

# India's Quest for Fusion Energy & Road to ITER

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Recognizing the limitations of currently available resources, India's quest for new energy sources is common for all nations, which are in a state of rapid growth and aspire to seek a respectable place on the global canvas of peaceful and sustainable co-existence. Lack of adequate energy denies opportunity to lead a developed and precludes realization of human potential into what it could have been. The global impact can be gauged from the fact that among the 17 Sustainable Development Goals, spelt out after an extensive study by the UN, the 7th Goal is about 'affordable and clean energy'. Today or in very near future –the whole world is or will be in a situation that will require every conceivable energy source to be tapped, improved in efficiency, made cost-effective and be equipped with a method to mitigate any adverse impact on the environment.

In spite of India's taking significant steps towards tapping every bit of both conventional and renewable energy sources, the demand is much higher than what is currently available and is still growing. If one takes a grand challenge of bringing parity with the world-average for the per capita consumption, the capacity has to be trebled! How fast can one add ~400 GW? No matter what we do and however staggering this figure is, there is no going back from this target. So, an equally challenging problem that emerges is how do we manage to grow on sub-optimal energy supply in the interim period. Techniques to reduce energy consumption by increasing efficiency of various processes need to be developed. For this one needs new tools, materials and research-infrastructure to innovate, improvise and harness the benefits of improvement on a mass-scale. Scales matter; even a tiny saving/improvement for a nation with billion people is quite impactful.

Advanced technologies like fusion hold the promise but have been traditionally considered too far away for any serious investment so far. The 'fear factor' of failure can be overpowering for policy makers. However, it's time to turn it around and ask ourselves: What difference will it make if fusion reactor works as desired? Well, it will make a tremendous difference. It deserves a try, just for that hope we have. The ITER Project is a collective expression of this global quest for energy in the form of the largest scientific endeavour involving more than half of the world population. The task however, is complex and embeds challenges of extreme kind. But fusion research is also all about innovative ways and can continue to provide the world with spin-offs while it graduates from hydrogen plasma to D-T and from there on to power-reactors.

India has come a long way in both fusion-science and technology via its well-conceived indigenous as well as collaborative measures. India's journey began in 1982 and it has grown in several areas of plasma and fusion research. A number of developments has taken place: tokamaks with copper-coils (ADITYA) and with superconducting coils (SST-1) have been built indigenously in the Institute for Plasma Research, Gandhinagar. The scientists have gained enormous experience in plasma operations of these tokamaks as well as in SINP-tokamak, which is located in the Saha Institute of Nuclear Physics, Kolkata. Now, an upgraded ADITYA-U is in place capable of experiments with shaped plasma. A host of auxiliary technologies have been developed and tested with the test-beds created in-house.

India needs to sustain the momentum of its fusion research to be able to reap the benefits from participation in ITER and to quickly channelize the success of ITER in its vision. The ITER participation has been followed in India with the blanket and the divertor technology development initiatives. Industrial applications of the plasma have come off age and last but not the least, the human resource development has taken place with a strong academic back-bone. In this talk, the above-mentioned developments are overviewed and an outline of the future plan –and how it blends with ITER participation is also presented.

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