TAG Meeting
December 15, 2020

Webinar

TAG Meeting Agenda

1. Administrative Items – Rich Wodyka
2. 2020 Collaborative Transmission Plan Study Report – Orvane Piper, Lee Adams, and Bill Quaintance
3. 2021 Study Scope Discussion – Mark Byrd
4. Regional Studies Update – Bob Pierce
5. 2020 TAG Work Plan Update and 2021 TAG Work Plan Preview – Rich Wodyka
6. TAG Open Forum – Rich Wodyka

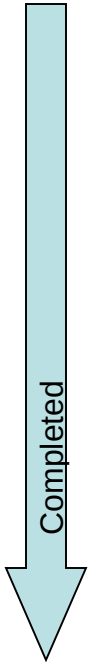
2020 Study Activities Update

Orvane Piper - Duke Energy Carolinas

Lee Adams - Duke Energy Progress

Bill Quaintance – Duke Energy Progress

Study Process Steps



1. Assumptions Selected
2. Study Criteria Established
3. Study Methodologies Selected
4. Models and Cases Developed
5. Technical Analysis Performed
6. Problems Identified and Solutions Developed
7. Collaborative Plan Projects Selected
8. Study Report Prepared

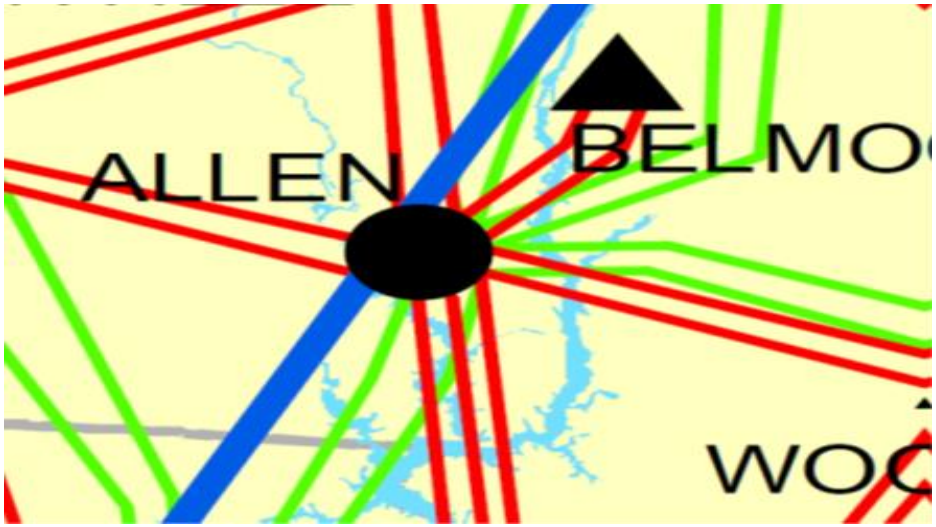
Annual Reliability Studies

- 2025 Summer
- 2025/2026 Winter
- 2030 Summer

New Projects in 2020 Plan

DEC South Point Switching Station, Construct – scheduled for December 2024

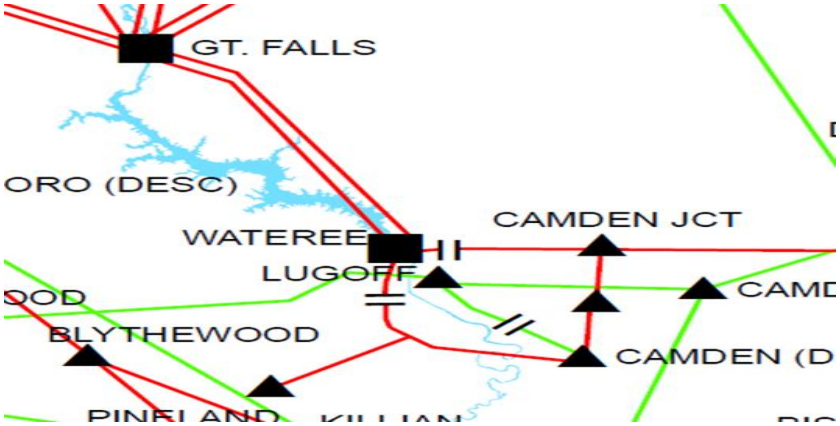
- **NERC Category P3 violation**
- **Problem:** Post-generation retirement at Allen Steam Station, loss of one 230/100 kV transformers at Allen may overload the remaining transformer.
- **Solution:** Upgrade to larger transformers.



New Projects in 2020 Plan

DEP Wateree 115 kV Plant, Upgrade 115/100 kV Transformers – scheduled for December 2022

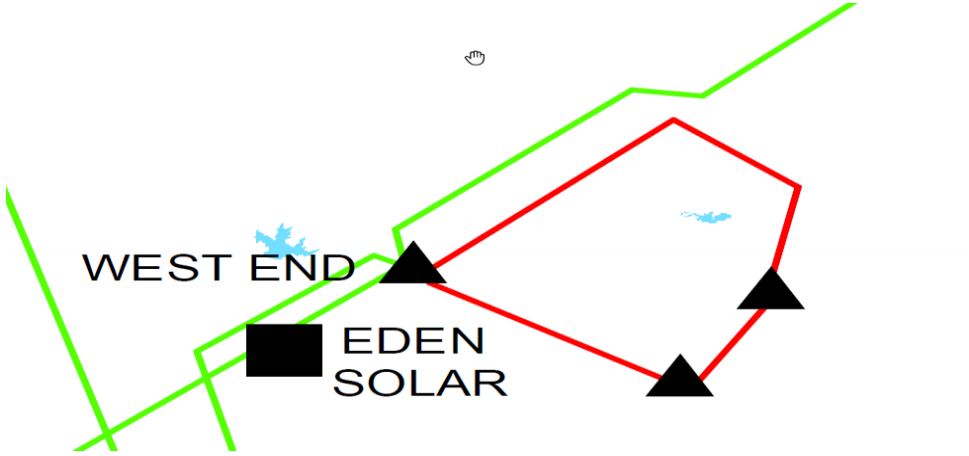
- **NERC Category P3 violation**
- **Problem:** By winter 2022-23, the NERC P3 outage of Robinson Nuclear plus outage of either the Richmond–Newport 500 kV line or the Camden–Lugoff 230 kV line causes an overload of the existing Wateree 115/100 kV transformers. In addition, the existing Wateree 115/100 kV transformers have reached end of life based on analysis from Asset Management.
- **Solution:** Upgrade existing transformers.



New Projects in 2020 Plan

DEP Carthage 230/115 kV Substation, Construct sub and loop-in Cape Fear-West End 230kV line and West End-Southern Pines 115 kV Feeder - scheduled for December 2027

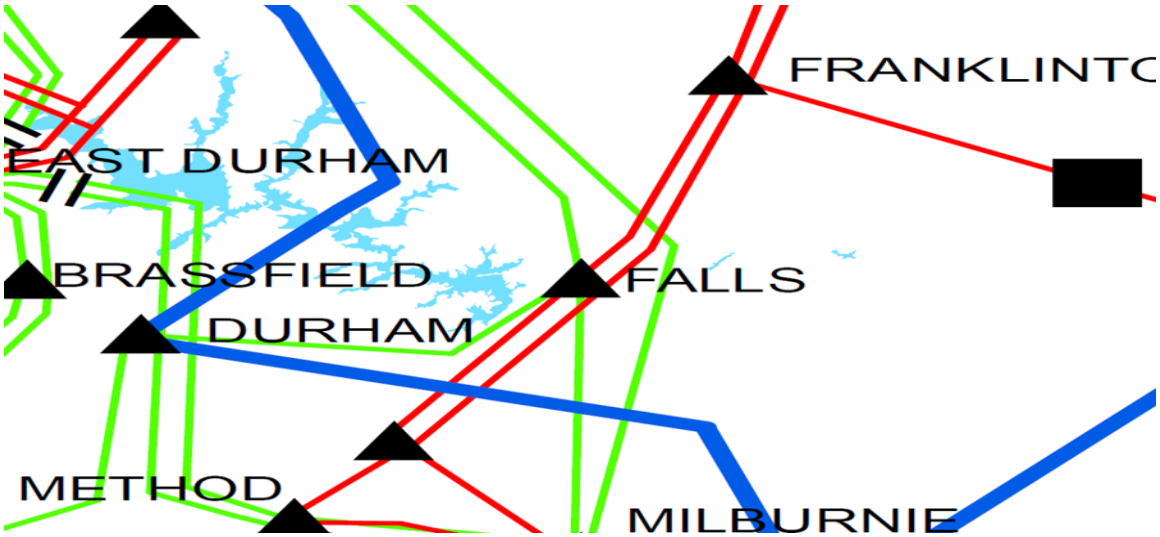
- **NERC Category P1 violation**
- **Problem:** By winter 2027-28, the NERC P1 outage of one West End transformer overloads the other and voltage at Southern Pines 115 kV drops below criteria.
- **Solution:** Construct new 230/115 kV substation in the Carthage area.



New Projects in 2020 Plan

DEP Falls 230 kV Sub, Add 300 MVAR Static Var Compensator – scheduled for December 2028

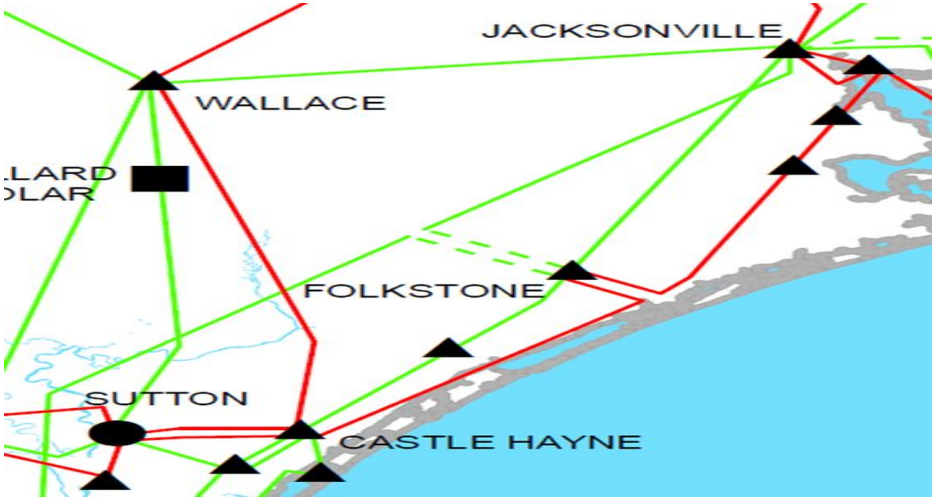
- **NERC Category P1 violation**
- **Problem:** With the future retirement of Roxboro and Mayo plants, several DEP areas were observed to have significant contingency voltage depression.
- **Solution:** Add 300 MVAR SVC at the Falls 230 kV Substation.



New Projects in 2020 Plan

DEP Castle Hayne-Folkstone115kV line, rebuild 556 MCM and 6-(2/0) Cu sections to 1272 ACSR – scheduled for December 2028

- **NERC Category P1 violation**
- **Problem:** By winter 2028/29, an outage of the Castle Hayne–Folkstone 230 kV line will cause the Castle Hayne 230 kV Sub-Folkstone 115 kV line to overload. This project will mitigate the overload problem.
- **Solution:** Rebuild approximately 25.91 miles of 115 kV line (Castle Hayne 230 kV Sub to structure #251) with 1272 MCM ACSR or equivalent.



New Projects in 2020 Plan

DEP Holly Ridge North 115kV SS, construct station, loop in CH-FS-115 and FS-JC-115, and build 0.5 mile 115kV feeder to JO EMC Folkstone POD – scheduled for December 2028

- **NERC Category P2-1 violation**
- **Problem:** By winter 2028-29, the NERC P2-1 opening of the Folkstone end of the Castle Hayne – Folkstone 115 kV line results in low voltages at stations on this line.
- **Solution:** Construct new 115 kV switching station northeast of Holly Ridge.

Comparison to Previous Collaborative Transmission Plan

	2019 Original Plan	2019 Plan Mid-year Update	2020 Plan
Number of projects with an estimated cost of $10 million or more each	14	14	17
Total estimated cost of Plan	$591 M	$632 M	$804 M

High Load Scenario Update

- **Assess the rapid load growth in 2025S / 2030S for the Union / Cabarrus County load area:**
  - **Clear Creek 100 kV Line**
    - **Loading issue on 9.1 mile section of line**
    - **DEC discussing alternative solutions with stakeholders impacted**
    - **Potential to be included in base Plan in the future depending on actual load growth**
  - **Rocky River 100 kV Line**
    - **Loading issue on 8.5 mile section of line**
    - **DEC evaluating a broader solution for local area issues which may resolve line loading issue**

Offshore Wind Study Update

- Preliminary Screening of 29 possible injection sites in eastern NC and 2 in VA
- Screening reviewed with sponsors
- Selection of 3 sites for more detailed study is currently under way
- Separate report expected by end of Q1-2021

Study Report Prepared

- **TAG is requested to provide any input to the OSC on the 2020 Collaborative Transmission Plan Study Report.**
- **Provide input by January 6, 2021 to Rich Wodyka (rawodyka@aol.com or rich.wodyka@gmail.com)**

Questions ?

2021 Study Scope Discussion

Mark Byrd - Duke Energy Progress

2020 Study

- **Base reliability case analysis – 2025 summer and 2025-2026 winter and 2030 summer**
  - **An "All Firm Transmission" Case(s) will be developed which will consider all confirmed long term firm transmission reservations with roll-over rights applicable to the study year(s)**
  - **DEC and DEP generation down cases will be created from the common Base Case**

2021 Proposed Study Scope

- **Base reliability case analysis – 2026 summer and 2026-2027 winter and 2031 winter**
  - **An "All Firm Transmission" Case(s) will be developed which will consider all confirmed long term firm transmission reservations with roll-over rights applicable to the study year(s)**
  - **DEC and DEP generation down cases will be created from the common Base Case**
- **Alternate scenarios/sensitivities – 2031 winter**
- **Study scope To Be Determined**

Past Studies' Alternate Scenarios

- **Hypothetical Imports/Exports re-evaluated every other year (last performed in 2019)**
  - **1000 MW transfers**
- **Hypothetical NC Generation**
  - **Fossil Fuel**
  - **Wind Energy**
    - **Off-shore – NCTPC only and NCTPC-PJM Joint Study**
- **Retirement of Coal Units**

Local Economic Study Requests

- Propose economic hypothetical scenarios to be studied as part of the transmission planning process
- Requests can include in, out and through transmission service
- Official TAG request to be distributed in January 2021

Public Policy Study Requests

- Provide input on public policies that are driving the need for local transmission for study
- Official TAG request to be distributed in January 2021

TAG Input Request

- **TAG is requested to provide any additional input to the OSC on the 2021 Study Scope, any additional suggested study scenarios, as well as input on Local Economic Study Requests and Public Policy Study Requests.**
- **Stakeholder feedback is needed!**
- **Provide input by February 4, 2021 to**

Rich Wodyka – Administrator
(rawodyka@aol.com / rich.wodyka@gmail.com)

Questions ?

Regional Studies Reports

Bob Pierce

Duke Energy Carolinas

SERC Long Term Working Group Update

SERC LTWG

- **Have provided data for MMWG 2020 Series steady state models which are now available to industry**
- **Working on MMWG 2020 Series dynamics models**
- **2025 Summer study results will be made public with FERC 715 filings**

SERTP

SERTP 4th Quarter Stakeholder Meeting

- Webex held on 12/3/20
- No impact on NCTPC from Economic Studies
- Covered modeling assumptions for next year

http://www.southeasternrtp.com/

NERC SAN FERNANDO EVENT REPORT

EVENT DESCRIPTION

- July 7, 2020, at 11:38:07 a.m. PDT
- Overhead static wire failed and fell across three phases on one of two 230 kV parallel circuits on a common tower structure.
- Caused a B-phase-to-ground fault on both circuits cleared in three cycles.
- At the same time, a nearby 230 kV circuit incorrectly operated for an external fault due to incorrect settings.
- At 11:41 PDT, one of the 230 kV lines tested and held
- At 11:41:31 PDT the second 230 kV parallel line with the permanent static wire fault tested and relayed out. This caused a bolted three phase fault that cleared in approximately two cycles.
- The three-phase fault significantly depressed BPS voltages across the Southern California area.

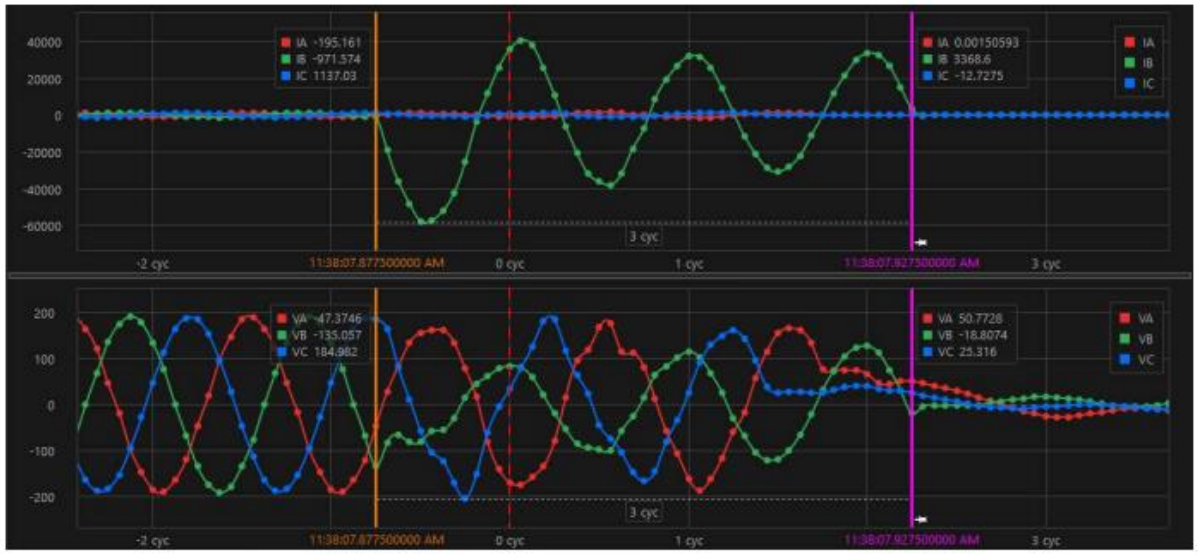


Figure 1.1: Event #1—B-Phase-to-Ground Fault on 230 kV Line [Source: LADWP]

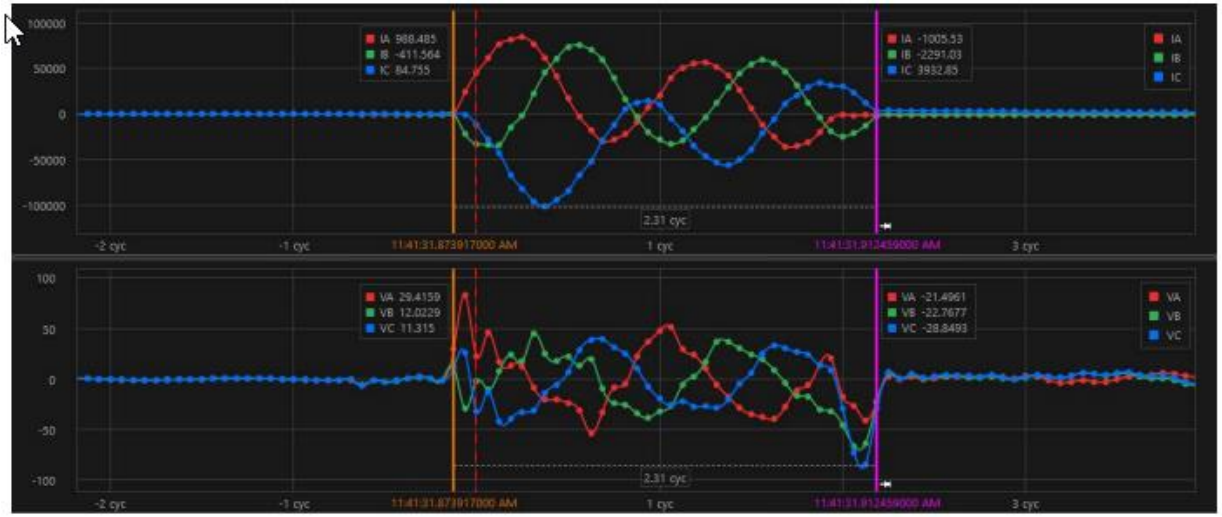


Figure 1.3: Event #2—Three-Phase Fault for Test on #2 230 kV Circuit [Source: LADWP]

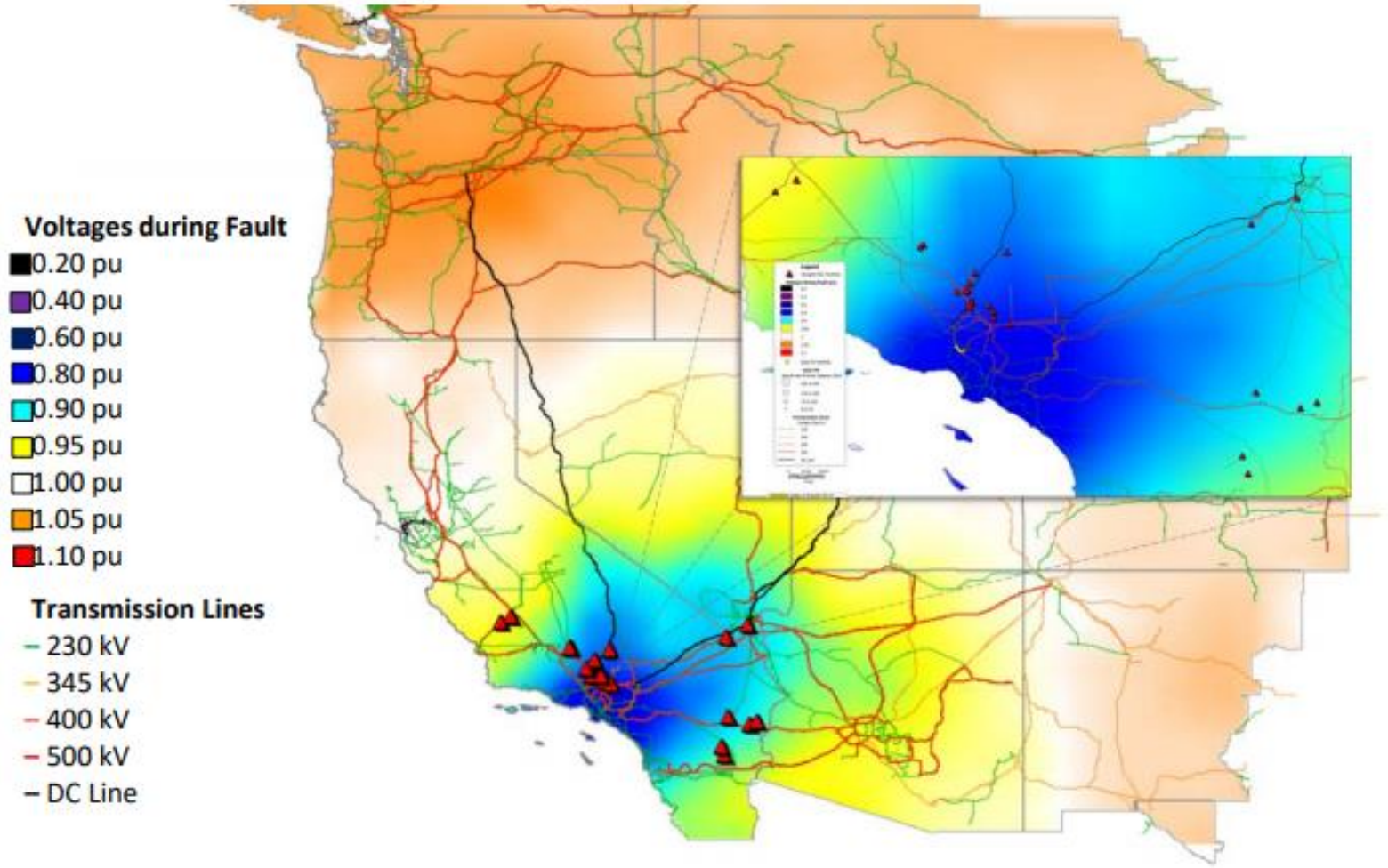


Figure I.1: Map of the Fault Location and Affected Facilities

Table 1.1: BPS-Connected Solar PV Reductions by Area		
Area	**Fault Event #1 [MW]**	**Fault Event #2 [MW]**
CAISO	122	901
SCE	100	535
PG&E	6	79
SDG&E	0	0
LADWP	83	62
IID	0	37
SRP	0	0
APS	0	0
Total*	**205**	**1,000**

* Summation of CAISO, LADWP, IID, SRP, and APS BA footprints

- **Poor Solar PV Data Resolution:** Almost all solar PV facilities involved in this disturbance were not able to provide adequate information to the analysis team to fully understand the causes of tripping and develop recommended mitigating actions. In many cases, the archived data had resolutions of one-minute or even five-minutes; this serves no useful purpose for post-mortem disturbance analysis. Data resolutions should be on the order of one-second, and other forms of high-speed data recording should be available from the individual inverters within the facility as well as at the plant-level controller. Point-on-wave digital fault recorder data is the most useful data for this type of analysis along with inverter fault codes and inverter oscillography data.
  - **Recommendation (GO, Generator Operator (GOP)):** All GOs and GOPs should ensure adequate data monitoring within their facilities for inverter-based resources to determine root causes of abnormal performance to BPS disturbances. This includes having access to inverter and plant-level settings, fault codes, oscillography records, digital fault recorder data, and archived plant data (i.e., SCADA data) with a resolution of one sample per second or faster. NERC Standards should be enhanced to ensure this data is available from all BPS generating facilities, as this continues to be a major issue limiting the ability to perform event analysis.
  - **Recommendation (TO, FERC):** All TOs should establish or improve data recording requirements for all BPS-connected generating resources, including both synchronous and inverter-based resources, to ensure appropriate data is available for event analysis. FERC may consider adding this capability to the pro forma *Large Generator Interconnection Agreement*.[3] Detailed recommendations are documented in NERC *Reliability Guideline: Improvements to Interconnection Requirements for BPS-Connected Inverter-Based Resources*.[4]

- **Continued and Improved Analyses Needed:** This event, as with past events, involved a significant number of solar PV resources reducing power output (either due to momentary cessation or inverter tripping) as a result of normally-cleared BPS faults. The widespread nature of power reduction across many facilities poses risks to BPS performance and reliability. Many of the issues identified in this disturbance appear systemic and are not being widely addressed by the solar PV fleet.
  - **Recommendation (Reliability Coordinator (RC), GO, GOP):** Analysis of inverter-based resource performance for system faults should be conducted on a regular basis to identify possible abnormal performance. Root cause analysis should be conducted for identified abnormal performance events to develop mitigating measures to improve fleet performance. RCs should be analyzing fleet performance after significant grid disturbances, identifying any abnormal performance, and ensuring affected entities are determining whether improvements to their facilities can be made to eliminate abnormal performance. It does not appear these activities are regularly taking place, and improvements to processes should be developed so that these activities occur more frequently by RCs and affected entities rather than primarily by the ERO Enterprise. Entities are strongly encouraged to share their lessons learned with NERC and its Inverter-Based Resource Performance Working Group (IRPWG) to help industry advance its capabilities moving forward.

- **Recommendation (NERC IRPWG, Industry):** NERC and its technical stakeholder groups (i.e., NERC IRPWG) should continue outreach and the development of recommended practices and reliability guidelines to help industry ensure BPS reliability as the penetration of BPS-connected inverter-based resources continues to increase. However, while outreach has been effective in supporting industry in these efforts, it is clear that outreach alone is not an effective means of minimizing possible abnormal behavior from these resources and developing mitigating measures to eliminate these issues. Additional actions (e.g., standards enhancements, updates to interconnection requirements, engagement in IEEE P2800 activities) are needed by industry to ensure entities are taking appropriate steps to support reliable operation of the BPS.

- **Inverter Tripping:** There were three causes of BPS-connected solar PV tripping during this disturbance—ac overcurrent protection, dc low voltage protection, and ac low voltage protection. The vast majority of inverters that tripped were from a single manufacturer that tripped on either ac overcurrent or dc low voltage protection. All inverter tripping was considered abnormal since the BPS fault events were normally-cleared and no resources were disconnected as a consequence of the faulted elements being removed. The primary form of tripping, ac overcurrent protection, is not considered in PRC-024 since it is not related to voltage or frequency protection within the facility. Similar to past disturbances involving tripping due to dc reverse current protection, phase jump protection, and phase lock loop loss of synchronism protection, none of these common trip mechanisms are captured in the latest version of PRC-024.

- **Recommendation (GO, GOP, TO, NERC, FERC):** Partial tripping of inverters within a facility is still considered tripping and has an adverse impact on BPS performance. Partial tripping of inverters during normally-cleared faults should not be considered an acceptable level of performance from inverter-based resources. Facility performance should be more closely reviewed for compliance with NERC Reliability Standards and other applicable interconnection requirements. GOs and GOPs should analyze partial tripping events and work with their inverter manufacturers to mitigate inverter tripping to the extent possible.

- **Recommendation (GO, GOP, TO, FERC):** Inverters are commonly tripped for reasons other than voltage- or frequency-related tripping, and the PRC-024 curves are often set directly in the inverter solely for compliance with PRC-024 rather than to protect the inverter from physical damage. These other forms of tripping (e.g., ac overcurrent, phase lock loop loss of synchronism) lead to partial tripping of many different solar PV facilities and have an adverse impact on BPS performance. These types of tripping should not be considered acceptable for normally-cleared BPS fault events and enhancements to PRC-024 (or a possibly a new standard focused on ride-through capability) should be made to account for these other forms of tripping.

- **Recommendation (TO, Transmission Planner (TP), Planning Coordinator (PC), TOP, RC):** Interconnection requirements should ensure that the models provided during the interconnection study process are able to account for all forms of tripping by inverter-based resources so that sufficiently accurate studies can be conducted by the TP and PC. In most cases, this will require the collection of accurate, plant-specific electromagnetic transient (EMT) models. TPs and PCs should be conducting studies during the interconnection process to ensure adequate fault ride-through while considering all possible forms of inverter tripping. Phase lock loop issues, dc reverse current tripping, ac overcurrent tripping, and any other form of tripping beyond simply PRC-024 protection requirements should be accurately modeled and tested by the TP and PC during their interconnection studies. Any unexpected or abnormal performance identified during interconnection studies should be addressed prior to allowing that facility to interconnect to the BPS (per the NERC FAC standards). Furthermore, all models should be updated after plant commissioning and checked to ensure that the model matches the as-built, plant-specific settings, controls, and behavior. Any modeling issues or performance issues identified by the TP and PC should be addressed as quickly as possible, reported to the TOP and RC, and corrective actions put in place in a timely manner.

- **Dynamic Behavior of Solar PV during Faults:** Many facilities had a dynamic response to the fault events in this disturbance; however, multiple facilities exhibited dynamic behavior that does not meet the recommended performance specified in previously published NERC reliability guidelines.[6] Some solar PV facilities use legacy inverters that cannot make improvements to performance. Other facilities have relatively newer inverters where changes could be made but were not made prior to the faults, signifying a lack of action being taken by industry to incorporate the recommendations set forth. Some facilities with newer inverter technology were able to use current injection during the fault (eliminating momentary cessation) but required tens of seconds to return to predisturbance output; this is not a preferred behavior. Concerted focus should be made by NERC Compliance Monitoring and Enforcement Program (CMEP) to ensure all BES facilities are meeting the requirements set forth in NERC Reliability Standards including the latest version of PRC-024.
  - **Recommendation (GO, GOP):** All existing solar PV facilities should review the recommendations in the NERC reliability guidelines and ensure that their equipment is configured to meet the recommendations set forth. Solar PV resources should eliminate the use of momentary cessation to the extent possible. If elimination is not possible, the momentary cessation settings should be configured (if possible) to minimize its use (lower voltage threshold) and return to predisturbance output within one second. If elimination is possible, other forms of current injection during fault ride-through (e.g., reactive current injection or some form of active and reactive current injection) should be used.

- **Recommendation (GO, GOP):** All existing solar PV facilities should review the recommendations in the NERC reliability guidelines and ensure that their equipment is configured to meet the recommendations set forth. Solar PV resources that use current injection should ensure that the inverter controls and plant-level controls are configured to allow the resource to return to predisturbance output (assuming no current limits are reached) within one second. Resources should not have a prolonged recovery of active power following a dynamic response to a fault event on the BPS. Plant-level ramp rates or other BA-imposed balancing ramp rates should not interfere with the resource returning to predisturbance output levels in a quick and stable manner after a BPS fault event.

- **Recommendation (TO):** TOs should ensure their interconnection requirements are clear regarding the dynamic performance requirements and settings for inverter-based resources. TOs are strongly encouraged to ensure resources are complying with these requirements and developing mitigation plans for any requirements that are not being met. In particular, these requirements should ensure clarity and consistency for post-fault recovery of active power following fault events. Furthermore, rise times and settling times should also be specified as well as any reactive current injection (e.g., "K-factor") settings for large disturbance voltage support.

- **Dynamic Model Accuracy:** NERC and WECC have previously identified[7] modeling issues in the interconnection-wide planning base cases, and modeling challenges continue to be an issue with industry. Discussions with GOs of solar PV facilities during this analysis have highlighted that changes to equipment may take place, but there is little to no emphasis put on getting TP or PC approval of these changes (as a material modification to the facility) prior to making them, nor on ensuring that the TP and PC receive updated dynamic models following those changes. NERC IRPWG has submitted a standard authorization request to modify FAC-002-2 to clarify the use of "material modification" in that standard.
  - **Recommendation (GO, GOP):** GOs and GOPs should ensure that any changes to plant-level settings, inverter settings, or facility topologies or ratings should be articulated to the TP, PC, BA, and RC. Any applicable interconnection requirements, per FAC-001-3 and FAC-002-2, must be met prior to these changes being made to the facility, including restudy of these changes by the TP and PC. GOs and GOPs should coordinate with their TP and PC to determine if any changes within the facility are considered "material" and require any additional restudy.
  - **Recommendation (TO, TP, PC, Industry):** TOs should ensure that their interconnection requirements are clear and any modifications to the facility that can or will change the electrical behavior of the facility (including any settings changes to inverters that affect its electrical output during steady-state or dynamic conditions) should be considered material and should be studied prior to those changes being made. TOs, TPs, and PCs should ensure that their processes for making these changes are timely and effective such that GOs are not discouraged from making these changes to support overall reliability of the BPS.

Questions ?

2020 TAG Work Plan

Rich Wodyka
Administrator

2020 NCTPC Overview Schedule

Reliability Planning Process

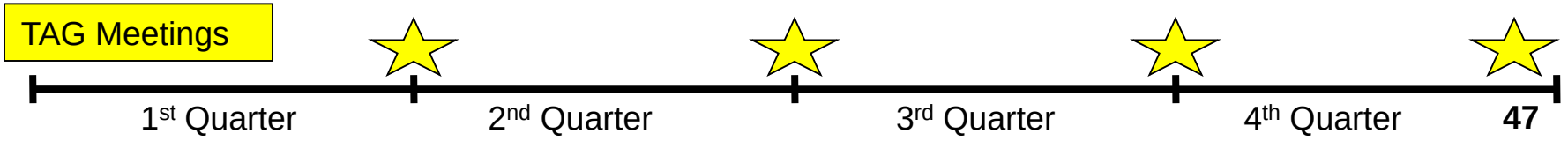
- Evaluate current reliability problems and transmission upgrade plans
- Perform analysis, identify problems, and develop solutions
- Review Reliability Study Results

Local Economic Planning Process

- Propose and select Local Economic Studies and Public Policy Study scenarios
- Perform analysis, identify problems, and develop solutions
- Review Local Economic Study and Public Policy Results

Coordinated Plan Development

- Combine Reliability and Local Economic Study and Public Policy Results
- OSC publishes DRAFT Plan
- TAG review and comment



January - February – March

- **2020 Study – Finalize Study Scope of Work**
  - ✓ **Receive request from OSC to provide input on proposed Local Economic Study scenarios and interfaces for study**
    - *TAG provide input to the OSC on proposed Local Economic Study scenarios and interfaces for study – No TAG requests received*
  - ✓ **Receive request from OSC to provide input in identifying any public policies that are driving the need for local transmission**
    - *TAG provide input to the OSC in identifying any public policies that are driving the need for local transmission for study - Request from Southeastern Wind Coalition received*
  - ✓ **Receive final 2020 Reliability Study Scope for comment**
    - *TAG review and provide comments to the OSC on the final 2020 Study Scope*

January - February – March

First Quarter TAG Meeting – March 23rd

- **2020 Study Update**
  - ✓ **Receive a report on the Local Economic Study scope and any Public Policy scenarios that are driving the need for local transmission for study**
  - ✓ **Receive a progress report on the Reliability Planning study activities and the final draft of the 2020 Study Scope**

April - May – June

Second Quarter TAG Meeting – June 22nd

- **2020 Study Update**
  - ✓ **Receive a progress report on study activities**
  - ✓ **Receive update status of the upgrades in the 2019 Collaborative Plan**

July - August – September

Third Quarter TAG Meeting – October 26th

- **2020 Study Update**
  - ✓ **Receive a progress report on the study activities and preliminary results**
  - ✓ **TAG is requested to provide feedback to the OSC on the technical analysis performed, the problems identified as well as proposing alternative solutions to the problems identified - Provide feedback by November 5th to Rich Wodyka (rawodyka@aol.com or rich.wodyka@gmail.com)**

October - November - December

Fourth Quarter TAG Meeting – December 15th

- **2020 Selection of Solutions**
  - ✓ **TAG will receive feedback from the OSC on any alternative solutions that were proposed by TAG members**
- **2020 Study Update**
  - ✓ **Receive and discuss final draft of the 2020 Collaborative Transmission Plan Report. Provide feedback by January 6th to Rich Wodyka (rawodyka@aol.com or rich.wodyka@gmail.com).**
  - ✓ **Discuss potential study scope scenarios for 2021 studies**

Questions ?

2021 TAG Work Plan

Rich Wodyka
Administrator

2021 NCTPC Overview Schedule

Reliability Planning Process

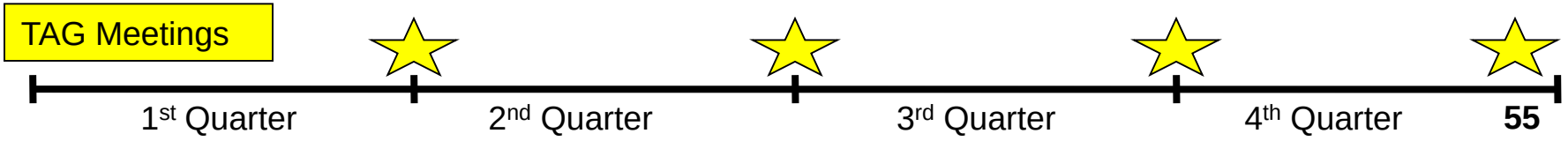
- Evaluate current reliability problems and transmission upgrade plans
- Perform analysis, identify problems, and develop solutions
- Review Reliability Study Results

Local Economic Planning Process

- Propose and select Local Economic Studies and Public Policy Study scenarios
- Perform analysis, identify problems, and develop solutions
- Review Local Economic Study and Public Policy Results

Coordinated Plan Development

- Combine Reliability and Local Economic Study and Public Policy Results
- OSC publishes DRAFT Plan
- TAG review and comment



January - February – March

➢ 2020 Study Update

- **Receive Final 2020 Collaborative Transmission Plan Report**
- **Receive Draft 2020 Offshore Wind Study Report**
  - ***TAG provide input to the OSC on Offshore Wind Study results***

➢ 2021 Study – Finalize Study Scope of Work

- **Receive request from OSC to provide input on proposed Local Economic Study scenarios and interfaces for study**
  - ***TAG provide input to the OSC on proposed Local Economic Study scenarios and interfaces for study***
- **Receive request from OSC to provide input in identifying any public policies that are driving the need for local transmission**
  - ***TAG provide input to the OSC in identifying any public policies that are driving the need for local transmission for study***
- **Receive final 2021 Reliability Study Scope for comment**
  - ***TAG review and provide comments to the OSC on the final 2021 Study Scope***

January - February – March

First Quarter TAG Meeting – TDB

- **2020 Offshore Wind Study Analysis**
  - **Receive report on and discuss the final draft of the 2020 Offshore Wind Study Report**
- **2021 Study Update**
  - **Receive a report on the Local Economic Study scope and any public policy scenarios that are driving the need for local transmission for study**
  - **Receive a progress report on the Reliability Planning study activities and the final 2021 Study Scope**

April - May – June

Second Quarter TAG Meeting – TBD

- **2021 Study Update**
  - **Receive a progress report on study activities**
  - **Receive update status of the upgrades in the 2020 Collaborative Plan**

July - August – September

Third Quarter TAG Meeting – TBD

- **2021 Study Update**
  - **Receive a progress report on the study activities and preliminary results**
  - **TAG is requested to provide feedback to the OSC on the technical analysis performed, the problems identified as well as proposing alternative solutions to the problems identified**

October - November - December

Fourth Quarter TAG Meeting – TBD

- **2021 Selection of Solutions**
  - **TAG will receive feedback from the OSC on any alternative solutions that were proposed by TAG members**
- **2021 Study Update**
  - **Receive and discuss final draft of the 2021 Collaborative Transmission Plan Report**
  - **Discuss potential study scope scenarios for 2022 studies**

Questions ?

TAG
Open Forum Discussion

Comments or Questions ?