

The Standby Import Terminal A New Concept in LNG

March 31, 2009

ABSTRACT: As winter in the northern hemisphere passes, so does another crisis for Russia's pipeline gas customers. In the southern hemisphere, a similar crisis was born by consumers of Bolivian gas. Increasingly, consumers are looking to use LNG to ensure security of supply and negotiate better terms for pipeline supply. New "standby" terminal designs are making LNG more practical for these needs. Currently, six standby terminals are operational, three are under construction and six more are planned.

Introduction

It was “the worst energy crisis Europe has experienced ... since the oil crisis in 1973,” Frank Umbach, an energy analyst for the Center for European Security Strategies, said about the recent gas dispute between Russia and Ukraine.¹ While blame for the curtailment is hard to assign, the outcome is the same as it was in January 2004 when gas supplies into Europe were cutoff during another cold spell.

As a result, calls for LNG diversity are ringing louder and clearer than ever in Europe, despite the current tightness of credit. “In the future, LNG is to supplement our traditional gas supply portfolio, thus contributing to security of supply for our customers throughout Europe,” Jochen Weise, an E.ON Ruhrgas board member, said in a statement.² E.ON buys most of its gas from Russia and therefore was adversely affected by the curtailment.

In Croatia, a high priority has been placed on a new LNG terminal on the island of Krk in the North Adriatic. Current plans call for import capacity of up to 15 bcm/y (1.5 bcf/d). The country, however, consumes just 3.2 bcm/y currently.³

Emergence of Standby Terminals

The key issue for governments and their regulated utilities is how much capital to tie up in a facility that may be used only intermittently during crises or severely cold weather.

In recent years, more than \$1.0 billion in investment has been needed to build a two-tank terminal capable of receiving and regasifying 15 bcm/y (1.5 bcf/d).

Moreover, these terminals need large staffs to operate and maintain them even when no LNG is being imported. They are designed for baseload operations with capacity utilizations above 90%. Minimal amounts of LNG are required at all times to keep LNG systems cold, lest cryogenic components warm above design temperatures where seals can realign and leak.

¹ “Analysis: EU aims to boost energy security.” Nicola, Stefan. *Energy News*. Berlin (UPI). Mar 20, 2009.

² “First gas from E.ON Ruhrgas operated Rita field in United Kingdom.” (<http://www.eon-ruhrgas.com/cps/rde/xchg/SID-7EC5009E-C40C4957/er-corporate/hs.xsl/presseinfo.htm?rdeLocaleAttr=en>). March 20, 2009.

³ Zeus Virtual Energy Library (<http://www.zeuslibrary.com/VEL/Import/224Croatia/224PO.asp>).

Standby terminals, however, can be built for small fractions of the cost of conventional terminals.⁴ Their capital costs tend to range between \$10 million and \$100 million instead of \$300 million to \$1.5 billion.⁵ While per-unit capacity may be more expensive, due to the need to charter specialized regasification ships or purchase partial cargos, these terminals cost much less per molecule of gas if the terminal spends more of its time in standby mode than in baseload operation. When not in use, the ship is free to sail away for service elsewhere.

Bolivia's Contribution to the LNG Industry

Thanks in part to Bolivian President Juan Evo Morales Ayma, several new types of standby LNG import terminals have emerged. When the Bolivian government nationalized its natural gas fields, energy security for Chile, Argentina, and Brazil was threatened.⁶ The situation became dire during the winter of 2008, prompting each country to move to find speedy, low cost solutions for LNG supply. Consistent with Latin American style, all three countries developed their own unique design.

In Argentina, ENARSA chose Exceleerate Energy's dockside-regas offloading design, which has been named Gasport®. See Figure 1. ENARSA and Exceleerate built the [Bahia Blanca](#) facility, at only one-tenth the capital cost of a conventional terminal, according to reports.

The facility was placed into service in less than 12 months and requires almost no staff when unused. Exceleerate's regas ship can enter charter service when not in use, thus mitigating the cost of LNG storage.



Figure 1: High pressure gas comes ashore via a jetty-mounted articulated gas loading arm. Photo courtesy of Exceleerate Enerav.



Figure 2: Dockside high-pressure gas transfer systems are thus far the most common type of standby terminal. Photo courtesy of Exceleerate Enerav.

⁴ "Gateways & GasPorts®." Exceleerate Energy. <http://www.exceleerateenergy.com/ports.html>.

⁵ "Exceleerate Energy Announces Successful Delivery of First LNG Cargo to South America's First-Ever LNG Import Facility." (http://www.exceleerateenergy.com/2008/06/exceleerate-energy-announces-successful_9370.html). Exceleerate Energy. June 9, 2008.

⁶ Zissis, Carin. "Bolivia's Nationalization of Oil and Gas." www.cfr.org/publication/10682/ Council on Foreign Relations. May 12, 2006.

A drawback to the Bahia Blanca design is that conventional carriers must offload their cargos into Excelerate's regas ship via hoses. See Figure 2. Despite Excelerate's demonstrated use of hoses and side-by-side transfer on several occasions, some LNG fleets refuse to serve the standby terminals unless standard chiksan loading arms are accessible.

Thus, the newer dockside-regas-type terminals are being built by Petrobras and Golar LNG in Brazil at [Pecém](#) and [Guanabara Bay](#) use conventional [chiksan loading arms](#) (Figure 3) and in some cases by Excelerate Energy, such as in Kuwait.



Figure 3: Sample of chiksan loading arms for LNG. *Photo courtesy of FMC Technologies.*

At Guanabara Bay near Rio de Janeiro, Brazil, LNG carriers can sail up to a dock to offload using chiksan arms. The LNG is pumped into the *Golar Winter* regas ship, which can store up to 138,000 liquid cubic meters. See Figure 4. Regasified LNG from the ship is then piped ashore.⁷

Likewise, at Pecém, conventional arms are used to transfer LNG from the carrier into the *Golar Spirit* regas ship, which can store up to 128,600 liquid cubic meters. See Figure 5.



Figure 4: The *Golar Winter*, which uses a gas-transport membrane containment system built by Hyundai Heavy Industries is being converted to an FSRU and then leased to Petrobras for service at Guanabara Bay. *Photo courtesy of Golar LNG.*



Figure 5: The *Golar Spirit*, Golar LNG's first FSRU, was converted by Keppel SY. The ship was built in 1982 by Kawasaki Heavy Industries. *Photo courtesy of Golar LNG.*

⁷ "Golar LNG Q3 2008 Results." Golar LNG. (http://www.golarlng.com/index.php?name=seksjon/Stock_Exchange_Releases/Press_Releases.html&pressrelease=1273121.html). Nov. 25. 2008.

Chile's Hybrid Design

Chilean consumers chose yet another design for two terminals along the Pacific Coast. At [Quintero](#) and [Mejillones](#), BG and GDF Suez respectively designed terminals to avoid the use of a regas ship by placing the vaporizers and a small amount of liquid storage onshore.⁸ See Figure 6.

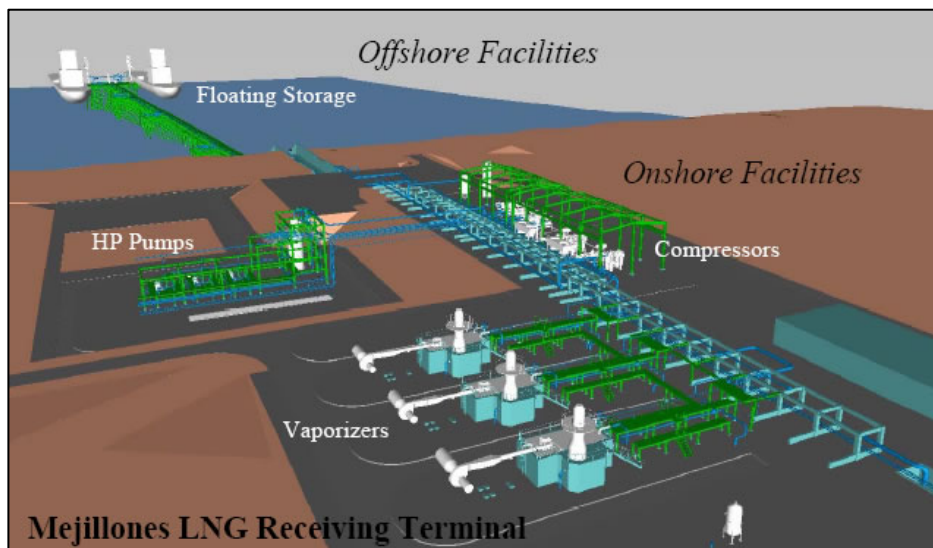


Figure 6: The Mejillones terminal will be a hybrid between offshore LNG storage in conventional ships and onshore vaporizers and sendout to power plants serving copper mines of Northern Chile. The project will use a conventional LNG carrier which will remain permanently moored to the jetty. After an international tender, GNL Mejillones selected Suez Global LNG's floating storage unit offer. *Graphic courtesy of GNL Mejillones SA.*

LNG can be piped from a conventional carrier into a relatively small onshore buffer tank, supplying about eight hours of inventory for uncoupling and coupling ships. At other times, the carrier itself provides the storage, slowly pumping its cargo to supply the vaporizers at a rate of some 3.5 bcm/y (342 mmcf/d, 2.5 million metric tons per year) in the case of Quintero.⁹

Should the terminal be idled for standby, the carrier can leave for other service, reducing the investment in unutilized equipment. Quintero is expected to be operational by 2009, Mejillones by January 2010.

⁸ "GDF SUEZ signs USD 393 million project financing contract for Central Termoeléctrica Andina." GDF Suez. (<http://www.suezenergyint.com/content/newsroom/pressreleases/20081222CTAprojectfinancing.pdf>). Dec. 22, 2008.

⁹ "Bienvenidos a la Energia. GNL Quintero. <http://www.gnlquintero.com/>.

Other Standby Designs: APL's Buoy

Perhaps the most famous standby terminal design employs the Advance Production Loading (APL) Systems deepwater buoy. Although at \$50 million to \$100 million, this design in general requires more capital investment than dockside designs. Moreover, more investment must be made to equip a ship for buoy service, as the ship must be able to mate with the underwater turret loading system, in addition to being able to vaporize LNG into high-pressure gas.

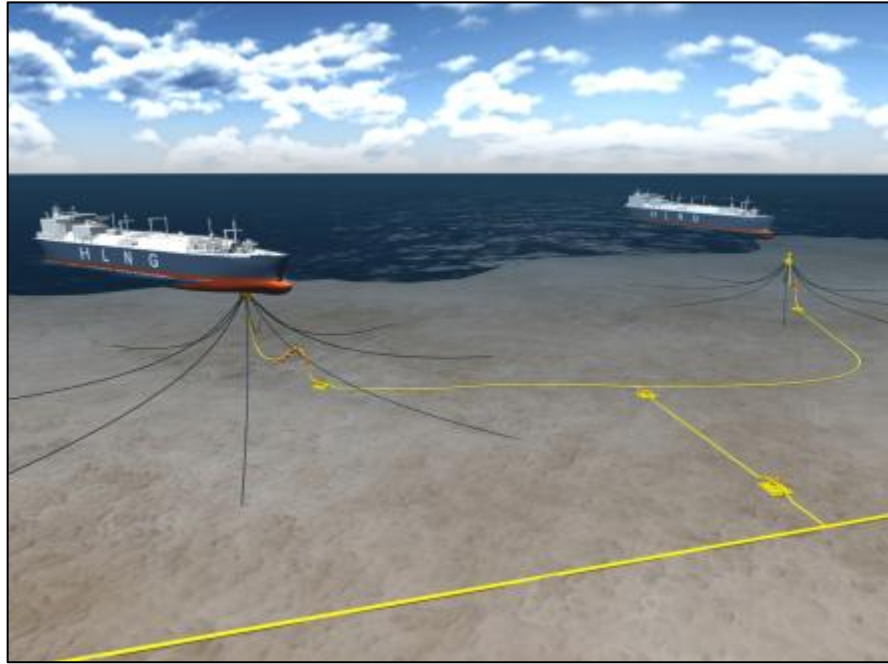


Figure 6: The Neptune project consists of two LNG storage-regas vessels (SRVs), an offshore terminal with two buoys and associated pipelines to shore. GdF-Suez received a DWP license permit from US federal authorities in March 2007. The first phase of the construction of Neptune LNG DWP is underway and includes the installation of a 20 km sub-sea pipeline which was completed in October 2008. The second phase, scheduled to begin in May 2009 and continue into September 2009, includes connection of the pipeline and installation of the two off-loading buoys for the project. *Graphic courtesy of Hoegh.*

APL turrets and buoys are being installed most commonly along densely populated shorelines where LNG ship access is impeded. Thus far, APL systems have been installed at [Gulf Gateway](#) in the Gulf of Mexico and at [Northeast Gateway](#) in Boston Harbor. Others are in the works at [Neptune Port](#) in Boston Harbor and [OLT Offshore LNG Toscana SPA](#) offshore Livorno, Italy.

TORP Technologies' HiLoad

The fifth standby design, the HiLoad, achieved a major milestone when TORP Technologies' affiliate, Remora ASA, floated the first HiLoad for service. While the unit pictured on the previous page in Figure 1 is for oil service, it will provide valuable operational experience with the concept.



Figure 7: Photo courtesy of Remora Technologies

| Appendix A | | | | |
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| Leading Standby Terminal Designs | | | | |
| Terminal Type, Designer | Typical Capital Cost for Fixed Facilities, Onshore Footprint | Limitations | Recent or Planned Installations | Primary Drivers |
| Gas port with hose transfer, Excelerate Energy, Exmar | Less than \$10 million, less than one hectare | Dependent on existing jetty, dock and channel. Terminal relies on LNG ships equipped with regasifiers and crews accustomed to ship-to-ship transfer using hose connections. | Teesside, UK | Interim supply |
| | | | Bahia Blanca, Argentina | Emergency supply to makeup for Bolivian curtailment |
| | | | Wilhelmshaven, Germany (under development) | Winter peak and security of supply |
| Gas port with conventional chikan arm transfer, Golar LNG, Excelerate Energy | Less than \$20 million, less than one hectare | More expensive due to cost of loading arms. Dependent on existing jetty, dock and channel. Terminal relies on LNG ships equipped with regasifiers. | Pecém, Brazil | Threat of Bolivian gas curtailment |
| | | | Guanabara Bay, Brazil | Threat of Bolivian gas curtailment |
| | | | Mina Al-Ahmadi GasPort® (MAAGP), Kuwait (under development) | Summer peak demand |
| Deepwater turret and buoy, Excelerate, Exmar, GDF Suez, Hoegh LNG | \$50 million to \$100 million, none | Limited to ships with capability to mate with turrets and regasify LNG | Dubai (under development) | Security of supply |
| | | | Quintero, Chile (under development) | Threat of Bolivian gas curtailment |
| | | | Mejillones, Chile (under development) | Threat of Bolivian gas curtailment |
| Conventional shore-based terminal with offshore LNG storage, BG Group and GDF Suez | \$50 million to \$100 million, less than 5 hectares | Small onshore buffer storage, which presents siting challenges | Gulf Gateway, Louisiana | Perceived decline in domestic production |
| | | | Northeast Gateway, Massachusetts, USA | Winter peak demand |
| | | | Neptune Port, Massachusetts, USA (under development) | Winter peak demand |
| Deepwater turret and buoy, Excelerate, Exmar, GDF Suez, Hoegh LNG | \$50 million to \$100 million, none | Limited to ships with capability to mate with turrets and regasify LNG | OLT Offshore LNG Toscana SPA, Livorno, Italy (under development) | Summer peak, security of supply |
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| | | | Port Dolphin , Tampa Florida, USA (under development) | Summer peak demand |
| HiLoad, Torp Technology | \$150 million, less than one hectare | Maintenance of HiLoad, full time staff | Bienville LNG , Alabama Gulf Coast (under development) ¹⁰ | TBA |

¹⁰ Note: On Oct. 9, 2008, Bienville LNG was rejected by Alabama Governor Bob Riley, citing environmental challenges with the terminal, centering around its incorporation of an open-loop system that would have required more than one hundred million gallons of seawater per day to operate. The terminal had come under heavy criticism from the National Marine Fisheries Service.