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Advanced Reactors: The future of the nuclear power?

By Nuclear Energy Insider

With thanks to Phil Hildebrandt (INL)
and Amir Afzali (Southern Nuclear)

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Question 1: What do you see the key benefits to advanced reactor technologies?

Advanced reactors span the spectrum from adaptations of light water reactor technology for small modular reactor configurations to considerably different reactor technologies with alternative coolants such as gases, molten salts and liquid metals utilizing both "open" and "closed" fuel cycles. Compared to conventional nuclear reactor technologies, certain advanced reactors offer opportunities for intrinsic safety, improved economics for energy production and extending the use of nuclear energy from primarily electric power generation to the cogeneration of power and process heat for industrial applications. High temperature advanced reactor technologies, in particular, can displace the use of fossil fuels currently used for direct firing and production of high temperature process heat (e.g., as steam and/or gas). Over 20% of the global energy utilization beyond electric power is in the industrial sector. Nuclear energy cogeneration for industrial use provides the opportunity to be more environmentally responsible through reduction of greenhouse gas emissions and promotes improved stewardship of natural resources by reserving the use of fossil fuels for feedstock.

Question 2: What do you think needs to change in the industry to allow for the commercial deployment of advanced reactors?

Commercialization and deployment of advanced reactor technologies and utilization for cogeneration applications requires several changes, including:

Revised business model: The current nuclear energy industry primarily produces electric power. The potential economic and business opportunities of expanding the applications to cogeneration need to be realized.

Revised regulatory framework: In the United States, like in many countries, the regulatory framework has been matured around the widespread use of nuclear reactors utilizing light water reactor technology for power generation. The technical and policy requirements will need to be changed to accommodate advanced nuclear energy technologies and cogeneration applications.

Acceptance by energy intensive end-users: Effective utilization of nuclear cogeneration process heat for industrial applications can be expected to require collocation of nuclear energy facilities with industrial plants (e.g., petrochemical, petroleum and metals refining process plants). Collocation introduces new interactions between regulatory agencies having jurisdiction. Such collocation practically requires that the safety case for the advanced reactor technology does

not pose an unacceptable threat to the non-nuclear process plant investment under all foreseeable conditions.

Question 3: Just how flexible are advanced reactors and how important are the non-electric uses in improving their viability?

Nuclear reactors using conventional technologies are well understood options for energy production and are acceptably safe for generating electric power with a minimum of environmental impact. Conventional nuclear technologies for electric power generation provide a known business risk -- for which there is considerable successful operating, maintenance and licensing experience and for which there is confirmed economic performance. Advanced reactor technologies offer potential benefits in areas such as improved economics, additional margins of safety, improved utilization of fissionable materials and operating conditions that support cogeneration of process heat for industry. The extent and flexibility in achieving such potential benefits compared to conventional technologies varies by the specific advanced reactor technology. The opportunity to expand the use of nuclear energy to non-electric applications via concepts such as cogeneration is a central business factor for owner/operators to consider in moving away from conventional technologies to advanced technologies.

Question 4: How feasible is the concept of having a nuclear-renewable hybrid energy system? And what will this mean for the industry?

Determining the overall technical, economic and business model viability of nuclear-renewable hybrid energy systems is a work in progress. In the United States, for the US Department of Energy the Idaho National Laboratory, the National Renewable Energy Laboratory and the Oak Ridge National Laboratory are jointly finalizing a preliminary roadmap for component development and systems integration utilizing detailed modeling and analysis of nuclear-renewable hybrid energy systems. Integrated hybrid energy systems have the potential to help revolutionize energy services at the system level in a manner that optimizes the economics, maximizes overall thermodynamic efficiency, reduces environmental impacts, and provides resources for grid management. However, the relevance in future energy markets is not yet completely understood.

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Amir Afzali
Licensing Director – Next Generation Reactors
Southern Nuclear

What do you see as the four key benefits of Advanced Reactor technologies?

1. More than 100 times more energy yield from the same amount of nuclear fuel.

2. Broader range of fuels and even raw fuels. Also, in some reactors, the ability to consume existing nuclear waste.

3. Improved safety characteristics, such as low operating pressurize, passive core protection functions, fuels that do not melt, and non-dependence on water cooling which avoids risks of loss of coolant accidents.

4. Portfolio of capabilities, such as:

    - high process heat generation to support needs of other of industrial sectors (such as Chemical industry or oil refineries)

    - small (small enough to replace diesel generators) or large (larger than the current fleet) sizes to meet different needs.

    - Load following capability to be able to supplement renewables electricity generation sources such as wind and solar to provide reliable carbon free electricity.

How important is investment in Advanced Reactor Technologies?

If our commitment to carbon free affordable energy generation is to be taken seriously, we must deploy nuclear energy as a major source of energy generation. The world is expected to significantly increase its energy demand by an emerging middle class in the developing world and the need to bring electricity to world citizens who do not have it today. This demand for clean energy cannot be met without a more rapid deployment of safer and more economical nuclear power. The key to achieving improved safety and commercial competitiveness is innovation. Investment is the key enabler in creating the right environment for innovation. In short, to develop and deploy advanced reactors, we need "Dreamers, Doers, and Dollars". Dreamers need the Doers and the Doers need the Dollars. It is as simple as that.

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What do you think needs to change in the industry in order to achieve commercial deployment of advanced reactors?

- Graded Public-Private investment to allow risk retirement for development and deployment of the first of the kind reactors. Higher public investment during early phases of development and deployment which is gradually reduced as the technology and licensing risks are removed.

- Regulatory framework that ensures global safe deployment of the technology while reducing the burden on the innovators.

Can advanced reactors compete against renewable sources?

- The answer is yes and easily yes but it is not necessary for the advanced reactors to compete with renewables. These sources of clean energy are complimentary and together provide better more and better options for the world citizens.

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This report has been released in conjunction with…

The International SMR and Advanced Reactor Summit 2016
14-15 April, Atlanta Georgia

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- Discover the **alternative applications of SMRs and advanced reactor technology** for military, industrial, desalination and heating purposes
- Assess the **development of the leading advanced reactor technologies** in order to incorporate them into your nuclear deployment strategy
- **Build the international SMR supply chain** and become part of the modular build revolution

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