

# Prospects of Green Ammonia in Fertilizer Industry



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# Introduction

- Ammonia is the second most produced chemical worldwide.
- World ammonia production was 185 million MT in 2021.
- Projected production is 223 million MT by 2030 and 330 million MT by 2050.
- About 85% of ammonia is used to manufacture fertilizers.

# Introduction

- Around 90% of ammonia is consumed at site as feedstock.
- About 30 million tonnes ammonia is transported by road, rail, pipeline and ship.

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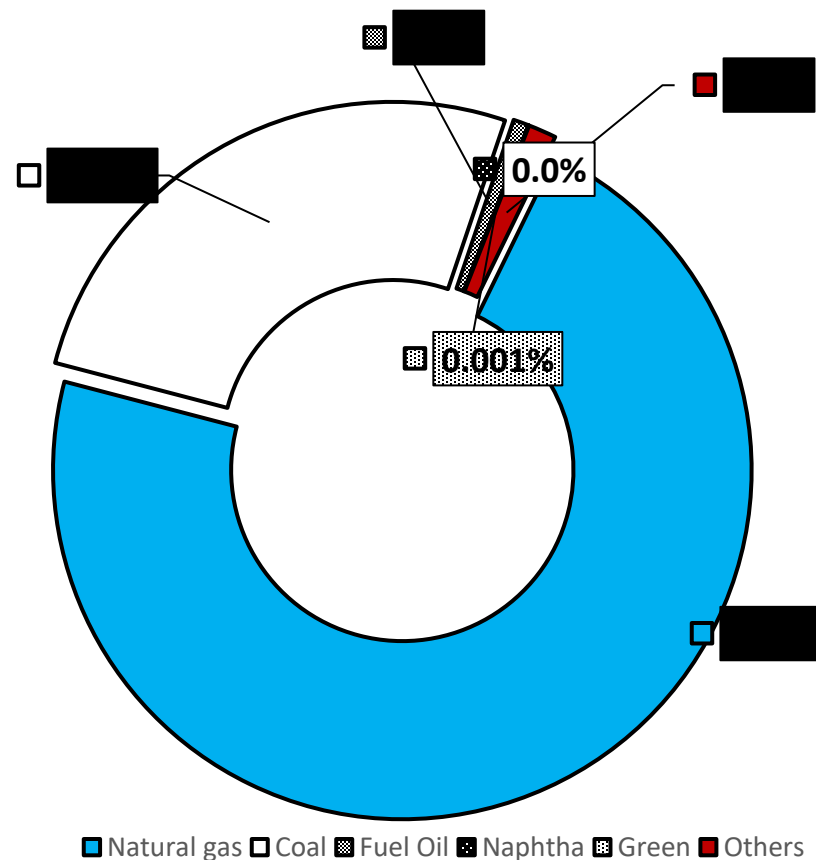
- Use of fossil fuels to manufacture ammonia accounts for 1.3% of total GHG emissions.
- Indian ammonia plants generate less than 2.0 MT CO<sub>2</sub> per MT ammonia.
- Most Indian ammonia production is used to produce urea. An average of 1.3 MT CO<sub>2</sub> per MT ammonia is converted to urea.

# Production, Import and Consumption of Fertilizers (2022-23)

<b>Fertilizer</b>	<b>Production</b>	<b>Imports</b>	<b>Consumption</b>
Urea	28.49	7.58	35.73
Single Super Phosphate	5.64	NIL	5.02
DAP	4.35	6.58	10.53
Other Complex Fertilizers	9.30	2.75	10.07
Muriate of Potash (MoP)	NIL	1.87	1.63 (direct application balance is used in production of complex fertilizers)
Other Straight Fertilisers (AS, ACI, SOP)	0.79	0.18	0.84
<b>Total Products</b>	<b>48.57</b>	<b>18.96</b>	<b>63.82</b>

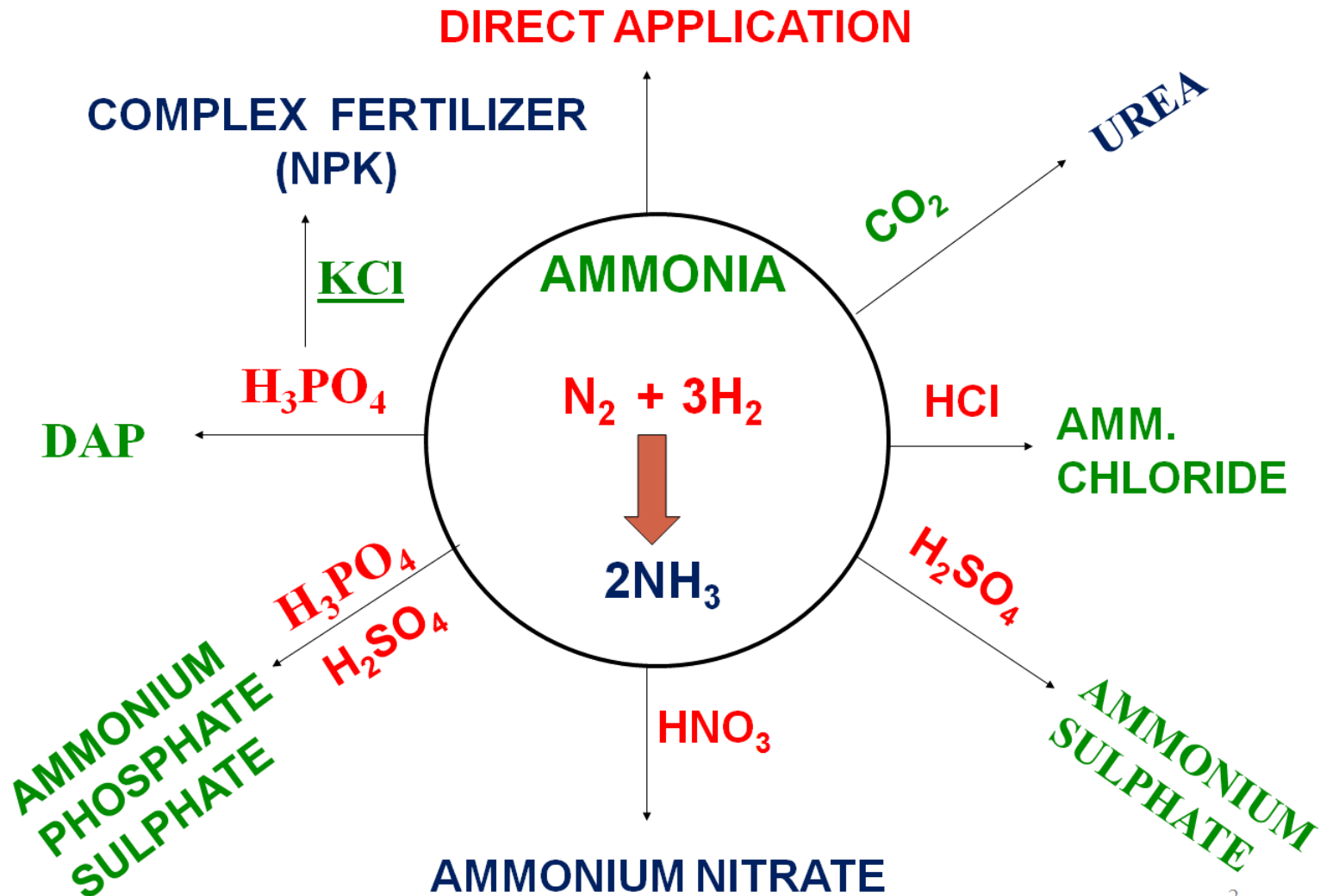
# Feedstock wise Ammonia Capacity, 2022

Feedstock	Capacity (million tonnes)
Natural Gas	166.2
Coal	60.4
Fuel Oil	1.7
Naphtha	0.017
Green	0.002
Others	3.0
Total	231.3



Source: IFA, Paris

# Ammonia is the building block of all nitrogen containing fertilizers



# Production and Use of Ammonia in India 2022-23 (Provisional)

Sl. No.	Sources of Ammonia	Million Metric Tonnes
1.	Domestic Ammonia Production	17.4
2.	Imported Ammonia	2.3
3.	Ammonia in imported DAP, NP/NPK and Urea	6.6
4.	Total Ammonia Utilized	26.3



# Production and Use of Ammonia in India

- Ammonia production is expected to go upto 19 million tonnes in 2023-24
- More than 95% of domestic ammonia will continue to be used to manufacture urea
- All the imported ammonia is used to manufacture complex fertilizers

# Other Uses of Ammonia

- Nitric Acid – Ammonia Nitrate – Explosives
- Refrigeration
- Chemical, Pharmaceutical and other industries
- NO<sub>x</sub> abatement
- Other Potential Uses
  - Marine Fuel
  - Fuel for Power Generation
  - Carrier of Hydrogen/Energy

# Natural Gas as Feedstock

- Almost 100% ammonia is produced in India using natural gas
- About 85% gas requirement is met by imported gas (LNG)

# First Ammonia Plant based on Electrolysis

- India Operated an ammonia plant using green hydrogen at Nangal, Punjab between 1961 to 1989.
- Hydrogen was generated by electrolysis using Hydro power.

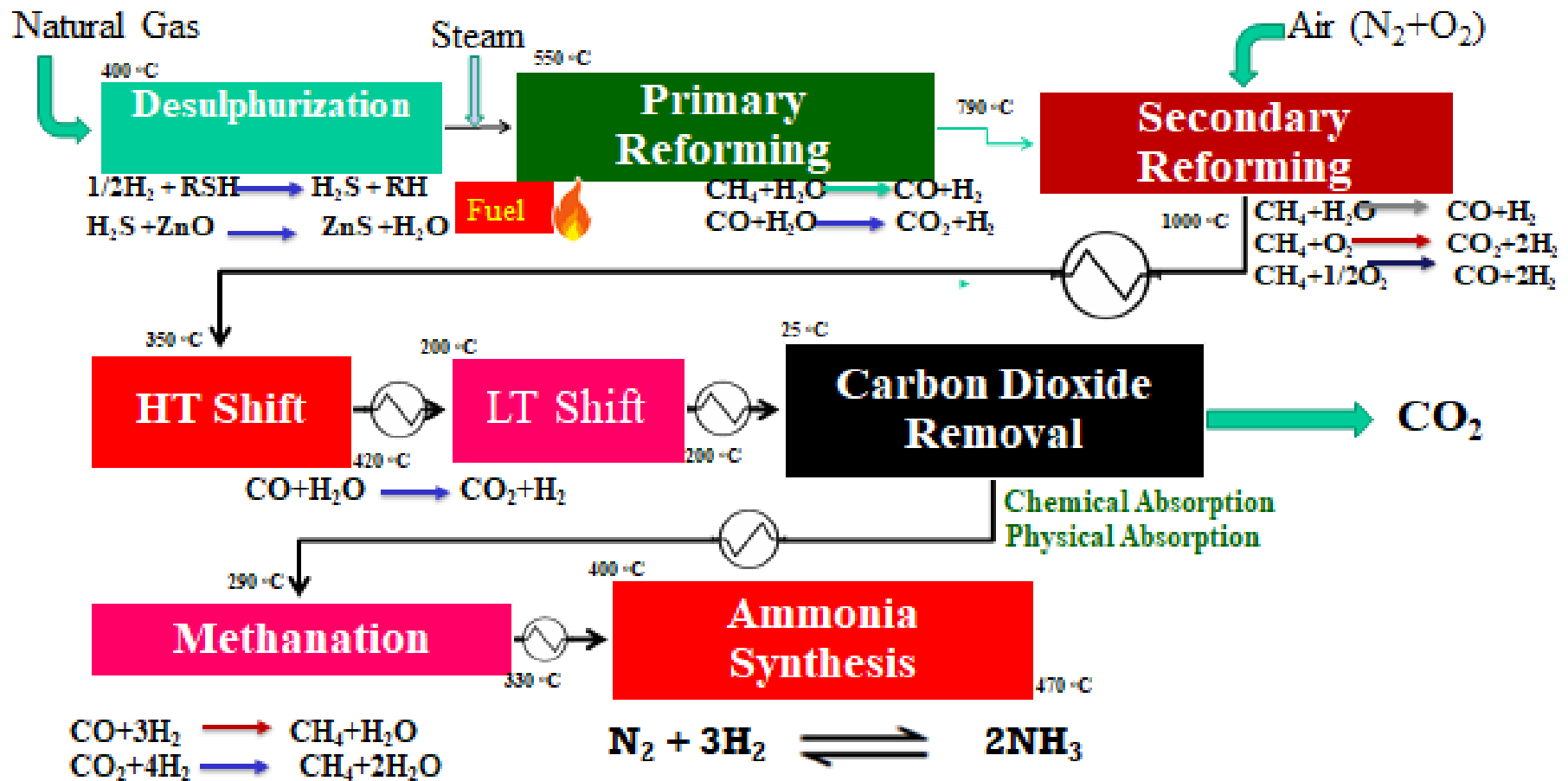
# Storage and Transportation of Ammonia

- Ammonia is hazardous chemical and toxic under ambient conditions.
- It is stored as liquid at  $-33^{\circ}\text{C}$  and atmospheric pressure.
- Ammonia is handled, stored and transported for more than 100 years.
- Risks associated with ammonia storage and handling are managed well.

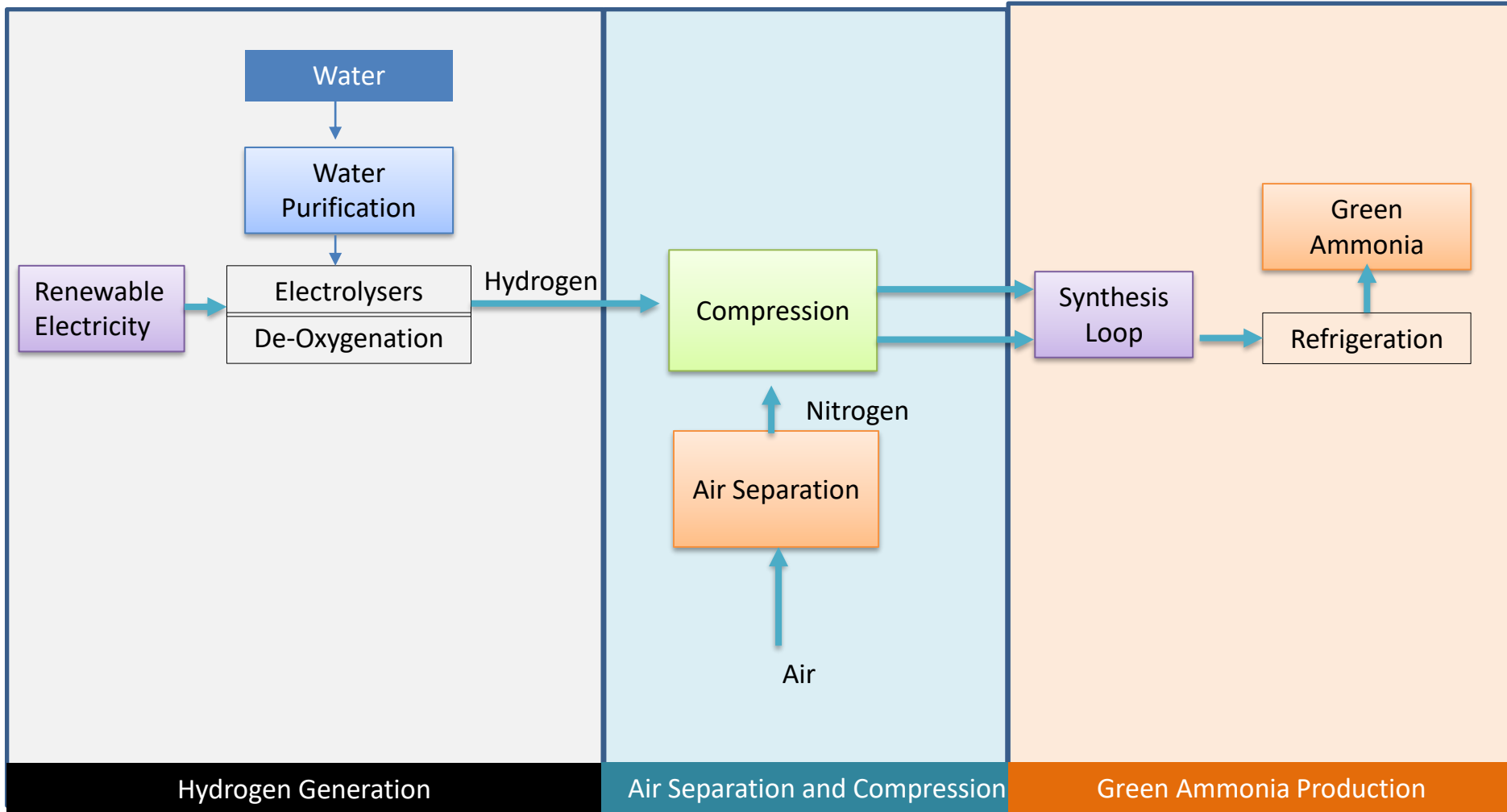
# Production of Green Ammonia

- Three major steps
  - Generation of  $H_2$  by electrolysis of water using renewable power.
  - Air separation to produce  $N_2$  using renewable power.
  - Synthesis of ammonia using renewable power.

# Conventional Ammonia Production



# Green Ammonia Production





# National Green Hydrogen Mission

- An outlay of Rs. 19,744 crores was approved in 2023.
- It provides for amongst other things incentives for manufacturer of electrolyzers and green hydrogen producers.

# Use of Green Ammonia

- The Green Hydrogen Mission documents states

***“to make India the Global Hub for production, usage and export of green hydrogen and its derivatives.” .....***

***“Two plants each for production of Green Hydrogen based Urea and Green Hydrogen based DAP are targeted to be set up through competitive bidding route. By 2034-35, it is targeted to substitute all Ammonia based fertilizer imports with domestic Green Ammonia based fertilizers.”***

- . Draft guidelines for sale and purchase of green ammonia has been prepared.

# Strategic Intervention for Green Hydrogen Transition

- To implement the Mission, a notification was issued on Strategic Interventions for Green Hydrogen Transition (SIGHT) Generation Based Incentive for Green Hydrogen Production on June 2023.
- It has proposed a maximum incentive of Rs. 50/kg production of green hydrogen in 2025-26 and it will be reduced to 80% in 2026-27 and 60% in 2027-28.

# Demand Generation

- Under Green Hydrogen Mission, there will be obligations on consuming sectors like refinery, fertilizer and city gas distribution to use Green Hydrogen.
- Industry should remain part of consultation for specifying quantities of Green Hydrogen to be used by different sectors will be specified.

# **Usage of Green Hydrogen/Ammonia in Fertilizer Sector**

# Incentive for Use of Green Hydrogen

- An incentive of a maximum Rs. 50/kg hydrogen will be provided. This equivalent to Rs. 8.82 per kg of green ammonia.
- The scheme is for only three years. The incentive will be reduced to Rs. 40/kg and Rs. 30/kg H<sub>2</sub> in second and third year respectively.

# Integrated Ammonia Urea Plants

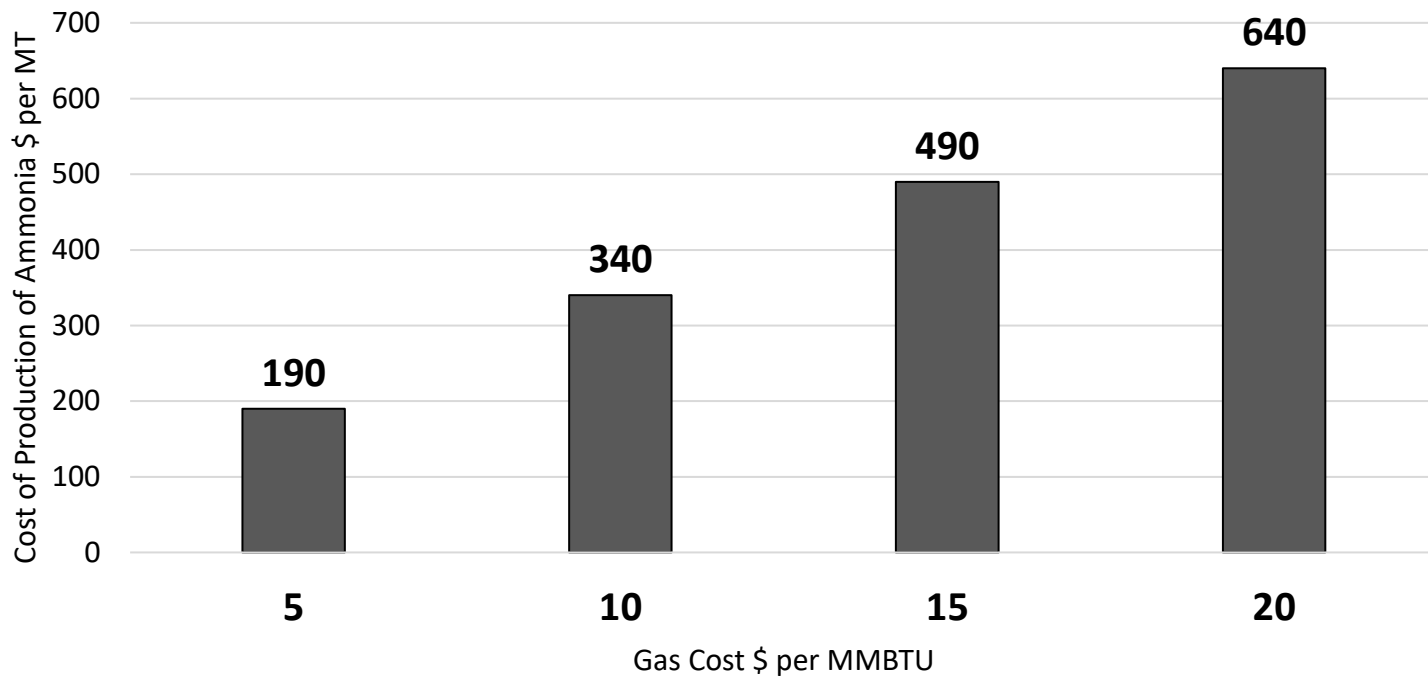
- Urea accounts for 82% nitrogen use in Indian agriculture.
- Most ammonia plants in India are integrated with urea plants.
- Almost 95% of domestic ammonia is converted to urea.
- Carbon dioxide is required to produce urea which is available in situ from feed natural gas.
- For conversion of green ammonia into urea, another source of CO<sub>2</sub> will have to be available and there will be additional cost for recovery of CO<sub>2</sub>.
- Any partial substitution of grey ammonia with green ammonia will result in operation of grey ammonia plant at partial load. This will result in inefficient operation of ammonia plant with higher specific energy consumption and proportionate quantity of CO<sub>2</sub> will be required.

# Non Urea Fertilizers

- About 3 million tonnes of ammonia is used for non-urea fertilizers where CO<sub>2</sub> is not required.
- Most of this ammonia is imported and fertilizer plants are located at various ports.
- Green ammonia can easily be utilized to replace this grey ammonia.
- Large quantity of non urea fertilizers are imported. If these are produced in India, another 1 million tonne of ammonia will be required.
- The production of other non urea fertilizers can be increased to replace urea. This will also create additional demand for ammonia.

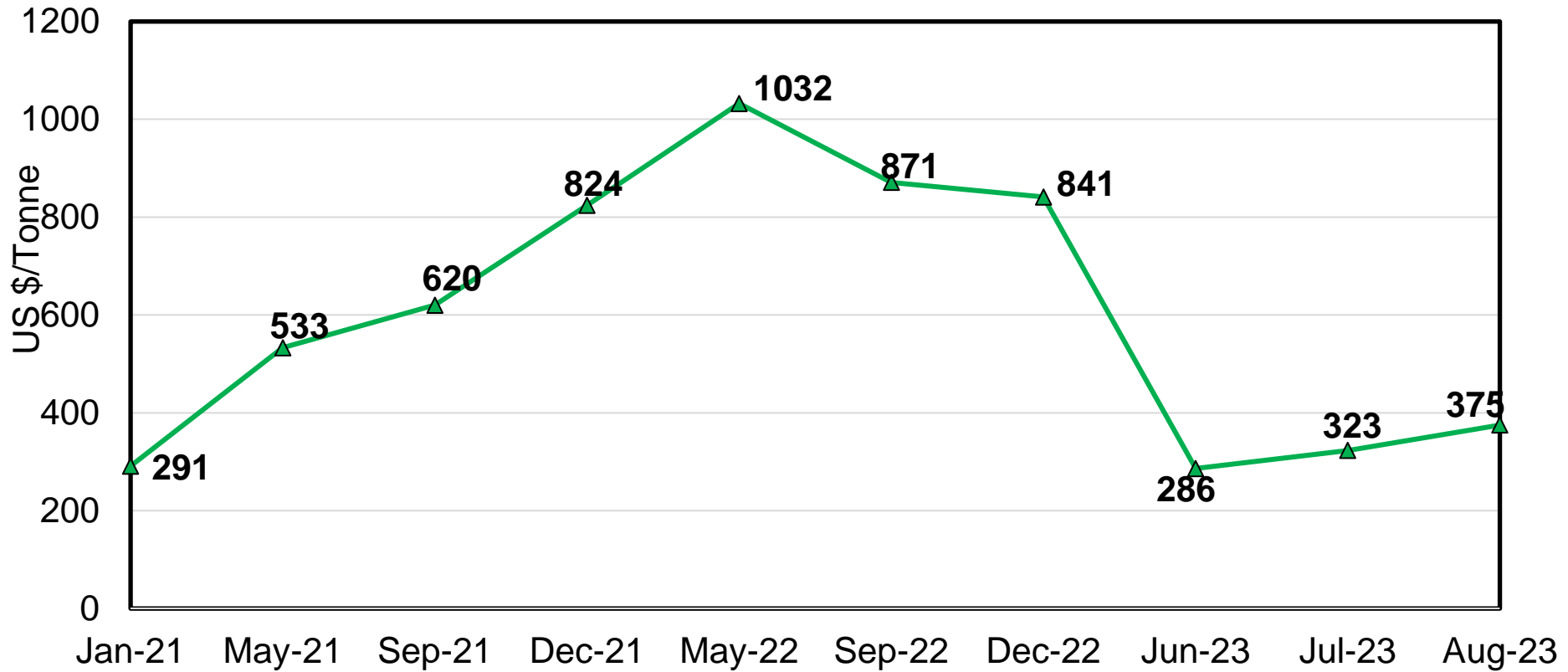


# Cost of Production of a Typical Grey Ammonia Plant



Assumption : Typical energy consumption of 30 million BTU per MT ammonia

# CFR (India) Prices of Ammonia



Source: CRU Fertilizer Historical Prices.

# Viability Gap for Use of Green Ammonia

- All indications are that cost of green ammonia will be USD 550-750 per MT.
- Incentive provided under the Mission remains inadequate.
- There are Commercial/Contractual Issues which can perhaps be resolved with the help of the government.

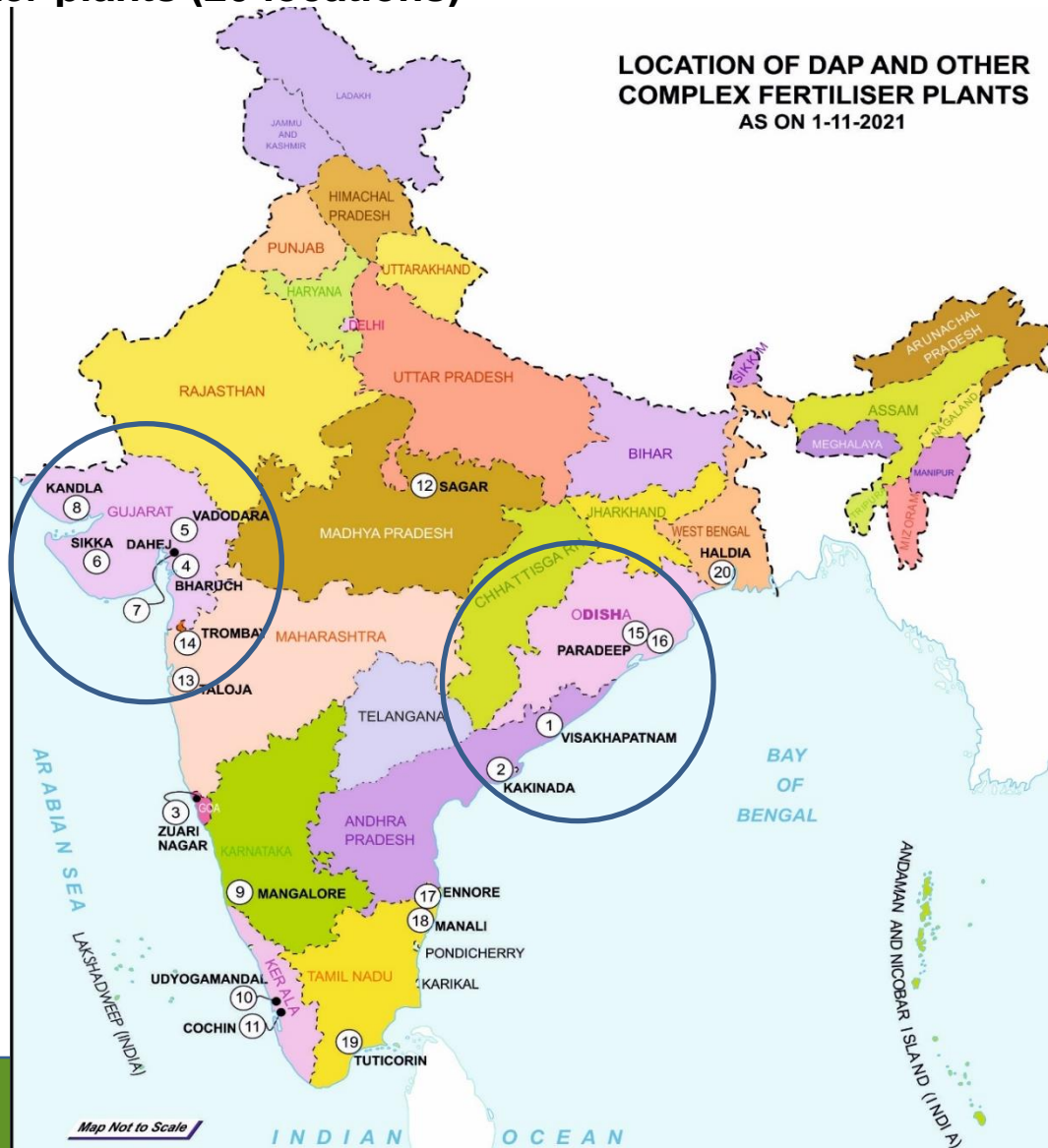
# Implications for Cost of Fertilizers

- Use of green ammonia for production of fertilizers will increase its cost of production.
- Indian manufacturers have to compete with imports.
- Either subsidy or retail price for farmers will have to be increased due to insufficient incentive under Green Hydrogen Mission.
- Cost of production of green ammonia is expected to come down in next 5-7 years making it economically viable option for production of non-urea fertilizers.

# Location of Green Ammonia Plants

## Option 1 : Proximity to complex fertilizer plants (20 locations)

Sl. No	Locations
1	Kandla, Gujarat
2	Sikka, Gujarat
3	Dahej, Gujarat (now closed)
4	Vadodara, Gujarat
5	Bharuch, Gujarat
6	Trombay, Maharashtra
7	Taloja, Maharashtra
8	Goa
9	Mangalore, Karnataka
10	Udyogmandal, Kerala
11	Cochin, Kerala
12	Tuticorin, T.N.
13	Manali, T.N.
14	Ennore, T.N.
15	Kakinada, A.P.
16	Vizag, A.P.
17 & 18	Pradeep, Odisha
19	Haldia, W.B.
20	Sagar, M.P.



# Location of Green Ammonia Plants

Option 2 : Proximity to green hydrogen generation source

Option 3 : Proximity to other ammonia users

Actual location of a green ammonia plant will depend on availability of renewable power, cost of transmission of electricity, cost of storage and transportation of hydrogen and ammonia, etc.

# Way Forward

- Several commercial plants for production of green hydrogen based on different electrolysis technologies are proposed.
- Construction of Green Ammonia plants next to green hydrogen plants.
- Replacement of grey ammonia with green ammonia used for manufacture of fertilizer products other than urea.
- Achievable targets for use of green ammonia.
- Short/medium-term contracts for green ammonia purchase based on import parity price of grey ammonia.

**Thank You**