LNG Marine Transportation Market Trends - FSRU as Europe's Way Out of Russia -

Senior Researcher, Gas Group
Seiya Matsukura

1. Introduction

The world handled 372.3 Mt (Million tonnes) of LNG in 2021, up 16.2 Mt from the previous year, with 19 LNG exporting countries and 44 LNG importing countries, including the newly added Croatia. The importance of LNG marine transportation will continue to grow. In Europe, a major consumer of natural gas, LNG imports accounted for 114.8 Bcm (Billion cubic metres) (about 80 Mt) of the 561.9 Bcm (about 410 Mt) of natural gas imports in 2020, and pipeline (PL) imports accounted for 447.1 Bcm (about 330 Mt). Of the PL imports, Russian gas accounted for 167.7 Bcm (120 Mt), or 38%, but the invasion of Ukraine in February 2022 prompted Europe to make a sharp policy shift away from dependence on Russian gas. Currently, there are 33 land-based LNG import terminals and 6 floating LNG terminals in operation in Europe, and the introduction of FSRUs (Floating Storage and Regasification Units), which have short lead times, is particularly urgent. This paper reviews the LNG marine transportation market, summarizes the progress and challenges in the introduction of FSRUs as part of Europe's efforts to move away from Russia.

2. LNG Marine Transportation Market Trends

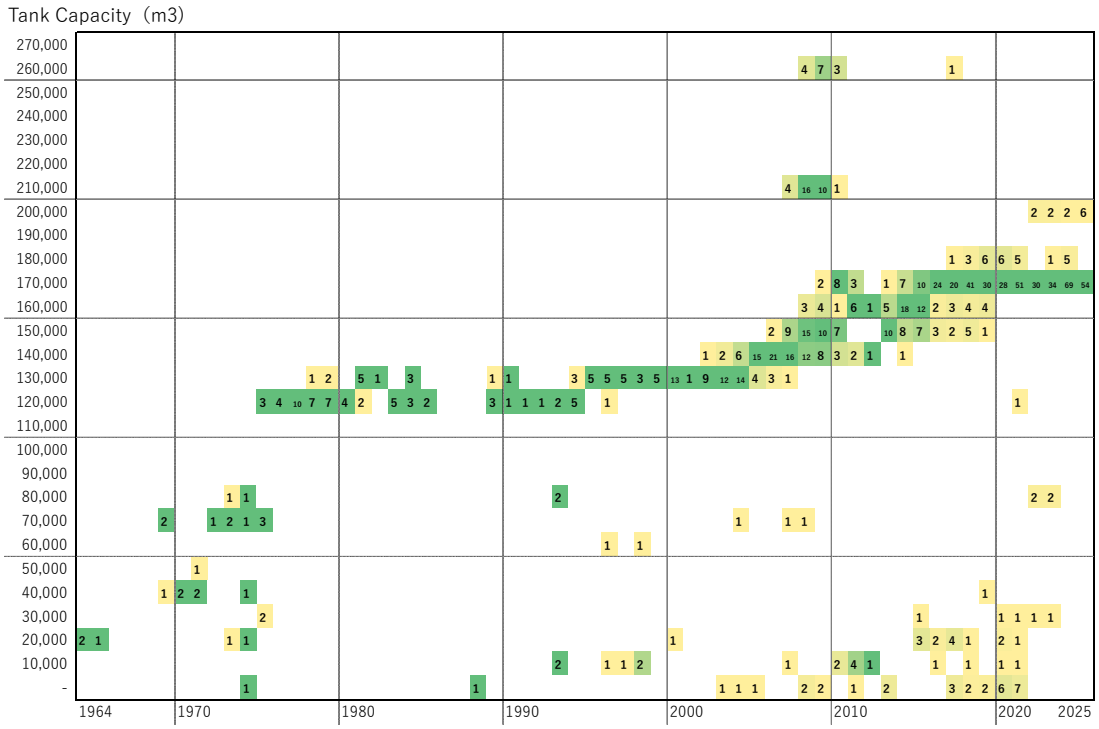

Figure 2a: LNG Carriers Delivered by Capacity (1964-2025) *Including FSRU and LNG bunker vessels

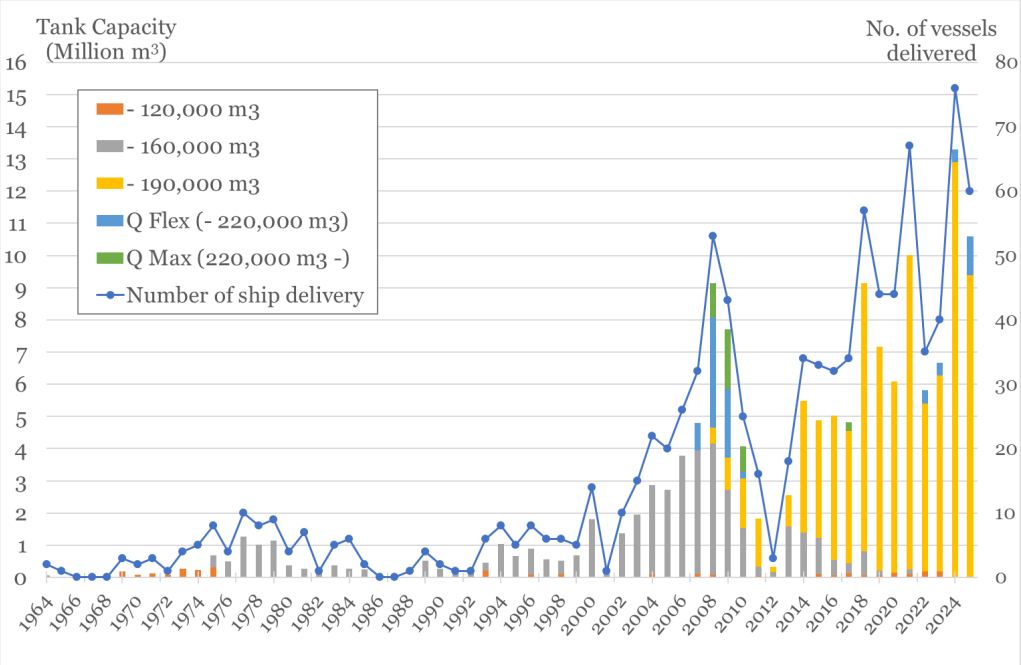

Figure 2b: LNG Carriers Delivered (1964-2025) *Including FSRU and LNGBV
Source: IEEJ from various sources.

Regarding new LNG carriers, 68 were delivered in 2021 (47 in the previous year), a record high. This includes 5 FSRUs, 10 small vessels[1] (including 8 LNG bunkering vessels (BVs)), and 53 LNG carriers, bringing the total number of LNG carriers in operation to 700 (including 48 FSRUs and 31 small vessels). The average capacity of new delivered (excluding FSRUs and small vessels) was 174,897 m^3, reflecting the design of Panamax vessels[2] as standard (Figure 2a, b).

With 111 new LNG carriers ordered in 2021 and 40 in 2020 the total number of newbuild ships on order as of the end of 2021 was 196, including 5 FSRUs and 25 small vessels (22 LNGBVs and 3 LNG carriers). The number of LNG carriers ordered is expected to remain at a high level. On the other hand, the deliveries of LNG carriers on order will be extended beyond 2026 or later, as available dock spaces at shipyards by 2025 have been booked out. One of the factors is QatarEnergy's (QE) LNG transportation arrangements for both the Qatar NFE (North Field East) LNG expansion and the Golden Pass LNG project in the United States. Specifically, in April 2020, QE signed a USD 3 billion contract with Hudong-Zhonghua Shipbuilding Corporation, a subsidiary of China State Shipbuilding Corporation (CSSC), to reserve shipbuilding capacity until 2027, and in June 2020, QE signed a contract with three major shipbuilders in Korea, Daewoo Shipbuilding & Marine Engineering (DSME), Hyundai Heavy Industries (HHI), and Samsung Heavy Industries (SHI), to reserve the majority of their shipbuilding capacity until 2027 (USD 19.2 billion). The size of these shipbuilding capacities is estimated to be equivalent to about 60% (over 100 vessels) of the world's LNG shipbuilding capacity by 2027.

[1] Ships of less than 50,000 m3 are thereafter listed as small vessels.

[2] the largest vessel type that could pass through the old Panama Canal with a full load before the 2016 expansion.

3. FSRU Market Trends

3-1. FSRU (Floating Storage & Regasification Unit)

An FSRU is an LNG carrier or a floating structure equipped with LNG storage and regasification facilities and moored at a pier to perform the same function as an onshore LNG receiving terminal (Figure 3-1). Other types of LNG storage vessels include LNG RVs (Regasification Vessels), which transport LNG themselves, moor offshore, and deliver the vaporized gas using subsea PLs, and FSUs (Floating Storage Units), which do not have regasification facilities. Applications include short-term demand increases such as seasonal demand increases, energy security, transitional use until the completion of an onshore terminal by taking advantage of the flexibility of installation and removal, and LNG trial installations.

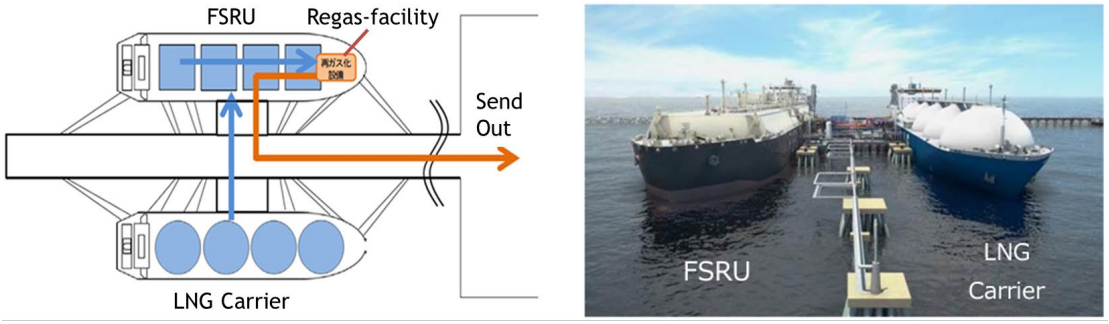

Figure 3-1: Gas supply by FSRU, Ship-to-Ship (STS) system
Source: MOL, JOGMEC, Engie

3-2. Comparison with Onshore LNG receiving terminal

Table 3-2: Comparison of FSRUs and Onshore LNG receiving terminal

Item	FSRU	Onshore terminal
Expenses	○ Low CAPEX (New delivered: USD 300-500 million) ・Converted vessels: Less than half of new ones are expected. In addition, jetty, breakwater, etc. are required. × High OPEX (~USD 280,000/day @ 4 Mt/y)	× High CAPEX (~USD 1 billion) ○ Low OPEX (~USD 130,000/day @ 4 Mt/y)
Lead Time	○ Short (New shipping: approx. 3 years from contract) ・Renovated vessels: about 1 to 2 years. /Existing ship lease: approx. 0.5 years at the earliest. ・Relatively few permits and licenses required.	× Long (approximately 4-5 years or more) ・Complex and lengthy permitting process
Removal/ Diversion	○ Possible (conversion to other areas or LNGC). ・Reduction of stranded asset risk.	× Basically not possible
Extensibility	× Low (tank and vaporizer capacity limitations)	○ High (can be increased to meet demand)
Secure	△ Affected by ocean and weather conditions	○ Less susceptible to ocean and weather

Compared to onshore terminals, FSRUs are suitable to short-term use to meet demand surges and transitional use due to their lower CAPEX, shorter lead time from investment decision to installation, and

flexibility in dismantling and conversion. On the other hand, onshore are suitable to long-term demand, due to superiority in stable supply and scalability against rough weather and sea conditions (Table 3-2).

3-3. FSRU Market Trends

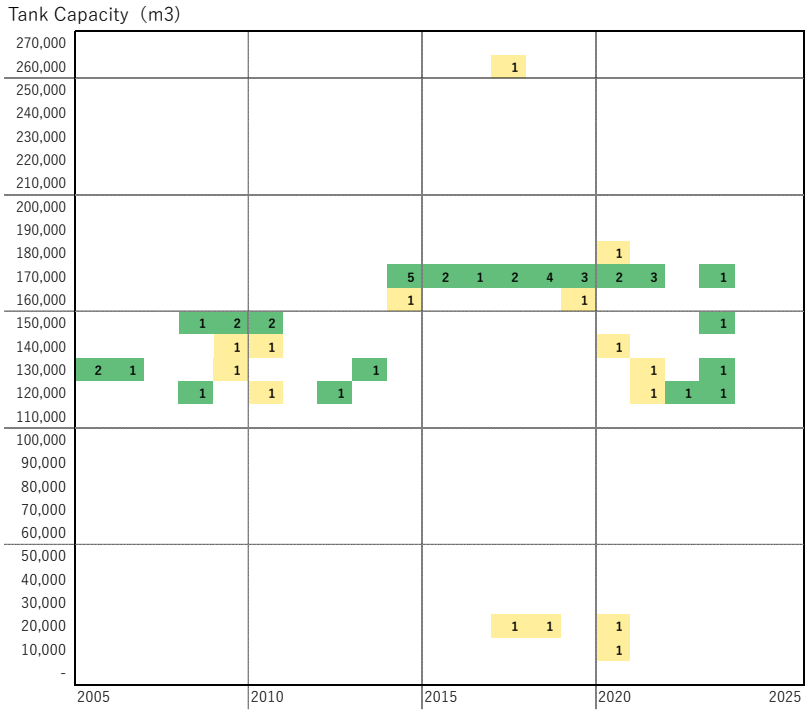

Figure 3-3a: FSRU Delivered by Capacity (2005-2023)

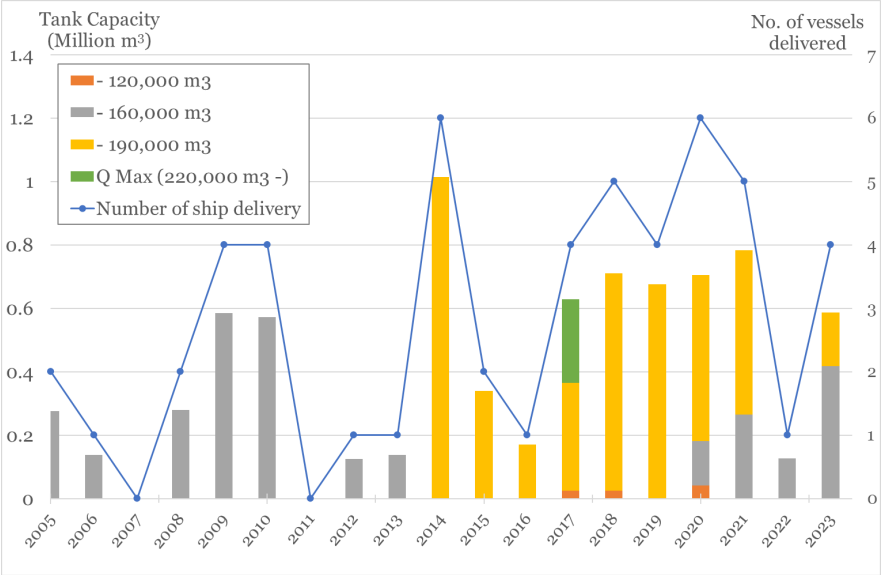

Figure 3-3b: FSRU Delivered (2005-2023)

As for FSRUs, 48 units were in operation at the end of 2021, including 10 FSRUs which converted from conventional LNG carriers, and 5 units under construction (including 4 converted). As for capacity, since 2014, many 170,000 m3 class vessels have been introduced, similar to LNG carriers. The total capacity at the end of 2021 was about 7.1 Mcm (Million cubic metres), doubling in the last five years (Figure 3-3).

3-4. Changes in the FSRU market after the invasion of Ukraine

Table 3-4: List of FSRUs (as of end of 2021)

No.	Built	Vessel Name	Send out (MTPA)	Storage (m3)	Owner	Location (As of 2021)
1	1977/2010	Golar Freeze	3.6	125,000	New Fortress Energy	Old Harbour, Jamaica
2	1977/2012	Nusantara Regas Satu (ex Khannur)	3.0	125,000	New Fortress Energy	Nusantara, Indonesia
3	1981/2008	Golar Spirit	1.8	129,000	New Fortress Energy	Laid up
4	2003/2013	FSRU Toscana (ex Golar Frost)	2.8	137,500	OLT Offshore	Toscana, Italy
5	2004/2009	Golar Winter	3.8	138,000	New Fortress Energy	Pecem, Brazil
6	2005	Excellence	3.8	138,000	Excelerate Energy	Moheshkhali, Bangladesh
7	2005	Excelsior	3.5	138,000	Excelerate Energy	Hadera, Israel ⇒ Albania (2023)
8	2006	Summit LNG (ex Excelerate)	3.8	138,000	Excelerate Energy	Summit LNG, Bangladesh
9	2008	Explorer	6.0	150,900	Excelerate Energy	Jebel Ali, Dubai, UAE
10	2009	Express	3.8	151,000	Excelerate Energy	Ruwais, Abu Dhabi, UAE
11	2009	Exquisite	4.8	150,900	Nakilat-Excelerate Energy	Port Qasim Karachi, Pakistan
12	2009	Neptune (ex GDF Suez Neptune)	3.7	145,130	Höegh LNG	LNGC ⇒ German(2023)
13	2010	Cape Ann (ex GDF Suez Cape Ann)	3.7	145,130	Höegh LNG	Tianjin, China ⇒ France (2023)
14	2010	Exemplar	4.8	150,900	Excelerate Energy	Argentina ⇒ Finland (2022)
15	2010	Expedient	5.2	150,900	Excelerate Energy	GNL Escobar, Argentina
16	2014	Experience	6.0	173,400	Excelerate Energy	Guanabara Bay, Brazil
17	2014	Golar Eskimo	3.8	160,000	New Fortress Energy	Aqaba, Jordan
18	2014	Golar Igloo	5.8	170,000	New Fortress Energy	Kuwait ⇒ Netherland (2022)
19	2014	Höegh Gallant	2.8	170,000	Höegh LNG	Old Harbour, Jamaica
20	2014	Independence	4.0	170,000	Höegh LNG ⇒ Klaipèdos Nafta (KN)	Klaipeda, Lithuania
21	2014	PGN FSRU Lampung	2.9	170,000	Höegh LNG	Lampung LNG, Indonesia
22	2015	BW Singapore	5.7	170,000	BW Gas	Egypt (-2023) ⇒ Italy (2024)
23	2015	Golar Tundra	5.5	170,000	Golar LNG	LNGC ⇒ Italy (2023)
24	2016	Höegh Grace	4.0	170,000	Höegh LNG	Cartagena, Colombia
25	2017	BW Integrity	5.0	170,000	BW Gas	Port Qasim GasPort, Pakistan
26	2017	Höegh Giant	3.7	170,000	Höegh LNG	Jaigarh, India
27	2017	Bauhinia Spirit/ MOL FSRU Challenger	4.1	263,000	MOL / Vopak	(Hong Kong) ⇒ Singapore (2022)
28	2017	Exmar S188 (ex Exmar FSRU)	4.6	25,000	Exmar Offshore	Laid up ⇒ Netherland (2022)
29	2018	Golar Nanook	5.5	170,000	New Fortress Energy	Sergipe, Brazil
30	2018	Höegh Esperanza	6.0	170,000	Höegh LNG	LNGC ⇒ German (2022)
31	2018	Höegh Gannet	5.5	170,000	Höegh LNG	LNGC (Santos, Brazil)
32	2018	Karunia Dewata	0.4	26,000	JSK Group	Benoa, Indonesia
33	2018	Marshal Vasilevskiy	2.0	174,000	Gazprom	Kaliningrad, Russia
34	2009/2019	BW Batangas (ex BW Paris)	4.2	162,500	BW Gas	LNG ⇒ Philippines (2023)
35	2019	BW Magna (ex BW Courage, Açu FSRU)	5.7	173,400	BW Gas	Port Açu, Brazil
36	2019	Höegh Galleon	3.7	170,000	Höegh LNG	LNGC (Australia) ⇒ German (2022)
37	2019	Turquoise (ex Turkey FSRU)	5.7	170,000	Kolin Construction	Etki, Turkey
38	2020	Excelerate Sequoia	6.0	173,400	Maran Gas Maritime	Bahia, Brazil
39	2016/2020	FSRU Hua Xiang(ex. Hua Xiang 8)	0.1	14,000	Zhejiang Huaxiang	Amurang, Indonesia
40	2020	FSRU Jawa Satu	2.4	170,000	PT Jawa Satu Regas	Java, Indonesia
41	2005/2020	LNG Croatia (ex Golar Viking)	1.9	140,208	LNG Hrvatska	Kirk, Croatia
42	2020	Torman	2.0	28,000	Gasfin Development	Tema LNG, Ghana
43	2020	Vasant 1	5.0	180,000	Swan Energy	Jafrabad , India
44	2003/2021	BW Tatiana (ex Gallina)		137,001	BW Gas Invenergy JV	El Salvador
45	2021	Ertugrul Gazi	4.1	170,000	BOTAS	Dörtyol, Turkey
46	1994/2021	LNGT Powership Africa (ex Dwiputra)		127,386	KARMOL	Senegal
47	2021	Transgas Force		174,000	Dynagas	LNGC ⇒ German (2023)
48	2021	Transgas Power		174,000	Dynagas	LNGC ⇒ German (2023)
49	1991/2022	LNGT Powership Asia (ex NW Shearwater)		127,500	KARMOL	Brazil
50	2002/2023	ETYFA Prometheas(ex Galea)		136,967	DEFA	Cyprus
51	2010/2023	TBN (ex Gaslog Chelsea)		153,000	Gaslog	Greece
52	1994/2023	TBN (ex LNG Vesta)		127,547	KARMOL	Mozambique
53	2023	TBN		170,000	Wison Offshore	-
-	2003/2024	Golar Arctic		140,000	Golar LNG ⇒ Snam	LNGC ⇒ Italy (2024)

Source: Compiled by IEEJ from GIIGNL

While global demand for LNG carriers has been increasing, new deliveries of FSRUs have slowed since 2018. As of the end of 2021, 10 vessels, or about one-fifth of the total, had either been temporarily used as LNG carriers (LNGCs) or were effectively idle. However, after Russia's invasion of Ukraine in February 2022, the situation changed drastically, and by mid-2022, all FSRU vessels, including existing, newly built and under-conversion, had been effectively sold out. In addition, there have been a number of moves to divert to Europe from FSRU projects already in operation in other regions (Table 3-4).

3-5. Major FSRU operators

In the FSRU market, Golar LNG, Höegh LNG, and Excelerate Energy are three well-established companies, and the strengths of each company include standardization of specifications through multi-owned and chartered vessels, cost reduction, and operational flexibility. Other companies are also diversifying their services, with MOL (Mitsui O.S.K. Lines) and Karpowership launching the world's first LNG power generation vessel business under the KARMOL brand in 2019, and Golar LNG selling a portion of its business to NFE (New Forest Energy) in 2021. New entrants and diversification of services are underway. The characteristics of the main FSRU operators are summarized below.

(1) Golar LNG: Norwegian company started LNG transportation business in 1970, and has recently entered into FSU and LNG trading business. In April 2021, it sold Golar LNG Partners LP and Hygo Energy Transition, part of its business, to NFE in an effort to restructure its asset portfolio. The company has chartered 8 FSRUs owned by other companies.

(2) Höegh LNG: Established in 2006 as a subsidiary of Leif Höegh & Co, a Norwegian LNG shipping company, and since 2009 has been rapidly expanding its offshore vaporization business using its own FSRUs. With 10 FSRUs owned by the company, it is the world's largest FSRU supplier.

(3) Excelerate Energy: Established in the United States in 2003, The company has been engaged in LNG transportation and LNG receiving business using FSRUs. In 2005, the company started commercial operation of the world's first FSRU (LNG RV type), followed by a policy shift to the pier-fixed type that has now become the mainstream. The company will promote the introduction and operation of FSRUs in the Middle East, South America, Asia, and other regions, centering on the 8 FSRUs owned by the company.

(4) New Fortress Energy (NFE): Established in the United States. in 2014, NFE owns and operates natural gas and LNG-related infrastructure, vessels, and logistics assets. In August 2022, the company established a JV Energos Infrastructure (80% Apollo managed fund, 20% NFE) with Apollo to operate 11 LNG The company will operate 11 LNG related vessels, including 6 FSRUs, 3 FSUs, and 2 LNG carriers.

(5) Mitsui O.S.K. Lines (MOL): Established in 1884, MOL is the world's largest LNG carrier and the only Japanese company to own and operate an FSRU. The company delivered the world's largest vessel, the MOL FSRU Challenger (renamed Bauhinia Spirit) (263,000 m3) in October 2017, and in August 2019 Together with Karpowership, the company launched the world's first LNG power generation vessel business under the unified KARMOL brand.

3-6. Major FSRUs introduced in each country

As of the end of 2021, 48 FSRUs are in operation, 13 in Asia, 11 in the Americas, 6 in the Middle East, 6 in Europe, 2 in Africa, and 10 are as LNGC. Below is an overview of the non-European regions.

(1) Americas: In Puerto Rico, a U.S. territory in the West Indies, the San Juan LNG receiving terminal (FSRU) went operational in 2020, and in Argentina, Excelerate Energy's FSRU Exemplar is operating at the Bahía Blanca port in that country. In Brazil, Petrobras has signed a lease agreement with Excelerate Energy to operate the Bahia LNG import terminal, where Golar Winter FSRU is operating.

(2) Oceania: Australian Industrial Energy (AIE) concluded an FSRU charter contract with Höegh LNG for the Port Kembla terminal in New South Wales, with operations scheduled to start in mid-2023.

(3) Asia: In the Philippines, three projects are taking shape. First, FGEN LNG is constructing an FSRU terminal in the First Gen Clean Energy Complex in the Batangas region. Second, Excelrate Energy plans to build an FSRU terminal offshore Batangas, but in September 2022, the country's Department of Energy announced that it had not yet approved the construction plan. In October 2022, AG&P completed the conversion of the LNG carrier ISH into an FSU for the PHLNG (Philippines LNG) import terminal offshore Batangas, with operations scheduled for early 2023. In China, CNOOC has already installed an FSRU at the Tianjin LNG terminal in Tianjin Port. In India, Petronet LNG in November 2022 approved an investment in an FSRU terminal with an annual capacity of up to 4 Mt at the port of Gopalpur in the country's east, and is proceeding with the installation until 2026.

In Singapore, the country's regulator EMA (Energy Market Authority) announced precautionary measures to ensure energy security in October 2021, specifying a Standby LNG Facility (SLF) (security-compliant LNG inventory) to install the world's largest FSRU Bauhinia Spirit (former MOL FSRU Challenger, 263,000 m3) is on standby (scheduled by the end of March 2023) to enhance energy security.

3-7. Example of FSU (Floating Storage Unit) Application in Japan

Although there has been no experience utilizing FSRUs in Japan so far, there is a track record of FSUs functioning as storage tanks until an onshore terminal goes into operation in Hokkaido in 2011. Specifically, JAPEX used a combination of natural gas supply from the Yufutsu oil and gas field and externally procured LNG as a stable supply measure to meet peak winter demand from November 2011 to March 2012. An ocean-going LNG carrier was chartered, moored at the pier, transshipped to a domestic vessel using the STS (Ship-to-Ship) method. This first STS-type LNG in Japan was conducted by MOL, which deployed its LNG carriers as FSUs and conducted a total of 51 STS operations (Figure 3-6).

Figure 3-6: LNG STS trans-shipment in Hokkaido (2011-2012)

	Ocean-going vessel	Domestic vessel
Ship, Capacity	LNG Taurus (125,000m3)	Akebono Maru (3,500m3)
Note	2011/11-2012/3, moored at the pier	Between the Yufutsu LNG receiving terminal and an ocean-going vessel moored at the pier

Source: JAPEX

4. FSRU as a de-Russian Measure by Europe

4-1. REPowerEU: European Policies to Break Away from Dependence on Russia

Table 4-1: European Natural Gas (PL, LNG) Imports and Sources (Bcm) (2020)

From / To	Methods	Netherlands	Norway	Other Europe	Azerbaijan	**Russia**	Iran	Algeria	Libya	United States	Qatar	Others	Total imports (Bcm)	Russia Dependency (%)
Belgium	PL	8.4	7.5	1.7	-	**-**	-	-	-	-	-	-	**17.6**	0%
	LNG	-	†	-	-	**0.9**	-	-	-	1.3	0.9	2.0	**5.1**	17%
France	PL	3.8	17.6	1.7	-	**2.6**	-	-	-	-	-	-	**25.8**	10%
	LNG	-	0.8	-	-	**5.0**	-	4.3	-	2.6	5.0	1.9	**19.6**	26%
Germany	PL	13.0	31.2	1.6	-	**56.3**	-	-	-	-	-	-	**102.0**	**55%**
	LNG	-	-	-	-	**-**	-	-	-	-	-	-	**-**	**-**
Italy	PL	1.6	5.4	8.4	†	**19.7**	-	11.5	4.2	-	-	-	**50.8**	39%
	LNG	-	-	†	-	**-**	-	2.8	-	2.1	-	7.2	**12.1**	0%
Netherlands	PL	-	20.0	7.2	-	**11.2**	-	-	-	-	-	-	**38.4**	29%
	LNG	-	-	-	-	**-**	-	-	-	-	-	-	**-**	**-**
Spain	PL	-	1.2	2.1	-	**-**	-	9.1	-	-	-	-	**12.3**	0%
	LNG	-	0.5	0.1	-	**3.4**	-	0.5	-	5.4	3.4	7.6	**20.9**	16%
Turkey	PL	-	-	-	11.1	**15.6**	5.1	-	-	-	-	-	**31.8**	49%
	LNG	-	0.1	-	-	**0.2**	-	5.7	-	2.8	0.2	5.8	**14.8**	2%
Ukraine	PL	-	-	14.7	-	**-**	-	-	-	-	-	-	**14.7**	0%
	LNG	-	-	-	-	**-**	-	-	-	-	-	-	**-**	**-**
United Kingdom	PL	1.0	23.7	0.3	-	**4.7**	-	-	-	-	-	-	**29.7**	16%
	LNG	-	0.4	-	-	**2.9**	-	†	-	4.7	2.9	7.6	**18.6**	16%
Other EU	PL	-	0.3	56.7	†	**55.2**	-	0.4	-	-	-	-	**112.6**	49%
	LNG	-	2.3	0.2	-	**4.7**	-	0.7	-	6.7	4.7	4.5	**23.7**	20%
Rest of Europe	PL	0.3	-	6.3	2.2	**2.5**	-	-	-	-	-	-	**11.3**	22%
	LNG	-	-	-	-	**0.1**	-	-	-	-	0.1	- †	**0.1**	100%
Total Eurpope (Bcm)	PL	28.1	106.9	100.7	13.4	**167.7**	5.1	21.0	4.2	-	-	-	**447.1**	38%
	LNG	-	4.1	0.3	-	**17.2**	-	13.9	-	25.6	17.2	36.4	**114.8**	15%
	Total	28.1	111.0	101.0	13.4	**184.9**	5.1	34.9	4.2	25.6	17.2	36.4	**561.9**	33%
Total Eurpope Ratio (%)	PL	6%	24%	23%	3%	**38%**	1%	5%	1%	0%	0%	0%	**100%**	
	LNG	0%	4%	0%	0%	**15%**	0%	12%	0%	22%	15%	32%	**100%**	
	Total	5%	20%	18%	2%	**33%**	1%	6%	1%	5%	3%	6%	**100%**	
Total Eurpope (Million-tonnes)	PL	20.7	78.6	74.0	9.8	**123.2**	3.8	15.4	3.1	-	-	-	**328.6**	
	LNG	-	3.0	0.2	-	**12.7**	-	10.2	-	18.8	12.7	26.8	**84.4**	
	Total	20.7	81.6	74.3	9.8	**135.9**	3.8	25.6	3.1	18.8	12.7	26.8	**413.0**	

Source: Compiled by IEEJ from bp Statistical Review of World Energy 2021 († =less than 0.1)

After the invasion of Ukraine in February 2022, the EU declared a phased reduction of Russian natural gas imports, and countries in the region planned to build or expand LNG receiving terminals and introduce FSRUs. In March, the EC (European Commission) announced REPowerEU, which aims to procure an additional 50 Bcm (about 37 Mt) of LNG and 10 Bcm (about 7 Mt) of PL, and European countries will significantly reduce their dependence on Russian products, which had accounted for 38% of PL supply (Table 4-1).

4-2. LNG Receiving Projects in Europe

The advantages of the FSRU, which EU countries are promoting as a measure to end the use of Russian gas, include the fact that LNG imports can begin within 12 months (6 months at the earliest) after project approval if existing vessels are chartered, whereas onshore receiving terminals require a lead time of 3 to 5 years from the FID to completion. The short-term charter is also said to reduce the risk of lock-in, making it an easy-to-use method for Europe, which is pursuing a decarbonization policy in the future.

As of the end of 2021, 33 onshore terminals and 6 FSRUs were in operation in Europe, with an LNG regasification capacity of about 188 Mt/y, which accounts for about 20% of the global LNG receiving

terminal capacity of 990 Mt/y (Table 4-2). Although the construction of LNG terminals in Europe has been stagnant in recent years, Croatia began operating an FSRU at its Krk LNG receiving terminal in 2021, and Turkey, where demand for gas power generation is growing, has also introduced an FSRU in 2021.

Table 4-2: Current and planned LNG receiving terminals in Europe (as of November 2022)

No.	Country	Operation			Construction / Plan		
		Onshore	FSRU	Capacity (Mt/y)	Onshore	FSRU	Capacity (Mt/y)
1	Norway	2		0.5			—
2	Sweden	2		0.6			—
3	Finland	3		0.6		1	3.8
4	Lithuania		1	2.9			—
5	Poland	1		3.7	(Expansion)		3.7
6	Germany			—	3	6	30.0
7	Netherlands	1		8.8		2	11.5
8	Italy	4	1	12.1	(Expansion)	3	13.5
9	Belgium	1		6.6	(Expansion)		6.0
10	United Kingdom	3		36.0	(Expansion)		3.8
11	France	4		25.6		1	3.7
12	Spain	7		49.2			—
13	Portugal	1		5.6			—
14	Malta		1	0.5			—
15	Croatia		1	1.9			—
16	Albania			—		1	3.5
17	Greece	1		5.1		1	5.9
18	Turkey	2	2	28.5		1	—
19	Gibraltar	1		0.1			—
20	Cyprus			—		1	1.3
Total		33	6	188.3	7	17	86.7

Source: IEEJ

As of November 2022, European LNG buyers are expected to secure at least 17 FSRUs (Table 4-2, Figure 4-2). These include six in Germany, three in Italy, two in the Netherlands, and one each in the other countries of France, Finland, Albania, Greece, Turkey, and Cyprus. In addition, Poland and the U.K. are also considering the project, which could bring the total number of FSRUs in Europe to more than 20. Some of the plans have substantial government support, which increases the certainty that the projects will be completed. And while each country is working to build LNG import flows, also planning future diversions to decarbonized fuels such as hydrogen and ammonia to minimize the risk of becoming stranded assets.

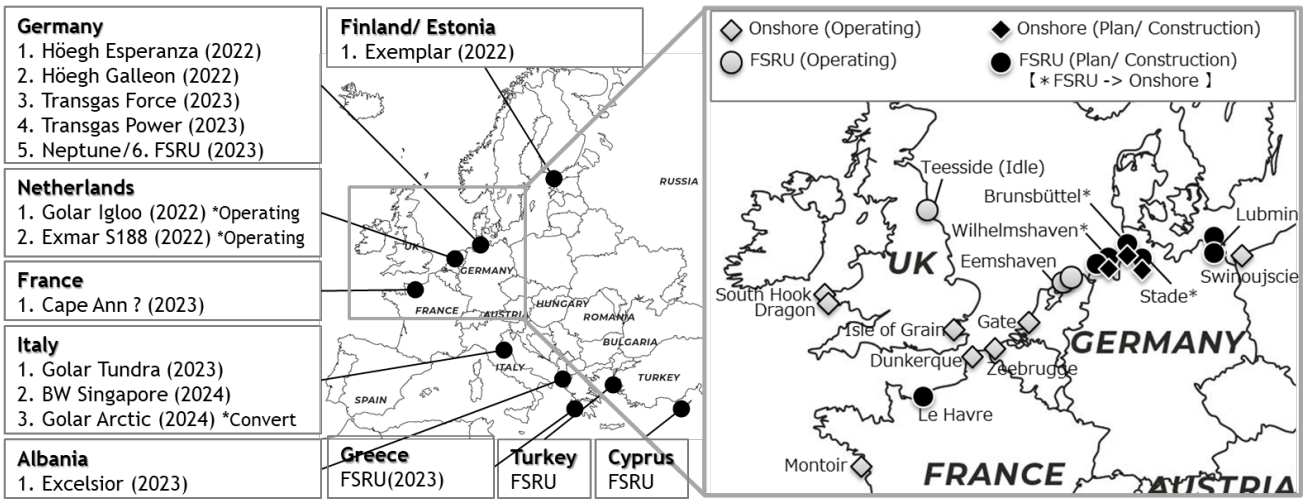

Figure 4-2: New FSRU Projects in Europe
Source: IEEJ

(1) Germany has the largest LNG receiving capacity expansion plan in Europe, with 6 FSRUs (2 at Wilhelmshaven, Brunsbüttel, 2 at Lubmin, Stade) and 3 onshore terminals (Wilhelmshaven, Brunsbüttel, and Stade: to be converted from FSRUs to onshore terminals), planning to have a capacity of about 30 Mt/y, or about 40% of the country's demand. In June 2022, the country's LNG Acceleration Act came into effect, and the LNG import terminal is now under construction. The law expedited approval, bidding, and review procedures for the necessary connections for the terminal, and established exemptions from environmental impact assessments.

The government has leased five FSRUs, and has instructed RWE and Uniper to charter the vessels. Wilhelmshaven and Brunsbüttel will be operational in 2022/23, Stade at the end of 2023, Lubmin after the end of 2023, and the fifth unit will again be in service at Wilhelmshaven. A sixth unit is to be built in Lubmin by the end of 2022 by a private consortium.

The Wilhelmshaven terminal is planned by Tree Energy Solutions (TES), E.ON, and ENGIE to be operational in winter 2023 with an annual capacity of 5 Bcm. TES has also been working on a hydrogen terminal project since 2019, aiming for large-scale hydrogen import by 2025. The terminal will consist of 6 piers and 10 onshore tanks with a total capacity of 2 Mcm and a direct connection to the natural gas, hydrogen, and CO_2 pipeline network. The Stade terminal is part of the Hanseatic Energy HubHA (HEH), including Dow, Fluxys, Partners Group, and Buss Group The consortium plans to start receiving LNG from the FSRU at the end of 2023 and convert it to an onshore receiving terminal from 2026, with an annual regasification capacity of 13.3 Bcm. The Brunsbüttel terminal will be jointly constructed by KfW, Gasunie, and RWE in March 2022, with KfW investing 50% on behalf of the German government and Gasunie operating the terminal. The terminal will have an annual regasification capacity of 8 Bcm and is expected to be operational in 2026. In the future, the company plans to convert the terminal into an import terminal for green hydrogen and ammonia.

(2) Netherlands: In March 2022, EXMAR, a Belgian shipping company, signed a five-year charter

contract with Gasunie of the Netherlands for the Eemshaven LNG project north of Groningen. Two FSRUs (Golar Igloo and Exmar S188) were installed at the Eemshaven LNG receiving terminal in September 2022 and started operation in a record time of only 6 months from planning to completion. The terminal is planned to be converted for green hydrogen storage in the future.

(3) Italy: In May 2022, Golar sold its existing LNG carrier, Golar Arctic, to Italy's Snam, which will convert it into an FSRU over the next two years. The vessel will be installed by Snam in the Sardinia Portovesme port area. In June, Snam purchased FSRU Golar Tundra from Golar LNG, which will be installed in the central and northern regions of Sardinia and put into service in spring 2023. In July, Snam and BW LNG signed an agreement for Snam Group to acquire FSRU BW Singapore. In October 2022, the government of Singapore instructed Snam to install and start operation of the FSRU by the end of March 2023, and there are plans to receive 5 Bcm of LNG at the Piombino port in the Toscana region. However, on October 20, local and environmental groups protested the FSRU project.

(4) France is considering the deployment of one FSRU at the port of Le Harvre in the northern part of the country. The project, initiated by TotalEnergies and the Ministère de la Transition écologique, could increase regasification capacity by 5 Bcm. The Cape Anne, one of the two FSRUs owned by TotalEnergies and currently in operation in China, is scheduled to be commissioned in June 2023, with commissioning scheduled for September 2023.

(5) Finland: One FSRU deployment is being considered on the country's south coast. In April 2022, the Finnish and Estonian governments announced an MOU agreeing to jointly lease an FSRU. In May 2022, Excelerate Energy and Gasgrid Finland Oy subsidiary signed a 10-year charter agreement for the FSRU, under which Excelerate Energy will deploy the FSRU Exemplar. In August 2022, Gasgrid Finland signed an agreement with Fortum to install the FSRU at its port in Inkoo in December 2022.

(6) Albania: The deployment of one FSRU is under consideration. In 2021, Excelerate Energy signed a contract with Italy's Snam and Albania's national gas company Abgaz to build a natural gas pipeline in Albania. Prior to that, Excelerate Energy signed an MOU for a feasibility study on the development of an integrated power solution, including an FSRU LNG receiving terminal at the southern port of Vlora in the country. FSRU Excelsior for the Vlora FSRU LNG project in Israel after the contract expires at the end of 2022, with plans to bring it on stream in Q2 2023.

(7) Greece: The deployment of one FSRU is under consideration. In January 2022, Greece Gastrade announced an FID for the construction of the Independent Natural Gas System (INGS) at Alexandroupolis, where the FSRU will be connected to the Greek national natural gas transportation network. The FSRU will be connected to the Greek national natural gas transportation network and the INGS is expected to be operational by the end of 2023. The regasification capacity is estimated at 5.5 Bcm.

4-3. Challenges in implementing FSRU

FSRUs can provide a rapid response to short-term increases in demand, However, there are also demand-side, supply-side, and other policy and regulatory issues to be addressed in their implementation. Therefore, it is still unclear to what extent the plan will proceed in Europe.

(1) Demand side: Many FSRU facilities are difficult to modify after construction and may not meet the specifications of the demand side (e.g., large/small tank capacity, maximum flow/pressure for regasification, open/closed seawater loop system for regasification, flexible/hard cargo hoses, and availability of LNG reload function). In addition, the profitability of an FSRU requires an annual demand of around 3 Mt/y of LNG, and in an environment such as Japan, where demand is scattered and nationwide gas pipeline connections are not yet established, it would be practically difficult to introduce an FSRU. In other countries, national companies and state-owned firms are the main players to hedge risks.

(2) Supply Side: The global shortage of shipbuilding capacity makes it difficult to rapidly increase production of FSRUs. There are also concerns about the uneven distribution of shipyard orders to China and Korea and a shortage of human resources (engineers for tank welding, crew for LNG carriers, etc.), which could lead to a short- to medium-term shortage of LNG supply and future decarbonization-oriented stagnation of fossil fuel infrastructure investment.

(3) Other environmental policies/regulations: The first issue for the introduction of FSRUs is environmental risk (regulations for each port, such as water temperature changes, sewage/drainage, noise and smoke emissions, etc.), which accounts for the largest number of risk factors. Other risk factors include maritime/weather risks (restrictions due to typhoons, high waves, storm surges, etc.), policy change risks (changes in energy policy, project owner's operational policy, etc.), and emerging country risks (delays in construction and licensing of jetties and power plants, project cancellation due to financial difficulties, etc.).

5. Conclusion

Europe, which aims both to phase out its dependence on Russia and to decarbonize in the future, is rapidly expanding FSRUs as transition infrastructure, which is highly compatible with its own strategy. Europe's sudden large-scale purchase of LNG has driven up prices to levels that make procurement difficult, forcing emerging and developing countries to return to coal and oil, threatening not only their industries but also their energy security. This will lead to delays in decarbonization, which in turn will worsen the rate of economic growth. And the possible rapid withdrawals from FSRUs and LNG envisaged for Europe in the future could lead to further market disruption. For a sustainable society, a realistic path forward is to utilize LNG as a low-carbon fuel as much as possible and gradually increase the ratio of decarbonized fuel. As Japan aims to realize a realistic energy transition in Asia, it is necessary to take the lead in showing the world " what a responsible developed country should do “.

Contact: report@tky.ieej.or.jp