

DEPARTMENT OF ATOMIC ENERGY

The Department of Atomic Energy (DAE) has been following a well-focused mandate of developing and establishing indigenous technological base for deriving sustainable benefits from nuclear applications, both for power production and for a wide range of societal applications. During the period 2014-2017, DAE has delivered several benefits of indigenous development to the nation and some of these are briefly highlighted here.

- 1) **Nuclear Power Programme:** Steady growth for nuclear power on a sustained basis is one of the prime objective of DAE. Kudankulam Nuclear Power Project (KKNPP 1 & 2) became operational adding 2000 MW electricity. Country now has 22 reactors with installed capacity of 6780 MWe. Construction has commenced for KKNPP 3 & 4 (2000 MWe). Prototype Fast Breeder Reactor (500 MWe) is undergoing commissioning and is expected to achieve first criticality this year.

India Nuclear Insurance Pool (INIP) for Rs.1500 crore has been operationalised with separate insurance policies for operators and suppliers. DAE's Nuclear Liability Fund Rules was laid on the table of Parliament in March 2016. IAEA's Convention on Supplementary Compensation for Nuclear Damage (CSC) was signed in October 2010 and ratified in February 2016. With these measures, India has now completed all the steps required for augmentation of nuclear installed capacity with domestic as well as international technologies.

- 2) **Uranium Mining and supply:** Electricity generation from nuclear power plants has been continuously increasing due to increased availability of uranium from imported as well as domestic sources. Actions have been taken to start new uranium mines in the country. Towards this, exploratory mining operation started at Rohil (Rajasthan). Tummalapalle Uranium production plant became operational. An additional 50,000 T Uranium ore resource was established making the total identified country reserve to 250000 T. Import of Uranium from Canada commenced in 2015. Total import of Uranium from Kazakhstan, Russia and Canada is around 4000 Tonnes. Procurement of Uranium from Australia is in progress.
- 3) **Research & Development:** An industrial scale process was set up to separate ^{137}Cs from high level liquid waste (HLLW) and manufacturing irradiation source based on ^{137}Cs in vitrified non-dispersive pencil form. More than 100 such ^{137}Cs pencils have been manufactured and utilized in 8 blood irradiators. DHRUVA reactor at Trombay, producing medical isotopes, operated at full power throughout 2016 and touched its highest ever capacity factor since its

commissioning. A simple, user friendly, quick and cost effective kit for onsite determination of Cr (VI), a carcinogenic compound in water was developed.

- 4) **Nuclear Technologies for Societal Benefits – Health:** A large number of medical centres in the country are using radiopharmaceuticals supplied by DAE Units, BRIT & BARC, for diagnosis and therapy of certain diseases, particularly cancer. Construction has been taken up for Homi Bhabha Cancer Hospital at Chandigarh and Vizag and completed the Sangrur facility at Punjab and a 250 bed Mahamana Pt. Madan Mohan Malaviya Cancer Centre in BHU Campus, Varanasi, UP. National Cancer Grid has been set up which facilitates 96 cancer care centres across the nation same level of cancer treatment facility. As a part of the global initiative to combat cancer, The Hon'ble Prime Minister announced the gifting of one Bhabhatron unit each to Tanzania, Kenya and Mangolia during his visit to these countries.
- 5) **Nuclear Technologies for Societal Benefits - Environment:** Technologies developed by DAE help enhancing the environmental safety, and in turn, support the Swachata Bharat Abhiyaan Mission. The BARC biogas plant Nisargruna for processing bio-waste for production of energy or cooking gas has been installed in over 200 places until 2016. Construction of radiation based dry sludge hygeneisation plant for Ahmedabad Municipal Corporation is in advanced stage and expected to be operational this year. A pilot scale facility for textile dye effluent treatment of capacity 100000 Litre/ day using radiation grafted material is being commissioned at Surat, Gujarat.
- 6) **International nuclear Cooperation:** Inter government agreements (IGA) / MoU were signed with Japan, Vietnam, Australia, UK, USA, France, Russia, Canada, Kazakhstan, Sri Lanka.

India formally joined the Paris Climate Change Agreement by submitting its instrument of ratification at UN headquarters in New York on October-2-2016, the birth anniversary of Mahatma Gandhi.

During the 4th Nuclear Security Summit (NSS) held in Washington DC in March 2016, Prime Minister of India has announced India's contribution of US \$1 million to the IAEA's Nuclear Security fund (NSF).

- 7) **Mega Science Projects:** India became an Associate Member of European Organization for Nuclear Research (CERN) on January 16, 2017. MoU was signed with National Science Foundation, USA for setting up third Laser Interferometer Gravitational-Wave Observatory (LIGO) centre at Hingoli, Maharastra. Major construction works for Atmospheric Cerenkov Experiment (MACE) Telescope, one of the world's largest telescope at the highest altitude is nearing completion at Hanle, Ladakh which will become operational in 2017.

- 8) Education and training:** The National Institute of Science Education and Research (NISER) was dedicated to the nation by the Prime Minister in February 2016. NISER is offering science education through 5 different schools and is making outstanding contributions to science education.

Northern India's first permanent exhibition on nuclear power "Hall of Nuclear Power" was inaugurated in New Delhi on January 16, 2016 by Dr Jitendra Singh. It is spread over an area of about 700 sq. m., with over 60 permanent exhibits, covering various aspects of nuclear energy.

The Department of Atomic Energy (DAE) has undertaken various initiatives for energy security and benefit of society and thereby contributing to the Nation building. The major highlights of the achievements of the Department during the last three years are as follows:

- Under Prime Minister Shri Narendra Modi's leadership, country has seen major achievements in the field of civil nuclear cooperation.

The implementation of the civil nuclear cooperation agreement with the U.S. got boost when Prime Minister hosted US President Mr Barack Obama in New Delhi on January 25-27, 2015. Since then, the Administrative Arrangement for implementing the agreement has been signed and the India Nuclear Insurance Pool set up to implement the understanding on civil nuclear liability, which has addressed international and domestic concerns on India's Civil Liability for Nuclear Damage Act of 2010.

Civil nuclear cooperation with Russia and France has also been taken forward. During Prime Minister's visit to France in April 2015, an MoU between M/s Larsen and Toubro and M/s Areva aimed at cost reduction by increasing localization for the Jaitapur project in Maharashtra was signed. On December 22, 2015, during Prime Minister's visit to Russia, a Joint Programme of Action for Localization of Manufacturing in India for Russian-designed Nuclear Power Plants was signed. A minimum of 12 reactor units will be built with Russian collaboration.

Following the signing of a contract for long-term supply of uranium during Prime Minister's visit to Canada in April 2015, the first consignment of uranium reached India in December 2015. Likewise, a long term contract for purchase of uranium was signed during Prime Minister's visit to Kazakhstan in July 2015.

In a major development, a civil nuclear cooperation agreement with Australia was brought into force on 13 November 2015 along with the Administrative Arrangement for implementing the Agreement. The fuel supply arrangements with Canada,

Kazakhstan and Australia will bolster energy security by supporting the expansion of nuclear power in India.

The Prime Minister Shri Narendra Modi and the Japanese Prime Minister Shri Shinzo Abe, signed the Agreement for Cooperation in the Peaceful Uses of Nuclear Energy between the two countries, on November 11, 2016, which reflects a new level of mutual confidence and strategic partnership in the cause of clean energy, economic development and a peaceful and secure world.

A Nuclear Cooperation Agreement (NCA) has been signed between India and UK in October 2015. A MoU has been signed between the Department of Atomic Energy of the Government of India and the Department of Energy and Climate Change of the Government of United Kingdom of Great Britain and Northern Ireland concerning Cooperation with the Indian Global Centre for Nuclear Energy Partnership (GCNEP).

Inter-Governmental agreement with Sri Lanka for cooperation in peaceful uses of Nuclear Energy was signed in February 2015.

In combination with initiatives taken at home, in particular the passage through the Parliament of the amendment to the Atomic Energy Act for enabling NPCIL to enter into Joint Ventures with other PSUs, these agreements have laid a solid foundation for the expansion of nuclear energy in India. A promising area has at last been energized for implementation.

Unit 1, (1000 MWe) of the Kudankulam Nuclear Power Project (KKNPP) was dedicated to the nation on August 10, 2016 by the Prime Minister Shri Narendra Modi and Russian President Shri Vladimir Putin. Second Nuclear power reactor Unit of 1000 MWe capacity at Kudankulam in Tamil Nadu achieved criticality on 10th July, 2016. This is the second 1,000 MWe pressurised water reactor to go critical in the country. The first unit at Kudankulam went critical in July 2013. The Unit 2 (1000 MWe) of Kudankulam Project was later dedicated to the Indo-Russian Partnership on October 15, 2016 during the BRICS Summit by the Prime Minister Shri Narendra Modi and Russian President Mr. Vladimir Putin.

On October 15, 2016, laying of Foundation of Units 3&4 of KKNPP was also done by the Prime Minister Shri Narendra Modi and Russian President Mr. Vladimir Putin.

- India becomes Associate Member of CERN, Geneva (November 21, 2016). India and European Organization for Nuclear Research (CERN) signed an agreement making India an Associate Member State of CERN. This follows CERN Council's adoption of the resolution to this effect on September 15, 2016. The agreement was signed by Dr. Sekhar Basu, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy and CERN Director General Dr. Fabiola Gianotti in Mumbai. Participation in CERN programmes is a success story of scientific collaborations and cooperation where researchers from large number of national Institutes and Universities from India work together in forming active

collaborations in the pursuit of fundamental knowledge, achieving scientific and engineering breakthrough as well as training the next generation of scientists.

- The MoS Dr Jitendra Singh inaugurated the “Hall of Nuclear Power” in New Delhi on January 16, 2016. This is Northern India’s first permanent exhibition on nuclear power, built in the national capital at National Science Centre (NSC).

- Cabinet granted ‘in-principle’ approval to the LIGO-India mega science proposal. The Union Cabinet chaired by the Prime Minister Shri Narendra Modi has given its ‘in principle’ approval to the LIGO-India mega science proposal for research on gravitational waves, on February 17, 2016. The proposal, known as LIGO-India project (Laser Interferometer Gravitational-wave Observatory in India) is piloted by Department of Atomic Energy and Department of Science and Technology (DST). The approval coincided with the historic detection of gravitational waves a few days ago that opened up of a new window on the universe to unravel some of its greatest mysteries.

- India supplied indigenous teletherapy machine Bhabhatron, for cancer treatment to Bougando Medical Centre in Tanzania. The Prime Minister Shri Narendra Modi had earlier announced the donation of the Bhabhatron II Teletherapy machine to the Centre during his visit to Tanzania in July 2016.

- Novel design of CO₂ sorbents. Scientists at the Tata Institute of Fundamental Research, DAE have developed a novel design of CO₂ sorbents that show superior CO₂ capture capacity and stability over conventional materials.

- BARC developed kit for detection of Chromium contamination of water (August 17, 2016). BARC has developed a simple, user friendly, quick and cost effective kit for onsite determination of Cr (VI), which meets IS10500 as well as EPA criterion. It provides the much needed solution to measure the level of Chromium contamination in drinking water and tap water, lakes, rivers as well as ground water. This is yet another example of BARC’s efforts towards ‘Make in India’ campaign of the Government of India. This kit can be used for detection of carcinogenic Chromium in ground water around the Ganga belt.

- BARC and Sree Chitra Tirunal Institute for Medical Sciences & Technology signed MoU for joint development of Deep Brain Stimulator. As per the Memorandum of Understanding (MoU) signed between BARC & SCTMIST on August 12, 2016, BARC will develop the device as per specifications provided by SCTMIST and SCTMIST will be responsible for clinical trials, testing and qualification. Electronics Division, Reactor Control Division and Centre for Design & Manufacture of BARC will participate in the development of various subsystems. The 1st prototypes are planned to be available in 3 years.

- Technologies developed by DAE help enhancing the environmental safety, and in turn, support the Swachh Bharat Abhiyaan. Eight BARC biogas plant, Nisargruna, for processing bio-waste for production of energy or cooking gas, have been installed this year, taking the total of such plants to 198. BARC has demonstrated radiation hygienisation of urban sewage sludge for safe disposal, and scope to use the resultant bi-product as organic manure. A radiation plant to more

efficiently hygienise dry sewage sludge is planned to be set up in Ahmedabad. DAE is also participating in water quality analysis aspects, as technology provider-cum-adviser in support of Clean Ganga project.
