NexantECA

Technology and Costs

Biorenewable Insights: Sustainable Fertilizers

Sustainable Fertilizers is one in a series of reports published as part of NexantECA's 2023 Biorenewable Insights program.

Overview

In recent years, the global fertilizer industry has begun on its track towards sustainability following the introduction of the United Nations' Sustainable Development Goals and Paris Agreement. The transition towards sustainability is supported by governments and industry stakeholders, through the initiatives of programs, policies, and declared sustainability goals. Sustainability in the fertilizer industry lies in the production and efficient application of fertilizer, especially ammonia, being the fundamental feedstock to all nitrogenous fertilizer.

Ammonia production currently emerges as a notable contributor to carbon emissions. It constitutes the largest source of direct emissions within the chemical industry, currently emitting approximately 450 million metric tons of CO_2 annually due to its energy-intensive process. The industry's substantial scale, producing nearly 200 million tons annually, underscores its profound impact on overall emissions. Attaining net-zero carbon emissions by the stipulated timeframes (2050, 2060, etc.) hinges on the decarbonization of ammonia. This necessitates transformative shifts towards adopting low-carbon-intensity ammonia.

This report evaluates the techno-economic analysis of various routes to produce sustainable fertilizers in regions, as well as the capacity analysis, strategic implications to the existing market, and associated greenhouse gas emissions of these processes.

Technologies

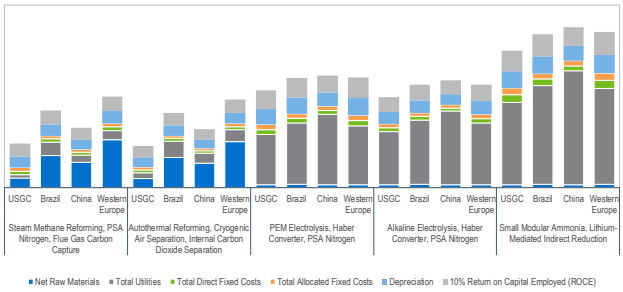
This report covers the key technologies necessary for all aspects of ammonia production, and the derivatives such as urea and ammonium nitrates. This report also covers the processes for the production and recycling of phosphorus, potassium, and multinutrient fertilizers.

- Ammonia Synthesis: Haber-Bosch Process, Lithium-Mediated Electroreduction, Electrically Enhanced Haber-Bosch Synthesis
- Hydrogen: Reforming (SMR and ATR), Electrolysis (alkaline, PEM, SOEC and AEM), Gasification
- Nitrogen: Cryogenic, Adsorptive and Indirect ATR
- Urea: Bosch-Meiser process
- Phosphorus fertilizer: Phosphorus recovery and recycling
- Ammonium Phosphate: Tennessee Valley Authority (TVA) process, Pipe reactor process
- Potassium Fertilizer: Potassium recovery
- NPK Fertilizer: Nanofertilizer, Bioformulation fertilizer, NPK nutrients recovery

Process Economics

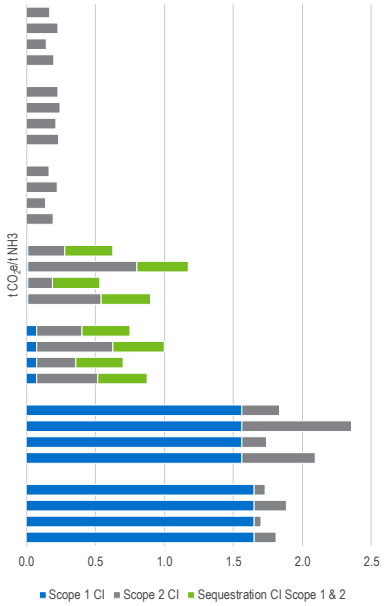
Cost of production estimates expressed in terms of US$ per ton of low CI ammonia and ammonium fertilizers for four locations (United States Gulf Coast, Western Europe, Brazil, and China) are presented for production of ammonia from various pathways:

- Steam Methane Reforming (SMR) with Carbon Capture
- Autothermal Reforming (ATR) with Carbon Capture
- Alkaline Electrolysis and Haber Conversion
- Proton Exchange Membrane (PEM) Electrolysis and Haber Conversion
- Small Modular Ammonia



Carbon Intensity

This report includes models of scope 1 and 2 emissions for the selected ammonia and ammonium fertilizers pathways mentioned above, as well as regional carbon intensity baselines, in terms of ton CO_2 eq per ton of low CI ammonium fertilizers produced.



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The BI program (sister program to the world renowned TECH program, formerly known as PERP) is globally recognized as the industry standard source of process evaluations of existing, new and emerging technologies of interest to the renewable energy and chemical industries.

BI's comprehensive studies include detailed technology analyses, process economics, as well as capacity analysis and impacts on conventional industry. Reports typically cover:

- Trends in technology
- Strategic/business overviews and/or developer profiles
- Process Technology:
- Chemistry
- Process flow diagrams and descriptions of established/conventional, new and emerging processes
- Process economics – comparative costs of production estimates for different technologies across various geographic regions
- Capacity tables of plants and analysis of announced capacities
- Regulatory and environmental issues where relevant

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A subscription to BI comprises:

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- Cost of production tables in spreadsheet format (as requested)
- Consultation time with the project team

An annual subscription to BI includes 10 reports published in a given program year. Reports can also be purchased on an individual basis, including reports from previous program years.

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Technology and Costs comprises the Technoeconomics – Energy & Chemicals (TECH) program, the Biorenewable Insights program (BI), and the new Cost Curve Analysis. These programs provide comparative economics of different process routes and technologies in various geographic regions.

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