INTEGRATED LNG VALUE CHAIN FOR THE BALTIC SEA REGION

WP3 Task 2: Integrated LNG Business Models

BUSINESS MODELLING AND VALUE PROPOSITION TEMPLATES FOR DELIVERING PARTNERS

Working Document

Project:	"LNG Value Chain for Clean Shipping, Green Ports and Blue Growth in Baltic Sea Region – Go LNG" (ERDF part-financed, Baltic Sea Region Programme 2014–2020)
	WP3 – Integrated LNG Value Chain, Task 3.2
Responsible:	PP5 – WU
Scope of the event:	Working Group Template
	Working languages: English
Delivering partners:	Go LNG Project Partners
	Business Cases for LNG Business Model Development:
	- Klaipeda Science & Technology Park – NG distribution centre for BSR based on ISO container technology production and filling center - Klaipedos Nafta – Klaipeda LNG terminal infrastructure to be used as LNG distribution and storage hub for LNG in South East of BSR - Logistik Initiative Hamburg – LNG use for Maritime, Road transport and Port equipment in port of Hamburg - Wismar University of Applied Sciences – Task Leader, Implementing Overall Task
	Associated Partners, Strategic Consultants and Experts
Deadline for filling in:	first draft by the 28th September 2017

ATI erc gGmbH
education – research – furtherance of cooperations

Interreg Baltic Sea Region

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

Template for LNG Business Model: **HAMBURG business case**

1. Key Partners

Becker Marine Systems: local, Hamburg-based, LNG2power port equipment engineering, design and operation

AIDA Cruises: user/demand for LNG

Hamburg Port Authority: landlord, responsible for the water- and land-based infrastructure, charging and collecting port fees

Cruise Gate Hamburg: cruise terminal operator for the 3 cruise terminals in the Port of Hamburg

Shipping companies calling at Port of Hamburg

Brunsbüttel Ports GmbH: private port operator and landlord at Port of Brunsbüttel, cooperating with Port of Hamburg in the ElbeSeaports network

Gasunie (Netherlands), Oiltanking GmbH (Hamburg, Germany) & Royal Vopak (Netherlands) as potential investors for a Brunsbüttel based import and small scale terminal infrastructure

Meyer Werft, Papenburg, Germany: shipbuilding, building of LNG fuelled cruise ship(s)

tankpool24, Mabanaft Deutschland: providing (mobile) LNG gas station infrastructure

SCANIA: manufactoring LNG fuelled trucks

Trucking companies Walter Lauk, Container-Transport-Dienst (CTD), Konrad Zippel and others: users/demand for LNG

2. Key Activities

Existing/operating:

LNG Hybrid Barge "Hummel": Power supply via LNG (LNG2power) for cruise ships while in port. So far only used for one ship: AIDAsol.
- Status: operating since 2015, as a pilot project, 2016: used at a total of 16 ship calls of AIDAsol
- Key Partners involved into activity: Becker Marine Systems (design, engineering & operation), AIDA Cruises (user/demand for LNG), Hamburg Port Authority (constructional equipment and preparation of cruise terminal HafenCity for usage of LNG Hybrid Barge)

LNG truck to ship activities: LNG supply via LNG-truck for cruise ships at the Cruise Terminal Steinwerder. Direct supply to dual fuel engine for energy supply while in port. So far only used for one ship: AIDAprima.
- Status: operating since 2016
- Key Partners involved into activity: AIDA Cruises (user/demand for LNG), Cruise Gate Hamburg (terminal operator)

LNG Powerpac: Power supply concept for container ships through LNG while in port (LNG2power). System of 2x 40 ft containers for power supply without landside infrastructure, thus wireless and flexible, no landside/onshore infrastructure investments. Capacity: 8.2 tons LNG
- Status: pilot project, starting 2018, funded by BMVI
- Key Partner involved into activity: Becker Marine Systems (engineering & operation/ execution of pilot), N. N. (container terminal operators and shipping companies)

Environmental Ship Index (ESI): Port fee discounts for ships calling at port of Hamburg that fulfil certain sustainability criteria in order to give incentives for clean shipping
- Status: established since 07/2011. Discounts for LNG use (either LNG2power or LNG fuelled ships) have been appended in 2015 and were further increased in 07/2017
- Key Partner(s) involved into activity: Hamburg Port Authority (as responsible authority for defining and charging port fees from the shipping companies)

Planned/future activities:

LNG Import and Small Scale Terminal at Port of Brunsbüttel: Port of Brunsbüttel is part of the port cooperation network ElbeSeaports, located at Elbe estuary and Kiel canal, about 70 km downstream from Hamburg. LNG Terminal Brunsbüttel could supply Hamburg region with LNG.
- components/facts: 4 to 5 bcm per year, equipped with 1 tank (220,000 m3) in the first stage, 1 jetty for ships up to 210,000 m3, truck loading infrastructure & pipeline grid connection included in the concept
- Status: planning stage. A location decision has been made in the favour of Brunsbüttel in 04/2017. Currently a feasibility study is being elaborated and the formation of an investor's joint venture is in progress. An investment decision is expected for 2018, with an expected investment volume of 400-500 m €)
- Key Partner(s): Brunsbüttel Ports (as private port operator and landlord), Gasunie (NL), Oiltanking GmbH (Hamburg, GER), Royal Vopak (NL) als potential investors (joint venture)

Bunkering of LNG fueled cruise ships: AIDA Cruises is a first mover concerning LNG in Hamburg (see above) and is extending LNG usage in the future. It has LNG fueled cruise vessels currently on order
- Status: The first one (AIDAnova) is currently being built at Meyer Werft in Papenburg, Germany (keel laying 09/2017) and will be delivered in autumn 2018. It will be the world's first completely LNG fueled cruise ship! A sister ship is expected to be operating from 2021. Thus, first ship calls could become realistic for Port of Hamburg starting at summer season 2019
- Key Partner(s): AIDA Cruises (as user/demand for LNG bunkering), Meyer Werft (Papenburg, GER) (shipbuilding company), N. N. (LNG bunkering services, probably ship to ship)

LNG gas stations for trucks within the Port of Hamburg: In order to promote LNG-fueled trucks coming to/from the Port of Hamburg, Hamburg Port Authority is planning a pilot project for two (mobile) LNG gas stations within the port. This pilot project also includes a LNG truck rental concept in order to allow different trucking companies to "test" LNG fueled trucks without having to invest into own vehicles in the first stage („transport FutureLab" concept).
- Status: preliminary planning, concept phase, project start date uncertain/unknown

- Key Partner(s): Hamburg Port Authority (coordination and possible project lead, landlord and planning authority), tankpool24 and Mabanaft Deutschland (providing mobile gas station infrastructure), SCANIA (providing rental LNG truck(s) for the project), Trucking companies as test users (Walter Lauk, CTD, Konrad Zippel, but open to further interested trucking companies)

3. Key Resources

Key resources are mostly private investments. This is true for LNG Hybrid Barge and LNG Powerpacs and for cruise shipbuilding (AIDA Cruises), for Meyer Werft through R&D investments on innovative cruise ship and LNG usage concepts as well as for the planned import and small scale terminal infrastructure in Brunsbüttel (no investment decision yet, see above) and planned LNG truck gas stations.

Also, public co-funding of pilot projects, precisely the funding of LNG Powerpac development through the German Ministry of Transport (BMVI). The funding is carried out within the framework of the Government's mobility and fuel strategy, which is aiming to promote and support the increased use of alternative fuels for maritime applications, such as the use of LNG.

Public financial, organisational and institutional resources have been and are being used: constructional equipment and preparation of cruise terminal HafenCity for usage of LNG Hybrid Barge, organization and enabling truck to ship LNG usage on cruise terminal premises by Cruise Gate Hamburg, implementation and management of the Environmental Ship Index (ESI) by Hamburg Port Authority as well as organizational effort on expediting pilot projects/ test cases, such as the possible LNG truck test case within the Port of Hamburg (see above).

4. Customer Relationships

As described under 2. (Key activities)

5. Channels

Import & small Scale Terminal: Terminal to grid/pipeline, terminal to truck and terminal to ship LNG supply

LNG demand as fuel (maritime as well as trucks) and as power supply for vessels while in port (direct LNG supply to Dual fuel engine or LNG2power concept)

Please see Chapter 05 of the additionally provided PowerPoint presentation ("transport chain = value chain") for a detailed overview and visualisation.

6. Customer Segments

Currently:
Cruise Shipping (power supply while in port only, truck2ship and ship2ship via LNG Hybrid Barge)

Planned:
Cruise shipping (LNG fueled cruise ships/ bunkering)
Container shipping (power supply while in port via LNG Powerpacs)
Road transport (LNG fueled trucks via LNG gas stations in the port)

7. Cost Structure

Expected investment for import and small scale terminal infrastructure in Brunsbüttel: 400 to 500 m € (note: no investment decision so far!)

LNG Powerpac project budget, including design, planning, production, testing and initiation: 3.5 m €

LNG Hybrid Barge construction costs: around 13 m €

For LNG fueled trucks, the current cost structure would be as follows, based on calculations by the Logistics Initiative Hamburg[1]:

[1] See: Logistik-Initiative Hamburg: Leitfaden LNG – Liquefied Natural Gas in der Logistik, November 2015

There are no universal statements available on the profitability of a LNG truck compared to comparable diesel vehicles. Ultimately, it is always case by case considerations for each market participant, depending on the respective framework conditions and parameters that need to be checked. Nonetheless, following a simplified presentation of the economic framework and cost structure of LNG fueled trucks compared to diesel trucks can be shown.

Due to the smaller batch sizes, the acquisition costs for LNG trucks are higher than diesel vehicles. A typical list price of a LNG truck is around 110,000 €, a comparable diesel vehicle at 80,000 €. Moreover, due to shorter oil change intervals and the fact that in mono-fuel vehicles spark plugs are wearing parts, higher maintenance or service costs arise for LNG trucks. However, diesel trucks have to be equipped with the AdBlue technology, an exhaust aftertreatment that takes place in the SCR catalyst, in order to meet Euro VI limits. Concerning consumption, AdBlue adds additional costs for the use of diesel, too.

The lower fuel consumption of LNG trucks (assumption for the calculation: 30 liters of diesel vs. 26 kg LNG per 100 km, due to the possibility of different pressures LNG is measured in kg, since the calorific value per kg is always identical) and the cheaper price of LNG (assumption for this calculation: diesel 1.20 € per liter vs. LNG 1.10 € per kg, one kilogram of natural gas corresponds to about 1.3 liters of diesel, accordingly one liter of LNG currently costs around € 0.85) lead to a cost advantage in fuel consumption for LNG trucks.

Ultimately, very similar to current fuel prices per kilometre arise for LNG fueled trucks compared to diesel fueled ones. However, these can only be achieved with appropriate annual mileage. Below is a short calculation of the economy framework for a LNG truck compared to a diesel truck.

A mileage of 100,000 km per year is assumed, a depreciation for wear and tear (depreciation) to five years, a residual value of € 17,500, an interest rate of 3.5% and the costs already mentioned above (CAPEX of 110.,000 € vs. 80,000 € for LNG vs. diesel truck, OPEX such as).

The table shows a calculation on monthly costs in € calculated based on the above mentioned assumptions:

Type of cost	Diesel	LNG
depreciation and interest	1,184.57	1,728.74
maintenance or service costs	500.54	625.67
Fuel consumption and AdBlue	3,145.00	2,383.00
Total monthly costs	**4,830.11**	**4,737.41**

Total cost of ownership based on a 5 year expected useful life thus is at around 290,000 € for a diesel truck whereas for a LNG truck it is at 285,000 €.

This short overview shows that already today, under the stated conditions, cost advantages can arise for LNG fueled trucks!

LNG cost structure example for cruise ships and container ships using power supply while in port via LNG power barge or LNG Powerpacs (LNG2power):

The cost of LNG supply as ship bunker or as power supply for ships while in port is mainly dependant on the logistics supply chain. The supply chain on the other hand is depending on the availability of LNG through access points such as small scale LNG terminals. As for Hamburg, LNG demand is mostly and mainly served through LNG supply from Gate terminal in Rotterdam, logistics supply chain costs are comparably high. This is supported by the fact that no constant and regular LNG supply demand is existing yet, forcing suppliers to create custom-made and specific supply chain solutions for clients with LNG demand in Hamburg and thus also increasing LNG logistics costs.

Thus, he price for the provision of LNG always depends on the particular application case and there is no lump-sum price for the provision of LNG in a port. For each customer, an individual supply chain and appropriate specific supply concept is built, taking into account the tank size of the customer, time available for refueling, long term or short term contract commitments as well as quantity to be provided.

Basically, based on the calculations calculated for customers, according to local LNG supply stakeholders in Hamburg it can be said that the use of LNG can currently offer a price advantage of 5-20% compared to today's MGO prices, depending on where and how far to the nearest LNG terminal.

Even though logistics supply costs are rather high for Hamburg, it can be assumed that a price advantage of 5 % is currently realistic for Hamburg compared to MGO prices. Assuming an average fuel MGO consumption of 15 tons per stay in port for a cruise ship or container ship while in port and taking into account an average MGO price per ton of 495 € per ton (= 580 USD) overall fuel costs of 7,425 € arise for MGO.

A 5% cost advantage for LNG compared to MGO usage would therefore result in cost savings of 371 € per stay in port per ship. With the completing of an import and small scale terminal in the Hamburg region (Brunsbüttel, see chapter 2: key activities), resulting in much shorter distances concerning logistics chains and LNG supply, this cost advantage could possibly reach 10 or 15%, resulting in cost savings of 740 to 1150€ per stay on fuel consumption while at pier/ in port.

Adding to this cost savings, discounts on port fees apply for ships using LNG to power concepts while in port / at pier in Hamburg. According to the Port Fees and Charges 2017 of Hamburg Port Authority[2], a cruise ship with BRZ of 80,000 in the main season would face a regular charge of port fees of 19,456 €. Assuming an ESI score of 51 for the cruise ship[3], a 10% refund on port fees would apply (= 1,946 €).

On top, the usage of shore power or LNG to power concepts while in port (such as LNG Power Barge or LNG Powerpacs) would account for an additional 15% refund on the remaining port fees would apply, accounting for another 2,627 € of refund. Thus a total of 4,537 € cost savings would apply per stay in port due to ESI compliance and LNG to power use. Together with the above mentioned cost savings concerning fuel consumption, around 4,900 € cost savings can be achieved for each stay in port of Hamburg for the given example of an 80,000 BRZ cruise ship. Comparable ranges also apply for cargo ships.

[2] See https://www.hamburg-port-authority.de/fileadmin/user_upload/Hamburg_Port_General_Terms_and_Conditions_Pricelist_2017.pdf
[3] For calculation examples on ESI, see http://www.environmentalshipindex.org/Public/Home/ESIExample

This shows, that especially due to extensive refunds on port fees and charges for sustainable compliance, using LNG as power supply in port, already enables significant cost savings and thus economic advantages today, even without existing LNG infrastructure (e. g. small scale terminal) in the region.

8. Value Propositions

(1) Cost savings: Total Cost of ownership is already lower today when using LNG both as truck fuel and as power supply for vessels while in port in combination with ESI discounts on port fees

(1) Product innovations that can be used as USP, e.g. by shipbuilding and engineering companies involved (Becker Marine systems, AIDA Cruises, Meyer Werft and others), increased R&D knowledge and capacities and possibly patents.

(2) Achievement of approved quality, sustainability and innovation status and especially perception, that can be communicated and used towards customers of the shipping companies (here: cruise tourists).

(3) Increased flexibility trough offering of additional options on fueling and in port power supply towards shipping companies.

(4) Reduced air polluting (CO2, NOx, particulates etc.) and noise emissions and thus improved sustainability of the maritime and road transport segments involved. This again positively influences image and perception of the stakeholders involved.

(5) Compliance to and promoting of political strategies and/or regulatory requirements towards reducing air pollution and noise emissions and thus risk prevention concerning possible future restrictions, operational limitations or penalties.

(6) Excellent availability and especially future availability expectations of LNG on the world market and thus expected future development of decreasing costs on LNG usage whereas MDO/ fuel oil costs may increase

(7) High security of supply due to plurality of LNG producers and suppliers

9. Revenue Streams

Public co-funding for product innovations, precisely LNG Powerpacs, see information under point 3.

Currently existing activities: LNG (truck to ship) respectively power through LNG supply (LNG Hybrid Barge) is being charged to shipping company (here: AIDA Cruises). At the same time the shipping company achieves cost savings through ESI discounts on port fees.

The same logic will apply to the LNG Powerpacs once the pilot projects starts.

10. Please describe your products, services or other experiences that allow you to arrive at Value Generation, Proposition and Capturing from Interactions and Activities along the LNG Value Chain

As described above.

11. Please describe your value proposition according to the Segments of Customer, Performance, Finances & Revenues and Learning Experiences

Customer:
Achievement of approved quality, sustainability and innovation status and especially perception, that can be communicated and used towards customers of the shipping companies (here: cruise tourists).
Positively influenced image and perception of the stakeholders involved due to their actions towards increasing sustainability.

Performance:
Increased flexibility trough offering of additional options on fueling and in port power supply towards shipping companies.
Reduced air polluting (CO2, NOx, particulates etc.) and noise emissions and thus improved sustainability of the maritime and road transport segments involved. This again positively influences image and perception of the stakeholders involved.
High security of supply due to plurality of LNG producers and suppliers.

Finances & Revenue:
Compliance to and promoting of political strategies and/or regulatory requirements towards reducing air pollution and noise emissions and thus risk prevention concerning possible future restrictions, operational limitations or penalties that could otherwise negatively affect revenues or company income.
Excellent availability and especially future availability expectations of LNG on the world market and thus expected future development of decreasing costs on LNG usage whereas MDO/ fuel oil costs may increase

Learning Experience:
Product innovations that can be used as USP, e.g. by shipbuilding and engineering companies involved (Becker Marine systems, AIDA Cruises, Meyer Werft and others), increased R&D knowledge and capacities and possibly patents.

12. Please describe any technological, resource-based, legal, environmental or other enablers that facilitate achievement of value and delivery to your customers and your company / institution (governance, technological capacity, distributional links, legal and regulatory framework, etc.)

In addition to already described key partners/stakeholders participating in the enabling of LNG use cases and business models for Hamburg, the following can be added:

Legal and regulatory framework: The local administration "Behörde für Umwelt und Energie" (BUE) of the Free and Hanseatic City of Hamburg (local environmental and energy authorities) represents the responsible authorizing body for LNG related permissions, such as operating the LNG Hybrid Barge and LNG Powerpacs as well as any truck2ship or ship2ship LNG transfer/ bunkering processes.

Thus, the authority is a key player in order to enable and allow achievements of value towards increased LNG usage. So far, several key partners have mentioned the rather reluctant and sceptical role of the authority towards LNG use. A lack of existing formalities on LNG use in the maritime context requires single and special approvals which often prove themselves as inefficient and costly both concerning time and effort.

It would thus represent a significant improvement towards predictability of legal conditions and framework if a nationwide fixed regulatory framework could be established in the futre, allowing all stakeholders suitable handling confidence and principles of legal certainty towards their LNG business model development.

13. Please describe how LNG in your business enable the following:

Differentiation – occurring e. g. as a differentiation between shipping companies using or not using LNG for their fueling or in port power supply in order to use this for image related public relations and in order to comply to own sustainability goals or strategies. The same is true for cruise shipping companies, that aim to create a USP

through offering LNG fueled (or LNG use in port) cruise ships towards their customers through the value generation of sustainability conformity.

Diversification – occurring especially for the shipping industry concerning their options both on power supply in the port as well as fueling. Development of LNG business cases in Hamburg thus adds further options to choose from

Innovation – LNG use in the maritime context generating product innovations, such as LNG Hybrid Barge or LNG Powerpacs as well as innovative shipdesigns and ship engineering, e.g. new LNG fueled AIDA cruise ship generation

14. Please describe how do you measure value generation (tools, methods) and briefly mention Value Impact Scenarios

Measuring tools and methods are available for environmental impact respectively contribution towards sustainability. E. g. for the LNG Hybrid Barge, measurements during operation have been carried out through an analysis of the actual (air and noise) emissions. This was defined as an obligatory measurement/analysis by the authorizing body BUE (see point 12) for the opration of the barge. Results showed the following environmental saving potential per call of an average cruise ship:

- minus -512 kg NOx
- minus 3 kg SOx
- minus 0.6 kg particulates and
- minus -7,150 kg CO2

For REFERENCES