GREENZO ENERGY INDIA LIMITED
ISO 9001-14001

GREEN AMMONIA

POWERING THE FUTURE OF FERTILIZERS

NH_3
GREEN AMMONIA

Presented By :

GREENZO ENERGY INDIA LIMITED

DIRECTOR'S STATEMENT

At Greenzo Energy, we believe that green ammonia is not just a fuel of the future but a cornerstone for sustainable agriculture and clean industry. By integrating renewable hydrogen with advanced ammonia technologies, we aim to decarbonize fertilizer production and empower farmers with climate-friendly solutions. Our commitment is to lead this transition—delivering innovation that supports global food security while contributing to a zero-carbon future.

Sandeep Agarwal
Founder & Managing Director

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1. EXECUTIVE SUMMARY

Ammonia (NH_3) plays a vital role in modern industry, serving as the core component in nitrogen-based fertilizers, with approximately 80% of global production directed to this sector. Today, most ammonia is produced from non-renewable fuels, with around 72% derived from natural gas via steam reforming, making it inexpensive (220-500 USD/ton) but highly carbon-intensive with the growing demand for fertilizers and the urgent need to reduce greenhouse gas emissions, shifting toward low-carbon, green ammonia presents a critical opportunity. This transition not only supports a zero-carbon future but also enables the decarbonization of fertilizer production, paving the way for sustainable agriculture worldwide.

Greenzo Energy is committed to becoming a pioneer in the hydrogen economy by bridging the gap between renewable power and clean fuel applications. With advanced alkaline electrolysers and integrated hydrogen-to-ammonia systems, we are driving the global transition toward carbon-free fuels.

2. WHY GREEN AMMONIA?

- **Hydrogen Carrier of Choice:** Ammonia (NH_3) is the most popular green hydrogen carrier as it is carbon-free and has a high hydrogen content (17.8% by weight).
- **Efficient Energy Storage:** Easier to store and transport than hydrogen, with established global infrastructure for shipping and storage.

TECHNOLOGICAL PATHWAYS: FROM RENEWABLE HYDROGEN TO SUSTAINABLE AMMONIA

3. OUR TECHNOLOGY EDGE

3.1 Hydrogen Production:

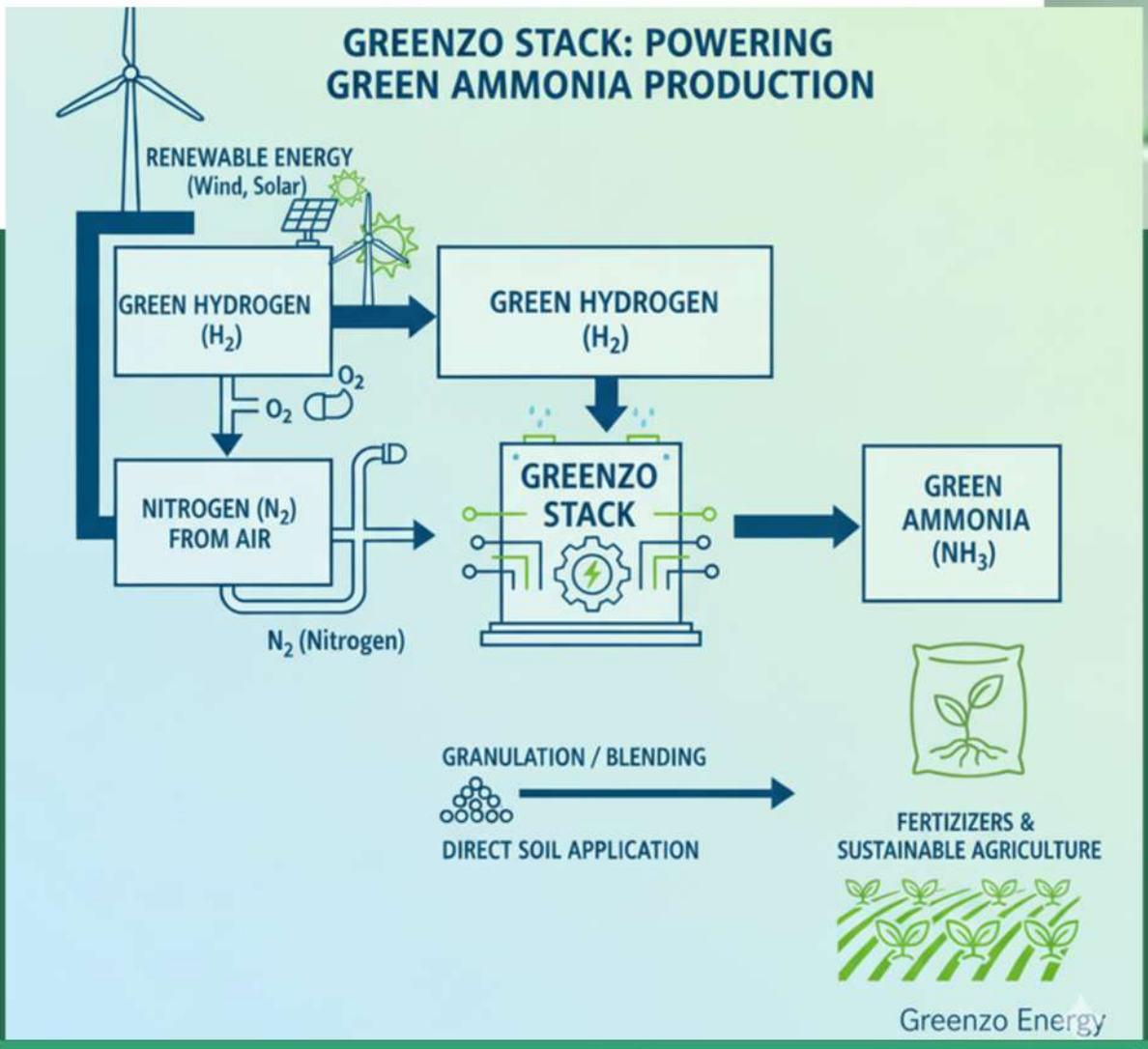
- Produced from renewable-powered electrolysis of water.
- 100% clean and sustainable, ensuring zero fossil input.

3.2 Ammonia Synthesis

- Integration with the Haber-Bosch process for large-scale NH_3 production.
- Powered by renewable electricity, enabling true "green ammonia."

3.3 Hydrogen Recovery from Ammonia

- Conversion technologies include electrochemical, thermochemical, and photocatalytic methods.
- Use of innovative catalysts (Ni, Co, La, perovskites) to reduce reliance on costly Ru catalysts.



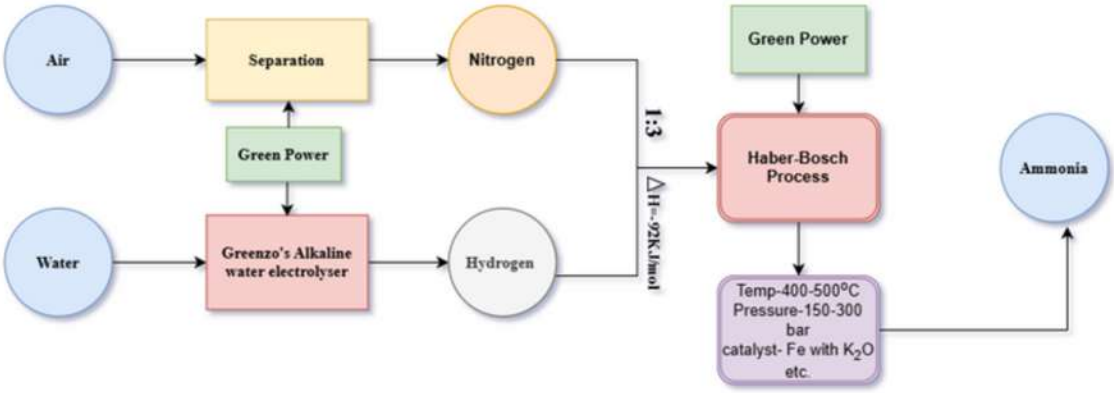
4. PROCESS OF MAKING GREEN AMMONIA

The Haber-Bosch process is the industrial method used to produce ammonia (NH_3) from nitrogen (N_2) and hydrogen (H_2) gases.

Reaction:

$$N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$$

Nitrogen from Air (78%) and hydrogen from Alkaline water electrolyser



3.4 Process Conditions

Temperature: ~400–500 °C, Pressure: ~150–300 bar, Catalyst: Iron (Fe) with promoters like K_2O, Al_2O_3, CaO to increase efficiency. Purification to remove CO, CO_2, and sulfur.

Synthesis loop:

- **N_2 and H_2 mixed in ratio 1:3.**
- **Passed over iron catalyst at high pressure and temperature.**
- **Only 15–20% of gases convert to NH_3 in one pass.**

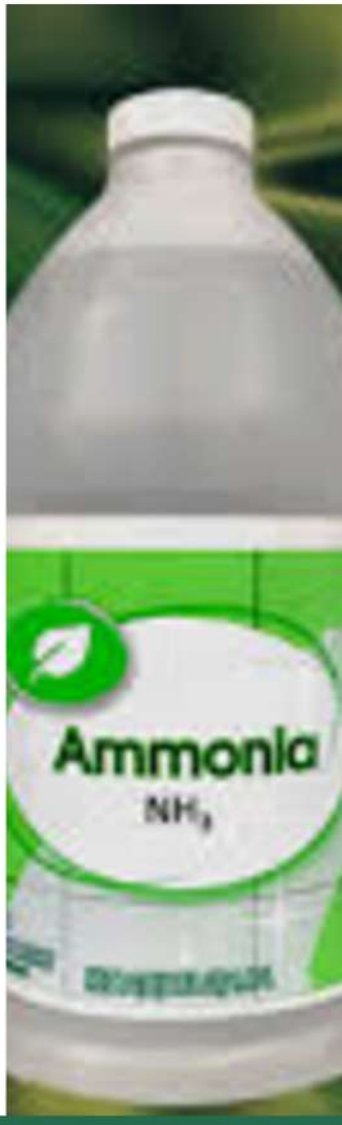
Ammonia Separation:

a. Reaction mixture cooled → NH_3 condenses as a liquid.

b. Unreacted N_2 + H_2 recycled back.

5. HOW GREENZO CAN SUPPORT GREEN AMMONIA PRODUCTION

At Greenzo, we specialize in alkaline water electrolyser stacks that enable cost-effective and scalable green hydrogen production. Since hydrogen is the key feedstock for green ammonia, our technology plays a central role in building a reliable green ammonia value chain.



6. HYDROGEN PRODUCTION FOR AMMONIA SYNTHESIS

- Our alkaline water electrolysers deliver high-efficiency hydrogen from renewable electricity. This hydrogen, when combined with nitrogen (from air separation units), enables green ammonia synthesis via the Haber-Bosch process.
- Greenzo stacks are engineered for MW-scale projects, making them ideal for integration with large-scale ammonia plants.
- Our low operating cost and long stack lifetime provide a competitive edge over other electrolyser technologies, crucial for reducing the levelized cost of green ammonia.
- By ensuring a stable hydrogen supply, we support smooth integration with ammonia liquefaction, cryogenic storage, and global shipping infrastructure.
- With Greenzo electrolysers, green ammonia plants can displace fossil-based hydrogen (from natural gas), helping industries transition to carbon-free fertilizers, fuels, and hydrogen carriers.
- This not only supports local energy security but also positions projects for export-ready green ammonia markets, where cryogenic storage and transport are essential.

7. CONCLUSION:

The fertilizer industry stands at a pivotal moment in the transition toward sustainable agriculture. By adopting green ammonia as a low-carbon alternative, manufacturers can significantly reduce greenhouse gas emissions while meeting the growing global demand for nitrogen-based fertilizers.

Integrating renewable hydrogen and clean ammonia technologies not only enhances environmental responsibility but also strengthens economic resilience by future-proofing production processes. Green ammonia thus represents a win-win solution supporting both productive agriculture and a zero-carbon future.

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