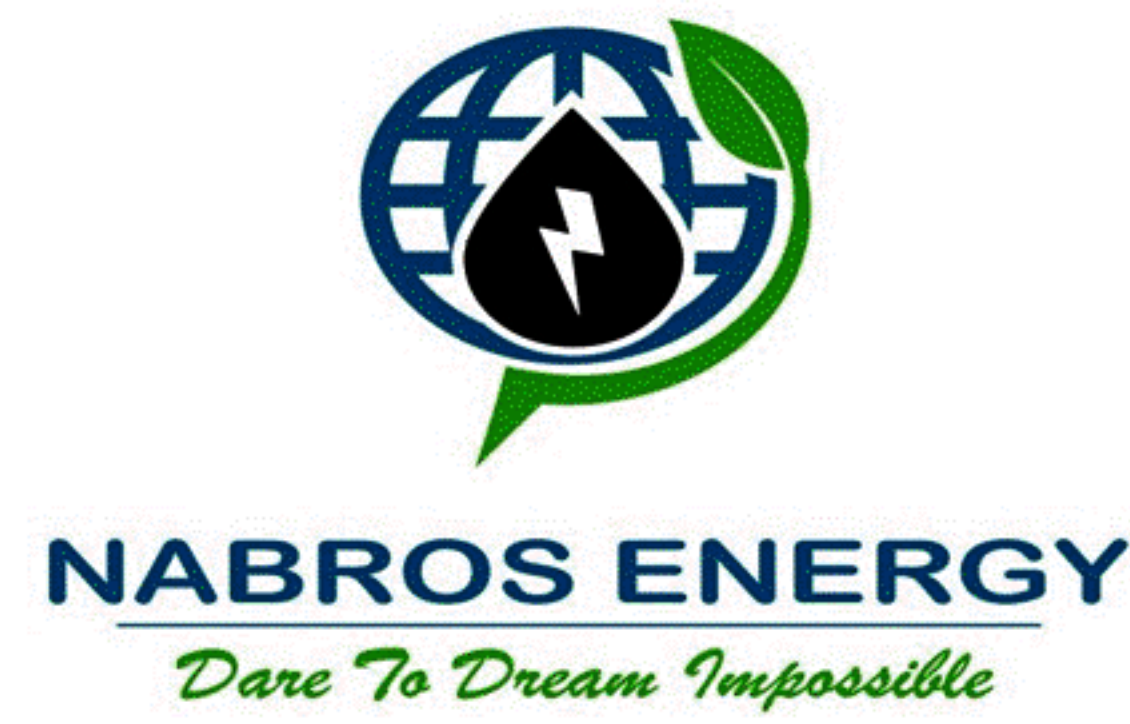


POTENTIAL OF ALLAM CYCLE WITH NATURAL GAS TO REDUCE CARBON DIOXIDE EMISSION IN INDIA



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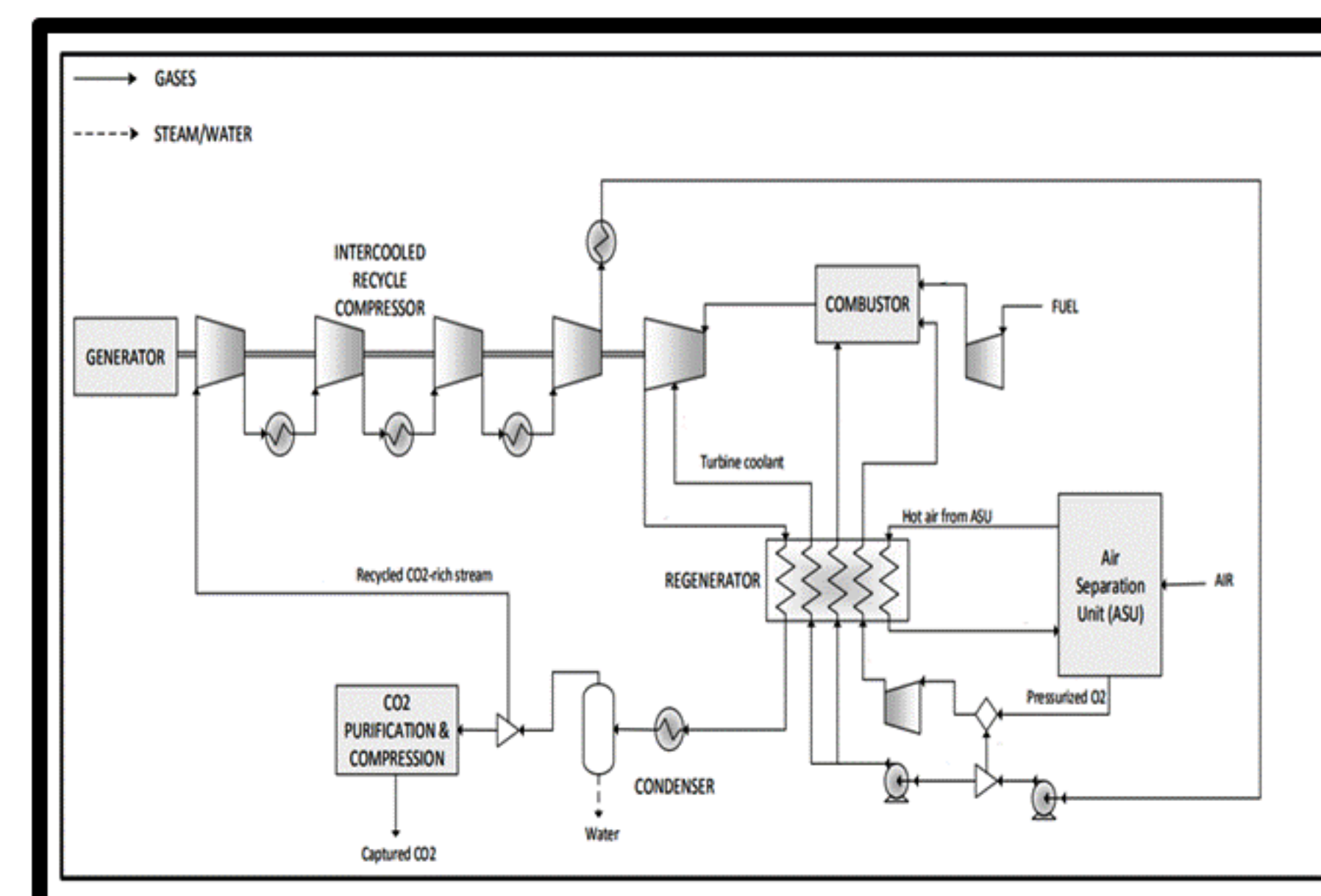


Introduction

- The utility electricity sector in India has one national grid with an installed capacity of 330.86 GW as on 31 December 2017, of which 66.2 % is fossil fuel based. The utility electricity sector in India emitted 2066.01 Mt CO₂ in 2015.
- India is one of the fast-growing economies and power demand will also be high in future. India is also committed to reduce greenhouse gas emission level by 33 % in 2030 as compare to 2005. Allam cycle is newly developed complete green energy power cycle with nearly 59 % efficiency.
- CO₂ emission from coal is 214.3 pounds, and 117 pounds from natural gas, per million British Thermal Unit (BTU). CO₂ emission is less in case of natural gas compare to coal.
- This paper shows the thermodynamic analysis of natural gas based Allam cycle and NTPC (Dadri) combined gas power plant. This paper also shows the comparison of thermal efficiency, exergy destruction in all component for both cycles.
- This paper also highlights the possibility of reduction in CO₂ emission by newly developed Allam power cycle

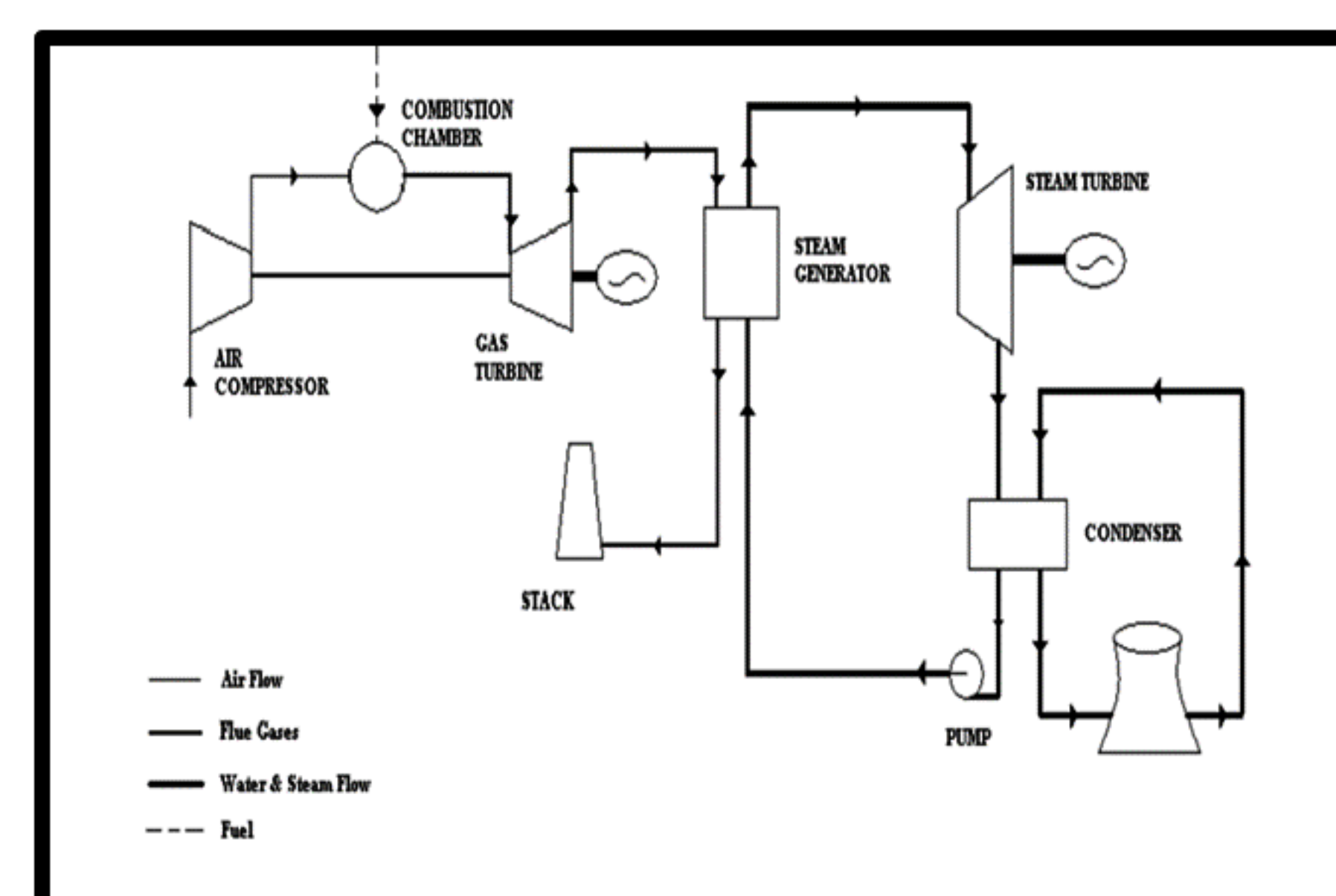
Allam Power Cycle

- The Allam cycle is a novel CO₂, oxy-fuel power cycle.
- Allam cycle is a process to convert fossil fuel into mechanical power and capturing the generated carbon dioxide plus water.
- Type of fuel used in combustion process is natural gas or gasifier coal. The Allam cycle uses a single turbine, driven by mixture of water and carbon dioxide, as working fluid. Use of pure oxygen (99.5%) instead of air in combustion resulted in 97% CO₂ at combustion outlet.
- The exhaust gas is cooled in heat exchanger, and the steam is condensed and separated from the flow, becoming a potential source of fresh water.
- The carbon dioxide is compressed mechanically, and a small amount (matching the added amount of CO₂ from continuous fuel combustion) is captured at high pressure and ready for transmission through pipeline.



Dadri Power Cycle

- NTPC Dadri has both coal and gas fired thermal power plant based in Uttar Pradesh, India.
- In this paper, combined gas power plant has been analysed.
- Combined cycle power station burns natural gas or gasified coal with air to drive a gas turbine and then uses the hot exhaust gas to heat water and drive a steam turbine.
- The gas based plant consists of 4 gas turbines and 2 steam turbines.



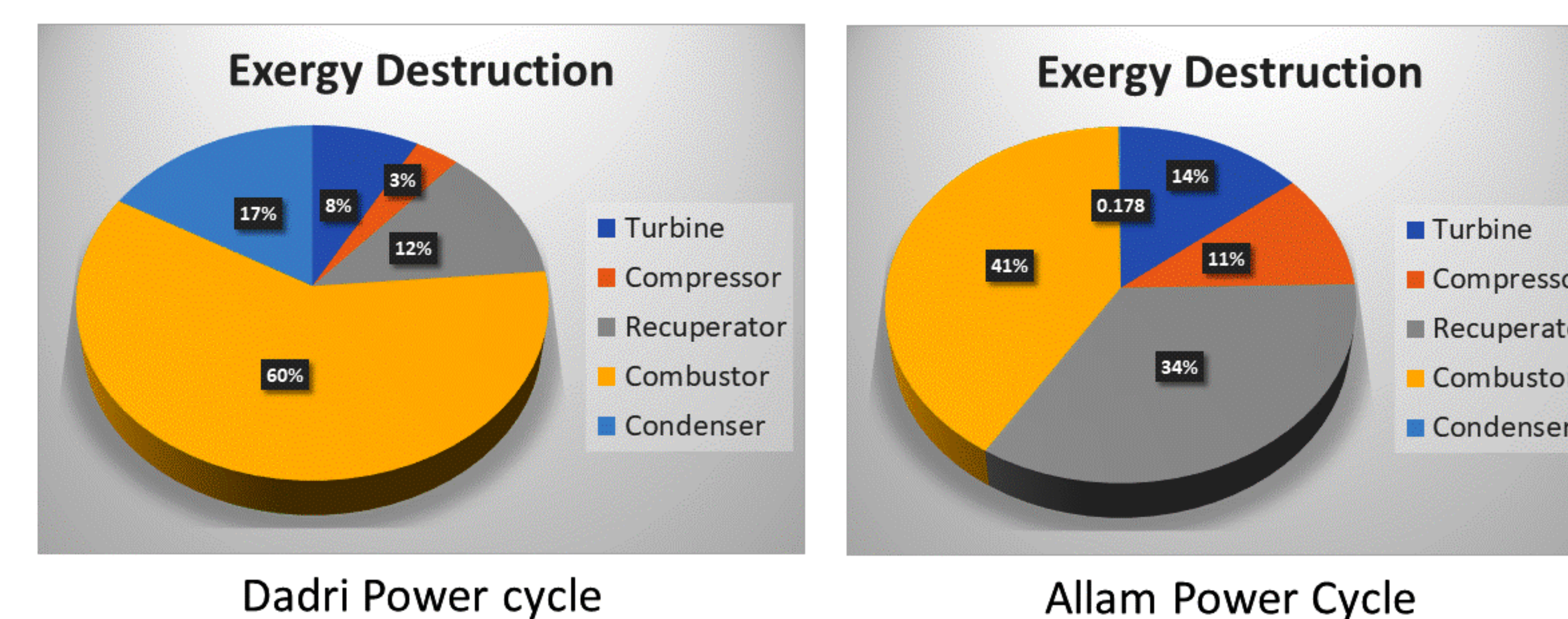
Methodology



First Law & Second Law Analysis

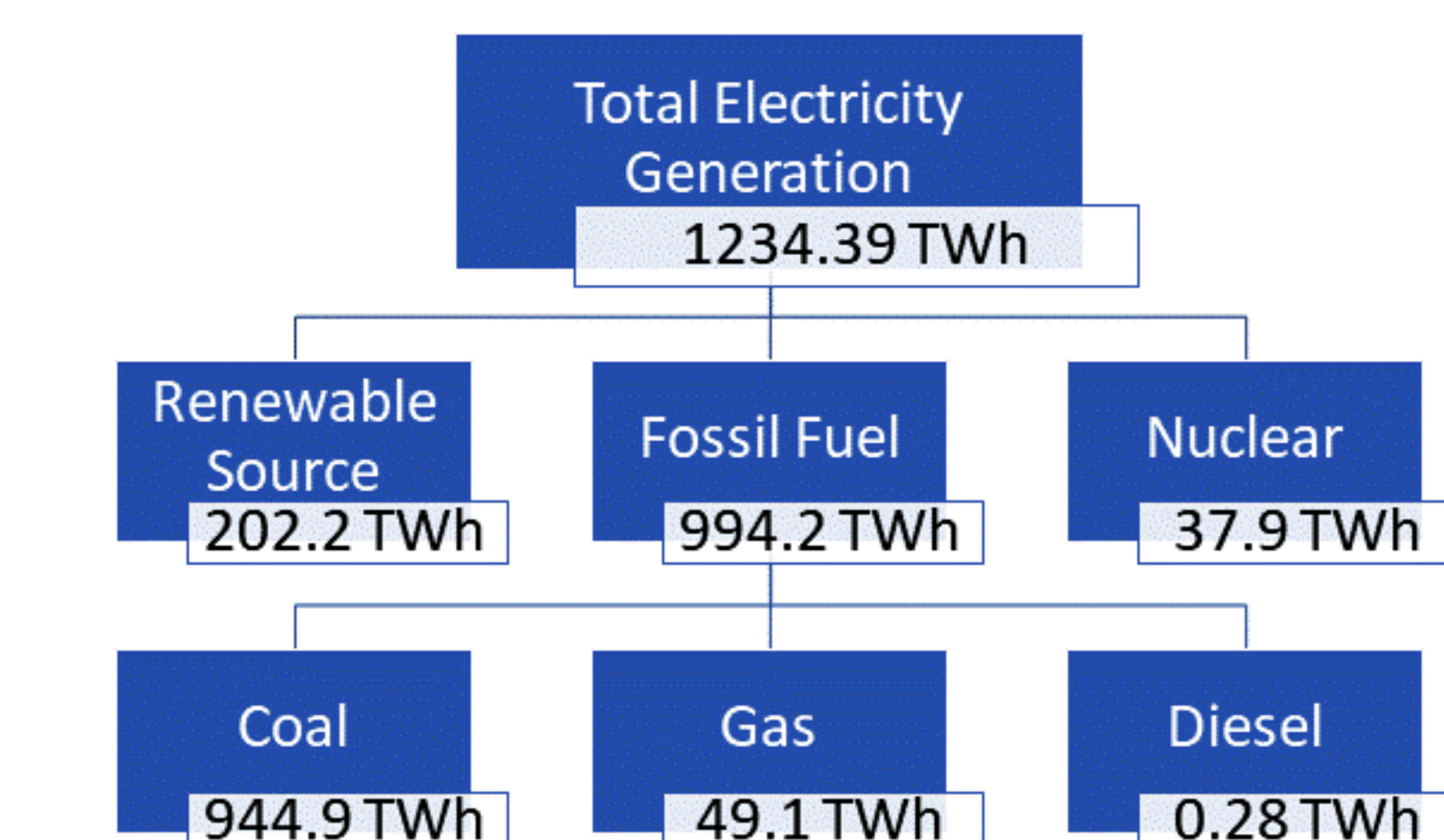
	Allam POWER CYCLE	DADRI POWER CYCLE
First law efficiency	54.6587%	48.17%
Second law efficiency	54.995%	58.61%
Exergy destruction in turbine	40.553 MW	12.562 MW+21.133 MW (gas +steam turbine)
Exergy destruction in compressor	30.092 MW	14.131 MW
Exergy destruction in combustor	91.779 MW	250.062 MW
Exergy destruction in recuperator	117.152 MW	51.392 MW
Exergy loss in condenser	0.499 MW	69.522 MW
Gross power generation	640 MW	640 MW

Exergy Destruction



Result & Discussion

- In Allam Cycle Carbon dioxide is the main constituent of the working fluid and highly efficient for driving a turbine, when reaches to its supercritical state in the combustion unit. Energy losses from phase transitions of water can be avoided, which allows Allam cycle plants to recover more energy in their heat exchangers as compare to combined cycle plants. With 59% efficiency, carbon dioxide capture is already a part of the Allam cycle, whereas in conventional plants, the capture must be added as an external function, that decreases the overall efficiency approximately by 10 %.
- Gas power plant installed Capacity is 25,329.38 MW in India, which is 7.66 % of total installed power capacity. Electricity generation by gas is 49,094 GWh in India as of Fiscal Year 2016-17, which is 4 % of total electricity generation.



Electricity generation by source in India in FY 2016-17

Conclusion

- The Study shows, 18.8 % (by mass) reduced fuel consumption in Allam cycle as compare to combined power generation cycle for gross power generation of 640 MW, that leads to 18.8% less CO₂ production.
- It is estimated that use of Allam power cycle for gas based power plant will reduce CO₂ generation by 0.93 % in India. As Allam Power Cycle being 100% carbon capturing process (Green Energy), CO₂ emission will reduce by 4.93% of total CO₂ emission.
- Government of India has taken various measures to reduce environmental emissions of greenhouse gases from thermal power generation. If we convert all gas and coal based power plant to Allam power cycle, that will result in nearly 40 % - 44% reduction in greenhouse gases emission.

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