SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution

Coimbatore-35

23GET102 – Basic Civil and Mechanical Engineering

I B.E. CST/ I SEMESTER

UNIT IV : I.C Engines and Power Plant Engineering

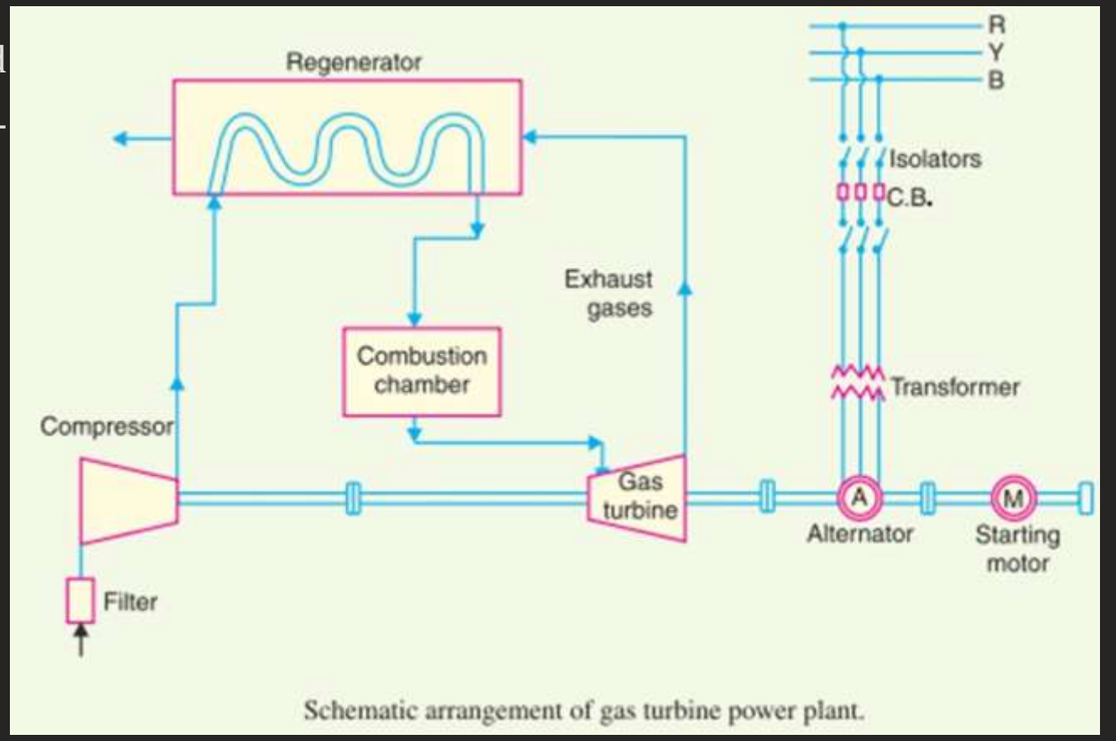
Topic 6 : Gas Power Plant

What Is a Gas Power Plant?

DT-Empathy

Gas power plants burn natural gas to generate electricity through sophisticated gas turbines, converting chemical energy into electrical power through a multi-stage process.

The transformation follows a precise sequence: **chemical energy → thermal energy → mechanical energy → electrical energy**, achieving remarkable efficiency in modern installations.



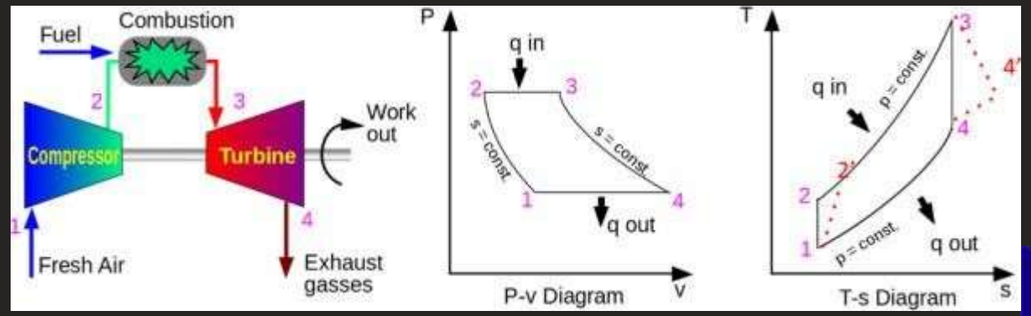
Schematic arrangement of gas turbine power plant.

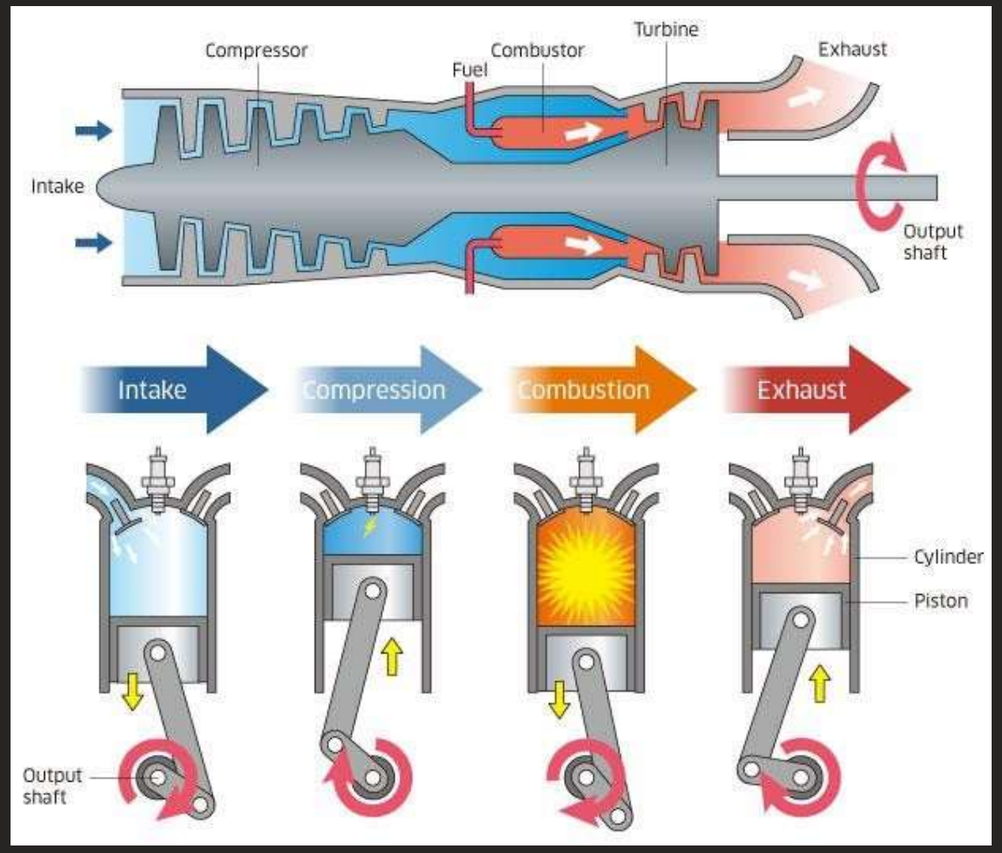
Essential Components

- Compressor: Pressurizes incoming air
- Combustor: Burns natural gas with compressed air
- Turbine: Spins from hot expanding gases
- Generator: Converts mechanical rotation to electricity

How It Works: The Gas Turbine Cycle

DT - Ideate





Air Compression

Compressor pressurizes incoming air to 15-30 times atmospheric pressure, preparing it for combustion.

Combustion

Combustor burns natural gas with compressed air, creating hot expanding gases at extreme temperatures.

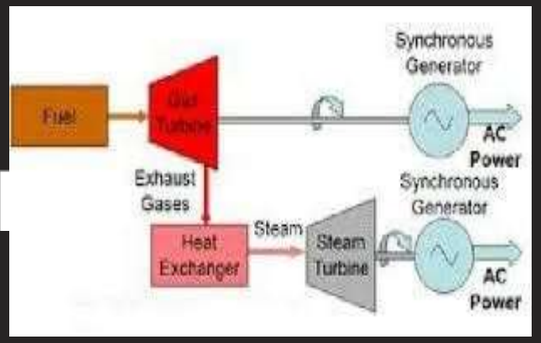
Power Generation

Turbine blades spin from hot gases at high speed, driving the generator to produce electricity.

Exhaust Release

Exhaust gases exit containing waste heat—captured in combined cycle plants for additional power.

Simple Cycle vs Combined Cycle Plants

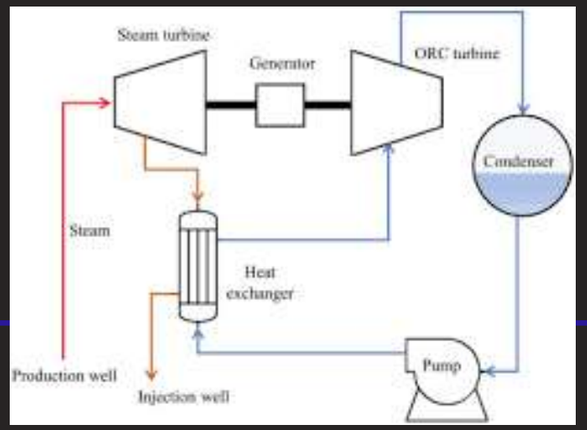


Simple Cycle Plants

Efficiency: 30-35% thermal efficiency

Advantages: Quick start-up capability, responsive to demand spikes

Best Use: Peak power and emergency backup during high-demand periods



Combined Cycle Plants

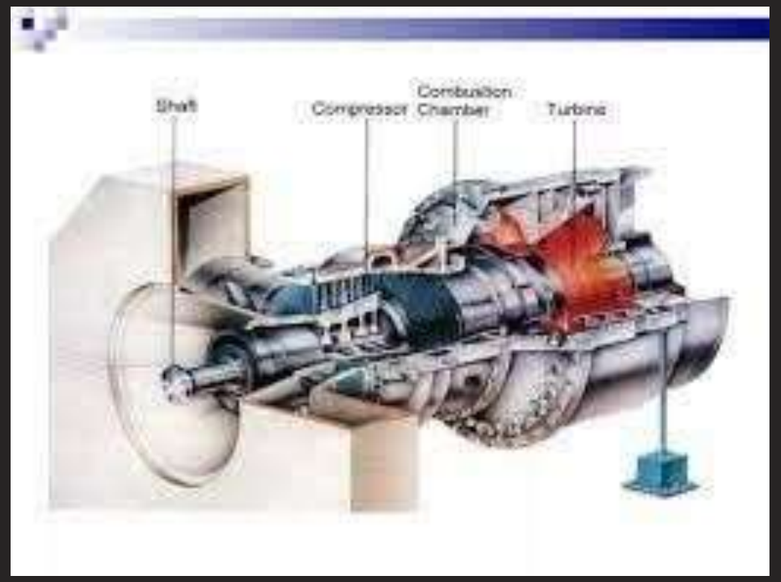
Efficiency: 60-65% thermal efficiency

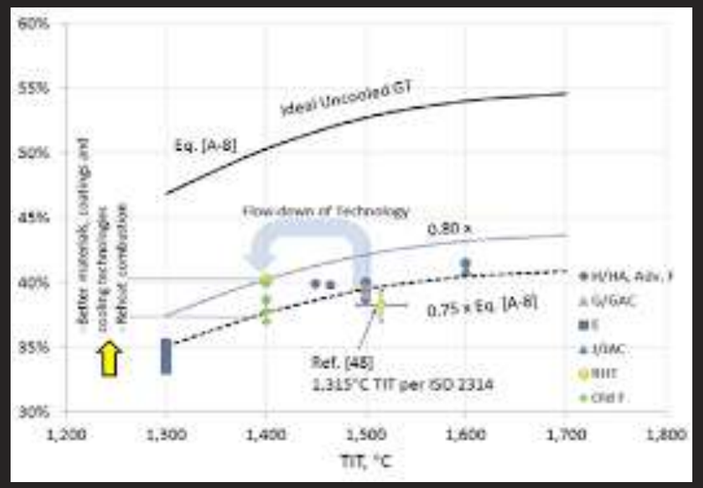
Advantages: Captures exhaust heat to power steam turbine, maximizing fuel use

Best Use: Base load and intermediate power generation with superior economics

Impact: Combined cycle plants produce up to **50% more electricity** from the same amount of fuel, dramatically improving cost-effectiveness and reducing environmental impact per kilowatt-hour generated.

Efficiency Breakthroughs





Extreme Temperatures

Advanced turbines operate at temperatures up to **2600°F**, pushing the boundaries of materials science to extract maximum energy from fuel.

Cooling Innovation

Sophisticated cooling technologies and ceramic coatings protect turbine blades, enabling higher operating temperatures while maintaining durability.

60%+ Efficiency

Modern combined cycle plants achieve thermal efficiency exceeding 60%, significantly reducing fuel consumption and greenhouse gas emissions per unit of electricity.

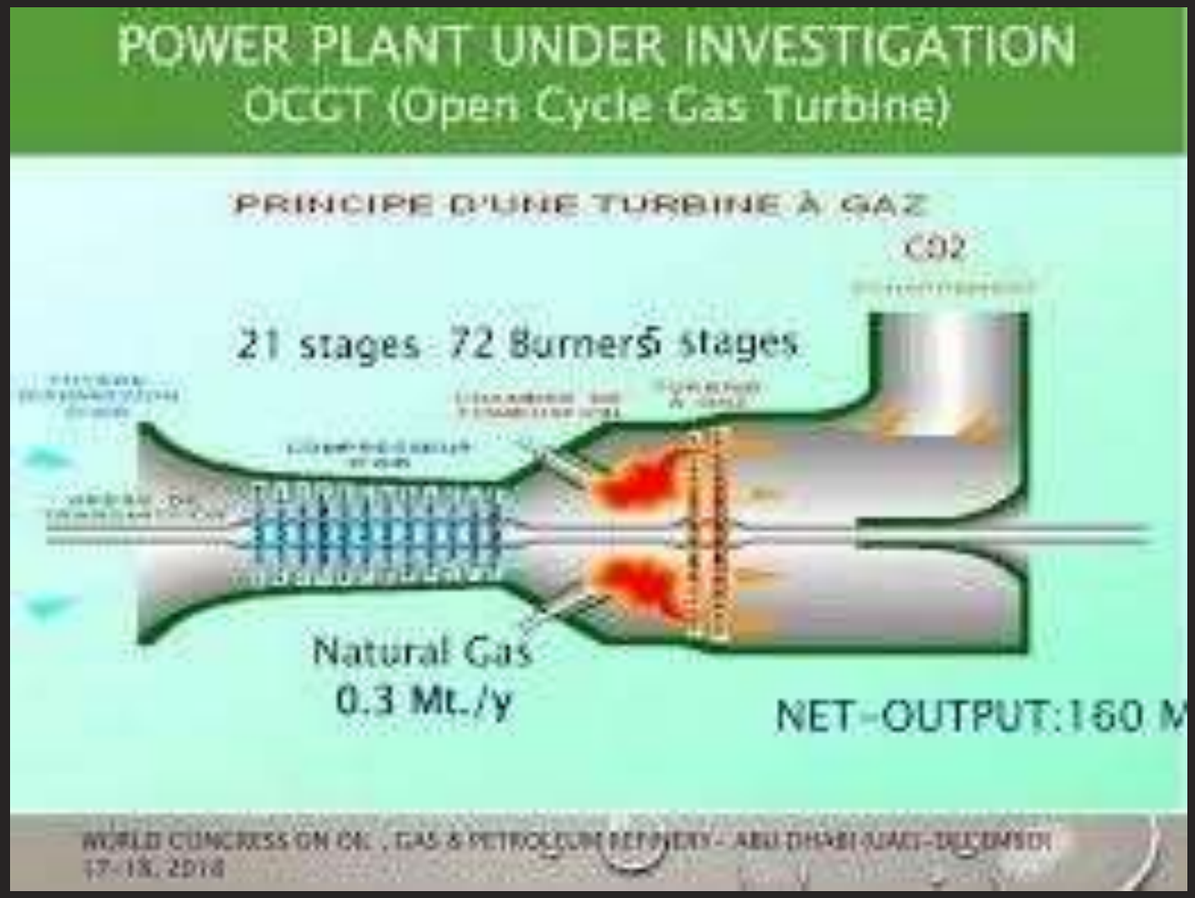
Environmental Impact: Cleaner but Not Clean

The Advantages

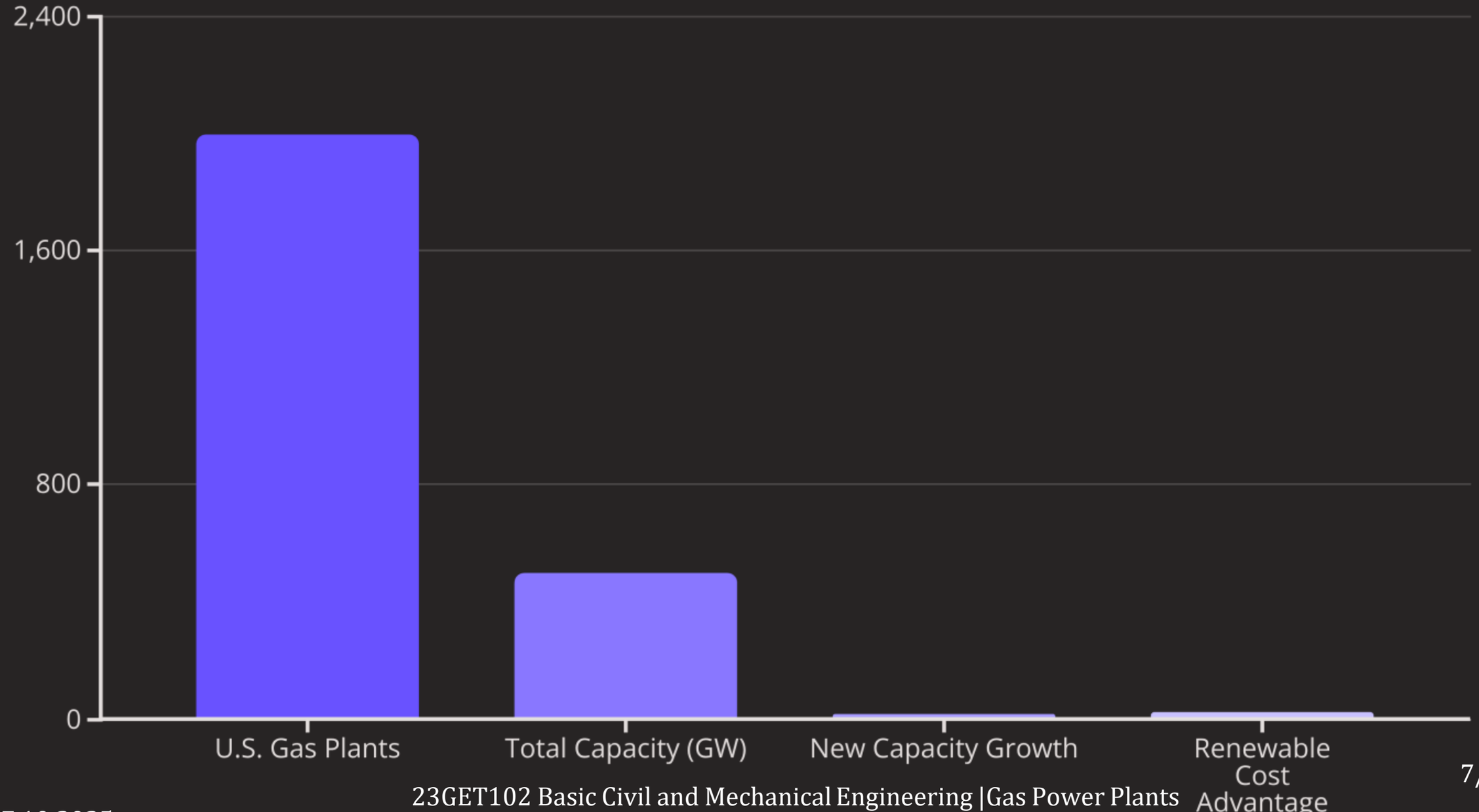
- Emits 50-60% less CO_2 than coal per unit of electricity
- Dramatically lower NOx, SOx, and particulate matter emissions
- Cleaner combustion with fewer toxic byproducts
- Reduced mercury and heavy metal emissions

The Challenges

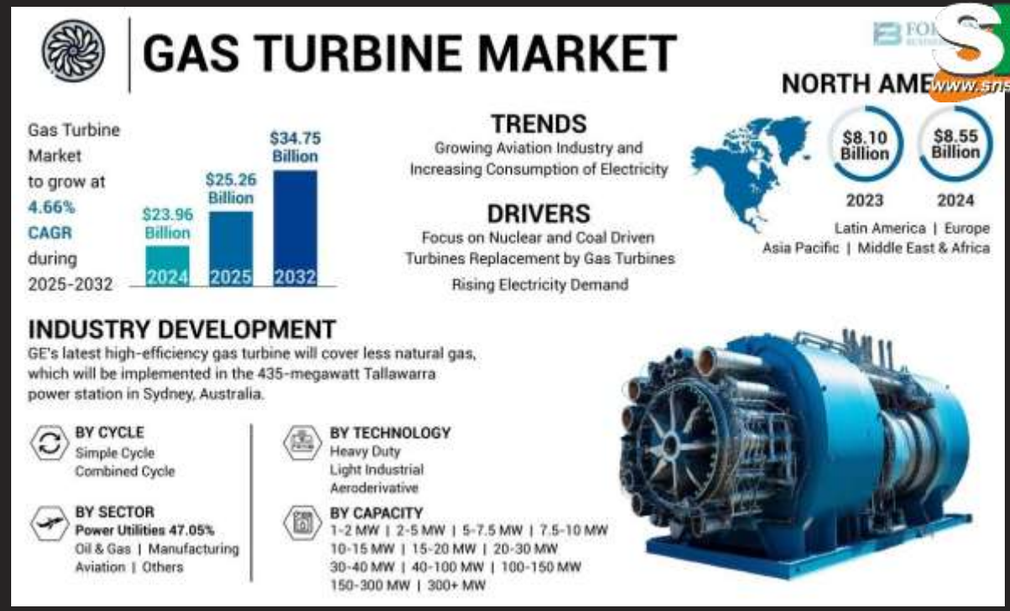
- Still produces significant CO_2 emissions contributing to climate change
- Methane leaks during extraction, processing, and transport
- Gas plants account for ~23% of global electricity generation
- Not a long-term solution for carbon-neutral energy goals



Current Trends and Challenges



The Future of Gas Power Plants



1

2024-2030

Advanced Turbines: Next-generation turbines with higher efficiency ratings and lower emissions profiles enter commercial operation.

2

2030-2040

Hydrogen Blending: Gas plants increasingly blend hydrogen with natural gas, reducing carbon intensity while maintaining reliability.

3

2040-2050

Full Transition: Combined heat and power (CHP) systems and cogeneration maximize overall energy efficiency as grid transforms.

The transition requires balancing emissions reduction with grid reliability—gas plants will play a critical role during the decades-long shift to renewable-dominant energy systems, serving as flexible backup and stabilization resources.

Conclusion: Balancing Power and Planet

Essential Today

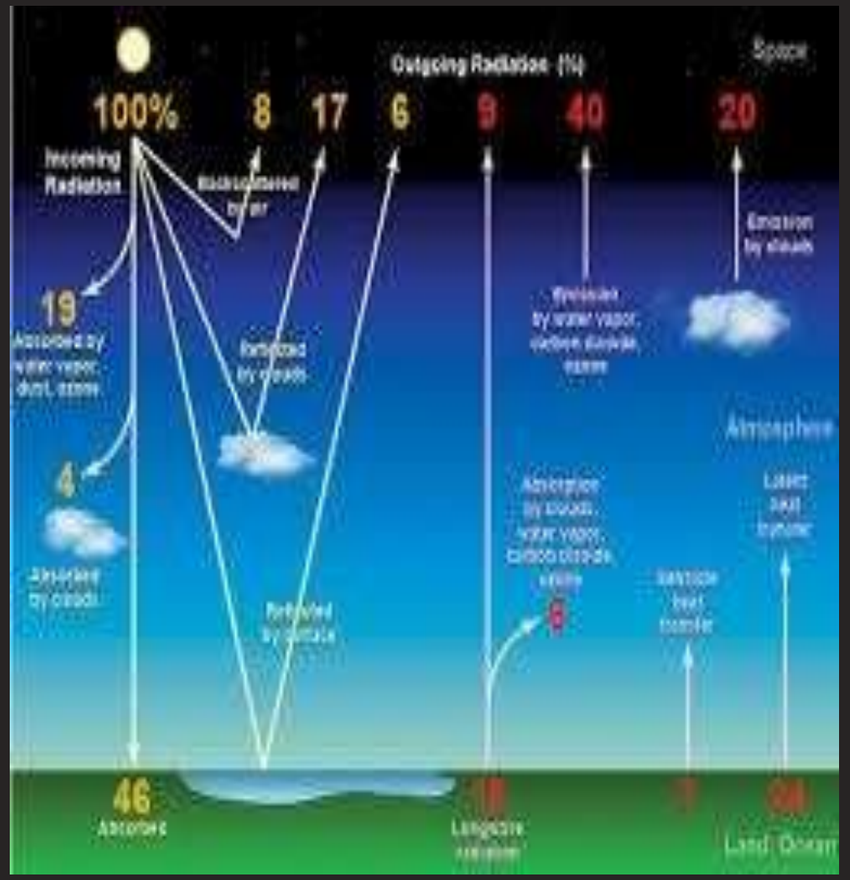
Gas power plants provide vital reliable electricity, ensuring grid stability and meeting baseload and peak demand across the globe.

Progress Made

Efficiency gains, emissions controls, and combined cycle technology significantly improve performance, but don't eliminate climate impact.

Future Forward

The path ahead requires integrating cleaner energy sources, hydrogen blending, carbon capture, and smarter grid management strategies.



The Challenge: Gas power represents a critical bridge technology—cleaner than coal, more flexible than nuclear, but still carbon-intensive. Success depends on rapid innovation in storage, renewables, and grid technology to phase out fossil fuels while maintaining energy security.

Assessment- Quiz

1. The Missing Step PuzzleQuestion:Fill in the missing component in the sequence:Air Compressor → ? → Turbine → ExhaustAnswer:✅ Combustion ChamberExplanation:After the air is compressed, fuel is added and burned in the combustion chamber, producing high-temperature, high-pressure gases that drive the turbine.

2. The Energy Thief PuzzleQuestion:In a simple gas turbine plant, 1000 kJ of heat is added, and 400 kJ of work is produced.Where did the missing 600 kJ go?Answer:✅ Lost as heat in exhaust gases and system losses.Explanation:A gas turbine exhaust carries a lot of heat that is not converted into work — part of it can be recovered in a combined cycle using a heat recovery steam generator (HRSG).

The Pressure Drop PuzzleQuestion:If there's a pressure loss in the combustion chamber, what happens to the turbine output?Answer:✅ Turbine output decreases.Explanation:Less pressure at turbine inlet means less expansion and therefore less work done — overall cycle efficiency drops.

References

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