Fuel Diversification to Improve Transportation Resilience in Tampa Bay, FL

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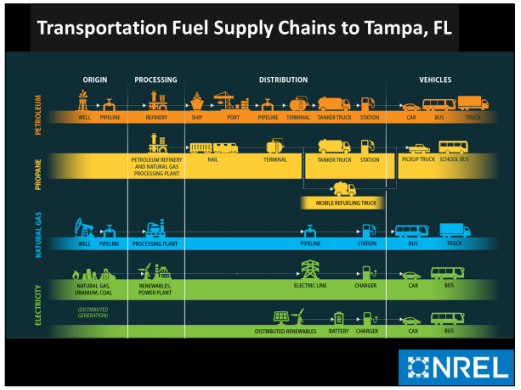
State of Transport Resilience

- Hurricanes are increasing in frequency, intensity, duration, and projected to continue increasing (NOAA 2019, Kossin 2018)
- Most transportation resilience progress has been made by state DOT's, and has been focused on roads and bridges
- FEMA funding directed overwhelmingly to recovery, not preparation222
- Department of Energy seminal report "United States Fuel Resiliency: US Fuels Supply Infrastructure" Sept 2014
- A series of disasters proved the value of transportation fuel diversification
- The Initiative for Resiliency in Energy through Vehicles (IREV)
  - By DOE, Clean Cities, and the National Association of State Energy Officials (NASEO)
  - Case studies on EVs, biodiesel, natural gas, and propane vehicles
  - Toolkits developed for Virginia and Lancaster County
  - Tracking tool helps combine and visualize inventory

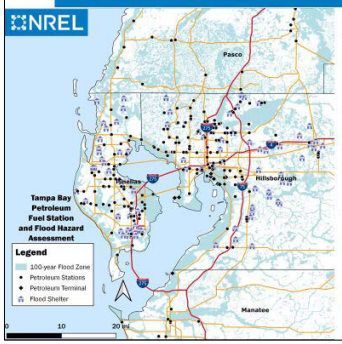
5-Pronged Approach to Resilience

1. **Redundancy**
   - Multiple fuels, sources, modes, and routes to reach Tampa
   - Multi-purpose vehicles
2. **Storage**
   - Have fuel stored nearby when source gets cut off
3. **Access**
   - Make sure access to stored fuel is maintained during natural disaster
   - Location of storage
   - Communication is key
4. **Resupply**
   - Ensure that local storage facilities are resupplied as soon as possible after a disaster
   - Renewable energy to resupply EVs
5. **Efficiency** (get the most work done for given amount of fuel)
   - Maximize passengers/cargo/jobs per vehicle
   - Maximize miles per gallon (or BTU)

Transportation Fuel Supply Chains to Tampa, FL



Petroleum: Key Information



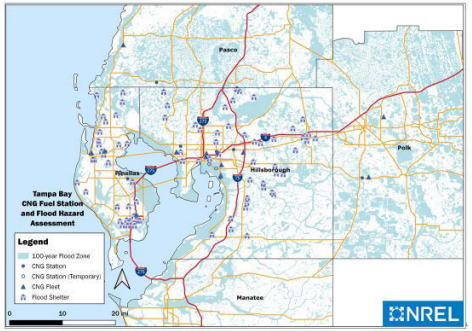
Stocks in storage at bulk terminals and distribution centers can provide 3-5 days of supply of gasoline and diesel

Florida has enacted legislation requiring gas stations within a half mile of evacuation routes be equipped with a backup electrical generator.

Natural Gas: Key Information

- Natural gas supply chain less likely to shut down than petroleum due to the large amount of redundancy in the system.
- Transmission Pipeline—the loss of one compressor station would reduce flow 25%. Losing 3 stations in series could halt operation.
- Transfer from transmission to distribution takes place at the city gate. Most cities have 6 or more gates.
- Distribution lines are kept pressurized to avoid infiltration.
- Some CNG stations have natural gas-powered generators in case of electrical outages.
  - Tracked in Alternative Fuels Data Center
- Natural gas powered compressors can be brought to the fleet.
- Superstorm Sandy
  - The Port Authority of NY and NJ used CNG vehicles to provide critical services when gasoline was in short supply
  - CNG "jitney" buses continued to operate in Atlantic City (PBS MotorWeek highlight)
- Hurricane Harvey
  - Freedom buses in Houston

Natural Gas

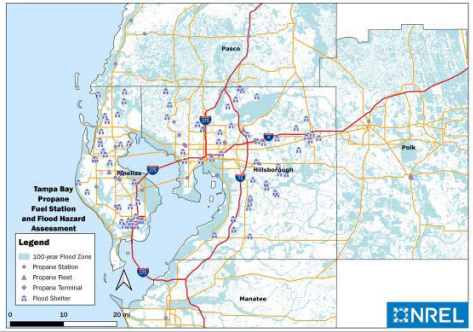


Propane: Key Information

- Propane arrives via rail to Tampa; from Pennsylvania, West Virginia, and Ohio.
- Propane can be stored indefinitely (it doesn't degrade) and accessed quickly
- Propane allows for mobile fueling (wet-hosing)
- Takes about the same amount of time to refuel as gasoline

HOCON portable propane dispenser "rescue unit." Source: Hocon Autogas

Propane



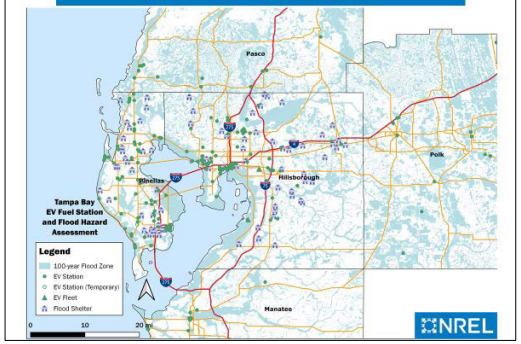
Electric Vehicles: Key Info

- EVs are the only vehicles that don't need oxygen
- Distributed generation can provide electricity to vehicles when the grid is down, if designed correctly
- EVs, PHEVs, and Fuel Cell vehicles can provide backup power to appliances, buildings and potentially to microgrids
- In CA wildfires, PG&E has Class 5 Utility trucks with exportable power modules to provide power to shelters
- During Japan's 2011 earthquake/tsunami, oil refineries were destroyed and EVs were a tremendous asset
  - Used to transport doctors, deliver supplies, and inspect buildings for safety
  - Inspired the "Leaf to Home" power stations
  - Honda also offers power exporter

Nissan Leaf "Vehicle to Home" module

Source: InsideEVs

Electric Vehicles



Notable Findings From Site Visits

1. Chokepoint at Port Tampa—Pilots need to board tankers on the open ocean and navigate 43-mile narrow channel
2. Hurricane Irma shut the Port down for 5 days, and traffic was backed up longer
3. Fuel Mules operate on regular municipal gas lines (60 psi) and contain their own natural gas-powered generators
4. Tampa's grid circuits are 950 customers each
5. Transmission control module is the lowest electronic component on a school bus, but can be moved higher
6. Most school buses have "Edulog" trackers

Notable Findings From Workshop

- "Push teams" are trucks that clear the roads after a hurricane
- Tampa is considering a BRT lane that needs to be used strategically
- SunSmart E-Shelters program is equipping schools/emergency shelters with solar panels
  - Sky is abnormally clear directly after hurricanes
- Hurricane Irma impacted 65 out of 67 counties and 6.8 million people evacuated
  - Gas Buddy was used to connect drivers to available fuel
- There are resilience plans being made at local, regional, and state levels that could benefit from a transportation fuel resilience plan

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