Emerging Issues and Data Needs for LCA Modeling of Electricity

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This Briefing Draws on Insights from a Few of Our Recent Journal Papers

- **We would like to acknowledge the hard work of the coauthors**
  - Paulina Jaramillo
  - Jeremy Michalek
  - Mikhail Chester
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  - Timothy Skone

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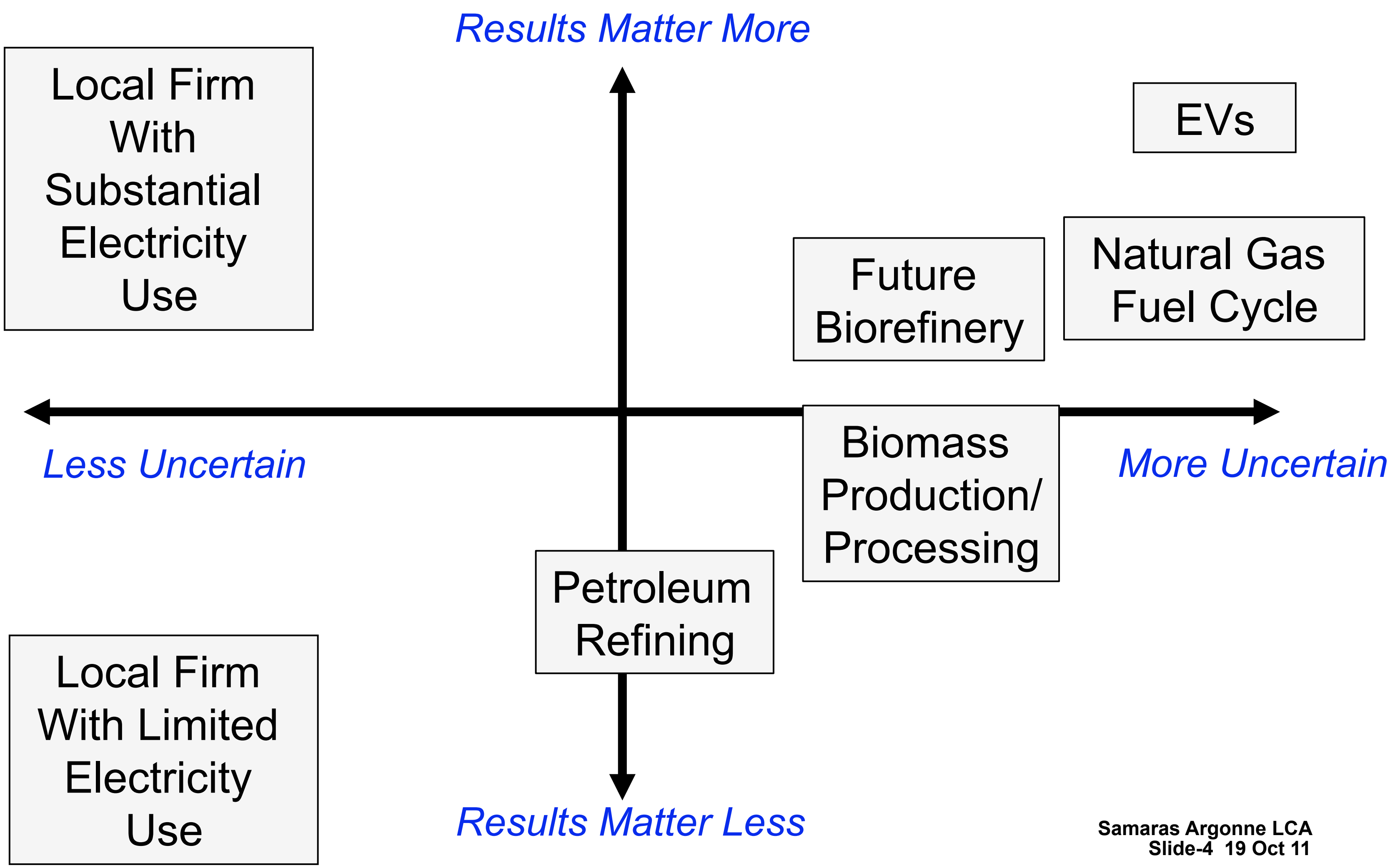
This Briefing Continues the Discussion on Some Critical LCA Issues

- **What are some outstanding and emerging issues for electricity LCA?**
- **Are current modeling methods sufficient?**
- **What are the key LCA inputs needed in the next year or two ?**
- **Figuring out what matters and establishing consistency for policymakers**

Electricity LCAs Have Varying Levels of Importance and Uncertainty



Emerging Issues Will Be Defining Baselines, Boundaries, and Acceptable Uncertainty Ranges

- **Two separate and challenging tasks:**
  - **Understand electricity generation impacts for a functional unit**
  - **Understand electricity fuel cycle impacts for that case**

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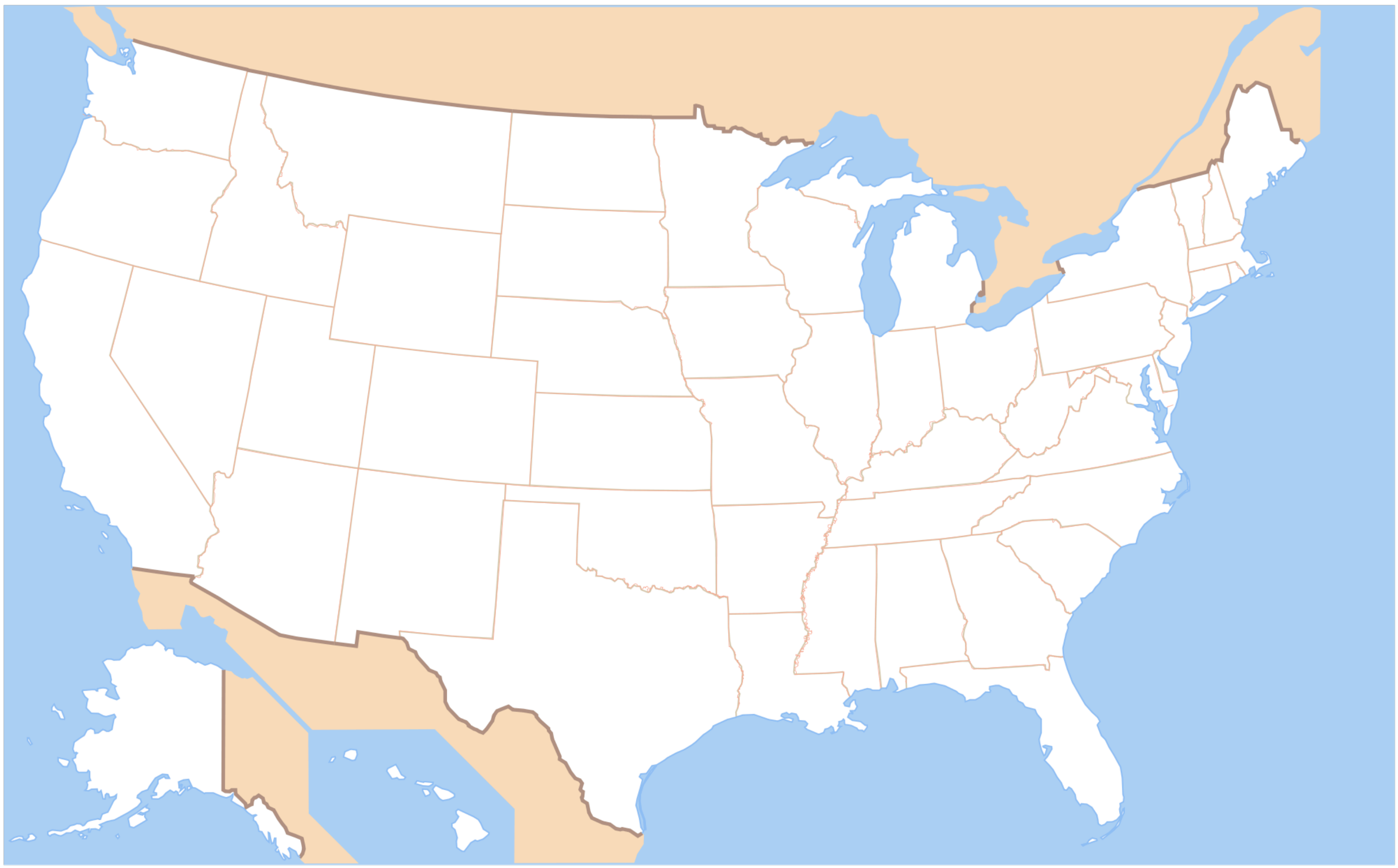

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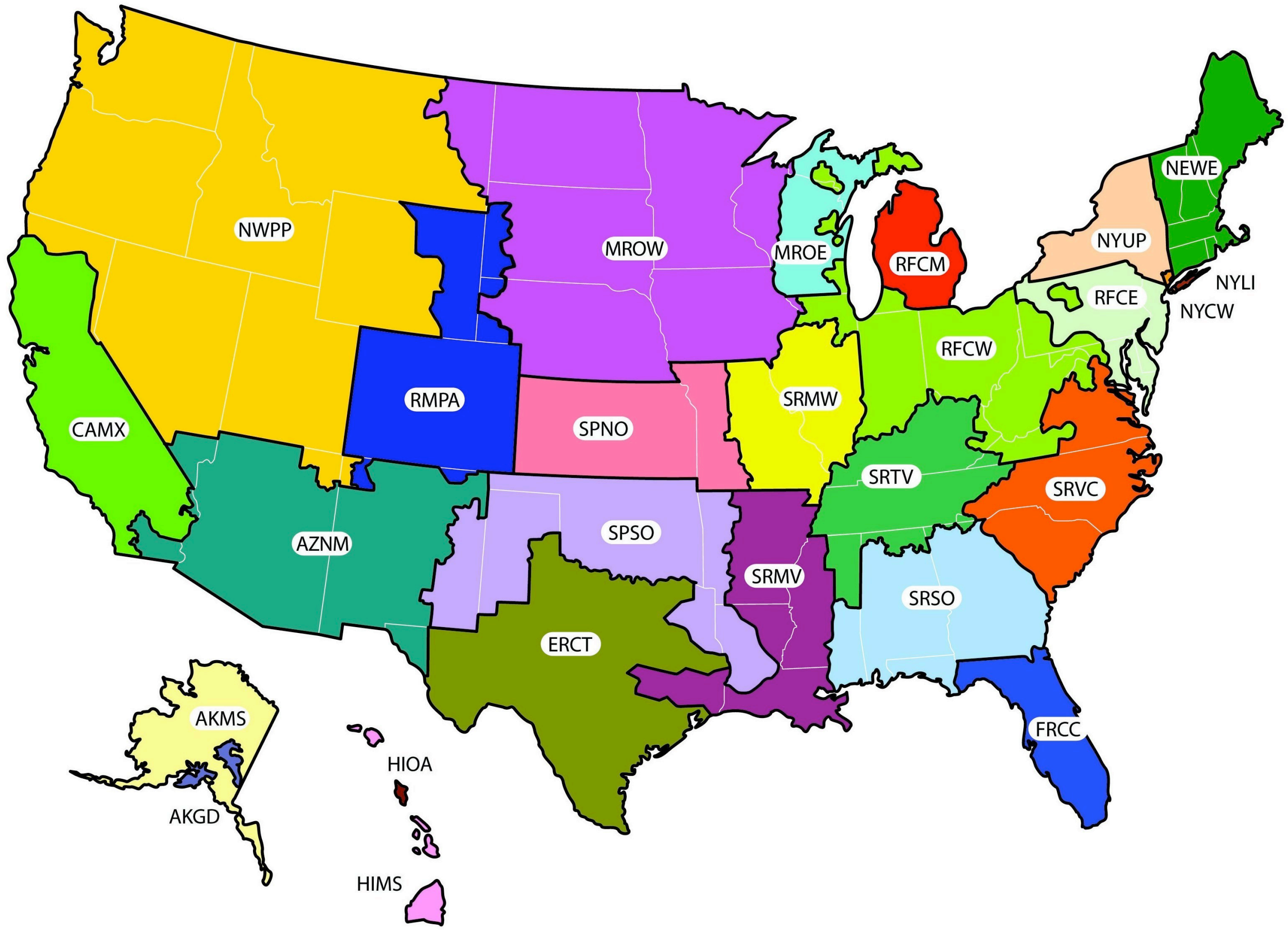

Source: EPA

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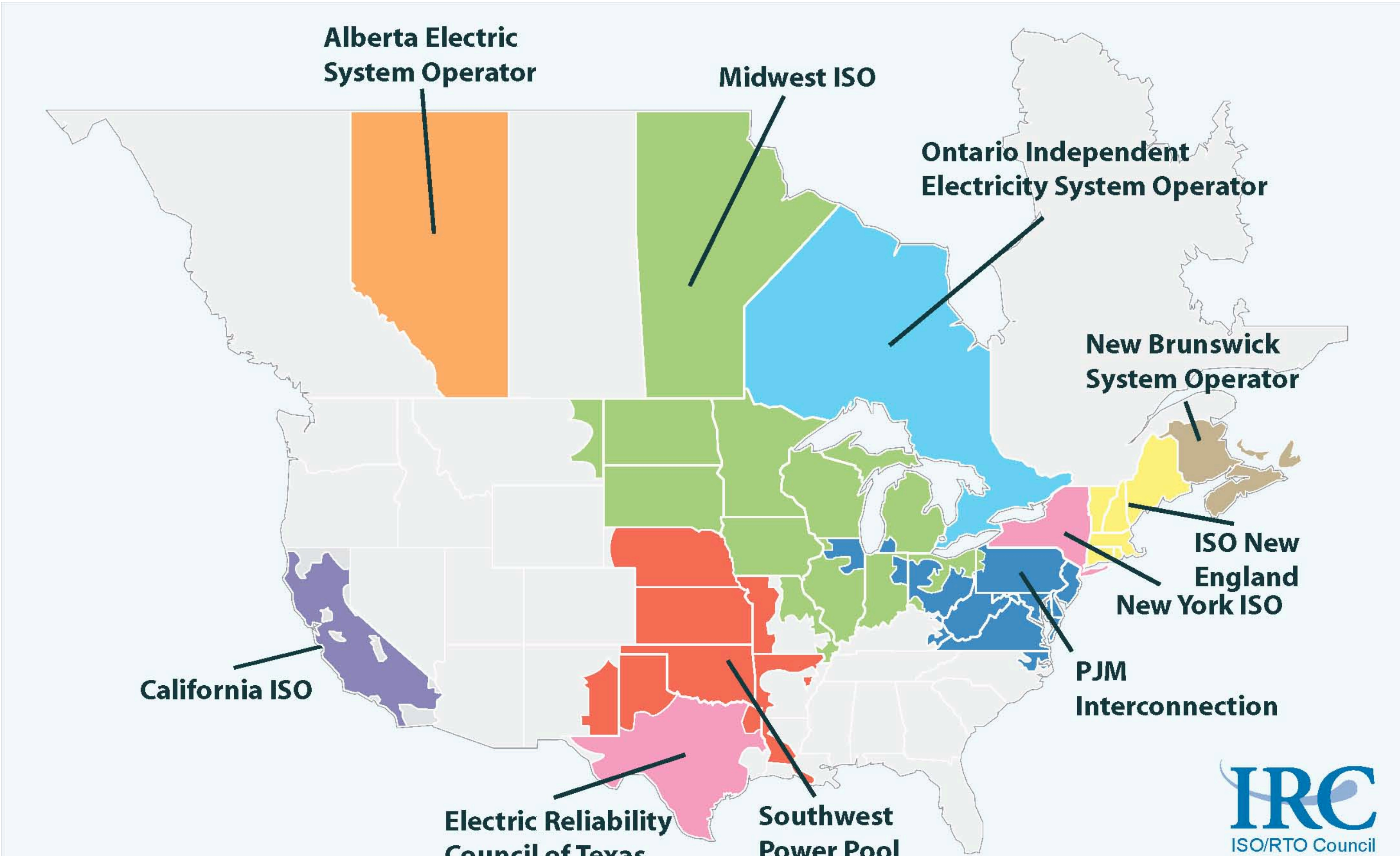

Source: ERCOT

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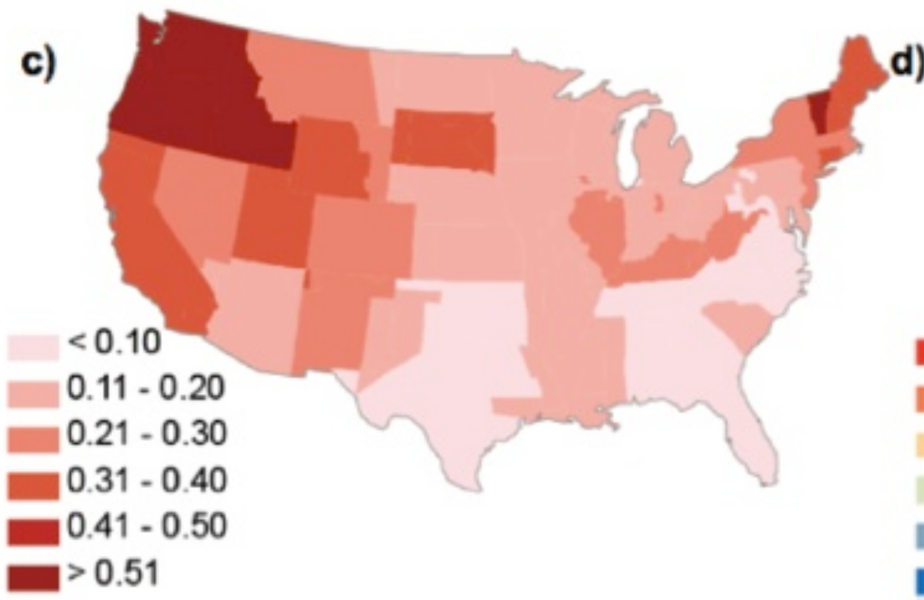

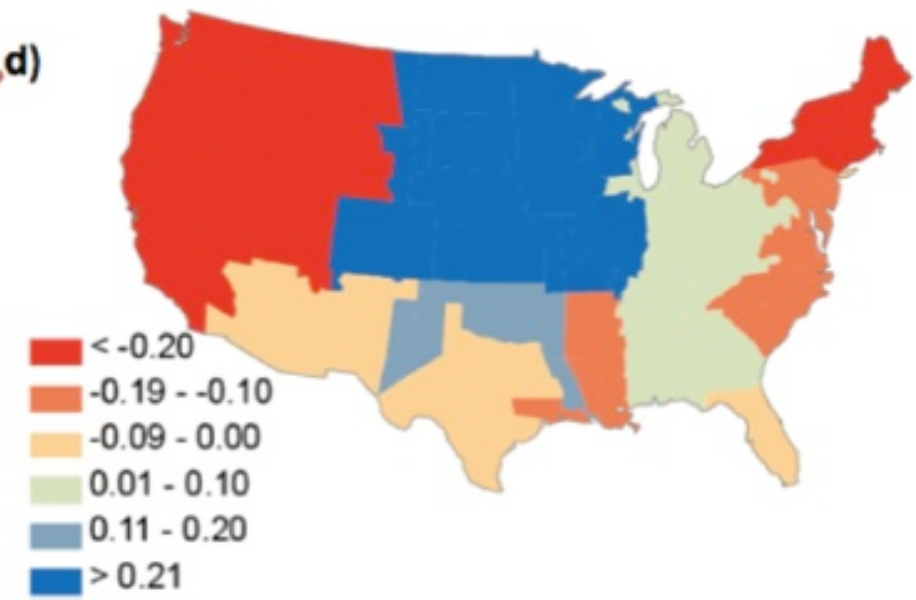

Source: Weber, C., Jaramillo, P., Marriott, J., Samaras, C., 2010. Life cycle assessment of grid electricity: What do we know and what can we know? *Environmental Science and Technology*, 44(6) 1895-1901.

Emerging Issues Will Be Defining Baselines, Boundaries, and Acceptable Uncertainty Ranges

- **Two separate and challenging tasks:**
  - **Understand electricity generation impacts for a functional unit**
  - **Understand electricity fuel cycle impacts for that case**
- **Use of state or eGrid subregions omits life cycle impacts and results in “winners” and “losers”**
  - **Right now, an entity can choose the most favorable boundaries and baselines for purchased electricity impacts**
- **Arguments for and against marginal electricity impacts and consequential electricity LCAs will intensify**
  - **How do we sort out the “good” LCAs and how can the and their inherent uncertainty be best utilized by policymakers?**

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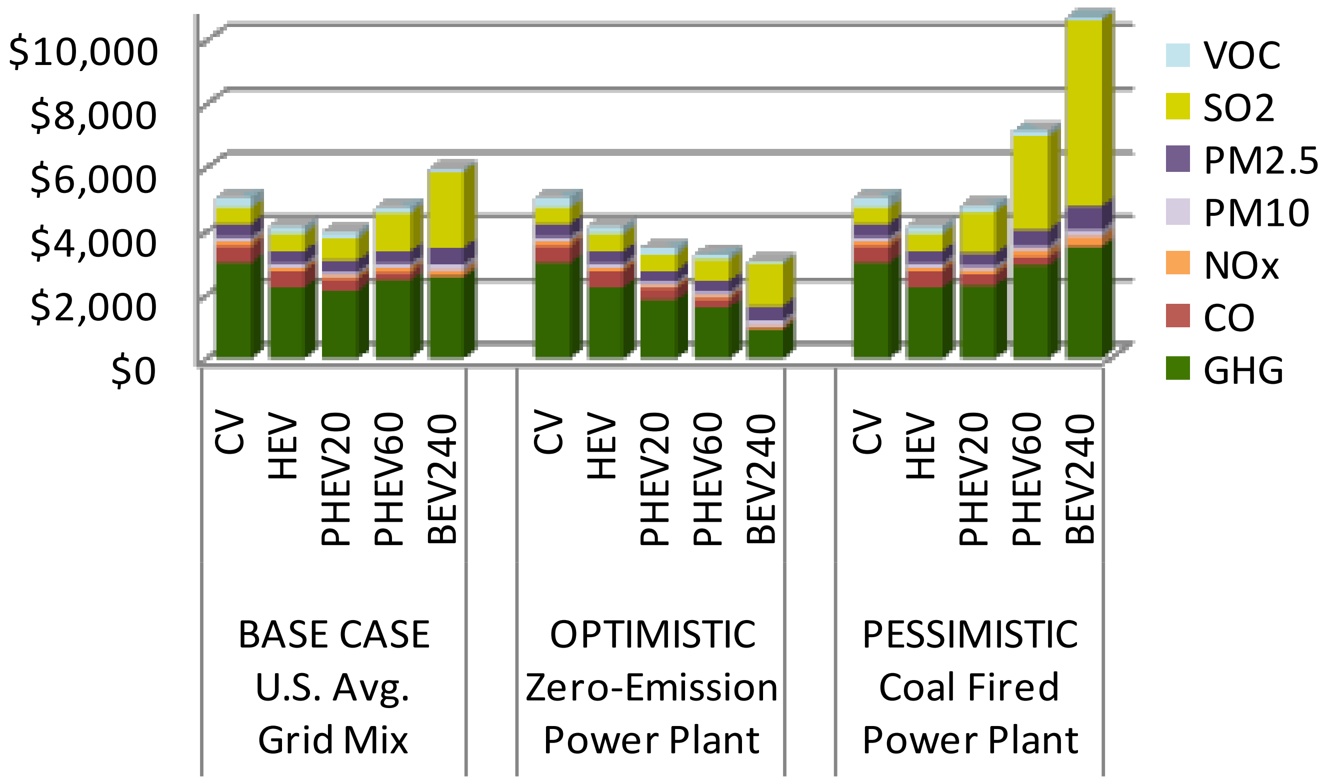
- **Need to make decisions under uncertainty but need transparent inputs**

Current Modeling Methods Are Helpful But Subject to Model, Data, and Scenario Uncertainty

- **We can use or edit GREET, or attempt to append eGrid with upstream impacts**
- **We can develop our own process-based, input-output, or hybrid models**
- **We can parameterize and use bounding analysis**
- **We can conduct grid dispatch analyses in certain areas**

Example: Lifetime Emissions Damages Could be Higher With Evs

- **Emissions damage reduction potential of plug-in vehicles**
  - **Optimistic: $1000 damage reduction over the life**
  - **Pessimistic: $6000 damage increase over the life**



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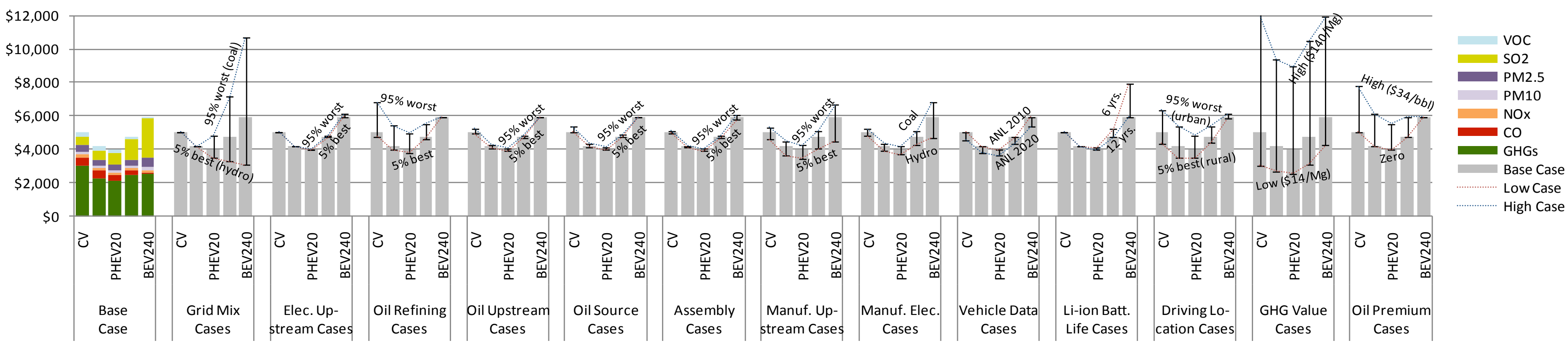
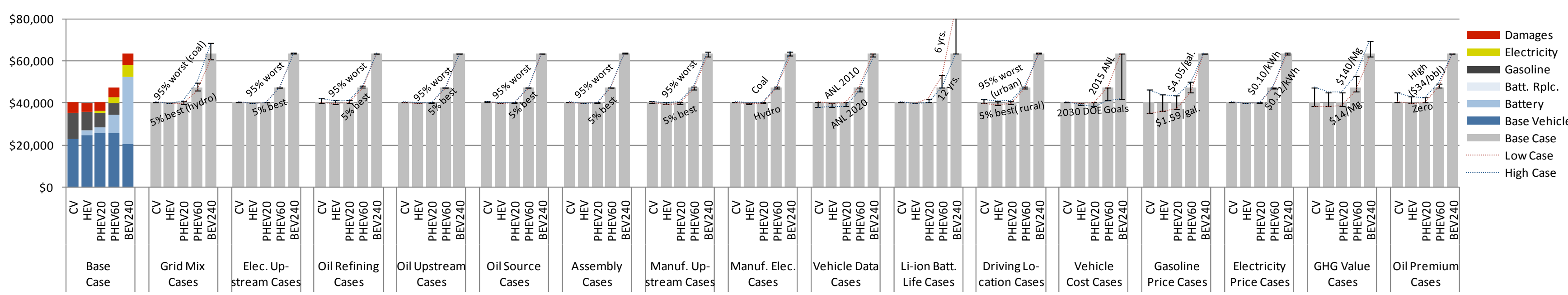
Source: Michalek, J.J., Chester, M., Jaramillo, P., Samaras, C., Shiau, C-S.,N., Lave, L.B. 2011. Valuation of Plug-in Vehicle Life Cycle Air Emissions and Oil Displacement Benefits. *Proceedings of the National Academies of the USA*. 108(40) 16554-16558.

Sensitivity Analyses Essential, But Complexity Can Get Overwhelming





Source: Michalek, J.J., Chester, M., Jaramillo, P., Samaras, C., Shiau, C-S.,N., Lave, L.B. 2011. Valuation of Plug-in Vehicle Life Cycle Air Emissions and Oil Displacement Benefits. *Proceedings of the National Academies of the USA*. 108(40) 16554-16558.

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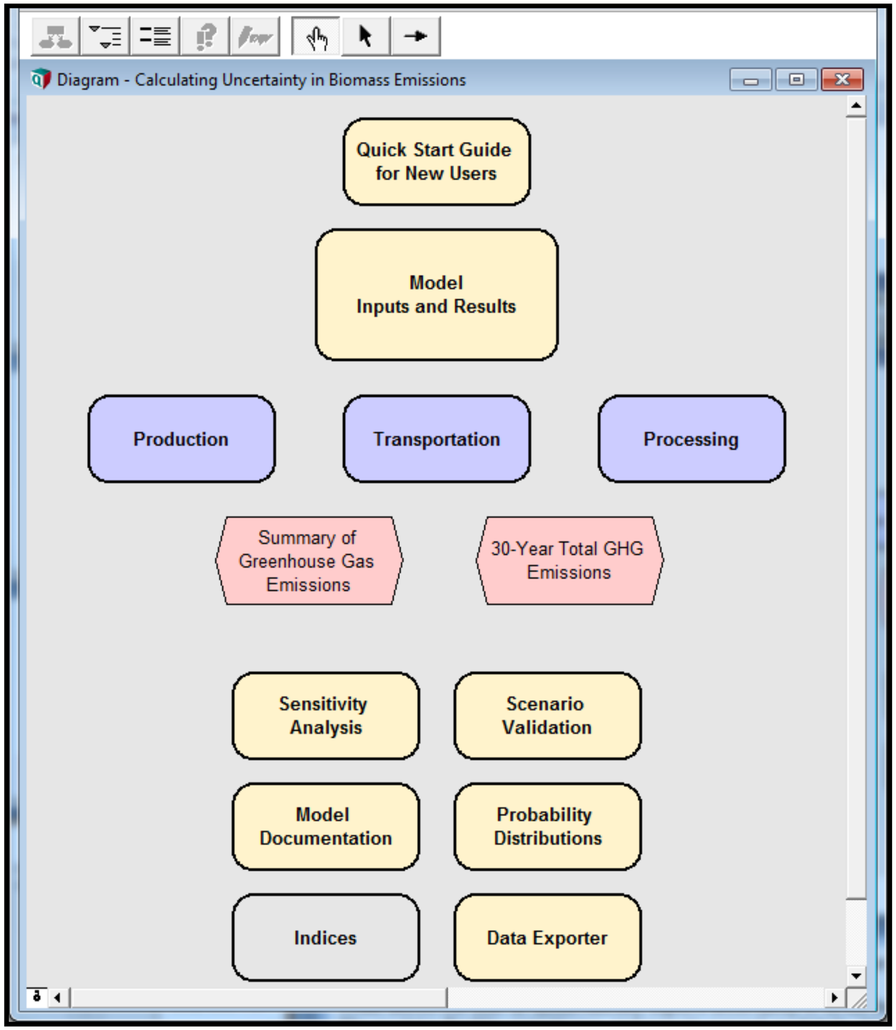
The Most Useful Models Are Transparent, Documented, Peer-Reviewed and Revised Regularly



The Calculating Uncertainty in Biomass Emissions (CUBE) model:

- A tool for analyzing the life cycle inventory of emissions from biomass production
- Includes seven feedstocks:
  – switchgrass, mixed prairie biomass, corn grain, corn stover, hybrid poplar, forest residue, mill residue
- Impacts examined across region, feedstock and prior land use
- Based on literature and consultation with biomass-energy experts
- Publicly available at: www.rand.org/ise/projects/bioemissions.html

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- **Are current modeling methods sufficient?**
- **Need to make decisions under uncertainty but need transparent inputs**
- **What are the key LCA inputs needed in the next year or two ?**
- **Capture impacts from evolving grid and important upstream processes and think about long-term evolution of current tools**

Key Near-term Data Will be How Grid Changes and Upstream Natural Gas Impacts

- **As the electricity fleet continues to evolve, eGrid and GREET should have frequent updates**
  - **What if GREET evolved into a documented, peer reviewed, and crowd sourced model that is updated every three years? What if eGrid and GREET were coupled? What if they used electricity balancing areas rather than subregions?**
    - **This would allow satisficing for large policy questions and allow individual researchers to use components for individual analyses and checks**
- **As more shale gas comes online and is used for electricity production, we need an understanding of how this affects life cycle electricity GHGs from electricity**

Summary

- What are some outstanding and emerging issues for electricity LCA?
- Figuring out what matters and establishing consistency for policymakers
- Are current modeling methods sufficient?
- Need to make decisions under uncertainty but need transparent inputs
- What are the key LCA inputs needed in the next year or two ?
- Capture impacts from evolving grid and important upstream processes and think about long-term evolution of current tools

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