DEMAND FOR LIQUIFI0ED NATURAL GAS DEVELOPMENT AND IMPACTS TO ICHTHYOPLANKTON

Justin E. Farrell, Louisiana Sea Grant College Program

The global demand for energy continues to surge as the world's population increases, industries expand and both developed and developing nations seek greater economic growth. World energy consumption is expected to increase by nearly 57 percent from 2002 to 2025 with the majority of consumption likely to occur in developing nations (EIA 2005). Oil is expected to remain the world's foremost source of energy through 2025, however the fastest growing source of primary energy consumed worldwide, is natural gas, which is expected to rise at a rate of 2.3 percent annually from 2002 to 2025 (92 trillion cubic feet in 2002 to 156 trillion cubic feet in 2025; EIA 2005). Similar to oil, natural gas demand will be greatest in developing nations where its use is expected to double by 2025. Industrialized nations are expected to increase consumption at an average rate of 1.6 percent per year from 2002 to 2025 with North America consuming the largest share.

The United States relies heavily on imports of oil and natural gas and has been supplementing its international dependence with domestic sources. Most of our domestic supply is located on federal lands and in the outer-continental shelf, where oil and natural gas have been extracted for years. The energy industry has focused heavily on offshore energy supplies due to their relative abundance and development of these resources yielded more than 600 million barrels of oil and approximately 4.5 trillion cubic feet (Tcf) of natural gas during 2002 and 2003 (US Commission on Ocean Policy 2004). The statistics indicate clearly how important natural gas will be to the world economy and more specifically to the United States. The world sits atop approximately 6,040 Tcf of natural gas, much of which is located in the Middle East, Eastern Europe and Asia (EIA 2005). Unfortunately, foreign natural gas is not an economically efficient fuel source unless it is converted into liquid form for transport.

The Institute for Energy, Law, and Enterprise at the University of Houston outline four processes which make liquefied natural gas (LNG) available to the U.S. market, they are: exploration/production, liquefaction, shipping, and regasification/storage (Delano et al. 2003). To make natural gas more economical to transport, it is liquefied through a cryogenic process termed liquefaction. This reduces its volume by a factor of 600, and the super-cooled LNG can then be shipped aboard large double-hulled ships that are specially insulated and designed prevent rupture or leakage in an accident (Delano et al. 2003). However, in order for it to enter the U.S. pipeline network as natural gas, the LNG must be returned to a gaseous state. Proposed LNG terminals in the Gulf of Mexico (GOM) typically use one of two processes for LNG vaporization, commonly referred to as open or closed-loop systems.

The Environmental Impacts of LNG Development

An extensive pre-existing pipeline infrastructure has made the GOM an attractive target for proposed LNG terminals. For a good review of the regulations and siting of proposed and approved LNG terminals in the GOM, please see MacDuffee & Delgado (2005). As stated previously, in order for LNG to enter the GOM pipeline network as natural gas, the LNG must undergo regasification. Proposed LNG terminals typically use one of two processes for LNG vaporization, open or closed-loop systems, although a third "hybrid" alternative (using both open and closed systems) is burgeoning (MacDuffee & Delgado 2005). In all processes, water passes by the LNG to warm it.

The current debate centers on the environmental impact of the open-loop system, most commonly comprised of open rack vaporization (ORV). An ORV system uses ambient temperature seawater drawn from the Gulf of Mexico to return LNG to a gaseous state. The primary benefit of an ORV system is that it uses renewable resources, no fossil fuels are burned, and there are no increased greenhouse gas emissions, such as CO, CO_2, and NOx (Yang & Huang 2004). But since hundreds of millions of gallons of water per day are pumped by one LNG terminal, opponents assert that ORVs have the potential to negatively impact ichthyoplankton (larval fish and eggs) populations through entrainment, e.g. organisms being sucked into the water intake and subject to thermal shock; or impingement, e.g. organisms trapped against the intake screens. Additionally, the seawater is chlorinated to prevent marine growth or bio-fouling inside the system, causing additional chemical shock to entrained organisms. Companies do mitigate for entrainment in the design phase by limiting intake rates and using wedgewire (or other) screens, however the Gulf of Mexico Fishery Management Council believes that the cumulative impacts of several LNG terminals will contribute to the decline of harvestable stocks by fishermen and affect the sustainability of some managed species (Morris 2005). For Shell's ORV-approved Gulf Landing LNG terminal, the equivalent yield potentially lost to ORV was estimated to be 1-3 % of total landings (commercial & recreational) for red drum, and <1% of commercial landings for gulf menhaden and red snapper (USCG 2004).

The alternative regasification process is a closed loop system, such as submerged combustion vaporization (SCV). SCV is a process where combusted fuel gases, consisting of either a portion of the regasified natural gas or diesel, are sparged into a submerged water bath to vaporize LNG (Yang & Huang 2004). While the use of SCV would reduce the entrainment of marine species and the thermal effect of the discharged water, there are other environmental considerations. Increased air emissions of NOx, CO, and CO_2 are associated with SCV, although environmental analyses conducted to date do not suggest them as a significant source of pollution to the marine environment.

Perhaps the most outspoken opponents of ORV development in Louisiana are recreational and commercial fishermen and environmental organizations. For example, the Gulf Restoration Network, Sierra Club, the Louisiana Charter Boat Association, and their counsel from the Tulane Environmental Law Clinic have filed a Petition for Review concerning Shell's approved ORV use on its Gulf Landing terminal offshore Louisiana (Sarthou & Viles 2005). Similarly, the Coastal Conservation Association, when commenting on Conoco Phillips' proposed Compass Port LNG terminal, expressed concerns over ichthyoplankton impacts and continued access to popular hard-bottom fishing grounds. A list of organizations that have opposed open-loop terminals in the GOM, as of August 2005, can be found at http://louisiana.sierraclub.org/lng.asp. The outcome of these actions remains undecided, but the argument is being framed as one of economics versus the environment. For instance, Shell estimated the increased costs of converting its ORV-approved Gulf Landing LNG terminal would run approximately $20 million to $43 million annually, and would burn 1.2 to 1.6 percent of its imported LNG (USCG 2004). That is $321 million to $670 million worth of fossil fuel over the thirty-year life of proposed terminal (USCG 2004).

Very recently, an evaluation commissioned by the Center for LNG of the technical work assessing the environmental impacts from LNG in the GOM has just been completed (Nielson et al. 2005). The objectives of this study was review and assess the uncertainty and scientific validity of key assumptions used to estimate information on life history and prediction of losses for key species. Nielson et al. (2005) concluded the EIS assessments contained numerous conservative assumptions that significantly over-estimate the potential for adverse impacts from offshore LNG projects. For example, the impact of the ORV-approved Gulf Landing LNG project was estimated to be equivalent to the loss of 8 mature female redfish. Similarly, industry sources reported that cumulative impacts from LNG projects in the Gulf region were found to be smaller as well (but see also OilOnline 2006). The implication of this study is still being evaluated.

Hybrid systems and technological solutions

Hybrid regasification systems, which use both open and closed loop systems simultaneously, are emerging as a possible technological solution in lieu of the environmental concerns surrounding ORVs and the economic consideration given to SCVs (MacDuffee & Delgado 2005). Similarly, Mustang Engineering has developed a proprietary ambient air vaporization process called LNG Smart™. The LNG Smart™ technology has the potential to reduce fuel gas consumption and NOx and CO_2 air emissions by as much as 90%, when compared to conventional SCV technology (Mustang Eng. 2006). The process can also be used in lieu of ORVs, reducing the potential harmful effect on marine life. Mustang's process also yields a large amount of fresh water as a byproduct, which can be treated to become potable.

However, for both ORVs and SCVs, additional impacts on coastal and marine resources exist, including increased turbidity and marine mammal collisions due to LNG carrier traffic, increased construction activities, and increased ship-channel dredging (MacDuffee & Delgado 2005). Although the United States has a strong demand for energy and LNG may supplement our nation's energy shortfalls, the federal government, industry and others involved in the LNG licensing process should proceed cautiously to ensure there is a balance between economic needs and the protection of coastal and marine resources.

References

Delano, F., G. Gulen, and M.M. Foss, 2003. Introduction to LNG: An overview on liquefied natural gas (LNG), its properties, the LNG industry, safety considerations, Institue for Energy, Law & Enterprise, University of Houston, Houston, TX. Retrieved on February 6, 2006, from http://www.beg.utexas.edu/energyecon/lng/documents/IELE_introduction_to_LNG.pdf.

Energy Information Administration (EIA), 2005. International Energy Outlook 2005, Office of Integrated Analysis and Forecasting, U.S. Department of Energy, Washington D.C. Retrieved on February 7, 2006, from http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2005).pdf.

MacDuffee, D., and P. Delgado, 2005. Liquefied Natural Gas: A primer on needs, regulations, environmental implications, and trends. The Coastal Society 27(3): 1, 4-5, 11.

Morris, J., 2005. Letter to Maritime Administration Jamian, April 05, 2005. Retrieved on February 6, 2006, from http://dmses.dot.gov/docimages/pdf92/334910_web.pdf.

Mustang Engineering, 2006. Retrieved on February 7, 2006, from http://www.mustangeng.com/content.aspx?midstream_LNGSMART.

Nielsen, R.D., T.C. Ginn, L.M. Ziccardi, and P.D. Boehm, 2005. An evaluation of the approaches used to predict potential impacts of open loop LNG vaporization systems on fishery resources in the Gulf of Mexico. Exponent, Inc., Washington, DC. Doc. No. BN02922.001 01F1 1005 DN21. Retrieved on February 6, 2006, from http://www.lngfacts.org/newsroom/Eval-OLV.pdf.

OilOnline, 2006. Offshore LNG project impacts on marine life assessed to be minimal. Retrieved on February 6, 2006, from http://www.oilonline.com/news/headlines/internet/20060117.Offshore.20116.asp.

Sarthou, C. and A. Viles, 2005. Sierra Club, Gulf Restoration Network, and Louisiana Charter Boat Association Ask Federal Court to Overturn Permit for Imported Liquefied Natural Gas Facility Because It Will Harm Louisiana's Vital Fisheries. NEWS RELEASE, Gulf Restoration Network, New Orleans, LA. Retrieved on February 7, 2006, from http://healthygulf.org/fisheries/LNG/PressRelease041505.htm.

U.S. Coast Guard (USCG) 2004. Final Environmental Impact Statement (FEIS) for the Gulf Landing LLC Deepwater Port License Application, USCG-2004-16860, available at http://dms.dot.gov.

U.S. Commission on Ocean Policy, 2004. An Ocean Blueprint for the 21st Century. Final Report, Washington, DC. ISBN#0-9759462-0-X.

Yang, C.C., and Z. Huang, 2004. Lower emission LNG vaporization. LNG Journal November/December, 24-26.

Justin E. Farrell
Louisiana Sea Grant College Program
212 Sea Grant Building
Baton Rouge, LA 70803, USA
Ph (225) 578-6348
Fax (225) 578-6331
E-mail: jfarrell@lsu.edu