USAID
FROM THE AMERICAN PEOPLE

BOSNIA AND HERZEGOVINA ENERGY POLICY ACTIVITY

REPORT ON LIQUEFIED NATURAL GAS (LNG) TERMINALS AND THEIR DEVELOPMENT PROGRESS THAT WOULD BE ACCESSIBLE FOR BIH – 2023 EDITION

JUNE 2023
This publication was produced for review by the United States Agency for International Development.
It was prepared by DT Global.

BOSNIA AND HERZEGOVINA ENERGY POLICY ACTIVITY

REPORT ON LIQUEFIED NATURAL GAS (LNG) TERMINALS AND THEIR DEVELOPMENT PROGRESS THAT WOULD BE ACCESSIBLE FOR BIH – 2023 EDITION

JUNE 2023

Contract No:
72016819C00002

Submitted to:
USAID Bosnia and Herzegovina (BiH) Economic Development Office

Prepared by:
DT Global

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

BCM	Billion Cubic Meters
BiH	Bosnia and Herzegovina
CAPEX	Capital expenses
CEF	Connecting Europe Facility
DESFA	Hellenic Gas Transmission System Operator S.A.
EU	European Union
FEED	Front-End Engineering Design
FID	Final Investment Decision
FSRU	Floating Storage Regasification Unit
FSU	Floating Storage Unit
GBS	Gravity Based Structure
HFO	Heavy Fuel Oil
IAP	Ionian Adriatic Pipeline
LCNG	Liquid to Compressed Natural Gas
LNG	Liquefied Natural Gas
LNGC	LNG Carrier
NG	Natural Gas
MOU	Memorandum of Understanding
MTPA	Million Tons Per Annum
NTF Ltd.	Naftni Terminali Federacije Ltd.
OPEX	Operational expenses
PLEM	Pipeline End Manifold
SoS	Security of Supply
SW	Southwest
TAP	Trans Adriatic Pipeline
TSO	Transmission System Operator
USA	United States of America

1. INTRODUCTION

Natural gas (NG) is one of key energy sources for Europe and the world. Although most of the NG in the world is transported and distributed through NG pipelines, NG is also being liquefied, whereby the NG is transformed from its natural gaseous state into liquid, also known as liquefied natural gas (LNG). By conducting this transformation, the volume of NG is reduced by approximately 600 times, and LNG becomes a suitable solution for transportation over longer distances. Such transportation is achieved with vessels known as LNG carriers (LNGC), by which LNG is transported to regasification facilities/terminals. In those regasification terminals, LNG is transformed back to a gaseous state and sent-out to the NG pipeline system. This basic chain of activities, i.e., the process of NG production, NG liquefaction, LNG transportation and LNG regasification, is known as the LNG value chain. Additionally, LNG that is stored in storage tanks can be further distributed in its liquefied state, which is an added value of the value chain, known as small-scale LNG distribution.

There are numerous applications for NG and LNG use. While NG/LNG's main use is as a fuel source for heating facilities and powering electrical power plants, it can also be used as fuel in both a gaseous or liquefied state in shipping, road and railroad traffic. Also, NG/LNG can be used as an energy source in applications that are not connected to the NG transmission/distribution pipeline networks, such as small-scale regasification facilities that can be used for covering peak demands or other industrial facilities that use NG/LNG as fuel. As such, a basic overview of possible uses of NG/LNG in the Bosnia and Herzegovina (BiH) market will be provided in this report.

It was LNG as a source of NG that played a significant role for EU NG SoS during the last heating season 2022/2023, as a substitute for the missing NG that was traditionally supplied using pipeline transport. Of the total 337.4 BCM of NG imported into the EU during 2022, the share of LNG increased from 23% in 2021 to 39%, while the share of pipeline gas fell from 77% in 2021 to 61%.[1] This trend continues in 2023 and it is important to mention that the import of LNG to the EU from the USA liquefaction terminals has increased the most.

This report will address LNG terminals that are accessible to the BiH market, i.e., LNG terminals from which NG can be provided to the BiH market either in its gaseous or liquefied state. Due to their geographical location vis a vis BiH, regional developed terminals in Croatia, Italy and Greece will be assessed in detail, as they represent the most viable source of NG/LNG supply. Special attention will be addressed to the LNG terminal in Croatia, as Croatia is a neighboring county to BiH, and the Terminal on the Island of Krk in Croatia is the most likely candidate to provide NG/LNG to BiH market.

From the LNG terminals located in the above-mentioned countries, only the ones that have been constructed, are under construction, or are close to completion, will be assessed, as the purpose of this report is to give a realistic and comprehensive assessment on possible sources of NG/LNG to BiH from regional LNG terminals. Also, the possibility to transport NG/LNG from other regional terminals will be assessed, in basics.

Finally, some small-scale LNG satellite station opportunities will be described, including the proposed small-scale LNG station in the port of Ploče, which could serve as one of the possibilities to easily supply BiH with LNG.

[1] https://www.kpler.com/blog/global-lng-represents-39-of-eu-gas-imports-in-2022

2. LNG VALUE CHAIN AND POSSIBILITIES TO USE NG/LNG IN BIH

A basic overview of the LNG value chain will be provided in the following segment of the report. The LNG value chain consists of following major segments:

- NG production
- Liquefaction of NG
- Transport of LNG
- Regasification of LNG
- Distribution of NG/LNG

In the past, the main business model of the LNG industry has been the large-scale NG liquefaction, LNG transport, regasification of LNG and distribution of NG to end users via NG pipelines. However, use of LNG in applications that are not connected to NG pipelines is becoming more frequent, particularly in the recent decade. In that respect, distribution of LNG can be considered as part of the LNG value chain as well.

For end users of NG coming from LNG receiving terminals, the capabilities/services of these LNG receiving terminals are most important; and these services will be further elaborated in the report. Such receiving LNG terminals, or also known as "LNG regasification terminals," are usually located onshore or offshore, and are used to regasify or transform LNG into NG and send the NG to the transmission pipeline system. Terminals in the region that could supply BiH market with NG/LNG are addressed specifically in sections 3 and 4 of this report.

When considering the use of NG/LNG in BiH market it must be noted that the possibilities are existing and vast. NG/LNG could not only be used for heating purposes, but for industry applications as well. Also, from the perspective of current facilities, by introducing NG/LNG into the BiH market, the transition from less environmentally friendly fuel sources such as coal and heavy fuel oil (HFO) to NG/LNG could be made. This development is also in line with the BiH Strategy on adaptation to climate change and low emission development of BiH (local: Strategija prilagođavanja na klimatske promjene i niskoemisionog razvoja Bosne i Hercegovine za period 2020.-2030.).

In addition to the use of NG from pipelines, LNG could be used in the BiH market as fuel for peak shaving facilities, which could be used in some of the larger NG consuming areas. Such facilities are usually used for covering peak demands in seasons when there is an increased demand or interruption of the supply of NG. In such situations currently, less environmentally friendly fuel sources are being used. Also, industrial uses of LNG and Liquid to Compressed Natural Gas (LCNG) refueling solutions can also be implemented.

As described below, the supply of LNG also could most likely be achieved via road transport primarily through the LNG terminal located on the Island of Krk, in Croatia. To provide additional sources of supply, it is necessary to construct additional LNG infrastructure in the form of a small-scale LNG satellite station in the vicinity of BiH. There the LNG can be transported to the satellite station with LNG bunkering/feeder vessels, and from the station further to BiH via road or railway transport. The ideal small-scale LNG satellite station could be constructed in the port of Ploče, i.e., on the location of Naftni Terminali Federacije Ltd. (NTF Ltd.).

The proposed location has several benefits, listed below, which are usually assessed while determining a suitable location for an LNG bunkering/reloading station:

- existing direct access to the Adriatic Sea;
- existing access to other means of LNG transportation (road and railway system);
- an existing ownership/concession right by a BiH company over the land that would be needed to construct the bunkering/distribution station; and
- existing operators of the oil terminal who are experienced and well trained in dealing with hazardous liquids and can easily be trained to operate with LNG.

Since there is a strong possibility that a small-scale LNG satellite station in the port of Ploče could be constructed in the future, the possibility of supplying BiH with LNG from this station will also be assessed in the following parts of the report. In addition to assessing the possibility of constructing and using the satellite station on the location of NTF Ltd., it must be noted that some other LNG infrastructure project developers have started to assess possibilities of constructing LNG stations on other micro-locations within the Port of Ploče as well. Such a possibility is described in section 4 of this report, and if the small-scale LNG station is constructed, it might be one of the possible sources of supply for BiH market. The same project developer is also planning to construct additional satellite stations in Croatian ports of Zadar, Rijeka and Split, and such stations could represent future entry points for LNG from regional LNG terminals. However, only the possibility of supplying LNG to BiH market from local LNG terminals via the satellite station on the location of NTF Ltd will be provided in this report as that station has several benefits more when compared to other planned small-scale LNG satellite stations in Croatia.

Additionally, when considering the BiH case, it is also important to note that an energy strategy, which covers the use of NG on BiH territory, was developed by BiH authorities, namely, the Framework Energy Strategy of BiH until 2035 (local: Okvirna energetska strategija Bosne i Hercegovine do 2035. godine). In the strategy the LNG terminal on the Island of Krk was determined to be a valid source of NG/LNG in the future, whereby special attention was also given to the case of transporting NG without the use of NG pipeline infrastructure, i.e., transport LNG in its liquid form (without regasification). Transport of LNG was also mentioned in the strategy as a valid option when sourced from the port of Ploče.

In terms of current and planned NG pipeline connections between BiH and neighboring counties, NG is currently being imported to BiH only through the interconnection with Serbia. As this interconnection was built in 1979, it represents old infrastructure, which experiences high usage in the winter, when NG consumption is at its peak.

Although there are existing plans to connect BiH with the transmission system of Croatia, even on multiple locations on the border between two countries, there are currently no interconnections available. To increase the security of supply (SoS) and diversify NG sources, further efforts should be made in order to construct such NG pipeline connections between BiH and neighboring countries.

Possibilities to connect BiH NG system with the Croatian system, and the possibility to supply NG to BiH from various terminals through the existing and/or planned NG pipeline connections will be assessed in the following parts of the report.

3. REGIONAL LNG TERMINALS

As seen below in Figure 1, there are several LNG terminals in the region which can be considered as potential sources of NG/LNG for the BiH market, primarily due to their geographical locations. However, they also provide benefits in terms of their existing and planned additional services, which will be further elaborated in the report. Due to the recent events in Ukraine, the geopolitical scale in Europe has changed and energy source diversification has become even more important. In order to increase NG SoS and diversify NG supply sources, countries in the region have started to implement fast track LNG terminal solutions, mostly based on Floating Storage Regasification Unit (FSRU) technology. Various countries in Europe have started to implement such fast track solutions, led by Germany, which has for example secured services of four FSRU vessels in a single year2. However, majority of these LNG terminals will not be described in the report, as they are geographically located further away from BiH market and NG/LNG supply from those terminals would be unrealistic.

Regional LNG terminals include:

Existing LNG terminals:

- LNG terminal on the Island of Krk in Croatia
- LNG terminal Revithoussa in Greece
- LNG terminal Rovigo in Italy
- LNG terminal Toscana in Italy
- LNG terminal Panigaglia in Italy

LNG terminals under construction/commissioning

- LNG terminal Alexandroupoli in Greece
- LNG terminal Piombino in Italy

Planned LNG terminals:

- LNG terminal Thessaloniki in Greece
- LNG terminal Corinth in Greece
- LNG terminal Thrace in Greece
- LNG terminal in Port of Volos in Greece
- LNG terminal Porto Empedocle in Italy
- LNG terminal in Adriatic Sea in Italy
- LNG terminal in Portovesme in Italy
- LNG terminal in Porto Toress in Italy
- LNG terminal in Calabria Province in Italy
- LNG terrminal Vlore in Albania
- LNG terminal Bar in Montenegro

[2] www.upstreamonline.com

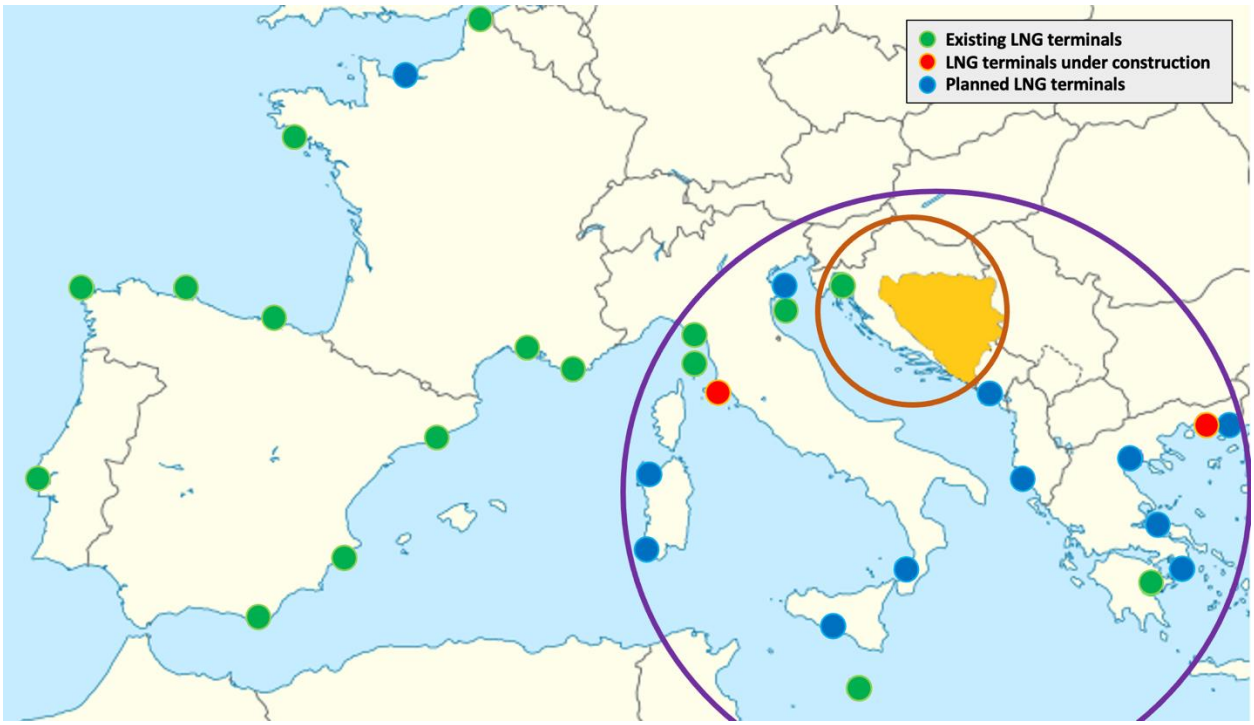

Figure 1. LNG receiving terminals in region[3]

As shown in Figure 1 above, LNG terminals are divided into two distinctive circles, whereby the LNG terminal in Croatia (circle indicated in brown color) is evidently the closest existing one to BiH market.

LNG terminals in Albania, Montenegro, Italy and Greece can be found in the othercircle (indicated in purple color), which represents a larger distance from the BiH market. Regional terminals shown are:

- Italy: three existing LNG terminals (Rovigo, Toscana and Panigaglia), one terminal in construction (Piombino) and five planned LNG terminals.
- Greece: one existing LNG terminal (Revithoussa), one LNG terminal under construction (Alexandroupoli) and four planned LNG terminals.
- Albania: one planned LNG terminal.
- Montenegro: one planned LNG terminal.
- Malta: one constructed LNG terminal.

Out of these LNG terminals, only the ones that are constructed or are in a relatively advanced stage of development will be assessed in detail.

In addition, to increase the diversification and SoS of NG, Italy has recently started to construct one LNG terminal based on FSRU solution and plans to construct five more FSRU based terminals in the future, especially addressing the recent events in Europe which have underlined the importance of energy SoS and diversification of supply.[4] Even although the Piombino LNG terminal is in a relatively

[3] www.entsog.eu and www.gie.eu.
[4] https://www.reuters.com/business/energy/italy-eying-two-floating-lng-plants-cut-russia-gas-reliance-sources-2022-03-22/

advanced stage of development, as it is expected to be in commission soon, it will not be described in detail, since the terminal is located on the west side of Italian coast.

Following the successful development of the LNG terminal in the port of Alexandroupoli, the development of four new FSRU-based projects in Greece has also gained momentum.[5] However, majority projects in Greece are presently at relatively early stages of development, and they will not be further assessed in the report.

The three closest LNG terminals (Krk, Rovigo and Revithoussa) will be described in detail, as they represent a valid source of NG/LNG to BiH market. In addition, the Alexandroupoli terminal in Greece will be described as part of this report as the construction of this project has started and thus can be considered a potential candidate to supply the BiH market with NG as ofearly 2024.[6]

Other LNG terminals in Greece and Italy will not be assessed as thoroughly as the three closest developed LNG terminals. However, a basic overview of other large-scale LNG terminals that could supply BiH market with NG/LNG will be provided in the Annex of this report.

An appropriate figure was prepared for each of the countries/LNG terminals described below, with a visualization of possible routes of supply to BiH market either by the sea or by land transport. As an ending point within BiH the city of Sarajevo was chosen as a reference, as it currently represents the largest consumer of NG in BiH and potentially can be the largest consumer of NG/LNG in the future. Transport by rail was not considered, as such transportation mean is in the early stages of development in EU.

3.1 LNG TERMINALS IN CROATIA

LNG terminal Krk basic information

Being geographically closest to the BiH market, the Krk LNG terminal in Croatia is the most viable direct supply source of NG/LNG for BiH. The LNG terminal is located on the Island of Krk, Primosko-goranska county in the North Adriatic, in the relative vicinity of large industrial port and city of Rijeka.

The project is of strategic importance not only for Croatia, but also for the European Union (EU). As such, the project has received a grant of 101 mil. EUR from the EU through the Connecting Europe Facility (CEF) fund. The main goal of the LNG terminal on the Island of Krk is to become an energy hub to ensure energy needs and SoS through the new NG supply route for the countries of Central and Southeastern Europe.

The project is implemented in two stages, where the floating LNG terminal based on a FSRU was constructed in the first stage, and the full-scale onshore LNG terminal will be constructed in the second stage of the project. Such development will, however, depend on the development of the NG market in the region. In terms of recent project developments, the terminal owner and operator signed a contract on April 14th, 2023, for the construction of an additional regasification module on the FSRU, which will increase the capacity of the terminal for 250,000 m^3/h, and is to be installed on the vessel in summer of year 2025. Such construction is in line with the timeline of the construction of additional NG pipeline

[5] https://balkangreenenergynews.com/launch-of-works-on-alexandroupolis-lng-terminal-in-greece-heralds-reduced-dependence-on-russian-gas-for-the-balkans/

[6] https://english.news.cn/20220503/9866bbac787c428e8df758ff30dbd05e/c.html

capacities in Croatia, which will enable approximately 6.1 billion cubic meters (BCM) to be send-out annually from the terminal.[7]

The construction of the onshore part of the terminal was completed in late 2020, with all then possible tests and pre-commissioning works carried out without the presence of the FSRU. As the main part of the terminal, the LNG carrier (LNGC) 'Viking' was converted into an FSRU named "LNG Croatia" and the vessel arrived at the terminal site fully converted on December 1, 2020. Once the FSRU arrived at the terminal site on the Island of Krk, activities related to the commissioning of the FSRU and onshore facilities began. The terminal was successfully commissioned with the arrival of the first LNGC at the terminal on January 1, 2021. Between then and the time of writing this report, the LNG terminal on the Island of Krk has received 63 LNGCs that have unloaded 8.4 million m^3 of LNG to the tanks of the FSRU. Furthermore, the terminal has exported more than 5 BCM of NG to date.[8]

Alongside its main purpose to deliver NG in its gaseous state to the Croatian NG pipeline network, the terminal has the technical capability to reload LNG to bunker/feeder vessels, and to reload LNG directly from the FSRU to tank trucks This technical option is an added value of the terminal and can be used by market players from BiH as well. Basic technical characteristics of the terminal are provided in Table 1 below, and further in the report.

The LNG terminal on the Island of Krk consists of the following main elements:

- FSRU "LNG Croatia"
- Jetty for FSRU/LNGC mooring
- Onshore part of the terminal with a control building and auxiliary facilities
- High-pressure connection pipeline

Figure 2. LNG terminal on the Island of Krk[9]

[7] www.lng.hr/en/
[8] *www.lng.hr*
[9] Ibid.

FSRU "LNG Croatia"

The FSRU is berthed at a jetty as the main part of the terminal where all major activities, including LNG loading, temporary LNG storage, LNG unloading, and regasification are conducted. As mentioned above, the FSRU is a conversion from an LNGC and has the technical characteristics stated in Table 1 below.

Jetty with auxiliary facilities

The FSRU vessel "LNG Croatia" that is moored to the jetty, is connected to the mooring system and to high pressure offloading arms through which NG (after being regasified) enters the connecting pipeline. In addition to the mooring of the FSRU "LNG Croatia," the jetty is also designed for the indirect acceptance of LNGCs, which are moored side by side to the FSRU vessel during transfer of LNG to the FSRU. In addition, the jetty has been designed to accept trucks, which can provide various services to the FSRU or load LNG directly from the FSRU as stated in the report.[10]

High-pressure connection pipeline

As part of the terminal and in order to connect the terminal to the transmission system operator (TSO) network, a 4.2 km pipeline was constructed. The pipeline connects the terminal to the TSO network at Omišalj gas node. Additionally, the TSO constructed approximately 20 km of pipeline to connect the gas node to the existing network, and the construction had been completed before the arrival of the FSRU at the site. The terminal can also provide additional services as stated in the Table 2 below.

Table 1. Main technical characteristics of the terminal on the Island of Krk[11]

Main technical characteristics	
Total LNG storage capacity	140,206 m^3
Maximum transfer capacity (from LNGC to FSRU)	8,000 m^3/h
Maximum reloading capacity (from FSRU to LNGC)	1,500m^3/h
Maximum reloading capacity (from FSRU to tank trucks)	40 m^3/h
Maximum LNG regasification capacity	451,840 m^3/h (Due to the limitations of the NG transmission system, the maximum regasification capacity is 338,000m^3/h)
Type of regasification system	Open loop system[12]

Table 2. Additional services at the terminal on the Island of Krk[13]

Additional services at the terminal	
LNG loading to trucks	Available
LNG loading to feeder/bunkering vessels	Available

[10] Ibid.
[11] Ibid.
[12] In the open-loop system, seawater is used to heat (regasify) LNG and cooled seawater is discharged from the vessel.
[13] Ibid.

NG/LNG supply possibilities from Krk LNG terminal:

In terms of how to supply the BiH market with NG using the terminal on the Island of Krk, there are multiple ways to transport NG/LNG that is handled on the terminal. Possible ways include:

- **Delivery of NG through planned pipeline connection(s)** between Croatia and BiH (marked as possible route no. 1 on Figure 3 below).
- **Delivery of NG through existing pipeline connection** (marked as possible route no. 2 on Figure 3 below).

In addition to transporting regasified NG from the terminal to the BiH market via NG pipelines, there are also possibilities of transporting NG in its liquefied form, i.e., LNG from the terminal to the BiH market. These possibilities include:

- **Delivery of LNG with feeder/bunkering vessels** to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on Figure 3 below).
- **Delivery of LNG by road transport** (marked as possible route no. 4 on Figure 3 below).

Delivery of NG through planned pipeline connection(s) between Croatia and BiH (marked as possible route no. 1 on Figure 3 below).

The proposed route(s) shown in Figure 3 and other figures in Section 3 are approximate, and do not represent exact possible route(s); as for this, further analysis would need to be conducted. The city of Sarajevo was chosen as the destination point within BiH as it currently represents the largest consumer of NG in BiH and can potentially be the largest consumer of LNG coming from small-scale LNG satellite stations.

Unfortunately, there are currently no existing interconnections between Croatia and BiH. However, there are several possible and planned solutions, which include interconnections at the towns of:

- Slavonski Brod (on the Croatian side) and Bosanski Brod (on the BiH side) – *North Interconnection*
- Rakovica (on the Croatian side) and Tržac (on the BiH side) – *West Interconnection*
- Imotski (on the Croatian side) and Posušje (on the BiH side) – *South Interconnection*

The Interconnection at Zagvozd - Imotski (Croatian side) – Posušje – Tomislavgrad – Novi Travnik with branch to Mostar (BiH), i.e., the South Interconnection, is the most advanced project of the three listed above. On the Croatian side, a pipeline of approximately 52 km needs to be constructed from Dugopolje near Split all the way to Zagvozd, as well as an additional 22 km pipeline between Zagvozd and the border between Croatia and BiH, as shown in Figure 3 below.[14] In that respect, the Croatian TSO has started preparing the design documentation for such a pipeline connection with an operational pressure of 75 bar and an annual maximum capacity of 1.5 BCM of NG.[15] The South Interconnection between Croatia and BiH is the most realistic one, and further steps were taken to realize the project from BiH side as well.

Along with necessary modifications on the Croatian TSO system, an additional pipeline would need to be constructed on the BiH side, which corresponds to 115 km of NG pipeline from Posušje to Travnik (a connection to a currently existing pipeline) with a branch of approximately 46 km in order to connect the pipeline with the town of Mostar. In that respect, further financing was provided for the preparation of project-related documentation.[16] Additionally, multiple memorandums of understanding (MOUs) and

[14] Proceedings, 36th international scientific & expert meeting of gas professionals, June 2021
[15] Ibid.
[16] http://hr.n1info.com/English/NEWS/a420270/EU-approves-preparation-of-documentation-for-new-Bosnia-Croatia-gas-pipeline.html.

similar documents were signed in previous years between the two respective TSOs, Plinacro and BH-Gas. Furthermore, in December 2021 the House of Representatives of the FBiH Parliament adopted the proposal of the Law on South Interconnection of BiH and Croatia, thus leaving only one step left before the law officially enters into force – the adoption by the House of Peoples of the FBiH Parliament. By constructing such infrastructure, the town of Sarajevo, as the main user of NG in BiH, along with all other users on the BiH NG pipeline system could be supplied from different sources, which would increase the SoS and bring additional competitiveness. This would result in lower prices for end users. However, there has been no progress made in the meantime, as further challenges arose in the permitting procedures. In addition, the Law on South Interconnection is still awaiting final adoption by the FBiH Parliament's House of Peoples. Unfortunately, the realistic timeline for the construction of this pipeline is still unknown, so it is more realistic to assess NG/LNG supply to BiH market from local LNG terminals from perspective of other possibilities.

Delivery of NG through existing pipeline connection (marked as possible route no. 2 on Figure 3 below).

As shown in Figure 3 below, in terms of existing pipeline connection(s), the regasified NG from the terminal on the Island of Krk must be transported through the TSO systems of Croatia, Hungary and Serbia for the NG to reach the BiH system. However, transport of NG throughout the existing system, meaning transport of NG being regasified on the terminal, is unlikely as this regasified NG would need to pass through multiple countries before entering BiH system. Also, in this case, flow direction of the NG in determined pipeline(s) would need to be considered, which could further complicate the possibility of having NG from the terminal on the Island of Krk in BiH system, if transported through currently existing systems.

With minor modifications to the TSO systems of Croatia and Serbia, overall bypassing of Hungary could be achieved. Such bypassing could be achieved if the connection between Sotin (on the Croatian side), and Bačko Novo Selo (on the Serbian side) is made. In that case supply of NG from the LNG terminal on the Island of Krk to the BiH market could be achieved through the existing NG pipeline system. According to publicly available information, the interconnection should be operational by 2027.17 The project is being developed by Croatian and Serbian TSOs, but each of them are doing it separately, such that the Croatian TSO is in a more advanced stage of development, while on the Serbian side further development activities are needed to come to the Final Investment Decision (FID) on the construction of the pipeline. From recent developments, the project developer on the Croatian side has initiated public hearing on environmental acceptability of the project, which was held on May 11, 2023.[18]

Delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on Figure 3 below).

Supply of LNG to BiH could be made either via road transport, or indirectly by the LNG bunkering/satellite station in the port of Ploče. At that station, LNG could be reloaded from bunker/feeder vessels to an onshore storage tank of reduced capacity, compared to capacities of large-scale LNG terminals, whereby LNG could be transported further to BiH via road transport (on tank

[17] Source: Catalog of Potential Eastern European Natural Gas Investment Projects in Support of the Three Seas Initiative, May 2021

[18] https://www.vusz.hr/novosti-najave-i-sluzbene-obavijesti/javna-rasprava-u-postupku-procjene-utjecaja-na-okolis-za-dva-zahvata-magistralni-plinovod-

trucks and ISO containers[19]). In Figure 3 below, a possible route is marked as solution no. 3, whereby the LNG is being shipped by LNG bunker/feeder vessels to port of Ploče, and LNG is then further transported to BiH market via road transport.

Regarding the possibility of LNG reloading from the terminal to the bunker/feeder vessels, the LNG terminal on the Island of Krk has confirmed it is possible to perform such operations. LNG reloading from ship to ship, the first of its kind in the Mediterranean, was performed on May 21, 2021,[20] during which LNG was reloaded to the Avenir Accolade ship, which has an LNG storage capacity of 7,000 m^3. LNG loaded at the terminal was used for commissioning a newly built LNG terminal in Sardinia.[21]

This operation confirmed that LNG reloading from the terminal on the Island of Krk is a possible solution, and in case an LNG bunkering/satellite station is built in the port of Ploče, this mode of transport could be a solution for supplying BiH with LNG.

Transportation of LNG by railway will not be assessed in this report as this type of transportation is relatively new in Europe and further efforts are needed to introduce this kind of transport as a regular way of transporting LNG over longer distances. Further development of transport of LNG by rail is expected, but a conservative approach is recommended when making estimates on the availability of transport of LNG by rail because it is in such early stages.

However, if LNG transportation by railway becomes feasible soon, such a solution can be easily implemented from the LNG bunkering/satellite station in the port of Ploče as there is an existing railways system present in the vicinity of the proposed small-scale LNG satellite station, and there is a railway system existing from the port of Ploče to Sarajevo.

Development of this transportation method (delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče) is heavily dependent on the development of the satellite station itself and should be assessed further when, and if, such station is constructed. Although the supply of LNG to this station will be possible from other LNG terminals/opportunities, the supply of LNG from the Island of Krk could be the most viable solution as it is the closest to the small-scale LNG satellite station, meaning that it most likely would be most cost-effective to use supply from this terminal.

Delivery of LNG by road transport (marked as possible route no. 4 on Figure 3 below).

Transport of LNG by road transport of smaller capacity (by tank trucks and with ISO containers) is one of the most practical means of supplying LNG to end users. In terms of the supply of LNG from the terminal on the Island of Krk via road transport, such transportation would most probably be available either directly from the LNG terminal, through the bunkering/satellite station in the Port of Ploče, or some other port in the Adriatic if such a station is built there.

As the option of reloading from the LNG terminal on the Island of Krk directly to the tank truck was introduced in April 2022, this mode of transport is currently the best option for the rapid introduction of LNG in the BiH market.

[19] ISO containers are storage tanks that can be easily placed and removed from a truck, which leaves a full tank at the customer site and loads the empty tank on the truck. They are intermodal containers, meaning they can be used for different modes of transport: ship, rail and truck and are built to the applicable ISO standard. https://www.chartindustries.com/Industry/Industry-Products/Mobile-Delivery-Equipment/ISO-Containers.

[20] www.lng.hr.

[21] www.avenirlng.com

Until present day, 172 loadings of tank trucks have been performed at the LNG terminal on the Island of Krk, which means that this mode of transport can be considered a reliable solution for supplying BiH with LNG.[22] The truck loading station features the following technical parameters:

- LNG loading from the FSRU vessel is done via a flexible hose, where one additional hose is used to feedback vapors formed in the tanks of the tank truck during operation;
- Each truck has a time interval of four hours available to arrive at the terminal, perform the LNG loading operation and leave the terminal area;
- Tank truck loading operations may be performed only when there are no LNG tankers at the terminal that reload LNG to the FSRU and when there are no other service vehicles within the boundaries of the terminal;
- Each truck may have a maximum width of 2.6 meters, must not weigh more than 40 tons after loading and must have tanks pre-cooled to no less than minus (-) 50°C.

Figure 3. NG/LNG supply possibilities from LNG terminal on the Island of Krk[23]

[22] https://lng.hr

[23] www.entsog.eu/maps#, routes superimposed by author.

3.2 LNG TERMINALS IN GREECE

LNG terminals in Greece, which will be described further in this section of the report, include:

- Onshore LNG terminal on the Island of Revithoussa (existing)
- FSRU based LNG terminal in the port of Alexandroupoli (under construction)

3.2.1. LNG TERMINAL REVITHOUSSA

LNG terminal Revithoussa basic information

Revithoussa LNG terminal is located on the Island of Revithoussa, 45 km west of Athens, in Greece and it is currently the only LNG terminal in the country. The terminal is owned and operated by the project company Hellenic Gas Transmission system operator (DESFA).

As the terminal is providing SoS and operational flexibility to the Greek NG transmission system, i.e., it serves as large-scale peak shaving facility for Greece and the region, it is an important NG infrastructure project. The terminal conducted an upgrade of the system in 2018 and currently has 225,000m^3 of storage capacity. The owner of the terminal has contracted a Floating Storage Unit (FSU) in 2022 to service the terminal for an initial period of 12 months, which significantly increases the LNG storage capacity of the terminal up to 370,000 m^3. The contracted vessel is named 'Methane Lydon Volney' and has a storage capacity of 145,000 m^3. The vessel received its first cargo, as an FSU, in November 2022.[24] The addition of the FSU also enables simultaneous loading and unloading LNG from the terminal to/from LNGCs/LNG bunker vessels. In addition, the terminal has heavily invested in the provision of additional small-scale services, and it recently commissioned a station for LNG loading into tank trucks, which will be addressed below.

The LNG terminal on the Island of Revithoussa consists of the following main elements:

- Three LNG storage tanks
- Floating storage unit (under temporary contract)
- Control building and auxiliary facilities
- Regasification facility
- Jetty for LNG reloading into LNG storage tanks
- Jetty for LNG bunkering/feeder vessels activities (being developed)
- LNG truck loading facilities

Table 3. Main technical characteristics of the terminal on the Island of Revithoussa[25]

Main technical characteristics	
Terminal total onshore LNG storage capacity	225,000 m^3
Terminal additional temporary (FSU) capacity	140,000 m^3
Minimum transfer capacity from LNGC	7,250 m^3/h
Maximum LNG regasification capacity	990.000 m^3/h (The above-mentioned number includes the auxiliary regasification capacity)

[24] www.lngprime.com
[25] www.desfa.gr/en/national-natural-gas-system/lng-facility.

Main technical characteristics	
Type of regasification system	Open and Closed[26] loop system
Maximum flowrate into tank trucks	100 m^3/h

The terminal will or is planning to provide additional services as stated in the Table 4 below.

Table 4. Additional services at the terminal on the Island of Revithoussa[27]

Additional services at the terminal	
LNG loading to trucks	Available
LNG loading to feeder/bunkering vessels	Under construction

NG/LNG supply possibilities from Revithoussa LNG terminal

There are multiple ways to supply the BiH market with NG/LNG that is handled on the terminal. These possibilities include:

- **Delivery of NG through planned pipeline connection(s)** between, Greece, Albania, Montenegro, Croatia and BiH (marked as possible route no. 1 on Figure 4 below).
- **Delivery of NG through existing pipeline connection** (marked as possible route no. 2 on Figure 4 below).

In addition to transporting regasified NG from the terminal to the BiH market via NG pipelines, there are also possibilities of transporting NG in its liquefied form, i.e., LNG from the terminal to BiH market. These possibilities include:

- **Delivery of LNG with feeder/bunkering vessels** to planned LNG a bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on Figure 4 below).
- **Delivery of LNG by road transport** (marked as possible route no. 4 on Figure 4).

Delivery of NG through planned pipeline connection(s) between Greece, Albania, Montenegro, Croatia and BiH (marked as possible route no. 1 on the Figure 4 below).

In order to transport NG from the Revithoussa LNG terminal, multiple pipelines need to be constructed. In addition to the one that would need to be constructed between Croatia and BiH at point Imotski (on the Croatian side) and Posušje (on the BiH side), the Ionian Adriatic Pipeline (IAP) should be completed as well, as shown in Figure 4.

Delivery of NG through existing pipeline connection (marked as possible route no. 2 on the Figure 4 below).

As shown in Figure 4 below, in terms of existing pipeline connection(s), the NG from the Revithoussa LNG terminal could be transported through the TSO systems of Greece and a newly built NG pipeline interconnection between Bulgaria and Serbia (Balkan Stream, as part of Turk Stream) for the NG to reach BiH.

However, transport of NG through that system would be complex due to the need to pass through multiple countries before entering the BiH system and the questionable, non-transparent possibility of booking transmission capacity. Also, the capacity of the existing NG pipeline interconnection of Serbia

[26] In a closed loop system, the medium used to heat (regasify) LNG is re-circulated and not discharged into the sea.
[27] Ibid.

and BiH is in question, as well as the possibility of increasing the transport capacity by building the New Eastern Interconnection.[28]

Delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on Figure 4 below).

As described above, supply of LNG to BiH could be made indirectly through the LNG bunkering/satellite station in the port of Ploče. LNG could be reloaded from bunker/feeder vessels at that station, whereby it could be transported further to BiH via road transport, as shown in Figure 4 below, as route no. 3.

Development of this transportation route (delivery of LNG through feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče) is heavily dependent on the development of the satellite station itself, and should be assessed further when, and if, such station is constructed.

However, it should be noted that Revithoussa LNG terminal is heavily investing in its small-scale LNG opportunities, which include the construction of the jetty for LNG bunker/feeder vessels. The FID for the jetty was made in Quarter 1 of 2021, and the jetty will be constructed in late 2023.[29] Once constructed, the Revithoussa LNG terminal reloading facilities could be used to supply the BiH market as well. Additionally, Greece is also developing its bunker/feeder vessel fleet which could be used for this kind of supply.

Delivery of LNG by road transport (marked as possible route no. 4 on Figure 4 below).

As described above in the report, transport of LNG by road transport is one of the most practical means of supplying LNG to end users. The LNG truck loading station on Revithoussa LNG terminal was put in operation in 2022, with the capacity to offer about 3,550 truck loadings on an annual basis.[30]

As the Revithoussa LNG terminal is located on an island, trucks need to be transported from mainland Greece, which is done by special ferries. Ferries can transport trucks from three ports, Elefsina, Perama Megaridos and Almira. The ferries have a transport capacity of two trucks per voyage.[31]

Direct transport of LNG in its liquefied from the Revithoussa LNG terminal to BiH is one of the most promising ways to deliver NG, given that loading LNG onto trucks is already available from 2022.

The truck loading station features the following technical parameters:

- One loading bay, with an estimated duration of 60 minutes for each reloading operation, including preparatory activities.
- LNG loading from terminal is done via a flexible hose, where one additional hose is used to feedback vapors formed in the tanks of the tank truck during operation.
- Each truck may have a maximum width of 2.55 meters and must not weigh more than 42 tons after loading.

[28] Detailed possibilities of NG transport over this direction, as well as all the challenges of its realization, are described in detail in Chapter 3.2 Option 2 - BiH trader contracts the purchase and transmission of gas through Serbia of the Report on the possible impact of new transmission gas pipelines and LNG plants on the price of natural gas for end-customers in BiH, which is a part of the USAID Energy Policy Activity project.
[29] www.ceenergynews.com
[30] Ibid.
[31] www.desfa.gr

Figure 4. NG/LNG supply possibilities from Revithoussa LNG terminal[32]

3.2.2. LNG TERMINAL ALEXANDROUPOLI

LNG terminal Alexandroupoli basic information

LNG terminal Alexandroupoli will be constructed in Northeastern Greece, approximately 17.6 kilometers from the town of Alexandroupolis. The LNG terminal is planned to be constructed as a floating LNG terminal, based on a FSRU solution. After the LNG is regasified it will be transported to the shore via a subsea pipeline. The connection of the FSRU with the submerged pipeline will be made through a submerged turret and a set of flexible pipelines. The FID for the project was made in February 2022 and the construction of the terminal began in May 2022. It is expected that the terminal will become operational in late 2023.[33]

The NG from the terminal is planned to be delivered to consumers in Greece, Bulgaria, Serbia and North Macedonia. This was confirmed at the ceremony held to mark the beginning of the construction of the terminal, where representatives of mentioned countries stressed the importance of the project in increasing SoS and diversifying the supply of NG for their countries.[34] Also, it is expected that the NG

[32] www.www.entsog.eu/maps#, route diagrams superimposed by author.
[33] http://www.gastrade.gr/en.
[34] www.intellinews.com

can be transported to Romania, Moldova, Ukraine and Hungary, although this is heavily dependent on the direction of NG flow in the pipelines.

The LNG terminal Alexandroupoli will consist of the following main elements:

- FSRU
- Submerged turret and a set of flexible risers
- Submerged high-pressure pipeline
- Onshore metering station

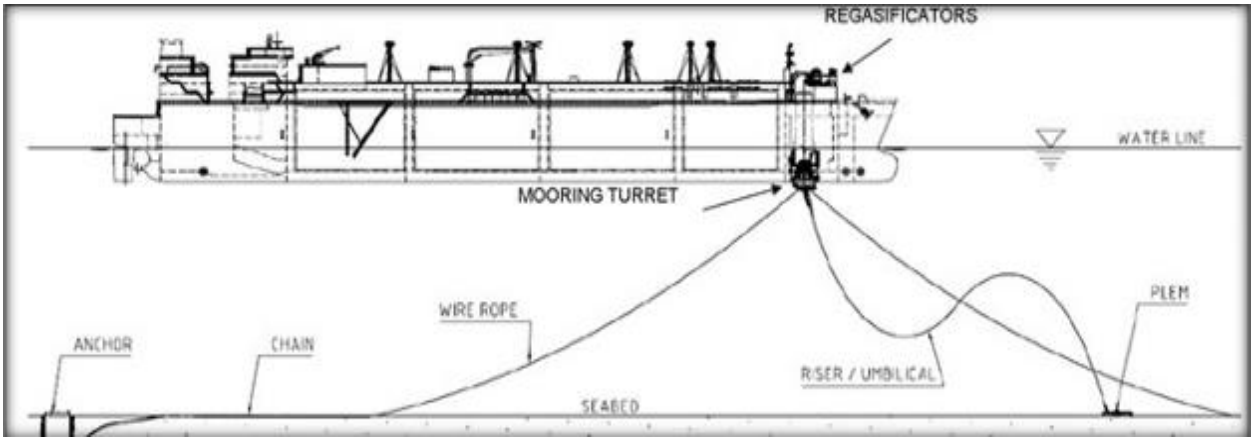

Figure 5. Visualization of the LNG terminal Alexandroupoli[35]

As it is the case with floating LNG terminal on the Island of Krk, which is also based on an FSRU solution, the 'heart' of the system will be the FSRU, where all major activities will be conducted. The FSRU will be located 17.6 km Southwest (SW) from the port of Alexandroupolis. The terminal/FSRU will have the main technical characteristics as indicated in Table 5 and Table 6 below.

The FSRU will be connected to the NG pipeline system through a mooring turret whereby the NG, which has been regasified, is sent through flexible risers which connect the turret to the Pipeline End Manifold (PLEM). The PLEM represents the connection between the FSRU and the subsea NG pipeline. The length of the submerged NG pipeline is approximately 24 km; the pipeline goes onshore for an additional 4 km, where it reaches the metering station and is connected to the Greek TSO network.

Table 5. Expected technical characteristics of the LNG terminal Alexandroupoli[36]

Expected main technical characteristics	
Total LNG storage capacity	153,500 m^3
Minimum transfer capacity from LNGC	Up to 10,000 m^3/h
Maximum LNG regasification capacity	Up to 937,500 m^3/h
Type of regasification system	Combined loop system

[35] www.gastrade.gr
[36] Ibid.

In addition to main technical characteristics, the terminal will or is planning to provide additional services as stated in Table 6 below.

Table 6. Expected additional services on the LNG terminal Alexandroupoli.

Expected additional services at the terminal	
LNG loading to trucks	Not possible on the terminal as the terminal is an offshore structure
LNG loading to feeder/bunkering vessels	Likely (status of consideration unknown)

NG/LNG supply possibilities from Alexandroupoli LNG terminal

In terms of possibilities to supply NG from the Alexandroupoli LNG, there are multiple ways to supply the BiH market with NG/LNG that is handled on the terminal, however unlikely. These possibilities include:

- **Delivery of NG through planned pipeline connection(s) between Greece, Albania, Montenegro, Croatia and BiH** (marked as possible route no. 1 on Figure 6 below).
- **Delivery of NG through existing pipeline connection** (marked as possible route no. 2 on Figure 6 below).

In addition to transporting regasified NG from the terminal to the BiH market via NG pipelines, there is a possibility of transporting NG in its liquefied form, i.e., LNG from the terminal to BiH market. These possibilities include:

- **Delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče** (marked as possible route no. 3 on Figure 6 below).
- **Delivery of LNG by road transport**
- **Delivery of NG through planned pipeline connection(s) between Greece, Albania, Montenegro, Croatia and BiH** (marked as possible route no. 1 on Figure 6 below).

Like the case of Revithoussa LNG terminal, in order to transport NG from the Alexandroupoli LNG terminal, there should be multiple pipelines constructed. In addition to the one that would need to be constructed between Croatia and BiH, the IAP should be completed as well, as shown in Figure 6 below.

Delivery of NG through existing pipeline connection (marked as possible route no. 2 on the Figure 6 below).

As shown in Figure 6 below, in terms of existing pipeline connection(s), the NG from the Alexandroupoli LNG terminal could be transported through TSO systems of Greece, Bulgaria, and Serbia for the NG to reach BiH. As mentioned above, Serbia has started with commercial operations of the newly constructed pipeline which connects Bulgaria and Serbia. However, as this pipeline is part of Turk Stream, transporting primarily NG from Russia through Turkey and Bulgaria, it is highly unlikely that NG from Alexandroupoli LNG terminal could be transported to BiH through this pipeline.

This means of transportation would represent a very complex route for transporting NG through the existing NG pipeline system. However, with the construction of the planned NG connection between Bulgaria and Serbia at Nis-Dimitrovgrad-Sofia connection point, NG could be delivered to BiH system from Alexandroupoli LNG terminal.

Delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on Figure 6 below).

As described above, the supply of LNG to BiH could be made indirectly by LNG bunkering/satellite station in the port of Ploče. At that station LNG could be reloaded from bunker/feeder vessels whereby it could be transported further to BiH via road transport, and the proposed route from Alexandroupoli LNG terminal is provided in Figure 6 below, as route no. 3.

Development of this transportation means (i.e., delivery of LNG with feeder/bunkering vessels to a planned LNG bunkering/satellite station in the port of Ploče) is heavily dependent on the development of the satellite station itself, and should be assessed further when, and if, such station is constructed.

In terms of the Alexandroupoli LNG terminal, no direct plans to have such reloading ability exist. However, if considering the development of such abilities with only minor technical modifications, as was the case of LNG terminal in Croatia, it can be expected that the Alexandroupoli LNG terminal will have such abilities.

Delivery of LNG by road transport

In the case of the Alexandroupoli LNG terminal, as it is located offshore, it is practically impossible for the terminal to have abilities to reload LNG to trucks. Additionally, if the project company would desire to develop such an opportunity on the mainland, major investments would need to be made in that respect. Therefore, such an opportunity was not assessed in this report.

Figure 6. NG/LNG supply possibilities from Alexandroupoli LNG terminal[37]

[37] www.entsog.eu/maps#.

3.3 LNG TERMINALS IN ITALY

LNG terminals in Italy, which will be described further in this section of the report, include:

- Gravity-based structure (GBS) offshore LNG terminal also known as 'Adriatic LNG terminal' near the town of Rovigo (existing)

3.3.1. LNG TERMINAL ROVIGO (ADRIATIC LNG TERMINAL)

Adriatic LNG terminal basic information

LNG terminal Rovigo, also known as "Adriatic LNG terminal," is a GBS LNG terminal.

The terminal is located in the Adriatic Sea, approximately 15 kilometers offshore, on the eastern Italy coastline. It is connected to the NG transmission network through an underwater NG pipeline. The main technical characteristics of the terminal are provided in Table 7 below.

The Adriatic LNG terminal consists of the following main elements:

- Reinforced concrete structure (GBS), with two LNG tanks located inside the structure
- Regasification facility
- Mooring and LNG unloading facilities
- Auxiliary systems

Table 7. Main technical characteristics of the Adriatic LNG terminal[38]

Main technical characteristics	
Terminal total LNG storage capacity	250,000 m^3
Minimum transfer capacity from LNGC	7,250 m^3/h
Maximum LNG regasification capacity	Approximately 914.000 m^3/h
Type of regasification system	Open loop system

In addition to its main technical characteristics, the terminal will or is planning to provide additional services as stated in the Table 8 below.

Table 8. Additional services at the Adriatic LNG terminal.

Additional services at the terminal	
LNG loading to trucks	Not possible at the terminal as it is offshore structure
LNG loading to feeder/bunkering vessels	Under consideration

NG/LNG supply possibilities from Adriatic LNG terminal

In terms of possibilities to supply NG from the Adriatic LNG terminal, there are multiple ways to supply the BiH market with the NG that is handled at the terminal, which include:

- **Delivery of NG through planned pipeline connection(s)** between Italy, Slovenia, Croatia and BiH (marked as possible route no. 1 on Figure 7 below).

[38] https://www.desfa.gr/en/national-natural-gas-system/lng-facility.

- **Delivery of NG through existing pipeline connection** (marked as possible route no. 2 on Figure 7 below).

In addition to transporting regasified NG from the terminal to BiH market via NG pipelines, there are also possibilities of transporting NG in its liquefied form, i.e., LNG from the terminal to BiH market. These possibilities include:

- **Delivery of LNG with feeder/bunkering vessels** to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on Figure 7 below).
- **Delivery of LNG by road transport**.

Delivery of NG through planned pipeline connection(s) between Italy, Slovenia, Croatia and BiH (marked as possible route no. 1 on Figure 7 below).

In order to transport NG from the Adriatic LNG terminal, there should be multiple pipelines constructed. This also includes the connection that would need to be constructed between Croatia and BiH, as shown in Figure 7. In addition to the construction of the NG pipeline connection, a major constraint to the flow of NG from the Adriatic LNG terminal could be the current direction of NG flow in the pipeline(s).

Delivery of NG through existing pipeline connection (marked as possible route no. 2 on Figure 7 below).

As shown in Figure 7 below, in terms of existing pipeline connection(s), the NG from the Adriatic LNG terminal could be transported through the TSO systems of Italy, Slovenia, Croatia, Hungary and Serbia for the NG to reach BiH. However, transport of NG through the existing system, meaning transport of the NG which is being regasified on the Adriatic LNG terminal, is unlikely since it is also connected to the potentially unfavorable direction of NG flow in TSO pipeline systems.

This means of transportation would represent a very complex route and from all the proposed NG transportation means from the Adriatic LNG terminal, transport of NG through the existing NG pipeline system would be the most unlikely way of NG supply.

Delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on Figure 7 below).

As described above, the supply of LNG to BiH could be made indirectly by LNG bunkering/satellite station in the port of Ploče. At that station LNG could be reloaded from bunker/feeder vessels, whereby it could be transported further to BiH via road transport (on tank trucks or ISO containers); the proposed route from Adriatic LNG terminal is provided in Figure 7 below, as the route no. 3.

Development of this transportation means (i.e., delivery of LNG with feeder/bunkering vessels to the planned LNG bunkering/satellite station in the port of Ploče) is heavily dependent on the development of the satellite station itself, and should be assessed further when, and if, such station is constructed.

In terms of the Adriatic LNG terminal, it can be expected that the terminal will have such abilities in the future as it is currently assessing such opportunity; however, the specific timing is currently unknown.[39]

[39] http://www.ship2shore.it/.

Delivery of LNG by road transport

Like the case of Alexandroupoli LNG terminal, the Adriatic LNG terminal is located offshore, and it is practically impossible for the Adriatic LNG terminal to have the ability to reload LNG onto trucks. Therefore, such an opportunity was not assessed in this report.

However, there is a possibility to deliver LNG with trucks from one of the small-scale LNG terminals planned in Italy, and that will be assessed further in the report.

Figure 7. NG/LNG supply possibilities from Adriatic LNG terminal[40]

[40] www.entsog.eu/maps#, route diagram superimposed by author.

4. ADDITIONAL LNG SUPPLY POSSIBILITIES VIA SMALL-SCALE LNG SATELLITE STATIONS

In addition to various opportunities that can supply the BiH market with NG in its gaseous or liquefied form, there are multiple possibilities to supply the BiH market with NG in its liquefied form, including LNG, through small-scale LNG satellite stations.

The following LNG satellite stations have been identified as potential sources for BiH, due to their geographical positions and level of development:

- Ravenna coastal depot, Italy;
- LNG distribution station in Rijeka, Zadar, Ploče and Split, Croatia; and
- Venice LNG satellite station, Italy.

Although the LNG distribution market in Italy is the largest in the region and there are multiple additional small-scale satellite LNG stations being constructed or in the planning stage of development, only the ones that are in the permitting stage and located near the Adriatic coastline will be analyzed further in the report.

For all mentioned small-scale satellite LNG stations, a respective figure was prepared with a visualization of possible routes of supply to the BiH market either by sea or by land transport. Transport by rail was not considered since transportation is in its early stages of development in Europe.

4.1 LNG SUPPLY POSSIBILITIES FROM THE RAVENNA COASTAL DEPOT

One of most advanced small-scale LNG distribution facilities relatively close to BiH is the Ravenna coastal depot facility, which primarily serves the large Italian market that has a consumption for approximately 200,000 tons of LNG per year. The facility was commissioned in September 2021 when the project owner unloaded the first cargo at the terminal.[41] The satellite station has the possibility of sourcing LNG from terminals in Italy, Greece, Spain and Croatia. According to publicly available information, the project owners have agreed on sourcing LNG from Spain.[42]

At the same time as the project was constructed, the project development company entered a partnership with a vessel provider, which constructed a vessel that will be used to transport LNG. A 30,000 m^3 storage capacity vessel named 'Ravenna Kunusten' will be used and was delivered to the project owner in February 2021.[43] The vessel was also used to supply LNG from the LNG terminal in Barcelona to the LNG terminal on the Island of Krk in Croatia in September 2022, showing the flexibility of LNG supply in the Mediterranean Sea/region.[44]

The intention of the project is to supply both vessels and trucks with LNG, consisting of:

- Storage tank of 20,000m^3 LNG storage capacity;
- A jetty to accommodate vessels up to 30,000m^3 LNG storage capacity;
- Six truck loading facilities; and
- Control and auxiliary systems facilities.

[41] www.offshore-energy.biz.
[42] Ibid
[43] https://www.edison.it/en/small-scale-lng.
[44] Ibid

As it can be seen in Figure 8 below, the position of the Ravenna coastal depot facility is favorable for the BiH market, as LNG can be transported to BiH market by different means including:

- **LNG being transported with road transportation to the BiH market,** including tank truck and ISO containers (marked as possible route no. 1 on Figure 8 below; or
- **LNG being transported with an LNG bunkering/feeder vessel to a satellite bunkering station in the port of Ploče,** where it can be further transported to the BiH market (marked as possible route no. 2 on Figure 8 below.

Figure 8. LNG supply possibilities from Ravenna coastal depot[45]

From a logistical point of view, the most favorable solution would be to transport LNG using road transport via route no. 1 as all other routes depend on the development of either the LNG small-scale satellite stations in the port of Rijeka, Zadar, Split or the LNG small-scale satellite station in the port of Ploče. From an assessment point of view, only the proposed small-scale satellite station in the port of Ploče was taken into consideration because other previously mentioned ones are in such early stages of development.

Considering that the LNG terminal on the Island of Krk commissioned a dedicated truck loading station in April 2022 and already has the possibility to reload LNG to bunker/feeder vessels, it seems that the option of supplying LNG to the BiH market from the LNG terminal on the Island of Krk is the most

---

[45] www.entsog.eu/maps#, routes superimposed by author.

viable one. However, supply from the Ravenna coastal depot might be considered as an alternative. In addition to developing the Ravenna coastal depot, the project owner of the satellite station has entered development of other similar projects in port of Naples, Port of Oristano and Port of Brindisi. However, no recent developments have been made in respect to those projects.[46] The project owner of the Ravenna costal depot has also recently signed an MOU with the government owned LNG infrastructure company, 'Snam', on further development of small-scale satellite LNG infrastructure in Italy, which further emphasizes the importance of developing such infrastructure in the region.[47]

4.2 SUPPLY FROM LNG DISTRIBUTION STATION IN CROATIA

Although the Republic of Croatia has constructed an LNG terminal that has the ability to reload LNG to bunker/feeder vessels and the ability to reload LNG directly into tank trucks, the Krk LNG terminal operator/owner is also developing sub-projects of constructing dedicated LNG bunkering stations. Although, initially, such station was planned to be constructed in port of Rijeka, the project developer recently announced that such station could be constructed in either Rijeka, Zadar, Split or even in Ploče, depending on technical, spatial and financial parameters.[48]

Development of such a small-scale LNG satellite station in one of the above mentioned ports is considered not only as added value for the region in terms of further LNG supply opportunities but also as one of the requirements coming from legislation from the Republic of Croatia and the obligations Croatia overtook as being part of EU.

The satellite stations would likely source LNG from the LNG terminal in Croatia, but they could also source LNG from other LNG terminals, such as those in Italy, Spain and Greece.

From the above mentioned ports in Croatia, the implementation of a satellite station in port of Zadar has recently gained momentum and was considered the most likely place where the first satellite station would be constructed. However, plans to construct such a station were temporarily suspended due to overlapping activities from both the port owners and the satellite station project developer as they both were planning to construct infrastructure on the same micro-location. The project in Zadar was in a well-advanced stage, where the Environmental Impact Assessment was being performed, but the project is delayed until all spatial challenges are resolved. [49] The satellite station should have been constructed in three phases:

- First phase, considering construction of:
    - A jetty for receiving the LNG bunkering/feeder vessels
    - LNG tanks with storage capacity of 3,000 m^3
    - Recondensation facility
    - Facility to reload LNG to trains (one station for reloading)
    - Facility to reload LNG into trucks and ISO containers (two stations for reloading)
    - Facility to reload LNG/LCNG as fuel (four stations for reloading)
- Second phase, considering expansion of storage capacity from 3,000 m^3 to 7,500 m^3
- Third phase, considering expansion of storage capacity from 7,500 m^3 to 30,000 m^3.[50]

[46] Ibid
[47] Ibid
[48] https://www.novilist.hr/
[49] https://zadarskilist.novilist.hr/
[50] Ibid

However, if the second location in port of Zadar would not be suitable for implementation of a station with these technical parameters, the project owner/developer would need to adjust the solution based on available space. From the perspective of development of other LNG satellite stations in Croatia, it is realistic that they could follow the same staged approach and with similar LNG reloading capabilities being implemented on any chosen location.

As can be seen from Figure 9 below, the positions of all of the mentioned LNG distribution stations are favorable for the BiH market. LNG can be transported to BiH by different means, including:

1. **LNG being transported with road transportation** to the BiH market, including a tank truck and ISO containers (marked as possible route no. 1 on Figure 9 below); and
2. **LNG being transported by an LNG bunkering/feeder vessel to the satellite bunkering station in port of Ploče**, (in this case only represented as an option developed by Krk LNG terminal operator/owner as the project developer), where it can be further transported to the BiH market (marked as possible route no. 2 on Figure 9 below). This option considers that if such a station is developed and constructed by Krk LNG terminal operator/owner, the proposed satellite station on the location of NTF Ltd. would be considered redundant. However, LNG could be transported to BiH market from the station developed by Krk LNG terminal operator/owner as well and for that reason the route is indicated in Figure 9 below).

The possibility of supplying LNG with railway transportation has not been considered in this report as the project company currently does not consider ita possibility in the project documentation, but the opportunity should be considered when, and if, the system will be implemented.

As is the case for the Ravenna coastal depot, the most favorable solution to supply LNG from the LNG distribution stations in the Ports of Rijeka, Zadar or Split to the BiH market, from a logistical point of view, would be to transport LNG by trucks over route no. 1, as the other solution depends on the development of the LNG small-scale satellite station as part of the port of Ploče.

Considering that the LNG terminal on the Island of Krk already has a dedicated truck loading station constructed as well as the possibility to reload LNG to bunker/feeder vessels, the option of supplying LNG to the BiH market from the LNG terminal on the Island of Krk is the most viable one in this initial stage. LNG supply from the distribution station in the Port of Rijeka, Zadar, Split and Ploče might only be considered as an alternative.

However, once the LNG small-scale satellite stations in the Port of Rijeka, Zadar, Split and Ploče, or in some other location in Croatia become operational, they might represent one possible source of LNG for the BiH market. At that moment, a review of the situation, including a revaluation of the feasibility/economics of LNG supply to the BiH market from these small-scale satellite stations, should be conducted.

Figure 9. Supply possibilities from LNG distribution station in the port of Rijeka[51]

Additionally, the market participants could be encouraged to implement and construct various other small-scale satellite stations on the coast of Croatia, and the development of small-scale satellite stations in Croatia should be closely followed when assessing LNG supply options for BiH.

4.3 LNG SUPPLY POSSIBILITY FROM VENICE LNG SATELLITE STATION

Venice LNG coastal storage facility is located in the Veneto Region, the industrial part of Venice, Italy. The project is being developed by a project company, Venice LNG S.p.a, formed in 2017. From a logistical point of view, the satellite station is quite similar to Ravenna costal depot examined in the section above. The main aim of the project is to create a new supply point for LNG distribution in Porto Marghera. The project should be supplied by a dedicated vessel of 4,000m³ storage capacity.[52]

[51] www.entsog.eu/maps#, routes superimposed by author.

[52] https://www.port.venice.it/en/venice-lng-terminal.html

The project was recognized for its strategic importance by the EU, and as such, has received funding under the CEF program in the amount of 18.5 million EUR.

The project has, in addition to a previously obtained Environmental Compatibility License, also obtained an Authorization Decree in December 2020 for the construction and operation of the station, which was issued by the Ministry of Economic Development and the Ministry of Infrastructure and Transport, in agreement with Veneto Region. In order to confirm commercial feasibility of the project, the development company conducted an open season procedure and its results will serve to make the final decision on construction.[53]

In order to conduct the necessary tendering and thereafter the construction of the satellite station, the project company is already working on the FEED solution. In accordance with available information, the Venice LNG coastal storage facility's start of operation is expected in 2024, however, that date might be unrealistic as there were no recent news on the development of the station.

In terms of LNG supply, the satellite station could source LNG in similar ways as the Ravenna coastal depot facility, including sourcing LNG from terminals in Italy, Greece, Croatia, etc.

The intention of the project is to supply both vessels and trucks with LNG, consisting of[54]

- Storage tank of approximately 32,000m^3 LNG storage capacity;
- Jetty to accommodate vessels up to 30, 000m^3 LNG storage capacity;
- Truck loading facilities; and
- Control and auxiliary systems facilities.

As can be seen from Figure 10 below, the position of the Venice LNG coastal storage facility is favorable for the BiH market. LNG can be transported to BiH market by:

- **LNG being transported with road transportation to the BiH market including tank truck and ISO containers** (marked as possible route no. 1 on the Figure 10 below);
- **LNG being transported with LNG bunkering/feeder vessel to satellite bunkering station in the port of Ploče, where it can be further transported to the BiH market** (marked as possible route no. 2 on the Figure 10 below).

As it is the case for the Ravenna coastal depot, from a logistical point of view, the most favorable solution to supply LNG from the Venice LNG coastal storage facility to the BiH market would be to transport LNG by trucks over route no. 1.Any other solution depends on the development of either the LNG small-scale satellite stations in the port of Rijeka, Zadar, Split or the LNG small-scale satellite station in the port of Ploče.

Because the LNG terminal on the Island of Krk has a dedicated truck loading station and can already reload LNG to bunker/feeder vessels, it seems that the option of supplying LNG to the BiH market from the LNG terminal on the Island of Krk is the most viable one. Supply from Venice LNG coastal storage facility might only be considered as an alternative. In addition, the exact timing of the construction of the LNG storage facility is unknown, while the LNG terminal on the Island of Krk has already been constructed.

[53] https://lngjournal.com/index.php/.
[54] http://www.venicelng.it/index_eng.html.

However, once the Venice LNG coastal storage facility becomes operational, it might represent one possible source of LNG for the BiH market. At that time, a review of the situation, including a revaluation of the feasibility/economics of LNG supply to the BiH market from the Venice LNG coastal storage facility should be conducted.

Figure 10. LNG supply possibilities from Venice LNG storage facility[55]

Additionally, taking into account the current development plans of the Venice LNG small-scale satellite station, it is more likely that the facilities in Croatia and Italy (including the LNG terminal on the Island of Krk and Ravenna coastal depot) will supply LNG/NG to BiH, considering that these facilities are already operational. Therefore, the option of the LNG satellite station in Venice should be considered least likely from the above-mentioned additional LNG supply opportunities.

4.4 OTHER SMALL-SCALE LNG SUPPLY POSSIBILITIES

A small-scale LNG satellite station in the port of Oristano on the Island of Sardinia can also be noted as a possibility to supply the BiH market with LNG. This station was constructed and became operational in 2021 and received its first LNG cargo loaded on a bunkering/feeder vessel at the LNG terminal on the Island of Krk.[56] The station has a capacity of 9,000m³ and is supplied with LNG with a dedicated feeder vessel. Although the satellite station on the Island of Sardinia is completed and operational,

[55] www.entsog.eu/maps#, routes superimposed by author.
[56] Ibid

transportation of LNG by trucks can be excluded as a possibility to supply LNG from this facility to BiH. However, as described above, the supply of LNG to BiH could be made indirectly through the LNG bunkering/satellite station in the port of Rijeka, Zadar, Split or Ploče.

Additionally, the Revithoussa LNG terminal project development company is also constructing an LNG feeder vessel and in January 2020, DESFA and the European Investment Bank signed a loan agreement for 20 million EUR, which represents 50% of the total cost for the purchase of a bunkering vessel.[57] The vessel will have a storage capacity of approximately 4,000 m^3, type C tanks, a loading capacity of 8,000 m^3 and a discharge rate capacity of 640 m^3/h.

This LNG bunkering vessel will represent the first of its kind of vessel in the Eastern Mediterranean and could supply the proposed small-scale LNG satellite station in the port of Ploče. However, the vessel's main purpose will be to load LNG at Revithoussa terminal and reload LNG as fuel to vessels in Piraeus.

According to publicly available information, delivery of the vessel is expected in 2023.[58]

In addition, other project developers have increased efforts to further introduce LNG in the regional market. For example, further investments were made in construction of LNG bunkering vessels, which are to be delivered in the forthcoming period.[59]

5. CONCLUSIONS

While there are various LNG terminals in the EU that could supply the BiH market with NG/LNG, the distance from the LNG terminals and the end users must be carefully considered because of the cost. The further the distance, the greater the end user's price would be as it would reflect additional capital (CAPEX) and/or operational (OPEX) costs and logistical obstacles. For this reason, distance is one of the most important reasons why the regional LNG terminals located in Croatia, Italy or Greece are the most viable choices for additional BiH NG supply.

This report finds that the LNG terminal on the Island of Krk is the most viable option for a new source of supply of NG in BiH, either in its gaseous or liquefied state. The LNG terminal on the Island of Krk is not only the closest terminal to the BiH market but can also provide additional services that the BiH market might need to fully develop its NG/LNG market. The constructed LNG terminal on the Island of Krk offers the service of LNG reloading into tank trucks and already has the ability to reload LNG to bunker/feeder vessels, which makes the terminal even more commercially attractive to possible BiH end users.

Within BiH there are multiple possibilities to further increase the use of NG while introducing the use of LNG in the market. NG could not only be used for heating purposes, but also for industry applications. Also, from the perspective of current facilities, by introducing NG/LNG into the BiH market, the transition from less environmentally friendly fuel sources such as coal and HFO to NG/LNG could be made.

In addition to the use of NG from pipelines, NG could be used in the BiH market in its LNG form. Possibilities to use LNG include peak shaving facilities in some of the larger NG consuming areas, industry use of LNG and LNG/LCNG refueling solutions.

[57] https://www.maritime-executive.com/article/greece-to-get-its-first-lng-bunkering-vessel.
[58] https://www.bunkerspot.com/europe/.
[59] www.rivieramm.com/

Whereas LNG terminals in Italy and Greece could also serve as valid sources of NG/LNG, considering their distance from the BiH market, the supply of NG from those terminals is more likely to be in liquefied form only as transportation via pipelines would most likely be unfeasible due to transportation costs. Further, there are opportunities identified in the region in terms of small-scale LNG satellite stations, such as in the port of Ploče. Although in the early stage of documentation preparation, they could represent a possibility to supply the BiH market directly with LNG via road transport and indirectly by sea transport.

As the situation on the LNG market is constantly developing and regasification terminals as 'sources' of NG/LNG in the region are developing their services accordingly, the dynamics of these developments should be monitored closely and periodically re-assessed in order to confirm or determine the best possible source of NG/LNG for the BiH market.

This is even more important considering the fact that it was LNG as a source of NG that largely contributed to the stability and SoS of the EU gas market during the last heating season 2022/2023. It is precisely the plans of large EU gas consumers (e.g., Germany, Italy, Poland), which have traditionally used NG supply using pipeline transport, to build additional LNG regasification capacities (mainly in the form of FSRUs) that indicate the increasing importance of LNG as a source of supply of NG.

Due to that reason, it is necessary to pay appropriate attention to LNG terminals and small-scale satellite stations development, in terms of enhancing possibilities and SoS of NG/LNG to the BiH NG market.

6. ANNEX

To provide a full overview of options for LNG supply of BiH, the Annex sections below provides information on other LNG terminals in Greece, Italy and other European countries, which are further away from the BiH market.

A more detailed analysis of the terminals that are in a less developed stage will not be provided as part of this report. It must be noted that the majority of planned projects were considered unfeasible, and no serious efforts were made to restart development in recent years. However, due to recent events in Europe and increased concerns in terms of SoS and diversification of NG supply, development of these projects has restarted in 2022, and as such they will be described in the following part of the report.

6.1. OTHER LNG TERMINALS IN ITALY, GREECE, ALBANIA AND MONTENEGRO

6.1.1. OTHER LNG TERMINALS IN ITALY

Other LNG terminals in Italy include:

- LNG Terminal Toscana (constructed)
- LNG terminal Panigaglia (constructed)
- LNG terminal Piombino (in construction)
- LNG terminal in the Adriatic Sea (planned)
- LNG terminal Porto Empedocle in Italy (planned)
- LNG terminal in Portovesme in Italy (planned)
- LNG terminal in Porto Toress in Italy (planned)
- LNG terminal in Calabria Province in Italy (planned)

6.1.1.1. LNG TERMINAL TOSCANA

LNG terminal Toscana basic information

LNG terminal Toscana combines multiple characteristics from the above-mentioned LNG terminals. Like the LNG terminal on the Island of Krk, the LNG terminal Toscana is a conversion project in that it was converted from an LNGC into an FSRU. Similarly to the Alexandroupoli project from Greece, it uses offshore submerged turret technology since the project is located 22 km offshore between the towns of Livorno and Pisa in the Tyrrhenian Sea.

The same process as the one on the planned terminal in the port of Alexandroupolis is utilized, where NG, after being regasified from LNG, is transported to the shore via a subsea pipeline. The connection of the FSRU with the submerged pipeline is made through a submerged turret and a set of flexible risers where the NG is then transported to the existing TSO NG pipeline system. The LNG terminal Toscana consists of the following main elements:

- FSRU;
- Submerged turret and a set of flexible risers; and
- Submerged high-pressure pipeline.

Table 9. Main technical characteristics of the LNG Toscana terminal.60

Main technical characteristics	
Terminal total LNG storage capacity	137,100 m^3
Minimum transfer capacity from LNGC	12,000 m^3/h
Maximum LNG regasification capacity	625.000 m^3/h
Type of regasification system	Combined loop system

In addition to the main technical characteristics, the terminal will or plans to provide additional services as stated in the Table 10 below.

Table 10. Additional services at the terminal on the LNG Toscana terminal.

Additional services at the terminal	
LNG loading to trucks	Not possible on the terminal as it is an offshore structure
LNG loading to feeder/bunkering vessels	Available

NG/LNG supply possibilities from Toscana LNG terminal

In terms of possibilities to supply NG to BiH from the Toscana LNG terminal, there are multiple ways to supply the BiH market with the NG/LNG that is handled on the terminal, which includes:

- **Delivery of NG through a planned pipeline connection(s)** between Italy, Slovenia, Croatia and BiH (marked as possible route no. 1 on the Figure 11 below); and
- **Delivery of NG through an existing pipeline connection** (marked as possible route no. 2 on the Figure 11 below).

In addition to transporting regasified NG from the terminal to the BiH market via NG pipelines, there are also possibilities of transporting NG in its liquefied form (LNG), from the terminal to the BiH market. These possibilities include:

Delivery of LNG with feeder/bunkering vessels to a planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on the Figure 11 below); and

Delivery of LNG by road transport (not assessed).

In order to transport NG from the Toscana LNG terminal, there should be multiple pipelines constructed, as is the case with other LNG terminals in Italy. This also includes the connection that would need to be constructed between Croatia and BiH, as shown in the Figure 11. In addition to the construction of the NG pipeline connection, a major constraint to the flow of NG from the Toscana LNG terminal could be the current direction of NG flow in the pipeline(s).

Delivery of NG through the existing pipeline connection (marked as possible route no. 2 on the Figure 11 below).

As shown in Figure 11 below, in terms of the existing pipeline connection(s), the NG from the Toscana LNG terminal could be transported through the TSO systems of Italy, Slovenia, Croatia, Hungary and Serbia to reach BiH. However, transport of NG through the existing system, meaning the transport of NG that is being regasified in the Toscana LNG terminal, is unlikely, which is also connected to the possibly unfavorable direction of NG flow in TSO systems.

[60] https://www.desfa.gr/en/national-natural-gas-system/lng-facility.

This means of transportation would represent a very complex route, and out of all the proposed NG means of transportation from the Toscana LNG terminal, transport of NG through the existing NG pipeline system is the most unlikely way to NG supply.

Delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on the Figure 11 below).

As described above, the supply of LNG to BiH could be made indirectly by LNG bunkering/satellite station in the port of Ploče. At that station, LNG could be reloaded from bunker/feeder vessels, whereby it could be transported further to BiH via road transport. This proposed route from Toscana LNG terminal is provided in Figure 11 below, as route no. 3.

Development of this transportation means for delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče is heavily dependent on the development of the satellite station itself, and should be assessed further when, and if, such station is constructed. The Toscana LNG terminal has started offering the services of LNG reloading from the FSRU into feeder/bunkering vessels with reloading capacity of 900 m^3/h. In addition, the project owner has obtained the permit to operate a reloading station on the FSRU vessel, which allows for reloading activities within the regulatory framework.[61]

However, considering the distance from the Toscana LNG terminal in terms of LNG transport by sea, it is more likely that the BiH market will be supplied either by a terminal in Croatia or by one of the small-scale LNG terminals that are planned in Italy, including currently well-developed projects in Ravenna, Venice and on Sardinia. The opportunity of transporting LNG via sea from the Toscana LNG is unlikely, as is transporting NG through existing NG pipeline network.

Delivery of LNG by road transport

Like the case of the Adriatic and Alexandroupoli LNG terminals, the Toscana LNG terminal is located offshore, and it is practically impossible for the terminal to have the ability to load LNG to trucks. Therefore, such an opportunity was not assessed in this report.

[61] https://shipandbunker.com/news/emea/945549-italian-terminal-wins-small-scale-lng-supply-permit.

Figure 11. NG/LNG supply possibilities from Toscana LNG terminal[62]

6.1.1.2. LNG TERMINAL PANIGAGLIA

LNG terminal Panigaglia basic information

The Panigaglia LNG Terminal was commissioned in 1971 and it is Italy's oldest LNG terminal. The terminal is an onshore type, and it was constructed with an aim to receive LNG from Libya. The terminal is located near the town of La Spezia at the coastline of the Ligurian Sea.

The Panigaglia terminal consists of the following main elements:

- Two LNG storage tanks;
- Vaporization facility;
- A jetty for receiving LNGC; and
- Auxiliary systems.

[62] www.entsog.eu/maps# , routes superimposed by author.

Table 11. Main technical characteristics of the Panigaglia LNG terminal[63]

Main technical characteristics	
Terminal total LNG storage capacity	100,000 m^3
Minimum transfer capacity from LNGC	12,000 m^3/h
Maximum LNG regasification capacity	437.500 m^3/h
Type of regasification system	Closed loop system

In addition to the main technical characteristics, the terminal will or plans to provide additional services as stated in Table 12 below.

Table 12. Additional services at the terminal on the Panigaglia LNG terminal

Additional services at the terminal	
LNG loading to trucks	Currently assessed
LNG loading to feeder/bunkering vessels	Available

NG/LNG supply possibilities from Panigaglia LNG terminal

In terms of possibilities to supply NG from the Panigaglia LNG terminal there are multiple ways to supply the BiH market, which include:

- **Delivery of NG through planned pipeline connection(s) between Italy, Slovenia, Croatia and BiH** (marked as possible route no. 1 on the Figure 12 blow); and
- **Delivery of NG through existing pipeline connection** (marked as possible route no. 2 on the Figure 12 below).

In addition to transporting regasified NG from the terminal to BiH market via NG pipelines, there are also possibilities of transporting NG in its liquefied form (LNG) from the terminal to BiH market. These possibilities include:

- **Delivery of LNG with feeder/bunkering vessels** to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on the Figure 12 below); and
- **Delivery of LNG by road transport (marked as possible route no. 4 on Figure 12).**
- **Delivery of NG through planned pipeline connection(s) between Italy, Slovenia, Croatia and BiH (marked as possible route no. 1 on the Figure 12 below).**

Similar to Toscana LNG terminal, in order to transport NG from the Panigaglia LNG terminal, there should be multiple pipelines constructed. In addition to the construction of the NG pipeline connection, a major constraint to the flow of NG from the Panigaglia LNG terminal could be the current direction of NG flow in the pipeline(s).

Delivery of NG through existing pipeline connection (marked as possible route no. 2 on the Figure 12 below).

As shown in Figure 12 below, in terms of existing pipeline connection(s) the NG from the Panigaglia LNG terminal could be transported through the TSO systems of Italy, Slovenia, Croatia, Hungary and Serbia to reach BiH, as is the case of other LNG terminals in Italy. However, transport of NG which is being regasified on the Panigaglia LNG terminal is unlikely, which is also connected to the possibly unfavorable direction of NG flow in pipelines.

[63] https://www.desfa.gr/en/national-natural-gas-system/lng-facility.

This means of transportation would represent a very complex route and transport of NG through existing NG pipeline system would be the most unlikely way of NG supply from the terminal.

Delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on the Figure 12 below).

As described above, the supply of LNG to BiH could be made indirectly by LNG bunkering/satellite station in the port of Ploče. At that station LNG could be reloaded into trucks from bunker/feeder vessels and then transported further to BiH via road transport. The proposed route from Panigaglia LNG terminal is provided in Figure 12 below, as the route no. 3.

The development of this means of transportation is heavily dependent on the development of the satellite station itself, and should be assessed further when, and if, such a station is constructed. In terms of the Panigaglia LNG terminal, such an opportunity is currently available.[64]

Delivery of LNG by road transport (marked as possible route no. 4 on the Figure 12 below).

Delivery of LNG by road transport to BiH is a viable possibility from the Panigaglia LNG terminal, and there are plans to introduce such facilities at the terminal.[65] Considering development plans of the small-scale LNG terminals which are planned in Italy, it is more likely that LNG could be supplied from one of the LNG small-scale LNG satellite stations instead from the Panigaglia LNG terminal.

[64] www.bunkerspot.com
[65] Ibid.

Figure 12. NG/LNG supply possibilities from Panigaglia LNG terminal[66]

6.1.1.3. LNG TERMINAL PIOMBINO

Due to recent events in Europe, the diversification of energy sources has become even more important and emphasized by various governments. Italy has decided to implement fast track solutions, whereby its state-owned company has purchased two FSRU vessels, i.e. 'FSRU Golar Tundra' and 'BW Singapore'. Vessels will be deployed to serve as integral parts of two LNG terminals, one terminal that is currently being constructed in the port of Piombino, and the other LNG terminal that will be constructed in Adriatic Sea, offshore of Ravenna.

The more advanced project is the LNG terminal Piombino, which will utilize the vessel 'FSRU Golar Tundra' as part of the terminal. The LNG terminal Piombino consists of the following main elements:

- FSRU Golar Tundra; with regasification capacity of 5 BCM annually
- A jetty for mooring the FSRU vessel and indirectly LNGCs;
- NG send-out systems
- Auxiliary systems.

[66] www.entsog.eu/maps#, routes superimposed by author.

The terminal has recently received the LNG, which will be used for commissioning purposes and the plan of the project developer is to commission the terminal by the end of May 2023[67]. However, the terminal has faced challenges from the local authorities, who have questioned the safety aspects of the terminal and filed court complaints in 2022. The courts have postponed decision on allowing further implementation of the project until June 2023, so the realization of the project is unknown.[68] If the projects receives full clearance, it could represent one of the possible sources of NG/LNG to BiH market; however, due to geographical position of the project it is more likely that the NG/LNG is supplied to BiH market from the possibilities located on Eastern side of Italy.

NG/LNG supply possibilities from Piombino LNG terminal

In terms of possibilities to supply NG from the Piombino LNG terminal there are multiple ways to supply the BiH market, which include:

- **Delivery of NG through planned pipeline connection(s)** between Italy, Slovenia, Croatia and BiH (marked as possible route no. 1 on the Figure 13 below); and
- **Delivery of NG through existing pipeline connection** (marked as possible route no. 2 on the Figure 13 below).

In addition to transporting regasified NG from the terminal to BiH market via NG pipelines, there are also possibilities of transporting NG in its liquefied form (LNG) from the terminal to BiH market. These possibilities include:

- **Delivery of LNG with feeder/bunkering vessels** to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on the Figure 13 below); and
- **Delivery of LNG by road transport** (not assessed).

Delivery of NG through planned pipeline connection(s) between Italy, Slovenia, Croatia and BiH (marked as possible route no. 1 on the Figure 13 below).

Similar to all LNG terminals in Italy, in order to transport NG from the Piombino LNG terminal, there should be multiple pipelines constructed. In addition to the construction of the NG pipeline connection, a major constraint to the flow of NG from the Piombino LNG terminal could be the current direction of NG flow in the pipeline(s).

Delivery of NG through existing pipeline connection (marked as possible route no. 2 on the Figure 13 below).

As shown in the figure 11 below, in terms of existing pipeline connection(s) the NG from the Piombino LNG terminal could be transported through the TSO systems of Italy, Slovenia, Croatia, Hungary and Serbia for the NG to reach BiH, as is the case of other LNG terminals in Italy. However, transport of NG which is being regasified on the Piombino LNG terminal is unlikely, which is also connected to the possibly unfavorable direction of NG flow in pipelines.

This means of transportation, which represents a very complex route and transport of NG through existing NG pipeline system, would be the most unlikely way of NG supply from the terminal.

[67] www.lngprime.com

[68] www.reuters.com

Delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on the Figure 13 below).

As described above, the supply of LNG to BiH could be made indirectly by LNG bunkering/satellite station in the port of Ploče. At that station LNG could be reloaded into trucks from bunker/feeder vessels and then transported further to BiH via road transport. The proposed route from Piombino LNG terminal is provided in Figure 13 below, as the route no. 3.

The development of this means of transportation is heavily dependent on the development of the satellite station itself and should be assessed further when, and if, such a station is constructed. In terms of the Piombino LNG terminal, such an opportunity could be available as the majority of FSRU vessels offer this possibility, although this option is still not confirmed.

Delivery of LNG by road transport

Delivery of LNG by road transport to BiH from the Piombino LNG terminal is considered unlikely, as there are no plans to introduce such facilities at the FSRU based terminal, and as such was not assessed as part of this report. Considering development plans of the small-scale LNG terminals, which are planned in Italy, it is more likely that LNG could be supplied from one of the LNG small-scale LNG satellite stations instead from the Piombino LNG terminal.

Figure 13. NG/LNG supply possibilities from Piombino LNG terminal[69]

[69] www.entsog.eu/maps#, route diagram superimposed by author.

6.1.1.4. LNG TERMINAL IN ADRIATIC SEA

As indicated previously in the report, Italy has decided to implement fast track solutions to increase its NG diversification capabilities, whereby its state-owned company has purchased two FSRU vessels, one of which is the 'BW Singapore'. According to various sources, the 'BW Singapore' should be implemented in the Adriatic Sea off the coast of Ravenna.

The terminal should have regasification capacity of 5 BCM and should be commissioned in year 2024 as the FSRU 'BW Singapore' is currently chartered to a third party until November 2023.[70]

Although the terminal is in preparation stage only, once constructed, it could represent a viable source of NG/LNG to BiH market.

NG/LNG supply possibilities from LNG terminal in the Adriatic Sea

In terms of possibilities to supply NG from the LNG terminal in the Adriatic Sea, there are multiple ways to supply the BiH market, which include:

- **Delivery of NG through planned pipeline connection(s)** between Italy, Slovenia, Croatia and BiH (marked as possible route no. 1 on the Figure 14 below); and
- **Delivery of NG through existing pipeline connection** (marked as possible route no. 2 on the Figure 14 below).

In addition to transporting regasified NG from the terminal to BiH market via NG pipelines, there are also possibilities of transporting NG in its liquefied form (LNG) from the terminal to BiH market. These possibilities include:

- **Delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče** (marked as possible route no. 3 on the Figure 14 below); and
- **Delivery of LNG by road transport** (not assessed).

Delivery of NG through planned pipeline connection(s) between Italy, Slovenia, Croatia and BiH (marked as possible route no. 1 on the Figure 14 below).

Similar to all LNG terminals in Italy, in order to transport NG from the LNG terminal in the Adriatic Sea, there should be multiple pipelines constructed. In addition to the construction of the NG pipeline connection, a major constraint to the flow of NG from the LNG terminal in the Adriatic Sea could be the current direction of NG flow in the pipeline(s).

Delivery of NG through existing pipeline connection (marked as possible route no. 2 on the Figure 14 below).

As shown in Figure 14 below, in terms of existing pipeline connection(s) the NG from the LNG terminal in the Adriatic Sea could be transported through the TSO systems of Italy, Slovenia, Croatia, Hungary and Serbia to reach BiH, as is the case of other LNG terminals in Italy. However, transport of NG which is being regasified on the LNG terminal in the Adriatic Sea is unlikely, which is also connected to the possibly unfavorable direction of NG flow in pipelines.

[70] Ibid

This means of transportation would represent a very complex route and transport of NG through existing NG pipeline system would be the most unlikely way of NG supply from the terminal.

Delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 3 on the Figure 14 below).

As described above, the supply of LNG to BiH could be made indirectly by LNG bunkering/satellite station in the port of Ploče. At that station LNG could be reloaded into trucks from bunker/feeder vessels and then transported further to BiH via road transport. The proposed route from LNG terminal in the Adriatic Sea is provided in Figure 14 below, route no. 3.

The development of this means of transportation is heavily dependent on the development of the satellite station itself, and should be assessed further when, and if, such a station is constructed. In terms of the LNG terminal in the Adriatic Sea, such an opportunity could be available, as the majority of FSRU vessels offer this possibility, although this option is still not confirmed.

Delivery of LNG by road transport

Like in previous cases, the LNG terminal located in the Adriatic Sea is an offshore facility, and it is practically impossible for the terminal to have the ability to load LNG to trucks. Therefore, such an opportunity was not assessed in this report.

Figure 14. NG/LNG supply possibilities from LNG terminal in Adriatic Sea in Italy71

---

[71] www.entsog.eu/maps#, route diagram superimposed by author.

6.1.1.5. LNG TERMINAL PORTO EMPEDOCLE

LNG terminal in Porto Empedocle is a planned terminal on the Island of Sicily in Italy. The project was stopped in 2016 due to market reasons, however, due to recent events in Europe, the project has regained momentum.[72]

The project intends to have 8 BCM of regasification capacity annually, and has already gained necessary permits, so the implementation should be more straightforward when compared to other projects in Italy. According to various sources, the cost of constructing the proposed terminal is estimated to be around 1 billion EUR, while the construction duration is expected to be three years from reaching FID. Location of the LNG terminal in Porto Empedocle in Italy is shown in Figure 1.

The possibility of supplying BiH market from the LNG terminal in Porto Empedocle would need to be assessed if the terminal reaches a mature level of development.

6.1.1.6. LNG TERMINAL IN PORTOVESME

The LNG terminal in Portoversme in Italy is a planned terminal, developed by the Italian government-owned LNG infrastructure company 'Snam'. The LNG terminal should utilize an FSRU vessel which is to be converted from an LNGC 'Golar Artic' into an FSRU.[73]

The vessel has storage capacity of 140,000 m^3 of LNG, but no information is available on the regasification capacity nor if the vessel/terminal is going to provide additional services such as LNG reloading. According to latest information, the conversion of the LNGC to an FSRU, and as such start of project operation, is expected during 2024. Location of the LNG terminal in Portovesme in Italy is shown in Figure 1.

The possibility of supplying BiH market from the LNG terminal in Portoversme would need to be assessed if the terminal reaches a mature level of development.

6.1.1.7. LNG TERMINAL PORTO TORESS

One of the projects with smaller capacity is the LNG terminal in Porto Toress in Italy. The project intends to implement FSRU with storage capacity of 25,000m^3, which will be utilized to serve housing and industrial users in the local area. Currently, the seabed investigations are ongoing, and the project is expected to be operational in year 2024.[74] Location of the LNG terminal in Porto Toress in Italy is shown in Figure 1.

The possibility of supplying BiH market from the LNG terminal in Porto Toress would need to be assessed if the terminal reaches mature level of development. However, considering small capacity of the terminal it is highly unlikely that the terminal in Porto Toress could be considered as one of possible sources.

6.1.1.8. LNG TERMINAL IN CALABRIA PROVINCE

The LNG terminal in Calabria province in Italy, also known as Gioia Tauro, or the LNG Medgas project, is a proposed LNG terminal in Italy. The project was stopped in 2017 due to market reasons, however,

[72] Ibid
[73] Ibid
[74] www.unionesarda.it/en/

due to recent events in Europe, the project has regained momentum, similar to the Porto Empedocle project.[75]

The project intends to have 12 BCM of regasification capacity annually and has already gained a part of necessary permits, so the implementation should be more straightforward when compared to other projects in Italy. According to various sources, the cost of constructing the proposed terminal is estimated to be around 1 billion EUR. Location of the LNG terminal in Calabria province in Italy is shown in Figure 1.

The possibility of supplying BiH market from the LNG terminal in Calabria province will need to be assessed if the terminal reaches a mature level of development.

As a conclusion, it is unlikely that the NG would be supplied from LNG terminals in Italy through existing and/or planed NG pipelines due to multiple constraints. This is also the case with LNG terminals in Greece as there are multiple NG pipelines to be constructed, including the large scale IAP.

6.1.2. OTHER LNG TERMINALS IN GREECE

Other LNG terminals in Greece include:

- LNG terminal Thessaloniki in Greece (planned)
- LNG terminal Corinth in Greece (planned)
- LNG terminal Thrace in Greece (planned)
- LNG terminal in Port of Volos in Greece (planned)

As these projects are in the early stage of development a more detailed analysis of the terminals will not be provided as part of this report. However, they are described shortly in the following text of the report.

The possibility of supplying the BiH market from the terminals mentioned would need to be assessed if the terminals reach a mature level of development.

6.1.2.1. LNG TERMINAL THESSALONIKI

LNG terminal Thessaloniki is a planned LNG terminal in Thermaic Gulf in Greece. The project intends to utilize an FSRU of 170,000 m^3 of storage capacity, with 7.3 BCM of regasification capacity annually.

According to various sources, the cost of constructing the proposed terminal is estimated to be around 550 mil EUR, while the terminal should be operational by 2025. Location of the LNG terminal Thessaloniki in Greece is shown in Figure 1.

6.1.2.2. LNG TERMINAL CORINTH

LNG terminal Corinth is a planned LNG terminal in Greece, close to Athens. The project intends to utilize an FSRU of 210,000 m3 of storage capacity, with 4.2 BCM of regasification capacity annually. From recent developments, the project has received an approval for construction form the Greek Ministry of development.[76]

[75] www.reuters.com

[76] www.ceenergynews.com/lng

According to various sources, the cost of constructing the proposed terminal are estimated to be around 340 mil EUR, while the terminal should be constructed in third quarter of 2023 or in 2024. [77] Location of the LNG terminal Corinth in Greece is shown in Figure 1.

6.1.2.3. LNG TERMINAL THRACE

LNG terminal Thrace is a planned LNG terminal in the Aegean Sea in Greece. The project intends to utilize an FSRU of 170,000 m^3 of storage capacity, with 6 BCM of regasification capacity annually. From recent developments, the project developer has applied for a new Independent Natural Gas System license to Greece's regulatory authority.[78]

The estimated cost and timeline for the project implementation are currently not known. Location of the LNG terminal Thrace in Greece is shown in Figure 1.

6.1.2.4. LNG TERMINAL IN PORT OF VOLOS

LNG terminal in port of Volos, also known as Argo FSRU is a planned LNG terminal in Greece. The project intends to utilize an FSRU of 170,000 m^3 of storage capacity, with 5.2 BCM of regasification capacity annually. From recent developments, the project has received an approval for construction form the Greek Ministry of development in February 2022.[79]

According to various sources, the cost of constructing the proposed terminal is estimated to be around 225 mil EUR. The project developer estimates to reach FID in June 2023, and start of operation at beginning of 2025.[80] Location of the LNG terminal in port of Volos in Greece is shown in Figure 1.

6.1.3. LNG TERMINAL BAR IN MONTENEGRO

LNG terminal in port of Bar is the first planned terminal to be constructed in the country of Montenegro. The terminal will primarily be used as a NG source for Montenegro, however, with the construction of additional infrastructure can supply NG to neighboring countries, such as BiH, Kosovo, Serbia and Albania.

As part of Montenegro energy transition strategy, the state-owned power utility company Elektroprivreda Crne Gore is planning to construct three power plants, which should use NG as a primary fuel source. [81] One of the proposed power plants is to be constructed in the port of Bar, and in that respect an MOU was signed in 2022 between the above mentioned state-owned company and LNG terminal project developer company LNG Alliance. The MOU was signed with the aim to investigate further possibilities of constructing not only power plant in Bar, but also power plant in Podgorica and connecting both power plants to the planned LNG terminal. [82]

Under the considerations of the MOU, a feasibility study and an Environmental and Social Impact Study are to be performed, which should determine technical and commercial solutions for a construction of the power plant in port of Bar and in Podgorica. Based on the feasibility study, the investment model should be established, and if the positive FID is made, the LNG terminal in port of Bar would be

[77] Ibid
[78] Ibid
[79] www.lngprime.com
[80] www.argusmedia.com
[81] Ibid
[82] www.prnewswire.com

constructed. In addition of constructing the LNG terminal and associated infrastructure, the MOU considers possibility of constructing a dedicated pipeline to Podgorica, to the location of the second planned power plant.

The LNG terminal would envisage implementation of an FSU, whereby it is not known if the regasification would be provided on the vessel or onshore. The project developing company has also stated that in addition to the terminal offering service of supplying NG via pipelines, it would offer service of supplying LNG to the market via ISO containers loaded on track or trains, which makes a terminal one of the possible sources of NG/LNG to BiH, if the terminal is constructed.[83]

In May 2022, the project developer has completed the pre-feasibility study according to which the terminal should have initial capacity of 0.4 Million Tons Per Annum (MTPA), with the possibility of increase to 1.2 MTPA. In addition, the terminal should be constructed with the possibility to handle "green ammonia" in the future, while the FID is expected in Q3 2023.[84]

In terms of pipeline construction, as Montenegro does not have a developed NG pipeline network/market, significant investments would be required for the country to be interconnected with NG pipelines. The country has also planned to connect to the IAP, which should interconnect the already constructed transmission system of Croatia and Trans Adriatic Pipeline (TAP). IAP would represent the backbone of NG network/market development in not only Montenegro but could also be used as one of NG sources for BiH, as it might serve as source of potentially 5 BCM of NG annually, which could be used by the whole region.

Although, according to those MoUs, the project FID for the Bar LNG terminal is expected in 2023, and the construction of the terminal can only be considered from 2024 onward. The NG/LNG supply possibilities from the terminal in Montenegro will be assessed further in the report due to the relative vicinity of the terminal to BiH market and the plans of the project developer to implement solutions that could supply LNG to BiH market through ISO containers quickly after the terminal is constructed.

From recent developments, the government of Montenegro has signed an additional MoU with two United States based project development companies, on the possibility of constructing the terminal and the associated power plant in port of Bar. According to this MoU, the LNG terminal would be of an onshore type, with a smaller capacity of approximately 40.000 m^3. The LNG terminal project will need to go through FEED phase; however, the cost is already estimated to be between 130 and 250 mil. EUR. The MoU also considers the construction of a gas-fueled combined cycle power plant with a capacity between 240 and 440 MW and located in the vicinity of the LNG terminal. The combined cycle power plant project will also need to go through FEED phase; however, the cost is already estimated to be between 200 and 500 mil USD. According to the MoU, the projects are expected to be operational from 2025. This development represents only an additional step towards realization of the LNG terminal project in Montenegro, in either floating or onshore form. However, as only MoUs between the Government of Montenegro and various project developers are being signed at this moment, the development of the project is unsure, and the possibility of supplying LNG/NG to BiH market could be analyzed only when full plans on the development are known.

[83] Ibid

[84] www.serbia-energy.eu

NG/LNG supply possibilities from Bar LNG terminal

In terms of possibilities to supply NG from the Bar LNG terminal there are multiple ways to supply the BiH market, if the terminal is constructed, which include:

- **Delivery of NG through planned pipeline connection(s)** between Montenegro, Croatia and BiH (marked as possible route no. 1 on the Figure 15 below). Transportation through currently existing pipelines would be highly unlikely, as the NG would have to pass through the systems of Albania, Greece, Bulgaria and Serbia before entering BiH's market, and for that reason, this possibility will not be assessed in this report.

In addition to transporting regasified NG from the terminal to BiH market via NG pipelines, there are also possibilities of transporting NG in its liquefied form (LNG) from the terminal to BiH market. These possibilities include:

- **Delivery of LNG with feeder/bunkering vessels** to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 2 on the Figure 15 below); and
- **Delivery of LNG by road transport** (marked as possible route no. 3 on the Figure 15)

Delivery of NG through planned pipeline connection(s) between Montenegro, Croatia and BiH (marked as possible route no. 1 on the Figure 15 below).

In order to transport NG from the Bar LNG terminal, there should be multiple pipelines constructed, including the large-scale IAP pipeline system. Also, considering that the send-out capabilities of the LNG terminal in Bar would be low, compared with the capacities sent through the IAP pipeline, the supply of NG to BiH from LNG terminal in Bar is considered to be highly unlikely.

Delivery of LNG with feeder/bunkering vessels to planned LNG bunkering/satellite station in the port of Ploče (marked as possible route no. 2 on the Figure 15 below).

As described above, the supply of LNG to BiH could be made indirectly by LNG bunkering/satellite station in the port of Ploče. At that station LNG could be reloaded into trucks from bunker/feeder vessels and then transported further to BiH via road transport. The proposed route from Bar LNG terminal is provided in Figure 15 below, route no. 3.

The development of this means of transportation is heavily dependent on the development of the satellite station itself and should be assessed further when, and if, such a station is constructed. In terms of the Bar LNG terminal, as the project developer considers non-conventional solutions, such as distribution of LNG in ISO containers in development phase, it can be expected that reloading of LNG from the terminal to feeder/bunkering vessels will also be available.

Delivery of LNG by road transport (marked as possible route no. 3 on Figure 15).

Delivery of LNG by road transport to BiH could be a viable possibility from the Bar LNG terminal, as there are plans to develop such facilities at the terminal from early operation of the terminal. These facilities represent the most viable possibility of the LNG terminal in Bar to be used as one of sources for LNG to BiH market.

Figure 15. NG/LNG supply possibilities from LNG terminal Bar in Montenegro[85]

6.1.4. LNG TERMINAL VLORE IN ALBANIA

LNG terminal in port of Vlore is the first planned terminal to be constructed in the country of Albania. The project is being implemented to facilitate energy sustainability of Albania, which is heavily affected by unpredictable and high costs of importing energy from neighboring markets.

The project was in preparation for several years but has regained momentum in year 2021 when Excelerate Energy, ExxonMobil and Republic of Albania signed an MOU to perform a feasibility study for the development of the terminal in Southern Albania.[86]

Under the agreement, the FSRU provider Excelerate Energy should have used one of its vessels, i.e. Excelsior FSRU, to be used at the terminal, which should have supplied regasified NG to a local power plant. However, the Excelsior was deployed in Germany, following the signing of a five-year charter contract with the German government and no further plans on utilizing one of the other FSRUs are available.

[85] www.entsog.eu/maps#, route diagram superimposed by author.

[86] Ibid

The Vlore project should have consisted of utilizing one of the FSRUs with 5 BCM capacity, modifications to the jetty, and a 350 MW power plant reactivation and expansion. According to various sources, the feasibility for this option should have been conducted in 2022, with the terminal going in operation in the second half of 2023, however no further updates are available at the moment.

Additionally, in July 2022, Excelerate Energy has announced that it has signed an MOU with a Bulgarian company regarding the sale of 1 BCM of NG downstream of the planned terminal. The NG should be transported from the terminal to the Southern Europe's Gas Corridor through the Vlora-Fier Gas Pipeline.[87]

Considering the uncertainty about the project development, for both the project to serve as source of NG for the power plant and as source of NG to surrounding countries, it is not feasible that the terminal will become operational in the near future. Additionally, the supply of NG from the terminal in Albania would require additional investment in the NG pipeline systems of Albania, Montenegro, Croatia and BiH. As such developments are unlikely to be implemented in the near future the supply of the NG from the terminal in port of Vlore to BiH will not be assessed as one of possible supplies sources in this report.

[87] https://www.excelerateenergy.com/news

6.2. OTHER LNG TERMINALS IN EUROPE AND REGION

In addition to the LNG terminals described above, there are other LNG terminals in Europe and in the region which could serve as possible sources of NG/LNG to the BiH market. Due to their distance from the BiH market, however, it should be mentioned that transport of NG, meaning NG that is being regasified in these terminals, is highly unlikely. The regasified NG from those terminals would most probably be used as a fuel source in some of the transit countries, whereby this regasified NG would need to pass through multiple countries before entering the BiH system, as described further in the text. Also, in that case, flow direction of the NG in determined pipeline(s) would need to be considered, which could further complicate the possibility of having regasified NG from those terminals in BiH system.

However, supply of NG in its liquefied state ,LNG, could be possible from LNG terminals and this opportunity will be assessed in the following segments of the annex.

Large LNG regasification terminals in Europe and the region have historically developed large scale regasification services as their main business model. However, terminals have started to provide additional services in the last decade, whereby existing or planned LNG terminals are rapidly working to enable such additional services on their respective terminals, enabling a small-scale LNG market to further develop. These additional services on LNG terminals include:

- LNG to truck loading (including reloading to ISO containers);
- LNG to bunker/feeder vessel reloading; and
- LNG reloading to rail transport (including reloading to ISO containers, however not developed much to date).

LNG small-scale markets have already developed in countries that have constructed LNG terminals. Additionally, relatively new terminals such as ones in Poland and Lithuania have introduced small-scale possibilities, while Greece is planning to have such capabilities in the forthcoming period. A more detailed view on the existing/planned additional services of the LNG terminals in Europe and the region is provided in Table 13 below (where "+" stands for feasible option, and "-" stands for non-feasible option).

Table 13. Additional services offered on LNG terminals (addition to regasification)[88]

Country	LNG terminal	Reloading to bunker ship/s	Truck loading	Rail loading
Belgium	Zeebrugge	+	+	Available through ISO containers
Croatia	Krk*	+	+	Currently Assessed as part of satellite station
Cyprus	Vasiliko Port	-	-	-
France	Fos Tonkin	+	+	Currently Assessed
	Montoir de Bretagne	+	+	Currently Assessed
	Fos Cavaou	+	+	+
	Dunkerque	+	+	-

[88] GIE small scale LNG Map 2018 https://www.gie.eu/index.php/gie-publications/maps-data/gle-sslng-map.

Country	LNG terminal	Reloading to bunker ship/s	Truck loading	Rail loading
Greece	Revithoussa	+	+	-
	Alexandroupolis *	Currently Assessed	-	-
Italy	Panigaglia	Currently Assessed	Currently Assessed	-
	Rovigo/Adriatic	Currently Assessed	-	-
	OLT Toscana	+	-	-
	Piombino *	Currently Assessed	-	-
Lithuania	Klaipėda	+	Part of satellite station in close vicinity of the terminal	-
Malta	Delimara	-	-	-
Poland	Świnoujście	Currently being developed	+	Currently being developed
Spain	Barcelona	+	+	Currently Assessed
	Cartagena	+	+	Currently Assessed
	Huelva	+	+	+
	Bilbao	+	+	Currently Assessed
	Mugardos I	+	+	-
	El Musel	+	+	-
	Sagunto I	+	+	-
Turkey	Marmara Ereglisi	+	+	-
	Aliaga Izmir	-	+	-
	Aliaga Etki	-	-	-
	Dortyol	-	-	-
	Aliaga*	-	-	-
	Saros	-	-	-

If considering supplying NG/LNG to BiH from terminals other than those in Croatia, Italy and Greece, there is a slight possibility to supply NG/LNG from existing or planned LNG terminals in Europe. However, only LNG terminals which are geographically close to the BiH market and offer additional services will be assessed in the further section of the annex, as NG/LNG transport to BiH market from other LNG terminals would most likely be economically unfeasible due to relative distance from BiH market.

6.2.1. NG/LNG SUPPLY POSSIBILITIES FROM LNG TERMINALS IN SPAIN

Spain is one of the most developed NG/LNG markets in the world and has the largest number of LNG terminals in Europe, all constructed as onshore facilities, including the following terminals:

- LNG terminal Barcelona;
- LNG terminal Cartagena;
- LNG terminal Sagunto;

- LNG terminal Bilbao:
- LNG terminal Huelva:
- LNG terminal Mugardos and
- LNG terminal Musel.

Only terminals Barcelona, Sagunto, and Cartagena on Eastern side of Spain are close enough to BiH to consider; and the rest of terminals in Spain will not be considered in this report. These three mentioned terminals have truck loading abilities whereby only the LNG terminal in Barcelona can receive 50 trucks per day.[89]

LNG terminal Barcelona

As the Barcelona LNG terminal has a developed LNG reload service, it can be considered as a valid source of LNG to BiH market. Being geographically closest to BiH from the other assessed LNG terminals in Spain, if considering NG transport via pipelines, it could be considered as a possible source of NG for BiH. That would, however, be highly unlikely due to relative distance to BiH market.

When considering all factors, the supply of NG/LNG from LNG terminal in Barcelona can be considered as the most possible one from Spain, if there is any chance of NG/LNG being supplied from the Spanish market.

As there are multiple pipelines that would need to be constructed (NG would need to pass through the transmission network of several countries including Spain, France, Italy, Slovenia and Croatia), including the NG pipeline connection between Croatia with BiH, it is highly unlikely NG can be sourced from any of Spanish LNG terminals in gaseous form. Construction of all pipelines on the route, while also considering flow direction of NG in existing pipelines, could further complicate the possibility of having regasified NG from those terminals in the BiH system and as such, this possibility will not be assessed as part of the report.

[89] www.enagas.com.

Figure 16. NG/LNG supply possibilities from LNG terminal in Spain[90]

In terms of supply possibilities, it would be more likely that NG is delivered to BiH in its liquefied form (LNG). Such LNG supply to the BiH market could be achieved via:

- Land transport (marked as possible route no. 1 on the Figure 16 above); or
- Sea transport (marked as possible route no. 2 on the Figure 16 above).

All considered means of land transport (transport of LNG via trucks), could be considered as a likely solution. In terms of development, it is important to mention that such transportation means do not depend on any further development of the system as all necessary infrastructure already exists.

In terms of sea transport, LNG could be delivered from the LNG terminal in Barcelona to the BiH market with bunkering/feeder vessels through the LNG bunkering/reload station in port of Ploče in Croatia, as the shortest route possible. However, this solution depends on the development of the mentioned LNG bunkering/reload stations which currently do not exist, and this solution could be only assessed when, and if, the stations are constructed. It is important to mention that LNG was already supplied by bunker/feeder vessels from terminal in Barcelona to small-scale LNG satellite stations and large-scale LNG terminals in Italy and Croatia. Therefore, the possibility of transferring LNG over larger distances via sea transport and delivery to BiH market could be one of the possibilities.

[90] www.entsog.eu/maps#, routes superimposed by author.

6.2.2. NG/LNG SUPPLY POSSIBILITIES FROM LNG TERMINALS IN FRANCE

France is one of the most developed NG/LNG markets in Europe. All constructed terminals are of onshore type, while the one planned is to be an FSRU solution. LNG terminals in France include:

- LNG terminal Fos Cavaou;
- LNG terminal Fos Tonkin;
- LNG terminal Dunkerque;
- LNG terminal Montoir-de-Bretagne; and
- LNG terminal in Le Havre (planned).

As the LNG terminals in the western part of France (LNG terminal Dunkerque,Montoir-de-Bretagne and Le Havre) are to be too far from BiH, it would be unpractical to observe them as a possibility to supply the BiH market with NG/LNG. Therefore, only terminals Fos Cavaou and Fos Tonkin, on east side of France, will be assessed.

From the two terminals identified, both have LNG reload to bunker/feeder vessel and LNG reload to truck loading abilities.

The following assessment criteria have been taken into consideration while determining the possibility of supplying the BiH market with NG/LNG from LNG terminals in France:

LNG terminal Fos Cavaou

- Considering that Fos Cavaou LNG terminal has LNG reload abilities, it can be considered as a valid source of LNG to BiH market.
- Being geographically approximately the same distance to BiH as other assessed LNG terminals in France, if considering NG transport via pipelines, it could be considered as a possible source of NG for BiH, however highly unlikely.
- The LNG terminal Fos Cavaou has a railway transportation possibility, however, as this type of transportation is in the very early stages of development and will not be assessed in more detail in this report, it is not presented in the following figures.

LNG terminal Fos Tonkin

- Considering that Fos Tonkin LNG terminal has LNG reload abilities, it can be considered as a valid source of LNG to BiH market.
- Being geographically approximately the same distance to BiH as other assessed LNG terminals in France, if considering NG transport via pipelines, it could be considered as a possible source of NG for BiH, however highly unlikely.
- The LNG terminal Fos Tonkin has most recently made developments in offering railway transportation possibility, however, as this type of transportation is in the very early stages of and will not be assessed in more detail in this report, it is not presented in the following figures.[91]

When considering all factors, the supply of NG/LNG from both LNG terminals can be considered as a possibility from France.

As there are multiple pipelines that would need to be constructed (NG would need to pass through transmission network of several countries including France, Italy, Slovenia and Croatia), including the

[91] www.elengy.com

NG pipeline connection between Croatia with BiH it is highly unlikely that NG can be supplied from France to BiH market. Construction of all pipelines on the route, while also considering flow direction of NG in existing pipelines, could further complicate the possibility of having regasified NG from those terminals in BiH system, and as such possibility of supplying NG via pipelines was not assessed in this report.

Figure 17. NG/LNG supply possibilities from LNG terminals in France[92]

In terms of supply possibilities, it would be more likely that NG is delivered to BiH in its liquefied form (LNG). Such LNG supply to the BiH market could be achieved via:

- Land transport (marked as possible route 1 on Figure 16 above); and
- Sea transport (marked as possible route 2 on Figure 16 above).

All considered means of land transport (transport of LNG via trucks), could be considered as a likely solution. In terms of development, it is important to mention that such transportation means do not depend on any further development of the system as all necessary infrastructure already exists.

In terms of sea transport, LNG could be delivered from terminals in France to the BiH market with bunkering/feeder vessels through the LNG bunkering/reload station in port of Ploče in Croatia, as the shortest route possible. However, this solution depends on the development of the mentioned LNG

[92] www.entsog.eu/maps#, routes superimposed by author.

bunkering/reload station in port of Ploče which currently does not exist, and this solution could be only assessed when, and if, the station is constructed.

6.2.3. NG/LNG SUPPLY POSSIBILITIES FROM LNG TERMINALS IN TURKEY

Turkey is a well-developed NG/LNG market with five LNG terminals currently in operation. Of these five, there are two onshore terminals that could be considered viable options to supply BiH with NG/LNG. These include:

- LNG terminal Marmara Ereglisi; and
- LNG terminal Aliaga (Izmir).

Onshore LNG terminals Aliaga (Izmir) and Marmara Ereglisi have LNG to truck reloading capacity. LNG reload to bunker/feeder vessels is being considered on LNG terminal Aliaga (Izmir), however, no infrastructure was developed to offer such possibility. From recent developments, an MOU was signed between project owner of the Marmara Ereglisi LNG terminal and other Turkish and Japanese partner companies to further develop LNG bunkering infrastructure, however no strict timeline was set. [93] Both of these terminals are approximately the same distance from BiH so they both were taken into consideration as a possible source of NG/LNG to BiH market.

When considering all factors, the supply of NG/LNG from both LNG terminals can be considered as a possibility as presented in Figure 18 below (marked as possible route no. 1 on the Figure). However, the NG pipeline route no. 1 in Figure 18 is marked by dashes as there are multiple pipelines that would need to be constructed (NG would need to pass through transmission network of several countries including Turkey, Greece, Albania, Montenegro and Croatia), including the NG pipeline connection between Croatia with BiH.

The NG from the Turkish LNG terminal could be transported through the TSO systems of Turkey, Bulgaria and a newly built NG pipeline interconnection between Bulgaria and Serbia (Balkan Stream, as part of Turk Stream) to reach BiH, as presented in Figure 16, pipeline route 2.

However, transport of NG through that system would be complex due to the need to pass through multiple countries before entering the BiH system and the questionable, non-transparent possibility of booking transmission capacity. Also, the capacity of the existing NG pipeline interconnection of Serbia and BiH is in question, as well as the possibility of increasing the transport capacity by building the New Eastern Interconnection.

[93] ibid

Figure 18. NG/LNG supply possibilities from LNG terminals in Turkey[94]

In terms of possibilities, it would be more likely that NG is delivered to BiH in its liquefied form (LNG), rather than NG being transported via NG pipeline. Such LNG supply to the BiH market could be achieved via:

- Land transport (marked as possible route 3 on the Figure 18 above).

Sea transport of LNG was not considered as relevant for the case of Turkey for several reasons. Other countries, such as Italy, Croatia, Greece and Spain are planning or already have abilities to transport LNG by sea. Sea transport could be assessed from the perspective of other three LNG terminals in Turkey, which are FSRU based terminals, but these terminals are current being used to supply only NG to the NG network and there are no publicly available plans to add LNG bunkering services.

Also, LNG bunkering via LNG feeder/bunkering vessels in Turkey is slowly being introduced and will be a possibility in the forthcoming period. The country actually plans to become a local hub for LNG distribution, however, no further information on that development is available to make an assessment on when such possibilities will be feasible. Considering the distance from the BiH market, it will be an unlikely source of LNG delivery, as other terminals/small-scale satellite stations can be a more viable source of LNG due to geographical reasons.

[94] www.entsog.eu/maps#, routes superimposed by author.

6.2.4. NG/LNG SUPPLY POSSIBILITIES FROM LNG TERMINAL IN CYPRUS

LNG terminal in bay of Vasilikos is the first planned LNG terminal to be constructed in the country of Cyprus. The terminal will primarily serve as a NG source for a local power plant. The terminal will utilize an FSRU vessel, which is currently being converted from an LNGC to an FSRU and has a storage capacity of 135,000 m^3.[95]

It is expected that the terminal becomes operational in late 2023 or early 2024. However, it is highly unlikely that NG/LNG would be sourced from this terminal due to relatively big distance from BiH market, even by bunkering/feeder vessels, and therefore supply of NG/LNG from this terminal was not assessed as part of this report.

6.2.5. NG/LNG SUPPLY POSSIBILITIES FROM LNG TERMINAL IN MALTA

LNG terminal in Marsaxlokk is the first LNG terminal constructed in the country of Malta, in 2017. Similar to the project in Cyprus, the terminal primarily serves as a NG source for a local power plant. The terminal utilizes an FSU vessel with a storage capacity of 126,000 m^3.

As the primary use of the terminal is to serve a local power plant, it is highly unlikely that NG/LNG would be sourced from this terminal. Also, in addition to the terminal not offering such services, supply even by bunkering/feeder vessels is highly unlikely due to the large distances from the BiH market and therefore the supply of NG/LNG from this terminal was not assessed in this report.

[95] https://lngprime.com/asia/cyprus-fsru-conversion-nearing-completion-in-china/75346/

U.S. Agency for International Development

www.usaid.gov