LCA and uncertainty – implications for decision making

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Two Types

- For LCA purposes it useful to think of uncertainty in 2 way:
  - "uncertainty about the value of empirical quantities" and "uncertainty about model functional form".
    - Parameter Uncertainty
    - Model Uncertainty
- Empirical quantities represent properties of the real world, which, at least in principle, can be measured, now or in the future.

Morgan *et al*., 2009

Uncertainty

- “Uncertainty is ubiquitous. Of course, the presence of uncertainty does not mean that people cannot act.”

Morgan *et al*., 2009

ISO 14044

- Defines Uncertainty Analysis
  - "systematic procedure to quantify the uncertainty introduced in the results of a life cycle inventory analysis due to the cumulative effects of model imprecision, input uncertainty and data variability"
- It commands –
  - "An analysis of results for sensitivity and uncertainty shall be conducted for studies intended to be used in comparative assertions intended to be disclosed to the public."

Well we need to start somewhere!

The results and conclusions of this LCA are reported according to the International Organization for Standardization (ISO)'s 14040/44 standards.

The Life Cycle Inventory (LCI) results for the foil pouch production compared to the foil-less pouch show a reduction in primary energy use from 0.219 to 0.210MJ, resulting in a savings of approximately 4.1%. Carbon dioxide emissions are also reduced from 10.371 to 9.317g of CO_2, a savings of 10.2% in favor of the foil-less pouch. However, water inputs show an increase from 0.279 to 0.741L, which is approximately 2.5 times greater for the proposed foil-less pouch compared to the current foil pouch. This is largely due to the use of Ethylene Vinyl Alcohol (EVOH) in the foil-less pouch.

Point Estimates

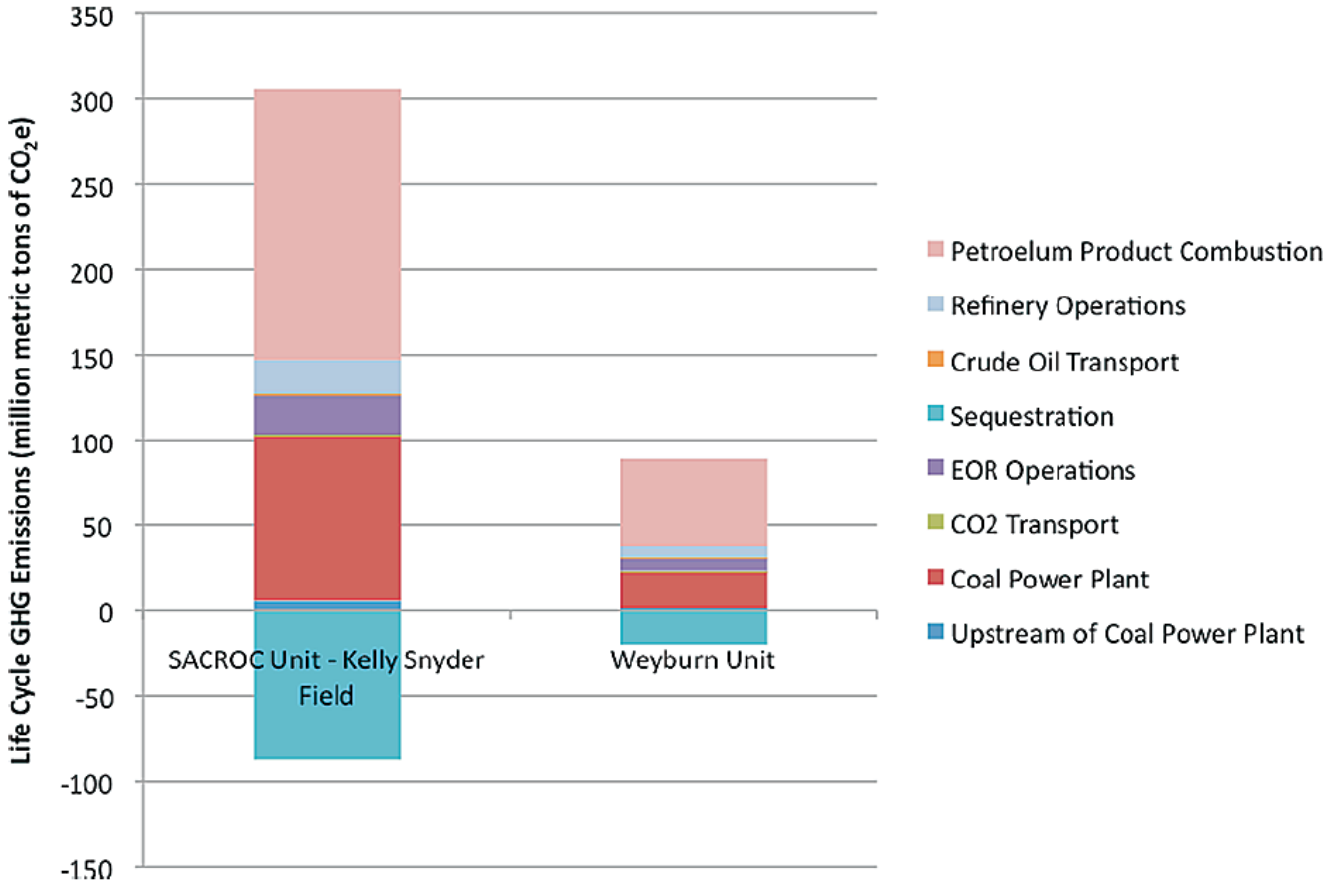


FIGURE 3. Sources of GHG emissions for SACROC Unit and Weyburn Unit.

Jaramillo, *et al*. 2009

Ranges

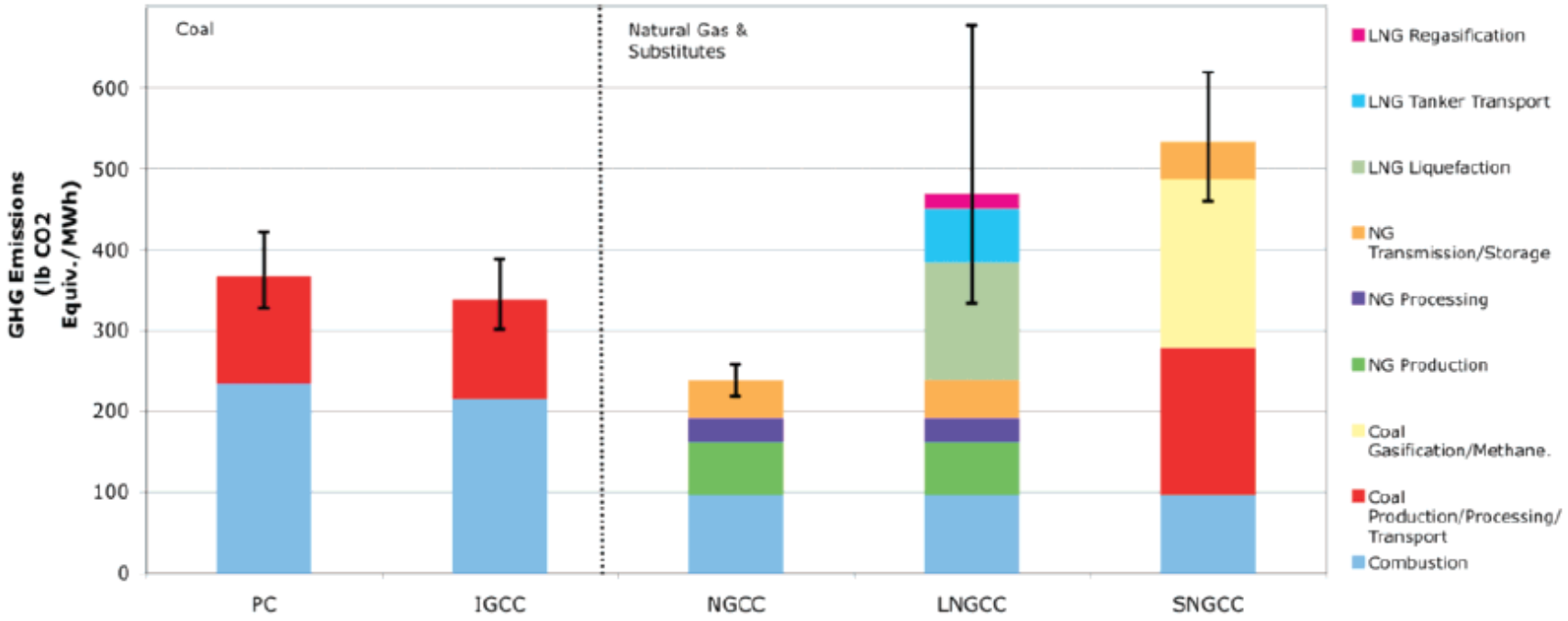
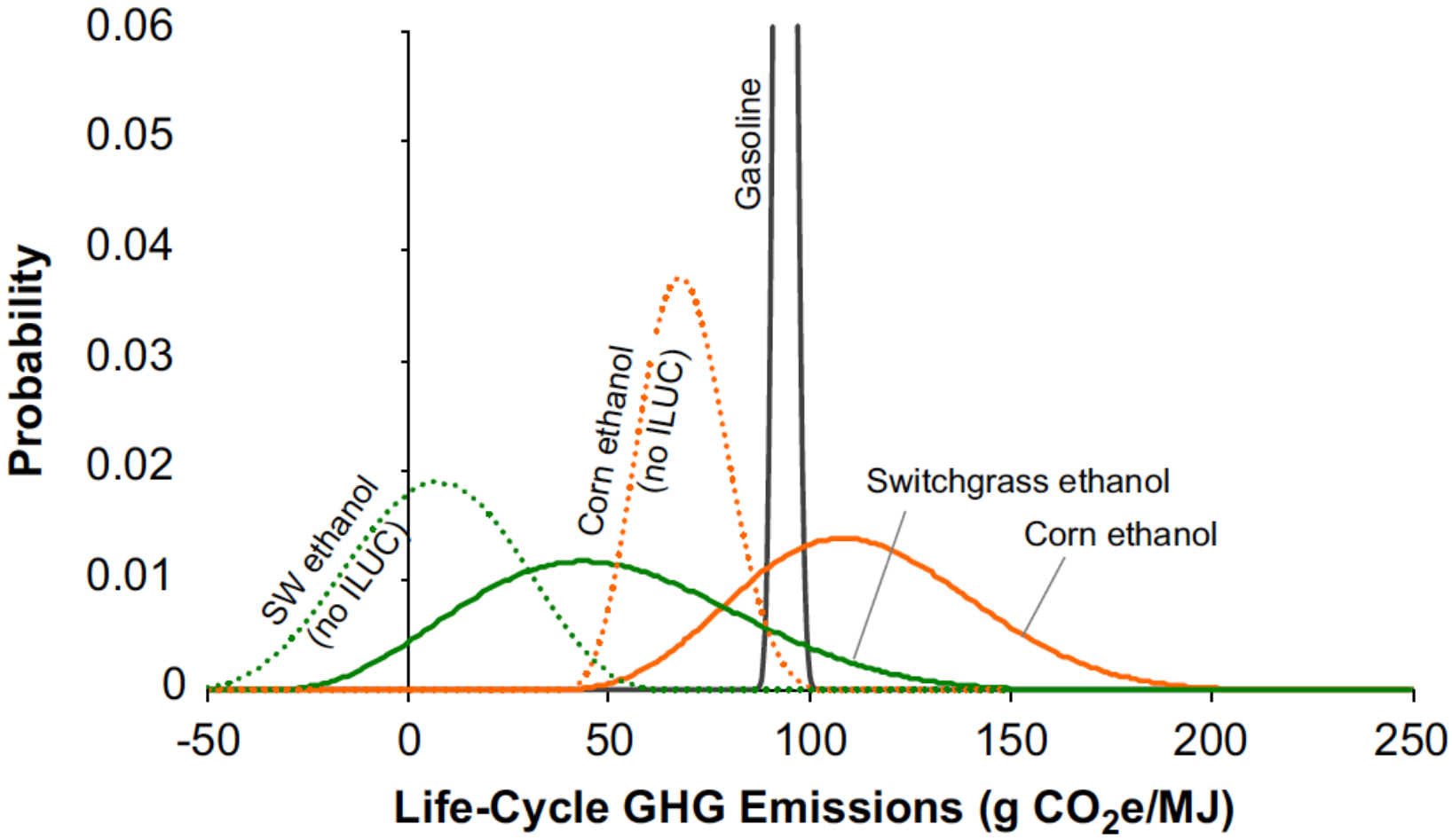


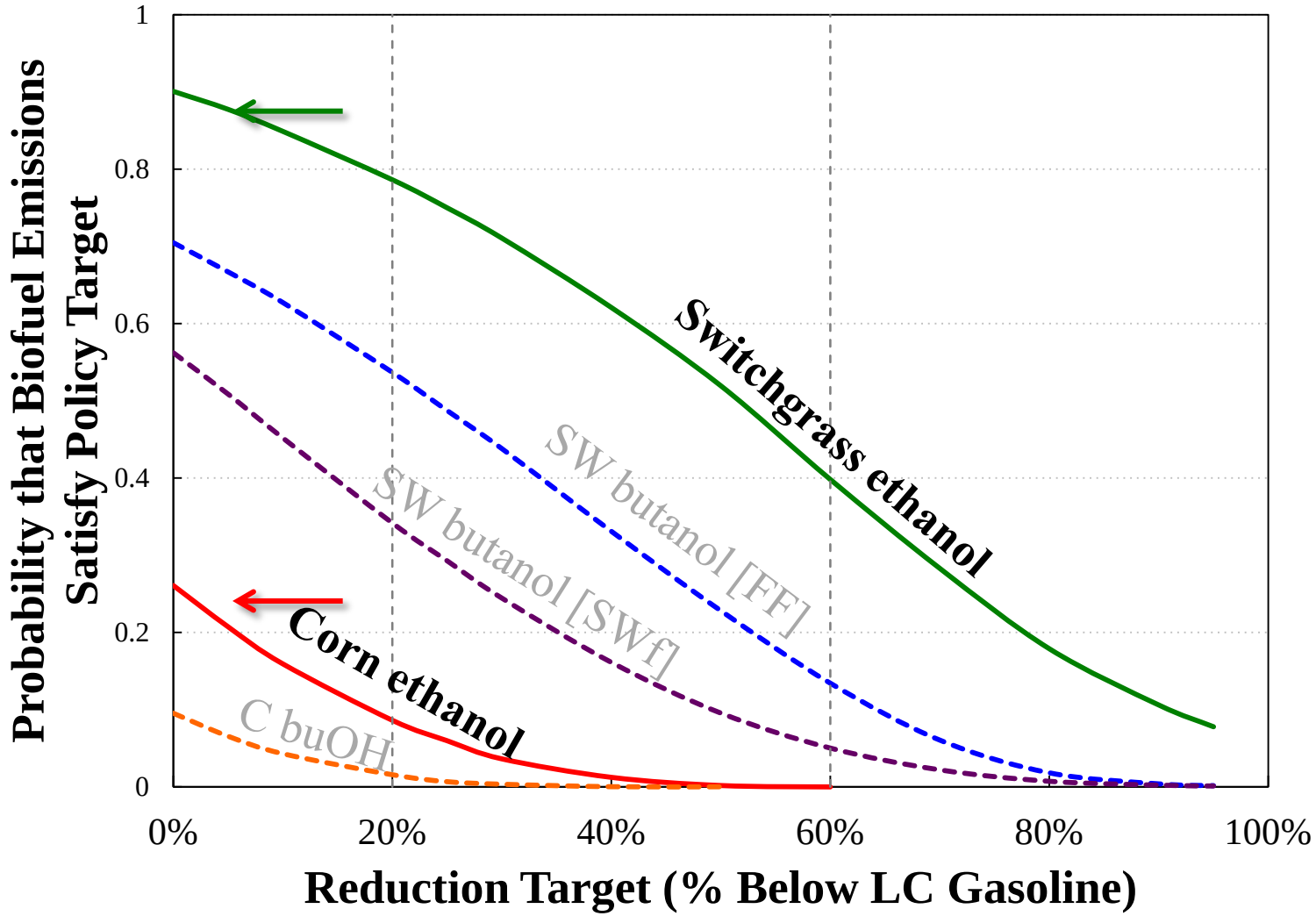
FIGURE 3. Midpoint Life-Cycle GHG Emissions Using Advanced Technologies with CCS.

Jaramillo, *et al*. 2009



Kocoloski *et al.*, 2013

How Likely Will You Achieve Goals?



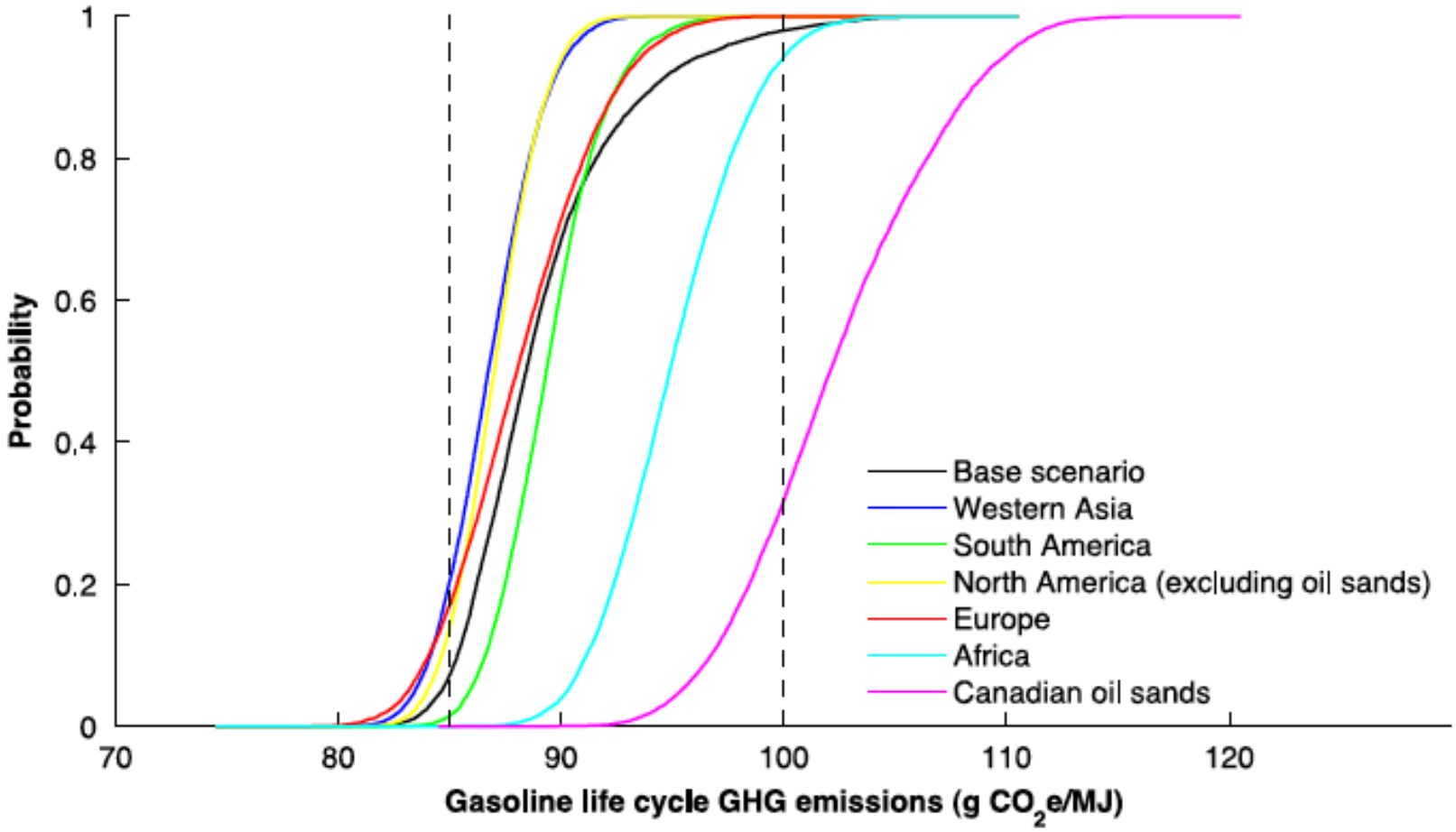
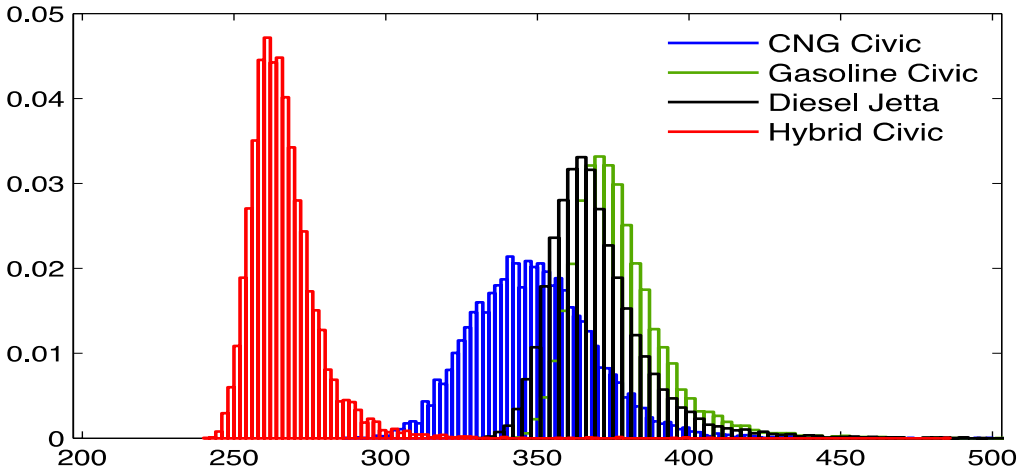
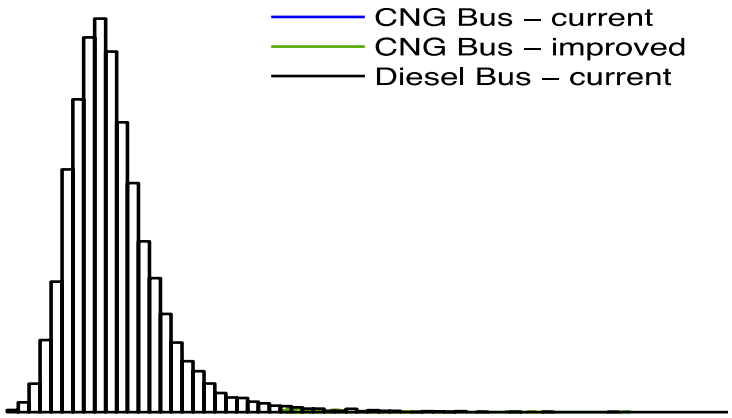


Fig. 3. Cumulative distribution functions with a comparison of life-cycle GHG emissions of gasoline produced from crude oil obtained from different regions with base scenario—90% confidence interval for base scenario represented by dashed lines.

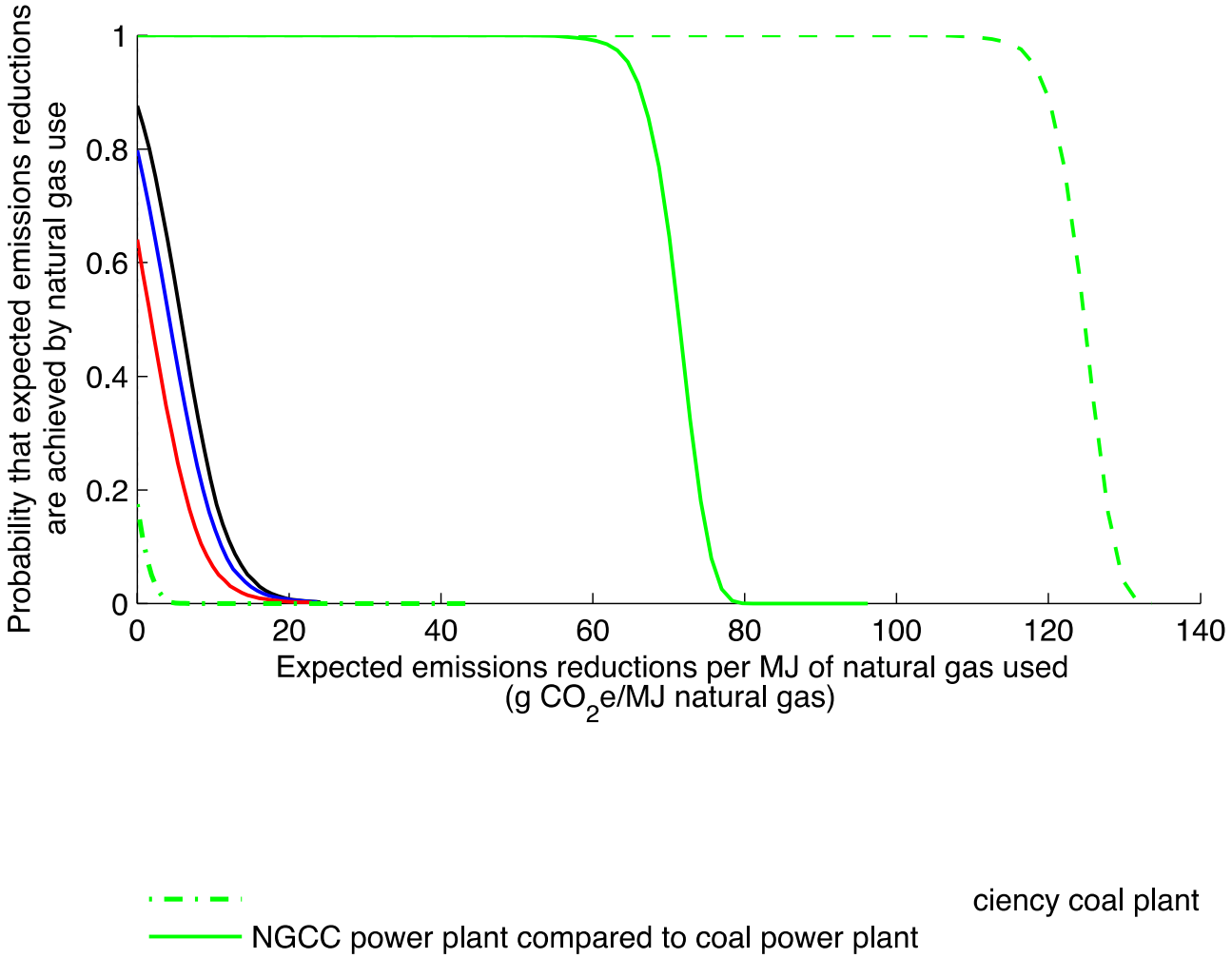


(a)



(b)

Venkatesh *et al*. 2011 ES&T 45:8182–8189



Venkatesh et al. 2011

DO IT!

Value of "DOING IT"

- Leads to insights you might not otherwise gain from your analysis
- Can guide policy targets
- Gives some idea of the "robustness" of an policy designs

Acknowledgements

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References

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Some Reasons for Uncertainty

- Parameter uncertainty can arise:
  - lack of data;
  - inadequate or incomplete measurement;
  - statistical variation arising from measurement instruments and methods;
  - systematic error
  - subjective judgments needed to estimate its nature and magnitude;
  - and inherent randomness

Morgan *et al*., 2009

Some Reasons for Uncertainty

- Model Uncertainty is broader in scope and can arise from many of the same sources as uncertainty for parameter uncertainty:
  - how to allocate emissions from one process across multiple co-products;
  - how economically-mediated production impacts will evolve over space and/or time;
  - what global warming potentials to use for greenhouse gas emissions; and,
  - what processes to include in the system boundary.

Morgan *et al*., 2009

Variability

- Some authors refer to a from of uncertainty as "variability."
  - How a quantity can vary across space, time, or other relevant dimensions
- In practice for LCA analyses, maintaining the distinction between uncertainty and variability is not especially important and simply can be treated as uncertainty in many instances

Morgan *et al*., 2009