CALIFORNIA ENERGY COMMISSION

DOCKET
09-ALT-1
DATE SEP 14 2009
RECD. SEP 23 2009

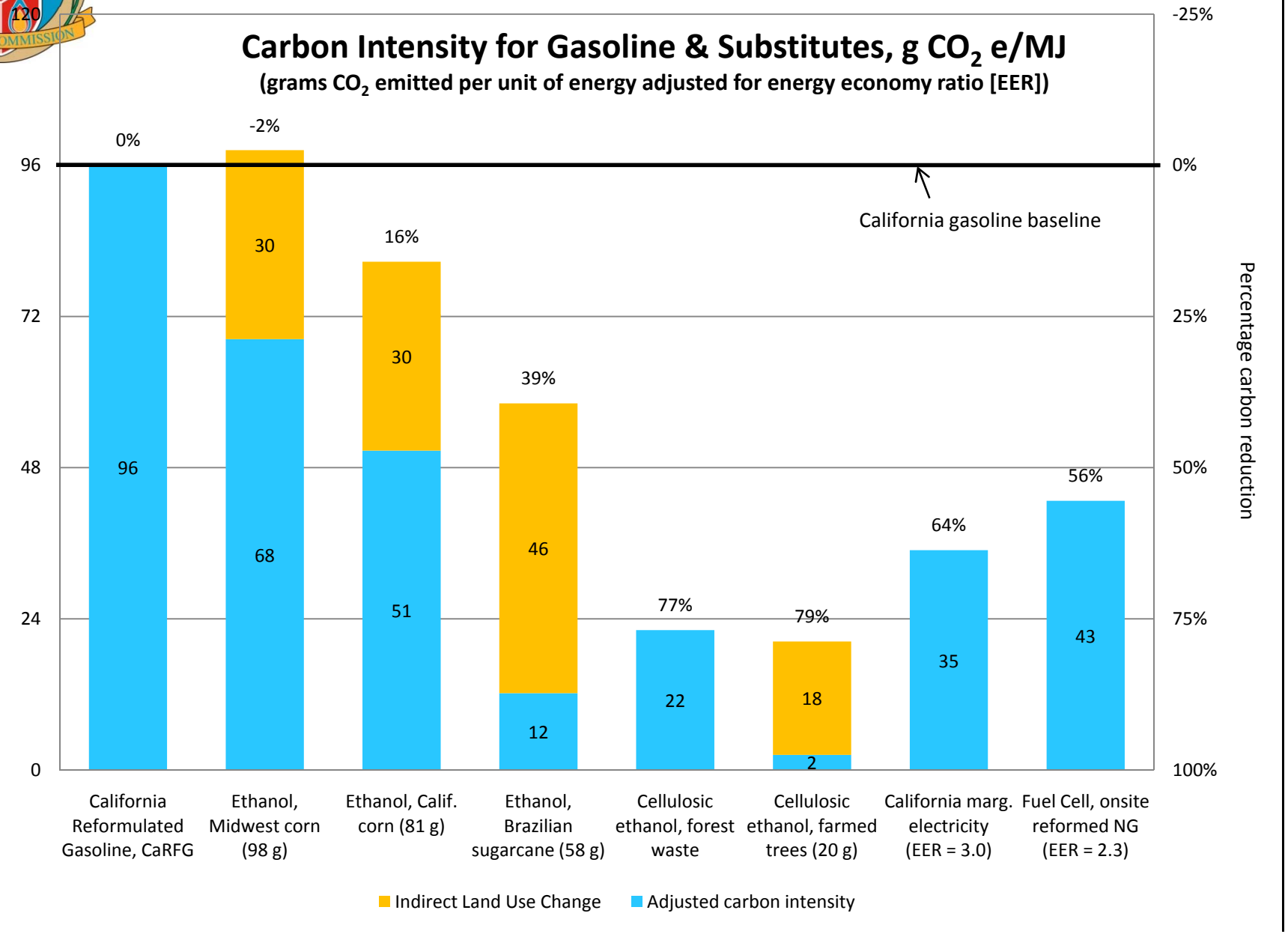
CARBON INTENSITY OF BIOFUELS

Ysbrand van der Werf

California Energy Commission
Biofuels Workshop
Sacramento, California
14 September 2009

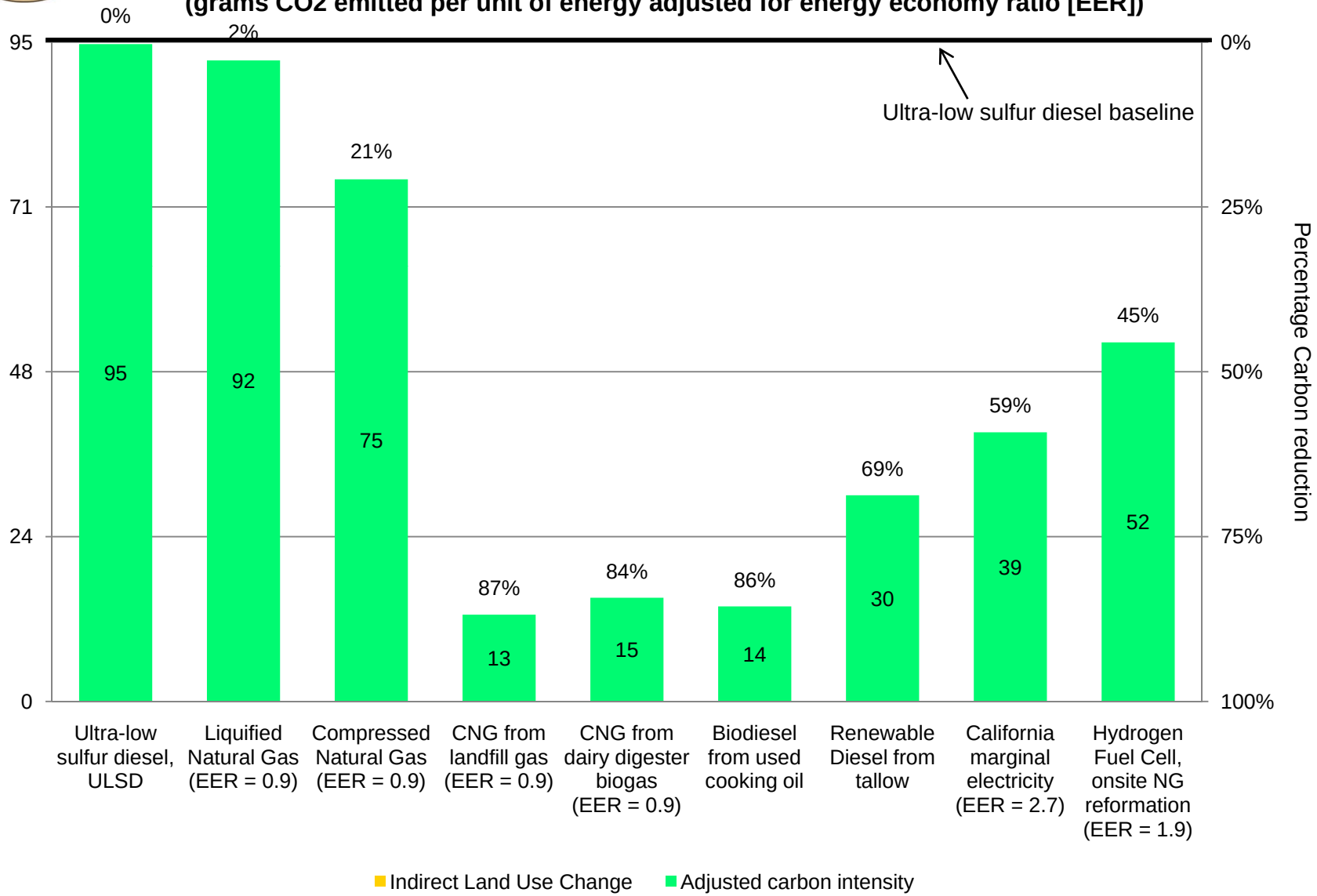
Outline

- Gasoline and substitutes
- Diesel and substitutes
- Emerging and potential pathways
- Components of pathways
- What we learned from ARRA proposals


Carbon Intensity for Gasoline & Substitutes, g CO_2 e/MJ
(grams CO_2 emitted per unit of energy adjusted for energy economy ratio [EER])
120
96
72
48
24
0
-25%
0%
25%
50%
75%
100%
Percentage carbon reduction
California gasoline baseline
0%
-2%
16%
39%
77%
79%
64%
56%
96
30
68
30
51
46
12
22
18
2
35
43
California Reformulated Gasoline, CaRFG
Ethanol, Midwest corn (98 g)
Ethanol, Calif. corn (81 g)
Ethanol, Brazilian sugarcane (58 g)
Cellulosic ethanol, forest waste
Cellulosic ethanol, farmed trees (20 g)
California marg. electricity (EER = 3.0)
Fuel Cell, onsite reformed NG (EER = 2.3)
Indirect Land Use Change
Adjusted carbon intensity

Carbon Intensity for Diesel & Substitutes, g CO2 e/MJ

(grams CO2 emitted per unit of energy adjusted for energy economy ratio [EER])



Emerging and Potential Pathways

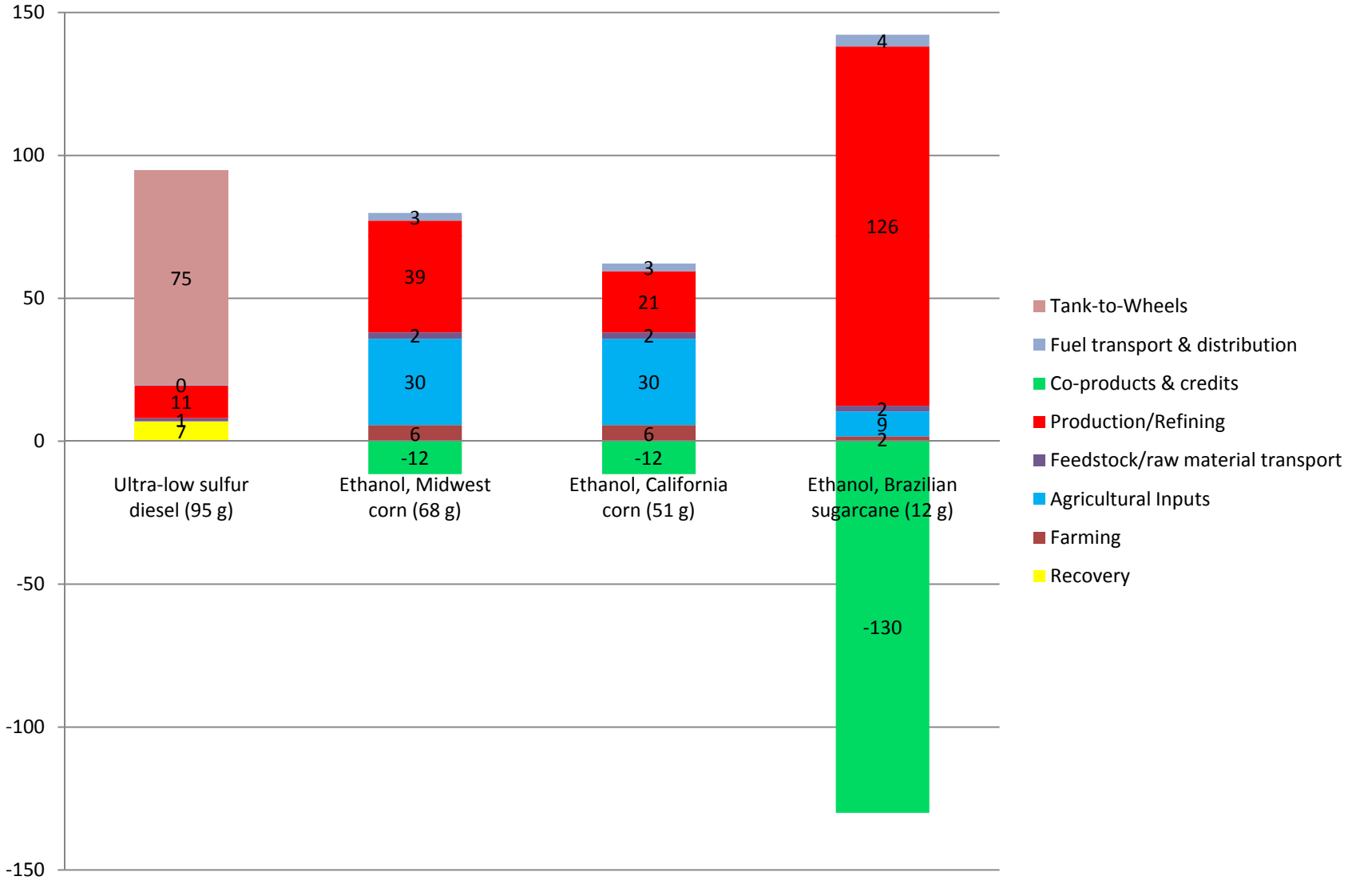
- Dairy digester gas in an ethanol biorefinery
  - Direct carbon intensity reduced from 51 to 18 g CO_2 e/MJ or 65 percent
  - Total carbon intensity reduced from 81 to 48, or 40 percent
- California sugarcane ethanol
  - Direct carbon intensity comparable to Brazilian sugarcane
  - Range of 5 to 20 g CO_2 e/MJ
- California sweet sorghum
  - Comparable to California sugarcane

Components of Pathways

- Ultra low-sulfur diesel (ULSD)
  - Low emissions from refining
- Corn ethanol has higher well-to-tank carbon intensity
- Brazilian sugarcane ethanol
  - Very high carbon intensity of refining
  - Very high co-product credit

Components of Biofuel Pathways, g CO_2 e/MJ

(grams CO_2 emitted per unit of energy)



Lessons from calculating GHG intensity for AB 118 proposals in summer 2009

- If there is no pathway, CEC staff will estimate a proxy GHG intensity
- It is often surprisingly difficult to find the necessary information in the proposal
- Sometimes the GHG intensity is calculated in the proposal, but data and equations are not provided
  - Need to verify assumptions and methods
  - Obvious mistakes

Lessons learned

- GHG intensity is a difficult calculation
- CEC aims for consistency in calculation between proposals
- Its never a bad idea to put feedstock, processes, vehicles, assumptions, equations, and other such information together on a single page of the proposal

Contact Information

Ysbrand van der Werf
Emerging Fuels and Technologies Office
California Energy Commission
916-654-4531
yvanderw@energy.state.ca.us