

# “Rebound effect”, alternative fuels and LCA

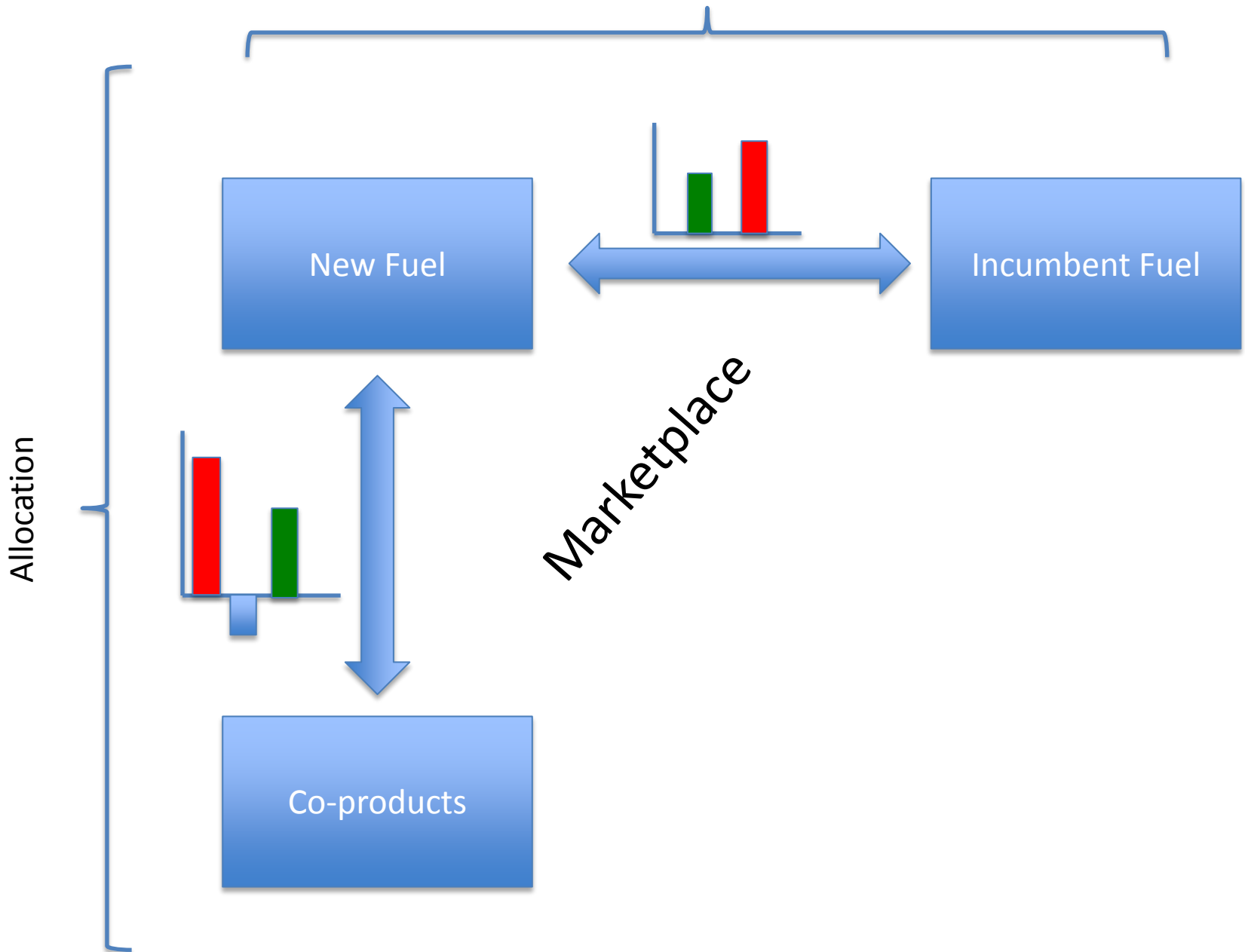
Michael Griffin

Carnegie Mellon University

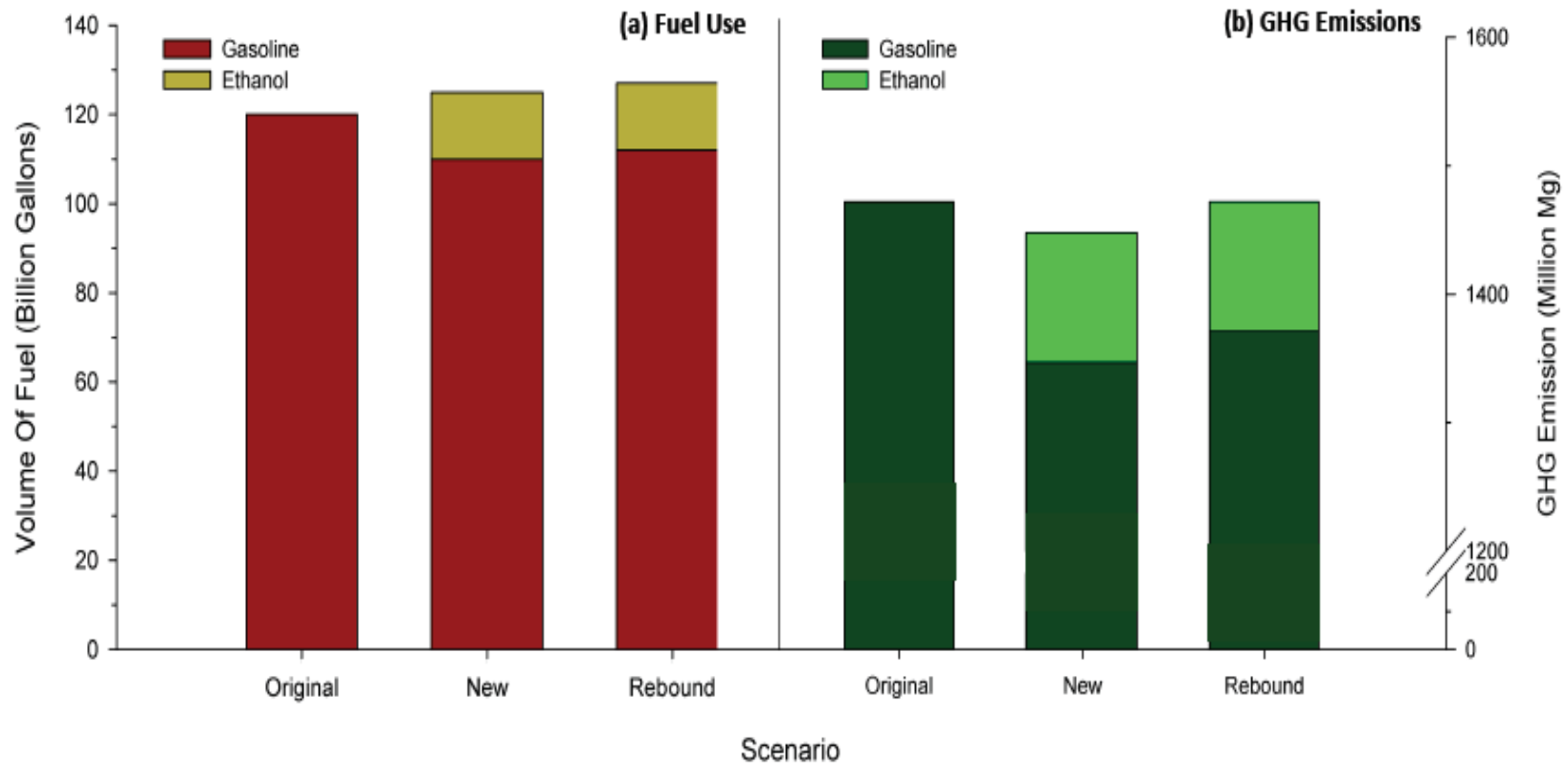
# Life Cycle GHG Emissions



# Market Displacement



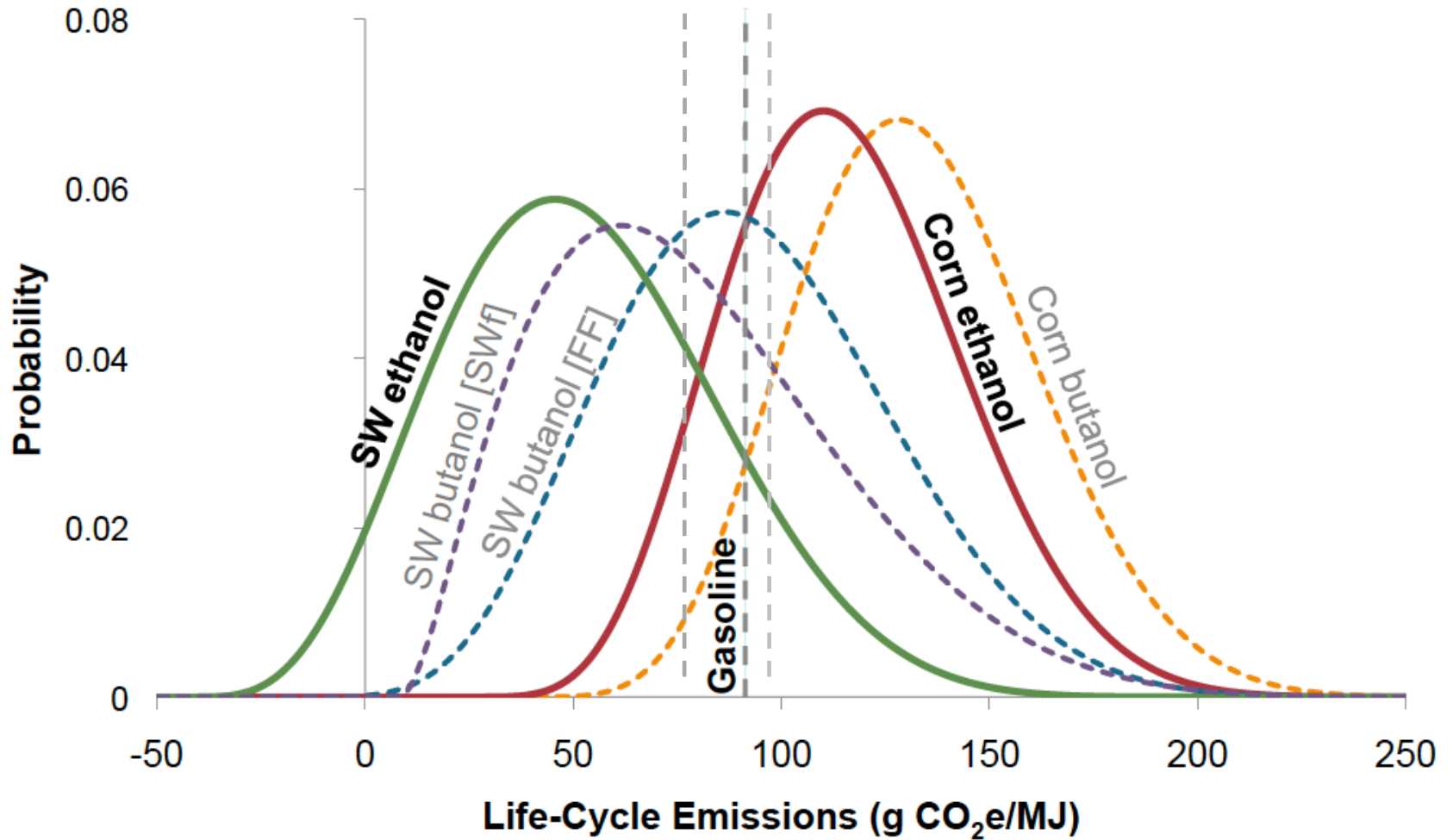
# Hypothetical “Rebound Effect” on the Adoption of a Biofuel



# Market Displacement

- Rajagopal *et al.* (2011) Energy Policy 39:228–233.
- 7.5% mandated corn ethanol use
- 5 or 6% increase in blended fuel price
- Nationally
  - 2 to 3% decrease consumption of blended fuel
  - 8 to 9% decrease in petroleum use nationally.
- In the rest of the world (ROW).
  - 2 to 3% decrease in world oil prices
  - Consumption increases by almost a percent point
- Overall global fuel use decreases by slightly more than 1%.
  - National emissions decreased by 0.22 to 0.25 Gt/yr CO<sub>2</sub>
  - Adding back ROW increased emission results a decrease of 0.12 to 0.13 Gt/yr CO<sub>2</sub>.

# Probability distributions - GHG



# Allocation: Coal to Liquids

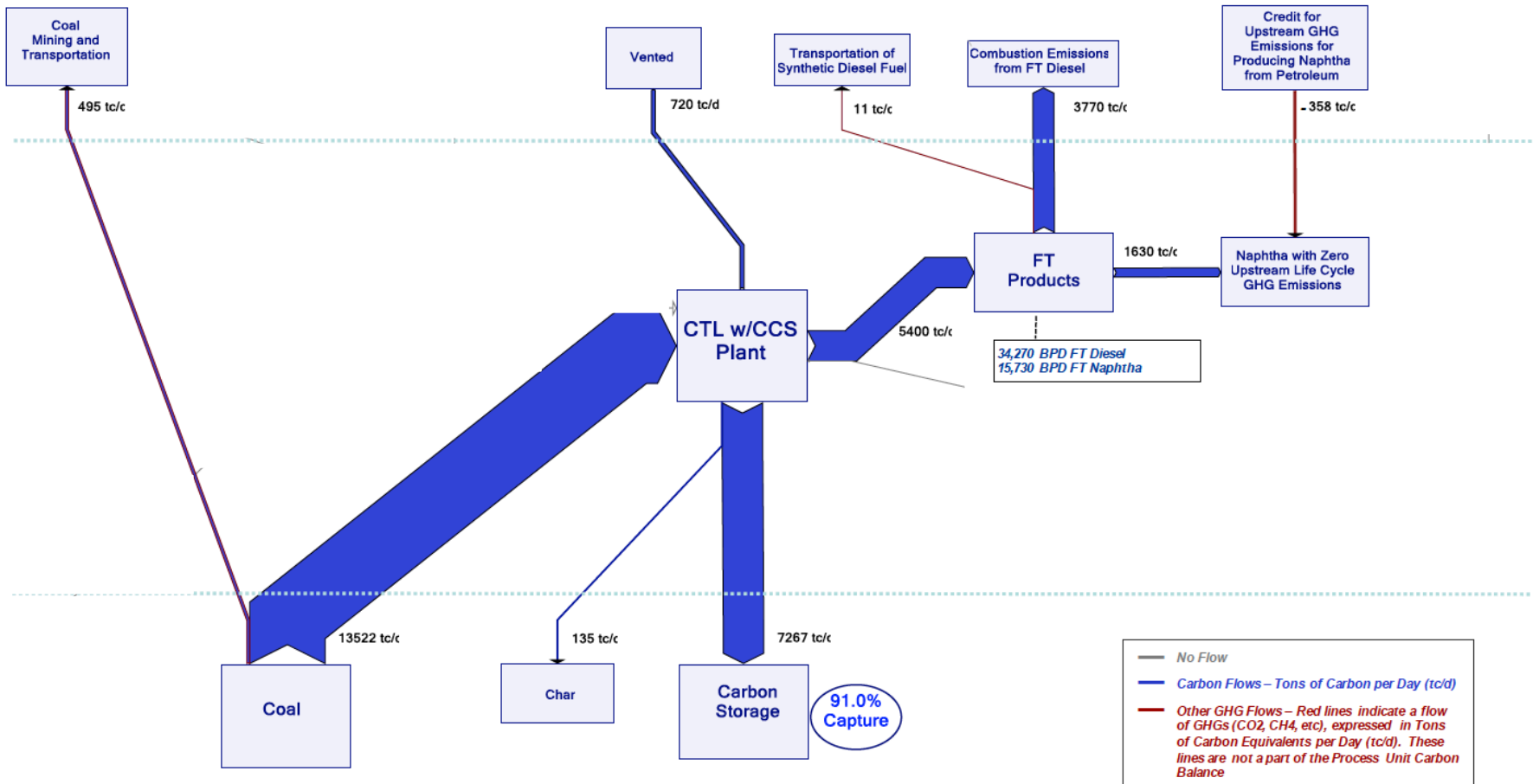
Coal to Liquids (CTL) is a commercial process which converts coal into diesel fuel, producing a concentrated stream of CO<sub>2</sub> as a byproduct. Coupling the process with carbon sequestration ..... results in **a fuel with appreciably less (5-12%) life cycle Greenhouse Gas (GHG) emissions than the average U.S. petroleum-derived diesel.**

NETL 2009 DOE/NETL-2009/1349

In a best-case scenario, coal-based FT-liquids have emissions only **comparable** to petroleum based fuels.

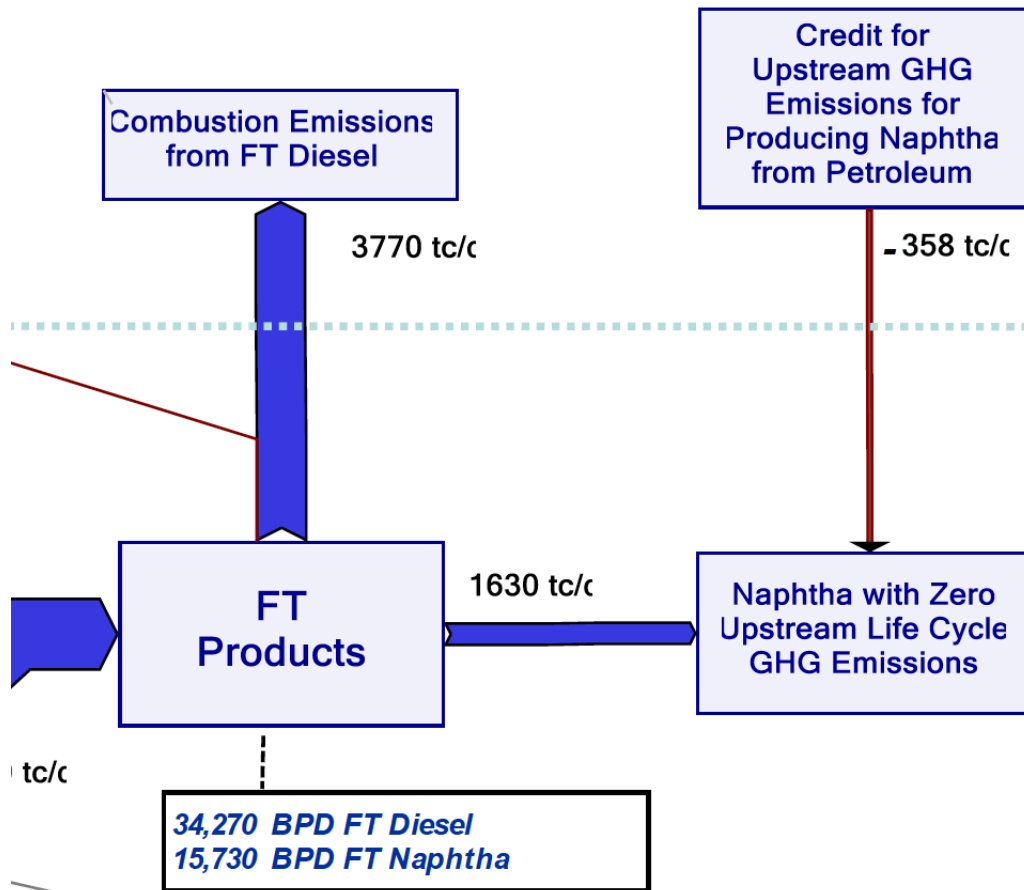
Jaramillo *et al.* 2008

# Coal to Liquids





# Coal to Liquids



- Costs
- Pet Naphtha Fate
  - Oil Reduction
  - Gasoline Production
- Long term response by refinery
  - Capital Investment
  - Make more diesel

# Other Examples

- Cellulosic ethanol – achieves negative GHG emissions (electricity offsets)
- Corn ethanol (co-product offsets)
  - Replacing Corn and corn products as animal feed
  - Replacing Soybean production (meal and oil)
- Biodiesel (co-product offsets)
  - Replacing corn meal
  - Interesting the corn ethanol and biodiesel of offsetting each other!

# Framing

- Life Cycle Assessment
  - Is being recommended for policy decision-making
    - “Countries with sufficient resources should conduct comprehensive LCAs of current and potential biofuel production chains” (IRGC, 2009)
  - Is being specified in government regulation.
    - EISA 2007 – RFS2, government purchase of fuels
    - CA LCFS
    - Appliance Standards – looking at LC emissions
  - Is being specified in certification programs
    - Inmetro – Brazil
    - European EN14214 standard for biodiesel
  - Company performance measures
    - Carbon Footprinting and Labeling



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