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Greenhouse Gas Estimates of LNG Exports Must Include Global Market Effects

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Typical GHG assessment techniques assume LNG replaces other fuel source at 1:1 ratio

- Low-cost natural gas production in the US and Canada has led to a boom in liquefied natural gas (LNG) export capacity.

LNG export capacity from US and Canada.[1-4]

	Cumulative export capacity (Bcfd)	Cumulative % of domestic production	Cumulative % of global production
2021 in-service	11.4	11%	3%
Under construction	27.0	27%	7%
Approved for development	76.9	76%	20%

- Greenhouse gas (GHG) emissions are typically quantified using attributional lifecycle analysis (ALCA), which considers direct emissions from producing, exporting, and combusting natural gas.[5-9]
- Changes in emissions from LNG exports are calculated by taking the difference between the attributional lifecycle emissions of LNG and another fuel source, typically coal.

$$\Delta\, GHG\ Emissions = (ALCA\ GHG)_{LNG} - (ALCA\ GHG)_{coal}$$

- By implicitly assuming perfect substitution between LNG and coal, this ignores natural gas and coal use quantity changes in response to energy price changes.

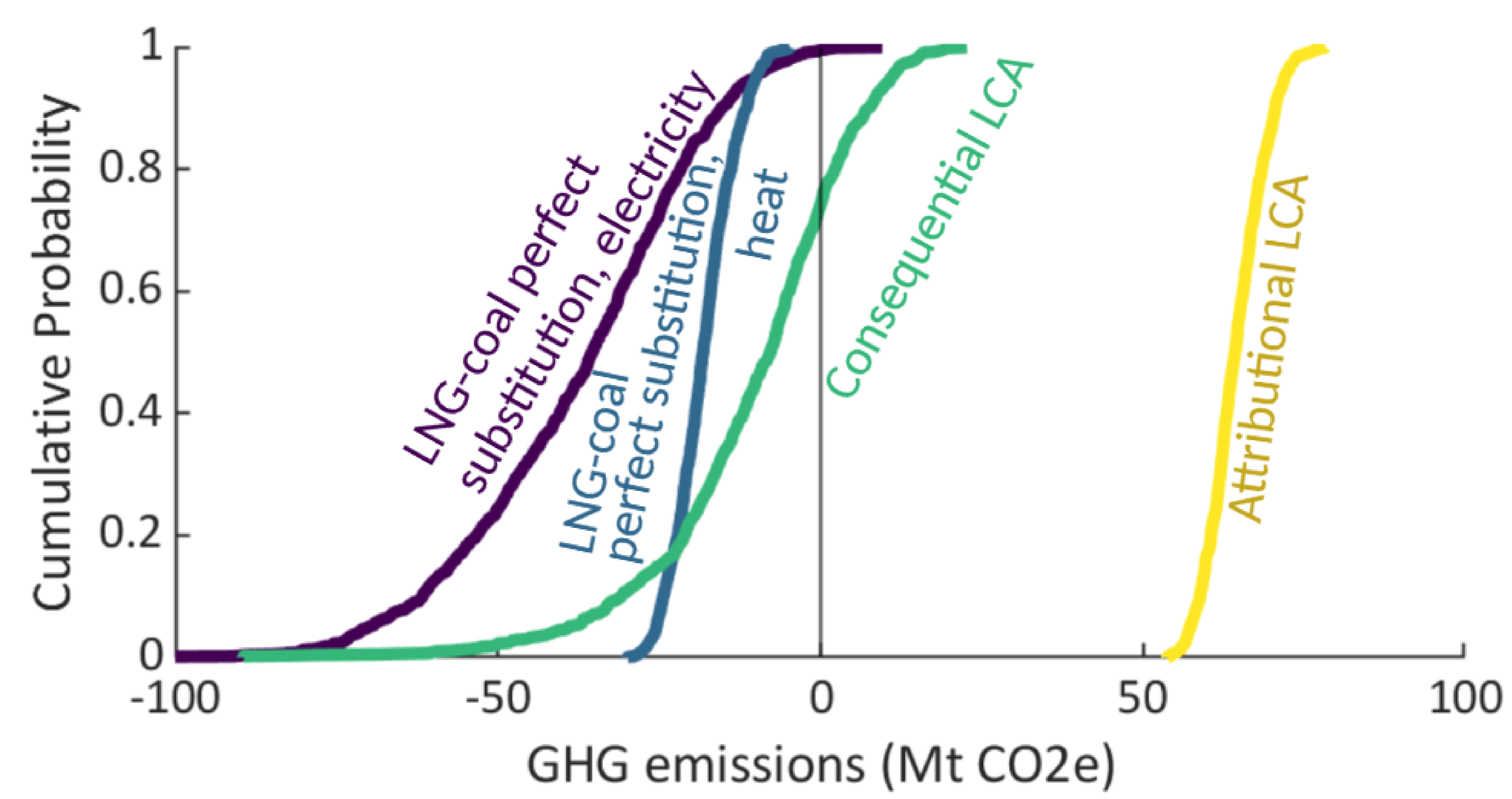
How do GHG assessments of LNG export terminals change if actual LNG-coal substitution rates and rebound effects on international natural gas consumption due to lower prices are considered?

Methods

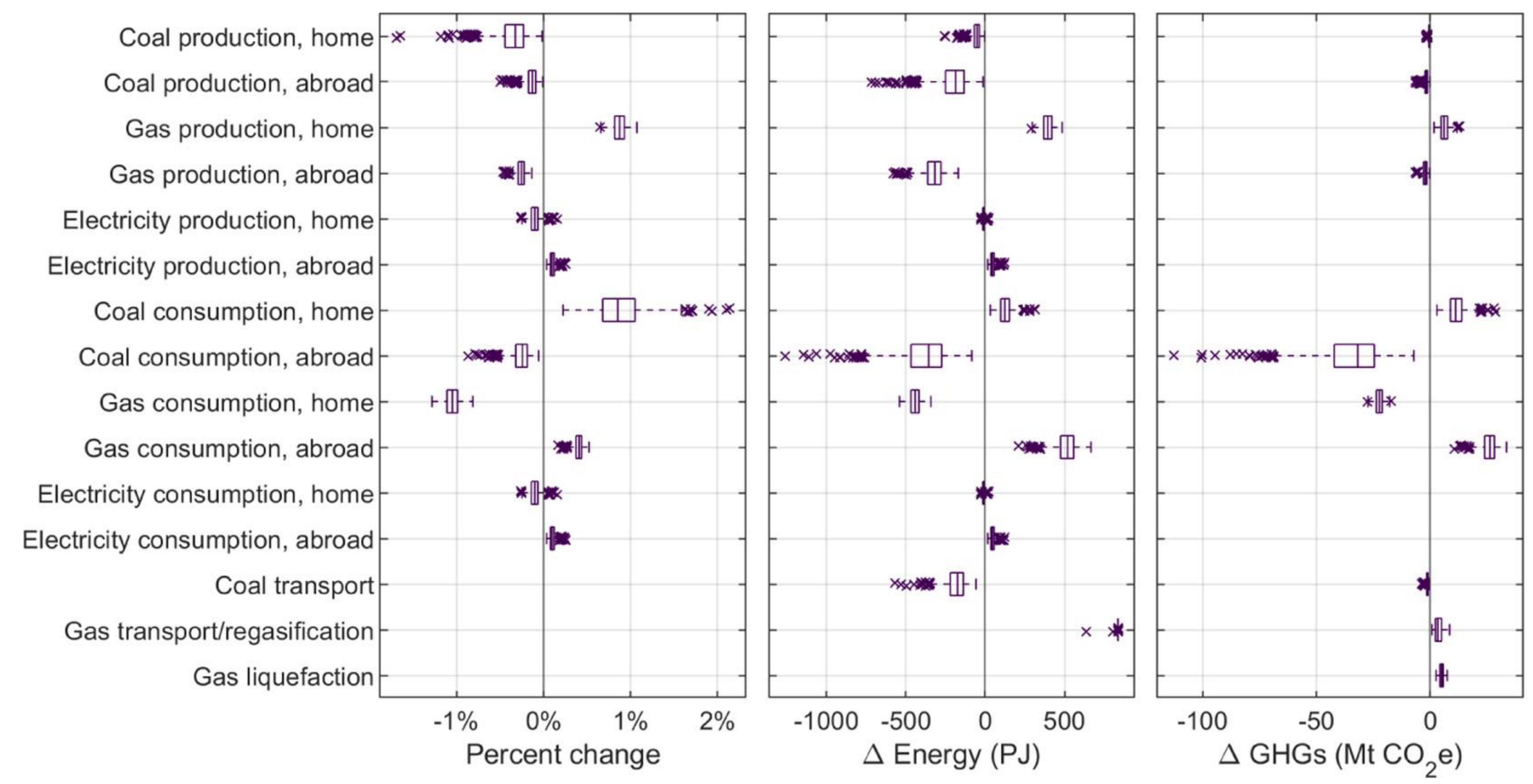
1. Evaluate a 2.1 Bcfd LNG export project, equivalent to one of the largest LNG projects under construction in the US.[1]
2. Use a partial equilibrium economic model to estimate changes in energy use with a two-region (Home & Abroad) and three-commodity (coal, natural gas, and electricity) representation from a 2.1 Bcfd increase in LNG export capacity.[10-11]
3. Adopt emission values from previous ALCA studies to calculate changes in GHG emissions.
4. Combination of attributional LCA and economic modelling is a consequential LCA estimate that includes the market effects of an LNG export project on natural gas and coal use.

GHG benefit of LNG exports is smaller and less certain when market effects included

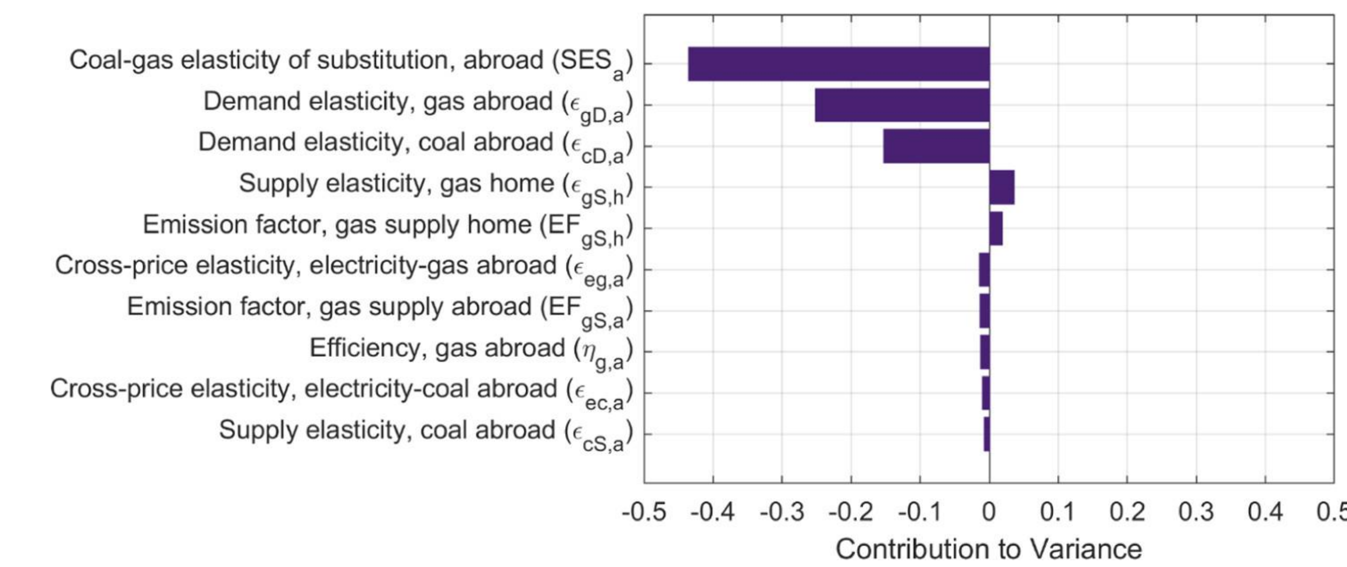
- Consequential LCA, which includes market effects, leads to estimates 25-30 Mt CO2e higher than when assuming perfect LNG-coal substitution for electricity generation.
- At the median, both methods estimate GHG reductions; however, estimated median consequential LCA reductions are 80% smaller when using consequential LCA.



- Domestically, coal use increases in response to higher Home region natural gas prices.
- Abroad, lower priced natural gas leads to increased energy use overall. International natural gas consumption rises more than coal consumption falls, which is particularly notable given higher electric efficiencies of natural gas.



Uncertainty in international market response to coal and gas demand accounts for 84% of the variance.



Conclusions

- Ignoring the market effects of LNG export terminals overstates their climate benefit.
  - Domestically, more coal consumption.
  - Internationally, rebound effect from lower energy prices leads to more energy consumption. At median, for every increase in gas consumption by 1 unit, coal consumption falls by 2/3 of a unit.
- International energy and climate policy ultimately determine how much, if any, domestic LNG terminals will provide a climate benefit.
- LNG project regulators should require consideration of substitution and rebound effects in GHG assessments of LNG terminals.

Limitations

- Model does not consider future structural changes in technology, policy, and geopolitics.
- Energy sources other than coal and natural gas are not included in the model.
- Partial equilibrium model may not characterize rebound effect as well as a general equilibrium model.
- Sensitivity of results to market power is not assessed, such as Qatar as an LNG monopoly or China as a coal monopsony.

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