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IIEC International Institute for Energy Conservation
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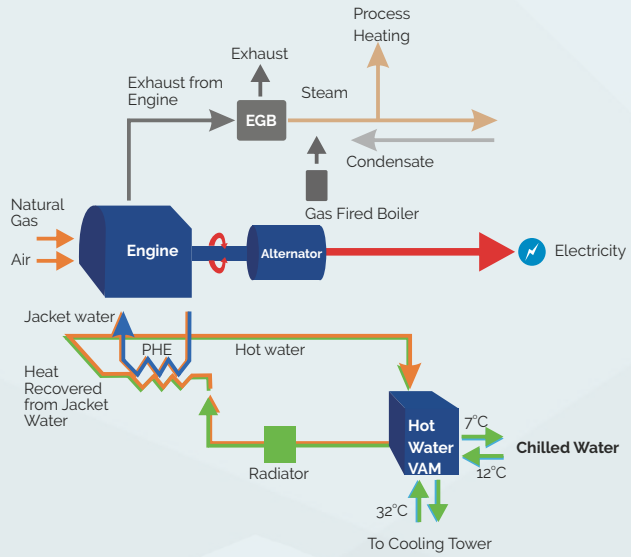
# Tri-generation

Tri-generation technology is a technology that can provide simultaneously three forms of output energy: electrical power, heating and cooling. Trigeneration is also known as CCHP (Combined Cooling, Heating and Power) or CHRP (Combined Heating, Refrigeration and Power). In essence, trigeneration systems are CHP (Combined Heat and Power) or co-generation systems, integrated with a thermally driven refrigeration system to provide cooling as well as electrical power and heating. CHP systems consist of a power system which can be an internal combustion engine driven by a fossil fuel or a biofuel, an external combustion engine or other thermally or chemically driven systems coupled to a generator which produces electricity. A heat recovery system recovers heat from the power system and exhaust gases to be used for heating applications. Effective operation of CHP systems requires maximum utilisation of both electrical power and heat. Where there are seasonal variations in heat demand, the utilisation efficiency of CHP systems can be increased if the excess heat is used to power thermally driven refrigeration technologies. Trigeneration systems can have overall efficiencies as high as 90% compared to 33%-35% for electricity generated in central power plants.

## Schematic of a tri-generation system




## Tri-generation Application and Potential End Use

| Output energy | Application | Suitable Building type |
|---|---|---|
| Electricity + Heat + Cooling | Electricity and heat generation from gas. Can be used for better utilization of biogas. | Campus, society, shopping complex, large developments with multiple building types. |

# Advantage of Tri-generation

- Cost Saving
- High operating efficiency
- Reduced electricity consumption
- Environment friendly
- Buffer against increase in electricity cost
- Reliable and good quality uninterrupted supply of power, cooling and heating
- Less dependence on grid power availability or captive power plants

## Suitability

- Suitable to local context but requires intense planning.
- Some of the potential consumers of the technology are commercial establishments such as hospitals, hotels, shopping malls and technology parks; industries such as dairy, food and beverage, and pharmaceuticals; and large engineering manufacturing facilities.

## Market Feasibility

- Proven technology
- Same equipment can be used to generate cooling, hot water, and electricity in a building

As per Energy Efficiency Services Limited (EESL), trigeneration can reduce the end user's primary energy demand by 60-70 per cent, increase overall energy efficiency by almost 75 per cent, and cut greenhouse gas emissions by up to 30 per cent. The trigeneration system can provide 300 tonnes of refrigeration for every MW of power it generates, saving up to 195 kW of electricity, and eliminating the need for investments in centralised cooling equipment and hot water boilers. Further, by creating a parallel source of electricity through captive generation, trigeneration can protect consumers against surging tariffs.

According to the IEA's Energy Policy Review Report the potential of trigeneration technology in India's energy scenario is estimated at 15 GW, which can be scaled up to 30 GW over the next five years. Tapping into this potential will require an investment of Rs 9 trillion across the building and industry sectors, resulting in an annual emission reduction of 32.2 million tonnes.

A trigeneration system consisting of an internal combustion (IC) engine integrated with biomass gasification may offer a combination for delivering heat, electricity and cooling cleanly and economically. The producer gas generated by the gasifier is used to provide electricity for building use via the IC engine. The waste heat is recovered from the engine cooling system and exhaust gases to supply hot water to space heating, excess heat is also used to drive an absorption cooling system. The proposed system is designed to meet the energy requirements for selected commercial buildings and district heating/cooling applications.

## Major suppliers of Tri-generation

- EPSL Trigeneration Pvt. Ltd.
- Clarke Energy India Pvt. Ltd.
- Anama Energies Pvt. Ltd.
- Green Power International (GPI)

## Case Study

| | |
|---|---|
| **Case study** | Pushpanjali Cross lay Hospital |
| **Location** | Ghaziabad, India |
| **Climate Type** | Composite |
| **Building Type** | Hospital; 400 bed tertiary care |
| **Area** | 5000 sq. mt. |
| **System Description** | Tri generation system<br>1000 TR air conditioning load.<br>Components to meet the heating and cooling loads include a gas genset (1.7 MW), 600 TR capacity Vapour Absorption Machines (VAM) with heat recovery, and electrical chillers of 400 TR capacity. |
| **System Cost** | Total capital cost including DG backup was 9 crore INR. Additional capital investment for the Tri generation system was nearly 3.4 crore INR. Cost of power generated through the Tri generation system (using natural gas) is 3.4 INR/ kW. Net savings of 3.8 INR/ kW or approximately 3 crore INR annually is achieved through this system. |
| **System Performance** | The system provides uninterrupted and reliable power supply, without any fluctuations to the hospital. Power supplied by natural gas is more environmentally friendly than the coal-based power supplied through the grid. Operating cost of this system is 1.36 lakhs INR per day compared to 2.25 lakh INR for using electrical chillers running on grid supply. |