



Nuclear Energy Development Challenges

(November 28, 2008; New Delhi)

Considering that India's hydrocarbon reserves are under severe strain, it is imperative for the country to develop its nuclear energy potential even beyond what is possible based on indigenous uranium resources. In September 2008, the 45-member Nuclear Suppliers' Group gave its nod to an India-specific waiver, allowing nuclear resources and technology trade with India. Prior to the waiver, and based on indigenous resources alone, nuclear energy based power generating capacity was set to increase from 3.31 GW in 2006 to 6.78 GW by 2010, and to 15.18 GW by 2020. Further growth will be based on fast reactors, given limited indigenous nuclear fuel and no imports.

As per a scenario by the Department of Atomic Energy (DAE), Government of India, potential for growth based on fast reactors is substantial, and installed nuclear capacity by 2052 based on indigenous resources can be as high as 208 GW. With access to the international market post the NSG waiver, the DAE expects that nuclear energy generation capacity can go up to 70 GW by 2031/32 and to 275 GW by 2052, if India imports 6 GW by 2020. This can be further increased depending upon the extent of imports, and sustained over decades based on thorium which is available in plenty in the country. The challenge now lies in harnessing this potential.

The stakeholder dialogue brought together policymakers, officials from the atomic energy establishment, strategic thinkers, legal practitioners, energy experts and technologists. The issues discussed at the dialogue are as follows.

Nuclear energy development in India: the way forward

- India's efforts to enhance nuclear power generation remain focused on the three-stage program which optimally utilizes the country's modest Uranium and abundant Thorium resources (Figure 2).
- India needs to aggressively locate uranium resources domestically as well as tap international trade in uranium. The country could import uranium and set up more pressurized heavy water reactors based on indigenous technology, or could choose to set up light water reactors in collaboration with other countries. Going by the indigenous route, scaling up in the country has been slow.
- Pursuit of the closed fuel cycle (where spent fuel is reprocessed) is necessary to ensure energy sustainability and credible waste management. The US-India

Nuclear Agreement assumes the award of reprocessing rights for which procedures need to be negotiated.

- In order to reduce the capital costs of nuclear power plants likely to be set up by the Nuclear Power Corporation of India Limited (NPCIL) in collaboration with foreign companies, it will be necessary for the latter to manufacture a significant percentage of equipments and components in India. This will further enhance the capability of Indian companies to manufacture complex equipment. While extensive localization of manufacturing activity and engineering services will help reduce capital costs, it would also enable Indian companies to competitively export equipment and services for nuclear power projects.
- It is important to ensure that the country has access to state of the art, end-to-end technologies. It is expected that the NSG guidelines will facilitate the import of dual use equipment and material software.
- Policymaking on nuclear energy development needs to take into account the unique characteristics of nuclear power generation, which includes constant monitoring of plants, physical security, nuclear material accounting, and export controls.

The nuclear industry

- Nuclear power program requirements include design of plants, construction, manufacture, and commissioning and operation. The Atomic Energy Act permits production of prescribed equipment by any entity (public/private) under a license. A private utility cannot engage in generation. The Act, however, permits a private company to partner the NPCIL in a nuclear power generation project, with the NPCIL holding at least 51 % of the share.
- India's nuclear energy roadmap requires a large trained manpower. Mixed plant designs call for a diverse, versatile workforce. The Homi Bhabha National Institute, under the Department of Atomic Energy, has the status of a deemed university, and offers advanced degrees. The Bhabha Atomic Research Centre's training schools have also substantially increased their intake of students.

Social and environmental issues

- Nuclear power plants can be set up on coastal sites, and on inland sites where water is available. Identification of sites needs to take into account availability of land, density of population in the area, access to cooling water, and seismic factors. The selection of plant sites can, however, become an issue of contention. There is a possibility of social unrest over land acquisition for nuclear power plants, and their operation around inhabited areas.
- The treatment and disposal of radioactive waste is a key concern in nuclear energy development. The country has carried out a mapping of nuclear waste disposal repositories, and has sought to reduce waste through the closed cycle approach.
- Public acceptance of increasing number of nuclear power plants is crucial. Domestic constraints arising from public opposition may remain notwithstanding the low-carbon nature of nuclear energy. It is important to initiate a public

education campaign and discuss the activities of the Department of Atomic Energy in the public domain.

Legal imperatives

- The working of the nuclear energy establishment needs to be made more transparent.
 - In keeping with the increased possibility of public-private partnerships and engagement with foreign partners, the need for a comprehensive liability regime was discussed.
 - The nuclear agreement requires India to put its fast breeder reactors that use imported fuel, under safeguards. It must be assessed whether the implementation of the separation plan will have any implications for the strategic program.
 - The NSG waiver will come into operation only when the India-specific safeguards agreement has been signed, and India has declared the civilian nuclear facilities to be put under safeguards.
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Areas identified for further engagement:

- The stakeholders emphasized the need to take up a detailed assessment of the financial costs involved in meeting the nuclear energy targets set by the government.
- Since import of uranium is necessary for growth of the nuclear energy sector in India, the country needs to identify import sources, and initiate thinking on the required terms of engagement.
- The nuclear energy establishment needs to define the required scope and extent of a liability regime.
- As waste management remains a significant concern of energy experts and environmentalists, a study of waste management practices need to be conducted in order to identify the best possible options and learn from the experiences of other countries.