Tampa Bay Case Study for Fuel Resilience: Takeaways and Lessons Learned

Project # JDC-9-92236-01

Prepared for:

National Renewable Energy Laboratory

Prepared by:

USF Center for Urban Transportation Research

Alexander Kolpakov
Austin Marie Sipiora

August 2020
While the Tampa Bay region has not been directly hit by a major hurricane since 1921, it is considered one of the most vulnerable areas in the United States to hurricanes and severe tropical weather. A particular vulnerability stems from the fact that all petroleum fuel comes to the area through Port Tampa Bay, which can be (and has been in the past) impacted by hurricanes and tropical storms. This report covers previous fuel challenges, vulnerabilities, and lessons learned by key Tampa Bay fleets during the past 10 years (mainly as a result of most recent 2017 Hurricane Irma) in order to explore ways to improve the area’s resilience to natural disasters. Some of the strategies can include maintaining emergency fuel supply, prioritizing fuel use, strategically placing the assets around the region to help with recovery, investing in backup generators (including generators powered by alternative fuels), planning for redundancies in fuel supply networks, developing more efficient communication procedures between public fleets, improving hurricane planning, and upgrading street drainage systems to reduce the threat of local flooding.
Executive Summary

The state of Florida is geographically vulnerable to hurricanes. Since 2000, seven major hurricanes—Category 3 or higher—have made landfall in Florida, with some years experiencing several major hurricanes and tropical storm events. While the Tampa Bay region has not endured a direct hit by a major hurricane since 1921, the Tampa Bay metropolitan statistical area (MSA) is considered one of the most vulnerable areas in the United States to hurricanes due to a highly concentrated coastal population and limited disaster evacuation routes.

In addition to infrastructure damage, hurricanes and storms disrupt the supply of essential resources such as fuel. A particular vulnerability in Tampa Bay comes from the impact of hurricanes on port operations. All fuel that comes to the region is delivered through Port Tampa Bay. If the port is unable to receive ships due to hurricane winds or storm surge, fuel cannot be delivered to the area.

While all port terminals in the state typically have fuel storage that can last from a few days to a few weeks, the terminals might be able to provide fuel for only a limited amount of time due to the higher demand and limited supply following a storm. Port Tampa Bay has less fuel storage capacity compared to other Florida ports, which necessitates more frequent deliveries.

The Tampa Bay region has a robust history of implementing alternative fuels to reduce reliance on petroleum, improve air quality, offer more fuel options, and reduce lifecycle vehicle costs. Several major public and private fleets in Tampa Bay have embraced alternative fuels, including CNG, propane, and electric vehicles (EVs). In addition to offering environmental and operating cost advantages, alternative fuel vehicles (AFVs) provide another benefit by utilizing fuel supply channels that may be more resilient to disruptions caused by hurricanes.

There are currently four state incentives in Florida related to alternative fuels, including credits and exemptions for biofuels production, weight exemptions for idle reduction technologies and natural gas vehicles (NGVs), as well as permission to local governments to help property owners fund electric vehicle charging infrastructure installation. None of these incentives provide funding for the acquisition of AFVs or alternative fueling infrastructure.

One of the most successful alternative fuel rebates offered by the state of Florida was the Natural Gas Fuel Fleet Vehicle (NGFFV) Rebate Program, which was established by the Florida Legislature in 2013 and existed until 2018. During the four years that the NGFFV program was funded, 46 public and private fleets from six counties in Tampa Bay (including Hillsborough, Pinellas, Polk, Pasco, Manatee, and Sarasota Counties) were awarded $6.2 million for the acquisition or conversion of 552 natural gas vehicles. Although a few Florida utilities offer limited rebates for EVs and electric vehicle supply equipment (EVSE), none of them are available in the Tampa Bay area.

In addition to offering a brief overview of the Tampa Bay vulnerabilities, the current report summarizes some of the lessons learned by select public fleets from the most recent hurricane,
Hurricane Irma (2017). The analysis presents case studies from Port Tampa Bay, Hillsborough County, Pinellas County, the City of St. Petersburg, Pinellas Suncoast Transit Authority, and Hillsborough Area Regional Transit Authority, discussing challenges and lessons learned by these fleets from previous hurricane events. Some of these lessons include the following:

- Asset staging is a key step that many public fleets in Tampa Bay perform during hurricane pre-landfall preparation in order to preserve assets by moving them from low-lying areas to higher elevations.
- Several public fleets in Tampa Bay have high-water capable vehicles that are critical for navigating flooded streets after a hurricane.
- For Hurricane Irma, recovery mainly focused on debris removal, which was a significant problem with severe impacts. Debris removal required the use of off-road equipment, loaders, dump trucks, and claws trucks.
- Fuel strategy is critical to fleet preparation during an emergency event. All the public fleets presented in the current report have fueling storage sites, both underground and above ground, with wide-ranging capacities. Fueling priority plans are implemented to determine which vehicles fuel first during a shortage.
- Accurately predicting the burn rate for fuel usage under emergency conditions is challenging, but it is an essential calculation for estimating fuel supply needs, particularly for public agencies responsible for fueling generators.
- Fuel diversification is an important resiliency strategy, including diversifying fuel sources and types such as alternative fuel vehicles, flex-fuel vehicles, and solar-powered EV charging stations.
- During Irma, public fleets generally did not encounter critical fuel shortages due to a variety of factors. For example, sharing of fuel resources is another strategy employed by fleets. While Port Tampa Bay did not run out of fuel reserves, delayed fuel deliveries impacted all the fleets described in this report.
- In general, standing water was not an issue during Hurricane Irma. However, localized flooding was a problem, and the fleets deployed high-water vehicles and four-wheelers to access flooded roads.

The overall impact of Hurricane Irma was significant. It demonstrated the vulnerabilities of the conventional fuel supply in Tampa Bay and highlighted the challenges public fleets face in performing critical functions immediately after a storm. The data collected by the Florida Department of Emergency Management (FDEM) indicate that Hurricane Irma caused massive fuel shortages. Right before and during hurricane landfall, 75–80 percent of gas stations ran out of gasoline and 38–55 percent of stations ran out of diesel.

Most of the surveyed stations in Tampa Bay remained without gasoline until at least the day after Hurricane Irma (September 12, 2017). The number of stations without gasoline decreased immediately before hurricane landfall (September 8–9), then increased slightly during impact (September 10–11), and continued decreasing post-hurricane as the area continued recovering and restoring fuel supply. Diesel availability, on the other hand, began decreasing right after the storm, possibly due to a large increase in demand.
The data demonstrate that power outages after Hurricane Irma contributed significantly to the fuel shortage issue. For example, while 25.5 percent of stations in Tampa Bay reported having gasoline during hurricane landfall (on September 10), only 15.2 percent had both gas and power, enabling them to dispense fuel.

The experiences and lessons learned from the public agencies discussed in this report will be useful for future hurricane planning and are meant to improve Tampa Bay’s resilience to natural disasters. Some of the strategies that can be implemented to improve the area’s resilience and address the existing challenges and vulnerabilities include maintaining an emergency fuel supply, prioritizing fuel use, strategically placing assets around the region to help with recovery, investing in backup generators (including generators powered by alternative fuels), planning for redundancies in fuel supply networks, developing more efficient communication procedures between public fleets, improving hurricane planning, and upgrading street drainage systems to reduce the threat of local flooding.
# Table of Contents

Technical Report Documentation ................................................................................................ ii
Executive Summary .................................................................................................................... iii
List of Tables ............................................................................................................................. vii
List of Figures ............................................................................................................................ vii
List of Acronyms ....................................................................................................................... viii
Introduction ................................................................................................................................1
Objective .....................................................................................................................................2
Study Area ..................................................................................................................................3
Existing Alternative Fuel Conditions in Tampa Bay ................................................................. 4
   Local Alternative Fuels Coordination in Tampa Bay ................................................................. 4
      Infrastructure – Alternative Fuels .......................................................................................... 4
      Infrastructure – Electric Vehicle Charging Stations ............................................................. 6
      Vehicles ................................................................................................................................. 10
   Rebates and Incentives ............................................................................................................ 18
Lessons Learned from Past Experiences .................................................................................... 22
   Port Tampa Bay ....................................................................................................................... 22
   Hillsborough County .............................................................................................................. 22
   Pinellas County ....................................................................................................................... 23
   City of St. Petersburg .............................................................................................................. 23
   Pinellas Suncoast Transit Authority (PSTA) ............................................................................. 24
   Hillsborough Area Regional Transit (HART) ........................................................................... 25
   HART Hurricane Emergency Plan ......................................................................................... 26
   Hurricane Irma’s Impact on Fuel Shortage in Tampa Bay ....................................................... 29
   Hurricane Irma and Power Outages in Tampa Bay ................................................................. 29
   Summary of Lessons Learned ................................................................................................. 30
Recommended Actions for Preparation for Future Natural Disasters/Emergencies ............... 32
Conclusion ................................................................................................................................34
References ................................................................................................................................35
List of Tables

Table 1 - Hillsborough and Pinellas Counties Alternative Fueling Infrastructure, July 2020 ........6
Table 2 - Description of Florida Incentives ..................................................................................19
Table 3 - Florida NGFFV Program Summary (2013–2018) ..........................................................19
Table 4 - NGFFV Awards in Tampa Bay Region by Year ...............................................................20
Table 5 - EVSE and EV Incentives Provided by Florida Utilities .................................................21

List of Figures

Figure 1 - Map of Tampa Bay .......................................................................................................3
Figure 2 - Public CNG Stations in Tampa Bay ..............................................................................5
Figure 3 - Tampa Bay Propane for Vehicle Refueling Stations .....................................................5
Figure 4 - EVSE Locations in Pinellas County .............................................................................7
Figure 5 - EVSE Locations in Hillsborough County .................................................................7
Figure 6 - Tampa Bay CNG Fuel Stations and Flood Hazard Assessment ...............................8
Figure 7 - Tampa Bay Propane Fuel Stations and Flood Hazard Assessment ............................9
Figure 8 - Tampa Bay Electric Vehicle Stations and Flood Hazard Assessment .......................9
Figure 9 - HART Maintenance Facility .....................................................................................11
Figure 10 - HART CNG Vehicle Fleet ......................................................................................12
Figure 11 - HART CNG Fueling Facility ....................................................................................12
Figure 12 - PSTA Battery Electric Bus ......................................................................................13
Figure 13 - City of Tampa CNG Refuse Hauler .........................................................................14
Figure 14 - Clearwater Gas Public CNG Filling Station ............................................................15
Figure 15 - City of Clearwater CNG Refuse Hauler .................................................................15
Figure 16 - TPA CNG Ford F-550 .............................................................................................16
Figure 17 - Pinellas County Schools Clearwater Bus Garage Compound ...............................17
Figure 18 - PEV Sales in Florida (2010-2020) ..........................................................................18
List of Acronyms

**AC**: Alternating current

**AFV**: Alternative fuel vehicle

**BEV**: Battery electric vehicle

**CNG**: Compressed natural gas

**CUTR**: Center for Urban Transportation Research

**DC**: Direct current

**DCFC**: Direct current fast charging

**DEP**: Florida Department of Environmental Protection

**DOE**: U.S. Department of Energy

**EMS**: Emergency Medical Services

**EOC**: Emergency Operations Center

**EV**: Electric vehicle

**EVCI**: Electric vehicle charging infrastructure

**EVSE**: Electric vehicle supply equipment

**FDACS**: Florida Department of Agriculture and Consumer Services

**FDEM**: Florida Department of Emergency Management

**FDOT**: Florida Department of Transportation

**FEMA**: Federal Emergency Management Agency

**GHG**: Greenhouse Gas

**HART**: Hillsborough Area Regional Transit

**kW**: Kilowatt

**kWh**: Kilowatt hour

**LNG**: Liquefied natural gas

**LPG**: Liquefied petroleum gas

**MOU**: Memorandum of understanding

**MSA**: Metropolitan statistical area

**NGV**: Natural gas vehicle
NGFFV: Natural Gas Fuel Fleet Vehicle Rebate Program
NREL: National Renewable Energy Laboratory
PEV: Plug-in vehicle
PHEV: Plug-in hybrid electric vehicle
PSTA: Pinellas Suncoast Transit Authority
TBCCC: Tampa Bay Clean Cities Coalition
TPA: Tampa International Airport
USF: University of South Florida
Introduction

The state of Florida is geographically vulnerable to hurricanes. Since 2000, seven major hurricanes—Category 3 or higher—have made landfall in Florida, with some years experiencing several major hurricanes and tropical storm events. Hurricanes and tropical storms bring high wind, storm surge, and flooding.

In addition to infrastructure damage, hurricanes and storms also disrupt the supply of essential resources such as fuel. A particular vulnerability in Tampa Bay comes from the impact of hurricanes on port operations. All fuel that comes to the area is delivered on fuel tankers through Port Tampa Bay. If the port is unable to receive ships due to hurricane wind or storm surge, fuel cannot be delivered to the area.

While all port terminals in the state typically have fuel storage that can last from few days to few weeks, the terminals might be able to provide fuel for only a limited amount of time after a storm due to higher demand and limited supply. Port Tampa Bay has less fuel storage capacity compared to other Florida ports, which necessitates more frequent fuel deliveries.

Public fleets in Tampa Bay implement a variety of measures and planning approaches to ensure that critical operations can be performed without interruption before and immediately after hurricane events. Some of the strategies involve spreading mobile assets between multiple locations to avoid them being destroyed if one or several locations are seriously compromised, moving vehicles to high-elevation areas before the storm to protect them from potential flooding, maintaining fuel storage capable of sustaining fleet operations in case of supply interruption, investing in emergency generators, sharing resources (including fuel) with neighboring public fleets, and fuel diversification strategies (including alternative fuels).

The current report discusses a few case studies highlighting the natural disaster responses of some Tampa Bay public fleets, focusing mainly on recent events (during the past 10 years). These case studies offer context-specific examples of how Tampa Bay fleets and stakeholders responded to natural disasters, and they provide information on what the fleets learned and what they would do differently in the future. The case studies can be used to inform other regions in the United States on the response to natural disasters and how to plan for them. The information presented in this report can also be used to demonstrate fueling and fleet planning and strategies employed in Tampa Bay during natural disaster conditions to assist local leaders and emergency management departments in incorporating transportation fuel resiliency into broader resiliency planning.
Objective

The objective of this case study report is to provide context-specific examples of how Tampa Bay fleets and stakeholders responded to natural disasters, summarize lessons learned, and describe what they would do differently in the future in order to inform other regions in the United States on the response to natural disasters.
Study Area

Tampa Bay is situated along the west central Florida coast and is a particularly vulnerable region due to its highly concentrated coastal population and limited disaster evacuation routes. While the region has not endured a direct hit by a major hurricane since 1921, the Tampa Bay metropolitan statistical area (MSA) is considered one of the most vulnerable areas in the United States to hurricanes and severe tropical weather. For the purpose of this summary report, the Tampa Bay region refers to the Tampa Bay MSA, which includes the larger metropolitan areas of Tampa, St. Petersburg, and Clearwater, as well as the smaller municipalities and incorporated areas within Pinellas and Hillsborough Counties. The City of Tampa is bordered to the south by Hillsborough Bay and to the west by Tampa Bay, which is comprised of Old, Middle, and Lower Tampa Bay. Hillsborough and Tampa Bays are large, shallow estuaries that connect to the Gulf of Mexico and are key shipping and freight routes for Port Tampa Bay, which is the largest port in the state of Florida by size and tonnage. The port spans over 5,000 acres and the port district includes portions of Tampa Bay, Hillsborough Bay, McKay Bay, Old Tampa Bay, and the Hillsborough River.

Figure 1 - Map of Tampa Bay

Source: Esri ArcGIS Online
Existing Alternative Fuel Conditions in Tampa Bay

The Tampa Bay region has a robust history of implementing alternative fuels to reduce reliance on petroleum, improve air quality, provide more fuel options, and reduce lifecycle vehicle costs. On-road transportation is a significant contributor to regional urban air pollution and greenhouse gas (GHG) emissions; in 2018, transportation accounted for 23.1 percent of Florida’s total energy consumption according to the Energy Information Administration, State Energy Data System (1). Since 2010, 9.3 billion gallons of gasoline and 1.4 billion gallons of diesel fuel have been sold in Tampa Bay, which includes Pinellas and Hillsborough Counties (2).

This section provides an overview of the current conditions of the alternative fuel market in the Tampa Bay region. The alternative fuels considered in this report include readily available transportation fuels, including biodiesel, compressed natural gas (CNG), propane autogas (LPG), ethanol, and electricity. Other fuels, such as hydrogen and liquefied natural gas (LNG), are not considered in this overview as the market for these alternative fuels is currently limited in the Tampa Bay region. Alternative fuels are used for diverse applications including light-duty passenger cars, medium-duty trucks, and heavy-duty vehicles, as well as some off-road equipment.

Local Alternative Fuels Coordination in Tampa Bay

Tampa Bay Clean Cities Coalition (TBCCC), a U.S. Department of Energy–designated coalition, aims to bring together stakeholders and advance the deployment of alternative fuels and other advanced vehicle technologies in its six-county Tampa Bay region. TBCCC is housed at the Center for Urban Transportation Research (CUTR) at the University of South Florida. TBCCC convenes key alternative fuel stakeholders in the region—including city and county governments, utilities, nonprofit organizations, fuel and vehicle manufacturers, and industry leaders—to address alternative fuel adoption and reduce the region’s carbon emissions, improve air quality, and enhance local and regional economies. Several of the major municipalities in Tampa Bay have committed to incorporating alternative fuel vehicles (AFVs) into their fleets as part of broader fleet sustainability efforts.

Infrastructure – Alternative Fuels

As of July 2020, the Tampa Bay region has 36 publicly available alternative fuel stations, including CNG, propane, and E-85 (and excluding electric vehicle charging stations). There are five publicly accessible CNG stations (see Figure 2) and four CNG private stations located within the greater Tampa Bay region (the private stations are used primarily to fuel refuse haulers and transit buses). There are 15 public propane refueling stations in the region (see Figure 3), though some of the stations included in the figure have limited vehicle fueling services.
In addition to propane and CNG, the Tampa Bay region has 12 retail gasoline stations that also sell E-85. There are no public stations for biodiesel (B-20). The University of South Florida operates a transit fleet of B-20 buses and has a private station located on campus. MacDill Air Force Base also supports a private biodiesel station on base. Table 1 summarizes the inventory
of alternative fueling stations (excluding electric vehicle supply equipment) in Pinellas and Hillsborough Counties as of July 2020.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Ownership</th>
<th>Number of Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiesel</td>
<td>Private</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Public</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>2</strong></td>
</tr>
<tr>
<td>CNG</td>
<td>Private</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Public</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>9</strong></td>
</tr>
<tr>
<td>Ethanol (E-85)</td>
<td>Private</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Public</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>16</strong></td>
</tr>
<tr>
<td>Propane (LPG)</td>
<td>Private</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Public</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>19</strong></td>
</tr>
<tr>
<td>All Fuels</td>
<td>Private</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Public</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>46</strong></td>
</tr>
</tbody>
</table>

**Source:** U.S. DOE Alternative Fuel Data Center (3,4)

**Infrastructure – Electric Vehicle Charging Stations**

Electric vehicle (EV) charging stations are primarily concentrated in the denser urban areas within Tampa Bay. The Atlas EV Hub reports 21 direct current fast charging (DCFC) stations with a total of 89 ports located within Pinellas and Hillsborough Counties (5). The DCFC stations are dispersed throughout the two counties, primarily at high-traffic retail locations. There are also 198 Level 2 stations (435 ports) located within the two counties (5). Figures 4 and 5 depict the distribution of electric vehicle supply equipment (EVSE) in Pinellas and Hillsborough Counties; the orange rings indicate the concentration of DCFC stations and ports, and the blue indicate Level 2 EVSE station locations and number of ports.
Figure 4 - EVSE Locations in Pinellas County

Source: Atlas Public Policy (5)

Figure 5 - EVSE Locations in Hillsborough County

Source: Atlas Public Policy (5)
As part of this case study analysis, the National Renewable Energy Laboratory (NREL) developed maps of the alternative fueling stations located in Tampa Bay, which also depicts their proximities to areas at increased risk for flooding and flooding shelters. Figures 6, 7, and 8 detail the overlay of alternative fueling stations in the Tampa Bay area and their proximities to major roadways, evacuation corridors, flood shelters, and flood zones.

![Figure 6 - Tampa Bay CNG Fuel Stations and Flood Hazard Assessment](image)

Source: NREL (6)
Figure 7 - Tampa Bay Propane Fuel Stations and Flood Hazard Assessment

Source: NREL (7)

Figure 8 - Tampa Bay Electric Vehicle Stations and Flood Hazard Assessment

Source: NREL (8)
There are several state-led initiatives currently underway to facilitate the expansion of EV infrastructure within the state of Florida, including the Tampa Bay area. As EV adoption continues to grow in Florida, developing the infrastructure needed to meet the increased charging demand becomes critical. Several of these initiatives specifically target EVSE infrastructure expansion to support evacuation efforts to enhance regional resiliency and facilitate hurricane response and recovery.

*Florida Electric Vehicle Roadmap*

The Florida Electric Vehicle Roadmap is an initiative sponsored by the Florida Department of Agriculture and Consumer Services Office of Energy and produced by the Central Florida Clean Cities Coalition. The roadmap, which is in development at time of this writing, aims to identify EV charging infrastructure grid impacts and potential solutions, locate areas that are lacking in EV charging infrastructure, develop best practices for EV siting, and identify technical and regulatory barriers to EV infrastructure expansion (9).

*Florida Senate Bill 7018*

Florida Senate Bill 7018 authorizes the Florida Department of Transportation (FDOT) to develop a master plan to coordinate the development of electric vehicle charging station infrastructure (EVCI) along the state highway system, which includes consideration for EVSE to facilitate hurricane evacuation.

*DEP Diesel Emissions Reduction $25 Million EVCI Funding*

Funding in the amount of $25 million from the State of Florida’s allocation of the Volkswagen Settlement will be used to install EV charging infrastructure around the state. In July 2020, the Florida Department of Environmental Protection (DEP) announced that the state is adding 74 new electric vehicle charging stations along the state’s major highways to facilitate longer-distance highway travel and to support hurricane evacuation efforts.

**Vehicles**

*Fleet Vehicles*

There are a variety of public and private fleets currently operating alternative fuels in the Tampa Bay region, including fuels such as propane, CNG, biodiesel, hybrid-electric, plug-in hybrids, and battery electric vehicles. Below are descriptions of the major regional alternative fuel users, which encompass an array of fleet types, including municipalities, distributors, transit agencies, city and county agencies, airports, utility providers, and refuse haulers. The entire Tampa Bay region, which also includes Pasco, Polk, Sarasota, and Manatee Counties, has experienced 13.6 percent growth in the total number of CNG vehicles since 2017, which is primarily due to the increased use of CNG-powered school buses and refuse haulers¹ (10).

¹ Note that this figure is pulled from a series of Transportation Technology Deployment Reports (2017, 2018, and 2019) for the Tampa Bay Clean Cities Coalition. The data is self-reported and does not include the entire population of alternative fuel users in the region.
While there has been a slight decrease in propane vehicle applications in the six-county Tampa Bay region (2 percent decrease since 2017), the propane school bus market is strong, with four of the six county school districts transitioning to propane and CNG buses (10).

**Hillsborough Area Regional Transit (HART)** is the largest public transportation provider in the region. The organization provides transit service in Hillsborough County, the largest and most populous county in Tampa Bay, with more than 14 million trips per year. HART has committed to convert its fleet of more than 230 buses and vans to compressed natural gas. HART currently operates 26 CNG shuttle buses, 18 CNG vans, and 70 CNG transit buses, with plans to gradually replace retired diesel-powered vehicles with CNG. HART operates its own CNG fast-fill fueling facility, which contains four 300-hp compressors, storage tanks, a backup generator, and four fast-fill CNG dispensers that service the fleet’s CNG transit buses and paratransit shuttle vans.

![Figure 9 - HART Maintenance Facility](image)
Pinellas Suncoast Transit Authority (PSTA) operates a modest battery electric transit bus fleet as well as a large fleet of hybrid-electric diesel buses. Over 40 percent of all PSTA fixed-route buses are hybrid-electric. PSTA was one of the first transit agencies in Florida to adopt battery electric transit buses and currently operates two electric buses on an urban circulator loop.

Figure 12 - PSTA Battery Electric Bus

TECO Energy serves as the electric utility for a portion of the coalition’s territory and actively supports and promotes the use of natural gas as an alternative transportation fuel. TECO Peoples Gas is the natural gas supplier for most of the Tampa Bay region and has a supply presence in southeast, northeast, central, and west Florida. TECO has installed 8 private CNG stations in the region to date, including 7 fast-fill stations and 1 time-fill station, as well 36 Level 2 EV charging stations (29 private and 7 public). TECO’s diverse alternative fuel fleet currently includes light-duty plug-in electric hybrid vehicles (PHEVs), several battery electric vehicles (BEVs), and electric lift bucket trucks.

Duke Energy is the electric utility for Pinellas County. Duke’s alternative fuel fleet servicing the Tampa Bay region includes light-duty PHEVs and BEVs, as well as plug-in step vans and electric forklifts.

City of Tampa currently operates heavy-duty CNG vehicles (mostly refuse trucks) and owns a private CNG time-fill station, with plans to continue expanding its alternative fuel fleet.
City of Clearwater, a municipality located in the densely populated area of Pinellas County, opened its first public (fast-fill) CNG station in October 2011 and currently operates one public (fast-fill) station and one private (time-fill) station. The City’s 70-vehicle refuse fleet is 100 percent CNG; the City also operates light- and medium-duty dedicated and bi-fuel CNG vehicles. Clearwater Gas maintains the public fast-fill CNG stations located off Hercules Avenue in Clearwater, Florida. The Clearwater natural gas filling station has four pumps as well as a mobile refueling system.
Figure 14 - Clearwater Gas Public CNG Filling Station

Figure 15 - City of Clearwater CNG Refuse Hauler
**Tampa International Airport (TPA)** is the largest of the three regional airports owned by the Hillsborough County Aviation Authority. TPA operates a diverse alternative fuel fleet, spanning from electric and hybrid vehicles to propane autogas and CNG. The airport operates CNG-powered pickup trucks, vans, heavy-duty transit buses, shuttles, and trucks, as well as low-speed electric vehicles, hybrid light-duty cars, and PHEVs. TPA has been operating a public CNG fueling station on its property since March 2012, in addition to providing 22 public-access electric charging stations capable of charging up to 24 vehicles simultaneously.

![Figure 16 - TPA CNG Ford F-550](image)

**University of South Florida (USF)** is the largest university in the Tampa Bay region and one of the largest public universities in the nation, with campuses in Tampa, St. Petersburg, and Sarasota. The Tampa campus is serviced by the university transit system known as Bull Runner, which provides transportation to students and faculty on and around the campus using transit vehicles (cutaway vans and buses) that run on biodiesel (B-20). The university also has 16 public-access Level 2 EV charging stations located on the main campus in Tampa.

**Hillsborough County School District** currently operates 98 propane school buses. Hillsborough County has constructed a private propane station with the capacity of 18,000 gallons to fuel its expanded propane fleet.

**Pinellas County School District** currently operates 130 propane school buses and plans to continue converting diesel fleet buses to propane in the coming years. The district has three private propane fueling facilities with tank capacities from 12,000 to 30,000 gallons in each facility.
Saddle Creek Logistics is a national third-party company that has established itself as a leader in using CNG in over-the-road heavy-duty trucks. Along with its corporate offices, the company has a significant campus in the region that includes over 2 million square feet of warehousing space, packaging, and fulfillment facilities. The location is home to a CNG station to service the current fleet of 98 CNG semi-trucks.

J.J. Taylor Distributing, a beer distribution firm, has also converted part of its fleet to CNG. The distribution company currently operates a fleet of 76 heavy-duty CNG trucks.

Dillon Transport is a national delivery company with large representation in the Tampa Bay area that demonstrates a strong commitment to alternative fuels. The company operates 155 heavy-duty CNG trucks.

**Consumer Vehicles**

The region’s light-duty vehicles run predominately on conventional fuels, although electric vehicle adoption is increasing in the region. Hillsborough County consistently ranks in the top five counties for BEV/PHEV registration in the state of Florida. In 2018, there were 4,427 PEVs registered in Pinellas and Hillsborough Counties, with 19.8 percent of Florida’s total PEVs located in the greater Tampa Bay region. While there has been some (minimal) adoption of BEVs by local government agency and utility fleets, most of the light-duty electric cars are consumer vehicles. Atlas EV Hub reports that there are currently 6,860 plug-in vehicles registered in Hillsborough and Pinellas Counties, of which 4,576 (66 percent) are full battery electric vehicles (5). There are approximately 1.94 battery electric vehicles per 1,000 people. While sales data specific to Pinellas and Hillsborough Counties are not available, state EV sale
trends indicate that the number of EVs are growing statewide. Figure 18 shows PEV sales in Florida from 2016 to 2020.

![Figure 18 - PEV Sales in Florida (2016-2020)](image)

Source: Atlas Public Policy (11)

As vehicle technologies advance and PEVs become more commercialized, there are several fleet applications for transition to an electric powertrain, including potential applications for school bus fleets, policy vehicles, and transit fleets.

**Rebates and Incentives**

To expedite the adoption of advanced propulsion technologies and to promote the use of alternative fuels, both federal government and state officials around the country have established various economic incentives to make alternative technologies attractive, or at least competitive with traditional technologies and fuels. Some states are more active than others in promoting alternative fuels/technologies.

Currently, there are four state incentives in Florida that are related to alternative fuels, including credits and exemptions for biofuels production, weight exemptions for idle reduction technologies and natural gas vehicles (NGVs), as well as permission to local governments to help property owners fund electric vehicle charging infrastructure installation. However, none of those incentives provide any funding to acquisition, conversion, or operation of alternative fuel vehicles or alternative fueling infrastructure. Table 2 summarizes Florida's alternative fuel incentives in more detail.
Table 2 - Description of Florida Incentives

<table>
<thead>
<tr>
<th>Incentive Program</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Vehicle Supply Equipment (EVSE) Financing</td>
<td>Property owners may apply to their local government for funding to help finance EVSE installations on their property or enter into a financing agreement with the local government for the same purpose. § 163.08, Fla. Stat. (2019)</td>
</tr>
<tr>
<td>Excise Tax Exemption for Biodiesel Produced by Schools</td>
<td>Biodiesel fuel manufactured by a public or private secondary school is exempt from the diesel fuel excise tax and the associated registration requirements. § 206.874(7), Fla. Stat. (2011)</td>
</tr>
<tr>
<td>Idle Reduction and Natural Gas Vehicle (NGV) Weight Exemption</td>
<td>Any motor vehicle equipped with idle reduction technology may exceed the gross vehicle or internal bridge weight by the amount equal to the certified weight of the idle reduction technology, up to 550 pounds (lbs.). To be eligible, the operator must present written verification of the weight of the idle reduction technology and demonstrate that it is fully functional at all times. Any NGV may exceed the limits by up to 2,000 lbs. § 316.545, Fla. Stat. (2011)</td>
</tr>
<tr>
<td>Ethanol Production Credit</td>
<td>County governments are eligible to receive waste reduction credits for using yard clippings, clean wood waste, or paper waste as feedstock for the production of clean-burning fuels such as ethanol. § 403.706.4(b), Fla. Stat. (2019)</td>
</tr>
</tbody>
</table>

Natural Gas Fuel Fleet Vehicle Rebate Program

One of the most successful alternative fuel rebates offered by the state of Florida was the Natural Gas Fuel Fleet Vehicle (NGFFV) Rebate Program, which was established by the Florida Legislature in 2013 and was administered by the Florida Department of Agriculture and Consumer Services (FDACS) Office of Energy. The legislation provided $6 million per fiscal year ($2.4 million for public fleets and $3.6 million for private fleets) in recurring funds from FY 2013–14 through FY 2017–18, to offer rebates for the purchase, conversion, or lease of natural gas fuel fleet vehicles.

The NGFFV program made available rebates of up to $25,000 per vehicle and $250,000 per applicant per fiscal year for up to 50 percent of the incremental cost associated with the conversion, purchase, or lease of natural gas vehicles. While active, the program distributed $20.9 million to public and private applicants to fund the purchase, lease, or conversion of 1,948 natural gas vehicles in Florida (12). Table 3 summarizes NGFFV program utilization. The Florida Legislature did not fund the program during the 2017 legislative session, therefore FY 2016–17 was the program’s last active year.

Table 3 - Florida NGFFV Program Summary (2013–2018)

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Vehicles Approved for Funding</th>
<th>Total Rebate Amount Awarded ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013–2014</td>
<td>272</td>
<td>3.9</td>
</tr>
<tr>
<td>2014–2015</td>
<td>518</td>
<td>5.2</td>
</tr>
<tr>
<td>2015–2016</td>
<td>598</td>
<td>5.8</td>
</tr>
<tr>
<td>2016–2017</td>
<td>560</td>
<td>6.0</td>
</tr>
<tr>
<td>2017–2018</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>1,948</td>
<td>20.9</td>
</tr>
</tbody>
</table>

Program statistics indicate that of the 1,948 vehicles that received rebate assistance, 907 vehicles (46.6%) were dedicated CNG, 119 vehicles (6.1%) were bi-fuel CNG, 649 vehicles
(33.3%) were dedicated propane, 196 vehicles (10%) were bi-fuel propane, and 77 vehicles (4%) were LNG vehicles (12).

Tampa Bay and south Florida were the areas that benefitted the most from the Natural Gas rebate program as there was a strong concentration of rebates awarded in these regions. During the four years of funding, 46 public and private fleets from TBCCC’s six-county area (including Hillsborough, Pinellas, Polk, Pasco, Manatee, and Sarasota Counties) took advantage of the program, receiving funding for the acquisition or conversion of 552 natural gas vehicles. From 2014 to 2017, fleets from Tampa Bay region were awarded $6.2 million for the acquisition and conversion of natural gas vehicles, accounting for 29.6 percent of all funds awarded by the NGFFV program during that time. Table 4 summarizes NGFFV program utilization by Tampa Bay fleets by fiscal year (12).

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Number of Approved Applicants</th>
<th>Number of NG Vehicles Funded</th>
<th>Amount of Rebate ($)</th>
<th>Percentage of Statewide Rebate Total Funds (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013–2014</td>
<td>10</td>
<td>122</td>
<td>2,333,146.25</td>
<td>59.8</td>
</tr>
<tr>
<td>2014–2015</td>
<td>14</td>
<td>154</td>
<td>1,677,899.24</td>
<td>32.3</td>
</tr>
<tr>
<td>2015–2016</td>
<td>15</td>
<td>226</td>
<td>1,681,794.60</td>
<td>29.0</td>
</tr>
<tr>
<td>2016–2017</td>
<td>7</td>
<td>50</td>
<td>502,399.91</td>
<td>8.4</td>
</tr>
<tr>
<td>Total</td>
<td>46</td>
<td>552</td>
<td>6,195,240.00</td>
<td>29.6</td>
</tr>
</tbody>
</table>

**Utility-Provided Rebates in the United States**

Forty-three utility companies operating in 25 states currently offer various rebates covering the cost of equipment, installation, or site preparation for residential or commercial EVSE. The typical rebate amount for residential Level-2 EVSE ranges from $100 to $1,000, with an average rebate amount of $471. Additionally, three utilities offer free Level-2 EVSE for residential customers.

The typical utility rebate amount for commercial EVSE installations ranges from $250 to $32,000 for Level-2 stations and from $6,000 to $120,000 for commercial DC fast charging stations. The average utility rebate for a commercial Level-2 charging station is $4,069, while the average rebate for commercial DCFC is $43,286. Additionally, two utilities offer a free Level-2 charger or DCFC to commercial customers, while two other utility companies offer Level-2 chargers with a 50% discount to commercial customers.

Sixteen utility companies operating in 10 states offer rebates to their customers for purchasing or leasing plug-in electric vehicles, including battery electric vehicles and plug-in hybrids. A typical utility-provided EV rebate ranges from $50 to $1,000 for plug-in hybrids and from $50 to $2,500 for battery electric vehicles. The average utility-provided EV rebate across the country is $383 for PHEV and $954 for BEV (12).

**Utility Incentives**

There are currently no state-funded financial incentives for EV or EV charging infrastructure in Florida. Five of the state’s utilities offer financial incentives for EVs or EVCI. The existing incentives offer free Level-2 of DCFC chargers or cover the cost of hardware, networking
services, and warranties to commercial site hosts. Yet, there are few incentives for residential EVSE installations. Only one utility (Kissimmee Utility Authority) offers a small incentive ($100) to residential customers for installing an EV charger. Three Florida utilities provide incentives for purchasing or leasing EVs that range from $100 to $1,000. Jacksonville Electric Authority offers by far the most generous incentive to EV owners, providing customers a $500 rebate for purchasing or leasing new plug-in electric vehicles with the battery capacity of less than 15 kilowatt hour (kWh) and a $1,000 rebate for new electric vehicles with larger than 15 kWh battery capacity. Table 5 summarizes EVSE and EV incentives currently offered by Florida utility companies (13).

Table 5 - EVSE and EV Incentives Provided by Florida Utilities

<table>
<thead>
<tr>
<th>Utility</th>
<th>EVSE Incentive</th>
<th>EV Incentive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Residential</td>
<td>Commercial</td>
</tr>
<tr>
<td>Brickell Energy</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cost of hardware</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• network service</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• management service</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• warranties</td>
</tr>
<tr>
<td>Duke Energy</td>
<td>--</td>
<td>Free Level-2 or DCFC</td>
</tr>
<tr>
<td>Jacksonville Electric Authority</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Kissimmee Utility Authority</td>
<td>$100</td>
<td>--</td>
</tr>
<tr>
<td>Orlando Utility Commission</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Note that none of the utility incentives are available in the Tampa Bay area. Tampa Bay utilities currently do not offer any EV or EVSE rebates and/or incentives.

Local Rebates
In 2017, Sarasota County implemented the ChargeUP! Sarasota Program that offers rebates to certain types of businesses, nonprofits, and local governments within the county to buy and install EV charging stations. The rebate provides the following for a new, publicly available station (14):

- Nonprofits or government organizations: 50 percent of cost, up to $4,000 maximum
- For-profit organizations/businesses: 25 percent of cost, up to $2,000 maximum

Sarasota County has a history of EV leadership, being the first local government in Florida to add EVs to its fleet and being the second in the state for number of EVs per capita. The ChargeUP! program is currently the only known EVSE rebate program in the Tampa Bay area.
Lessons Learned from Past Experiences

This section summarizes some of the lessons learned from past hurricanes in the Tampa Bay area, focusing mainly on recent events such as Hurricane Irma (2017). While Tampa Bay had not experienced a direct hit for many years, it was impacted multiple times by hurricanes and tropical storms bringing wind damage, flooding, and power outages. The experiences and lessons learned of the public agencies detailed in this section will benefit future hurricane planning and improve Tampa Bay’s resilience to natural disasters.

Port Tampa Bay

One of the biggest vulnerabilities to Florida’s fuel supply is that all the state’s petroleum fuel comes through ports that are subject to closures and disruptions during hurricanes. Port Tampa Bay is a critical transportation hub and an important gateway for fuel supply to the state. Approximately 45 percent of Florida’s gasoline comes through Port Tampa Bay. Past hurricanes brought relatively low storm surge (5-6 feet), which was not enough to damage port infrastructure. However, a higher storm surge can cause flooding and damage to the port.

Port Tampa Bay’s vulnerability also results from the configuration of the port and waterways leading to the port. The 43-mile-long channel leading to the port requires approximately four hours for ships to cover the distance. Additionally, the channel is narrow and can accommodate only one-way traffic for mid-sized (or larger) cargo ships, which can create significant bottlenecks.

Due to the complexity of the port channel, large cargo ships are guided through the channel by trained local pilots. In the case of an approaching hurricane (when the waves are high enough) or when weather conditions are poor (i.e., foggy), pilots suspend service and ships are not able to enter or exit the port.

Hillsborough County

In advance of Hurricane Irma, Hillsborough County prepared by relocating vehicles and equipment from low-lying areas to higher ground, and ensured they were not consolidated in one location in case that location became compromised. That strategy has worked well in the past, allowing the county to avoid major transportation disruptions.

Police escorts for fuel tankers may be needed to ensure timely delivery on congested roads impacted by evacuation efforts. The worst negative impact the county experienced in the past was not from the storm itself, but from panic fuel buying pre-landfall. Even when the port is not closed and fuel can be delivered, transportation bottlenecks at Port Tampa Bay can delay fuel shipments by several hours.

Fleets need to have a backup fuel supply and storage in order to operate during disasters when supply is limited, and they need to plan for operating several days without fuel shipments from the port. The county has six fueling sites and a variety of storage tanks in different locations.
When fuel availability is limited (which does not happen during every storm), coordination with the emergency management department is key to establishing fueling priority and ensuring efficient use of critical resources.

**Pinellas County**

The standard procedure for Pinellas County to prepare for a hurricane involves fueling up vehicles and equipment assets and parking them in several strategic locations around the county. To prepare fuel supplies, the county stores fuel at 17 fueling sites. Geographically spreading critical fuel resources reduces the risk of site(s) becoming damaged or inoperable.

While the county has agreements with four vendors to supply fuel, all the agreements have force majeure clauses. Previous hurricane events demonstrated that fuel event procedures were not always followed during disasters. During Hurricane Irma, the county did not experience fuel shortages, but there were four days where no deliveries could be made: one day pre-landfall, two days during landfall, and one day post-landfall. This emphasizes the need to have adequate fuel storage to support fleet operations for several days, keeping in mind that fuel burn rate during and after a hurricane may be significantly higher than during normal operations. While there was adequate fuel supply from Port Tampa Bay to support local demand, the primary issue during Hurricane Irma was a lack of tanker drivers since many people evacuated the state. In some cases, drivers had to be brought in from out of state.

Another lesson learned is that communication between public fleets at all levels, as well as the sharing of resources, is an effective way to improve the area’s resilience and ensure that critical resources are employed where they are most needed. While Pinellas County was able to maintain fuel supply, a few municipalities within the county (City of St. Petersburg, City of Largo) experienced shortages. Communication between city and the county officials and an abundant fuel supply enabled the county to provide fuel deliveries to assist the municipalities.

**City of St. Petersburg**

The City of St. Petersburg owns high-water tactical vehicles including Humvees, two-and-half-ton trucks, and five-ton trucks that are former military vehicles now used to transport equipment and personnel during flooding incidents. While these vehicles were not deployed after Irma (since the storm did not cause significant flooding), they have been successfully used during other hurricanes.

Given the potential difficulties in traditional fuel supply during natural disasters, the city is considering investing in E-85 (mainly for light-duty vehicles) as part of a broader fuel diversification strategy to allow fleet operations on different fuels and leverage flex fuel capabilities during emergencies. Additionally, the city is exploring options for solar charging systems to power its growing electric vehicle fleet.
Clearing the roads from debris after a hurricane is critical to restoring transportation functions. The city utilizes a prioritized plan that identifies which streets will be cleared first after the storm. The city also employs a tiered system to prioritize fuel usage in the event of a shortage:

- **Tier 1**: law enforcement, lifesaving, fire emergency, medical services, transportation to hospitals
- **Tier 2**: life-sustaining (fuel for facilities, critical care, special needs, and shelters)
- **Tier 3**: public health and property-saving, environmental health and containment, mitigation, law enforcement, and fire infrastructure so buildings would be tier 3 for generators
- **Tier 4, 5, 6**: all other vehicles and other fueling requirements

Vehicles are assigned RFID tags that must be swiped in order to fuel, and fuel is dispensed according to tier level and limits of fuel that can be dispensed within a certain timeframe and are recorded on the tag.

The main fueling strategy involves fuel diversification and accurately measuring and dispensing during emergency situations. Previous events have demonstrated that calculating a fleet’s fuel burn rate during emergency operation is difficult. There are multiple factors that may affect the burn rate, including the path of the storm, nature of the damage (wind vs. flooding), road closures, power outages, and types of vehicles involved in recovery efforts. It is not uncommon for fleets to consume three to four times more fuel during emergency response/recovery compared to normal operations. A reliable analytical tool estimating fuel consumption during emergency operations would be beneficial for planning purposes.

Prior to Hurricane Irma, the City of St. Petersburg moved critical vehicles (high-water and debris-pushing vehicles) to higher elevation areas to enable rapid response following the storm. When the city was approaching its fuel reserve limits after Hurricane Irma, it was able to purchase a truckload of fuel from a neighboring city, underscoring the importance of communication and good relations between public fleets in an area.

The city recently upgraded its stormwater mitigation plan and ground piping equipment, which has helped reduce local flooding, an issue not only after hurricanes, but also after heavy rains. Drainage design and stormwater treatment play a vital role in reducing an area’s vulnerability to severe weather events, including hurricanes, tropical storms, and local flooding.

**Pinellas Suncoast Transit Authority (PSTA)**

While Pinellas Suncoast Transit Authority (PSTA) did not experience an issue with standing water during Hurricane Irma, this is a concern for Pinellas County since a large portion of it is located in low-lying areas. As a result, a heavy precipitation event can cause significant flooding, as was experienced during Tropical Storm Hermine in 2016.

If bus operators encounter standing water conditions, they are instructed not to go through water that is deep enough to touch lug nuts on the wheels. Water touching the lug nuts is a rule...
of thumb that is used by PSTA for all bus types (diesel and alternative fuel) because it is easy for the driver to visualize how deep water can be and because such water level is safe for the bus undercarriage components, including rear differential, air brake system, as well as many grease-lubricated parts that can be damaged if submerged in water. One of PSTA’s bus drivers violated the “lug nut rule” during a recent storm and stalled an electric bus in standing water. This incident demonstrated that electric buses are just as, if not more, vulnerable than diesel buses to damage if operated in extreme standing water conditions.

While PSTA’s facility is rated to withstand a 15-foot storm surge during a hurricane, the base floor elevation of the buildings on site is only 9 feet. When a hurricane approaches, PSTA relocates its buses to strategic high points in the county, including Countryside High School and Clearwater High School. PSTA stops bus service when sustained winds reach 45 mph.

The key to ensuring uninterrupted operations of the bus fleet during a disaster is maintaining adequate fuel storage. PSTA currently has on-site fuel storage capacity of 80,000 gallons of diesel and 8,000 gallons of gasoline and is adding another 20,000 gallons of diesel, bringing total on-site diesel storage to 100,000 gallons. Additionally, the fuel capacity of vehicle fuel tanks is 25,000 gallons, which are kept full in anticipation of a hurricane. These measures allow PSTA to have enough fuel for at least 14 days of fleet operation, providing resilience to potential fuel supply interruptions after a hurricane.

**Hillsborough Area Regional Transit (HART)**

At Hillsborough Area Regional Transit (HART), hurricane preparation is a year-round process. It begins with quarterly training through Hillsborough County’s Emergency Operations Center (EOC). HART is one of four organizations in the county designated to transport people from their homes to shelters during a hurricane, along with the Sunshine Line, Hillsborough County Schools, and Emergency Medical Services (EMS) for people who have special needs.

Each spring, HART leadership begins annual storm preparations by participating in quarterly meetings with city and county emergency services personnel to discuss strategies for evacuating residents, setting up temporary shelters, communicating with the public and first responders, and other tactics to be deployed before, during, and after a weather-related event. HART also has on standby a team of more than 100 volunteers who can be counted on to report to work during weather events.

When the Hurricane Irma was approaching, HART implemented the following measures to prepare for landfall:

- Fully fueled all buses, vans, and company vehicles before the storm.
- Transferred two-thirds of the bus fleet to designated safe places (in high-elevation areas) to minimize potential loss.
- Filled five HART generators with diesel fuel.
- Turned off non-essential electrical circuits in the facilities to prevent fire.
• Sent elevators in all buildings to the top floor so that cabs wouldn’t be destroyed by floodwater.
• Planned back-ups in the event designated shelters filled up.
• Paratransit vans were divided between two park-n-ride locations and HART headquarters to prevent the entire fleet being damaged.

Due to the massive statewide evacuation during Hurricane Irma, diesel fuel for first responders and electrical crews sent from other states to assist with recovery efforts was in short supply. Since HART had stored both diesel and CNG, the Authority decided to utilize its CNG vehicles to transport evacuees back home and perform other post-storm duties. That freed up its diesel reserves to provide fuel for 40 emergency vehicles from Tennessee, Georgia, the Carolinas, and Mississippi.

Lessons learned from Hurricane Irma:

• There is no such thing as too much communication—including minute-by-minute updates and evacuation plans.
• Regular tabletop drills and exercises before the storm are helpful so that everyone is clear about their role and responsibility.
• Always prepare for the worst-case scenario. Do no become complacent after years of hurricane near-misses.
• Label vehicles indicating where they should be stored before an emergency to avoid confusion once an evacuation call is given.
• Make sure all vehicles are fully fueled before the storm.
• Determine which vehicles might be needed before storing them and park them accordingly.
• Maintain adequate supply of fuel (diesel and gasoline).
• Build a large volunteer army. Regardless of how much they prepare before the event, some volunteers might not be able to work once the hurricane hits due to road conditions and damage to their own homes.
• Plan alternative routes that buses can take to reach shelters in case roads are blocked by debris.
• Develop a communication plan in the event power is out for a long time. Don’t rely on cell phones and social media (may not be available if power is out).
• Install redundant internet circuits in case one system goes down.
• Keep accurate records of personnel hours and expenses for reimbursement by the Federal Emergency Management Agency (FEMA).

HART Hurricane Emergency Plan
In order to guide actions during hurricanes, many public agencies employ a hurricane emergency plan. This plan specifies procedures and duties during emergencies and is updated annually. While emergency plans of different agencies may vary in detail, they often apply...
similar general approaches to planning and emergency operation procedures. Highlights of HART’s hurricane emergency plan are provided below. HART’s Hurricane Emergency Plan (the Plan) attempts to cover all areas of responsibility that could be affected by a hurricane, severe tropical storm, flooding, and so on. Many aspects of the Plan can be put into action in the case of any type of disaster or epidemic.

HART’s Plan is intended to provide the citizens of Hillsborough County with organized transportation for evacuation to designated disaster shelters to protect them from the adverse effects of a hurricane. The Plan assigns responsibilities and establishes procedures for the coordinated effort necessary for hurricane mitigation, preparedness, response, and recovery.

Plan timeline:

- April 1 – Administrative staff begins reviewing the Plan
- May 15 – Changes to be sent to Document Control Librarian for processing
- May 15 – Copy of the Plan sent to key personnel for review and comment prior to June 1
- If a hurricane arrives prior to Plan finalization and approval for the current season, all preparations will be completed using the previous year’s plan

The Plan directs personnel to do the following:

- Identify areas to safely store equipment (staff vehicles, vans, buses, streetcars)
- Inventory all emergency equipment and supplies
- Coordinate emergency purchasing agreements with Purchasing Department
- Ensure availability of petty cash on hand (minimum of $1,000)

Off-site fuel for transit vehicles may be purchased only at the following stations:

- For CNG vehicles, Trillium CNG (4612 50th St.)
- For non-CNG vehicles, Marathon Gas (2611 N. 40th St.) and Citgo (2610 N. 40th St.)

There are four backup generators at HART facilities:

- Administration building – 450-kilowatt (kW) generator with 1,000-gallon fuel tank
- Preventive maintenance building – 125-kW generator with 400-gallon fuel tank
- Heavy maintenance building – 80-kW generator with 203-gallon fuel tank (provides emergency power to fuel lane, maintenance supervisor’s office, roof-mounted ventilation fans, and CNG gas detection panel)
- CNG fueling station – 1,600-kW generator with 7,000-gallon fuel tank (provides power for continuous operation of CNG fueling station for 90 run hours)

In order to ensure compliance with air regulations, the Plan directs HART to keep generator run logs to document the operating hours for each generator regardless of its physical location.

Fueling procedures included in the Plan are as follows:
• Once a Hurricane Warning goes into effect, all HART vehicles are fueled to “full”, the 21st Avenue fuel storage tanks are filled to maximum capacity, and arrangements are made throughout the hurricane season for off-site fueling locations.
• If the fuel pumping system goes down, vehicles should be taken to off-property fueling locations.

The vehicle dispersion plan for a Category 3 or greater storm that is projected to have a direct hit on Tampa includes the following:

• Move 74 big buses to USF property/campus (HART/USF signed MOU)
• Move 28 big buses and Trolleys to Hidden River Park N Ride
• Keep 183 big buses at HART’s 21st Avenue bus garage facility

HART priorities during any type of emergency are as follows:

• Life Safety
• Incident Stabilization
• Property Conservation
• Recovery and Restoration

June through November is officially "Hurricane Season" in Florida, with the peak months being August, September, and October. The four stages of hurricane operations include the following:

• Hurricane Watch – can be issued when hurricane conditions are expected within 48 hours; regular scheduled operations continue
• Hurricane Warning – issued when hurricane conditions (sustained wind of 74+ mph) are possible within 36 hours; bus operations continue until winds reach 39 mph or above
• Hurricane Operations
• Post-Hurricane Operations

Emergency shelters in Hillsborough County:

• HART will obtain a current list of Hurricane Disaster Shelters from the Hillsborough County EOC
• This list is updated annually
• 15 public shelters for lower intensity storms
• 31 public shelters for higher intensity storms

Evacuation routes:

• HART will operate nine evacuation routes designated A through J
• Each route terminates at an approved Red Cross evacuation shelter
• Information and preparation tips are available on the HART website: http://www.gohart.org/Pages/maps-emergency-evac.aspx
Hurricane Irma’s Impact on Fuel Shortage in Tampa Bay

The data on fuel availability collected by the Florida Department of Emergency Management (FDEM) indicate that diesel was more available in Tampa Bay before and during Hurricane Irma than gasoline, while gasoline was more available than diesel after the hurricane. The share of stations that were without gasoline before and during the hurricane ranged from 75 to 80 percent, compared to 38–55 percent for stations without diesel. At the same time, the share of stations without gasoline after the hurricane continued decreasing, reaching 24 percent by September 15, while the number of stations without diesel ranged from 50 to 60 percent post-hurricane. The decrease in diesel availability after the storm could have resulted from a large increase in demand during the storm recovery period, or from a significant disruption in diesel supply immediately after the storm. The exact cause is unknown and will need further investigation.

Most of the surveyed stations in Tampa Bay remained without gasoline until at least the day after Hurricane Irma impacted the region (September 12, 2017). The number of stations without gasoline decreased immediately before hurricane landfall (September 8-9), then increased slightly during the time of impact (September 10-11), and continued decreasing after the hurricane as the area continued recovering and restoring fuel supply. After September 13 (the second day after hurricane impact), the number of stations in Tampa Bay that had gas exceeded the number of stations that did not.

The data demonstrate that power outages after Hurricane Irma contributed significantly to the fuel shortage issue. In order to continue dispensing fuel, gas stations need both fuel and power. For example, while 25.5 percent of Tampa Bay stations reported having gasoline during hurricane landfall (on September 10), only 15.2 percent had both gas and power, enabling them to dispense fuel.

Hurricane Irma and Power Outages in Tampa Bay

Overall, Hurricane Irma impacted 28 Tampa Electric Company (TECO) substations and knocked out 220 (out of 738) circuits. During the week following the hurricane, TECO replaced 207 electric poles, 356 transformers, more than 17,000 fuses, and more than 23,000 splices as part of the recovery effort. TECO also received more than 500,000 calls from customers during this time, and over 70 percent of the calls were handled by an automated system. Overall, about 425,000 TECO customers (over 55 percent of total TECO customers) were affected by the hurricane. The number of customers without power peaked at 335,000 on September 11, 2017, the day after landfall, and continued decreasing during the restoration phase. Despite restoration efforts, more than 95,000 TECO customers remained without power three days after the hurricane. It took TECO approximately a week to fully restore power to all customers. TECO deployed seven Fold-Out Rigid Temporary Shelters (FORTS) as well as Mobile Command Centers to assist during recovery. This equipment proved valuable for recovery efforts as TECO had to open six incident bases in multiple locations to manage more than 3,000 external personnel who were brought in to help. The key success factors during recovery included a
prioritization and triage process to restore the most critical customers first (hospitals, nursing homes, water treatment), developing an accurate estimated time of repair (ETR) schedule 24 hours after the hurricane, and coordination with state and multiple neighboring counties.

Summary of Lessons Learned

The key lessons learned from Hurricane Irma on fuel considerations in the Tampa Bay area are summarized as follows:

- Timing is critical to determining when normal operations should be suspended in order to have sufficient time to allocate resources for relocating assets and preparing the fleet to endure the storm and initiate recovery as soon as possible.
- Asset staging, which involves relocating vehicles and other fleet assets to higher elevation staging areas within the county, is a key step that many public fleets in Tampa Bay perform during the hurricane pre-landfall preparation phase in order to preserve assets by moving them from low-lying areas. In addition to protecting assets, it makes them accessible, allowing recovery operations to begin quickly after the storm passes.
- Utilization of high-water capable vehicles is important for response and recovery operations. Several public fleets in Tampa Bay have high-water capable vehicles that can operate through flooded areas. These vehicles and equipment can successfully navigate flooded streets to perform essential services, including evacuations, route clearing, setting up barricades, and managing utilities.
- Prioritizing debris removal is a necessary first step after a storm to ensure transportation can resume operations. Generally, transportation functions cease when sustained wind speed reaches 40–45 mph or higher. For Hurricane Irma, recovery was mainly focused on debris removal, which was a significant problem and the impacts were severe. Debris removal required the use of off-road equipment, loaders, dump trucks, and claws trucks. A local municipality in Pinellas County purchased snowplows to assist with these efforts.
- Fuel strategy is important for fleet preparation during an emergency event. All the public fleets presented in this report have fueling storage sites, both underground and above ground, with wide-ranging storage capacities. Fueling priority plans are implemented to determine which vehicles fuel first during a shortage. Some fueling systems also follow a fuel triage protocol that limits the amount of fuel dispensed depending on whether the vehicle or equipment is identified as critical or non-critical.
- Accurately predicting the burn rate for fuel usage under emergency conditions is challenging, but it is an important calculation for estimating fuel supply needs particularly for public agencies responsible for fueling generators. It is not uncommon for fleets to consume significantly more fuel (e.g., three to four times more) during emergency events than during normal operations.
• Fuel diversification is a key resiliency strategy, including diversifying fuel sources and types such as alternative fuel vehicles, flex-fuel vehicles, and solar-powered EV charging stations.

• Fuel resource sharing between municipalities and counties is another critical strategy. During Irma, the public fleets in general did not encounter critical fuel shortages, though this was due to a variety of factors. One of the fleets had ample fuel storage and was able to not only sustain operations, but also provide fuel for other agencies. Another fleet indicated key last-minute fuel purchases were enough to sustain operations. While Port Tampa Bay did not run out of fuel reserves, fuel deliveries were delayed, which impacted all the fleets described in this report.

• In general, standing water was not an issue during Hurricane Irma. However, localized flooding was a problem, and the fleets deployed high-water vehicles and four-wheelers to access flooded roads. In addition, one of the fleets deploys water-pumping trucks to mitigate floodwaters.
Recommended Actions for Preparation for Future Natural Disasters/Emergencies

(1) Ensuring adequate fuel storage – Public agency fleets, especially those responsible for performing critical transportation functions (e.g., evacuation, transportation to/from hospitals) should maintain adequate fuel storage. We recommend storing enough fuel to sustain a fleet’s operation for 7-14 days (3-5 days minimum) without any fuel deliveries, keeping in mind that operations during emergencies may require significantly more fuel use than during normal operations.

(2) Diversifying fuel supply – Public agency fleets in Tampa Bay should explore fuel diversification strategies, including transitioning a portion of their fleet to alternative fuels. Potential alternative fuel technologies may include CNG, propane, ethanol and electric vehicles. These alternative fuels are delivered to Tampa Bay through various channels, including pipeline, rail, and truck, which reduces the vulnerability of supply constraints. CNG is delivered to Tampa Bay through a pipeline that is typically not affected by the storms. During past hurricanes, CNG infrastructure proved resilient in Tampa Bay, with limited supply interruption. Propane is delivered by truck and can be stored indefinitely without degradation to fuel properties. While propane fuel deliveries may be affected by hurricanes due to road closures, they are not affected by closures or damage to port infrastructure, reducing supply vulnerabilities. Ethanol is delivered to Tampa Bay by rail to Port Tampa Bay where it is blended to appropriate blends. Higher blends of ethanol (e.g., E-85) allow for lower usage of gasoline and may be preferred in the case of gasoline shortage. While ethanol deliveries go through Port Tampa Bay and would be vulnerable to port infrastructure disruptions, they are not impacted by port closures to ship traffic resulting from a hurricane. Fleets running flex-fuel vehicles (capable of running on both conventional gasoline and E-85) can choose the fuel that is more available during an emergency and are less likely to experience fuel disruptions. While power outages caused by hurricanes can complicate electric vehicle charging, electric vehicles (especially heavy-duty vehicles with large batteries) can double as mobile generators to supply power to critical facilities (shelters, hospitals, emergency operation centers) in the case of an emergency or natural disaster. The technology exists that allows converting the DC power of electric vehicle batteries into AC output and supplying it to outside energy consumers (11). While not being extensively used currently, this technology had been tested in the past in real-world emergency situations and is certainly worth exploring.

(3) Planning for worst-case scenarios – Public agencies should always plan for worst-case scenarios when conducting emergency planning and preparation. While Tampa Bay has not experienced a direct Category 4 or 5 hit in nearly a century, public agency fleets need to be prepared to address all possible disruptions that may result from the worst storm conditions.
(4) **Implementing a robust communication and sharing procedure** – We highly recommend developing more efficient communication procedures between public agency fleets and implementing a system that would allow sharing resources in the case of an emergency. In addition to coordinating through the emergency operations center (EOC), public agencies and local governments currently use the phone to communicate with neighboring agencies/governments during a disaster and can lend fuel if they have excess fuel available. A more robust system that would track in real time the fuel availability of all participants and allow allocating fuel (or other resources) to the entities that need them the most would greatly benefit the citizens of Tampa Bay and improve the area’s resilience to natural disasters. All essential public agency fleets should implement a system to accurately track fuel usage during hurricanes. The Tampa Bay agencies interviewed for this paper indicated that they find it difficult to predict fuel usage during hurricane operations, noting that fuel usage during a disaster is typically significantly higher than during normal operations. Developing and implementing an accurate fuel usage tracking system for emergency operations will help fleets with fuel planning for emergency scenarios.

(5) **Implementing a fuel prioritization system** – All essential public agency fleets should implement a fuel prioritization system that allows rationing and prioritizing fuel use in the case of a shortage. Prioritized vehicles should include those involved in the most urgent operations and those that are most fuel efficient.

(6) **Installing emergency generators** – Public agencies can benefit from investing in emergency generators to support fueling stations, including those capable of operating on alternative fuels (propane or CNG). Gas stations should be prioritized that can more easily receive deliveries during and after a hurricane, and that are on less reliable sections of the grid.

(7) **Upgrading street drainage systems** – Finally, local jurisdictions in Tampa Bay (including cities and counties) are encouraged to consider upgrading street drainage systems (especially in low-lying areas) to reduce the threat of local flooding during major storms and hurricanes.
Conclusion

While the Tampa Bay region has not endured a direct hit by a major hurricane since 1921, the Tampa metropolitan statistical area is considered one of the most vulnerable areas in the United States to hurricanes and severe tropical weather. A particular vulnerability comes from the fact that all petroleum fuel enters the area through the port. Port Tampa Bay is a critical transportation hub in west-central Florida and an important gateway to the state’s fuel supply. Port operations are significantly affected by hurricanes and major storms. The channel that leads to the port is 43 miles long and requires four hours for ships to cover the distance. High waves and heavy fog can stop waterway traffic to the port even if it is open and capable of accepting inbound ships.

Previous hurricanes and storms have demonstrated how port disruptions can affect fuel supply in the Tampa Bay Area. Hurricane Irma (2017) forced Port Tampa Bay to remain closed for about five days, causing area fuel shortages. Sample data provided by GasBuddy indicate that over 75 percent of gas stations in the Tampa Bay area were without gasoline during Hurricane Irma, and at least 40 percent remained without access to gasoline three days after the hurricane.

In addition to fuel shortages, Tampa Bay also experienced power outages as a result of Hurricane Irma. Approximately 425,000 TECO customers were affected by the 2017 hurricane, and it took the utility company about a week to restore power to all customers.

Tampa Bay public fleets shared various strategies that they have employed to ensure hurricane preparedness, including maintaining an emergency fuel supply (that can support operations from several days to several weeks), prioritizing fuel use, strategically placing assets around the region to help with recovery, investing in backup generators, and planning for redundancies in fuel supply networks.

Fleets responsible for performing critical transportation functions are recommended to maintain fuel storage that will be enough to sustain operations for 7-14 days without any fuel deliveries. Fleets are also encouraged to explore fuel diversification strategies including transitioning a portion of their fleet to alternative fuels, such as CNG, propane, ethanol, and electric vehicles. Additionally, all fleets can benefit from investing in emergency generators, including those that can operate on alternative fuels (propane or CNG).

It is highly recommended that more efficient communication procedures are developed between public fleets and a system is implemented that allows sharing resources in the case of an emergency. All essential fleets should also implement a system to accurately track fuel usage during hurricanes in order to assist with planning.

Finally, local jurisdictions in Tampa Bay are encouraged to consider upgrading street drainage systems to reduce the threat of local flooding during major storms and hurricanes.
References


