
Freight Futures
September 2024
DELAWARE VALLEY
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REGIONAL
PLANNING COMMISSION

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Executive Summary

The Delaware Valley Regional Planning Commission (DVRPC) conducted the Freight Futures study to anticipate and adapt to changes in the supply chain and freight activities in the Greater Philadelphia area through 2040. In alignment with the principles of Connections 2050, the Long-Range Plan for Greater Philadelphia, Freight Futures assesses the impact of freight infrastructure and activities on sustainability, resilience, and equity across the region.

Scenario Planning

DVRPC utilized scenario planning, a method to explore potential future conditions and their impacts on freight and supply chain activities, to evaluate the future impacts of freight in the region. This involved a four-step process.

- **Define a Central Focus**: Document the key research question(s) to be addressed by the exercise.
- **Identify Future Forces**: Identify future forces affecting the global and local supply chain.
- **Develop Distinct Scenarios**: Create scenarios that represent both likely and unlikely futures from key forces and trends, and provide narrative summaries for each.
- **Generate Actionable Recommendations**: Summarize actions and improvements to be considered by key stakeholders including guidance on implementation and funding opportunities where applicable.

Central Focus

What critical constraints does the DVRPC region need to address in order to make freight-related activity more sustainable, resilient, and equitable between now and 2040?

Future Forces

Future Forces are key external trends and conditions that affect the supply chain and are not under the control of the region's freight stakeholders. The identification of forces formed the basis of the trends in each of the distinct scenarios and are imperative to their cohesive construction. Examples include demographic, environmental, regulatory, and economic forces. With input from stakeholders, including government agencies, transportation authorities, rail and port companies, and local development corporations, future forces were identified and evaluated for their likelihood and impact potential. Two driving forces, external disruption and innovation, were singled out as the most influential drivers and used to form the central axes around which the scenarios are organized.

Scenarios

Building on the understanding of the future forces, the project team developed four distinct scenarios along the axes of external disruption and innovation:

- **"Pre- Pandemic Déjà Vu,"** which envisions a return to pre-disruption and a globalized supply chain;
- **"Green and Clean Growth,"** which forecasts increased demand for sustainable goods and investment in clean industrial policies;
- **"Disruption is the Only Constant,"** which anticipates the continuous need for adaptation to supply chain disruptions; and
- **"America's Workshop Reborn,"** which predicts revitalized domestic manufacturing and technology adoption.

Based on these scenarios, potential impacts were documented across different facets of the freight system, including workforce development, rail service promotion, truck parking provision, adaptive reuse, and incentives for electric vehicle connectivity.

Recommendations

The recommendations are categorized into sustainability, resilience, and equity strategies. Sustainability strategies focus on supporting investments in green infrastructure, promoting rail usage, and ensuring multimodal access to industrial sites. Resilience strategies emphasize robust infrastructure, redundancy, and coordination to withstand crises. Equity strategies highlight workforce development, commuter access, and thoughtful redevelopment of outdated warehouses. These recommendations aim to mitigate the worst outcomes and amplify the best conditions of each scenario.

Freight Futures emphasizes a proactive approach to mitigate risks and capitalize on emerging opportunities within the evolving landscape of the global supply chain. It provides comprehensive recommendations and guidance on implementation and funding opportunities to advance these strategies, positioning the Greater Philadelphia region for a more sustainable, resilient, and equitable freight future by 2040.

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Source: DVRPC

Introduction

The supply chain forms the backbone of global commerce – an intricate web connecting manufacturers, distributors, and consumers across vast distances. It has evolved rapidly over the past three decades in response to the growth of e-commerce, globalization, a changing climate, shifting geopolitics, and new technologies, among other external forces. This evolution of the supply chain will create unique opportunities and challenges for Greater Philadelphia's economy and quality of life.

External disruptions, not under the control of local stakeholders, may provide destabilizing challenges that need to be addressed. Local supply chain operations are deeply impacted by international trade and geopolitics – the volatile interactions and power dynamics between nations. Trade wars and tariffs can be imposed which affect the cost and flow of goods across international borders. Political instability can disrupt freight transportation corridors like the Suez Canal and Taiwan Strait, which in turn can cause delays and supply chain inefficiencies that impact domestic trade.

Another important group of external forces are the environmental challenges that stem from a changing climate and increasingly frequent, severe weather events. Stronger storms can cause disruptions in freight flows and the facilities that manage goods movement. The increasing unpredictability of climate conditions has forced governments to innovate and rethink their reliance on traditional industrial inputs, and energy sources like oil. This in turn is causing a frenzy of development in renewable energy and other alternatives.

The growth of e-commerce and its resulting shift in consumer behavior has provided additional challenges. Larger, more numerous distribution and logistics facilities have arisen to accommodate the consumer's desire for increasingly speedier home delivery. This has placed greater strain on local roads, utilities, and municipal services. Advances in automation provide opportunities for efficiency, but the effect on the workforce is yet to be fully understood. All of these external forces combine to create a complex web of challenges that demand policymakers' attention.

Amidst these uncertainties within this intricate network, strategic foresight is critical. Scenario planning is a crucial tool for the region, weaving together hypothetical conditions and potential disruptions to help guide freight stakeholders in fortifying supply chain resilience for an unknown future. One particular area where scenario planning proves vital is in forecasting potential futures for freight – globally and within Greater Philadelphia. However, the purpose of the exercise is not to define an aspirational future, but to reveal a range of potential conditions that planners should take into account when planning for an uncertain future. DVRPC engaged in a very similar process when creating the Dispatches from Alternate Futures scenarios to inform the *Connections 2050 Long-Range Plan for Greater Philadelphia* (DVRPC publication #20012)

As the world grapples with volatile geopolitical shifts, technological advancements, climate change, and unforeseen challenges such as natural disasters and pandemics, the ability to anticipate and adapt is key. This proactive approach not only helps to mitigate risks but also positions freight stakeholders to capitalize on emerging opportunities in the ever-evolving landscape of supply chains and freight management.

Project Overview

This report was undertaken by the DVRPC Freight Program with the goal of providing the region's governments and freight stakeholders with a set of actionable recommendations that have the potential to guide Greater Philadelphia's supply chain towards

greater sustainability, resilience, and equity by 2040. These goals align well with the overall principles of the region's Long-Range Plan. It is organized into the following sections:

- **Central Focus:** documents the key research question(s) to be addressed by the exercise;
- **Future Forces**: identifies future forces affecting the global and local supply chain;
- **Scenarios**: details the scenario generation process and provides narrative summaries for each of the four developed scenarios built off the most likely and impactful future forces; and
- **Strategies and Recommendations**: summarizes a series of actions and improvements to be considered by key stakeholders, as well as guidance on implementation and funding opportunities to advance those recommendations where applicable.

Stakeholder Outreach

In order to best reflect the needs of the region's freight stakeholders, both public and private, DVRPC consulted with members of the Delaware Valley Goods Movement Task Force. Members were engaged through a combination of online surveys and both in-person and virtual workshops between July 2023 and December 2023. A list of participating organizations follows:

- Amtrak
- Bucks County
- Burlington County
- Chester County
- City of Philadelphia
- CSX
- Delaware County
- Energy Transfer
- Federal Highway Administration (FHWA)
- Keystone State Railroad Association (KSRRA)
- Lansdale Warehouse Company
- Lehigh Valley Planning Commission (LVPC)
- Marcus Hook Borough
- Mercer County
- Michael Baker
- Montgomery County
- New Jersey Economic Development Authority (NJEDA)
- New Jersey Railroad Association (NJRRA)
- NJDOT
- NJ Transit
- Norfolk Southern
- North Jersey Transportation Planning Authority (NJTPA)
- NorthPoint Development
- Owner-Operator Independent Drivers Association (OOIDA)
- Penn Terminals
- PennDOT
- Pennsylvania Motor Truck Association (PMTA)
- Philadelphia Industrial Development Corporation (PIDC)
- PhilaPort
- Regional Rail, LLC
- Rhinehart Railroad Construction
- SMS Rail
- South Jersey Port Corporation (SJPC)
- South Jersey Transportation Planning Organization (SJTPO)
- U.S. Coast Guard
- Wilmington Area Planning Council (WILMAPCO)
- WSP

Scenario Planning Process

Freight Futures is a freight-centered exploratory scenario planning effort, which utilizes a similar process as the *Dispatches From Alternate Futures*

DELAWARE VALLEY GOODS MOVEMENT TASK FORCE

The Delaware Valley Goods Movement Task Force was established to maximize the Delaware Valley's goods movement capability by sharing information and technology between public and private freight interests, promoting the region's intermodal capabilities and capacity, and developing and implementing a regional goods movement strategy. It advises the DVRPC Board on goods movement issues, studies, and projects.

scenarios. The process is not meant to identify a single preferred future, but instead multiple potential futures that can help DVRPC, and the region's freight stakeholders, to recognize blind spots and craft dynamic strategies. The process is composed of four distinct phases (Figure 1).

1. Define the Central Focus

Defining the central focus or question to be answered by the scenario planning exercise is a critical first step. It serves as the grounding element and ensures that the resulting scenarios and recommendations directly address the specific challenges and opportunities that matter most to the region's freight stakeholders.

2. Define Key Trends and Forces

A necessary step in the development of plausible and realistic scenarios is identifying the key external trends and conditions that affect the supply chain and are not under the control of the region's freight stakeholders. Key trends and forces affecting freight are varied with a significant emphasis on geopolitical, trade, and environmental forces. Understanding these trends and their relationship to each other helped DVRPC craft a diverse range of plausible alternative futures for the supply chain in Greater Philadelphia.

3. Develop Distinct Scenarios

After identifying the key trends and forces affecting the supply chain, DVRPC developed multiple distinct scenarios that cover a spectrum of possibilities. The structural foundation for each scenario is established by two dominant driving forces or overarching trends. The scenarios were informed by stakeholder outreach efforts and internal consultations with other DVRPC sections. These scenarios may represent best-case and worst-case scenarios, as well as variations in between.

4. Generate Actionable Recommendations

Once the scenarios are constructed and analyzed, the next step is to distill actionable recommendations that can guide decision-makers in navigating the complexities of an uncertain future. This involves the formulation of strategic suggestions or actions based on the insights gained from exploring each alternative future scenario. Typically, robust and universal actions are considered that are beneficial across a range of futures, as well as adaptive or contingent actions that may benefit only one or a few of the identified scenarios. Important aspects of this phase are identifying common themes, highlighting divergent strategies, and defining next steps for local decision-makers and stakeholders.

WHAT IS SCENARIO PLANNING?

Scenario Planning is a collaborative planning exercise that seeks to project the uncertainty associated with anticipated trends and external conditions that are not under the control of the participating stakeholders.

Figure 1: Freight Futures Scenario Planning Timeline

Source: DVRPC

Source: DVRPC

Central Focus

Defining the Central Focus

The initial stage in the scenario planning process involves establishing a clear central focus to steer the exercise. The considerations of the region's freight stakeholders were carefully examined, based on insights gathered through previous meetings of the Delaware Valley Goods Movement Task Force (DVGMTF), outreach efforts, and consultations with the counties.

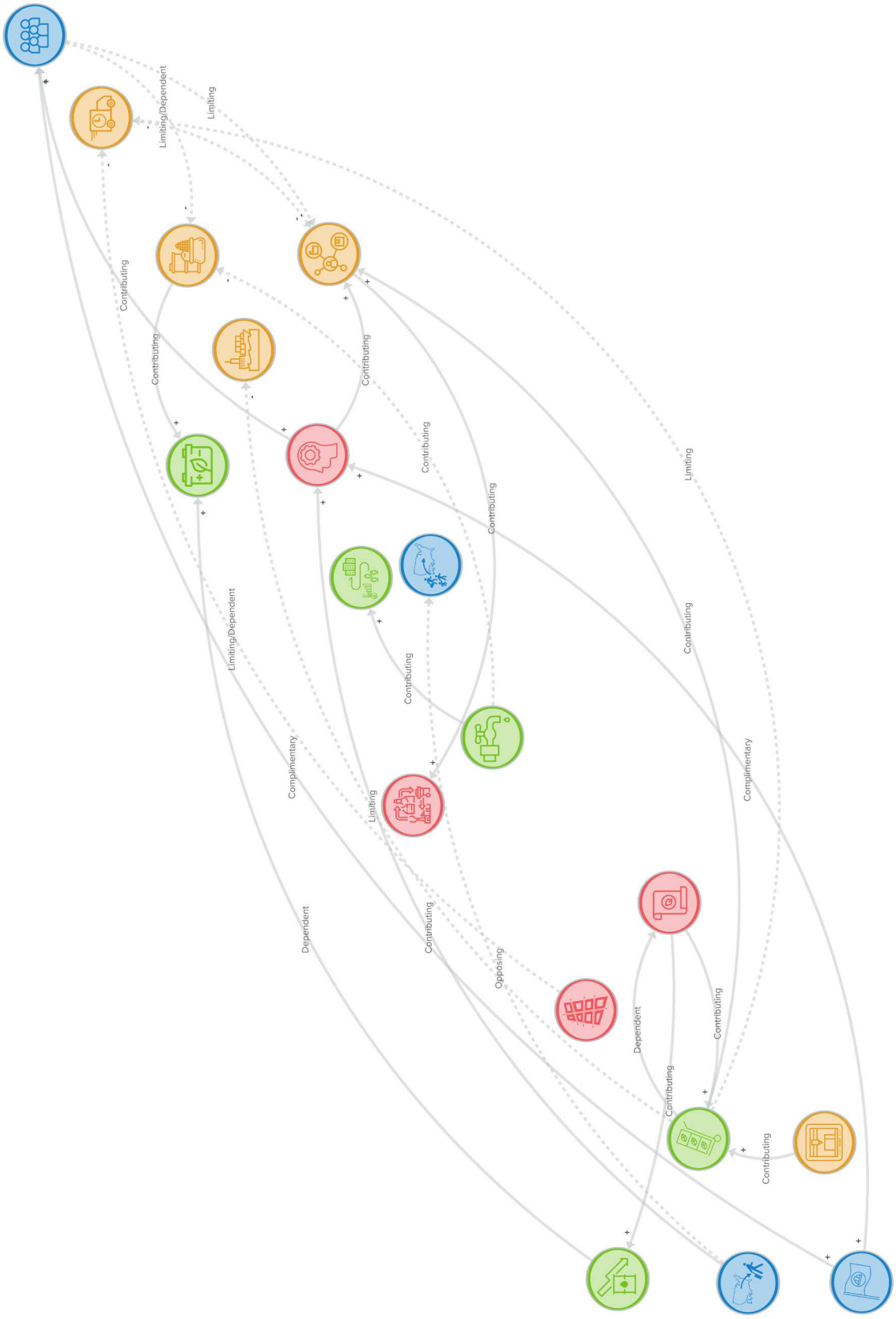
This comprehensive assessment determined that issues pertaining to sustainability, resilience, and equity ranked highest in significance when contemplating freight infrastructure and the supply chain in the Greater Philadelphia area. This aligns well with the overarching principles set out in the *Connections 2050 Long-Range Plan for Greater Philadelphia.*

The Freight Futures scenario planning exercise aims to anticipate and adapt to supply chain changes expected over approximately 15 years, projecting towards around 2040. Although this time frame is shorter than the current *Long-Range Plan*, the effort is meant to serve as a transitional, near-term regional freight plan. Trends and conditions analyzed in the upcoming chapter are evolving rapidly and profoundly compared to the past. Regional goods movement could significantly transform within years rather than decades. Consequently, the DVRPC Freight Program has proactively identified strategies and recommendations to enhance the sustainability, resilience, and equity of freight-related activities by 2040.

CENTRAL FOCUS:

What critical constraints does the DVRPC region need to address in order to make freight-related activity more sustainable, resilient, and equitable between now and 2040?

Figure 2: Future Forces Survey and Meeting Response Summary



Future Forces

Identifying Future Forces

An exhaustive review of periodicals and literature was conducted to identify key trends and conditions, referred to as future forces in this study. The results of that review encompassed a wide array of factors, including economic, social, technological, environmental, and geopolitical influences. Additionally, internal and external stakeholders were interviewed to gather diverse perspectives on prevailing trends and conditions. Insights from these stakeholders provided valuable real-world context and aided in identifying potential blind spots.

Following the identification of future forces, input was collected from the region's freight stakeholders to assess two key aspects of each force: the likelihood and strength of impact. For the purposes of this exercise, likelihood is defined as the probability of the force occurring, while impact is defined as the strength of the force. A survey was distributed to members of the Delaware Valley Goods Movement Task Force (DVGMTF) in June 2023, garnering responses from a diverse range of public and private stakeholders. These survey responses were then utilized to map the forces based on the two key aspects (Figure 2). Additionally, stakeholders were given the opportunity to provide input through the Future Forces Workshop held at the July 2023 DVGMTF meeting. During this workshop, participants were introduced to each force, discussed potential impacts on the Greater Philadelphia supply chain, and explored the interconnections between these forces.

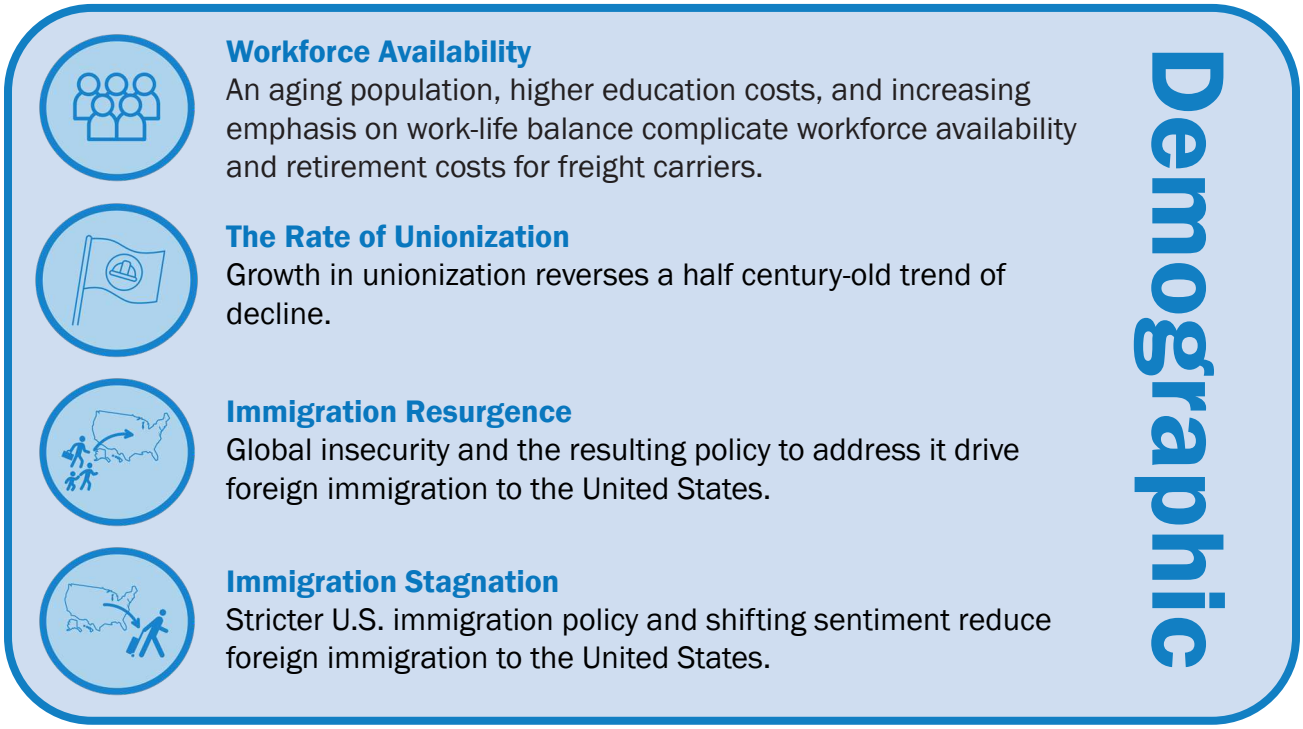
This collective knowledge serves as the bedrock for the development of distinct, purposeful scenarios, tailored to the intricacies of freight, and allowing for strategic planning in the midst of uncertainty.

Categories

Eighteen future forces were identified during the exercise and were sorted into four different categories. Numerous demographic forces (Figure 3) are linked to shifts in population dynamics and workforce characteristics. While environmental forces (Figure 4) considered in this study encapsulate evolving trends in energy sourcing, resource availability, and consumer preferences. The regulatory/political forces (Figure 5) center around industrial policies and local governance. Lastly, economic forces (Figure 6) encompass a broad spectrum of conditions, reflecting trends in market dynamics, manufacturing processes, and overall demand.

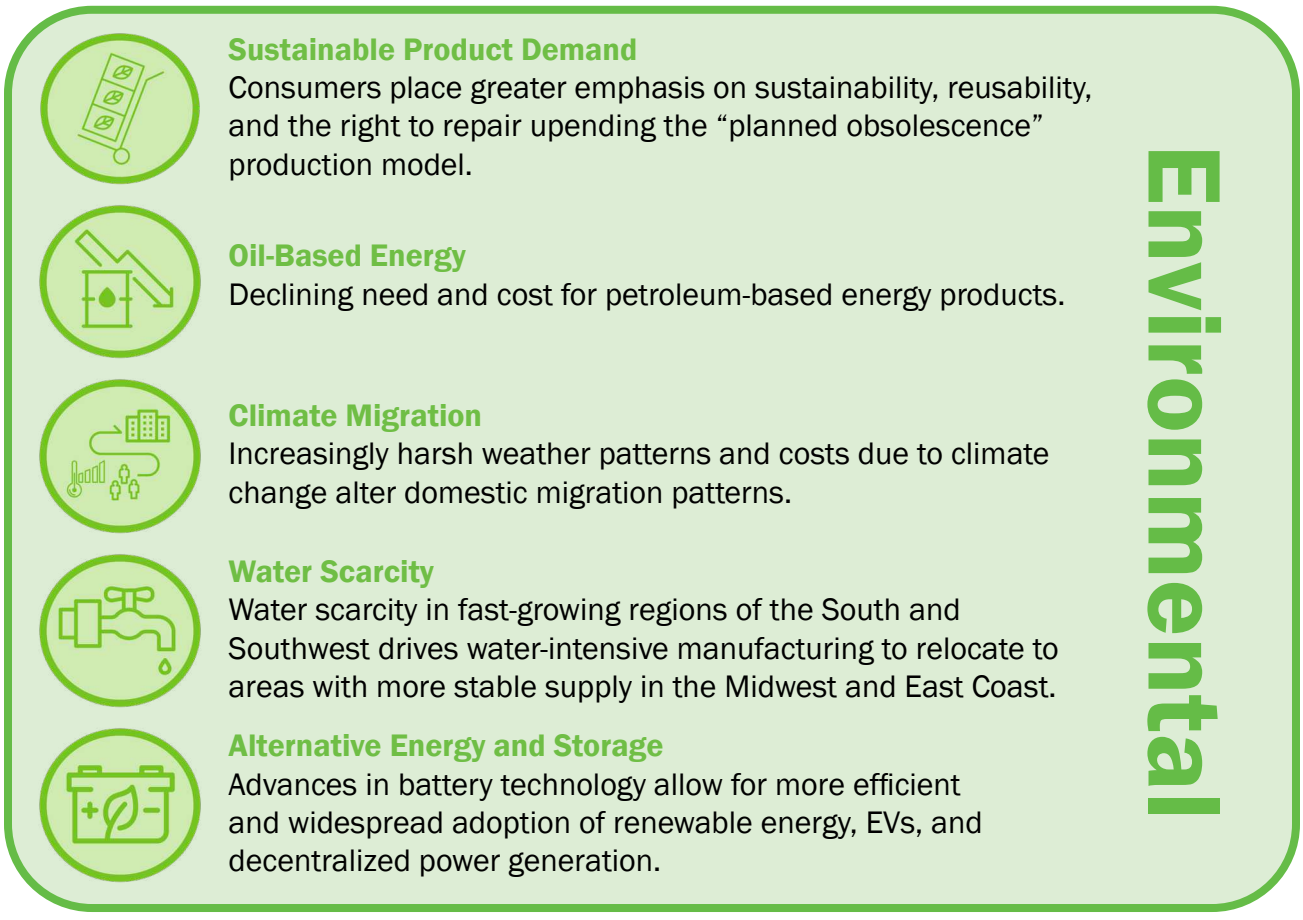
Source: DVRPC

Figure 3: Demographic Forces



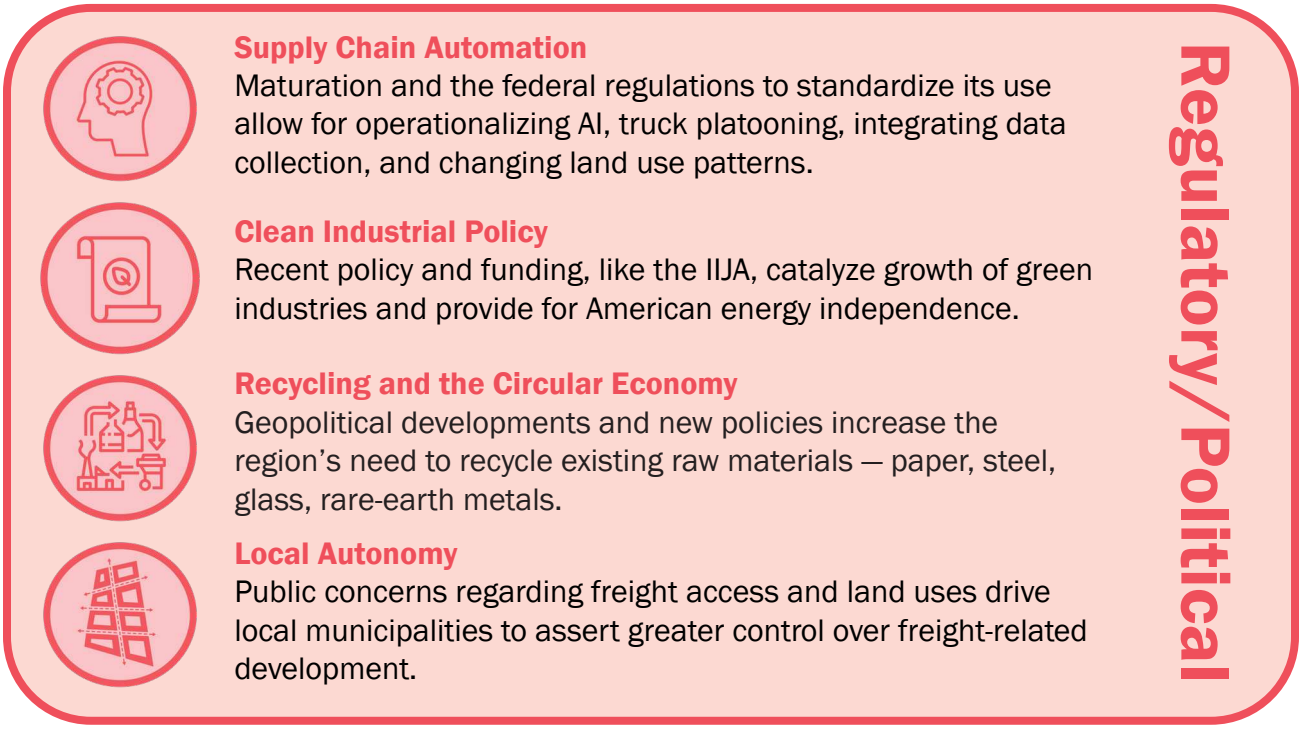
Source: DVRPC

Figure 4: Environmental Forces



Source: DVRPC

Figure 5: Regulatory/Political Forces



Source: DVRPC

Figure 6: Economic Forces

Source: DVRPC

Source: DVRPC

Scenarios

Constructing exploratory scenarios is a way to evaluate future uncertainty. Four scenarios (Figure 7) were crafted using the impacts of future forces insights gathered from the region's freight stakeholders. The July 2023 DVGMTF Future Forces Workshop played a critical role in shaping these four scenarios, allowing stakeholders to engage in discussions regarding the potential impacts of various future forces on operators and the supply chain. This collaborative process led to the identification of two key drivers used to define the scenarios, that represent the most impactful and uncertain themes driving change.

These two driving forces, external disruption and innovation, form the central axes around which the scenarios are organized. They became apparent when conversations regarding forces tended to hinge on them. Forces such as those relating to migration, East Coast imports, commodity price volatility were all discussed as external disruptors affecting each scenario, while forces such as delivery on demand, supply chain automation, and alternative energy were all understood as innovations that could potentially affect each scenario.

Leading Indicators

Going forward, local officials and freight operators should keep an eye on certain leading indicators — trends and conditions — that can predict which scenarios may unfold. Economic indicators, such as the percentage and total volume of e-commerce sales, are useful for gauging both consumer demand and the need for additional distribution and logistics space. Global economic trends, including international trade volumes and the adoption of tariffs, will show whether the economy is becoming more globalized or inwardly-focused.

Additionally, tracking the implementation of new environmental policies, the use of renewable energy, and the adoption of electric vehicles (EVs) by freight operators can indicate the region's progress toward fostering a greener economy. Monitoring demographic trends, such as migration rates, regional population growth, and educational attainment, can provide insights into the future direction of the labor market.

These indicators can help the Delaware Valley Regional Planning Commission (DVRPC), local governments, and freight stakeholders understand which scenarios the region is trending towards at any given time. They also enable regional officials to adopt policies that better align with the universe of current conditions affecting the supply chain.

KEY DRIVERS

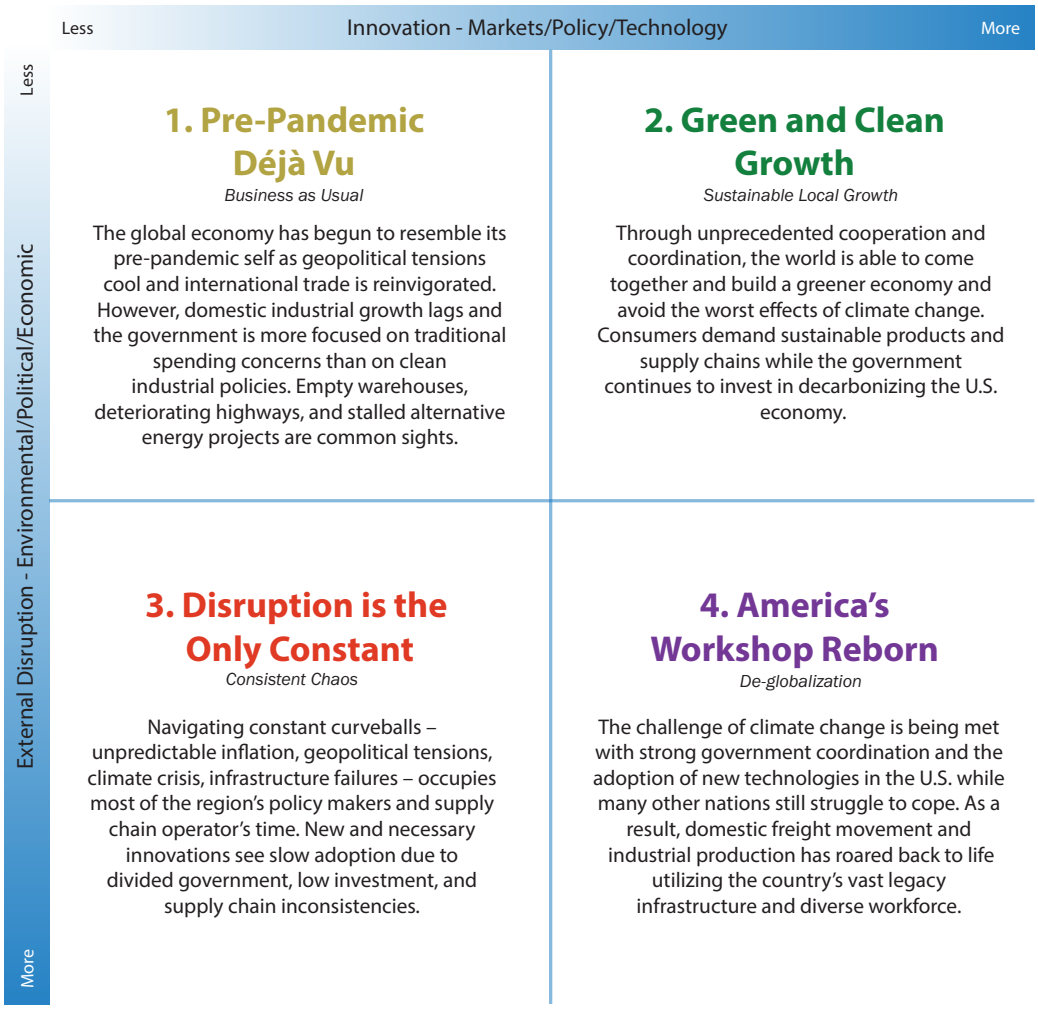
External Disruption

External disruptions can come in many forms — geopolitical, climate, social — and have the potential to shift the direction of our domestic supply chain and industries. Disruptions in these scenarios are primarily external and centered around geopolitics, the economy, investment, migration, and the environment.

Innovation

The speed and degree of innovation is a significant determinant of the ability of the supply chain to keep up with changing industry practices, labor demands, regulation, technology, and external disruptions.

Figure 7: Freight Futures Scenarios Matrix



Source: DVRPC

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1. Pre-Pandemic Déjà Vu

Less External Disruption/Less Innovation

The Earth escapes the worst-case impacts of climate change and sees milder, manageable impacts that are mitigated using existing technologies. International relations between the U.S. and its economic competitors begin to thaw, resulting in trade increases, supply chain stabilization, and price normalization. Alternative energy adoption has leveled off after funding from the IIJA and other post-pandemic investments run out, and the impetus for further adoption diminishes.

In the 2020's, new national climate policy and investment is shelved in favor of traditional spending concerns. Infrastructure investment decreases, and funding is focused on state-of-good-repair and targeted improvements to intercity and trans-continental freight links. Legislators relax interstate truck weight restrictions and as a result, the interstate highway system is showing its age and buckling under the pressure of heavier freight loads and increased trips. A more stable climate led to a rebirth in international trade and supply chain reliance. Port activity in the U.S. reorients toward the Pacific region as imports from Asia pick-up once again and newer markets in the Global South are still in their adolescence.

By the 2030's, global supply chains see less stress, and prices and commodity flows stabilize. Alternative energy growth slows as oil prices are driven down and stabilize, making the established commodity more attractive. The materials and resources necessary for industrial development in the U.S. are more available than in the recent past, supporting some industrial growth. Migration to the U.S. due to geopolitical tensions decreases and results in a smaller workforce to sustain existing consumption — let alone steady increases. Freight operators are slow to integrate automation technology into the supply chain, which drives the continued need for low- and semi-skilled labor up. The circular economy loses steam in the U.S. due to low economic feasibility, investment, and lack of impetus.

Climate Impacts on the Local Supply Chain in 2040

A more stable climate leads to less near-shoring in response to weather-related disruptions. Increased trade with Asia also results in a decrease in traffic at East Coast ports while those on the West Coast see growth. Cross-country rail and truck trips into the region increase and disruptions are not uncommon due to aging infrastructure. Slower rates of local industrial growth and reduced port activity lead to an increasing supply of outmoded, older warehouse space on the market while new, non-speculative developments are often built to the lowest environmental standard requirements. Less local political urgency is placed on resiliency efforts and regionalism.

Geopolitical and Economic Impacts on the Local Supply Chain in 2040

The region sees slow rates of industrial growth due to the reinvigoration of international trade, leading to the absorption of high-ceiling warehouse space constructed during the early 2020's and high vacancy rates and redevelopment pressure on older facilities. Greater reliance on less-sustainable products and older freight technologies results in worsening air quality and traffic congestion conditions for local communities. Lack of migration to the area, work-life balance challenges, and strenuous work conditions cause warehouse operators to churn through the local labor pool faster than it can be replaced.

Infrastructure and Technology Impacts on the Local Supply Chain in 2040

The region's MACH 2 Hydrogen Hub produces moderate improvements in industrial energy use and diversity, but larger success is impeded as local needs rely more on existing gas power than new wind or solar installations as originally planned. Local infrastructure is struggling under continued delivery truck trips and calls for action from residents to restrict truck

access reaches a fever pitch. Residents demand new policies from state and federal government that limit heavy freight movements on local roads in both urban and rural areas, in turn limiting the options for business expansions. Most new development relies on redevelopment of existing industrial areas, increasing the costs of construction.

SPOTLIGHT: WAREHOUSING IN GREATER PHILADELPHIA

Over the past few years, the region has witnessed a significant surge in warehouse development, emblematic of the region's evolving industrial landscape. Fueled by the rise of e-commerce and shifting consumer behaviors, this growth depends on several factors. First, the strategic location of Greater Philadelphia, with its proximity to other major metropolitan areas in the Northeastern U.S. and Eastern Canada, as well as robust transportation infrastructure, has positioned the region as a prime distribution and logistics hub. In addition, the increasing shift to e-commerce has increased the need for more efficient last-mile delivery solutions.

However, this rapid expansion isn't without its challenges. As warehouses proliferate, concerns regarding land use, environmental impact, workforce access, and traffic congestion continue to grow. The influx of trucks and vehicles associated with distribution centers can strain local road networks and contribute to air pollution, resulting in calls for sustainable development practices and transportation planning.

The proliferation of modern, state-of-the-art facilities also raises questions about the fate of older, outdated warehouses, especially if warehouse inventory continues to grow. While some may undergo renovation and adaptive reuse to meet contemporary needs, others risk becoming obsolete and sitting vacant, potentially exacerbating quality-of-life concerns and prompting further disinvestment in certain areas.

In navigating these complexities, municipalities and planners can strike a balance between fostering economic growth and mitigating negative externalities. Collaborative efforts involving local governments, industry leaders, and community representatives are important to ensuring new warehouse developments and the redevelopment of outdated ones aligns with broader goals of sustainability, resilience, and equity in the region.

Source: DVRPC

2. Green and Clean Growth

Less External Disruption/More Innovation

Through an unprecedented level of coordination and effort, global institutions and nation-states are able to minimize the worst effects of climate change. Global tensions have cooled, and migration due to resource shortages and unpredictable weather patterns diminishes. Consistent funding and appetites for green initiatives, clean industries, and sustainable products grow.

By the late 2020's, a highly organized global grassroots movement keeps sustainability at the forefront of policy development, even as the risk of climate catastrophe continues to moderate. Consumers demand products that are built-to-last with the "right to repair," upending planned obsolescence production operations domestically and abroad. With global conflict less likely, supply chains stabilize, allowing technology deployment to proceed at a faster pace. Infrastructure investment is higher compared to eras past. Special emphasis has been placed on grid-capacity for the integration of renewable power sources, allowing their use to soar.

In the 2030's, local planning and resident-centered economic development drives the creation of smaller, artisan-focused supply chains in major metropolitan areas across the U.S. Emphasis on local sourcing and sustainability has led to significant market share growth for American-made products and a demand for sustainable packaging. The circular economy sees significant investment and support from both public and private entities.

Technology that optimizes freight movements along the National Highway System begins wide-scale pilot-testing, starting with truck platooning. Rail is shifting to electric and hydrogen-powered locomotives and is favored by producers as a more sustainable alternative to trucks. This increased business leads to some capacity concerns. Precision-railroading across the national rail network is common, aided by advancements in AI technology, but experiences significant local opposition from communities cut off by ever longer trains. Despite the calls for greater sustainability in the supply chain, increases in domestic production and e-commerce increase traffic on local roads and lead to a proliferation of industrial developments throughout the country.

Climate Impacts on the Local Supply Chain in 2040

The momentum that grew during the IIJA and IRA investments of the 2020's carries on and continues to build out a green future for Greater Philadelphia. Heavy federal investment in green technology and alternative energy has made these technologies cost competitive, resulting in significant growth in their market share and the achievement of federal and state clean energy goals. Solar arrays on civic structures, businesses, and residences are a common sight, while wind farms continue to rise off the coast of New Jersey, powering millions of homes with renewable electricity. Small, artisan manufacturers take advantage of the region's legacy infrastructure and consumer demand for locally made products. Traditional petroleum-based businesses in the region struggle to adapt to the shifting energy landscape, while their former employees seek job training and new opportunities provided by the rapidly growing alternative energy sector.

Geopolitical and Economic Impacts on the Local Supply Chain in 2040

Technology and automation adoption is enhanced by government subsidy and consumer demand for sustainable products and supply chains. Near-shoring picks up pace, especially to legacy industrial areas in the U.S. such as Philadelphia. This benefits small and large manufacturers alike. An abundance of industrial infrastructure and college graduates helps Greater Philadelphia to expand its global profile as a leader in the production of cutting-edge research and technology. Less migration to the U.S. and slow rates of population growth in the region lead to workforce shortages for rapidly growing industries,

especially in semi-skilled and unskilled roles. Strong labor organization provides workers with stable pay and benefits, even for less strenuous jobs, due to the integration of new technology.

Infrastructure and Technology Impacts on the Local Supply Chain in 2040

Greater Philadelphia sees significant investments in both existing and new infrastructure assets. Investments in grid capacity allows the region to utilize renewable energy generated outside of our region, like that generated from off-shore wind farms off the Jersey Shore. MACH 2 proved that it is possible to generate green and affordable hydrogen, which has helped to decarbonize the hard to decarbonize industries, such as manufacturing, trucking, and marine transportation. Advancements in on-site electricity generation and battery storage — coupled with supportive state policy — have allowed warehouses and large industrial property owners to have on-site access to reliable, low cost electricity.

Adoption of AI-powered operations in the supply chain allows for the optimization of deliveries, and decreased freight-related congestion on the interstate and other highways. Despite this, local roads are still congested from the increase in small-scale, local manufacturing and delivery. Services that provide basic necessities in reusable packaging, like household cleaners and foods, must now make two trips instead of one to complete the cycle of re-use, leading to more freight-related traffic on local roads. Aging Class III rail infrastructure can't keep up with increased usage, and delays are becoming common.

3. Disruption is the Only Constant

More External Disruption/Less Innovation

The Earth continues to experience increasing impacts of climate change resulting in more frequent and intense weather events. Government in the U.S. remains divided over the policies and investments needed to advance technology development and adoption throughout the supply chain, and inconsistent responses to these disruptions make large-scale infrastructure investment harder to come by.

During the 2020's, global tensions rise to their highest level in years. Continued conflicts in the Middle East, Eastern Europe, Asia, and the Global South lead to resource shortages, high inflation, and the disruption of international trade corridors. Conflicts in places like the Taiwan and Malacca Straits lead to trade disruptions for critical components of advanced technology production across the globe.

Historic investment levels set in the early 2020's did not continue beyond the mid-2020's due to a divided government, halting momentum of the clean energy transition before any significant progress has been achieved. The effect is that all levels of government are increasingly focused on emergency management and repair, while neglecting other important fiscal concerns. The Suez Canal, St. Lawrence River, and Panama Canal see more disruption due to drought and other climate extremes. Climate and economic refugees move faster than capital investment can respond. There is greater emphasis placed on expanding domestic recycling capacity, which is seen as an accessible and relatively low-tech solution for partial relief from consistent supply chain bottlenecks.

By the 2030's, infrastructure failures and disruptions are common, and their lifespans are shorter due to the effects of increasingly severe weather. There is minimal advancement in technology due to chronic funding shortfalls. The rollout of alternative fueling, charging, and storage infrastructure are still in their infancy and move in fits and starts due to limited investment in upgrading the power grid. Long-haul trucking operators are slow to adopt EVs in their first decade of wide availability as a result. Natural gas production remains strong.

Climate Impacts on the Local Supply Chain in 2040

Lack of consensus between Philadelphia and its surrounding counties leads to the inability of institutions to coordinate effectively and align their infrastructure resiliency investments. Disruptions in global trade mean interruptions in supply at the ports along the Delaware River hampering industries inland, breakdowns in wider distribution of goods across the Northeastern U.S. and Eastern Canada, and disorder to truck driver's schedules. Climate refugees, both industrial operators and residents, begin to trickle into the region adding stress to an already stretched housing stock. Local flooding and aftermath from major weather events cause local supply chain and industrial disruptions.

Geopolitical and Economic Impacts on the Local Supply Chain in 2040

Technology and AI adoption is hindered locally by the inconsistent supply of necessary components and finished goods. Near-shoring has picked up pace — but a lack of technology enhancements prevents local industries from taking full advantage of producing advanced, high-value products like pharmaceuticals and medical equipment locally. Small-scale manufacturers and artisans see a resurgence in the region due to the access to legacy infrastructure and the increasing consumer emphasis on avoiding global supply chain disruptions by relying on locally produced goods.

Infrastructure and Technology Impacts on the Local Supply Chain in 2040

The Greater Philadelphia region experiences significant infrastructure failures because of the amount and age of its legacy assets as well as the impacts of climate hazards on this aging infrastructure. Infrastructure operators struggle to

keep up with maintenance. New infrastructure is difficult to complete due to supply chain issues and volatile economic conditions like inflation. Only the most critical improvements are able to be funded by both federal and local sources under the current funding regime. The ports see an uptick in volumes from those transporting recyclable materials to facilities in the region.

The region does not have access to clean, cost-competitive hydrogen or electricity, rendering goods movement dependent on inefficient and polluting energy sources. Curb space is a hot commodity for on-demand deliveries and in critical shortage with little to no new innovation in curbside management in the last 20 years. Low-tech solutions, like bike-based delivery, are relied on in Center City to cope with ever-increasing traffic congestion. Communities increase their advocacy against new distribution and logistics developments due to a perceived imposition of greater freight-related traffic and pollution.

4. America's Workshop Reborn

More External Disruption/More Innovation

Climate change continues to impact the region, but historic investments made in the early 2020's pay off with the adoption of new technology and coordinated government response that prevents the worst-case climate change scenario. Despite global disruptions, the U.S. government's steadfast focus on clean industrial policies, infrastructure investments, and technology adoption throughout the supply chain brings stability to the domestic supply chain and an influx of industrial near-shoring. Alternative fueling, battery technology, as well as upgraded power distribution and charging facilities have progressed making EVs viable.

In the 2020's, global tensions are high and protracted conflicts in the Middle East, Eastern Europe, and the Global South lead to resource shortages, unpredictable inflation, and the disruption of international trade corridors. Despite these external stresses, governments in the U.S. rally around clean industrial policies and investments. Domestic and international allies' resources, such as rare-earth metals, are discovered due to new exploration techniques and lead to greater supply stability. In addition, U.S. businesses increase the pace of "de-risking" by near-shoring.

In the 2030's, with coordinated federal support, widespread adoption of mature AI programming has led to greater operational efficiency in the supply chain by better predicting disruptions and rerouting. The integration of AI, and other advanced technologies, in manufacturing allows for the reduction of a semi-skilled workforce while creating new positions for specially trained technical workers. Infrastructure failures and disruptions are still common, but they are managed by more efficient and coordinated responses. There has been significant progress in the incorporation of macro-scale supply chain monitoring and operational advancements.

Federal and local authorities rally behind clean industrial policies, which help promote industrial carbon capture, fleet electrification, and regional cooperation; and focus on reducing the backlog of transportation infrastructure projects needed to support domestic supply chain growth. Africa's emergence as a center for low-value added manufacturing sets the East Coast up for increased trade activity. Climate migration, both domestic and international, continues to increase. Water scarcity issues in the South and Southwest U.S. are harder to mitigate and drive industrial and population migration north.

Oil-based energy use and extraction peaks due to external market manipulations and the rise of alternatives. Alternative fueling, power, and storage initiatives (such as solid-state batteries) are maturing with sustained investment despite facing continued economic and geopolitical headwinds. The electric grid faces an uphill battle to modernize and expand to meet new demand from renewables, but technology advancements in transmission have helped to ensure sustained progress. Long-haul electric vehicles (EVs) have become a viable reality and are slowly adopted by large-scale operators.

Climate Impacts on the Local Supply Chain in 2040

Climate events like hurricanes and increased flooding are still common in Greater Philadelphia, but impacts to local supply chains are mitigated through innovations in rerouting technology and local response time. Strong policy support for clean industries has led freight operators to incorporate electric and hydrogen energy vehicles into their fleets in greater percentages. This adoption has helped to mitigate local air quality, but not freight congestion concerns. Due to relaxed vehicle weight restrictions, the local freight system becomes even more reliant on truck-based movement, threatening rail's competitiveness. The ports see increased activity due to the need for carriers' flexibility around national weather-related disruptions.

Geopolitical and Economic Impacts on the Local Supply Chain in 2040

Technology and AI adoption is strong amongst supply chain operators in the region. Near-shoring, especially to legacy industrial areas, has picked up pace, aided by technology enhancements that enable the competitive production of high-value products like pharmaceuticals and medical equipment. Despite government support, local renewable energy projects are still troubled by feasibility concerns amidst volatile economic conditions; however, progress has still been made in shoring up the electrical grid to handle renewable energy. This has allowed the Philadelphia region to source renewable energy from other regions to advance local energy goals.

Due to strong policy support and international migration, the quality and abundance of Science, Technology, Engineering, and Mathematics (STEM) graduates from local institutions is high and feeds the ongoing development of advanced industries within the region. Labor organization is strong as a result of competition with AI and other technology improvements. However, new technologies are also seen as assisting labor with overcoming disruptions and are generally welcomed. The region's ports see activity increases from all over the globe as the region becomes a center of advanced manufacturing.

Infrastructure and Technology Impacts on the Local Supply Chain in 2040

The region sees greater infrastructure investment, going beyond state-of-good-repair projects. These investments help build a more stable and resilient freight system. Integration of routing technology in supply chain operations has led to less freight-related traffic on local roads, minimizing friction with local communities. However, truck parking is still limited due to lack of available land around freight centers, but existing lots have been upgraded with EV chargers. Renewable energy production is making steady progress despite setbacks. Industries that have the resources to invest in renewable energy are increasingly relying on their own generation (micro-grid) to remain resilient. The MACH 2 project has shown hydrogen's viability for manufacturing and supply chain operators looking to meet environmental goals, but less so on a national scale with limited applications for long-haul trucking. Natural gas remains cheaper due to local concentration of the industry in the region and is used as an intermediary while renewables continue to mature. The region sees migration of manufacturing back to the area due to its growing workforce, extensive legacy infrastructure, and warehouse capacity.

Source: DVRPC

Strategies and Recommendations

The purpose of the scenarios in this study is to chart potential futures for the supply chain in Greater Philadelphia and identify potential blind spots. However, the scenarios mark an intermediate phase, not the conclusive step of the process. The last phase involves crafting a set of strategies and recommendations intended to guide public officials and freight operators in fulfilling the central focus of this study—addressing critical constraints to enhance the sustainability, resilience, and equity of freight-related activities in Greater Philadelphia by 2040. Some critical constraints the region needs to address to fulfill the central focus are its aging infrastructure, workforce availability, and renewable energy availability.

The generation of recommendations necessitated additional outreach to comprehensively understand the impacts of each scenario on various modes and freight movements across the region. In December 2023, a virtual workshop took place, with participants assigned to one of four scenarios. Discussions were facilitated by DVRPC staff and participants were asked a series of questions regarding the effect of these scenarios on the different modes, freight operations, and the region's infrastructure. These discussions played a pivotal role in shaping the recommendations. Common themes across the groups included discussions on the availability of well-trained labor, fostering regional cooperation, promoting rail usage, and creating additional truck parking.

The strategies and recommendations are categorized according to the three primary principles at the core of our central focus. Each is accompanied by indicators outlining potential costs and time frames for implementation. While formulated in response to specific scenarios, these strategies and recommendations are intended to be viewed holistically, collectively aiming to mitigate the worst outcomes and amplify the best conditions of each scenario by 2040.

STRATEGY AND RECOMMENDATION KEY

Cost	Description
$	Projects anticipated to cost less than one million dollars
$$	Projects costing between one and ten million dollars
$$$	Projects costing more than ten million dollars

Timing	Description
Short	Projects with a short timeline, completing in less than three years, are often less complex and include proposed studies or coordination efforts.
Medium	Projects with a medium timeline, taking between three and ten years, typically involve smaller, less expensive infrastructure projects.
Long	Projects with a longer duration, exceeding ten years, represent some of the most intricate and multi-phased efforts.

Source: DVRPC

Sustainability Strategies and Recommendations

The sustainability strategies and recommendations outlined in Table 1 stem from all scenarios except for Disruption is the Only Constant. This underscores the significance and widespread nature of sustainability concerns across various potential futures for the supply chain in the region.

The region possesses an extensive freight infrastructure system dating back to the 1800s. While this infrastructure is robust, it is aging and requires substantial planning and investment to maintain its functionality and adapt to evolving goods movement patterns. These recommendations have the potential to not only impact the sustainability of the supply chain in the region but also equity. A greener and more efficient supply chain is likely to mitigate ambient air pollution along major corridors, particularly in areas with vulnerable populations such as children and the elderly.

Sustainability strategies and recommendations focus on ensuring the region supports investments in necessary infrastructure to facilitate efficient, green, and equitable freight movements where feasible. These efforts range from ensuring the region's electrical grid can accommodate the increased load from fleets transitioning to new electric trucks to advocating for adequate truck parking and amenities for drivers in new warehouse developments. Additionally, DVRPC and other stakeholders may promote the development of a diverse set of alternative power sources for use in the industrial sectors, such as hydrogen.

Table 1: Sustainability Strategies and Recommendations

Recommendation	Cost	Timing	Description
Support investment in rail infrastructure maintenance and growth, including standard weight access. *Applicable Scenarios: 1, 2, 4.*	$$$	Long	If an increase in inland manufacturing occurs due to more near-shoring, rail connections are important to promote sustainable goods movement, allow companies to meet environmental targets, and provide shippers with multiple options that keep businesses competitive. This requires the continued maintenance of existing lines, as well as the expansion of the network and its upgrade to 286k (ideally 315k) to carry fully loaded cars.
Incorporate truck parking requirements in local codes for any new warehouse construction or redevelopment. *Applicable Scenarios: All.*	$	Short	Truck parking is a perennial concern in any scenario where there is a significant increase in local production and resulting goods movement. It is important to ensure that any new truck parking has the infrastructure to adapt to multiple fueling futures.
Promote and incentivize the inclusion of both staging (short-term) and overnight (long-term) parking into warehouse site design. *Applicable Scenarios: All.*	$	Short	Truck parking remains a perennial issue in many of the region's municipalities and much of the issue is due to inadequate parking on or near warehouse sites. Municipalities can incentivize the addition of parking and other amenities like driver bathroom facilities by way of their local codes.
Study regional electrical transmission and distribution capacity and prioritize projects for enhancement. *Applicable Scenarios: All.*	$	Short	A robust and reliable electric grid is a prerequisite for the wide-scale electrification of vehicles and buildings. Governments and utilities need to work together to identify and address transmission and distribution capacity constraints and potential causes of disruption. A regional Freight Resiliency and Emergency Response Task Force or other entity may work with local utilities to identify areas of potential constraints and reliability concerns associated with increased electricity demand and create a prioritized list of projects for improvement.

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Recommendation	Cost	Timing	Description
Provide a network of designated truck parking facilities throughout the region. *Applicable Scenarios: All.*	$$$	Medium	Municipalities, in consultation with the counties and DVRPC, can identify, acquire, and develop sites appropriate for new truck parking facilities equipped with amenities such as full bathing and food service facilities, as well as charging opportunities for alternative energy vehicles.
Ensure multimodal access to industrial sites. *Applicable Scenarios: All.*	$	Short	To ensure shippers have the ability to respond to network disruptions and changing economic conditions while limiting carbon emissions, industrial sites should be designed with multimodal access where practical. Municipalities can promote multimodal access for new distribution and logistics developments by incentivizing existing Class 1 and shortline rail link preservation as well as the creation of new rail connections in local development codes, where applicable.
Incentivize the inclusion of EV and other alternative fuel infrastructure in new warehouse developments. *Applicable Scenarios: All.*	$	Short	Newly developed industrial sites should be designed with new vehicle technologies in mind (particularly electric) as sustainability is a chief concern in all scenarios. To make future EV installations more economical, electrical conduits and spare panel capacity should be required or incentivized for new distribution and logistics development.
Support the exploration of green hydrogen infrastructure and adoption by the supply chain. *Applicable Scenarios: All.*	$	Long	Support the exploration of repurposing fossil fuel infrastructure like pipelines for use with hydrogen. DVRPC, in conjunction with the counties and municipalities, can leverage federal IIJA investments by identifying opportunities for green, cost-effective hydrogen power pilot projects throughout the region's supply chain, as well as facilitating conversations with local communities and business members.
Preserve key industrial areas and provide adequate zoning for new areas (where appropriate) throughout the Greater Philadelphia region. *Applicable Scenarios: All.*	$	Short-Medium	Local municipalities can promote efficient, sustainable smart growth through their comprehensive plan's land use goals. Land use plans should include the provision and/or preservation of adequate land for industrial and supply chain-related uses — especially in existing industrial areas with multimodal connections. This can help the region create sustainable and accessible employment opportunities within both existing and new industrial zones.
Facilitate solar installations, battery storage, and micro-grid development on warehouse properties. *Applicable Scenarios: All.*	$	Short	Municipalities can promote the inclusion of solar generation on large, flat, and underutilized warehouse roofs and parking lots in local development codes. This may help move regional goals for renewable energy adoption in the supply chain forward by way of land use. In addition, the use of micro-grids may help operators maintain operations during disruptive weather and economic events, especially for large distribution and manufacturing facilities. Planning and coordination with local electric utilities to ensure that grid capacity and other interconnection requirements for distributed energy systems and microgrids should be facilitated by DVRPC in coordination with counties and municipalities.

Source: DVRPC

Resilience Strategies and Recommendations

Resilience focuses on the robustness of infrastructure and freight operations during crises and the ability to bounce back quickly after one occurs. Strategies and recommendations aimed at building a resilient supply chain in Greater Philadelphia make sense under each scenario.

Resilience within the freight system encompasses the durability of infrastructure assets, capable of withstanding frequent and severe weather events; and redundancy, such as ensuring emergency routes for trucks or double-tracking rail right-of-ways to minimize conflicts with public transport routes (see Table 2). Additionally, coordination, institutional support, and advocacy are central themes among these recommendations, essential across all levels of governance for success.

DVRPC can contribute to these efforts by offering data, identifying projects, and facilitating stakeholder engagement, while also connecting sponsors with funding opportunities to implement projects where applicable.

Table 2: Resilience Strategies and Recommendations

Recommendation	Cost	Timing	Description
Create and facilitate a regional Freight Resiliency and Emergency Response Task Force. *Applicable Scenarios: All.*	$	Short	Coordination is paramount. DVRPC can convene this task force, which can be composed of representatives from the major Class 1 and other shortline railroads, PhilaPort, SJPC, PHL, major trucking operators and representatives, PennDOT, NJDOT, and county emergency management agencies. This task force can set priorities for investment and policy changes to anticipate and respond to emergencies affecting the supply chain. This task force may also be activated during an emergency to better coordinate cross-river/regional response.
Work with both local and federal lawmakers to grant FHWA and other relevant agencies additional emergency response regulation relief for supply chain emergencies. *Applicable Scenarios: 1.*	$	Short-Medium	It is difficult for goods movers to adapt operations during emergencies like natural disasters or infrastructure failures. Implementing this recommendation allows the FHWA and other agencies to offer flexibility during supply chain emergencies, making sure goods continue to flow to, within, and from the region.
Work with local port operators to prioritize and secure funding for port resilience upgrades. *Applicable Scenarios: All.*	$$$	Long	DVRPC, in conjunction with local governments and port operators, can work towards identifying and implementing necessary resilience projects to strengthen the ports infrastructure against more frequent weather events and sea level rise.
Create new redundant rail connections near PHL Airport and Norristown Transportation Center to adequately facilitate both freight and public transportation movements. *Applicable Scenarios: All.*	$$	Medium	In an effort to facilitate efficient freight movement and avoid friction with public transportation at two critical chokepoints, Delaware and Montgomery Counties, the City of Philadelphia, SEPTA, and other necessary stakeholders may consider the creation of new redundant rail connections near PHL airport and Norristown Transportation Center to increase capacity and avoid bottlenecks.

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Recommendation	Cost	Timing	Description
Develop an emergency truck parking plan. *Applicable Scenarios: All.*	$	Short	Develop an emergency truck parking plan to ensure the safe movement of trucks on the road and protection of other road users during increasingly frequent and unpredictable extreme weather events. A regional Freight Resiliency and Emergency Response Task Force, as well as the PennDOT and NJDOT Freight Advisory Committees, can work together to develop an emergency truck parking plan.
Reevaluate road maintenance programs to include the effects of increased truck weight. *Applicable Scenarios: All.*	$	Short	DOT's may reevaluate their road maintenance and resurfacing programs to account for the effects of increased truck weights or volumes in the region. Maintaining a state-of-good-repair may require additional technologies or more frequent attention, both of which likely requires higher expenditures.
Work with Class 1 and local shortline railroads to identify service gaps, vulnerabilities, and the projects to address them. *Applicable Scenarios: All.*	$	Short-Medium	A regional Freight Resiliency and Emergency Response Task Force or other entity may work with all levels of rail provider in the region to determine where both inter- and intra-city connections, reliability, preservation, and state-of-good-repair are lacking in order to coordinate applications for funding to implement improvements. Federal programs like the Consolidated Rail Infrastructure and Safety Improvements (CRISI) Program and Rebuilding American Infrastructure with Sustainability and Equity (RAISE) are available to provide funding for a wide range of rail projects, either as singular projects or in packages.

Source: DVRPC

Equity Strategies and Recommendations

Equity stands as a central priority for both public and private freight stakeholders in the region. The recommendations pertaining to both sustainability and resilience play a role in alleviating numerous environmental equity issues highlighted by local communities. However, there are numerous social and economic equity challenges that demand attention.

Throughout the scenario planning process and outreach efforts, social and economic equity discussions have centered on workforce development, affordable access to jobs and services, and the form of new warehouse developments. A number of the strategies and recommendations outlined in Table 3 aim to address critical gaps in workforce development, which currently persist and are anticipated to exacerbate over time. Even with potential increases in migration to the region and a growing labor pool, there will remain a need to adequately prepare both new and existing residents for job opportunities. Supporting workforce development by facilitating the identification of gaps and linking stakeholders with institutions to establish training programs is a recurring theme within this set of recommendations.

In addition to bolstering workforce development, stakeholders must consider how their employees access their facilities. With many new warehouse developments situated in isolated industrial parks further from existing residential areas compared to previous eras, ensuring job access becomes a pivotal equity concern requiring attention.

Lastly, the location of existing, potentially outdated warehouses represents another equity concern raised by local counties and municipalities. Therefore, promoting thoughtful consideration of existing warehouse development and its potential for alternative community uses becomes imperative.

Table 3: Equity Strategies and Recommendations

Recommendation	Cost	Timing	Description
Support the creation of a rail apprenticeship program to build a steady pipeline of well-trained rail professionals and bolster retainment. *Applicable Scenarios: All.*	$$	Medium	Retaining rail workers remains an issue in all scenarios as it does currently. Rail training is largely handled through informal learning on-the-job and shadowing seasoned rail workers. An apprentice program can help to build a consistent pipeline of well-trained rail workers and bolster efforts to retain them. Rail operators are the primary implementer of an apprenticeship program, but local workforce development agencies and other entities can also help to administer such a program.
Promote investment in skilled workforce development. *Applicable Scenarios: All.*	$$	Medium	Investments in local trade schools and community colleges will help to develop a workforce that supports manufacturing jobs and that helps workers obtain the skills necessary to adapt to automation advances.
Promote the evolving study of consumer habits and related freight movements by standardizing the collection of data at a regional level. *Applicable Scenarios: All.*	$	Medium	DVRPC, in collaboration with PennDOT and NJDOT, can standardize the collection and publication of specific data sets related to consumer spending — such as delivery and household spending data — and origin/destination freight movements data within our region. This could help the involved agencies, as well as local governments and other outside observers, to conduct studies that evaluate the effects of changing habits and freight activity. In turn, this data will help inform new policies that reflect up-to-date conditions in the region.

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Recommendation	Cost	Timing	Description
Promote and incentivize outmoded warehouse redevelopment into other community-appropriate uses. *Applicable Scenarios: 1.*	$	Medium-Long	A potential glut of outmoded warehouse space provides local municipalities with valuable opportunities to redevelop the sites into modern, community-appropriate uses. Potential re-use strategies can focus on providing space for innovative new uses like indoor agriculture and sports facilities, while also identifying sites with potential for remediation and the construction of new housing or commercial developments where appropriate. This can also help guide new development towards better connected clusters of modern logistics facilities established in the last 20 years.
Support the creation of employment-specific commuter alternatives. *Applicable Scenarios: All.*	$$	Medium	As older warehouses that were better connected to transportation become obsolete, new services need to be created to connect employees. Many newer logistics centers in the region lack direct connections to SEPTA and other transportation services. Communities can alleviate some of this burden by coordinating with local Transportation Management Associations (TMAs) to provide alternatives like organizing vanpools or dedicated shuttle services. TMAs may also assist municipalities and large employers in obtaining funding for implementing these services.
Provide support for job training programs including retraining for workers in the fossil fuel industry. *Applicable Scenarios: 2.*	$$	Medium	In the "Green and Clean Growth" scenario, establish job training programs to ensure growing industries have an adequate workforce while addressing jobs lost in the fossil fuel sector. Energy and freight stakeholders can take the lead with the region's many vocational high schools and community colleges providing bases for workforce training programs aimed at the supply chain, transportation, and alternative energy sectors.

Source: DVRPC

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Conclusion

Since the onset of the global pandemic in 2020, the supply chain has experienced a constant state of change. Freight operators have swiftly adapted by integrating new technologies and operational approaches, even as uncertainty loomed. The ongoing evolution of geopolitical, climate, and demographic challenges introduces further uncertainty and complexity to operations. These macro-level trends and conditions exert distinctive impacts on regional economies worldwide, including the Greater Philadelphia area.

DVRPC worked with the DVGMTF to develop a set of scenarios that help to understand future uncertainty surrounding goods movement in the region through the year 2040. The central focus of this effort is to identify critical constraints that the region needs to address in order to make freight-related activity more sustainable, resilient, and equitable between now and 2040. The identified trends played a pivotal role in shaping four distinctive scenario futures. Scenario planning is a collaborative learning process that responds to external forces, transformational events, and technological advances by collecting participants' local knowledge and engaging them to wrestle with multiple uncertainties and implications.

These scenarios were arranged along two axes: the extent of external disruption and the level of market adoption of innovation. The first scenario, "Pre-Pandemic Déjà Vu," envisions a world that returns to the pre-disruption and "de-risking" state of the supply chain. The second scenario, "Green and Clean Growth," centers on a future with increased demand for sustainable, locally-produced goods and heightened investment in clean industrial policies and sustainable land use patterns. The third scenario, "Disruption is the Only Constant," portrays a supply chain consistently facing disruption, necessitating continuous adaptation to emergencies. The fourth and final scenario, "America's Workshop Reborn," features a revitalized domestic manufacturing base and robust technology adoption.

The Freight Futures project is part of a broader initiative assessing the Greater Philadelphia supply chain, offering guidance to public and private stakeholders for building a more sustainable, resilient, and equitable local supply chain. Positioned as a key resource, this project aids stakeholders in securing federal funding or partnerships for projects aligned with these objectives. These scenarios will help the Freight Program better understand the intricate web of interactions that effect supply chain movements. Upcoming projects such as the creation of a Regional Truck Network will benefit from the insights gained through this process. This project will also help DVRPC have nuanced, holistic conversations with local partners about the need for specific investments in the system, both infrastructural and policy-based.

The study's strategies and recommendations span various facets of freight movement, including workforce development, rail service promotion, truck parking provision, adaptive reuse, and incentives for electric vehicle connectivity all aimed at making the region's goods movement network more equitable, resilient, and sustainable. Leveraging the scenario planning process proved instrumental in crafting comprehensive recommendations. By defining a central focus, identifying future forces, and envisioning distinct futures, the study provides a systemic view of potential opportunities and constraints that regional supply chain operators must address over the next 15 years.

Freight Futures

CONTEXT AND ASSESSMENT

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Abstract:
The supply chain constitutes a delicate web of connections between producers, distributors, and consumers, This system is highly vulnerable to shocks from external forces like climate change, geopolitics, and new technology. The Freight Program undertook a scenario planning exercise to explore the trends affecting both the global and regional supply chain and to extrapolate them forward to 2040. Four distinct scenarios were created to better understand the future impacts of the various external forces effecting freight in our region. This report explores strategies and recommendations for addressing constraints and making the supply chain in Greater Philadelphia more sustainable, resilient, and equitable in 2040.

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DVRPC's vision for the Greater Philadelphia Region is a prosperous, innovative, equitable, resilient, and sustainable region that increases mobility choices by investing in a safe and modern transportation system; that protects and preserves our natural resources while creating healthy communities; and that fosters greater opportunities for all.

DVRPC's mission is to achieve this vision by convening the widest array of partners to inform and facilitate data-driven decision-making. We are engaged across the region, and strive to be leaders and innovators, exploring new ideas and creating best practices.

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