Developing a Position on Nuclear Power

AIChE's Nuclear Engineering Division recommends expanding the role of nuclear power and closing the nuclear fuel cycle.

In March 1979, the American Institute of Chemical Engineers published a policy statement in *Chemical Engineering Progress* supporting the reprocessing of spent nuclear fuel (SNF) and disposing of the waste in a geologic repository. AIChE concluded that viable technical solutions already existed at that time for the problems of high-level nuclear waste disposal and that government uncertainties were the source of delay.

Thirty years later, little expansion of nuclear power has occurred, even though continually improving safety and economic viability have been demonstrated. During this period, disposal of high-level nuclear waste has remained a government responsibility, but, with the rejection of the Yucca Mountain plan, a long-term spent-fuel disposition pathway has not been defined. As a result, there is no current high-level waste-disposal repository under consideration, nor is there an operating commercial nuclear-fuel recycling facility.

Today, the threat of global climate change and the United States' reliance on imported energy sources presents an opportunity for which nuclear power has become increasingly attractive for baseload electricity generation.

In 2009, AIChE's Nuclear Engineering Div. (NED) revisited its policy on nuclear power and the fuel cycle. This article presents the result of the investigation to the Institute at-large.

Wanted: Your Input

The Nuclear Engineering Div. is working with AIChE's Government Relations Committee to develop a position statement on expanding nuclear energy. Before it can become an official AIChE position, it must be presented to the AIChE membership to solicit members' comments, which is the purpose of this article. (Note that this article reflects the views of only the Nuclear Engineering Div., *not* AIChE.)

AIChE members are invited to comment on this draft position statement. Write to Stuart T. Arm, the 2009 chair of the Nuclear Engineering Div., at starm@energy-solutions.com, and join the online discussion at http://chenected.aiche.org.

Expanding the application of nuclear power

The Nuclear Engineering Div. fully supports the expansion of nuclear power in the U.S. as a key component of the nation's drive toward a low-carbon economy.

In 2007, the U.S. consumed 10^{13} kWh of electrical energy and emitted 6 billion m.t. of carbon dioxide. By 2030, U.S. electricity demand is expected to increase by 26%. Any associated carbon emissions are likely to increase in cost due to probable cap-and-trade legislation.

As a result, the U.S. will need cost-competitive, reliable, "carbon-free" energy-generation technologies to play an increasing role. This will require a combination of improved energy efficiency, increased use of renewable generation technologies, and expanded nuclear power to meet projected demand while also significantly reducing CO_2 emissions.

Nuclear power currently accounts for 20% of the total electrical energy produced in the U.S. and 70% of its carbon-free electricity production. Replacing nuclear power's share of total electricity production would require an additional 27 GW of generating capacity. If this electricity comes from new natural-gas- and coal-fired plants, an additional 100–400 million ton/yr of CO_2 would be emitted to the atmosphere. This represents about 10–40% of President Obama's 1-Gt mid-term (2020) carbon-reduction goal.

Nuclear power also has the potential to reduce emissions more than other apparently carbon-free sources on a

lifecycle basis. A 2006 German study *(1)* concluded that the environmental impact of nuclear power, including mining, transportation, enrichment, and use, presented one of the lowest carbon footprints of all electricity generation resources, second only to that of wind turbines.

Nuclear power has been shown to be the lowest-cost option for new, low-carbon electricity generation based on current resources, according to the U.S. Energy Information Administration's *2010 Annual Energy Outlook*. Nuclear power is typically about 6–13% more expensive than generation using coal or natural gas. However, the imposition of a penalty or tax on carbon emissions, such as under a cap-and-trade scheme (which is already used in Europe and is being considered in the U.S. and elsewhere), would improve the cost-competitiveness of nuclear power. Implementation of carbon capture and sequestration would also significantly increase costs for new coal and gas plants.

Although solar and wind energy will both provide an increasing share of the nation's electricity-generation capacity going forward, their intermittent nature (without massive electricity storage) and intense land-use requirements put a premium on stable, carbon-free baseload electric power production. With opportunities to develop additional hydroelectric power limited, nuclear generation is the remaining commercially proven, large-scale, greenhouse-gas-emissions-free option for baseload electricity.

This position on expanding nuclear energy use is consistent with that of the American Nuclear Society (ANS), described in its Position Statement 44 (www.ans.org/pi/ps/docs/ps79.pdf).

Closing the nuclear fuel cycle

The Nuclear Engineering Div. supports closing the nuclear fuel cycle to sustain the peaceful growth of nuclear power.

The U.S. currently practices a once-through, or open, fuel cycle, whereby SNF will be permanently disposed of in a geologic repository. The cancelled Yucca Mountain repository, as designed, would have held the existing inventory of spent fuel. However, expanded implementation of nuclear power would require additional repositories of that scale, or a much larger repository, if the U.S. continues with an open fuel cycle. Implementation would likely present significant economic, technical, and political challenges, given the experience with Yucca Mountain.

In a closed nuclear fuel cycle, SNF is processed to recover constituents that can be recycled in nuclear reactors to produce more energy. Having a closed nuclear fuel cycle benefits the nation in several ways.

First, it is sustainable. Recycling SNF can provide a reliable domestic source of nuclear fuel and minimize waste generation. As nuclear power expands globally, fuel production may not meet demand, even if current forecasts of sufficient uranium ore production prove to be accurate.

In addition, it is environmentally responsible. After recovery of uranium and other actinides for recycle, the residual radioactivity is contained in about 10% of the original volume, and environmental risks are reduced. This high-level waste should still be deposited in a geologic repository, but the reduced environmental risk compared with the original used fuel is such that perhaps only one repository (of Yucca Mountain scale) would be required this century. The high-level waste will decay to the same radiotoxicity as uranium ore within 1,000 yr, compared with 300,000 yr for unprocessed SNF.

Some regard recycling of SNF as a risk because of its perceived potential to increase the proliferation of nuclear weapons and other homeland-security issues. This opinion originally led the U.S. to abandon SNF recycling under the Carter administration in 1977. International and domestic monitoring of nuclear facilities in nations fully complying with the Nuclear Non-Proliferation Treaty for the past several decades has demonstrated that safeguards against the clandestine diversion or theft of nuclear material and technology are effective. The Nuclear Engineering Div. believes that by closing the nuclear fuel cycle, the U.S. can assume a position of technical leadership and contribute to a strengthening of international nuclear safeguards.

This position on recycling SNF and development of a geologic repository is consistent with that of the ANS and its Position Statement 45 (www.ans.org/pi/ps/docs/ps45.pdf).

In conclusion

The Nuclear Engineering Div. encourages the legislative and executive branches of government to work together to provide an economic, political, and regulatory environment that facilitates commercial and peaceful expansion of nuclear electricity generation, reprocessing of SNF, and development of a geologic repository for high-level waste as part of a closed nuclear fuel cycle. CEP

Literature Cited

1. **Fritsche, U. R., and S. Lim,** "Comparison of Greenhouse-Gas Emissions and Abatement Cost of Nuclear and Alternative Energy Options from a Life-Cycle Perspective," Öko-Institut e.V., Darmstadt, Germany (Jan. 2006).

Acknowledgments

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