Supporting our customers on the Path to Zero emissions

PATH2ZERO

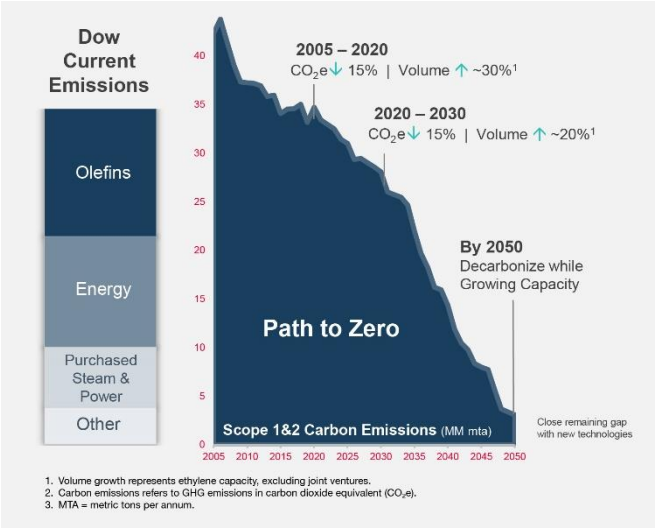
DOW GROWTH & NET-ZERO TRANSFORMATION

As a leading materials company committed to the power of science for more than 125 years, we have the responsibility and opportunity to step forward when our innovation can make a difference. We can imagine better ways to solve challenges related to climate change and to support our customers on their own journeys. Dow is taking decisive action to transition to a more sustainable future, and this article is designed to provide our partners with a deeper look at our planned Path to Zero.

Demonstrated progress and robust commitments

Dow reduced its greenhouse gas emissions by 15% between 2005-2020 and is on track to reduce carbon emissions by another 15% by 2030. Efforts such as implementing the use of renewable energy; a relentless focus on energy efficiency; and innovative manufacturing techniques have enabled progress to date. For example, Dow's most recently commissioned cracker, Texas-9, is the largest, most capital and operationally efficient cracker in our fleet – generating 60% less carbon emissions per ton of material produced compared to older crackers.

To achieve our commitment of carbon neutrality by 2050, Dow has outlined a roadmap to decarbonize our manufacturing assets while growing our ability to serve customers. This roadmap includes replacing end-of-life assets with high-efficiency, low-carbon assets.



Let's look at some of the actions we're taking as well as the challenges in front of us on this path to zero.

The energy hurdle

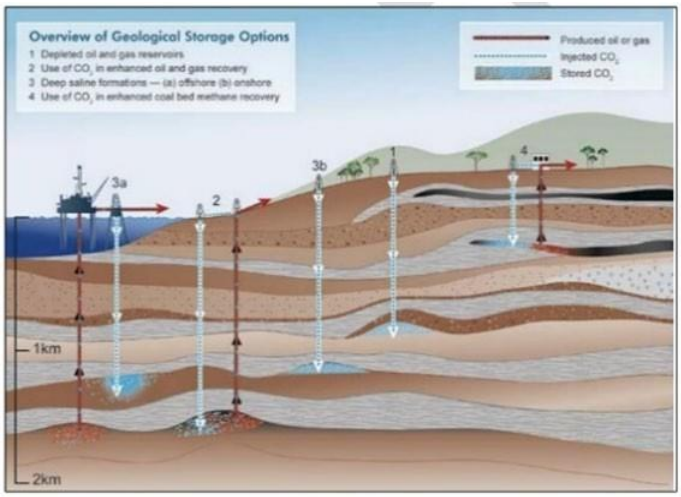
The combustion of fuel gas, which is mostly methane, accounts for nearly all of our scope 1 carbon emissions. To make our products, we import and use approximately 10 gigawatts of energy from fuel to produce heat, power and steam from more than 80 gas turbines, steam turbines, and boilers, and nearly 200 furnaces at 25 major manufacturing sites worldwide. On top of that, we purchase more than 1 gigawatt of power and steam from external utility providers.

We've been a leader in the use of renewable energy – such as solar and wind – and are among the top 20 corporate purchasers worldwide. This is a strategic choice that will continue to be important to our decarbonization efforts. Renewable energy, however, has limitations. Our manufacturing operations require around-the-clock supply of power, heat, and steam. We cannot have power interruptions when the sun isn't shining or the wind isn't blowing. In addition, while renewables generate enough electricity to run some of our processes, they cannot deliver the high temperatures and high-pressure heat and steam many of our processes require. Furthermore, our path to decarbonization will move us toward electrifying more of our processes, which will add more demand on already strained electrical grids. A significant increase in stable, reliable power generation will be needed.

Given this, Dow is pursuing many options for decarbonizing our energy assets, including investing in carbon capture and storage (CCS); using advanced small modular nuclear technologies; continuing to increase our use of renewable energy; as well as various clean hydrogen technologies.

The energy supply technologies selected by our manufacturing sites depend on a combination of factors, including site needs, the specific energy requirements of the processes we are operating, availability, reliability, cost, and environmental impact. Let's explore some of those options and the associated opportunities and challenges.

[1]Dow's Protect the Climate Target: By 2050, Dow intends to be carbon neutral (Scopes 1+2+3 plus product benefits)



Carbon capture and storage

Where high energy densities are needed, and fossil fuels are the best available option, CCS technology is an important decarbonization strategy. CCS involves the capturing, compressing, transporting, and storage of carbon in places like saline aquifers, depleted oil and gas fields, and coal seams. The Global CCS Institute reports that deep saline aquifers can potentially safely store up to 10,000 gigatons of carbon, which is more than 300 years of current global emissions. The International Energy Agency says that addressing climate goals cannot be reached without large scale CCS.

ADVANTAGES:

- Uninterrupted, reliable steam and electricity generation

DISADVANTAGES:

- Lack of infrastructure for transport and storage
- Technology adaptation
- Transportation and storage costs

DOW PATH FORWARD:

- Planning to implement CCS into 2 major sites (Fort Saskatchewan, Canada and Terneuzen, The Netherlands)
- Engaging governments and other industrial stakeholders on investment in CCS infrastructure

Nuclear

Advanced small modular nuclear reactors (SMRs) can safely and reliably generate carbon-free steam and electricity. Advanced nuclear offers the advantage of baseload replacement and supplementing renewables with better environmental performance and fewer issues than conventional nuclear. There are many advanced nuclear technology companies emerging around the globe, all offering different advantages and disadvantages. Dow currently has a project underway, supported by the U.S. Department of Energy and the State of Texas to replace existing gas-fired energy assets at its Seadrift, Texas (U.S.A.) site, with advanced SMRs to reduce emissions while providing a reliable supply of electricity and steam to the site.

ADVANTAGES:

- Uninterrupted, reliable, cost-competitive, low-carbon steam and electricity
- Small physical footprint for energy assets
- Government incentives to advance the technology

DISADVANTAGES:

- High capital expenses
- Developing advanced SMR supply chain
- Licensing and regulatory timeframes

DOW PATH FORWARD:

- SMR at our Seadrift, Texas, site, operational around 2030

Hydrogen

Hydrogen is an important resource that will enable economies to meet net-zero goals. While there are many types of hydrogen, “Grey” hydrogen is the most common and is generated from natural gas, or methane, through various processes such as steam methane reforming or auto thermal reforming. “Blue” hydrogen, occurs when the carbon emissions generated are captured and stored (using CCS). “Green” hydrogen is produced by using clean energy (typically from renewables) to split water into hydrogen and oxygen through electrolysis. Dow’s Path2Zero Fort Saskatchewan project and its Terneuzen 2030 project will both use an improved form of blue hydrogen called circular hydrogen. The sites will convert methane rich streams produced as a byproduct from our crackers into hydrogen and CO2. The hydrogen is then used as a clean fuel in the cracker furnaces. The CO2 will be captured onsite to be transported and stored using third-party CO2 infrastructure.

ADVANTAGES:

- Uninterrupted, reliable steam and electricity
- Powerful enough to run crackers

DISADVANTAGES:

- New technology scale-up
- High operating cost
- CCS infrastructure not available in all locations
- Insufficient renewable capacity for green hydrogen

DOW PATH FORWARD:

- Fort Saskatchewan and Terneuzen circular hydrogen
- Optimizing hydrogen allocation and production while retrofitting turbines for hydrogen fueling: >60% sites to be H2 ready by ~2040

Renewables

Dow is already a top user of clean energy in the chemical industry and top-20 among global corporations, having secured over 1 gigawatt of renewable power capacity for use at Dow sites around the world. This is equal to approximately 40% of our purchased electricity. Despite this significant commitment, we can't be solely reliant on renewable energy for our operational needs due to the limitations described earlier. We need access to higher energy density sources like fuel gas in the form of hydrogen for high pressure/volume steam and the critical cracking processes where our key raw materials, like ethylene and propylene, are manufactured. Lastly, even if we could overcome the intermittency and energy density limitations of renewables, the amount of land that would be required to meet all our needs would be prohibitive. For the approximately 4 gigawatts of energy we generate in the form of power and heat, you would need more than 10 million solar panels or 1,240 wind turbines covering tens of thousands of acres of land. Additionally, we would need significant resources (land and materials) for the large amount of energy storage required to compensate for intermittency (i.e. large scale batteries).

ADVANTAGES:

- Low carbon emissions

DISADVANTAGES:

- Intermittent supply
- High cost
- Land use
- Regional availability/infrastructure

DOW PATH FORWARD:

- Continued use of renewables to supplement other clean energy technologies

Developing Sustainable Manufacturing Technologies

Dow is investing in longer-term, future-focused manufacturing technologies that will be critical in the decarbonization of our manufacturing. For example, we are collaborating with Shell on technology to electrically heat steam cracker furnaces. Combining electrical cracking with clean electricity sources would reduce the CO2 footprint of the production process to near zero emissions. We've also developed our proprietary fluidized catalytic dehydrogenation technology (FCDh), which can be used to make cracking a less carbon intensive process. We are currently using the FCDh technology in a mixed-feed cracker in Louisiana to produce on-purpose propylene, reducing energy use and emissions by up to 20%. Additionally, we're building on the FCDh learnings to advance ethane dehydrogenation technology for ethylene production – which has the potential to reduce ethylene emissions by 40-50% when compared to traditional cracking.

ADVANTAGES:

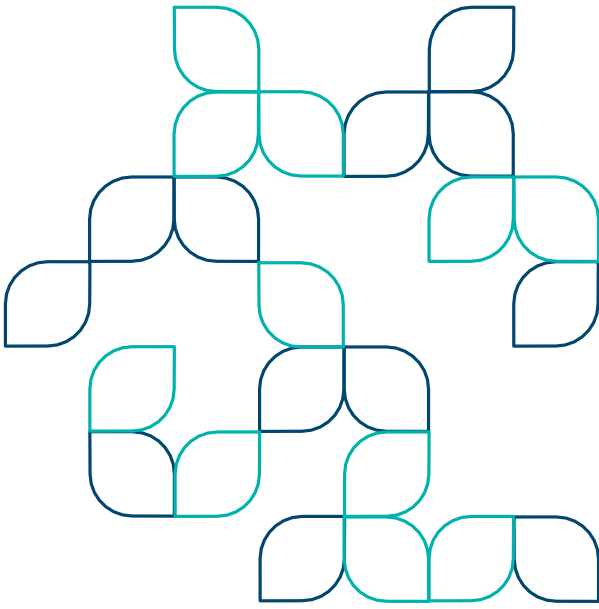
- Low carbon emissions
- Dow's 126 years of manufacturing and technological advancement

DISADVANTAGES:

- Electrification requires significant clean energy availability to provide emissions advantages
- New technology development takes significant time and resources

DOW PATH FORWARD:

- Continued R&D efforts to ensure that Dow is on the leading edge of sustainable manufacturing



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