GREENZO ENERGY INDIA LIMITED
ISO 9001-14001

GREEN HYDROGEN

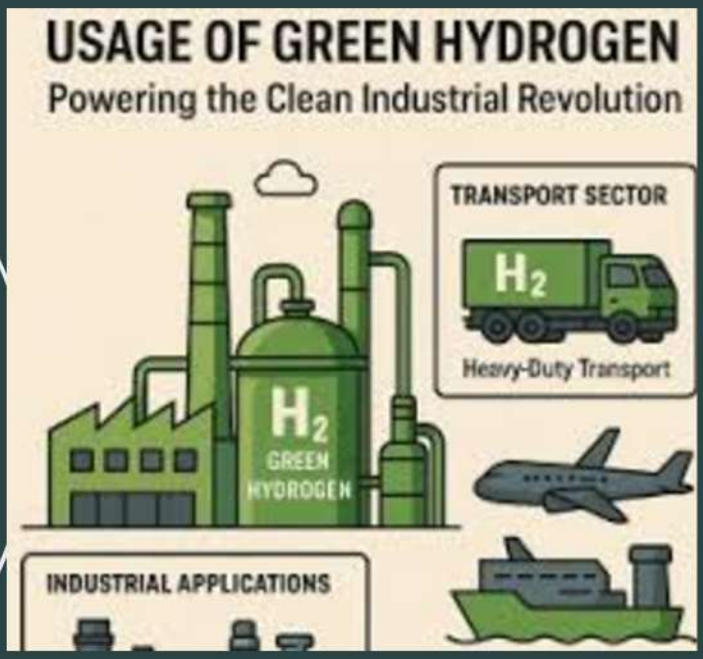
GREEN METHANOL REVOLUTION

PRESENTED BY:
GREENZO ENERGY INDIA LIMITED

MESSAGE FROM DIRECTOR

We, Greenzo Energy recognize the vital role green methanol will play in the global energy transition. By combining renewable hydrogen with captured CO_2, we are creating a sustainable fuel that not only decarbonizes heavy industry and transport but also turns emissions into a valuable resource. Our mission is to deliver scalable, reliable, and economically viable solutions that accelerate the adoption of e-methanol worldwide. Together, with our partners and stakeholders, we are shaping a cleaner, more resilient, and net-zero future.

Sandeep Agarwal
Founder & Managing Director



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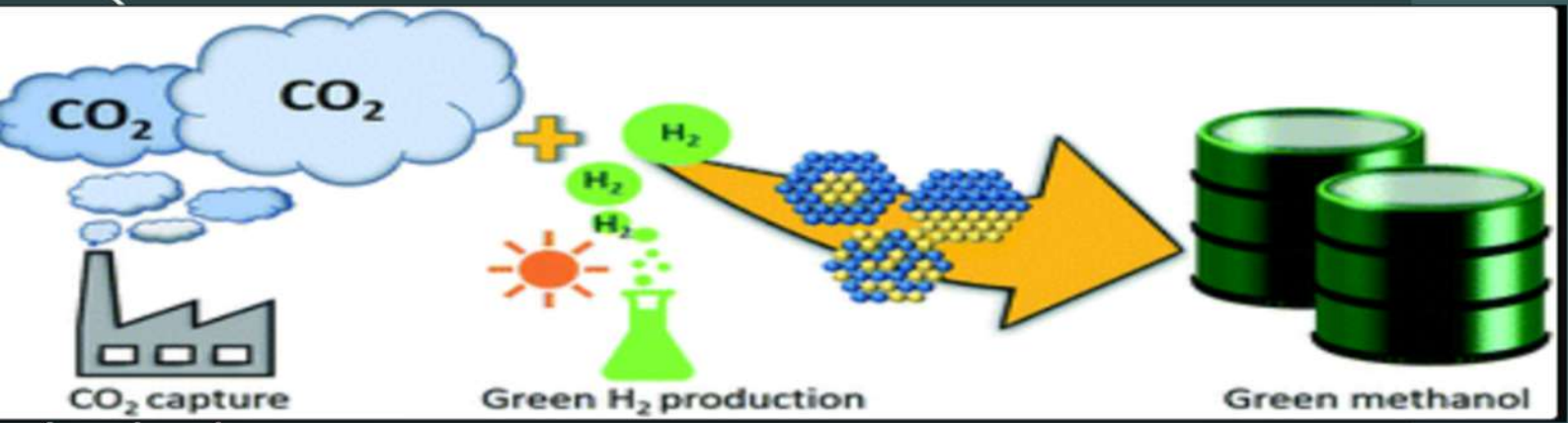
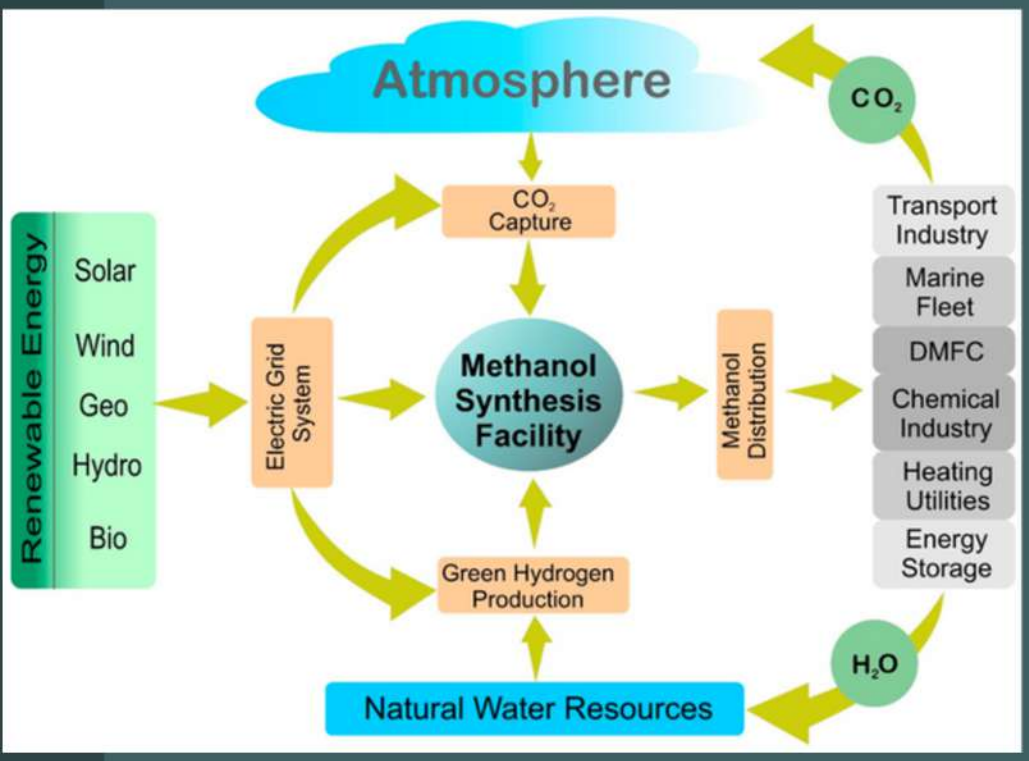
1. EXECUTIVE SUMMARY

Methanol (CH_3OH) is one of the world's most versatile chemical building blocks, widely used in the chemical, pharmaceutical, and energy industries. Today, over 90 million tonnes of methanol are produced annually, primarily from fossil fuels such as natural gas (65%) and coal (35%). However, as the world transitions towards cleaner energy, the focus is rapidly shifting to green methanol—produced from renewable electricity, green hydrogen, and captured carbon dioxide.

This Power - to - Methanol (PtMeOH) pathway offers a unique dual advantage: it transforms intermittent renewable energy into a storable liquid fuel and simultaneously enables the utilization of CO_2 as a valuable resource. With its potential to decarbonize "hard-to-abate" sectors such as heavy transport, shipping, and industry, e-methanol is emerging as a cornerstone fuel in the global energy transition.





2. E-METHANOL PRODUCTION FROM GREEN HYDROGEN

The captured CO_2 is converted into green methanol through catalytic hydrogenation with green hydrogen. The process is modelled in Aspen Plus and mirrors the configuration of commercial renewable methanol plants.

2.1 Key Process Features:

- Catalyst: $Cu/ZnO/Al_2O_3$ with promoters (Al, Zr, Cr, Si, B, Ga).
- Reactions:
  - $CO2+3H2 \leftrightarrow CH3OH+H_2O$..... .... (1)
  - $CO+H2O \leftrightarrow H2+CO_2$ ..... (2)
  - $CO+2H2 \leftrightarrow CH3OH$..... (3)
- Operating Conditions: 250–300°C, 50–100 bar.
- Separation & Recycling:
  - Product stream cooled to condense crude methanol.
  - Water and unreacted gases separated in flash units.
  - Unreacted CO_2 and H_2 are recycled to the reactor.
  - Minor purge (~1%) prevents inert gas accumulation.
- Purification: Distillation ensures fuel-grade methanol.
- Storage: Final product stored as liquid fuel at ambient pressure.

The process is thermally self-sufficient through heat integration, minimizing external energy demand. Methanol produced can be used as a clean transport fuel or chemical feedstock, supporting the energy transition.

3. E-METHANOL PLANT DESIGN & PROCESS FLOW

The proposed e-methanol production system integrates renewable energy with carbon capture technologies to deliver a sustainable fuel solution. The plant is designed around three key sections:

3.1 Hydrogen Production:

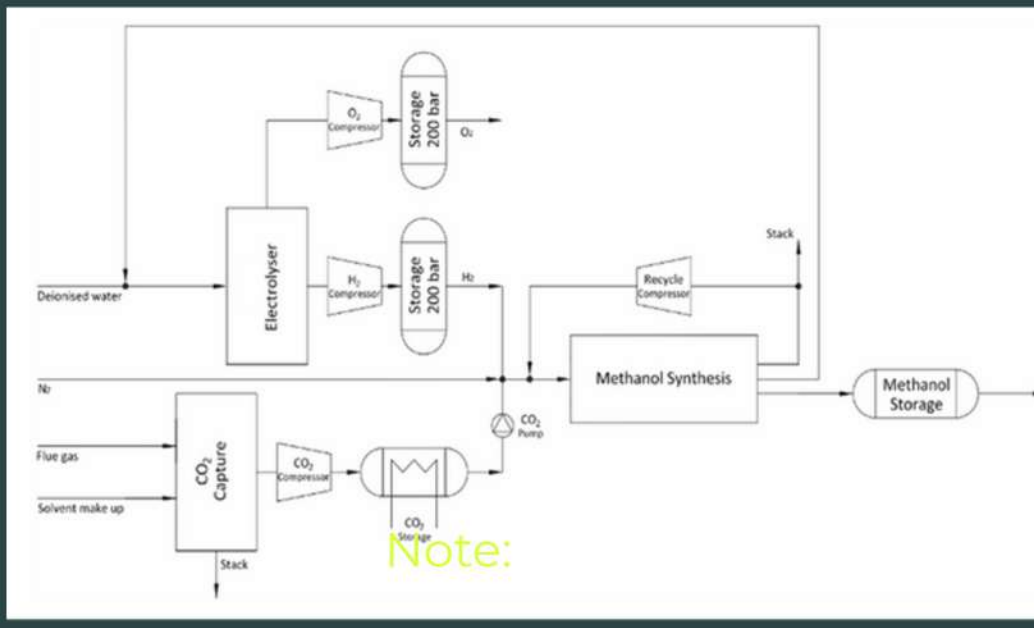
Green hydrogen is generated through alkaline water electrolysis, powered by wind and solar electricity.

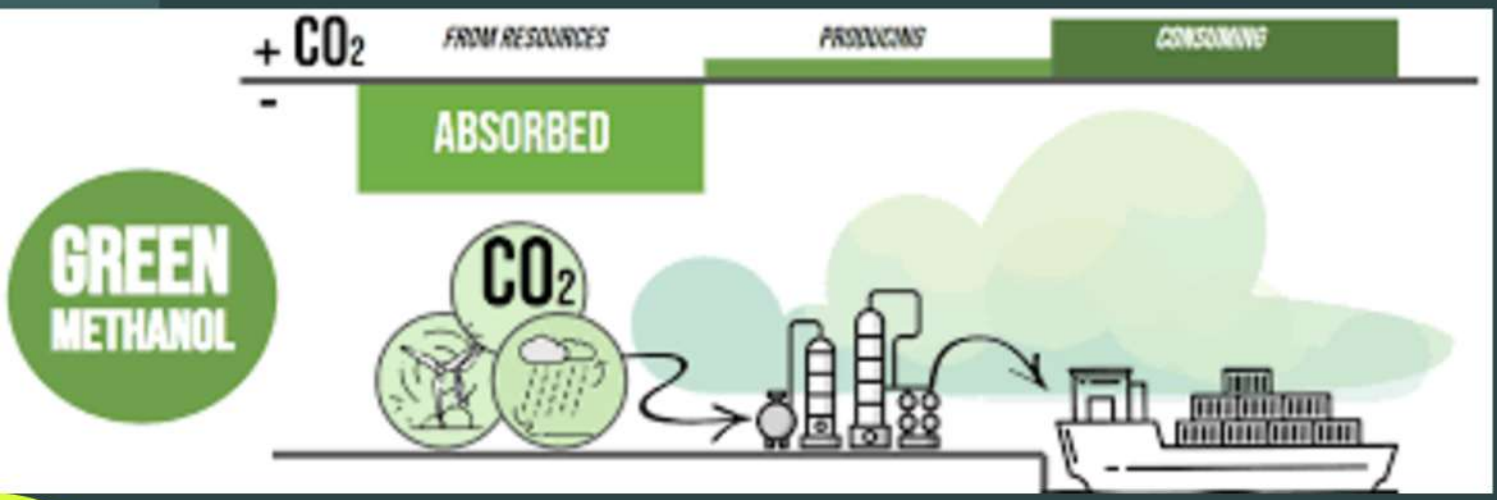
3.2 Carbon Capture :

CO_2 is separated from industrial flue gases using advanced amine-based capture systems.

3.3 Methanol Synthesis & Purification

Direct CO_2 hydrogenation is employed to produce high-purity e-methanol.





4. GREEN METHANOL: PAVING INDIA'S PATH TO A SUSTAINABLE ENERGY FUTURE

Green methanol, produced from renewable hydrogen combined with captured CO_2 or from sustainable biomass, is gaining momentum in India as a strategic clean fuel and chemical feedstock. It holds significant promise in accelerating India's energy transition by reducing reliance on fossil fuels, cutting carbon emissions, and advancing energy security.

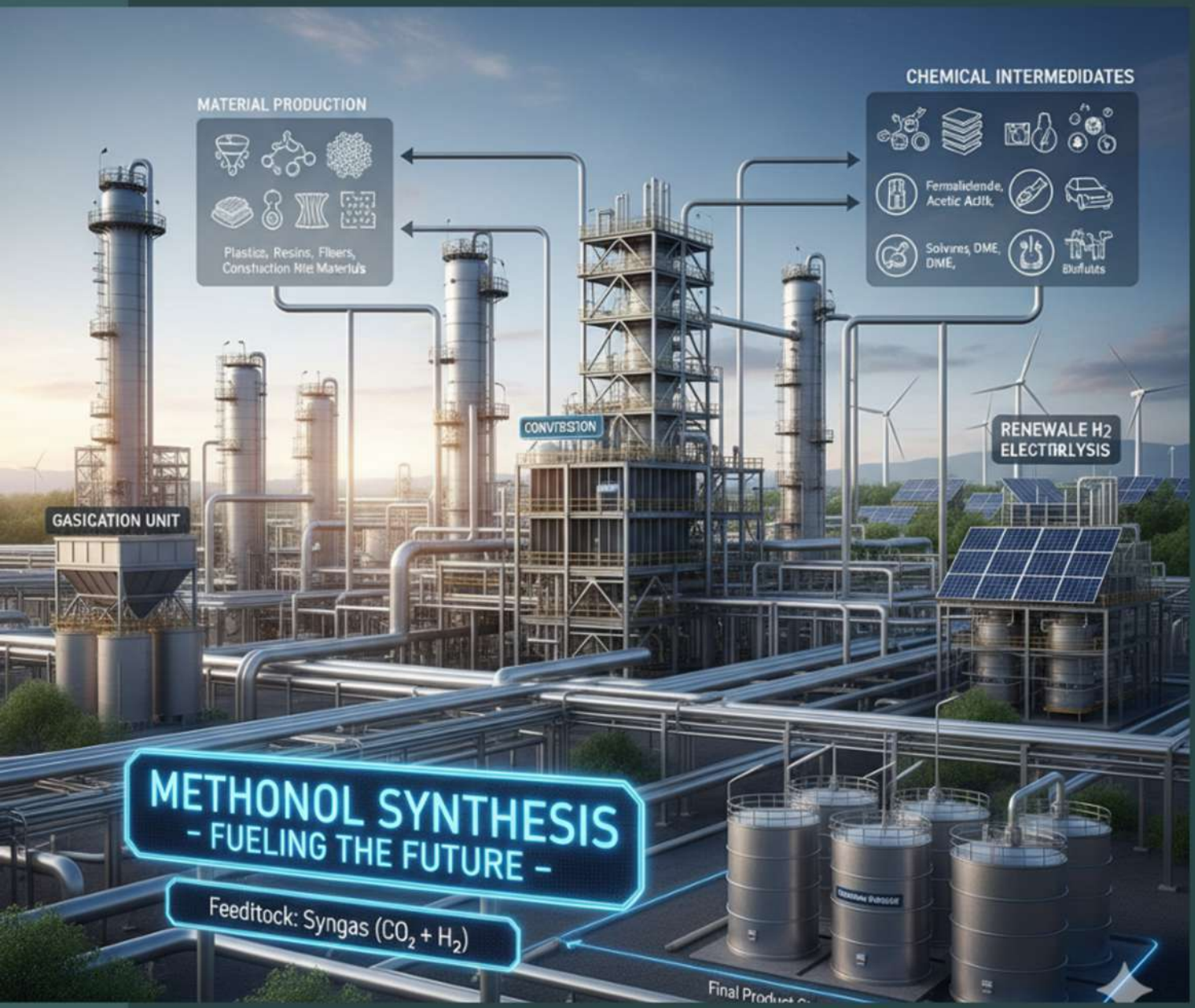
5. APPLICATIONS IN INDIA

5.1 Maritime Transport:

India's maritime sector is aligning itself with global sustainability trends by fostering clean fuels like green methanol. The government's commitment through the National Green Hydrogen Mission includes plans to transform key Indian ports—Kandla, Paradip, and Tuticorin—into green hydrogen and green methanol hubs to supply the domestic and international shipping markets. Indian shipyards are encouraged to build and retrofit green fuel-compatible vessels, supported by policy and financial incentives such as the ₹25,000 crore Maritime Development Fund. This will help scale the use of green methanol in marine transport, aligning with India's goal to reduce the carbon intensity of shipping by 40% by 2030 and achieve net-zero emissions by 2070.

5.2 Chemicals and Materials Industry:

India's large and growing chemical sector relies heavily on methanol as feedstock for plastics, solvents, and synthetic fuels. Currently, India imports nearly 90% of its methanol, mainly derived from fossil natural gas or coal. Transitioning to green methanol production will reduce import dependence and lower lifecycle greenhouse gas emissions. The government's Methanol Economy program emphasizes creating a domestic methanol supply utilizing coal gasification, biomass, and carbon capture to promote a circular carbon economy and energy security.



6. REGIONAL AND POLICY MOMENTUM IN INDIA

6.1 Domestic Production and Demand

India's methanol demand was around 3 million tonnes in 2022-23, with domestic production at about 0.8 million tonnes, operating well below capacity utilization. With imports accounting for about 90% of consumption, India spends significant foreign exchange on methanol imports. Green methanol production could catalyse domestic capacity utilization through sustainable routes, leveraging abundant biomass and renewable electricity resources, especially solar.

7. WHY CHOOSE GREENZO?

At Greenzo Energy, we are not just building plants – we are building the future of clean energy. Our expertise in renewable hydrogen, CO_2 utilization, and advanced electrolyser technology makes us the ideal partner for e-methanol projects.

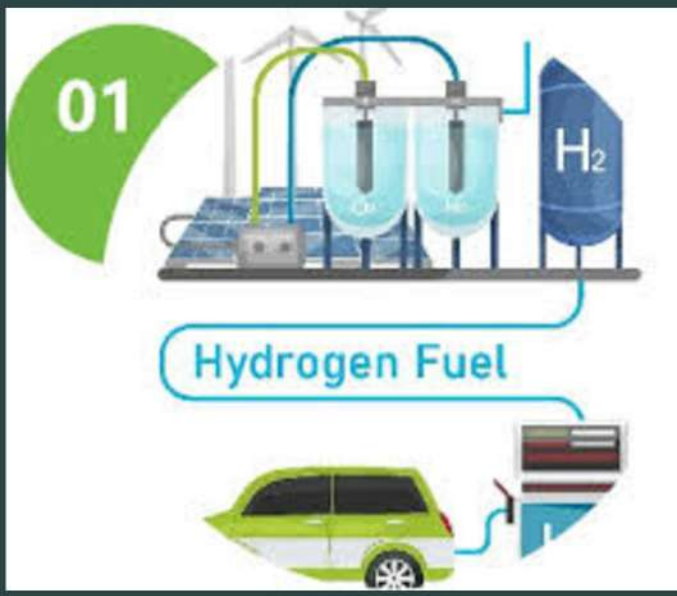
- Proven Expertise – Backed by a strong track record in renewable energy and hydrogen technologies.
- End-to-End Solutions – From electrolysers and CO_2 capture systems to methanol synthesis and purification, we deliver integrated turnkey projects.
- Scalable & Flexible Designs – Our distributed-scale plant configurations align with local renewable availability, ensuring efficiency and grid stability.
- Sustainability Focus – Every Greenzo project contributes to net-zero targets by replacing fossil-based methanol with renewable e-methanol.
- Innovation Driven – Our R&D-led approach ensures cutting-edge catalysts, optimized processes, and energy efficiency.

- Global Vision, Local Implementation – While aligned with global climate goals, we design solutions tailored to local feedstock and renewable energy resources.

With Greenzo, you gain a partner that combines technical excellence, economic viability, and environmental responsibility to accelerate the transition to a sustainable hydrogen economy.

8. CONCLUSION

Greenzo Energy is at the forefront of the renewable energy transition, transforming wind, solar, and captured CO_2 into sustainable e-methanol. Our integrated solutions from green hydrogen production and CO_2 capture to methanol synthesis and purification enable scalable, distributed, and economically viable clean fuel production.



By choosing Greenzo, stakeholders gain a reliable, innovative, and environmentally responsible partner that not only supports the decarbonization of hard-to-abate sectors but also strengthens energy security and grid stability. Together, we are building a net-zero future, one molecule of methanol at a time

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MetH$_2$anol™
Energy system

MetH$_2$anol™
Materials system

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