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The Future of Nuclear Power in India

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Abstract
Developing countries face obstacles to meeting their growing energy needs without extensively contributing to global warming. A potential solution to this challenge involves the use of nuclear energy. In this project, we examine India as a case study because it has the fastest growing energy needs in the world. What hurdles must India overcome in order to successfully invest in an aggressive nuclear development program? Despite significant diplomatic and geopolitical concerns, nuclear power must contribute to India’s energy solution because of its high energy yield and low carbon emissions.

Project Goals/Objectives
• Examine India’s current growing energy needs, their dependency on fossil fuels, and their history concerning nuclear power that would affect a national investment in nuclear power
• Use India’s situation as a template for other developing nations to look at as an example for embracing nuclear energy
• To determine whether or not India has the technological and economic capabilities to follow through with their plans for major nuclear energy development
• Analyze the political ramifications of India becoming a nuclear power

Economics of Nuclear Energy
• Because of effective designs of power plants, cost of electricity generated by nuclear energy is competitive.
• Cost of nuclear fuel is low because of use of domestic thorium.
• Nuclear power is very economical if plants are built away from coal reserves i.e. in north-western, western and southern India.

Recent Political Issues
• Pakistan is demanding a U.S. nuclear deal because it believes that it is unfair that India has one and it does not. The United States and other members of the Nuclear Suppliers Group will not be dealing with Pakistan in the near future since its top nuclear scientist has recently given nuclear secrets to Iran, North Korea, and Libya. While it is true that both Pakistan and India tested nuclear weapons in 1998, India has not undergone nuclear proliferation.
• Within the Nuclear Suppliers Group, China was the greatest opponent to the Indian deal. China did not want a U.S. friendly nuclear power in Asia. It took a persuasive letter from President Bush to the President of China to have China’s Nuclear Suppliers Group diplomats approve the India waiver.

Conclusions/Recommendations
• India should choose nuclear power as a solution to its growing energy needs for four reasons:
  o Nuclear power has a high energy yield
  o Nuclear power has low carbon emission
  o India has extensive thorium reserves that can be used as nuclear fuel
  o Economically it is favorable to build nuclear plants in western parts of the country.
• If India would like to successfully grow its nuclear program, India must first acknowledge that the first step is to cooperate internationally and sign the Nuclear Non-Proliferation Treaty.
  o This would allow a discourse of information to be relayed between India and countries that have well-established nuclear power programs.
  o We can look to India as a example for other developing countries because India’s potential international cooperation will result in both a successful energy program and a solution to reducing carbon emissions.
  o India’s example will illustrate how cooperation between nations will be necessary to address global warming.

Key Points
India’s economy and energy needs are growing at an impressive rate, much larger than other nations in the world, including other developing nations.
• Currently, India is getting a substantial majority of its energy from burning fossil fuels, making a contribution to global warming that will only increase as its economy grows.
• India has expressed an interest in alternative energy sources, principally nuclear power.
• India has a large percentage of the world’s thorium deposits within its borders that can be used as nuclear fuel.
• India’s reluctance to fully cooperate internationally, by refusing to sign the Nuclear Non-Proliferation Treaty, is partially inhibiting its progress in the nuclear realm.

Indian Nuclear History

1945: India becomes independent
1946: Atomic Energy Commission established
1947: War with Pakistan
1948: India signs Non-Proliferation Treaty
1950: India signs Nuclear Non-Proliferation Treaty
1956: India’s first nuclear power plant
1960: India’s second nuclear power plant
1962: War with China
1963: Two research reactors and four nuclear plants in operation
1964: India detonates both fission and fusion devices
1974: India signs Non-Proliferation Treaty
1975: India’s performance on 60,000 kilowatt heavy water reactor
1976: India’s third and fourth nuclear power plants in operation
1980: India’s fourth nuclear power plant
1989: India’s fifth nuclear power plant
1990: India’s fifth and sixth nuclear power plants
1994: Fast Breeder Reactor - Kakrapar in operation
1995: India signs the Comprehensive Test Ban Treaty
1996: India signs the Comprehensive Test Ban Treaty
1998: India detonates first nuclear device
1999: India signs the Comprehensive Test Ban Treaty
2000: India signs the Comprehensive Test Ban Treaty
2008: India signs the Comprehensive Test Ban Treaty
2010: India signs the Comprehensive Test Ban Treaty

Three Stage Nuclear Fuel Cycle
Because of India’s lack of uranium resources, every effort has been made to draw as much power as possible out of the uranium they do have. Using a combination of their Advanced Heavy Water Reactor and Fast Breeder Reactors, the Indian program is able to reprocess this fuel. After the uranium is run through the AHWR once, it is sent to a fast breeder reactor and used to produce energy once again. The plutonium which is extracted from the fast breeders is then used in the AHWR with ‘thorium’ as the main fuel. At the end of the third reaction, the nuclear waste is much less in volume and in a far less hazardous form.

Safety Features of the Indian Thorium Advanced Heavy Water Reactor Design
The Indian thorium fueled Advanced Heavy Water Reactor has been designed with safety as a top priority. It has several innovative and passive safety features that would effectively shut down the reactor in the event of any foreseeable accident. Along with the conventional active shutdown capabilities such as scramming or flooding the reactor with coolant, the reactor also has several passive shutdown systems that will automatically activate in the event of a hot shutdown, prolonged shutdown, or loss of coolant accident. During normal operation, coolant is circulated by natural convection instead of pumps, so a loss of power will not cause a loss of coolant. If a loss of coolant accident did happen, the rising temperature would cause the automatic release of a reactor poison into the system, that would kill the reaction. If this system were to fail, and the temperature continued to rise, the large gravity driven water pool at the top of the reactor building would automatically start flooding the bottom reactor cavity, effectively submersing the whole reactor core. If the reaction rate continues to increase, there is enough coolant to keep there is enough coolant to keep the reaction in check for 72 hours, more than enough time for the operator to step in and manually shut down the reactor.

Population in India

Energy Consumption in India