TAG Meeting
March 13, 2019

Webinar

TAG Meeting Agenda

1. **Administrative Items – Rich Wodyka**
2. **2019 Study Activities and Study Scope – Mark Byrd**
3. **Regional Studies Update – Bob Pierce**
4. **2019 TAG Work Plan – Rich Wodyka**
5. **TAG Open Forum – Rich Wodyka**

2019 Study Activities and Study Scope

Mark Byrd

Duke Energy Progress

Studies for 2019

- **Annual Reliability Study**
  - **Assess DEC and DEP transmission systems' reliability and develop a single Collaborative Transmission Plan**

- **Local Economic Studies**
  - **Assess two sites on DEC with hypothetical generation**
  - **Assess DEC and DEP interfaces with neighboring systems by modeling hypothetical transfers**
  - **No Local Economic Studies or Public Policy Studies submitted for 2019**

Technical Analysis

- Conduct thermal screenings of the 2024S, 2024/25W and 2029S base cases
- Conduct thermal screenings for two sites with hypothetical generation and various hypothetical import / export scenarios

Technical Analysis

Generation Study #1

A 2029 Summer Study will be performed to evaluate a hypothetical 2,200 MW Combined Cycle 2x1 (H/J-class) resource supply option located in Davidson County connected to DEC's 230 kV Buck to Beckerdite line.

Generation Study #2

A 2024 Summer and 2024/2025 Winter cases will be performed to evaluate a hypothetical 10 MW solar + 20 MWh / 10 MW battery storage system in Davidson County connected to DEC's 100 kV Buck to Beckerdite line.

2029S Hypothetical Import/Export

Resource From	Sink	Test Level (MW)
PJM	DUK[1]	1,000
SOCO	DUK	1,000
CPLE[2]	DUK	1,000
TVA[3]	DUK	1,000
PJM	CPLE	1,000

1 – DUK is the Balancing Authority Area for DEC
2 – CPLE is the eastern Balancing Authority Area for DEP
3 – This hypothetical transfer is intended to evaluate the impact of a 1,000 MW TVA transaction through the SOCO transmission system into DUK

2029S Hypothetical Import/Export

Resource From	Sink	Test Level (MW)
DUK	CPLE	1,000
DUK	SOCO	1,000
PJM	DUK/CPLE	1,000/1,000
DUK/CPLE	PJM	1,000/1,000
CPLE	PJM	1,000

2029S Hypothetical Import/Export

Resource From	Sink	Test Level (MW)
DUK	PJM	1,000
SOCO[4]	CPLE	1,000
DUK[5]	TVA	1,000
PJM[6]	SCEG	1,000

4 – This hypothetical transfer is intended to evaluate the impact of a 1,000 MW Southern Co transaction through the DEC transmission system into CPLE
5 – This hypothetical transfer is intended to evaluate the impact of a 1,000 MW DUK transaction through the SOCO transmission system into TVA
6 – This hypothetical transfer is intended to evaluate the impact of a 1,000 MW PJM transaction through the CPLE transmission system into SCEG

Study Process Steps

Completed

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

Study Assumptions Selected

- **Study Year's for reliability analyses:**
  - Near-term: 2024 Summer, 2024/2025 Winter
  - Longer-term: 2029 Summer
- **LSEs provided:**
  - Input for load forecasts and resource supply assumptions
  - Dispatch order for their resources
- **Adjustments may be made based on additional coordination with neighboring transmission systems**

Study Assumptions Selected

Company	Generation Facility	2024S	2024/2025W	2029S
DEC	Lincoln County CT (402 MW)	Yes	Yes	Yes
DEC	Reidsville Energy Center (477 MW)	Yes	Yes	Yes
DEC	Retired Allen 1-3 (617 MW)	No	Yes	Yes
DEC	Retired Allen 4-5 (564 MW)	No	No	Yes
DEC	High Shoals PV (16 MW)	Yes	Yes	Yes
DEC	Ruff PV (22 MW)	Yes	Yes	Yes
DEC	Gaston PV (25 MW)	Yes	Yes	Yes
DEC	Simmental PV (69.3 MW)	Yes	Yes	Yes
DEC	Lancaster PV (10 MW)	Yes	Yes	Yes

Study Assumptions Selected

Company	Generation Facility	2024S	2024/2025W	2029S
DEP	Retired Asheville 1-2 (384 MW)	Yes	Yes	Yes
DEP	Asheville CC (560 MW)	Yes	Yes	Yes
DEP	Retired Darlington Co 1,2,3,4,6,7,8,10 (514 MW)	Yes	Yes	Yes
DEP	Crooked Run Solar (70.1 MW)	Yes	Yes	Yes
DEP	Bay Tree Solar (70.1 MW)	Yes	Yes	Yes
DEP	Retired Blewett CTs 1-4 and Weatherspoon CTs 1-4 (232 MW)	No	Yes	Yes
DEP	Retired Roxboro Units 1-2 (1053 MW)	No	No	Yes

Study Criteria Established

- NERC Reliability Standards
  - Current standards for base study screening
  - Current SERC Requirements
- Individual company criteria

Study Methodologies Selected

- Thermal Power Flow Analysis
- Each system (DEC and DEP) will be tested for impact of other system's contingencies

Models and Cases Developed

- Start with 2018 series MMWG cases
- Latest updates to detailed models for DEC and DEP systems will be included
- Planned transmission additions from updated 2018 Plan will be included in models

Problems Identified and Solutions Developed

- Identify limitations and develop potential alternative solutions for further testing and evaluation
- Estimate project costs and schedule

Collaborative Plan Projects Selected

- Compare all alternatives and select preferred solutions

Study Report Prepared

- Prepare draft report and distribute to TAG for review and comment

Questions ?

Regional Studies Reports

Bob Pierce

Duke Energy Carolinas

SERC Long Term Working Group Update

SERC Long Term Working Group

- Have begun work on 2019 series of LTWG cases
- FRCC will be joining

SERTP

SERTP

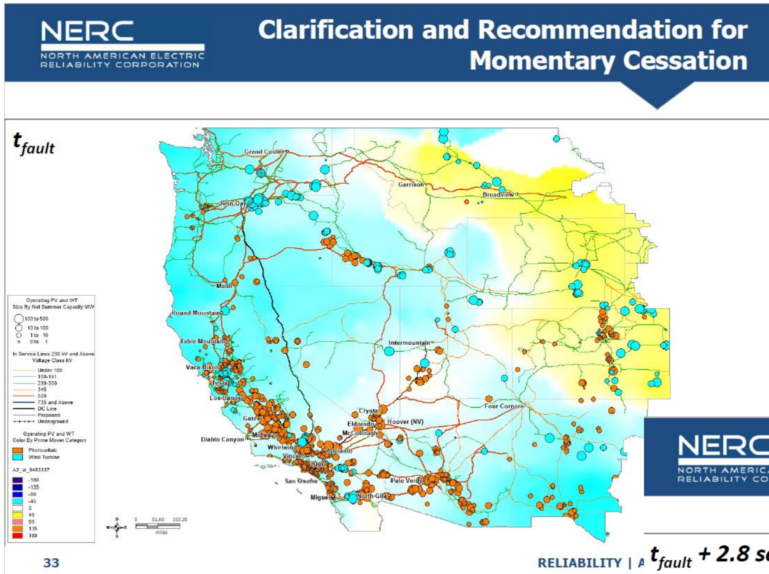
- 1st Quarter Meeting will be held on March 20th in Charlotte
- Determine Economic Planning Studies to be performed for 2019
- Training session on Inverter Based Generation Interconnection Standards

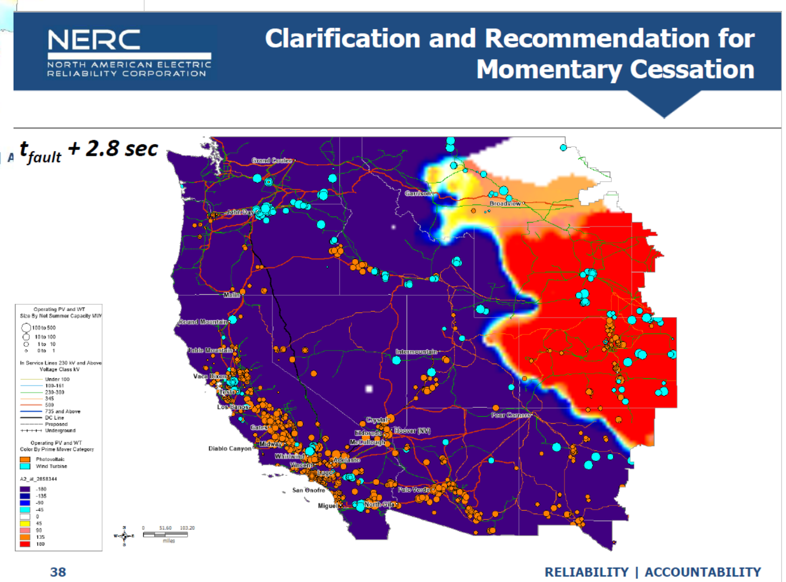
http://www.southeasternrtp.com/

NERC Inverter Based Resource Performance and Analysis Workshop

Blue Cut Fire – 8/16/16

Canyon 2 Fire – 10/9/17


NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION
Clarification and Recommendation for Momentary Cessation
t fault
Grand Coulee
Garrison
Broadview
Malin
Round Mountain
Table Mountain
Vaca Dixon
Intermountain
Crystal
Eldorado
McCullough
Hoover (NV)
Four Corners
Diablo Canyon
Midway
Whirlwind
Vincent
San Onofre
Palo Verde
Miguel
North Gila
33
RELIABILITY | A


NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION
Clarification and Recommendation for Momentary Cessation
t fault + 2.8 sec
Diablo Canyon
San Onofre
38
RELIABILITY | ACCOUNTABILITY

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Recommended Disturbance Monitoring for Inverter-Based Resources

White Paper
NERC SMS – November 2018

Executive Summary

Recent disturbance analyses of events involving inverter-based resources, including the Blue Cut Fire and Canyon 2 Fire, have demonstrated the lack of disturbance monitoring data available at these facilities to adequately determine the causes and effects of their behavior. This paper provides examples of these data issues, recommended data to be collected from inverter-based resources, existing industry best practices, and recommended solutions to address this potential reliability gap. It is recommended that developing requirements for a minimum level of data monitoring and recording be considered, as well as including requirements in pro forma generator interconnection agreements.

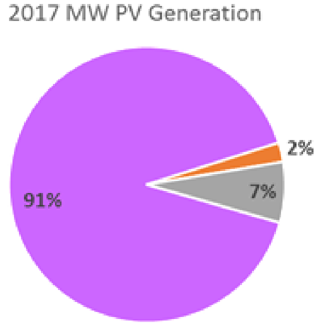
Table 1: Recommended Measurement Data and Retention			
Data Type	**Measurement/Data Points**	**Resolution**	**Retention**
Plant Control Settings and Static Values	This data includes the settings, set points, and other static information that should be captured about the plant. This information should be captured at a resolution sufficient to identify any changes (i.e., when settings are changed). Data points include: • Active power/frequency control mode of operation • Reactive power (current)/voltage mode of operation • Individual inverter mode of operation (e.g., reactive, voltage, or power factor) • Digital control system gains, time constants, limiters, etc.	Static, as changed	1 year

Table 1: Recommended Measurement Data and Retention			
Data Type	**Measurement/Data Points**	**Resolution**	**Retention**
Plant SCADA Data	The plant SCADA system is often a lower resolution repository of information that should include, at a minimum, the following data points: • All breaker statuses • Shunt (dynamic or static) reactive compensation statuses • Shunt (dynamic or static) reactive power output • Substation transformer status • Substation transformer tap position • Time synchronization (e.g., GPS status word) • Medium voltage collector system statuses • Individual inverter statuses • External control signals from the BA, RTO, RC, etc. • External automatic generation control signals • Active and reactive power commands sent to individual inverters • Active and reactive power output of individual inverters • Overall plant active and reactive power output • Point of Measurement voltage and medium voltage collector system voltages	1-2 seconds	1 year

Table 1: Recommended Measurement Data and Retention			
Data Type	**Measurement/Data Points**	**Resolution**	**Retention**
Sequence of Events Recording (SER) Data	SER devices should be sized to capture and store hundreds or thousands of event records and logs. SER events records can be triggered for many different reasons but include, at a high level, the following: • Event date/time stamp (synchronized to common reference (e.g., Coordinated Universal Time (UTC)) • Event type (status changes, synchronization status, configuration change, etc.) • Description of action • Sequence number (for potential overwriting)	≤ 1 millisecond	90 days
Digital Fault Recording (DFR) Data	This data should be captured for at least the plant-level (e.g., at the Point of Measurement) response to BPS events. It is typically high resolution (kHz) point-on-wave data, and triggered based on configured settings. Data points should include: • Bus voltage phase quantities • Bus frequency (as measured/calculated by the recording device) • Current phase quantities • Calculated active and reactive power output • Dynamic reactive element voltage, frequency, current, and power output	> 960 samples per second, triggered	90 days
Dynamic Disturbance Recorder (DDR) Data	A DDR (e.g., a PMU or digital relay with this capability) should capture the plant-level response during normal and disturbance events. This data should be captured continuously at the Point of Measurement and can be used for multiple purposes including event analysis and disturbance-based model verification. Data points should include: • Bus voltage phasor (phase quantities and positive sequence) • Bus frequency • Current phasor (phase quantities and positive sequence) • Calculated active and reactive power output	≥ 30 samples per second, continuous	1 year

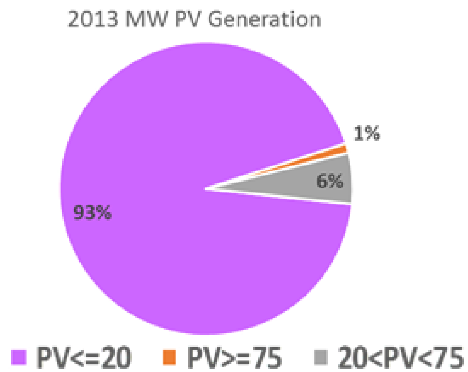
Table 1: Recommended Measurement Data and Retention			

Inverter Fault Codes and Dynamic Recordings	The individual inverters are highly complex pieces of equipment, with a vast amount of information continually being calculated and stored within them. The data from inverters are very high resolution. At a high level, for grid BPS faults, the following information should be available from the inverters for analysis by the GO:
	• All major and minor fault codes
	• All fault and alarm status words
	• Change of operating mode
	  ○ High and low voltage fault ride through
	  ○ High and low frequency ride through
	  ○ Momentary cessation (if applicable)
	  ○ PLL loss of synchronism
	• DC current and voltage
	• AC phase currents and voltage
	• Pulse width modulation index
	• Control system command values, reference values, and feedback signals
		Many kHz	90 days



1,186,655	Total Operable Generating Capacity (MW)
25288	Total PV Nameplate capacity (MW)
2778	Total number of PV units
2.13%	Amount of PV MW Generation

PV MW	No of Units	Total Nameplate Capacity (MW)
PV<=20	2,518	10,509
PV>=75	63	6,999
20<PV<75	197	7,780



1,164,022	Total Operable Generating Capacity (MW)
5389	Total PV Nameplate capacity (MW)
856	Total number of PV units
0.46%	Amount of PV MW Generation

PV MW	No of Units	Total Nameplate Capacity MW
PV<=20	799	2,746
PV>=75	9	1,082
20<PV<75	48	1,561

Figure 7: Solar PV Capacity Information [Source: Velocity Suites]

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Key Takeaways

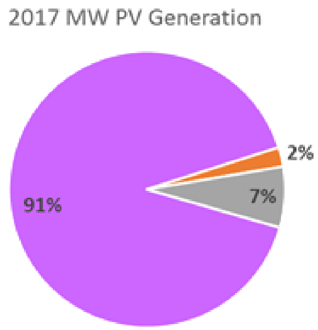
Inverter-Based Resource Performance and Analysis Workshop
February 2019

IRPTF FOCUS AREAS

- The NERC Inverter-Based Resource Performance Task Force (IRPTF) proves to be one of NERC's **most successful and effective stakeholder groups in addressing emerging reliability risks.** This is mainly attributed to the collaborative nature of this group, engaging a wide range of industry stakeholders including generation entities, transmission entities, inverter manufacturers, original equipment manufacturers (OEMs), research institutions, national laboratories, U.S. Department of Energy representatives, and regulatory entities.

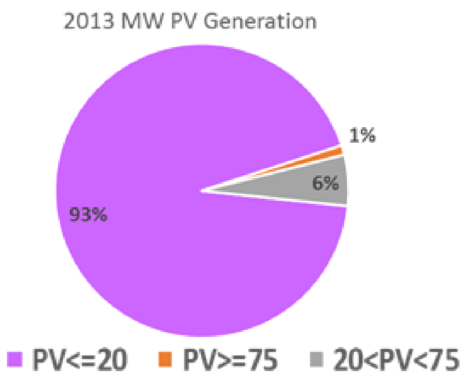
- The NERC IRPTF is developing a *Reliability Guideline: Improvements to Interconnection Requirements for BPS-Connected Inverter-Based Resources* **that can be used by TOs to improve the clarity and technical strength of their interconnection requirements for newly interconnecting inverter-based resources.**

- Many of the issues identified in past grid disturbances pertain to most, if not all, IBR's connected to the BPS. Recommendations developed for Bulk Electric System (BES) generation subject to NERC Reliability Standards **also apply to non-BES generation connected to the BPS.**



1,186,655	Total Operable Generating Capacity (MW)
25288	Total PV Nameplate capacity (MW)
2778	Total number of PV units
2.13%	Amount of PV MW Generation

PV MW	No of Units	Total Nameplate Capacity (MW)
PV<=20	**2,518**	10,509
PV>=75	**63**	6,999
20<PV<75	197	7,780



1,164,022	Total Operable Generating Capacity (MW)
5389	Total PV Nameplate capacity (MW)
856	Total number of PV units
0.46%	Amount of PV MW Generation

PV MW	No of Units	Total Nameplate Capacity MW
PV<=20	**799**	2,746
PV>=75	**9**	1,082
20<PV<75	48	1,561

Figure 7: Solar PV Capacity Information [Source: Velocity Suites]

- Transmission Operators, Balancing Authorities, and Reliability Coordinators **should be proactively analyzing all grid disturbances and monitoring the performance of their inverter-based resources** connected to the bulk power system. **Any anomalous behavior in the fleet response should be brought to the attention of their Regional Entity and the NERC IRPTF for technical discussion and to identify root causes and potential solutions.** This framework has led to lessons learned and improved performance of the inverter fleet. Examples of collaborative improvements include mitigation of erroneous frequency tripping and phase jump tripping, as well as increased transient overvoltage ride-through capability.

- The NERC **Alerts pertaining to solar photovoltaic (PV) resources are driving industry improvements** in IBR performance and ride-through during grid disturbances.

Recommended Performance of BPS-Connected IBR's

- GO's are strongly recommended to work with their inverter manufacturer(s) to **eliminate the use of momentary cessation** for existing solar PV facilities, to the extent possible.
- **Active power-frequency controls** should align with FERC Order No. 842.
- **Reactive power-voltage and reactive current-voltage controls** should align with FERC Order No. 827.
- Many areas of the BPS are experiencing a decrease in short circuit strength, driving the need for advanced studies and solutions for inverter-based resources to integrate into these low short circuit networks. Many different screening techniques are available and new screening methods are under development. **EMT simulations are often required to identify or confirm these situations exist.**

Modeling and Simulations of IBR's

- Due to the advanced controls of IBR's, the dynamic models are becoming increasingly complex. Industry should ensure a deep understanding of the models being used in system stability studies, and should ensure these models represent the actual equipment installed in the field. **The majority of models in the interconnection-wide planning cases used to represent solar PV resources do not accurately represent the resource installed in the field.**
- The existing NERC Reliability Standards pertaining to model verification, MOD-026-1 and MOD- 027-1, do not necessarily capture the majority of model parameters during conventional model verification test procedures. **These tests do not capture the model parameters focused on the large disturbance behavior of these resources, resulting in unverified and often incorrect parameter values for many resources.** However, the majority of stability studies involve large disturbance response, and therefore accurate and verified model parameters are critical to accurate stability simulation results. **Reconsideration and rethinking the means of ensuring accurate models may be needed…**

Modeling and Simulations of IBR's

- In many areas, EMT modeling and studies are becoming the norm. This may include EMT model benchmarking against the positive sequence stability models to ensure accuracy, EMT studies to ensure reliable integration for inverter-based resources, or regional (or system-wide) EMT studies to identify any system reliability issues, particularly in high inverter-based resource penetration regions. **Industry should be developing the expertise and capabilities to perform EMT studies.** Many transmission entities are requiring EMT models during the interconnection process for newly interconnecting resources.

- Interconnection studies and other system reliability studies, **in many cases, will not identify potential inverter tripping issues or other issues with ride-through performance since most of the forms of protection are not modeled.** In addition, positive sequence simulation tools are not adequate in identifying many forms of tripping such as tripping on sub-cycle transient overvoltage, loss of phase lock loop (PLL) synchronism, and DC reverse current.

Modeling and Simulations of IBR's

- There may be issues in ensuring that the as-built settings are being integrated into the finalized model parameters once an inverter-based resource completes commissioning. The model provided during the study phases of the interconnection process typically use default or generic parameters. **Upon commissioning, those model parameters must be updated in the dynamic models used by TPs and PCs for system reliability studies. And in many cases, it appears these updates are not being made.** Industry should address this potential modeling concern through guidance documentation and outreach to transmission entities establishing interconnection requirements.

Questions ?

2019 TAG Work Plan

Rich Wodyka

Administrator

2019 NCTPC Overview Schedule

Reliability Planning Process

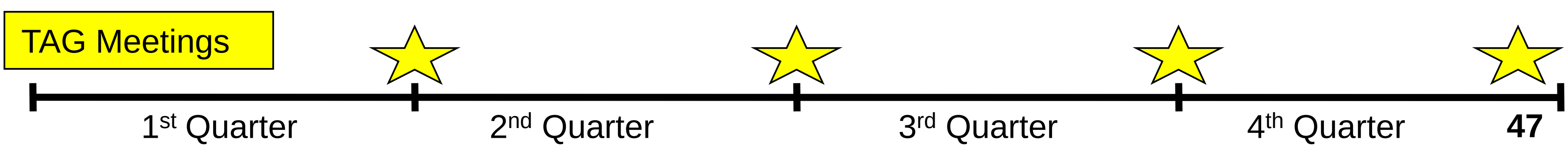
- Evaluate current reliability problems and transmission upgrade plans
- Perform analysis, identify problems, and develop solutions
- Review Reliability Study Results

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

- **2019 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 - No TAG requests received***
  - **Receive final 2019 Reliability Study Scope for comment**
    - – ***TAG review and provide comments to the OSC on the final 2019 Study Scope***

January - February – March

First Quarter TAG Meeting – March 13th

- **2019 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 2019 Study Scope**

April - May – June

<u>Second Quarter TAG Meeting – June 20th</u>

- **2019 Study Update**
  - **Receive a progress report on study activities**
  - **Receive update status of the upgrades in the 2018 Collaborative Plan**

July - August – September

Third Quarter TAG Meeting – TBD

➢ **2019 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

➢ **2019 Selection of Solutions**

- **TAG will receive feedback from the OSC on any alternative solutions that were proposed by TAG members**

➢ **2019 Study Update**

- **Receive and discuss final draft of the 2019 Collaborative Transmission Plan Report**
- **Discuss potential study scope for 2020 studies**

Questions ?

TAG
Open Forum Discussion

Comments or Questions ?