

Transporting growth: Delivering a chemical manufacturing renaissance

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*A report by PwC on behalf
of the American
Chemistry Council (ACC)*



pwc

Chemical manufacturing is on the verge of a renaissance. Low feedstock costs and more investment capital have generated a spate of new chemical projects. While this growth is a boon to the industry, the resulting increase in transportation demand underscores the need to address existing transportation infrastructure issues. New logistical challenges could slow down the movement of new chemicals and prevent the industry from realizing the full benefits of increased production.

This report shares findings of PwC's study on the link between anticipated growth of US chemical manufacturing and the logistics of transporting products to market.

PwC conducted a survey of 68 leading chemical companies, and elicited their views, through follow-up interviews, on transportation issues and challenges over the next several years. PwC also interviewed stakeholders in the truck, rail, and marine transportation sectors.

PwC also conducted an analysis comparing the nature and number of new US chemical plant projects forecast to come online in the next few years with current and future transportation capacity. PwC then estimated the costs of increased congestion and shipping delays resulting from the gap between potential demand and capacity.

Executive summary

The chemical industry is experiencing dramatic growth, with 264 new projects and more than \$161 billion in US-based capital investment projects announced since 2010.¹ This rapid expansion of the US chemical industry is largely the result of low-cost and abundant shale gas as an affordable feedstock and energy source, thus enabling US-based chemical producers to compete more effectively with their global counterparts.

This additional chemical and plastics production will be a boon to the US economy and to consumers. According to the American Chemistry Council, the new projects are forecast to provide a much needed lift to America's economy by creating an estimated 426,000 new jobs and \$301 billion in new economic output.² No other US manufacturing sector is on such a pace of expansion.

However, this tremendous opportunity for economic growth is unlikely to reach its full potential without addressing ongoing challenges across the US transportation infrastructure.

Unless resolved, logistics shortcomings across primary modes of transportation (truck, rail, marine container) will greatly affect the chemical industry and its customers. Our findings indicate that the cumulative potential impact is likely to include the following:

- **Excess Inventories** is additional inventory held due to transportation delays, and will likely translate to a cost of **\$22 billion** in working capital.
- **Capital Expenditures (CAPEX)** is expected to increase by **\$23 billion** for equipment and infrastructure required to handle increased congestion and delays.
- **Operating Costs** will likely increase by an additional **\$29 billion** over a ten-year period due to logistical inefficiencies.

Addressing these challenges is critical and will require the cooperation of all stakeholders—chemical manufacturers, policy makers, shippers, and others—to ensure the chemicals renaissance delivers its full economic potential.

¹ ACC, 2015 Year-End Situation and Outlook

² ACC, 2016 Infographic “Economic Impact of Shale Gas Investments and the Chemical Industry Infographic.”

The chemical industry: one of America's biggest shippers

Key chemistries experiencing capacity growth

Olefins:

The shale gas value chain begins with the cracking of natural gas liquids to form olefins. The most important olefins are ethylene and propylene. Olefins serve as the building blocks for many other products, including polyolefins. Olefins are gases and primarily transported by pipeline.

Polyolefins:

Polyolefins, such as polyethylene and polypropylene, are manufactured from olefins. Once processed, they become inert plastic pellets that are generally packaged in bags or sacks and transported by a variety of modes.

Methanol:

Methanol is a basic commodity widely used in industry to manufacture other chemicals. It is generally transported as a bulk liquid.

The chemical industry is a \$797 billion enterprise and a key element of the nation's economy. It is the nation's largest exporter, accounting for 14 percent of all US exports. Including imports, more than \$800 billion of chemistry products flow through the economy each year.³ The products of chemistry are present in some form in nearly every facet of the American economy. More than 881 million tons of chemical products were transported in 2015, making the chemical industry one of the country's largest shippers.⁴

Much of the current growth in the chemical industry in the US is due to the abundant supply of natural gas from shale deposits. US shale gas offers a more cost-stable source of feedstock for chemicals production than oil—the primary source of hydrocarbons for producers in Europe and Asia. While shale reserves are present in many parts of the world, the US is currently the global low-cost producer as a result of technological innovations in shale extraction.

It has been decades since significant new capacity for basic commodity chemicals has been built in the US. Today, however, the affordable feedstock available to US-based chemical companies is driving significant capital investment in new production. Capital spending in 2014 was \$33 billion; by 2020, it's expected to be about \$55 billion, an increase of 65 percent.⁵ Announced new major projects are expected to increase production volumes by about 53 million metric tons (MMTs) per year by 2020 (*Fig 1*). This amounts to an 18 percent increase in total industry capacity, not including normal incremental growth. The majority of the expansion projects are projected to come on-stream in 2017–2018, with most of the growth coming from the production of olefins, polyolefins, and methanol (*Fig 2*).

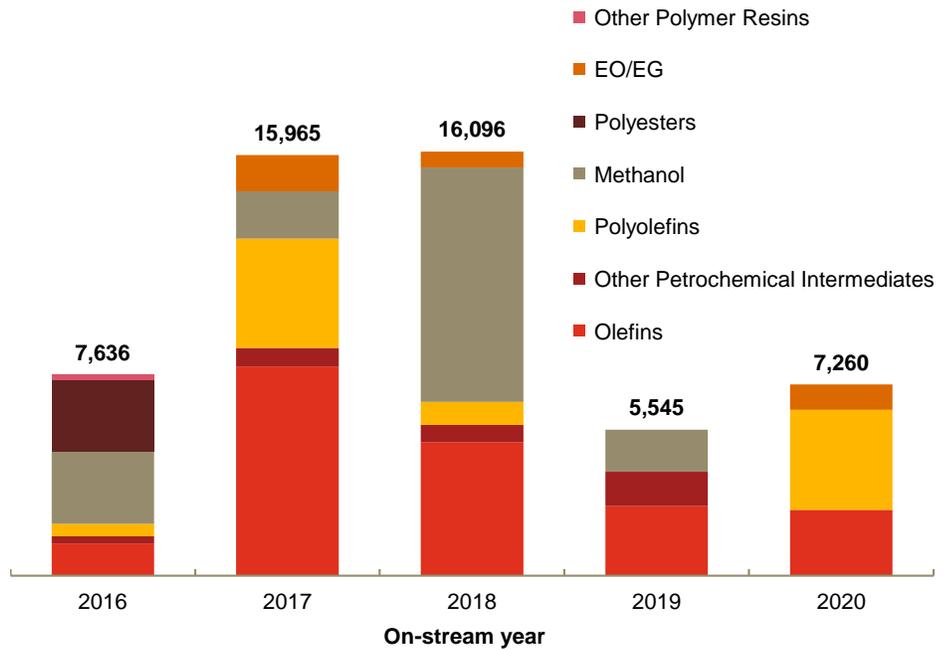
³ ACC, Guide to the Business of Chemistry, 2015

⁴ ACC, Guide to the Business of Chemistry, 2016

⁵ ACC, Year-End Situation and Outlook, 2015

Figure 1: The majority of the planned expansion is expected to come on-stream in 2017 and 2018

USA, KT/year by project on-stream date – by product classification

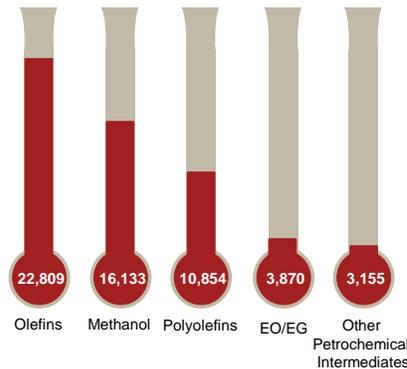


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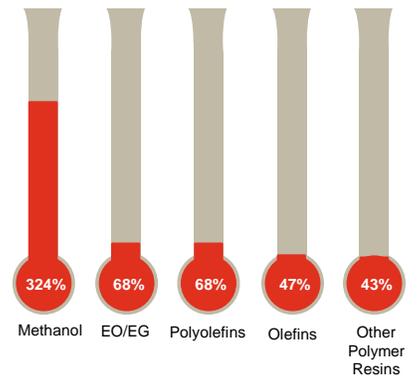
- 1) Data shown is for time horizon of present through 2021: the latest year of a project on-stream date available in ICIS data
 - 2) 'Project' capacity omits projects with the following statuses: Cancelled, On Hold, Shelved, Suspended, Uncertain
 - 3) 1,800 KT/year of Urea ammonium nitrate have been removed from project data (CF Industries) due to unavailability of current operating footprint of fertilizers
 - 4) 149,000 KT/year of Benzene have been removed from project data due to the majority of its production being allocated for gasoline
- Source: ICIS, PwC Analysis, ACC Analysis

Figure 2: Olefins, polyolefins, and methanol are expected to experience the largest gains in capacity

Capacity increase by chemical group
Top five groups (Units: KT/year)



Capacity increase as a % of existing capacity
Top five groups (Units: KT/year)



Notes:

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US logistics infrastructure: is it meeting the chemical industry's needs?

In recent years, chemical transportation has become a significant concern for manufacturers, driven by regulations, congestion issues, and increasing costs. In order to understand specific challenges, PwC conducted a survey of chemical manufacturers. PwC received responses from 68 chemical companies that included representation from small-, medium- and large-volume shippers.⁶

Their current use of transportation modes as a percentage of the total number of shipments was 61 percent truck, 24 percent rail, 14 percent marine container, and 1 percent other modes.

Below is an assessment of current transportation issues by mode, based on respondents' responses and PwC's research and analysis:

Truck

Trucking is the primary transportation mode used by the chemicals industry, representing an estimated 54 percent of overall industry shipments.⁷ Chemical companies use trucks to move their products directly to their customers (both short and long hauls), to warehouse and terminal locations, as well as for intermodal rail shipments. Another major use of truck transportation is for draying of containers from manufacturing or packaging locations into ports for export.

While all industries have truck-related transportation issues, the chemical industry has a unique set of challenges.

Specific regulatory requirements exist for hauling chemicals. For example, drivers for the chemical industry must pass a TSA security threat assessment (with a background check that takes 60 to 90 days to complete) and undergo security training to earn a TWIC (Transportation Worker Identification Credential) before they are allowed to enter many chemical manufacturing facilities. In addition, drivers must meet age and safety-record requirements for hazmat endorsements and interstate shipments.

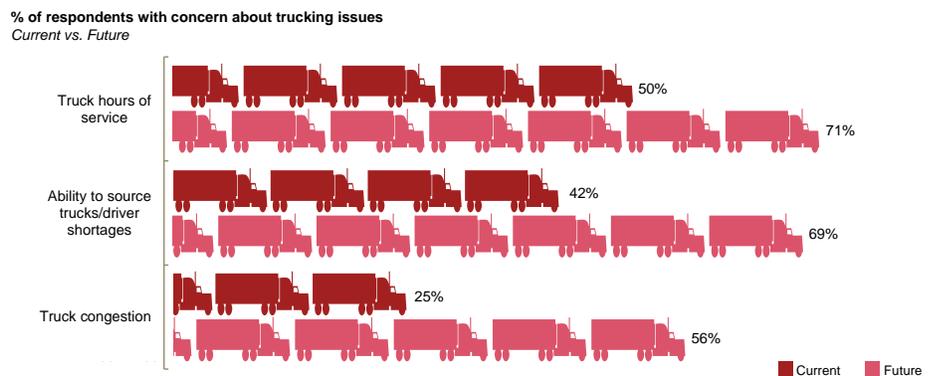
As a result of these requirements, chemical producers have struggled at various times with a shortage of skilled and certified drivers. This problem has been exacerbated by tighter hours-of-service rules, mandated by the Federal Motor Carrier Safety Administration (under CSA2010), which limit the amount of time a driver can spend on the road. More than half of the respondents PwC surveyed said they were concerned about truck hours of

service and their ability to secure qualified truck drivers. Respondents also reported that, on average, they experienced scheduling delays of more than a day to secure trucks. Smaller companies reported more difficulty in arranging transport.

While short-term improvements may occur due to seasonality and macroeconomic conditions, most industry experts do not see the driver shortage improving any time soon.⁸ The American Trucking Association (ATA) reports that the average age of drivers is 52 years and estimates that yearly driver retirements will account for 37 percent of new driver demand over the next decade. At this rate of retirement, it may be difficult to maintain even the current number of qualified truckers.

When asked about the future, approximately 70 percent of chemical company respondents voiced concern about truck hours of service and driver availability (*Fig 3*). At a time when the industry requires additional capacity and more drivers are needed, regulations and industry dynamics are further constraining the supply of qualified drivers.

Figure 3: Chemical companies expect trucking service issues to become more acute by 2020



Source: ICIS, PwC Analysis

Notes: 1) 'Percentage of concerned respondents' is calculated by number of respondents having 'Significant' or 'Moderate' concerns for any region over the total number of respondents. 2) 'Future' is defined as 2020 for this analysis

⁶ Large shippers: more than 2 million shipments per year; mid-size shippers: 100 thousand to 2 million shipments per year; small

shippers: less than 100 thousand shipments per year

⁷ ACC, Guide to the Business of Chemistry, 2015

⁸ ATA, Truck Driver Shortage Analysis 2015, October 2015

Marine container

Chemical companies make extensive use of marine-packed cargo for export purposes. This is particularly true for polyolefins, which cannot be shipped easily in bulk and must be bagged or boxed and then containerized. Containers are also used extensively to move packaged specialty chemicals.

Although a significant portion of US chemical production is located on the Gulf Coast areas near the ports of Houston and New Orleans, producers often use more distant East and West Coast ports. Gulf ports have generally been viewed as less than ideal facilities, primarily because the largest vessels do not call at these locations. About 32 percent of chemical export volume is moved long distance to ports such as Los Angeles and Charleston, SC.⁹

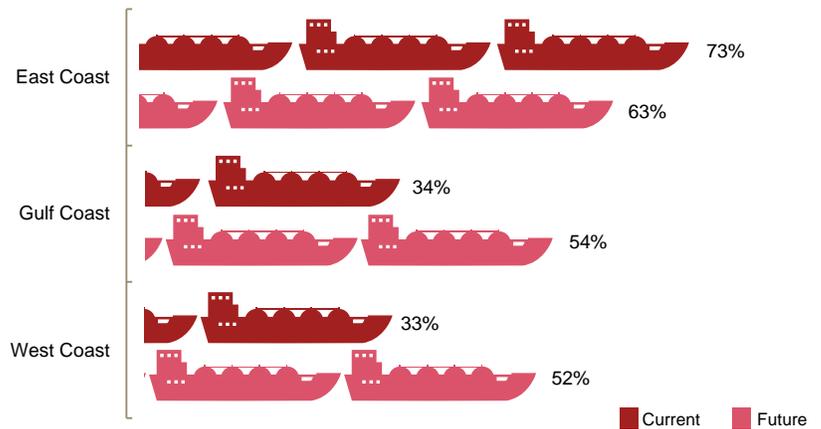
Although producers will incur a cost premium for going overland to these locations, they report receiving better and more frequent service from steamship lines.

While the non-Gulf ports offer some service benefits, they are not without their own issues. In 2015, West Coast marine transportation was disrupted by a contract dispute between the International Longshore and Warehouse Union (ILWU) and the Pacific Maritime Association (PMA). The dispute lasted months and caused major delays and increased costs as materials were diverted to alternative ports.

While West Coast labor issues are resolved for the time being, more than 60 percent of survey respondents remain concerned about port-related issues. They are increasingly concerned about the preparedness of Gulf Coast ports to handle current and future growth volumes (Fig 4).

Figure 4: Concerns over port congestion appears to be shifting from the West Coast to the Gulf and East Coasts

Percent of respondents with concerns about port congestion issues
Current vs. Future – by port



Source: PwC Analysis

Notes:

1) 'Percentage of concerned respondents' is calculated by number of respondents having 'Significant' or 'Moderate' concerns for any region over the total number of respondents

2) 'Future' is defined as 2020 for this analysis

⁹ Data from PwC survey

Rail

Rail transportation is typically used by chemical producers to ship bulk products to customers or to packagers before exporting their product in containers. Rail is an important transportation mode for commodity producers, since it is the preferred option for shipping high volumes.

Rail congestion has been a topic of discussion for many years among chemical producers. Survey respondents reported current average congestion-related delays of about four days on rail movements, with significant variation in transit times on individual shipments. Often, delays occur at major high-traffic nodes in the rail network that turn into choke points (e.g., Chicago, Houston, New Orleans, and East St. Louis). Shippers also report that local switching can result in significant delays, with cars parked in SIT (storage in transit) yards for periods of time.

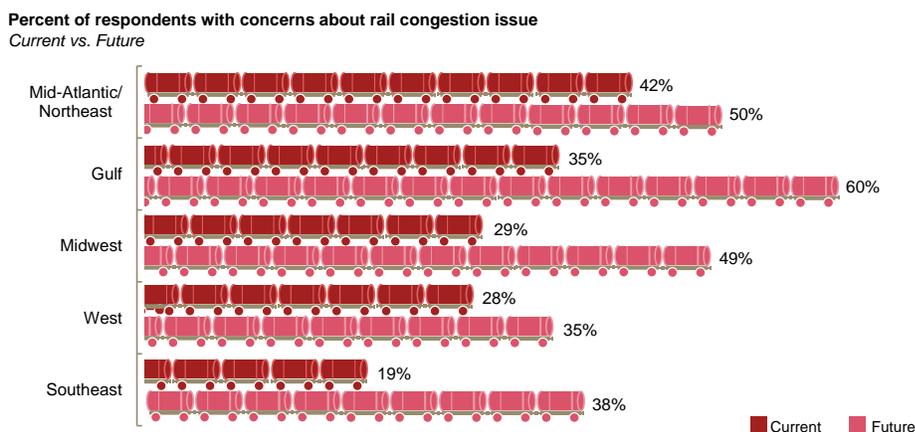
Delays can impact the industry in several ways. First, it becomes difficult for manufacturers to promise delivery dates to customers. This forces customers to hold greater inventories at their sites to hedge against uncertainty. Second, delays lengthen shipping time, thereby increasing levels of in-transit inventory. Finally, longer transit times result in product idling in railcars, fewer turns and more railcars needed to meet shipping requirements.

A likely root cause of delays in many locations is that railroad infrastructure is capacity constrained, due to a lack of strategic investment. While investment in the rail network has increased over the last few years, it has not been sufficient to address service issues and delays in some areas. In general, rail infrastructure is costly and requires significant time to upgrade. Space constraints may also exist that could prevent expansion in urban locations. For one or all of these reasons, it is difficult to quickly align rail infrastructure capabilities to changing market demands.

With congestion and service variability challenges in rail, chemical producers have looked for shipping alternatives as a way to maintain service levels. Survey respondents reported that they were currently transporting nearly 8 percent of their intended rail shipments using a sub-optimal mode (e.g., truck instead of rail), which equates to approximately 14 million tons of extra truck cargo annually. In addition, companies have started to ship on sub-optimal routes to avoid known congestion areas, increased the quantity of railcars in their fleet due to expected lower turns, and conducted forward-blocking railcars to improve transit times.

Chemical producers do not expect the situation to change in the near term. When asked about future concerns, 66 percent of survey respondents said they were concerned about rail congestion, and this concern is increasing substantially in the Gulf Coast and Midwest (Fig 5).

Figure 5: Rail concerns are growing across the network; however, future concerns are most significant in the Gulf



Source: ICIS, PwC Analysis

Notes:

1) 'Percentage of concerned respondents' is calculated by number of respondents having 'Significant' or 'Moderate' concerns over the total number of respondents

Fixing the future: logistics infrastructure needs to keep pace with chemical industry growth spurt

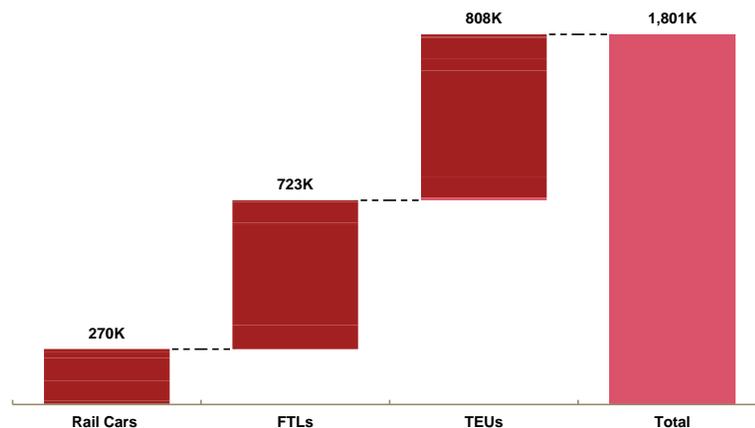
Overall volume and shipments

The large number of production assets coming online within the next five to seven years will likely lead to greater transportation demands, underscoring the need to address current issues. Chemical shipments could increase by approximately 36 million tons annually by 2020. Some of the volume, 20 million tons, will be olefins and methanol, which are shipped by pipeline/bulk. The remaining 16 million will be new rail, truck, and marine packed cargo shipments.

New capacity is projected to result in an additional 1.8 million annual shipments by 2020 across all modes of transportation (Fig 6), adding an additional 270,000 railcars, 723,000 truck FTLs,¹⁰ and 808,000 marine TEUs each year. Rail and trucking will be especially affected, since these modes already suffer from congestion-related delays.

Figure 6: The increase in production volumes will require an additional 1.8 million shipments

Annual number of additional shipments required to meet expected shipment volumes in 2020 by mode



Source: ICIS, PwC Analysis, ACC Analysis

Notes:

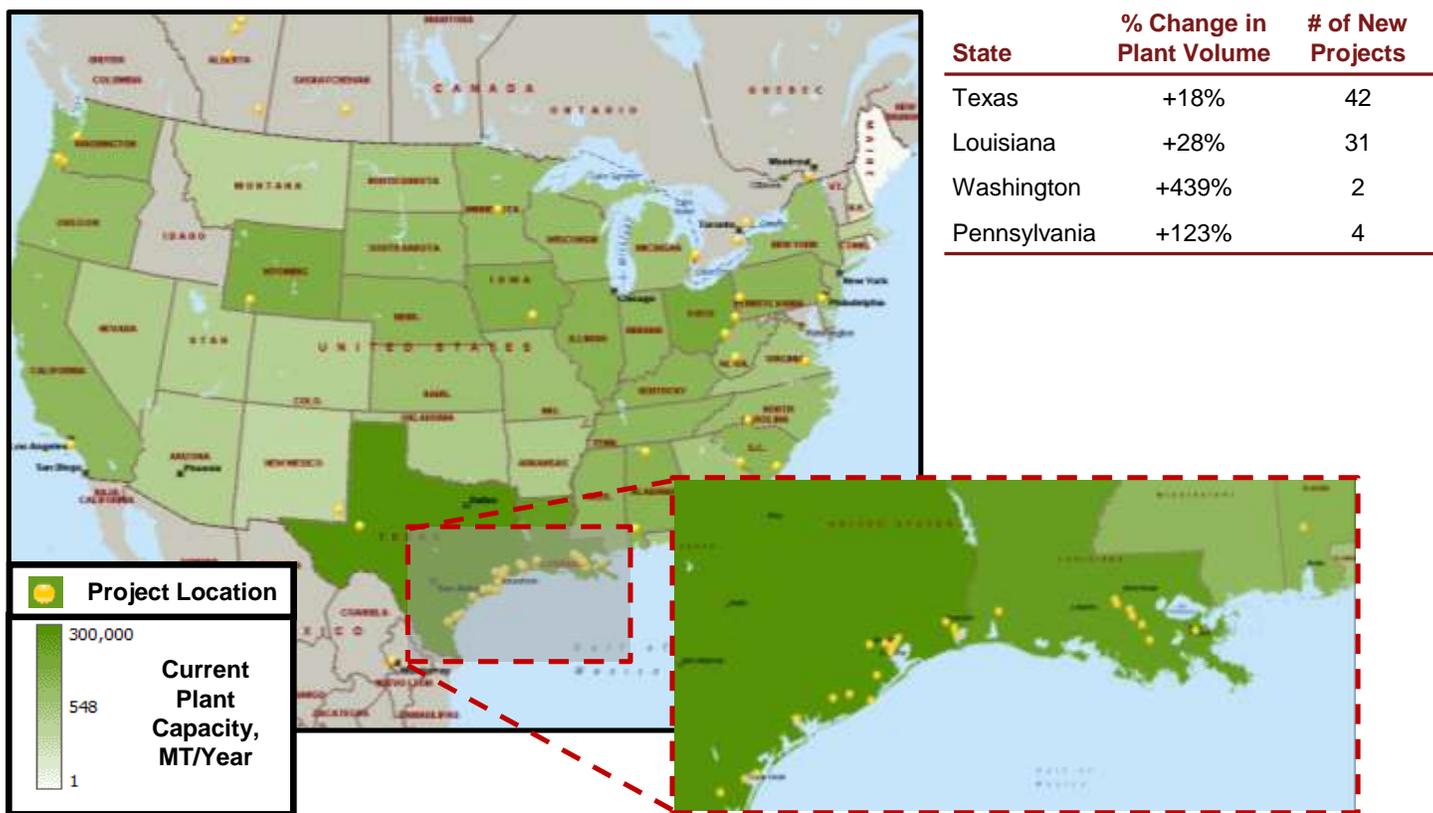
- 1) FTLs = Full Truckloads, TEU = Twenty-foot Equivalent Units
- 2) Tonnage assumptions per shipments: 95 tons per railcar shipment, 20 tons per TEU, 21 tons per FTL
- 3) Excludes Pipeline, Air, and Other modes of transportation

¹⁰ FTL is the acronym for ‘full truck loads,’ a measure of truck capacity. TEU stands for

‘twenty-foot equivalent unit’ and is the standard measure of a container ship capacity.

Transportation needs will be greatest in those areas of the country where most of the new production is taking place. Almost two-thirds of the active projects are occurring in Texas and Louisiana (Fig. 7) and therefore the Gulf will see the most significant impact. Other areas that may be impacted include Washington and Pennsylvania.

Figure 7: 63 percent of the active projects in the US are concentrated in Texas and Louisiana



Source: ICIS, PwC Analysis, ACC Analysis

The impact of future growth on transportation modes

Truck

Looking into the next decade, the driver shortage in the US is likely to become more acute, as new shipment volumes come online—particularly in the regions where new production is concentrated (Texas and Louisiana). The increase in both drayage and domestic shipment volumes will require several thousand new qualified drivers, along with new trucks, trailers, and chassis. And these new volumes, combined with the driver shortages, will likely lead to additional transportation sourcing delays. PwC estimates that these effects will add about \$8 billion in additional inventories to the chemicals industry supply chain by 2025. Also, longer trucking lead times could very well increase the need for expedited shipments. Over the next ten years, expediting costs due to truck availability constraints may total up to \$5 billion. New chemicals traffic will also be affected by—and contribute to—delays on local and interstate roadways, resulting in further additional costs including lost time and wear and tear on equipment. These costs could be passed on to customers or absorbed by manufacturers; in any case, such deepening logistics snarls would likely dampen productivity.

Marine container

The Gulf Coast marine shipping industry is nearing a major inflection point with the opening of the third Panama Canal lock and implementation of ‘New Panamax’ regulations, which will allow vessels up to 13,000 TEUs to transit the canal. These events will make it cost

efficient to service Gulf ports with larger vessels. The Port of Houston has been preparing for this eventuality by dredging to a channel depth of 45 feet to accommodate deeper draft ships. Houston and other ports have also been investing in new infrastructure, such as cranes and dock space, to support additional shipment volumes.

As additional containerized shipment volumes come online, the Gulf ports will be attractive for new exports, particularly for the polymer production coming online in that region. However, significant concerns persist over whether infrastructure in and around these ports (particularly in Houston), can support added volume. Manufacturers are concerned about capacity and yard congestion at local packaging facilities and transit delays on railroads in the vicinity of the ports. Also of concern is road congestion around at-grade crossings and the limited hours of service at the port gates. In addition, Texas does not currently allow overweight corridors to the port, which increases drayage costs relative to other port locations.

Gulf port issues have caused some manufacturers to plan new supply chains that bypass these areas, traveling longer distances to ports on the East and West Coasts. While these supply chains avoid congestion on the Gulf, they may result in other unwanted effects: greater overland shipping costs, more railroad and road congestion, more congestion at East and West Coast ports, and a worsening of the truck driver shortage. PwC estimates that the total extra costs associated with using sub-

optimal routes (e.g., shipping from the West Coast instead of the Gulf) could amount to \$10 billion over the next ten years.

Rail

The ability of rail infrastructure to handle new volumes is of special concern to chemical manufacturers. Sixty-five percent of manufacturers surveyed expect rail delays to worsen as new volumes come online. Track, SIT yard, and switching capacity are limited in many areas of the country, particularly in Houston and Chicago. Much like a highway traffic jam, new shipments transiting through congested areas will only exacerbate existing delays on shipments moving through the same area.

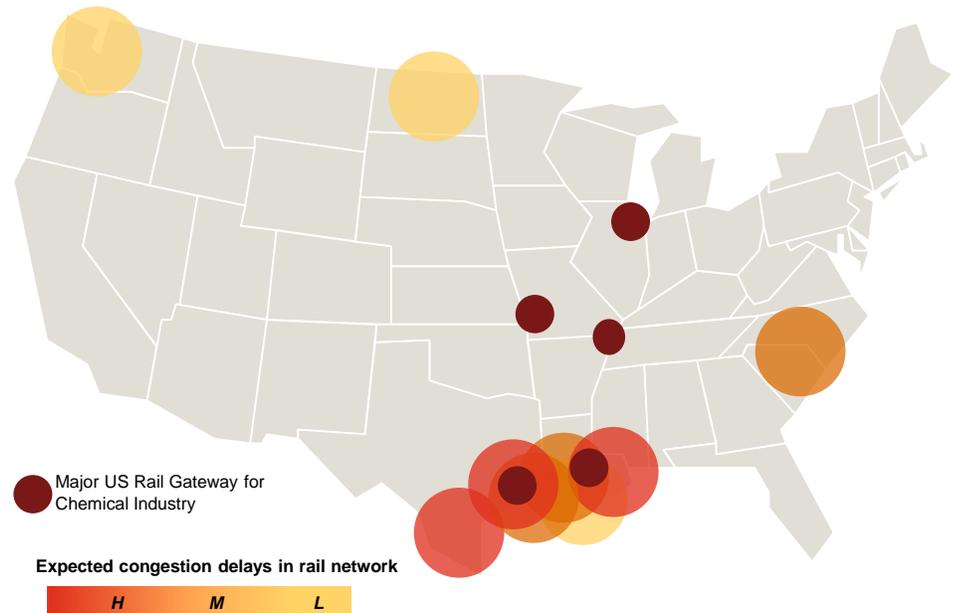
PwC modeled future rail delays based on current and expected new volumes, assuming system capacity remains static. According to a PwC analysis, overall, rail delays for chemical shipments could increase by more than 100 percent by 2025, assuming current rail conditions do not improve. Areas of particular concern include Baton Rouge, Corpus Christi, Houston, and New Orleans (*Fig 8*). Delays are expected to result in increased working capital as manufacturers hold more stocks in transit and customers hold extra inventory to mitigate against transit time variability (which tends to increase as delays increase). PwC estimates the cumulative extra inventory requirement driven by rail delays will reach \$14 billion by 2025.

As delays and transit time variability increase, chemical manufacturers will likely require more railcars to hold in-transit products, a significant expense whether the cars are leased or purchased. PwC estimates that today the chemical sector achieves between four to five turns on its cars annually and that almost 23,000 railcars are required to mitigate existing delays.

It is likely the industry will need significant numbers of new railcars by 2025 to mitigate against increased delays, as well as other infrastructure such as onsite storage track and new rail spurs. PwC estimates the total potential CAPEX will be \$20 billion to manage increasing delays and lower turns on railcars.

Chemical manufacturers often ship product by sub-optimal modes because rail delays can result in uncertain delivery times. As volumes increase, so do costs. Based on our analysis, shipping via sub-optimal modes (e.g., trucking instead of rail) will cost chemical companies up to \$12 billion by 2025.¹¹

Figure 8: Delays will be more acute in the Gulf Coast because of its existing rail congestion issues and chemical manufacturer concentration



Source: PwC Survey PwC Analysis

¹¹ Based on PwC analysis, using current conditions

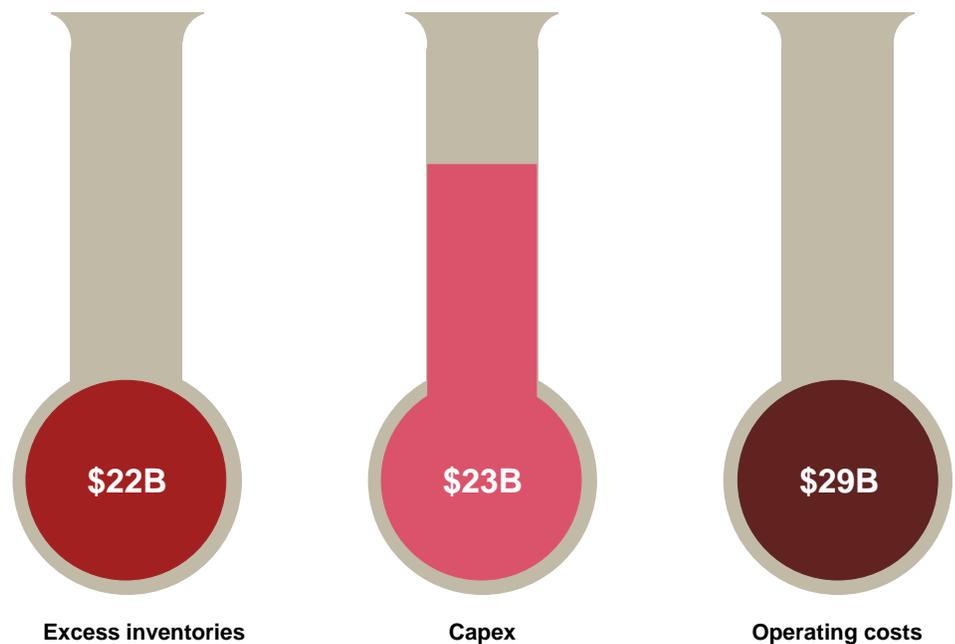
Cost of inaction

The US chemical industry is experiencing dramatic growth with significant capital investment in new projects and increased production volumes and output. Given the current challenges already present in the transportation network, chemical manufacturers will face additional transportation-related costs as industry shipments increase.

PwC estimated the additional transportation costs that would be incurred over the next ten years. These estimates are for the combined costs of rail, truck, and waterborne distribution of chemicals. Over the next decade,¹² chemical manufacturers will face an additional \$22 billion in working capital costs because of additional inventory held due to transportation delays in-transit and on customer premises.

Over the same time period, an additional \$23 billion in capital spending will be required for investments in equipment and infrastructure to handle increased congestion and delays. The industry could also face nearly \$29 billion in additional operating costs by 2025 due to the need for work-arounds, the use of sub-optimal lanes and modes, and the need for more expedited shipments.

Figure 9: Projected ten-year costs of transportation constraints on the chemical industry



¹² PwC analysis examined the ten-year period from 2016 to 2025

Opportunities for improvement

Each transportation mode has its specific challenges and presents different opportunities for improvement. However, many of the problems are systemic and call for the collaboration and resources of all stakeholders, including chemical manufacturers, transportation providers, and state, local, and federal governments. Below are some suggestions for improving current transportation issues and preparing for future needs:

Truck

Since PwC anticipates that the chemical industry will continue to struggle with the availability of qualified truck drivers for their shipments, the most important actions that can be taken to address these concerns are those that increase either the productivity or number of available drivers for the industry.

- Industry could increase the number of hazmat drivers by helping to fund TSA/TWIC checks for new drivers to defray the cost and/or funding communications that promote driver recruitment.
- Consider creating heavyweight corridors into the port of Houston, which would reduce the number of trucks on the road and ease the impact of driver shortages.
- Streamline the process by which military veterans can demonstrate trucking experience to earn a commercial driver's license and/or hazmat certification.
- Consider clarifying the definition of intrastate transport to include drayage to local ports, thereby increasing the number of drivers qualified to handle these loads.

Marine container

While the Gulf ports have begun to prepare for the increased volumes, it is unclear whether chemical manufacturers are fully aware of the investments being made and the options for future service. It is also unclear if manufacturers are sharing the most current information regarding their expansion plans.

Increasing communication amongst all players is critical to ensuring that optimal supply chains are developed for the longer term. Specific, suggestions include the following:

- Gulf Coast ports, chemical companies, and shipping lines may want to consider establishing a regular means to communicate on key issues and address specific transportation concerns including gate hours, ship sailing schedules and frequency, ports of call, container balancing, and unified chassis pools. The group should also work to increase transparency into port preparedness activities (e.g., increasing channel depth, dock expansion), gain alignment on evolving chemical requirements, and set industry expectations on volume growth and service requirements.
- Industry may want to consider working with public entities to ensure existing user fees and taxes are made available for harbor maintenance and upgrades to accommodate increases in shipping volumes.

Rail

Rail capacity constraints in the network are likely to worsen with increased volumes. Therefore, efforts should focus on ways to increase capacity or improve efficient use of the current network. Manufacturers and railroads should share information so that infrastructure investments are made where they are—and will be in the future—most needed to avoid bottlenecks. Also, at a transactional level, sharing shipment information may make it possible to minimize congestion through level-loading.

- Chemical companies, railroads, and other stakeholders (such as packagers and public entities) may want to consider establishing local working groups to address specific issues in local areas (such as has been done in Chicago). Such local working groups would be especially beneficial in Houston and Louisiana because of expected increases in volume. These groups would share planned production volumes and review potential impacts, work to improve flow within areas of high congestion, and cooperate to support PPP (public-private partnerships) and TIGER (Transportation Investment Generating Economic Recovery) grants to address specific infrastructure issues.
- To improve visibility across the supply chain, enhance efficiency, and minimize bottlenecks, all parties involved in the chemical transportation value chain should consider developing a mechanism for sharing shipment information. For instance, by sharing transactional shipment information, railroads can better plan use of their network, and chemical companies would in return gain visibility into transit plans and expected arrival dates at the customer. The earlier information is shared, the more likely bottlenecks can be averted.
- Chemical companies, especially those with major new capital projects, may want to inform their railroads about expected future volumes and timing. Railroads should model how the volumes would impact their networks and address bottlenecks before volumes come online. In cases where external factors create constraints (e.g., at grade crossings or landlocked yards), the parties should work together to identify potential solutions.

Methodology

PwC sent out a questionnaire to chemical companies focusing on their current and future concerns about transportation. PwC received responses from 68 chemical companies representing a cross section of products and production scale. Their current use of transportation modes as a percentage of the total number of shipments was as follows: 61 percent, truck; 24 percent, rail; 14 percent, marine container; and 1 percent, other.

PwC used publicly available sources for current industry and transportation numbers and five-year project data. Ten-year projections were based on current baselines, announced new projects for planned growth expansions in the chemicals project database (ICIS), and historical growth rates. For other segments without major project announcements, PwC assumed historical economic growth. In addition, economic regulation issues are outside the scope of this report.

To have a deeper conversation about how this subject may affect your business, please contact:

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