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 - Government Support and Vision
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 - Supporting Government Initiatives
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 - What is Compressed Biogas (CBG)?
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 - How is water scrubbing technology used in this?
 - How Water Scrubbing Technology Works:
 - Advantages of Water Scrubbing Technology:
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- Relevance to the UPSC Prelims and Mains syllabus under the following topics:
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Summary:

- **Inauguration:** Prime Minister Narendra Modi inaugurated GAIL's first Compressed Biogas (CBG) plant in Ranchi, Jharkhand, marking a significant step towards sustainable energy and waste management.
- **Plant Features:** The plant processes 150 tonnes of municipal solid waste daily, producing 5,000 kg of Bio-CNG and 25 tonnes of bio-manure.
- **Environmental Impact:** The project reduces carbon emissions, supports sustainable farming with bio-manure, and promotes a circular economy.
- **Government Initiatives:** The plant aligns with initiatives like Swachh Bharat Mission, Atmanirbhar Bharat, and the goal of Net Zero Carbon by 2038.

What is the news?

- In a major stride toward sustainable energy and waste management, Prime Minister Narendra Modi inaugurated GAIL's first Compressed Biogas (CBG) plant in Ranchi, Jharkhand. This project is a key initiative under the government's broader agenda of promoting clean energy and reducing dependence on fossil fuels.
- The plant, built in partnership with Ranchi Municipal Corporation, converts municipal solid waste into valuable bio-CNG and bio-manure, reinforcing India's commitment to achieving energy security, economic growth, and environmental sustainability.

Key Features of the CBG Plant

- **Location and Capacity:** The plant, located at the Jhir Dumping Site, Jhiri, in Ranchi, processes 150 tonnes of municipal solid waste daily. It has a capacity to produce 5,000 kg of Bio-CNG and 25 tonnes of bio-manure every day. The plant spans over 7.86 acres.
- **Fuel for Vehicles:** The bio-CNG produced will be supplied to nearby CNG stations, enabling them to fuel over 600 vehicles daily. This is a critical contribution to India's Atmanirbhar Bharat initiative, promoting the use of clean and indigenous energy resources.

Partnerships and Technology

- The project is the result of a Concession Agreement signed in March 2021 between GAIL and the Ranchi Municipal Corporation. The entire technology, including gas generation and purification, was designed and executed by CEID Consultants & Engineering Pvt. Ltd. The plant uses water scrubbing technology for purifying the biogas, a method that ensures efficient and eco-friendly gas production.
- The plant relies on wet waste collected from homes, businesses, and other sources by the Ranchi Municipal Corporation. By transforming waste into a valuable resource, the plant promotes a circular economy, in line with government initiatives like Waste to Wealth, Make in India, and Net Zero carbon emissions by 2038.

Government Support and Vision

- During the inauguration, Prime Minister Narendra Modi emphasized that this project represents a significant step in India's energy transition. The government has been promoting renewable energy, including biofuels, solar energy, and hydrogen, to meet future energy demands. The plant not only contributes to waste management but also advances goals related to clean energy, job creation, and rural economic development.

- The Union Minister of State for Defense, Sanjay Seth, and senior officials from GAIL, the Pollution Control Board, PESO, and Ranchi's local administration attended the ceremony, showcasing the collective government and private sector effort toward building a sustainable future.

Environmental and Economic Benefits

The inauguration of GAIL's CBG plant brings multiple environmental and economic benefits to Jharkhand and India as a whole:

- **Reducing Carbon Footprint:** The plant significantly reduces the dependency on fossil fuels, contributing to lower carbon emissions and promoting green energy.
- **Bio-Manure for Agriculture:** The 25 tonnes of bio-manure produced daily can be used as organic fertilizer, improving soil health and fertility in agricultural fields. This supports sustainable farming practices and reduces the need for chemical fertilizers, aligning with the government's goals for organic farming and sustainable agriculture.
- **Local Employment and Economic Boost:** The project creates local employment opportunities by involving the collection, processing, and distribution of waste and bio-products. It is expected to strengthen rural economies, especially by engaging local labor in waste collection and biogas plant operations.
- **Circular Economy:** The plant's ability to convert

waste into fuel and fertilizers represents a move toward a circular economy, where waste products are utilized to generate new resources. This approach not only minimizes waste but also maximizes resource efficiency.

Supporting Government Initiatives

The project aligns with several important government programs and policies:

- **Swachh Bharat Mission (Clean India):** By using municipal waste to generate energy, the plant plays a crucial role in managing waste efficiently.
- **Atmanirbhar Bharat (Self-reliant India):** The plant contributes to India's vision of becoming self-reliant in energy by utilizing domestic resources to produce clean energy.
- **Net Zero Carbon by 2038:** The production of biogas as a renewable energy source is a step toward achieving India's goal of reducing carbon emissions and moving towards net zero carbon by 2038.

Future Expansion Plans

- The success of the Ranchi CBG plant could set the

stage for more such plants across the country. GAIL is expected to continue investing in the CBG sector to enhance India's biogas production capacity, especially in urban areas where waste generation is high. By expanding such projects, India can further reduce its reliance on imported fuels, improve waste management, and create sustainable employment opportunities.

Conclusion: A New Era in India's Energy Transition

- The inauguration of GAIL's first CBG plant in Jharkhand marks a significant achievement in India's journey towards clean energy and sustainable development. It demonstrates how innovative technology and collaboration between government and private entities can address pressing challenges like waste management, energy security, and environmental conservation. With the potential to fuel hundreds of vehicles and generate valuable by-products like bio-manure, this project is not just a leap toward energy self-reliance but also a beacon of environmental responsibility and economic growth.
- As Prime Minister Modi continues to lead India into a new era of clean energy, initiatives like the Ranchi CBG plant highlight the importance of local solutions with global benefits. This project could serve as a model for future developments, reinforcing India's position as a leader in the global fight against climate change and energy insecurity.

What is Compressed Biogas (CBG)?

- It is an emerging renewable energy source that is derived from organic waste materials, providing an eco-friendly alternative to fossil fuels. CBG is produced by compressing the biogas obtained through the anaerobic digestion of biodegradable materials such as agricultural residue, food waste, manure, sewage, and municipal solid waste. Here's a detailed overview of CBG:

Key Features of Compressed Biogas (CBG):

Production Process:

- **Biogas Generation:** Biogas is produced when organic waste undergoes anaerobic digestion (decomposition in the absence of oxygen) by microbes. This process generates methane (CH_4) and carbon dioxide (CO_2), along with trace gases.
- **Purification:** The raw biogas is purified to remove impurities like carbon dioxide, hydrogen sulfide (H_2S), and water vapor, increasing the methane concentration to over 90%.
- **Compression:** After purification, the biogas is compressed to a high pressure to produce Compressed Biogas (CBG), similar to Compressed

Natural Gas (CNG) in composition and energy content.

Composition:

- CBG typically contains 90-98% methane, making it a high-energy, clean-burning fuel.
- It has similar properties to CNG, allowing it to be used as a transportation fuel or for energy generation in industries and households.

Sources of Biogas for CBG:

- Agricultural Waste: Crop residue, animal manure.
- Municipal Solid Waste: Organic fractions of city garbage, food waste.
- Industrial Waste: Effluents from food processing, breweries, and distilleries.
- Sewage: Wastewater treatment plants.

Applications:

- Fuel for Vehicles: CBG can be used in vehicles designed to run on CNG, reducing dependency on petrol and diesel.
- Energy Production: It can be used for generating electricity or heat in industries, and households.
- Fertilizers: The byproducts of biogas production (slurry or digestate) can be used as organic manure, enhancing soil fertility.

Environmental Benefits:

- **Reduction in Greenhouse Gases (GHG):** CBG production captures methane emissions from waste, which is a potent greenhouse gas, thereby reducing GHG emissions.
- **Waste Management Solution:** It helps in managing biodegradable waste effectively, preventing open landfills and reducing pollution.
- **Circular Economy:** Converts waste into a valuable energy source, promoting a sustainable cycle of waste reuse.
- **Reduced Dependency on Fossil Fuels:** Provides a renewable alternative to natural gas and other fossil fuels, enhancing energy security.

Government Initiatives Supporting CBG:

SATAT Initiative (Sustainable Alternative Towards Affordable Transportation):

- Launched by the Indian government in 2018, the SATAT initiative promotes the production of CBG from various waste sources to meet the growing demand for sustainable fuels.
- It aims to establish a large number of CBG plants across India, enabling the supply of CBG for vehicles and industries, creating a decentralized energy production model.

Atmanirbhar Bharat:

- CBG projects are aligned with the Atmanirbhar Bharat initiative, promoting self-reliance by reducing crude oil imports and fostering local production of renewable energy.

Waste to Wealth Mission:

- Under the Swachh Bharat and Waste to Wealth initiatives, CBG plays a key role in transforming urban waste into a valuable resource, promoting cleaner cities and waste management.

Challenges:

- Infrastructure: Scaling up the infrastructure for biogas production, purification, and distribution remains a challenge in many regions.
- High Initial Costs: Setting up CBG plants requires significant investment, which could be a barrier for small producers.
- Public Awareness: Limited awareness among stakeholders, including the general public, hampers the adoption of CBG as a mainstream fuel.

Future Potential:

- Scalability: With technological advancements, the potential for CBG production and usage is enormous, especially in rural areas, contributing to local employment, rural development, and sustainability.
- Contribution to India's Clean Energy Goals: CBG is

expected to play a significant role in achieving India's targets under the Paris Agreement and other global climate commitments, by reducing carbon emissions and promoting clean energy solutions.

How is water scrubbing technology used in this?

- Water scrubbing technology is one of the most commonly used methods for purifying biogas, particularly in Compressed Biogas (CBG) production. This technology helps remove impurities such as carbon dioxide (CO₂), hydrogen sulfide (H₂S), and other contaminants from biogas, making it suitable for compression and use as a fuel. Here's how water scrubbing works:

How Water Scrubbing Technology Works:

Raw Biogas Collection:

- The biogas generated from the anaerobic digestion of organic waste contains 50-65% methane (CH₄), along with impurities like CO₂, H₂S, and moisture. This raw biogas is collected from the digester and sent to the scrubbing unit for purification.

Water Absorption Process:

- The biogas is passed through a scrubbing column filled with water.
- The water is circulated in a counter-current flow, meaning the raw biogas is introduced from the bottom of the column while water flows down from the top.

Dissolution of CO₂ and H₂S in Water:

- Carbon dioxide (CO₂) and hydrogen sulfide (H₂S) are more soluble in water than methane (CH₄).
- As the biogas rises through the water column, CO₂ and H₂S get absorbed into the water, leaving the methane behind. This increases the methane concentration in the biogas.
- The process effectively removes CO₂ and H₂S, which are the main impurities, improving the quality of the biogas.

Methane Collection:

- The purified biogas, now enriched with over 90% methane, is collected at the top of the scrubbing column.
- This purified gas is then compressed to produce Compressed Biogas (CBG), which can be used as fuel.

Water Regeneration and Treatment:

- The water used in the scrubbing process, which now contains dissolved CO₂ and H₂S, can be regenerated

or treated for reuse.

- In some setups, the water is regenerated by stripping the dissolved gases out of the water, allowing it to be reused in the scrubbing process, reducing water consumption.

Advantages of Water Scrubbing Technology:

- **Simple and Efficient:** Water scrubbing is a relatively straightforward and cost-effective technology for biogas upgrading, especially when compared to other gas separation techniques like chemical absorption or membrane separation.
- **Environmentally Friendly:** It uses water, a non-toxic, easily available substance, and doesn't involve the use of harmful chemicals.
- **Scalability:** It can be used in both small-scale and large-scale biogas purification plants, making it suitable for diverse applications.
- **Effective CO₂ and H₂S Removal:** Water scrubbing efficiently removes large amounts of CO₂ and H₂S, two significant impurities in raw biogas.

Applications in CBG Production:

- In CBG plants, such as GAIL's CBG plant inaugurated in Ranchi, water scrubbing is often the preferred method to purify biogas before compressing it to produce Bio-CNG (Compressed Biogas). The purified gas can then be used as a clean, green fuel for vehicles, industries, and even households.

Challenges and Considerations:

- **Water Usage:** Water scrubbing requires a significant amount of water, which may be a limitation in regions where water is scarce. However, systems are designed to regenerate and reuse water to minimize consumption.
- **Cost of Regeneration:** The process of stripping the CO_2 and H_2S from water for reuse requires additional energy, which can add to operational costs.
- **H_2S Removal:** While water scrubbing can remove most H_2S , for biogas with very high H_2S concentrations, pre-treatment may be necessary to ensure complete removal.

Conclusion:

- Water scrubbing technology is a vital part of biogas purification in the production of CBG. It offers an efficient, cost-effective, and eco-friendly way to upgrade biogas, making it suitable for commercial use. By removing CO_2 and H_2S , this technology ensures that the biogas can be compressed and used as a clean fuel, contributing to sustainable energy solutions and reducing dependency on fossil fuels.



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 - Click on - Check Result
 - Scroll down - Check out Solutions too.
- Thank you.

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Category: General Studies

Which of the following government initiatives are directly aligned with the goals of GAIL's CBG plant in Ranchi?

- 1) Swachh Bharat Mission
- 2) National Biofuel Policy
- 3) Make in India
- 4) Pradhan Mantri Awas Yojana

- 1 and 2 only
- 1, 2, and 3 only
- 2, 3, and 4 only
- 1, 3, and 4 only

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Category: General Studies

Which of the following best describes the main objective of GAIL's first CBG plant inaugurated in Ranchi, Jharkhand?

- To generate electricity from municipal solid waste.

- To produce bio-CNG and bio-manure from municipal solid waste.
- To incinerate municipal solid waste and reduce landfill volume.
- To process plastic waste for recycling into energy.

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Category: General Studies

Which technology is primarily used in the purification process of biogas at GAIL's Ranchi CBG plant?

- Membrane separation technology
- Pressure Swing Adsorption (PSA)
- Water scrubbing technology
- Cryogenic separation technology

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Category: General Studies

The biogas generated at GAIL's Ranchi CBG plant will be supplied to:

- Power generation stations for producing electricity.
- Local CNG stations to fuel vehicles.
- Fertilizer production units for further processing.
- Residential homes for heating and cooking purposes.

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Category: General Studies

How does GAIL's CBG plant in Ranchi contribute to environmental sustainability?

- By reducing the reliance on chemical fertilizers.
- By producing renewable electricity from biogas.
- By reducing methane emissions from decomposing waste.
- By completely eliminating plastic waste from municipal sources.

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Check Rank, Result Now and enter correct email as you will get Solutions in the email as well for future use!

Check the Result

Your score is

0%

Restart quiz

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Mains Questions:

Below Mains Question

Write in Comment Section



Question 1:

Discuss the role of Compressed Biogas (CBG) plants in promoting sustainable waste management and energy security in India. How do such initiatives contribute to the government's goals of circular economy and carbon neutrality?(250 Words)

Model Answer:

Compressed Biogas (CBG) plants play a critical role in addressing two pressing issues in India: waste management and energy security. By converting municipal solid waste into bio-CNG and bio-manure, these plants promote the circular economy, where waste is treated as a resource rather than a problem.

Sustainable Waste Management:

- India generates a large amount of municipal solid waste, which often ends up in landfills, causing environmental and health hazards. CBG plants like

the one inaugurated by GAIL in Ranchi provide an effective solution by converting organic waste into useful products.

- The process helps in reducing the volume of waste in landfills, lowering greenhouse gas emissions from decomposing waste, and addressing challenges related to urban waste disposal.

Energy Security:

- CBG is a renewable energy source that reduces dependence on fossil fuels. The production of bio-CNG from waste contributes to India's efforts in achieving energy self-reliance and reducing the import of natural gas.
- Such plants are aligned with the Atmanirbhar Bharat initiative by utilizing local resources for energy generation.

Circular Economy:

- CBG plants contribute to a circular economy by utilizing waste and transforming it into fuel and organic manure. This process ensures that resources are continuously cycled through the economy, minimizing waste and enhancing resource efficiency.
- The bio-manure produced as a by-product improves soil health and supports sustainable agriculture by reducing the reliance on chemical fertilizers.

Carbon Neutrality:

- By reducing methane emissions from landfills and substituting fossil fuels with bio-CNG, CBG plants help reduce India's carbon footprint. This is crucial for achieving the government's target of Net Zero Carbon Emissions by 2070.
- The environmental benefits extend beyond carbon

reduction, as these plants also prevent pollution and soil degradation caused by untreated waste.

In conclusion, CBG plants are essential to achieving sustainable development, improving waste management, and enhancing energy security. They align with government initiatives like Swachh Bharat Mission, Make in India, and Clean India, Green India by offering holistic solutions that benefit the environment, economy, and society.

Question 2:

Examine the environmental and socio-economic impacts of GAIL's first CBG plant in Ranchi. How can such projects foster local development and contribute to India's clean energy goals?(250 Words)

Model Answer:

The inauguration of GAIL's first CBG plant in Ranchi is significant in addressing environmental concerns while also promoting socio-economic development at the local level. The following are key areas of impact:

Environmental Impact:

- **Reduction of Greenhouse Gas Emissions:** The CBG plant prevents methane emissions from untreated waste in landfills, contributing to climate change mitigation. Methane is a potent greenhouse gas,

and its capture and conversion into biogas help in lowering the overall carbon footprint.

- **Waste to Wealth:** The plant exemplifies the Waste to Wealth concept by converting 150 tonnes of municipal solid waste daily into 5,000 kg of Bio-CNG and 25 tonnes of bio-manure. This reduces the environmental hazards associated with unprocessed waste, including air, water, and soil pollution.
- **Cleaner Energy:** Bio-CNG is a clean fuel alternative that reduces the pollution caused by traditional fossil fuels, improving air quality and supporting India's clean energy transition.

Socio-economic Impact:

- **Employment Generation:** The project creates local employment opportunities, particularly in waste collection, transportation, and plant operations. It also supports the rural economy by involving local communities in the processing of agricultural waste (e.g., cow dung).
- **Improvement in Agriculture:** The bio-manure produced as a by-product offers an environmentally friendly alternative to chemical fertilizers, enhancing soil fertility and promoting sustainable farming practices. This benefits the agricultural sector, especially in rural areas.
- **Energy Accessibility:** The bio-CNG generated at the plant is supplied to local CNG stations, which can fuel over 600 vehicles daily. This promotes the use of clean energy in transportation, reducing fuel costs and providing an affordable energy alternative to the local population.

Fostering Local Development:

- The project is aligned with the Atmanirbhar Bharat (Self-reliant India) initiative by using local

resources for energy production, thus reducing dependency on imported fuels. By boosting local employment and supporting rural economies, the plant also contributes to inclusive growth in the region.

- The project supports the government's broader mission to foster a sustainable, circular economy, demonstrating how technology and innovation can drive local development while addressing global challenges like climate change and resource depletion.

Contribution to National Clean Energy Goals:

- Projects like the Ranchi CBG plant contribute to India's clean energy goals, including the National Biofuel Policy and targets for Net Zero emissions. By scaling such initiatives, India can significantly reduce its carbon footprint and transition toward renewable energy sources.
- In summary, GAIL's CBG plant in Ranchi is not only a landmark in clean energy production but also a catalyst for environmental sustainability and local development. Its success offers a replicable model for other regions, furthering India's progress toward a greener, more inclusive economy.

Remember: These are just sample answers. It's important to further research and refine your responses based on your own understanding and perspective. Read entire UPSC Current Affairs.

Relevance to the UPSC Prelims and

Mains syllabus under the following topics:



Prelims:

- **General Studies Paper I: General Science (Environment):** Topics like biogas, clean energy technologies, and environmental pollution control are part of the general science syllabus. Understanding renewable energy and waste management is essential for environmental awareness.
- **Current Events of National and International Importance:** Current initiatives like the inauguration of GAIL's CBG plant and its link to policies such as Atmanirbhar Bharat, Make in India, and Waste to Wealth provide context for national development projects.

Mains:

▪ **GS Paper I:**Urbanization and Problems of Waste Management:

The CBG plant addresses the issue of municipal solid waste management in cities, which is a key challenge of urbanization.

GS Paper II:Government Policies and Interventions for Development:

The government's role in promoting clean energy solutions like bio-CNG and the alignment of such projects with national initiatives such as Atmanirbhar Bharat and Swachh Bharat.

Governance and Infrastructure: Collaboration between public and private entities, such as GAIL and Ranchi Municipal Corporation, highlights public service delivery through infrastructure development.

GS Paper III:

Environment and Ecology:

Sustainable waste management, bio-CNG production, and its impact on reducing greenhouse gases like methane.

Pollution control and mitigation of environmental damage through technological interventions in solid waste management.

Energy Security and Clean Energy:

The importance of biofuels and renewable energy in reducing dependence on fossil fuels, and promoting energy security in alignment with India's clean energy goals like Net Zero by 2038.

Economic Development:

The role of clean energy in promoting the circular economy, creating employment, and supporting rural development through local initiatives.

Science and Technology:

Application of water scrubbing technology and

innovations in biogas purification for environmental sustainability.

Additional Linkages in Mains:

GS Paper IV (Ethics):

Issues of corporate social responsibility, environmental ethics, and sustainability can be discussed in the context of public sector involvement in green technologies.

Essay:

The theme of waste to wealth, sustainable urban development, and India's progress in clean energy could be included in essays related to sustainable development, environmental conservation, and India's energy future.



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Option 1


Option 2

Option 3



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