Nuclear Energy in India

A Market Overview – Selected slides

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Executive Summary

CURRENT STATUS OF NUCLEAR POWER IN INDIA

- India currently derives 2.6% of its total electricity requirement from nuclear energy. India is planning to increase this share to 10% by 2022 and 26% by 2052
- This translates to an increase in installed nuclear power generation capacity from the current level of 4,120 MW to 40,000 MW by 2020 and 250,000 MW by 2050
- To meet these targets, India will need to invest ~$65B between 2010 and 2020 in new power plants
- Significant investments will also be required to secure fuel for the 17 existing nuclear reactors, almost all of which are based on the Pressurized Heavy Water Reactor (PHWR) technology

MARKET ORGANIZATION

- Currently, the government, through the aid of public sector enterprises, controls nuclear power generation and fuel reprocessing activities in India
- However, the private sector is actively lobbying for an amendment to the Indian Atomic Energy Act to permit the entry of private sector players into this market. Approximately 40 companies including The Tata Group, Reliance Energy and the GMR Group are engaged in talks with the government for this purpose

SIGNIFICANT DEVELOPMENTS

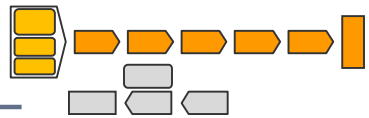
- Historically, India had been barred from international trade in Nuclear technology due to concerns of nuclear proliferation. As a result, India's Nuclear program developed independently and continued to rely upon PHWR technology, which was most conducive to indigenously available low grade Uranium
- In Sep 2008, the Nuclear Suppliers Group (NSG) adjusted its guidelines to remove India from the list of countries barred from nuclear trade. As a result, India will now be able to import Light Water Reactor (LWR) technology as well as high grade Uranium to enhance nuclear power production

Executive Summary

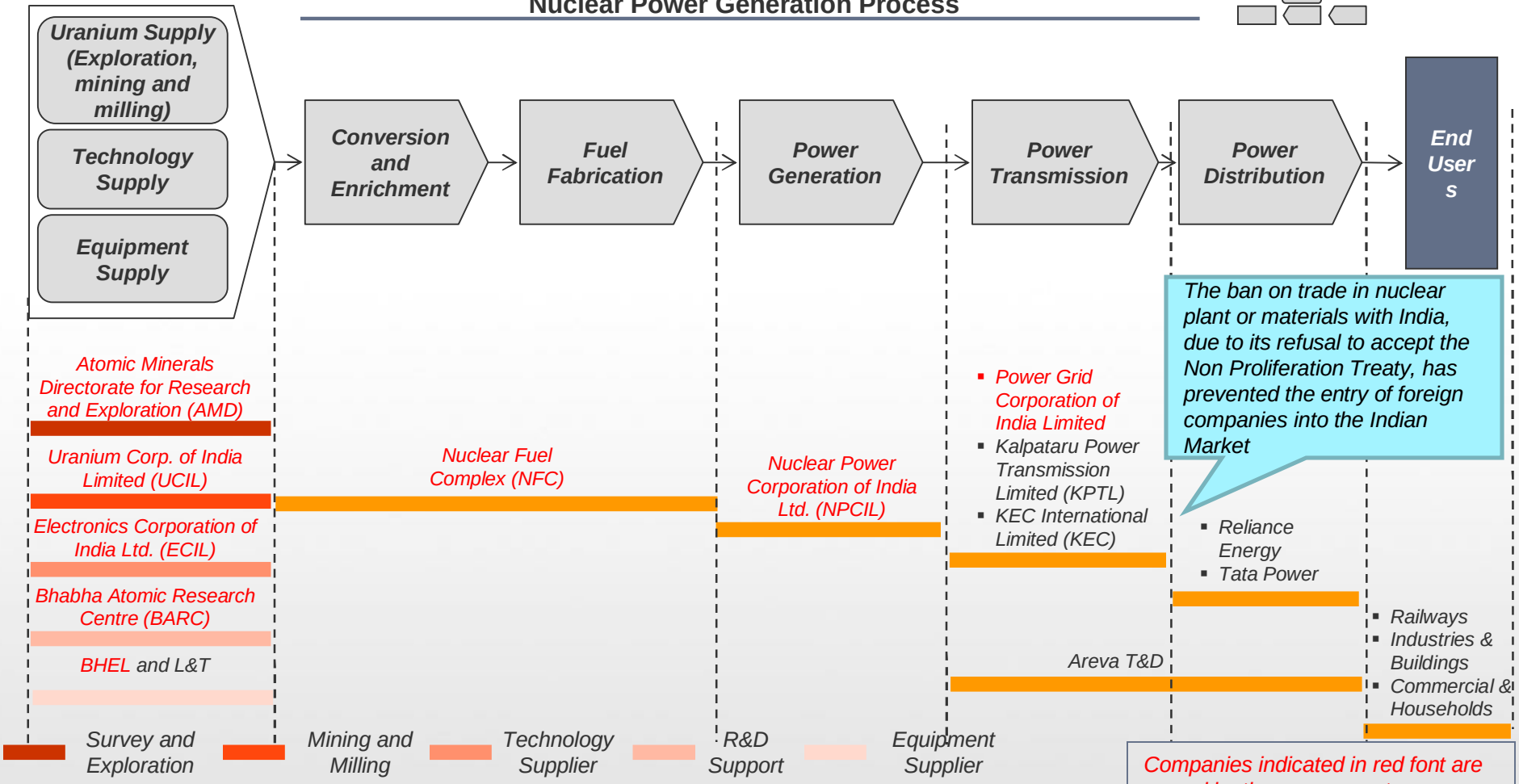
SIGNIFICANT DEVELOPMENTS (continued)

- India and the United States approved a deal to encourage trade and co-operation in nuclear energy. Global power majors like GE, Westinghouse, Areva and Rosatom are expected to re-launch talks for manufacturing and supply of nuclear power equipment
- The NSG Waiver and Indo US nuclear deal will also benefit a wide range of domestic and international companies operating at various stages along the value chain. The deal is expected to result in an increase in secondary support services such as transportation and nuclear fuel storage

Currently, the Nuclear Energy sector in India is comprised mainly of government enterprises and a few local companies



Nuclear Power Generation Process



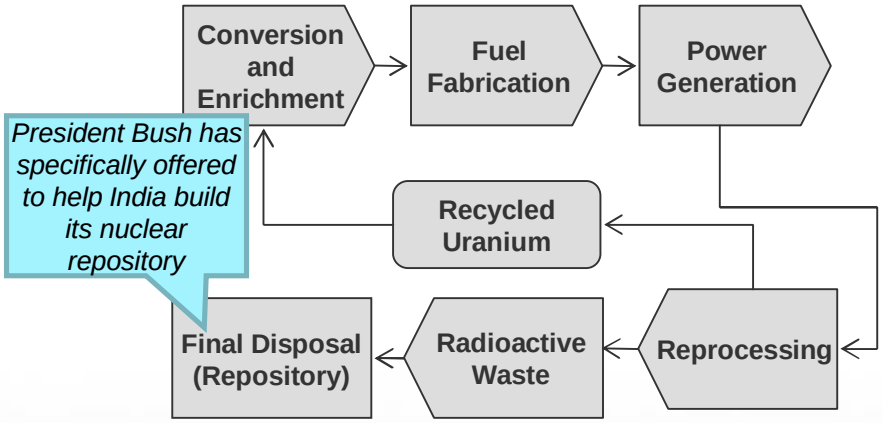
Note: The examples at various stages above are only illustrative and may not be exhaustive

Source:

(1) Nuclear power, Search.com Reference, http://www.search.com/reference/Nuclear_power, (accessed September 12, 2008)

(2) Nuclear Cycle, Government of India, http://india.gov.in/sectors/science/nuclear_cycle.php, (accessed September 15, 2008)

India has three nuclear fuel reprocessing plants and new projects are in the pipeline to rapidly increase reprocessing capacity



Key Highlights

- 95% of spent fuel produced after nuclear fission can be reused in power generation facilities after reprocessing
- Reprocessing separates components of spent nuclear fuel such as reprocessed uranium, plutonium, minor actinides, fission products, etc.
- The by products of reprocessing, mainly radioactive liquids, are embedded into borosilicate glass and put into interim storage and disposed off finally in deep underground repositories
- Reprocessing of fuel from power reactors is currently done on large scale in Britain, France and (formerly) Russia
- China, India and Japan are key countries where initiation and rapid expansion of reprocessing is taking place

Reprocessing Plants In India

Trombay Fuel Reprocessing Plant
•Initially commissioned in 1964 and later expanded and restarted in early 1980s
•Reprocesses natural uranium metal fuels and handles treatment of all the three categories of waste, i.e. High, Medium and Low

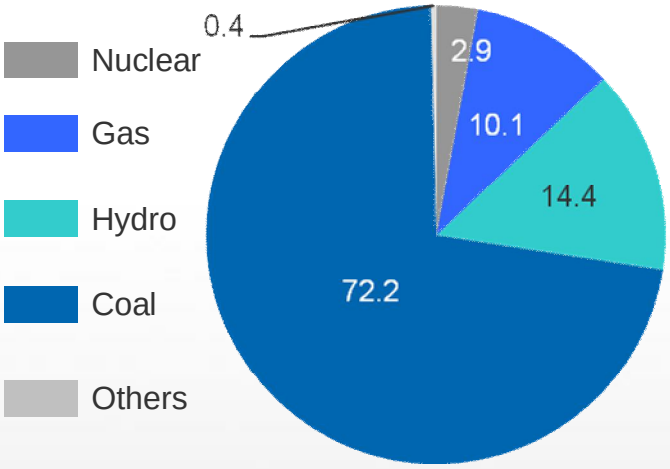
Tarapur Atomic Power Station (TAPS)
•Set up in India by the General Electric Co. of USA and became operational in 1969
•Provides electric power, reprocesses spent fuel from Tarapur reactors and immobilizes the associated wastes
•Is associated with the civilian nuclear program

Kalpakkam Atomic Reprocessing Plant (KARP)
•Commissioned in 1998 and has a capacity of 100 tonnes per annum
•Houses a Waste Immobilization Plant, interim storage facility and is the site for the new plant for reprocessing of fast reactor fuel (FRFRP)

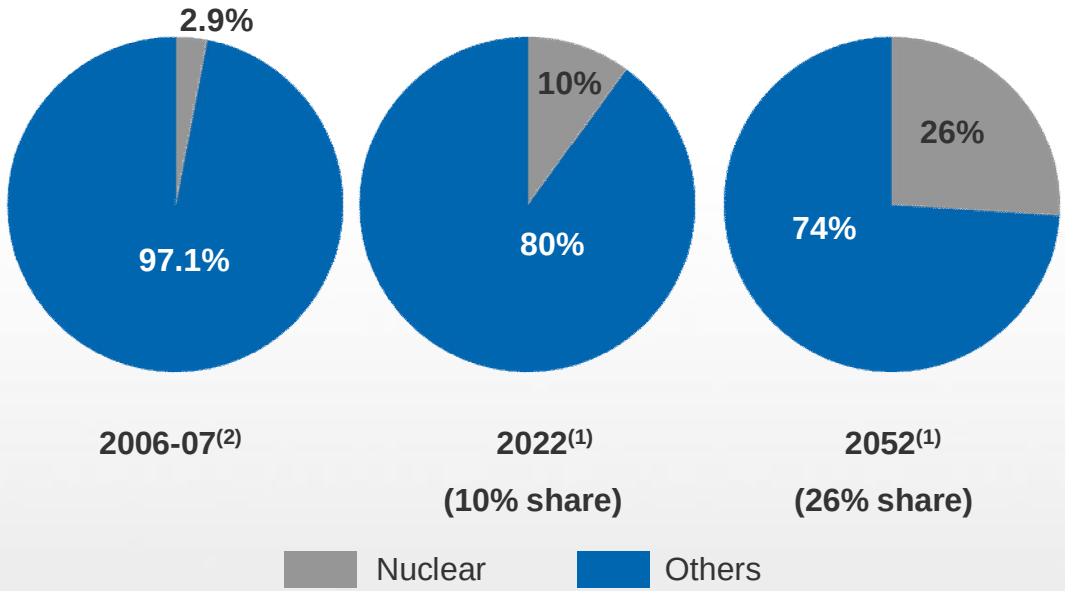
Source:
(1) Nuclear power, Search.com Reference, http://www.search.com/reference/Nuclear_power#Reprocessing, (accessed September 15, 2008)

However, India is currently pursuing an aggressive growth plan targeted to increase the share of nuclear power to 26% in 2050

Source of Electricity Generation in India (2006-07)[2]



Change in Share of Nuclear in Total Electricity in India



Source:
(1) Nuclear Power Worldwide: Status And Outlook, Science Daily, http://www.sciencedaily.com/releases/2007/10/071023103052.htm (accessed September 18, 2008).
(2) Annual report 2006-07, NPCIL (accessed September 18, 2008).

There are 17 nuclear power reactors currently operating in India[(1)]

Nuclear Power Reactors Currently Operating in India[(1),(2)]

Sl. No.	Unit	Location	Type*	Capacity (MWe)	Date of Commercial Operation
1	TAPS-1 Tarapur	Maharashtra	BWR	160	28-Oct-1969
2	TAPS-2 Tarapur	Maharashtra	BWR	160	28-Oct-1969
3	RAPS-1 Rawatbhata	Rajasthan	PHWR	100	16-Dec-1973
4	RAPS-2 Rawatbhata	Rajasthan	PHWR	200	01-Apr-1981
5	MAPS-1 Kalpakkam	Tamilnadu	PHWR	220	27-Jan-1984
6	MAPS-2 Kalpakkam	Tamilnadu	PHWR	220	21-Mar-1986
7	NAPS-1 Narora	Uttar Pradesh	PHWR	220	01-Jan-1991
8	NAPS-2 Narora	Uttar Pradesh	PHWR	220	01-Jul-1992
9	KAPS-1 Kakrapar	Gujarat	PHWR	220	06-May-1993
10	KAPS-2 Kakrapar	Gujarat	PHWR	220	01-Sep-1995
11	KAIGA-1 Kaiga	Karnataka	PHWR	220	16-Nov-2000
12	KAIGA-2 Kaiga	Karnataka	PHWR	220	16-Mar-2000
13	RAPS-3 Rawatbhata	Rajasthan	PHWR	220	01-Jun-2000
14	RAPS-4 Rawatbhata	Rajasthan	PHWR	220	23-Dec-2000
15	TAPS-4 Tarapur	Maharashtra	PHWR	540	12-Sep-2005
16	TAPS-3 Tarapur	Maharashtra	PHWR	540	18-Aug-2006
17	KAIGA-3 Kaiga	Karnataka	PHWR	220	06-May-2007
	Total			**4,120**	

- In India, The Nuclear Power Corporation of India Ltd (NPCIL) is currently responsible for design, construction, commissioning and operation of thermal nuclear power plants
- According to KPMG, India needs to build 250,000 Mwe of nuclear capacity by 2050 in order to meet its energy requirements

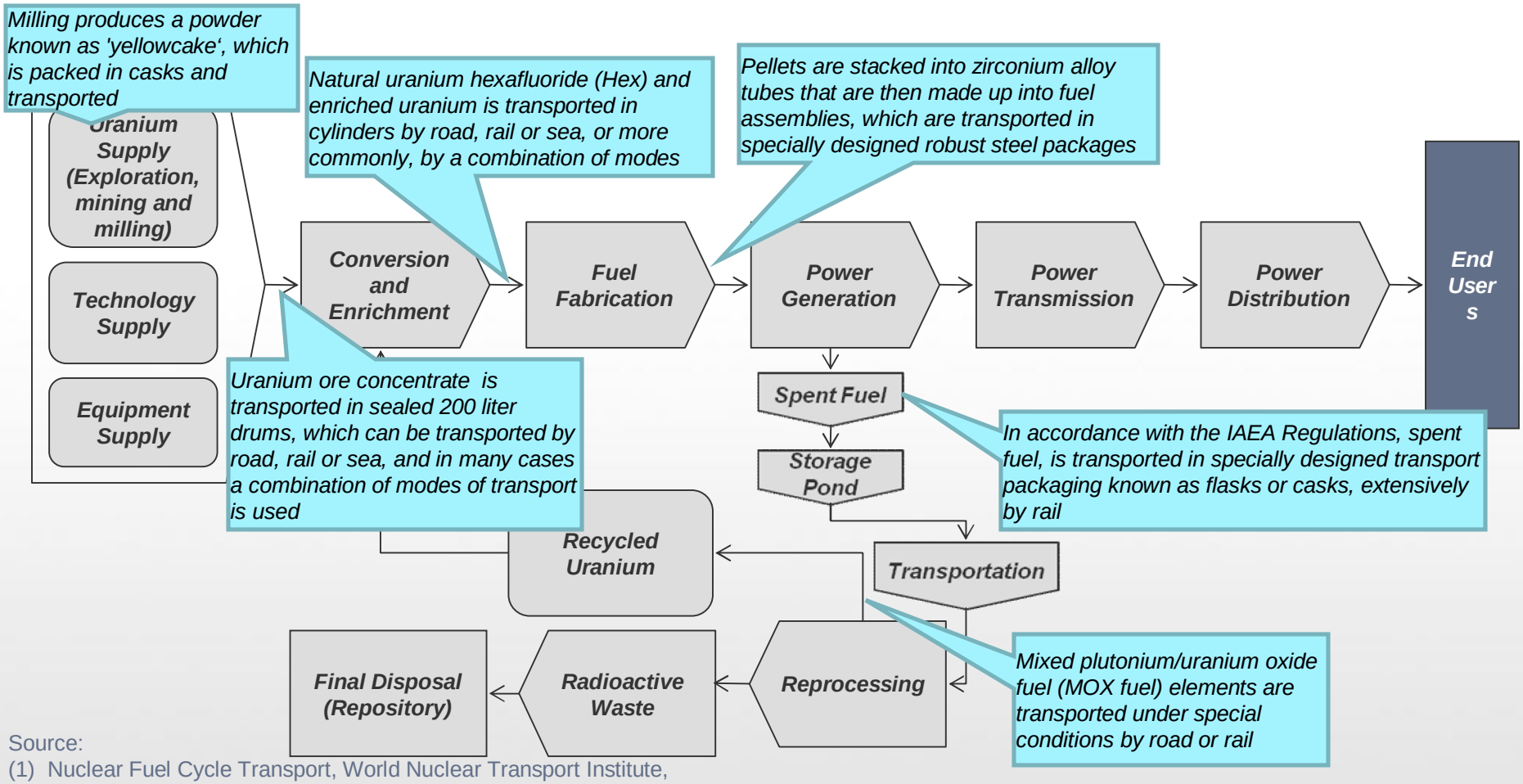
Note: * BWR stands for Boiling Water Reactors, PHWR stands for pressurized heavy water reactor

Source:

(1) Nuclear Power Plant in Operation, Nuclear Power Corporation of India Ltd, http://www.npcil.nic.in/PlantsInOperation (accessed September 17, 2008)

(2) India Energy Outlook - 2007 , KPMG, http://www.kpmg.ie/DestinationIndia/pubs/IndiaEnergy_07.pdf, accessed Sep 17,2008

The Indo US Nuclear Deal also provides growth opportunities for vital support services such as transportation that form an integral part of the value chain



Source:

(1) Nuclear Fuel Cycle Transport, World Nuclear Transport Institute, http://www.wnti.co.uk/UserFiles/File/public/publications/factsheets/wnti_fs_2007/FS-4.pdf, (accessed September 19, 2008)

(2) What is transported and how? World Nuclear Transport Institute, http://www.wnti.co.uk/nuclear-transport-facts/what-is-transported-and-how, (accessed September 19, 2008)

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