RENEWABLE ENERGY SOLUTIONS: EMERGING TECHNOLOGIES TO WATCH

How will clean energy policies and markets impact the development of the competitive energy business in North America? The outcome remains uncertain, but new technology to meet the challenge of providing clean, renewable energy is not waiting for regulators to agree on new policy initiatives and market incentives. Throughout Europe and North America, growing demand for cleaner, renewable energy and for greater energy security are driving development of promising new technologies. Innovative ideas are being studied and tested, bringing to light emerging new solutions not only for providing cleaner electricity, but also for improving the reliability of existing renewable technologies through energy storage.

BY LIZ HICKS AND KARIN CORFEE, KEMA

KEMA is at the forefront of developments that offer much promise for our energy future. A global company that specializes in business and technical consulting, operational support, measurement and inspection, testing and certification, KEMA has already supported and enhanced the development of renewable energy in Europe by applying its expertise to the challenges facing today's energy players.

Established in the Netherlands in 1927, KEMA now supports the diverse needs of energy clients worldwide. The company focuses much of its work on developing innovative strategies that produce cleaner energy, renewable energy market research and policy analysis, and on new approaches to deliver and use energy more efficiently. KEMA's long-standing reputation as an independent organization, and its reputation for testing and certification of many electrical products and high-voltage components, enables the company to provide trusted technical solutions, strategic advice, and insight into many energy issues.

INNOVATIVE ENERGY STORAGE TECHNOLOGIES

KEMA is engaged in a U.S.-based project for Beacon Power to evaluate performance and life

cycle costs of a 20 megawatts flywheel-based power plant designed to perform frequency regulation ancillary services in three independent system operator (ISO) markets.

KEMA developed a model to compare the life cycle cost of a flywheel plant with four types of commercially available fossil power generation technologies used to perform frequency regulation services, as well as with a lead acid battery storage system functioning similarly to the flywheel system. Results of the analysis show that flywheel-based regulation can be expected to have significantly lower life cycle costs (LCC) compared to several competing technologies studied. The modeling also examined CO_2, SOx, and NOx emissions and demonstrated that flywheel-based frequency regulation can be expected to create significantly lower NOx and SO_2 emissions.

Several European energy storage projects in which KEMA is involved may also have useful applications in the North American market. One of these, the Redox Flow battery, presents an interesting alternative to traditional pumped or compressed air energy storage. The Redox Flow technology combines an electrode and catalyst assembly with a membrane electrode assembly into one operational system. It is anticipated that this type of storage technology can assist in the integration of small-scale, sustainable generation units into the distribution network while maintaining power quality.

Another European storage project involved transportable storage systems. Transportable storage provides a flexible asset for network management, introducing possibilities for deferral of investment in expensive switchgear and avoidance of stranded assets. KEMA is part of a European consortium for the Sixth Framework Program, a demonstration project using transportable and flexible storage systems with participation from France, the Netherlands, Poland, Italy, Cyprus, Germany and Spain. Storage systems will be evaluated at five sites using a technical/economic assessment tool, which includes intelligent prediction software. Each storage system will be tested at a minimum of two sites, to assure that the storage systems can be successfully transported and operated.

TAPPING INTO THE POWER OF BLUE ENERGY

A promising renewable energy technology, Blue Energy, is derived from harnessing the physical and chemical differences between fresh and salt water. Like osmosis, the process uses membranes. However, instead of using pressure to create energy, Blue Energy relies on reverse electrodialysis.

KEMA is currently testing this technology in the Netherlands and believes that Blue Energy has the potential to generate ten times more power than currently generated in the Netherlands from wind farms. This capability would have significant environmental benefits, since no greenhouse gases are released in generating the electricity. This technology has enormous potential for other countries rich with river deltas, such as Brazil, China and Bangladesh.

WHAT IS BLUE ENERGY?

Blue Energy is the name given to electricity produced by harnessing the difference between fresh water and salt water. It requires two types of membranes, one that is selectively permeable for positive ions and one that is selectively permeable for negative ions. Salt water that is separated from fresh water between two such mem-

TECHNICAL ILLUSTRATION BY RUDOLF AND ROBERT DAS.

The Energy Island in the Netherlands and Europe works by incorporating pumped hydro storage in an inverse offshore pump accumulation station (IOPAC).

branes will lose both its positive ions and negative ions. This charge separation produces a potential difference that can be used directly as electrical energy.

The technology's key material is special membranes made from the electrical modification of plastics. Thanks to recent advances by KEMA in the electrical modification of plastics, the special membranes needed for Blue Energy now can be made economically. The new application of KEMA's electrical modification method to the production of ion exchanging membranes means that Blue Energy is becoming more affordable. While prices do need to fall further and the membrane quality needs further improvement before the technology becomes truly economically feasible, advances in this technology provide exciting insight into the possibilities of our energy future.

HOW DOES BLUE ENERGY WORK?

Fresh water naturally tries to mix with salt water. Fresh and salt water can be placed in adjacent tanks separated by the special membranes. Once the fresh water has passed through the membranes, it will not flow back the other way, leaving potential energy that can be tapped with a water turbine.

Blue Energy plants could be created at every river mouth. Best applications of this technology are in coastal areas such as the

Netherlands, India, or Bangladesh. Plants can be situated at sites where fresh water floats into the sea or at industries with salt waste water streams. It is anticipated that plants of 25 megawatts and greater could provide energy at a cost that is roughly equal to the cost of offshore wind. Larger plants may be able to achieve even lower costs, especially if a concentrated salt solution such as brine is available.

KEMA is currently developing a plant composed of multiple modules with a total capacity of 250 kilowatts, to be initially located at a coastal test site.

ENERGY ISLAND HARNESSES OFFSHORE WIND ENERGY

Another new concept, the Energy Island, is generating much interest in the Netherlands and Europe. Designed by KEMA, Lievense and the Das brothers, the concept incorporates pumped hydro storage in an inverse offshore pump accumulation station (IOPAC).

HOW DOES THIS WORK?

When there is a surplus of wind energy on the Energy Island, the excess energy is used to pump sea water out of the interior 'subsurface-lake' into the surrounding sea. When there is a shortage of wind power, sea water is allowed to flow back into the interior 'lake' through commercially available generators to produce energy. The IOPAC is unique compared to conventional pumped hydro storage systems in that it would be stationed on an artificial island off the Dutch coast in the North Sea and composed of a ring of dikes surrounding a 50-meter deep reservoir. The island itself would be built from materials dredged to deepen the interior reservoir.

KEMA analysis estimates that the proposed Energy Island storage system would have a maximum generation capacity of 1,500 megawatts, depending on the water level. The system also would have an annual storage capacity of more than 20 gigawatt hours – enough energy to offset 500 to 840 kilotons of CO_2 emissions. KEMA will soon conduct further analysis of the costs and benefits of additional regulating reserve, download wind power, CO_2 reduction, and environmental impacts.

The combination of electricity storage and offshore wind energy provides synergies. Electricity storage is a well-established practice that offers considerable added value for the energy sector. Storage increases the technical reliability of the power supply, stabilizes the cost of electricity, and can help to hold down CO_2 emissions. Investment in large-scale storage can substitute for investment in the replacement or new development of peak production capacity. The integration of electricity storage within the power supply has numerous environmental benefits, particularly if storage is combined with wind-powered generating capacity on a large scale.

The first phase of an ongoing feasibility study recently concluded that the Energy Island is an attractive and technically feasible renewable energy option. In the next phase, KEMA will participate in a detailed location study to investigate technical capabilities, and economic and ecological viability.

WHAT TOMORROW'S TECHNOLOGIES MEAN FOR TODAY'S UTILITIES

There are many commercially viable energy storage and renewable energy options available to utilities today. In addition, there are numerous exciting renewable energy solutions currently under development that may be commercially operational within the next decade. Today's utilities are looking to develop comprehensive strategies to incorporate clean technologies, renewable energy and the efficient delivery and use of electricity.

KEMA brings together a strong understanding of the best available clean technologies as well as the most promising emerging technologies to help utilities plan their future energy portfolios. This expertise is combined with extensive experience in electric power grid operations, renewable energy project development and grid integration, a deep understanding of the current state of energy infrastructure, comprehensive experience with integrated resource planning, and expertise in evolving regulatory policies. KEMA offers services and solutions that address the complex issues of developing renewable energy in a rapidly changing environment.

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