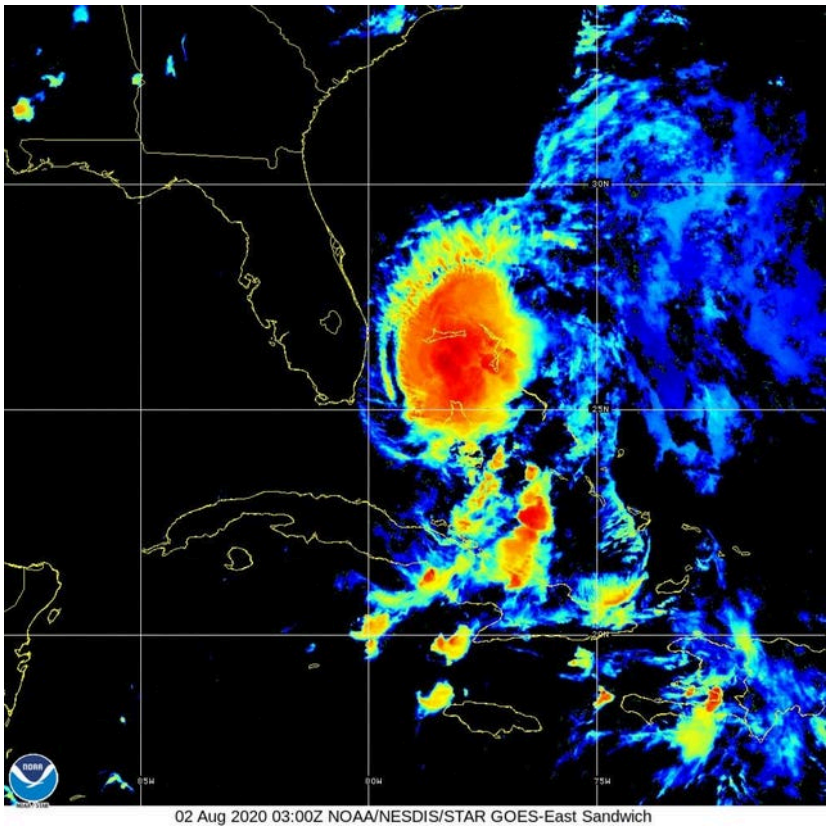
Power Delivery Performance

Hurricane Isaias

Storm Date: Aug 1, 2020

Report Date: Feb 11, 2021



02 Aug 2020 03:00Z NOAA/NESDIS/STAR GOES-East Sandwich

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Executive Summary

On August 1st, 2020, Hurricane Isaias outer rain bands started to impact the Florida coastline with winds, heavy rainfall and localized flooding. FPL prepared by staging several crews throughout the state to support the restoration efforts for this potential hurricane impact. Isaias paralleled the Florida coast never making landfall but bringing tropical storm force winds up the east coast before leaving FPLs service territory August 3rd.

Based on the movement of the storm and the investments to the FPL Grid since 2006, the winds effectively did not challenge the structural integrity of the system. During Hurricane Isaias, Transmission and Distribution Hardening and Smart Grid worked together to reduce the customer interuptions, severity, amount of damage, and improved situational awareness.

https://weather.com/storms/hurricane/news/2020-08-05-hurricane-isaias-recap-puerto-rico-bahamas-united-states-impacts

Executive Summary (Continued)

Results: According to the Carver data this was a three day event. Total customers affected was 39,920. 34% of customers were restored in one day and 100% of customers restored in three days. The average customer outage was 84 minutes and we did not have any customers out longer than 13 hours.

FPL Transmission System and Substations FPL transmission experienced 0 pole failures and one line sections relay. In addition, there was no substations out or major substation equipment damages. Substation experienced three momentary events caused by animals.

FPL Distribution System performed well in Isaias and demonstrated that the investments in the Distribution Feeder Hardening Program, Pole Inspection Program (PIP) and Smart Grid are providing benefits. The system performed as designed and greatly helped to reduce severe damage, duration of restoration and provided the ability for the grid to self- heal. These investments were key to the speed of storm restoration.

There were no feeder poles down primarily due to the hardening efforts and the inspections of the non-hardened poles. Distribution damage was primarily due to vegetation falling into FPL lines, only two poles was reported as down.

Underground Feeders experienced no outages. Overhead Hardened Feeders performed significantly better than non-Hardened Feeders; however, non-Hardening feeders still benefitted from the Pole Inspection Program (PIP).

Underground Laterals performed 5.6X better than Overhead Laterals with vegetation (40% of Trouble Tickets) being the leading cause of Overhead Lateral outages. FPL's next step for grid hardening, Storm Secure Lateral Undergrounding program, which began in 2018, experienced no outages.

Smart Grid provided benefits with AFS (Automated Feeder Switches) Self-Healing operations avoiding 18K Customer Interuptions.

Hurricane Isaias Quick Stats

Meteorology

- Isaias did not make landfall in Florida, however it did bring tropical storm force winds up the east coast and feeder bands that impacted the remaining FPL area from Saturday August 1st, through through Monday August 3rd, 2020.

Vegetation

- 31% of CI was due to Vegetation
- 44% of all tickets restored required Vegetation work
- 4 feeder outages were due to vegetation

Distribution System Performance

- **Feeders Out** **25**
  - UG 0
  - Hardened 6
  - Non-Hardened 19
  - Hardened Feeders performed 2.9X better than non-Hardened Feeders
  - There were no UG Feeder Outages

- **Laterals Out** **245**
  - OH 200
  - UG 45
  - Underground Laterals performed 5.6X better than Overhead Laterals
  - There were no outages on Storm Secure UG Lateral Hardening program

- **Distribution Transformers**
  - Single phase UG Transformers performed 32X better than OH Transformers

- **Poles Down**
  - Hardened Feeder 0
  - Non-Hardened Feeder 0
  - Lateral,Service,Telephone 2

- **Smart Grid**
  - Automatic Feeders Switch (AFS) teams avoided 18K Customer Interruptions

Transmission and Substation System Performance

- Transmission Out 1 line sections
- Transmission Poles Down 0
- Substations Out 0

Other

- Injuries OSHA 0
- Forensics Teams Deployed 2 personnel (transmission, substation, distribution)

Customer Outages

- Average customer outage was 84 minutes
- Total outages
    - 39,920 customers were affected at least once

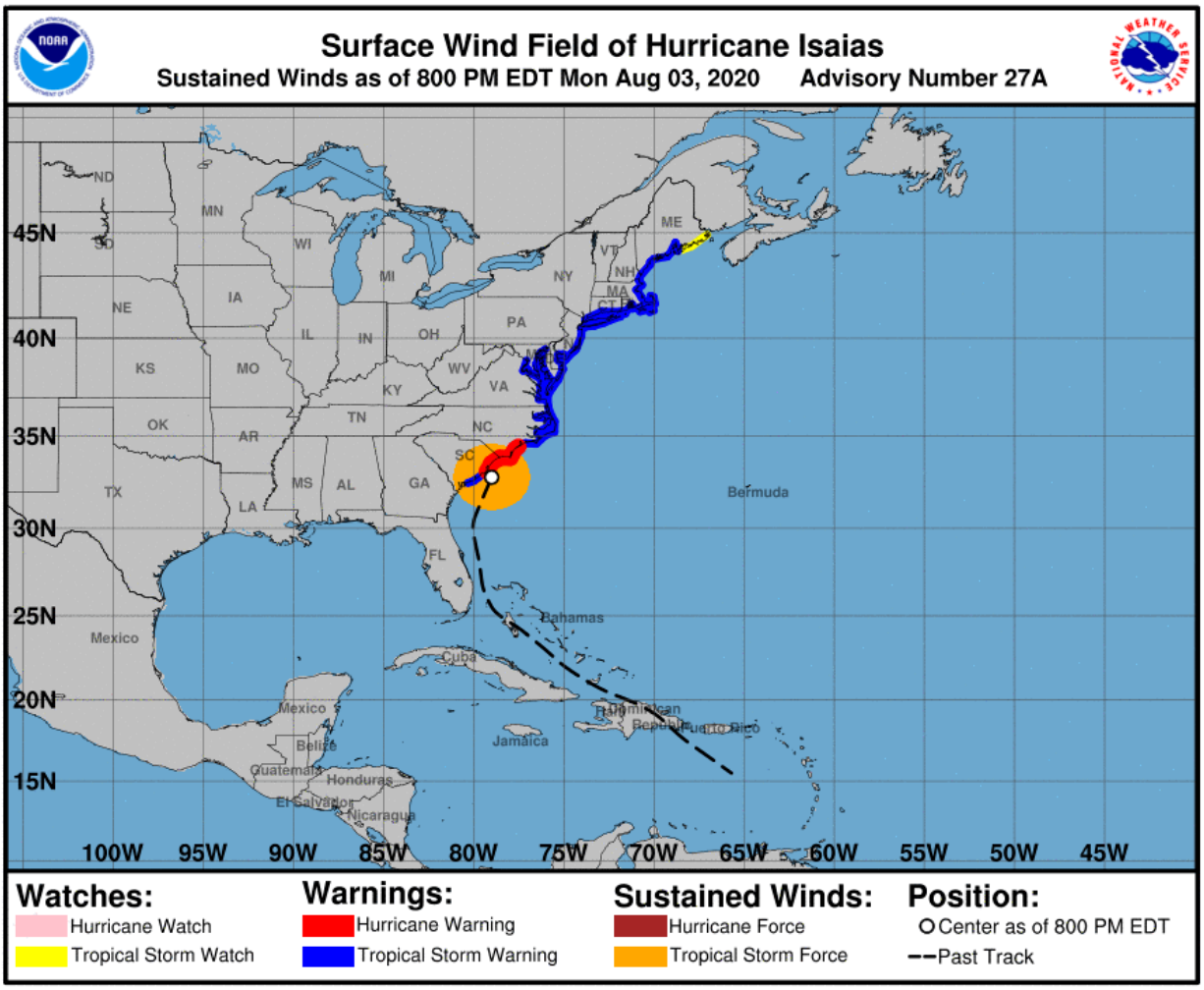
Carver Tracking

- Start All Areas 08/01/20 @ 10AM
- Stop All Areas 08/03/20 @ 12AM

Storm Characteristics and Weather

Hurricane Isaias originated from a vigorous tropical wave off the coast of Africa that was first identified by the National Hurricane Center on July 23, 2020. The tropical wave gradually became more organized, and became Tropical Storm Isaias on July 30. Isaias marked the earliest ninth named storm on record, surpassing 2005's Hurricane Irene by eight days. Isaias strengthened into a Category 1 hurricane the next day, reaching a peak intensity of 85 mph. On August 1st, the storm made landfall on North Andros, Bahamas and subsequently weakened to a tropical storm before paralleling the east coast of Florida and Georgia. As it approached the Carolina coastline, it re-intensified to a hurricane shortly before making landfall near Ocean Isle Beach, North Carolina, at 11:10 PM EDT on August 3rd as a high-end Category 1 hurricane, and proceeded to accelerate up the East Coast of the United States. Across eastern North Carolina, Isaias produced heavy rainfall, minor storm surge and tornadoes. www.weather.gov

Actual Storm Path

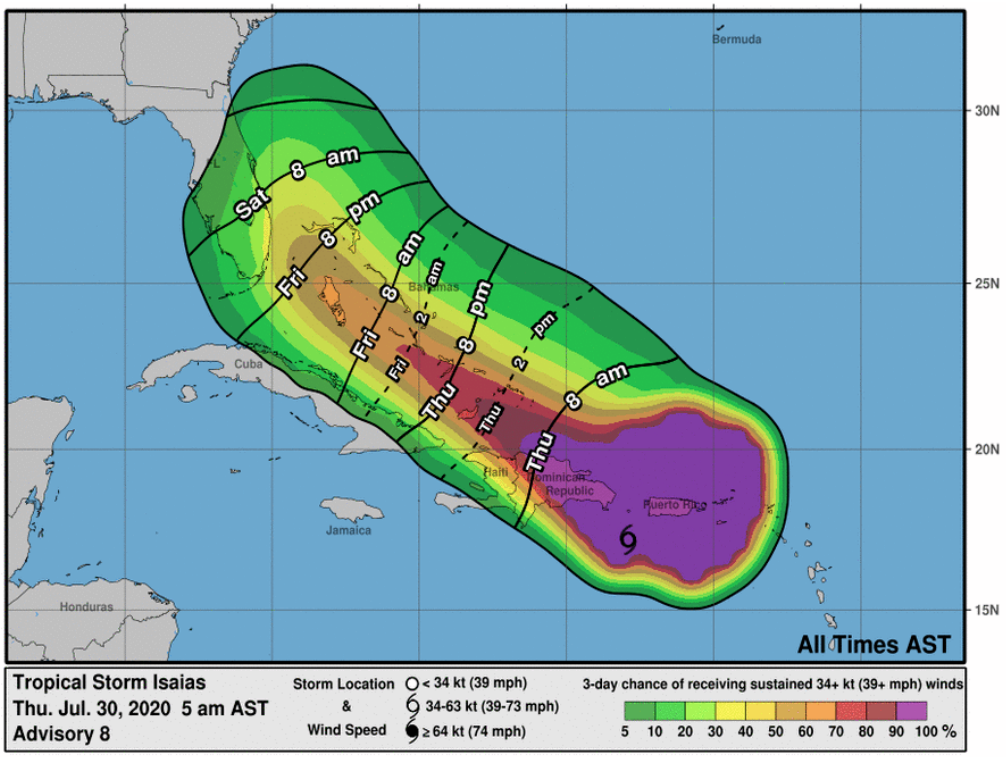


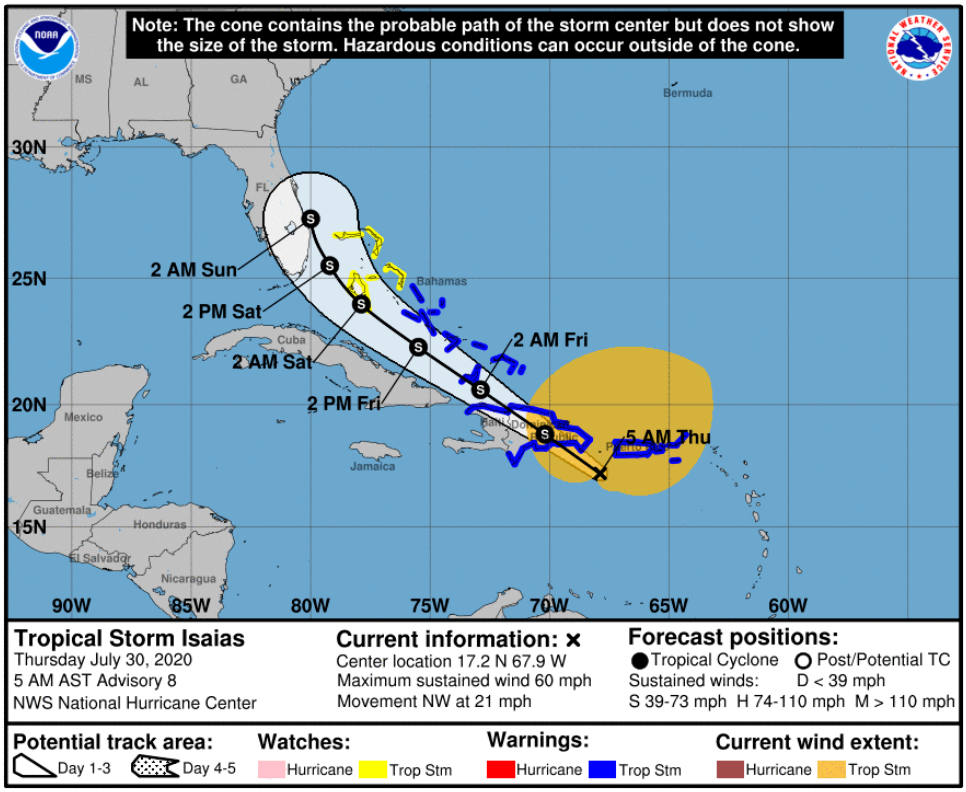
Best track positions for Hurricane Isaias, July, 29 2020 – Aug, 03 2020 (Source NHC)

Pre-Landfall Storm Path

72 Hour Pre-Landfall

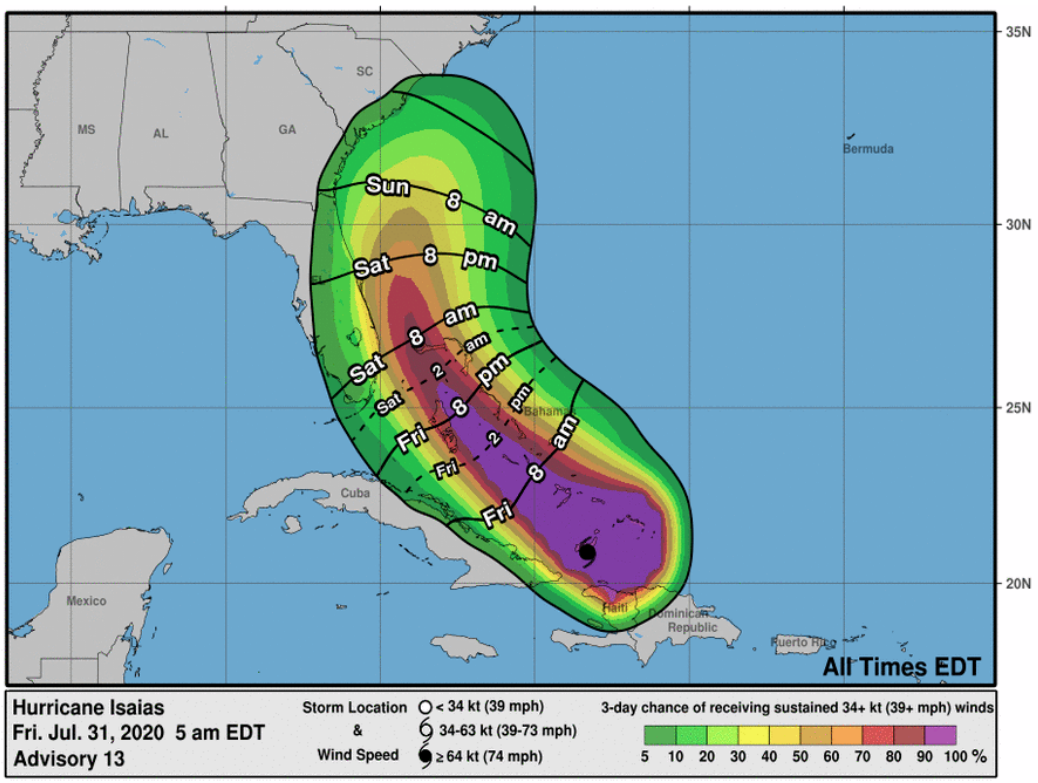
- NHC Track 7/30/2020 5:00AM Advisory

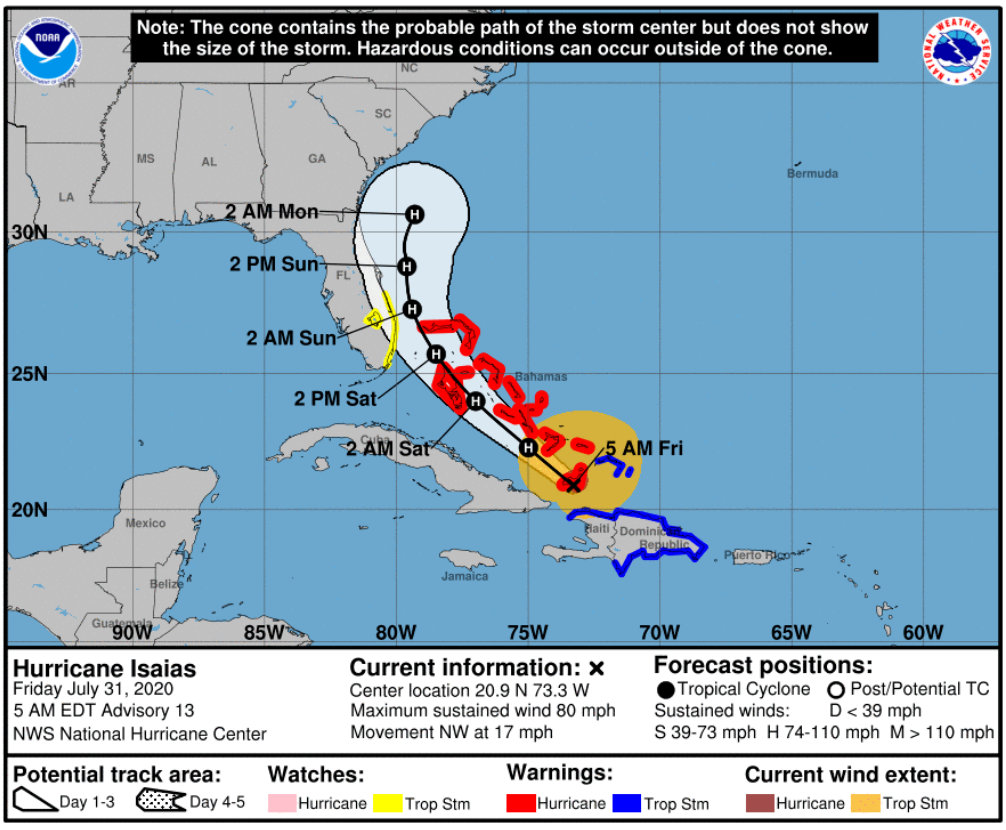




48 Hour Pre-Landfall

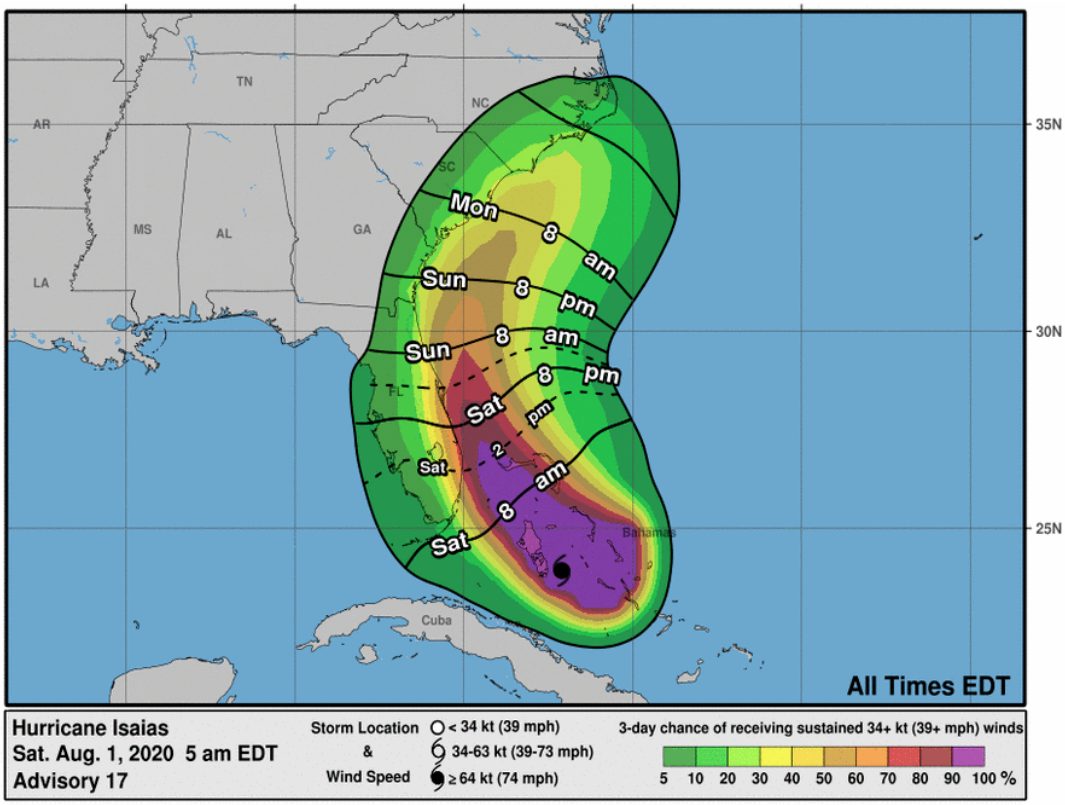
- NHC 7/31/2020 5:00AM Advisory

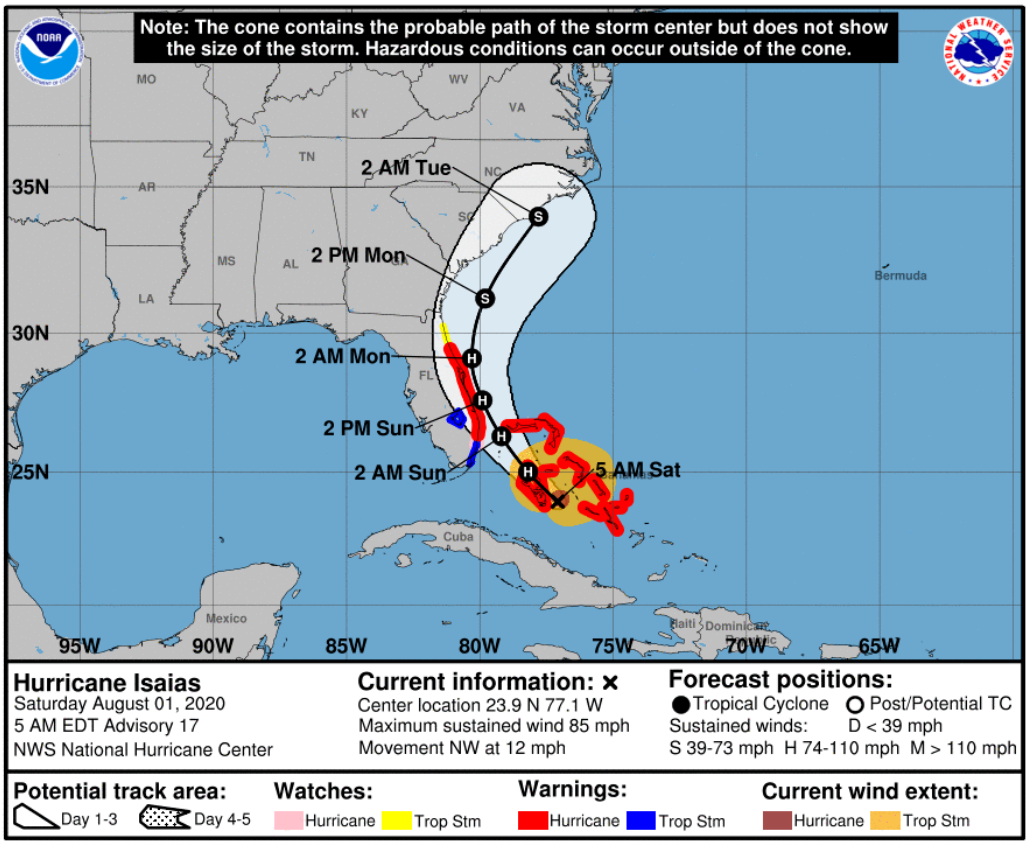




24 Hour Pre-Landfall

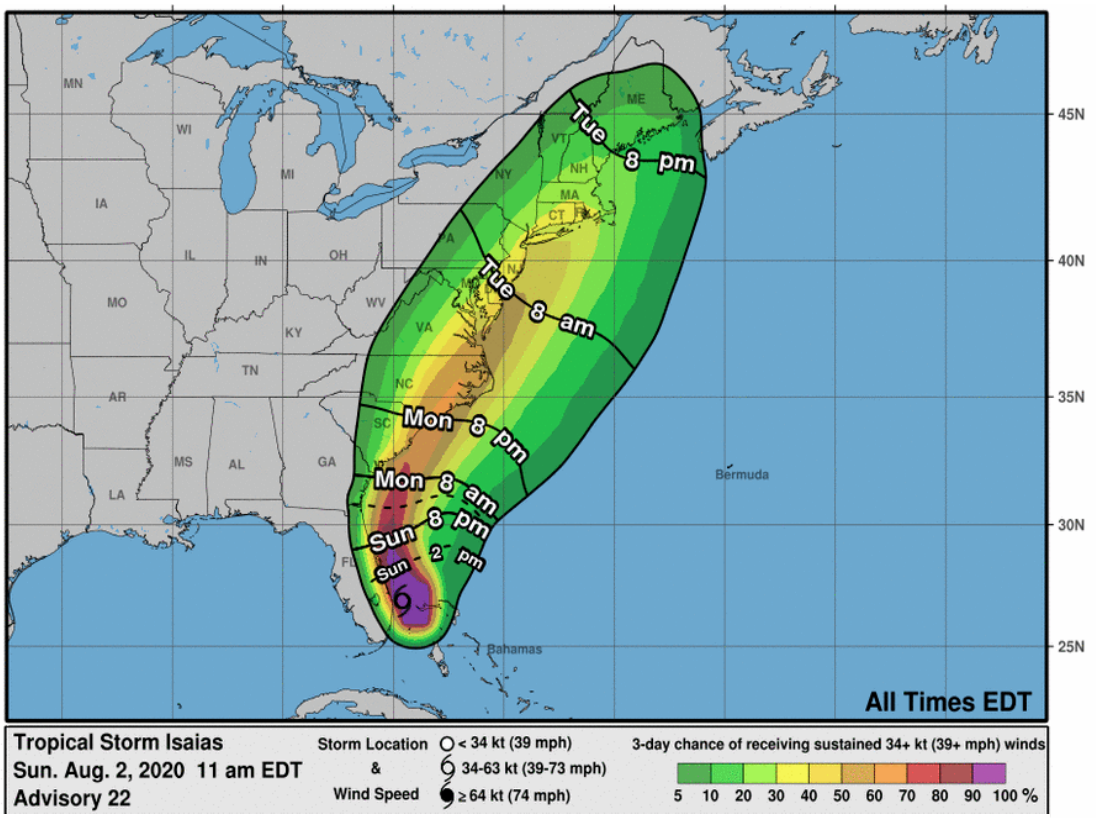
- NHC 8/1/2020 5:00AM Advisory

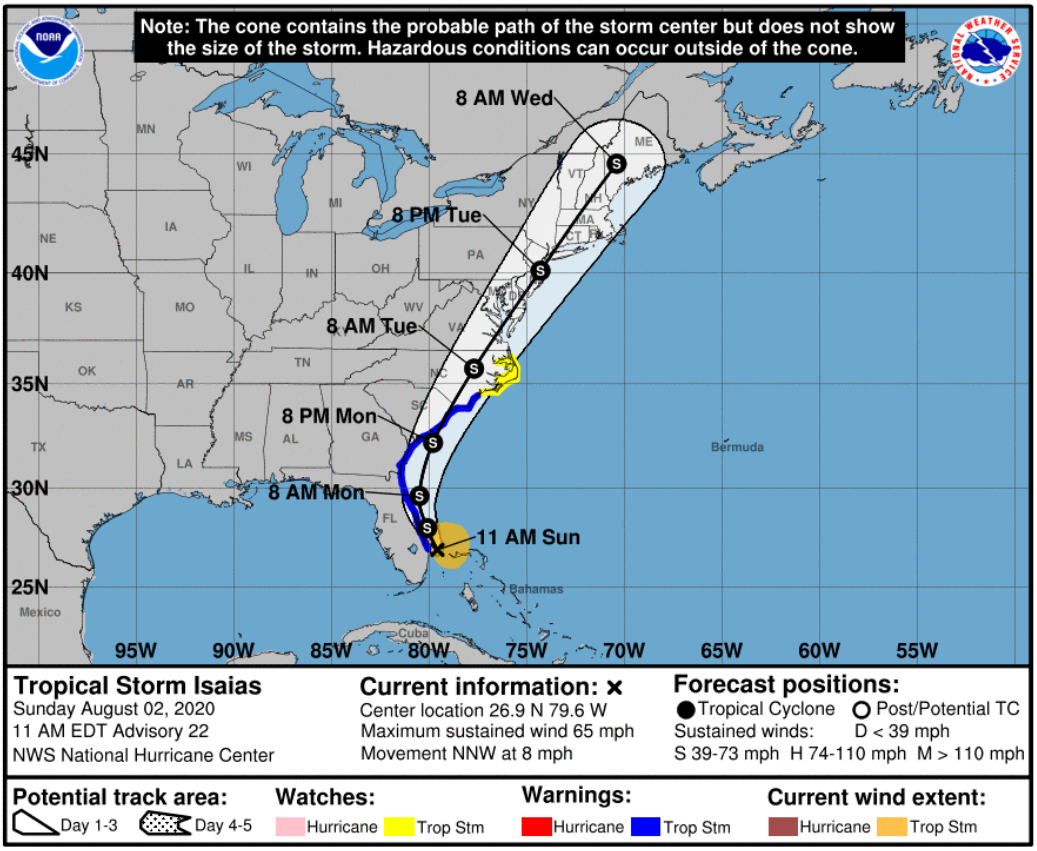




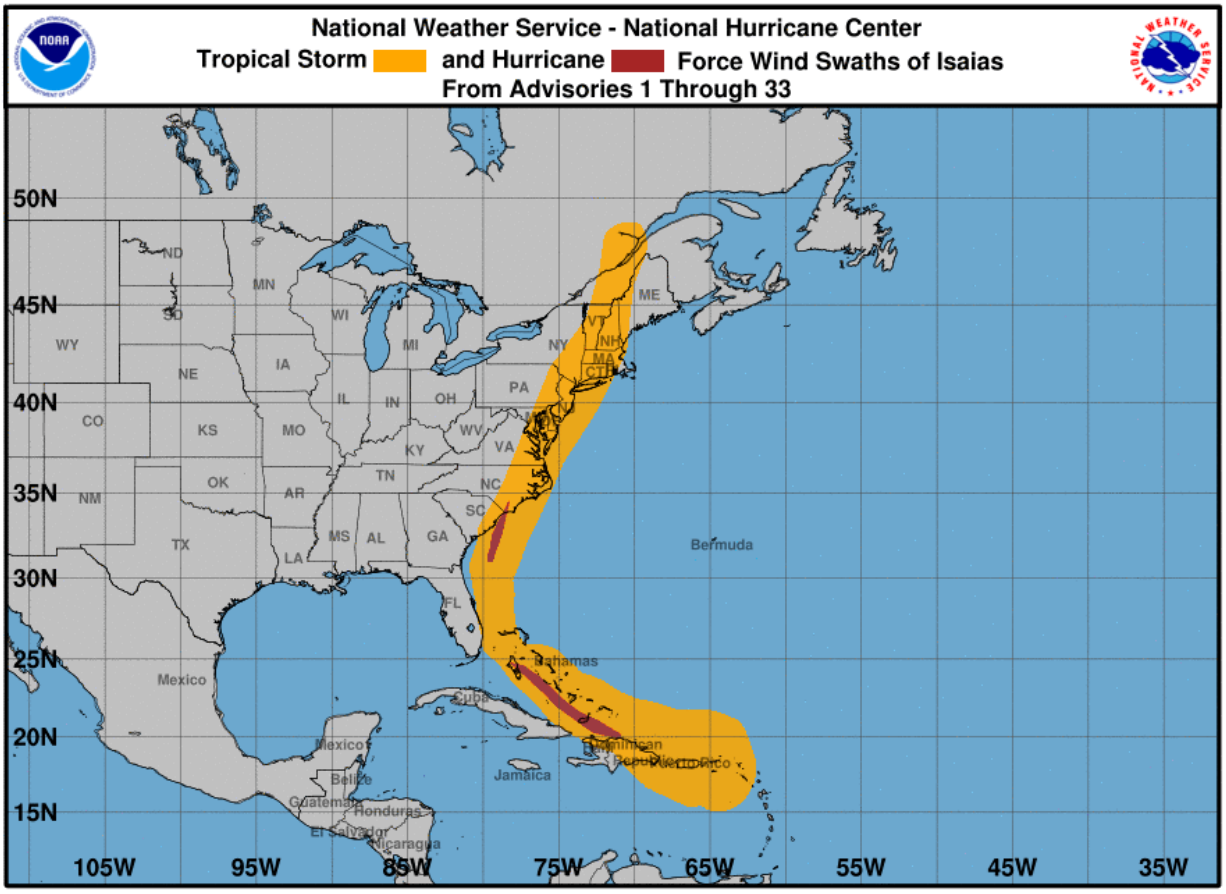
Final Hour (Closest track to Florida Peninsula)

- NHC 8/2/2020 11:00AM Advisory





Actual Wind History (Source: NHC)



Transmission Line Performance

Overall Transmission Performance was good during the storm event. Only one line relay occurred.

Damage / Component Failures

- 0 poles down
- 0 spans with phases down
- 0 spans replaced

Line Events

- (8/1) 13:57 Miami-Riverside Line Relay Root cause: distribution underbuilt flashed up at 188A19. Plastic bag caused distribution pothead to flash.

Substation Performance

Overall Substation Performance was good during the storm event.

- 0 Distribution Substations of 622 total Substations were out
- 0 Major Equipment Damage
- No flooded substations
- No substation communications were completely lost.
- System protection operated as expected
- No stations experienced battery loss due to extended outage.
- No mobile equipment was deployed.

Substation events

- (Palm Aire Substation) (8/1) squirrel on bus tie 2W114 disconnect 2L108; 7,476 Customers experienced a momentary outage. Bus tie breaker 2W94 closed to restore T_2135; Field personnel confirmed no damage and T_2521 was restored.
- (Grandview Substation) (8/2) T_2985 locked out and bus-tie 2W83 closed at 12:57:15. 3,106 Customers experienced a momentary outage. Root cause: Squirrel made contact with station service disconnect switch 2L57. TX returned to service
- (Lake Ida Substation)T_1421 locked out and bus-tie 2W52 closed at 15:51:07. 6,799 Customers experienced a momentary outage. Field personnel found flash marks caused by iguana on low side transformer bushing.

Distribution Performance

Distribution System performed well in Hrricane Isaisa and demonstrated the investments in the Distribution Hardening Program, Pole Inspection Program (PIP) and Smart Grid have helped to reduce the number and severity of outages. This was key to improving speed of restoration.

Pole Down Summary

- Hardened Feeder 0
- Non-Hardened Feeder 0
- Lateral, Service, Telephone 2

Feeder Summary

	Affected	% Affected
Feeders Out	**25**	**0.88%**
o UG	0	
o Hardened	6	0.42%
o Non-Hardened	19	1.24%

Excludes outages caused by Transmission and Substation

- No Hardened Feeder Poles down
- Hardened Feeders performed 2.9X better than non-Hardened Feeders
- The primary objective of hardening is to reduce restoration times by minimizing the number of pole failures during extreme wind weather events.

Lateral Summary

	Affected	% Affected
Laterals Out	**245**	**0.13%**
o OH	200	0.23%
o UG	45	0.04%

- Underground Laterals perforded 5.75x better than Overhead Laterals.
- Vegetation is the leading cause of Overhead Lateral outages
- No Hardened Laterals experienced an outage
- Excludes outages caused by Feeder, Substation or Transmission outages

Smart Grid Summary

- Self-Healing AFS (Automated Feeder Switch) operations avoided 18K Customer Interruptions (CI) during the storm.

Pole Performance

Distribution Poles performed well in Isaias. Hardened poles performed better than non-Hardened poles. The investments in the distribution hardening program, pole inspection program (PIP) and smart grid have helped reduce the number and severity of outages during storm events. The severity of damage was minimized and the speed of restoration was faster due to the efforts of the hardening programs that FPL has employed.

- 0 Hardened Feeder poles down
- 2 Total poles replaced to restore power

Pole Damage Details

- No Hardened Feeder Pole down*
- Information based on the carver data

Distribution Pole Failure %			
Pole Type	**Failures**	**Total # of Poles**	**Failure Rate**
Hardened Feeders	0	187,149	0.0000%
Non-Hardened Feeder	0	210,644	0.0000%
OH LAT	2	736,937	0.0003%
Overall	2	1,134,730	0.0002%

Feeder Performance

- Underground Feeders performed better than Overhead Feeders.

Feeder Performance by Feeder Type

- Excludes Transmission and Substation Outages
- OH Hardened Feeder includes OH-to-UG conversions as a part of Hardening
- Data based on Adjusted Carver Report, 8/3/20 12:00 AM

Hardened vs non-Hardened Feeder Performance

- Hardened Feeders make up 41% of the Feeder population.
- No feeder poles were broken or down during this event.
- Hardened Feeders performed 2.9X better than non-Hardened Feeders
- Data based on Adjusted Carver Report, , 8/3/20 12:00 AM

$$\text{Hardened Feeder Performance Ratio} = \frac{\text{Number of Non-Hardened Feeders Out*}}{\text{Total Number of Non- Hardened Feeders}} \text{ to } \frac{\text{Number of Hardened Feeders Out*}}{\text{Total Number of Hardened Feeders}}$$

* Affected = Feeders out at least one time

$$\frac{19 / 1{,}531}{6 / 1{,}431} = \frac{1.24\%}{0.42\%} = 2.9\text{X Better}$$

Feeder Outage Causes

- Data based on TCMS tickets
- Vegetation accounted for 13% of the feeder tickets

Cause Code	Percentage
Equip Failed OH	34.8%
Tree/Limb	13%
Customer Request	13%
Other (explain)	13%
Hurricane	8.7%
Storm w/no equip damage	6%
Vehicle	6%
Unknown	4.3%
Total	100%

Lateral Performance

- Underground Laterals performed better than Overhead Laterals.
- Based on the assessment of outage performance UG Laterals performed 5.65 times better than OH Laterals.
- Lateral outages do not include outages caused by Feeder, Substation or Transmission
- Storm Control Laterals (SCL) were not created for this event
- Data based on Adjusted Carver Report, 8/3/20 12:00 AM

Laterals Out	Affected	Population	% Affected
OH	200	87,336	0.23%
UG	45	111,095	0.04%
Total	245	198,431	0.13%

$$\frac{\underline{200 / 87{,}336}}{45 / 111{,}095} = \frac{\underline{0.23\%}}{0.04\%} = 5.65$$

Underground Laterals performed 5.75X better than Overhead Laterals

$$\text{UG Lateral Performance Ratio} = \frac{\text{Number of OH Laterals Out*}}{\text{Total Number of OH Laterals}} \text{ to } \frac{\text{Number UG Laterals Out*}}{\text{Total Number of UG Laterals}}$$

* Affected = Laterals out at least one time

Lateral Outage Causes

- Data based on TCMS tickets
- Vegetation accounted for 40% of OH lateral tickets and 33% of UG lateral tickets

Cause Code	UG Percentage	OH Percentage
Vegetation	33%	40%
Hurricane/Storm	7%	21%
Other	16%	14%
Equip Failed OH	4%	11%
Unknown	3%	4%
Animal	11%	2%
Balance of Outages	4%	8
Equip Failed UG	22%	0
Total	**100%**	**100%**

SSUP UG Laterals performed 100% better than Non-SSUP UG Laterals

SSUP vs Non-SSUP Interruptions			
UG LAT Type	**UG LAT N**	**# of Locns**	**% of N**
Non-SSUP	45	110,800	0.04%
SSUP	0	295	0.00%
Total UG LAT	**45**	**111,095**	**0.04%**

* # of locations refers to fuse switches

Distribution Transformer and Padmounted Switch Performance

Transformer Interruptions

- UG performed 32X better than OH transformers
- Source Carver file

OH vs UG 1ph TX Interruptions			
TX Type	**TX N**	**1ph TXs**	**% of N**
1ph OH TX	677	428,037	0.158%
1ph UG TX	13	264,239	0.005%

Refuse Only for OH Transformers was 354% higher than UG Transformers

OH vs UG TX Refuse Rates			
Ticket Type	**Refuse Only**	**Total TX tickets**	**Refuse Rate**
OH TX	192	719	27%
UG TX	1	17	6%
LAT TOTAL	**193**	**736**	**26%**

Pad Mounted Switches

- There was no pad-mount switch failures related to the storm
- This information is based on teams reviewing trouble tickets, materials that were issued, and reports from the areas
- No failed switches were sent to the Reliability Assurance Center for RCA (Root Cause Analysis)

AFS (Automated Feeder Switch)

Automatic Feeder Switches (AFS) isolate, transfer load, interrupt faults and have pulse close capabilities. They automatically reroute electricity to reduce the amount of customers affected when an adverse condition affects the power lines.

AFS Performance:

- 18K Customer Interruptions (CI) avoided during the storm

AFS Availability

- AFS units were 97% available.
    - Winds speeds did not exceed 75 MPH so the AFS teams were not disabled

ALS (Automated Lateral Switch)

Automatic Lateral Switches (ALS) clear temporary faults, provides enhanced protection and coordination. During storm events with extreme winds for extended period of time, ALS performance is similar to a fuse.

ALS OH Laterals performed 52% better than Non-ALS OH Laterals

ALS vs Non-ALS Interruptions			
OH LAT Type	**OH LAT N**	**# of Locns**	**% of N**
Non-ALS	102	28,320	0.36%
ALS	103	59,016	0.17%
Total OH LAT	**205**	**87,336**	**0.23%**

ATS OH Transformers locations performed 288% worse than Non-ATS OH Transformers

ATS vs Non-ATS Interruptions			
OH TX Type	**OH TX N**	**# of Locns**	**% of N**
Non-ATS	630	541,095	0.12%
ATS	89	19,706	0.45%
Total OH TX	**719**	**560,801**	**0.13%**

Refuse Only for ALS Laterals was 43% lower than Non-ALS Laterals

OH LAT Refuse Rates			
OH LAT Type	**Refuse Only**	**Total OH LAT tickets**	**Refuse Rate**
Non-ALS	35	102	34%
ALS	20	103	19%
OH LAT TOTAL	**55**	**205**	**27%**

Refuse Only for ATS Transformers was 89% lower than Non-ATS Transformers

OH TX Refuse Rates			
OH TX Type	**Refuse Only**	**Total OH TX tickets**	**Refuse Rate**
Non-ATS	189	630	30%
ATS	3	89	3%
OH TX TOTAL	**192**	**719**	**27%**

General Definitions / Acronyms

Affected - include only one interruption per device (for feeder, lateral, transformer, etc) if the device goes out multiple times

ALS – Automated Lateral Switch

AFS – Automated Feeder Switch

Broken or Downed Pole – Cannot carry electricity

Customers Affected - Customers that experienced an outage

CI - Customers Impacted which are customers that may have gone out more than once or nested outages.

CI Avoided – Customer Interruptions Avoided

CMH – Construction Man Hours (Labor)

DA – Distribution Automation

D&A – Design and Applications which coordinate the forensic operations and forensic patrols

ESDA - Electric Storm Damage Assessment is a mobile app and primary tool that facilitated the collection and characterization of the major types of damage on the Distribution system.

Hybrid Feeder - Combination of Feeder and Lateral miles between 5% - 95% UG

Impacted – includes any interruption per device (for feeder, lateral, transformer, etc) if the device goes out multiple times

Interruptions - Total number of customer outages

Mean Higher High Water (MHHW) – An average of higher high water heights over time. Numbers are reported as the value above that regions value.

NHC – National Hurricane Center

NOS – National Ocean Service

OH Feeder - Combination of Feeder and Lateral miles < = 5% UG

RCA – Root Cause Analysis

TCMS – Trouble Call Management System

UG Feeder - Combination of Feeder and Lateral miles > = 95% UG