“GBEP STUDY TOUR FOR CAPACITY BUILDING: BIOENERGY WEEK”

Bioenergy Carbon Footprint
Implications on market development

Marcelo Moreira

Brasilia
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➔ www.iconebrasil.org.br

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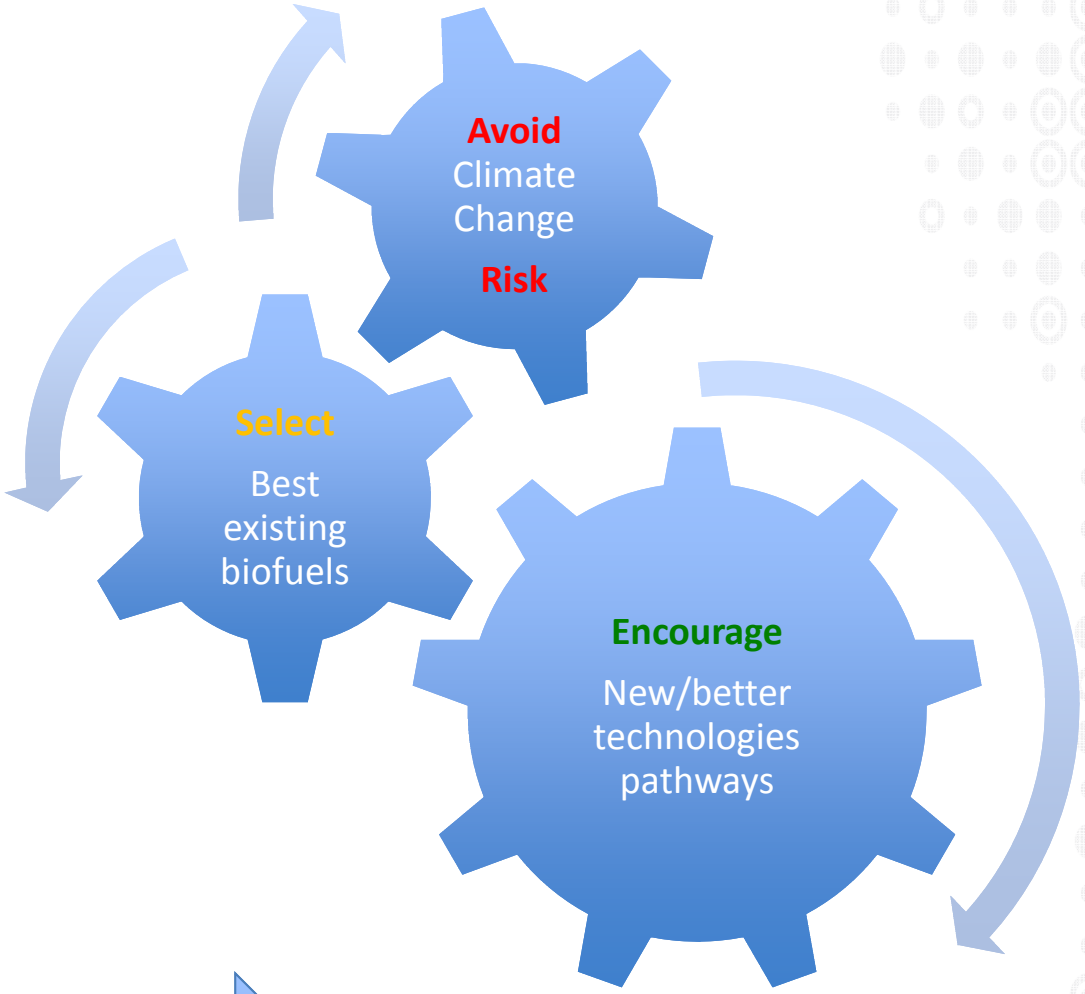
Institute for International Trade Negotiations

Motivation



LCA (Carbon Footprint) emerges as an useful communication tool for scientists, policymakers, companies, NGOs…

- Dialogs on policies, Incentive mechanisms, market protection

3 Main policies in the biofuels world

- **Renewable Fuel Standard RFS2 – US Federal:**
  - *Volume: 36 billion gallons in 2022: Cellulosic (min 16BG), advanced (min 21), renewable (max 15), biodiesel (TBD).*
  - *Market segregated according to GHG savings and feedstock.*
  - *RIN market.*
- **Low Carbon Fuel Standard LCFS – State of California:**
  - *10% reduction on total GHG emissions by 2020.*
  - *No segregation. Each biofuel pathway has its own Carbon Intensity (CI) value.*
  - *Carbon Credits according to CI values.*
- **Renewable Energy Directive and Fuel Quality Directive – EU**
  - *Minimum GHG savings for qualification.*
  - *20% renewable energy in transport in 2020, of which 10% biofuels*
  - *Additional sustainability criteria.*
  - *Actually a new proposal by the EU Commission regarding iLUC.*

Rules of the game

	EPA RFS2	CARB LCFS	EU RED
GHG reduction thresholds	20% Renewable 50% Advanced 60% Cellulosic	10% for the fuel Mix	At least 35%. 50% after 2017 60% after 2018
Type of LCA	Consequential (comprehensive)	Atributionnal and consequential	Attributional and consequential
Scope	Well to wheels	Well to wheels	Well to wheels
Functional unit	MJ of fuel (LHV)	MJ of fuel (LHV)	MJ of fuel (LHV)
Impact assessment	Lifecycle emission savings compared to fossil	Lifecycle emission savings compared to fossil	Lifecycle emission savings compared to fossil
Fossil comparator	Gasoline (93 gCO_2eq/MJ)	Gasoline (96 gCO_2eq/MJ)	Gasoline (84gCO_2eq/MJ)
LUC and iLUC	Both are considered	Both are considered	LUC yes, depends on the project
Constituents of emissions and GWP	CO2: 1; CH4: 21; N2O: 310 (NRC 2010)	CO2: 1; CH4: 25; N2O: 298 (IPCC 2007) Also: VOC: 3.1; CO 1.6	CO2: 1; CH4: 23 ; N2O: 296 (IPCC 2001)
Tools for calculating	EPA spreadsheets and GREET1.8_C	GTAP + CA-GREET	No. Biograce software is available.
Co-product treatment	System expansion (displacement)	System expansion (displacement)	Recommends allocation (energy). Cogeneration has a particular interpretation.

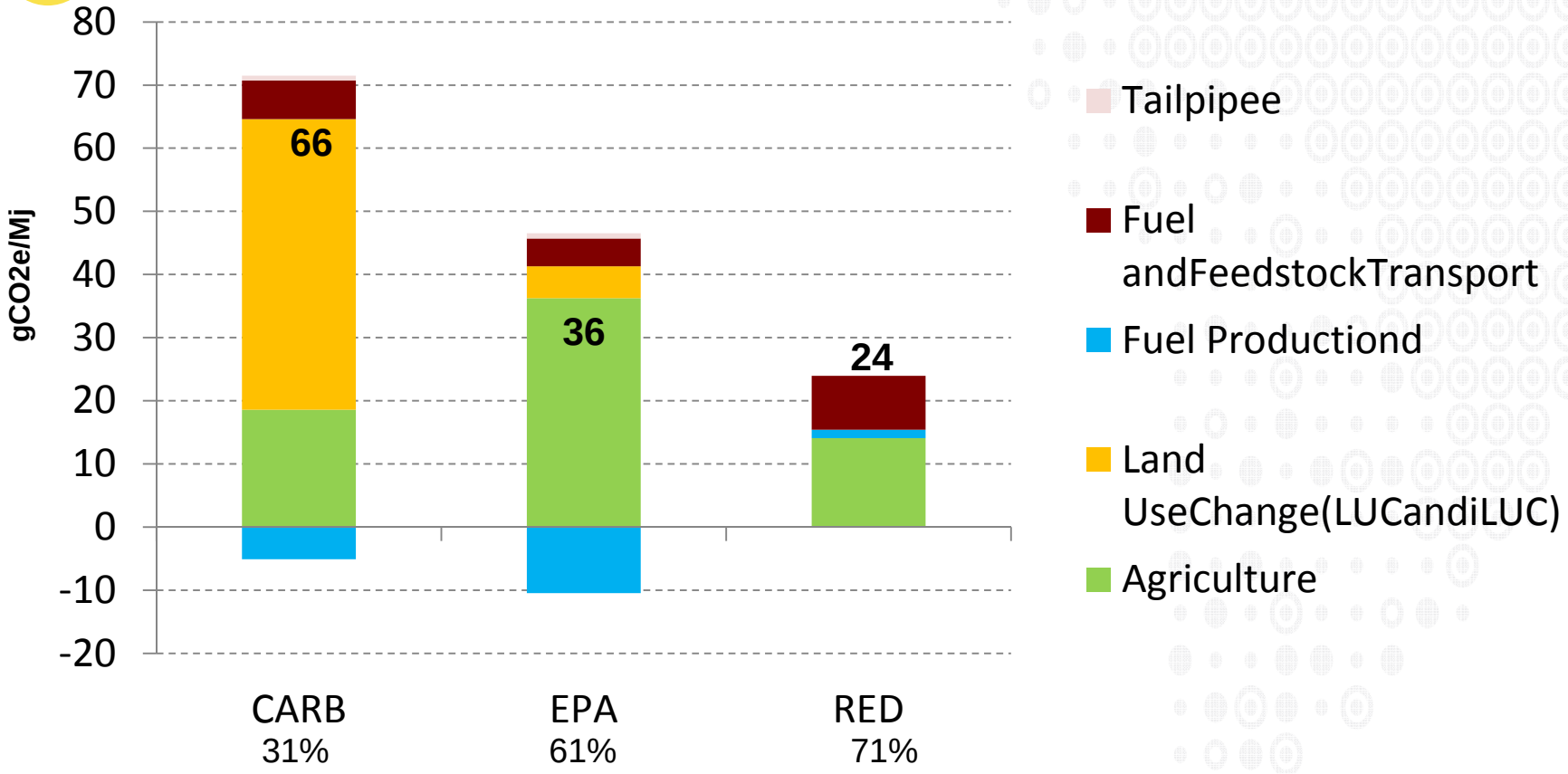
Source: ICONE, original data from EPA, CARB, RED/Biograce

System boundaries

	EPA RFS2	CARB LCFS	EU RED
Extraction and /or production of feedstock	yes	yes	Yes
Capital goods	no	no	no
Transport and distribution	yes	yes	yes
Final combustion	yes (only the emissions of N2O and CH4, CO2 biogenic)	yes (only the emissions of N2O and CH4, CO2 biogenic)	Zero (biofuels 100% biogenic)
Land Use Change	yes (direct and indirect)	yes (direct and indirect)	Officially yes; but No in most cases
Other indirect effects	yes	No	No
Chemical inputs	yes	yes	yes

Source: ICONE, original data from EPA, CARB, RED/Biograce,

Comparable GHG results: sugarcane ethanol

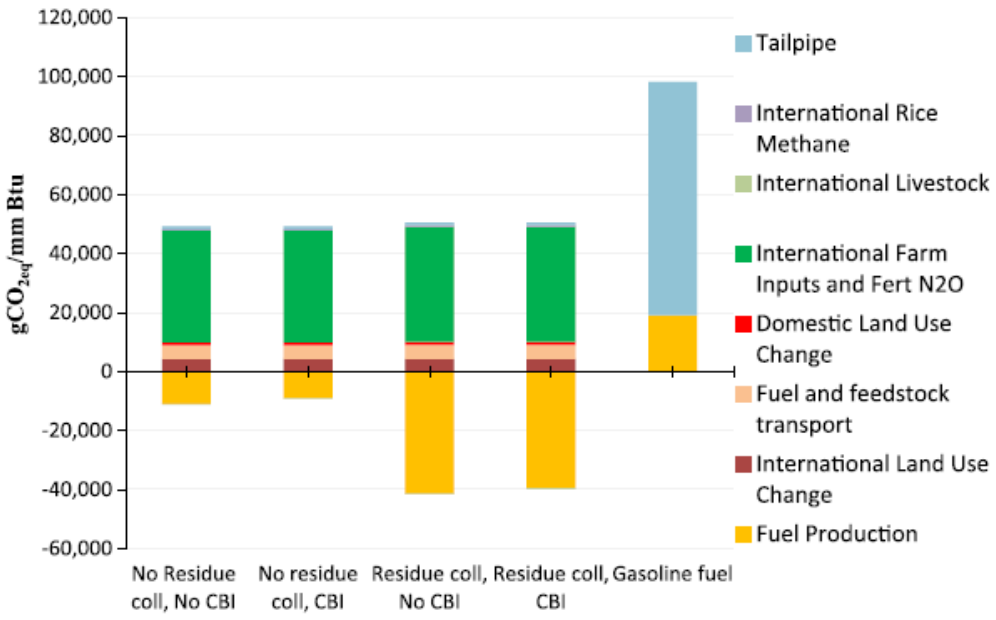


- CARB has highest LUC+iLUC emissions
- EPA agriculture is extremely influenced about assumption on N2O cycle. (use of perennial grasses instead of sugarcane)
- RED has highest transport emissions

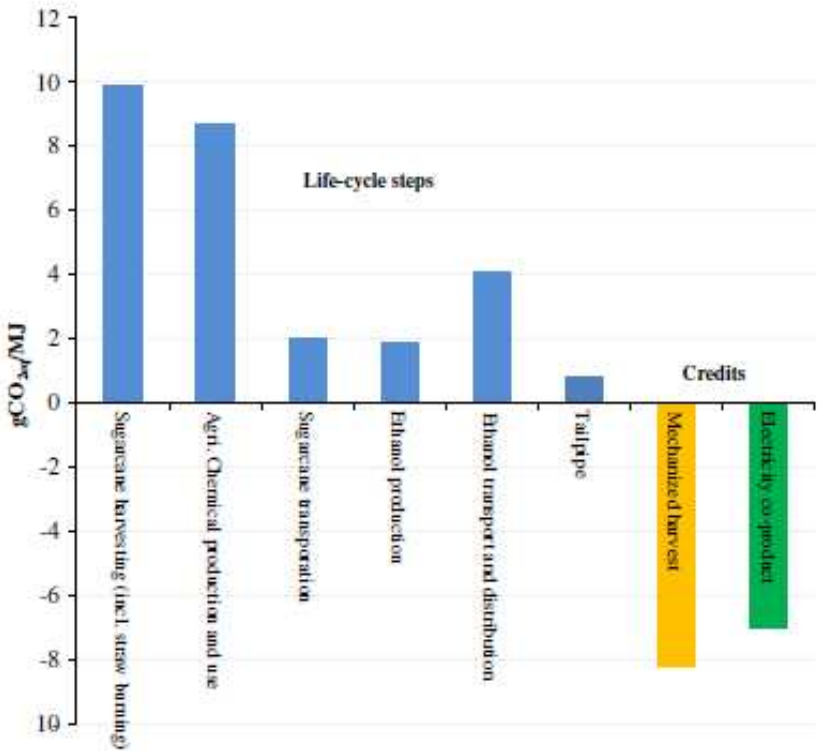
Source: EPA, CARB, Khatiwada et al 2012, ICONE

LCA estimates (different pathways)

EPA



CARB



Source: , Khatiwada *et al* 2012, original data from EPA, CARB

Developing a new LCA pathway

- Jet fuel (kerosene)
- Reference year 2022
- Consumed in Brazil
- Use of trash in cogeneration system
- **Two** different methodological approaches
  - No changes in agricultural step
  - Adapted industrial step
  - Updated iLUC calculations (for CARB)

Special thanks to: IDB, Boeing, EMBRAER, WWF and Amyris

System description

Seabra and Moreira
Objective: Communication (Demo flight Rio+20)
(2012)

EPA's RIA | 150 km by trucks | 150 km by trucks

Sugar cane cultivation and transport → FENE production → Transport → Hydrogenation → Transport → Fuel use

Amyris estimates | Amyris estimates | IPCC's emission factors

Moreira, Seabra and Gurgel
Objective: Scientific Paper
(under development)

ARB Staff Report | 150 km by trucks | 150 km by trucks

Sugar cane cultivation and transport → FENE production → Transport → Hydrogenation → Transport → Fuel use

Amyris projection | Amyris projection | IPCC's emission factors

Main parameters

- Projected production pattern in 2022
- 150 million liters in 2022 (CARB)
- Agricultural yield:
  - EPA: 78,2 (direct LCA); 94 (land use model).
  - CARB: 75 (direct LCA); 81 (land use model).
- Yield 27 t cane/ FENE
- Electricity:
  - Production 195 Kwh/ t cane
  - Consumption 68 Kwh/ t cane
- Hydrogenation 1.04 t renewable jet fuel/t FENE.

Results of the studies

(g CO_2eq/MJ)

EPA	
Sugarcane production Include LUC	50.7
FENE production	
Chemicals	1.9
Biomass combustion	3.4
Electricity Surplus	-45.7
Yeast	-0.6
FENE transport	0.3
Hydrogenation	4.3
Biojet fuel transport	0.3
Biojet fuel use	0.6
Net emissions	**15.2**

Preliminary numbers. Do not quote or cite

Discussion: maturity of carbon footprint analysis for biofuels

- Direct LCA method is mature
  - (some important questions remain on co-product treatment...)
- iLUC Models are improving, results are getting closer
- Better data is required in both direct and indirect emissions calculation

- The major risk regarding iLUC is to make the wrong assumptions.

Discussion : biofuels carbon footprint analysis developments

- **Requests on LCA (our experience)**
  - Scientific development
  - Avoidance of unfair trade barriers
  - Corporate image (suppliers and buyers)
  - Corporate strategy/ product development

- LCA can be an useful tool to guide policies, but conditions must be respected.
  - Respect scientific development
  - Keep improving knowledge on sensible areas
  - Limit the political interventions on LCA

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Thank you

mmoreira@iconebrasil.org.br

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