IDEA2022

Building Connections

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INTERNATIONAL DISTRICT ENERGY ASSOCIATION

CHP as the Backbone of an Industrial Microgrid in Toronto

Steve Quinlan, CEM Engineering

Johnathan Coleman, Solar Turbines Canada Ltd.

CEM ENGINEERING
Building A More Functional World

Solar® Turbines
A Caterpillar Company

THE INTERNATIONAL GROUP, INC.

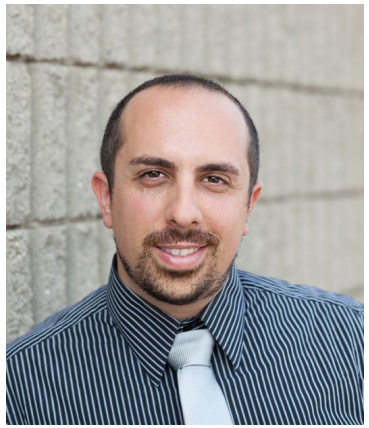
- The World's only dedicated Paraffin and Microcrystalline wax producer utilizing internally sourced materials
- Founded in Toronto, Ontario in 1943
- 9 plants across North America

Dorin Marian

- *Manager of Energy, Engineering and Maintenance*
- *Over 20 years experience working at IGI*
- *Internal champion of CHP project*

CEM ENGINEERING
Building A More Functional World

- Thermal Power project delivery firm, founded in Niagara Region in 2001
- Designed over 44 CHP Projects, with 3 offices across Canada
- Owner's Engineer on IGI Project



Steve Quinlan

- *Manager of Electrical Engineering*
- *15 years experience working at CEM*
- *Electrical Lead and EOR of CHP Project*

Solar® Turbines
A Caterpillar Company

- World's largest manufacturer of combustion turbines (1 to 39 MW)
- Over 16,000 units installed with over 3 billion operating hours experience
- Turbine OEM on IGI Project

John Coleman

- *Senior Account Manager for Canada, NY & New England*
- *35 years experience in the power industry*
- *Principal Engineer for Solar Canada*

Problem

Why did IGI consider a Microgrid with On-site Generation?

1. Resiliency
   - Impact of power interruption on process (especially wax temperature)
   - Improve continuous (24/7) operation & reduce/eliminate shutdowns

2. Economics
   - Reduce energy (electricity and fuel) costs
   - Reduce process losses due to unplanned shutdowns

- IGI experienced a local electrical utility outage and a natural gas curtailment event at the same time, resulting in a complete 'freeze-up' of the plant.

Solution

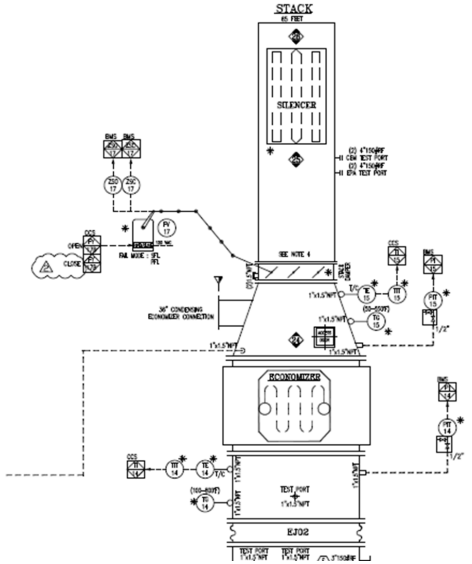
- Cogen provides both electrical and steam resiliency while also reducing operating costs.
- Combustion turbine-based CHP to supply all electric (3 MW) and thermal (90,000 lb/hr) plant loads.
- Electrical and thermal generation capacity sized to supply all plant loads in islanded (grid disconnected) mode of operation.
- The Province of Ontario provided grants (up to 40% of the eligible project costs) for high-efficiency behind-the-meter cogeneration projects that result in a reduction in electricity consumption.
- IGI visited multiple GTG sites who raved about their GTGs and how well they islanded, demonstrating the capabilities of the solution.

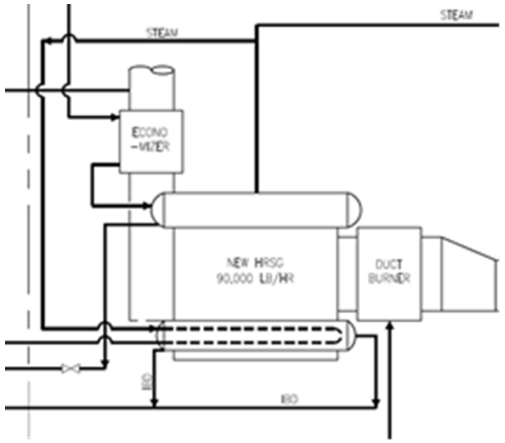
Case Study: International Group Inc.

- 3.5 MW Gas Turbine (Centaur 40) with dual fuel
- Rentech Heat Recovery Steam Generator with supplementary firing
- Emerson Vilter Fuel Gas Booster Compressor
- New 5 kV & 27.6 kV Electrical Switchgear
- Automatic islanding capability
- Black start capability
- Installed inside new cogen building, located within existing plant footprint

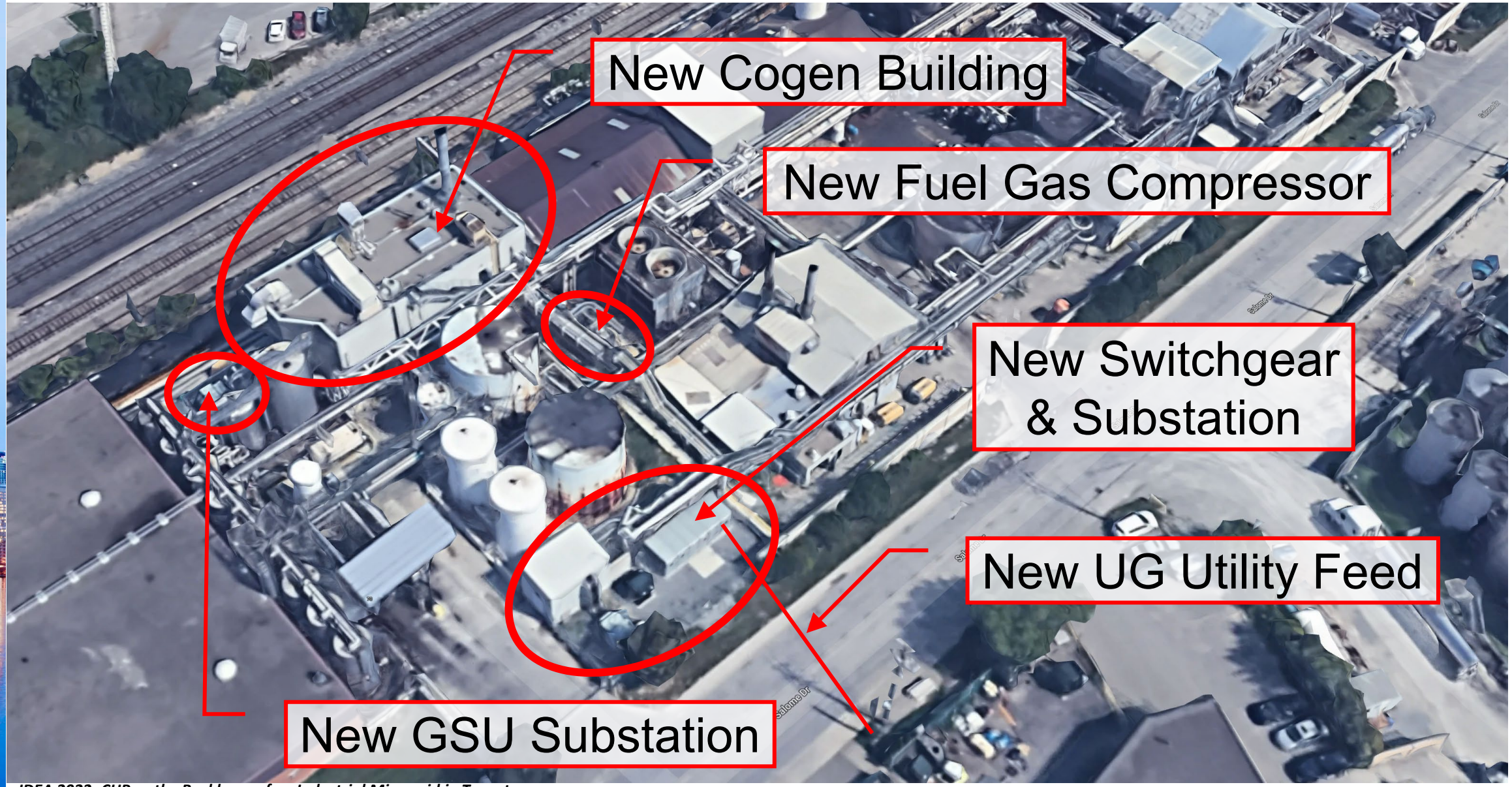
THE INTERNATIONAL GROUP, INC.

Case Study: International Group Inc.





Case Study: International Group Inc.



Project Overview

2018

2019

FEED, Permits, Design

Construction

Commissioning

Construction: GTG & HRSG

Major equipment installation in constrained urban operating plant

Construction: Cogen Building

GSU Substation

Construction: Fuel Systems

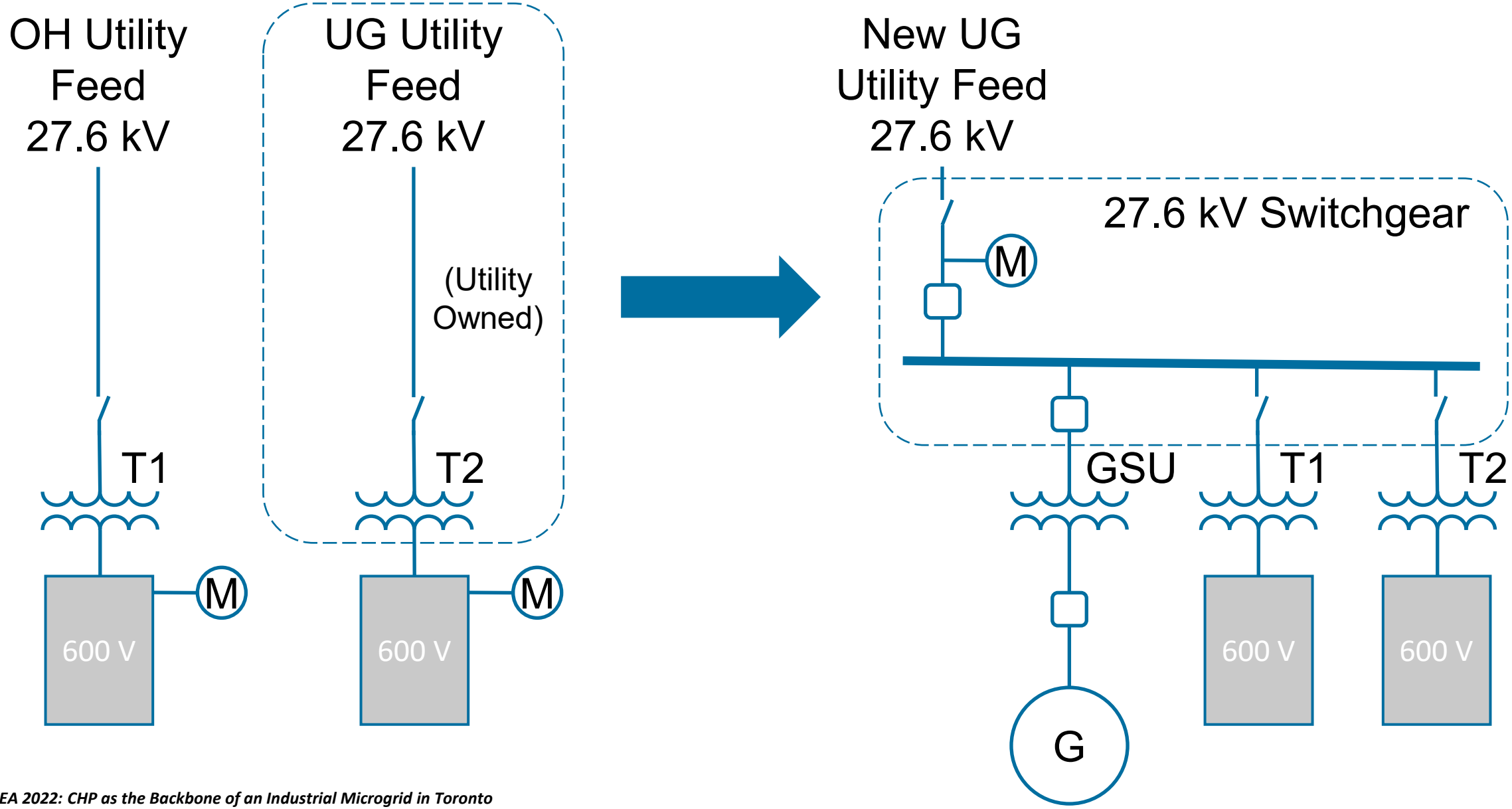
Fuel Gas Booster Compressor (FGBC)

Diesel Tank

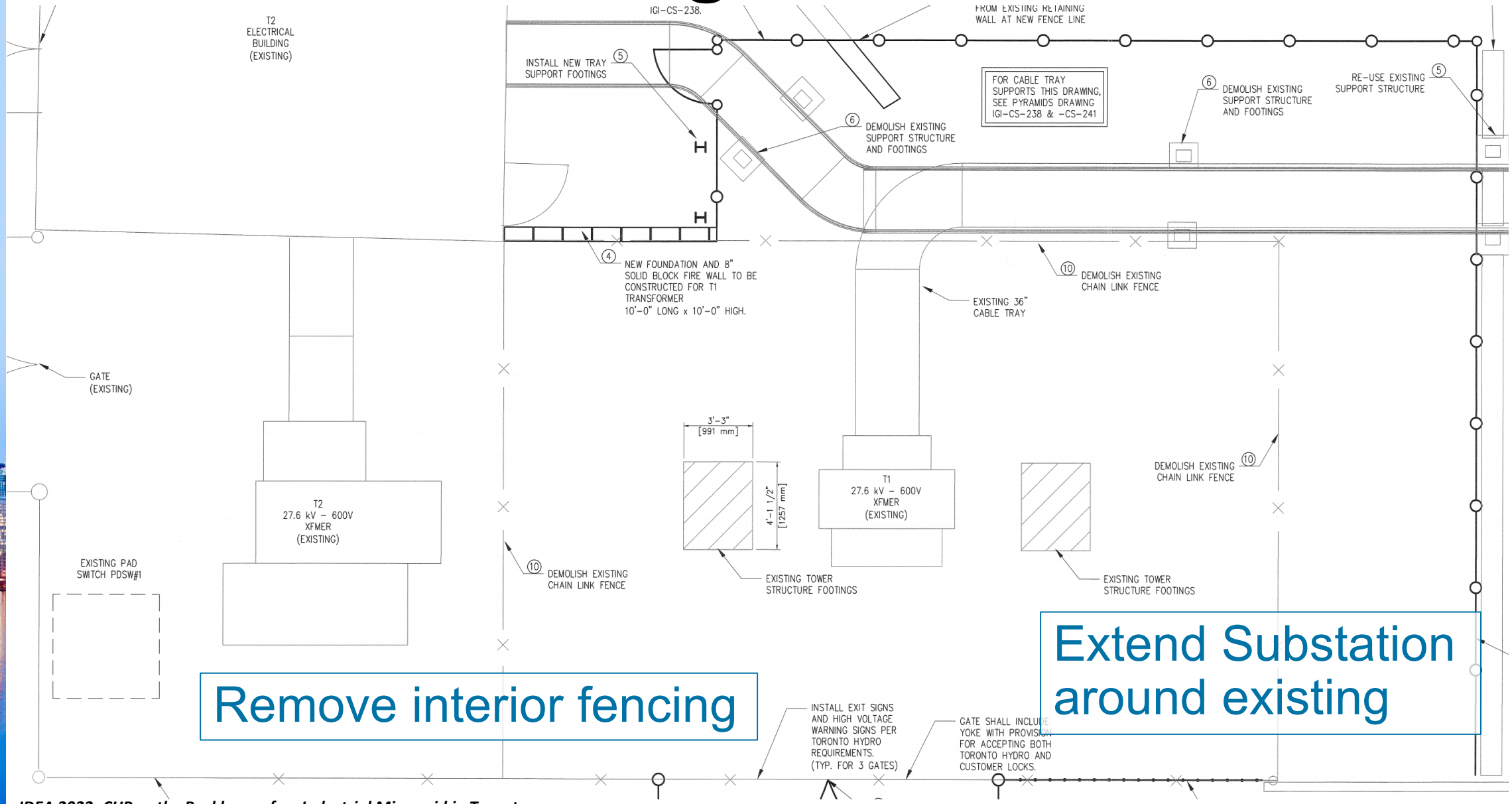
Electrical Substation Upgrade

- Existing load was divided between two separate utility services, with one utility-owned transformer.
- Reconfiguration and new 27.6 kV switchgear was necessary to supply full plant load and allow for islanding.
- New substation to be built within existing substation footprint, while still in service, without shutdowns (minimal interruption).
- New substation must meet new utility standards, requirements, and approval process, in addition to generation interconnection approvals.

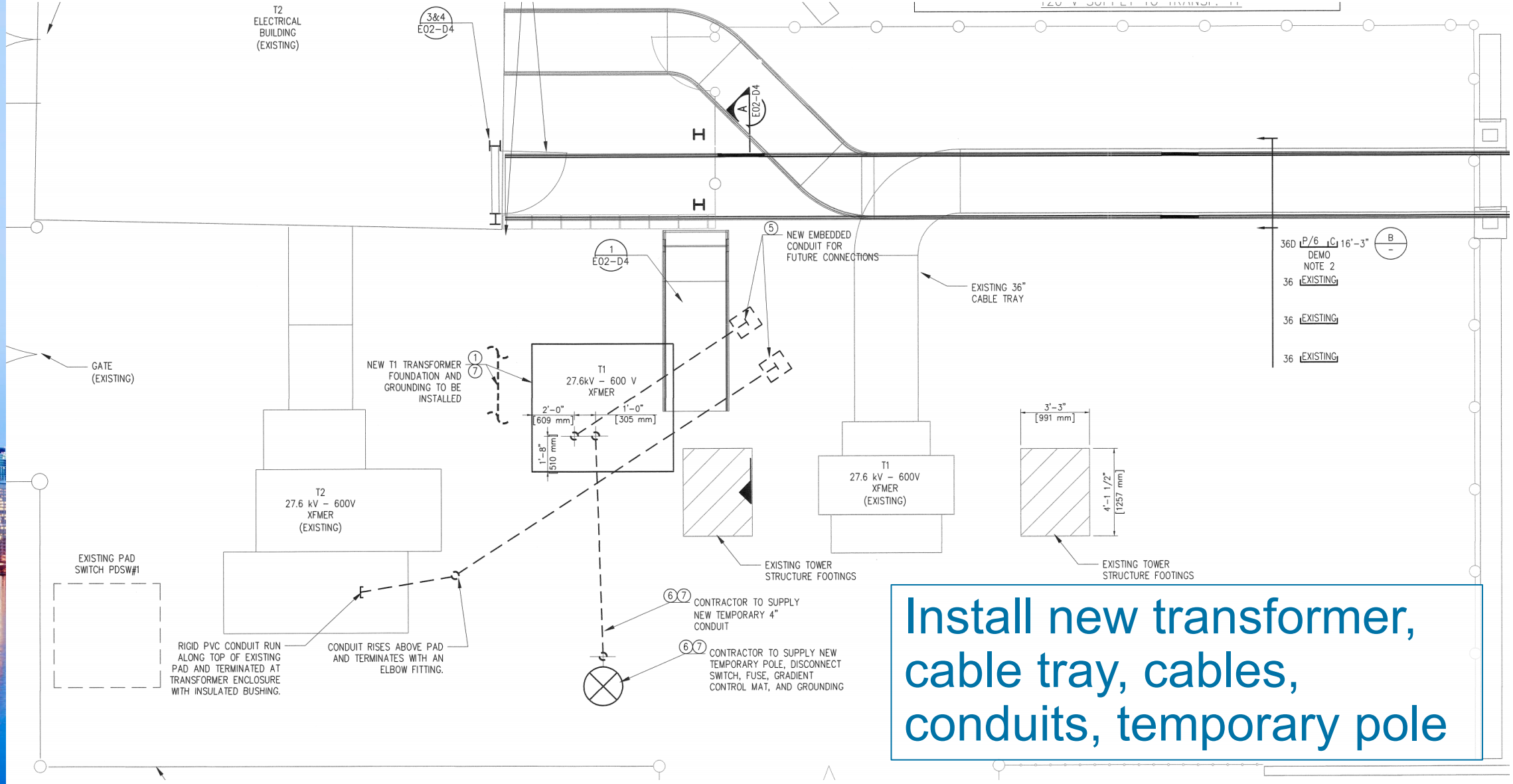
Electrical Substation Upgrade



Electrical Reconfiguration – Phase 1

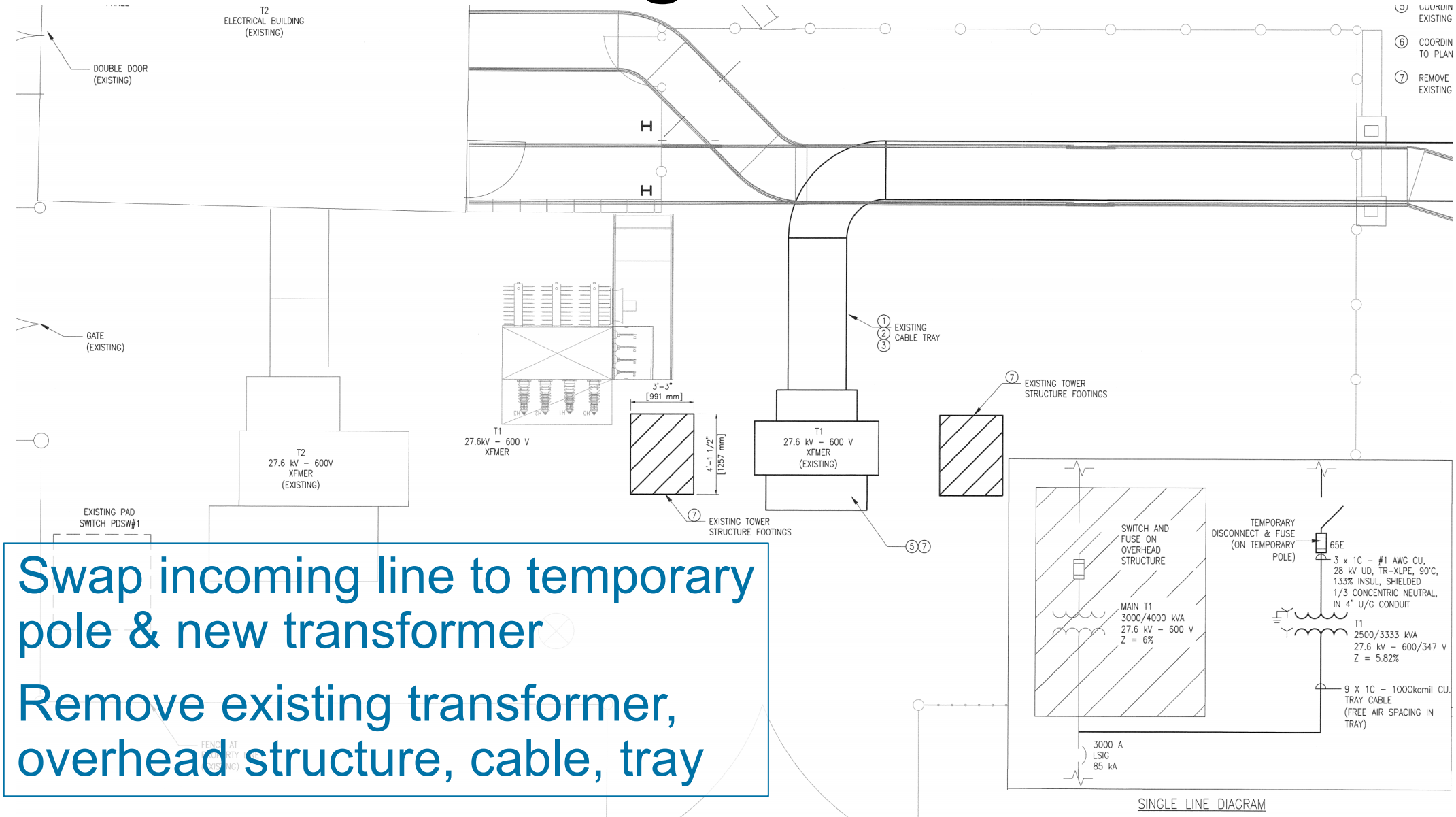


Electrical Reconfiguration – Phase 2



Install new transformer, cable tray, cables, conduits, temporary pole

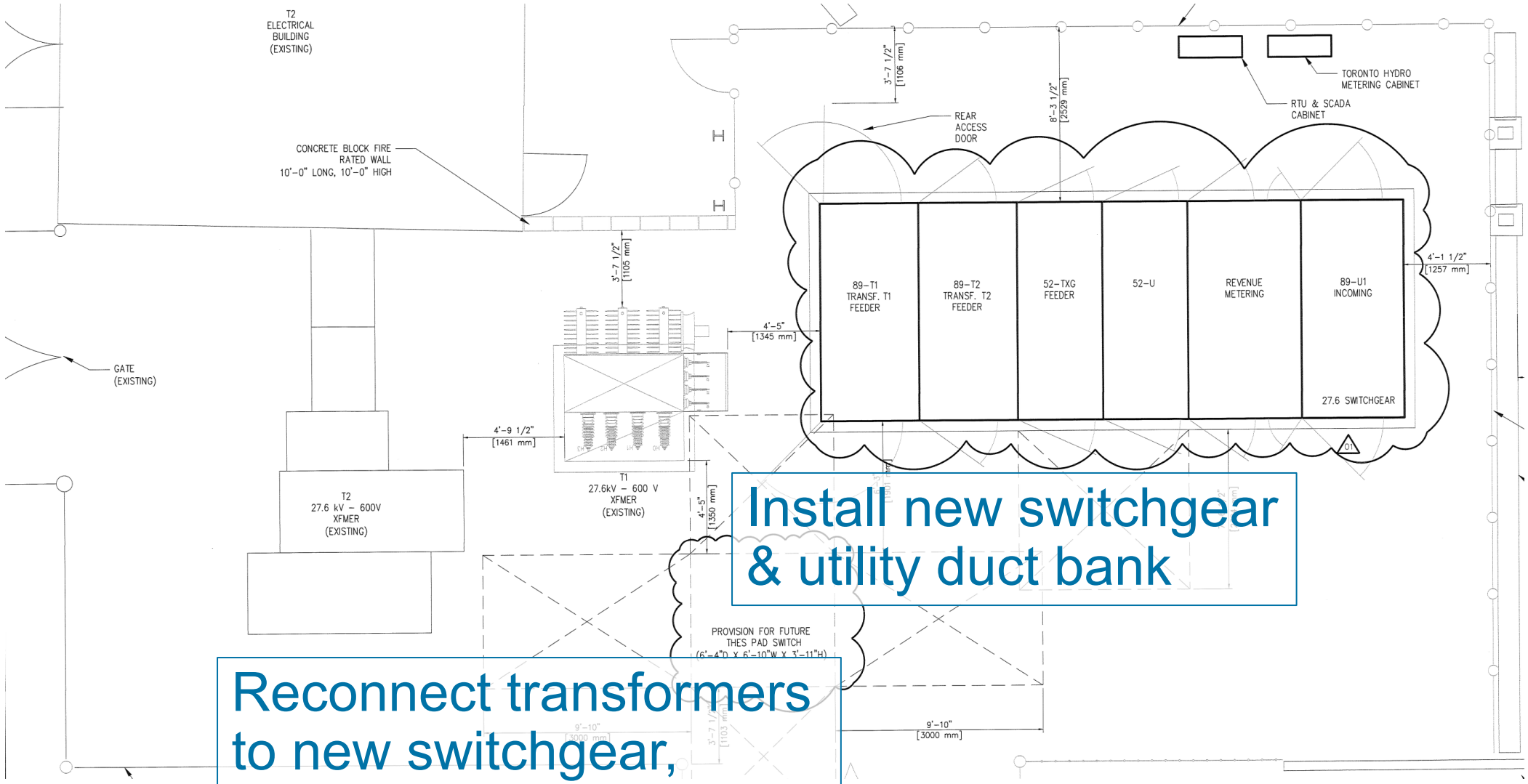
Electrical Reconfiguration – Phase 3



Swap incoming line to temporary pole & new transformer

Remove existing transformer, overhead structure, cable, tray

Electrical Reconfiguration – Phase 4



Install new switchgear & utility duct bank

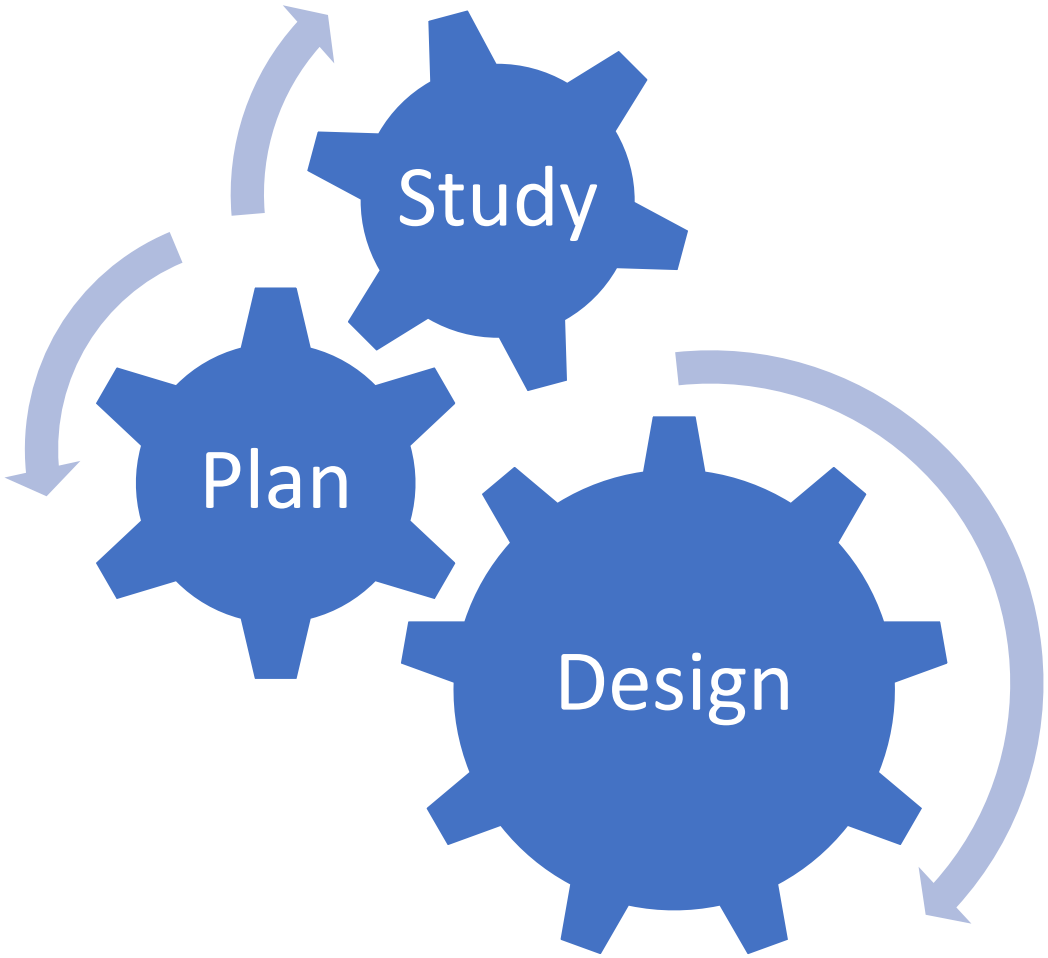
Reconnect transformers to new switchgear, remove temporary pole

Electrical Reconfiguration – Phase 4

Lessons Learned

- Project Development
- Permits/Approvals
- Design Considerations
- Commissioning
- Plant Operation

Project Development



- Proper Front End Engineering and Design (FEED) is required to properly assess CAPEX estimates.
- Although smaller projects may have less development funds available to support this, **FEED effort focused on key risk factors is critical to project success**; avoids costly oversights or underestimation of project costs.

Permits/Approvals

- Authorities Having Jurisdiction
  - Develop permitting plan early.
  - Early and continuous engagement/communication, and documentation.
  - Coordination with multiple utility departments adds complexity.
  - Thorough awareness of utility standards is essential (may change over the course of the project).

- Equipment Certification
  - Establish certification requirements early.
  - Specify factory certification wherever possible (CSA/UL labels prior to shipment) to facilitate local inspector's approval at site.

Permits/Approvals

- Noise (residential area)
  - Incumbent air and noise consultant was hired to complete Emissions Summary Dispersion Model (ESDM) for air permit and Acoustic Assessment Report (AAR) for noise permitting.
  - Silencers were installed for gas turbine ventilation, gas turbine combustion inlet and HRSG exhaust.
- Municipality – given the nature of the site in an urban area, the City of Toronto was engaged early to support permitting and avoid the requirement for public consultation.
- Noise limits and local stakeholders drove the decision to build the whole plant in a building.

Design Considerations

- Site Specific Design Considerations
  - Protect air inlets from snow, ice, rain, bugs, pollen, dust
- Built-in Provision for Resiliency Upgrades
  - Black start transfer switch with connection box for diesel generator
  - Combustion turbine with dual fuel (natural gas & diesel) capability
- Even minor design issues/challenges can cause operational issues; high temperatures in the building due to insufficient HVAC can cause GTG/HRSG trips.
- Non-interruptible gas contract for GTG to guarantee grant contract obligations are met and ensure they could always make power and heat to keep the plant 'warm' at all times.

Commissioning

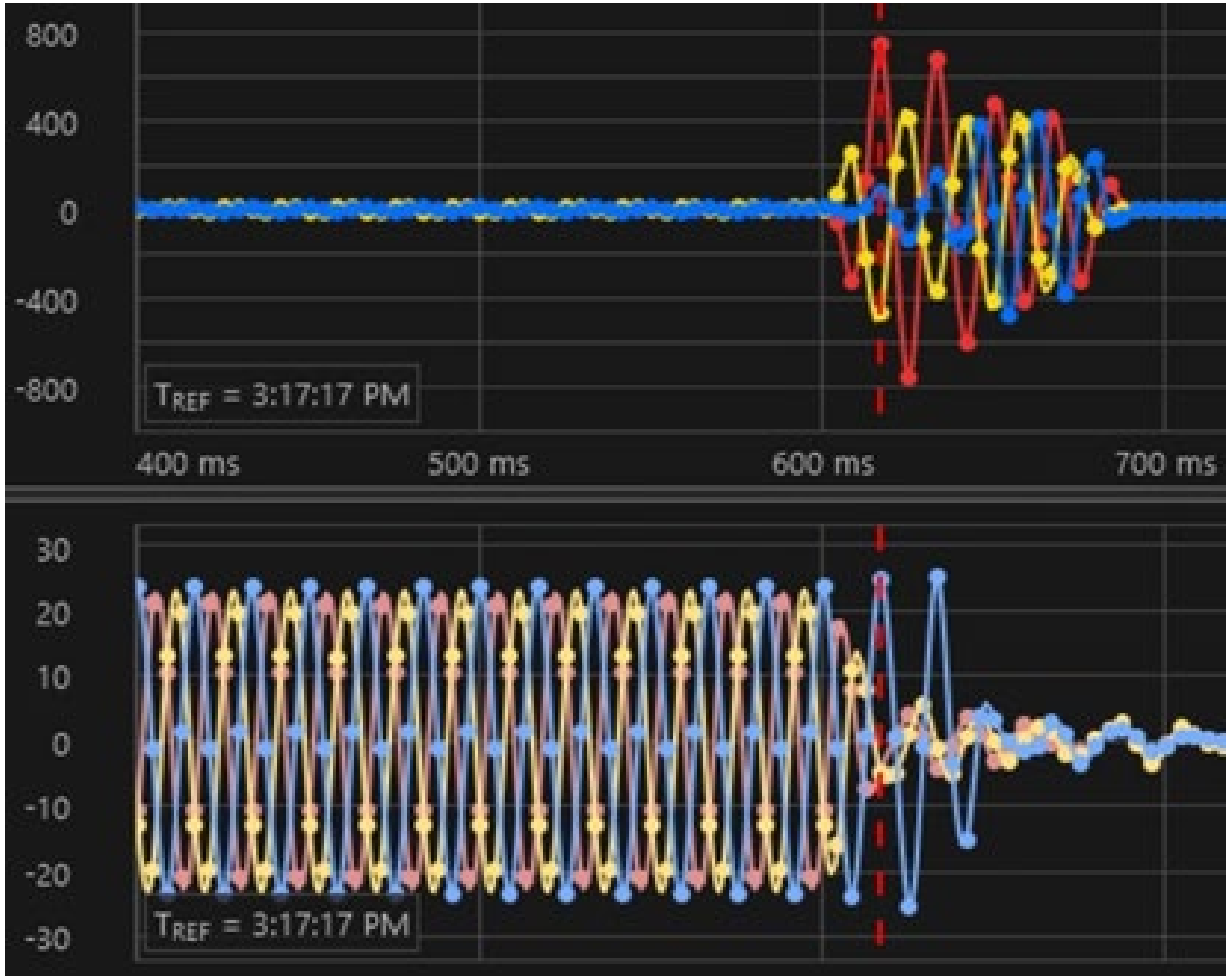
- Develop commissioning plan during engineering phase.
- Plan for load bank testing to avoid impact/risk to plant loads.
- Include sufficient contingency in commissioning schedule.
  - Especially when multiple entities need to participate in witness testing.

Commissioning

- Ensure synchronization devices measuring different sides of a transformer account for phase shift (+/- 30°?).
- Unpredictable synchronization voltages may indicate a ferroresonance condition; damping system may be needed to stabilize voltages consistently.
- Generator import control should be tested for expected process load changes and tuned to ensure stable response.
  - Be aware of process operations that impact load and simulate risk of reverse power tripping.
  - Avoid overly sensitive power export protection to allow for smooth, efficient response to load transients.
- Use time-synchronized event data for troubleshooting.

Plant Operation – Planned Islanding

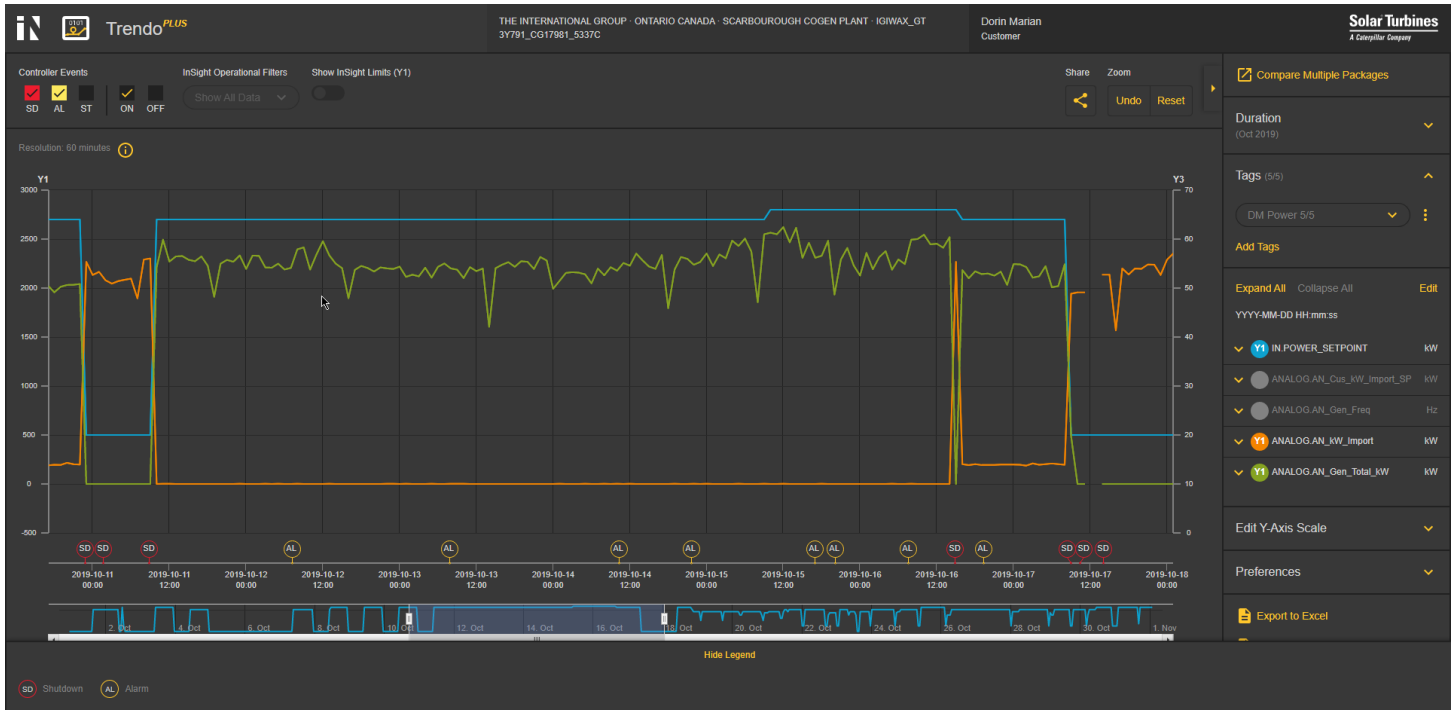
- Localized lightning strike can impact plant equipment faster than islanding can occur, leading to shutdowns.
- Proactively islanding the plant in response to predicted weather events can mitigate risk from exposure to the grid and increase resiliency.



Plant Operation – Planned Islanding

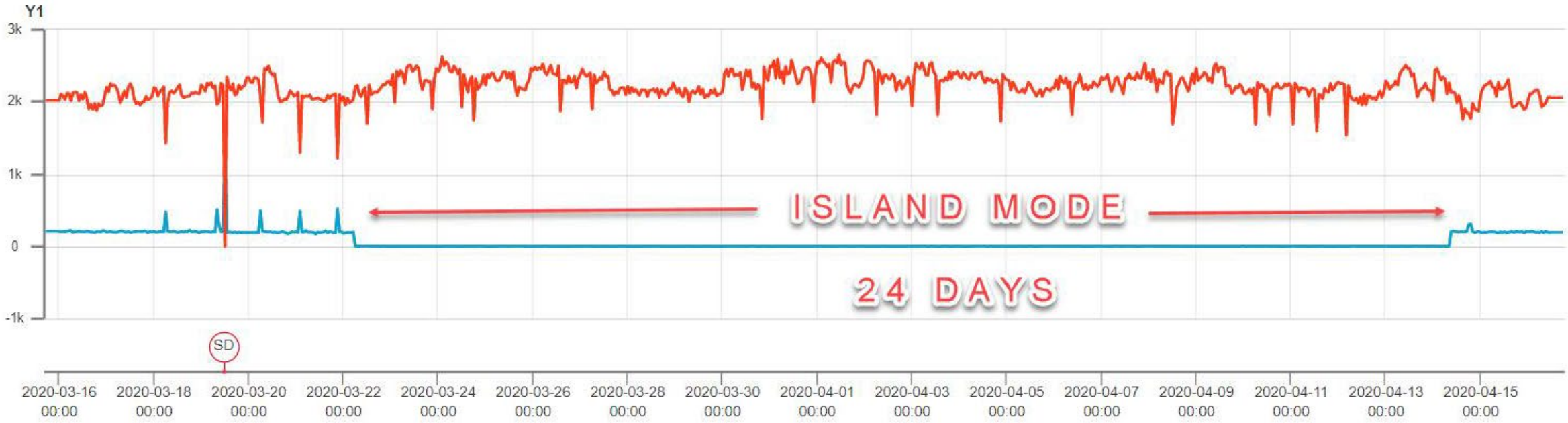
- Utility maintenance outages (switching to alternate feeder) necessitate cogen shutdown or planned islanding:
  - 3.5-hour planned outage: decided to island; outage became 5 days
  - 2 day planned outage: decided to shut down; outage became 8 days

- Experience from these outages increased IGI's confidence in the system's reliability as well as the economic benefits of islanding.



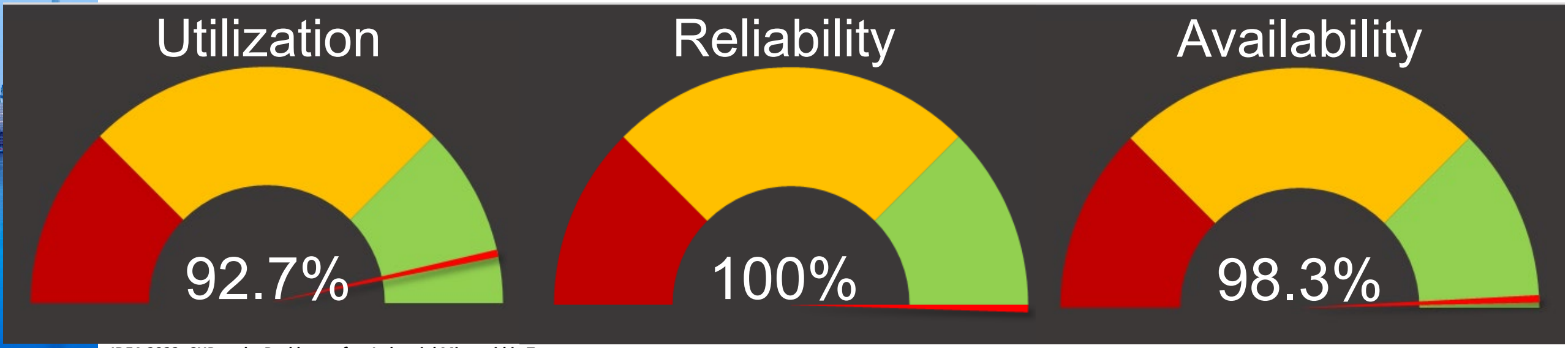
Plant Operation – Planned Islanding

- Subsequent 3-hour planned outage was extended to 24 days.
- Proactively islanding the plant saved considerable cost and further increased confidence.
- Now the plant islands continuously, except for maintenance.



Results

- Project efficiency target achieved in accordance with grant.
- Long Term Maintenance Contract maximizes reliability, ensures continuous operation, tracks performance, and identifies issues.
- Total Run Time: >22,000 hours
- Operational Statistics for April 2021 – March 2022:



Questions?

Thank You!

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