Exploring transport bioLNG

Fact-finding, market prospects, business cases

CE Delft

Committed to the Environment

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Summary

On 23 March 2017 the Port of Rotterdam Authority signed a Letter of Intent with parties aligned with the National LNG Platform to explore the potential for developing bioLNG as a transport fuel in the Port. In mid-2017 this led to the project 'Exploratory study on bioLNG' being commissioned by the Port of Rotterdam Authority and the National LNG Platform, additionally underwritten by Gelderland Provincial Executive, the Twente Port Authority and LTO Glaskracht Nederland, a greenhouse horticulture trade association.

The aim of the project is, first, to bring together the currently available knowledge on the issue and, second, to explore the options for large-scale development of bioLNG as a transport fuel.

Procedure

The project encompasses two fact-finding missions - on 'technology and feedstocks' and 'policy and regulations' - two market surveys - on the supply and demand sides of bioLNG markets in three transport sectors (trucks, inland shipping, maritime shipping) - and three business cases based on different models. The market surveys and business cases assume biogas production via biomass digestion.

Findings

Technology

The overall conclusion is that bioLNG is one of the options available for reducing the environmental footprint of long-haul and heavy transport, with the literature study indicating a 70% reduction of Well-to-Wheel CO_2 eq. emissions for bioLNG compared with fossil diesel (Euro V).

Policy

The business cases are climate policy-driven, i.e. from a policy setting geared not specifically to bioLNG production but more generically in pursuit of carbon emissions reduction and growth of the share of renewables in the energy mix. As further limiting conditions, sustainability criteria were also included. How exactly the business cases develop will depend on the specific policy targets adopted and their implementation in concrete policies. The EU's precise policy for post-2020 has not yet been established, however.

To secure the Paris Agreement targets, generally but also with respect to the carbon emissions of long-haul and heavy transport, requires not only very robust measures but also their very swift implementation (the target of max. +1.5°C will already be reached in 2025). Policymakers are therefore not only looking for ways to achieve drastic emission cuts, but are also giving serious consideration to the need for 'negative CO_2 emissions', i.e. permanent CO_2 removal from the atmosphere. Moving forward, this will also create additional opportunities for bioLNG, because of the biogenic CO_2 stream arising during liquefaction.

The most critical parameters in the business cases are the feedstock price, the price paid for the raw biogas from the digesting plant by the bioLNG producer and, above all, the value of the Renewable Fuel Units (RFUs). All three parameters are highly dependent on the specific policies adopted.

Demand scenarios

As time proceeds, volume demand for LNG and, with time, for bioLNG for maritime shipping will far outweigh that for inland shipping and trucks. To kick-start demand for bioLNG by shipping, and particularly maritime shipping, will require robust policy that is internationally harmonized. It seems likely that demand for bioLNG will first start growing in the truck sector. In the table below, projected volume demand for LNG in 2030 is reported in the bottom row (with 100% replacement of LNG by bioLNG). The figures for trucks and inland shipping refer to national demand, those for maritime shipping to projected LNG bunkering in Rotterdam. Table 1 provides a synopsis of four different scenarios for the uptake of bioLNG in LNG markets.

Table 1 - BioLNG demand volumes per scenario in 2030 (kt/a). Projected LNG demand in 2030 (with 100% replacement of LNG by bioLNG) is given in the bottom row of the table

Scenarios for bioLNG uptake in LNG markets	**Trucks**			**Inland shipping**			**Maritime shipping**			**Total (kt bioLNG)**
	Low	**Medium**	**High**	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**	
National, low gear to Paris	**3%**			**0%**			**0%**			
	2	**6**	9	0	**0**	0	0	**0**	0	2 **6** 9
International, low gear to Paris	**10%**			**4%**			**3%**			
	5	**21**	29	1	**10**	15	34	**68**	101	40 **99** 145
National, full speed ahead to Paris	**50%**			**30%**			**10%**			
	27	**106**	145	10	**78**	113	113	**225**	338	149 **409** 596
International, full speed ahead to Paris	**100%**			**100%**			**100%**			
	55	**212**	290	32	**260**	378	1,125	**2,250**	3,375	1,211 **2,722** 4,043

Taking the medium values for each transport mode, the carbon emissions reduction associated with the 100% bioLNG uptake scenario is 600 kt CO_2 eq./a for trucks, 700 kt CO_2 eq./a for inland shipping and 6,000 kt CO_2 eq./a for maritime shipping, giving a total of 7,300 kt CO_2 eq./a.

Feedstock availability

An analysis of the digestion feedstocks available and the volume of biogas expected to be available for bioLNG production gives the following picture in comparison with the demand side in table 1.

With the feedstocks regionally available *at present* in the Rotterdam area (mainly waste streams from the foods and beverages industry) approximately 16 kt/a bioLNG can be produced. Comparison with Table 1 shows that current *regional* feedstocks can go some way to 'greening' the projected LNG market for trucks and inland shipping. A projection of the aggregate feedstocks *nationally* available for bioLNG production in 2030 indicates potential production of approx. 412 kt/a bioLNG, enough to 'green' virtually the entire projected LNG market for trucks and inland shipping. There is, additionally,

the option of importing digestible biogenic waste. There is enough digestible feedstock available in the Netherlands for greening the LNG demand of maritime shipping in the three more modest uptake scenarios, but not for the 100% uptake scenario for maritime shipping, though.

The CO_2 demand of greenhouse horticulture can be approximately half-covered in 2030 from bioLNG production, i.e. as off-gas from the scrubbing of the raw biogas. BioLNG production thus constitutes a substantial source of biogenic CO_2 for greenhouse horticulture.

Business cases

Positive business cases can be made for bioLNG from digestible feedstocks. In all the situations considered the cost price of the bioLNG exceeds that of fossil LNG and the business case is governed by returns on RFUs.

The business case calculations based on nationally available and importable feedstocks show cost price ranges for the produced biogas of 10-35 €ct per Nm^3 raw biogas and (using these raw biogas cost prices as input) of 68-123 €ct per kg bioLNG. Assuming an RFU value of 43 €ct per kg bioLNG (single-counted) leads to interesting business cases in which bioLNG can compete with fossil LNG. The calculated cost prices depend very much on the cost price of the feedstock and the RFU value and, in the current market situation, also on the digester's price for the raw biogas. In general, digesters are now found to prefer earning their money from biogas via the 'SDE route' (supported by the Renewable Energy Incentive Scheme), because this gives longer-term financial security than the RFU route.

Business Model 1 (Rotterdam local), with sales to the truck market, is interesting as an model for kick-off but has only limited scope for further scaling as there is insufficient regionally available digestible biomass. This business case stands or falls by the potential for selling CO_2 in the port area.

While Business Model 3 (bioLNG import) provides an interesting business case, it is questionable whether it is realistic to ship the bioLNG to the Netherlands, given that the biogas and/or bioLNG can also be used in the producing country or elsewhere. Development will depend on the how global climate policy plays out generally and how policies geared specifically to transport sectors do so. The business case considered here shows that potential demand for bioLNG from maritime shipping can be greened entirely using bioLNG produced from internationally available waste streams when it comes to the bunker volumes in Rotterdam (the world's second largest bunkering port). This is important because of the perspective of a future 100% greening of the LNG market, for shipping too. We would stress that the business case considered here is merely one example and that the biogenic waste streams must derive from production processes meeting sustainability criteria.

Of the three business models considered, Business Model 2 (Rotterdam full-scale), with large-scale industrial plant (digestion and bioLNG) in the port area, offers the best perspective for economic development at Rotterdam Port because of the large feedstock streams, the scope for marketing digestate via the Port, the industrial scale of the business model, and the production of and regional markets for biogenic CO_2, for which there is serious interest from, *inter alia*, greenhouse horticulture.

Main policy recommendations

Market parties including Port Authority and National Government

Jointly develop a 'bioLNG roadmap' geared to ultimate large-scale greening of transport LNG markets using bioLNG. For the Port Authority this means, among other things, facilitating development of the required large-scale supply chains, including development of feedstock streams, and together with market players developing new business models geared to economies of scale.

Market parties

One option for addressing the combined risk associated with feedstock price, available feedstock volumes and marketing of bioLNG is to make open price calculation agreements with, for example, supermarket chains, which can supply feedstocks and use the bioLNG for their own deliveries.

National Government

As this market is policy-driven, the main investment risk lies in the policy realm. Create long-term investment security for large-scale biogas production and ensure additionally that biogas sales via bioLNG in long-haul and heavy transport is an attractive proposition. To this end there are various options available:

- Create financial security in the RSU system by setting a minimum price for RSUs.
- Another, already feasible option relates to giving parties the option to switch between the RFU and SDE route for their returns in any given time period.
  Yet another option is to introduce a premium for using advanced biofuels in the transport sector (including waste-derived biogas and bioLNG), as Italy has recently done, for example.