

European Commission
DG Energy - ENER.B.4
'Internal Energy Market: Security of Supply'
DG Energy - ENER.A.3
'International Relations & Enlargement'
Rue De Mot 24-26
B-1049 Bruxelles
Belgium

Dear Sir or Madam,

We provide this information to the docket for comment on the consultation on an EU strategy for liquefied natural gas and gas storage. We are submitting by email per instructions at the following URL.

<https://ec.europa.eu/energy/en/consultations/consultation-eu-strategy-liquefied-natural-gas-and-gas-storage>

We address several specific questions and offer a link to our open access paper for use by the Commission and others. The paper is available at

<http://www.sciencedirect.com/science/article/pii/S0301421515300665>

Our general findings are summarized first.

General research findings relevant to this consultation:

- Natural gas reduces local air pollutants compared to traditional maritime fuels.
- LNG may exhibit lower warming potential compared to GHGs from petroleum fuels under certain conditions and time frames, but climate neutral or climate mitigating benefits are pathway dependent.
- Drivers and barriers for LNG transition exist and need to be considered jointly in a EU strategy
- Well-designed energy policy can promote better regional low-GHG LNG infrastructure

Question 3 and Question 5: **Natural gas infrastructure must be improved to ensure methane leakage control under any policies that intend to control GHGs and net warming potential for LNG.** Our information may be considered as generally related to the need for low-leakage infrastructure investment to ensure the best use of LNG in terms of avoiding net penalties for GHGs through methane leakage and boil off. Specifically, our published research evaluated diverse upstream pathways to determine the potential benefit from a natural gas transition by identifying those fuel production pathways that may incur the least emissions. The results shows that differences in upstream processes and leakage integrity significantly affected the quantities of upstream methane emissions, and that some pathways produce upstream emissions similar to or exceeding the methane slip of downstream uses by diesel combustion. Some upstream LNG pathways we examined increased net GHGs (on a GWP100 basis) by up to 12% in a marine vessel context. In summary, this research shows that methane emissions from natural gas fuel in our transportation context are highly affected by the way natural gas is obtained, the amount of time and distance it is transported by pipelines, and the amount of time in storage.

Question 6 and Question 7 and Question 9 and Question 10: **There appear to be both drivers and barriers for Europe's transition to using more LNG.** Our research identified five drivers

affecting the transition to LNG in transport, particularly for maritime transport, including environmental regulation of air emissions, social policies involving alternative energy and GHGs, fuel infrastructure technology, economic price of fuels, and demand for transport services. We evaluated nine IEA regions using the World Energy Balance data, including OECD Europe. The assessment published in our Energy Policy paper indicated that the following actions are likely to be positive drivers for LNG in OECD Europe: i) efforts to reduce air emissions from the transport sector, ii) the Commission's energy infrastructure policies and planning, and iii) potential market demand for increased trade and regional transport (by maritime vessels at least). OECD Europe reflects leading action to control ship emissions, both through international agreements to designate special areas under MARPOL Annex VI, and in European Commission directives. OECD Europe is among the regions of high maritime demand where natural gas consumption is also substantial. The assessment considered the following conditions to be potential barriers to LNG use in OECD Europe: i) relatively clear and increasing policies to control GHGs through climate policies, and ii) the relative prices for natural gas and marine fuels in the OECD European region, compared with the world price average and other regional pricing trends. OECD Europe natural gas pricing trends most closely match the world average natural gas pricing, perhaps consistent with Europe's history as a net importer of natural gas from other IEA regions.

Question 11: Technology improvements are needed to minimize both upstream and downstream (vehicle/vessel) releases of methane while achieving high fuel economy in transportation for both freight and passenger services. As stated above, the research we recently published in Energy Policy journal outlines a clear need for improved energy infrastructure to minimize methane leakages in natural gas and LNG upstream pathways. The research also identifies the important need for continued innovation by transport engine manufacturers, particularly spark-ignited engines, to reduce further the methane slip, or uncombusted methane in engine exhaust. Recent research, cited in our paper, suggests that the emissions factors for spark-ignited (Otto-cycle) 4-stroke combustion engines are different than compression-ignition (Diesel-cycle) engines for some pollutants, including methane.

Respectfully submitted,

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