

# ***Sustainability of Biofuels and Life Cycle Assessment***

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**IEA Bioenergy Task 39  
April 2018**

# *(S&T)<sup>2</sup> Experience*

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- Developer of GHGenius.
- Do a large number of biodiesel and renewable diesel CI calculations for the California LCFS.
  - Provide guidance and feedback to CARB on their model development work.
- Did several new pathway applications for RFS2.
- Have added fuel pathways to BioGrace for some fuels for the EU.
- Developed a model for the calculation of the regional GHG emissions of the top 10 grains and oilseeds in Canada.
- Developed the materials emission module for the transportation LCA model for the Danish Energy Agency.
- Did study on the GHG emissions of NG supply to Europe.

# Work for CRC

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- In 2013 undertook a project for the Coordinating Research Council that looked at four modelling frameworks, EPA RFS2, GREET, GHGenius, and BioGrace/JEC.
- Transportation Fuel Life Cycle Assessment: Validation and Uncertainty of Well-to-wheel GHG Estimates
  - Available at <https://crcao.org/reports/recentstudies2013/E-102/CRC%20E%20102%20Final%20Report.pdf>
  - Looked at 6 pathways
    - Petroleum gasoline/diesel
    - Corn ethanol
    - Soy biodiesel/renewable diesel
    - Sugarcane ethanol
    - Cellulosic ethanol
    - Natural gas

# Recent Work for CRC

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- Follow on project has just been released.
- Review of Critical Parameters for Transportation Fuel Pathways
  - [https://crcao.org/reports/recentstudies2018/E-102-2/CRC%20Project%20E102-2%20Final%20Report\\_March%202018.pdf](https://crcao.org/reports/recentstudies2018/E-102-2/CRC%20Project%20E102-2%20Final%20Report_March%202018.pdf)
- Looked at the same six pathways and reviewed the literature between 2010 and 2015 for new information that would help to reduce the uncertainty with some of the data in the models.

# Corn Ethanol

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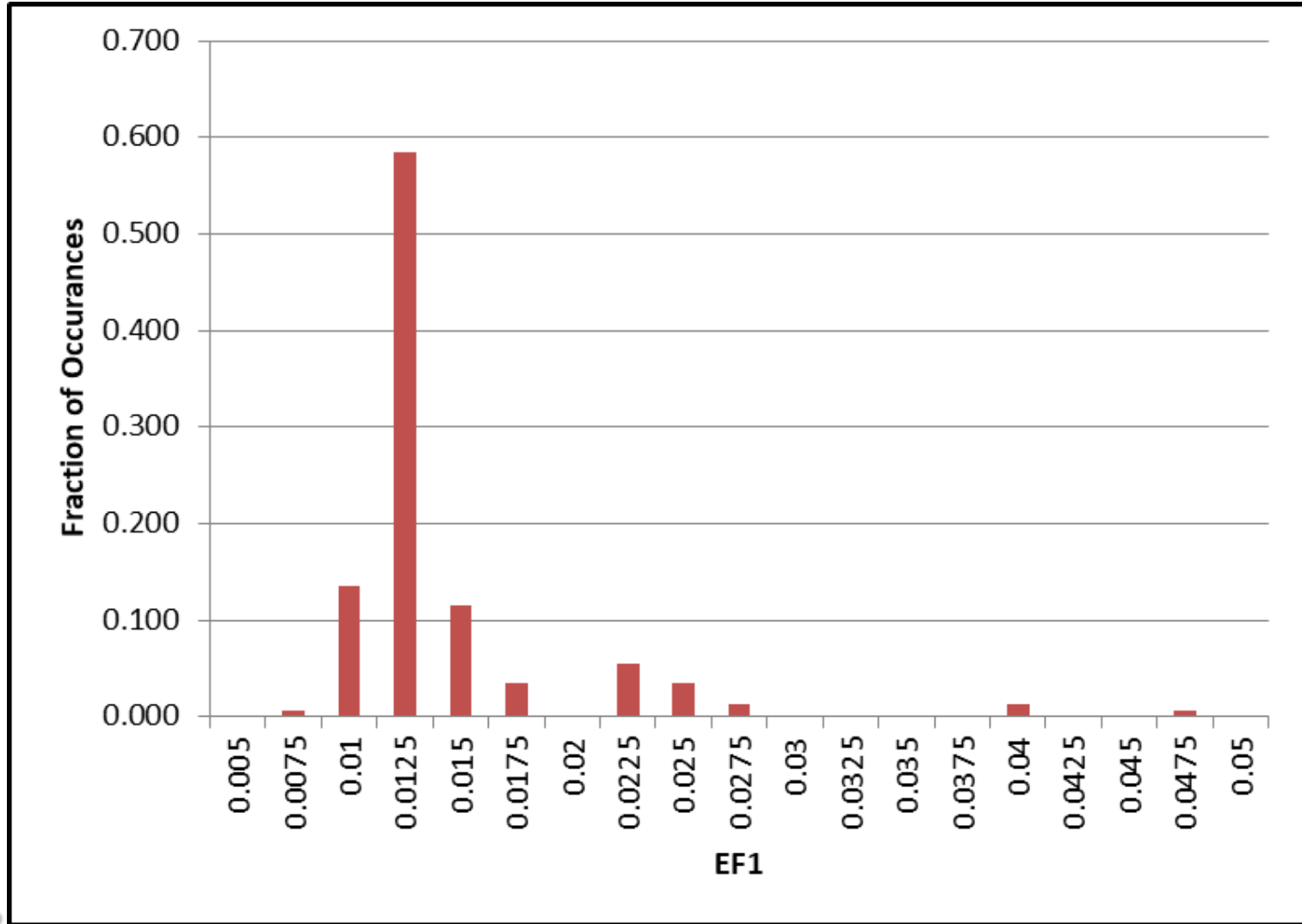
- There was more emphasis on this pathway than the others in the terms of reference.
- Interested in trends for key parameters
- Three focus areas
  - N<sub>2</sub>O emissions from corn production
  - Energy use at ethanol plants
  - Co-product

# *N<sub>2</sub>O Emission Factors*

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- There is a lot of information available for some regions of the world.
- Applied the JRC GNOC model to US corn production by Ag District.
  - 147 regions in the US.
  - Represent 76 million acres
  - Some with irrigation.

# $N_2O$ Emission Factors



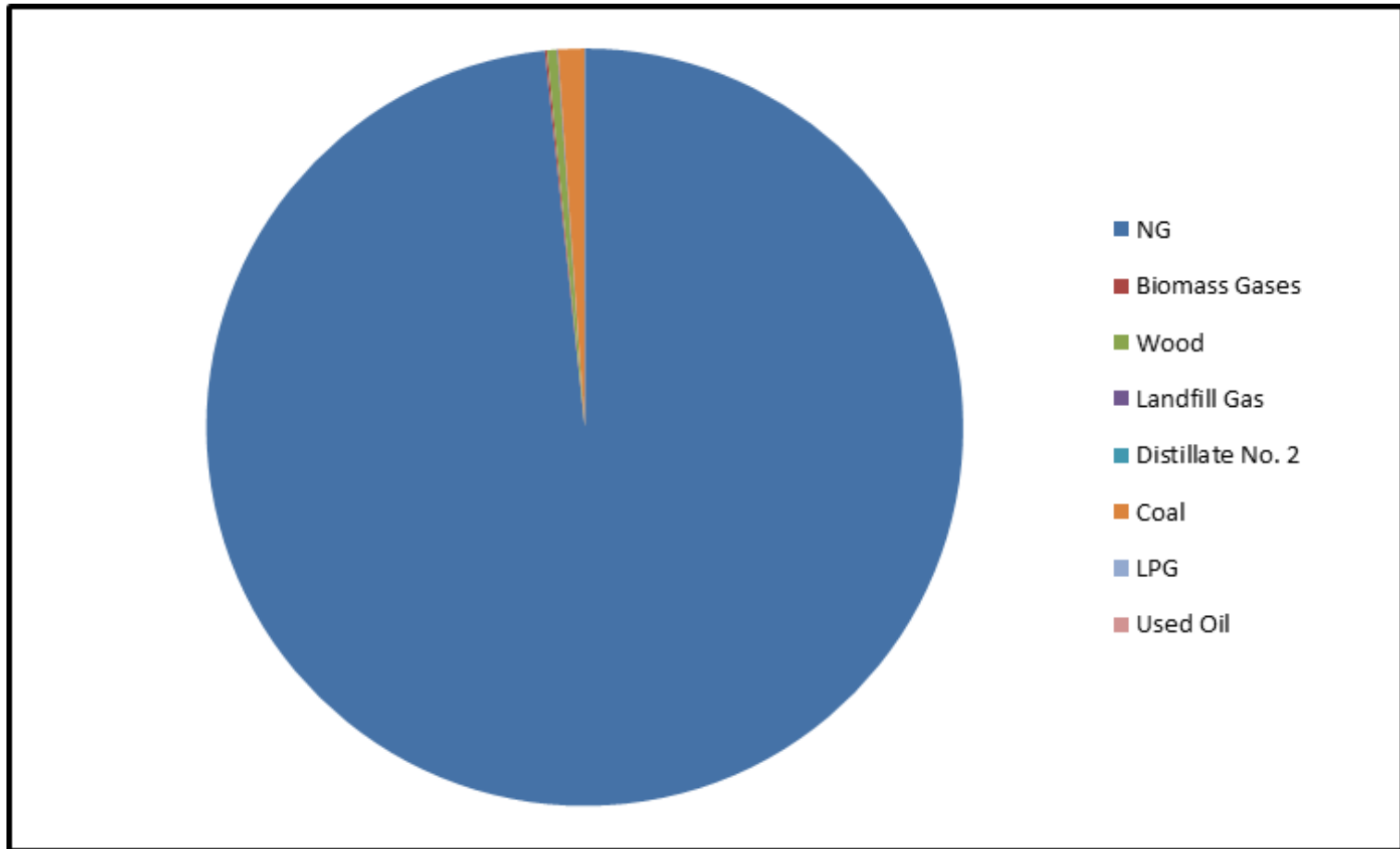
# Energy Use

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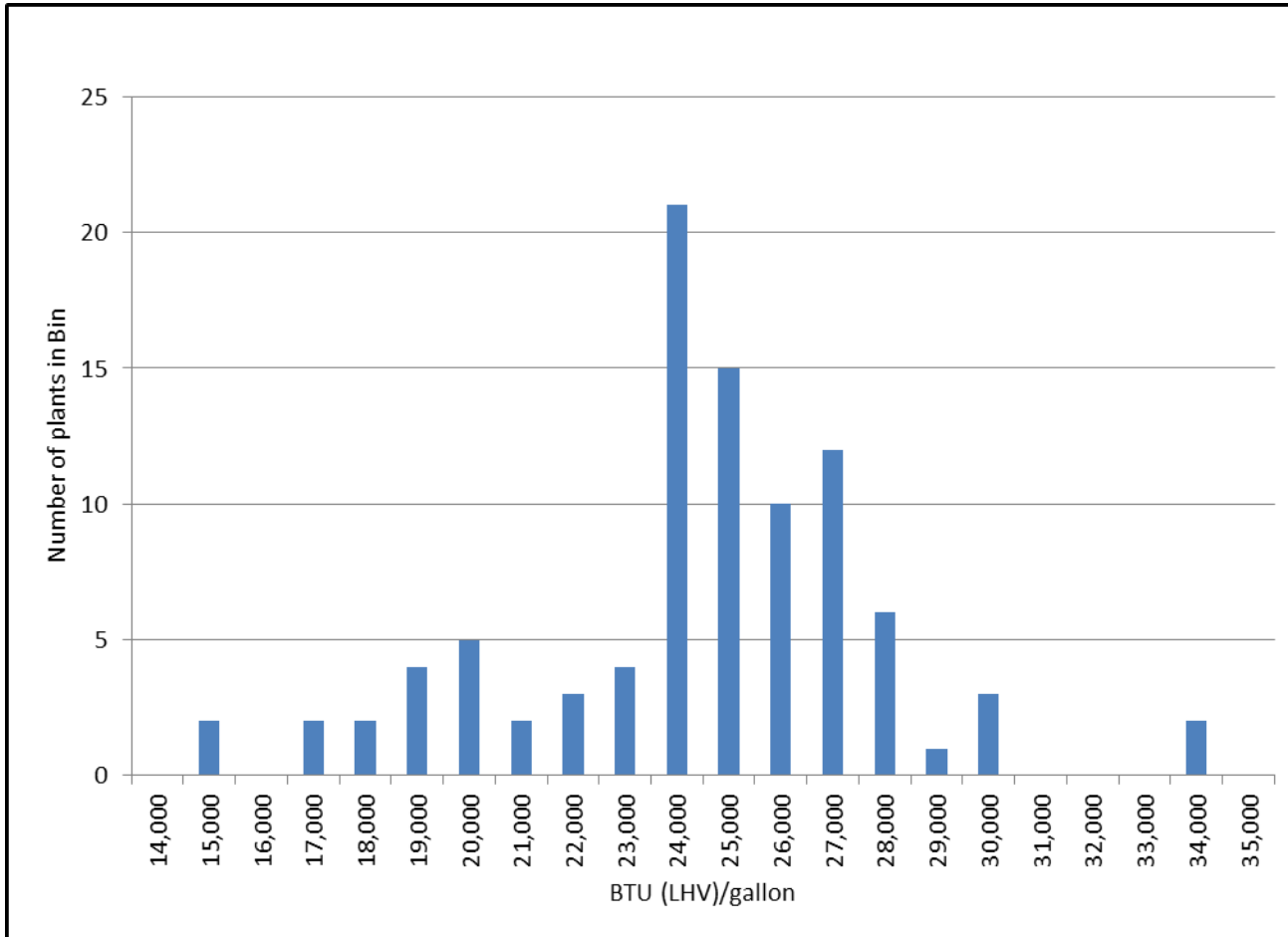
- Extracted data on energy use for 2014 from the US EPA Flight Database for all dry mills in the US (160).
  - Data is third party verified.
  - Hardly any coal fired plants left. They have mostly switched to natural gas.
  - Database doesn't have production data.
    - Many plants do publish their annual production.
    - Through the RFA contacted members for production data.
    - Ended up with 93 plants with energy use and production data representing 65% of total production.



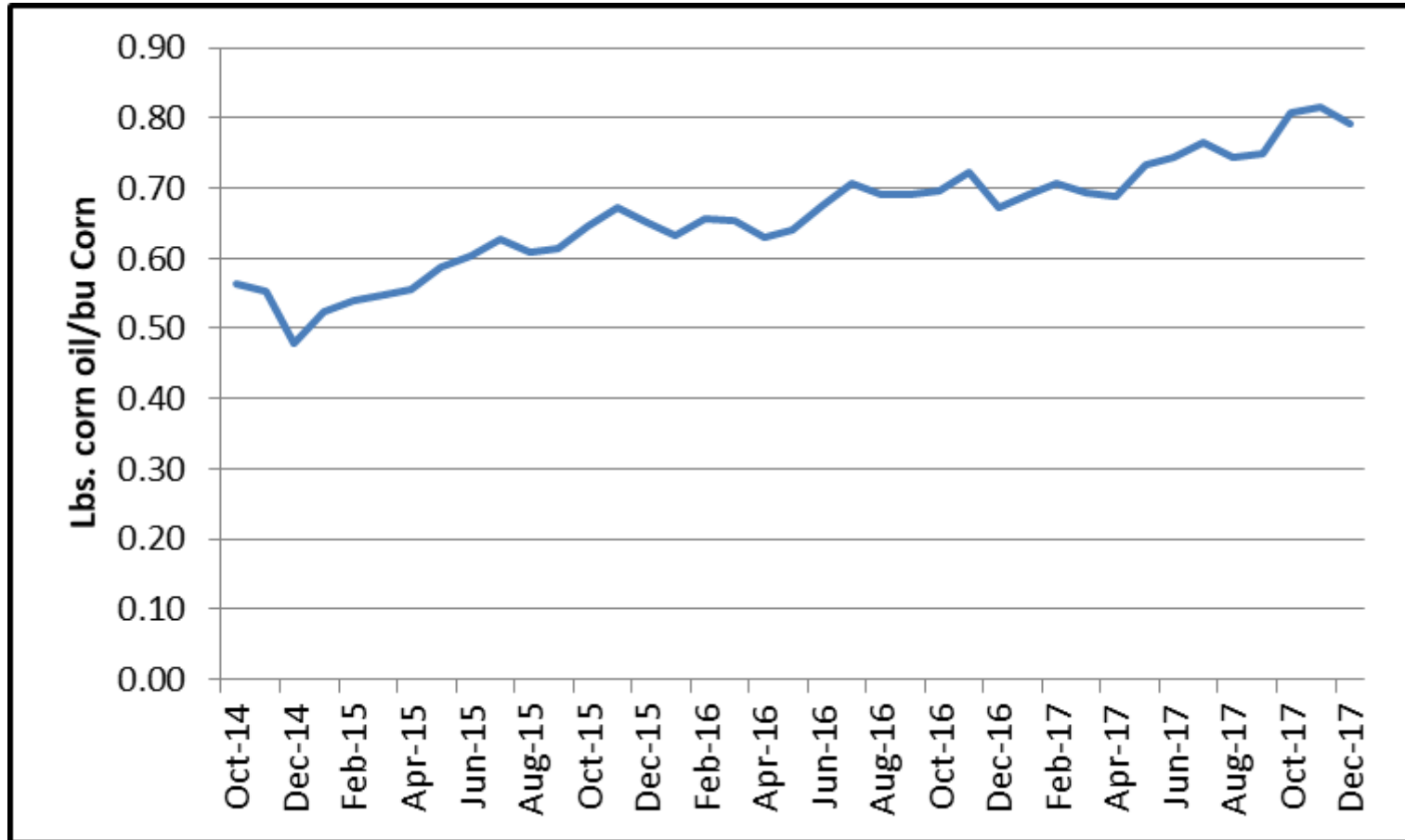
# Type of Energy



# Energy Intensity



# Co-products



## *Other Pathways*

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- Conduct a review of literature published between 2010 and 2015, including the literature used to support the default values in GREET 2014, GHGenius 4.03a, and BioGrace, to determine a range of values for key parameters.
- Determine if there are additional key parameters not identified in E-102 for each of the pathways.
- Scan the literature to assess potential future trends for the key parameters.

# *Findings*

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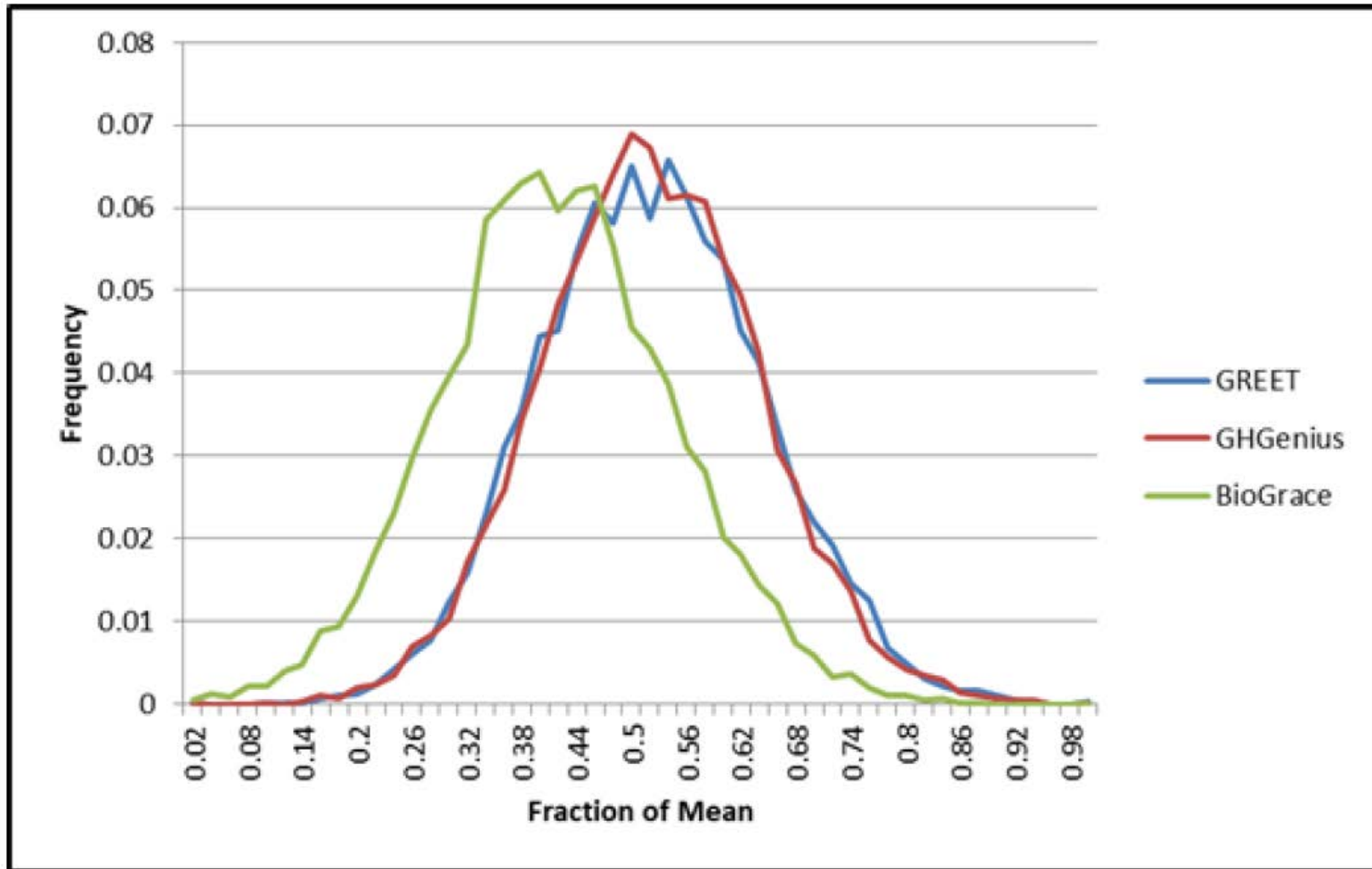
- The public data sets for the other fuels are not as rich as the information on corn ethanol but there is some data available.
  - International Association of Oil and Gas Producers
  - NOPA
  - NBB
  - CRC project on CNG stations

# Monte Carlo Simulations

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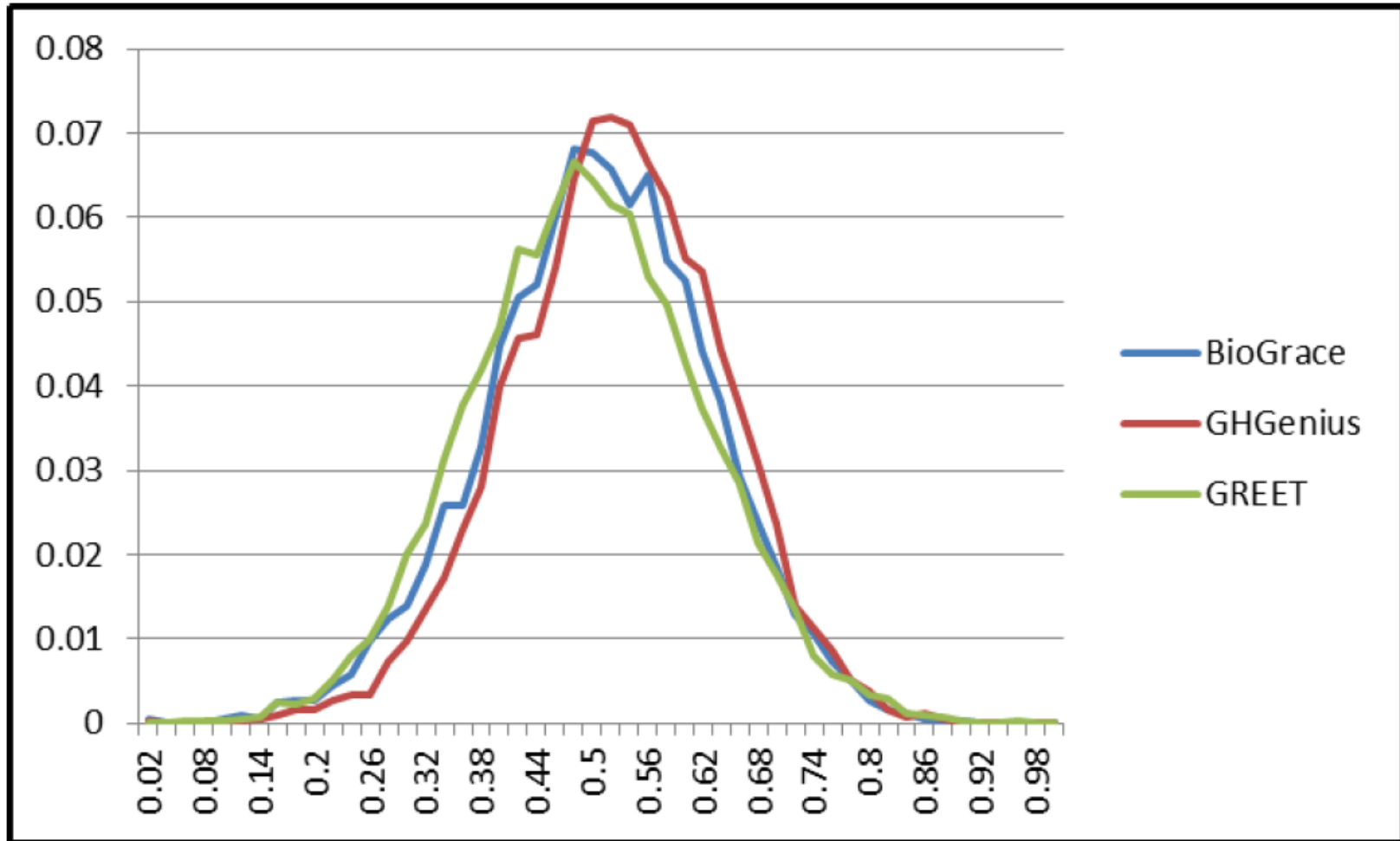
- Harmonized the input data in the models and ran Monte Carlo simulations for each model and pathway.
- General agreement with some exceptions.

# Corn Ethanol



$(S\&T)^2$

# Sugarcane Ethanol



(S&T)<sup>2</sup>



# *Suggestions for Further Work*

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## ➤ Policy Related

- In conjunction with Task 38?
- Provide guidance to regulators on issues such as
  - Definition for waste feedstocks
  - Implications of allocation choices
  - Appropriate system boundaries

## ➤ Science based

- Development of high quality, geographic specific, life cycle inventories for secondary data that could be utilized in any model.
- Particular need for enzymes, catalysts, sulphiding agents, and acids and bases unique to biofuel processes.



# Questions?

(S&T)<sup>2</sup>