

# Depth Charge

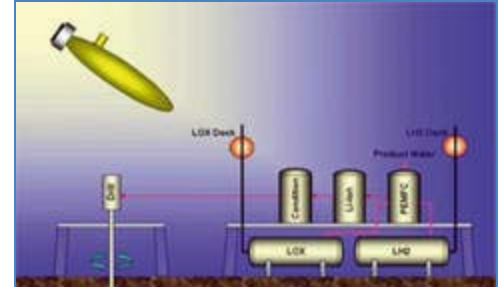
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There's a business case to be made for seafloor power generation at deepwater Gulf of Mexico oil fields. Now a Houston-based research team is looking at the technological possibilities, along with the considerable challenges. **Russell McCulley** reports.

With oil & gas production moving into deeper water and more operations being carried out further from a field's surface facilities, operators increasingly are incorporating subsea production systems in development schemes. In time, scientists say, most operations will be carried out on the sea floor, including the power generation needed to operate subsea equipment. But little work has been done so far to determine how such power generation systems will look.



Late last year, a team led by the Houston Advanced Research Center (HARC) started laying the foundation for the development of seafloor power systems. The project, funded in large part through the federal government's Energy Policy Act of 2005, is still in the very early stages, says HARC senior research scientist Richard Haut. 'We're still in a data gathering mode. Our goal, within the first year, is to identify two or three concepts' from a wide field of technologies, come up with plans for prototypes and gain an understanding of the environmental impacts of the finalists, he says. 'Right now, we are still identifying' which technologies are good candidates, he says. 'We haven't yet started to narrow the field.'

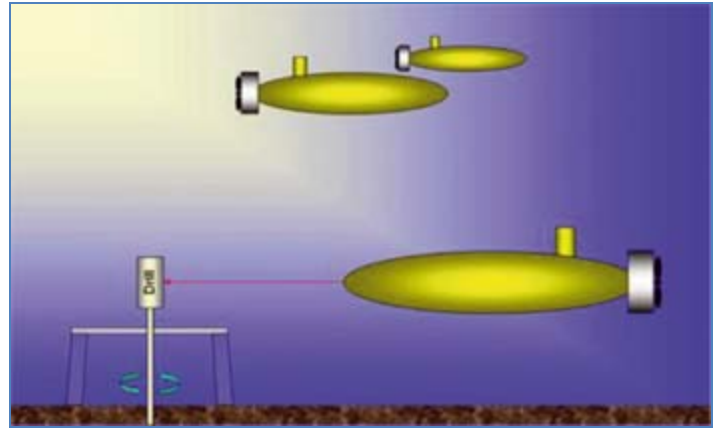
Haut, who chairs the environmental advisory board for the Research Partnership to Secure Energy for America (RPSEA), a consortium of industry, academic and independent research programs, says the point is to eliminate the need for extensive – and expensive – umbilicals used to supply power and hydraulics to subsea fields located miles from their surface facilities. 'What we are trying to do is completely do away with the umbilical,' he says. 'How can you, first, eliminate all hydraulic functions' – including the development of an electric downhole safety valve, which some service companies are attempting – 'and what about chemical injection? If you think about the amount of power that these systems will need, you're looking at some huge cables needed to transport that amount of power great distances.'

The technologies that make the final cut will have to be capable of generating considerable energy. Oil companies with extensive deepwater operations are looking for systems that can generate between 10MW and 30MW, Haut says. 'That's getting up there, in terms of power.' Whatever system emerges from the HARC study will be a hybrid that combines both energy conversion and storage capabilities, and the list of options to be screened includes both power generation and advanced battery systems. Researchers are looking at existing technologies, but as Haut notes, 'nothing has been designed yet to function in 10,000ft of water.'

Along with HARC, the research team includes experts from Lawrence Livermore National Laboratory, the Naval Facilities Engineering Service Center, and Yardney Technical Products, which has done extensive work developing battery systems for NASA and the US military. The Curtiss-Wright Corporation and GE have signed on to the effort, along with supermajors Chevron, Shell and Total. The budget for the initial four-year phase of the project is \$600,000, which

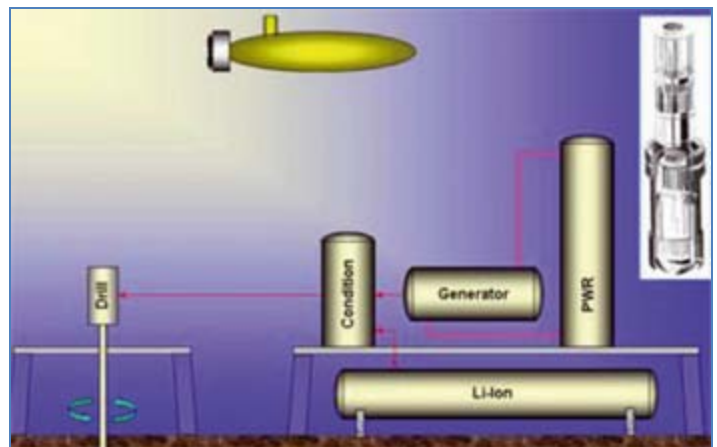
includes a 20% contribution from industry sources. A second phase, if the program can secure the estimated \$16-\$18 million needed to continue, will entail the design, fabrication and testing of prototypes.

An April status report listed the power conversion technologies under consideration: proton-exchange membrane fuel cells powered with hydrogen and oxygen; fuel cells, internal combustion engines or turbines powered by natural gas produced at the subsea site; solid state thermoelectric and thermionic generators powered with natural gas, geothermal sources and radioisotopes; surface renewable energy sources such as solar, wind and wave power; ocean current-powered turbines on the sea floor; and small pressurized water nuclear reactors, also known as PWRs, that can use low-enrichment fuel.



The report offered initial assessments of the potential power sources, downplaying surface renewable sources (although wind could be used as a 'transition' technology that takes advantage of existing infrastructure while subsea systems are being developed). It also offered encouraging notes on natural gas-powered fuel cells and – although researchers acknowledge that public perception could be problematic – nuclear power. Haut says the team has taken interest in small nuclear reactors under development at Toshiba. The company hopes to have a 10MW compact nuclear power system that can operate for up to 30 years without refueling ready for commercial distribution within the coming decade. 'We will be taking a close look at those devices and see if they can be marinized,' Haut says.

The HARC team is also investigating a number of energy storage strategies, including compressed gas storage; liquid redox batteries; secondary batteries in sealed pressure vessels; pressure-tolerant secondary batteries; and other nonconventional battery systems, including oil-compensated polymer gel lithium ion, polyurethane potted polymer gel lithium ion and next generation solid state lithium ion batteries.



Haut says the prototype subsea power system will likely be a combination of technologies, and that other hurdles beyond power generation remain. 'One question is what the electrical connections will look like,' he says. 'High-power connections, in saltwater, under pressure – that's a major technical element that needs to be addressed.'

If the project proceeds, the first deepwater subsea power generation system to emerge from the HARC effort would likely be deployed in the Gulf of Mexico, Haut says. But research, development and permitting could take 15 years or more. 'This is not something that will be put in the water in five years,' he says. 'It will be quite some time.' OE

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**by: Russell McCulley**