





BASF engineers work on a test facility in Ludwigshafen, Germany, that produces hydrogen without CO₂ emissions.

c&en's

GLOBAL TOP

50

The industry is recovering from the COVID-19 pandemic

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The global chemical industry made it through the worst of the COVID-19 pandemic with scratches and abrasions but few broken bones.

According to data from C&EN's Global Top 50 survey, the world's largest chemical firms posted a 7.1% decline in chemical sales from 2019, to \$795.8 billion in 2020, the fiscal year on which the survey is based.

It's not a bad result, considering that economies around the world were shut down early last year to stem the global health crisis. The 50 firms that appeared in C&EN's previous survey, which was mostly based on performance in prepandemic 2019, posted a 5.0% decline in chemical sales.

And although 2020 chemical earnings fell 22.6% for the 44 of the 50 firms that disclose chemical profits, they fell more—28.2%—in 2019 for the 46 companies disclosing profits on the list, when business in many major markets and economies was beginning to slow.

According to the European Chemical Industry Council, a trade association, global chemical output declined by 0.1% in 2020. The industry basically ended up where it started.

Oil prices tell some of the story. Early last year, as the economy froze up and people stayed home, crude prices crashed, dragging chemical prices down with them. Petrochemical volumes, howev-

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CREDIT: BASF

er, were relatively strong because some products, such as polyethylene, saw an uptick in demand.

Indeed, COVID-19 affected the chemical industry unevenly. For instance, chemical companies that sell materials to aerospace and automotive customers were hit hard. But suppliers of materials for food packaging and personal protective equipment saw strong sales.

COVID-19 wasn't the only theme for the year. Another one, not reflected in the data, was sustainability. Almost all chemical firms are focused far more on environmental performance than they were just a few years ago.

For instance, more than a dozen members of the Global Top 50 have major plastics recycling initiatives. A similar number of companies are looking to make ammonia and hydrogen via water electrolysis rather than from natural gas. Still others are overhauling basic petrochemical processes to make them more energy efficient. Dow, Shell, Sabic, and BASF, for example, are developing ethylene crackers that run on renewable electricity.

Despite the year's volatility, the survey was marked by few changes. Companies heavily laden with petrochemical operations generally saw declines in sales and fell in the ranking. Companies that make industrial gases or agricultural chemicals tended to rise.

Three companies in the Global Top 50 a year ago didn't make it this year. Ecolab fell off the list because it divested an oil-field chemical business. SK Innovation and PTT Global Chemical were both victims of declines in petrochemical sales.

Now that it is breaking out chemical sales again, Shell rejoins the Global Top 50 this year after a 5-year hiatus. Rongsheng Petrochemical, which makes polyester chemicals, debuts this year. The former DowDuPont agricultural chemical business, Corteva Agriscience, made the cut as well.

1 BASF

► **2020 chemical sales:** \$67.5 billion

For the second year in a row, BASF leads the Global Top 50 as the world's largest chemical maker. And because it managed, despite the COVID-19 pandemic, to avoid a big decline in sales, the German chemical company widened its sales lead over the number 2, Sinopec, from about \$5 billion in 2019 to nearly \$21 billion in 2020. Though BASF is an industry leader, its greenhouse gas emission goal—released in 2019—had been relatively modest: keep its carbon dioxide output level as it grows throughout the 2020s.

This year, BASF changed course and unveiled a more ambitious target: a drop of 25% compared with 2018 emissions by the end of the decade. Because BASF is building a major complex in China, the new goal means the firm will need to halve emissions from its current operations. BASF is working on technologies that will help it meet the ambitious target. It is testing renewable energy-powered electric heaters in steam crackers, as opposed to fossil-fueled furnaces, and it plans to use electrolysis to generate hydrogen. The German company trimmed its portfolio recently. In June, it completed the sale of its pigment business to Japan's DIC for \$1.4 billion. And BASF and Clayton, Dubilier & Rice are selling their Solenis water treatment chemical joint venture to the private equity firm Platinum Equity in a deal valued at \$5.25 billion.

2 Sinopec

► **2020 chemical sales:** \$46.7 billion

Being China's largest chemical maker, Sinopec was hit by the COVID-19 pandemic before most of the world's other large chemical companies. Indeed, the company saw a 24% decline in chemical revenues last year. It also experienced a 38% slump in operating profit. Despite the setback, Sinopec is focused on long-term growth and has a more ambitious capital expansion program than most large chemical companies. For instance, Sinopec will complete construction of new ethylene cracker complexes this year and in the next 2 years in Zhenhai, Hainan, and Tianjin, China. Additionally, it will begin construction next year on a large propane dehydrogenation plant in Zhenhai that it hopes to finish in 2025.

3 Dow

► **2020 chemical sales:** \$38.5 billion
Tightening its belt in the face of the

COVID pandemic, Dow launched a cost-cutting program last July. The firm said it was reducing its workforce by 6%—about 2,200 jobs—in an effort to save more than \$300 million annually by the end of 2021. The program is also hitting manufacturing: the company is shutting down amine and solvent plants in the US and Europe and closing small polyurethane plants and coatings reactors. Dow also divested terminal and rail assets in 2020. Amid the cuts, the company is making investments. For example, Dow plans to build a \$250 million specialty chemical plant in Zhanjiang, China. Initially, the plan will focus on new specialty polyurethane and alkoxyate facilities. Dow says it may launch additional projects at the site in the future.

4 Ineos

► **2020 chemical sales:** \$31.3 billion

The British chemical maker Ineos reunited most of the old BP Chemicals in January when it completed its \$5 billion purchase of BP's aromatics business. The business, which generated sales of about \$3.6 billion in 2020, is one of the world's largest producers of purified terephthalic acid, a polyethylene terephthalate raw material. The business is also a large acetic acid producer. It will join BP's former olefin and polyolefin business, which Ineos acquired in 2005 for \$9 billion. In a smaller purchase last year, Ineos bought out its partner Sasol's 50% interest in Gemini HDPE, a high-density polyethylene joint venture in La Porte, Texas. The partners completed the plant, housed at an Ineos site, in 2017. When it isn't making acquisitions, Ineos is investing in sustainability. At its Rafnes site in Norway, the firm is installing a 20 MW electrolyzer to make hydrogen from water. And its Ineos Styrolution unit is planning a plant in France that will depolymerize polystyrene into its raw material, styrene.



Sabic's innovation center in Riyadh, Saudi Arabia

CREDIT: SABIC

Global Top 50

The COVID-19 pandemic made its mark on the ranking, with many firms posting precipitous declines in sales during 2020.

RANK		COMPANY	CHEMICAL SALES (\$ MILLIONS)	CHANGE FROM 2019	CHEMICAL SALES AS % OF TOTAL SALES	HEAD- QUARTERS	CHEMICAL OPERATING PROFIT ^b (\$ MILLIONS)	CHANGE FROM 2019	CHEMICAL OPERATING PROFIT AS % OF TOTAL OPERATING PROFIT	CHEMICAL OPERATING PROFIT MARGIN ^c	IDENTIFIABLE CHEMICAL ASSETS (\$ MILLIONS)	CHEMICAL ASSETS AS % OF TOTAL ASSETS	OPERATING RETURN ON CHEMICAL ASSETS ^d
1	1	BASF	\$67,491	-0.3%	100.0%	Germany	\$4,904	-11.8%	100.0%	7.3%	\$91,616	100.0%	5.4%
2	2	Sinopec	46,656	-24.3	15.7	China	1,502	-37.5	78.6	3.2	26,945	14.3	5.6
3	3	Dow	38,542	-10.3	100.0	US	2,556	-27.4	100.0	6.6	61,470	100.0	4.2
4	6	Ineos	31,310	-4.0	100.0	UK	1,697	-32.8	100.0	5.4	n/a	n/a	n/a
5	4	Sabic	28,792	-16.4	92.3	Saudi Arabia	1,609	-62.4	134.7	5.6	74,402	94.4	2.2
6	5	Formosa Plastics ^a	27,711	-16.0	72.4	Taiwan	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7	12	LG Chem	25,477	5.1	100.0	South Korea	1,523	100.8	100.0	6.0	35,059	100.0	4.3
8	7	Mitsubishi Chemical	25,323	-9.3	83.0	Japan	1,504	-11.2	91.9	5.9	40,428	81.6	3.7
9	10	Linde	24,392	-4.1	89.5	UK	5,362	9.5	92.5	22.0	n/a	n/a	n/a
10	9	LyondellBasell Industries	23,407	-13.7	84.3	US	2,938	-36.3	154.6	12.6	n/a	n/a	n/a
11	8	ExxonMobil Chemical	23,091	-15.8	12.9	US	2,675	180.1	-9.5	11.6	38,059	11.4	7.0
12	11	Air Liquide	23,089	-6.3	98.8	France	2,305	0.0	122.3	10.0	43,824	97.4	5.3
13	13	PetroChina	21,769	-4.3	7.8	China	1,588	220.0	14.4	7.3	n/a	n/a	n/a
14	14	DuPont	20,397	-5.2	100.0	US	1,661	-40.4	100.0	8.1	70,904	100.0	2.3
15	26	Hengli Petrochemical ^a	17,265	45.7	78.2	China	n/a	n/a	n/a	n/a	n/a	n/a	n/a
16	17	Sumitomo Chemical	15,822	1.7	73.9	Japan	745	28.3	53.9	4.7	21,372	57.2	3.5
17	15	Toray Industries	15,196	-14.2	86.1	Japan	900	-31.6	83.7	5.9	n/a	n/a	n/a
18	19	Shin-Etsu Chemical ^f	14,019	-3.0	100.0	Japan	3,673	-3.4	100.0	26.2	31,661	100.0	11.6
19	18	Evonik Industries	13,919	-6.9	100.0	Germany	1,065	-21.5	100.0	7.6	23,844	100.0	4.5
20	16	Reliance Industries ^a	13,600	-22.4	18.7	India	n/a	n/a	n/a	n/a	n/a	n/a	n/a
21	20	Covestro	12,216	-13.7	100.0	Germany	835	-0.5	100.0	6.8	14,747	100.0	5.7
22	—	Shell Chemicals	11,721	-13.6	6.5	Netherlands	808	69.0	-4.1	6.9	n/a	n/a	n/a
23	22	Yara	11,591	-9.9	100.0	Norway	1,176	18.9	100.0	10.1	16,605	100.0	7.1
24	32	Braskem	11,348	11.9	100.0	Brazil	1,394	228.5	100.0	12.3	16,687	100.0	8.4
25	25	Mitsui Chemicals	11,348	-9.5	100.0	Japan	767	14.3	100.0	6.8	14,593	100.0	5.3
26	29	Syngenta	11,208	5.9	78.4	Switzerland	2,161	-1.7	94.2	19.3	n/a	n/a	n/a
27	27	Bayer	11,204	-4.3	23.7	Germany	n/a	n/a	n/a	n/a	n/a	n/a	n/a
28	34	Solvay	11,084	-13.5	100.0	Belgium	1,135	-25.1	100.0	10.2	19,160	100.0	5.9
29	34	Wanhua Chemical	10,636	7.9	100.0	China	1,921	10.1	100.0	18.1	19,373	100.0	9.9
30	28	Indorama	10,589	-6.0	100.0	Thailand	306	4.9	100.0	2.9	14,475	100.0	2.1
31	23	Lotte Chemical	10,354	-19.2	100.0	South Korea	302	-67.8	100.0	2.9	16,422	100.0	1.8
32	40	Johnson Matthey	9,951	12.3	49.5	UK	396	-3.7	61.3	4.0	2,898	68.1	13.7
33	42	Umicore	9,738	16.6	41.2	Belgium	256	-38.2	42.4	2.6	7,786	81.8	3.3
34	31	Asahi Kasei	9,283	-9.3	47.1	Japan	622	-28.0	33.0	6.7	14,683	52.9	4.2
35	30	DSM	9,249	-10.0	100.0	Netherlands	867	-17.0	100.0	9.4	16,390	100.0	5.3
36	33	Arkema	8,996	-9.8	100.0	France	641	-36.1	100.0	7.1	12,222	100.0	5.2
37	38	Air Products	8,856	-0.7	100.0	US	2,138	0.8	100.0	24.1	25,169	100.0	8.5
38	39	Mosaic	8,682	-2.5	100.0	US	693	27.7	100.0	8.0	19,790	100.0	3.5
39	41	Hanwha Solutions	8,596	1.6	81.4	South Korea	467	38.5	96.9	5.4	14,604	76.9	3.2
40	36	Eastman Chemical	8,473	-8.6	100.0	US	1,095	-16.3	100.0	12.9	16,083	100.0	6.8
41	35	Chevron Phillips Chemical	8,439	-9.6	100.0	US	n/a	n/a	n/a	n/a	17,026	100.0	n/a
42	—	Rongsheng Petrochemical ^a	8,359	47.2	53.8	China	n/a	n/a	n/a	n/a	n/a	n/a	n/a
43	37	Borealis	7,780	-15.9	100.0	Austria	300	-56.4	100.0	3.9	12,095	100.0	2.5
44	43	Westlake Chemical	7,504	-7.6	100.0	US	465	-32.9	100.0	6.2	13,835	100.0	3.4
45	48	Sasol	7,288	4.1	63.1	South Africa	-5,776	def	def	def	10,165	62.3	def
46	45	Nutrien	7,156	-7.4	34.2	Canada	1,407	-33.9	70.5	19.7	24,106	51.1	5.8
47	44	Lanxess	6,965	-10.3	100.0	Germany	466	-27.0	100.0	6.7	10,132	100.0	4.6
48	46	Tosoh	6,864	-6.8	100.0	Japan	822	7.5	100.0	12.0	9,204	100.0	8.9
49	47	DIC	6,567	-8.8	100.0	Japan	371	-4.0	100.0	5.7	7,660	100.0	4.8
50	—	Corteva Agriscience	6,461	3.3	45.4	US	625	-9.9	60.4	9.7	13,099	35.5	4.8

Sources: Company documents, C&EN analysis. **Note:** Some figures converted at 2020 average exchange rates of US\$1.00 = 5.1587 Brazilian reais, 6.9042 Chinese yuan, 0.8764 euros, 74.1429 Indian rupees, 106.7754 Japanese yen, 1,180.5554 South Korean won, 3.75 Saudi riyals, 16.4932 South African rand, 29.4568 New Taiwan dollars, and 31.3070 Thai baht. *def* means deficit. *n/a* means not available. **a** Prior-year rankings have been revised from the July 27, 2020, issue of C&EN to reflect restated prior-year results and changes in exchange rates. **b** Chemical sales less administrative expenses and cost of sales. **c** Chemical operating profit as a percentage of chemical sales. **d** Chemical operating profit as a percentage of identifiable chemical assets. **e** C&EN estimates. **f** Chemical sales include a significant amount of nonchemical products.

5 Sabic

► 2020 chemical sales: \$28.8 billion

Saudi Arabia's state oil company, Saudi Aramco, completed its purchase of a 70% stake in the petrochemical maker Sabic in June 2020. The purchase was meant to diversify Aramco, which today depends heavily on oil and gas. But soon after the deal closed, the firms announced they were reevaluating the scope of a planned complex that was to convert 400,000 barrels per day of crude oil into 9 million metric tons (t) per year of petrochemicals. Their new, more modest plan is to build an ethylene cracker and derivatives units that will be integrated with existing Aramco refineries. In another instance of Sabic and Aramco working together, the companies shipped 40 t of ammonia to a power plant in Japan last September. The ammonia is considered "blue" because carbon dioxide emitted during its manufacture was captured and used for enhanced oil recovery and methanol production in Saudi Arabia. In another strategic move, Sabic carved out a stand-alone business that includes its polyphenylene oxide, polyetherimide, and compounding units. The company got the businesses with its purchase of GE Plastics in 2007. Sabic had sought to combine them with Clariant's masterbatch business, but those talks broke down in 2019.

6 Formosa Plastics

► 2020 chemical sales: \$27.7 billion

The \$9.4 billion petrochemical complex that Formosa Plastics is planning in St. James Parish, Louisiana, is in hot water. It faces fierce opposition both locally



Air Liquide supplied 400 kg of green hydrogen to Paris de l'hydrogène, an event where artists colorfully illuminated the Eiffel Tower.

from community organizations worried about pollution and nationally from environmental groups that wish to stop the mounting production of plastics. Sharon Lavigne, head of the local group Rise St. James, recently received the prestigious Goldman Environmental Prize for her efforts, a sign that the Formosa project has high-profile opposition. The project also faces practical hurdles. Notably, the US Army Corps of Engineers suspended a permit for the facility in November. Formosa Plastics had better luck in Point Comfort, Texas, where it started up an ethylene cracker and low-density polyethylene unit last year.

7 LG Chem

► 2020 chemical sales: \$25.5 billion

LG Chem and another South Korean firm, SK Innovation, settled a battery technology dispute in April that threatened to snarl US production of electric vehicles. LG had accused SK of trade secret theft and will now get a \$1.8 billion cash payment and future royalties. SK nearly abandoned plans to produce batteries in Georgia over the conflict. The settlement was important enough that US president Joe Biden weighed in, noting in a statement that the US needs "a strong,

diversified and resilient U.S.-based electric vehicle battery supply chain." In other news related to batteries, LG announced in April that it had more than tripled its capacity in Yeosu, South Korea, to make carbon nanotubes, used as a conductive additive.

8 Mitsubishi Chemical

► 2020 chemical sales: \$25.3 billion

Jean-Marc Gilson took over as the Japanese company's CEO in April, replacing the retiring Hitoshi Ochi. As a non-Japanese CEO, Gilson is a rarity in Japan and a first for Mitsubishi Chemical. One of the company's major projects is the construction of a US methyl methacrylate (MMA) plant using its Alpha technology, which makes the acrylic resin precursor from ethylene, methanol, and carbon monoxide rather than the hydrogen cyanide and acetone typically used. Mitsubishi had been considering such a project for nearly a decade. Now, the firm is buying land in Geismar, Louisiana, and hopes to have a plant completed by 2025. Additionally, the company has closed an older MMA plant in Beaumont, Texas, paving the way for the new one. Mitsubishi is also trying to make acrylics more recyclable. The firm is building a demonstration plant in Japan with Microwave Chemical to test technology for breaking down acrylics using microwave radiation. It is also working with Agilyx on disassembling the polymers with pyrolysis.

9 Linde

► 2020 chemical sales: \$24.4 billion

Linde is gearing up to bring its industrial gas and engineering expertise to bear on sustainable chemistry. At a coal-fired power plant in Springfield, Illinois, it is



Samsonite is making its Magnum Eco line of suitcases from recycled polymer supplied by the LyondellBasell joint venture Quality Circular Polymers.

installing a carbon-capture pilot plant. In Burghausen, Germany, Linde aims to make methanol from green hydrogen and carbon dioxide in partnership with Wacker Chemie. And a joint venture between Linde and ITM Power is planning a hydrogen-producing electrolyzer, dubbed the world's largest to be based on proton-exchange membranes, by 2022. Linde is also working with BASF and Sabic to develop cracking furnaces that run on electricity furnished by alternative energy rather than fossil fuels. With Shell, the company is working on a catalytic oxidative dehydrogenation process to make ethylene.

10 LyondellBasell Industries

► 2020 chemical sales: \$23.4 billion

Most large chemical companies nowadays are plunging into plastics recycling to counter public backlash, and Lyondell-Basell Industries is at the front of the pack. CEO Bob Patel is one of the founders of the Alliance to End Plastic Waste, formed by industry to address the recycling problem. And Lyondell has its own initiatives. It and the waste management firm Suez bought the plastics recycler Tivaco and are combining it with Quality Circular Polymers, a recycling venture Lyondell and Suez started in 2018. Quality Circular has some high-profile clients. For example, Samsonite is using its resin for a line of sustainable suitcases. Meanwhile, Lyondell continues to grow its core petrochemical business, often on the cheap. In December, the firm bought, for the bargain price of \$2 billion, a 50% interest in a new ethylene cracker and two polyethylene plants that the struggling Sasol had built. Similarly, it bought into an ethylene cracker joint venture already under construction in China.

11 ExxonMobil Chemical

► 2020 chemical sales: \$23.1 billion

While oil companies such as Shell and BP were redefining themselves as alternative energy players in recent years, ExxonMobil stuck with petroleum. The firm was taking what it considered a realistic position. Oil and gas are cheap and convenient, it argued, and would be hard to dislodge from the energy market for the next few decades. But COVID-19 hit the oil and gas business hard. ExxonMobil racked up a gaping corporate loss of \$28 billion in 2020, even as its chemical unit earned an operating profit of \$2.7 billion. The company is facing shareholder pressure to change, and it is starting to respond. For example, in April, it outlined

a \$100 billion plan to store 100 million metric tons per year of carbon dioxide in the Gulf of Mexico. The new environmental consciousness trickles down into chemicals. At a complex in France, ExxonMobil Chemical plans to host a pyrolysis plant that breaks down waste plastics into

chemical raw materials. And at its Baytown, Texas, chemical facility, it is testing a plastics recycling process. Separately, in a rare move, ExxonMobil is divesting a business, selling its Santoprene thermoplastic vulcanizate operation to Celanese for \$1.15 billion.

Spending

Most companies pulled back on capital spending during the COVID-19 pandemic, but less so on R&D.

	CHEMICAL CAPITAL SPENDING			CHEMICAL R&D SPENDING		
	2020 (\$ MILLIONS)	CHANGE FROM 2019	% OF CHEMICAL SALES	2020 (\$ MILLIONS)	CHANGE FROM 2019	% OF CHEMICAL SALES
Air Liquide	\$3,011	1.4%	13.0%	\$346	-4.4%	1.5%
Air Products	2,509	26.1	28.3	84	15.1	0.9
Arkema	690	-4.7	7.7	275	-3.2	3.1
Asahi Kasei	941	-3.8	10.1	308	-10.4	3.3
BASF	3,570	-18.2	5.3	2,380	-3.3	3.5
Borealis	701	63.4	9.0	172	4.0	2.2
Braskem	535	2.9	4.7	49	1.2	0.4
Corteva Agriscience	250	-14.7	3.9	n/a	n/a	n/a
Covestro	803	-22.6	6.6	299	-1.5	2.4
DIC	306	-3.9	4.7	113	-3.8	1.7
Dow	1,252	-36.2	3.2	768	0.4	2.0
DSM	523	-11.9	5.7	454	14.0	4.9
DuPont	1,194	-51.7	5.9	860	-9.9	4.2
Eastman Chemical	383	-9.9	4.5	226	-3.4	2.7
Evonik	1,091	8.6	7.8	494	1.2	3.5
ExxonMobil Chemical	1,813	-6.2	7.9	n/a	n/a	n/a
Hanwha Chemical	455	-42.5	5.3	62	39.9	0.7
Indorama	536	0.7	5.1	19	45.9	0.2
Johnson Matthey	298	-18.6	3.0	249	-2.5	2.5
Lanxess	520	-10.2	7.5	123	-5.3	1.8
LG Chem	4,689	-11.3	18.4	945	1.9	3.7
Linde	3,455	-9.7	14.2	n/a	n/a	n/a
Lotte Chemical	680	-10.1	6.6	68	-5.4	0.7
LyondellBasell Industries	1,763	-30.3	7.5	113	1.8	0.5
Mitsubishi Chemical	2,179	11.5	8.6	n/a	n/a	n/a
Mitsui Chemicals	702	4.2	6.2	317	-7.1	2.8
Mosaic	1,171	-8.0	13.5	n/a	n/a	n/a
Sabic	3,505	-34.2	12.2	n/a	n/a	n/a
Sasol	1,495	-43.3	20.5	n/a	n/a	n/a
Shell Chemicals	2,640	-35.5	22.5	109	-2.7	0.9
Shin-Etsu Chemical	2,212	-12.0	15.8	480	5.6	3.4
Sinopec	3,795	16.8	8.1	n/a	n/a	n/a
Solvay	518	-39.5	4.7	342	-7.1	3.1
Sumitomo Chemical	669	-17.4	4.2	n/a	n/a	n/a
Syngenta	n/a	n/a	n/a	577	5.7	5.1
Tosoh	474	-17.2	6.9	183	7.1	2.7
Umicore	360	-30.2	3.7	225	2.5	2.3
Wanhua Chemical	n/a	n/a	n/a	296	19.8	2.8
Westlake Chemical	525	-33.3	7.0	n/a	n/a	n/a
Yara	739	-30.7	6.4	91	1.1	0.8

Sources: Company documents, C&EN analysis. Note: Figures are for companies on the top 50 list reporting capital and/or R&D expenditures. n/a means not available.

12 Air Liquide

► **2020 chemical sales:** \$23.1 billion

Air Liquide has ambitious sustainability goals, including becoming carbon neutral by 2050. As a symbolic gesture in that direction in May, the company provided green, or carbon-neutral, hydrogen to Paris de l'hydrogène, an event where artists colorfully illuminate the Eiffel Tower. More tangibly, that same month, Air Liquide, Rothschild & Co., and the Solar Impulse Foundation announced a \$236 million fund to foster environmentally friendly companies. The consortium will invest in areas such as clean energy, sustainable food, the circular economy, smart cities, and sustainable mobility. Air Liquide's venture capital arm has invested \$120 million in 35 companies since it was founded in 2013. In April, for instance, it announced an investment in Inopsys, a specialist in the on-site treatment of wastewater generated while making pharmaceuticals and fine chemicals.

13 PetroChina

► **2020 chemical sales:** \$21.8 billion

PetroChina will bring a pair of unique petrochemical projects—which cost a total of \$2.5 billion—on line later this year. The company is building ethylene crackers in Tarim and Changqing, China, that will use ethane sourced from domestic natural gas fields as their feedstock. These projects wouldn't be unusual in the US or the Middle East, where oil and natural gas are cheap and plentiful, but ethylene crackers in resource-constrained China are mostly fed with naphtha derived from imported oil. The country also sources petrochemical feedstocks from coal. Both routes to ethylene are relatively expensive and put China at a competitive disadvantage.

14 DuPont

► **2020 chemical sales:** \$20.4 billion

As DuPont separated from DowDuPont in 2019, observers wondered how long the company would last. DuPont executive chairman Ed Breen once presided over the breakup of the industrial conglomerate Tyco, causing some to reckon he had similar plans for DuPont. It now appears that DuPont is here to stay, with Breen satisfied that the company has done enough portfolio restructuring to stand on its own. The largest of those moves came in February, when the company completed the sale of its Nutrition & Biosciences division to International Flavors & Fragrances. The sale yielded \$7.3 billion in proceeds. DuPont also agreed to sell its biomaterials busi-

ness, a producer of 1,3-propanediol, and it divested its stake in the polysilicon maker Hemlock Semiconductor. Breen elected to keep DuPont's electronic materials business, which he had been considering selling. In fact, DuPont is adding to this business, agreeing in March to purchase Laird Performance Materials, which makes materials for heat management in electronics, for \$2.3 billion.

15 Hengli Petrochemical

► **2020 chemical sales:** \$17.3 billion



Evonik Industries makes lipids for mRNA vaccines in Hanau, Germany.

Hengli Petrochemical's growth has been amazing. Last year, the company came out of nowhere to debut at 26 in the Global Top 50. In 2020, and despite the COVID-19 pandemic, the Chinese petrochemical maker's chemical sales grew by a whopping 46%. Construction at an almost unbelievable pace is responsible for this growth. In 2020 alone, Hengli started two large production lines for purified terephthalic acid (PTA), a polyester raw material, in Dalian, China. The lines, which use technology from Invis-ta, bring Hengli's PTA capacity to 12 million metric tons (t) per year. In November, Hengli signed a licensing agreement, also with Invista, for two more PTA lines at its site in Huizhou, China. In addition, the company plans to build a plant in Dalian to make a biodegradable plastic from PTA, adipic acid, and 1,4-butanediol. Hengli says the plant will have 450,000 t of annual capacity, a large figure for a biodegradable plastic.

16 Sumitomo Chemical

► **2020 chemical sales:** \$15.8 billion

The Japanese chemical maker has emphasized green projects of late. In June, it signed an agreement to use Ginkgo Bioworks' synthetic biology capabilities to improve the production of an undisclosed biobased chemical and to make other Sumitomo Chemical products. Sumitomo's similar relationship with Zymergen resulted in a biobased film for displays and touch screens. Sumitomo is also building a pilot plant in Chiba, Japan, that will make

ethylene from ethanol supplied by Sekisui Chemical. In addition, Sumitomo is planning a facility in Singapore that will make methanol from carbon dioxide and hydrogen. To investigate even more technologies with low environmental impact, Sumitomo is building a research facility in Chiba.

17 Toray Industries

► **2020 chemical sales:** \$15.2 billion

The Japanese chemical maker had a rough 2020 because of the COVID-19 pandemic. Chemical sales were down 14%, and chemical operating profit dropped 32%. Toray Industries' carbon fiber composites business saw a 23% sales drop. Airlines were decimated by COVID-19-related travel restrictions and halted aircraft orders, forcing the company to shut a composite materials plant in Spartanburg, South Carolina. Toray's textile fiber business

also struggled because of slack demand for apparel and industrial fibers during the pandemic. The performance wasn't offset by brisk business in nonwoven fabrics for medical masks and gowns.

18 Shin-Etsu Chemical

► **2020 chemical sales:** \$14.0 billion

Shin-Etsu Chemical's Shintech subsidiary calls itself the world's largest polyvinyl chloride (PVC) maker. A new investment, announced in January, should help it expand that lead. Shintech intends to spend \$1.3 billion to build new capacity in Plaquemine, Louisiana, for PVC and its precursors chlorine and vinyl chloride. The company will complete a previously announced project—of similar cost and scope—at the site this year. Strengthening another business in which it has a strong position, Shin-Etsu will spend \$285 million to expand photore-sist output in Taiwan and Japan.

19 Evonik Industries

► **2020 chemical sales:** \$13.9 billion

Recently, Evonik Industries has been favoring small acquisitions that provide access to new technology. In June, it inked an agreement to buy Infinitec Activos for an undisclosed sum. Infinitec specializes in delivery methods—such as peptide-studded gold and sapphire nanoparticles, lipid vesicles, and nanoscale alginate hydrocol-loid capsules—for cosmetic ingredients. In November, Evonik bought Houston-based Porocel Group, a provider of refinery cata-lysts and catalyst regeneration services, for \$210 million. Evonik has built a burgeoning business in lipids for the delivery of mes-senger RNA (mRNA) used as a COVID-19 vaccine. And it recently launched a collabo-ration with Stanford University to develop a degradable polymer-based system for de-livering mRNA therapeutics. In more tradi-tional industrial chemistry, the company is building a \$470 million plant in Marl, Ger-many, for making nylon 12, a high-end poly-mer critical for automotive applications such as brake lines. Evonik is considering the sale of its superabsorbent polymer unit, which employs 800 people.

20 Reliance Industries

► **2020 chemical sales:** \$13.6 billion

Reliance Industries has been trying to sell a 20% stake in its refining and chemical business to Saudi Aramco, but talks are going slowly. To ease the deal and allow for other transactions, such as an initial public offering of the business, Reliance is now carving the business into a stand-alone

firm. It expects to complete the process by year's end. But Reliance, India's largest private sector company, isn't losing interest in chemicals. Just last month, the firm an-nounced a massive investment in Abu Dha-bi, United Arab Emirates, with Abu Dhabi National Oil to build chlorine, ethylene dichloride, and polyvinyl chloride plants.

21 Covestro

► **2020 chemical sales:** \$12.2 billion

Covestro spun off of Bayer in 2015 with just two main chemistries: polyurethanes and polycarbonates. The company finally made a major diversification move in April with its \$1.8 billion purchase of DSM's resin and functional materials business, which generated sales in 2019 of about \$1.2 bil-lion. In the transaction, Covestro is getting 3D-printing materials, antireflective coat-ings for photovoltaic panels, adhesives for recyclable carpets, acrylic resins for paints, and optical fiber coatings. In its core busi-ness, Covestro is spending \$50 million to build a plant in Map Ta Phut, Thailand, by the end of next year that makes its Vulkol-lan polyurethane elastomers.

22 Shell Chemicals

► **2020 chemical sales:** \$11.7 billion

Shell Chemicals returns to the Global Top 50 after a 5-year hiatus because it is disclosing its chemical sales figures again. The return comes as the larger Shell orga-nization plans massive changes that will profoundly impact both its chemical and oil businesses. Shell plans to achieve net-zero carbon emissions by 2050, meaning it will have to reduce, or offset, all its greenhouse gas emissions. It will redefine itself as something other than an oil company. Its 13 refineries will become 6 energy and chem-ical "parks" that will increasingly supply renewable energy and chemicals produced from alternative feedstocks. Shell is part of a consortium that will build a water elec-trolysis plant in Germany to make green hydrogen. The firm is replacing 16 ethylene steam cracker furnaces in Moerdijk, the Netherlands, with 8 new ones to reduce carbon emissions by 10%. Shell is collab-orating with Dow to replace conventional gas-fired ethylene furnaces with electrically heated ones that run on renewable power. And it is starting to use synthetic crude oil derived from waste plastics at its ethylene cracker in Norco, Louisiana.

23 Yara

► **2020 chemical sales:** \$11.6 billion

The Norwegian fertilizer maker aims

to get into the business of ammonia fuel for shipping and other industries. Yara plans to install water electrolysis units at its Porsgrunn, Norway, facility to generate the hydrogen it needs to make about 500,000 metric tons per year of ammonia. The plant currently generates hydrogen from natural gas. The electricity for the process would come from Norway's grid, already almost completely renewable thanks to the country's expansive hydroelectric power resources. Yara wants to produce such green ammonia outside Norway, too. In Pilbara, Australia, it plans to make ammonia with solar power. And in Sluiskil, the Netherlands, it is studying ammonia based on offshore wind.

24 Braskem

► **2020 chemical sales:** \$11.3 billion

Many people would think of Dow and BASF as the technology giants in industrial chemistry. But Braskem, a Brazilian petrochemical maker, is a technological heavy hitter too. It is partnering with the University of Illinois Chicago on a route to ethylene based on the electrochemical reduction of carbon dioxide from flue gas. At its chlor-alkali complex in Maceió, Brazil, Braskem will host a pilot plant to make ethylene dichloride using a novel process developed by the start-up Chemetry. In this energy-saving process, called eShuttle, chloride ions react with cuprous chloride (CuCl) to form cupric chloride (CuCl₂), which reacts with ethylene to form the polyvinyl chloride raw material. In Pittsburgh, Braskem recently completed a \$10 million expansion of its technology and innovation center to allow work on recycling, 3D printing, and catalysis.

25 Mitsui Chemicals

► **2020 chemical sales:** \$11.3 billion

Mitsui Chemicals is increasingly em-phasizing sustainability. In June, the Japanese company announced that it will investigate, with BASF, the efficacy of the chemical recycling of plastics—such as using pyrolysis to break them down into an ethylene cracker feedstock. Mitsui is also spending \$370 million to triple capacity for the polyurethane raw material methy-lene diphenyl diisocyanate in Yeosu, South Korea. The company is seeing increased demand for the product in energy-saving insulation. In a small acquisition in Octo-ber to build on its eyeglass lens business, Mitsui acquired Cotec, which makes hydrophobic and antireflective ophthalmic lens coatings.