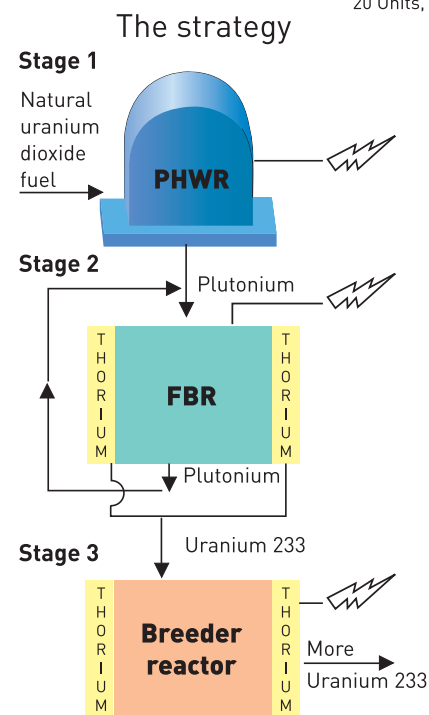
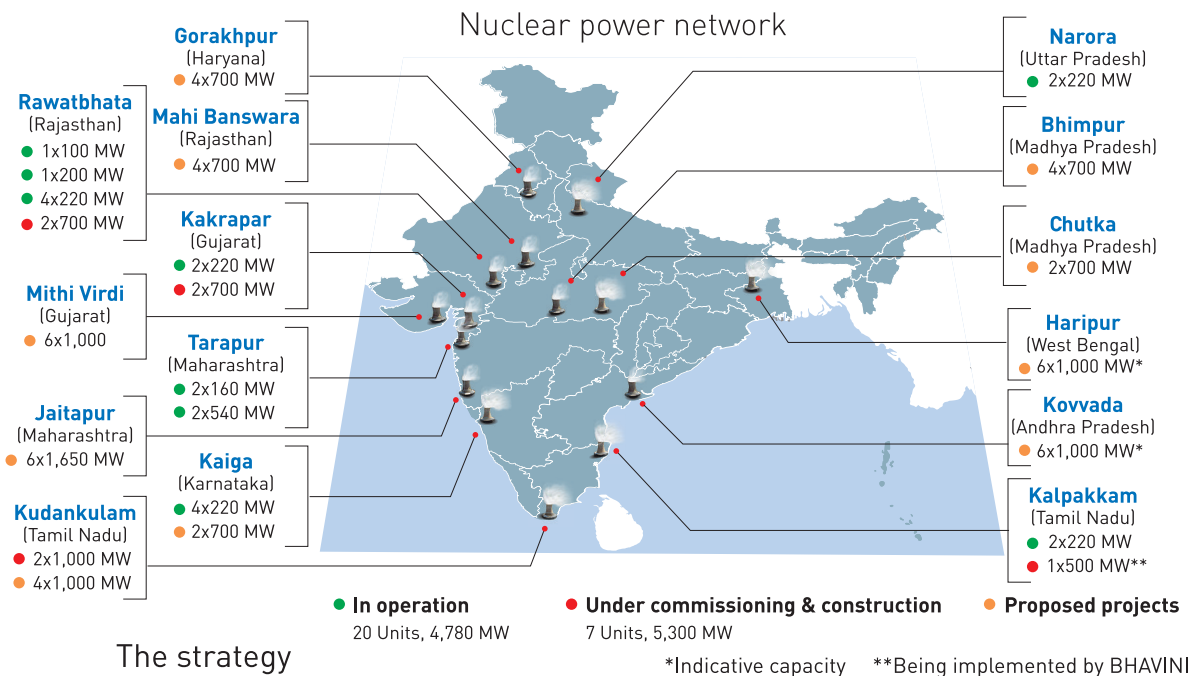


India's nuclear power

While the performance of India's nuclear power reactors offers plenty of reasons to cheer, there are many hurdles ahead. BY T.S. SUBRAMANIAN



THE mood in Nuclear Power Corporation of India Limited (NPCIL) now is upbeat. The fifth unit of the Rajasthan Atomic Power Station (RAPS-5) at Rawatbhata achieved a record continuous operation for 765 days at its full capacity of 220 MWe on September 6. Vinod Kumar, Station Director, RAPS 5 and 6, is proud of this, the second best achievement for a Pressurised Heavy Water Reactor (PHWR), after the 540 MWe seventh unit at Pickering Nuclear Generation Station in Canada achieved a world record in 1994 by running

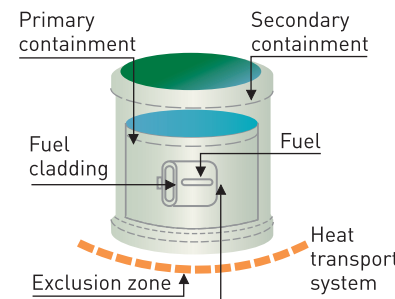
continuously for 894 days. Both RAPS-5 and Pickering-7 are PHWRs, which use natural uranium as fuel and heavy water as coolant and moderator. RAPS-5 is an indigenous reactor built by NPCIL, a public-sector undertaking (PSU) under the Department of Atomic Energy (DAE).

POWER FROM KUDANKULAM
There are other reasons, too, for the buoyant mood in NPCIL. The 1,000 MWe first unit at the Kudankulam Nuclear Power Station in Tamil Nadu will begin

NPCIL at a glance

Date of establishment	September 17, 1987	Number of units in commercial operation	19*	Total installed capacity	4,680 MW
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Safety of nuclear power stations



NPCIL has given paramount importance to safety in terms of design, construction and operation of nuclear power stations. To ensure the safety of a reactor, a defence-in-depth philosophy is followed, which leads to multiple barriers, diversity, redundancy, independence and fail-safe design of the safety-related systems.

commercial generation of power in September. The second 1,000 MWe unit there is racing towards criticality. The Kudankulam units are Light Water Reactors (LWRs) imported from Russia but assembled by NPCIL in civil works completed by it. They use enriched uranium as fuel and light water as coolant.

THREE-STAGE PROGRAMME
India has envisaged an interlinked three-stage nuclear electricity generation programme. In the first stage, India already has 18 PHWRs.

The spent uranium from these reactors is reprocessed to obtain plutonium-239. The second stage aims at building breeder reactors using this plutonium-239 and uranium as fuel. By March 2015, India will enter the commercial domain of breeder reactors when its 500 MWe Prototype Fast Breeder Reactor (PFBR) at Kalpakkam, Tamil Nadu, reaches criticality. Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI), another PSU of the DAE, which is tasked with building breeder reactors, will build four more breeders, including another two at Kalpakkam.

In the third stage, uranium-233 and thorium will drive the advanced thorium reactors. The DAE plans to build a 300 MWe Advanced Heavy Water Reactor (AHWR), which will use thorium as fuel. India right now has 21 reactors with a total installed capacity of 5,780 MWe. This is a mix of 18 PHWRs and three LWRs (two at Tarapur and one at Kudankulam).

TARGET AND CHALLENGES
The DAE's target is to generate 20,000 MWe by 2020. It can reach 10,080 MWe by 2017 by building four PHWRs of 700 MWe each (two each at Rawatbhata and Kakrapar in Gujarat), the second unit at Kudankulam, and the PFBR. If the construction of Kudankulam 3 and 4 begins in 2015, it is possible for the installed nuclear power capacity to reach 12,080 MWe by 2020.

Generation in 2013-14
(as on March 31, 2014)

Thermal	792.477
Hydro	134.848
Nuclear	34.227
From Bhutan	5.598
Total	967.150

in billion units

Installed capacity (in MW)
(as on March 31, 2014)

Thermal	1,68,255
Nuclear	4,780
Renewable	29,463
Hydro	40,531
Total	2,43,029

This will be far short of the target of 20,000 MWe. There is uncertainty about the construction of 18 imported reactors of more than 1,000 MWe each, with six units each at Kovvada in Andhra Pradesh, Mithi Virdi in Gujarat and Haripur in West Bengal, because land has to be acquired from farmers. The Mamata Banerjee government has firmly shut the door on the Haripur project. Excavation of natural uranium from Andhra Pradesh and Meghalaya will have to be stepped up to drive the 700 MWe indigenous PHWRs under construction and those in the pipeline. Whether it can be done, given the strong opposition to uranium mining projects from the Lambadi tribal people, naxalites and the local people in Andhra Pradesh, and the Khasi Students' Union in Meghalaya, is a moot question.

Performance of NPCIL

Particulars	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Generation (MUs)	17,324	18,804	16,956	14,927	18,831	26,473	32,455	32,863	35,333
Availability factor (%)	89	85	83	82	92	89	91	90	88
CRISIL credit rating	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA

MU: Million units; AAA = Highest safety

* In addition to these units, RAPS-1 (100 MW) is owned by the Department of Atomic Energy and managed by NPCIL and is under permanent shutdown.