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Metrics for Evaluating Conventional and Renewable Energy Technologies






Natural Gas And The Transformation Of The U.S. Energy Sector: A Program Studying Multi-Sector Opportunities And Impacts Scoping Workshop

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December 2012

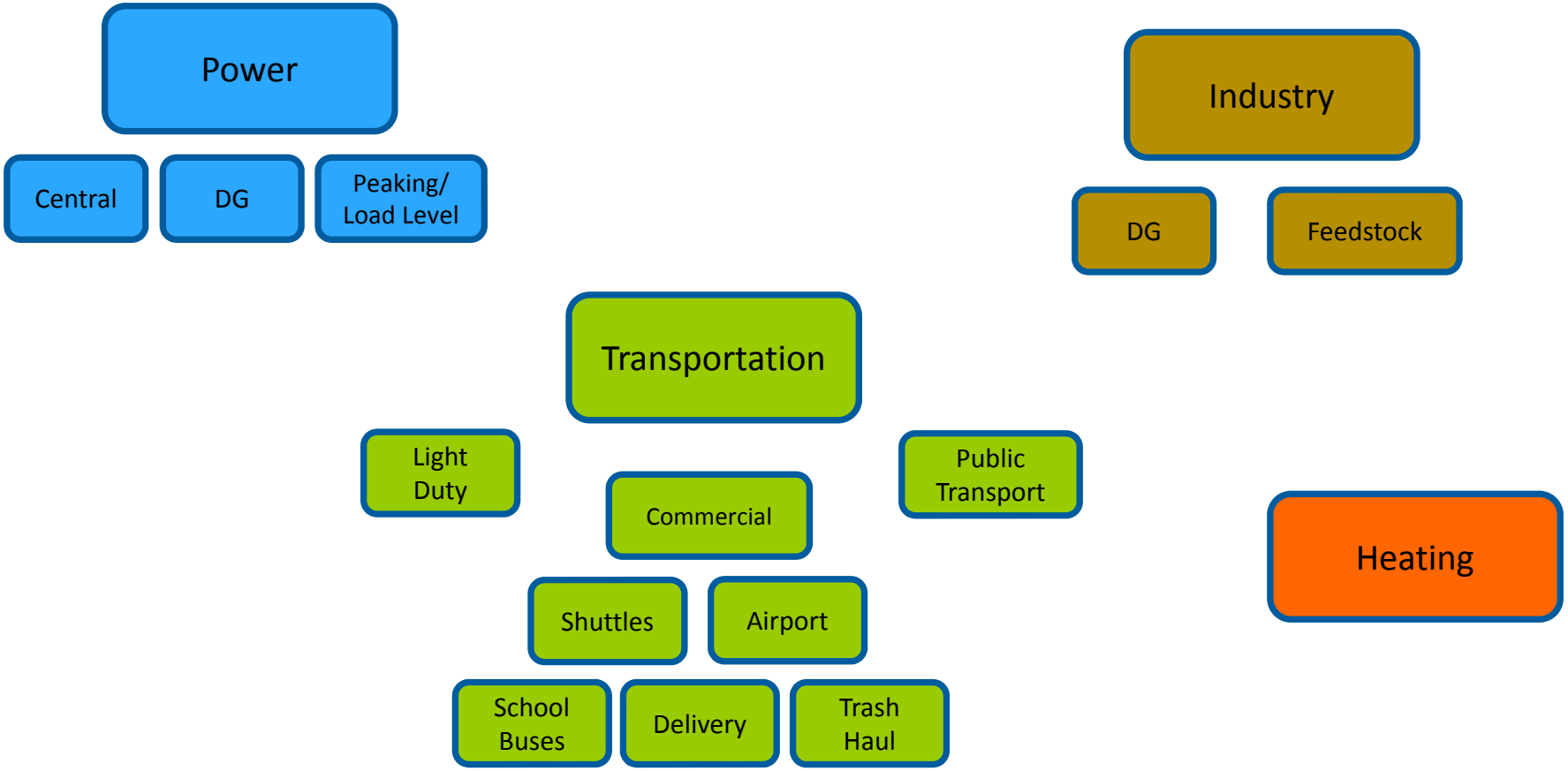
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Outline

- Numerous pathways for greater use of natural gas – how do we know if we're going down the "best" pathways?
- Choosing between pathways can be done methodically
- Choose metrics wisely
  1. Stakeholders have varying views
  2. Markets have varying needs
     a) Commercial viability
     b) Environmental sustainability
     c) Seasonal demand
     d) Price sensitivity
  3. Some metrics are actually misleading
  4. Trade-offs are very likely
- Communication of impacts is one of the most difficult aspects of analysis: Visual presentation helpful.

Gas Destinations



Choosing Metrics

Metrics should be:

- Relevant to multiple stakeholders
- Able to cover a range of scenarios
  - Technology
  - Time
  - Location
- Able to provide a systems-level and local-level view of impacts
- Ideally quantifiable
- Linked to actual impacts
- Easily communicated.

Proxy Metrics

There's a long history of wanting to designate a single metric (or a very few metrics) that can be a proxy for the larger set.

- Net energy
  - Biggest con: Not all resources available in the same quantities and with the same impacts
- LCOE (cost)
  - Biggest con: Variations in finance assumptions (e.g., depreciation, hurdle rate, inflation); not singing from the same song book
- Combined score(s)
  - Biggest con: Value judgments and personal experiences.

Different stakeholders care about different impacts.

Choosing Metrics Wisely

The wrong metric can mislead or cloak the real issues

For Example:

- ~~Energy Use~~
  - Metrics seeking to define energy use, particularly between different energy sources and for different end uses, do not reflect the societal, economic, or environmental costs.

- ~~Resources~~
  - Knowing how much of a non-renewable resource is consumed is unimportant without an understanding of the societal, economic, and environmental costs of the alternative.

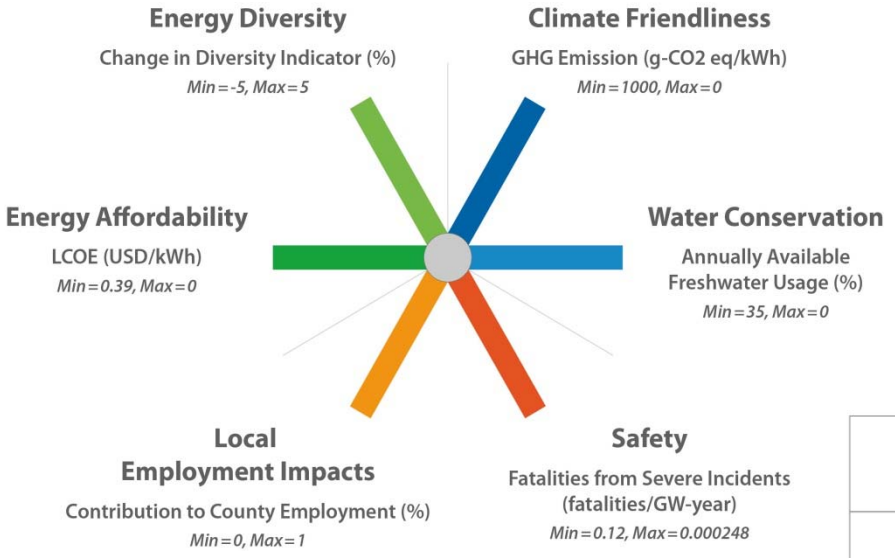
- ***Impacts***
  - All energy systems have impacts. Metrics to elucidate the societal, economic and environmental impacts between systems can help decision makers understand the pros and cons of different systems.

Determining the "Best" Pathways

Some Examples of Informative Metrics

Social	Environmental	Economic
• Health impacts • New technology acceptance • Education opportunities and needs • Employment • GDP • Gender impacts • Rural development • Energy access • Safety and security • Energy security • Food security • Cultural preservation.	• GHG emissions • Primary energy use • Biodiversity • Water use and impact • Air quality • Land use impacts • Soil health.	• Cost of energy • Employment • Industry expansion • Trade impacts • Energy imports and security • Market demand • Climate resilience • Social license to operate • Infrastructure "lock-in" • Technology innovation "lock-out."

Visualization



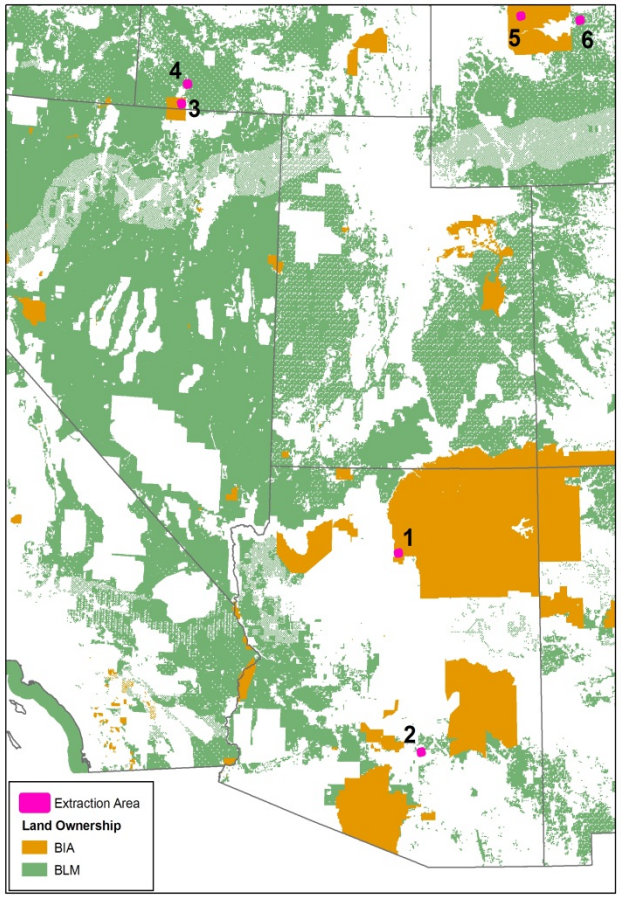
The challenge is to communicate across stakeholder groups.

	Technology A	Technology B	Technology C
Location 1			
Location 2			

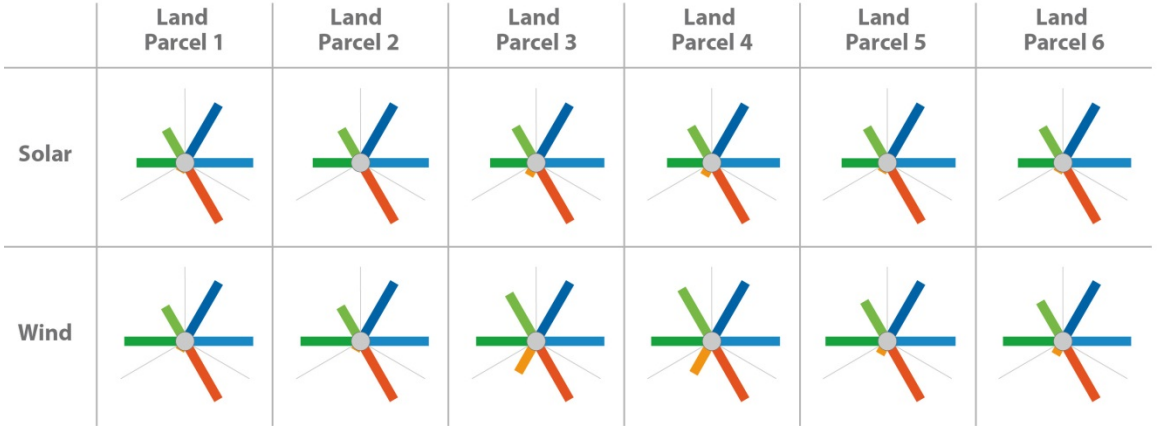
Trade-offs between impacts are very likely.

The goal is to inform decision-makers.

Geographic Differentiation



Analysis and presentation of trade-offs should include location, technology, and time.



Analysis Certainty

Analysis rarely gives you *"The Answer"*

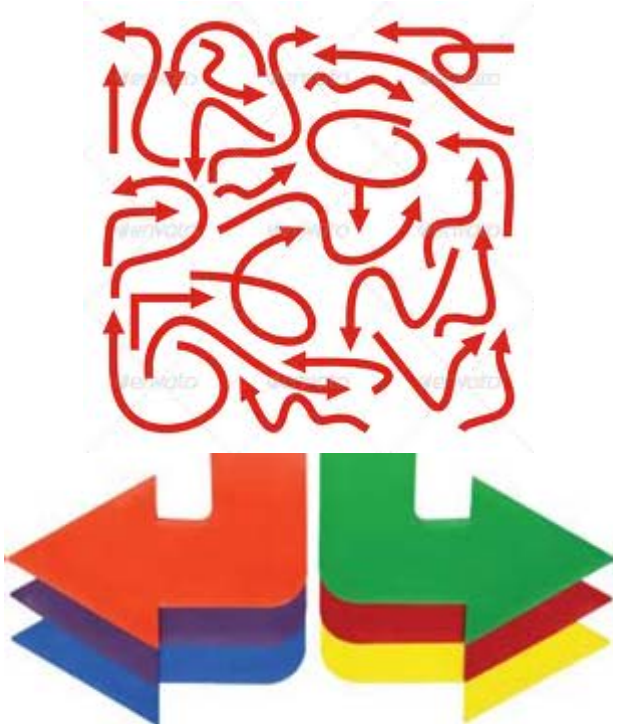
- If done well, it will point you in the right direction and help you ask the next set of questions
- Insight is the goal.

Most important step in any analysis is the ***sensitivity analysis***

- Even more important than data collection
- Must work to understand the impact of variation in assumptions
- Think about "What if" scenarios and "What if not" scenarios.

Metrics

- Choosing between pathways can be done methodically
- Choose metrics wisely
  1. Stakeholders have varying views
  2. Markets have varying needs
     a) Commercial viability
     b) Environmental sustainability
     c) Seasonal demand
     d) Price sensitivity
  3. Some metrics are actually misleading
  4. Trade-offs are very likely
  5. Include interactions between markets
  6. Visual presentation helpful.



Research Recommendation

- Perform a multi-metric analysis to more clearly define the pros and cons of the various pathways for increased natural gas use. Choose metrics to illuminate the market, economic, and sustainable trade-offs.
- Incorporate these multi-metrics into complementary analyses and models.