The Environmental Footprint of Gas Transportation: LNG vs. Pipeline

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Executive summary

1. Motivations underlying the research

End-use combustion generates the majority (80–90%) of the CO_2 emissions from the natural gas value chain and has received due attention in academic research and political discussion. In this paper, we focus on the environmental footprint of the rest of the value chain: extraction, processing and transportation.

The main objective of this paper is to estimate and compare the environmental footprints of pipeline and LNG gas upstream value chains. The analysis is based on the real data from the fields, processing and transportation facilities on the Norwegian Continental Shelf (NCS). We estimate the unit emissions of CO_2 (carbon dioxide), NO_x (nitrogen oxides), nmVOCs (non-methane volatile organic compounds) and CH_4 (methane) associated with the extraction, processing and transportation of natural gas.

2. A short account of the research performed

In order to perform a reasonable comparison, we consider ten pipeline chains, which represent the variety of the value chain configurations on the NCS. We consider fields of different size and age connected to each of the three major gas processing plants; two fields with offshore processing; and also fields connected to the main electricity grid onshore and the fields using feed gas to generate electricity. There is only one large-scale LNG chain on the NCS. As the estimates are sensitive to the distance over which the LNG is shipped, we consider three alternative destinations.

The total emission intensities of pipeline and LNG chains are estimated by adding up emission intensities on all segments of the defined parts of the chains. The emissions relating to extraction include those by mobile units used to drill production wells. Exploration (seismic surveys by special ships, exploration drilling by drilling rigs) and support activities provided by supply vessels and helicopters and emissions relating to the storage and loading of oil and NGL/condensate are excluded from the analysis.

Figure 1 shows the CO_2 emission intensities of the considered chains. The footprint of the pipeline chains varies from 2.4 kg/Sm3o.e. for the Ormen Lange chain to 352.4 kg/Sm^3o.e. for the Statfjord chain. The largest contributor to the CO_2 footprint of the pipeline chains is the offshore segment, which is due to gas-based energy production. Turbines account for about 90% of the total emissions of the fields not connected to the main electricity grid onshore. The footprint of the LNG chain varies from 286.2 kg/Sm^3o.e. for the shortest route to 364.7

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kg/Sm^{3}o.e. for the longest route. The main emissions contributors are power generation for liquefaction and fuel combustion for sea shipping.

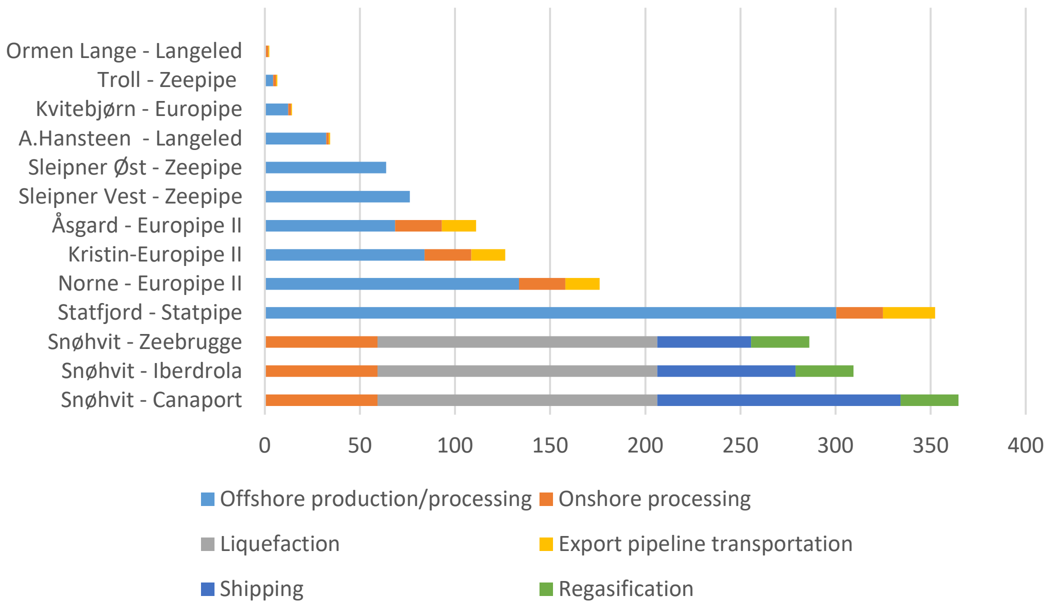

FIGURE 1. CO2 EMISSION INTENSITY (KG/SM3O.E.)

3. Main conclusions and policy implications of the work

The results of this comparative study corroborate the general findings of other studies that pipeline transportation chains environmentally outperform LNG-based chains, as LNG chains comprise extra processing steps. The most important observation is the variability of the environmental performance of different technological solutions and the corresponding emission intensities. This limits the usability of average estimates and restricts the scope for drawing general conclusions regarding pipeline transportation emission intensities. In cases where the fields are geographically close to the shore and electricity is available from the main grid, pipeline transportation is indeed 'green'. In other cases, long distances and the need to generate power offshore make pipeline transportation significantly more CO_2 emission-intensive. Due to technological specificity, LNG chains are significantly more CH_4- and nmVOC-intensive than pipeline chains. With regard to NOx emissions, there is no clear advantage of the considered pipelines over LNG chains.

A direct comparison of pipeline and LNG transportation may not by reasonable in cases where LNG is transported over long distances where pipeline transportation is impossible. However, the choice between a possibility of receiving pipeline gas and importing LNG over long-distances should be also evaluated from the perspective of its environmental impact.

The evaluation and analysis of emissions to air from gas production and transportation chains should also contribute to decision-making regarding new major infrastructure development, especially in remote areas like the Barents Sea. In light of the increasing environmental concerns and stricter environmental policies of many gas-consuming countries, infrastructure development decisions of gas producers may affects their competitive positions in the markets.