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MARKETS

# The Shale Revolution's Staggering Impact in Just One Word: Plastics

Petrochemicals, once simply a cheap byproduct, are powering a U.S. manufacturing boom and export bonanza

The shale boom has lowered the price for the raw materials used to make plastics. PHOTO: ISTOCK

*By Christopher M. Matthews*
June 25, 2017 1:29 p.m. ET

When new parents in Rio de Janeiro buy baby food in plastic containers, they are bringing home a little piece of the U.S. shale revolution.

That boom in drilling has expanded the output of oil and gas in the U.S. more than 57% in the past decade, lowering prices for the primary ingredients Dow Chemical Co. DOW -0.56% ▼ uses to make tiny plastic pellets. Some of the pellets are exported to Brazil, where they are reshaped into the plastic pouches filled with puréed fruits and vegetables.

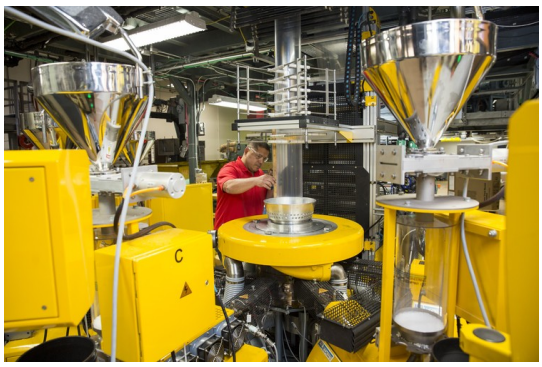
Tons more will be shipping soon as Dow completes $8 billion in new and expanded U.S. petrochemical facilities mostly along the Gulf of Mexico over the next year, part of the industry's largest transformation in a generation.

The scale of the sector's investment is staggering: $185 billion in new U.S. petrochemical projects are in construction or planning, according to the American Chemistry Council. Last year, expenditures on chemical plants alone accounted for half of all capital investment in U.S. manufacturing, up from less than 20% in 2009, according to the Census Bureau.

Integrated oil firms including Exxon Mobil Corp. and Royal Dutch Shell PLC are racing to take advantage of the cheap byproducts of the oil and gas being unlocked by shale drilling. The companies are expanding petrochemical units that produce the materials eventually used to fashion car fenders, smartphones, shampoo bottles and other plastic stuff being bought more and more by the world's burgeoning middle classes.

"It's a tectonic shift in the hemispherical balance of who makes what to essentially feed the manufacturing sector," said Dow Chief Executive Andrew Liveris, referring to the

growth of production in the U.S. His company now plans to double down on its U.S. expansion with a $4 billion investment in a handful of projects over the next five years.



A new petrochemical facility in Freeport, Texas, on the Gulf of Mexico is part of Dow Chemical's $8 billion investment. PHOTO: SCOTT DALTON FOR THE WALL STREET JOURNAL

Companies are eagerly launching new U.S. petrochemical projects—310 in all according to the Chemistry Council—because at a time of uncertainty over when demand for transportation fuels may peak, due to electric cars and ride sharing, the world's appetite for plastics is expected to rise for decades to come.

That demand typically grows at least 1.5 to 2 times as fast as global gross domestic product, according to industry analysts. That theoretically makes petrochemicals one of the safer fossil fuel investments, though skeptics question whether the margins on U.S.-made plastics can last.

The new investment will establish the U.S. as a major exporter of plastic and reduce its trade deficit, economists say. The American Chemistry Council predicts it will add $294 billion to U.S. economic output and 462,000 direct and indirect jobs by 2025, though analysts say direct employment at plants will be limited due to automation.

For energy companies, the build-out creates a new market for byproducts they previously had little use for. Drillers have been flush for years with the raw materials but have left them in the gas stream to be burned off, because no one wanted them. A spike in demand in coming years could make drilling more profitable.

Petrochemical companies are betting the price of the feedstocks—their most costly expense—will remain low for years due to shale drilling. As a result, net U.S. petrochemical exports, which include plastic as well as products such as fertilizer, adhesives and solvents, will grow to $110 billion a year by 2027 from $17 billion last year, according to IHS Markit . That would come close to the value of Saudi Arabia's current annual oil exports.

"There's no other industry that comes close to that level of growth," said IHS economist Thomas Runiewicz.

Many of the companies investing in the U.S. are foreign, including Saudi Arabia's state-owned chemical company and some of the largest petrochemical companies in Brazil, Japan and Thailand.

Dow's plant in Freeport, when fully operational by the end of the year, will produce 1.5 million metric tons of ethylene annually. PHOTO: SCOTT DALTON FOR THE WALL STREET JOURNAL

In April, Exxon said it selected a site near Corpus Christi, Texas, for a $9.3 billion petrochemical complex it is building jointly with Saudi Basic Industries Corp. The

proposed facility, the largest of its kind in the world, is expected to be done by 2021 and produce 1.8 million metric tons a year of ethylene, the main component of plastic.

"We don't see this as a bet," said Neil Chapman, president of the chemicals unit at Exxon, which is investing a total of $20 billion in such projects along the Gulf of Mexico. "You've got to pinch yourself sometimes and say 'this is the envy of the world.' "

Dow's plant in Freeport, Texas, when fully operational by the end of the year, will produce 1.5 million metric tons of ethylene annually. The company plans to export at least 20% of the plastic it makes in the U.S. and is particularly eyeing Latin America as a ripe market.

Dow expects plastic baby food containers will be a booming business in Brazil, where an increasingly career-oriented female population is favoring prepared baby foods in innovative packaging to save time, according to a 2015 World Health Organization study. That is expected to fuel projected annual growth of about 10% in sales of the industry's flexible and rigid plastic packaging in Brazil, the report said.

"We are taking advantage of population growth, the rising middle class and the on-the-go lifestyle," said Paloma Alonso, Dow's vice president of plastics in South America. "The Gulf investment is really essential for us."

The U.S. investments aren't without risk. American petrochemical facilities mostly run on ethane, a byproduct tied to natural gas prices, while counterparts in Asia and Europe primarily use naphtha, a crude oil derivative.

Ethane prices fell when U.S. natural gas prices fell in 2009, while naphtha prices increased as oil prices soared to more than $100 a barrel in 2011. Since then oil has fallen below $50 a barrel, making companies that use naphtha more competitive. Natural gas prices remain historically low, but the wave of new ethane demand could drive up prices.

Paul Bjacek, a chemicals expert at Accenture , said diminishing margins might push smaller companies or private-equity investors out of the second wave of investment, but larger operators will move ahead.

"The margins are still good, they're just not as good as they were, which was amazing," he said.

Human beings have been using pliable materials found in nature, such as rubber, for centuries. But when Leo Baekeland, a Belgian-born American chemist, invented the first fully synthetic plastic derived from coal in 1907, it set off the modern consumer era, flooding the market with cheap durable goods almost entirely derived from fossil fuels.

Chemists can take the carbon atoms found in fossil fuels and rearrange them to create chains of atoms longer than those found in nature, which in turn can be used to make everything from nylon stockings to PVC piping.

Oil and gas byproducts, including ethane, butane and propane, are sent to huge furnaces called "steam crackers," which use superheated steam fed at high pressure to break apart molecules. Ethane is cracked into a smaller molecule, ethylene. The majority of ethylene in turn is used to make a plastic called polyethylene, and formed into pellets.

Millions of these U.S.-made pellets will be loaded into 25 kilogram sacks and sent via cargo ships to factories around the world, where they will be melted and shaped into plastic products.

By the end of the decade, energy consultancy PCI Wood Mackenzie estimates the U.S. chemical industry will have increased its capacity to make ethylene by 50%.

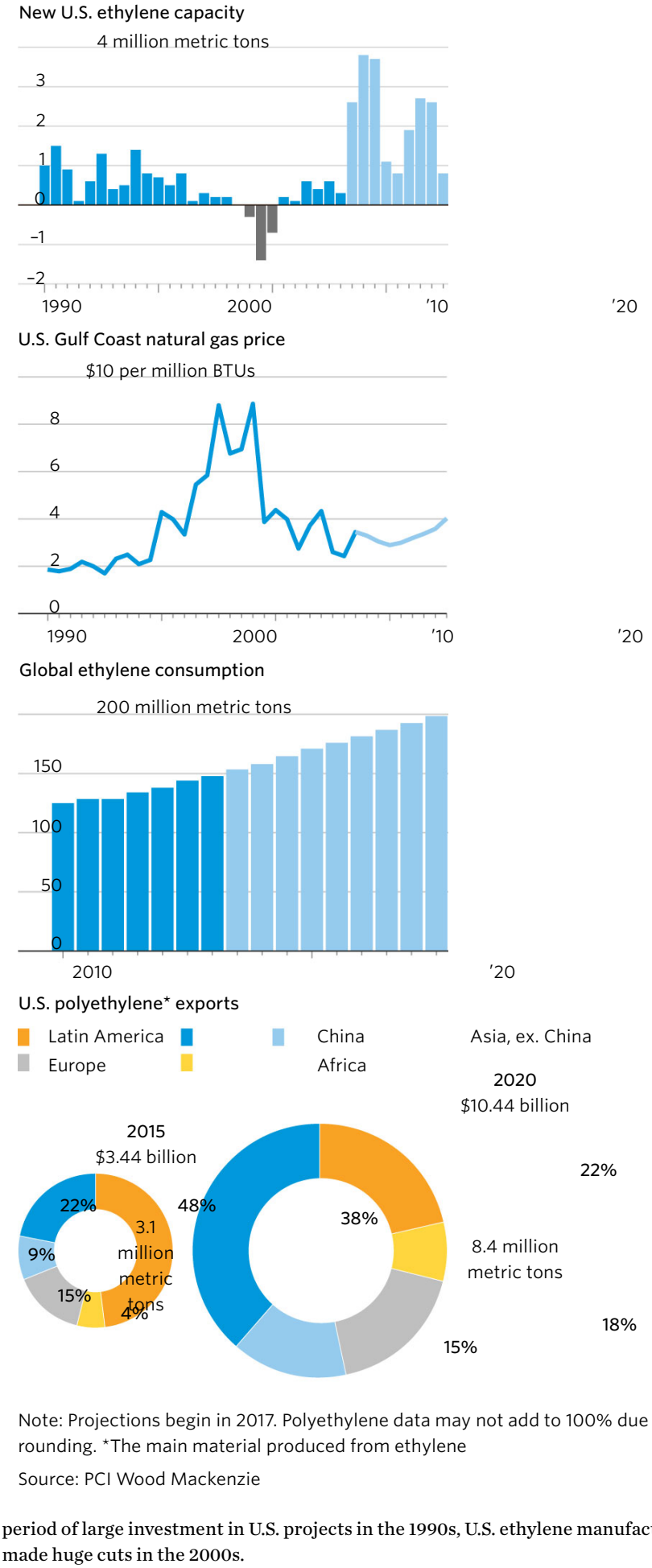
The world consumed more than 147 million metric tons in 2016 of ethylene and will need more than 186 million tons by 2023 to meet global demand, according to the consultancy. It said U.S. exports of polyethylene, the plastic pellets, are expected to reach $10.5 billion by 2020.

China is also rushing to build new plastics factories to meet domestic demand, which is already more than double U.S. demand and is expected to grow 6% annually.

The boom in U.S. petrochemicals is a big turnaround from just a decade ago. Following a

**Plastic Model**

While natural gas prices remain at low levels, petrochemical companies have been pouring money into expanding production of ethylene, made from gas byproducts. The world's consumption has soared, and the U.S. forecasts major growth in exports.




Note: Projections begin in 2017. Polyethylene data may not add to 100% due to rounding. *The main material produced from ethylene

Source: PCI Wood Mackenzie

period of large investment in U.S. projects in the 1990s, U.S. ethylene manufacturers made huge cuts in the 2000s.

Employee Tommy Scott examines bottle caps being made at the Dow plant on Friday. PHOTO: SCOTT DALTON FOR THE WALL STREET JOURNAL

Instead, chemical companies invested in large projects in the Middle East and Asia, attracted by cheaper raw materials and closer proximity to manufacturers, who had also fled the U.S. because of higher costs. The tough times were exacerbated by falling demand for plastic as the financial downturn took hold in 2009.

More than a dozen facilities on the U.S. Gulf were shut down in 2008 and 2009. Dow alone closed a half dozen plants on the Gulf and laid off 5,000 employees world-wide. Chevron Phillips Chemical, a joint venture between Chevron Corp. and Phillips 66 , temporarily closed two factories and ran others at lower capacity. LyondellBasell shut down its complex in Chocolate Bayou, Texas, and declared bankruptcy in the U.S.

"The industry was really looking inward and saying 'it's not dead but it's not going to grow anymore,' " said Steve Zinger, a petrochemical consultant at PCI Wood Mackenzie.

Then came the fracking revolution. By 2010, as U.S. drillers used horizontal drilling and hydraulic-fracturing technologies to release vast oil and gas deposits trapped in rocks, they also unlocked raw materials for petrochemicals. U.S. production of natural gas byproducts has grown from two million barrels a day in 2008 to more than 3.7 million in 2016, according to energy consultant RBN Energy LLC.

The petrochemical industry was slow to react due to uncertainty about the long-term viability of U.S. shale drilling. Initially, companies invested only in adding capacity to existing U.S. facilities. By 2012, they started building.

Later this year, a new Chevron Phillips facility capable of producing 1.5 million metric tons of ethylene a year is coming online in Baytown, Texas. It covers a plot the size of 44 football fields and is made up of 350 miles of pipe, 40,000 tons of steel and 140,000 tons of concrete. It has taken four years to finish.

During the height of its construction, more than 4,500 construction workers and engineers were on site. Once operational, it will only take around 200 employees to run.

In the U.S., $185 billion in new petrochemical projects are in construction or planning. Above, the Dow facility in Freeport on Friday. PHOTO: SCOTT DALTON FOR THE WALL STREET JOURNAL

"I had told the board the U.S. was not a growth play, but by 2010 I saw things were changing," said Ron Corn, Chevron Phillips' senior vice president of projects. "Of course, once you put in the capital, you have to wait five years."

For Chevron Phillips, the biggest challenge isn't profitably making plastic pellets. It is getting them to market in a crowded Gulf Coast.

Because there is so much traffic in the Port of Houston, and a dearth of shipping containers there, the company has created a fleet of 2,750 railcars to divert many of the pellets north to Fort Worth. From there, they will be sent by train to ports in Long Beach, Calif., and Charleston, S.C., where they will be shipped to Asia and South America. Some exports will also leave from Houston and Freeport, Texas.

"Everyone has the same great idea at the same time in this industry," Mr. Corn said. "The way you win is on logistics."

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*Appeared in the June 26, 2017, print edition as 'Shale's Huge impact In One Word: Plastics.'*