Delmarva Chemicals Manufacturing Supply Chain Study

Draft Final Report

Delivered to the Wilmington Area Planning Council (Wilmapco): November 1, 2013

- Overview
- Macroeconomic trends and the Delmarva economy
  - International, national, and regional macroeconomic trends
  - The Delmarva economy
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- Chemicals industry analysis
  - US chemicals industry overview
  - US chemicals industry trends: Key products and feedstocks
  - Delmarva chemicals industry
- Supply Chain Analysis
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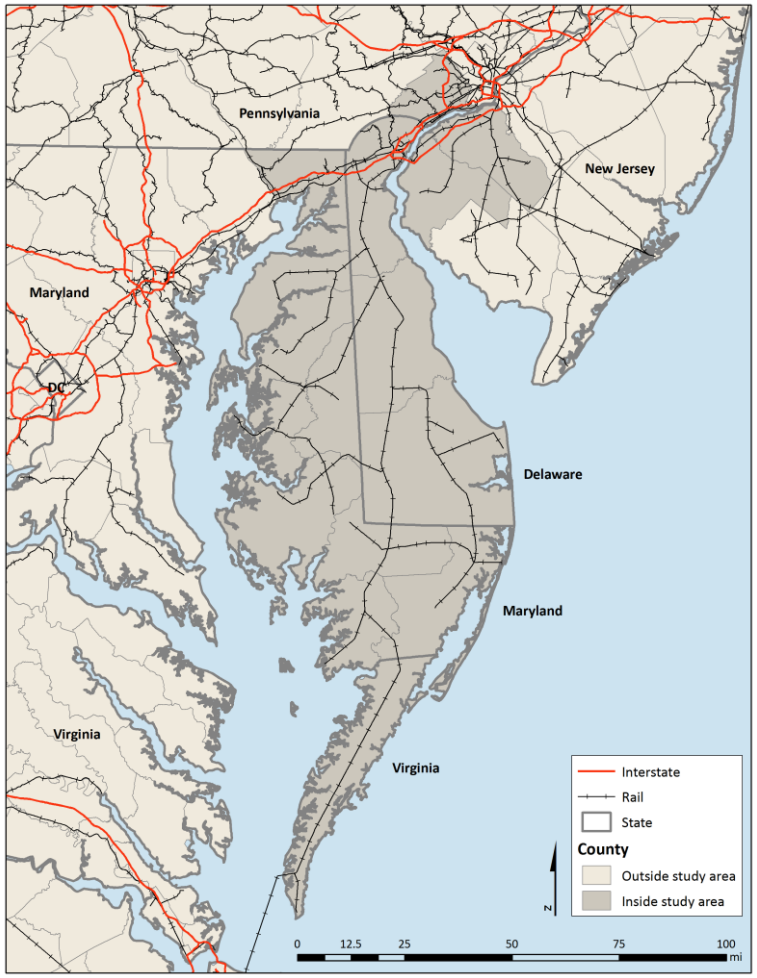
- Economic Opportunities and Policy Priorities
  - SWOT analysis
  - Possible interventions and current status
  - Scenario analysis: Key transportation gaps

Project description and goal

- The Delmarva Chemicals Supply Chain study aims to evaluate the opportunity for increased chemical manufacturing and related activities in the Greater Wilmington and Delmarva region potentially made possible by oil and gas development in the Marcellus shale play.
- The study synthesizes various chemicals and transportation industry forecasts and insight with interviews with regional industry leaders to evaluate potential opportunities and identify priority transportation policies and investments.

Map of the study region



- Delaware: Entire State
- Maryland: Eastern Shore
- Virginia: Accomack and Northampton counties
- Pennsylvania: Delaware County
- New Jersey: Gloucester and Salem counties

Geographic scope

- The study area, while focused on Delmarva, incorporates Pennsylvania and New Jersey counties adjacent to Greater Wilmington.
- Manufacturing and goods movement through these adjacent areas, especially petroleum and chemicals industry activities just over the Delaware border in Marcus Hook, Delaware County, PA, directly impacts chemicals and transportation industries in Greater Wilmington.
- The study will address, as needed, those factors outside the study area that may impact chemicals industry economic activity in Delmarva.
  - In particular the study will cover the development of Marcellus shale and supply chains developing from western Pennsylvania to the Philadelphia and Wilmington metropolitan areas.
  - Economic linkages with the wider northeast “mega-region” and between other major regions are also explored to describe chemicals product development supply chains and demand markets.

Summary of findings

- Delmarva regional chemicals manufacturing has declined in recent years due to in part to a lower demand and high production costs, in part due to uncompetitive raw materials and energy sourcing.
- Domestic demand is recovering, while international demand for chemicals should increase substantially, especially in Asia.
- The study region enjoys a critical mass of petroleum and chemicals manufacturing and distribution. These economies of agglomeration provide the region with legacy infrastructure and “know-how” attractive to investment.
- The opportunity to source potentially large-scale, cheap, and plentiful non-gas liquids (NGLs) from Marcellus natural gas extraction in western Pennsylvania could give regional chemical manufacturers a competitive advantage, especially for specialized, high-value, low-weight downstream products.
- Most (90%) of US investment in chemicals manufacturing, however, will be in the Gulf Coast. The Mariner East pipeline is a good first step, and increased pipeline capacity, coupled with manufacturing and port facility investment, is necessary to create a more competitive regional economic environment for manufacturing.

Summary of findings, con't.

- Current inbound and outbound commodity flow forecasts estimated for this study suggest continued modest growth of regional chemicals production, especially high-value, low-weight specialty chemicals, plastics, and pharmaceuticals.
- A revival of regional basic chemicals and derivates manufacturing is possible if NGL/natural gas pipeline are developed towards the Delaware Bay and manufacturers see cost benefits to locating production near potential markets and the Northeast US, Europe, and (possibly) Asia. Scenarios analyzed include:
  - **Scenario 1A**: A best-case scenario would include the development of an ethylene cracker facility near Marcus Hook and/or propane- or methane-based derivative plants, reviving regional basic chemicals manufacturing.
  - **Scenario 1B**: If Shell builds an ethylene cracker in Western PA, the Delaware River/ Bay region could see increased downstream chemicals manufacturing and limited basic chemicals growth.
  - **Scenario 1C**: If no ethylene units are not built in the Northeast, there may be some opportunities for chemicals industry growth in energy-intensive industries which will still benefit from low-cost natural gas such as chlor-alkali, as well as NGL transportation activities centered on export.
  - **Scenario 2**: In a worst-case scenario, either production levels do not materialize or nearly all activities and benefits accrue to the US Gulf Coast, Canada, or North Dakota. Delmarva area chemicals manufacturing would then likely resume previous trends favoring specialized chemicals and R&D but off-shoring or relocation of other chemicals manufacturing.

Summary of findings, con't.

- Besides NGL and natural gas pipelines, no single transportation investment will necessarily induce increased regional chemicals manufacturing and related activities. Nor should chemicals interests alone justify public investments.
- There are numerous priority projects identified by industry, however, that are underway or under consideration by regional transportation authorities.
- The most important proposed policies, or those likely making a positive impact across most scenarios include (in relative order of importance to the regional chemicals industry, as evaluated in this study):
  - Highway capacity and congestion mitigation, including improving truck access to existing major seaports (Wilmington and Baltimore) and airports (PHL and BWI)
  - Rail congestion alleviation in New Castle county, including improved access to major seaports (Marcus Hook, Wilmington, Baltimore)
  - Greater coordination with the Delaware River Regional Planning Commission (DVRPC) and other regional transportation authorities for joint marketing and coordinated investment
  - The Chesapeake Connector
  - Maintaining Delaware River/ Bay dredging to 45+ ft.
  - Maintaining secondary rail service to Lower Delmarva

Summary of findings, con't.: Evaluation of transportation policy priorities

Scenario	1A	1B	1C	2
Coordination with DVRPC on planning/marketing				
Chesapeake Connector				
Rail congestion alleviation in New Castle County				
Highway capacity and congestion mitigation				
Secondary rail service to Lower Delmarva				
Delaware Bay dredging to 45+ feet				
Port of Wilmington strategic investment				
New Castle airport cargo operations*				

Key
High Benefit
Moderate Benefit
Minimal Benefit

- Note: seaport and airport freight access are important to Delmarva chemicals manufacturing, but the analysis suggests current market, facilities, and community constraints to cargo operations at New Castle. The study adopts the position that efficient roadway connectivity to BWI or PHL is more viable.

Summary of findings, con't.

- The study identified a number of other challenges and priorities for the regional chemicals industry that would have to be addressed outside the scope of transportation policy:
  - Reportedly high energy costs in Delaware relative to neighbors
  - Long-term skilled workforce constraints
  - Coastal Zone Management regulations likely prohibiting new chemicals manufacturing investment on the Delaware Bay
  - Other tax and regulatory issues

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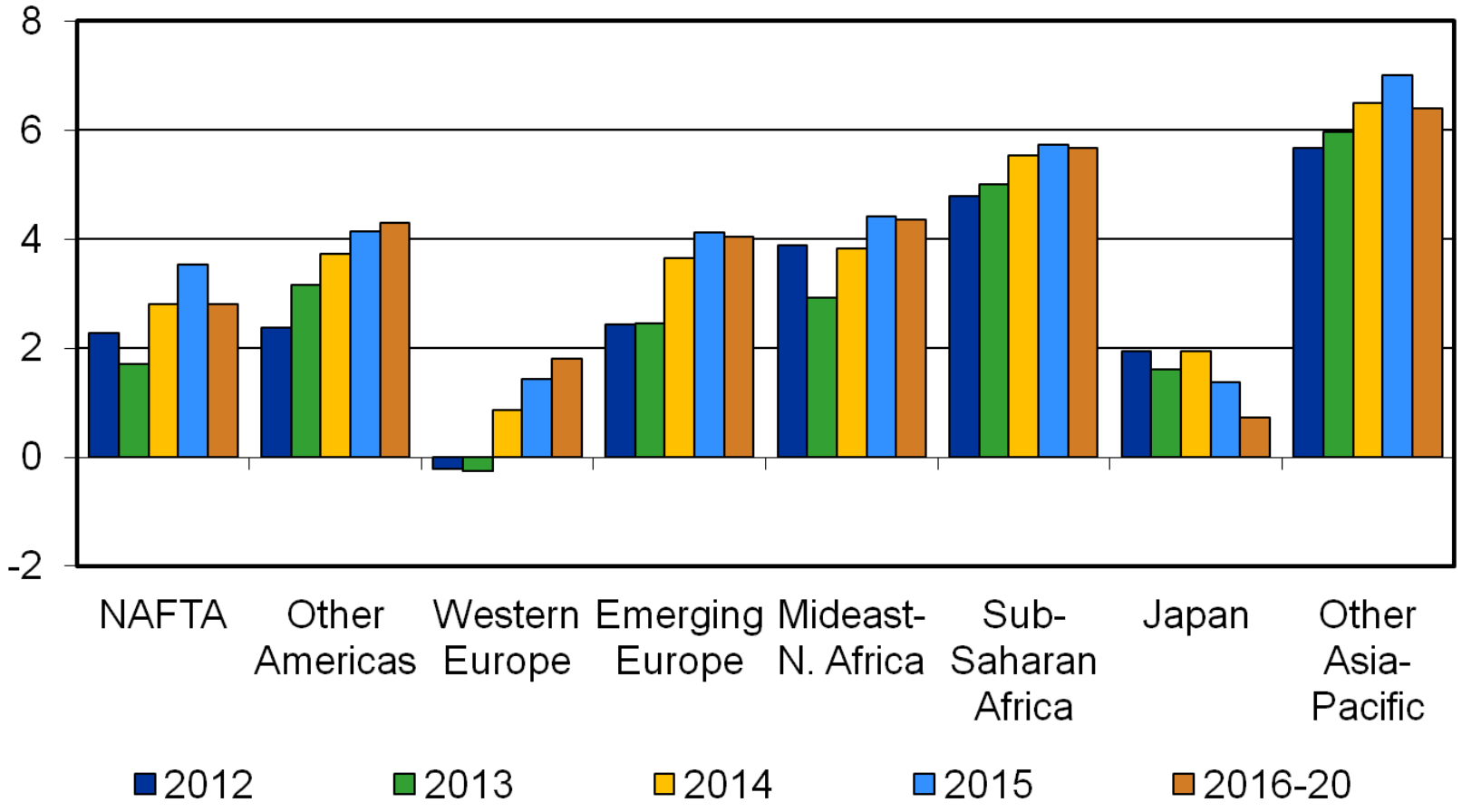
Global economy: Trends suggest slow but improving short-term economic growth…

- Global economic growth remains sluggish in 2013 due to, among many factors, fiscal tightening and political uncertainties.
- Fiscal policy headwinds are slowing US growth in 2013, but a housing market rebound and improving consumer finances will boost growth in 2014-15.
- The Eurozone's long recession will soon end, but the recovery will be gradual.
- China's growth is wavering as exports and investment decelerate. The need for financial sector consolidation will limit the scope of policy stimulus.
- Asia will lead global growth, while Latin America and Africa will do relatively well by historical standards.
- Developed countries will lead a pick-up in global growth in 2014.

…but better long-term prospects, especially in Asia-Pacific and Africa



US economy outlook: Sluggish short-term growth, but business investment, an energy boom, and trade point to long-term growth

- The economy's fundamentals are improving pointing to long-term growth, but several headwinds will restrain near-term growth.
- Consumers will cautiously increase spending in response to gains in asset values (e.g., home values), employment, and income.
- Homebuilding will surge through 2015 then stall as interest rates rise.
- Interest rates will rise significantly over the next four years as monetary accommodation is withdrawn.
- **Business investment will remain a driving force, picking-up again in 2014.**
- **The energy boom is creating jobs, investment, and a competitive manufacturing advantage, especially in many commodity petrochemicals.**
- **Increased exports will help support future growth.**

US economic growth continues on an upward trajectory in 2014 and 2015

Annual % Change

	2012	2013	2014	2015
Real GDP	2.2	1.8	2.9	3.5
Consumption	1.9	2.1	2.6	2.8
Residential investment	12.1	14.8	18.5	21.5
Business fixed investment	8.0	4.3	6.8	7.9
Federal government	-2.2	-5.9	0.4	-0.9
State & local government	-1.4	-1.5	0.1	0.8
Exports	3.4	1.7	5.2	5.6
Imports	2.4	1.0	5.1	4.9

- Real GDP growth will be driven by residential investment, business investment, and trade.
- However, government investment will continue to dampen GDP growth.

Other key US indicators point to a strengthening economy, with modest inflation

Annual % Change (Unless Otherwise Noted)

	2012	2013	2014	2015
Industrial production	3.6	2.5	3.3	3.8
Payroll employment	1.7	1.6	1.6	1.9
Light-vehicle sales (Millions)	14.4	15.4	15.8	16.2
Housing starts (Millions)	0.78	0.97	1.23	1.56
Consumer Price Index	2.1	1.3	1.5	1.7
Core CPI	2.1	1.8	2.0	1.9
Brent crude oil price ($/barrel)	101	96	88	88
Federal fund rate (%)	0.1	0.1	0.2	0.4
10-year Treasury yield (%)	1.8	2.2	2.7	3.1

- Payroll, industrial production, and light-vehicle sales will rebound in 2014-2015.
- Low oil prices help moderate inflation, but the Fed will begin increasing interest rates by 2014-2015 as growth picks up.

Near-term economic conditions in the US suggest reasonable growth opportunities for the domestic chemicals industry

- Stable growth in GDP, employment, and production should support domestic demand for chemicals.
- Increases in business investment, industrial production, housing starts, and automotive sales will also help drive demand for industrial chemicals and plastics.
- Low inflation and, in the short term, low interest rates support investment.
- Low energy costs will provide a competitive advantage for some chemicals manufacturing.
- Cost competitiveness advantages are increasing U.S. chemical export and this trend is expected to continue to grow.

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The Delaware economy is growing steadily, and chemicals are a driving force for manufacturing and trade.

- Employment grew steadily at 1.6% year-over-year in April, 2013. Delaware is expected to recover pre-recession peak employment levels by the third quarter of 2015.
- Population increased 1% from 2011 to 2012, ahead of the national growth rate of 0.7%, making Delaware the 18th fastest growing state.
- Food processing followed by **chemicals (including pharmaceuticals)**, financial services, leisure/hospitality services, and professional and business services are the top industries.
- Delaware's manufacturing sector has contracted in recent decades. For example, since 1985 Delaware has lost 5,000, or roughly half, of its automotive manufacturing jobs and 3,000 indirect jobs accounting for $350 million in gross state product.
  - Losses in manufacturing have been offset by growth and knowledge-based industries.
  - Delaware has the highest concentration in the financial services employment among 50 states at 10.7% of all nonfarm jobs.
- **Chemicals make up over 40% of Delaware's total annual exports at $2.3 billion. Other leading export industries are computer/electronic products ($597 million) and transportation equipment ($561 million)**.
- **Although less concentrated than in Greater Wilmington, Lower Delaware has a fair share of industries involved in chemicals manufacturing and petroleum distribution and transportation, especially around Dover and Seaford.**

The overall Maryland economy relies heavily on government and technology; Delmarva areas are driven by agriculture and hospitality

- Maryland will return to pre-recession peak employment levels in the third quarter of 2013 thanks to a cushion provided by federal government and private sector jobs.
- The federal government is the largest employer in Maryland with 19.8% of total nonfarm employment.
- With the sequester in effect, the federal government has shed jobs, but this has been somewhat balanced by state and local governments job gains.
- Over the next 10 years, the professional/business services sector will continue to grow and replace the public sector as the largest employer.
- Scientific and technological research plays an important role in Maryland's economy. The state is home to a number of internationally recognized federal research agencies, including the National Institutes of Health, NASA's Goddard Space Flight Center, and the National Oceanic and Atmospheric Administration.
- Maryland is also home to growing biotechnology, telecommunications, and computer-science industries, especially in the I-270 corridor. Maryland is among the top 10 states in terms of concentration of high-tech employment, and it is among the top 3 in biotechnology.
- **Leading Eastern Shore industries include agriculture, fishing, and leisure/hospitality services. Agriculture is supported in part by increasing trade to emerging economies.**
- **Salisbury is a regional center for petroleum and chemicals distribution.**

The Virginia economy is highly diverse, helping to withstand the sequester; Delmarva areas are mostly concentrated in agriculture.

- Economic growth is expected to continue in 2013, with 1.1% growth in employment and 1.2% growth in gross state product.
- The federal sequester has hurt the Virginia economy, particularly in federal government employment and spending. This primarily affects Northern Virginia, but also other areas with high levels of economic linkages to the defense sector.
- The private service economy remained relatively unaffected as financial (4.0% y/y), education/health (3.0% y/y), and leisure/hospitality service (1.6% y/y) sectors all registered above-average growth.
- Professional and business services will recover fastest and expand vigorously.
- Virginia is home to over 20% of the national workforce in both tobacco and shipbuilding. Other major employers include the tourism, coal mining, and furniture manufacturing industries.
- Virginia has the fifth largest concentration of high tech companies (mostly in Northern Virginia) in the US. The sector is at risk, however, due to declining investment trends in information technology.
- **Delmarva counties are mostly concentrated in agriculture, following the trends observed in Maryland's Eastern Shore (and Lower Delaware).**

Shale extraction in Western PA and petroleum and chemicals agglomerations in Eastern PA share critical linkages with Northern Delmarva

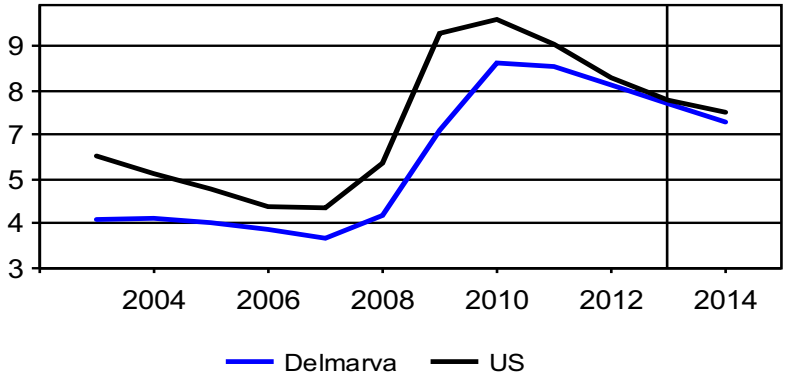
- Pennsylvania's economy is expected to add jobs at a 1.3% CAGR between 2013 and 2018. This growth rate would rank Pennsylvania among the lowest of all states.
- Pennsylvania's population growth is expected to remain below the national average, limiting job growth.
- The construction sector will provide a boost to overall employment over the next five years due to housing recovery and growth in natural gas drilling.
- **Continued development of the Marcellus Shale natural gas deposit, and eventually the Utica Shale, will provide jobs in the mining industry.**
- **The state may also attract jobs in industries that can benefit from natural gas supplies, either through low-cost energy or as feedstock.**
- **Chemicals were Pennsylvania’s top export category in 2012, accounting for one-fifth of total exports and valued at more than $7.7 billion.**

Southern New Jersey is also an important part of the N. Delmarva/SE PA chemicals agglomeration, especially for pharmaceuticals

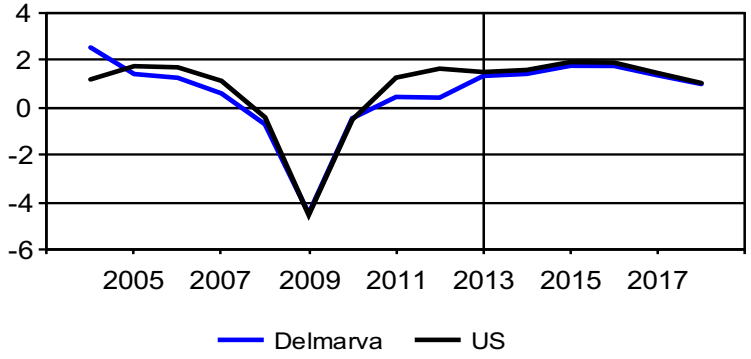
- After four years of job losses (from 2008 to 2011) New Jersey will experience modest but steady job growth through 2018 of 1.3%.
- New York firms eager to escape high costs are relocating to New Jersey in search of lower rents.
- The state also still has a large telecommunications industry, including both services providers, such as AT&T and Verizon, and equipment manufacturers, such as Lucent Technologies.
- New Jersey has an extensive multi-modal freight and passenger transportation network, centered on Newark International Airport and Port Newark/Elizabeth. Nearly 10% of the state's workforce is employed in the transportation, warehousing, and wholesale trade industries.
- South New Jersey has strong presence in tourism, fishing, and **chemical manufacturing**.
- **New Jersey maintains a diverse base of manufacturing industries. The state has the greatest concentration of pharmaceutical firms in the world.**

Overall, Delmarva has experienced low unemployment for a decade, but jobs, income, and wage growth are slowing versus the US

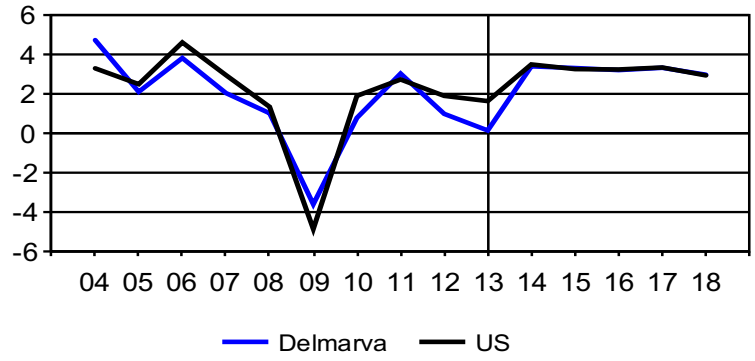
Unemployment Rate
(Percent)



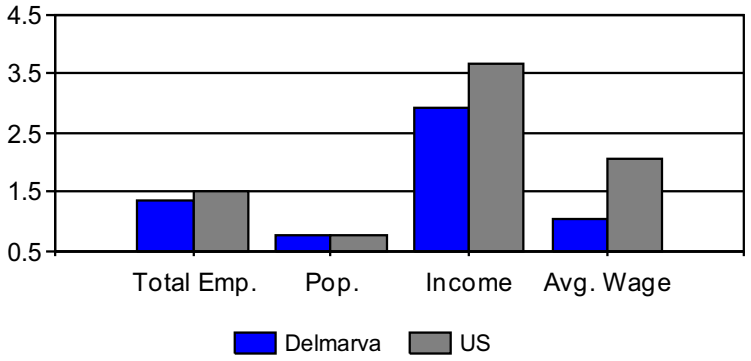
Total Employment
(Percent change, annual rate)



Real Personal Income
(Percent change, annual rate)

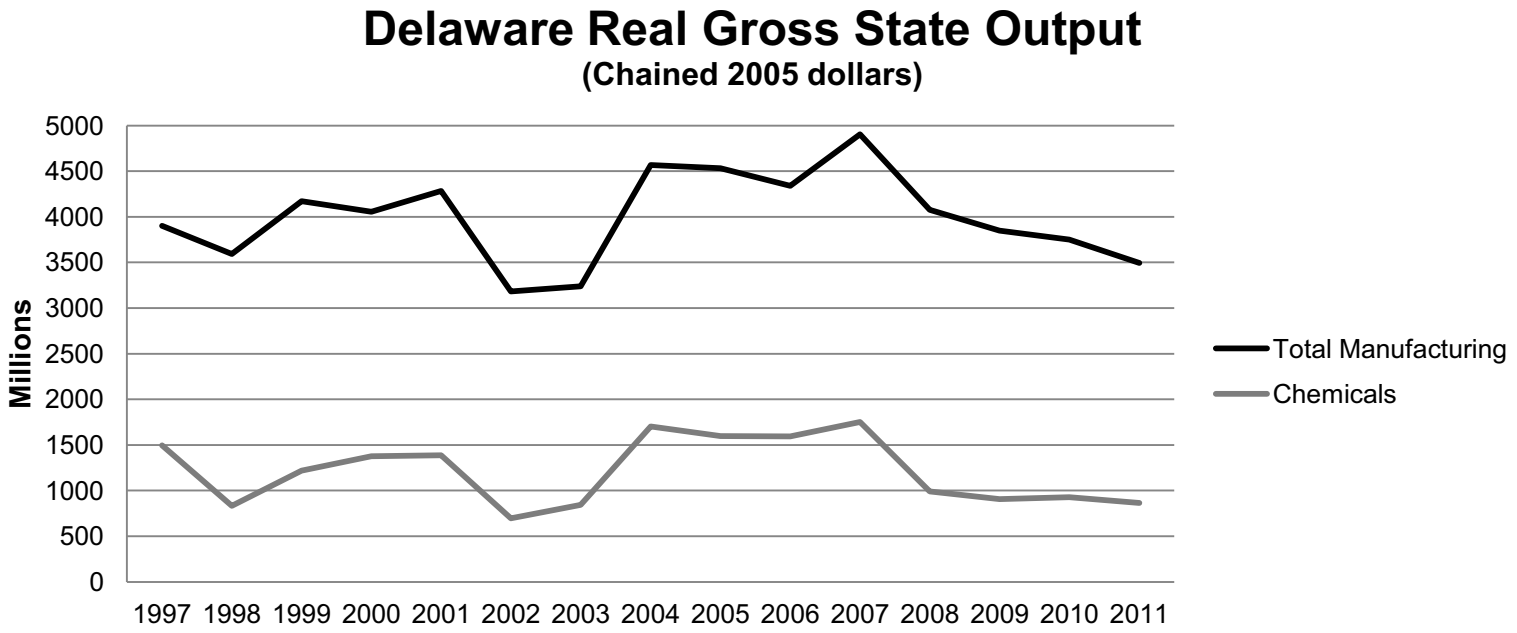


Growth Relative to US Average
(Average annual percent change, 2012 to 2014)



The chemicals industry in Delmarva is essentially the key driver of manufacturing sector performance

- Delaware's economy accounts for 77% of total output on the Delmarva peninsula, thus serving as a good proxy for the region.
- Chemicals output is highly influential to total manufacturing output in Delaware. A shale-driven rebound in for the chemicals industry would fuel a revival in regional manufacturing.



Transportation is critical to Delmarva jobs and provides the infrastructure assets to support petroleum & chemicals agglomerations

- Trade and Transportation is Delmarva's largest employment sector, accounting for 19% of total Delmarva payrolls.
- Over the course of the Great Recession, this sector lost 10,000 jobs (2007-2009).
- Trade and transportation is very sensitive to economic fluctuations.

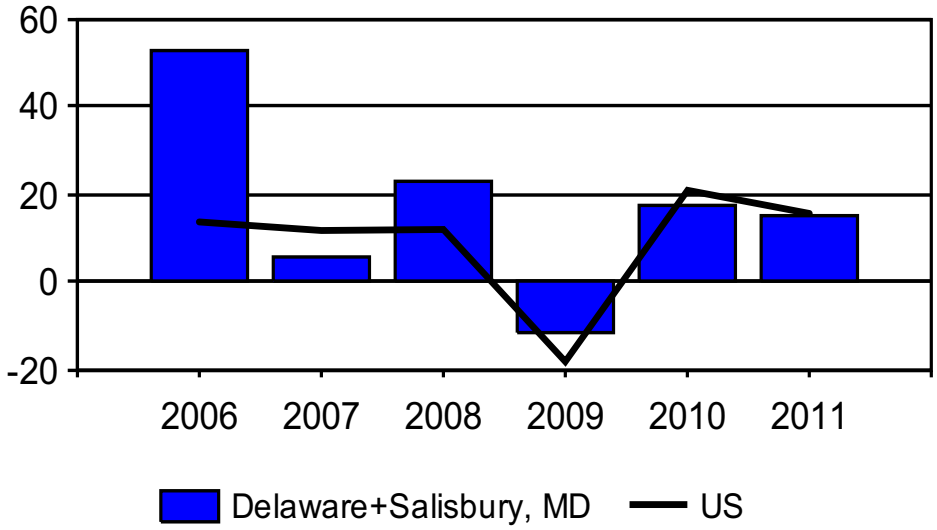
	2007	2008	2009	2010	2011	2012	2013
Delmarva							
Total Employment (Thousands)	632.2	627.7	599.6	596.9	599.6	602.1	610.1
Percent Change	0.6	-0.7	-4.5	-0.5	0.4	0.4	1.3
Trade, Transportation, Utilities (Thousands)	120.8	119.0	110.7	110.2	110.9	111.3	109.9
Percent Change	0.1	-1.5	-7.0	-0.5	0.7	0.4	-1.3

- The trade and transportation sector is critical to the chemicals sector and vice versa. The industry supports raw materials input, logistics, and transport of final products to domestic and foreign markets.

Exports are also critical to the Delmarva economy, and emerging markets will drive demand for new chemicals manufacturing

- Exports helped lead the Delmarva economy out of the Great Recession
  - Delmarva's export growth was twice the national rate from 2006 and 2010.
  - Key commodities: chemicals, electronics, transportation equipment, machinery
  - Key destinations: Canada, China, UK, Japan

Total Exports
(Percent change, annual rate)



Summary of Delmarva economic trends

- Northern Delmarva:
  - Chemicals and petroleum refining are highly important drivers of regional manufacturing, but have lost ground to financial and personal and business services in recent decades.
  - Increases in industrial production, growing foreign demand, and declining raw materials and energy costs point to a potential rebound for chemicals manufacturing after decades of decline.
  - Trade and transportation is poised to rebound from the Great Recession, supported by increased industrial production and international trade.
- Southern Delmarva.
  - Agriculture, poultry, and food processing industries could benefit from increased consumption in the developing world. This will also support growth in transportation and logistics industries.
  - Tourism is a very important, but highly cyclical, and should benefit from economic recovery.
  - Government spending impacts Dover directly via state government, Dover AFB, and supporting industry; and tourism indirectly (i.e., spending from residents in Metropolitan DC)
  - Although concentrated in Northern Delmarva, chemicals and petroleum supply chains extend to areas in Southern Delmarva, particularly near Dover, DE; Salisbury, MD; and Seaford, DE. These areas could also see benefits from a revival in regional chemicals manufacturing.

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Key external factors impacting Delmarva economy and the chemicals industry

- Shale oil, gas, and non-gas liquid (NGL) production, especially in Marcellus/Utica plays
- Re-activation of regional petroleum refining
- Panama Canal expansion
- Re-shoring of manufacturing
- Environmental regulations

Shale oil, gas, and NGL production offers new economic development opportunities

- Marcellus Shale natural gas exploration recently slowed due to a drop in natural gas prices. As prices recover, however, gas-directed drilling in the US lower 48 states will rebound by late 2014.
- Eastern Pennsylvania, New Jersey, and Delmarva will benefit from cheaper energy, raw materials, and energy product transportation.
- The growth in natural gas production and demand is coming partly at the expense of the coal industry, as domestic energy plants shift to gas-fired generation. Some of the lost domestic demand is being offset by coal exports, notably to China.
- Since coal dominates rail freight in the United States, many rail routes will lose service. Rapid development of petroleum, natural gas, and NGLs coupled with insufficient pipeline supply, however, is currently helping to keep up demand on many of these routes.
- Industrial gas demand remains a source of growth, with significant investments in new ammonia, methanol, and ethylene facilities under way near Philadelphia.
- **Delmarva is poised to take advantage of increased natural gas production if it can modernize facilities and distribution systems.**

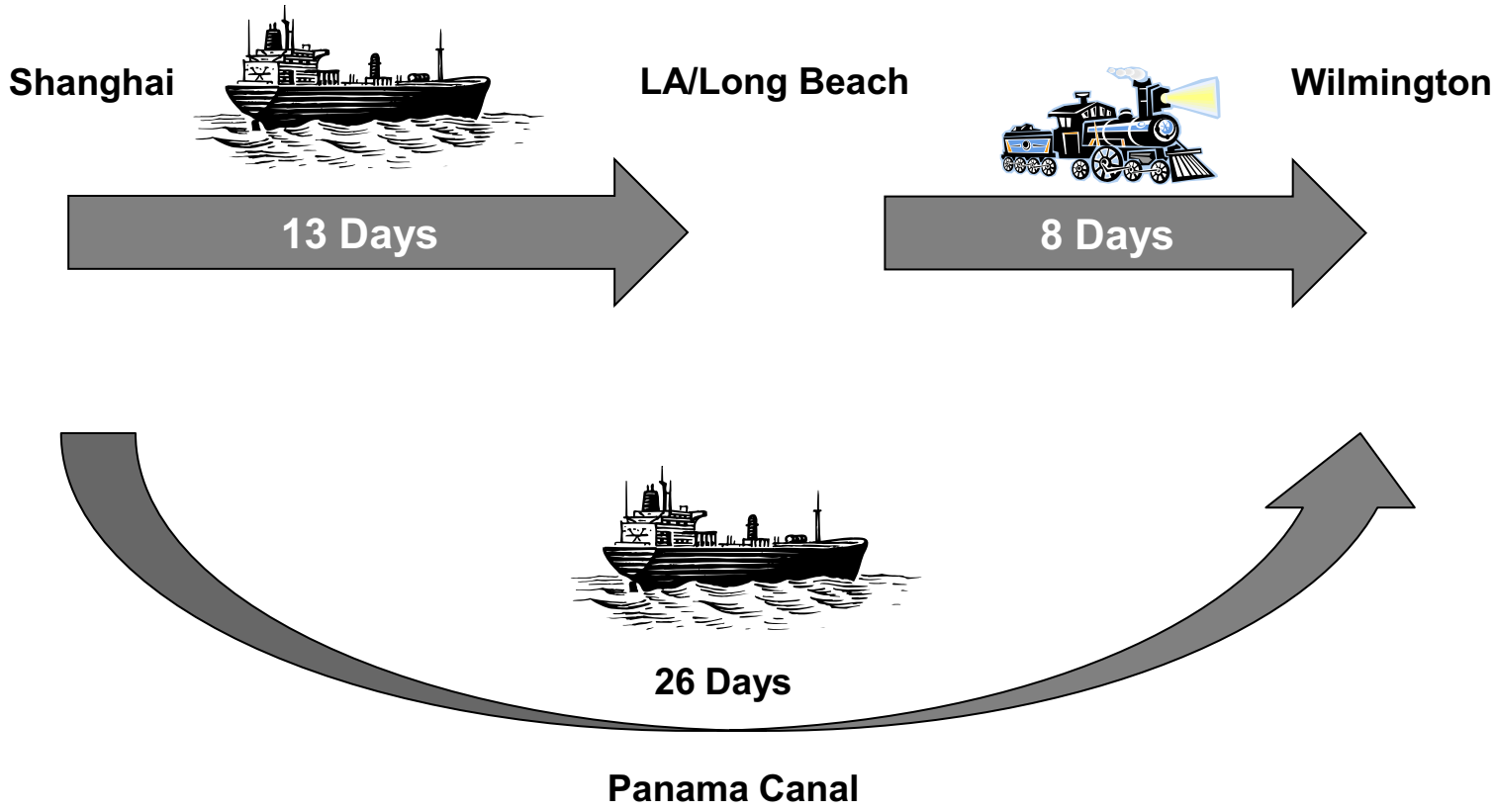
Growth in mid-Atlantic crude oil and regional refining provides opportunities for Delmarva petroleum and chemicals manufacturing

- Existing refining capacity in the Philadelphia region currently processes crude oil coming from the Bakken formation in North Dakota via by rail. Products are for both domestic use and export.
- The infrastructure for processing crude in Delaware Bay is plentiful, but refineries require modification to handle Bakken shale.
- Oil refineries are along the Delaware River south of Philadelphia, close to Wilmington. They are located in Delaware County, PA
  - Former Sunoco Refinery, Marcus Hook, PA
  - Monroe Energy LLC, Trainer, PA
  - Braskem PP Plant, Marcus Hook, PA
- Crude oil is being shipped into the Southeast PA/Northern Delaware area on 120-car unit trains, and refineries are struggling to handle trains of this size. There is a need for rail capacity to handle these new trains.
- Lack of regional pipeline infrastructure limits the advantages for handling Bakken crude in Northeast vis-à-vis the Gulf Coast. **However, existing refining capacity on the Delaware Bay combined with Marcellus development, facilities modernization, and rail and/or pipeline investment could improve the attractiveness of the region for oil refining.**

The Panama Canal expansion will affect vessel sizes, potentially requiring larger berths and channels for the largest tankers

- The Panama Canal expansion will impact global goods movements, allowing larger shipments and greater economies of scale to reduce per-unit/ton costs. Completion is scheduled for 2015.
- The new locks will permit the passage of container vessels with up to 12,500 TEUs, as well as larger oil and gas tankers (VLCCs and VLGCs, respectively), bulk cargo vessels, and vehicle carriers.
- Shipments from China to East Coast through expanded Panama Canal will still take several additional days compared to rail trans-shipment via West Coast ports, but freight costs will be about 33% lower.
- Of the major US East Coast ports, only Norfolk and Baltimore have the requisite 50-foot depth channel to handle the largest container vessels. New York and Miami will finish dredging by the time that the new locks are complete.
- The Delmarva region, especially in the north, will likely experience spillovers in (mostly) through traffic due to increased container volumes on the East Coast. This could create congestion of regional road, rail, and intermodal networks, but will have a less direct effect on regional port infrastructure (the Port of Wilmington does not handle containers).
- **The Port of Wilmington is closer to the Atlantic Ocean than the Port of Philadelphia, making it a logical location for petrochemicals and plastics originating in the study region.**
- **Although the existing 40-foot channel will not allow passage of larger Post Panamax ships to either port, dredging is underway to increase the Delaware River channel to 45 feet (by 2017). This should support most chemicals, product, and gas vessels.**

On average, the LA/Long Beach land bridge saves five days from Shanghai to Wilmington, but costs nearly 50% more



Re-shoring of manufacturing to North America is occurring and points to a recovery in chemicals manufacturing

- Manufacturing of durable goods is on the rise in the US. Many industries that once led the off-shoring of heavy manufacturing are now bringing that production back to the US and other parts of North America, in particular Mexico. The rationale is:
  - Aligning design and production in consumer markets to better customize products to local conditions.
  - Streamlining supply chains and reducing transportation costs of finished products.
  - Lowering the global risks associated with overseas manufacturing.
- Car manufacturing is possibly the most high-profile industry moving manufacturing back to North America, especially Mexico and Southeast U.S.
- The implications of re-shoring for Delmarva are not yet fully apparent, as this trend is still very much developing. However, Automotive manufacturing is not expected to return as strongly to the Northeast/Mid-Atlantic.
- **ILC Dover recently moved over 100 manufacturing jobs from Mexico to Delaware. If this becomes a trend, then Delmarva will be well positioned to benefit from expanded regional chemicals manufacturing.***

*http://www.areadevelopment.com/newsItems/1-18-2013/ilc-dover-relocates-manufacturing-facility-sussex-county-delaware2347934.shtml

Environmental regulations support increased natural gas production, creating cheap petrochemical feedstock byproducts

- The combination of environmental regulation and cheaper gas is forecasted to reduce coal's share of US energy generation from 42% to 35% by 2020.
- The EPA is currently considering rules regarding ozone-affecting emissions (SO_x and NO_x), mercury, the treatment of ash waste, and the use of cooling water in energy generation. Final rules are expected by 2015.
- More stringent rules could lead to the shuttering of more coal-fired generation plants. Many companies are shuttering old coal-fired plants and replacing with gas-fired and alternative energy generation facilities.
- The primary impact of EPA regulations on Delmarva might be declining rail volumes to and from coal-fired generation plants in Delmarva peninsula. If coal-fired energy production declines significantly, Norfolk Southern might be challenged to continue regular service to central and southern Delmarva.

Advantages for Wilmington and Delmarva

Delmarva has some important competitive advantages, including proximity to large metro areas such as New York, Philadelphia, and Baltimore-Washington, D.C., but lower taxes. Other key advantages include:

- An above-average share of highly skilled scientific and technical workers
- A tradition of technical development and innovation
- Modest but steady population growth and a low cost of living
- A favorable regulatory climate
- **High research and development spending driven by companies such as DuPont and AstraZeneca**
- **A critical mass of chemical, pharmaceutical, and biomedical companies**
- **Proximity to Marcellus offers regional chemicals manufacturing a potentially cheap, nearby source of high-volume, low-cost natural gas and NGLs**

Challenges for Wilmington and Delmarva

- Automation and consolidation in the financial industry could suggest longer-term challenges to employment in the professional and business services sector, which has for decades offset manufacturing decline.
- If austerity persists, transportation and defense industries, in particular, could face headwinds.
- Limited rail infrastructure and facilities to service 120+ rail cars could restrict opportunities to take advantage of transportation-supported economic growth.
- The depth of the Delaware Bay channel will preclude passage of larger vessels, limiting economies of scale in shipping. Most chemical tankers should still be able to pass through, but larger petroleum product tankers may not, at least until new dredging is completed.
- Pipeline infrastructure is currently inadequate to take full advantage of Marcellus NGL extraction. This investment will come, but the region will need to compete with manufacturing and transportation economies of scale of the Gulf Coast.
- **Most capital expenditures in the US petrochemicals manufacturing and distribution are likely to flow from the Gulf Coast due to existing supply chains, manufacturing agglomerations, and infrastructure.**

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  - US chemicals industry trends: Key products and feedstocks
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  - SWOT analysis
  - Possible interventions and current status
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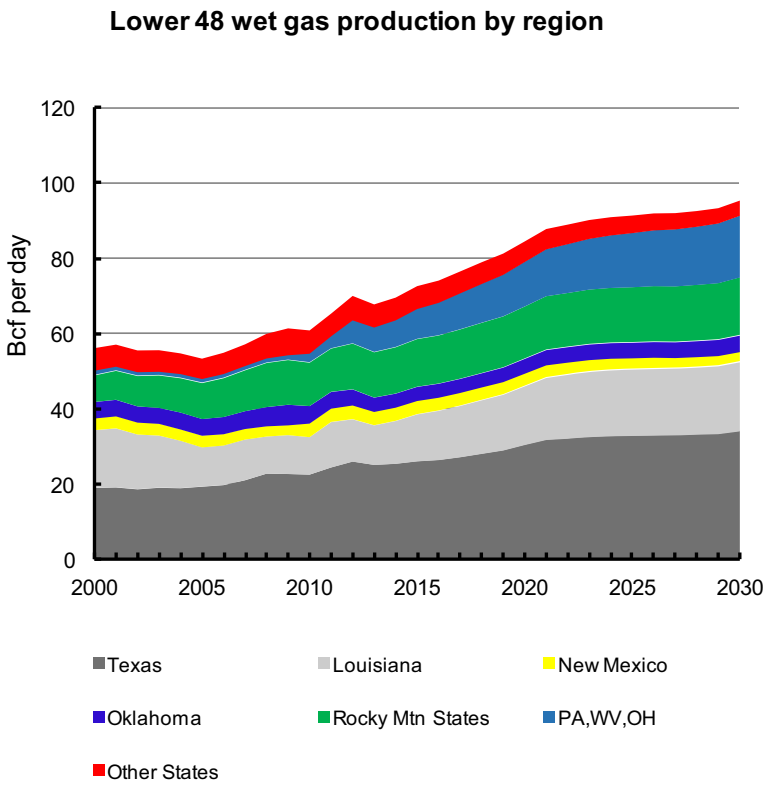
Key Findings: US chemical industry trends

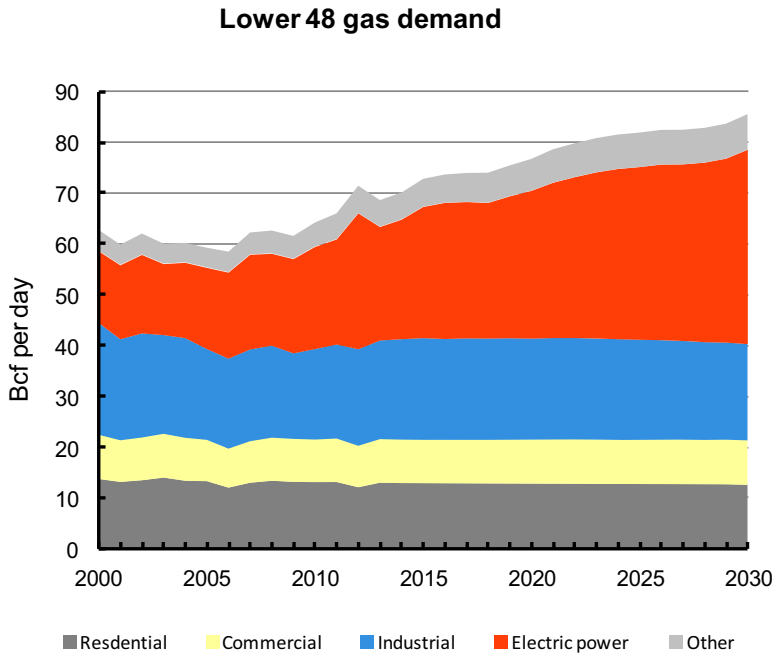
- The US chemicals industry faced declining production in the previous decade on account of over-supply of high-cost chemicals, declining demand, and no domestic feedstock price advantage. Off-shoring of manufacturing became more prevalent.
- The US chemicals industry has since rebounded to meet increasing demand (including exports) after decades of decline, fueled by cheaper crude oil and NGL feedstocks from shale and non-conventional hydrocarbon extraction.
- Ethylene and other petrochemicals production is helping to drive this turnaround. Ethylene, propylene, and other petrochemicals are the building-blocks for many final products, such as various plastics for manufactured products, packaging for products, and industrial uses (e.g., PVC pipes, etc.).
- Massive new investment in domestic ethylene cracking facilities will transform crude and NGLs into cheap, geographically proximate petrochemicals for export and to support domestic basic chemicals, plastics, and pharmaceutical industry manufacturing. Most plant investment will be in the U.S. Gulf Coast region.
- Pipeline development should displace rail for carrying most NGL feedstocks.

US natural gas



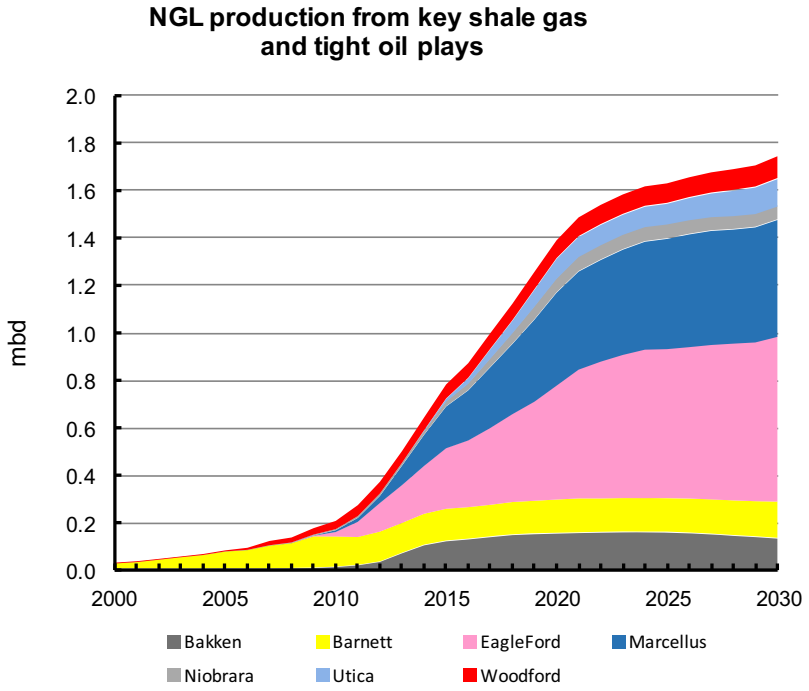
- Production is expanding quickly due to rapid development of shale gas resources.
- Forecasts are preliminary and subject to significant changes as the “unconventional” (i.e., shale) revolution continues to develop:
  - IHS’ present forecast for Lower 48 wet gas production anticipates that supply will grow significantly.
  - Also facing considerable uncertainty is how future supply in Canada and Mexico will develop.

US natural gas



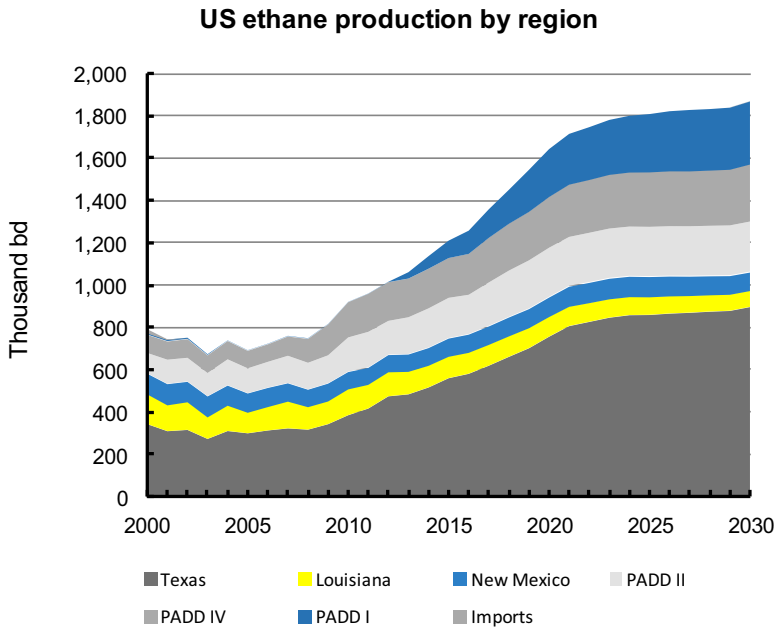
- While cheap natural gas demand is expected to grow substantially for use in electricity, little demand growth is expected elsewhere.
- Besides becoming a more cost advantaged feedstock for certain chemicals, natural gas will also help lower chemicals production costs (e.g., again, for electricity).

US natural gas liquids (NGLs)



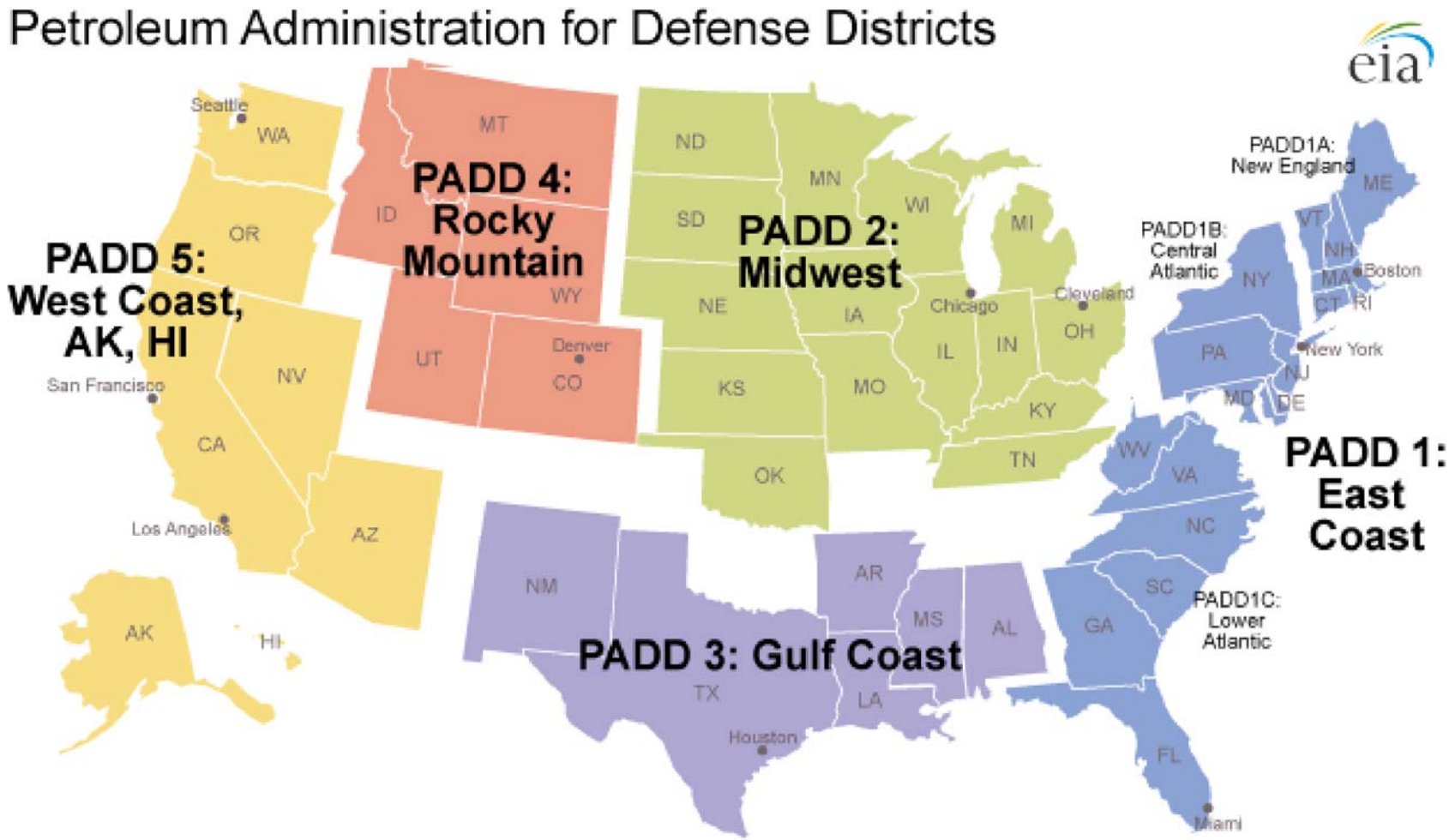
- NGLs are essentially an important byproduct of natural gas extraction.
- NGLs, especially ethane and liquid petroleum gas (i.e. LPG, which includes propane and butane), are key feedstocks for petrochemical production.
- Marcellus shale (and to a lesser extent Utica) in the Northern Appalachia region are expected to contribute significantly to US supplies of NGL.

NGLs - Ethane

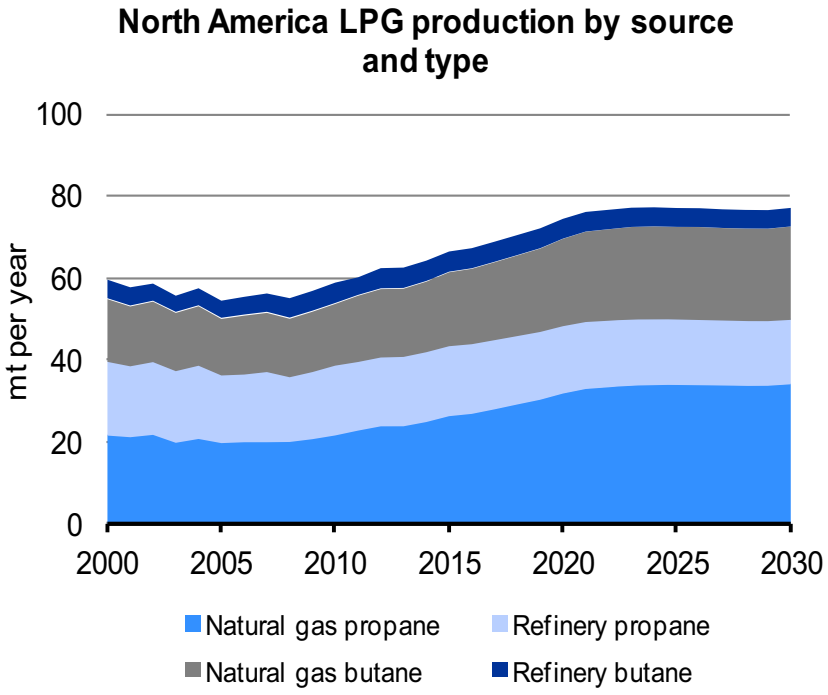


- Ethane and its derivatives are the highest-volume feedstock for petrochemical production.
- Production will expand in many regions—from both traditional and new regions, especially PADD I (East Coast), Central Atlantic (see diagram on the next page).
- Ethane is considered a key chemical feedstock because it is the precursor to ethylene, which is the highest volume chemical, globally and in the US.

PADD map



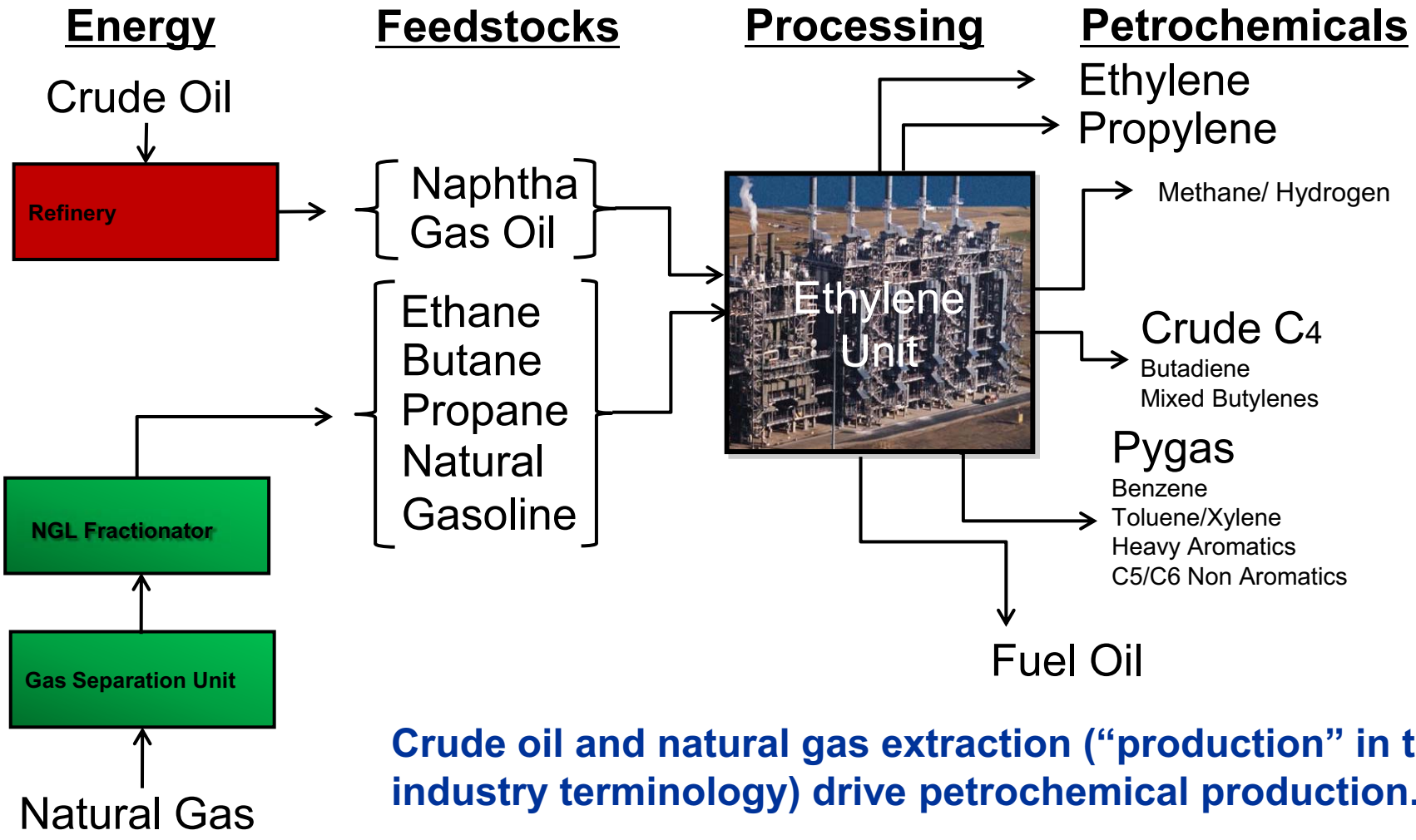
Liquid petroleum gas (LPG)



Source: IHS CERA.

- LPG supply is expanding rapidly owing to shale gas and tight oil development in North America.
- LPG is typically used for heating and cooking and some fuel and industrial uses, but also serves as a petrochemical feedstock.
  - Note: The specification for LPG in the North American heating market is 95% propane. Internationally, a mix of propane and butane is typical.
- Propane, especially, is a high-volume feedstock for basic chemicals production.

How natural gas and NGLs drive petrochemical manufacturing



Crude oil and natural gas extraction ("production" in the industry terminology) drive petrochemical production.

Ethylene capacity in North America is expected to grow rapidly in the current decade

- North American ethylene capacity increases to leverage advantaged ethane price points.
- Most of the investment will be on the Gulf Coast.
- Shell is planning an ethylene cracking unit in western Pennsylvania, which could provide cheap, local petrochemical feedstocks to help revive chemicals manufacturing in the Mid-Atlantic, including Delmarva.
- A new ethylene production facility in the greater Wilmington area (including Marcus Hook) is possible.

Summary of North American ethylene and derivative capacity additions

Projected North American. Ethylene and Derivative Capacity Additions (2012 - 2020)
(Thousand Metric Tons per Year)

Ethylene Capacity Additions		2012	2013	2014	2015	2016	2017	2018	2019	2020	Total Additions through 2020
Company	Location										
BASF/Total	Port Arthur. TX			180							180
ChevronPhillips	Cedar Bayou, TX						1000	500			1500
Dow	Taft & Freeport		386						1500		1886
Eastman	Longview, TX		90								90
Equistar	All Locations		121	310	90	363					884
ExxonMobil	Baytown, TX					750	750				1500
Formosa	Point Comfort, TX					200	600				800
Ineos	Chocolate Bayou	54	60								114
OxyChem	Ingleside, TX					550					550
Sasol	Lake Charles, LA								1000	400	1400
Shell	Monaca, PA						1000				1000
Westlake	All Locations		80	90	140						310
Williams	Geismar, LA	20	70	210							300
Braskem Idesa	Mexico					1000					1000
Nova	Sarnia				250						250
	Announced:	74	807	790	480	2863	3350	500	2500	400	11764
	Firm	74	807	790	140	2313	2350	500	2500	400	9874
Derivative Capacity Additions											-
	LAO		50	300				100	100		550
	HDPE				400	1100	651	375	125	375	3026
	LDPE				150	150	1120				1420
	LLDPE		68			450	1750	500	430	500	3698
	EDC		50								50
	EO				50	325	325				699
	TOTAL:		167.5	300	600	2025	3846	975	655	875	9443

Note: Highlighted figures indicate hypothetical capacity additions that have not been indentified or not confirmed by the indicated firms

The emerging US energy advantage is driving the chemicals manufacturing rebound

- US natural gas prices have declined while world crude prices have grown since the early 2000s. Though these differentials will likely narrow in the next few years, US natural gas should retain a significant cost advantages over the next five years and the foreseeable future.
  - US natural gas prices (per heating value, i.e. British thermal unit, BTU) were four times those of crude oil in 2000. The positions have since reversed.
  - Many producers in Asia and Europe use naphtha, from crude oil, as the basic feedstock for chemicals manufacturing.
  - US natural gas is now cheaper than all other world producing regions, except the Middle East.
- In 2000, US exports of ethylene, propylene, and vinyls accounted for only 2.5% (~2.5 million metric tons) of total production. That figure will likely increase to about 30% by 2025 to 12.5 million metric tons.

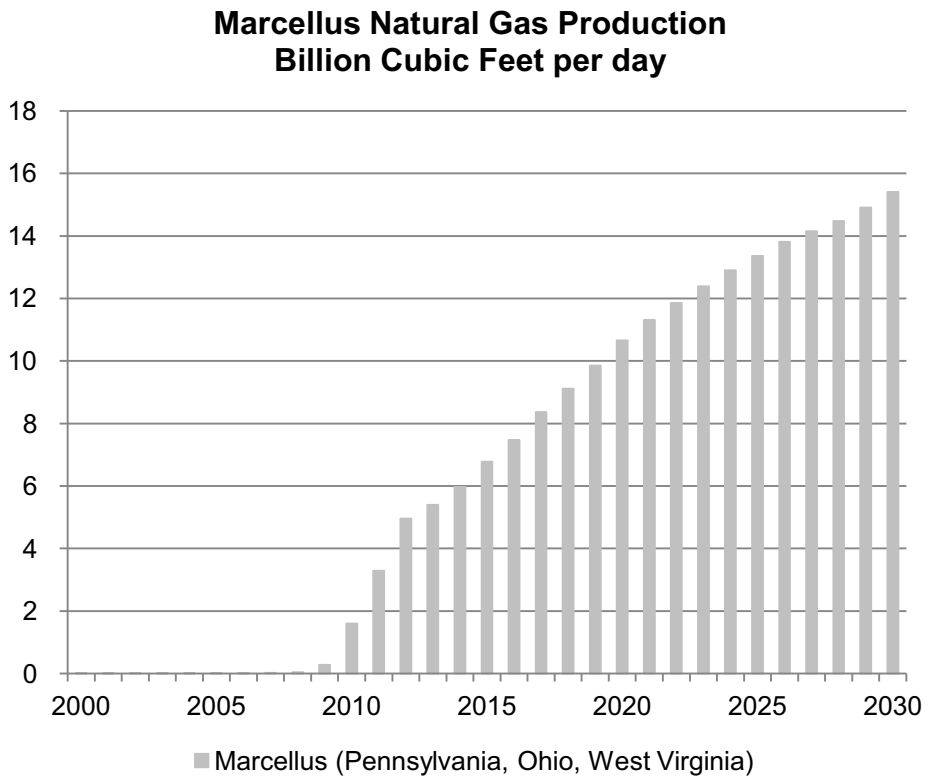
Emerging US chemical industry trends

- Investment in plants, equipment, and logistics.
- More NGL production and pipeline construction.
- More domestic production of ethylene and its derivatives.
- Eventually more domestic production of propylene and butadiene (from LPG).
- More chemicals production based on natural gas (including methanol, ammonia, and fertilizers).
- Greater exports of hydrocarbons and chemicals.
- More countries will develop shale, eventually providing competition in the long term.

Chemicals industry trends, continued

- Less NGL rail shipments, as pipeline infrastructure is developed.
- Less coal shipment, as natural gas-fired plants replace coal-fired plants.
- Less costly energy.
- Less polyethylene export to Mexico due to Mexican domestic production.
- Less co-product production (i.e., greater export of raw materials).

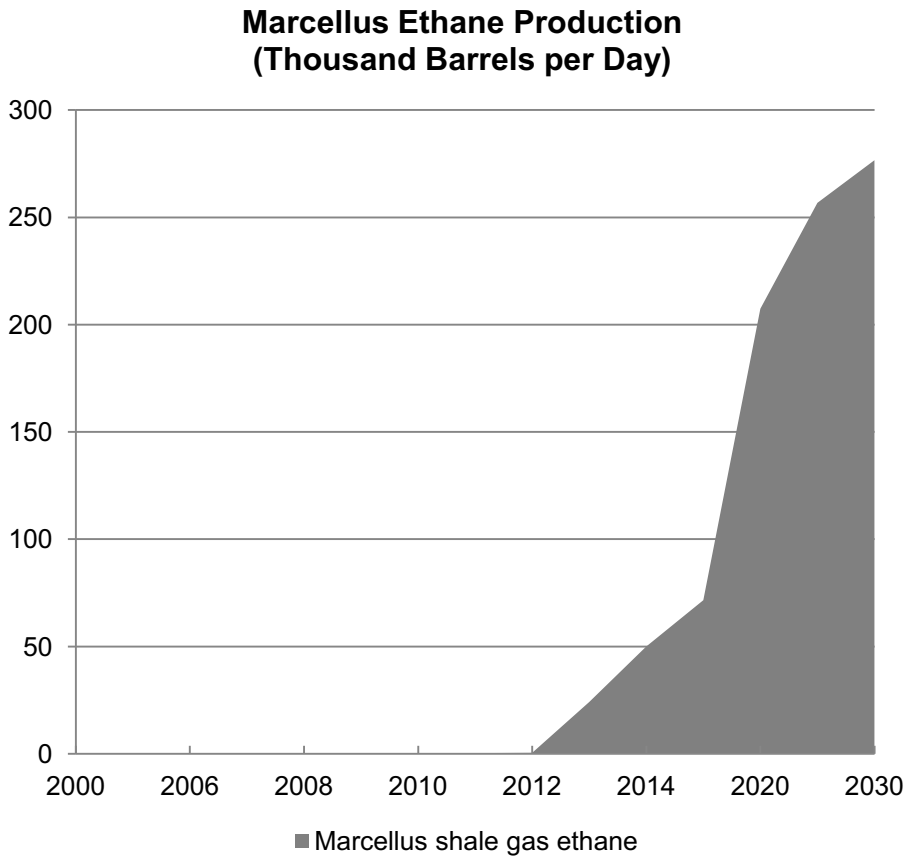
Marcellus natural gas and the Delmarva regional chemicals industry



Please note the caution regarding these "early days" forecasts, per the note earlier in this report.

- Production of natural gas is expected to grow rapidly in the coming decades as result of Marcellus extraction.
- Growth in Marcellus production will benefit domestic chemicals industries, especially in close geographic proximity if efficient delivery methods exist.

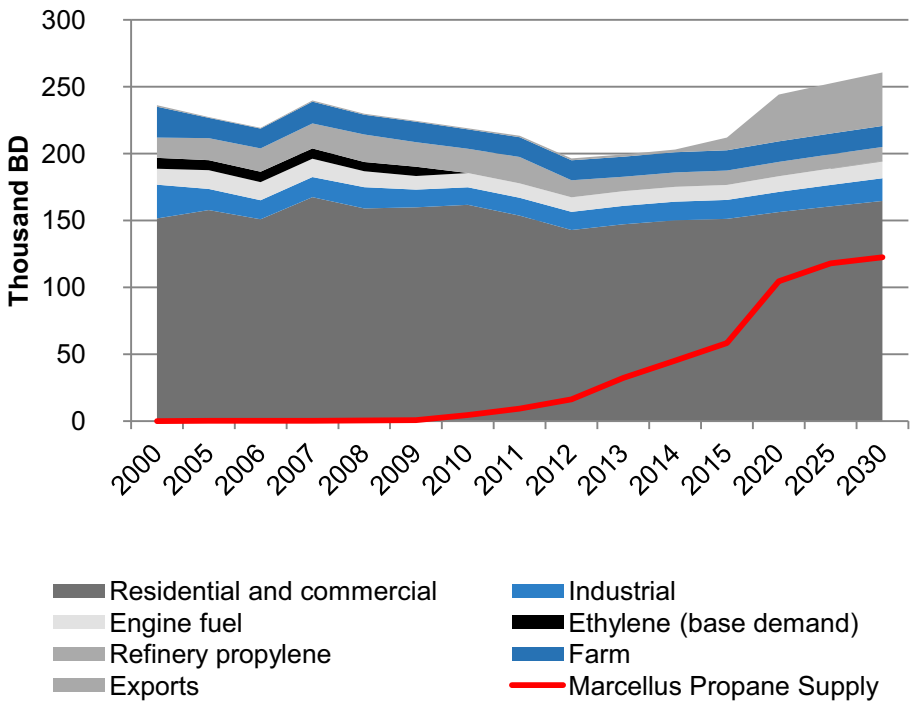
Marcellus ethane production



Please note the caution regarding these "early days" forecasts, per the note earlier in this report.

- Future ethane potential greatly exceeds actual current "recovery."
- The potential availability of such high volumes of ethane compared to demand will drive down volumes, providing a significant feedstock cost advantage for US manufacturers.
- If NGL pipelines can be developed towards Marcus Hook, Delmarva-region chemical manufacturers will enjoy significant cost advantages.

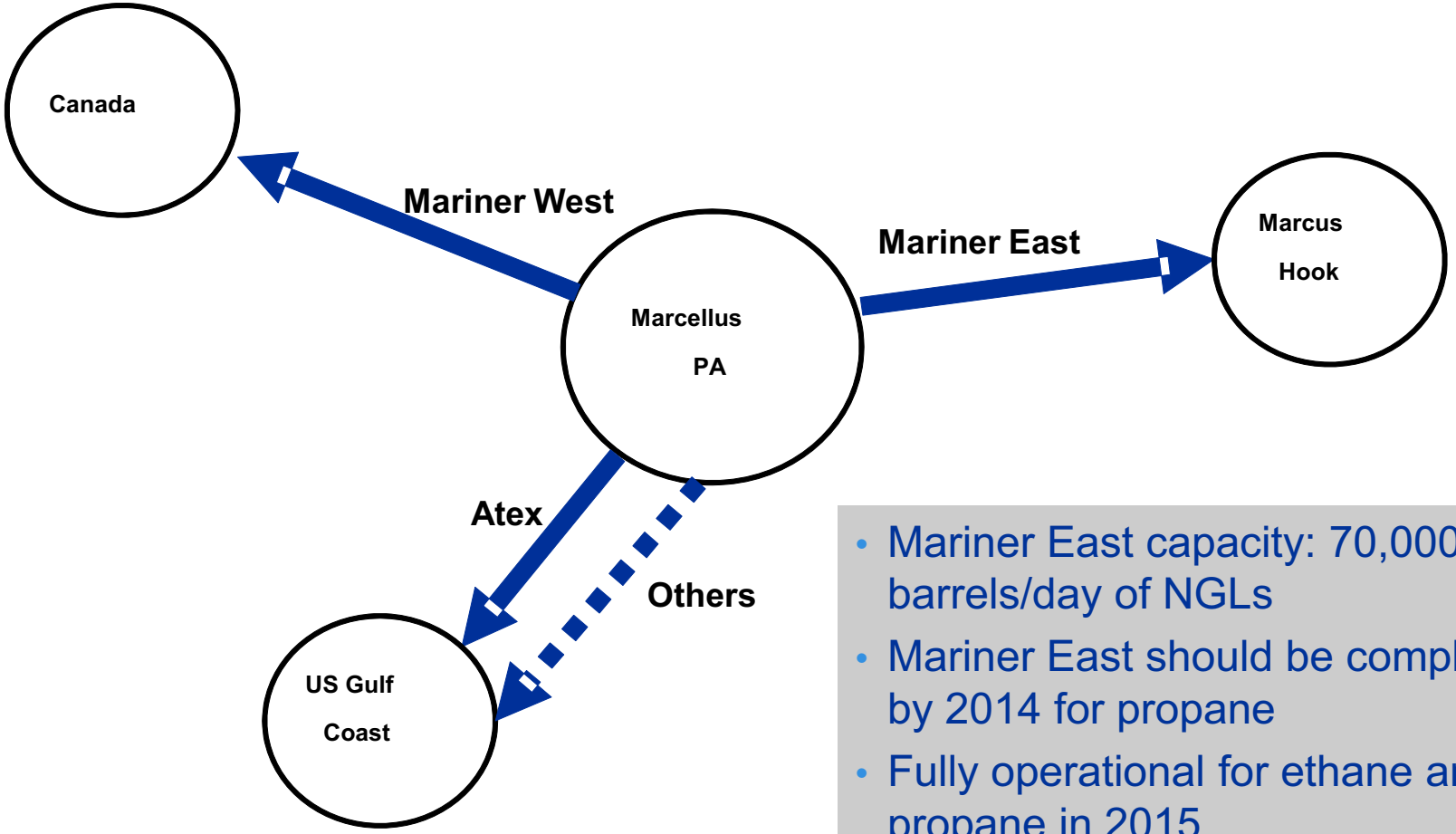
Marcellus propane production



Please note the caution regarding these “early days” forecasts, per the note earlier in this report.

- Rates of production of Marcellus propane production will far exceed growth in demand.
- The supply and demand imbalance will reduce the price of propane, which could support domestic propylene and polypropylene production and export.
- If the necessary pipeline infrastructure were developed it is conceivable that the Delmarva region could benefit from increased Northeast propylene and polypropylene production.

Likely NGL pipeline development and emerging ethane supply chains



- Mariner East capacity: 70,000 barrels/day of NGLs
- Mariner East should be completed by 2014 for propane
- Fully operational for ethane and propane in 2015

Key takeaways of the US chemicals industry landscape

- Due to the Shale Gas development and the resulting competitively priced hydrocarbon feedstocks, North America is expected to see renewed growth of ethylene capacity.
  - This will likely start to happen in earnest during the 2016-2020 time frame, during which North America will re-emerge as one of the top ethylene-producing regions.
  - The key feedstocks will be ethane and propane .
- Ethylene capacity additions of 7.6 million metric tons are expected during 2012-20.
- Additionally, given the economics, IHS expects that more projects may be announced in future, some by 2020 and others continuing as far forward as 2030.
- Demand is forecasted to grow by 11 million metric tons during 2012-20 at AAGR of about 4 percent. Domestic demand will not grow as fast as demand in developing regions, and low cost ethylene due to shale gas will enable North America to export. Key derivatives like polyethylene and EO/EG are easy to ship and have ready markets in Asia.
- Competitively priced propane may also allow growth in on-purpose propylene production in the U.S.
- While most of this new petrochemical investment and related infrastructure buildup will be in the US Gulf Coast region, the Northeast U.S., especially West Virginia, Pennsylvania, and Delaware, are thought likely to get a reasonable share of this development.

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Delaware chemicals industry: Key products and feedstocks

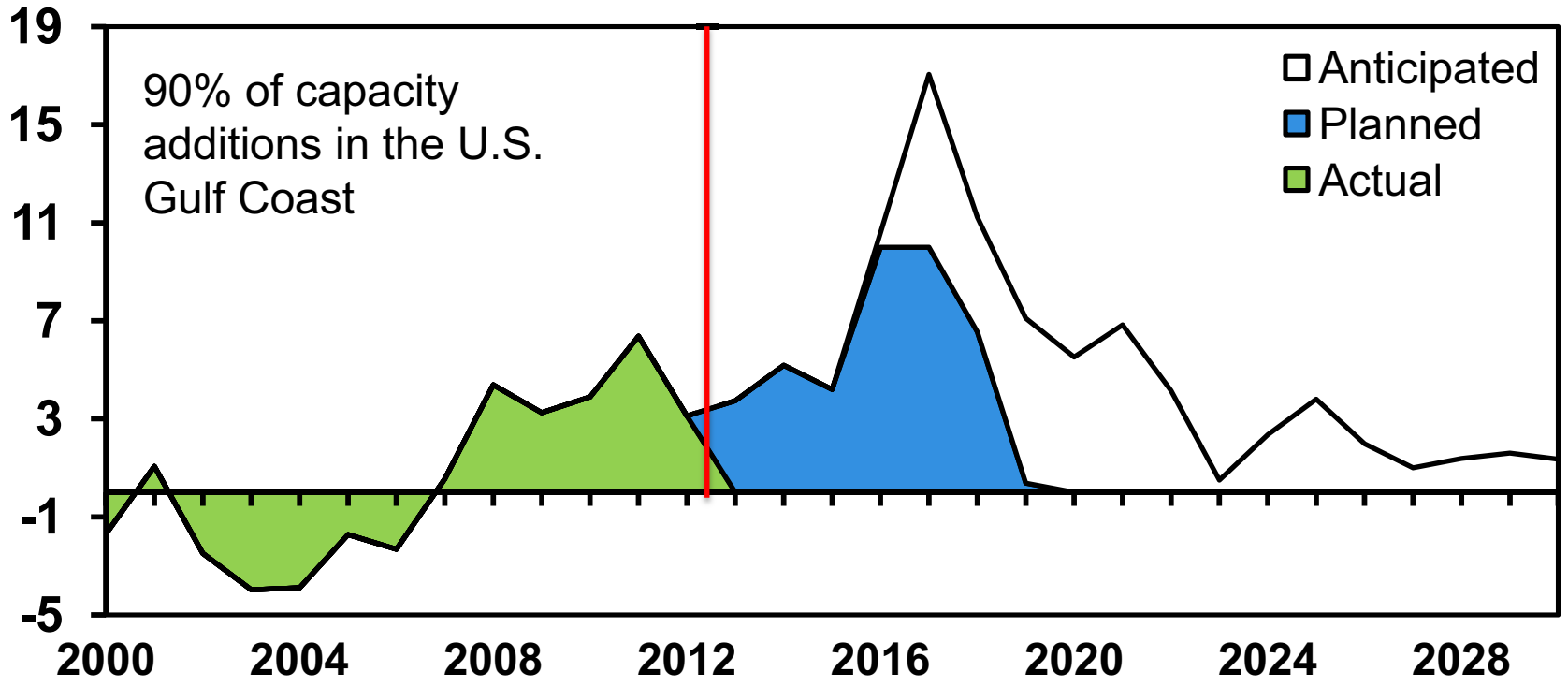
The following pages show IHS Chemical's current outlook for these chemicals. Note, however, that these forecasts are sensitive to various industry and economic variables and can change quite significantly from time to time. They are provided here only to illustrate the overall U.S. trends at a high level.

Key Findings: Regional chemicals products and feedstocks

- The Delmarva-area chemicals industry has increasingly focused on specialty chemicals, but still produces large volumes of some basic chemicals. Moreover, the regional chemicals industry requires other intermediate chemicals as inputs.
- Ethylene and propylene and their co-products are among the highest-volume chemicals produced and consumed, primarily as intermediates to other chemicals production. Proximity to cheap petroleum, gas, and NGL feedstocks is important for manufacturing these key commodities.
- Demand for numerous other commodities is growing worldwide, and many of these top chemicals are produced in the Delaware Bay area.

US net capacity changes in top 20 chemicals

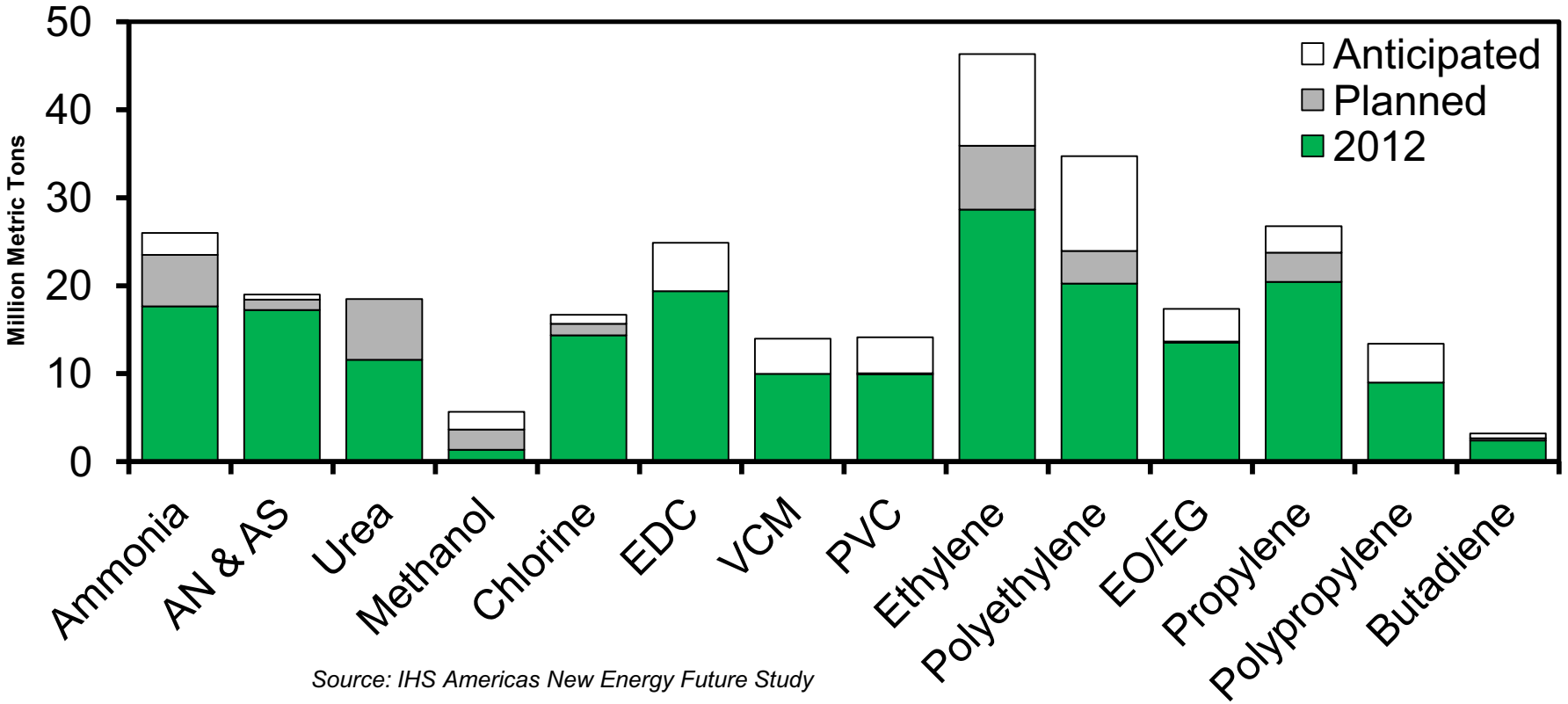
- 13 million metric tons of capacity have been added since 2010.
- Planned additions would add 40 million metric tons by 2018.
- Over 45 million metric tons of additional capacity are anticipated by 2030.



Source: IHS Americas New Energy Future Study

Top chemicals capacity expansion in the US

- The U.S. capacity impact is very broad.
- Ethylene and polyethylene production will lead the way.



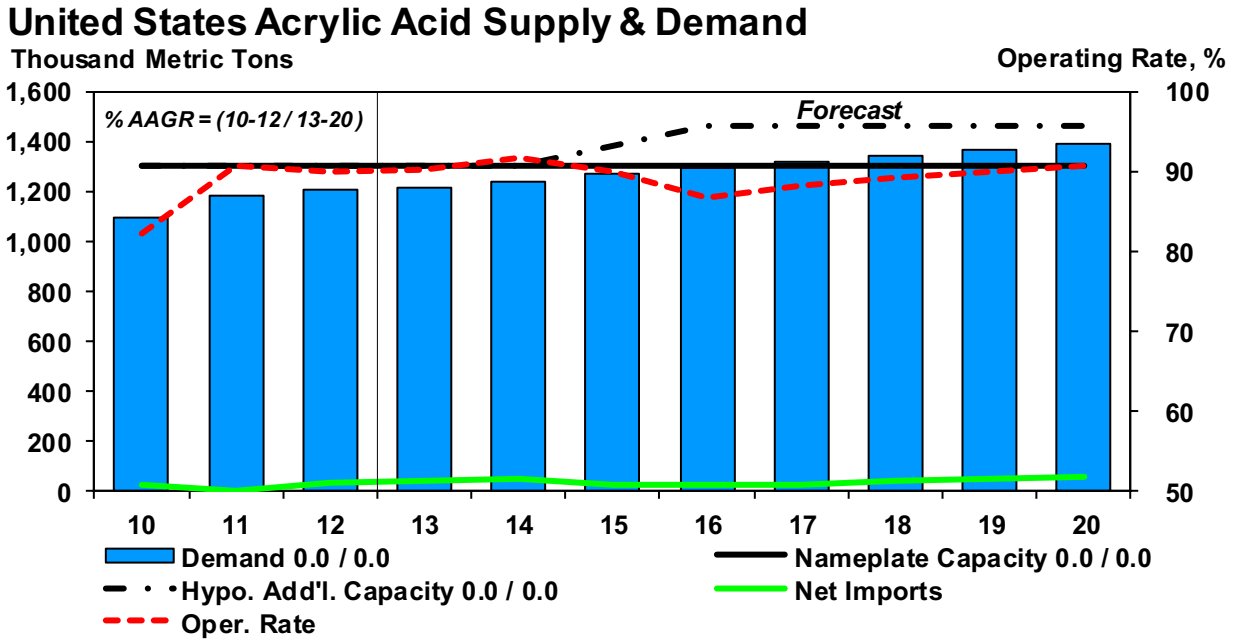
Source: IHS Americas New Energy Future Study

The key products and their feedstocks that are most likely to affect the Delaware markets and infrastructure are as follows:

- Acrylic Acid
- Benzene
- Caustic Soda
- Chlorine
- Ethylene
- Ethylene Dichloride
- Ethylene Oxide
- High Density Polyethylene
- Low Density Polyethylene
- Linear Low Density Polyethylene
- Monoethylene Glycol
- Nylon 6 & 6,6
- Polyester Bottle Resin
- Propylene Oxide
- Polypropylene
- Propylene (Polymer & Chemical Grade)
- Terephthalic Acid (PTA)
- Titanium Dioxide
- Polyvinyl Chloride (PVC)
- Vinyl Chloride Monomer (VCM)

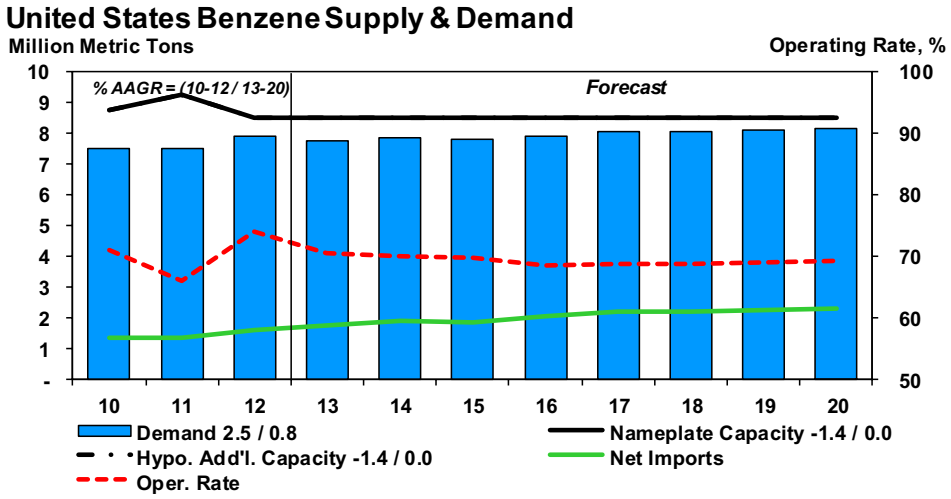
Note: Forecasts for supply and demand are current estimates and subject to change due to market conditions as well as substantial investments in production capacities

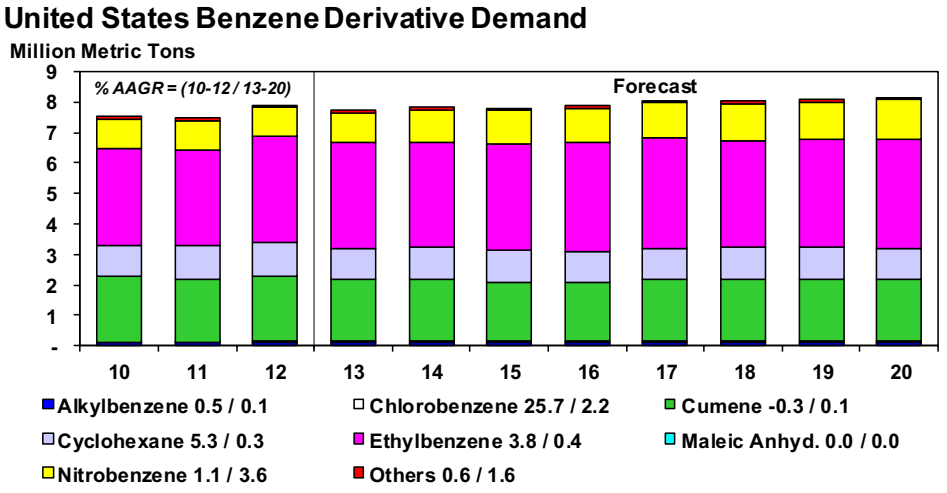
Acrylic Acid



- Some typical end-use products made from acrylic acid:
  - Coatings, paints, paper chemicals, adhesives and cements, and disposal diapers

Benzene

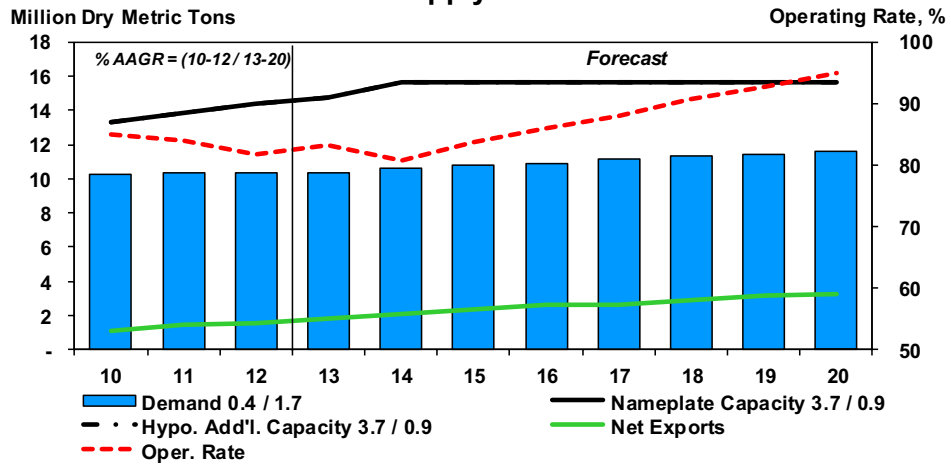




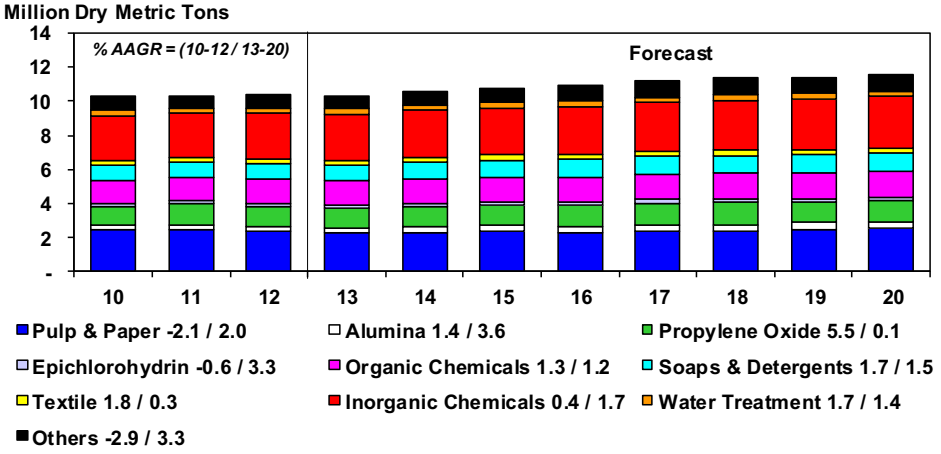
- Some typical end-use products made in part from benzene:
  - Molded parts, such as automotive parts, adhesives, home fixtures,
  - Bottles, pharmaceuticals, and medical/dental items.

Caustic Soda

United States Caustic Soda Supply & Demand



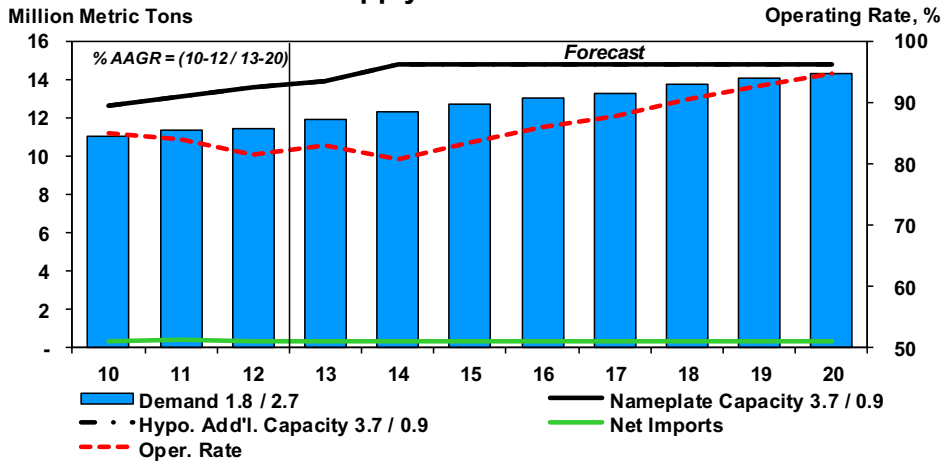
United States Caustic Soda Derivative Demand



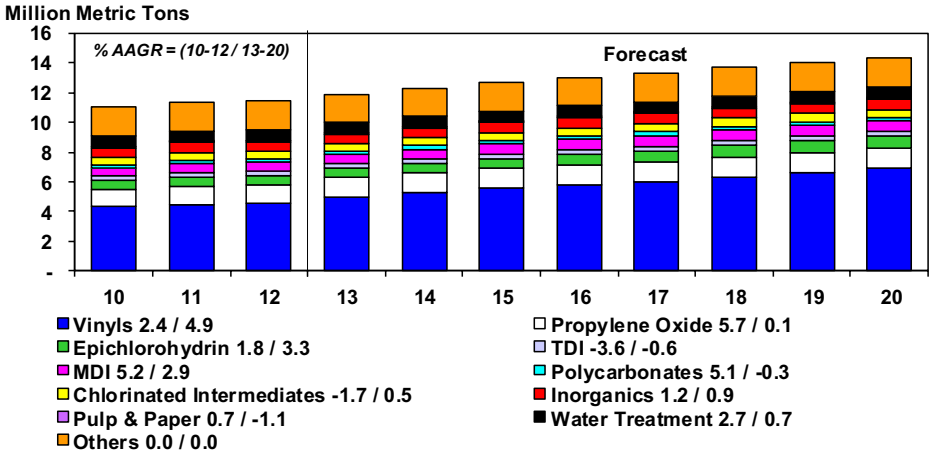
- Some typical end-use products made in part from caustic soda (i.e. sodium hydroxide):
  - Aluminum, paper making (pulping), detergents, oil and gas drilling muds, food processing and drain cleaners.

Chlorine

United States Chlorine Supply & Demand



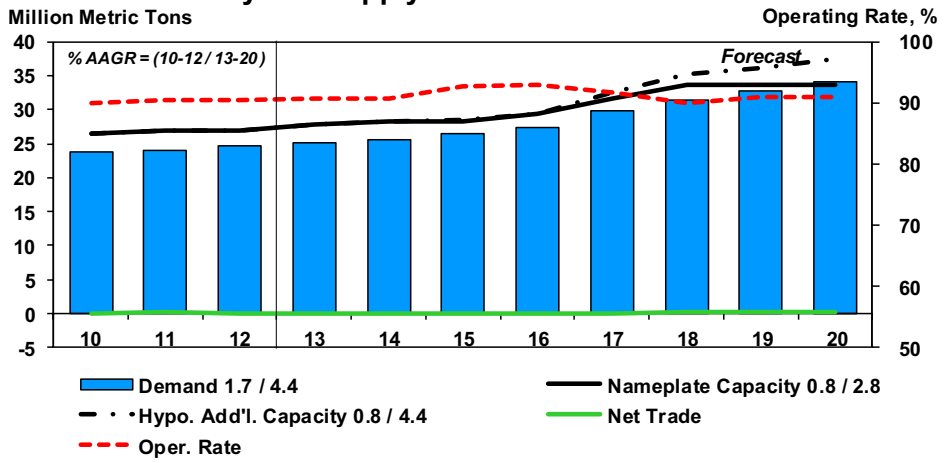
United States Chlorine Derivative Demand



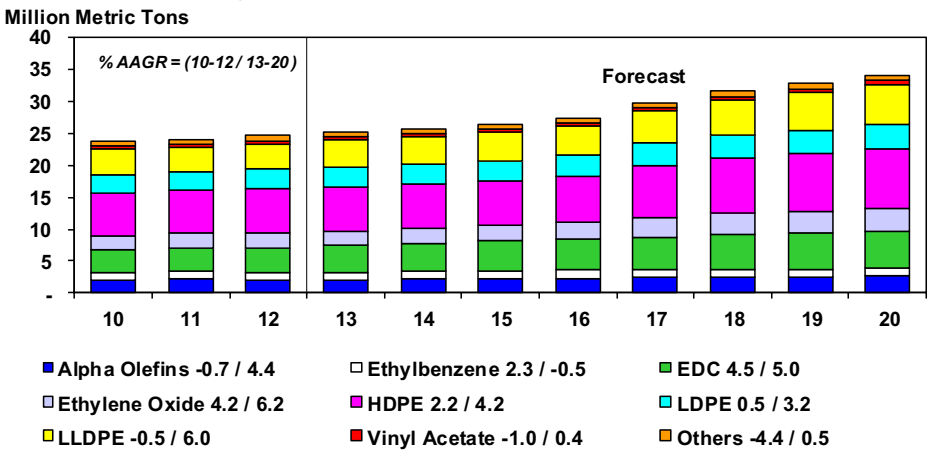
- Some typical end-use products made in part from chlorine:
  - Plastics (i.e. vinyls, polyinyl chloride) – used for pipes, window and door frames, fencing; paints, coatings, molded parts (consumer and commercial).

Ethylene

United States Ethylene Supply & Demand



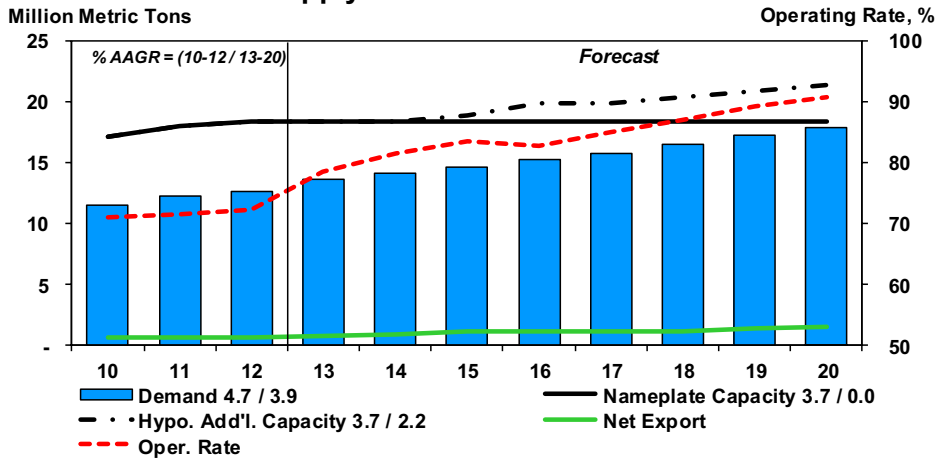
United States Ethylene Derivative Demand



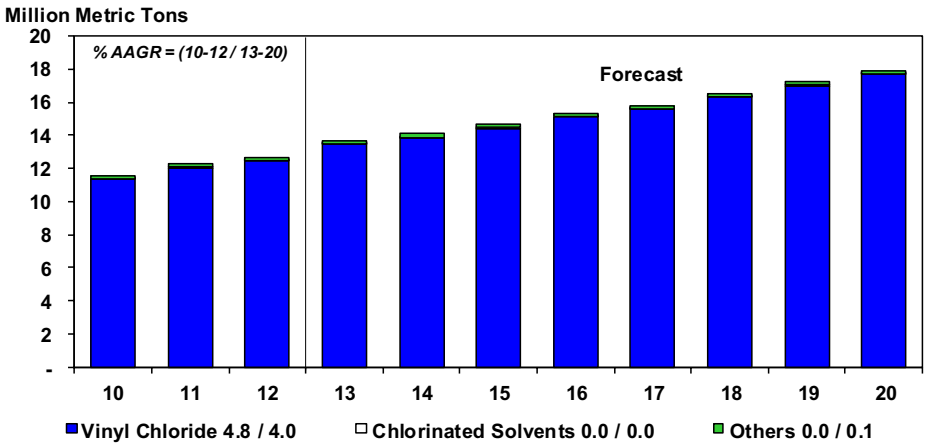
- Some typical end-use products made in part from ethylene:
  - Polyethylene (LDPE, LLDPE, HDPE) – bottles, plastic bags, piping, housewares, toys and many others; vinyls, detergents, adhesives, solvents, antifreeze, and many others.

Ethylene Dichloride (EDC)

United States EDC Supply & Demand



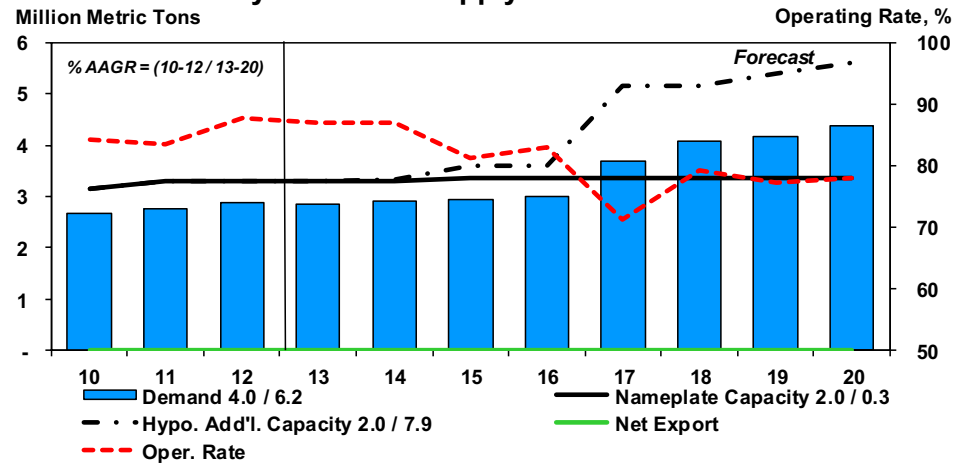
United States EDC Derivative Demand



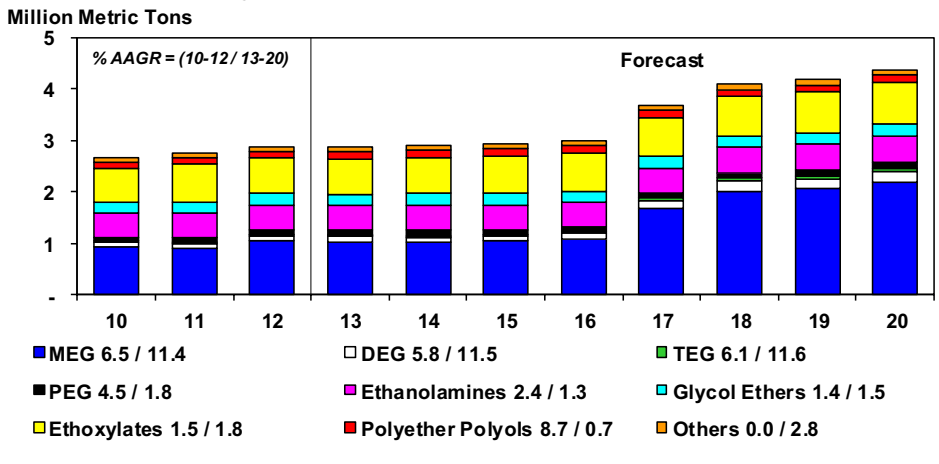
- Some typical end-use products made in part from ethylene dichloride:
  - EDC is made from ethylene and chlorine, primarily, and is a step in the vinyls chain to polyvinyl chloride (PVC), and thus is used to make such diverse products as pipes, window and door frames, fencing; paints, coatings, molded parts (consumer and commercial).

Ethylene Oxide

United States Ethylene Oxide Supply & Demand



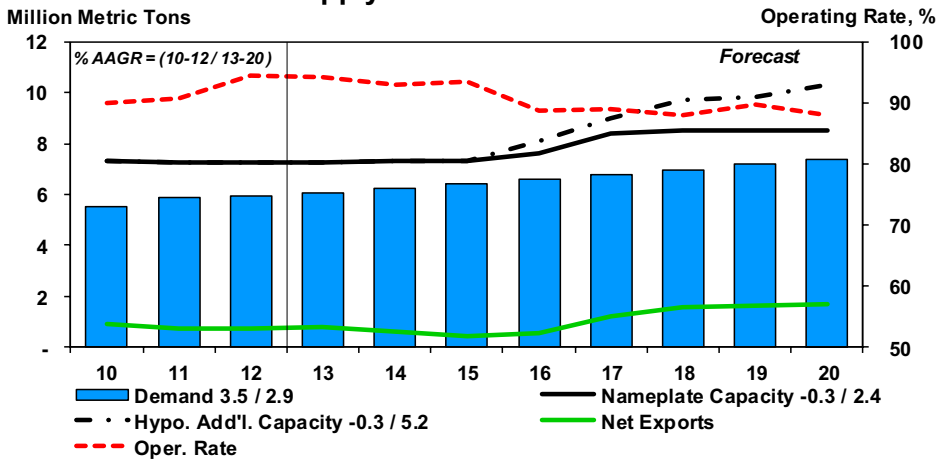
United States Ethylene Oxide Derivative Demand



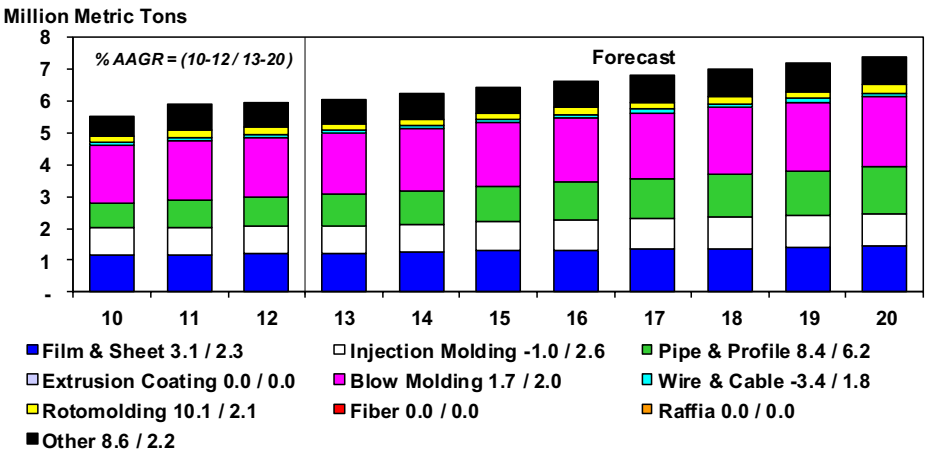
- Some typical end-use products made in part from ethylene oxide (EO):
  - Sterilizing agent (whole facility, medical devices), ethylene glycol (antifreeze, polyester fibers and bottles, brake fluid, hydraulic fluid, solvents) and ethanolamines (detergents, and various speciality chemicals). Ethylene Oxide is a bit tricky to transport and is frequently consumed "over the fence". In North America it is sometimes shipped by rail, but not by truck, and is virtually never transported by ship anywhere in the world.

High Density Polyethylene (HDPE)

United States HDPE Supply & Demand



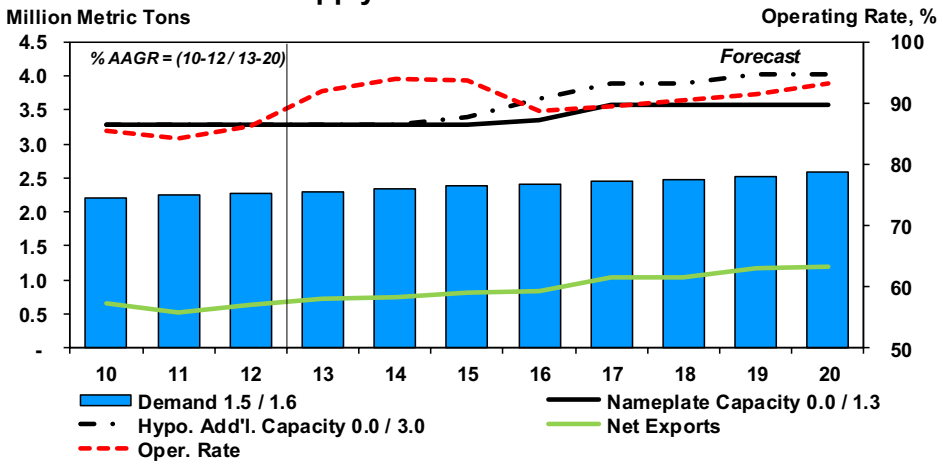
United States HDPE Derivative Demand



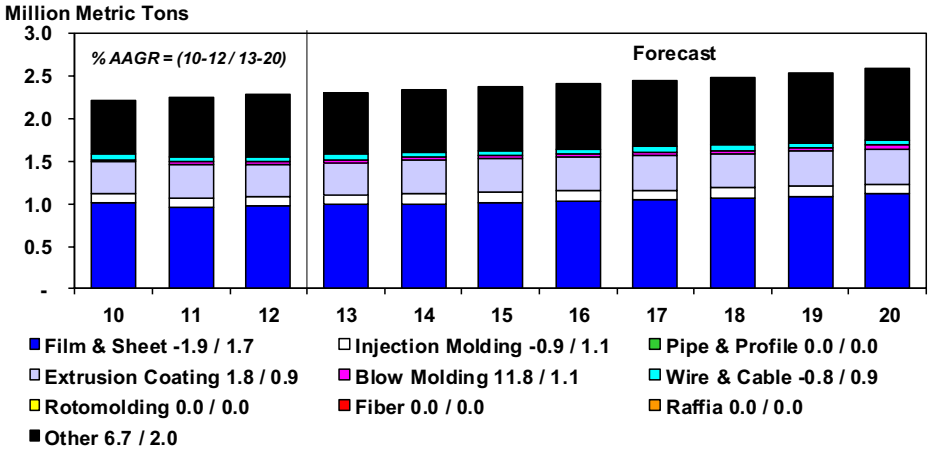
- Some typical end-use products made in part from high density polyethylene (HDPE):
  - Fabricated parts, via rotomolding, injection molding, and blow molding; such as piping, “profiles”, wire and cable. “Converters” or “fabricators” buy the resin to make end use products, such as bags, bottles, containers, buckets, lids, housewares and commercial goods.

Low Density Polyethylene (LDPE)

United States LDPE Supply & Demand



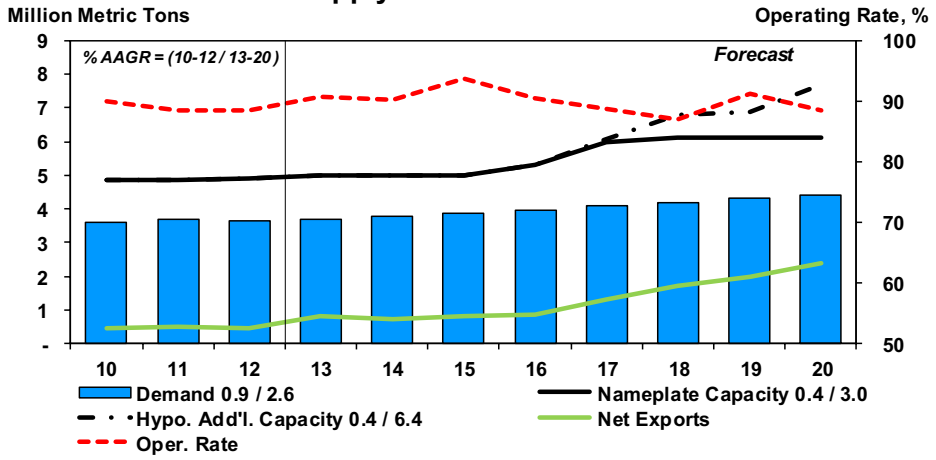
United States LDPE Derivative Demand



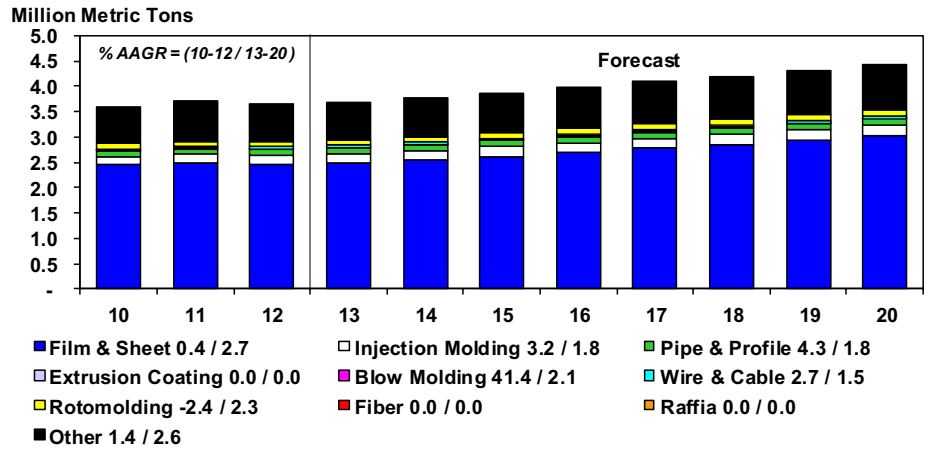
- Some typical end-use products made in part from low density polyethylene (LDPE):
  - Fabricated products, via extrusion coating, injection molding, and blow molding; such as film and sheet, wire and cable. “Converters” or “fabricators” buy the resin to make end use products, such as bags, bottles, containers, buckets, lids, housewares and commercial goods.

Linear Low Density Polyethylene (LLDPE)

United States LLDPE Supply & Demand

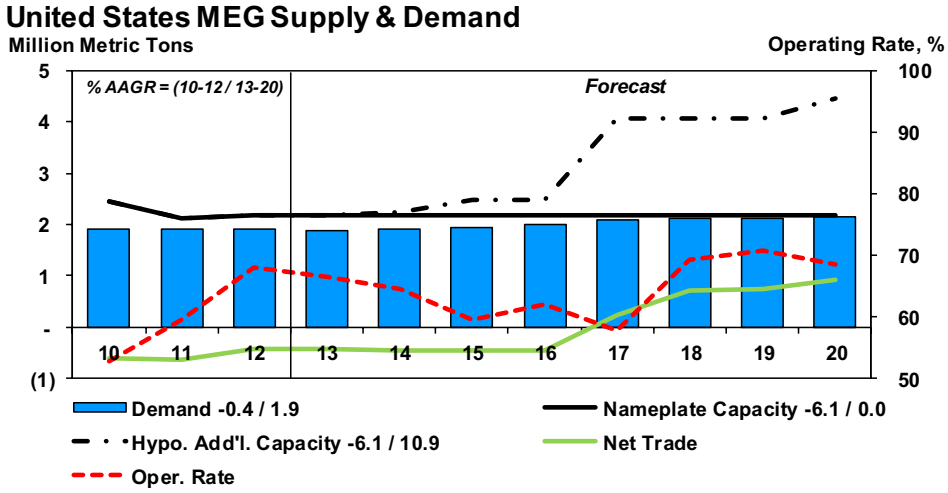


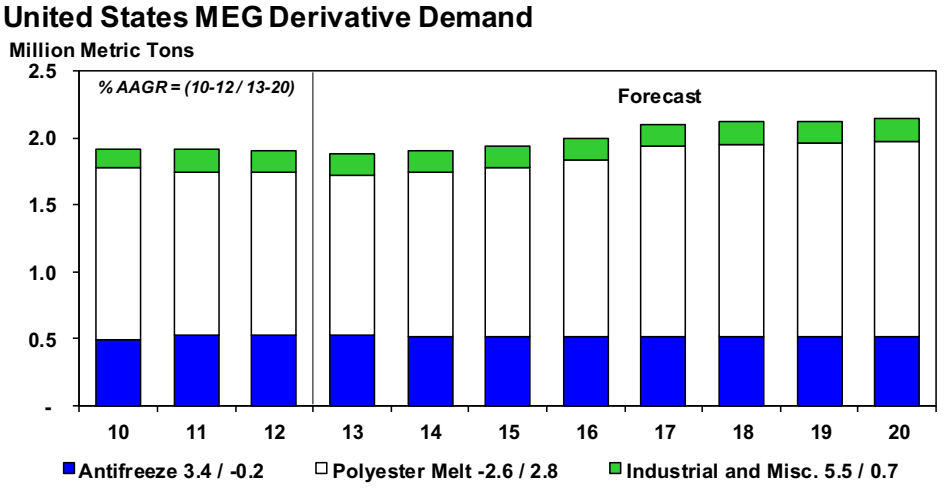
United States LLDPE Derivative Demand



- Some typical end-use products made in part from linear low density polyethylene LLDPE):
  - Fabricated products, via blowing, injection molding and rotomolding ; such as film and sheet, piping, “profiles”, wire and cable. “Converters” or “fabricators” buy the resin to make end use products, such as film, bags, housewares and commercial goods.

Monoethylene Glycol (MEG)

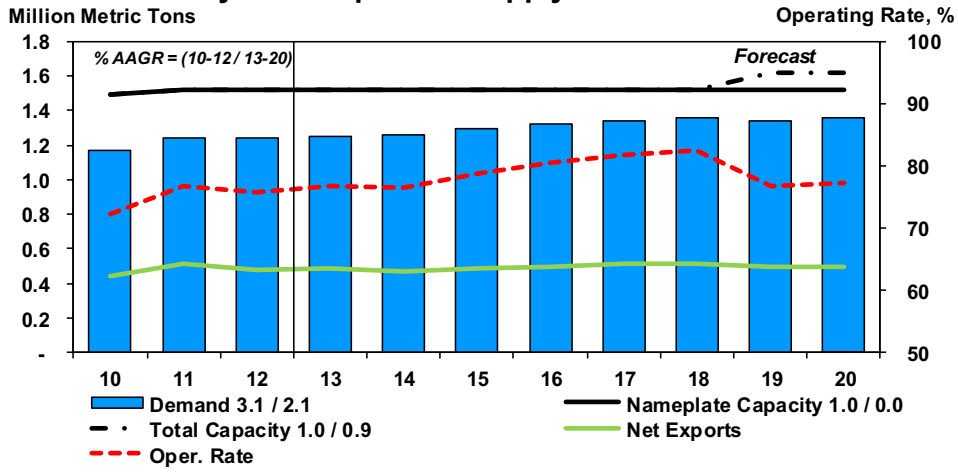




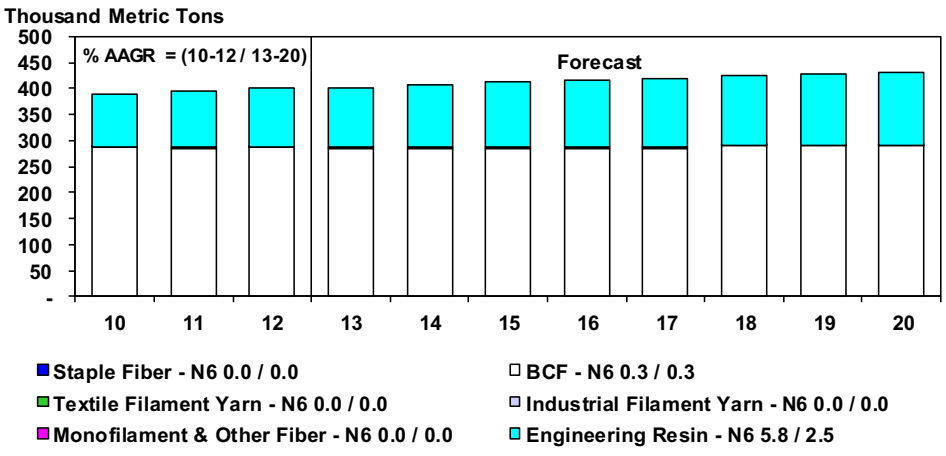
- Some typical end-use products made in part from monoethylene glycol (MEG):
  - MEG is the principal ingredient in most automotive anitfreeze formulations, and a key intermediate chemical to make polyester fiber and resin (for bottles). The byproducts of DEG and TEG are also very useful chemicals, although they are used in niche applications in much smaller volumes than MEG.

Nylon

United States Nylon - Chip/Resin Supply & Demand

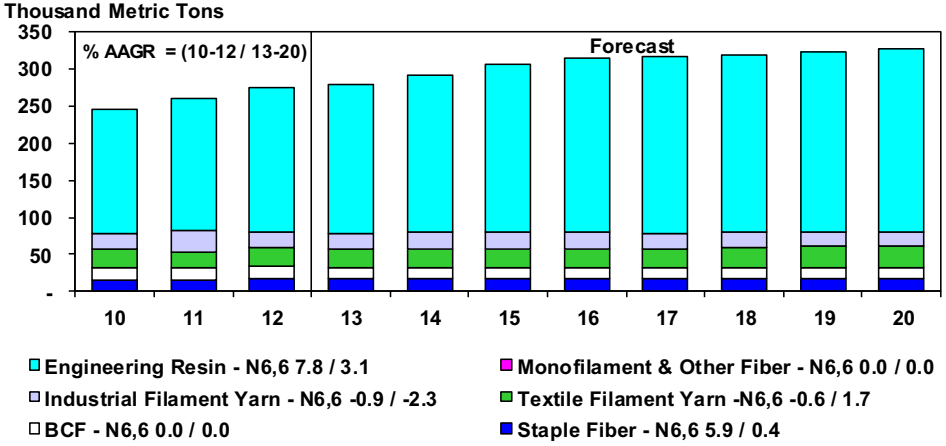


United States Nylon - Chip/Resin Derivative Demand - Nylon 6

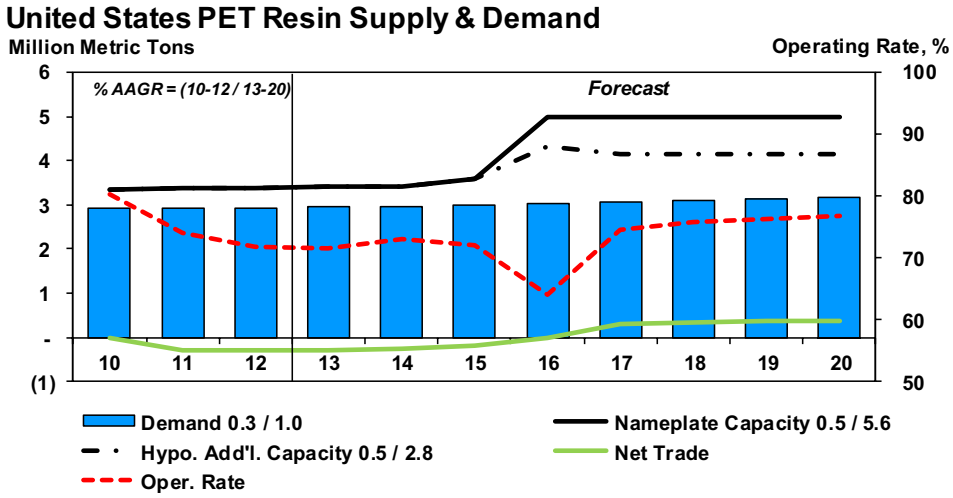


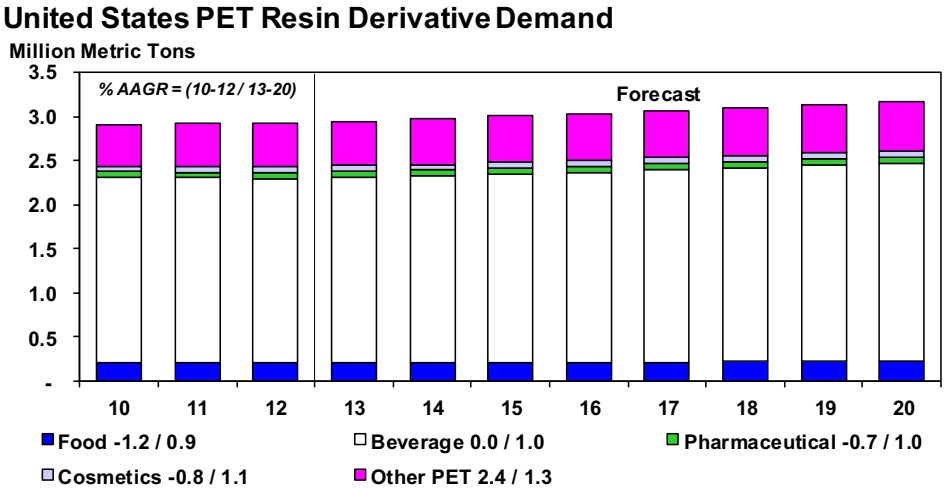
- Nylon resin is made into important textile fibers (carpeting, sports, stockings, etc.), but nylon is also an important engineering resin:
  - Diverse consumer and industrial applications (automotive parts, sport and leisure goods, wire and cable insulation, etc.).

United States Nylon - Chip/Resin Derivative Demand - Nylon 6,6



Polyester Bottle Resin (PET)

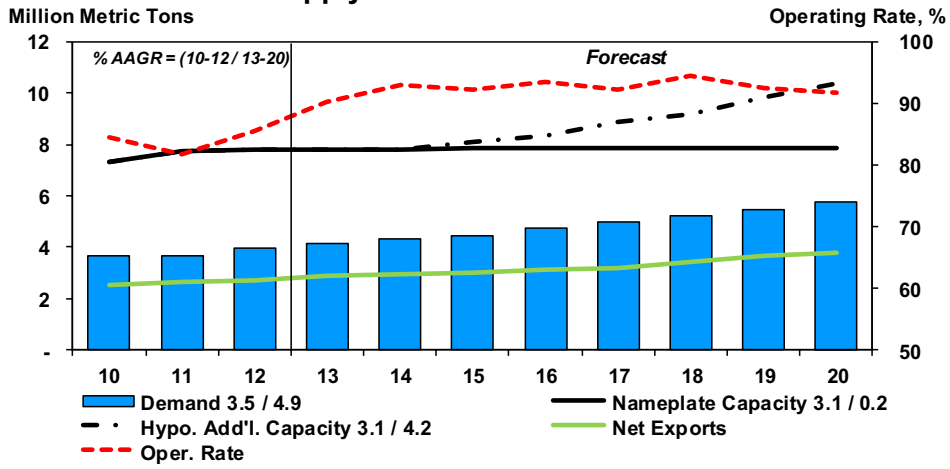




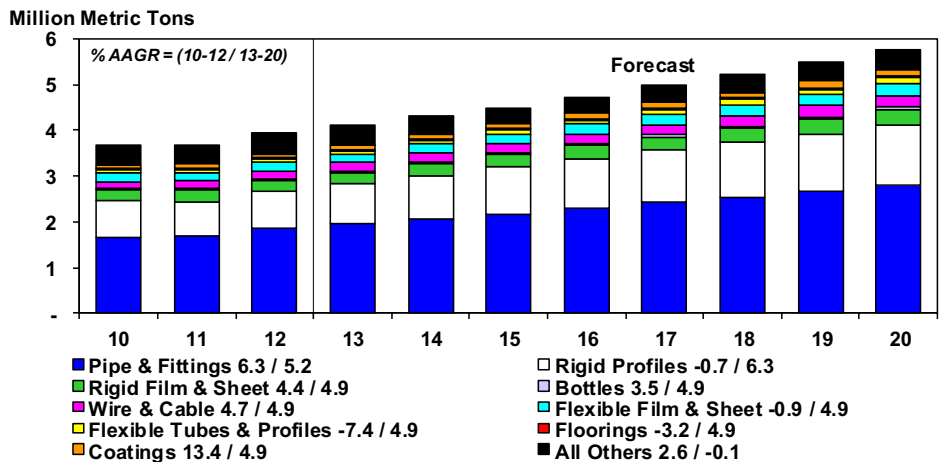
- Some typical end-use products made from PET Bottle Resin:
  - PET Bottle Resin is a different PET product than fiber, and has its primary use in food and beverage packaging and bottles, but also other diverse uses such as other molded products, adhesives, hoses, wheels, and coatings.

Polyvinyl Chloride (PVC)

United States PVC Supply & Demand



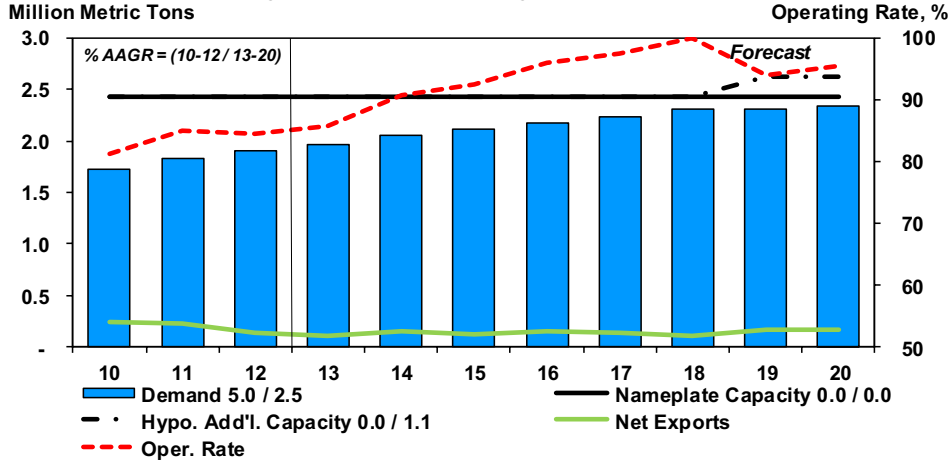
United States PVC Derivative Demand



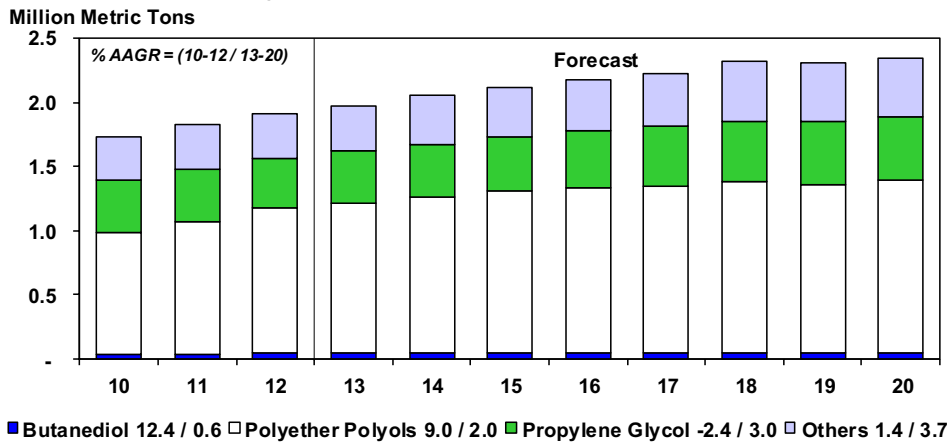
- Some typical end-use products made in part from PVC:
  - PVC includes emulsion and resin, and is one of the “workhorse” petrochemical resins, used in, for instance, house siding, window frames, doors, fences, and other products. PVC resin is in pellet form and can be shipped by rail, truck, or ship.

Propylene Oxide

United States Propylene Oxide Supply & Demand



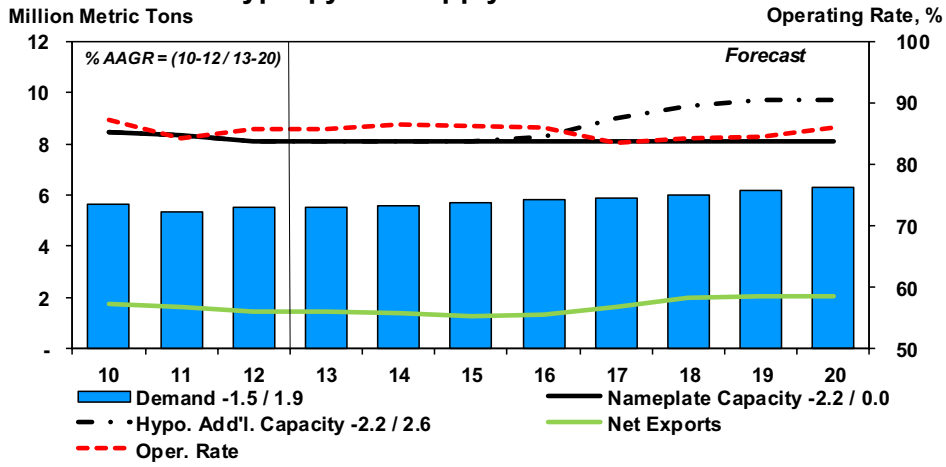
United States Propylene Oxide Derivative Demand



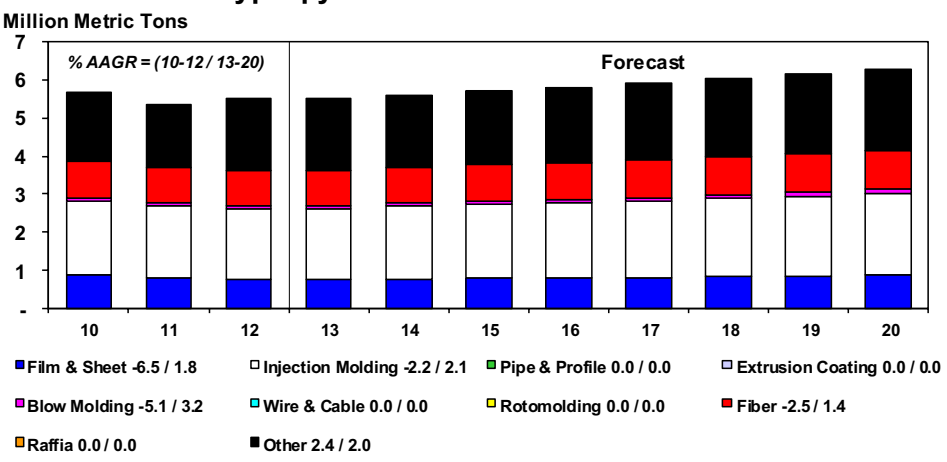
- Some typical end-use products made in part from propylene oxide (PO):
  - Propylene oxide is a chemical intermediate that is used in butanediol, polyols, propylene glycol. It has uses in polyurethane foam, fiberglass composites, surfactants, detergents, solvents, antifreeze, and pharmaceutical materials, and others.

Polypropylene

United States Polypropylene Supply & Demand



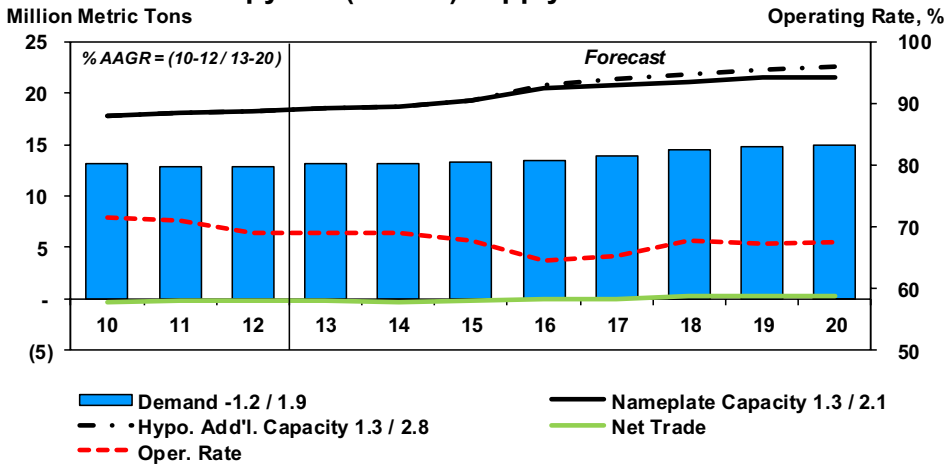
United States Polypropylene Derivative Demand



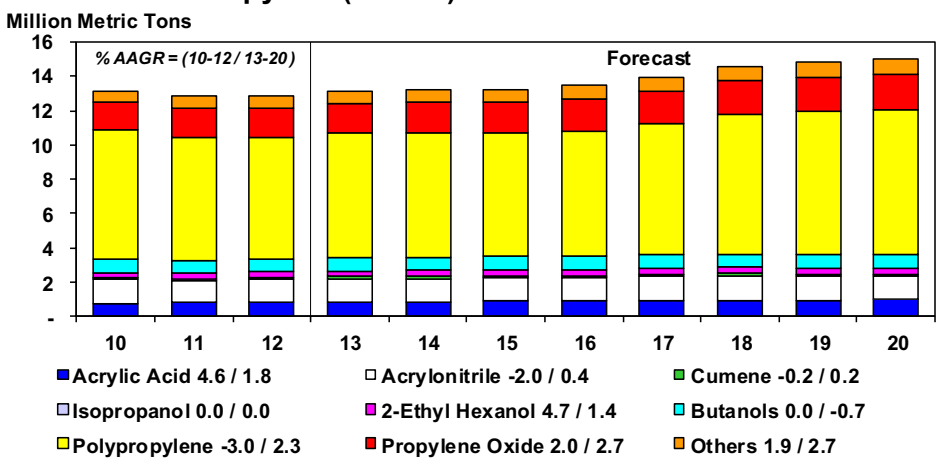
- Some typical end-use products made in part from polypropylene (PP):
  - Polypropylene consumes over half of the propylene used for chemical production. PP is a versatile polymer, and has use as fiber (such as for carpeting), film and sheet (non-woven), molded parts (injection molding and blow molding), such as for bottles and appliance components.

Propylene (Polymer Grade/Chemical Grade)

United States Propylene (PG/CG) Supply & Demand

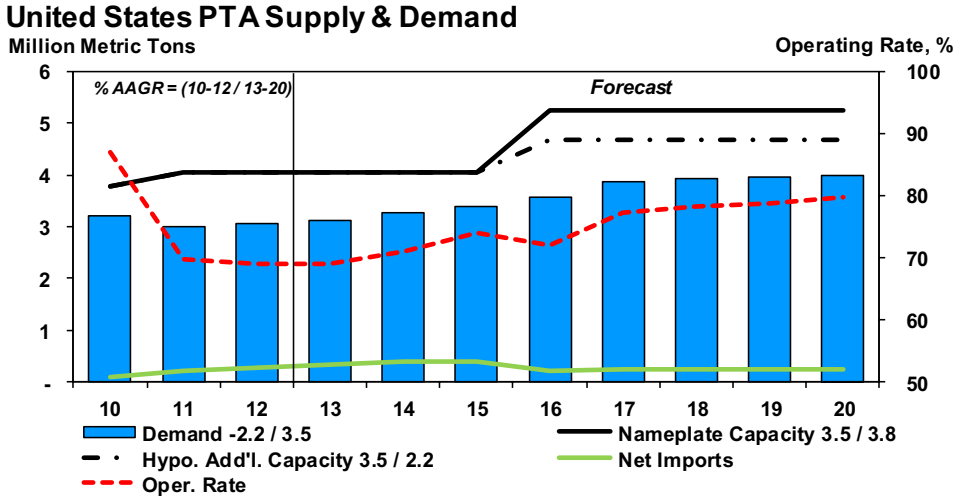


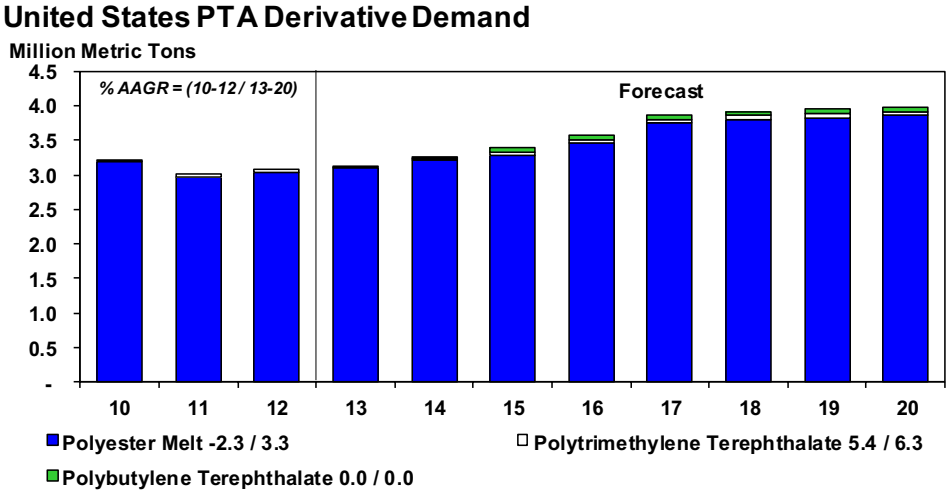
United States Propylene (PG/CG) Derivative Demand



- Some typical end-use products made in part from propylene:
  - Propylene is an intermediate that has a large number of chemical derivatives, with each then "flowing" to end-uses. The ultimate end-use products from propylene include the following: plastics and fibers, molded plastic parts, nylon goods, housewares, automobile parts, disposable diapers, antifreeze, functional fluids (e.g. hydraulic), adhesives and others.

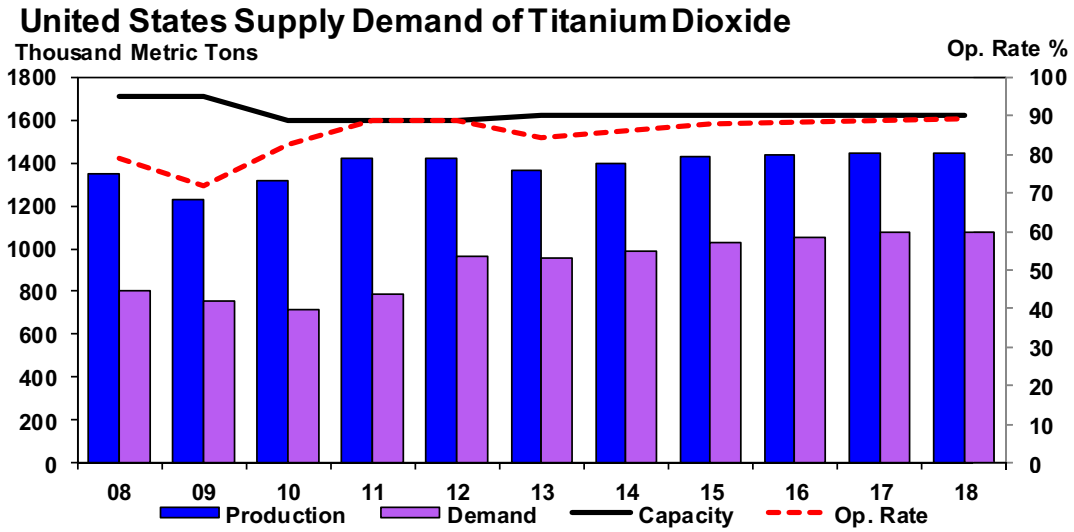
Terephthalic Acid (PTA)

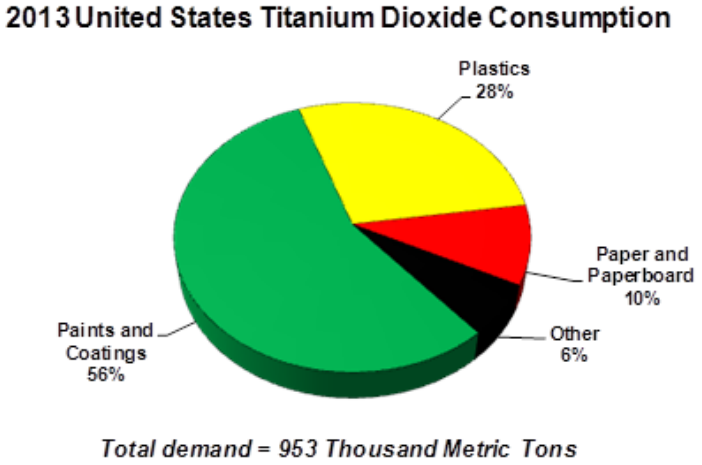




- Some typical end-use products derived at least in part from PTA:
  - Polyester resin and fiber, and all the various products made from them.

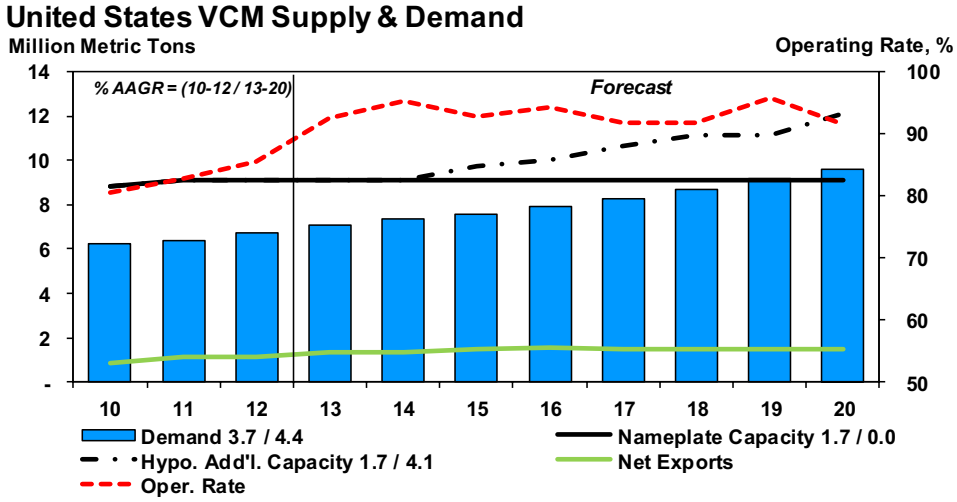
Titanium Dioxide

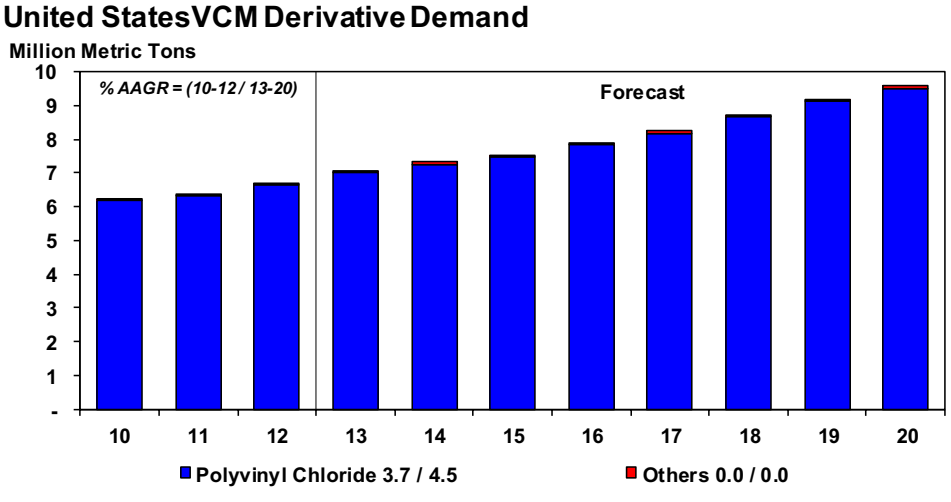




- In the U.S, paints and coatings and plastics are the major outlets for TiO2. Both combined represent 84% of the total consumption. Demand tends to be seasonal and is the highest in the spring and summer as paint sales peak.

Vinyl Chloride Monomer (VCM)





- VCM is an intermediate chemical (“monomer”), that is made from EDC and used to make PVC.
  - VCM is seldom shipped very far, although it can be if necessary. As a result, PVC plant sites typically make VCM, which is then processed on-site to make PVC. PVC resin is in pellet form and can be shipped by rail, truck, or ship.

- Overview
- Macroeconomic trends and the Delmarva economy
  - International, national, and regional macroeconomic trends
  - The Delmarva economy
  - Macro trends impacting chemicals and transportation/logistics industries
- Chemicals industry analysis
  - US chemicals industry overview
  - US chemicals industry trends: Key products and feedstocks
  - Delmarva chemicals industry
- Supply Chain Analysis
  - Regional transportation assets
  - Delmarva goods movement analysis
- Economic Opportunities and Policy Priorities
  - SWOT analysis
  - Possible interventions and current status
  - Scenario analysis: Key transportation gaps

Chemicals industries in the Delmarva region

- The following slides provide in-depth profiles of major chemicals manufacturers in the study region.
- This presentation includes all known information. These profiles will be enhanced and expanded after industry interviews.

Key Findings: Delmarva chemicals industry

- About a dozen regional manufacturers account for much of the Delmarva region chemical production capacity. Products are diverse, and many are highly specialized, including pharmaceuticals.
- The Delmarva region produces many plastics such as poly-vinyl chloride (PVC) piping, and also large quantities of basic chemicals such as sulfuric acid and benzene.
- The Delmarva region would be well placed to benefit from Marcellus NGL extraction for the production of ethylene, propylene, and derivates of these chemicals if and when sufficient investments in pipelines and facilities are delivered.

History of the Delmarva chemicals industry

- The chemicals industry in the Wilmington area and Delmarva peninsula dates from the beginnings of chemical production in the Americas in the early 1800s.
  - Some of the original players in Delaware include: Diamond Shamrock Corp (caustic, chlorine, and polyvinyl chloride), DuPont (gunpowder, nylons, and specialties), Formosa (PVC), Getty Oil (benzene, toluene, DMT), Reichhold (nitrile rubber, polyvinyl acetate, styrene butadiene latex) Sunoco (ethylene, propylene, ethylene oxide), and Hercules (started in the late 1800s, originally a DuPont affiliate dynamite company. The company was recently acquired by Ashland, and it has diversified into specialties over the years.).
  - Many of those operations have assets inplace now, albeit under different names.
- In recent decades, the industry has gradually shifted toward specialties, partly fueled by the access to the basic chemicals from refineries, the port facilities, the strong pharmaceutical operations of many companies in New Jersey and New England, and proximity to end-use population centers.
- The emergence of the natural gas and natural gas liquids from the Marcellus Shale area is anticipated to spur major changes in the chemical industry in Greater Wilmington and Greater Philadelphia over the next ten to fifteen years.

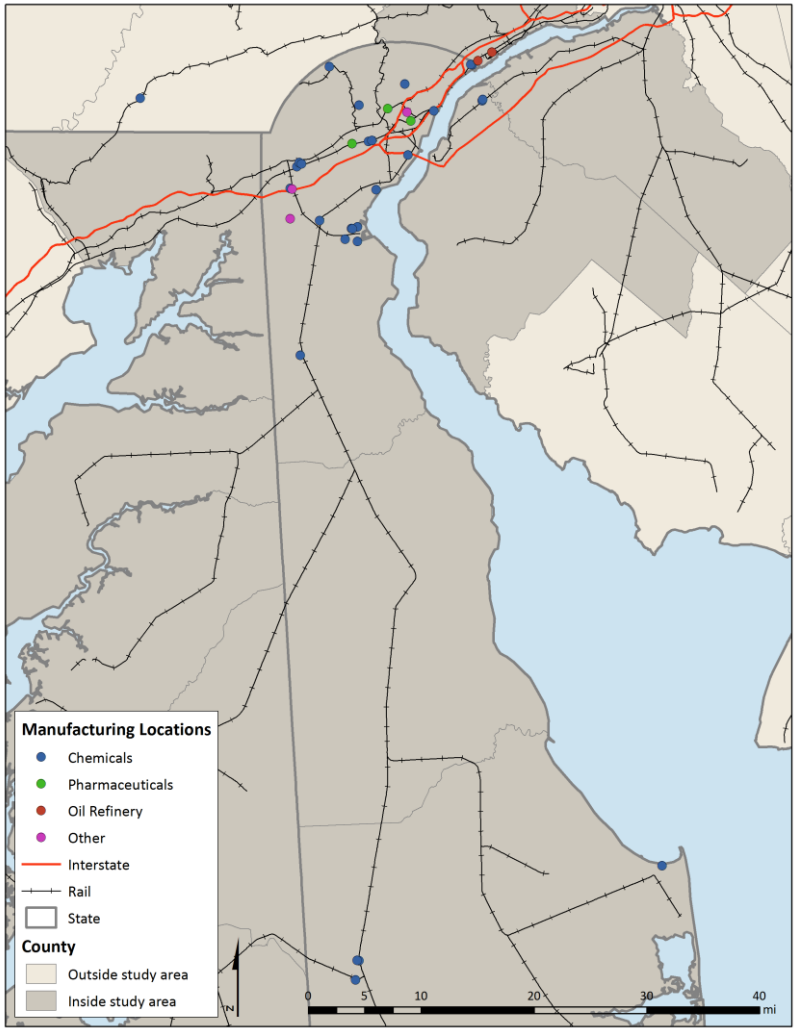
Potential significant changes in the chemical industry in the greater Delmarva region

- NGL pipelines built to move hydrocarbons such as propane and ethane east from the Marcellus production.
- Expansion of natural gas pipeline serving the area.
- Construction of ethylene, ethylene glycol, and/or polyethylene production capacity in the Marcellus or greater Delmarva area.
- Construction of methane- (dry gas) based chemical production in the area, to potentially include methanol, ammonia, and urea.
- Construction of a gas to liquids plant (GTL), or a LNG (liquified natural gas) plant, utilizing methane and oriented toward the export markets.
- Construction of new and enhanced rail, trucking, terminal, port and docking facilities to export products from the new plants in world-scale ships/tankers.

Marcellus and opportunities for Delmarva chemicals manufacturing

- Development of Marcellus shale alters some North American market expectations.
- Previously the Greater Wilmington region had stable petroleum refineries, but commodity chemical production was under economic pressure.
  - The price differential between mid-continent and global crude oils pressured those refineries, but that situation appears to be re-normalizing.
- With the advent of attractively priced natural gas, and now low-cost ethane and propane from the Marcellus, the region is offering a potentially attractive combination of aspects for commodity petrochemical investment.
  - Possibilities are ethylene (from ethane), ethylene derivatives (such as polyethylene, ethylene glycol, and vinyls), propylene (from propane), and even methane-based chemicals (conceivably ammonia, methanol, chlor-alkali, and acetic acid, for instance),
- The Marcus Hook site (formerly Sunoco) offers some advantages in existing infrastructure, but each project will need substantial study and time to develop. Product export to Europe and elsewhere is plausible and is being studied.
- These commodity chemical investments are thought likely to come to fruition in concert with infrastructure investment and developments over the next ten years.
  - Renewed investment in fine and specialty chemicals would likely follow later in time.

Chemicals manufacturing and the Delmarva Peninsula



The chemicals that will likely have the greatest impact are those already produced in in the region and their key feedstocks … *continued*

Company and Product	City	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Notes
		-000- Metric Tons (Unless Otherwise Noted)											
BASF Corp.													
OTHER STYRENE DERIVATIVES	Seaford	27	27	27	27	(27)	(27)	(27)	(27)	(27)	(27)	(27)	
Croda Chemicals													
ETHOXYLATES	New Castle	36	36	36	36	36	36	36	36	36	36	36	
Delaware City Ref. (PBF Energy)													
ALKYLATION	Delaware City	(4,095)	8,190	8,190	8,190	8,190	8,190	8,190	8,190	8,190	8,190	8,190	(Bbls/Calendar Day)
BENZENE	Delaware City	(40)	80	80	80	80	80	80	80	80	80	80	
CATALYTIC REFORMING	Delaware City	(49,650)	16,050	16,050	16,050	16,050	16,050	16,050	16,050	16,050	16,050	16,050	(Bbls/Calendar Day)
COKER UNITS	Delaware City	(20,925)	41,850	41,850	41,850	41,850	41,850	41,850	41,850	41,850	41,850	41,850	(Bbls/Calendar Day)
FLUID CATALYTIC CRACKING UNITS	Delaware City	(41,000)	82,000	82,000	82,000	82,000	82,000	82,000	82,000	82,000	82,000	82,000	(Bbls/Calendar Day)
METHYL TERTIARY BUTYL ETHER	Delaware City	(50)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	
POLYGAS/DIMERSOL	Delaware City	(2,750)	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	(Bbls/Calendar Day)
PROPYLENE: REFINERY GRADE	Delaware City	(59)	117	117	117	117	117	117	117	117	117	117	
	Total - KMT	(149)	197	197	197	197	197	197	197	197	197	197	
	Total - Bbls/Day	(118,420)	153,590	153,590	153,590	153,590	153,590	153,590	153,590	153,590	153,590	153,590	
DuPont													
ANHYDROUS HCL	Edge Moor	68	68	68	68	68	68	68	68	68	68	68	
TITANIUM DIOXIDE	Edge Moor	170	170	170	170	170	170	170	170	170	170	170	
Sulfuric Acid	Delaware City	175	175	175	175	175	175	175	175	175	175	175	
	Total	413	413	413	413	413	413	413	413	413	413	413	
Formosa Plastics USA													
POLYVINYL CHLORIDE	Delaware City	65	65	65	65	65	65	65	65	65	65	65	

The chemicals that will likely have the greatest impact are those already produced in in the region and their key feedstocks … *continued*

Company and Product	City	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Notes
		-000- Metric Tons (Unless Otherwise Noted)											
Invista													
NYLON 6,6 CHIP/RESIN	Seaford	(15)	(15)	(15)	(15)	(15)	(15)	(15)	(15)	(15)	(15)	(15)	
NYLON STAPLE FIBER	Seaford	30	30	30	30	30	30	30	30	30	30	30	
	Total	30	30	30	30	30	30	30	30	30	30	30	
Kuehne													
CAUSTIC	Delaware City	36	36	36	36	36	36	36	36	36	36	36	
CHLORINE	Delaware City	33	33	33	33	33	33	33	33	33	33	33	
OTHER CAUSTIC SODA DERIVATIVES	Delaware City	40	40	40	40	40	40	40	40	40	40	40	
OTHER CHLORINE DERIVATIVES	Delaware City	33	33	33	33	33	33	33	33	33	33	33	
	Total	142	142	142	142	142	142	142	142	142	142	142	
NVF													
PULP	Yorklyn	6	6	6	6	6	6	6	6	6	6	6	
Oxy													
CAUSTIC	Delaware City	(81)	(81)	(81)	(81)	(81)	(81)	(81)	(81)	(81)	(81)	(81)	
CHLORINE	Delaware City	(139)	(139)	(139)	(139)	(139)	(139)	(139)	(139)	(139)	(139)	(139)	
OTHER CAUSTIC SODA DERIVATIVES	Delaware City	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	
POTASSIUM HYDROXIDE	Delaware City	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	
	Total	(323)	(323)	(323)	(323)	(323)	(323)	(323)	(323)	(323)	(323)	(323)	
Sunoco													
ETHYLENE	Claymont	(113)	(113)	(113)	(113)	(113)	(113)	(113)	(113)	(113)	(113)	(113)	

The chemicals that will likely have the greatest impact are those already produced in in the region and their key feedstocks … *continued*

- Companies and key products not shown in previous capacity listing include:
  - Air Liquide – Air gas production and product development[1]
  - Ashland – Acetate and acrylic copolymer resins.
  - Dow – Manufacturing, no chemical production (imported/consumed).
  - FMC Biopolymer – Cellulose acetate phthalate dispersions, croscarmellose sodium, ethyl cellulose polymer dispersions, and microcrystalline cellulose.
  - Graham Packaging – Polyethylene packaging.
  - Lubrizol – Acrylic elastomers and polyacrylate emulsions.
  - Noramco – Pharmaceuticals

[1] Not confirmed

Air Liquide

Location(s): Newark, DE (Research Facility) and New Castle, DE (Next to PBF Delaware City Refinery). Merchant Products Group U.S. headquarters in Malvern, PA (north of Wilmington).

Total Operating Capacity: Not known

Age: Newark research facility – 2007, Newark, DE. New Castle air gases plant or distribution center – not known.

Key Products: Oxygen, nitrogen, argon, steam, power and water (possibly sourced from Delaware City)

Key Feedstocks: Electric power.

Ashland (formerly Ashland / Hercules Chemical)

Location(s): Elkton, MD (acetate and acrylic copolymer resins)

Total Operating Capacity[1]: Not clear; Probably less than 100 KTPA

Age: Not known

Key Products: Acetate and acrylic copolymer resins

Key Feedstocks: Vinyl acetate, acrylic acetates

[1] Total capacity currently believe to be in operation

BASF

Location(s): Seaford, DE

Total Operating Capacity[1, 2]: 27 KMT

Age: 2006; BASF announced plant closure by 2013 year end

Key Products: Other styrene derivatives; emulsion resins (i.e. acrylic polymer emulsions), acrylic resins (copolymer), and acrylic resin solutions

Key Feedstocks: Styrene, acrylonitrile.

Company and Product	City	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Notes
		-000- Metric Tons (Unless Otherwise Noted)											
BASF Corp.													
OTHER STYRENE DERIVATIVES	Seaford	27	27	27	27	(27)	(27)	(27)	(27)	(27)	(27)	(27)	

[1] Total capacity currently believe to be in operation

[2] Capacities in parentheses represent idle capacity

Croda Chemicals

Location(s): New Castle, DE

Total Operating Capacity[1]: 36 KMT

Age: 2004

Key Products: Ethylene oxide and other alcohols; ethoxylates, which are intermediates to surfactants; and other specialty chemicals

Key Feedstocks: Ethylene, ethylene oxide, various fatty acids and possibly propylene oxide

Company and Product	City	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
		-000- Metric Tons (Unless Otherwise Noted)										
Croda Chemicals												
ETHOXYLATES	New Castle	36	36	36	36	36	36	36	36	36	36	36

[1] Total capacity currently believe to be in operation

Dow Electronic Materials

Location(s): Newark, DE

Total Operating Capacity[1]: Not known

Age: Not known

Key Products: Semiconductor products (photoresists, metallization, specialized slurries and precursors)

Key Feedstocks: Not known

Note: Dow may only make hard goods, not chemicals *per se*, in its Newark, DE plant.

[1] Total capacity currently believe to be in operation

DuPont Company

Location(s): Delaware City, Edgemoor, and Wilmington, DE

Total Operating Capacity[1]: 413 KTM

Age: Titanium dioxide, pre-1980s, and sulfuric acid, since 2006

Key Products: Sulfuric acid and titanium dioxide[2] (anhydrous HCl is a TiO2 by product).

Key Feedstocks: Sulfuric Acid, soda ash, and titanium ore. Also, various specialty/fine chemicals and plastics for DuPont specialty products, including high-performance plastics in Wilmington

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Company and Product	**City**	**-000- Metric Tons (Unless Otherwise Noted)**										
DuPont												
ANHYDROUS HCL	Edge Moor	68	68	68	68	68	68	68	68	68	68	68
TITANIUM DIOXIDE	Edge Moor	170	170	170	170	170	170	170	170	170	170	170
Sulfuric Acid	Delaware City	175	175	175	175	175	175	175	175	175	175	175
	Total	413	413	413	413	413	413	413	413	413	413	413

[1] Total capacity currently believe to be in operation

[2] DuPont will be spinning off its TiO2 production, but manufacturing should continue in Edgemoor

FMC Biopolymer

Location(s): Newark, DE

Total Operating Capacity[1]: unclear

Age: unknown

Key Products: Cellulose acetate phthalate dispersions, croscarmellose sodium, ethyl cellulose polymer dispersions, and microcrystalline cellulose

Key Feedstocks: Cellulose intermediates, acetic acid, and others

[1] Total capacity currently believe to be in operation

Formosa Plastics

Location(s): Delaware City, DE

Total Operating Capacity[1]: 65 KTM

Age: Pre – 1980s, expanded in the 1980's and 1990's

Key Products: PVC

Key Feedstocks: Vinyl chlorine monomer

Company and Product	City	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
		-000- Metric Tons (Unless Otherwise Noted)										
Formosa Plastics USA												
POLYVINYL CHLORIDE	Delaware City	65	65	65	65	65	65	65	65	65	65	65

[1] Total capacity currently believe to be in operation

Graham Packaging Company

Location(s): Newark, DE

Total Operating Capacity[1]: Not known

Age: Not known

Key Products: Polyethylene packaging and possibly other products

Key Feedstocks: Polyethylene resin and possibly others

[1] Total capacity currently believe to be in operation

Invista

Location(s): Seaford, DE

Total Operating Capacity[1,2]: 30 KMT

Age: From DuPont in 2004, Built by DuPont in 1980's or prior, Mostly idled or shutdown.

Key Products: Nylon 6,6

Key Feedstocks: Nylon 6,6 chip/resin

Company and Product	City	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
		-000- Metric Tons (Unless Otherwise Noted)										
Invista												
NYLON 6,6 CHIP/RESIN	Seaford	(15)	(15)	(15)	(15)	(15)	(15)	(15)	(15)	(15)	(15)	(15)
NYLON STAPLE FIBER	Seaford	30	30	30	30	30	30	30	30	30	30	30
	Total	30	30	30	30	30	30	30	30	30	30	30

[1] Total capacity currently believe to be in operation

[2] Capacities in parentheses represent idle capacity

Kuehne Company

Location(s): Delaware City, DE

Total Operating Capacity[1]: 142 KMT

Age: 1999 start - up

Key Products: Bleach, caustic soda, chlorine, hydrochloric acid, and potassium hydroxide (potash caustic)

Key Feedstocks: Brine (salt solution) and electric power

Company and Product	City	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
		-000- Metric Tons (Unless Otherwise Noted)										
Kuehne												
CAUSTIC	Delaware City	36	36	36	36	36	36	36	36	36	36	36
CHLORINE	Delaware City	33	33	33	33	33	33	33	33	33	33	33
OTHER CAUSTIC SODA DERIVATIVES	Delaware City	40	40	40	40	40	40	40	40	40	40	40
OTHER CHLORINE DERIVATIVES	Delaware City	33	33	33	33	33	33	33	33	33	33	33
	Total	142	142	142	142	142	142	142	142	142	142	142

[1] Total capacity currently believe to be in operation

Lubrizol Company

Location(s): Pedricktown, NJ (Southern New Jersey, across Delaware River from Wilmington)

Total Operating Capacity[1]: unclear

Age: Not known

Key Products: Specialty polymers (acrylic elastomers and polyacrylate emulsions)

Key Feedstocks: Acrylic intermediates (acrylic acid, acrylic esters, etc.)

[1] Total capacity currently believe to be in operation

NVP

Location(s): Yorklyn, DE

Total Operating Capacity[1]: 6 KMT

Age: Pre – 1980's

Key Products: Specialty pulp products

Key Feedstocks: Raw wood or pulp, and caustic soda

Company and Product	City	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
		-000- Metric Tons (Unless Otherwise Noted)										
NVF												
PULP	Yorklyn	6	6	6	6	6	6	6	6	6	6	6

[1] Total capacity currently believe to be in operation

Noramco, Inc.

Location(s): Wilmington, DE

Total Operating Capacity[1]: Not known

Age: Not known

Key Products: Active pharmaceutical ingredients

Key Feedstocks: Various fine chemicals

[1] Total capacity currently believe to be in operation

Oxychem

Location(s): Delaware City, DE

Total Operating Capacity[1,2]: 0 KMT

Age: Plant idled in 2006; Site dates back to the mid – 1960s

Key Products: Caustic and chlorine

Key Feedstocks: Brine and electricity

Company and Product	City	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
		-000- Metric Tons (Unless Otherwise Noted)										
Oxy												
CAUSTIC	Delaware City	(81)	(81)	(81)	(81)	(81)	(81)	(81)	(81)	(81)	(81)	(81)
CHLORINE	Delaware City	(139)	(139)	(139)	(139)	(139)	(139)	(139)	(139)	(139)	(139)	(139)
OTHER CAUSTIC SODA DERIVATIVES	Delaware City	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
POTASSIUM HYDROXIDE	Delaware City	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
	Total	(323)	(323)	(323)	(323)	(323)	(323)	(323)	(323)	(323)	(323)	(323)

[1] Total capacity currently believe to be in operation

[2] Capacities in parentheses represent idle capacity

PBF Energy (Delaware City Refinery)

Location(s): Delaware City, DE

Total Operating Capacity[1]: 197 KMT and 153,590 Bbls/day

Age: 2010 (From Valero who acquired from Premcor in 2006)

Key Products: Benzene and propylene

Key Feedstocks: Crude oil

Company and Product	City	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Notes
		-000- Metric Tons (Unless Otherwise Noted)											
Delaware City Ref. (PBF Energy Partners)													
ALKYLATION	Delaware City	(4,095)	8,190	8,190	8,190	8,190	8,190	8,190	8,190	8,190	8,190	8,190	(Bbls/Calendar Day)
BENZENE	Delaware City	(40)	80	80	80	80	80	80	80	80	80	80	
CATALYTIC REFORMING	Delaware City	(49,650)	16,050	16,050	16,050	16,050	16,050	16,050	16,050	16,050	16,050	16,050	(Bbls/Calendar Day)
COKER UNITS	Delaware City	(20,925)	41,850	41,850	41,850	41,850	41,850	41,850	41,850	41,850	41,850	41,850	(Bbls/Calendar Day)
FLUID CATALYTIC CRACKING UNITS	Delaware City	(41,000)	82,000	82,000	82,000	82,000	82,000	82,000	82,000	82,000	82,000	82,000	(Bbls/Calendar Day)
METHYL TERTIARY BUTYL ETHER	Delaware City	(50)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	
POLYGAS/DIMERSOL	Delaware City	(2,750)	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	(Bbls/Calendar Day)
PROPYLENE: REFINERY GRADE	Delaware City	(59)	117	117	117	117	117	117	117	117	117	117	
	Total - KMT	(149)	197	197	197	197	197	197	197	197	197	197	
	Total - Bbls/Day	(118,420)	153,590	153,590	153,590	153,590	153,590	153,590	153,590	153,590	153,590	153,590	

[1] Total capacity currently believe to be in operation

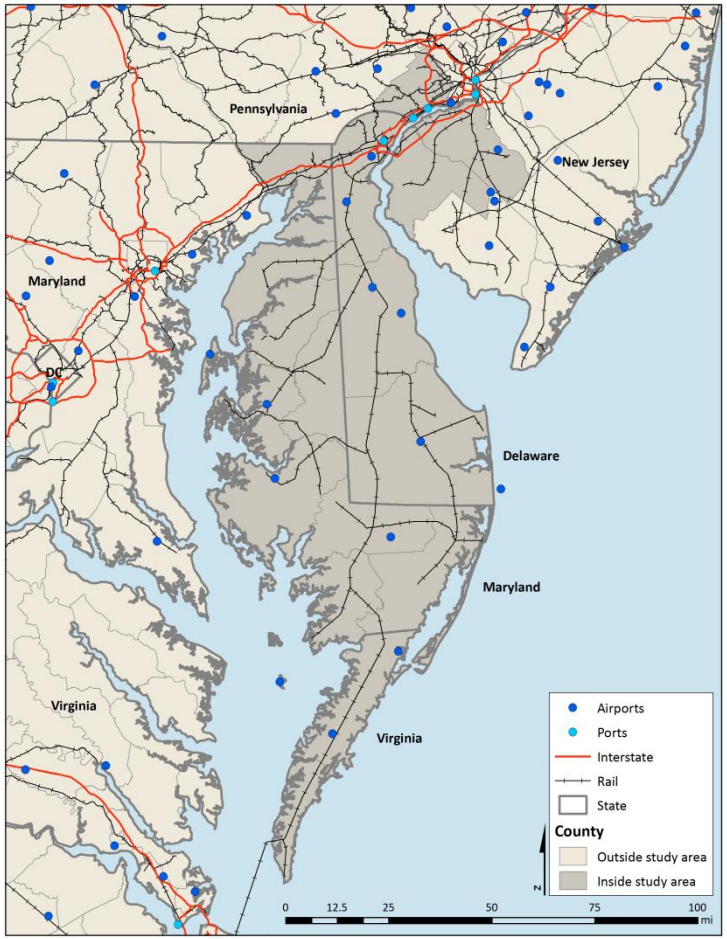
[2] Capacities in parentheses represent idle capacity

Summary of Delmarva chemicals industry trends and opportunities

- Petroleum refineries and petrochemicals are closely linked since many refineries produce aromatic chemicals (benzene, toluene and sometimes para-xylene) as part of their business.
- In the last year, a number of bellweather events occurred:
  - The Sunoco refinery in Marcus Hook, PA shutdown permanently.
  - The Chevron refinery in Trainer, PA was bought by an affiliate of Delta Airlines.
  - The Sunoco refinery in South Philadelphia, PA was partly divested to become Philadelphia Energy Solutions.
  - At Marcus Hook there are substantial infrastructure and energy assets that could be reconfigured into terminal or chemical plant facilities. Export of ethane or propane is conceivable.
  - At the two refineries sold/divested, significant upgrading investments have been made and there may be more investment for which the feasibility is now being studied.
- Chemical or energy products that benefit from low-priced feedstocks or energy are most likely to see new investment: ethylene, polyethylene, propylene, polypropylene, chlor-alkali, vinyls, methanol, ammonia, hydrogen, and air gases.
- If infrastructure (especially pipeline and port-side storage and loading facilities) investment is made linking Marcellus to Marcus Hook, then the chemicals industry in the Delaware Bay could be poised for a revival in investment, manufacturing, and/or transport.

- Overview
- Macroeconomic trends and the Delmarva economy
  - International, national, and regional macroeconomic trends
  - The Delmarva economy
  - Macro trends impacting chemicals and transportation/logistics industries
- Chemicals industry analysis
  - US chemicals industry overview
  - US chemicals industry trends: Key products and feedstocks
  - Delmarva chemicals industry
- Supply Chain Analysis
  - Regional transportation assets
  - Delmarva goods movement analysis
- Economic Opportunities and Policy Priorities
  - SWOT analysis
  - Possible interventions and current status
  - Scenario analysis: Key transportation gaps

Regional transportation assets for chemicals freight



Regional transportation assets for the Delmarva chemicals industry

Mode	Assets	Key Role in the Regional Supply Chain
Roadways	Interstate & Regional Highways	• Refined petroleum customer deliveries • Pharmaceutical feedstocks and customer deliveries • Some intermediate plastics feedstocks • Deliveries to warehouses and airports • Access to employees (car and bus)
Freight Rail	• Norfolk Southern • CSX • Regional Short Line Railroads	• Crude petroleum feedstocks for refining and refinery-grade chemical manufacturing • Feedstocks of ores, fatty acids, sodium-based compounds, and other inorganic/organic chemicals for consumer and specialty chemicals manufacturing • Intermediate plastics and fibers feedstocks for high-end plastics production • Key hazardous petrochemicals feedstocks for various regional chemicals products
Seaports	• Private Terminals (PBF, Marcus Hook, etc.) • Port of Wilmington • Port of Baltimore • Port of Philadelphia	• Crude petroleum feedstocks for refining and refinery-grade chemical manufacturing • Coke deliveries to customers in Europe via Wilmington • Plastics/electronics products delivered to Asia via Baltimore • Possible future basic chemicals processing/ manufacturing and export via Marcus Hook
Airports	• Philadelphia International Airport (PHL) • Baltimore-Washington International (BWI) • New Castle Airport (ILG)	• Pharmaceutical and specialty plastics deliveries to customers worldwide (especially Asia) primarily via UPS, FexEx, and DHL (PHL & BWI) • New Castle Airport does not have major cargo operations, but Frontier Airlines began regular scheduled passenger service on July, 2013 (168 Seat Airbus A320) to Chicago-Midway (3/wk), Denver (4), Houston-Hobby (2), Orlando (2), and Tampa (2)
Passenger Rail	• Amtrak • SEPTA • MARC	• Provides access to workforce, extending to Philadelphia and Baltimore (via future Elkton MARC extension)

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Key findings: preliminary summary of petroleum and chemicals freight flows

- The study region tends to add value to the petroleum and chemicals supply chains. The per-ton values of outbound goods exceed those of inbound goods.
- Inbound and outbound commodity flow forecasts estimated for this study suggest overall continued growth of regional chemicals production, especially high-value-added specialty chemicals, plastics, and pharmaceuticals.
- Recent trends suggest declining shares of regional petroleum product production in favor of industry consolidation in the Gulf Coast. This trend is being altered, however, with increased refining of Bakken and Canadian shale-based crude.
- Truck transportation dominates total transportation flows, mostly on account of outbound flows of refined petroleum to other Mid-Atlantic markets.
- Inbound crude petroleum rail shipments will grow in the foreseeable future, possibly displacing some maritime tanker shipments. Diversion of inbound crude to pipeline and coastal sea routes is possible, but not likely before 2018.
- Rail traffic will continue to grow. Dry chemical and hazardous gas feedstocks (e.g., chlorine and ethylene oxide) and solid manufactured products (e.g., plastics) will not likely be diverted once pipelines are developed.

Freight flows analysis approach

- The data presented in this section are extracted from Transearch, IHS's proprietary database of domestic commodity flows.
- Transearch combines econometrics and transportation industry data to forecast commodity flows of domestic goods movement at the county-by-county level.
- Data is reported at the Standard Transportation Commodity Code (STCC) 4 level and the geographic unit is the Business Economic Area (BEA).
- Commodity flow forecasts are assigned to modes of transportation (truck, railroad, inland-waterway barge, and air) and routed on the transportation network.
- Forecasts are based on historical data, but the current-year Transearch version forecasts begin in 2011. More recent shifts in market trends may not yet be captured in these baseline estimates, but are discussed in the narrative.
- Forecasts in this study will be referred to as the "**baseline case**." More recent trends not reflected in these numbers, such as increased use of unit trains to deliver crude petroleum to the study region, will be covered in the narrative.

Freight flows analysis approach, cont'd.

- Railway figures are estimated using private rail waybill carload data for Delaware provided by the US Department of Transportation Surface Transportation Board (STB). Estimates for study areas outside of Delaware utilize less-detailed public waybill data. STB commodity waybill data is requested for other study areas.
- Pipeline flows are not currently highly relevant to chemicals, plastics, and pharmaceutical production in the study area. Future opportunities, however, may be tied to NGL pipelines under construction from the Marcellus shale area to Marcus Hook and natural gas distribution, generally, throughout the study region.
- Goods covered in flow forecasts include domestic legs of exports and imports, but only those links to and from the points of exit/entry.

Business Economic Area (BEA) description

- Business Economic Areas (BEA) are the basic geographic units of measure for freight transportation. IHS has estimated study area forecasts from BEA data.
  - BEAs define the relevant regional markets surrounding metropolitan or micropolitan statistical areas, wholly partitioning the lower 48 states.
- For freight forecasting purposes, the study area includes all of the Salisbury, MD BEA and parts of the Philadelphia, PA and Washington, DC BEAs.
- Commodity and transportation flows associated with counties corresponding to the study area include:
  - *Philadelphia BEA*: Kent and New Castle (DE); Cecil (MD); Gloucester and Salem (NJ); and Delaware (PA)
  - *Washington BEA*: Caroline; Dorchester, Kent, and Talbot County, MD
  - *Salisbury BEA*: Sussex (DE); Somerset, Wicomico, and Worcester County (MD); Accomack and Northampton County (VA)

Chemicals and petroleum products commodity descriptions in Transearch (STCC 4 Codes)

Chemical Commodities

Industrial Chemicals	Paints, Lacquers, Etc.
Ind, Inorg, or Org Chemicals	Gum or Wood Chemicals
Potassium or Sodium Compound	Agricultural Chemicals
Industrial Gases	Fertilizers
Crude Prod Of Coal, Gas, Petroleum	Misc Agricultural Chemicals
Cyclic Intermediates or Dyes	Misc Chemical Products
Inorganic Pigments	Adhesives
Misc Industrial Organic Chemicals	Explosives
Misc Indus Inorganic Chemicals	Printing Ink
Plastic Mater or Synth Fibres	Chemical Preparations, Nec
Drugs	Surface Active Agents
Soap or Other Detergents	Cosmetics, Perfumes, Etc.
Specialty Cleaning Preparations	

Petroleum Commodities

Petroleum Refining Products	Misc Coal or Petroleum Products
Liquefied Gases, Coal or Petroleum	*Other Commodities*

Other Commodities

Chemical or Petroleum Waste	Chemical or Fertilizer Mineri Crude
Misc Plastic Products	

Mapping the major chemicals produced in and near the study region to STCC 4 codes

Potassium or Sodium Compound	Industrial Gases	Crude Prod Of Coal, Gas, Petroleum	Misc Industrial Organic Chemicals	Plastic Mater or Synth Fibres	Liquefied Gases, Coal or Petroleum
Sodium (Soda),Caustic (Sodium Hydroxide) And Potassium (Potash),Caustic, Mixed, In Solution	Vinyl Chloride (Chloroethene Or Chloro- Fg Ethylene)	Benzene (Benzol)	Acrylic Acid	Linear Low density polyethylene - LLDPE	Ethylene,Cryogenic Liquid
Chlorine			Ethylene Dichloride	Nylon	Propylene
			Ethylene Oxide	Polyester Bottle Resin (PET)	
			Mono Ethylene Glycol (MEG)	Polyvinyl Chloride,Other Than Liquid	
			Propylene Oxide	High-density polyethylene - HDPE	
			Polypropylene Glycol	Low-density polyethylene - LDPE	
			Terephthalic Acid (Benzene-Para-Dicarboxylic Or Para-Phthalic Acid,Or Terephthalic Anhydride)		

Overview of total petroleum and chemicals commodity flows in the study region

- Truck dominates overall flows, mostly on account of distribution of regional refined petroleum products within the Mid-Atlantic and nearby regions.
- Overall truck and rail flows grow in the short-term, but begin to decline in the long term due in part to petroleum refining industry consolidation in the Gulf Coast.
- Chemicals (including pharmaceuticals and plastics but excluding crude petroleum and petroleum products), however, grow robustly across all modes (1.7% by truck, 2.2% by rail, 2.4% by river, and 3.1% by air).
  - Rail and river transport remain critical in the future.
  - Pipelines are less helpful for many current chemicals and products manufactured from chemical feedstocks (i.e., dry bulk chemicals, plastics, etc.), but could play a role in expanding basic chemicals manufacturing utilizing Marcellus NGL feedstocks. Crude pipelines are less likely.
  - Regional pharmaceuticals manufacturing growth will require truck and air parcel services.
  - The overall value per ton is higher for chemicals (including pharmaceuticals and plastics but excluding petroleum) due to the high value of many chemicals and chemical products.

Total chemicals and petroleum flows, all modes

Total Tonnage - Thousand Tons

Mode	2011	2015	2020	2025	2030	CAGR 2011 - 2030
Truck	90,544	90,549	96,613	96,581	91,931	0.1%
Rail	3,285	3,463	4,031	4,496	4,683	1.9%
Water	12,674	11,296	10,696	10,642	9,804	-1.3%
Air	7	7	8	10	12	3.1%
Total	**106,510**	**105,315**	**111,347**	**111,729**	**106,430**	

Total Value - Million USD

Mode	2011	2015	2020	2025	2030	CAGR 2011 - 2030
Truck	108,504	110,470	123,499	131,989	136,439	1.2%
Rail	4,356	4,587	5,351	5,906	6,161	1.8%
Water	11,382	10,102	9,554	9,503	8,729	-1.4%
Air	1,968	2,053	2,469	2,934	3,469	3.0%
Total	126,209	127,211	140,873	150,331	154,798	

Total chemicals flows only, all modes

Total Tonnage - Thousand Tons

Mode	2011	2015	2020	2025	2030	CAGR 2011 - 2030
Truck	23,692	24,444	28,111	30,985	32,352	1.7%
Rail	2,905	3,090	3,677	4,154	4,376	2.2%
Water	1,805	1,876	2,254	2,590	2,842	2.4%
Air	7	7	8	10	12	3.1%
Total	**28,409**	**29,418**	**34,050**	**37,738**	**39,581**	

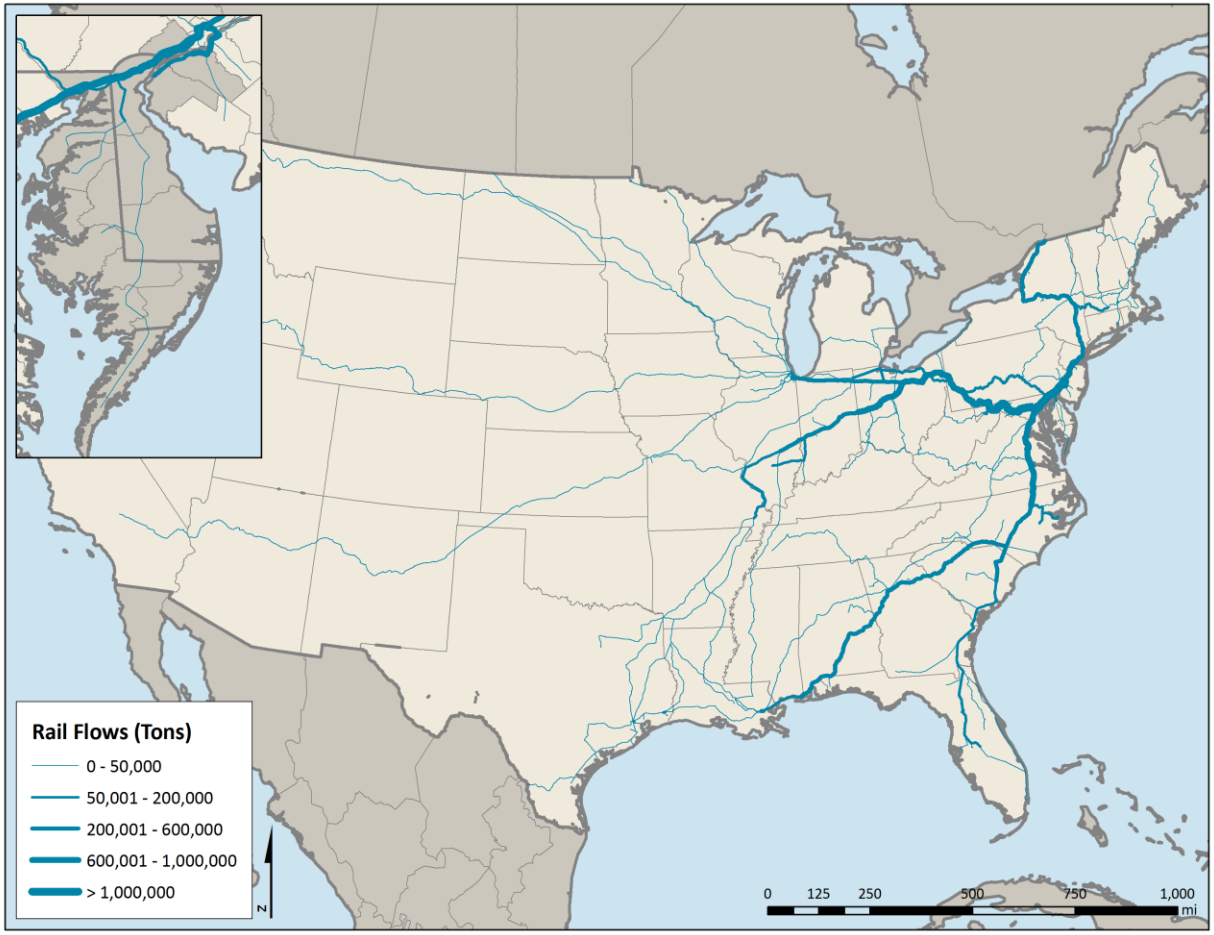
Total Value - Million USD

Mode	2011	2015	2020	2025	2030	CAGR 2011 - 2030
Truck	47,738	50,108	60,944	72,089	82,035	2.9%
Rail	3,898	4,138	4,924	5,493	5,791	2.1%
Water	1,515	1,559	1,909	2,217	2,444	2.5%
Air	1,968	2,053	2,469	2,934	3,469	3.0%
Total	**55,119**	**57,858**	**70,246**	**82,733**	**93,738**	

Overview of total rail flows in the study region

- Historical data suggests that inbound petroleum and chemical flows will grow more than twice as fast as outbound flows from 2011 to 2030 (1.9% vs. 0.8% CAGR).
- This occurs, in part, because the models assume the continuation of a historical shift towards Gulf Coast consolidation of production.
- Greater investment in regional petroleum refining, gas extraction, transportation (especially pipeline and rail), and chemicals manufacturing capacity could lead to more rapid growth of outbound traffic than forecasted in the baseline scenario.
- Although inbound tonnage is higher than outbound tonnage, the total value of outbound goods is much higher. This is due in large part to the fact that the remaining regional chemicals manufacturing (and petroleum refining) tends to add value to inputs, creating more valuable outputs.
- The study region shows strong inter-regional ties with the Midwest, Gulf Coast, and Canada for chemicals rail movements.

Total rail flows: *Strong ties to the Midwest, the Gulf Coast, and Canada*



Total rail flows: Chemicals and petroleum

Chemicals and Petroleum Tons Forecast - Thousand Tons

	2011	2015	2020	2025	2030	CAGR 2011-2030
Outbound	371	390	415	439	428	0.8%
Inbound	522	564	661	733	748	1.9%
Through	2,343	2,466	2,915	3,286	3,471	2.1%
Local	49	43	39	39	36	-1.6%
Total	**3,285**	**3,463**	**4,031**	**4,496**	**4,683**	1.9%

Chemicals and Petroleum Value Forecast - Million USD

	2011	2015	2020	2025	2030	CAGR 2011-2030
Outbound	738	798	865	908	888	1.0%
Inbound	535	568	666	738	767	1.9%
Through	3,026	3,170	3,774	4,214	4,464	2.1%
Local	57	51	46	46	43	-1.5%
Total	**4,356**	**4,587**	**5,351**	**5,906**	**6,161**	1.8%

Total rail flows: Chemicals only (including pharmaceuticals and plastics)

Chemical Tons Forecast without Petroleum and Products – Thousand Tons

	2011	2015	2020	2025	2030	CAGR 2011-2030
Outbound	351	373	399	423	413	0.9%
Inbound	468	509	609	682	704	2.2%
Through	2,086	2,209	2,668	3,048	3,260	2.4%
Total	**2,905**	**3,090**	**3,677**	**4,154**	**4,376**	2.2%

Chemical Value Forecast without Petroleum and Products – Million USD

	2011	2015	2020	2025	2030	CAGR 2011-2030
Outbound	715	777	846	889	871	1.0%
Inbound	469	503	603	677	713	2.2%
Through	2,714	2,858	3,475	3,927	4,208	2.3%
Total	**3,898**	**4,138**	**4,924**	**5,493**	**5,791**	2.1%

Overview of inbound rail flows

- The Great Lakes region serves as both a trans-shipment hub and intermediary manufacturing location for raw materials sourced from the Midwest, Plains, Pacific Northwest, and Canada.
  - The Potassium/Sodium Compounds are the top rail inbound commodities by tonnage. DuPont and Kuehne, among others, consume large quantities as inputs for regional manufacturing. Significant mining occurs in Northern Michigan, including caustic soda and other salts.
  - Commodity plastics, the top inbound category by value, are produced in the Midwest and ship to the study region as inputs for specialty plastics (Dupont) or high-end manufactured goods (Dow).
  - Chemicals Preparations are the fastest growing inbound rail commodity, including various fatty acids used by Croda and others as key inputs for detergents and OTC personal care products.
  - Miscellaneous Organic Chemicals are important feedstocks for FMC Biopolymer (acetic acid), Dupont (Newark, and other locations), Croda, and regional pharmaceutical companies. These are sourced largely from the Midwest, but also from the Gulf Coast and South Atlantic.
- The Gulf Coast is a primary source of other key chemical commodity inputs.
  - Industrial Gas is the second-fastest-growing commodity group. Formosa sources vinyl chlorine monomer (VCM), a key input for PVC pipe production, from its Gulf manufacturing facilities.
  - Although volumes are small, Miscellaneous Industrial Organic Chemicals such as Ethylene Oxide (EO) from the Gulf Coast are critical inputs to regional manufacturers, especially Croda.

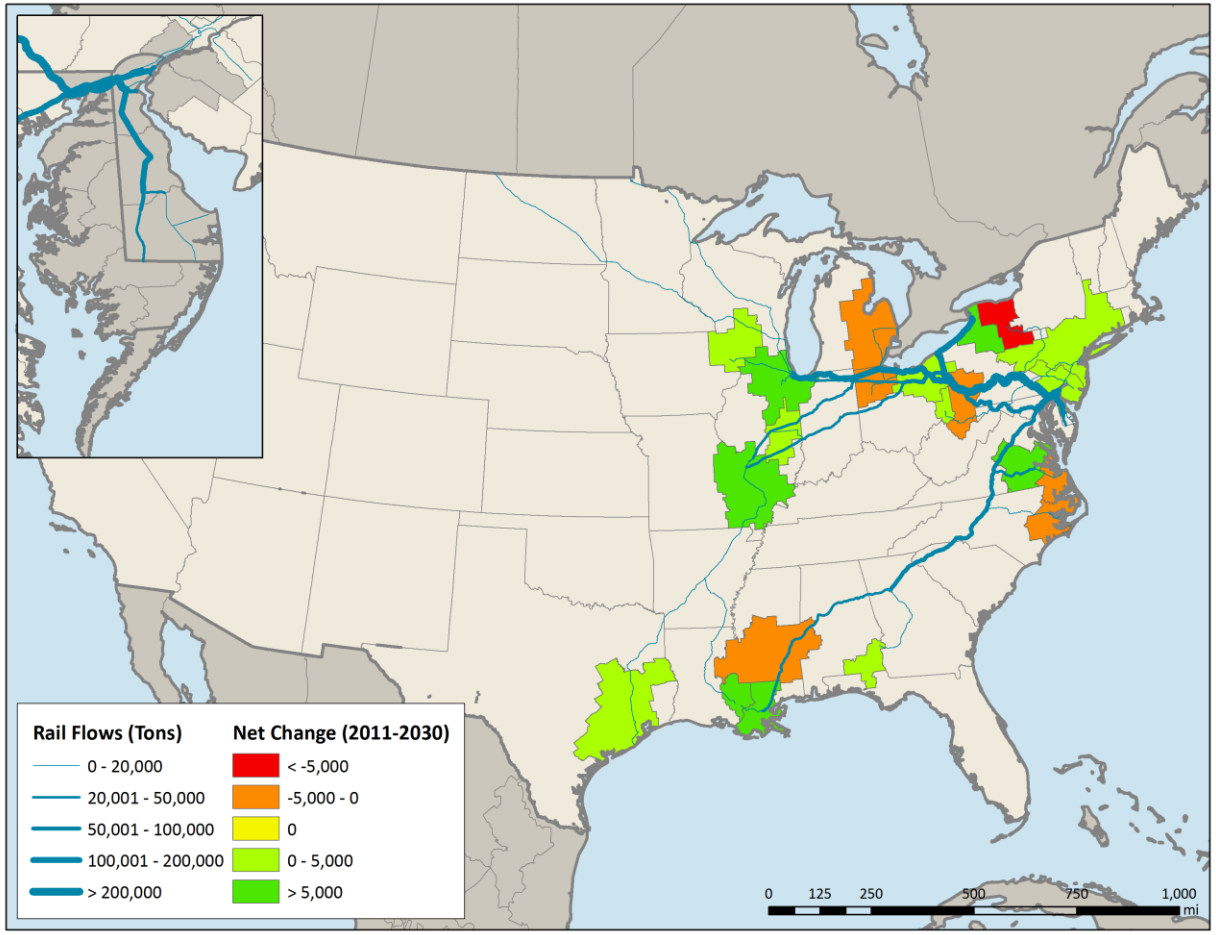
Overview of inbound rail flows, cont'd

- Plastic Materials and Synthetic Fibers are the top inbound commodities by value given the high relative prices of these intermediate goods. For example, DuPont fabricates key plastic resins in its Centerville, OH plant, which are shipped to Newark for manufacturing high-end automotive and aerospace plastic parts.
- Increased regional production of Chemicals Preparations, especially EO, could displace some of these inbound flows.
  - Croda is seeking to reduce supply chain risk by producing its own EO, as shipping costs from the Gulf Coast are high ($25,000 per rail car) and growing at 10-12% per year.
  - The location of an ethylene cracker in western PA or at Marcus Hook could allow for the entrance of a regional EO manufacturer to serve Croda and other companies in the Northeast/Mid-Atlantic
- These 2011 baseline estimates do not account for the rapid expansion of crude petroleum shipments via rail from Canada to the PBF refinery which could reach 300 train cars per day (215,000 barrels/day or 10.7 million metric tons per year). There is minimal threat of crude pipeline competition in the near term.
- NGLs will likely move via pipeline rather than rail in the long term. Thus, liquefied gases will not likely make up a significant share of inbound rail traffic, regardless of regional chemicals industry growth.

Inbound rail flows to the study region: Top inbound commodities

	Tons (000s) 2011	Tons (000s) 2030	CAGR 2011-2030	Value ($M) 2011	Value ($M) 2030	CAGR 2011–2030
Potassium or Sodium Compound	153	253	2.7%	49	81	2.7%
Plastic Mater or Synth Fibres	84	139	2.7%	181	302	2.7%
Liquefied Gases, Coal or Petroleum	65	53	-1.1%	65	54	-1.0%
Misc Industrial Organic Chemicals	55	72	1.5%	68	89	1.4%
Industrial Gases	53	108	3.8%	11	22	3.7%
Petroleum Refining Products	38	31	-1.1%	46	37	-1.1%
Fertilizers	32	30	-0.3%	14	13	-0.4%
Chemical Preparations, Nec	15	34	4.4%	51	115	4.4%
Misc Indus Inorganic Chemicals	7	10	1.8%	14	20	1.9%
Inorganic Pigments	4	5	0.9%	15	17	0.6%

Inbound rail flows to the study region: *Key ties to Great Lakes, Gulf Coast and South Atlantic*



Inbound rail flows to the study region:
Top origins by tonnage (2011)

Origin BEA	Destination BEA	Commodity	Thousand Tons
Buffalo, NY	Philadelphia, PA	Potassium or Sodium Compound	84
Chicago, IL	Salisbury, MD	Potassium or Sodium Compound	42
New Orleans, LA	Philadelphia, PA	Industrial Gases	28
St. Louis, MO	Philadelphia, PA	Plastic Mater or Synth Fibres	24
Chicago, IL	Philadelphia, PA	Misc Industrial Organic Chemicals	23
Chicago, IL	Philadelphia, PA	Plastic Mater or Synth Fibres	23
Chicago, IL	Philadelphia, PA	Potassium or Sodium Compound	20
Norfolk, VA	Salisbury, MD	Fertilizers	20
Rochester, NY	Philadelphia, PA	Liquefied Gases, Coal or Petroleum	18
Buffalo, NY	Philadelphia, PA	Plastic Mater or Synth Fibres	15

Inbound rail flows to the study region
Top origins by value (2011)

Origin BEA	Destination BEA	Commodity	Million USD
St. Louis, MO	Philadelphia, PA	Plastic Mater or Synth Fibres	52
Chicago, IL	Philadelphia, PA	Chemical Preparations, Nec	51
Chicago, IL	Philadelphia, PA	Plastic Mater or Synth Fibres	49
Buffalo, NY	Philadelphia, PA	Plastic Mater or Synth Fibres	33
Chicago, IL	Philadelphia, PA	Misc Industrial Organic Chemicals	28
Buffalo, NY	Philadelphia, PA	Potassium or Sodium Compound	27
Rochester, NY	Philadelphia, PA	Liquefied Gases, Coal or Petroleum	18
New Orleans, LA	Philadelphia, PA	Plastic Mater or Synth Fibres	17
Baton Rouge, LA	Philadelphia, PA	Plastic Mater or Synth Fibres	16
Cleveland, OH	Philadelphia, PA	Inorganic Pigments	15

Inbound rail flows to the study region
Top origins by tonnage (2030)

Origin BEA	Destination BEA	Commodity	Thousand Tons
Buffalo, NY	Philadelphia, PA	Potassium or Sodium Compound	139
Chicago, IL	Salisbury, MD	Potassium or Sodium Compound	70
New Orleans, LA	Philadelphia, PA	Industrial Gases	58
Buffalo, NY	Philadelphia, PA	Plastic Mater or Synth Fibres	41
St. Louis, MO	Philadelphia, PA	Plastic Mater or Synth Fibres	35
Chicago, IL	Philadelphia, PA	Chemical Preparations, Nec	34
Chicago, IL	Philadelphia, PA	Plastic Mater or Synth Fibres	33
Chicago, IL	Philadelphia, PA	Potassium or Sodium Compound	33
Chicago, IL	Philadelphia, PA	Misc Industrial Organic Chemicals	29
St. Louis, MO	Philadelphia, PA	Industrial Gases	24

Inbound rail flows to the study region
Top origins by value (2030)

Origin BEA	Destination BEA	Commodity	Million USD
Chicago, IL	Philadelphia, PA	Chemical Preparations, Nec	115
Buffalo, NY	Philadelphia, PA	Plastic Mater or Synth Fibres	88
St. Louis, MO	Philadelphia, PA	Plastic Mater or Synth Fibres	76
Chicago, IL	Philadelphia, PA	Plastic Mater or Synth Fibres	72
Buffalo, NY	Philadelphia, PA	Potassium or Sodium Compound	45
Chicago, IL	Philadelphia, PA	Misc Industrial Organic Chemicals	36
New Orleans, LA	Philadelphia, PA	Plastic Mater or Synth Fibres	25
Baton Rouge, LA	Philadelphia, PA	Plastic Mater or Synth Fibres	23
Chicago, IL	Salisbury, MD	Potassium or Sodium Compound	23
Detroit, MI	Philadelphia, PA	Petroleum Refining Products	21

Summary: Key regional inbound rail flows

Top Commodity Groups	Key Regional Inputs	Top Origins	Top Users
Potassium or Sodium Compound	Caustic Soda, Various Salts, Chlorine, and possibly Sulfuric Acid	Midwest	DuPont, Kuehne
Plastics	Commodity Plastic Resins	Midwest	DuPont, Dow
Organic Chemicals	Acetic Acid among Numerous	Midwest, Gulf Coast, South Atlantic	FMC Biopolymer, DuPont, Croda, Astra-Zeneca and Other Pharmaceuticals
Industrial Gases	Vinyl Chloride Monomer	Gulf Coast	Formosa
Petroleum	Crude Petroleum	Great Plains, Canada	PBF Energy
Chemical Preparations	Various Fatty Acids	Midwest	Croda
Misc Indus Inorganic Chemicals	Ethylene Oxide	Gulf Coast	Croda

Overview of outbound rail flows

- Chemicals produced in the study region by rail are principally destined for the Great Lakes and growing industrial regions of the South Atlantic.
- Industrial Inorganic Chemicals are the top outbound commodity by tonnage for the study region
  - Anhydrous Hydrochloric Acid and Sulfuric Acid are produced at DuPont Edgemoor and Delaware City plants, respectively
  - Kuehne produces Chlorine, Caustic Soda, and derivatives thereof
- Some of the inorganic chemicals produced regionally stay within the region.
  - DuPont operates a Spent Acid Regeneration Facility in Delaware City, producing Sulfuric Acid for PBF Energy and recycling/regenerating waste. DuPont also recycles some chlorine in the production of Titanium Dioxide at its Edgemoor Facility.
  - Kuehne (and, previously, Oxychem) also supply numerous regional chemical manufacturers.
- Inorganic Pigments (e.g., paints and adhesives) are the top outbound commodities by value.
  - Titanium Dioxide produced at DuPont's Edgemoor facility drives regional outbound rail flows.
- Crude products of Coal, Gas, and Petroleum such as Benzene produced at PBF Energy are the fastest growing outbound commodities by tonnage and value.

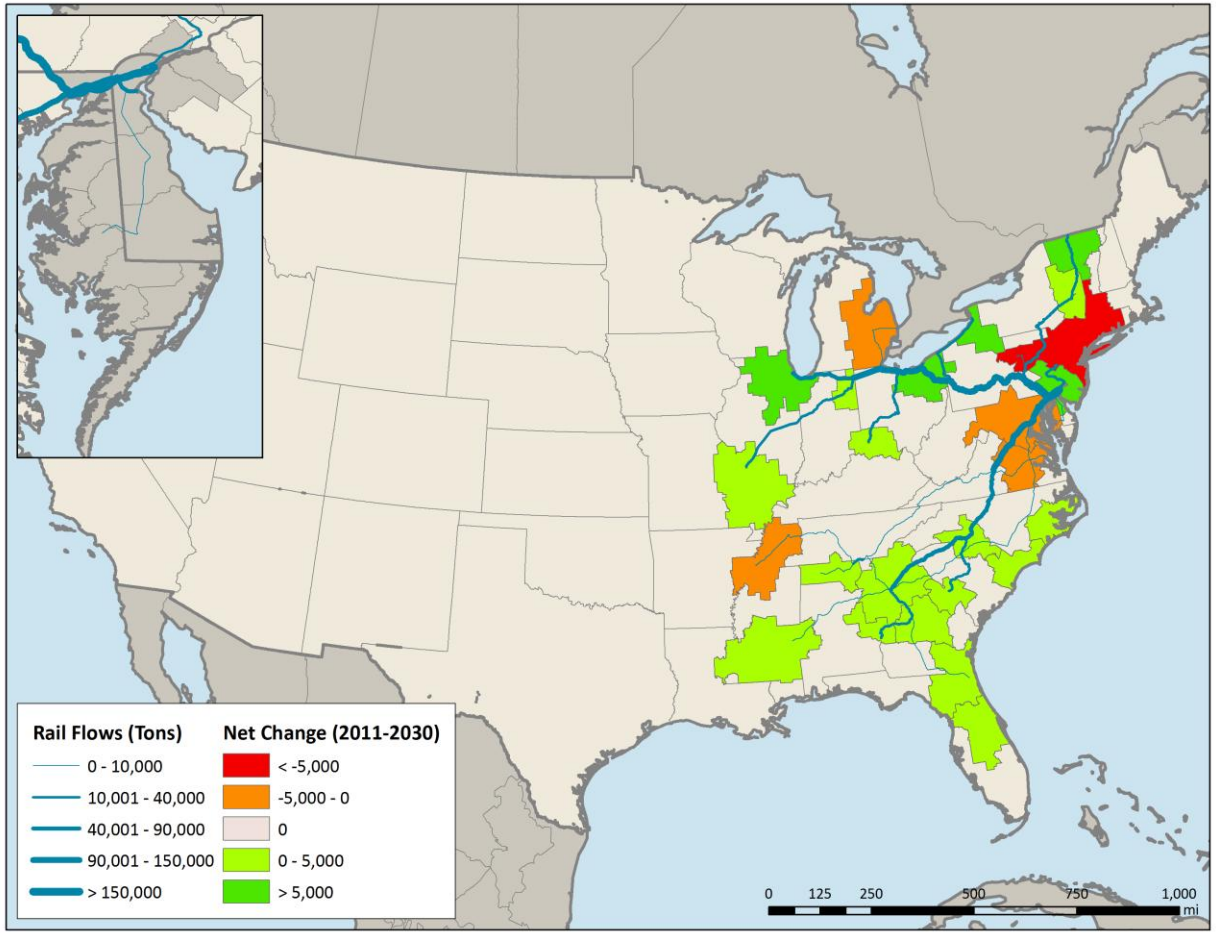
Overview of outbound rail flows, cont'd

- The baseline case suggests a continued decline of Liquefied Gases such as propylene and ethylene in the region.
  - This trend should shift in a positive direction with Marcellus extraction, the investment in the Mariner East pipeline, and regional ethylene cracking.
  - PBF Energy is already a producer of propylene and could possibly expand production.
- Chicago, the largest BEA in the industrial Midwest, not surprisingly, is the top destination for goods produced and shipped from the study region.
- Population and economic growth in the South Atlantic supports increased demand for inputs for building materials and inorganic pigments.

Outbound rail flows from the study region: Top outbound commodities

	Tons (000s) 2011	Tons (000s) 2030	CAGR 2011-2030	Value ($M) 2011	Value ($M) 2030	CAGR 2011-2030
Misc Indus Inorganic Chemicals	125	164	1.5%	256	337	1.5%
Inorganic Pigments	112	134	0.9%	402	479	0.9%
Chem or Fertilizer Mineri Crude	62	67	0.4%	5	6	0.4%
Liquefied Gases, Coal or Petroleum	36	23	-2.3%	36	23	-2.3%
Misc Coal or Petroleum Products	20	15	-1.5%	23	17	-1.5%
Crude Prod Of Coal, Gas, Petroleum	13	21	2.7%	15	25	2.7%
Fertilizers	4	4	-0.2%	2	2	-0.2%

Outbound rail flows from the study region: *Key ties to the Midwest and industrial Southeast*



Outbound rail flows from the study region
Top destinations by tonnage (2011)

Origin BEA	Destination BEA	Commodity	Thousand Tons
Philadelphia, PA	Chicago, IL	Inorganic Pigments	40
Philadelphia, PA	Chicago, IL	Misc Indus Inorganic Chemicals	33
Philadelphia, PA	Augusta, GA	Chem or Fertilizer Mineri Crude	30
Philadelphia, PA	New York, NY	Liquefied Gases, Coal or Petroleum	25
Philadelphia, PA	Jackson, MS	Misc Coal or Petroleum Products	20
Philadelphia, PA	Burlington, VT	Misc Indus Inorganic Chemicals	16
Philadelphia, PA	Greenville, NC	Chem or Fertilizer Mineri Crude	16
Philadelphia, PA	Cleveland, OH	Misc Indus Inorganic Chemicals	16
Philadelphia, PA	Columbus, GA	Inorganic Pigments	16
Philadelphia, PA	Cincinnati, OH	Inorganic Pigments	16

Outbound rail flows from the study region
Top destinations by value (2011)

Origin BEA	Destination BEA	Commodity	Million USD
Philadelphia, PA	Chicago, IL	Inorganic Pigments	143
Philadelphia, PA	Chicago, IL	Misc Indus Inorganic Chemicals	67
Philadelphia, PA	Columbus, GA	Inorganic Pigments	58
Philadelphia, PA	Cincinnati, OH	Inorganic Pigments	58
Philadelphia, PA	Macon, GA	Inorganic Pigments	43
Philadelphia, PA	Burlington, VT	Misc Indus Inorganic Chemicals	33
Philadelphia, PA	Cleveland, OH	Misc Indus Inorganic Chemicals	33
Philadelphia, PA	Buffalo, NY	Misc Indus Inorganic Chemicals	33
Philadelphia, PA	Burlington, VT	Inorganic Pigments	29
Philadelphia, PA	St. Louis, MO	Inorganic Pigments	29

Outbound rail flows from the study region
Top destinations by tonnage (2030)

Origin BEA	Destination BEA	Commodity	Thousand Tons
Philadelphia, PA	Chicago, IL	Inorganic Pigments	53
Philadelphia, PA	Chicago, IL	Misc Indus Inorganic Chemicals	43
Philadelphia, PA	Columbus, GA	Inorganic Pigments	18
Philadelphia, PA	Cincinnati, OH	Inorganic Pigments	18
Philadelphia, PA	Cleveland, OH	Misc Indus Inorganic Chemicals	24
Philadelphia, PA	Macon, GA	Inorganic Pigments	13
Philadelphia, PA	Burlington, VT	Misc Indus Inorganic Chemicals	22
Philadelphia, PA	Buffalo, NY	Misc Indus Inorganic Chemicals	22
Philadelphia, PA	Atlanta, GA	Misc Indus Inorganic Chemicals	16
Philadelphia, PA	Burlington, VT	Inorganic Pigments	9

Outbound rail flows from the study region
Top destinations by value (2030)

Origin BEA	Destination BEA	Commodity	Million USD
Philadelphia, PA	Chicago, IL	Inorganic Pigments	191
Philadelphia, PA	Chicago, IL	Misc Indus Inorganic Chemicals	88
Philadelphia, PA	Columbus, GA	Inorganic Pigments	64
Philadelphia, PA	Cincinnati, OH	Inorganic Pigments	64
Philadelphia, PA	Cleveland, OH	Misc Indus Inorganic Chemicals	49
Philadelphia, PA	Macon, GA	Inorganic Pigments	48
Philadelphia, PA	Burlington, VT	Misc Indus Inorganic Chemicals	46
Philadelphia, PA	Buffalo, NY	Misc Indus Inorganic Chemicals	45
Philadelphia, PA	Atlanta, GA	Misc Indus Inorganic Chemicals	33
Philadelphia, PA	Burlington, VT	Inorganic Pigments	32

Summary: Key regional outbound rail flows

Top Commodity Groups	Key Regional Outputs	Top Destinations	Top Producers
Inorganic Chemicals	Sulfuric Acid, Anhydrous Hydrochloric Acid Chlorine, and Caustic Soda	Midwest, Northeast, Canada	DuPont, Kuehne
Inorganic Pigments	Titanium Dioxide	Midwest, Southeast	DuPont
Petroleum Refining Products	Benzene	Mid-Atlantic	PBF Energy

Overview of total truck flows in the study region

- Trucks are more versatile and tend to carry higher value-added products compared to rail or barge.
- Total commodity flows are dominated by truck:
  - This trend is dominated by outbound flows of petroleum and petroleum products due to heavy regional refining activity including at PBF Energy.
  - Baseline forecasts suggest declining flows of petroleum refining due to consolidation in the Gulf Coast, but increased processing of Canadian (and possibly Bakken) crude could reverse this trend.
- Slightly different trends are evident for chemicals (including pharmaceuticals and plastics but excluding petroleum and petroleum products) by tonnage:
  - Inbound and outbound flows are currently more closely balanced, but inbound tonnage grows faster over the next 20 years.
  - However, the value of outbound goods ostensibly produced (or warehoused and distributed) in the study area grows nearly as fast as the value of inbound commodities.
  - The baseline trend is that regional chemicals production continues to shift from high volume to high value-added products, such that outbound cargo value grows faster per ton than inbound cargo.
  - Opportunities to increase the trajectory of outbound shipments could increase with investment in regional chemical feedstock extraction, transport, and manufacturing.

Total truck flows: Petroleum and chemicals

Chemical Tons Forecast - Thousand Tons

	2011	2015	2020	2025	2030	CAGR 2011 - 2030
Through	9,722	10,354	12,282	13,813	14,666	2.2%
Outbound	71,934	70,666	73,050	70,300	64,290	-0.6%
Inbound	7,800	8,425	10,137	11,307	11,854	2.2%
Local	1,088	1,104	1,144	1,161	1,121	0.2%
Total	**90,544**	**90,549**	**96,613**	**96,581**	**91,931**	0.1%

Chemical Value Forecast - Million USD

	2011	2015	2020	2025	2030	CAGR 2011 - 2030
Through	28,361	30,131	37,061	44,308	50,831	3.1%
Outbound	69,208	68,535	72,219	71,400	67,855	-0.1%
Inbound	10,183	11,035	13,412	15,476	16,982	2.7%
Local	751	769	807	805	771	0.1%
Total	**108,504**	**110,470**	**123,499**	**131,989**	**136,439**	1.2%

Total truck flows: Chemicals only

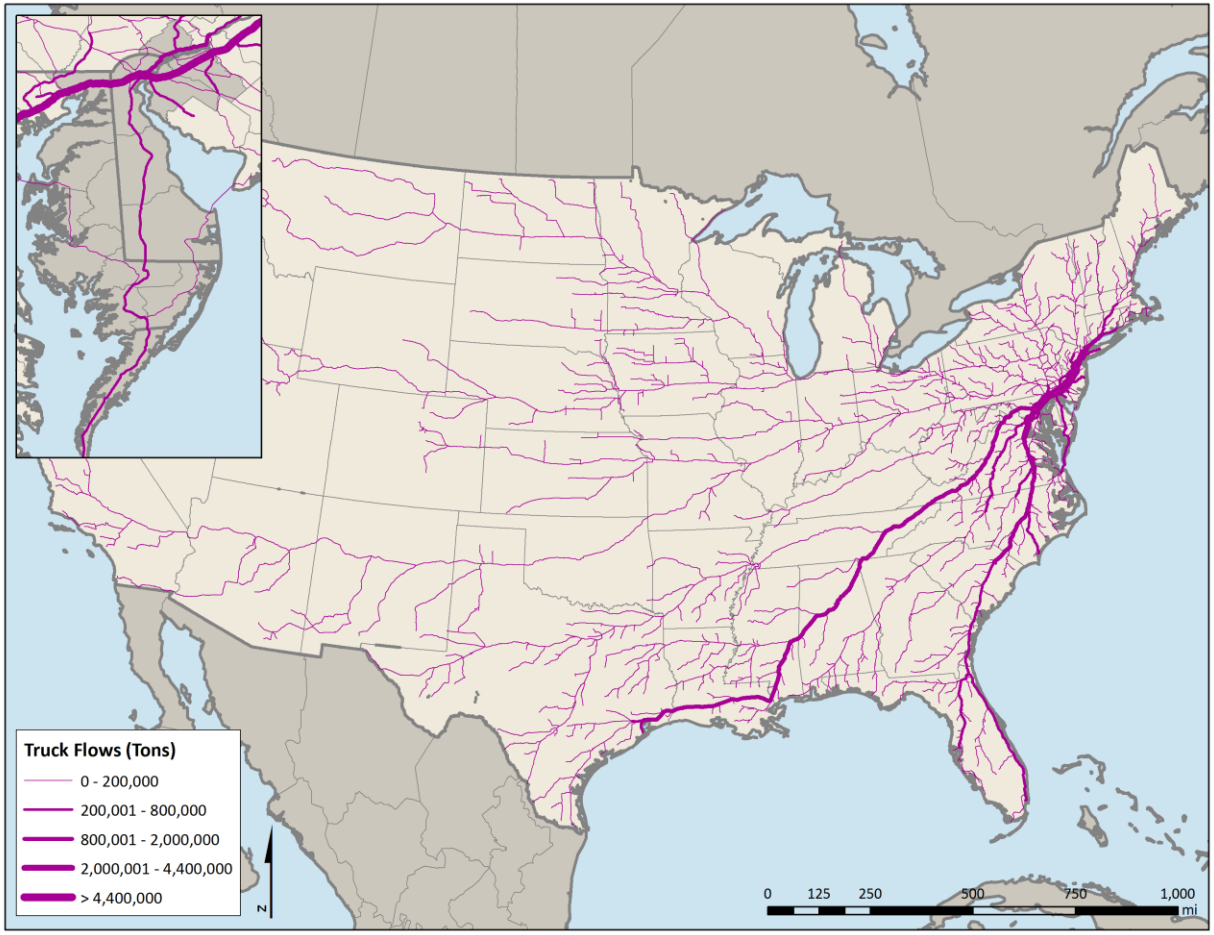
Chemical Tons Forecast without Petroleum and Products - Thousand Tons

	2011	2015	2020	2025	2030	CAGR 2011 - 2030
Through	9,268	9,877	11,738	13,233	14,108	2.2%
Outbound	6,353	5,939	6,077	6,324	6,316	-0.1%
Inbound	7,505	8,096	9,770	10,892	11,408	2.2%
Local	567	532	525	536	521	-0.4%
Total	**23,692**	**24,444**	**28,111**	**30,985**	**32,352**	1.7%

Chemical Value Forecast without Petroleum and Products - Million USD

	2011	2015	2020	2025	2030	CAGR 2011 - 2030
Through	28,231	29,707	36,575	43,788	50,330	3.1%
Outbound	9,298	9,400	11,028	12,943	14,880	2.5%
Inbound	9,933	10,754	13,098	15,121	16,600	2.7%
Local	276	248	243	236	225	-1.1%
Total	**47,738**	**50,108**	**60,944**	**72,089**	**82,035**	2.9%

Total truck flows through the study area: *Strong ties to Gulf Coast and Mid-Atlantic*



Summary of inbound truck flows

- Commodities coming to the study region by truck are principally sourced from the Gulf Coast and Southeast.
- While many inbound goods may be used in chemicals and, especially pharmaceuticals manufacturing, much of the inbound truck tonnage from the Gulf Coast and Southeast are also consumed by other sectors in the region.
- Industrial organic chemicals are by far the top inbound commodities and are used especially in pharmaceutical manufacturing.
  - AstraZeneca, Noramco and other regional pharmaceutical companies source inputs, often industrial organic chemicals, almost exclusively by truck.
  - These products have numerous uses both as end-use products (e.g., anti-freezes) or inputs to non-chemical manufacturing (e.g., construction materials).
  - Other industrial organic chemicals are used in fuel production input (PBF Energy), over-the-counter (OTC) personal care products, plastic bottle-making for local beverage distributors, and specialty manufacturers (e.g. engineering plastic parts).
  - Organic chemicals inbound shipments may also be displaced if cheap NGLs sourced form Marcellus lead to regional investment in ethylene and propylene derivatives.

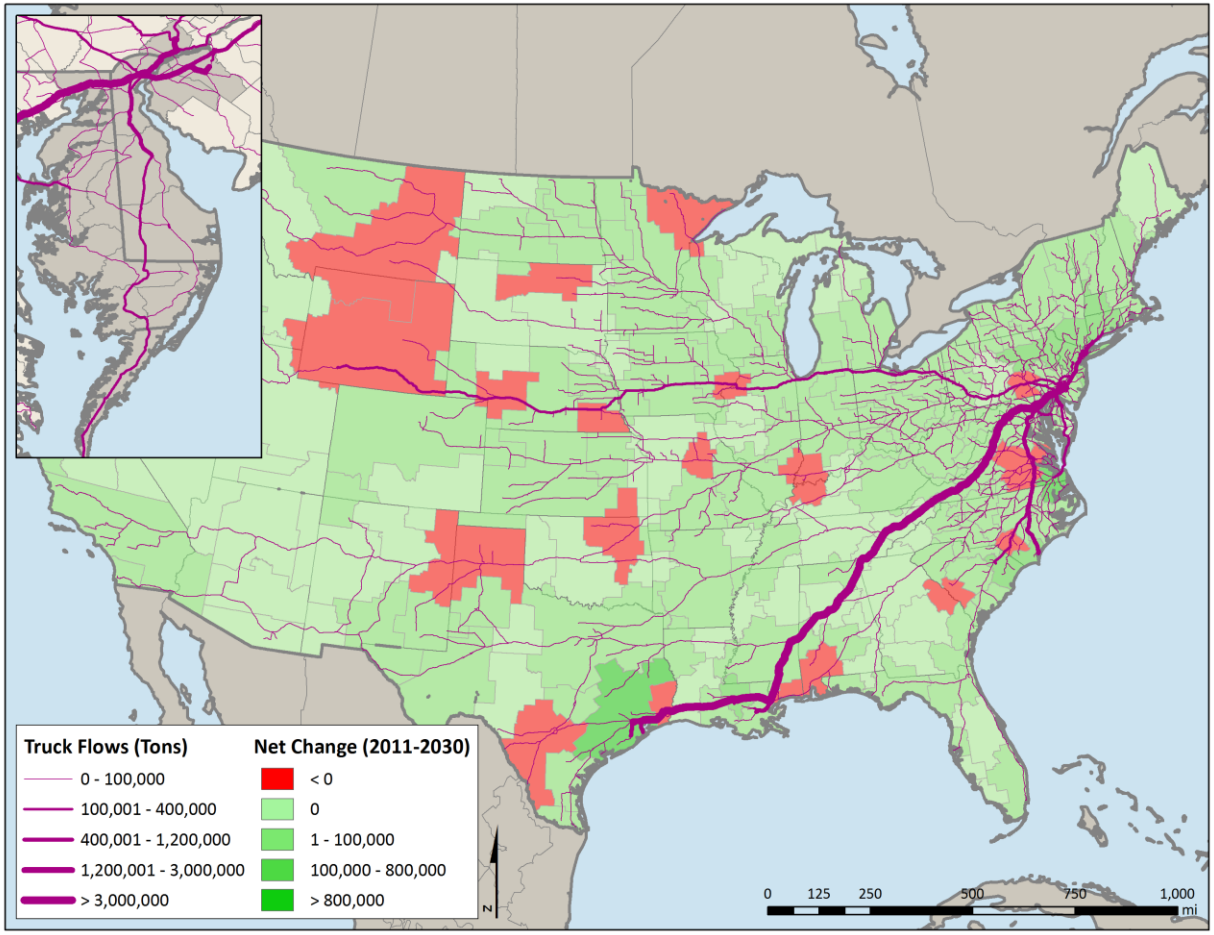
Summary of inbound truck flows, cont'd

- Crude Production of Coal, Gas, and Petroleum is the second largest inbound cargo class by volume. While the baseline case suggests continued rapid growth, regional benzene and methanol production could displace Gulf coast inbound volumes.
- Pharmaceuticals are the fastest growing inbound chemical commodity by value and tonnage. The Greater New York Metropolitan Area is a key origin (and destination) in this supply chain.

Inbound truck flows to the study area: Top commodities

Commodity	Tons (000s) 2011	Tons (000s) 2030	CAGR 2011 - 2030	Value ($M) 2011	Value ($M) 2030	CAGR 2011 - 2030
Misc Industrial Organic Chemicals	3,620	5,640	2.4%	3,537	5,519	2.4%
Crude Prod Of coal, gas and petroleum	974	1,609	2.7%	822	1,359	2.7%
Cyclic Intermediates or Dyes	439	617	1.8%	442	623	1.8%
Plastic Mater or Synth Fibres	338	539	2.5%	713	1,155	2.6%
Misc Indus Inorganic Chemicals	333	418	1.2%	566	711	1.2%
Potassium or Sodium Compound	298	406	1.6%	89	121	1.6%
Misc Coal or Petroleum Products	283	421	2.1%	242	360	2.1%
Fertilizers	254	312	1.1%	84	103	1.1%
Liquefied Gases, Coal or Petroleum	213	210	-0.1%	173	170	-0.1%
Chem or Fertilizer Mineri Crude	209	194	-0.4%	14	13	-0.4%
Soap or Other Detergents	89	142	2.5%	152	243	2.5%
Cosmetics,perfumes, Etc.	80	133	2.7%	319	530	2.7%
Drugs	69	163	4.6%	1,264	2,984	4.6%

Inbound truck flows to the study region: Strong intra-regional ties to the Mid-Atlantic and the Gulf Coast



Inbound truck flows to the study region:
Top origins by tonnage (2011)

Origin BEA	Destination BEA	Commodity	Thousand Tons
Houston, TX	Philadelphia, PA	Misc Industrial Organic Chemicals	1,882
Houston, TX	Philadelphia, PA	Crude Prod Of Coal,gas,petroleum	889
New Orleans, LA	Philadelphia, PA	Misc Industrial Organic Chemicals	516
Baton Rouge, LA	Philadelphia, PA	Misc Industrial Organic Chemicals	380
Richmond, VA	Philadelphia, PA	Misc Industrial Organic Chemicals	264
Wilmington, NC	Philadelphia, PA	Plastic Mater or Synth Fibres	212
Wilmington, NC	Philadelphia, PA	Misc Industrial Organic Chemicals	190
Wilmington, NC	Philadelphia, PA	Cyclic Intermediates or Dyes	169
Houston, TX	Philadelphia, PA	Cyclic Intermediates or Dyes	160
New York, NY	Philadelphia, PA	Misc Indus Inorganic Chemicals	147

Inbound truck flows to the study area:
Top origins by value (2011)

Origin BEA	Destination BEA	Commodity	Million USD
Houston, TX	Philadelphia, PA	Misc Industrial Organic Chemicals	1,835
New York, NY	Philadelphia, PA	Drugs	1,016
Houston, TX	Philadelphia, PA	Crude Prod Of Coal,gas,petroleum	752
New Orleans, LA	Philadelphia, PA	Misc Industrial Organic Chemicals	502
Wilmington, NC	Philadelphia, PA	Plastic Mater or Synth Fibres	435
Baton Rouge, LA	Philadelphia, PA	Misc Industrial Organic Chemicals	370
New York, NY	Philadelphia, PA	Cosmetics,perfumes, Etc.	265
Richmond, VA	Philadelphia, PA	Misc Industrial Organic Chemicals	257
New York, NY	Philadelphia, PA	Misc Indus Inorganic Chemicals	250
Wilmington, NC	Philadelphia, PA	Misc Industrial Organic Chemicals	185

Inbound truck flows to the study region:
Top origins by tonnage (2030)

Origin BEA	Destination BEA	Commodity	Thousand Tons
Houston, TX	Philadelphia, PA	Misc Industrial Organic Chemicals	2,928
Houston, TX	Philadelphia, PA	Crude Prod Of Coal,gas,petroleum	1,489
Norfolk, VA	Philadelphia, PA	Misc Industrial Organic Chemicals	731
New Orleans, LA	Philadelphia, PA	Misc Industrial Organic Chemicals	557
Baton Rouge, LA	Philadelphia, PA	Misc Industrial Organic Chemicals	467
Wilmington, NC	Philadelphia, PA	Misc Industrial Organic Chemicals	355
Wilmington, NC	Philadelphia, PA	Plastic Mater or Synth Fibres	281
Richmond, VA	Philadelphia, PA	Misc Industrial Organic Chemicals	238
Wilmington, NC	Philadelphia, PA	Cyclic Intermediates or Dyes	228
New York, NY	Philadelphia, PA	Misc Coal or Petroleum Products	220

Inbound truck flows to the study region:
Top origins by value (2030)

Origin BEA	Destination BEA	Commodity	Million USD
Houston, TX	Philadelphia, PA	Misc Industrial Organic Chemicals	2,854
New York, NY	Philadelphia, PA	Drugs	2,389
Houston, TX	Philadelphia, PA	Crude Prod Of Coal,gas,petroleum	1,259
Norfolk, VA	Philadelphia, PA	Misc Industrial Organic Chemicals	713
Wilmington, NC	Philadelphia, PA	Plastic Mater or Synth Fibres	578
New Orleans, LA	Philadelphia, PA	Misc Industrial Organic Chemicals	543
Baton Rouge, LA	Philadelphia, PA	Misc Industrial Organic Chemicals	455
New York, NY	Philadelphia, PA	Cosmetics,perfumes, Etc.	433
Wilmington, NC	Philadelphia, PA	Misc Industrial Organic Chemicals	346
New York, NY	Salisbury, MD	Drugs	296

Summary: Key regional inbound truck flows

Top Commodity Groups	Key Regional Inputs	Top Origins	Top Users
Organic Chemicals	Polyethylene, Polypropylene, Various Pharmaceutical Inputs, and Many Other Important Manufacturing Inputs	Gulf Coast and South Atlantic	AstraZeneca, Noramco, Graham Packaging, Invista, Regional Bottling Operations, and Others
Products of Crude Production	Methanol	Gulf Coast	Widely Used In Chemicals and Other Manufacturing

Summary of outbound truck flows

- All of the top destinations for chemicals produced and or distributed through the study region are in the Northeast and Mid-Atlantic. Therefore, the key markets for regionally-produced goods are in relatively close proximity.
- Petroleum Refining Products are by far the top regional outbound commodity by tonnage, followed by Liquefied Gases.
  - Baseline trends suggest a decline in long-term outbound flows of these products from the region on account of industry consolidation in the Gulf.
  - This trend could potentially be partially reversible with a combination of investment in Marcellus extraction, pipeline and other transportation infrastructure, and regional refining and ethylene production.
- Plastic materials and synthetic fibers are the fastest growing commodity groupings by tonnage and value.
  - DuPont Newark facilities are poised to increase production of specialty plastic parts (e.g. for automobile, machines and aviation) as U.S. demand expands. About 50% of these goods move by truck (the rest by air).
  - Formosa ships PVC pipes by truck.
- Specialty products such as personal care formulations and pharmaceuticals and their intermediates also generally move by truck.

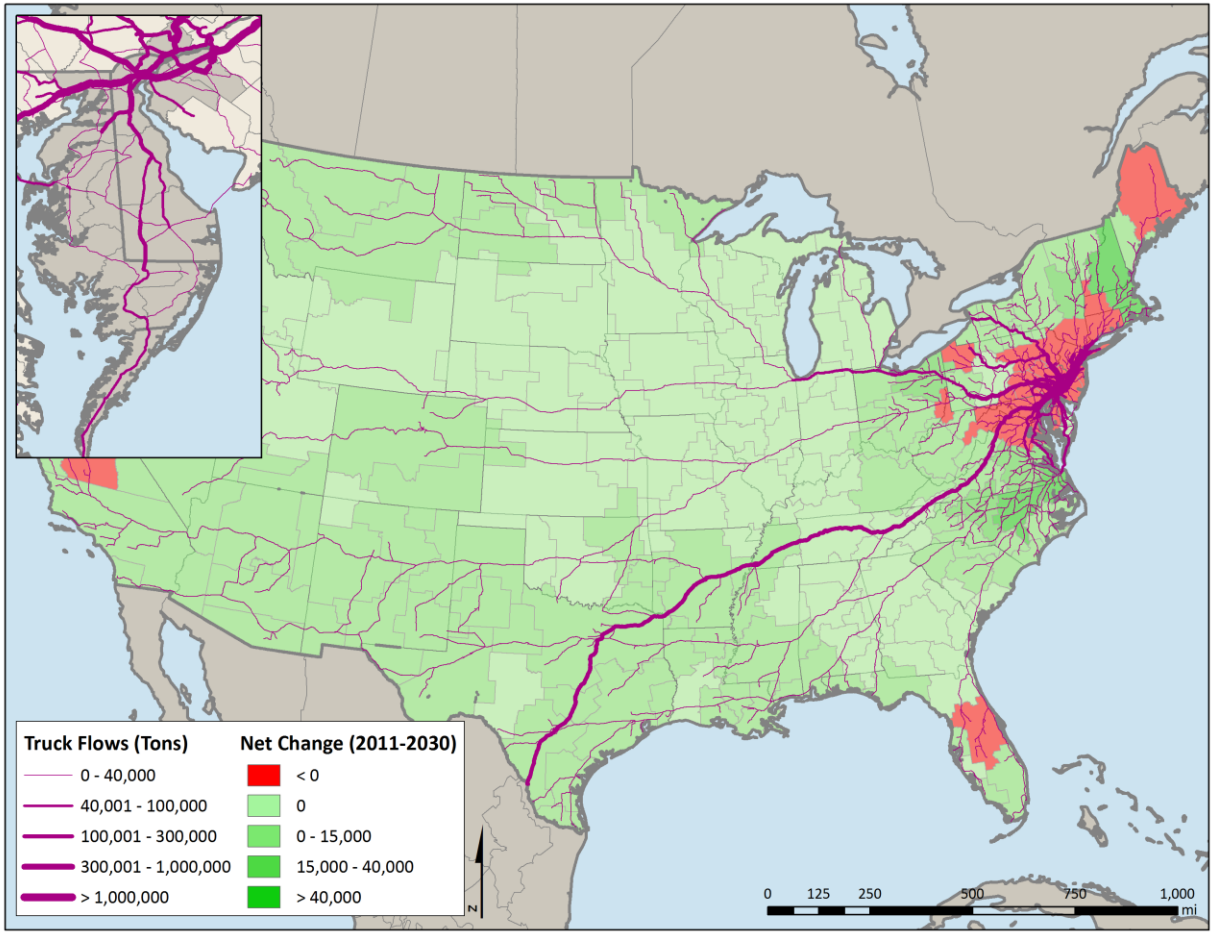
Summary of outbound truck flows, cont'd.

- Outbound truck flows of specialty cleaning products are also growing rapidly
  - Esters and surfactants produced regionally by Croda are distributed though a third-party logistics firm in Delaware primarily via truck.
- New York is the largest market for regionally produced refined petroleum products and pharmaceuticals.

Outbound truck flows from the study region: Top outbound commodities

Commodity	Tons (000s) 2011	Tons (000s) 2030	CAGR 2011 - 2030	Value ($M) 2011	Value ($M) 2030	CAGR 2011 - 2030
Petroleum Refining Products	65,382	57,923	-0.6%	59,739	52,931	-0.6%
Liquefied Gases, Coal or Petroleum	3,602	1,895	-3.3%	2,926	1,539	-3.3%
Chemical or Fertilizer Mineral Crude	739	823	0.6%	46	51	0.5%
Fertilizers	381	444	0.8%	126	147	0.8%
Specialty Cleaning Preparations	290	468	2.6%	491	794	2.6%
Crude Prod Of coal, gas and petroleum	277	347	1.2%	230	288	1.2%
Plastic Mater or Synth Fibres	269	725	5.4%	607	1,650	5.4%
Misc Coal or Petroleum Products	199	51	-6.9%	171	44	-6.9%
Misc Plastic Products	193	485	5.0%	632	1,591	5.0%
Drugs	132	272	3.9%	3,086	6,607	4.1%
Surface Active Agents	94	151	2.5%	193	321	2.7%
Potassium or Sodium Compound	64	101	2.4%	20	32	2.4%
Misc Industrial Organic Chemicals	6	13	4.5%	16	38	4.5%

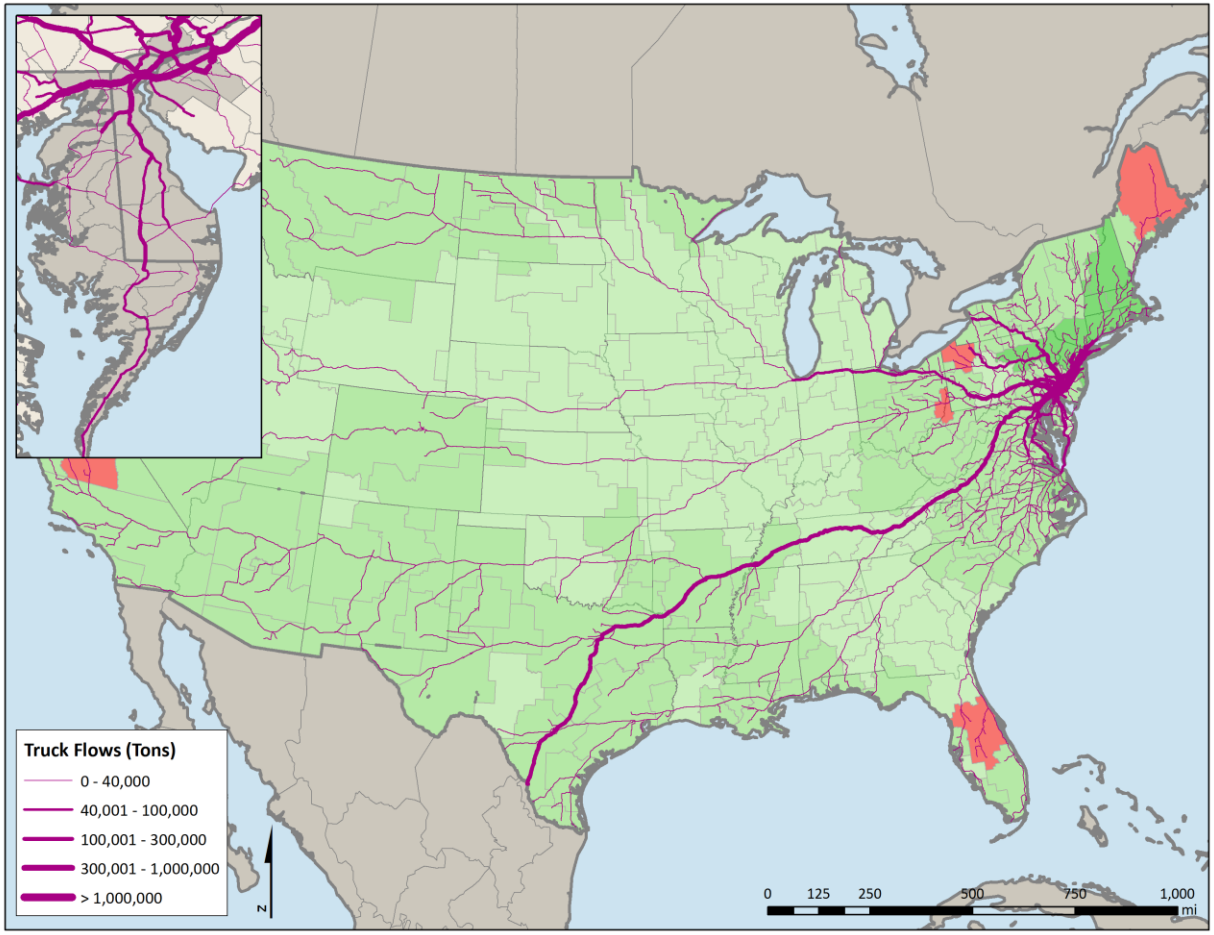
Outbound truck flows from the study region: *Key markets in the Mid-Atlantic and other proximate regions*



Evolving Mid-Atlantic market

- The previous map forecasts declining growth in flows to the Mid-Atlantic. This is in part a reflection of recent declining historical trends for liquid gases.
- Marcellus shale extraction could lead to a revival in regional production of liquid gases, reversing this trend.
- The slide illustrates outbound truck flows again excluding the fast-changing liquid gas grouping. Growth is slow but steady to Mid-Atlantic, reflecting regional economic and population growth patterns.

Outbound truck flows from the study region:
Excludes liquid gases



Outbound truck flows from the study region: *Top destinations by tonnage (2011)*

Origin BEA	Destination BEA	Commodity	Thousand Tons
Philadelphia, PA	New York, NY	Petroleum Refining Products	28,099
Philadelphia, PA	Washington, DC	Petroleum Refining Products	18,211
Philadelphia, PA	Philadelphia, PA	Petroleum Refining Products	11,434
Philadelphia, PA	Harrisburg, PA	Petroleum Refining Products	5,412
Philadelphia, PA	New York, NY	Liquefied Gases, Coal or Petroleum	1,863
Philadelphia, PA	Washington, DC	Liquefied Gases, Coal or Petroleum	755
Philadelphia, PA	Philadelphia, PA	Liquefied Gases, Coal or Petroleum	726
Philadelphia, PA	Richmond, VA	Petroleum Refining Products	640
Philadelphia, PA	Norfolk, VA	Petroleum Refining Products	573
Philadelphia, PA	Philadelphia, PA	Chem or Fertilizer Mineri Crude	514

Outbound truck flows from the study region:
Top destinations by value (2011)

Origin BEA	Destination BEA	Commodity	Million USD
Philadelphia, PA	New York, NY	Petroleum Refining Products	25,670
Philadelphia, PA	Washington, DC	Petroleum Refining Products	16,637
Philadelphia, PA	Philadelphia, PA	Petroleum Refining Products	10,445
Philadelphia, PA	Harrisburg, PA	Petroleum Refining Products	4,944
Philadelphia, PA	New York, NY	Liquefied Gases, Coal or Petroleum	1,513
Philadelphia, PA	New York, NY	Drugs	1,184
Philadelphia, PA	Buffalo, NY	Drugs	883
Philadelphia, PA	Washington, DC	Liquefied Gases, Coal or Petroleum	613
Philadelphia, PA	Philadelphia, PA	Liquefied Gases, Coal or Petroleum	590
Philadelphia, PA	Richmond, VA	Petroleum Refining Products	585

Outbound truck flows from the study region: *Top destinations by tonnage (2030)*

Origin BEA	Destination BEA	Commodity	Thousand Tons
Philadelphia, PA	New York, NY	Petroleum Refining Products	20,855
Philadelphia, PA	Washington, DC	Petroleum Refining Products	19,409
Philadelphia, PA	Philadelphia, PA	Petroleum Refining Products	10,601
Philadelphia, PA	Harrisburg, PA	Petroleum Refining Products	5,250
Philadelphia, PA	New York, NY	Liquefied Gases, Coal or Petroleum	867
Philadelphia, PA	Philadelphia, PA	Chem or Fertilizer Mineri Crude	525
Philadelphia, PA	Richmond, VA	Petroleum Refining Products	472
Philadelphia, PA	Philadelphia, PA	Liquefied Gases, Coal or Petroleum	467
Philadelphia, PA	Norfolk, VA	Petroleum Refining Products	431
Philadelphia, PA	Syracuse, NY	Petroleum Refining Products	396

Outbound truck flows from the study region: *Top destinations by value (2030)*

Origin BEA	Destination BEA	Commodity	Million USD
Philadelphia, PA	New York, NY	Petroleum Refining Products	19,052
Philadelphia, PA	Washington, DC	Petroleum Refining Products	17,731
Philadelphia, PA	Philadelphia, PA	Petroleum Refining Products	9,685
Philadelphia, PA	Harrisburg, PA	Petroleum Refining Products	4,796
Philadelphia, PA	New York, NY	Drugs	2,413
Philadelphia, PA	Non-CMA, ON	Drugs	1,275
Salisbury, MD	New York, NY	Drugs	715
Philadelphia, PA	New York, NY	Liquefied Gases, Coal or Petroleum	704
Philadelphia, PA	New York, NY	Specialty Cleaning Preparations	593
Philadelphia, PA	Norfolk, VA	Drugs	507

Summary: Key regional outbound truck flows

Top Commodity Groups	Key Regional Outputs	Top Destinations	Top Producers
Petroleum Refining Products	Gasoline, Propylene, Fuel Additives	Mid-Atlantic and Northeast	PBF Energy
Specialty Cleaning Preparations	Numerous Detergents and OTC Personal Care Products	Mid-Atlantic and Northeast	Croda
Plastics and Synthetic Fibers	Specialty Automotive and Aerospace Materials, PVC Piping, Nylons, and Other Cellulose-based Materials	Mid-Atlantic and Northeast	DuPont, Formosa, Invista, FMC Biopolymer
Pharmaceuticals	Numerous Pharmaceuticals Products	Mid-Atlantic and Northeast	Astra-Zeneca, Noramco, and Others

Airport and seaport logistics

- Airports
  - About half of all outbound Dow electronics equipment shipments fly to Asia
  - About half of all DuPont – Newark specialty plastics output moves via air through PHL and BWI to customer destinations. UPS, FedEx, and DHL services are utilized.
  - Outbound regional pharmaceuticals manufactured products traveling long distances typically move as air cargo.
- Seaports
  - PBF Energy ships coke to Europe via the Port of Wilmington.
  - About half of Dow Electronics products move via the Port of Baltimore to destinations in Asia.

Pipelines

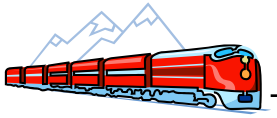
- Crude oil
  - There are no current proposals to build crude pipelines from the mid-Continent through the US to the Northeast/ Mid-Atlantic.
  - There is a proposal to build a pipeline from Alberta (with a ramp to carry Bakken crude as well) to St. John, New Brunswick (Energy East) by 2018, which is pending approval by Canadian regulatory authorities.
  - A combination of pipeline plus tanker shipment from St. John to the Delaware Bay would likely be cheaper than current rail rates by about $4-5 per barrel.
  - If the Energy East pipeline is built, US rail companies would likely lower prices, and an equilibrium will be reached.
    - No Energy East Pipeline: Estimated 6-7 unit trains per day to region, roughly split between the Philadelphia and Wilmington areas.
    - Energy East Pipeline: Estimate 3 unit trains per day to region, roughly split between the Philadelphia and Wilmington areas.

Pipelines, cont'd.

- NGL
  - Mariner East capacity: 70,000 barrels/day of NGLs
  - Mariner East should be completed by 2014 for propane
  - Fully operational for ethane and propane in 2015
- Natural gas (methane)
  - There are two proposed major expansions of natural gas pipelines east-west and north-south through the mid-Atlantic.
  - The pipelines will mostly add capacity and connectivity to areas already served by major natural gas trunk lines.
  - The major (and planned) natural gas pipelines pass near Northern Delaware, mostly bypass the Delmarva Peninsula.
  - Delmarva may benefit from regional increases in methane supply, but will pay a relative premium to serve areas off of main pipelines.

Summary of key elements of the Delmarva chemicals manufacturing supply chain

- Caustic Soda
- Chlorine
- Intermediate Plastics
- Acetic Acid
- Vinyl Chloride Monomer
- Ethylene Oxide



- Methanol
- Polyethylene
- Polypropylene

- Specialty Plastics
- Pharmaceuticals

- Sulfuric Acid
- Caustic Soda
- Benzene
- Titanium Dioxide
- Anhydrous Hydrochloric Acid
- Chlorine

- Detergents
- Personal care Products
- Propylene
- Pharmaceuticals
- Automotive and Aerospace materials
- PVC Piping

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  - Possible interventions and current status
  - Scenario analysis: Key transportation gaps

Overview of SWOT analysis

- Wilmapco and the study team conducted meetings and interviews with chemicals and transportation industry representatives and government officials in the Delmarva area to solicit feedback on the future of chemicals manufacturing in Delmarva.
- This section summarizes the regional strengths, weaknesses, opportunities, and threats to regional chemicals manufacturing identified during this primary research phase.
- The feedback paints a mixed picture, but one of guarded optimism if the right policies and investments can successfully leverage the Marcellus/Utica shale opportunity.

Summary of regional supply chain strengths and weaknesses

Strengths	Weaknesses
Transportation	**Transportation**
• Central location: One-third of U.S. population is within a one-day drive	• Bottlenecks on rail corridor through Cecil County due to shared use of track with Amtrak
• Generally good highway access and low congestion	• Congestion on the rail corridor from Newark to Edgemoor
• Regional logistics service providers experienced with chemicals	• Dependence on a single rail company for service up and down the Delmarva Peninsula and to the Gulf Coast
• Legacy infrastructure for petroleum and chemicals loading/offloading at regional ports	• Inadequate berth depths for largest LNG and LPG tankers at Marcus Hook and regional ports.
• Multiple Class I rail operators between Delmarva and the Midwest and Canada	• Air cargo access is challenging for just-in-time deliveries of certain specialty products
• Development of NGL pipeline to Marcus Hook	• Port of Wilmington does not have regular service to destinations in Asia
• Dredging of the Delaware Bay Channel to 45 feet	• Distance to suppliers and costs of shipment for some key hazardous feedstocks from the Gulf Coast
• Proximity to seaports and airports in Philadelphia and Baltimore	• General lack of connectivity of Southern Delmarva manufacturing areas to the Northern Delmarva cluster.
Other Policy Domains	**Other Policy Domains**
• Critical mass and regional “know-how”	• State’s size leads to lack of bargaining on energy pricing
• Partnerships with the University of Delaware and Philadelphia area universities	• Coastal Zone Management regulations complicated development
• Good trade schools (Williamson and DelTech)	• Lack of sufficient workforce long term

Summary of other regional advantages and challenges for chemicals manufacturing

Opportunities	Threats
• Sustained economic growth in the United States and abroad increases market demand for chemicals manufacturing products from the region	• The Coastal Zone Management Act's inflexibility could make it impossible for any major chemicals manufacturer to develop new facilities unless already situated in an existing "grandfathered" site.
• Mariner East pipeline provides low feedstock costs to support some existing and possible future chemicals manufacturing. In particular, ethylene and derivative production would be beneficial to the chemicals industry. A methanol plant would have strong positive impacts on related industries such as construction.	• The Delaware Basin Commission Moratorium on LNG could slow the development of natural gas and pipelines to the region, which might otherwise lower energy costs and/or spur new basic chemicals manufacturing in the region (e.g., methanol and ammonia)
• The U.S. Gulf Coast is growing congested, and at some point the region's economies-of-scale advantages could be diminished.	• The combination of consolidation of commodities chemical manufacturing in the Gulf Coast with increased rail shipping costs for hazardous chemicals (EO and VCM) may lead some industries to consider relocating south.
• Building-out natural gas pipelines to source cheap Marcellus extraction could give regional manufacturers an energy cost advantage (or perhaps reduce the current disadvantage)	• Risk of rail bottlenecks (Northern Delmarva) or rail availability (Southern Delmarva) place risk on feedstock procurement.
• As transportation costs from the U.S. Gulf Coast increase, there could be a growing market in the Northeast for regionally-produced commodity chemicals.	• Underinvestment in transportation infrastructure, in general, is a constant threat. This includes port dredging, road maintenance, rail maintenance, etc. This threat is not necessarily unique to the region.
• Panama Canal expansion offers new opportunities for closer direct trade relationships with Asia	• Workforce – the combination of an aging regional workforce with competition for skilled employees in the Gulf Coast could reduce availability of employees for regional industry expansion.
• Current engagement of industry with local universities and trade schools helps build a robust skilled regional workforce as a competitive advantage.	• Energy prices – unreliable and/or unaffordable energy relative to neighbors could inhibit growth within Delaware, specifically.
	• Timing – in a fast changing global energy and trade landscape, reacting too slow could lead to missed opportunities.

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Overview of policy interventions analysis

- In its chemicals supply chain meetings and interviews, the study team gauged industry and policymaker concerns and priorities for regional transportation policy and investment.
- This section summarizes policy interventions identified by industry, other regional government officials, and IHS that could support and grow current regional chemical manufacturing.
- Many of the possible interventions are currently being addressed or are under consideration in planning efforts by various regional transportation authorities.

Regional chemicals industry policy priorities

Transportation

- Coordinate with DVRPC on transportation planning and regional marketing
- Completing the 3rd rail line as part of the Chesapeake Connector/ Susquehanna Bridge Replacement and eliminating the at-grade crossing.
- Mitigate rail congestion between Newark and Edgemoor within Delaware
- Maintain good highway access and mitigate congestion
- Maintain reliable rail service to Lower Delaware
- Maintain dredging in the Delaware Bay and at regional seaports
- Implement a strategic investment plan for the Port of Wilmington, including exploring potential regular service to Asia and more regular service to Europe
- Position New Castle Airport to potentially attract cargo service for specialty goods such as pharmaceuticals, high-end plastics, and specialty chemicals.

Other Policy Domains

- Build out any pipeline and related support infrastructure required to increase access to low-priced methane in order to lower energy costs and/or to provide cheap feedstocks for potential future chemicals manufacturing.
- Push for modifications to the Coastal Zone Management Act to allow greater development combined with modern environmental mitigation techniques
- Push Delmarva Power to lower energy prices.
- Help develop the workforce necessary for high-end chemicals manufacturing through regional institutions of higher learning and trade schools.
- Work constructively with the Delaware Basin Commission to lift moratorium on LNG transport.
- Maintain low taxes and easy, reliable permitting processes

Industry priorities and existing regional plans

Transportation Priority	Progress to Date
• Coordinate with DVRPC on transportation planning and regional marketing	• Participation of Wilmapco staff at DVRPC planning meetings
• Construct a 3rd rail line as part of the Chesapeake Connector/ Susquehanna Bridge Replacement	• Chesapeake Connector Project preliminary engineering studies have been completed for a 6.3-mile 3rd rail line. Options include a $162.2 million project with at-grade crossings of existing track or a $349.5 million option with grade-separated crossings.
• Mitigate rail congestion between Newark and Edgemoor within Delaware	• USDOT and DelDOT recently funded a $1 million project to improve rail access to the Autoport at the Port of Wilmington. • The 2011 Wilmapco MPO Regional Transportation Plan calls for $7.3 million to improve a CSX bridge crossing to improve rail flows. The 2014-2017 TIP includes the project but does not appropriate government funding.
• Maintain good highway access and mitigate congestion	• The 2014-2017 Wilmpaco TIP includes the final phases (~$53 million) of the ~$190 million Delaware Turnpike Improvement Program. • The 2014-2017 Wilmapco TIP includes about $430 million of the $700 million in planned investment to upgrade the US 301 corridor in Southern New Castle County. • The 2011 Wilmapco Regional Transportation Plan calls for $500 million in upgrades to I-95 in Cecil County, but funding is not yet programmed.
• Maintain reliable rail service to Lower Delaware	• Delmarva freight plan is developing long-term planning scenarios
• Maintain dredging in the Delaware Bay and at regional seaports	• The USACE is dredging the Delaware River Channel to 45 feet.
• Implement a strategic investment plan for the Port of Wilmington, including exploring potential regular service to Asia and more regular service to Europe	• It is not clear to what extent long-term master planning or business plans have been developed.
• Position New Castle Airport to potentially attract cargo service for specialty goods such as pharmaceuticals, high-end plastics, and specialty chemicals	• A 2007 business plan for the Airport suggested that air cargo service is unlikely for ILG due to lack of adequate facilities, neighborhood impacts of nighttime operations, and competition from PHL and BWI. • PHL's master plan calls for relocating UPS's major operations, but the plans are controversial and UPS has threatened to leave PHL if implemented.

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Overview of scenario analysis

- The purpose of this analysis is to qualitatively evaluate the relative importance of different policy proposals identified in this study.
- Four plausible future scenarios are identified and possible transportation interventions are evaluated for relative importance in each case.
- Possibly important policy considerations include: rail and pipeline capacity expansion, congestion management (rail and roadway), and ease of access to major airports and seaports, and possible coordination with other regions in the Delaware River Valley.

Scenarios summaries

- **Scenario 1**: Natural-gas-induced regional chemicals industry growth
  - **Scenario 1A**: Growth in Delmarva basic chemicals and downstream chemicals manufacturing
  - **Scenario 1B**: Growth in Delmarva downstream chemicals manufacturing
  - **Scenario 1C**: Stable Delmarva chemicals manufacturing presence
- **Scenario 2**: Limited Marcellus impact leads to status quo Delmarva trends

Scenario 1A description

- Optimistic Marcellus/Utica production, robust regional NGL and natural gas pipeline development, displacement of imports in the Northeast, and increased exports out of the Delaware River/ Bay
- Development of ethylene and derivative manufacturing in Marcus Hook or elsewhere on the Delaware River/ Bay
- Possible methanol, ammonia, and other methane-based manufacturing in the region
- Possible propane derivate manufacturing in Marcus Hook

Scenario 1B description

- Strong Marcellus/Utica production and Shell's investment in an ethylene cracker supports basic chemicals development in Western PA
- Western PA basic chemicals manufacturing displaces imports in the Northeast, and increased exports out of the Delaware River/ Bay
- Cheaper basic chemical feedstocks from Western PA and lower energy costs from natural gas support growth in downstream chemicals manufacturing in the Delaware River/ Bay area
- It is still possible for some methanol or propane derivative basic chemicals manufacturing growth in the Delaware River/ Bay area

Scenario 1C description

- Strong Marcellus/Utica production and NGL and natural gas pipelines to the Delaware River/ Bay region support increased exports or raw feedstocks through regional ports
- No ethylene crackers are built in the Northeast, limiting the potential opportunities for regional downstream chemical industries to take advantage of cheap regional feedstocks
- Natural gas lower energy costs in the Delaware River/ Bay area are helping to retain existing manufacturing activities in the region and possibly promote increased chlor-alkali or bleach manufacturing
- Much of the Marcellus/Utica production moves via pipeline to the US Gulf Coast

Scenario 2 description

- Marcellus/Utica production either does not materialize due to economic or environmental factors, or most of the flows (and economic benefits) are directed to the US Gulf Coast, Ontario, or elsewhere
- Northeast pipeline development is either scrapped or underutilized (e.g., Mariner East)
- Delmarva regional chemicals manufacturing resumes previous trends favoring high-value, low-weight specialty chemicals manufacturing as well as R&D, with basic chemicals moving offshore or to the US Gulf Coast

Exogenous causes

All Scenario 1

- High global crude oil prices increase demand for natural gas as a lower-cost energy and fuel alternative
- Regional imbalances in natural gas production, consumption, and prices create opportunities for trade
- Increased exports from global exporters and imports from global importers
- US becomes a major exporter of natural gas (and some NGLs)
- Increased congestion in the US Gulf Coast

Scenario 2

- Global crude oil prices fall, making the economics of unconventional natural gas extraction less favorable
- Natural gas prices increase, decreasing Northeast US feedstock price advantages
- Environmental and social concerns concerning fracking slow project development in many locations in the US

Regional manufacturing opportunities

Scenario	1A	1B	1C	2
Trade, transportation, and logistics growth				
New basic chemicals manufacturing in “grandfathered” and inland industrial sites				
New downstream chemicals manufacturing				
Retain existing manufacturing				

Key	
High Probability	
Moderate Probability	
Low Probability	

Transportation policy priorities

Scenario	1A	1B	1C	2
Coordination with DVRPC on planning/marketing				
Chesapeake Connector				
Rail congestion alleviation in New Castle County				
Highway capacity and congestion mitigation				
Secondary rail service to Lower Delmarva				
Delaware Bay dredging to 45+ feet				
Port of Wilmington strategic investment				
New Castle airport cargo operations				

Key	
High Benefit	
Moderate Benefit	
Minimal Benefit	

Summary of transportation policy and investment options

- Coordination with DVRPC and other Delaware River/ Bay authorities on regional marketing and system investment could help attract more regional investment in optimistic growth cases. In less optimistic cases, however, sub-regions may have to both coordinate and compete to attract more limited investment.
- Strategic rail and road investment within the Delaware Bay region aimed at improving efficiency and throughput will support greater industry agglomeration benefitting all. Actual investments are difficult to determine in advance of industry location decisions, but may involve issues such as grade crossings and right-of-way issues more so than major capacity expansions.

Summary of transportation policy and investment options, cont'd.

- The chemicals (and especially refining activities at PBF energy) lend support for the need to address the Chesapeake Connector. Pipeline investment in Canada could, however, provide competition to rail in the long-term for Canadian/Bakken crude
- Access to airports and seaports is critical. In the short-term, providing efficient road and rail intermodal connectivity to Philadelphia (air) and Baltimore (sea) is the logical solution. In the most optimistic long-term scenarios, opportunities might emerge to increase global trade lane coverage at the Port of Wilmington or begin cargo operations at New Castle airport (less likely)
- Maintaining dredging of the Delaware River to at least 45 feet will be important to all scenarios involving increased trade of NGL raw materials, most likely via larger Marcus Hook gas vessel berths

Summary of transportation policy and investment options, cont'd.

- Maintaining secondary rail service to Lower Delmarva is important for many industries. There is some existing demand for the chemicals industry, and any scenario involving large-scale basic chemicals manufacturing may require rail access to inland industrial sites due to Coastal Zone Management development restrictions on coastal sites.