

Toshiba's Contributions to India through Thermal Power Generation Technology, Part 2

- Next Generation Technologies -

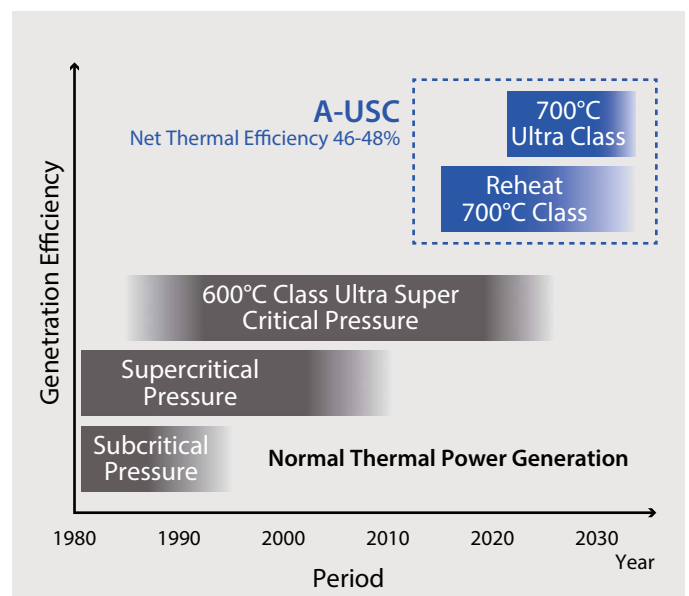
From the glowing incandescence of the large shopping complexes seen from the city highway to the factories crowding the industrial zones on its outskirts, Delhi is a constant reminder of the vast and increasing amounts of electricity that fast growing India consumes.

Today, 70% of that electricity is produced from thermal power generation—and as one of the most reliable, well developed and widely used form of generation, thermal power is projected to be the mainstay of power source to meet the country's needs for years to come. While the government's new energy policy calls for greater use of solar power and other renewables, thermal power plants will long continue to play a central role in securing stable energy supply.

That is why Toshiba is promoting a range of technical approaches to provide sustainable power through thermal power in India.

Improved generation efficiency demonstrate solutions to problematic CO₂ emissions

The power industry is increasingly called on to reduce carbon dioxide emissions, including those from coal-fired power plants. There are two main approaches, one centering on improving generation efficiency. Increasing steam temperatures and pressure allows plant to produce electricity more efficiently, meaning that there will be less consumption of fuel (coal) and lower emissions of carbon dioxide.



Toshiba continues to make considerable progress in developing thermal power technologies that meet both environmental and generation efficiency challenges by operating at very high pressures and temperatures. The steam condition in steam turbines can be categorized into two types: Subcritical (Sub-C) pressure and Super Critical (SC) pressure. The latter was developed over the years, from the initial SC to Ultra Super Critical (USC) and on to Advanced Ultra Super Critical (A-USC). Current state-of-the-art USC plants operate at a steam temperature of 600°C, and the A-USC Toshiba is currently developing is

expected to operate at 700°C—this will further improve generation efficiency and cut CO₂ emissions by a further 10%. Toshiba participated in the A-USC development project from 2008 to 2016, working to establish nickel-based alloy technologies for 700°C class steam turbines, and achieved excellent results. Currently, Toshiba is promoting R&D to improve the reliability of those A-USC technologies.

Technology to capture CO₂

The second approach is focused on capturing and sequestering CO₂ produced during thermal power generation to prevent it entering the atmosphere. There are high expectations for this approach, and it is seen as a bridge from the fossil fuels of the present to a bright green future.

Toshiba is focusing on using an alkaline aqueous amine solution to capture emissions. Its advantage is that it can be applied to existing power plants, but the drawback is that it consumes relatively large energy in the process of capturing CO₂. The company is gathering data on real-world results from a demonstration project at a thermal power plant site in Japan, and working to lower such energy requirements. The technology is now amongst the best in the world in this field.

Another approach Toshiba is investigating is Carbon Capture and Utilization (CCU), which effectively utilizes collected CO₂ to useable products and fuels. Again in Japan, a CO₂ separation and capture system delivered to Saga City, a local government, and installed at a waste incinerator is capturing high purity CO₂ that is used for commercial algae cultivation at a nearby plant factory.



World's First Commercial-Use CCU System

Achieving zero emission:

Revolutionary generation technology to capture CO₂ whilst generating electricity

Of course, the ultimate solution to CO₂ emissions is to eliminate them. In order to achieve this goal, Toshiba is developing the world's first Direct-Fired Supercritical Oxy-Combustion CO₂ Power Cycle Generation System in partnership with U.S. companies—NET Power, LLC., 8 Rivers Capital, CB&I, and Exelon Corporation.



This advanced system achieves the same generating efficiency as a high performance combined-cycle power plant, and also captures CO₂ at high-pressure, securing zero emission without any increase in electricity costs. It is also environmentally-friendly, as the system burns natural gas with oxygen and releases no nitrogen oxide, a source of environmental pollution.

As one of the world's fastest growing economies, India needs to rapidly boost its power generation capacity while drastically lowering emission levels. Toshiba aims to provide solutions to these twin problems by providing industry-leading thermal power equipment technologies and quality **FOR THE NEXT INDIA.**

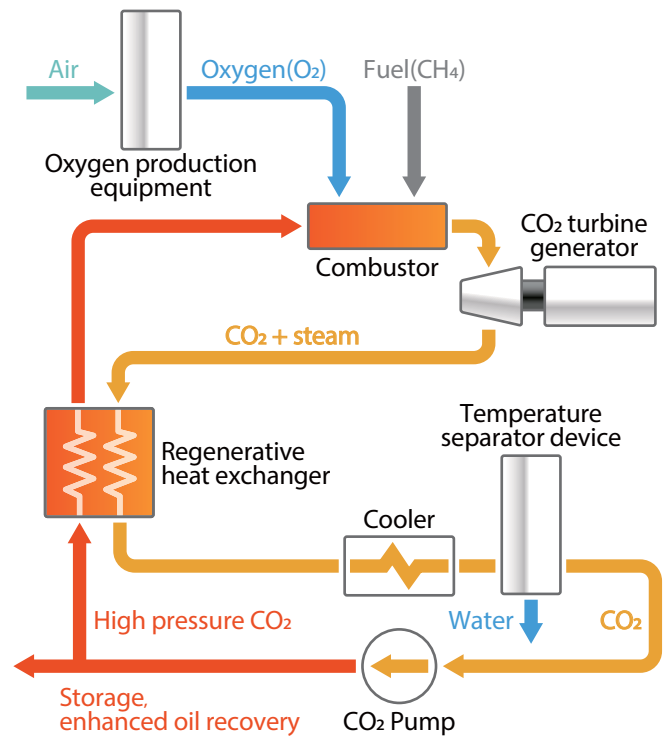


Image of the Supercritical CO₂ Thermal Power Plant System

FOR THE NEXT INDIA