GOVERNMENT OF INDIA
DEPARTMENT OF ATOMIC ENERGY

LOKSABHA
UNSTARRED QUESTION NO - 5097
ANSWERED ON 02/04/2025

TECHNOLOGIES DEVELOPED BY DAE

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Will the PRIME MINISTER be pleased to state:-

(a) the details of technologies being developed by the Department of Atomic Energy (DAE) specifically for renewable energy integration, medical applications and national security;
(b) the key partnerships or collaborations established by DAE during the last year to accelerate research and development in these areas;
(c) the initiatives undertaken for human resources development including the number of scientists and technical personnel trained during the last three years and the institutions involved; and
(d) the new projects or initiatives planned by DAE in 2025 for expanding applications of nuclear and allied technologies across various sectors?

ANSWER

THE MINISTER OF STATE FOR PERSONNEL, PUBLIC GRIEVANCES & PENSIONS AND PRIME MINISTER'S OFFICE (DR. JITENDRA SINGH)

(a) The details of technologies being developed by the Department of Atomic Energy (DAE) for renewable energy integration, medical applications and national security are given below.

1. Renewable energy integration:

Technology has been developed for extraction and purification of samarium (Sm) neodymium (Nd) and rare earth metals, for magnetic applications required in wind turbine.

2. Medical applications:

i. Radiopharmaceuticals:

Bhabha Atomic Research Centre (BARC) a constituent unit of DAE is involved in the development of radiochemicals and radiopharmaceuticals for various oncological and non-oncological applications. BARC has developed 90Y-labeled glass microspheres (Bhabhaspheres) for the treatment of unresectable liver carcinoma, ready-to-use

injections of 177Lu-DOTA-TATE for the treatment of neuroendocrine cancers, 177Lu-HA for radiation synovectomy of medium-sized joints and 90Y-HA for radiation synovectomy of large-sized joints. These products are regularly supplied through Board of Radiation and Isotope Technology (BRIT) to various hospitals of the country for the treatment of cancer patients. BARC has also developed the technology for production of high specific activity no-carrier-added 177Lu and 64Cu (theranostic radionuclide) suitable for the treatment of cancer patients. Additionally, BARC has developed and started supplying (through BRIT) radiolabelled skin-patches for the treatment of Keloids.

ii. Ligands for Radiopharmaceuticals:

BARC has developed and deployed peptide-based ligand, PSMA-617, for use in prostate cancer therapy as import substitute. The indigenously developed nuclear medicine ligand, 177Lu-PSMA617 is regularly supplied to hospitals pan India. Synthesis protocols have been optimized for affordable sestaMIBI production and it is regularly used as 99mTc-MIBI for heart imaging in Indian patients. Recently, another ligand, PSMA-11 has been developed for production of 68Ga-PSMA11 for diagnosis of prostate cancer.

iii. Radioprotector for cancer patients:

BARC has developed chlorophyllin based nutraceutical tablets for mitigating the side effects of cancer radiotherapy. This Food Safety and Standards Authority of India (FSSAI) approved nutraceutical is aimed at enhancing the quality of life for cancer patients. It has shown remarkable results, particularly in pelvic cancer patients suffering from radiotherapy-induced Cystitis (Blood in urine). The product has been commercialised by licensee.

iv. Production of radioisotope Lu-177:

BARC developed process for indigenous production of medically very important radioisotope Lu-177 for cancer treatment. The process is being scaled up to ensure India's self-sufficiency in carrier-added Lu-177-based medicines.

v. Indigenous Digital radiotherapy simulator for tumour localization, radiotherapy treatment planning and plan verification has been developed for more accurate radiation dose delivery leading to improved clinical performance. More than 30 such machines are operational.

vi. NOx based wound dressing:

A cost effective advanced wound dressing, specifically designed for diabetic foot ulcer (DFU) and other chronic wounds, has been developed. It enables in-situ generation and delivery of therapeutically optimised nitric oxide (NOx) to promote wound healing. The technology has been transferred to two private firms and approval of Drugs Controller General of India (DCGI) has been obtained for manufacturing & commercialisation.

vii. Bio-available curcumin formulation (CUR-Gel):

Curcumin, the active constituent from turmeric is well-proven immunomodulatory and anti-inflammatory agent for general health benefits. However, its therapeutic efficacy is limited due to poor bioavailability. The intended formulation has been designed to facilitate the curcumin absorption through buccal cavity and to improve its bioavailability. The know-how of the technology has been transferred.

viii. The proton beams from 30 MeV Medical Cyclotron Facility (MCF) at Chakgaria campus, Variable Energy Cyclotron Centre (VECC) Kolkata, is producing radioisotopes / radiopharmaceuticals (in collaboration with BRIT), which are used for cancer diagnostics.

ix. Commercial production and supply of Radiopharmaceuticals, 18F-Sodium Fluoride (for bone scanning), and Gallium-68-PSMA (for diagnostics of Prostate cancer) have been started.

x. Production and successful human application of Thallium-201-Chloride Radiopharmaceuticals has been (for conducting Cardiac studies, diagnosis of brain tumour) successfully carried out first time in India.

xi. Production of various radio-pharma products, such as, PET radiopharmaceutical, Copper-64-Chlodide, SPECT radioisotopes Iodine-123 and Lead-203, have been initiated on trial basis Jointly with Board of Radiation & Isotope Technology (BRIT) at the Medical Cyclotron Facility.

xii. VECC is also engaged in the development of first indigenous 18 MeV Medical Cyclotron (MC18) in India in collaboration with BARC.

xiii. Magnetocardiography (MCG) and Magnetoencephalography (MEG): Magnetocardiography (MCG), is complementary to Electrocardiography (ECG), being used for functional heart imaging. It is sensitive even under rest condition to detect coronary ischemia. Using this system, various research investigations have been carried

out on both healthy volunteers and on patients with different cardiac dysfunctions from DAE hospital, Kalpakkam and JIPMER, Puducherry. These investigations are aimed towards highlighting the unique diagnostic information provided by MCG which is not readily observed in those of the conventional voltage based techniques like Electrocardiogram (ECG).

xiv. Thermal Imaging for Early Detection of Breast Cancer - Technique has been applied for early detection of breast cancer successfully as an adjunct imaging modality in rural area and is now proposed on a larger scale.

xv. Radio-isotope Production: The indigenous production of Sr-89 is an important societal need and a valuable import substitution; it is a pure beta emitter with a half-life of 50.5 days and used for palliative care of bone metastatic cancer. Production of Sr-89 with high specific activity at Fast Breeder Test Reactor (FBTR), Kalpakkam was successfully demonstrated. The product satisfied all the Quality Control Parameters as per the US, European and International Pharmacopeia. Bio-distribution study in progress. This technology ensures increased availability and complete import substitution.

xvi. Pilot scale production of radio isotopes (Y-90 & P-32) for the benefits of society was initiated during April, 2024

xvii. "Mobile Health – Wellness Program for the Rural Population" is being implemented in the rural areas with DAE developed Technologies.

xviii. Raja Ramanna Centre for Advanced Technology (RRCAT) has developed the following technologies for medical applications:

- Tuberculoscope - A low-cost fluorescence imaging device for rapid diagnosis of tuberculosis (TB).
- OncoDiagnoScope- Tablet computer based, user-friendly portable optical spectroscopic device for screening/ diagnosis of oral cavity cancer.
- Raman Probe - The Raman probe is meant for in situ measurement of good quality Raman spectra from low Raman-active materials like biological tissues.
- Vision Enhancement Module (VEM) - A low-cost fluorescence imaging tool for in-vivo screening/diagnosis of malignant and potentially malignant lesions of human oral cavity.
- NeelBhasmi - UV based area sanitization device to inactivate various micro-organisms including corona viruses.

3. National security:

- Indigenous Cargo Container Scanner system has been designed and developed. This is a dual energy-based gantry type system which can be used at land ports. A demonstration unit was operationalised at BARC.
- BARC has developed Ballistic Resistant (BR) jackets utilizing indigenously developed Hot-Pressed Boron Carbide (HPBC) and Carbon Nanotube (CNT) technologies which are ~20% lighter than the existing jackets. The Level-III BR jackets weighs around 4.8 kg with trauma less than 20 mm, whereas Level-III+ BR jackets with boron carbide backed with CNT-polymer composite weighs around 6.5 kg with trauma less than 15 mm. This technology has been transferred to MIDHANI and 3 more reputed companies for large scale production.
- Indira Gandhi Centre for Atomic Research **(IGCAR)** a constituent unit of DAE is involved in the development and deployment of compact Ion Mobility Spectrometer (IMS) at important security posts as an import substitute, for trace level detection of explosives and narcotics, by taking swab samples.

(b) **The key partnerships or collaborations:**

RRCAT has signed MoU with Lord's Mark Industries Pvt. Ltd., Thane, Maharashtra for translation of RRCAT technologies (Tuberculoscope, OncoDiagnoScope, Raman Probe, Vision Enhancement Module (VEM)) to industries with collaborative work to improve the product qualification by regulatory bodies.

(c) **The initiatives undertaken for human resource development:**

- Bhabha Atomic Research Centre (BARC) provides training to the Trainee Scientific Officers (TSOs) in BARC Training School under one-year 'Orientation Course for Engineering Graduates and Science Postgraduates (OCES)' programme. This training programme is continuing since 1957. These TSOs are selected from various disciplines of engineering and basic sciences. The data for last three years is listed in the table-1 below.

Table-1: Number of TSOs joined the OCES programme in last three years

Year	2024	2023	2022
Total TSOs joined	201	171	163

Various Institutions of the Department of Atomic Energy (DAE) are part of this training programme e.g., BARC, IGCAR, RRCAT, NFC, AMDER etc.

Apart from OCES, a total 140 scientific and technical personnel have been recruited either directly or through Category-I and Category-II training in the last three years. Breakup of the appointments is given in the table-2.

Table-2: Number of scientists and technical personnel joined directly or through Category-I and Category-II training in last three years

Sr. No.	Designation	Nos.
1	Scientific Officer/D	5
2	Sub-Officer B	1
3	Technical Officer/C	56
4	Scientific Assistant/B	18
5	Nurse/A	19
6	DPOF/A	9
7	Scientific Assistant/C (2 through CAT-I)	22
8	Technician/B (3 through CAT-II)	8
9	Technician/D (2 through CAT-II)	2
TOTAL		140

A total of 428 trainees in Category-I and 850 trainees in Category-II joined BARC recently and are under training. BARC also provides opportunities for project trainees and PhD students.

- Management Development Programme by Administrative Training Institute, DAE at GCNEP, Bahadurgarh during 27.01.2025 to 30.01.2025. Number of Scientists and Technical personnel trained: 02

- Capacity Building Training Programme oraganised by ATI, DAE in collaboration with Arun National Institute of Financial Management, Faridabad during 02.09.2024 to 04.09.2024. Number of Scientists and Technical personnel trained: 01

- Initiatives are continuously undertaken at IGCAR for human resource development. The number of scientists and technical personnel trained during the last three years is tabulated below:

Training Programme	Brief Description	No. of Personnel trained		
		2024	2023	2022
Orientation Course for Engineering Graduates &Science Postgraduates (*OCES*)	One year orientation programme for Trainee Scientific Officers (TSO's)	20	29	20
Directly recruited Officer Training	3 months class room orientation	--	27	--
Stipendiary trainee CAT-I (Diploma level)	6 months of class room training & 18 months of on-the-job training.	79*	58	66
Stipendiary trainee CAT-II (Technician level)		77*	68	71

*Training under progress

- Total 20 scientific officers were trained at Raja Ramanna Centre for Advanced Technology (**RRCAT)** in last 3 years.
- Trade Apprenticeship Scheme at RRCAT (TASAR) is a long-term skill development program being run at RRCAT since 2018. It is implemented by Directorate General of Training (DGT), MSDE under 'The Apprentices Act, 1961' to impart on-the-job-training to ITI and school pass-outs. In the last three years, nearly 175 ITI passed students in various trades have successfully completed the training at RRCAT and awarded National Apprenticeship Certificate (NAC) by DGT.

(d) **The new projects or initiatives planned by DAE in 2025:**

- R&D for development of technologies in the applications of nuclear and allied technologies is a continuous process pursued under various projects. **BARC** has planned to pursue around 50 projects/ initiatives in year 2025. These projects are mainly aligned with the Amritkaal targets & Nuclear Energy Mission.

- Design and development of a 30 MeV Medical Cyclotron (MC30) and a 10 MeV PET cyclotron (MC10) and development of Gamma Camera for medical imaging these projects have been planned by **VECC** under new projects in 2025

- Upgradation of critical components of Fast Breeder Test Reactor (FBTR) towards life extension of the reactor

- Upgradation of sodium and water test facilities for troubleshooting and testing of critical systems of FBRs
- Extending technical support for integrated commissioning activities of PFBR leading to first approach to criticality and further operation
- Pilot scale production of radio isotopes (Y-90 & P-32) for the benefits of society
- Preliminary studies and inputs for the preparation of detailed project report for FBTR-II, a metal fueled FR along with reprocessing
- Testing and development of critical components and systems for the upcoming FBR-1 &2 as well as future FBRs
- Establishment of state-of-the-art facility for growth and characterization of single crystals for varied applications like radiation detectors, non-destructive examination applications and other sensors
- Green hydrogen production by copper-chlorine cycle developed by BARC and coupling with sodium systems in offline mode.

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