FDOT

Freight Mobility and Trade Plan

Technical Memorandum 4

Trends

April 2020

CONTENTS

FIGURES

TABLES

Introduction

This technical memorandum analyzes national and Florida freight related trends. The trends identified in this memo relate to Florida's population, economy, freight modes, and technology. This information was derived from a host of sources, including but not limited to the Bureau of Economic and Business Research (BEBR), the U.S Census Bureau, the Florida Chamber, Enterprise Florida, and the Freight Analysis Framework (FAF).

The evolution of freight transportation is largely shaped by trends in demographics, consumer behavior, economics, regulations, and technological advances. By analyzing the progression of these factors, planners and policy-makers can anticipate future impacts to plan for more efficient and sustainable freight environments. The following trends are shaping freight movement in Florida.

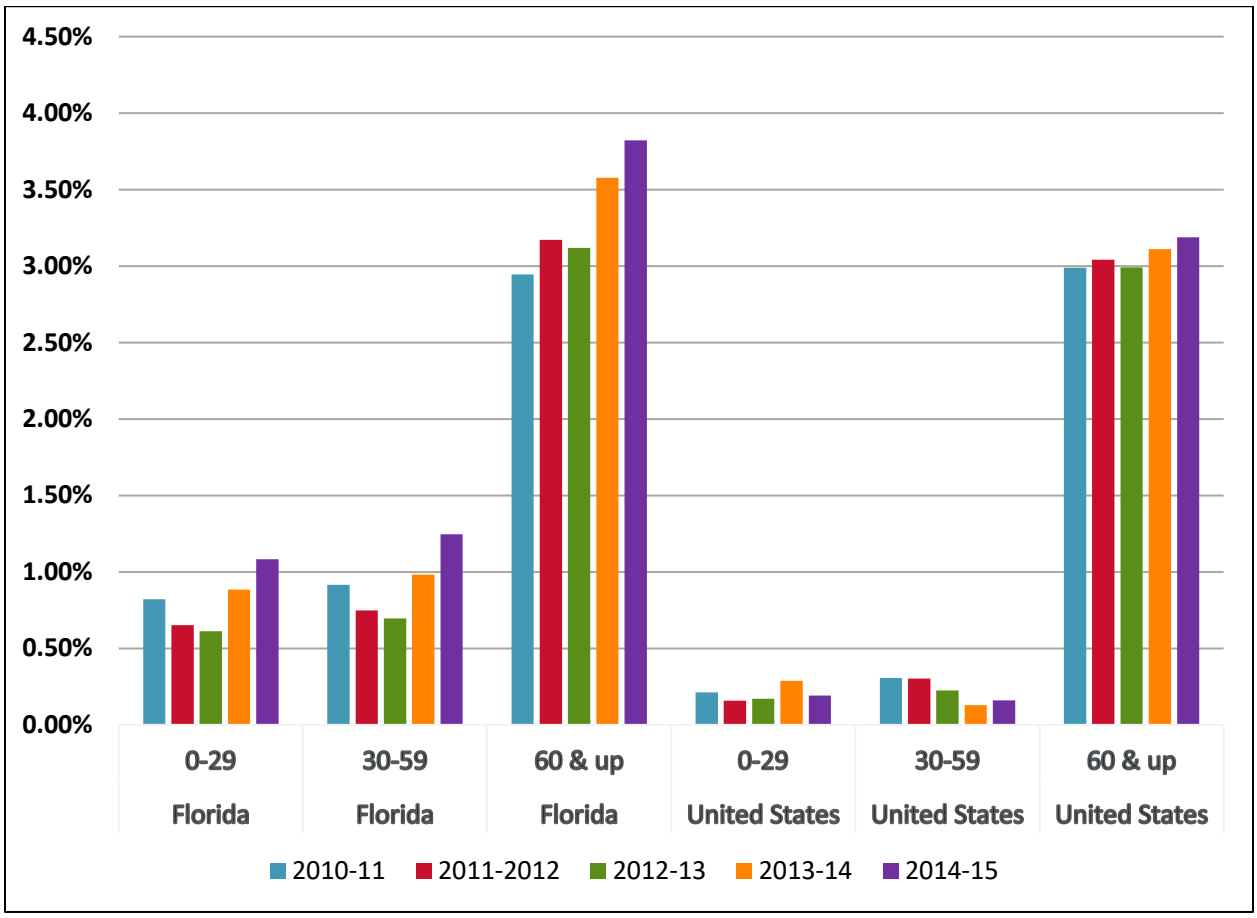
Population Trends

Florida currently has a population of 20.8 million, ranking third among the states. According to BEBR's forecasting model, Florida's population is expected to reach 27.4 million by 2045.[1] Florida's population is growing at a greater rate than that of the United States, signifying a net migration of residents from other states and countries. Florida's large population, evolving demographics and projected growth require the state and freight industry to develop and maintain a reliable, connected, and safe freight system. As Florida's population continues to grow so does the freight required to sustain daily life.

Aging

As Florida's population continues to grow, the population aged 60+ is growing at a notably quicker pace. Figure 1 shows the difference between Florida's and the United States' population growth rates by age cohort form 2010 to 2015.

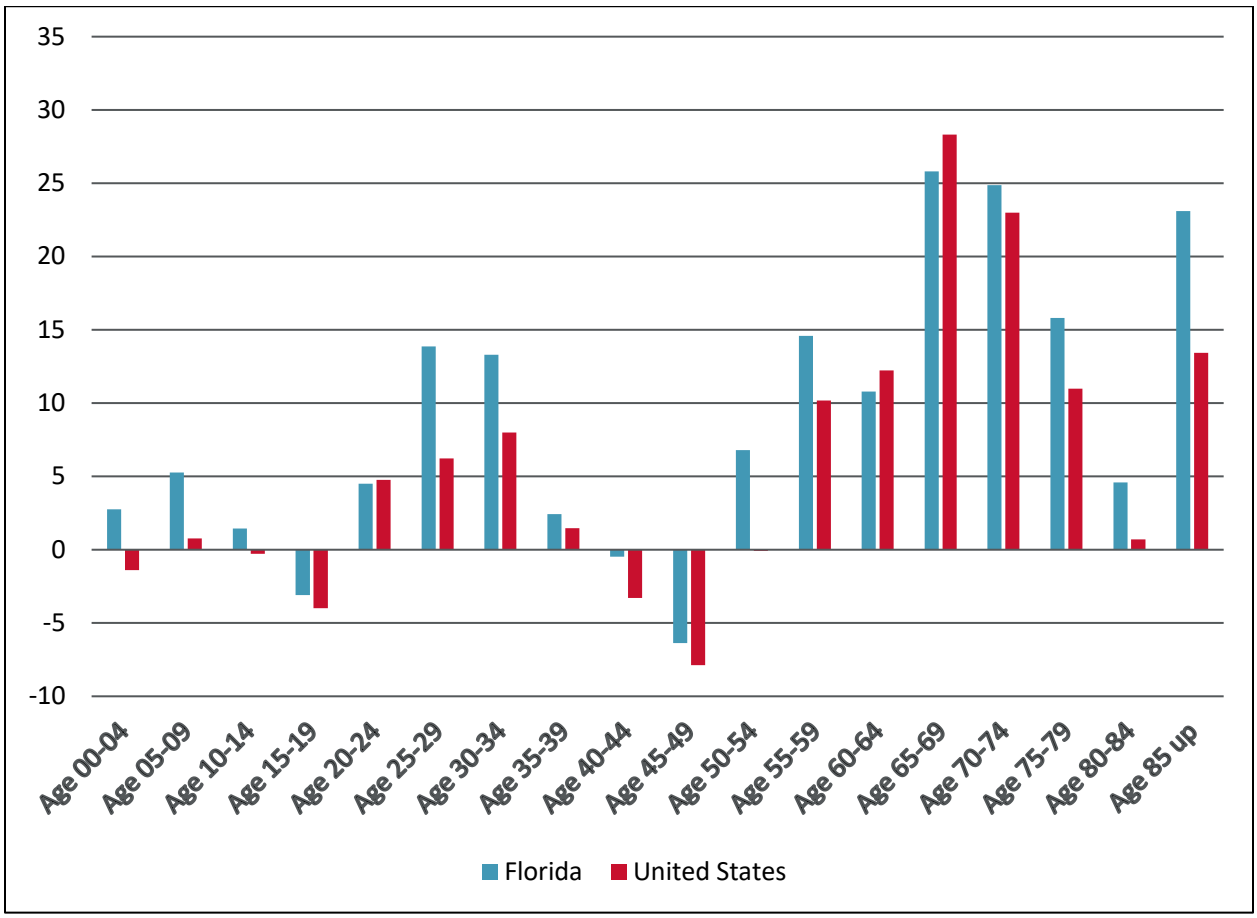
[1]Bureau of Economic and Business Research (BEBR). (2019) Retrieved from https://www.bebr.ufl.edu/population



Source: Bureau of Economic and Business Research, University of Florida, https://www.bebr.ufl.edu/population.

Figure 1 | Florida's Population Growth Rates, 2010-2015

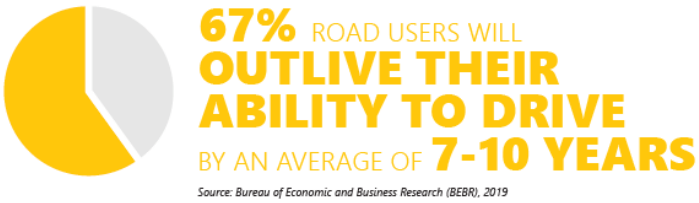
Trends show that the growth rate of most older age cohorts in the last five years have been greater than younger cohorts; in addition, the growth rates in Florida have mostly exceeded comparable cohorts for the United States as a whole (see Figure 2).



Source: Bureau of Economic and Business Research, University of Florida, https://www.bebr.ufl.edu/population.

Figure 2 | Florida's Population Growth Rates – by Age Cohort, 2010-2015

Within a few decades, residents aged 60 and older are expected to outnumber residents under the age of 18 (See Figure 2). In 2030, there will be comparatively fewer people in the working age population (age 25-64), bolstering the demand for labor and wages and a greater shift toward online shopping. These population trends will lead to a shift in freight distribution patterns.

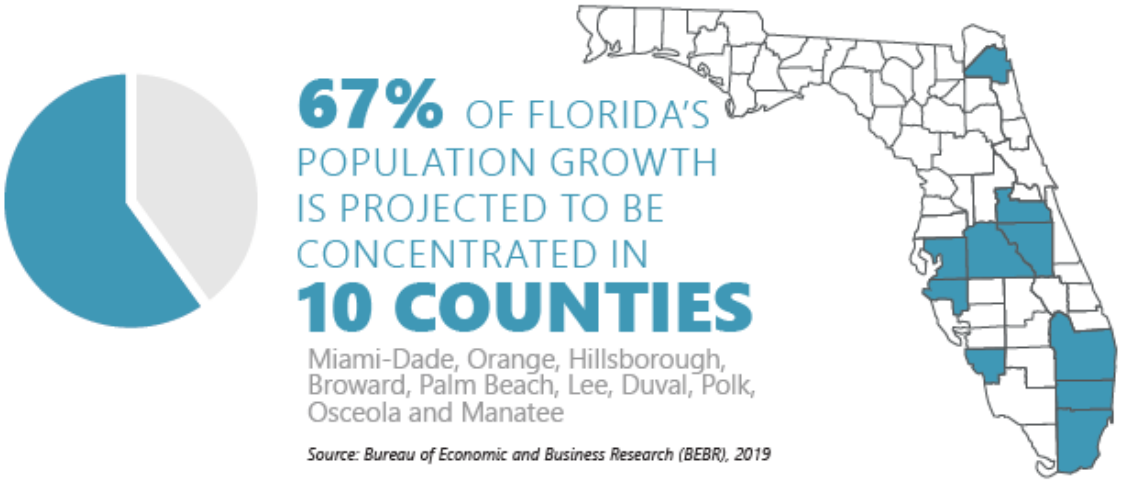


Urbanizing

Today, 9 out of 10 Floridians live in urban areas and this is unlikely to change into the future. 67% of the population growth is expected to be concentrated in ten counties.[2] Decades of

[2] U.S. Census Bureau. (2019). Retrieved from https://www.census.gov/

outward urban expansion have erased the defined boundaries for many of the state's urban areas, as economic ties between the expanding regions have been supported by the development of a roadway network.[3] By 2045, Florida is expected to become one integrated region in which there is little physical or geographic delineation between the metropolitan areas defined as urban centers.



The combination of population growth, demographic changes, and urbanization trends will have a transformative effect on Florida's supply chains. Increased congestion, higher numbers of urban deliveries and changing distribution networks are expected to have a significant impact on the state's economy and residents' quality-of-life.

Economic Trends

Growing Economy

The Florida economy is the 4th largest in the U.S. and 17th largest globally. Freight related industries - construction, manufacturing, trade, and logistics – support every facet of the state's economy. The trade sector has seen a tremendous growth with 40% increase in

[3] FDOT report on Florida Transportation Trends and Conditions, June 2014

wholesale trade and 80% in retail trade industries from 2009 to 2019. Transportation and warehousing industries have seen a 60% growth since 2009. Because of tourism and population growth, as well as a large population of retirees, Florida is largely a consumer state. This factor contributes significantly to the domestic trade imbalance, which manifests into the high quantity of empty trailers and containers moving out of Florida.

Tourism

In 2018, Florida saw 127 million visitors, up from 82.3 million in 2010. On an average day there are over 2.4 million, non-resident, visitors in Florida. While Florida has 20.8 million residents, Florida must "flex" its infrastructure and industries to accommodate a population 11% above its official tally. While the tourism industry supports 1.3 million jobs in Florida, it also increases the demand for freight. Approximately 50% of the tourists arrive via the roadways which adds to Florida's VMT.

Freight Transportation Choices

Florida's multimodal freight system is supported by all five freight transportation modes, shown in Figure 3, giving Florida businesses significant choices on how to convey their goods. Shippers and supply chain managers typically balance two key factors in determining freight modal choice – customer service and cost.

In 2017, trucks transported 65% of freight tonnage in the U.S. and rail accounted for approximately 10%.[4] FHWA's 2045 forecast shows that truck freight tonnage will increase modal share to 68% and rail tonnage will decline to 8%. However, many truckload carriers now utilize rail to transport both trailers and containers on long distance moves. This tactic not only reduces costs but also helps to off-set the driver shortage for the trucking industry. The trucking industry is a significant customer for the rail industry and while trucking and rail compete for some elements of the same freight market, they complement each other to a much larger degree. The Class I railroads focus on transporting many categories of goods and commodities, but are typically more profitable when moving freight over 600 miles. Conversely, the trucking industry's average length of haul is less than 400 miles. Figure 3 illustrates typical modal selection, depending upon variables related to shipment weight, shipment value, the origin and destination/distance, and when the product is needed. Although not shown, other variables enter into freight modal selection, including safety and security, transportation costs, reliability, and customer needs.

[4] U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5, 2019.

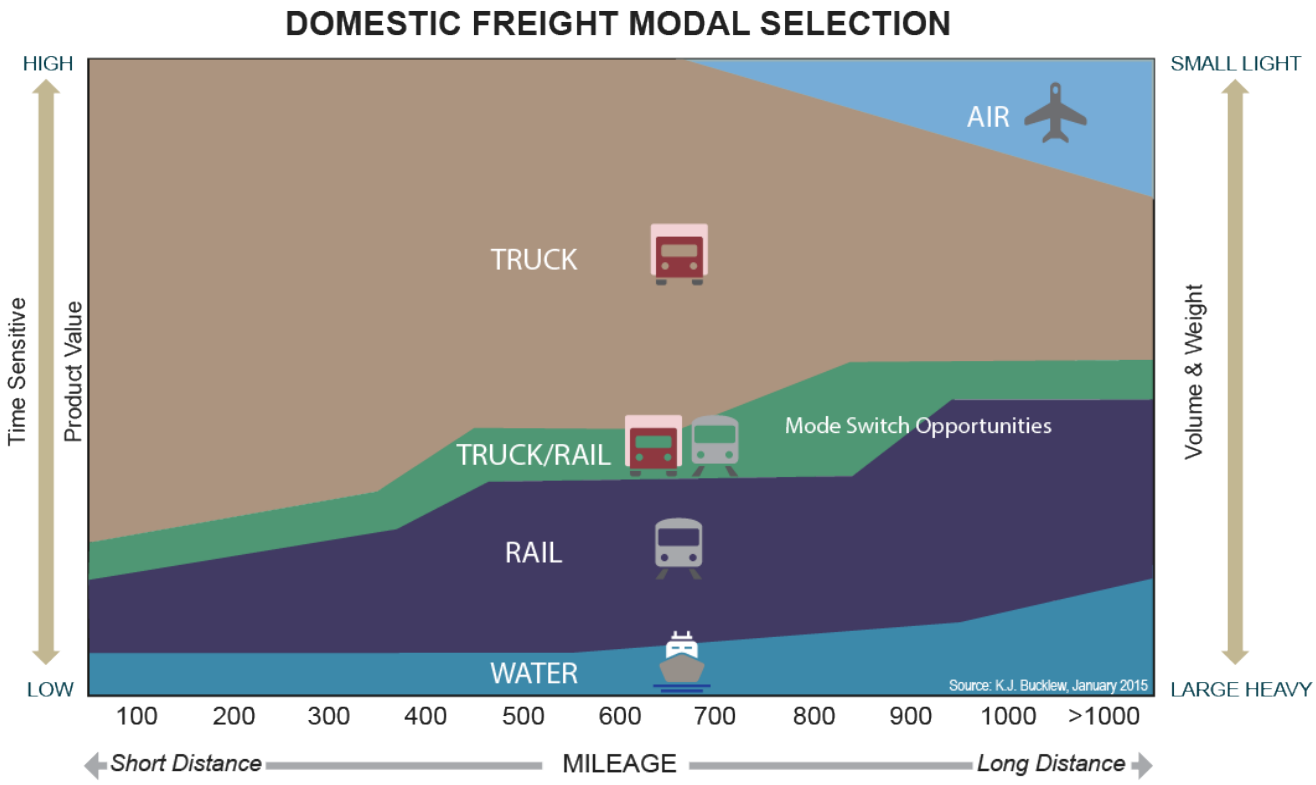


Figure 3 | Freight Mode Selection Framework

E-Commerce

The retail business model involving a direct, physical relationship between consumers and retailers is changing all over the world. E-commerce, defined as retail and business transactions involving the use of online platforms, is making waves in the retail industry. In 2017, total retail sales in the U.S. amounted to over $5 trillion,[5] of which e-commerce represented $449.9 billion, or nearly 9% of the total. The growth rate for e-commerce spending has ranged from 13% to 16% annually over the past five years, outpacing the 1% to 5% annual growth in traditional retail sales observed during the same time period.[6] It is estimated that Amazon was responsible for half of the nation's e-commerce sales in 2018.[7]

As e-commerce grows in popularity and efficiency, customers are increasingly expecting their orders to be fulfilled quickly. This contributes to the shift to smaller but increasing numbers of

[5] Monthly Retail Trade Report. "Estimates of Monthly Retail and Food Services Sales by Kind of Business." *U.S. Census Bureau*. Retrieved June 11, 2018. Available online: https://www.census.gov/retail/mrts/www/mrtssales92present.xls.

[6] Quarterly E-Commerce Report. "Estimated Quarterly U.S. Retail Sales (Not Adjusted): Total and E-commerce." U.S. Census Bureau. Retrieved January 4, 2019. Available online: https://www.census.gov/retail/mrts/www/data/excel/tsnotadjustedsales.xls.

[7] https://www.miamiherald.com/real-estate/article232817377.html

distribution centers/warehouses and more nimble delivery vehicles like delivery vans and personal vehicles.

Brick-and-mortar stores still remain an essential component of current retail operations, but retailers are becoming more flexible in how they reach and interact with consumers by decentralizing their distribution/fulfillment networks to bring inventory closer to consumers, sometimes even using their brick-and-mortar locations as e-commerce distribution centers.[8]

In order to get "close to clicks" for quick delivery, distributers like Amazon are looking to locate in dense urban areas. Amazon recently opened an 855,000-square-foot fulfillment center in Opa-Locka, bringing its industrial footprint in Miami-Dade County close to 1.5 million square feet of space. Roughly 4.5 million square feet of speculative industrial and warehouse space in Miami-Dade was under construction and/or delivered in 2018, despite continuous land-constraints and congestion issues.[9]

Gig Economy

The gig economy is changing the landscape of business, and affects freight in a variety of ways. For example, e-commerce deliveries are increasingly made by independent contractors using mobile applications to match their personal vehicle locations with deliveries. Another example is "Amazon Flex" as a Freight Mobility as a Service (FMaaS) solution, where just about anyone with a car and a smart phone can pick up parcels at a distribution center, route drop-offs, and make deliveries. Similarly, freight brokerage apps like the on-demand, real-time Uber Freight can match freight truckload shipments with available drivers/equipment.

Military Activity

Florida's multimodal freight system supports the deployment of military forces overseas. Not only is Florida home to 22 U.S. military bases with more than 56,000 active military personnel, JAXPORT serves as the point of embarkation for Fort Campbell, Kentucky deployed personnel. This Army installation is home to the 101st Airborne Division and is therefore a designated Power Projection Platform by the U.S. military. Each designated Platform is a U.S. Army installation that can strategically deploy active duty combat brigades in short notice. These efforts are supported in Florida by the 832nd Transportation Battalion – based at JAXPORT. Overall, large deployments of troops have decreased as a result of the drawdown in the Middle East and Afghanistan. However, smaller groups strategically deploying around the globe still rely on Florida's multimodal freight facilities.

[8] (ATRI Impacts of E-Commerce on Trucking, Feb 2019)
[9] https://www.miamiherald.com/real-estate/article232817377.html

Resilience

The impacts of disruption to the nation's freight system from both natural and man-made events have become increasingly apparent to planners, policy makers, freight stakeholders, and the public at large. With much of the nation's freight movement being multimodal and multi-state in nature, freight movement in each state has been impacted to some extent by disruptions from non-recurrent episodic events (like major storms or fires) or recurrent risks (like relative sea level rise). In response, freight transportation systems must become more resilient, in terms of their ability to: resist disruption; adapt quickly and provide emergency services immediately following disruption; and re-establish full operations following disruption.

> Resiliency is the ability to prepare and plan for, absorb, respond, recover from, and more successfully adapt to adverse events. Enhanced resilience allows better planning to reduce disaster losses – rather than waiting for an event to occur and paying for it afterward
>
> *FDOT Transportation Resilience Primer*

Since 1980, Florida has experienced 48 different billion-dollar (or more) damage natural disaster events, including drought, flooding, freezes, severe storms, hurricanes, wildfires, and winter storms.[10] Florida's location makes it a prime target for hurricanes, which can create storm surge over 20 feet high.[11] Aggravating this situation, strong (Category 5) Atlantic hurricanes are increasing in frequency.

Each year FDOT invests billions of dollars into improving and expanding the state's mobility infrastructure, much if not most of which has to regularly endure extreme weather conditions. Thus, resilience remains a critical factor of Florida's transportation system, particularly the Strategic Intermodal System (SIS), which carries the majority share of freight transport mileage in the state.

[10] National Oceanic and Atmospheric Administration, (2018). Billion-Dollar Weather and Climate Disasters: Overview. https://www.ncdc.noaa.gov/billions

[11] United States Geological Survey, (2018). Hurricane Michael Storm Tide and Pressure, Mexico Beach Pier, Florida. https://www.wunderground.com/cat6/Hurricane-Michael-Brought-Water-Levels-Over-20-High-Coast

Modal Trends

Highway

The growing population fueled by a growing economy has increased the number of trucks on the road (see Figure 4). The number of intra-regional and last-mile truck trips has increased while the average length of haul has declined with more distribution/fulfillment centers being built. Average trip lengths have decreased 37% since 2000, while urban vehicle miles traveled have increased for much of this period. Due to the more frequent but shorter trips, congestion and bottlenecks have increased in dense urban areas. Not only are vehicle miles traveled (VMT) increasing with shorter but more frequent trips, but trucking accidents and fatalities are on the rise since 2012.

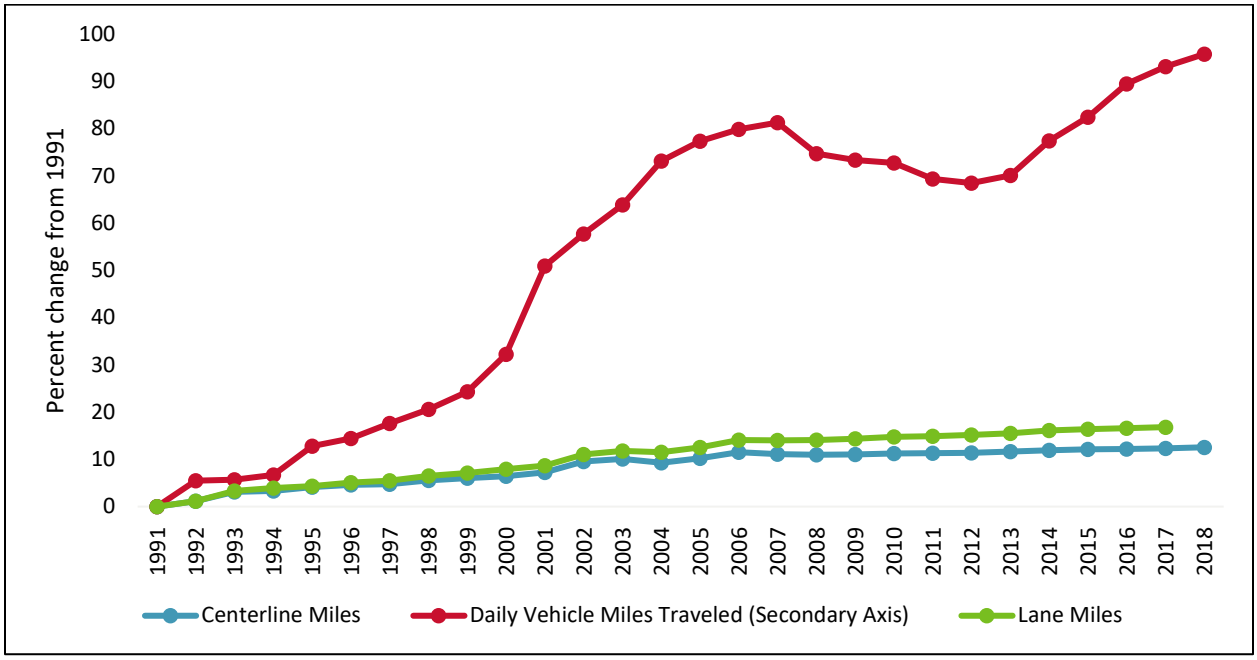


Figure 4 | Growth in Truck VMT

Alternative Fuel

Florida's businesses, local governments, and private citizens are realizing the benefits of alternatively fueled vehicles. Vehicle fleets are being converted to propane, compressed natural gas (CNG) and liquefied natural gas (LNG).[12]

The market for natural gas technology vehicles and fueling infrastructure has experienced substantial growth in the past few decades. Since the Natural Gas Fuel Fleet Vehicle Rebate Program's (2013-2018) inception, the number of private and public compressed natural gas

[12] Florida Department of Agriculture & Consumer Services, 2018 Office of Energy Annual Report

fueling stations in Florida has increased from 19 to 58 with another six stations planned as of May 2018.[13]

The use of electric vehicles is also increasing with technology, charging infrastructure, and consumer awareness. Improved battery performance has led to longer ranges, shorter recharge times, and lower maintenance, and has bolstered consumer confidence and public acceptance of electric vehicles.

> The Florida Department of Highway Safety and Motor Vehicles lists the number of registered electric vehicles in Florida as 82,682 as of December 30, 2018
>
> *2018 Office of Energy Annual Report*

Aviation and Aerospace

Tampa International Airport (TPA) has seen tremendous growth in the last decade. Cargo volume at TPA has doubled since 2015 largely due to the addition of Amazon air operations in 2015 and UPS in 2017, with other smaller airports like Lakeland International also adding Amazon services. In addition, the commercialization of the space industry is attracting significant private investment and creating a new paradigm for the space freight market.

Panama Canal

The expanded Panama Canal, coupled with increases in vessel sizes, has changed the flow of goods movement since 2016 on the West, Gulf and East Coasts. Goods from North East Asia that were previously offloaded from vessels on the West Coast and railed across the United States can now be moved on all-water routes directly to Florida seaports. The larger vessels and additional volumes are requiring new investment and technology in marine terminals. It has also required changes to truck movements accessing marine terminals for imported and exported goods.

The benefit to Florida is its proximity to the Panama Canal by about 150 nautical miles. The next closest port is Gulfport; however, it lacks the marine terminal capacity of PortMiami. PortMiami is one of a few East Coast seaports that can handle a fully-laden New Panamax container vessel; and JAXPORT is currently deepening its navigation channel to 47 feet.[14]

International Marine Industry

Although the Panama Canal has diverted 10% or more cargo to East Coast ports, the international sea shipping market has been in a state of fluctuation since 2008. The cost of fuel and desire to gain greater market shares has helped create alliances – most notably, recent

[13] Florida Department of Agriculture & Consumer Services, 2018 Office of Energy Annual Report
[14] The *2018 Panama Canal Expansion and Florida Seaports – Preliminary Study*

consolidations of several Chinese carriers. The result has been a larger share of the market controlled by fewer (larger) carrier services, which has affected rates. These factors can make it more difficult to serve Florida with large ships.

Cargo Theft

In 2018 there were 72 reported incidents of cargo theft in Florida. The total value stolen was $7,783,964. Since 2012, when the State of Florida first began participating in the FBI's Uniform Crime Reporting Program, there has been an uptick in the number of incidents reported, a reduction in the value of property stolen per incident, and increase in the value of property recovered. [15] See Figure 5.

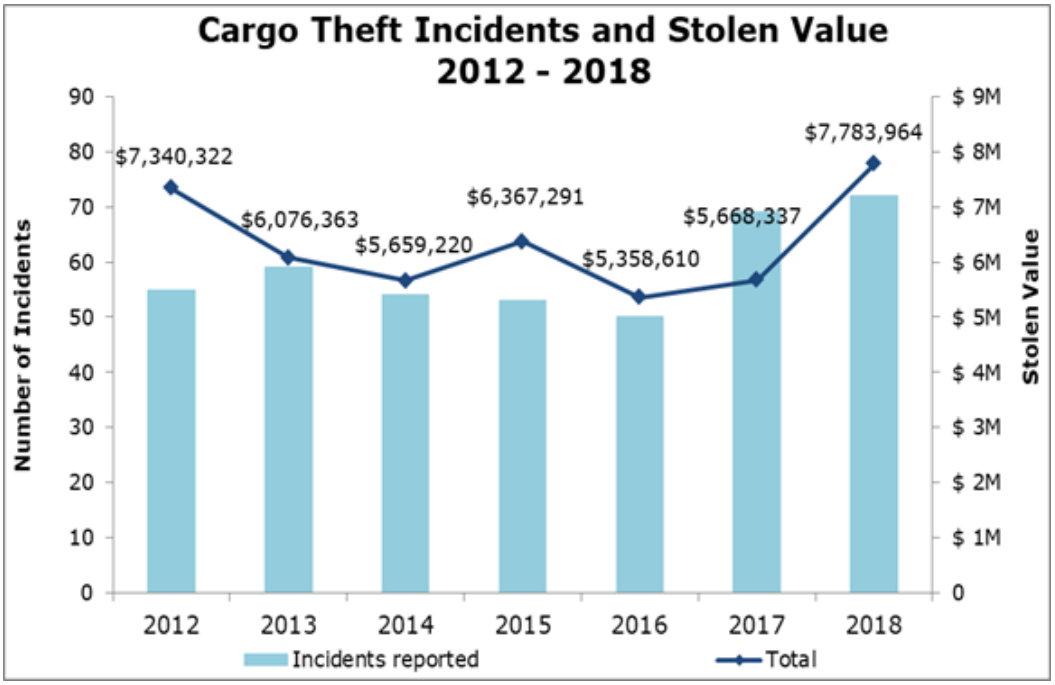


Figure 5 | Florida Cargo Theft

While Florida still rounds out the top three states for frequency of cargo thefts along with California and Texas, the number of thefts has recently seen a decline across the nation. In the second quarter of 2019, there was a 14% drop in "cargo theft events" from the same period a year ago. What was stolen still amounted to tens of millions in losses.[16]

[15] https://www.fdle.state.fl.us/FSAC/Crime-Data/Cargo-Theft.aspx

[16] https://www.truckinginfo.com/337434/cargo-theft-rate-drops-14-estimated-loss-still-enormous?utm_campaign=Daily%20Newsletter&utm_source=hs_email&utm_medium=email&utm_content=75303681&_hsenc=p2ANqtz-9tV7duQAsgrYq1aVKQRo0l_8b8TEQ2jR3fBC7SHaWPuc9sCUYUrh8iplMdapvHxEQdb8zrzofRDnrHv7PWdLYavZAuTw&_hsmi=75303681

Rising Insurance Costs

The trucking industry is facing the issue of rising insurance costs. Costs have risen due to litigation for crashes which result in damages, injuries, time-lost, and other associated factors. Vehicles equipped with expensive technology, declining insurer competition, and "nuclear verdicts," are contributing to the issue. The latter, resulting from a Florida tort law, allows juries to award damages if a trucker is 1% negligent, whereas in states like Georgia, juries demand that litigants prove a trucker is 50% negligent.[17]

Technology

Connected/Automated Vehicles (CAV)

Automation

Autonomous Vehicle (AV) and Connected Vehicle (CV) technologies hold great potential to significantly reduce crashes, improve capacity, and enhance mobility for all transportation users. It is estimated that 90% of all traffic accidents are the result of human error. The U.S. Department of Transportation (USDOT) and the National Highway Traffic Safety Administration (NHTSA) are aggressively pursuing the implementation of CAV technologies, which could potentially avoid up to 80% of all traffic accidents (assuming full adoption/market adoption).

Highly Automated Trucks (HATs) are currently being tested in Florida by companies like Starsky Robotics, who hope to have driverless deployments beginning in Florida by the end of 2020.[18] This includes autonomous operation on limited access facilities and/or rural divided highways, with supervision (in-cab or remotely), and tele-operation (remote control) for arterial roadways. Operation of HATs with no operator (driver) in the cab could lead FMCSA to consider HOS regulations specifically for this new business model, since HAT systems do not suffer from fatigue in the same way as humans.

While HATs are still in testing, the Advanced Driver Assistance Systems (ADAS) are currently used in trucks, primarily to improve safety and reduce fatigue on drivers; ADAS includes features such as active lane centering, adaptive cruise control, forward collision warning, automatic emergency braking, and blind spot monitoring. As trucks age and are replaced with newer models, Florida can expect to see more vehicles equipped with these technologies.

[17] https://www.bizjournals.com/jacksonville/news/feature/statewide-transportation/2019/03/florida-tort-law-makes-it-tough-for-truckers.html

[18] https://www.govtech.com/fs/automation/Florida-Roads-Could-See-Autonomous-Trucks-Next-Year.html

As seen in Figure 6,[19] Florida has been at the forefront of CAV investments. The map exemplifies Florida's early-adopter attitude towards CAV technology with a host of projects and initiatives underway.

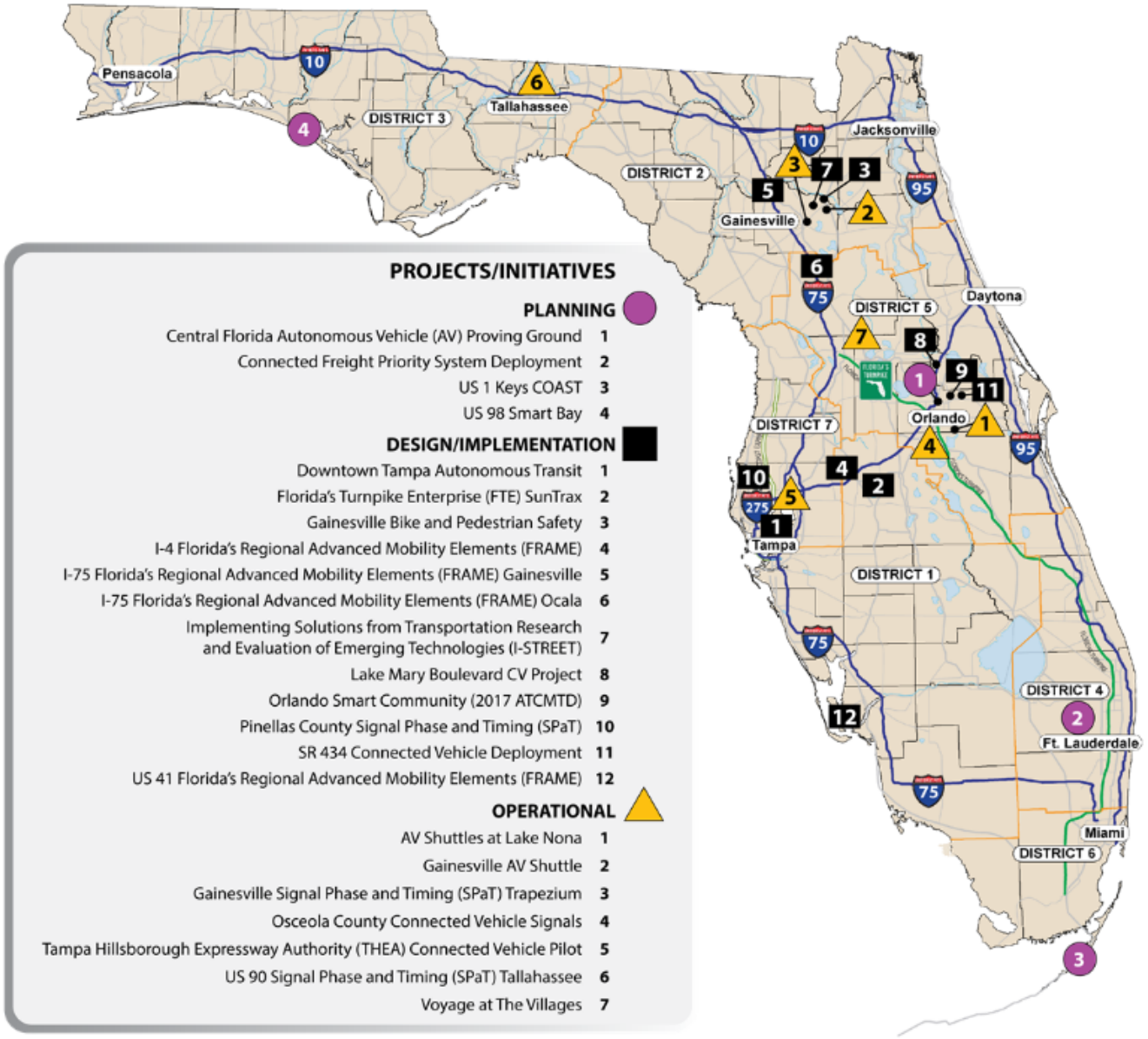


Figure 6 | Florida's CAV Projects/Initiatives

[19] https://www.fdot.gov/traffic/its/projects-deploy/cv/connected-vehicles

Truck Platooning

Truck platooning electronically synchronizes multiple trucks to allow them to operate closer together, one behind another. The use case for platooning is to improve fuel economy for all platooned trucks, however most of the efficiency gains are afforded to the rear truck(s). As with HATs, truck platoons have been successfully tested on public roadways, but are still not ready for full operation.

Driver-Assistive Truck Platooning (DATP) is likely to be the first iteration of truck platooning, but will likely be limited to two or three trucks per platoon. DATP is considered an ADAS at SAE Automation Level 1 (system controls braking & acceleration) or Level 2 (system controls braking, acceleration, and steering). This means that each driver must remain alert and focused on the task of driving, although perhaps at lower levels of stress.

Infrastructure-to-Vehicle (I2V) Communication

Infrastructure-to-Vehicle communication requires CV (4G, 5G, DSRC, or C-V2X) Road Side Units (RSUs) to be deployed within range of roadways. Freight specific CV applications include, but are not limited to, the following:

- Connected Vehicles for Freight Signal Priority – non-safety critical, designed to improve truck travel times
- Eco-Speed/Harmonization (recommended speed through a corridor to minimize braking and acceleration, maintain consistent speed) – non-safety critical, designed to improve truck travel times and/or fuel consumption
- Wrong Way Driver Warning – safety critical Basic Safety Message (BSM)
- Low Clearance Bridge Warning – safety critical BSM
- Queue Warning – safety critical BSM
- Notification to dis-engage DATP near areas of concern (identified bridges, dense-interchange locations, etc.)

Wide spread deployment of CV infrastructure is contingent upon if the automotive industry adopts 5G or DSRC radio technology. If 5G is determined to be more appropriate, then the telecommunications industry will be compelled to deploy 5G small cells along transportation corridors. If DSRC is determined to be more appropriate, then state DOTs and other transportation agencies will be compelled to deploy DSRC RSUs along their infrastructure. Urban areas and locations experiencing high crash rates will be prioritized for first deployment. Interstate facilities and state highways in rural areas will likely be equipped with CV infrastructure, but the deployment will lag behind higher priority areas.

Communication and Information Exchange

Big Data

There are currently 2.5 quintillion bytes of data created each day, and the pace is accelerating. Over the last two years alone, 90% of the data in the world was generated. By 2020, it is estimated that more than 40 trillion gigabytes of data will be generated annually.[20]

While organizations have been using warehouse and distribution system data to conduct transportation and freight analysis for decades, 'big data' allows for the harvesting of the enormous datasets in non-traditional ways.[21] Big data is already changing the freight industry with its ability to increase transparency, optimize consumption, improve process quality and performance, and create new revenue streams from new data/products.[22]

There is a push for open source datasets as well as open source computing environments (R, python, OpenStreetMap) for universal accessibility. The advent of applications like Trucker Path, which informs truckers about available parking spaces, is helping the industry deal with some of its greatest challenges.

Truck Parking Availability System (TPAS)

In Florida, the limited availability of truck parking spaces has caused overcrowding and overflow at existing truck parking locations. At times, truck drivers turn to parking on the interstate mainline, ramp shoulders, or in vacant lots. To address the issue, the FDOT is in the process of deploying a statewide Truck Parking Availability System along I-4, I-10, I-75 and I-95 at welcome centers, weigh stations, and rest areas. TPAS is helping to improve the safety of truck drivers by identifying safe locations to park along the interstate system and maximizing their HOS requirements by lowering the amount of time spent to find parking spaces.

Container Identification System

Another trend impacting all modes stems from increased connectivity and advances in cargo tracking through any given trip. Radio Frequency Identification (RFID) tracking of containers and/or rail cars/trailers could significantly reduce time spent identifying and tracking cargo – and ultimately inform supply chain optimization and decision-making (i.e. carrying inventory cost, etc.)

Blockchain

Blockchain allows for an entire supply chain network to contribute to data validation, helping build trust and confidence among users in the data and information. Data is stored in a

[20] FTP
[21] https://www.xeneta.com/blog/big-data-shipping-analysis
[22] https://cerasis.com/big-data-in-the-transportation/

decentralized manner, and the integration of data is simplified because all systems connect to a single node of access.[23] The logistics industry is already incorporating elements of blockchain, like using transactional 'live' databases for real-time exchange of bill of ladings, contracts, financial exchanges, etc. Multiple levels of actors (administrator, user, observer, etc.) can have various levels of access.

Multimodal Freight Technology

Positive Train Control

Positive Train Control (PTC) systems are technologies designed to automatically stop trains when they enter certain crash-prone conditions. Mandated by Congress as part of the Rail Safety Improvement Act of 2008 (RSIA) on passenger rail corridors, PTC helps to prevent accidents related to human error, like train-to-train collisions, derailments caused by excessive speed, unauthorized train movement onto sections of track where maintenance activities are taking place, and movement of a train through a track switch left in the wrong position.[24] PTC can also increase rail throughput and capacity through better communication/coordination.

However, railroads and commuter rail agencies are facing potential deadline difficulties with meeting the December 2020 deadline for PTC implementation. The 2020 deadline was delayed by Congress from its 2018 deadline, which had in turn been extended by Congress from the original 2015 deadline. Many PTC suppliers are keeping up with the demand for PTC systems despite funding challenges have led to compressed schedules to meet the 2020 deadline.[25]

NexGen

NexGen is the name of a FAA-led overhaul of the nation's air traffic control system. It helps airlines, general aviation operators, pilots, and air traffic controllers get access to data and tools that help passengers and cargo arrive at their destinations more quickly, while consuming less fuel and producing fewer emissions. This transformation involves an ongoing rollout of improvements which began in 2007 and are expected to be complete in 2025.[26]

Port Automation

Port automation for seaports and airports could significantly improve on-facility operations resulting in greater throughput of cargo and passengers. Automated cranes could improve capacity/throughput/productivity (containers per hour). Although, when an automated crane

[23] https://enterprise-info.trimble.com/blockchain-technology#freight
[24] https://www.aar.org/campaigns/ptc/
[25] https://www.enotrans.org/article/as-2020-deadline-looms-railroads-face-ptc-implementation-challenges/
[26] https://www.faa.gov/nextgen/what_is_nextgen/

fails, it takes longer than a standard crane to become operational again. As with the new CAV technologies, the industry will need to hire/contract new skillsets.

Similarly, Automated Ground Vehicles (AGVs) can be used for on-site movement of cargo, which boosts capacity as a result of decreased processing and handling times. There are, however, liability issues as cargo changes 'hands' (firms) many times, and everyone involved must approve that their property can be moved via AGV.

Drone/Robot Delivery

The nature of freight deliveries is morphing in both urban and rural settings. Drones, or Unmanned Aerial Vehicles (UAVs), and robots, or Personal Delivery Devices (PDDs), are being tested to fulfil last-mile delivery needs.

UAVs can deliver packages to their final destination once a truck reaches a strategic location and deploys them. The benefits include significant fuel/time savings for parcel delivery services and a reduction in costs for maintenance of unpaved roads to rural counties. Delivery vehicles currently add significant wear and tear on these facilities as a result of e-commerce. UPS has estimated that cutting off the last mile for each of their 66,000 delivery drivers would amount to $50 million in savings.[27]

PDDs can legally operate on sidewalks in FL (F.S. 316.2071), making last-mile deliveries as courier service providers do currently. In several cities around the United States, Postmates, a third-party delivery app, is testing PDDs that deliver food from local restaurants to people's homes. Important considerations include how they will navigate dense urban areas and pedestrians, and how sidewalk/curb-side management policies might evolve in their wake.

3D Printing

As manufacturers adopt 3D printing, the commercial transportation industry could evolve dramatically. 3D printing allows for companies to produce finished goods using a printing machine and 'raw' material input, localizing production. Without the need to procure parts and pieces from all over the globe, shipments of materials could be greatly reduced. One estimation says 3D printing could disrupt freight by as much as 41% of air cargo, 37% of ocean freight, and 25% of truck freight in loss of annual value.[28]

---

[27] Business Insider. Desjardins, J. (2018, March 11) *Amazon and UPS are betting big on drone delivery*. Retrieved from https://www.businessinsider.com/amazon-and-ups-are-betting-big-on-drone-delivery-2018-3

[28] Strategy + Business. Rothfeder, J. (2015, April 20) *The Imagination Gap: Business leaders in at least 16 sectors are still not fully prepared for the digital transformation of their industries*. Retrieved from https://www.strategy-business.com/article/00334?gko=86e01

Integrating Technology

The plethora of technologies is challenging to integrate and incorporate into processes and systems to enhance freight mobility. Understanding the benefits and costs of the technologies, the complexity and cost to implement, utilize and maintain, and knowing the capabilities of the technology and foreseeing its unintended consequences is a daunting responsibility.

Technologies are tools and techniques that enhance efficiency, reliability, safety, security, economic development, and support improvements to the environment. The technologies should be considered in light of how they will best support Florida's freight mobility goals.

Commodity Flow Analysis

This section uses the Freight Analysis Framework (FAF) and Enterprise Florida to analyze the commodity flows in Florida. The FAF is produced through a partnership between the Bureau of Transportation Statistics (BTS) and FHWA. It integrates data from a variety of sources to create a comprehensive summary of freight movement across states and major metropolitan areas by all modes of transportation. The FAF provides estimates for tonnage and value of commodities by regions of origin and destination, commodity type, and mode. Enterprise Florida uses Wiser Trade information and U.S. Census Bureau Foreign Trade Division to compute these statistics.

It is important to define two terminologies here:

- Merchandise trade consists of those goods that are shipped to, from, and through Florida, regardless of where they were produced, as well as those goods that are produced, grown, or mined in Florida and are shipped from the state to an overseas destination.
- Florida-origin data series measures the value of merchandise exports grown, mined, manufactured, assembled or that otherwise had value added in Florida regardless of where the goods exit the United States. The origin of movement series attempts to ascertain the transportation origin of exports, e.g., it tries to allocate exports to states based on where the export journey began.

Freight Analysis Framework

Figure 7 illustrates the commodity flow for the state of Florida using the Freight Analysis Framework, 2017 data (4.5 version). As expected, the majority of commodity movement is within the state (595.9 million tons) and imports (134.6 million tons) to Florida highly outnumber exports (55.8 million tons). These numbers emphasize that Florida is predominantly a consumer state. Subsequent figures and statistics provide a comprehensive summary of the current (2017) and forecasted (2045) commodity flows for the state of Florida. Additionally, the major commodity types and the modal splits for different commodity flow movements are identified.

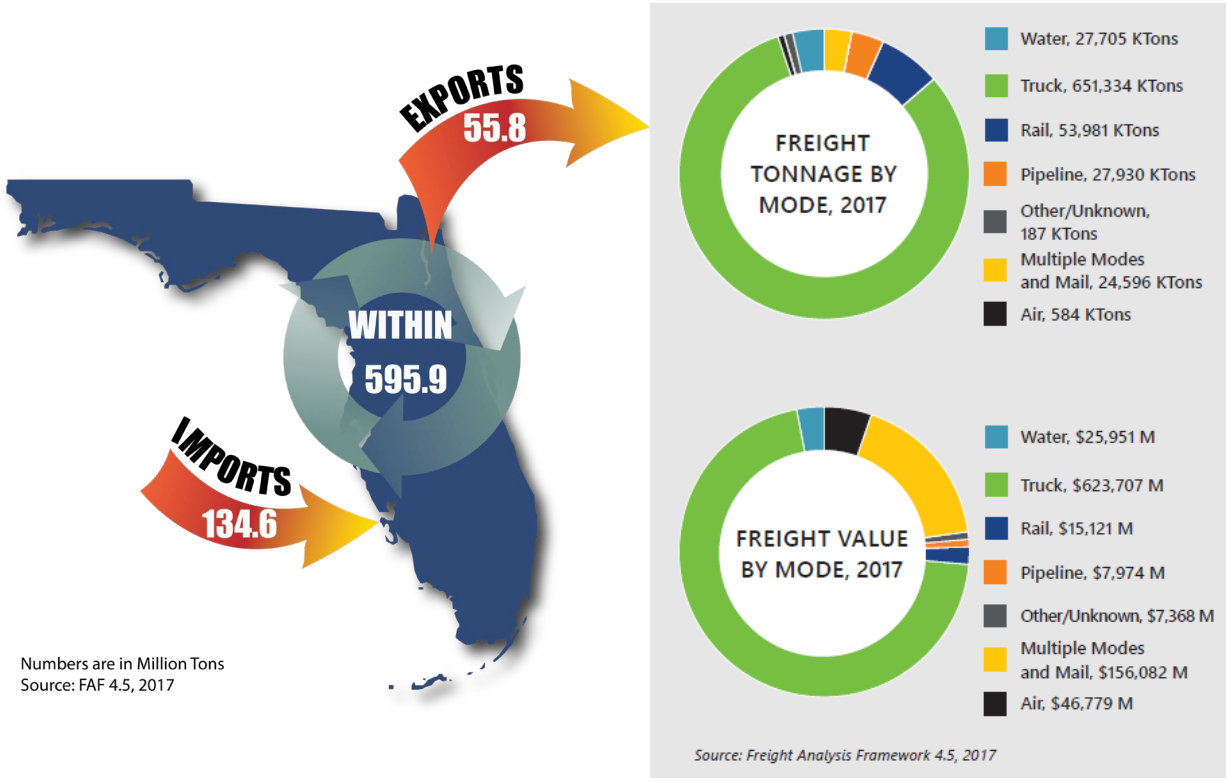


Figure 7 | Commodity Movement In, Out and Within Florida

Figure 8 provides the modal splits for exports (in tonnage) for 2017. Trucks export 68.1% of commodity tonnage from Florida. Rail (15.8%) and multiple modes and mail (12.8%) are the other major export modes.

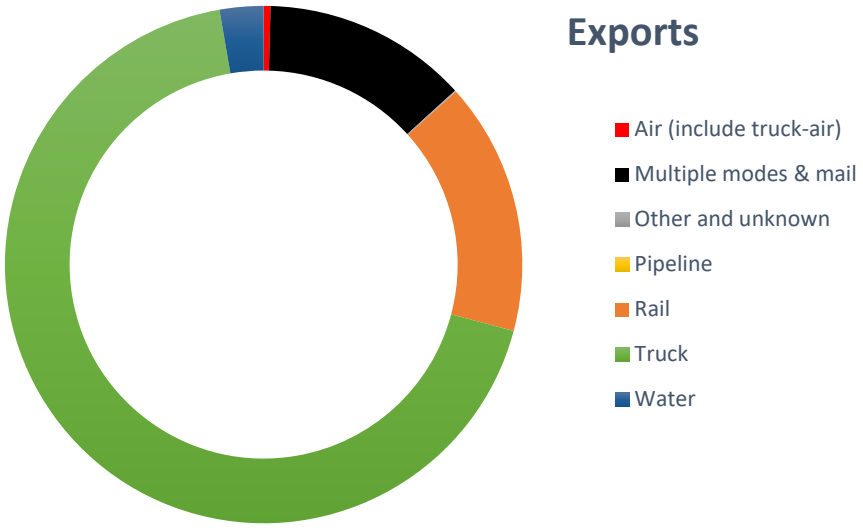


Figure 8 | Modal Splits (Exports – 2017 KTons)

Figures 9 and 10 provide the top 10 export (domestic and foreign) commodity flows. Other foodstuffs, fertilizers and other agricultural products are the top commodities in tonnage. Similarly, motorized vehicles, electronics and pharmaceuticals are the top commodities in value.

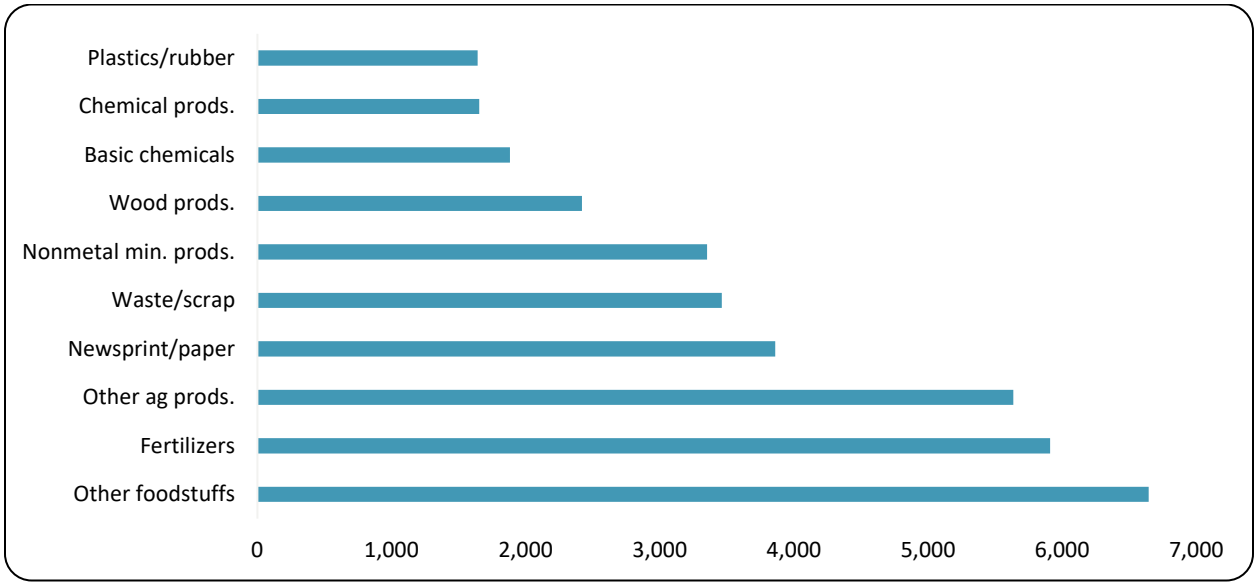


Figure 9 | Top 10 Export Commodities (in KTons) in 2017

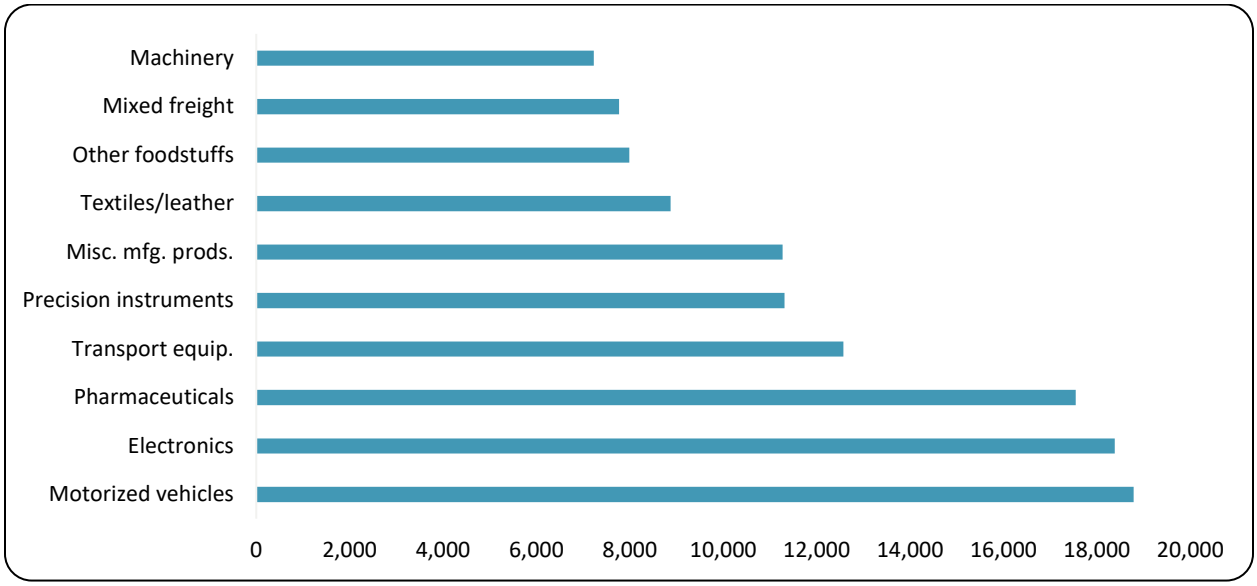


Figure 10 | Top 10 Export Commodities (in Million $) in 2017

Figure 11 provides the modal splits for imports (in tonnage) for 2017. Truck (37.4%), rail (21.4%), pipeline (19%) and water (13.1%) are the major import modes. The majority of pipeline imports

are from Alabama to Florida (18%) which are for products of petroleum and coal, not elsewhere classified (coal n.e.c.).[29]

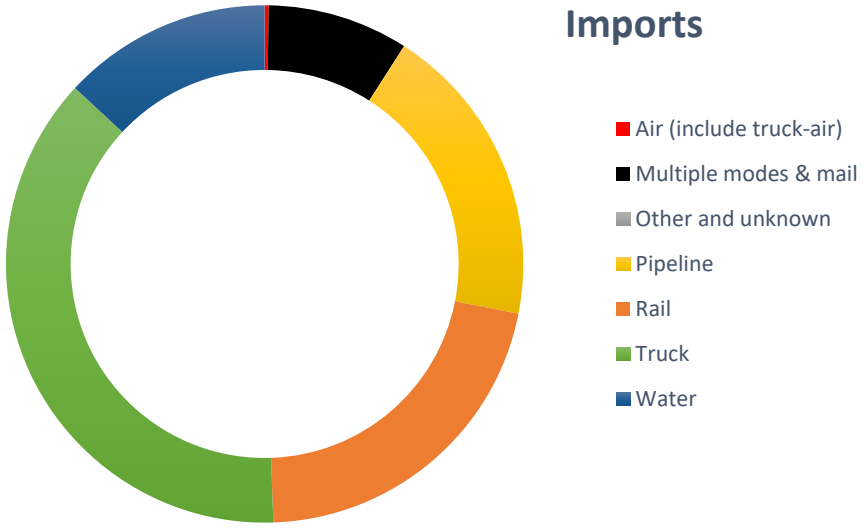


Figure 11 | Modal Splits (Imports – 2017 KTons)

Figures 12 and 13 provide the top 10 import (domestic and foreign) commodities. Coal-NEC (Not Elsewhere Classified), gravel and gasoline are the top commodities in tonnage. Similarly, motorized vehicles, electronics and miscellaneous manufacturing products are the top commodities in value.

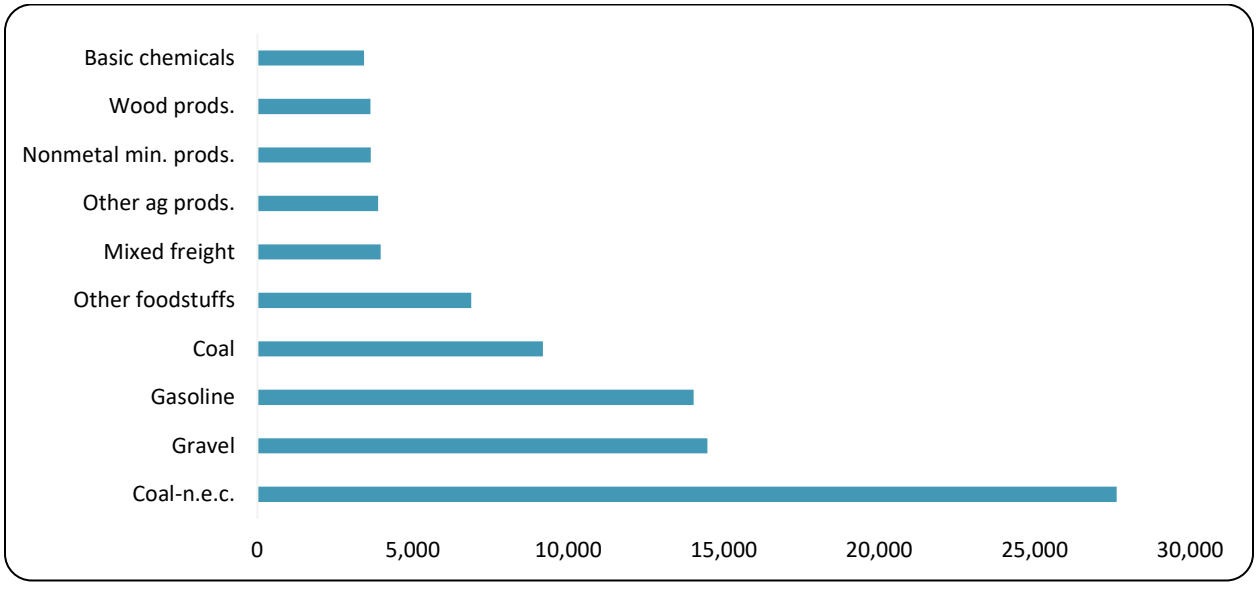


Figure 12 | Top 10 Import Commodities (in KTons) in 2017

[29] SCTG2 Dictionary

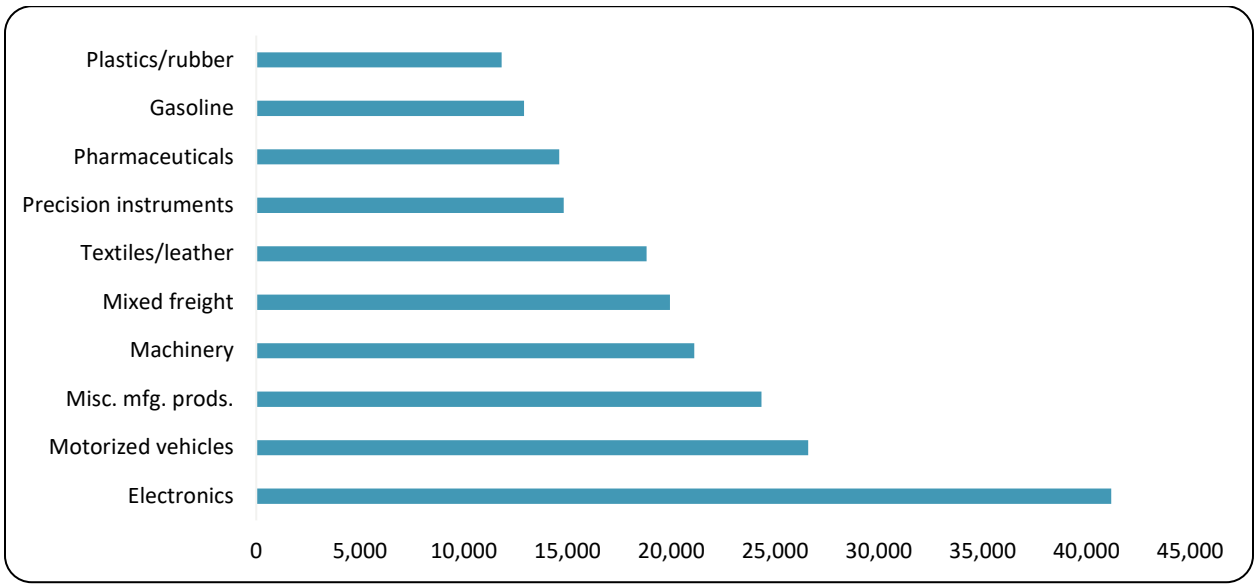


Figure 13 | Top 10 Import Commodities (in Million $) in 2017

Figure 14 provides the modal splits for commodity movement within Florida (in tonnage) for 2017. Trucks haul more than 95% of commodity tonnage within the state.

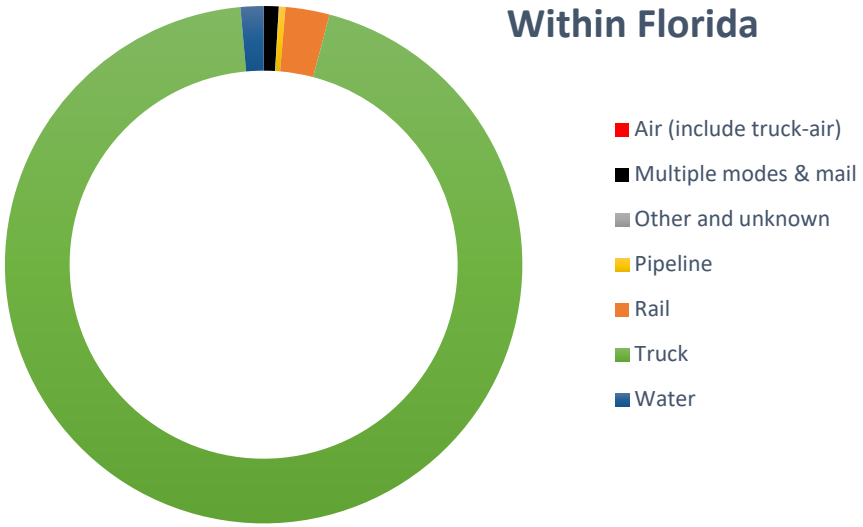


Figure 14 | Modal Splits (Within Florida – 2017 KTons)

Figures 15 and 16 provide the top 10 commodity flows within the state of Florida. Gravel, natural sands, nonmetallic mineral products, gasoline and waste/scrap are the top commodities in tonnage. Motorized vehicles, electronics and pharmaceuticals are the top commodities in value.

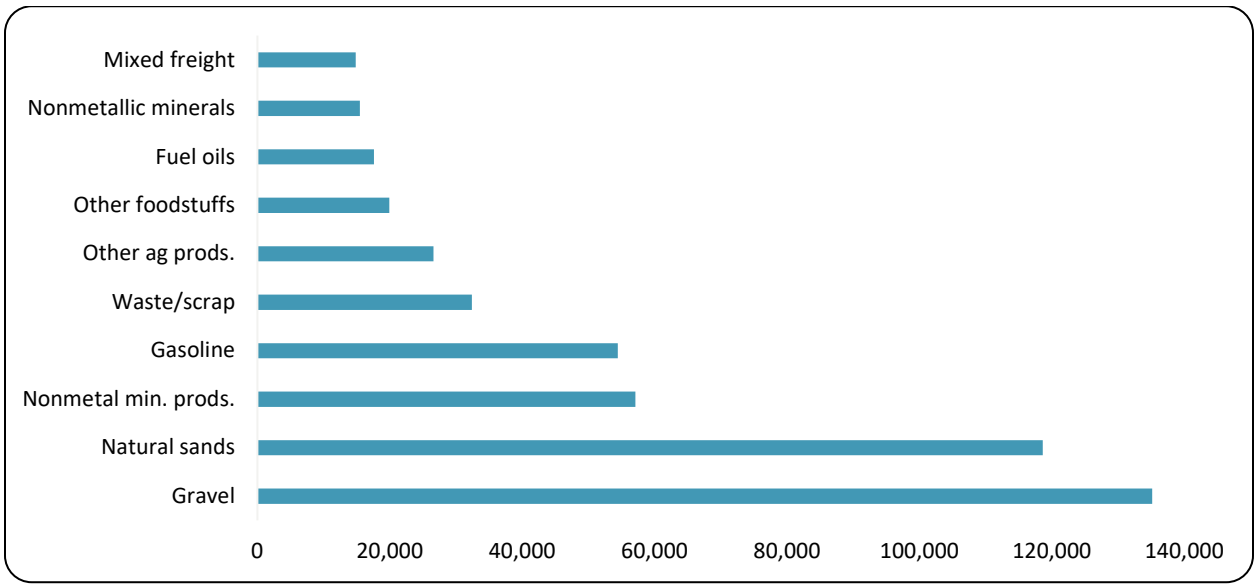


Figure 15 | Top 10 Commodities (in KTons) Movement Within Florida in 2017

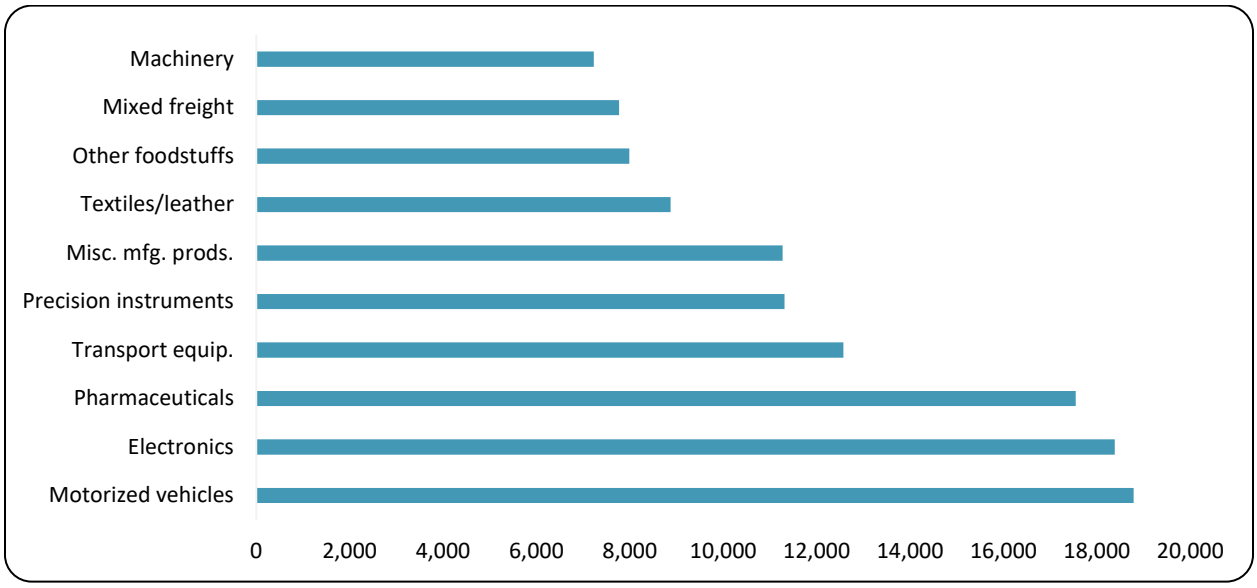


Figure 16 | Top 10 Commodities (in Million $) Movement Within Florida in 2017

Figure 17 illustrates the forecasted change in the commodity tonnage from 2017 to 2045 for different modes. The statistics below indicate that the air mode (includes truck-air) has the highest estimated growth rate. This is primarily driven by forecasted growth in high value goods. Truck freight is expected to have an increase of approximately 80% with rail expected to grow significantly too. Water is forecasted to have a decrease in imports which is primarily driven by a forecasted decrease in gasoline imports from Louisiana. FAF 4.5 documentation[30] supports this

[30] Freight Analysis Framework Inter-Regional Commodity Flow Forecast Study, 2016

inference under the following assumptions: *"Meanwhile, the growth in domestic energy products used primarily for motor vehicle fuel such as gasoline and diesel (the former is a component of SCTG 17, while the latter is a component of SCTG 18) peaks around 2020 as fuel efficiency standards and changing transportation patterns drive 2045 consumption below 2012 levels."* Trucks are forecasted to dominate commodity movement within Florida (95%) in 2045.

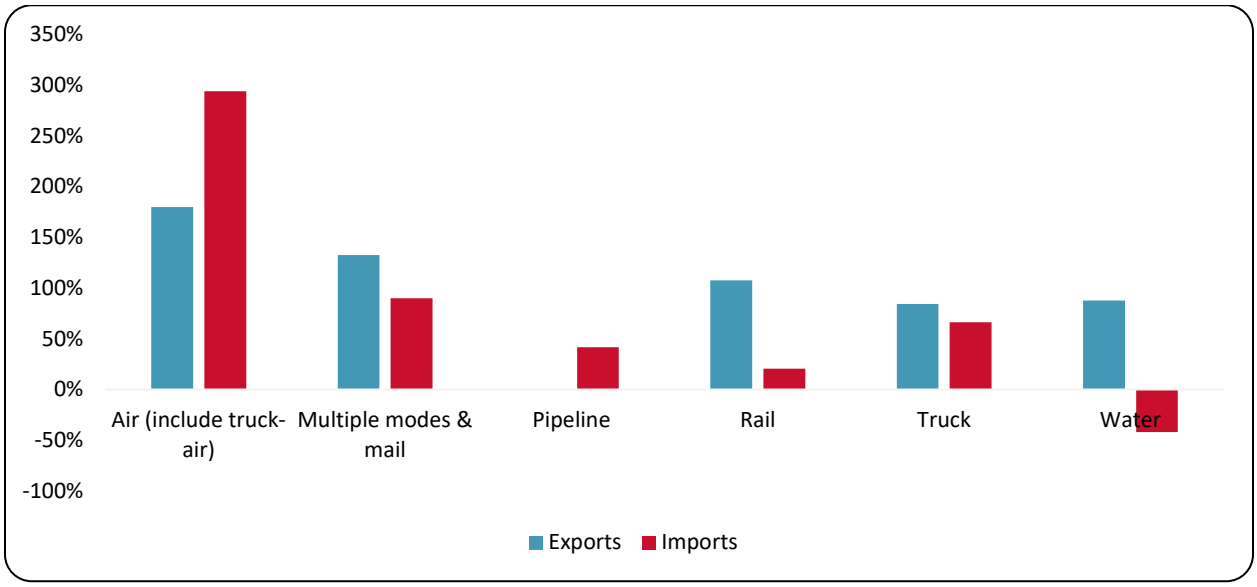


Figure 17 | Forecasted Percent Change in Tonnage Movement from 2017 to 2045

Figures 18 through 21 include the top 10 import and export commodities (KTons and Million$) for forecast year 2045. It is important to note the top commodities are not forecasted to change considerably from 2017 to 2045.

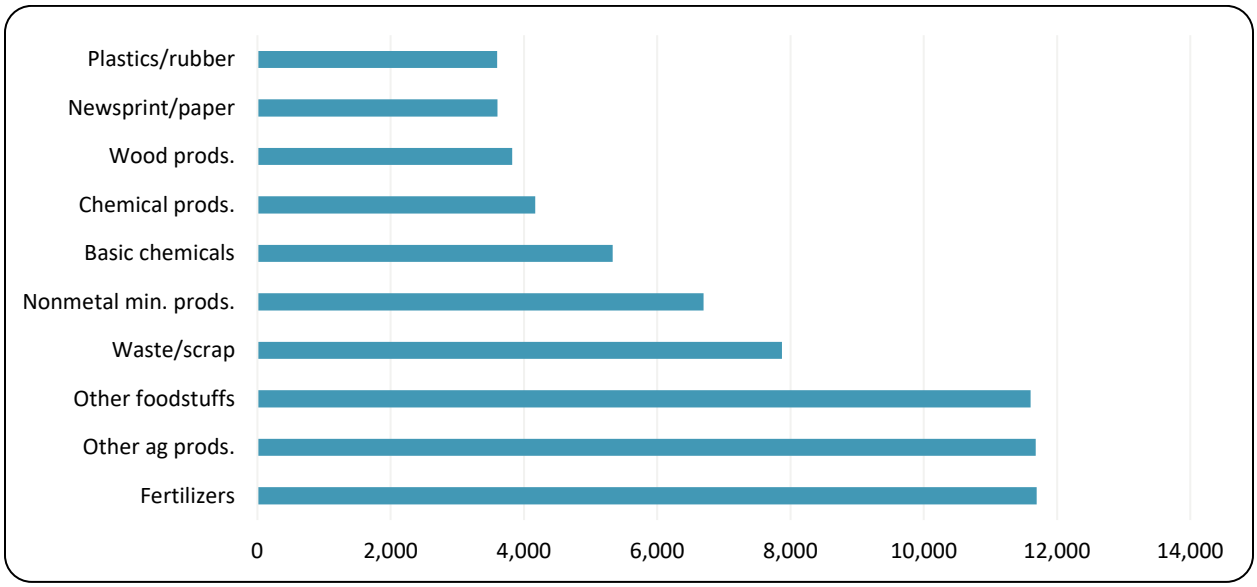


Figure 18 | Top 10 Export Commodities (in KTons) in 2045

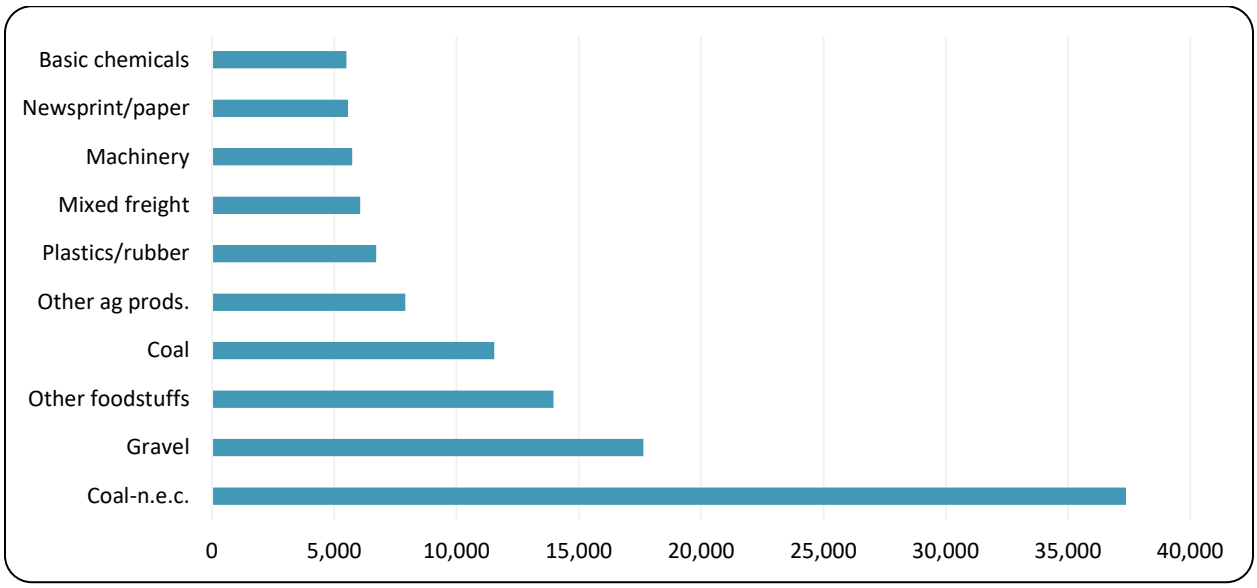


Figure 19 | Top 10 Import Commodities (in KTons) in 2045

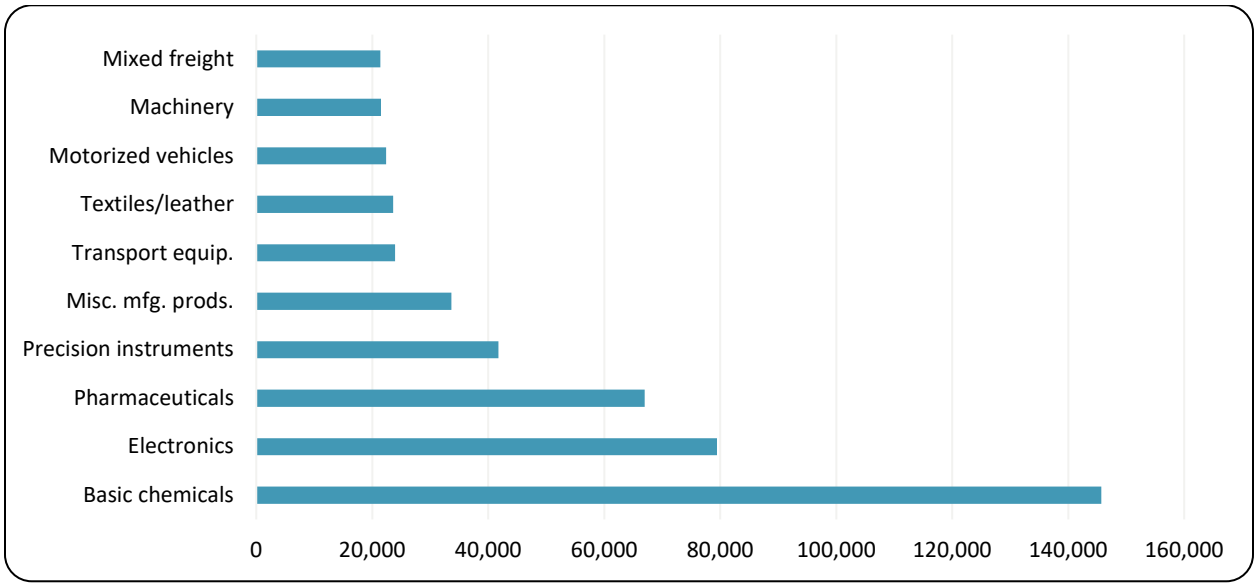


Figure 20 | Top 10 Export Commodities (in Million $) in 2045

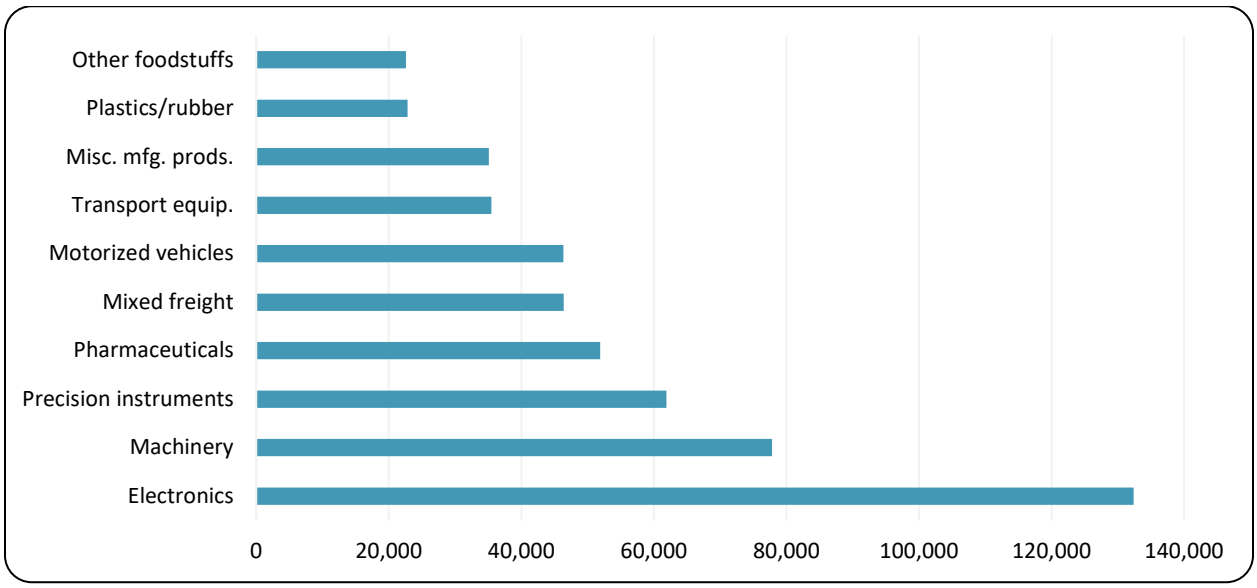


Figure 21 | Top 10 Import Commodities (in Million $) in 2045

Table 1 | Percent Change in Tonnage for Major Commodities via Air (Includes Truck-Air) from 2017 to 2045

Exports			Imports		
Top 10 commodities (2045)	**2045 (ktons)**	**Percent growth (from 2017-2045)**	**Top 10 commodities (2045)**	**2045 (ktons)**	**Percent growth (from 2017-2045)**
Other ag prods.	183	361%	**Electronics**	399	709%
Electronics	104	422%	**Machinery**	306	312%
Meat/seafood	57	68%	**Precision instruments**	158	678%
Precision instruments	54	322%	**Chemical prods.**	107	487%
Transport equip.	53	115%	**Textiles/leather**	80	463%
Machinery	40	99%	**Articles-base metal**	68	326%
Textiles/leather	40	321%	**Pharmaceuticals**	68	775%
Articles-base metal	29	122%	**Plastics/rubber**	64	359%
Chemical prods.	26	720%	**Motorized vehicles**	42	44%
Plastics/rubber	20	122%	**Misc. mfg. prods.**	34	192%

Table 2 provides the percent change in tonnage (for all modes) from 2017 to 2045. The majority of commodities are forecasted to have an increase in exports (85.27%), imports (40.78%) and movements within Florida (27.67%).

Table 2 | Percent Change in Tonnage (All Modes) from 2017 to 2045

Commodity Types (SCTG2)	Exports	Imports	Within Florida
Alcoholic beverages	149.73%	84.51%	72.32%
Animal feed	96.54%	41.64%	52.61%
Articles-base metal	127.61%	41.54%	61.64%
Base metals	58.02%	29.17%	37.18%
Basic chemicals	183.17%	60.09%	100.49%
Building stone	435.01%	1115.54%	180.65%
Cereal grains	58.12%	-26.27%	37.65%
Chemical prods.	152.03%	107.40%	61.91%
Coal	-61.45%	25.75%	496.28%
Coal-n.e.c.	-48.46%	35.26%	64.99%
Crude petroleum	-76.54%	-	490.09%
Electronics	118.65%	105.60%	96.68%
Fertilizers	97.91%	440.80%	90.92%
Fuel oils	29.83%	-73.99%	-42.61%
Furniture	220.72%	67.80%	83.88%
Gasoline	-51.97%	-64.92%	-53.28%
Gravel	114.25%	21.90%	15.69%
Live animals/fish	127.53%	37.08%	40.91%
Logs	365.02%	46.60%	9.06%
Machinery	208.34%	219.68%	127.87%
Meat/seafood	133.79%	38.20%	72.80%
Metallic ores	-0.55%	305.69%	-40.31%
Milled grain prods.	88.67%	89.02%	85.73%
Misc. mfg. prods.	142.58%	28.22%	62.19%
Mixed freight	75.08%	52.70%	82.23%
Motorized vehicles	6.96%	52.01%	44.90%
Natural sands	87.57%	12.21%	21.12%
Newsprint/paper	-6.65%	79.28%	35.54%
Nonmetal min. prods.	99.84%	5.08%	11.75%
Nonmetallic minerals	67.23%	104.74%	36.28%
Other ag prods.	107.30%	103.96%	38.66%
Other foodstuffs	74.63%	103.05%	132.82%
Paper articles	38.92%	33.28%	27.48%
Pharmaceuticals	189.68%	291.09%	142.30%

Commodity Types (SCTG2)	Exports	Imports	Within Florida
Plastics/rubber	119.16%	113.45%	73.62%
Precision instruments	126.15%	161.20%	171.30%
Printed prods.	26.13%	14.23%	20.72%
Textiles/leather	81.64%	93.83%	74.75%
Tobacco prods.	-38.53%	-57.00%	-84.32%
Transport equip.	22.70%	223.08%	49.82%
Waste/scrap	127.48%	84.50%	70.00%
Wood prods.	58.02%	3.97%	21.38%
All commodities	**85.27%**	**40.78%**	**27.67%**

Figures 22 and 23 illustrate the FAF tonnage assignment on the major roadways in 2012 and 2045. The highest tonnage movement (>100,000 KTons) is forecasted for the following three corridor segments:

- I-75 between Turnpike and I-10
- I-10 between I-75 and Tallahassee
- I-95 traversing District 4 and 6

It is important to note that all major routes are forecasted to have a significant growth in truck tonnage movement.

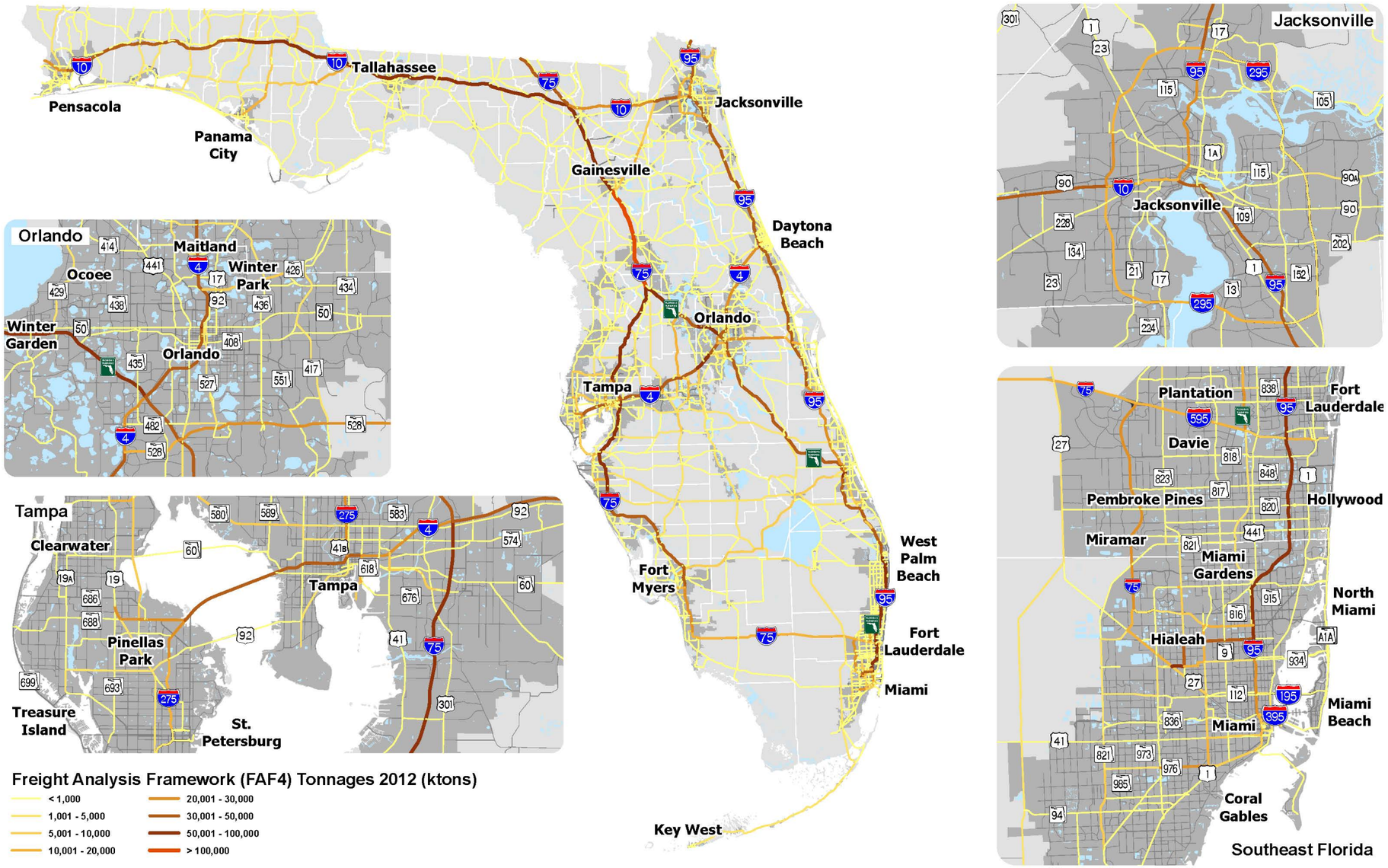


Figure 22 | Freight Analysis Framework (FAF4) Tonnage 2012 (KTons)

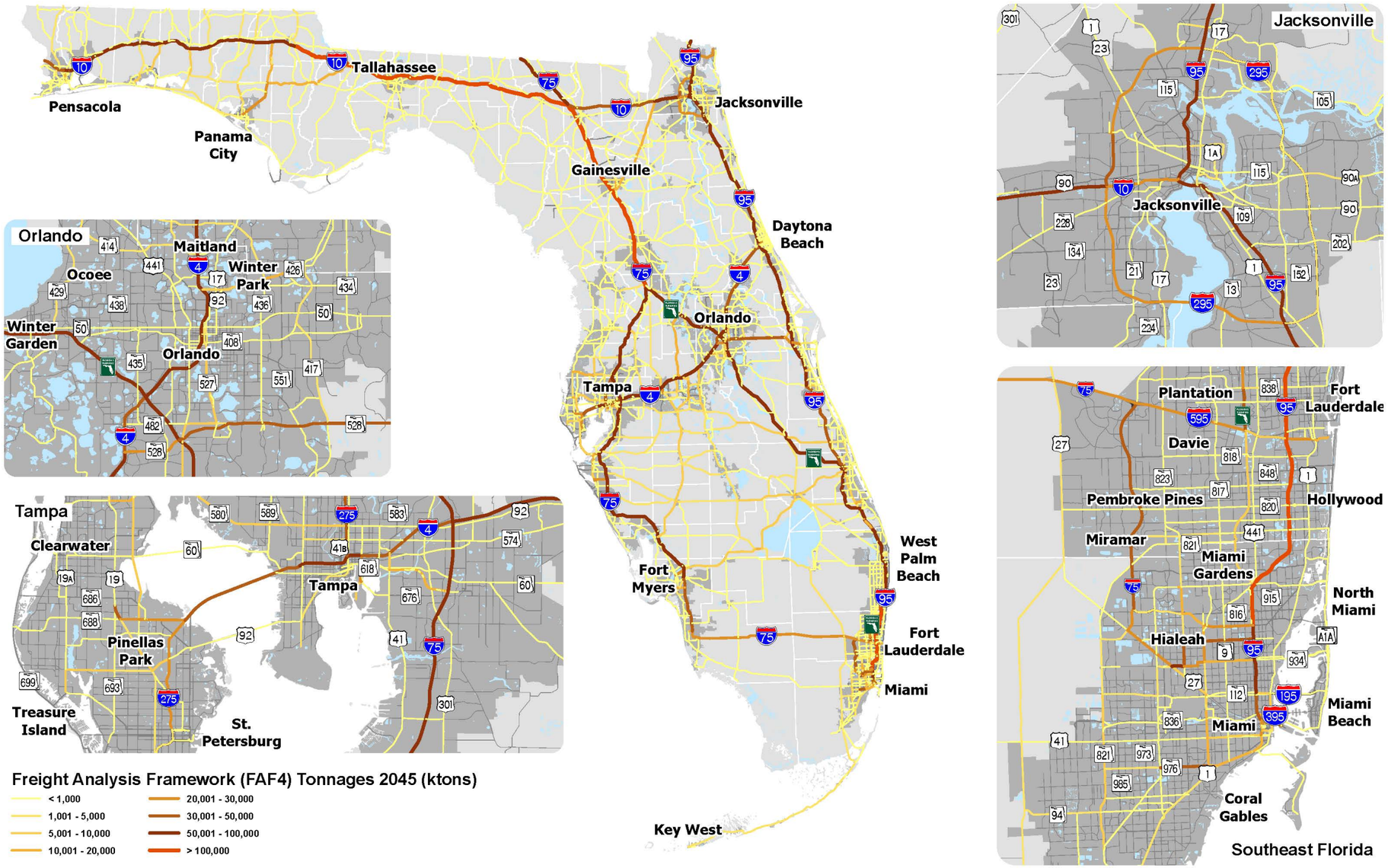


Figure 23 | Freight Analysis Framework (FAF4) Tonnage 2045 (KTons)

Enterprise Florida

According to Enterprise Florida, the state's total merchandise trade in 2018 increased by 4.0% to $153.5 million. Merchandise exports (goods shipped from or through the state) grew 4.7% to $73.5 million while imports increased by 3.3% to $80 million. Florida-origin exports gained 4.2% to $57.2 million last year, maintaining the status of the 8th largest export state in the United States. Figure 24 and Tables 3 through 8 below provide a snapshot of Florida international trade in terms of value ($) of commodities.

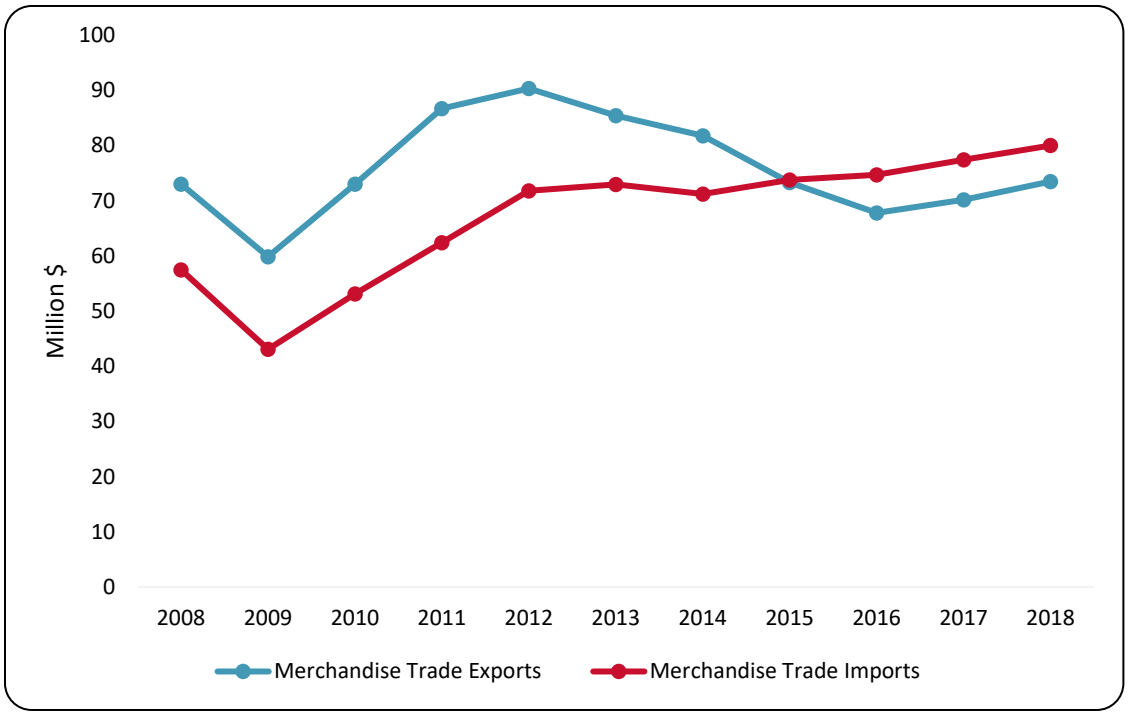


Figure 24 | Florida Merchandise Trade Exports and Imports (Million $)

Figure 24 illustrates the trends of the growth/decline of merchandise trade exports and imports in Florida. Trends indicate that there was a steady decline of merchandise trade exports from Florida from 2012 to 2016. Since 2016, the exports have shown an upward trend. Merchandise trade imports have shown a healthy growth since 2009 as it exceeded the trade exports in 2015.

Tables 3 and 4 provide the top 10 destinations for Florida merchandise exports and Florida merchandise imports respectively. South America and Central American countries are the major countries for Florida merchandise exports. More than 25% of the Florida imports come from China, Japan, and Brazil. Tables 5 and 6 provide the top 10 commodities for Florida merchandise exports and Florida merchandise imports respectively. The top merchandise export and import commodities for the state include electronics, aircraft parts, motor cars and their parts, and high value metals.

Table 3 | Top 10 Destinations for Florida Merchandise Exports

Rank	Description	Annual 2016 ($)	Annual 2017 ($)	Annual 2018 ($)	% Change 2017-2018
	TOTAL ALL COUNTRIES	67,839,914,053	70,191,646,748	73,502,783,317	4.7
1	Brazil	11,957,615,532	13,343,754,631	14,698,017,425	10.2
2	Colombia	4,055,552,798	4,193,702,823	4,444,501,446	6.0
3	Chile	3,650,629,223	3,886,824,016	3,987,143,488	2.6
4	Dominican Republic	3,111,165,288	3,021,872,452	3,239,131,216	7.2
5	Argentina	3,269,250,191	3,567,786,841	3,211,702,281	-10.0
6	Peru	2,508,955,582	2,401,687,390	2,572,993,114	7.1
7	Costa Rica	2,469,513,568	2,415,187,465	2,496,817,496	3.4
8	Paraguay	1,640,884,598	2,257,681,028	1,962,157,380	-13.1
9	Mexico	1,770,676,936	1,766,659,878	1,876,348,241	6.2
10	Honduras	1,897,579,731	1,874,822,163	1,861,591,390	-0.7

Table 4 | Top 10 Florida Merchandise Imports by Country

Rank	Description	Annual 2016 ($)	Annual 2017 ($)	Annual 2018 ($)	% Change 2017-2018
	TOTAL ALL COUNTRIES	74,731,434,457	77,454,618,115	80,029,174,669	3.3
1	China	8,982,653,187	9,563,256,204	10,762,325,849	12.5
2	Japan	6,534,957,092	6,972,360,020	7,107,963,960	1.9
3	Brazil	6,141,267,343	6,443,404,324	5,707,734,288	-11.4
4	Mexico	3,352,089,010	4,520,676,663	4,918,968,165	8.8
5	Chile	2,909,340,519	3,738,324,475	3,925,617,954	5.0
6	Germany	4,204,023,226	3,697,980,967	3,598,895,134	-2.7
7	Dominican Republic	2,799,632,023	2,858,812,984	3,205,338,851	12.1
8	Honduras	2,563,072,587	2,511,209,583	2,666,204,035	6.2
9	Colombia	3,631,075,639	3,052,245,416	2,529,136,043	-17.1
10	Italy	2,203,899,510	2,180,567,290	2,460,383,080	12.8

Table 5 | Top 10 Merchandise Export Commodities

Rank	Description	Annual 2016 ($)	Annual 2017 ($)	Annual 2018 ($)	% Change 2017-2018
	TOTAL ALL COUNTRIES	67,839,914,053	70,191,646,748	73,502,783,317	4.7
1	Civilian Aircraft, Engines, And Parts	7,141,502,238	8,177,780,476	8,996,354,653	10.0
2	Electric Apparatus For Line Telephony Etc., Parts	4,370,405,921	5,056,850,203	4,644,594,234	-8.2

Rank	Description	Annual 2016 ($)	Annual 2017 ($)	Annual 2018 ($)	% Change 2017-2018
3	Motor Cars & Vehicles For Transporting Persons	3,713,007,043	3,166,757,283	3,611,376,088	14.0
4	Automatic Data Process Machines; Magn Reader Etc.	2,860,352,256	3,076,810,578	3,065,240,541	-0.4
5	Gold (Incl Plat Plated), Unwr, Semimfr Or Powder	1,794,888,457	2,338,867,871	2,014,718,939	-13.9
6	Human Blood; Animal Blood; Antisera, Vaccines Etc.	1,305,948,808	1,223,545,625	1,641,812,375	34.2
7	Medical, Surgical, Dental Or Vet Inst, No Elec, Pt	1,609,744,835	1,547,122,214	1,616,112,340	4.5
8	Mineral or Chemical Fertilizers	1,510,566,729	1,428,649,213	1,399,269,571	-2.1
9	Electronic Integrated Circuits & Microassembl, Pts	1,058,948,646	1,240,923,524	1,199,865,652	-3.3
10	Parts & Access For Motor Vehicles (Head 8701-8705)	955,297,310	1,169,181,014	1,194,515,838	2.2

Table 6 | Top 10 Merchandise Import Commodities

Rank	Description	Annual 2016 ($)	Annual 2017 ($)	Annual 2018 ($)	% Change 2017-2018
	TOTAL ALL COUNTRIES	74,731,434,457	77,454,618,115	80,029,174,669	3.3
1	Motor Cars & Vehicles For Transporting Persons	10,695,291,472	11,901,849,319	11,386,135,644	-4.3
2	Imports Of Articles Exported And Returned, Unadvanced	3,585,439,165	3,511,494,480	4,231,933,015	20.5
3	Oil (Not Crude) From Petrol & Bitum Mineral Etc.	2,276,105,439	1,984,597,790	2,821,473,305	42.2
4	Electric Apparatus For Line Telephony Etc., Parts	2,597,861,772	2,758,380,461	2,621,203,397	-5.0
5	Gold (Incl Plat Plated), Unwrought, Semimfr Or Powder	4,615,478,748	3,212,131,398	2,240,372,443	-30.3
6	Refined Copper & Alloys (No Mast Alloy), Unwrought	1,162,836,761	1,849,447,404	1,903,683,543	2.9

Rank	Description	Annual 2016 ($)	Annual 2017 ($)	Annual 2018 ($)	% Change 2017-2018
7	Fish Fillets & Oth Fish Meat, Fresh, Chill Or Froz	1,549,024,378	1,714,895,797	1,869,289,666	9.0
8	Sweaters, Pullovers, Vests Etc., Knit Or Crocheted	1,329,181,103	1,550,373,867	1,779,558,185	14.8
9	Imports Of Articles Exported And Returned, Advanced Abroad	1,621,672,554	1,986,713,469	1,728,176,248	-13.0
10	T-Shirts, Singlets, Tank Tops Etc., Knit Or Crochet	1,539,982,493	1,509,214,884	1,712,747,651	13.5

Tables 7 and 8 provide the top 10 Florida-origin exports by country and top 10 Florida-origin export commodities respectively. South America, Canada, Mexico, and Central American countries are the major countries for Florida-origin exports. The top origin export commodities from the state include electronics, aircraft parts, motor cars and their parts, and high value metals.

Table 7 | Top 10 Florida-Origin Exports by Country

Rank	Description	Annual 2016 ($)	Annual 2017 ($)	Annual 2018 ($)	% Change 2017-2018
	TOTAL ALL COUNTRIES	52,031,706,238	54,914,286,865	57,240,939,285	4.2
1	Brazil	3,593,395,698	4,086,385,558	4,510,329,619	10.4
2	Canada	3,501,336,042	3,585,057,264	3,749,187,041	4.6
3	Mexico	2,830,100,596	3,078,531,389	3,335,060,512	8.3
4	Colombia	2,186,779,345	2,298,547,744	2,431,055,522	5.8
5	Germany	1,950,081,089	2,368,292,808	2,296,689,699	-3.0
6	United Kingdom	1,425,417,936	1,491,841,685	2,103,382,541	41.0
7	China	1,205,565,717	1,864,919,590	2,073,823,687	11.2
8	Chile	1,872,693,664	1,815,531,517	1,927,578,212	6.2
9	Paraguay	1,508,709,981	2,114,124,778	1,781,212,681	-15.8
10	Dominican Republic	1,708,002,902	1,551,633,995	1,673,937,876	7.9

Table 8 | Top 10 Florida-Origin Exports by Commodity

Rank	Description	Annual 2016 ($)	Annual 2017 ($)	Annual 2018 ($)	% Change 2017-2018
	TOTAL ALL COUNTRIES	52,031,706,238	54,914,286,865	57,240,939,285	4.2
1	Civilian Aircraft, Engines, And Parts	5,420,025,366	6,325,870,677	6,581,974,387	4.1
2	Electric Apparatus For Line Telephony Etc., Parts	3,790,782,654	4,338,775,434	4,271,941,373	-1.5
3	Automatic Data Process Machines; Magn Reader Etc.	1,817,079,614	2,057,953,947	1,999,472,981	-2.8
4	Gold (Incl Plat Plated), Unwrought, Semimfr Or Powder	1,804,394,618	2,238,107,018	1,997,189,244	-10.8
5	Mineral or Chemical Fertilizers	1,755,501,464	1,707,116,658	1,700,490,204	-0.4
6	Medical, Surgical, Dental Or Vet Inst, No Elec, Pt	1,092,359,295	1,108,481,070	1,188,375,336	7.2
7	Electronic Integrated Circuits & Microassembly, Pts	1,054,804,596	1,249,118,815	1,180,106,446	-5.5
8	Motor Cars & Vehicles For Transporting Persons	1,155,958,617	970,711,464	1,024,548,096	5.6
9	Exports Of Articles Imported For Repairs Etc.	627,332,234	731,422,838	879,796,267	20.3
10	Parts Etc. For Typewriters & Other Office Machines	736,003,620	710,231,402	766,921,642	8.0

Moving Forward

The trends in this tech memo were identified as a means of better understanding the direction of Florida's freight needs. By analyzing the expected changes in Florida's population, economy, and other aspects surrounding daily life, future actions and recommendations can be made with a high degree of accuracy. Through the utilization of multiple data sources, the freight trends are ensured to be accurate, useful, and holistic. The FMO office is equipped to ensure that investments keep Florida's freight system on the leading edge of freight design, project prioritization and implementation for the nation.

Rickey Fitzgerald
Manager, Freight & Multimodal Operations
Florida Department of Transportation

605 Suwannee Street, MS 25
Tallahassee, FL 32399
850.414.4702
rickey.fitzgerald@dot.state.fl.us