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Fuel Diversification to Improve Transportation Resilience: a Backgrounder

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Transportation Fuel Resilience in Tampa Bay Workshop
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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
- 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

Working Definitions

- ***Resilience*** is the ability to withstand small to moderate disturbances without loss of service, to maintain minimum service during severe disturbances, and to quickly return to normal service after a disturbance.
- ***Vulnerabilities*** come from natural disasters, physical human threats, chokepoints, and interdependencies between the various systems.

Source: DOE 2014

Why is NREL here?

- We provide technical support the Department of Energy Clean Cities coalitions, including Tampa Bay
- We've been working on multiple aspects of resilience for over 15 years

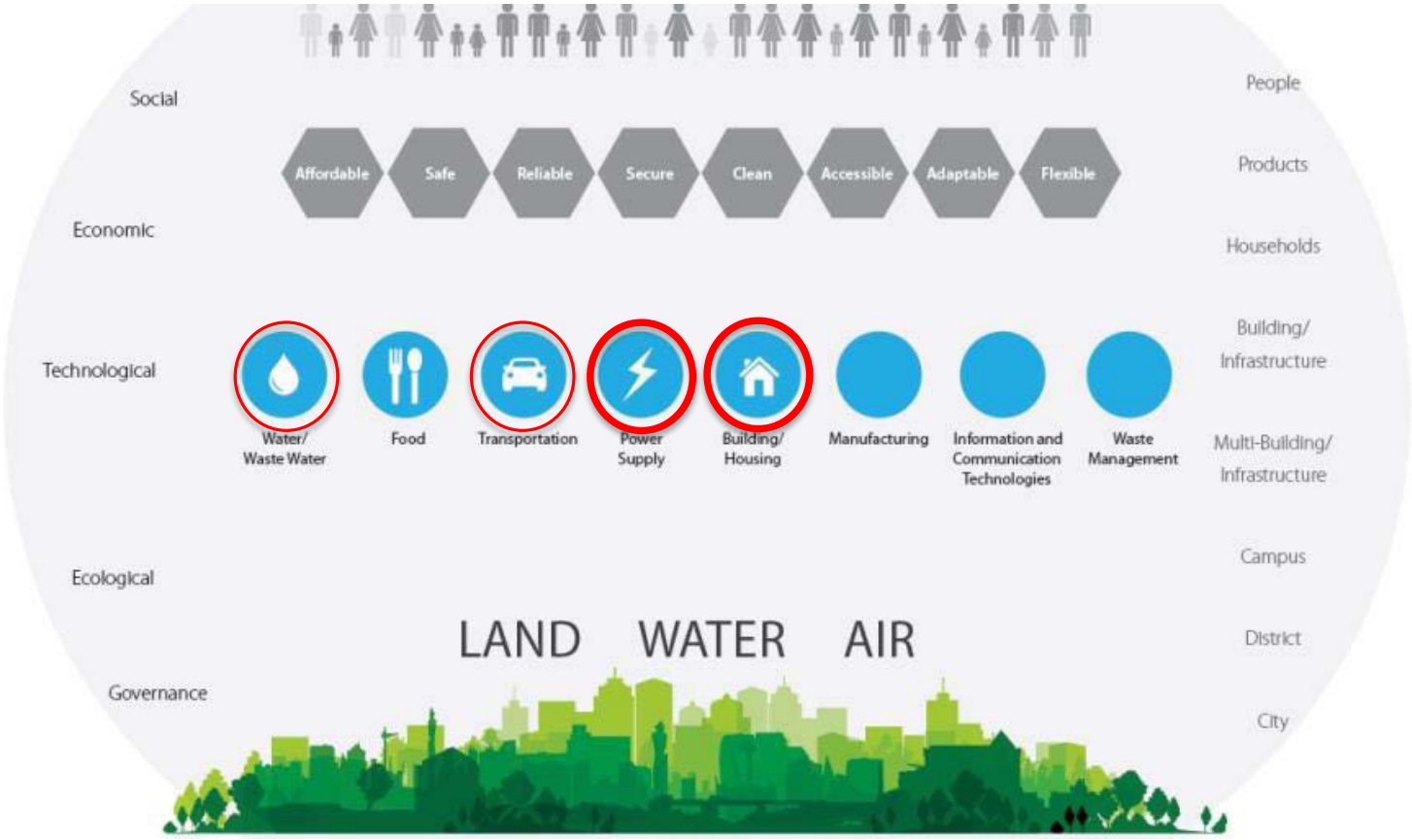
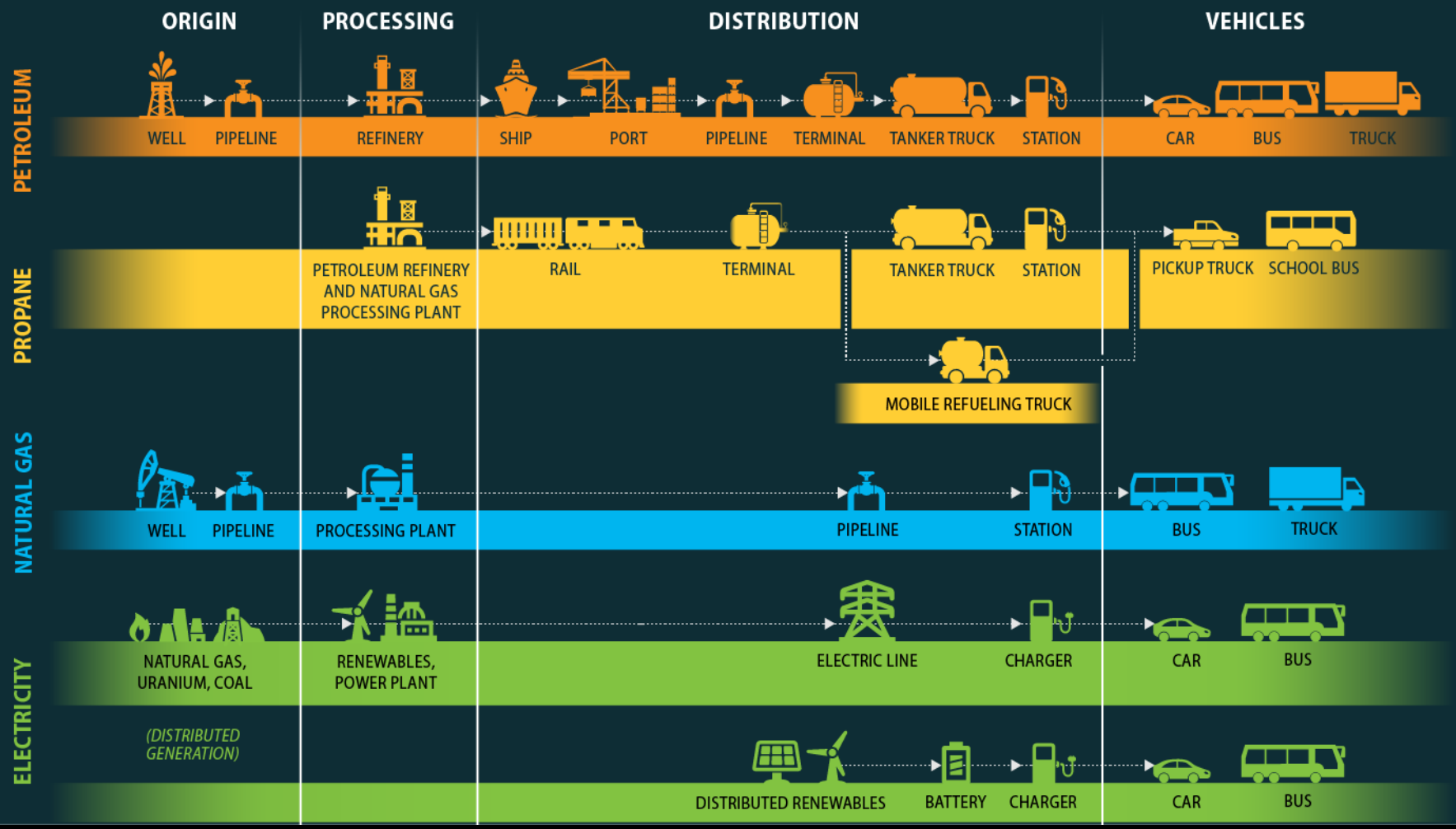


Figure Source: Gillies, Hotchkiss, NREL 2018

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 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)

Alternative Fuels to Improve Resilience



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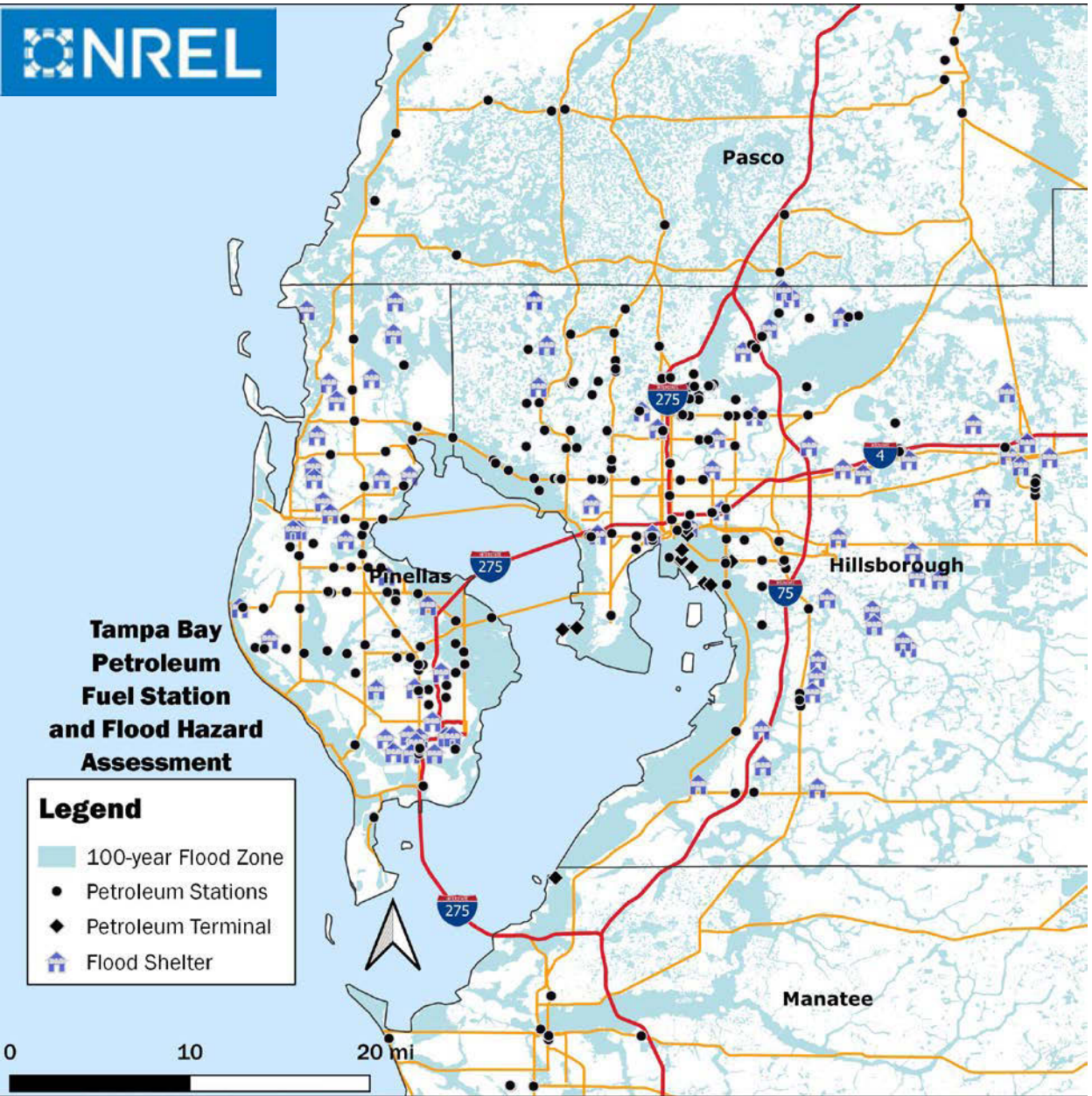
Fuel Interdependencies and Timing

- Electricity outages impact oil refineries, NG processing plants, pipelines, terminals, and refueling stations
- Evacuations pose a threat to all refueling systems because many personnel are not available to make repairs
  - Some energy companies are pursuing safe havens that get exemptions from evacuation plans
- Past hurricanes show electricity most likely to be disrupted, then petroleum pipelines, then natural gas pipelines
  - There is currently more redundancy with natural gas pipelines than with petroleum

Petroleum: Key Information



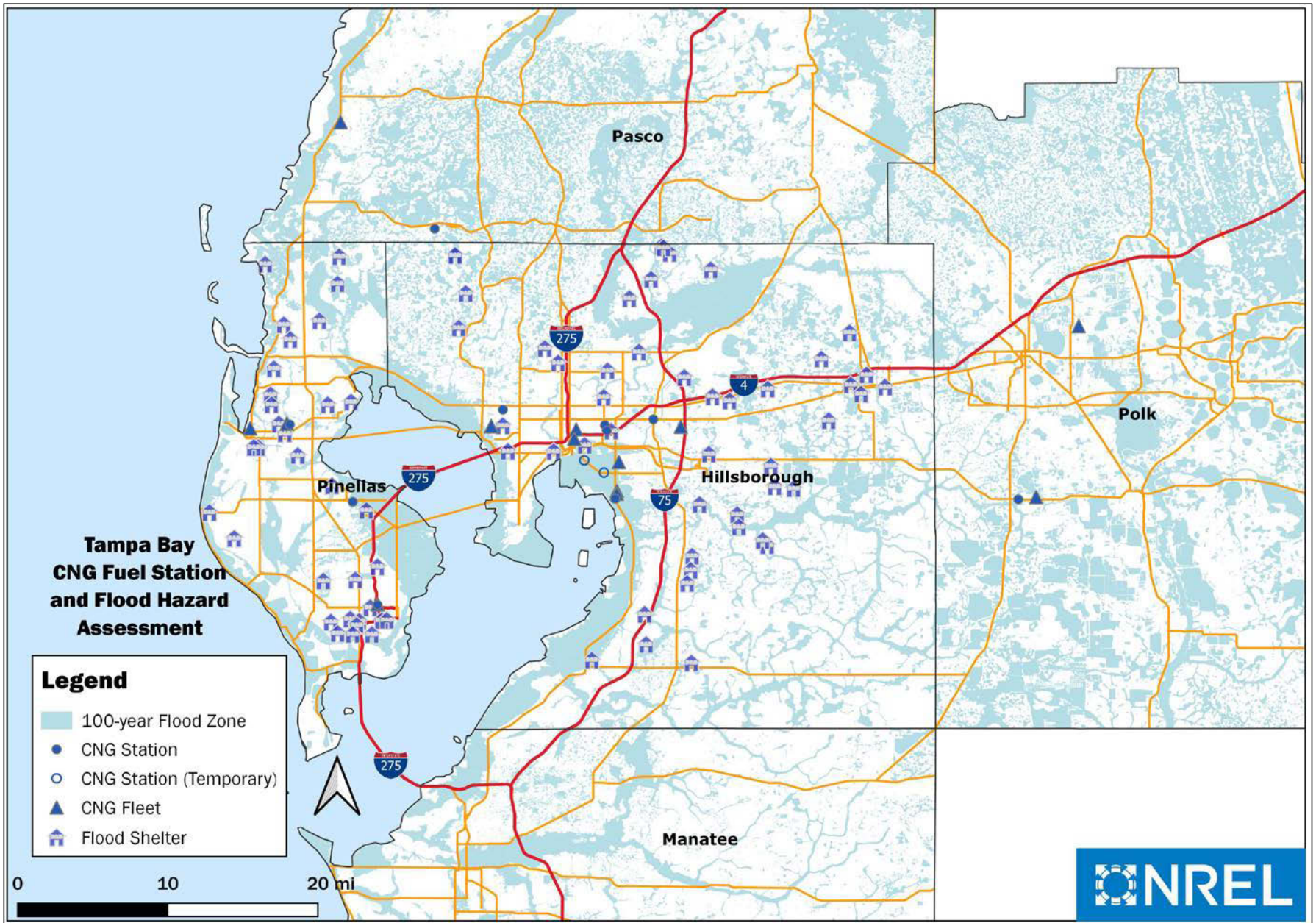
Stocks in storage at bulk terminals and distribution centers can provide 3-5 days of supply of gasoline and diesel

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 is relatively free of chokepoints 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. Clearwater has four.
- Distribution lines are kept pressurized to avoid infiltration.
- Some CNG stations have natural gas-powered generators in case of electrical outages.
  - Tracked in AFDC
- 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


Pasco
Pinellas
Hillsborough
Polk
Manatee
275
4
75
Tampa Bay
CNG Fuel Station
and Flood Hazard
Assessment
Legend
100-year Flood Zone
CNG Station
CNG Station (Temporary)
CNG Fleet
Flood Shelter
0
10
20 mi
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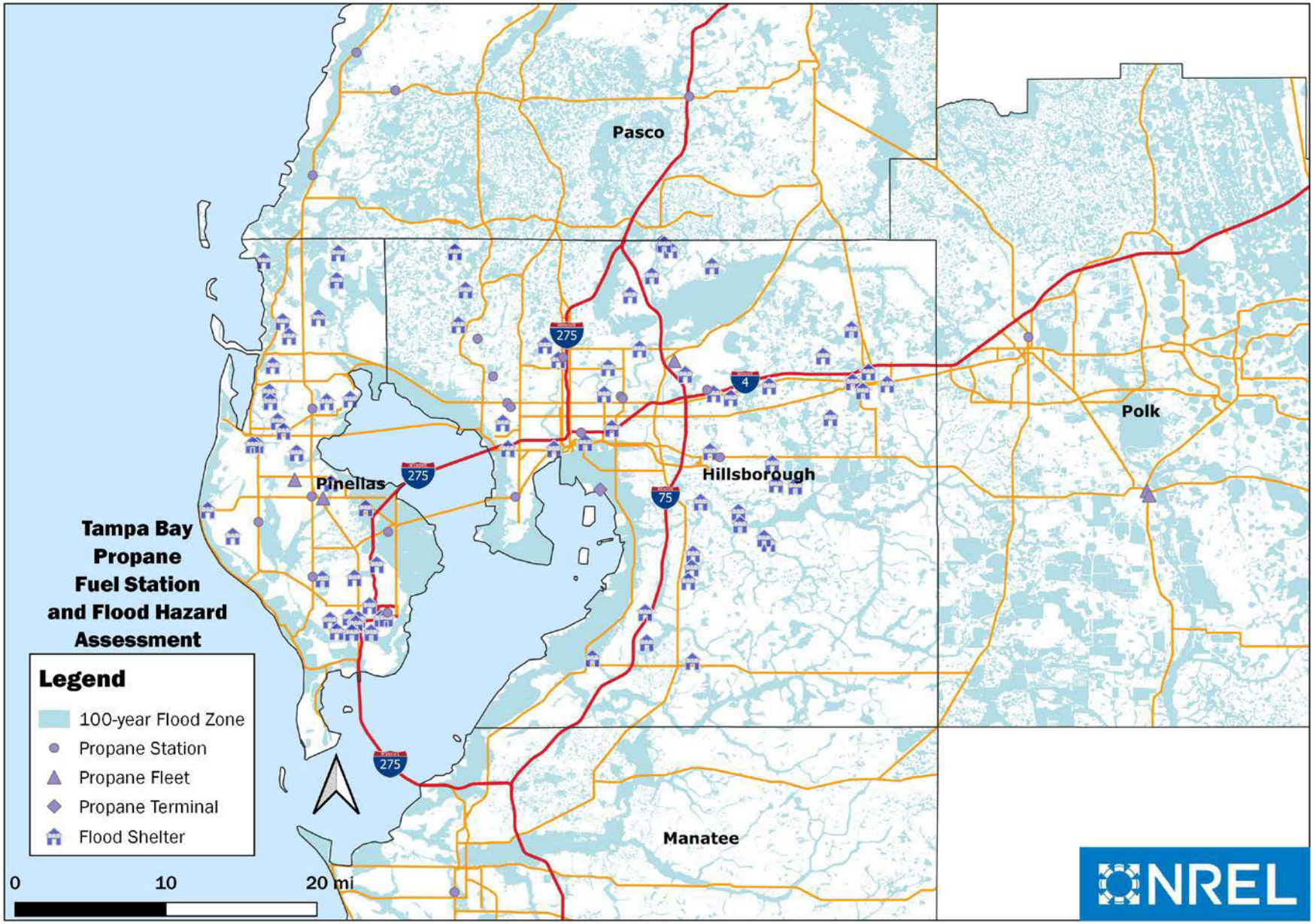
Propane: Key Information

- 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
- Only fuel that doesn't require an on-site electrical pump or compressor (though often needed for metering)

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

Propane


Pasco
Pinellas
Hillsborough
Polk
Manatee
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Tampa Bay Propane Fuel Station and Flood Hazard Assessment
Legend
100-year Flood Zone
Propane Station
Propane Fleet
Propane Terminal
Flood Shelter
0
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20 mi
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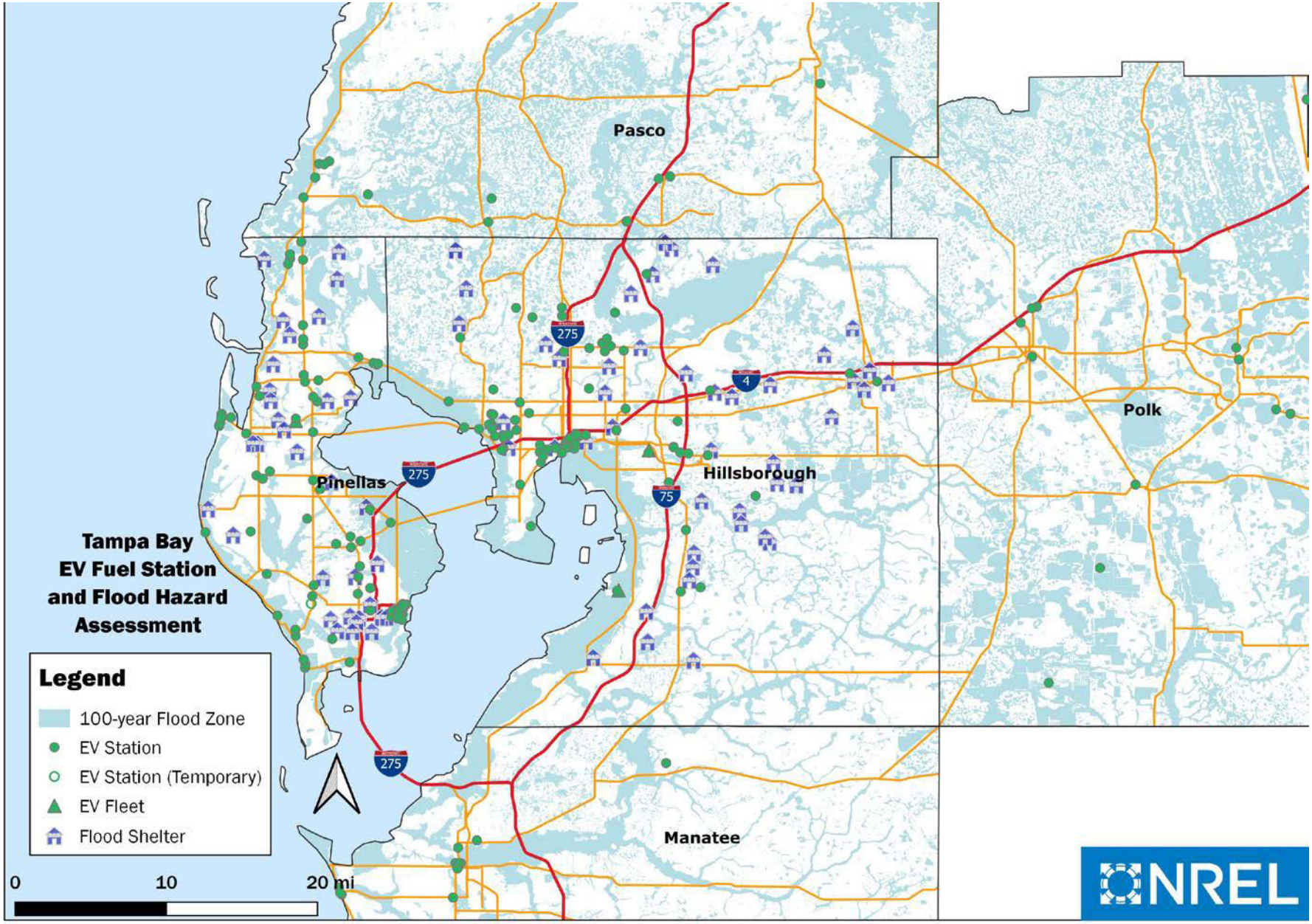
Electric Vehicles: Key Info

- EVs are the only vehicles that don't need oxygen to operate
  - Tesla Model S YouTube sensation
- 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



Purpose of Workshop

1. To brainstorm ways to make Tampa's transportation system more resilient by strategically using alternative fuels:
   - Assess and plan storage, access, resupply, and efficiency of these fuels
   - Match disaster transportation needs with capable vehicles using given fuels
2. To explore the interdependencies of Tampa's needs and how electric vehicles can provide critical electricity during and after hurricanes.
3. To integrate cohesively with Tampa Bay Region and Florida resilience plans.
4. To set an example for other cities to follow.

Questions?

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