Pathway to Arizona's Nuclear Future – 14235

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AEEFC

ABSTRACT

The Arizona Energy Education Fund Coalition (AEEFC), a 501(c)(3) non-profit entity, is an assembly of stakeholders from the private sector, government, education and energy industries dedicated to supporting K-12 (kindergarten through 12th grade), community colleges and universities through an enhanced program of smart nuclear generator expansion, isotope production, testing of breeder reactor power plants, recycling spent nuclear fuel in power generation facilities, and monitored retrievable storage systems in Arizona.

AEEFC priorities are to collaborate with stakeholders in Arizona to develop safe plans that will make Arizona the most nuclear friendly state benefiting all stakeholders, first of whom are students and citizens. Long term plans will include:

- Production of isotopes replacing Canada's Chalk River reactors which are scheduled for decommissioning.
- Advanced testing of breeder reactors that use a greater fraction of the available energy content of the nuclear fuel.
- Education of K-12 students as well as the general Arizona population so that they fully understand the benefits and safe use of nuclear power. Support by the local population is critical to nuclear development.
- Development of nuclear engineering programs in Arizona universities to drive the development of the next generation of nuclear power plants.
- Supply of nuclear generated electricity to California and Sonora, Mexico in exchange for water.

Arizona's location advantages are the lack of earthquakes, hurricanes, tsunamis, floods or frigid weather. Interstate highways and railroads are well developed and provide good access to many potential development sites.

INTRODUCTION

In 2010 the executive branch of the federal government rejected Yucca Mountain for long-term nuclear storage. The Blue Ribbon Commission on America's Nuclear Future [1] was established to lay out the concepts for waste management. For the next 20 years or more the power generators will likely continue to store spent nuclear fuel even though the federal government is responsible for the fuel's disposal pursuant to the Nuclear Waste Act of 1982.

The Department of Energy (DOE) and companies generating electricity using nuclear power have not prioritized or programed recycling spent fuel rods and they plan on storage systems for

the next 20 years or more. AEEFC is interested in supporting the testing and development of plants that can more fully consume nuclear fuel and reduce the need to recycle spent fuel assemblies. This type of technology is currently being developed by TerraPower as well as General Atomics and others. AEEFC supports the siting of these next generation power plants in Arizona in full compliance with state and federal laws as well as international "best practice" for such test reactors.

The Blue Ribbon Commission report emphasized the importance of community education and alignment prior to any successful waste management projects [2]. With the assistance of Arizona State University (ASU) and its Decision Theater, great progress can be made. ASU and the AEEFC are focused on funding education through nuclear development as well as providing a sound basis for education of Arizona residents.

DISCUSSION

Use of the Decision Theater

Arizona State University (ASU) has developed the "Decision Theater" which is a powerful modeling center to aid in planning and management of large, complex programs and projects for use in the examination of the markets. It is comprised of a panorama of monitor screens powered by sub-models that interact as a whole. The results of parameter input changes are instantly shown on the screens aiding the planning process in real time.

AEEFC intends to secure funding for the use of the Decision Theater and ASU's W.P. Carey School of Business to model and project the economic, environmental and social impacts of expanded nuclear power generation, temporary storage of spent fuel rods, as well as longer term development of recycling technology and temporary or permanent storage of vitrified recycle residue in one of Arizona's salt deposits. The Decision Theater has completed many projects for Arizona including water and power studies which contribute to their capability for mapping the Pathway to Arizona's Nuclear Future. Ultimately, AEEFC intends to work with the Decision Theater and interested corporate partners to produce a resource that could be used by public and private decision makers to examine the issues, challenges and benefits of locating nuclear development sites in Arizona.

Having K-12 and university partners in development of the plan as well as execution will be key to development of support for nuclear facilities.

Population and Power Growth in Arizona

Similar to the nation as a whole, coal is used to generate about 38% [3] of Arizona's electric power. The current federal administration would like to further restrict the use of coal to reduce greenhouse gas emissions and improve air quality. Wind and solar are not an acceptable substitute for base load generators on the power grid for obvious reasons; the sun and wind are intermittent, not to mention the capital and operating cost of wind and solar power generation for supplying base loads.

Arizona is projected to grow significantly in the coming years. Over the past 40 years the population in Arizona has increased an average of 40% every 10 years and is projected to increase between 40% and 80% during the next 30 years [4]. With a 60% increase there will be an additional 4,047,000 people in Arizona in 2043. The average Arizona resident uses 0.473 [5] cubic meters of water per day so an additional 1.924 million cubic meters per day will be required just for residential use by 2043. To produce this from saltwater at 6 kWh/m^3 [6] would require a 500 MW power plant operating continuously. Residential electricity consumption is about 5000 kWh per day in Arizona so the additional 4 million people would need a 4000 MW power plant operating continuously just for residential electricity consumption.

Mining, manufacturing, transportation and agriculture all require plentiful, low cost electricity to thrive and grow.

During the next 15 years Arizona power producers will handle power expansion needs through the construction and operation of natural gas fired power plants [7]. Natural gas pipelines are already planned to supply Sonora, Mexico with natural gas from pipelines in Arizona. Railroads are retrofitting locomotives to burn natural gas. Natural gas appears plentiful and low cost now but it will have limits at some point and nuclear power will be in much higher demand.

Bartering nuclear power for water

The population of the entire southwest United States as well as northern Mexico will continue to grow. More water will be required as noted above. Desalination plants are most efficient when they are located near the source of salt water. AEEFC supports the export of some additional nuclear power generation to California and Sonora, Mexico in exchange for their share of Colorado River water which will be used for the growing population of Arizona.

Solving the Spent Fuel Rod Storage Issue

In 2010 the federal government rejected Yucca Mountain for long term nuclear storage. The Blue Ribbon Commission (BRC) [8] on America's Nuclear Future was established to lay out the concepts for waste management. For the next 20 years or more the power generators will likely continue to store spent nuclear fuel even though the federal government is responsible for the fuel's disposal pursuant to the Nuclear Waste Act of 1982.

The DOE does not have a replacement for Yucca Mountain and is being sued successfully by power producers who have to store spent fuel assemblies at each power plant. Long term storage continues to be an unresolved problem. Light water reactors use less than 5% of the energy in a fuel rod before it is classified as depleted. To fully utilize the energy requires the use of a breeder reactor. Though no commercial breeder reactors have been licensed or built in the U.S. to utilize all of the potential power in a spent fuel rod, the price of uranium may rise or the cost of storage may rise to the level where design and use of breeder reactors is economic.

On June 17, 2009 Dr. Alan Hanson of AREVA testified before the House Committee on Science and Technology stating that only 4% of the used fuel mass is high level waste (HLW) [9]. The French vitrify HLW produced from 40 years of operation of its nuclear reactor fleet. The HLW contains virtually no fissile material, is very stable and resides in a building with a footprint that is less than two American football fields.

AREVA commissioned the Boston Consulting Group (BCG) study [10] that concluded the cost of recycling and the storage of vitrified high level waste is virtually equal to the cost of direct disposal of spent nuclear fuel in a Yucca Mountain-like repository. The BCG used proprietary data supplied by AREVA, including the use of the COEX separation process to support the study.

Both TerraPower and General Atomics are in the process of engineering breeder reactors for future testing, permitting and use. Since these concepts are not developed, tested or permitted, it is impossible to tell what level of reprocessing would have to be performed on spent fuel rods to make them into acceptable feed for any breeder reactor. General Atomics estimates the residual power available in all U.S. spent fuel rods is …"approximately equal to 9 trillion barrels of oil, an amount equivalent to 1,800 years at current oil consumption of 16 million barrels per day" [11].

The spent fuel rod storage issue may be best solved by recycling. The most efficient recycling would be to make fuel rods designed specifically for use in breeder reactors. A breeder reactor using 80% of the fuel value in a new or recycled fuel rod would be 20 times more productive than a light water reactor using 4%. As noted above, the cost of a new fuel rod made from newly mined uranium is roughly the same as a recycled fuel rod. The fuel cost of breeder reactors might be about 5% of light water reactors.

Monitored Retrievable Storage Systems in Arizona

Arizona has many surface sites and several salt deposits that could become Monitored Retrievable Storage Systems near Kingman, Holbrook, Safford and Picacho Peak.

CONCLUSIONS

Creating Support from the Citizens of Arizona

Education about safe nuclear fuel and garnering support from the K-12 students and their parents in Arizona is a key part of the AEEFC plan to fund education through the future development of the nuclear industry in Arizona. Use of the ASU Decision Theater is another key for decision makers in Arizona.

Solving the Nations' Spent Fuel Rod Challenge

AEEFC encourages support for the development of breeder reactors to fully utilize the energy in nuclear fuel rods.

Bartering Nuclear Power for Water

For the foreseeable future Arizona will continue to need more water as the population continues to increase. Within a few decades breeder reactors will become less expensive and more efficient than light water reactors. They will begin to solve the recycling vs. storage issue experienced today. Arizona should benefit from a power for water barter agreement with Sonora and California.

Funding Education

AEEFC intends to provide additional funding for K-12 and university level STEM (science, technology, engineering and mathematics) programs through the nuclear development in Arizona.

Creating High Quality Jobs

Nuclear energy is the most environmentally friendly source of electricity. Arizona needs the high quality jobs that will be made available through nuclear development.

REFERENCES

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