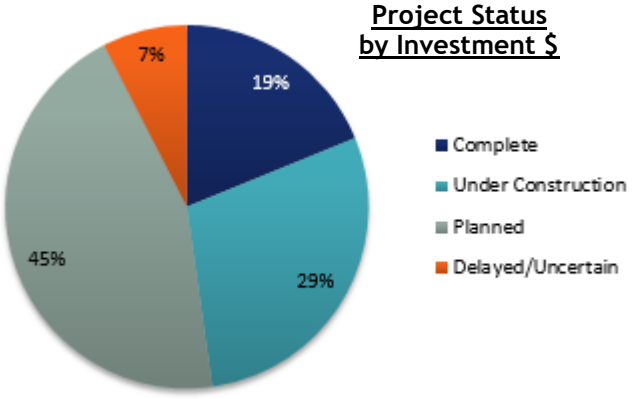
Notes on Shale Gas, Manufacturing & the Chemical Industry

American Chemistry Council - 2 June 2017

ACC's running tab of 310 announced projects represents a cumulative investment of $185.1 billion. Fully 62% of this is foreign direct investment.

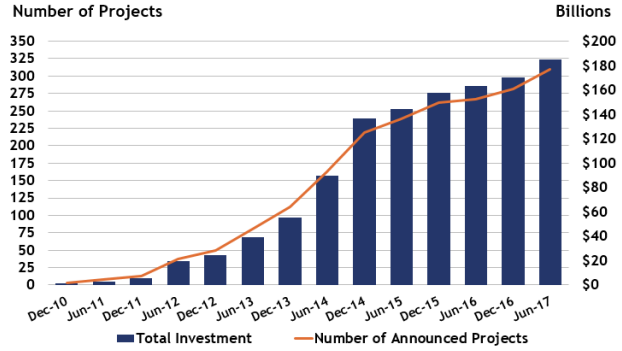
Shale Gas & the Manufacturing Renaissance



- ***Plentiful and affordable natural gas supplies*** have transformed America's chemical industry from the world's high-cost producer several years ago to among the lowest-cost producers today.
- As a result of technological advances in shale gas production—which have increased production and reduced costs—the U.S. has seen ***significant capital investment*** by manufacturing industries, driving new business and job growth. The benefits can be seen around the country, particularly in the Appalachian region and Gulf Coast.
- This oil and gas boom represents a ***positive shock to the U.S. economy***. A 2014 Congressional Budget Office study found that "real (inflation-adjusted) GDP product will be about two-thirds of 1 percent higher in 2020 and about 1 percent higher in 2040 than it would have been without the development of shale resources."
- In 2015, natural gas production from shale gas plays accounted for ***50% of total U.S. natural gas production*** and is expected to increase through 2040, according to the U.S. Energy Information Administration's *Annual Energy Outlook 2016*.

Impacts on the Chemical Industry

Cumulative Announced Chemical Industry Investments from Shale Gas

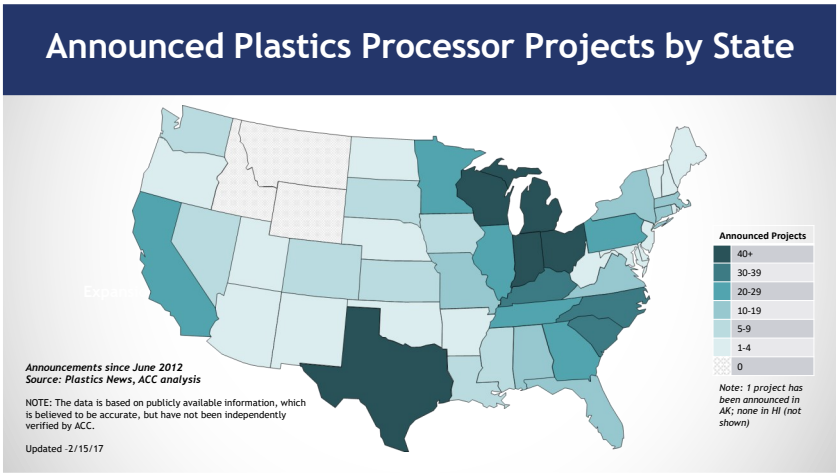


Source: ACC analysis

- The chemical industry, which uses natural gas as the key raw material (feedstock), as well as for heat and power at manufacturing plants, has seen ***significant capital investment*** as a result of this manufacturing renaissance.
- Companies from ***around the world*** are investing in new U.S. petrochemical production capacity, leading to industry revival and new jobs.
- Six ***new ethane crackers*** are currently under construction in the U.S.; two have been completed and there are several more in various stages of engineering and planning.
- ***Over $87 billion*** in new projects have been completed or are currently under construction.
- ACC's found that ***more than 460,000 jobs*** (direct and indirect) could be generated as the result of new manufacturing projects. ACC also found that these investment project could result in ***$294 billion*** in new economic impact.
- Shale gas and the abundance of natural gas liquids provides ***U.S. chemical producers with an advantage over global competitors*** that use more expensive, oil-based feedstock and energy supplies.
- In its 2015 "Fueling Export Growth" report, Nexant found that U.S. chemistry ***exports linked to shale gas could double*** from $60 billion in 2014 to $123 billion by 2030. The trade balance in plastic resins, in particular, is expected to accelerate.

Plastics Processors

- Of the announced chemical industry investment, 70% is bulk petrochemicals and plastic resins. ***Increased resin capacity*** means increased processing capacity.
- In addition, ***plastics processors are benefitting*** from the growing consumer desire for "Made in the USA" products; rising costs (wages) in China; the desire to reduce transportation/logistics costs; and the desire to have manufacturing facilities closer to customers and supply chains.
- ACC is tracking ***over 675 plastics processor projects, valued at nearly $20 billion***. 30% is new construction and 70% is expansions.
- Since June 2012, plastics processor projects have been announced by ***more than 525 companies in over 40 states***.



Announced Chemical Industry Projects Related to the Oil and Gas Boom

Addivant (expansion of antioxidant used in polyethylene manufacturing at Morgantown, WV)
Advanced Refining Technologies (ART) (new HPC plant at Lake Charles, LA)
Agrium (ammonia expansion and new urea plant at Borger, TX; restart at Kenai, AK)
Air Liquide (new ASUs at Beaumont, TX and Port Neches, TX and St. James Parish, LA; expansion of hydrogen and oxygen capacities at Freemont, TX; ASU expansion at Pasadena, TX; new hydrogen plant at La Porte, TX)
Air Products (new hydrogen unit in Mont Belvieu, TX; new liquid nitrogen plant at Odessa, TX; new hydrogen plant in Baytown, TX; new ASU in TN)
Airgas (new ASU and hydrogen plant at Calvert City, KY; new ASU at Tuscaloosa, AL)
AM Agrigen Industries (new urea plant in St. Charles Parish, LA)
Appalachian Resins (small cracker in Salem Township, OH)
Arkema (acrylic acid plant expansion and investment at Clear Lake, TX; new polyetherketoneketone plant at Mobile, AL)
Ascend Performance Materials (new propylene plant in Alvin, TX)
Ashta Chemicals (upgrading its chlorine, potassium hydroxide plant at Ashtabula, OH)
Badlands NGL's LLC (new polyethylene plant in North Dakota; possible 2nd PE plant, location TBD)
BASF (new formic acid plant in Geismar, LA and new worldscale chelating agents plant in Theodore, AL; 1,4-butanediol expansion at Geismar; propylene plant at Freeport, TX; plastics additives expansions)
BASF TOTAL Petrochemicals (converted cracker to ethane feed and added capacity at Port Arthur, TX)
BASF/Yara (new ammonia plant at Freeport, TX)
Braskem (new UHMWPE capacity at La Porte, TX; PP expansion at Seadrift, TX; new worldscale PP plant at La Porte, TX)
Braskem/ASCENT (new ethane cracker and three new polyethylene units at Washington, WV)
CB&I/Clariant (new Ziegler-Natta polypropylene catalyst production plant at Louisville, KY)
Celanese (acetic acid, VAM expansions at Clear Lake, TX)
Celanese/Mitsui JV (new methanol plants at Clear Lake and Bishop, TX)
CF Industries (fertilizer complex expansion at Donaldsonville, LA; ammonia and urea plants at Port Neal, IA)
Chevron Phillips (new ethane cracker, 1-hexane plant and NAO/PAO expansions at Cedar Bayou, TX; ethylene expansion, two polyethylene plants, new butane/hexane/octene plant at Sweeny, TX; studying a second "megaproject" in the U.S.)
Clariant Corp (ethylene oxide unit at Pasadena, TX)
Cronus Chemical (fertilizer complex at Tuscola, IL)
CVR Partners, L.P. (ammonia expansion at East Dubuque, IL)
Dakota Gasification (additional urea facility at Beulah, ND)
Dow Chemical (restarting ethane cracker at St. Charles, LA; revamping crackers at Plaquemine, LA and Freeport, TX; new cracker & subsequent expansions at Freeport, TX; propylene plant at Freeport, TX with possible second plant; EPDM, GMA, adhesives, polyethylene, and polyolefin elastomers plants at Freeport, TX and Plaquemine,

LA; and polyol and copolymer capacity at Freeport, TX)
Dow/Mitsui JV (chlor-alkali capacity at Freeport, TX)
DuPont (expansion of ethylene copolymers at Orange, TX)
Eastman Chemical (ethane cracker restarts at Longview, TX; co-polyester expansions at Kingsport, TN)
El Dorado Chemical Co/LSB Industries (new ammonia plant at El Dorado, AR)
Enterprise Products (propylene and isobutylene expansions at Mont Belvieu, TX)
Erco Worldwide (hydrochloric acid expansion; Port Edward, WI)
EuroChem (fertilizer complex at St. John the Baptist Parish, LA)
ExxonMobil Chemical (ethane cracker at Baytown, TX; two polyethylene plants at Mont Belvieu, TX; PE plant at Beaumont, TX)
Flint Hills Resources (restart/revamp of PDH at Houston, TX)
Formosa (ethane cracker; PDH, PP, PE, MEG, and chlor-alkali units at Point Comfort, LA; 2nd ethane cracker & derivatives at St James, LA)
Fortigen (new fertilizer plant; Geneva, NE)
Fund Connell USA Energy and Chemical Investment Corp (methanol manufacturing/exporting in the Gulf Coast)
G2X Energy (methanol plants in Pampa, TX and Lake Charles, LA)
Grannus LLC (new anhydrous ammonia plant at Kern County, CA)
Gulf Coast Ammonia (new worldscale ammonia plant; Gulf Coast)
Hexion (new formaldehyde plant and expansion in LA)
Hexion Inc.'s Oilfield Technology Group (triazine expansion; Diboll, TX)
HF Chlor-Alkali (hydrochloric acid expansion; Eddyville, IA)
Huntsman Corporation (ethylene/ethylene oxide expansions at Port Neches, TX; adding MDI capacity and a second MDI plant at Geismar, LA)
Incitec Pivot (new ammonia plant at Waggaman, LA)
Indorama Ventures (restart of ethylene and propylene capacity at Lake Charles, LA; new PET plant in Decatur, AL)
INEOS (debottlenecking ethane cracker and new linear alpha-olefins plant at Chocolate Bayou, TX; new PAO plant TBA)
INEOS Styrolution (new ASA plant at Bayport, TX)
Ingelside Ethylene LLC – OxyChem/Mexichem JV (ethane cracker at Ingleside, TX)
Iowa Fertilizer Company (new ammonia plant at Wever, IA)
J.R. Simplot Company (new ammonia plant at Rock Springs, WY)
Kaneka North America (expanding CPVC capacity at Pasadena, TX)
Koch Industries (fertilizer production expansions at Beatrice, NE and Enid, OK; possibly Ft. Dodge, IA)
Kuraray America Inc. (expanded EVOH/new PVOH capacity and VAM plant in Pasadena, TX; and PVA capacity at La Porte, TX)
LANXESS (Nd-PBR and EPDM expansions in Orange, TX)
Linde North America (gasification complex to support petrochemical expansion at La Porte, TX and Hillsboro, OR)
Linde North America (gasification complex to support petrochemical expansion at La Porte, TX; Hillsboro, OR; Lewisville, AR; Delta, OH; Claymont, DE)
Lion Copolymer (expansion of EPDM at Geismar, LA)
Lotte Chemical/Mitsubisi Chemical (monoethylene gycol plant at Lake Charles, LA)
Lotte ChemicalWestlake (new ethane cracker at Lake Charles, LA)
Lubrizol (new CPVC resins and compounds in Deer Park, TX; CPVC expansion at Louisville, KY)
LyondellBasell (expansion of ethane crackers at Channelview, Corpus Christi and La Porte, TX; methanol plant at Beaumont, TX; TEG expansion at Pasadena, TX; multiple PE expansions; worldscale PO/TBA plant at Channelview; possible new propylene plant)
M&G Chemicals (new terephthalic acid plant and PET plant at Corpus Christi, TX)
Matheson (ASU to supply Sasol's cracker in Lake Charles, LA)
MEGlobal (EO facility at Freeport, TX)
Methanex (relocated two methanol plants from Chile to Geismar, LA; considering a 3rd relocation)
Midwest Fertilizer (fertilizer complex; Mt. Vernon, IN)
Mitsubishi Rayon/Mitsui & CO (worldscale MMA plant in the Gulf Coast)
Mosaic Company (expansion of ammonia plant at Faustina, LA)
Nachurs Alpine Solutions (new liquid fertilizer plant at St. Gabriel, LA)
Natgasoline LLC (new methanol plant at Beaumont, TX)
Noltex (expansion of EVOH plant at La Porte, TX)
Northern Plains Nitrogen (fertilizer complex near Grand Forks, ND)
Northwest Innovation Works (multiple new methanol plants in OR and WA)
OCI Partners (ammonia restart and debottlenecking, methanol debottlenecking at Beaumont, TX)
Ohio Valley Resources (new ammonia/UAN plant at Rockport, IN)
OXEA Corporation (propanol, 2-ethylhexanol and butanol expansions at Bay City, TX)
OxyChem (new hydrochloric acid unit at Niagara Falls, NY; new chlor-alkali unit at Humphreys County, TN)
Pacific Coast Fertilizer (new fertilizer plant in Longview, WA)
Pallas Nitrogen Texas (new ammonia plant at Pasadena, TX)
Phibro LLC (in talks to develop new fertilizer plant)
PotashCorp (expansion of ammonia and urea plants at Lima, OH; ammonia expansion at Augusta, GA; restart of ammonia plant at Geismar, LA)
Praxair (nitrogen plants at Kirtland, NM, Greenville, TN and Spartanburg, SC; hydrogen/nitrogen plant at Freeport, TX; carbon monoxide expansion at Geismar)

Primus Green Energy (new methanol plant in the Marcellus region)
PTTGC-Marubeni (new ethane cracker and derivatives project; Mead Township, OH)
Rextac LLC (PDH plant and two PP lines at Odessa, TX)
Sabic/ExxonMobil (cracker & derivatives in the Gulf Coast)
Sasol North America (new ethane cracker and derivatives at Lake Charles, LA)
Sasol/INEOS JV (HDPE plant at Lake Charles, LA)
Shell Chemical (new ethane cracker & downstream facilities at Monaca, PA; alpha olefins/EO expansion at Geismar, LA; ethylene expansion at Deer Park, TX)
Shintech/Shin-Etsu (expansions of chlor-alkali, VCM, PVC and new ethane cracker at Plaquemine & Addis, LA)
Skyonic (hydrochloric acid expansion; San Antonio, TX)
Solvay (new PEEK plant at Augusta, GA; expanding hydrogen peroxide at Longview, WA)
South Louisiana Methanol (new methanol plant at St. James Parish, LA)
Stepan Co. (intermediate chemicals manufacturing at Ascension Parish, LA)
Sunoco Logistics (planning PDH unit at Marcus Hook, PA)
Syngas Energy Holdings (new methanol plant at St James Parish, LA)
Taminco (expansion of methylamine plant in Pace, FL)
TopChem Pollock (brownfield ammonia plant at Grant Parish, LA)
Toray Industries, Inc. (new integrated carbon fiber production in Spartanburg County, SC)
Total/Borealis/NOVA Chemicals JV (new cracker & PE unit at Port Arthur, TX)
TPC Group (expanding capacity for polyisobutylene and on-purpose butadiene at Houston)
US Magnesium (hydrochloric acid expansion; Salt Lake City, UT)
US Methanol (new methanol plants at Institute and Belle, WV)
US Nitrogen (ammonium nitrate plant at Greeneville, TN)
Wacker Chemie (expansion of VAE capacity at Calvert City, KY; new fumed silica plant at Charleston, TN)
Wanhua Chemical (new integrated MDI plant in LA)
Westlake Chemical (expansions of ethane cracker at Lake Charles, LA; ethylene expansion at Sulphur, LA; ethane feedstock conversion, ethylene expansions and PVC capacity at Calvert City, KY; and new chlor-alkali unit at Geismar, LA)
Williams Olefins (expanding ethylene, propylene capacities and considering a second cracker at Geismar, LA)
Yara (new fertilizer plant at Greeneville, TN)
Yuhuang Chemical (methanol plant and derivatives at St James Parrish, LA)
ZeoGas (methanol plant at Port Arthur, TX)

ACC's current list (pages 2-4) of announced chemical industry projects totals 310 projects, representing cumulative capital investments totaling $185.1 billion in the U.S. Fully 62% of this is foreign direct investment (or includes a foreign partner). Of these projects, 47% have been completed or are under construction, and another 44% are in the planning phase (by project investment $).
Suggested language:

ACC's running tab of 310 announced projects represents a cumulative investment of $185 billion. Fully 62% of this is foreign direct investment.

Notes & Information

ACC Economics & Statistics maintains this list and updates it regularly. The list is based on actual project announcements rather than conjecture of potential capital spending. The data are based on publicly available information, which is believed to be accurate, but have not been independently verified by ACC. Projects in Canada and Mexico are not included. For questions, please contact Heather R. Rose-Glowacki, Director, Chemical & Industry Dynamics.

For more information on shale gas and the chemical industry, visit:
http://chemistrytoenergy.com/shale-gas

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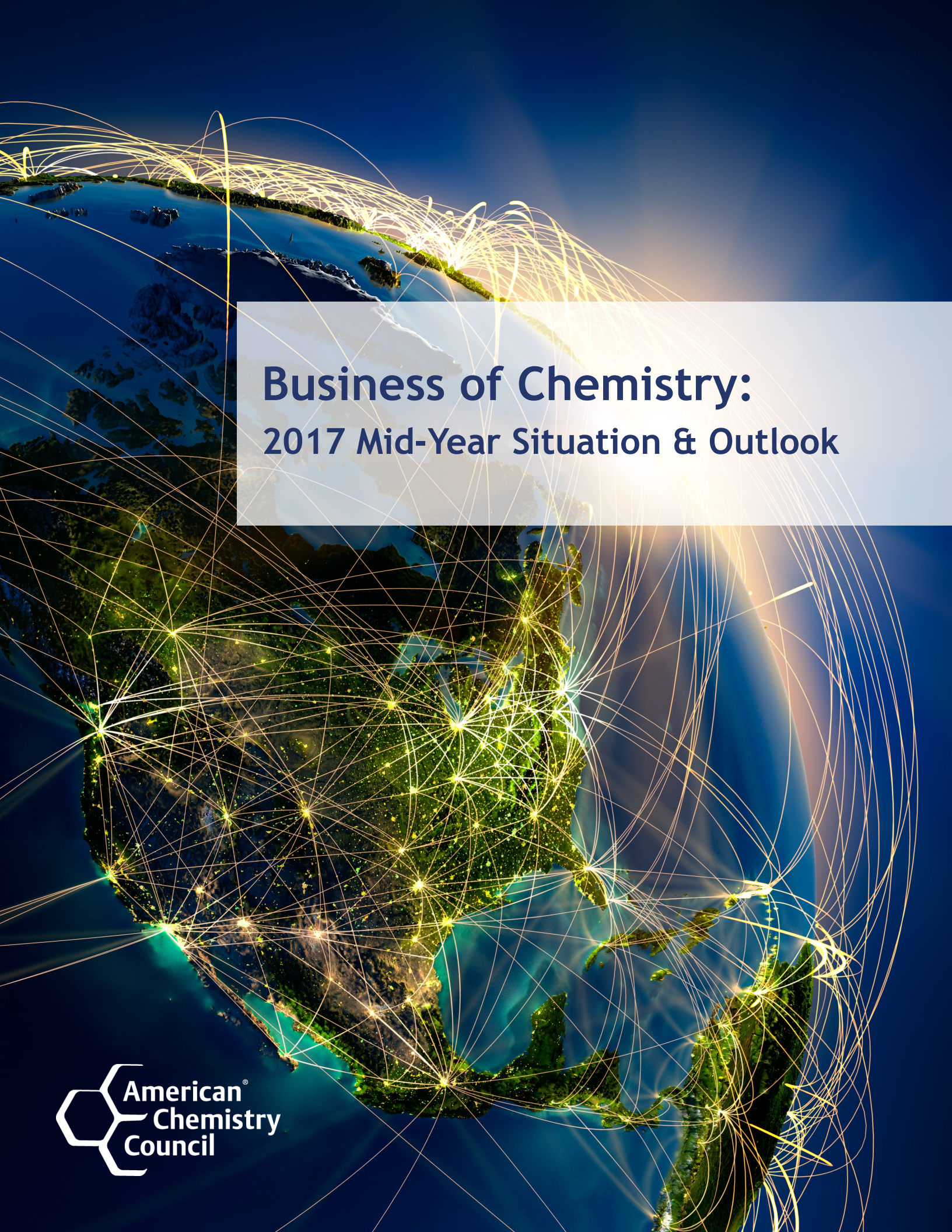
American® Chemistry Council



Business of Chemistry:
2017 Mid-Year Situation & Outlook

American® Chemistry Council

Mid-Year 2017 Chemical Industry Situation and Outlook

American Chemistry: Expanding and Poised for Continued Growth

June 2017

American® Chemistry Council

American chemistry moves forward

Output in American Chemistry will continue to increase in 2017 as key domestic end-use markets grow and a synchronized expansion in the world economy lifts export markets. In addition, surging supplies of natural gas and natural gas liquids from shale have vastly improved the competitiveness of U.S. chemical producers. Looking ahead, this competitive advantage and the investments it has motivated will translate into large production gains as new capacity comes online in the next few years.

Following a tough year in 2016 due to a combination of factors, including the high value of the dollar, soft export markets, weak manufacturing activity, and an inventory correction, the foundation is set for better performance in 2017 and beyond. With higher growth prospects across much of the globe and the fading impact of the dollar, exports are up. In addition, manufacturing appears to be turning a corner. Finally, chemical inventories are in a more balanced position going into mid-2017. An important end-use customer for chemistry, housing is set to continue its steady recovery. And despite a pull back from record-high vehicle sales, the automotive sector is expected to remain relatively strong. These factors, in addition to the continued competitive advantage from shale, lay the groundwork for positive growth this year.

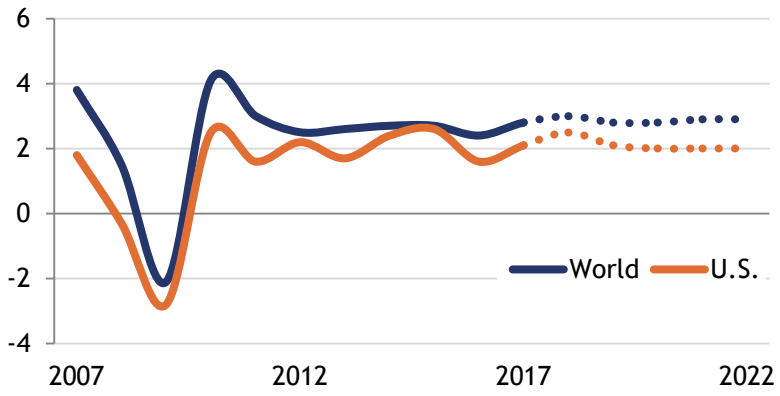
During 2017, output gains once again are expected to be strongest in agricultural chemicals. In addition, as new capacity comes online and demand firms both for domestic customers and those abroad, production of bulk petrochemicals & organics and plastic resins is set to grow at the fastest pace since 2010. Specialty chemicals is also set to grow as industrial activity accelerates.

The paradigm shift in competitive dynamics in petrochemicals and plastic resins has motivated significant investment in new capacity. While many investments have already been made to date, capital spending continues to grow through 2022. As a result, the chemical industry is expected to add jobs each year through the forecast horizon. With wages well above the manufacturing average, the expansion of payrolls will support families and local communities. In labs and production floors across the country, U.S. chemical producers will continue to innovate, focusing on improving efficiencies as well as on new, leading-edge product development.

U.S. and World Macroeconomic Situation & Outlook

Recovering fundamentals and the sustained unconventional gas advantage support U.S. growth prospects

World GDP (market exchange basis), Real U.S. GDP
% change Y/Y



ACC's CAB signals modest growth in the United States through the end of 2017.

In the United States, GDP will grow 2.1% in 2017. Stronger growth in business investment and consumer spending, combined with the easing of the inventory imbalance will characterize the economy this year. A deteriorated trade position, however, holds back GDP growth. We expect a stronger 2.5% pace in 2018 but growth will remain moderate thereafter. Long-term growth in the economy is expected to be more muted due to demographic, policy and other factors. ***The U.S. chemical industry*** will be a source of strength in the economic outlook as improvement in its customer industries and emerging markets occurs, and as the effects of enhanced feedstock competitiveness bolster growth.

The ongoing recovery in the oil and gas sector is also a leading factor behind improved economic growth. Business investment and inventories are typically to blame for variations in the business cycle and thus, we continue to monitor these measures. Business investment in the United States is beginning to reengage. The need to enhance productivity and competitiveness and post-election prospects for tax and regulatory reform are helping to foster renewed business investment in 2017. In the near term, U.S. economic growth will be led by higher business investment and to a lesser extent consumer spending, the latter aided further improvements in the employment situation and real wage gains. U.S. economic growth could approach (and even exceed) its potential should high taxes, regulatory burdens and economic policy uncertainty be removed. That said, the situation for policy improvement is still fluid and delays could take a toll on both business and consumer confidence.

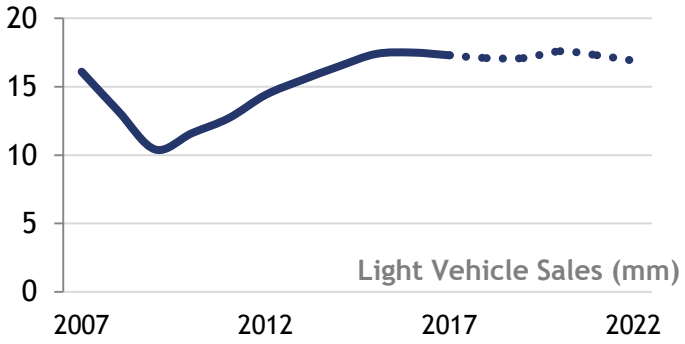
Overall, modest growth in the U.S. economy will continue through year-end 2017, which can be seen by examining the trends in **ACC's Chemical Activity Barometer (CAB)**. The CAB is a composite index of economic indicators that track the activity of the chemical industry. Due to its early position in the supply chain, chemical industry activity leads that of the broader economy and thus, the CAB can be used to anticipate potential turning points in the overall economy. The CAB is currently signaling continued growth in the U.S. economy through the end of 2017 and into 2018. Long-term growth in the economy, however, will be muted due to factors such as demographics but the right tax and regulatory policy could go a long way in boosting growth.

Outside of the U.S., world trade is reviving this year after lagging world GDP. Global manufacturing, which softened during 2015/16, is also anticipated to strengthen this year. A synchronized upswing in the global economy is underway and we are relatively optimistic. Overall, long-term global growth potential will likely be reached later this year or in 2018.

End-Use Markets

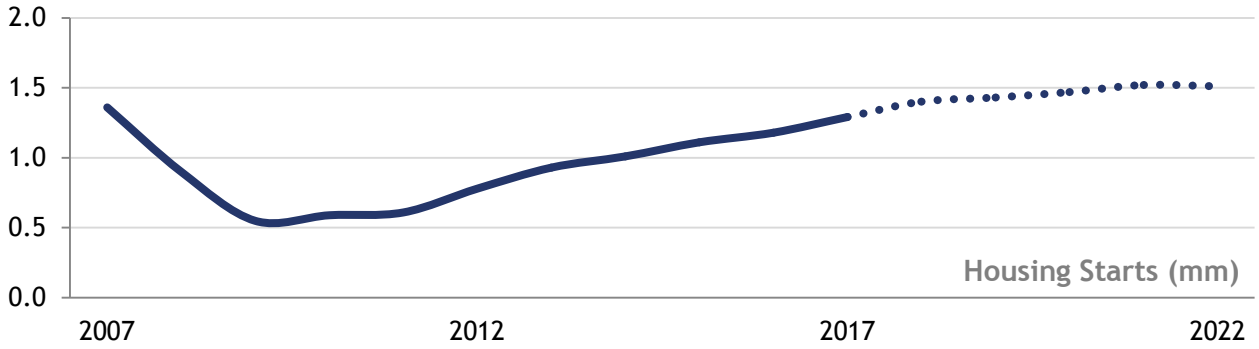
Housing and Capital Goods Manufacturing Lead

Nearly 85% of basic and specialty chemical sales are to the industrial sector which is rebounding after a difficult environment in 2016. Oil and gas development and mining are growing again, as are many manufacturing industries, including construction materials, appliances, machinery, computers, iron and steel products, and structural panels. Following a 1.2% decline in 2016, industrial production is expected to grow by 1.6% this year before accelerating in 2018 and 2019. Manufacturing growth will be strongest in those segments tied to construction and capital goods.



An important market for chemistry, with nearly $3,500 in chemistry per vehicle, ***light vehicle sales*** are set to ease in 2017 following several years of robust growth. Higher interest rates and rising inventories of used cars will provide headwinds in the coming year. A robust labor market and income gains, however, will keep sales at a relatively high pace over the next several years.

Housing is also a large consumer of chemistry (about $15,000 in chemistry per start) and the outlook is for continued progress. Household formations (the leading determinant of housing demand) are growing and job and income gains will continue to be supportive. Shortages of labor and available lots and higher interest rates, however, will constrain the pace of growth. Housing starts are set to improve to 1.29 million in 2017 and 1.40 million in 2018 as starts slowly close in on their long-term underlying demand pace of 1.5 million units per year by 2020.



U.S. Chemistry Situation & Outlook

Growth prospects continue to rise on feedstock advantage and gains in underlying demand in the U.S. and abroad

U.S. chemistry production continues to expand as domestic manufacturing accelerates and export markets recover. In addition, inventories are roughly balanced going into the second half of 2017. U.S. chemical production—excluding production of the pharmaceuticals segment, which is expected to contract this year—will expand 2.1% this year, 4.2% in 2018 and 4.1% in 2019. These higher growth rates reflect production from new shale gas-advantaged investments. Including pharmaceuticals, the chemical industry will expand this year at a slightly lower 1.1%. Growth in production volumes will accelerate and the industry will expand 3.8% in 2018 and by another 3.5% in 2019.

In the long term, the American chemical industry continues to grow. The economics of shale gas in the U.S. has fostered new investment and new capacity in the chemical industry which is now starting to come online. With the combination of the feedstock advantage from shale and strengthening economies in the U.S. and abroad, U.S. chemistry is poised for growth.

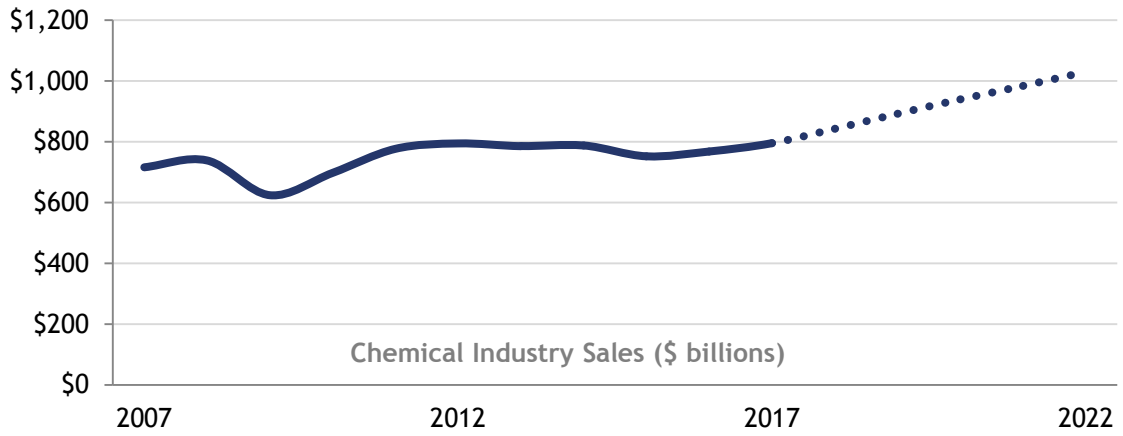
Chemical production will continue to grow across all regions of the U.S. during 2017. Over the next five years, the most dynamic growth will occur in the Gulf Coast region, followed by the Ohio Valley. **American chemistry revenues will exceed $1.0 trillion by 2022**.

U.S. chemistry output (excl. pharma) is expected to rise 2.1% in 2017 and 4.2% in 2018.

IN THE LONG TERM,
the U.S. chemical industry will grow faster than the overall U.S. economy.

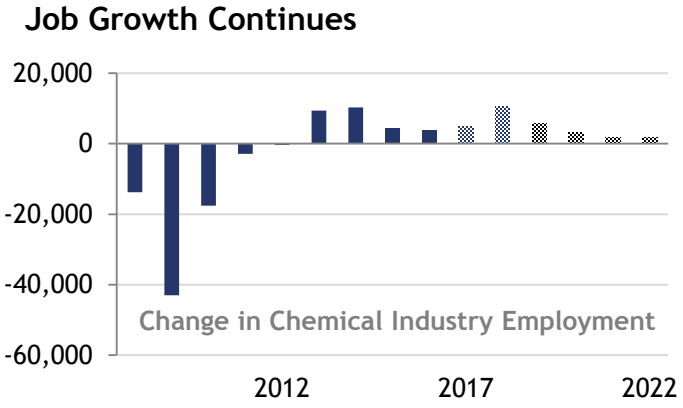
$1 TRILLION
In U.S. chemical industry sales by 2022

American Chemistry revenues projected to accelerate.



With the impact of the high dollar fading, better prospects abroad, shale advantage, and the resurgence of U.S. manufacturing, U.S. **basic chemicals** (inorganic chemicals, petrochemicals, plastic resins, synthetic rubber, and manufactured fibers) are on an upswing. Basic chemicals production is anticipated to grow 2.9% in 2017 and 5.7% in 2018. With new capacity continuing to come online through 2020, production volume growth continues to be strong (another 5.7% in 2019 and 4.6% in 2020). Growth rates slow, however, in 2021 and 2022. Basic chemicals exports will play a large role in expanding production, led by bulk petrochemicals and organics as well as plastic resins. There will be strength in the production of inorganic chemicals, synthetic rubbers and manufactured fibers as well.

In the **specialties chemicals** segment, production will pick up by 2.6% in 2017, an acceleration from last year, and grow further by 2.4% in 2018. Performance in specialty chemicals has been limited by weakness in key end-use sectors, but the growing rig counts and higher commodity prices through mid-2017 have boosted oilfield and mining chemical demand. And improvement in capital goods manufacturing and continued gains in construction have boosted demand for adhesives and sealants, paint additives, and water management chemicals. In the longer term, gains in specialty chemicals will continue to exceed the overall growth rate for the U.S. economy.



Chemical industry adding jobs

The industry's expansion continues to reverse a falling trend in employment. Employment in the chemical industry is expected to grow for a fifth consecutive year in 2017, by 0.6% to 816,000. As production expands, new jobs are expected to be added through 2022. Because chemical industry workers are among the highest paid in the manufacturing sector, growing payrolls will strengthen local economies.

Inventories are well balanced

Along the value chain downstream, an imbalance between sales and inventories emerged in late-2015. A subsequent correction characterized much of 2016 as retailers, wholesalers and manufacturers sought to rebalance inventories. A more balanced position is being reached. During this period chemical wholesale inventories became imbalanced as downstream customers continued to optimize inventories.

For chemical manufacturers, generally effective inventory management has occurred since the end of the Financial Crisis and has resulted in fairly well-balanced inventories relative to shipments. For chemical manufacturers, inventory-to-shipment ratios rose starting in 2011 and with downstream inventory rebalancing occurring ratios since mid-2016 have generally improved.

Capital/Infrastructure

The U.S. is the destination for chemical investment

The U.S. needs tax policies that will drive innovation, increase productivity and promote manufacturing competitiveness.

Over 300 new chemical production projects (valued at over $181 billion) have been announced; the dynamics for sustained capital investment are in place.

Average annual gains of about 6% per year in U.S. chemical industry capital spending are expected in 2017 and 2018 with a subsequent slowdown (and pause) expected. The 2020s will witness the second wave of investment.

$46 BILLION

In U.S. Chemical Industry Capital Spending by 2022

The United States is being favorably re-evaluated as an investment location and petrochemical producers have announced significant expansions of capacity in the U.S., reversing a decade-long decline. In fact, the gains to basic olefins capacity are estimated to range from up to 40%. Indeed, over 300 new chemical production projects, valued at over $181 billion altogether, have been announced through late-May 2017; 62% of these are foreign direct investment. The dynamics for sustained capital investment are in place and ACC continues to track the wave of new investment from shale gas.

A new capital spending cycle began in 2010 as chemical manufacturers recovered from the financial crisis. Initially, it was sustaining capital that drove investment in the U.S., with expenditures allocated towards equipment upgrades and other efficiency investments. The trend in capital investment, however, has rapidly accelerated and changed as significant expansions of existing petrochemical capacity—due to new supplies of natural gas—has become the driver. As a result, chemical industry capital spending in the U.S. expanded from $20.34 billion in 2010 to $32.08 billion in 2015. During 2015 and 2016, chemistry accounted for nearly one-half of total construction spending by the manufacturing sector. In 2016, progress in what has been referred to as the "first wave" of investment eased slightly in light of project scheduling completions and extensions, slow global growth, uncertainty, and U.S. tax policies that discourage business investment. Further gains are anticipated in this first wave in U.S. chemical industry capital spending, which will increase by 6.0% this year and 5.5% in 2018. In 2018, the first wave of investments will largely be completed and capital spending will slow. Expansions will continue and investments to improve operating efficiencies will play a role as well. In 2020, U.S. capital spending by the chemical industry will again increase as the second wave of projects enter their procurement and construction phases. Growth will be strong in 2021 and 2022 and by the latter year capital spending will reach $46.1 billion, 2.3 times the level when this capital spending cycle started.

Access to plentiful and affordable natural gas supplies is allowing the United States to capture an increasing share of global chemical industry investment. This trend will continue as **the United States remains the destination for chemical industry investment.**

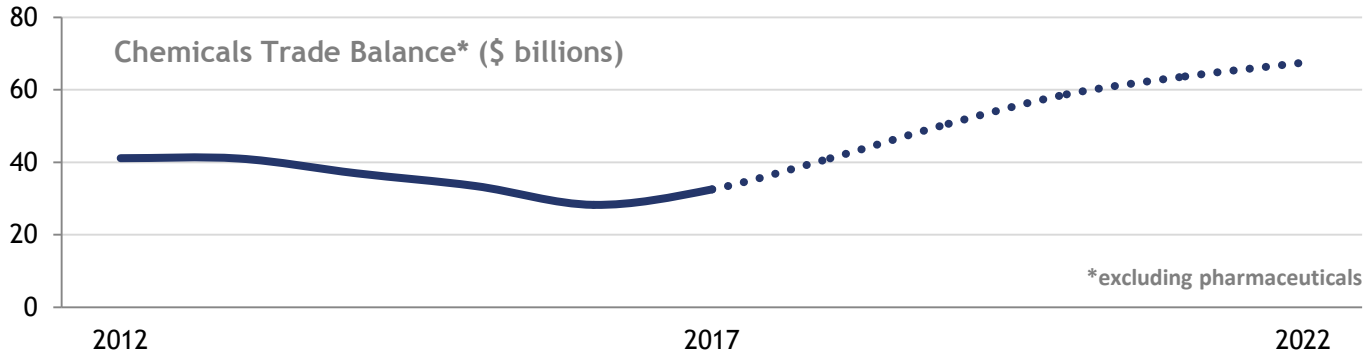
Thus far in the first wave, spending for buildings and structures presented strong opportunities, beginning with spending for site preparation and utilities and then building and installation taking over. Spending for process and other equipment are providing opportunities. Table 5 presents details on industry capital spending by segment and by asset type. During this cycle, capital spending for bulk petrochemical and for organic intermediates, along with spending for plastic resins, will account for a large share of the spending.

Trade

American chemical producers fortify their competitive position in supplying to the global market

With the American chemical industry expanding and export markets improving, total two-way U.S. chemicals trade will expand 4% this year to $215 billion following a 4% contraction in 2016. U.S. chemical exports will drive growth this year and going forward. Slow moving world and U.S. economies and a high U.S. dollar have challenged the nominal growth potential in U.S. chemical exports figures in recent years but, now, these factors are beginning to moderate. Driven by the basic chemicals sector, U.S. chemicals exports are expected to grow 5% this year to $128 billion. At the same time, imports will also grow but a slower pace. Imports are projected to rise 2% to $95 billion by the end of this year. The trade surplus in chemicals (excluding pharmaceuticals) will grow to $33 billion in 2017.

Looking forward, two-way trade between the U.S. and its foreign partners will grow steadily over the coming years, reaching $277 billion by 2022. American chemical producers will fortify their surplus position as U.S. exports accelerate as a result of new industry investment and improved demand from trading partners. The U.S. chemical trade balance is projected to reach $67.5 billion by 2022.



Conclusion

At the midway point in 2017, American chemistry is moving forward. A growing global economy, expansion in manufacturing and other key end-use customer industries, and a decisive competitive advantage in natural gas and natural gas liquids feedstocks, the table is set for growth in the coming years. We expect to see above-trend growth in basic chemicals over the forecast horizon, in addition to output gains in other segments.

The expansion in chemical industry capacity will lead to additions of high-paying jobs through the end of the decade as the U.S. chemical industry strengthens. Furthermore, U.S. chemical exports (excluding pharmaceuticals) will rebound this year and continue on a steady growth trajectory as export markets abroad become more robust and American producers reinforce their position as competitive suppliers to the global market.

TABLE 1
U.S. Macroeconomic Outlook

% Change Year-over-Year unless otherwise noted	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average 2023-27
Global Macroeconomic Indicators										
GDP (Market Exchange Rate basis)	2.7	2.7	2.4	2.8	3.0	2.8	2.8	2.9	2.9	2.9
World Trade	3.7	2.7	2.2	3.8	3.8	4.2	4.2	4.1	4.1	4.1
Industrial Production	3.2	1.7	1.7	2.4	2.6	2.6	2.6	2.8	2.7	2.7
Consumer Prices	3.2	2.8	2.8	3.1	3.3	3.1	3.0	3.0	3.2	3.3
U.S. Macroeconomic Indicators										
GDP	2.4	2.6	1.6	2.1	2.5	2.1	2.0	2.0	2.0	2.1
Consumer Spending	2.9	3.2	2.7	2.4	2.6	2.2	2.3	2.3	2.4	2.2
Business Investment	6.0	2.1	-0.5	4.3	4.4	3.7	3.0	3.3	2.8	3.3
Industrial Production	3.1	-0.7	-1.2	1.6	2.5	2.3	1.8	1.7	1.5	2.0
Light Vehicle Sales (mm)	16.5	17.4	17.5	17.3	17.1	17.1	17.6	17.3	16.9	17.0
Housing Starts (mm)	1.01	1.11	1.18	1.29	1.40	1.43	1.47	1.52	1.51	1.57
Consumer Prices	1.6	0.1	1.3	2.2	2.2	2.3	2.4	2.3	2.5	2.3
10-Year Treasury Notes (%)	2.54	2.14	1.84	2.62	3.02	3.43	3.43	3.79	4.06	4.10
Unemployment Rate (%)	6.2	5.3	4.9	4.6	4.4	4.6	4.4	4.5	4.6	4.8
Exchange Rate ($U.S./euro)	1.33	1.11	1.11	1.08	1.09	1.12	1.17	1.21	1.23	1.27
U.S. End-Use Market Output										
Construction	3.4	0.5	1.4	3.7	5.4	3.2	2.8	2.7	2.5	2.6
Food, Beverages & Tobacco	0.0	2.6	1.2	1.6	1.5	1.3	1.0	1.2	1.3	1.2
Textile Mill Products	7.6	0.5	2.5	-0.5	-1.6	-2.3	-2.5	-2.3	-2.1	-2.1
Apparel	-4.1	-1.0	-11.0	-4.1	-2.4	-3.5	-3.4	-2.7	-2.5	-2.3
Structural Panels	3.8	2.0	3.3	4.0	2.5	2.1	1.0	0.9	0.8	0.8
Paper	-1.0	-1.0	-2.6	1.0	0.4	0.3	0.2	0.3	0.4	0.5
Printing	-1.8	1.1	-1.0	-0.1	-1.7	-1.4	-1.2	-0.7	-0.5	-0.5
Petroleum Refining	-3.5	-2.3	3.2	2.9	2.1	1.8	0.7	0.5	0.5	0.5
Rubber & Plastic Products	2.7	1.6	0.4	0.9	3.0	3.0	2.3	2.0	2.0	2.0
Iron & Steel	-0.7	-9.7	-1.5	2.6	1.6	2.0	0.2	0.1	1.0	0.9
Fabricated Metal Products	1.8	-2.9	-3.0	1.7	2.5	2.1	1.0	0.8	1.1	1.4
Computers	4.5	1.1	1.4	4.8	4.5	3.2	2.1	2.7	2.9	2.2
Semiconductors & Electronic Components	20.9	0.8	2.5	4.1	6.5	4.7	3.6	4.4	4.2	3.0
Appliances	4.7	6.8	5.2	4.8	3.0	2.5	1.2	0.8	1.0	1.2
Motor Vehicles & Parts	9.3	5.2	4.1	1.0	1.9	1.2	3.4	1.0	-0.1	0.9
Aerospace	5.1	0.2	-1.5	0.3	3.5	4.1	5.2	4.9	2.6	3.6
Furniture	0.5	4.5	-0.1	1.2	2.2	1.7	0.7	0.9	1.3	1.4

TABLE 2
U.S. Chemistry Outlook: Production Volumes

% Change Year-over-Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average 2023-27
Total Chemicals Production Volume	**-1.1**	**1.8**	**0.7**	**1.1**	**3.8**	**3.5**	**2.8**	**2.4**	**2.3**	**2.1**
Production Volume by Segment										
Pharmaceuticals	-1.6	7.4	0.2	-0.5	3.0	2.5	2.3	2.5	2.8	2.9
Chemicals, excl. Pharmaceuticals	**-0.8**	**-1.5**	**1.1**	**2.1**	**4.2**	**4.1**	**3.1**	**2.4**	**2.0**	**1.6**
Agricultural Chemicals	-6.9	-4.7	11.3	7.9	6.2	4.7	1.6	1.0	1.1	1.0
Fertilizers	-3.2	-3.6	12.4	8.7	6.7	5.0	1.6	1.2	1.2	1.1
Crop Protection	-12.5	-6.7	9.6	7.4	5.9	4.5	1.6	0.9	1.0	0.9
Consumer Products	4.9	3.5	-0.9	-2.9	1.3	1.3	1.2	1.5	1.6	1.3
Basic Chemicals	-2.8	-3.0	0.0	2.9	5.7	5.7	4.6	3.1	2.3	2.6
Inorganic Chemicals	-4.2	-4.7	-1.9	0.9	3.9	2.1	1.2	1.2	1.3	2.1
Bulk Petrochemicals & Organics	-2.6	-0.2	0.1	3.7	6.4	7.1	5.9	3.8	2.7	3.0
Plastic Resins	-1.4	-9.0	0.8	3.6	6.5	7.3	6.0	4.0	2.8	2.8
Synthetic Rubber	-8.1	1.7	6.8	2.9	5.8	5.2	3.6	2.7	2.4	2.3
Manufactured Fibers	-3.3	-3.7	0.9	1.1	1.3	2.1	1.6	0.6	0.0	-0.4
Specialties	3.2	-0.6	2.3	2.6	2.4	1.9	1.6	1.6	1.7	2.3
Coatings	4.7	2.2	1.4	5.4	2.4	2.2	1.7	1.5	1.5	2.4
Other Specialties	2.6	-2.0	2.7	1.4	2.3	1.8	1.5	1.7	1.7	2.2
Production Volume by Region										
Gulf Coast	-2.4	-1.8	1.1	2.9	5.3	5.1	3.9	2.7	2.1	2.4
Midwest	-1.3	2.9	1.1	1.1	3.7	3.4	2.8	2.4	2.3	2.5
Ohio Valley	-1.2	0.1	1.9	2.2	4.1	4.0	3.1	2.3	2.0	2.2
Mid-Atlantic	-1.4	4.6	0.7	0.3	3.3	3.0	2.5	2.4	2.4	2.6
Southeast	-1.5	2.7	2.3	1.5	3.9	3.6	2.7	2.3	2.2	2.3
Northeast	-1.1	4.7	0.7	0.0	3.0	2.7	2.3	2.3	2.4	2.5
West Coast	-1.1	5.2	1.2	0.4	3.2	2.8	2.3	2.3	2.4	2.6

TABLE 3
U.S. Chemistry Outlook: Trade
Chemicals, excluding pharmaceuticals

	2014	2015	2016	2017	2018	2019	2020	2021	2022
Exports (billions)	$139.9	$128.6	$121.4	$127.8	$137.3	$148.3	$159.4	$167.4	$172.4
Imports (billions)	$103.0	$95.2	$93.2	$95.3	$96.3	$97.7	$100.6	$103.8	$104.9
Trade Balance (billions)	$36.9	$33.4	$28.2	$32.5	$41.1	$50.6	$58.7	$63.7	$67.5

TABLE 4
U.S. Chemistry Outlook: Other Indicators

	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average 2023-27
Shipments (billions)	$787.4	$751.6	$767.8	$794.5	$842.5	$892.3	$939.1	$983.6	$1,030.2	n/a
% Change Year-over-Year	0.2	-4.5	2.1	3.5	6.0	5.9	5.2	4.7	4.7	n/a
Capital Spending (billions)	$29.9	$32.1	$31.9	$33.8	$35.7	$36.2	$39.0	$42.6	$46.1	n/a
% Change Year-over-Year	3.2	7.4	-0.6	6.0	5.5	1.3	8.0	9.0	8.3	n/a
Employment (thousands)	803.0	807.3	811.1	816.0	826.7	832.5	835.8	837.4	839.1	n/a
% Change Year-over-Year	1.4	0.5	0.5	0.6	1.3	0.7	0.4	0.2	0.2	n/a

TABLE 5
U.S. Chemistry Capital Spending Outlook

Millions of Dollars	2014	2015	2016	2017	2018	2019	2020	2021	2022
Capital Spending	29,864	32,084	31,898	33,821	35,673	$36,153	$39,039	$42,551	$46,097
% Change	3.2	7.4	-0.6	6.0	5.5	1.3	8.0	9.0	8.3
Capital Spending by Segment:									
- Pharmaceuticals	4,787	7,120	7,523	7,695	7,918	7,797	8,207	8,833	9,343
Chemicals, exc. Pharmaceuticals	25,077	24,964	24,375	26,126	27,755	28,356	30,832	33,718	36,754
Agricultural Chemicals	4,329	5,497	5,544	5,938	6,473	6,616	6,972	7,472	7,986
All Other Chemicals	20,748	19,467	18,831	20,188	21,282	21,740	23,860	26,246	28,768
Basic Chemicals	16,766	15,962	15,313	16,744	17,856	18,456	20,514	22,701	24,998
Specialties	1,967	1,707	1,742	1,735	1,744	1,678	1,715	1,826	1,947
Consumer Products	2,015	1,798	1,776	1,709	1,682	1,606	1,631	1,719	1,823
Basic Chemicals:									
Inorganic Chemicals	2,947	2,643	2,711	2,850	2,962	2,936	3,083	3,362	3,655
Bulk Petrochemicals & Intermediates	9,330	8,600	8,119	9,244	9,858	10,249	11,581	13,035	14,480
Plastic Resins	3,702	4,137	3,926	4,069	4,405	4,622	5,165	5,557	6,043
Synthetic Rubber	251	226	212	215	226	228	240	261	286
Manufactured Fibers	536	356	345	366	405	421	445	486	534
Specialties:									
Coatings	354	309	322	326	334	323	331	349	368
Other Specialties	1,613	1,398	1,420	1,409	1,410	1,355	1,384	1,477	1,579
Capital Spending by Asset:									
Computers & Related	960	951	942	953	945	895	904	943	984
Communications Equipment	653	701	719	754	775	768	816	888	958
Instrumentation	3,793	4,037	4,110	4,399	4,576	4,634	5,020	5,595	6,135
Pressure Vessels & Other Fabricated Equipment	2,249	2,292	2,260	2,325	2,408	2,423	2,632	2,829	3,082
Special Industrial Machinery	4,498	3,822	3,753	3,849	4,063	4,160	4,477	4,950	5,204
General Industrial Equipment	9,619	10,016	10,089	11,345	12,033	12,322	13,496	14,562	15,822
Electric Transmission & Distribution	72	71	67	68	71	72	78	85	95
Motor Vehicles	201	257	256	260	264	258	282	308	325
Other Transportation Equipment	15	19	20	20	21	20	23	25	26
Furniture	298	298	298	302	310	308	327	358	392
Other Machinery & Equipment	1,319	1,386	1,368	1,419	1,509	1,529	1,649	1,835	2,030
Total Equipment	23,677	23,850	23,882	25,694	26,975	27,389	29,704	32,378	35,053
Manufacturing	5,883	7,891	7,648	7,739	8,281	8,339	8,871	9,651	10,467
Office Buildings	118	143	162	178	193	199	224	260	294
Other	186	200	207	210	224	226	240	262	283
Total Structures	6,187	8,234	8,017	8,127	8,698	8,764	9,335	10,173	11,044

TABLE 6
Global Economic Environment: Real GDP

% Change Year-over-Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average 2023-27
Real GDP										
United States	2.4	2.6	1.6	2.1	2.5	2.1	2.0	2.0	2.0	2.1
Canada	2.6	0.9	1.4	2.3	1.9	1.7	1.8	1.8	1.9	1.9
Mexico	2.3	2.5	2.1	1.6	2.0	2.6	2.8	2.9	3.1	3.2
Brazil	0.5	-3.8	-3.6	0.4	2.0	2.4	2.6	2.6	2.7	2.8
United Kingdom	3.1	2.2	1.8	1.7	1.3	1.6	1.9	2.0	2.0	2.0
Eurozone	1.2	2.0	1.7	1.7	1.7	1.5	1.5	1.4	1.4	1.3
France	0.6	1.3	1.2	1.4	1.4	1.3	1.3	1.2	1.3	1.4
Germany	1.6	1.5	1.8	1.8	1.7	1.4	1.3	1.2	1.2	1.2
Italy	0.1	0.8	0.9	0.8	0.9	0.8	0.9	0.9	0.9	0.8
Spain	1.4	3.2	3.2	2.6	2.2	2.0	1.9	1.7	1.6	1.4
Russia	0.7	-2.8	-0.2	1.1	1.6	1.7	2.1	2.1	2.2	2.2
Japan	0.3	1.2	1.0	1.2	0.9	0.8	0.3	0.8	0.7	0.6
China	7.3	6.9	6.7	6.5	6.0	5.5	5.4	5.2	5.1	4.9
India	7.2	7.9	6.8	7.3	7.5	7.5	7.5	7.4	7.1	6.9
South Korea	3.3	2.8	2.7	2.7	2.8	2.7	2.7	2.7	2.7	2.6
World GDP (Market Exchange)	2.7	2.7	2.4	2.8	3.0	2.8	2.8	2.9	2.9	2.9
World Trade	3.7	2.7	2.2	3.8	3.8	4.2	4.2	4.1	4.1	4.1

TABLE 7
Global Economic Environment: Industrial Production

% Change Year-over-Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average 2023-27
Industrial Production										
United States	3.1	-0.7	-1.2	1.6	2.5	2.3	1.8	1.7	1.5	2.0
Canada	4.2	-1.3	-0.3	2.9	1.7	1.6	1.2	1.4	1.3	1.3
Mexico	2.7	1.0	-0.1	2.4	2.8	3.1	3.1	2.6	2.6	2.7
Brazil	-2.9	-8.2	-6.8	1.4	2.4	2.6	2.8	3.1	3.0	3.0
United Kingdom	1.5	1.2	1.2	1.9	1.6	1.3	1.4	1.4	1.2	1.0
Eurozone	0.8	2.1	1.5	1.8	1.5	1.6	1.5	1.5	1.5	1.5
France	-0.9	1.9	0.2	1.0	1.1	1.2	1.0	0.8	1.0	1.1
Germany	1.4	0.9	1.0	2.2	1.6	1.4	1.4	1.5	1.4	1.2
Italy	-0.6	0.9	1.9	1.8	0.9	1.0	1.2	1.0	1.0	1.0
Spain	1.3	3.3	1.9	2.1	1.9	2.3	2.2	2.1	1.9	1.7
Russia	2.5	-0.7	1.3	2.6	2.7	2.7	2.3	2.7	2.5	2.3
Japan	3.6	2.9	1.8	3.7	1.4	1.4	-0.3	1.0	0.8	0.6
China	8.3	6.1	6.1	4.8	4.3	4.1	4.1	4.4	4.4	4.5
India	1.8	3.2	0.3	5.3	6.5	6.7	6.8	6.9	6.7	6.5
South Korea	2.5	-0.7	1.3	5.0	3.0	2.8	2.8	3.0	2.9	2.8
World Industrial Production	3.2	1.7	1.7	2.4	2.6	2.6	2.6	2.8	2.7	2.7

TABLE 8
Global Economic Environment: Inflation (Consumer Prices)

% Change Year-over-Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average 2023-27
Inflation (Consumer Prices)										
United States	1.6	0.1	1.3	2.2	2.2	2.3	2.4	2.3	2.5	2.3
Canada	1.9	1.1	1.4	2.0	2.0	1.9	2.0	2.0	2.0	2.0
Mexico	4.0	2.7	2.8	5.1	3.6	3.1	3.2	3.2	3.3	3.3
Brazil	6.3	9.0	8.7	4.6	4.7	4.6	4.5	4.4	4.3	4.2
United Kingdom	1.5	0.1	0.6	2.6	2.5	2.0	2.0	2.0	2.0	2.0
Eurozone	0.4	0.0	0.2	1.6	1.6	1.7	1.8	1.8	1.8	1.8
France	0.6	0.1	0.3	1.3	1.2	1.4	1.5	1.5	1.7	1.9
Germany	0.8	0.1	0.4	1.8	1.7	1.9	1.9	1.8	1.8	1.8
Italy	0.2	0.1	-0.1	1.3	1.1	1.6	1.6	1.7	1.8	1.8
Spain	-0.1	-0.5	-0.2	2.2	1.5	1.6	1.7	1.8	1.9	1.9
Russia	7.8	15.5	7.0	4.9	4.4	4.3	4.3	4.4	4.3	4.3
Japan	2.8	0.8	-0.1	0.7	1.0	1.3	1.7	1.3	1.4	1.6
China	2.0	1.4	2.0	2.2	2.4	2.7	2.9	2.9	3.0	3.0
India	5.9	4.9	4.9	5.0	5.4	5.2	5.2	5.1	5.1	5.1
South Korea	1.3	0.7	1.0	1.9	2.1	2.2	2.2	2.3	2.2	2.2
World Inflation	3.2	2.8	2.8	3.1	3.3	3.1	3.0	3.0	3.2	3.3

Methodology

This report presents an assessment of current conditions and expectations for the global business of chemistry, with particular emphasis on the U.S. The analysis uses economic data and publicly available information through mid-May 2017.

In looking ahead, several models of global output, trade, etc. for the business of chemistry are employed. In addition, we take into account forecasts made by economists at the national chemical associations in Europe (whose expertise ACC gratefully acknowledges) and from economic forecasting consultants and other institutions. ACC also gratefully acknowledges the macroeconomic and chemical industry expertise of IHS Markit and Oxford Economics, two of the leading providers of economic advice and consultancy services. The macroeconomic forecasts of the Economist Intelligence Unit (EIU), supplemented by forecasts provided by the IMF, OECD, the WTO, and various banks, were also important to our thinking.

For More Information

More details, historical data (back to 1994) and annual projections (to 2022 and beyond) for the tables in the report are available in spreadsheet format. For more information or to access the detailed data, contact ACC's Economics Department: **ACC_EconomicsDepartment@americanchemistry.com**

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