Performing LCA of Early-stage Energy Technologies at NETL

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Current mission of the Lab

Discover, integrate, and mature technology solutions to enhance the nation’s energy foundation and protect the environment for future generations.

LCA is a critical tool for both guiding research and evaluating whether research is accomplishing the mission.
Research and LCA at NETL are both largely fossil resource-based

• This is not universal (we think about biomass a lot, for instance), but it is a useful shortcut when talking about how we handle prospective LCA

• Note: Another useful shortcut is to talk in terms of power generation, but the approach is also applicable to fuels production, or resource extraction
Our view of what defines a “prospective LCA”

1. Determine how a technology will perform when mature
2. Define how a deployed technology will change the world around it (consequential LCA)
3. Examine how the technology will perform as the world changes around it (forecasting)

Because we are generally dealing with large-scale energy systems with intended 60-80 year lifetimes, 2 & 3 are considered one thing
Technology in fossil energy systems is most often evolutionary

- Most of the improvements which cross our desk are
  - *Incremental*, e.g. moving the efficiency from 37 to 39%
  - *Marginal*, i.e. a significant improvement, but to a relatively small portion of the overall system, e.g. new membrane for CO₂ separation in an otherwise conventional pulverized coal plant

- So uncertainty about the environmental performance of a hypothetical technology is dampened by overall system’s performance
Many innovative or advanced subsystems are already demonstrated or deployed

• For instance:
  • Post-combustion capture
  • Biomass co-firing
  • Gasification
  • Super- or ultra-super-critical combustion

• All demonstrated or deployed at significant scale, either in the U.S. or internationally

• So, performance data is already available
Absent performance data from demonstrations or deployments, use scenario and sensitivity analysis

- TRL 1-4 results are a good start
- Use scenarios, sensitivity analysis, or breakeven analysis to understand where the performance needs to be for it to meet a broader system goal
Supply chains are well-established

- Coal, natural gas, fuel, oil, biomass, as well as rail, barge, and pipeline transport – these are well understood and well characterized
Then, we’re at a consequential LCA...

- And all the temporal and scaling challenges associated with attempting to perform consequential LCA of large-scale energy systems
  - How will this thing behave when we release it into the world and let it run for the next 8 decades?
  - What major systems will it touch, what impact will it have, what is the footprint of that impact?
  - How will the touches, impacts and footprints change over time?
Summary thoughts on Prospective LCA

- Many LC evaluations of R&D-stage technologies don’t significantly change system performance

- Effort expended on an LCA should correlate with the readiness of the technology
  - Screening for red flags only at a stage when performance and feasibility is still uncertain

- Tools and methods used when conducting early-stage LCA are largely the same as for established systems
  - There will be data gaps and uncertainties that must be dealt with for both

![Normalized TRACI 2.1* Impacts for 1 kWh Delivered Electricity from a Solid-oxide Fuel Cell Power System](chart.png)
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