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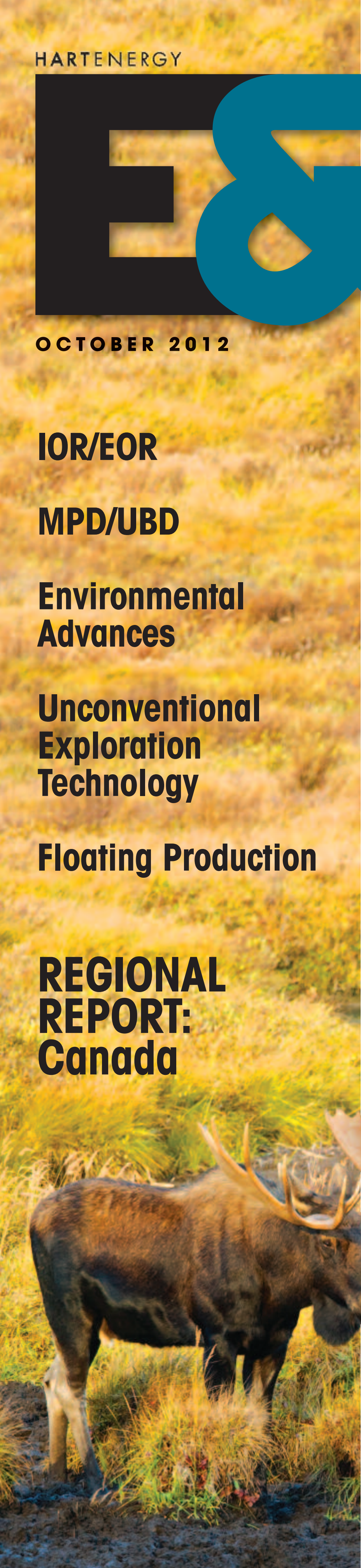

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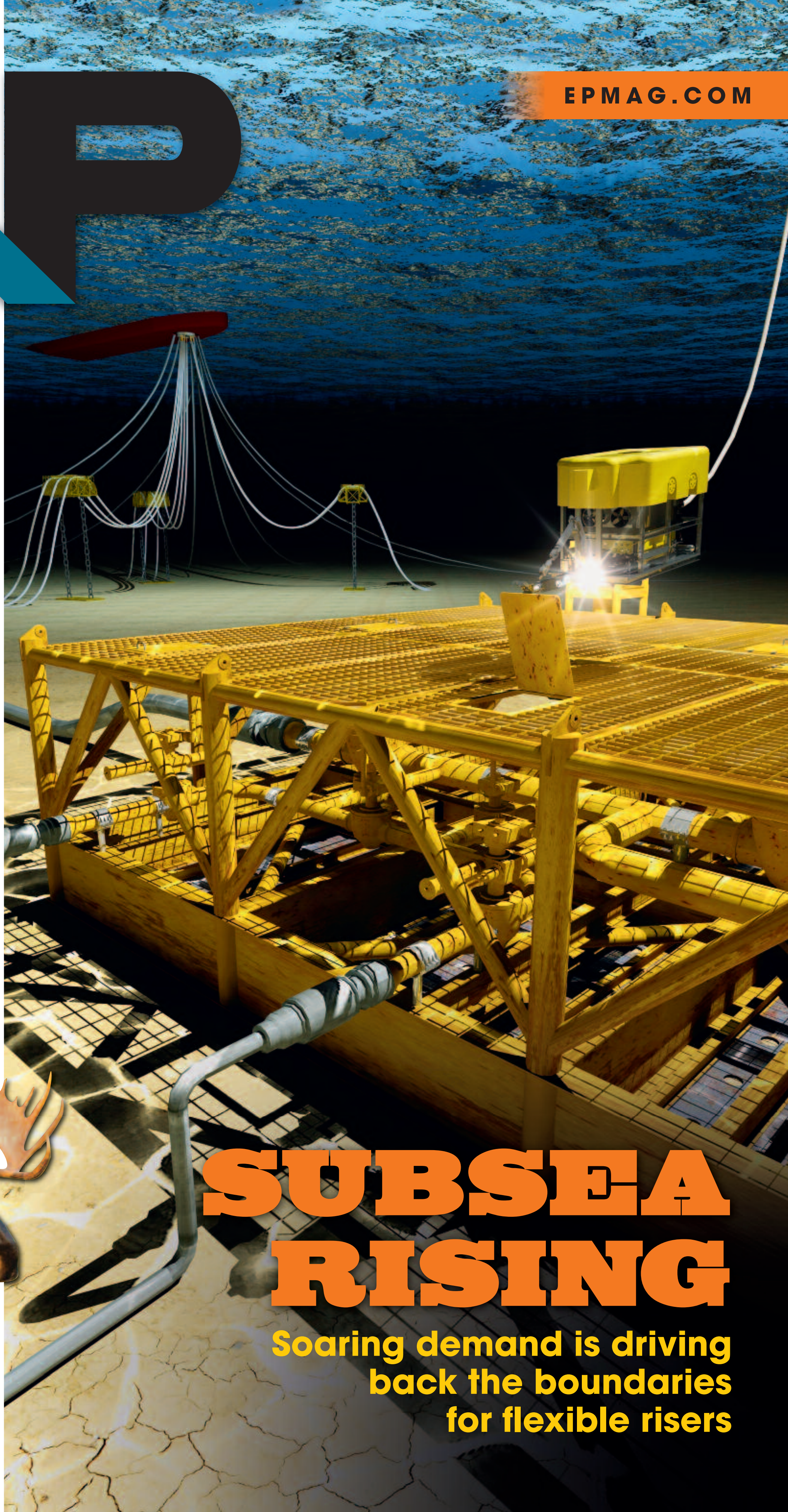
Environmental Advances

Unconventional Exploration Technology

Floating Production

REGIONAL REPORT: Canada



SUBSEA RISING

Soaring demand is driving back the boundaries for flexible risers

AS SEEN IN OCTOBER 2012 E&P

Technology changes the LNG equation

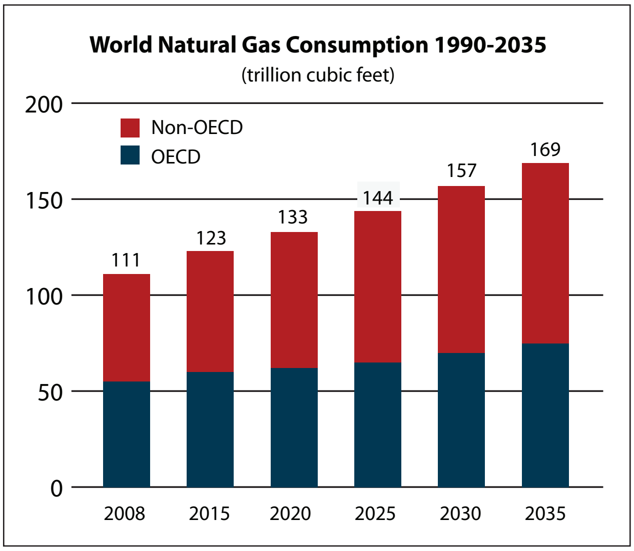
New floating LNG concepts are changing the way operators are looking at field development and will open production in formerly 'unreachable' areas.

William J. Sember, ABS

The global gas landscape is rapidly changing. Shale gas development in North America is a case in point. In the course of the last decade, the US has gone from searching for ways to address the possibility that the country could run out of gas to trying to find a solution for excess production. Now conversion work is under way to transform domestic facilities, originally constructed for LNG imports, for use as export facilities. While onshore resource development is altering the status quo, floating LNG (FLNG) is beginning to introduce a transformation of its own.

The emergence of floating gas production

With the world's demand for energy growing, it is increasingly important to find a cost-effective way to produce stranded reserves or associated gas. More than one-third of global gas reserves are stranded by their location or field size. With gas deposits often in remote or isolated areas far from coastal resources, "marinizing" production, liquefaction, and export facilities offers enormous potential for many future development projects. FLNG delivers the capability to produce reserves that otherwise would not be commercially viable.



The US Energy Information Administration (EIA) projects an increase in natural gas consumption of 58 Tcf between 2008 and 2035. (Source: US EIA "International Energy Outlook 2011")

Because FLNG vessels are located on site, the need for long, costly, and technically challenging subsea pipelines to shore is eliminated. Floating systems, by virtue of their placement offshore, also can reduce security and political risks, which is a noteworthy advantage, particularly in the regions of the world where operations are more hazardous than normal.

FLNG projects are being considered in varying degrees for developments offshore Malaysia, Papua New Guinea, Indonesia, Australia, Trinidad and Tobago, Israel, Brazil, Cyprus, and elsewhere. There are 17 potential FLNG projects being considered at the moment with production ranging from 1 to 5 million tons per annum (MTPA). In addition to a number of floating storage and regasification units (FSRUs) already in service, there are many more FSRU projects being considered for installation, all of which are targeted for completion by the end of 2020.

Capital costs for FLNG present another advantage. The investment required for marine and offshore facilities may be lower than that of land-based facilities. Construction costs can deliver considerable additional savings because an FLNG vessel can be built in any shipyard with suitable construction capacity and a skilled labor force.

Another advantage of FLNG is that many of the environmental permitting issues that delay land-based construction can be avoided when installation takes place offshore at a remote location or one distant from shore.

As recently as five years ago, floating solutions for the import and export of LNG were still considered new and novel concepts. Most of the proposed solutions, however, are adaptations of technologies that have been applied in offshore oil production projects or in onshore liquefaction facilities – a fact that could decrease the time required for adoption and implementation.

Some of these emerging proprietary technologies and transport designs already have come of age, and the industry is poised for the first projects, including Shell's Prelude field in the Browse basin offshore Western Australia. The *Prelude* FLNG vessel will be the largest vessel built to date at 488 m by 74 m (1,600 ft by 243 ft) and 600,000 dwt.

The Prelude project received environmental approval in late 2010 and has a target production start date of

Keeping pace with FLNG development

FLNG development will be guided by international standards for vessels as well as regulatory requirements, best industry practice, environmental considerations, recognized standards, and guides that are being developed specifically for FLNG.

The ABS "Guide for Building and Classing Floating Offshore Liquefied Gas Terminals," which was updated in March 2012, is based on the design and analysis experience with LNG carriers, independent tank liquefied gas carriers, and ship-type FPSOs. The newly updated guide provides criteria that can be applied in classing the hull and tank structures of floating offshore liquefied gas terminals with membrane tanks or independent prismatic tanks and covers liquefied gas terminals with ship-shaped or barge-shaped hull forms that have a single row of cargo tanks at the centerline or a row of two cargo tanks abreast.

As technology changes the face and the function of floating production, class societies will have to continue to develop new guides and rules to meet the industry's evolving needs. ■

2016. This inaugural project will be followed closely by several others offshore Indonesia and Malaysia.

FLNG is a different ballgame

Although the FLNG process as a concept is relatively new, the basic technologies that make it possible are not. Regasification and liquefaction, for example, are proven technologies that can be modified for the marine environment. Storage falls into the same category, as does offloading, for the most part. Recent technology developments have addressed such concerns as integrating subsea architecture with FLNG, offloading systems – in particular for harsher environments with tandem configurations based on flexible cryogenic hoses – and qualifying and testing components for application in LNG transfer systems.

While the technologies generally are transferrable, it is important to recognize that there are some significant differences between FLNG units and land-based liquefaction plants. One of these is the addition of vessel motion to the risk equation. Motions also impact offloading operations, and the separation distance between the FLNG and the carrier can introduce considerations for topsides arrangement.

Technical challenges in FLNG terminal design are being driven by a combination of design and operational issues. These include the increase in the size of terminal hulls and LNG containment systems, shallow-water load effects, partial filling (and associated sloshing), offloading operations, and critical interfaces between the hull and topside structure and between the hull and position mooring system.

Placing equipment on a floating structure also introduces mechanical stresses, which can affect the life expectancy of topsides processing equipment. Equipment used offshore is subjected to stress corrosion cracking resulting from vessel motions and corrosion resulting from saltwater spray. Space and weight limitations also pose challenges, including potential topsides congestion resulting from process equipment and a piping network that has to be installed in a relatively small area.

Global impact

With the expanding global focus on gas development, FLNG has a bright future. The amount of recoverable gas is tremendous, and FLNG will provide the means to produce it more quickly.

From a class society perspective, there are no showstoppers for the technology. FLNG vessels will be treated in the same manner as ships and FPSOs. ABS will continue to act in the capacity of third-party oversight, making certain that rules and standards are met and that surveys are scheduled to verify that a vessel can maintain safe operations throughout its lifecycle.

While there are challenges on the horizon, the time has come for commercialization and dissemination of FLNG technology. E&P

Proposed FLNG concepts cover a broad spectrum of dimensions and operational capabilities.

Hull size	> 100 m to 500 m (300 ft to 1,640 ft) length
LNG storage capacity	40,000 cu m to 300,000 cu m
Water depth	Shallow to deep water
Mooring	Spread, turret moored with the ability to weather vane
Operating environment	Mild to harsh
Production rate	1 MTPA to 5 MTPA
Feed gas	Rich to lean and with/without contaminants
Process plant	Expander, single-mixed refrigerant, dual-mixed refrigerant
Power	30 MW to 300 MW
Steam	100 tons to 600 tons

William J. Sember

William J. (Bill) Sember is an ABS Corporate Officer and Vice President Global Gas Marketing. His focus is on the development and support of gas projects worldwide. Prior to this role, he served as President and Chief Operating Officer, ABS Europe.

During his career at ABS, Sember has been Manager of the Offshore Engineering Department, Regional Vice President ABS Europe, Vice President Technology and Business Development, ABS Europe and Vice President Energy Project Development.

Sember has been an active participant in many industry associations, serving as Chairman of the Houston chapter of the OMAE, Chairman of the API Subcommittee on Floating Systems and Chairman of the IACS Working Party on Drilling Units. He has also served as Vice Chairman of the Board for the Centre for Marine CNG Inc.

Sember is a graduate of the US Merchant Marine Academy (USMMA) with a Degree in Marine Engineering and has completed the Advanced Management Program at Harvard Business School. He also holds a US Coast Guard marine engineers license and is a licensed professional engineer.

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