

# Role of Renewable Energy in Reducing Industrial Emissions and Mitigating Climate Change

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## Introduction

The relentless pace of industrialization has historically propelled economic growth and development across the globe, yet it has also left a lasting footprint on the environment. Industrial emissions, specifically those resulting from fossil fuel combustion, have been major contributors to Greenhouse Gases (GHGs), resulting in global warming and climate change. As climate-related risks continue to grow, transitioning to sustainable energy sources has become a critical priority. Renewable energy has emerged as a pivotal player in reducing industrial emissions and combating climate change by offering clean, efficient and increasingly cost-effective alternatives to traditional fossil fuels. Industrial emissions arise from several sources, including the burning of fossil fuels for power and heat, emissions from chemical processes and leaks from equipment or operations [1]. Key greenhouse gases-carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O)-are released in high volumes from industries such as manufacturing, cement production, iron and steel making, mining and chemicals production. The industrial sector accounts for about 24% of global greenhouse gas emissions, making it a significant target for climate change mitigation efforts. The cumulative effect of these emissions has been a steady increase in atmospheric GHG concentrations, contributing to rising global temperatures, melting polar ice caps, sea-level rise and erratic weather patterns. Reducing these emissions is vital for meeting international climate goals, including those set by the Paris Agreement, which aims to limit global warming to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C.

## Description

### The role of renewable energy in emissions reduction

Renewable energy sources such as solar, wind, hydroelectric, geothermal and biomass offer clean energy alternatives to fossil fuels. By replacing fossil fuels with renewable sources, industries can reduce their reliance on carbon-intensive energy, thus significantly reducing CO<sub>2</sub> emissions [2].

**Solar power:** Solar energy is one of the most widely adopted renewable energy sources, offering industries the ability to generate electricity and heat without carbon emissions. Photovoltaic (PV) panels can be installed on factory rooftops, parking structures, or nearby land to meet a significant portion of energy needs. As solar technology continues to improve, costs decrease and storage solutions evolve, solar power has become more viable even for energy-intensive industries, allowing them to cut emissions and, over time, save on operational costs.

**Wind power:** Wind energy is another major renewable source that industries are increasingly tapping into, especially in regions with favorable wind conditions. Wind turbines, whether onshore or offshore, generate

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electricity that can power operations, reducing the need for fossil fuels. As wind power grows, more industrial sectors are using it as a primary or supplementary energy source to stabilize energy costs and reduce emissions.

**Hydroelectric power:** Hydroelectric power provides a reliable and steady flow of energy that can supply industrial operations with significant amounts of electricity. However, its use is often limited by geographical constraints. Hydroelectricity remains an excellent option in areas with access to water sources and a low environmental impact from infrastructure, providing consistent and low-emission energy [3].

**Geothermal energy:** Geothermal energy offers a consistent and highly efficient energy source with a minimal environmental footprint. Industries requiring high amounts of heat, such as paper manufacturing and food processing, can benefit from geothermal solutions to meet heating and cooling needs, reducing emissions significantly.

**Biomass and bioenergy:** Biomass energy, derived from organic materials such as agricultural waste, wood and biofuels, is another renewable option for industrial use. By repurposing waste materials into energy, industries can reduce reliance on fossil fuels, thus lowering emissions. Bioenergy can also be tailored to serve as a flexible, on-demand energy source, complementing intermittent renewables like solar and wind.

### Challenges of integrating renewable energy into industrial sectors

While renewable energy has proven effective in reducing emissions, its integration into industrial sectors faces several challenges [4]:

**Energy storage and reliability:** Many renewable sources, such as solar and wind, are intermittent. Advances in energy storage technology are essential to provide a steady energy supply to industries with consistent energy demands.

**High initial costs:** Renewable infrastructure, such as solar panels and wind turbines, can require significant initial investment. Although these costs have been decreasing, upfront capital remains a barrier, particularly for small and medium-sized enterprises (SMEs).

**Grid infrastructure and connectivity:** In regions where renewable energy infrastructure is underdeveloped, industries may face challenges accessing renewable power or connecting renewable sources to their facilities. Upgrading grid systems and developing microgrids are critical to improving renewable energy access.

**Policy and regulatory barriers:** Inconsistent or insufficient policy support can hinder renewable adoption in industrial settings. Incentives, subsidies and supportive policies are essential to accelerating the transition to clean energy.

### Policy and regulatory support for renewable energy adoption

For renewable energy to become a mainstream solution in the industrial sector, strong policy and regulatory frameworks are essential. Governments and international organizations can drive the transition by:

**Providing subsidies and incentives:** Financial incentives, such as tax credits, grants and subsidies for renewable energy adoption, can reduce initial costs and encourage industries to shift toward cleaner energy sources.

**Implementing carbon pricing mechanisms:** Carbon taxes and cap-

and-trade programs place a financial cost on carbon emissions, incentivizing companies to reduce emissions and seek renewable energy solutions.

**Setting renewable energy targets:** National and regional renewable energy targets can drive industries to incorporate renewables into their energy mix, while also creating market certainty and driving investment in clean technologies.

**Streamlining regulatory approvals:** Simplifying the regulatory approval process for renewable energy installations, such as permits for wind and solar farms, can facilitate faster and more widespread adoption.

### Successful industrial applications of renewable energy

**Apple's renewable energy initiative:** Apple has achieved a significant reduction in emissions by powering its global facilities with 100% renewable energy, including solar, wind and biogas fuel cells. Its suppliers are also working toward 100% renewable energy targets, resulting in substantial emissions reductions across its entire supply chain.

**Siemens gamesa renewable energy:** Siemens Gamesa has implemented wind and solar solutions within its manufacturing processes, reducing its reliance on fossil fuels. This strategy has allowed Siemens Gamesa to serve as a model for other companies in the energy sector, demonstrating the potential of renewable energy to power industrial operations sustainably.

**Unilever's commitment to carbon-neutral manufacturing:** Unilever has adopted renewable energy across its manufacturing facilities, reducing emissions and setting an ambitious goal of reaching carbon neutrality by 2039. This commitment includes sourcing 100% of its energy from renewables and implementing energy efficiency measures [5].

## Conclusion

The role of renewable energy in reducing industrial emissions and combating climate change is indispensable. As technology advances, renewable energy becomes more accessible and economically viable, allowing industries to replace fossil fuels with clean alternatives. Although challenges remain, continued policy support, innovative technologies and successful case studies demonstrate the feasibility of a large-scale industrial transition toward renewable energy. By investing in renewable energy, industries can not only reduce emissions but also achieve long-term energy security, cost savings

and environmental stewardship. Ultimately, renewable energy represents a powerful tool in the fight against climate change, paving the way for a more sustainable and resilient industrial landscape.

## Acknowledgement

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## Conflict of Interest

None.

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