

Natural Gas, Formation, Sources, Distribution, Uses, Economy

May 25, 2026 • vajiramandravi.com



Natural Gas is one of the most important fossil fuels used in the modern energy system. It plays a crucial role in electricity generation, industrial production, domestic energy use, and fertilizer manufacturing. Compared to coal and oil, Natural Gas burns more cleanly and emits lower levels of air pollutants, making it a preferred transition fuel for many economies. Globally, Natural Gas contributes about one-fourth of total energy consumption, while India is gradually increasing its reliance on gas to reduce dependence on coal and imported crude oil. Its growing importance is closely linked with energy security, economic growth, and environmental concerns.

Natural Gas

Natural Gas is a naturally occurring hydrocarbon fuel found in underground geological formations, often alongside petroleum. It mainly consists of methane, usually around 95%, along with small quantities of propane, butane, pentane, hexane, carbon dioxide, nitrogen, hydrogen sulfide, and helium. It is colorless and odorless in its natural form, and for safety purposes, odorants like mercaptans are added before distribution. In the market, Natural Gas is traded based on its calorific value rather than volume, commonly measured in MMBTU, where one MMBTU is approximately equal to 1,000 cubic feet of Natural Gas.

Natural Gas Formation Process

Natural Gas forms through the slow transformation of buried organic matter under heat and pressure over millions of years deep underground.

- **Burial of Organic Matter:** Tiny marine plants and animals, along with terrestrial vegetation, got buried under layers of sand, silt, and rock millions of years ago, preventing oxygen exposure and slowing decomposition.
- **Heat and Pressure Action:** Continuous accumulation of sediments increased temperature and pressure, breaking complex organic compounds into simpler hydrocarbons, storing solar energy originally captured through photosynthesis.
- **Thermogenic Gas Formation:** At greater depths and higher temperatures, organic matter converted into methane rich Natural Gas, often alongside crude oil, making gas an important fossil fuel resource.
- **Biogenic Gas Formation:** In shallow sediments, microorganisms called methanogens produced methane by decomposing organic matter, contributing to gas deposits like coalbed methane.
- **Migration and Trapping:** Natural Gas migrated through porous rocks and accumulated under impermeable layers, forming reservoirs that could be associated with oil or exist independently.

Natural Gas Sources

Natural Gas is obtained from different geological settings, depending on whether it occurs with oil or independently.

- **Associated Gas:** This gas occurs along with crude oil, either dissolved in oil or as a gas cap above oil reservoirs, and is also known as wet gas due to heavier hydrocarbons.
- **Non Associated Gas:** Found in reservoirs containing only gas and no oil, this dry gas mainly consists of methane and is easier to process for direct consumption.
- **Sour Gas:** Natural Gas containing significant hydrogen sulfide or sulfur compounds is termed sour gas and requires extensive processing before use.
- **Sweet Gas:** Coalbed methane is known as sweet gas because it lacks hydrogen sulfide, making it less corrosive and easier to handle.
- **Unconventional Sources:** Shale gas, tight gas, and coalbed methane have become important sources, especially in countries like the United States and China.

Natural Gas Global Distribution

Natural Gas reserves are unevenly distributed across the world, concentrated in specific geological basins.

- **Russia:** Russia has the world's largest Natural Gas reserves, estimated at about 1,680 trillion cubic feet, with major fields in West Siberia and near the Arctic Circle.
- **Middle East:** Iran and Qatar hold the second and third largest reserves globally, with the South Pars-North Dome field being the world's largest gas field.
- **North America:** The United States has proven reserves of about 273 trillion cubic feet, with major fields like Hugoton spanning Oklahoma, Texas, and Kansas.

- Europe: The North Sea, especially off Norway and the Dutch coast, contains significant gas reserves that support European energy needs.
- Africa and Asia: Algeria's central basin, Nigeria's Niger Delta, and Indonesia's North Sumatra basin are major gas producing regions in Africa and Asia.

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Natural Gas Distribution in India

India's Natural Gas reserves are spread across onshore and offshore basins, with increasing exploration in recent decades.

- Western Offshore Fields: Bombay High and Bassein fields near Mumbai are major contributors, supplying gas for power generation and industrial use.
- Eastern Offshore Basins: The Krishna-Godavari basin holds deep water gas discoveries, including a major 2002 find estimated at 14 trillion cubic feet.
- Onshore Basins: Assam, Tripura, and Gujarat have long standing gas fields that supported India's early gas industry since the 1960s.
- Southern and Eastern Regions: Cuddalore district in Tamil Nadu and offshore Odisha have notable gas reserves contributing to regional energy supply.
- Future Potential Areas: Andaman and Nicobar Islands are estimated to hold up to 1,700 billion cubic meters of gas based on remote sensing, though commercial viability is yet to be established.

Natural Gas Organizations

International and national organizations play a major role in shaping Natural Gas production, pricing, and policy.

- **Organization of Petroleum Exporting Countries (OPEC):**
 - OPEC Role: The Organization of Petroleum Exporting Countries is a 12 member cartel that coordinates oil production policies, indirectly influencing gas markets linked to oil pricing.
 - OPEC Members: Countries like Saudi Arabia, Iran, Iraq, Venezuela, and Qatar use coordinated supply control to maintain higher profit margins in global energy markets.
- **Oil and Natural Gas Corporation India (ONGC):**
 - ONGC Background: Oil and Natural Gas Corporation is a Maharatna PSU under India's Ministry of Petroleum and Natural Gas, established in 1995.
 - ONGC Contribution: ONGC accounts for around 70% of India's domestic crude oil and Natural Gas production and is among India's highest profit making corporations.
 - ONGC Videsh: The international arm of ONGC operates in 16 countries, with major exploration projects in Vietnam, Iran, Africa, and Latin America.

Natural Gas Uses

Natural Gas is a versatile fuel used across multiple sectors due to its efficiency and cleaner combustion.

- **Power Generation:** Gas fired power plants generate over 20% of global electricity, providing reliable and flexible energy to balance renewable sources.
- **Domestic Use:** Natural Gas is widely used for cooking, heating, and water heating, producing high temperatures and efficient energy for households.
- **Transportation Fuel:** Compressed Natural Gas is used in buses, cars, and commercial fleets, offering a cheaper and cleaner alternative to petrol and diesel.
- **Fertilizer Industry:** Methane derived hydrogen is used to manufacture ammonia, which is essential for producing urea and nitrogen based fertilizers.
- **Industrial Applications:** Natural Gas is used in making glass, steel, plastics, dyes, inks, rubber products, and as fuel for industrial heating processes.

Natural Gas Economy

Natural Gas significantly influences national economies, energy security, and long term development strategies.

- **Energy Basket Role:** Natural Gas contributes about 25% of global energy consumption, while India currently uses only about 6%, aiming for 15% by 2030.
- **Indian Consumption Pattern:** Nearly 40% of India's gas is used in fertilizers, around 30% in power generation, and the rest in LPG and industries.
- **Import Dependence:** About 55% of India's Natural Gas demand is met through imported LNG, which is costlier and exposes the economy to global price shocks.
- **Infrastructure Development:** India is expanding pipelines through a National Gas Grid of 15,000 kilometers to improve regional access and reduce supply imbalance.
- **Economic and Environmental Impact:** Increasing gas use supports cleaner energy transition, reduces emissions, creates employment, and strengthens India's move toward a gas based economy.

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