Implementation of Synchrophasor Technology

June 24, 2020

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Meeting Participation

- Webcast participation (including audio):
  - https://www.meetview.com/UpdatestoMonitoringRequirements062020/
  - Click "Ask a Question" in the bottom right corner of the screen to ask a question
- Teleconference participation (audio only):
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- Public chat:
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- This stakeholder engagement is guided by the IESO Engagement Principles

Purpose

Today's presentation is intended to describe synchrophasor technology needs and related Market Rules changes being proposed.

To enable Transmitters and Generators to provide synchrophasor data to the IESO for operational and planning purposes, changes to the following Market Rules sections will be discussed:

- Appendix 4.15 – IESO Monitoring Requirements: Generators
- Appendix 4.16 – IESO Monitoring Requirements: Transmitters

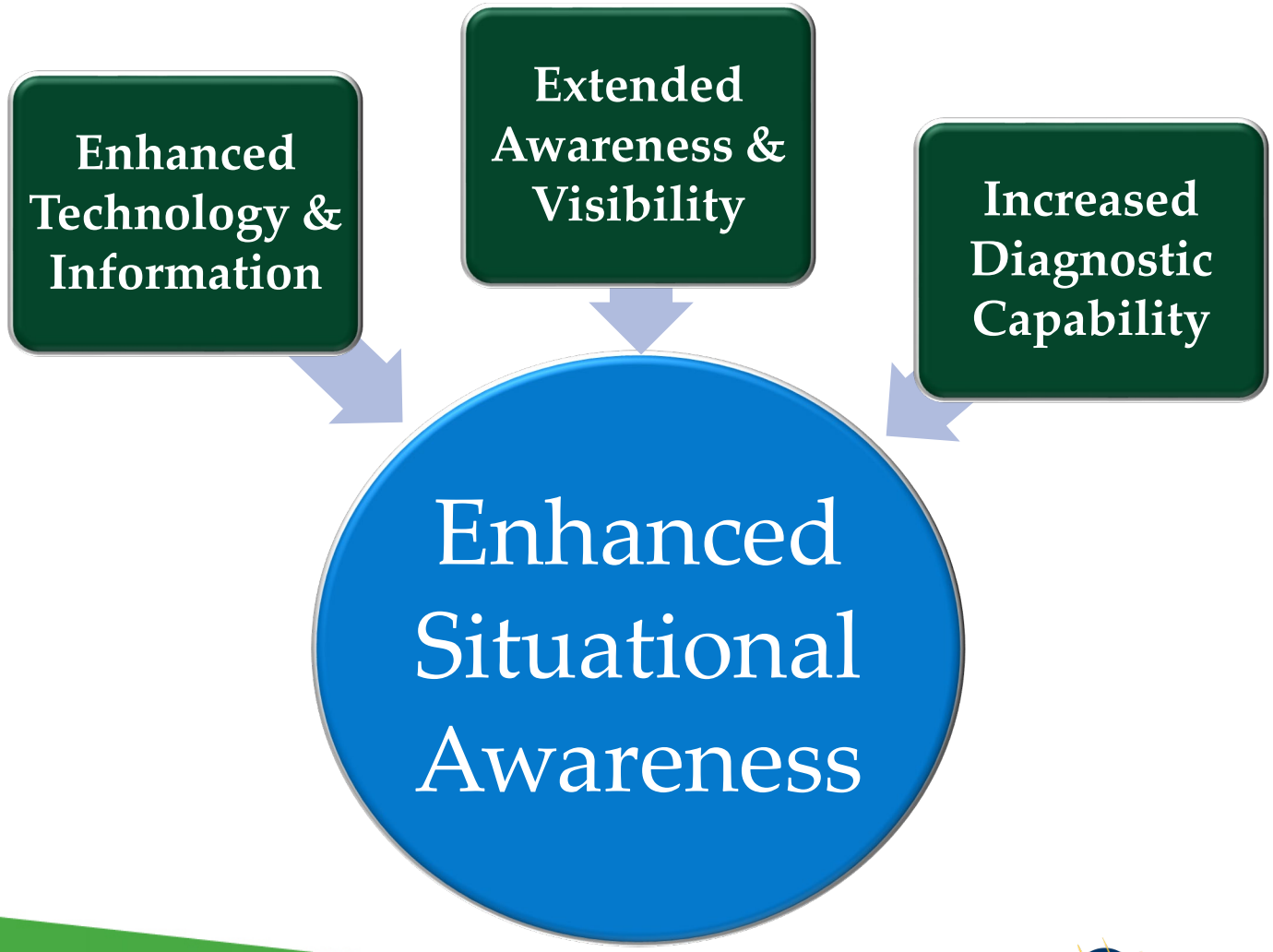
Next Steps (tentative)

- Today – introduction to proposed Market Rule changes and Implementation timeline
- July 15 – deadline for stakeholder feedback on today's presentation materials
- August – draft Market Rule redlines
- Q4 2020 – presentations to Technical Panel
- Q1 2021 – presentation to Board

Agenda

1. Introduction and Background: Synchrophasor Data and PMU
2. Growth of PMU Installations in North America
3. Applications of Synchrophasor Data
4. IESO PMU/Synchrophasor Data Integration Plan
5. Synchrophasor Data Needs and Proposed Market Rules Changes
   - SCADA Data Vs Synchrophasor Data
   - Why Synchrophasor Data is important
   - Synchrophasor Data in perspectives of Wide Area View
6. Proposed Market Rule changes
   - Who is Impacted and How
   - Synchrophasor Data Requirements
   - Implementation Schedule
7. Stakeholder Feedback

IESO's Situational Awareness Program



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Phasor Measurement Unit (PMU) Technology

Innovative Technology

+

Enhanced Information

→

Improved Monitoring & Detection

Improved Data & Analysis Capability

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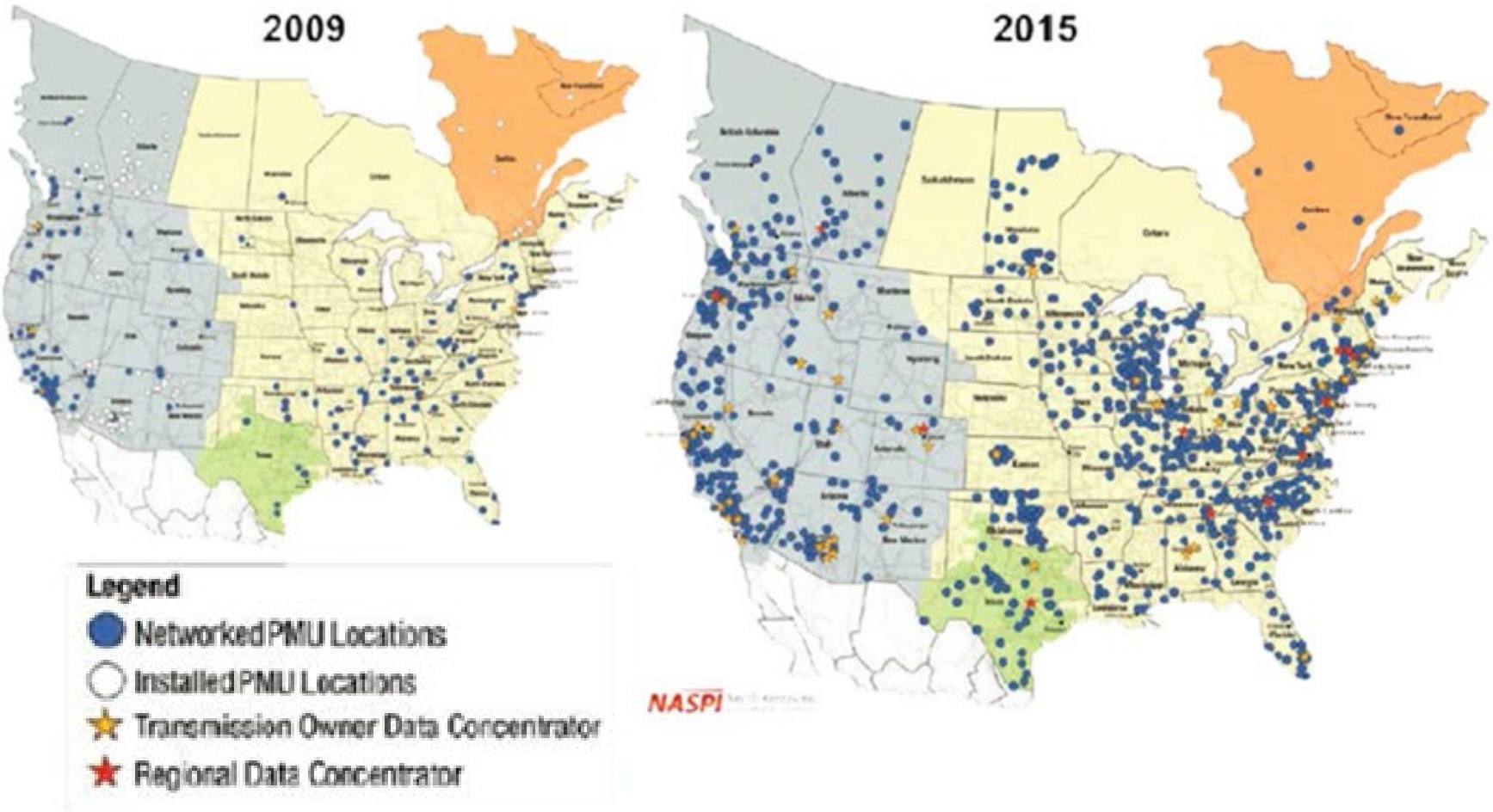
Growth of PMU Installations in North America



Applications of Synchrophasor Data: How it will help

Off-Line Applications:

- Verification and improvements of power system models, enabling better planning and operation decisions
- After-the-fact forensic event analysis

Real-Time Applications:

- Increased view of potential system separation, islanding and oscillations
- Allows all Reliability Coordinators to have a consistent view of the grid
- Enables robust means to understand the conditions of the power system
- Improved resilience and faster restoration of equipment from outages

To enhance and facilitate NERC regulatory compliance requirements
To move towards utilising new technology similar to industry peers

What PMUs/Synchrophasor Data Offer

Consideration	Currently	Future Synchrophasor Data
Real-time data communication methods, level of detail and accuracy.	Remote Terminal Units (RTUs) and Inter-control Center Communications Protocol (ICCP) provide real-time data to the IESO: • 1 data per 2-10 sec • Current & voltage magnitudes • Local time-stamp when IESO receives	PMU provides more capabilities, details and accuracy in data: • 30-60 data per 1 sec • Current & voltage magnitudes plus angles • Universal time-stamp as per GPS at source
Recording devices and data sources.	Digital Fault Recorder (DFR), Dynamic Disturbance Recorder (DDR) provide data for after-the-fact event analyses: • Non-continuous, triggered by voltage/frequency excursions • Data only available by request	PMU functionality is continuously available from different sources: • Stand-alone PMU devices • Intelligent Electronic Devices (IED) in protection relays • Modern Dynamic Disturbance Recorders (DDR)

IESO PMU/Synchrophasor Data Integration Plan

2008 - Present

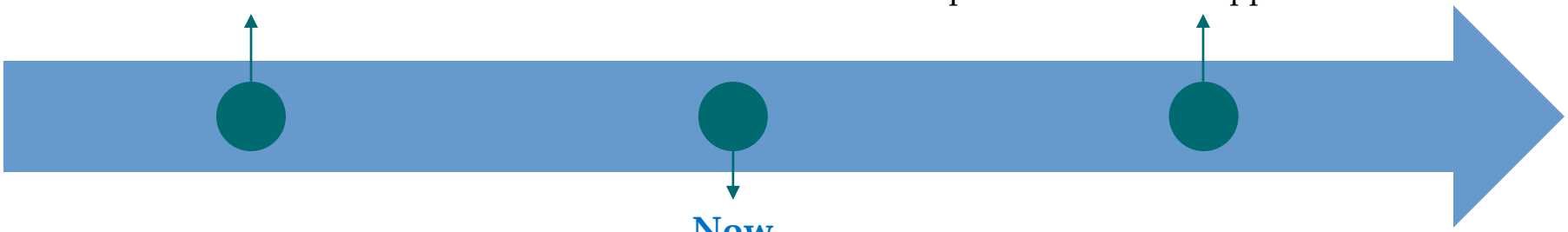
Phase 1: Pilot Project

- Data received from 11 pilot PMUs installed by Hydro One
- Data utilized for limited off-line applications

Estimated 2021 - 2024

Phase 3: Implementation of Plan developed in Phase 2

- Upgrade IT structure and implement Wide Area Monitoring System (WAMS)
- Acquire synchrophasor data from up to 200 PMUs (Ontario and external)
- Enhance off-line applications and implement real-time applications



Now

Phase 2: Analyze and Identify Requirements - Plan for Expansion of PMU Infrastructure

- Developed IESO Roadmap for PMU implementation
- Developed high-level technical and regulatory requirements for Ontario
- Stakeholder the requirements with participants

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SYNCHROPHASOR DATA NEEDS AND PROPOSED MARKET RULES CHANGES

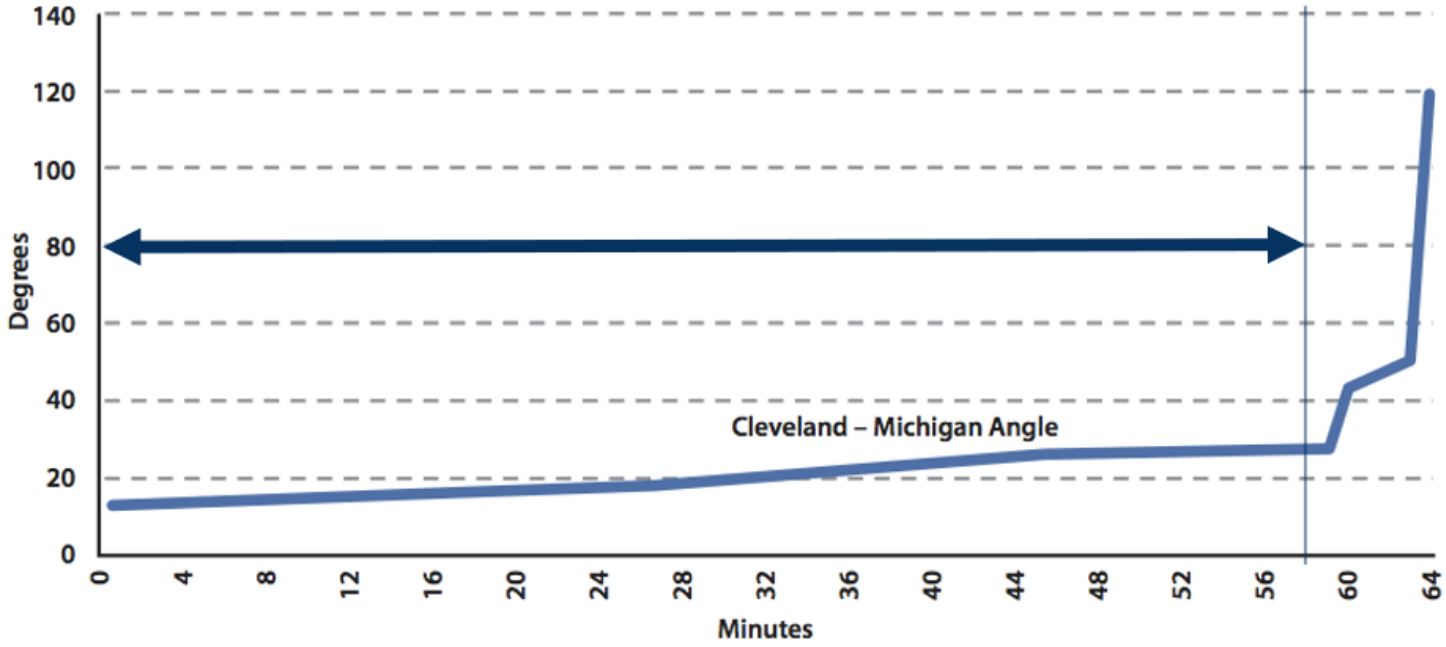
SCADA Data versus Synchrophasor Data

Consideration	SCADA Data	Future Synchrophasor Data
a) Time Skewness	SCADA data is time-stamped at the instant it is received at the Control Center, as opposed to the instant the measurement was taken.	Synchrophasor data is GPS time-stamped at the instant of measurement at source.
b) Angle Skewness	Voltage information received in SCADA data does not include angle. This requires angles be computed at the Control Center. This makes angles in wide-area views inconsistent.	Synchrophasor data has angle information.
c) Sample Rate	SCADA data is provided at a rate of 1 data point per 2 - 10 sec.	Synchrophasor data is provided at a rate of 30 - 60 data points per sec. Higher resolution in synchrophasor data exposes system conditions and events not detected with SCADA data.

NERC requires Reliability Coordinators to have real-time and after-the-fact ability to view the grid beyond its portion of the power system.
(a) and (b) pose challenges in just using SCADA data.

Importance of Synchrophasor Data (Angles)

(1) The 2003 August Northeast Blackout

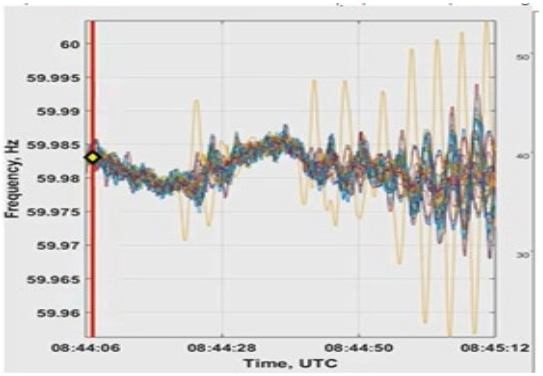


- Signs that the system was inching towards collapse were invisible due to the inability to monitor the behaviour of voltage angles in real-time.

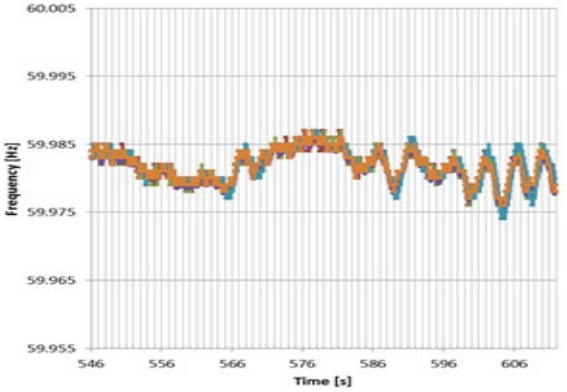
Importance of Synchrophasor Data (High Resolution)

(2) The 2019 January Oscillations across Eastern Interconnection

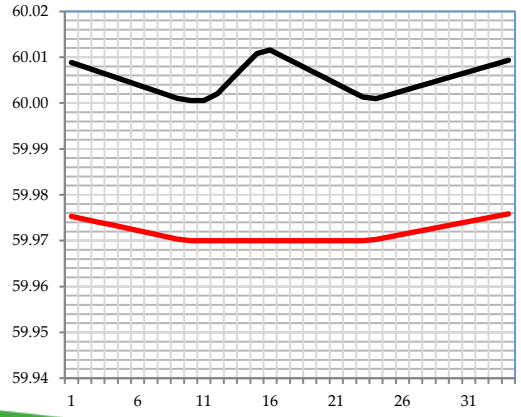
Frequency from FNET



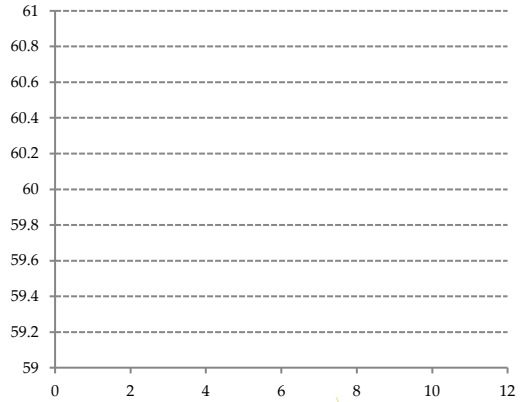
Frequency from Ontario Pilot PMUs



Frequency from Ontario SCADA



Frequency from Ontario DDR and DFR



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Synchrophasor data in perspectives of Wide Area View

- Synchrophasor data will be exchanged among Reliability Coordinators
- Synchrophasor data eliminates time and angle skew of data arriving from different Reliability Coordinators
- Enables high resolution measurements including angles to enter the IESO applications
- Facilitating viewing a wider portion of the interconnected grid more accurately and more consistently

Who is Impacted and How

Generation (applicable to Major Generation Facilities) – Appendix 4.15

- Generation Unit ≥ 100 MVA *(required quantities are current, voltage and frequency from generator terminal)*
- Aggregated Generation Units ≥ 100 MVA *(required quantities are voltage, aggregated current and frequency from generation facility side of the connection point to the grid)*

Transmitters (applicable to 50 kV and higher) – Appendix 4.16

- 500 kV stations, Bulk Power Stations, Stations required to restore the grid from black-start units *(required quantities are voltages and frequency from two station buses)*
- Circuits defining Interconnection Reliability Operating Limits (IROL) and Interties *(required quantities are currents, voltages and frequency from circuit terminals)*
- Dynamic reactive power devices *(required quantities are current, voltage and frequency from terminal)*

Synchrophasor Data Requirements

- Comply to latest approved *IEEE standard for Synchrophasor Measurements* at the time of the installation of the phasor data measuring device. Lesser standards are acceptable where data is generated by a pre-existing device
- Measure voltage, current and frequency quantities at a minimum rate of 30 samples per second.
- Provide positive sequence information of voltage and current quantities
- Provide data with a latency of no more than 100 msec
- The accuracy of Instrument Transformers must be equal or better than those used for SCADA measurements.
- Bandwidth must be adequate for the required data rate. Dedicated channels are preferred to avoid interruption and excessive latency.

Implementation Schedule

The IESO is proposing the synchrophasor data be provided to the IESO:

- At the time of the connection of the facility to the IESO-controlled grid, if it occurs after December 31, 2020*
- For a facility connected to the IESO-controlled grid on or before December 31, 2020*:
  - For the Market Participants having one facility, the phasor data to be provided by December 31, 2022*
  - For the Market Participants having more than one facility, the phasor data to be provided via mutually agreed staged implementation plan

*Effective dates are subject to change based on stakeholder feedback and market rule amendment implementation timelines

Summary and Stakeholder Feedback

- Today, the IESO has provided details on synchrophasor technology needs and related Market Rules changes being proposed.
- The IESO is seeking stakeholder feedback on Proposed Rules (slide 15), Requirements (slide 16) and Implementation Schedule (slide 17)
  - Please use the feedback form found under the June 24th entry of the Updates to IESO Monitoring Requirements: Phasor Data webpage and send to engagement@ieso.ca by July 15th
  - IESO will work to consider feedback and incorporate comments as appropriate and post responses on the Updates to IESO Monitoring Requirements: Phasor Data webpage