Research and development

Our unique and sustained approach to R&D

We take a fundamental approach to our research, which seeks to identify and progress new technologies that, once proven, could be deployed at a commercial scale by market participants.

As we work to advance carbon capture and storage, hydrogen and lower-emission fuels opportunities, we are also investing in research and development aimed at next-generation, lower-emission solutions. We determine which research projects to advance based on factors including advantage versus alternatives, the ability to scale, alignment with core capabilities and key partners, and the probability of commercial success.

Thousands of scientists and engineers, including more than 1,500 Ph.D.s, work at ExxonMobil. In R&D, they are exploring areas such as new catalytic and separation materials, novel low-energy process development and scale-up, advanced performance materials, and improved means of CO_2 storage. Our scientists have written more than 1,000 peer-reviewed publications and received more than 10,000 patents over the past decade. In addition, we collaborate with more than 80 universities around the world, four energy centers, and several U.S. national laboratories. These collaborations have increased knowledge in key areas important to the energy transition: fugitive methane emissions detection and modeling; optimization techniques to understand CO_2 storage; electrification of processes; lower-emission fuels; and energy systems models.

We also monitor emerging lower-emission technologies for future research opportunities and to improve understanding of likely energy transition pathways. Our research and development approach focuses on areas that align with our businesses.

Core R&D capabilities

- Engineering
- Process & scale-up
- Production technology
- Geoscience
- Emerging technology
- Modeling & data science
- Energy modeling
- Biology
- Catalysis
- Chemistry
- Physics
- Materials science

Energy center collaborations

Stanford | ENERGY Strategic Energy Alliance

SINGAPORE ENERGY CONSORTIUM

The University of Texas at Austin Energy Institute

MITei MIT Energy Initiative

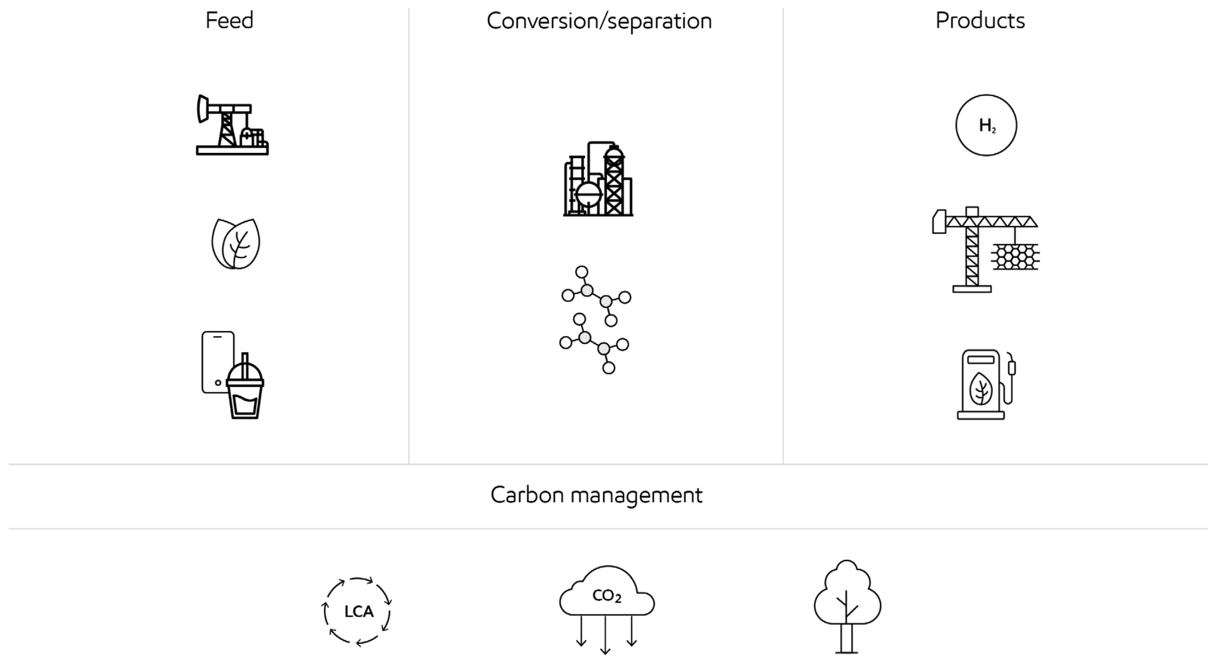
National labs

NATIONAL ENERGY TECHNOLOGY LABORATORY

NREL NATIONAL RENEWABLE ENERGY LABORATORY

INL Idaho National Laboratory

Innovating across our value chain



Feed

Biomass – We are working to expand the range of options for biofuels feedstocks, ranging from vegetable oils to wood wastes, cover crops, and more. These have potential application at our biofuels facilities, such as our Strathcona renewable diesel plant and future advanced biofuel deployments.

Plastic waste – We focus on plastics that are difficult to recycle mechanically, allowing us to use a wider range of mixed and soiled plastic waste to make valuable raw materials safely, reliably, and economically at scale.

Methane detection – We are testing and deploying innovative technology on the ground, in the sky, and even in space to identify and mitigate fugitive emissions in our natural gas value chain, which supports the production of low-carbon hydrogen.

Conversion/separation

New catalysts – Our catalysts have applications in performance materials and lower-emission fuels, including renewable fuels. For example, our dewaxing catalyst provides higher yield with less hydrogen consumption while improving the diesel flow at low temperatures.

Low-energy separations – Reducing the energy needed to sort molecules (i.e., isolate hydrocarbons for use in the refining or chemical process) can dramatically reduce emissions in our manufacturing. Our scientists are building off years of research with university partners to identify ways to improve the scalability of this technology.[1,2]

GHG abatement and energy efficiency – As part of our GHG roadmaps, we are working across our sites to apply modeling that can drive efficiencies, support future deployment of carbon capture in our operations, explore opportunities for electrification and heat recovery, and pursue the full range of large and small optimizations that may lower emissions.

Products

Hydrogen – We are developing improved, lower-cost technology for production of low-carbon hydrogen at scale. We are also working with leading combustion equipment manufacturers on burners to enable industrial fuel switching to hydrogen while controlling NOx emissions. In addition, we are working with the U.S. Department of Energy and industry organizations to evaluate safe and cost-effective hydrogen transport, which could enable us to grow the supply of hydrogen for a wide range of end users.[3]

Performance materials – We are developing and deploying new thermosets, thermoplastics, fillers, and lubricants to enable improved performance while using less materials and reducing energy use for products used in society. For example, our Proxxima™ thermoset resin system, based on Nobel Prize-winning technology, provides stepout advantages in a range of applications including wind turbine blades, concrete reinforcement, and automotive applications. We are also studying additional opportunities for materials in the energy transition.

Lower-emission fuels – Our continuing research in advanced biofuels could lead to improved longer-term solutions by converting lower-value, bio-based feedstock into renewable fuels. For example, we have identified a new pathway for the production of sustainable aviation fuel (SAF) from renewable methanol, which can produce jet fuel with high selectivity and lead to reduced GHG emissions. In addition, we are leading the industry through a technical evaluation of this pathway to certify its use in aircraft.

Carbon management

Post-combustion carbon capture – ExxonMobil and Mitsubishi Heavy Industries (MHI) have entered a strategic alliance to deploy MHI's leading CO_2 capture technology as part of ExxonMobil's end-to-end carbon capture and storage solution for industrial customers. The alliance also leverages our combined core capabilities in engineering and science to advance the carbon capture technology for improved performance and lower overall cost of CO_2 capture.

With our partner FuelCell Energy, we are progressing the development of a next-generation carbonate fuel cell technology for CO_2 capture from industrial point sources. A project is planned at our Rotterdam refinery to validate fuel cell performance and lower cost of CO_2 avoidance in an industrial deployment. We are developing commercialization options as part of our Low Carbon Solutions portfolio.

Direct air capture (DAC) – We believe there is potential for direct air capture to play an important role in reducing greenhouse gas emissions, and ExxonMobil plans to play a lead role in accelerating the development of cost competitive and scalable DAC technology with our in-house expertise and select partners. We are planning for a prototype demonstration of our DAC platform in early 2024. Our goal is to produce a low-cost commercial platform at scale, in line with the improvements we expect to realize through rapid learning cycles.

Carbon storage – To support the required scale-up of global geologic CO_2 storage, we continue to build on our experience and develop improvements such as rapid modeling tools. One such example is our support for Stanford University to develop a machine learning framework for CO_2 storage modeling.[4] Approaches like this have the potential to enable real-time modeling. Another area is our collaboration with the University of Texas at Austin, the National Energy Technology Laboratory, and Brooklyn College and the Benjamin Levich Institute at City College, both part of City University of New York, where our laboratory simulations indicate that the pore-scale sealing of caprocks is maintained under geological CO_2 storage conditions.

Nature-based solutions – We continue to evaluate the potential opportunities to remove carbon from the atmosphere, including prairies, grassland, and other nature-based options.

Life-cycle assessment – The Sustainable Energy System Analysis Modeling Environment (SESAME) tool we have been developing with the MIT Energy Initiative can perform full life-cycle assessments for more than 1,000 technology pathways, from primary energy sources to final products or services.[5]

Footnotes

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2. Siyao Li, Ruijiao Dong, Valentina-Elena Musteata, Jihoon Kim, Neel D. Rangnekar, J. R. Johnson, Bennett D. Marshall, Stefan Chisca, Jia Xu, Scott Hoy, Benjamin A. McCool, Suzana P. Nunes, Zhiwei Jiang, Andrew G. Livingston, Hydrophobic polyamide nanofilms provide rapid transport for crude oil separation, Science 377 (6614) (2022) 1555-1561.
3. HyBlend Project to Accelerate Potential for Blending Hydrogen in Natural Gas Pipelines, https://www.nrel.gov/news/program/2020/hyblend-project-to-acceleratepotential-for-blending-hydrogen-in-natural-gas-pipelines.html; HyBlend: Pipeline CRADA Materials R&D, https://www.hydrogen.energy.gov/docs/hydrogenprogramlibraries/pdfs/review22/in035_san_marchi_2022_o-pdf.pdf.
4. Gege Wen, Zongyi Li, Kamyar Azizzadenesheli, Anima Anandkumar, Sally M Benson, Real-time high-resolution CO_2 geological storage prediction using nested Fourier neural operators, Energy & Environmental Science 16 (2023) 1732-1741.
5. E. Gencer, S. Torkamani, I. Miller, T. Wu, F. O'Sullivan, Sustainable energy system analysis modeling environment: analyzing life-cycle emissions of the energy transition, Applied Energy 277 (2020) 115550.