

## **Bioeconomy & Low Carbon Technology Overview for December 2023**

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This summary of low carbon technology developments for December 2023 is based on the data and information collated by Gifford Consulting and presented on our website: [Gifford Consulting](#)

### **Highlights: December 2023**

More information on these articles can be found on our website dashboards.

### **Overview –December 2023 (based on the above bullet points):**

#### **Ammonia**

1. **Ammonia Production:** NYK, JERA Co., and Resonac Holdings in Japan have agreed to explore using ammonia as a ship fuel. This initiative, part of NEDO's Green Innovation Fund Project, involves developing an ammonia-fuelled tugboat. With the expected completion of the A-Tug next June, these companies aim to achieve the world's first safe and secure ammonia fuel supply for ships.

#### **Biobased chemicals**

2. **Biobased Chemicals (Dow):** Dow has committed to a \$6.5 billion project for the world's first net-zero Scope 1 and 2 emissions ethylene and derivatives facility, dubbed Path2Zero. Expected to begin in 2027, this facility is projected to be one of Dow's most cost-effective operations at full capacity.
3. **Biobased Chemicals (Clariant and Conser):** Clariant, a sustainability-focused chemical company, has partnered with Conser for supplying maleic anhydride catalysts. They plan to develop next-generation catalysts based on Clariant's SynDane series, aiming for enhanced productivity, cost efficiency, and sustainability. This collaboration is timely, given the growing global demand for maleic anhydride, a key component in various industries and biodegradable plastics.
4. **Biobased Chemicals (Aduro Clean Technologies):** Aduro Clean Technologies specializes in innovative water-based technologies for chemical recycling of waste plastics, converting heavy crude into lighter oil, and producing high-value fuels or chemicals from renewable oils. Their Hydrochemolytic™ technology, which operates at low temperatures and costs, offers a transformative approach to utilizing low-value feedstocks.

#### **Biobased Plastics**

5. **Biobased Plastics:** Clariant, a specialty chemical company, has secured a contract with Jiangsu Shenghong Petrochemical for its SynDane 3142 LA catalyst in a new maleic anhydride (MA) production plant in China. Set to start in 2025, this plant, with a 200,000 tons annual capacity, will be one of the world's largest MA production facilities.

## Biodiesel

6. **Biodiesel:** Chevron's acquisition of Renewable Energy Group, with 11 biorefineries in the U.S. and Europe, marked a significant milestone. In 2022, Chevron Renewable Energy Group produced 441 million gallons of renewable fuels, reducing approximately 3.9 million metric tons of carbon, solidifying its leadership in converting renewable resources into lower carbon biofuels.

## Biofuels

7. **Biofuels (Romania):** Clariant has decided to shut down its Sunliquid bioethanol production in Podari, Romania, and downsize related activities in Germany. Despite beginning production in 2022, the Podari plant did not meet Clariant's operational targets, prompting a strategic review of its options.
8. **Biofuels (Belgium):** A report by the European Court of Auditors highlights uncertainties and challenges facing the biofuels sector in Belgium. Issues like investment security, sustainability concerns, competition for biomass, and high costs are impeding the growth of biofuels.
9. **Biofuels (Finland):** Neste in Finland is transforming its Porvoo crude oil refinery into a renewable and circular solutions refining hub. This strategic change, initiated after a study in 2022, will proceed in phases with multiple investment decisions, aiming for completion in the mid-2030s.

## Biogas

10. **Biogas (Spain):** Biorig, part of Solarig, plans a 250 million euros investment in Spain to develop, construct, and operate 10 biomethane production facilities in the Castilla y León region, marking a significant move in the biogas sector.
11. **Biogas (Canada):** The Bureau de normalisation du Québec (BNQ) has published the Canadian standard CAN/BNQ 3672-100 for Biomethane Quality Specifications. This standard aims to ensure safe biomethane use in gas networks and equipment, reducing health and environmental risks.
12. **Biogas (UK):** Topsoe and Standard Gas have signed a MoU for a UK-based project to produce renewable natural gas and methanol from waste feedstocks. Topsoe will provide its technologies, including methanation and methanol technologies, for this project.
13. **Biogas (Australia):** Santos and Tokyo Gas collaborate on carbon-neutral e-methane production in Australia. E-methane, made from green hydrogen and CO<sub>2</sub> through carbon capture or Direct Air Capture technology, can utilize existing gas infrastructure, offering a sustainable alternative to natural gas.
14. **Biogas (Sweden):** Alfa Laval and Bisviridi, part of the UK's BioteCH<sub>4</sub> group, are collaborating to enhance the sustainability of organic and food waste recycling, leveraging Alfa Laval's expertise and BioteCH<sub>4</sub>'s operational experience in anaerobic digestion.
15. **Biogas (Standard Gas):** Standard Gas's SG100 technology, a decarbonization solution, generates clean energy for various sectors and produces biochar for agriculture, construction, and environmental uses. This technology offers a transformative alternative to landfill and incineration waste disposal, contributing to CO<sub>2</sub> reduction.

## Biojet/Sustainable Aviation Fuels

16. **Biojet (UAE):** Neste and ENOC Group are exploring the supply and purchase of sustainable aviation fuel (SAF) in Dubai and the MENA region. This collaboration underscores their commitment to reducing aviation greenhouse gas emissions and highlights SAF's vital role.
17. **Biojet (UK):** Johnson Matthey's BioForming Sugar to Aromatics (S2A) technology, developed with Virent, enabled the first 100% SAF trans-Atlantic flight by a commercial airline. This bio-based aromatic jet fuel component is crucial for fuel system performance and compatibility with existing aviation technology.
18. **Biojet (UAE):** In the UAE, a consortium including Masdar, TotalEnergies, and others contributed to a test flight demonstrating the conversion of Methanol to SAF. This flight, using aviation fuel from olefins, supports the certification of this new SAF production pathway.
19. **Biojet (Germany):** MAN's PBR technology in Germany, set to commission in 2024, efficiently produces synthesis gas for Sustainable Aviation Fuel (SAF) using the Fischer-Tropsch process. The PBtL process used is highly efficient and cost-effective, promising significant CO<sub>2</sub> reductions and competitive fuel pricing.
20. **Biojet (Illinois):** LanzaTech Global, Inc. and Tadweer (Abu Dhabi Waste Management Company) are assessing the feasibility of producing Sustainable Aviation Fuel (SAF) from municipal and commercial solid waste in Abu Dhabi, aiming to scale up SAF production.
21. **Biojet (Singapore and Middle East):** Singapore's Keppel Corporation and AM Green are exploring biogenic carbon-based sustainable fuel production, including bio and green methanol, ethanol, and SAF, in Southeast Asia and the Middle East. They also plan to collaborate on a bio-methanol project in India.
22. **Biojet (UAE):** NEXTCHEM's subsidiary MyRechemical has been commissioned for a feasibility study in the UAE to convert solid municipal waste into Sustainable Aviation Fuel (SAF). This project, aiming to produce up to 120,000 tons of SAF annually, is a significant step in waste-to-chemicals conversion.
23. **Biojet (Azure in Canada):** Azure announced plans for a Sustainable Aviation Fuel (SAF) production facility in Cherryvale, Kansas. Since June 2023, a Front-End Engineering and Design (FEED) study has been underway, expected to conclude in 2024. Azure aims for a final investment decision by early 2025, with hopes of commencing production in 2027.

## Biotechnology

24. **Biotechnology (Novozymes):** Novozymes, a leader in biosolutions, has introduced Quara<sup>®</sup> LowP, an enzymatic solution for the renewable diesel and SAF industry. This innovation transforms the feedstock pre-treatment process, marking a significant advancement in the sector.

## CO<sub>2</sub> Removal

25. **CO<sub>2</sub> Removal:** Current CO<sub>2</sub> removal (CDR) capacity is insufficient for businesses to achieve net-zero by 2050. Exploring a mature CDR market reveals potential first-mover advantages, highlighting the need for gigaton-scale development to support net-zero efforts.
26. **Commissioning of Biomass/Bio-Coal in Belgium:** ArcelorMittal Belgium has commenced the 35 ME Torero project, processing sustainable biomass as a raw material in its Ghent steelworks' blast furnace. The project aims to produce biogas for ethanol conversion, supporting the chemical industry's decarbonization.

## 27.E-Fuels

28. **E-Fuels (HIF Global):** HIF Global, a leading eFuels company, has partnered with Forico, Tasmania's largest private forestry manager, to develop Australia's first eFuels production facility, marking a significant step in sustainable fuel production.
29. **E-Fuels (Infinium in Texas):** Infinium, with Breakthrough Energy Catalyst, announced a \$75 million investment for Project Roadrunner in Texas. This facility will convert waste CO<sub>2</sub> and renewable power into low-carbon fuels like SAF, eNaphtha, and eDiesel, targeting both domestic and international markets.
30. **E-Fuels (Aramco and ENOWA):** Aramco and ENOWA are developing a unique synthetic electro fuel (e-fuel) demonstration plant in ENOWA's Hydrogen Innovation and Development Center. The plant aims to produce low-carbon synthetic gasoline from renewable hydrogen and captured CO<sub>2</sub>.

## Feedstock

31. **Feedstock (Raizen and GranBio/NextChem):** Little public information is available on Raizen's advancements in cellulose conversion facilities in Brazil. However, ongoing expansion and GranBio/NextChem's continued operations suggest overcoming technical and cost challenges. Clariant's Romanian plant's extended startup and UPM's prolonged construction in Germany indicate potential difficulties.
32. **Feedstock (New Energy Blue in Pennsylvania):** New Energy Blue formed New Energy Farmers LLC in Iowa, a biomass aggregation company supplying feedstock to the New Energy Freedom Biomass Refinery. This joint venture with Iowa farmers aims to support other biomass refineries in the Midwest.
33. **Feedstock (Tax Incentives Guidance):** The tax incentives guidance for clean energy fuels should recognize woody biomasses as eligible for tax incentives under IRA 2022 sections. This inclusion will support producers of sustainable aviation fuels, ground transportation fuels, renewable chemicals, and biomaterials.
34. **Feedstock (Acelen Renewables):** Acelen Renewables, a subsidiary of Acelen and sponsored by Mubadala Capital, enters the market with over \$2.5 billion in investments. Focused on producing renewable fuels, SAF, and Renewable Diesel from Macauba, the company plans to build a biorefinery in Bahia and develop local innovation hubs.
35. **Feedstock (The Extraction Economy and India's Approach):** The "electrify everything" movement contrasts with India's approach, focusing on harvesting rather than extraction. India's model, not reliant on rare-earth elements or fossil fuels, indicates a shift towards a more sustainable economy.
36. **Feedstock (US Department of Energy):** The US Department of Energy's Bioenergy Technologies Office announced an intent to fund research on low-carbon, purpose-grown energy crops. This funding aims to develop alternative carbon sources, crucial for decarbonizing transportation and industrial sectors.

## Hydrogen

37. **Hydrogen (GreenGo Energy in Mauritania):** GreenGo Energy's application for Megaton Moon in Mauritania aims to establish one of the world's largest green energy parks. The project plans 60GW/190TWh of hybrid solar and wind generation and 35GW electrolysis for green hydrogen and ammonia production, targeting completion between 2028 and 2035.
38. **Hydrogen (Jepri in Brazil):** PV magazine reports that Jepri and Ceará state in Brazil have agreed on a \$3.6B green hydrogen project in the Pecém Industrial and Port Complex. With a

1.2 million tons per year capacity, production is expected to start between late 2026 and early 2027.

39. **Hydrogen (Air Liquide and ENEOS in Japan):** Air Liquide and ENEOS are partnering to develop low-carbon hydrogen in Japan, covering the entire value chain from production using CCUS and electrolysis technologies to developing an international liquid hydrogen supply chain.
40. **Hydrogen (BASF in Germany):** BASF, with funding from German authorities, moves forward with the Hy4Chem-EI proton exchange membrane electrolyzer project at the Ludwigshafen site, partnering with Siemens Energy.
41. **Hydrogen (SK E&S in Korea):** SK E&S collaborates with GE Vernova, Air Liquide, and others for a low-carbon hydrogen plant in Korea. This MoU aims for mass hydrogen production, supporting the domestic hydrogen ecosystem and global carbon neutrality.
42. **Hydrogen (HYDEA Project in the Netherlands):** The HYDEA project, launched in Spain, involves a consortium of eleven partners from public and private sectors across Europe. It aims to test hydrogen and methanol as energy alternatives in Atlantic Area ports, promoting green hydrogen technologies.
43. **Hydrogen (Greenhill Energy in Australia):** Greenhill Energy plans a A\$425 million facility in Australia to convert landfill waste and biomass into high-value products like fertilizers, synthetic fuels, and low-cost clean hydrogen for power and transport.
44. **Hydrogen (Eneos and Sumitomo in Malaysia):** Eneos and Sumitomo Corp. will produce green hydrogen in Malaysia, exporting most to Japan. The project, in partnership with SEDC Energy, will use hydroelectric power for production, aiming for 90,000 tons annually by 2030.
45. **Hydrogen (ACWA Power in Saudi Arabia):** Saudi Arabia's ACWA Power signed an agreement for a \$4 billion green hydrogen project in Egypt. The first phase, producing 600,000 metric tons of green ammonia per year, is part of a larger plan for 2 million tons annually.
46. **Hydrogen (Mitsubishi Corporation and Amogy):** Mitsubishi Corporation and Amogy announce a partnership to accelerate ammonia-to-power and ammonia cracking technology for hydrogen carrier applications in East Asia. A joint study with SK Innovation will evaluate large-scale deployment and market expansion opportunities.

## Marine Fuels

47. **Marine Fuels (WinGD in Switzerland):** Swiss company WinGD signed an agreement for ammonia-fueled engines with Belgian bulk carrier operator CMB.TECH. The engines, built by CSSC Qingdao Beihai Shipbuilding and CSSC Engine Co, will power bulk carriers delivered through 2025 and 2026.
48. **Marine Fuels (Wärtsilä in Sweden):** Wärtsilä is set to expand its methanol engine portfolio, adding four new models to the existing Wärtsilä 32 methanol engine. This expansion makes Wärtsilä the industry leader with the most extensive methanol engine range.
49. **Marine Fuels (Egypt):** Egypt's Suez Canal economic zone and Scatec ASA signed a \$1.1 billion MoU for supplying ships with green fuel, reflecting a significant move towards sustainable marine fuel solutions.
50. **Marine Fuels (Maersk in Denmark):** A.P. Moller – Maersk is launching the first of its 18 methanol-enabled vessels in February 2024. The vessel will serve on the AE7 string connecting Asia and Europe, including major ports like Shanghai and Hamburg.
51. **Marine Fuels (OCI Global and X-Press Feeders in the Netherlands):** OCI Global and X-Press Feeders announced a deal for green methanol supply in Rotterdam from 2024. This

agreement, a first with a feeder container carrier, marks a critical step in shipping chain decarbonization.

52. **Marine Fuels (Singapore):** Singapore's Maritime and Port Authority (MPA) is calling for proposals to supply methanol as a marine bunker fuel starting from 2025. This initiative, part of Singapore's strategy to enhance its maritime sector, positions it as a future-ready, sustainable port.
53. **Marine Fuels (Ulstein Verft):** Ulstein Verft has ordered MAN 12V175D-MEV methanol-ready engines for two new service operation vessels for Bernhard Schulte Offshore. This move aligns with the maritime industry's shift towards cleaner, more sustainable fuel options.
54. **Marine Fuels (VARO Energy and Høegh Autoliners in Norway):** VARO Energy and Høegh Autoliners have formed a strategic partnership to supply 100% advanced biofuels for deep-sea transportation from Europe. This collaboration aims to significantly advance maritime decarbonization efforts, emphasizing both companies' commitment to sustainability.

## Market Development

55. **Market Development (Illinois):** GTI Energy's report, "Designs for Net-Zero Energy Systems," compares five comprehensive U.S. net-zero studies. It highlights the diverse possibilities and common strategies across various sectors for achieving net-zero emissions, providing valuable insights for future energy system designs.
56. **Market Development (Bold Goals Action Group):** The Bold Goals Action Group, after meetings in Sydney, San Francisco, and Ottawa, plans a Delhi meet-up on December 5th. Future meetings across various regions will refine and extend the Bold Actions for ratification at ABLC 2024 in Washington DC.

## Methanol

57. **Methanol (Pacífico Mexinol in Mexico):** Plans for the \$2.2bn Pacífico Mexinol facility in Topolobampo, Mexico, are progressing swiftly. This facility aims to produce net-zero emissions methanol and includes infrastructure for storage, export to Asia, and transport logistics.
58. **Methanol (ICR Technology):** The ICR (Integrated Condensation and Separation) technology enables the simultaneous condensation and separation of methanol and water within the reactor, a process not possible with conventional technologies.

## Packaging

59. **Packaging (Avantium N.V in the Netherlands):** Avantium N.V collaborates with Albert Heijn to introduce sustainable packaging using PEF (polyethylene furanoate), a 100% plant-based material. Refresco will produce Albert Heijn's new fruit juice bottles from PEF, marking a significant step towards sustainable packaging.

## Plastic Recycling

60. **Plastic Recycling (LyondellBasell in Germany):** LyondellBasell has decided to build its first industrial-scale advanced recycling plant in Wesseling, Germany. Using MoReTec technology, this facility will convert post-consumer plastic waste into new plastic materials, aiming for an annual capacity of 50,000 tonnes.
61. **Plastic Recycling (Cyclix International):** LyondellBasell has acquired a 25% stake in Cyclix International, a joint venture with Agilyx and ExxonMobil. This partnership accelerates the

development of a nationwide circular economy for plastics, enhancing innovation and infrastructure.

## Pyrolysis

62. **Pyrolysis (Global Biochar Deployment):** Research published in the Biochar journal by the International Biochar Initiative quantifies biochar's carbon removal potential across 155 countries. The study confirms biochar's significant role in reducing CO2 emissions and benefiting the environment.
63. **Pyrolysis (Nexa Resources and Aperam BioEnergia):** Nexa Resources will acquire 10,000 tons of bio-oil from Aperam BioEnergia for zinc oxide production, replacing fossil fuels. This biofuel, a byproduct of charcoal production from renewable forests, contributes to industrial decarbonization.

## Renewable Diesel

64. **Renewable Diesel (Tidewater Renewables in Canada):** Tidewater Renewables' HDRD Complex in Prince George, B.C., has begun commercial operations, producing approximately 1,500 bbl/d of renewable diesel. The facility works towards its 3,000 bbl/d capacity, emphasizing the growth of sustainable fuel production.
65. **Renewable Diesel (Neste and Coleman Oil Company in Washington):** Neste partners with Coleman Oil Company to expand the availability of Neste MY Renewable Diesel in Washington, U.S. This partnership aims to provide lower-emission fuel to various industries, enhancing the state's sustainability efforts.
66. **Renewable Diesel (Preem in Sweden):** Preem, a leader in the transition to renewable production in Sweden, has now, for the first time, produced a fully renewable HVO product. This milestone marks a significant achievement in the shift towards sustainable fuel production.

## Overview –December 2023 (based on the above bullet points):

The maritime energy sectors are witnessing significant advancements in sustainability and decarbonization efforts, as highlighted in recent global developments.

In Singapore, the Maritime and Port Authority (MPA) is spearheading an initiative to introduce methanol as a marine bunker fuel by 2025. This effort aligns with Singapore's ambition to be a leading sustainable port and maritime hub. Similarly, Ulstein Verft in Norway has ordered methanol-ready engines from MAN for new service operation vessels, signaling a shift towards cleaner fuel alternatives in maritime operations.

VARO Energy and Høegh Autoliners, also in Norway, have partnered to supply 100% advanced biofuels for deep-sea transportation from Europe. This collaboration underscores the maritime industry's commitment to reducing carbon emissions and adopting sustainable practices.

Recent initiatives regarding market development have included, GTI Energy's report, "Designs for Net-Zero Energy Systems," offers a comprehensive analysis of five U.S. net-zero studies. This meta-analysis highlights a range of strategies and commonalities across sectors for achieving net-zero emissions, crucial for guiding future energy system designs. The Bold Goals Action Group is similarly working towards sustainability, holding meetings across various global locations, including Sydney, San Francisco, Ottawa, and Delhi. These meetings are part of a broader effort to refine and extend Bold Actions for ratification at ABLC 2024 in Washington DC.

Mexico is making progress in methanol production with the announcement of the \$2.2 billion Pacifico Mexinol facility in Topolobampo, Sinaloa state. This facility aims to produce net-zero emissions methanol and is equipped with storage and export facilities, emphasizing Mexico's commitment to sustainable energy production.

In the Netherlands, Avantium N.V is collaborating with Albert Heijn to introduce sustainable packaging using 100% plant-based PEF (polyethylene furanoate). This initiative, with bottles produced by Refresco, positions Albert Heijn as a pioneer in adopting sustainable packaging solutions in the supermarket industry.

The plastic recycling sector is also evolving. LyondellBasell decided to build an advanced recycling plant in Wesseling, Germany, marking a significant step in addressing post-consumer plastic waste. Additionally, LyondellBasell has acquired a 25% stake in Cyclyx International, a joint venture focusing on developing a circular economy for plastics.

The potential of biochar in mitigating climate change is being recognized globally. A study commissioned by the International Biochar Initiative has quantified biochar's impact on CO2 removal across 155 countries, affirming its environmental benefits.

Initiatives related to pyrolysis included, Nexa Resources has entered an agreement with Aperam BioEnergia to acquire bio-oil for zinc oxide production, replacing fossil fuels. This sustainable solution from renewable forests highlights the industry's shift towards greener practices.

The renewable diesel sector is witnessing growth, with Tidewater Renewables' HDRD Complex in Canada achieving commercial operations. This facility is demonstrating increasing demand for sustainable fuel alternatives. Neste's partnership with Coleman Oil Company in Washington state furthers this trend by expanding access to renewable diesel, catering to various industries and reducing reliance on fossil diesel.

These developments across the globe indicate a significant shift towards sustainability in the maritime, energy, and packaging industries. With a focus on adopting cleaner fuels, recycling, and innovative technologies, these sectors are playing a crucial role in the global effort to reduce carbon emissions and combat climate change.

## **Companies: Significant Contributions – December – 2023**

1. **Maritime and Port Authority (MPA), Singapore:** Initiating proposals to supply methanol as a marine bunker fuel by 2025, emphasizing Singapore's commitment to becoming a leading sustainable port.
2. **Ulstein Verft, Norway:** Ordering MAN 12V175D-MEV methanol-ready engines for new service operation vessels, indicating a shift towards cleaner maritime fuel options.
3. **VARO Energy and Höegh Autoliners, Norway:** Forming a strategic partnership to supply 100% advanced biofuels for deep-sea transportation from Europe, contributing significantly to maritime decarbonization.
4. **GTI Energy, USA:** Publishing the "Designs for Net-Zero Energy Systems" report, a comprehensive analysis of U.S. net-zero studies, offering diverse strategies for achieving net-zero emissions across various sectors.
5. **Bold Goals Action Group:** Conducting global meetings to refine and extend Bold Actions for sustainability, planning for ratification at ABLC 2024 in Washington DC.



6. **Pacífico Mexinol, Mexico:** Announcing the development of a \$2.2 billion facility in Topolobampo to produce net-zero emissions methanol, including storage and export facilities.
7. **Avantium N.V and Albert Heijn, Netherlands:** Collaborating to introduce sustainable packaging using 100% plant-based PEF, with Avantium’s commercial plant for PEF set to operationalize the initiative.
8. **LyondellBasell, Germany:** Deciding to build its first industrial-scale advanced recycling plant in Wesseling, aiming to convert post-consumer plastic waste into new materials.
9. **Cyclyx International (Joint Venture: Agilyx and ExxonMobil):** Witnessing LyondellBasell acquiring a 25% stake, enhancing the development of a circular economy for plastics.
10. **International Biochar Initiative:** Commissioning a study quantifying biochar's impact on CO2 removal across 155 countries, highlighting its environmental benefits.
11. **Nexa Resources and Aperam BioEnergia:** Entering an agreement where Nexa will acquire bio-oil for sustainable zinc oxide production, demonstrating a shift towards greener industrial practices.
12. **Tidewater Renewables, Canada:** Achieving commercial operations at its HDRD Complex, producing renewable diesel and working towards its full capacity, underscoring the growth in sustainable fuel production.
13. **Neste and Coleman Oil Company, USA:** Partnering to expand the availability of Neste MY Renewable Diesel in Washington state, supporting the transportation sector's shift to sustainable fuels.

### Company Ranking – December 2023

Rank	Company Name	Frequency
1	Clariant	3
2	Neste	3
3	LyondellBasell	2
4	Acelen Renewable	1
5	ACWA Power	1
6	Aduro Clean Technologies	1
7	Air Liquide	1
8	Alfa Laval	1
9	Aramco	1

Rank	Company Name	Frequency
10	ArcelorMittal	1

## Topic & Theme Ranking – December 2023

Here is the table showing the frequency of the top 15 topics, ranked from the most frequent to the least frequent:

Rank	Topic	Frequency
1	Hydrogen	10
2	Biojet/SAF	8
3	Marine fuels	8
4	Biogas	7
5	Feedstock	5
6	Biobased chemicals	3
7	Biofuels	3
8	E-fuels	3
9	Renewable diesel	3
10	Market development	2
11	Methanol	2
12	Plastic recycling	2
13	Pyrolysis	2
14	Ammonia production	1
15	Biobased plastics	1

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