AREVA HTR: A process heat source to power many industrial applications

The most competitive vision for high-temperature process heat and hydrogen production in the future

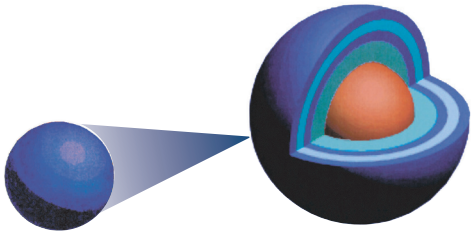
One of AREVA's long-term strategic initiatives is the development of fourth-generation nuclear reactors. Through its subsidiary AREVA NP is investing in a number of Gen IV projects, including the company's ANTARES Development Program. The ANTARES program is charged with creating a commercially competitive, advanced high-temperature reactor (HTR) for electricity production, as well as a variety of industrial applications requiring a process heat supply.

The AREVA HTR is a high-temperature heat source that:

- Can co-produce 300MWe/max 600MWth of electricity and heat up to 800°C/1,472°F
- Incurs lower fuel costs as a fraction of the operating costs compared to fossil fuels.
- Uses safe, clean, affordable nuclear energy —
  - Uranium ore price changes have minimal impact on production costs
  - Long-term production price stability is shielded from volatile fossil fuel costs
  - No CO_2 or greenhouse gas releases subject to potential future emissions taxes
- Optimizes resources through high-efficiency heat and power cogeneration — up to 90% depending on applications

AREVA HTR concept can serve a variety of process heat markets

HTR TRISO Fuel



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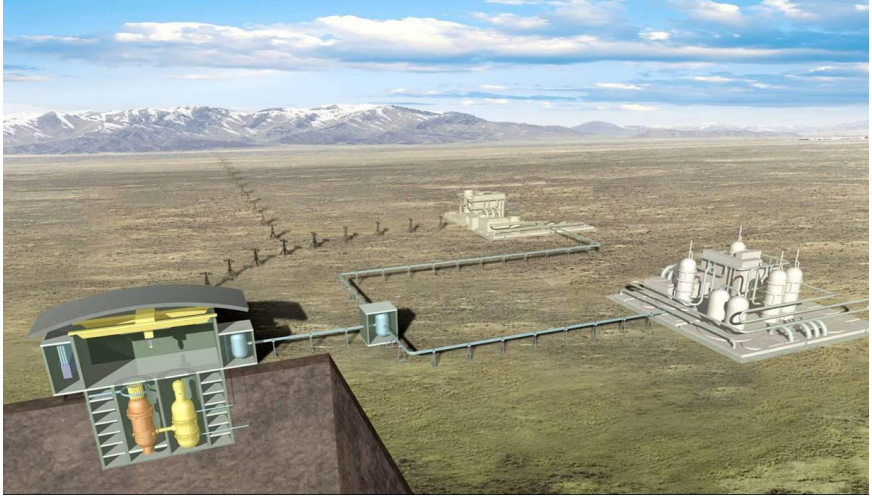

Courtesy of Idaho National Laboratory

BENEFITS

- No CO_2 emissions
- Efficient for producing both electricity and heat due to very high temperatures
- Diversification of energy sources increases energy independence and security
- More stable, predictable fuel costs than fossil fuels
- Adaptable to advanced fuel cycle, i.e., actinide burning

Applications for nuclear-generated process heat & electricity cogeneration

The indirect cycle design of the AREVA's HTR plant will be adaptable to industrial process heat supply and electricity generation, making it a versatile industrial nuclear heat source for a number of applications, including the following:

Petroleum Industry: Extraction and refineries

- Tar sands and heavy oil recovery — The AREVA HTR can provide the required high-pressure steam for field steam injection and the power for pumps used to extract the oil. It can also provide power for hydrogen production needed to upgrade the oil.
- Refining heavy oil with heat and hydrogen

Chemistry Industry

- Fertilizer
- Coupled Cl_2 and PVC chemistry

Coal Industry: Reducing CO_2 during the fabrication of synthetic fuels

- Synthetic gas production — Similar to coal liquefaction, coal gasification could bring independence from imports and decrease natural gas usage in various productions such as methanol and ammonia. Using nuclear heat to produce synthetic gas rather than fossil heat, virtually eliminates the production of CO_2 in that phase of the process.
- Coal liquefaction — Using the AREVA HTR to convert coal into synthetic oil optimizes such production while preserving the environment. In the U.S. with large coal deposits easily accessible, a substantial substitution for oil imports could be achieved.

Hydrogen production

In the short term, the AREVA HTR can be used as an external heat source for steam methane reforming, thus avoiding the use of natural gas as a fuel and reducing CO_2 emissions by one third. In the long term, the HTR will provide advanced hydrogen production from water splitting.

Other process heat applications include:

- Steel production
- Paper manufacturing
- Water desalination
- Any large use of both heat and power that would avoid the burning of gas or oil and the CO_2 emissions associated with that.

High Temperature Reactor Programs

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