  - www.arb.ca.gov/fuels/lcfs/lcfs.htm
  - Draft discussion language - soon
  - Board decision – December 2008

- **Enforcement**
  - 2010

- **Fully in effect**
  - 2020

Indirect effects (aka “market-mediated”)

- **There is widespread agreement that competition for land exists**
- **There are two published estimates of indirect land use change on biofuel GHG emissions**
  - Johannsen and Azar (2007)
  - Searchinger (2008)
- **It is not clear how best to treat these effects in a regulatory context**
  - California is likely to include indirect effects
- **Other effects are not yet considered**
  - Albedo changes
  - Evapotranspiration
  - Etc.

Considerable research on market-mediated effects of biofuel production are underway

- **Several researcher teams are working on estimating the size of indirect GHG effects**
  - Iowa State University (Bruce Babcock)
  - Texas A&M University (Bruce McCarl)
  - Chalmers University (Christian Azar)
  - Purdue University (Tom Hertel)
  - University of California Davis (Mark Delucchi)
  - University of California Berkeley (Alex Farrell)
  - University of Calgary (David Keith) *oil sands and natural gas*
  - others ?
- **An interim approach to indirect effects may be needed**
  - Assigning an implicit value of zero is incorrect
  - Risk-based framework might be most appropriate

GBEP checklist and some observations

1. Greenhouse gases to be covered

- Kyoto 6 gases
- Serious debate about inadequacies – Do we want to follow well-accepted approach or use the best scientific data and methods?

2. Direct effects of land use change- land directly converted to grow biofuel feedstocks

- Generally follows GBEP checklist
- California-specific analyses
- May follow IPCC, but may not

GBEP checklist and some observations

3. Effects of production cycle (GHG equivalents)

- Generally follows GBEP checklist
- GREET as a starting point
- California-specific analyses
- May follow IPCC, but may not

4. Wells to Wheels

- Fuel content (g CO2e / MJ)
- GREET as a starting point
- May be adjusted for “drivetrain efficiency”

Gasoline, spark ignited	1.0
Electricity	5.0
Diesel	??? – may be applied to light duty.

GBEP checklist and some observations

5. Comparison to petroleum fuel replaced

- Generally follows GBEP checklist
- GREET as a starting point
- Detailed studies underway (University research)
  - Heavy oil, tar sands, enhanced oil recovery, oil shale, coal-to-liquids
  - Electricity
  - Calgary, Carnegie Mellon, Berkeley, Princeton, Toronto

GBEP key issues needing resolution

1. Methodology Issues

o Energy balance calculations (e.g. are co-products included?)

- Prefer substitution (system expansion)
- May follow UK approach

2. Externalities

o Should criteria pollutants like particulate matter be included?

- No.
- There if fierce debate about this – and sustainability

o Should indirect land-use (shifting of land use patterns due to crops being diverted to biofuel production) be included? If so, how and to what extent?

- Yes
- Not clear how to do so, may adopt risk-based approach

GBEP key issues needing resolution

3. Future Considerations

- How are future technologies (e.g. cellulosic) accounted for?
  - Up to regulated entities
- Management of the process – review cycle, updating information, ensuring correct procedure has been followed
  - At least one “mid-term review” (about 2015)
- Timeframe for comparison e.g., 30 years, especially important for land use change, on going sequestration, etc.
  - CARB is likely to use a value like 20 or 30 years
  - This is a more complex problem than it appears and may change.
- Energy use in the manufacture of farm machinery
  - No
- Maintenance for machinery and plants
  - No

Future research needs

- **Reconciling economic growth, energy security, poverty alleviation, and climate protection**
  - Policies and programs that benefit all countries need a solid scientific foundation.
- **Improving the data for land use change modeling**
  - Understand *future* patterns of land use change
- **Analysis of advanced biofuels**
  - Improvements in starch/sugar (generation 1)
  - Accurate representation of generation 2+
- **Characterization of uncertainty**
  - Quantification and analysis
  - Implications for policy and business
- **Climate effects of fuel production (emission factors)**

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