



KINECTRICS

GridSim Power Lab

Grid Simulator Platforms and Experiences

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Kinectrics Company Overview

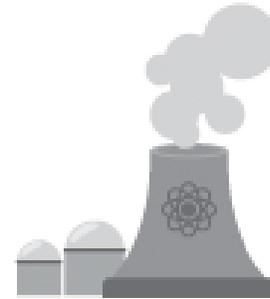


Company
Video ▶

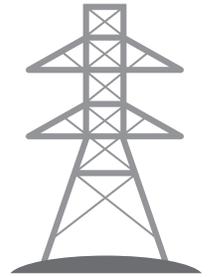
KINECTRICS IS AN INTEGRATED LIFE CYCLE MANAGEMENT SERVICES FIRM.

We deliver **sustainable & innovative** solutions to the toughest problems facing the electricity industry.

Focused on serving distinct **GLOBAL** markets:



NUCLEAR
+ **T&D**



PEOPLE



1100+ highly technical staff

FACILITIES



Over **30+** unique laboratories

CUSTOMER



HIGH Satisfaction Rating

“Safety is our Culture | Quality is our Promise”

Facilities & Equipment

Over 30+ state-of-the-art laboratories and 400,000 sq. ft. of operations facilities with specializations in:

- Transmission & Distribution
- Nuclear and Chemistry
- Tooling and Maintenance
- PPE
- Specialized Material
- Reverse Engineering



Kipling Campus



Downtown Toronto



Tiverton, ON



Teeswater, ON



Romania



India



Louisville, KY



Naperville, IL



Fremont, CA



United Kingdom

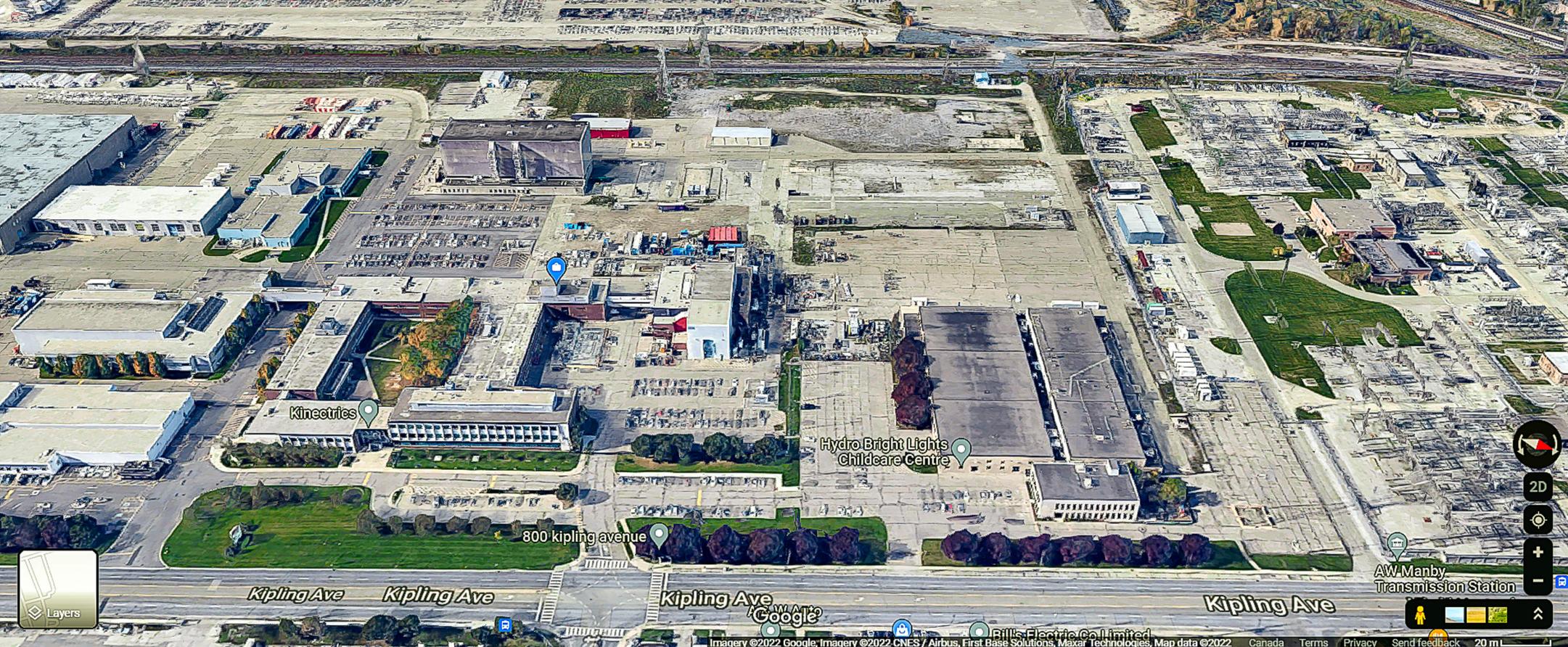


Germany

Kipling Campus, Toronto



Kipling Campus, Toronto



GridSim Power Laboratory



GridSim Power Laboratory

Overview

- Dynamic power testing for MW class equipment
- A state-of-the-art independent commercial lab
- Geared to the interests of utilities, developers, manufacturers, and standards organizations to **research, develop, test, and certify new technologies** in support of safe renewable power integration with the grid
- Testing of smart grid and distributed generation equipment and other medium power systems over a wide range of voltages and frequencies
- T&D expertise provides supportive consultation
- Working with accreditation bodies – UL, TUV, CSA, etc.



GridSim Power Lab Applications

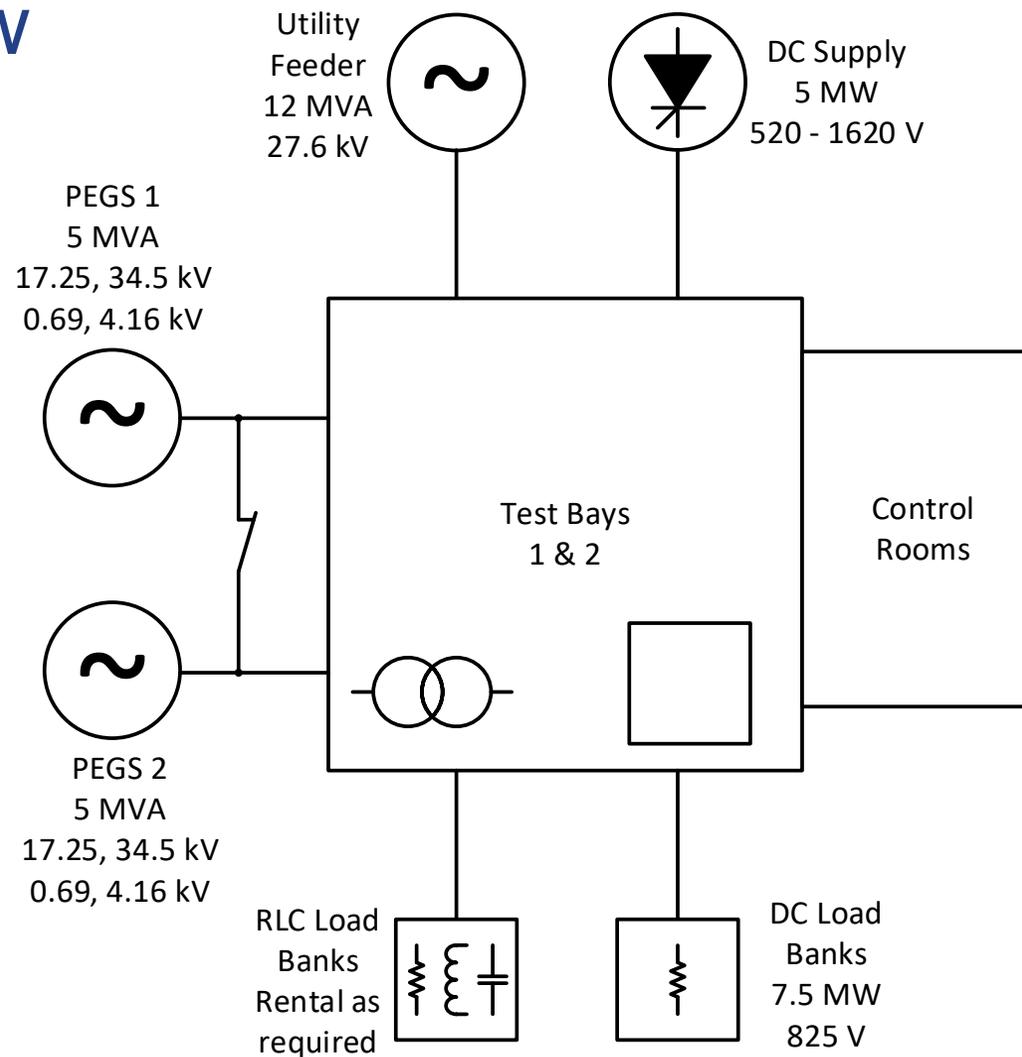
Key customer segments

- Distributed Energy Resources (DER)
 - PV Inverters, ESS Inverters, Wind Power Converters, Gensets, etc.
 - Certification testing - UL 1741 SA/SB & IEEE 1547.1-2020
 - Efficiency testing
 - Model validation
- Light Rail Transit (Power Substations)
 - Traction Rectifier Units (TRUs), Traction Inverter Units (TIUs) bi-directional systems
 - Type-testing to IEEE 1653 and EN 50327
- Other MV / Power equipment:
 - Transformers, converters, motors, pumps, blowers, etc.



GridSim Power Laboratory

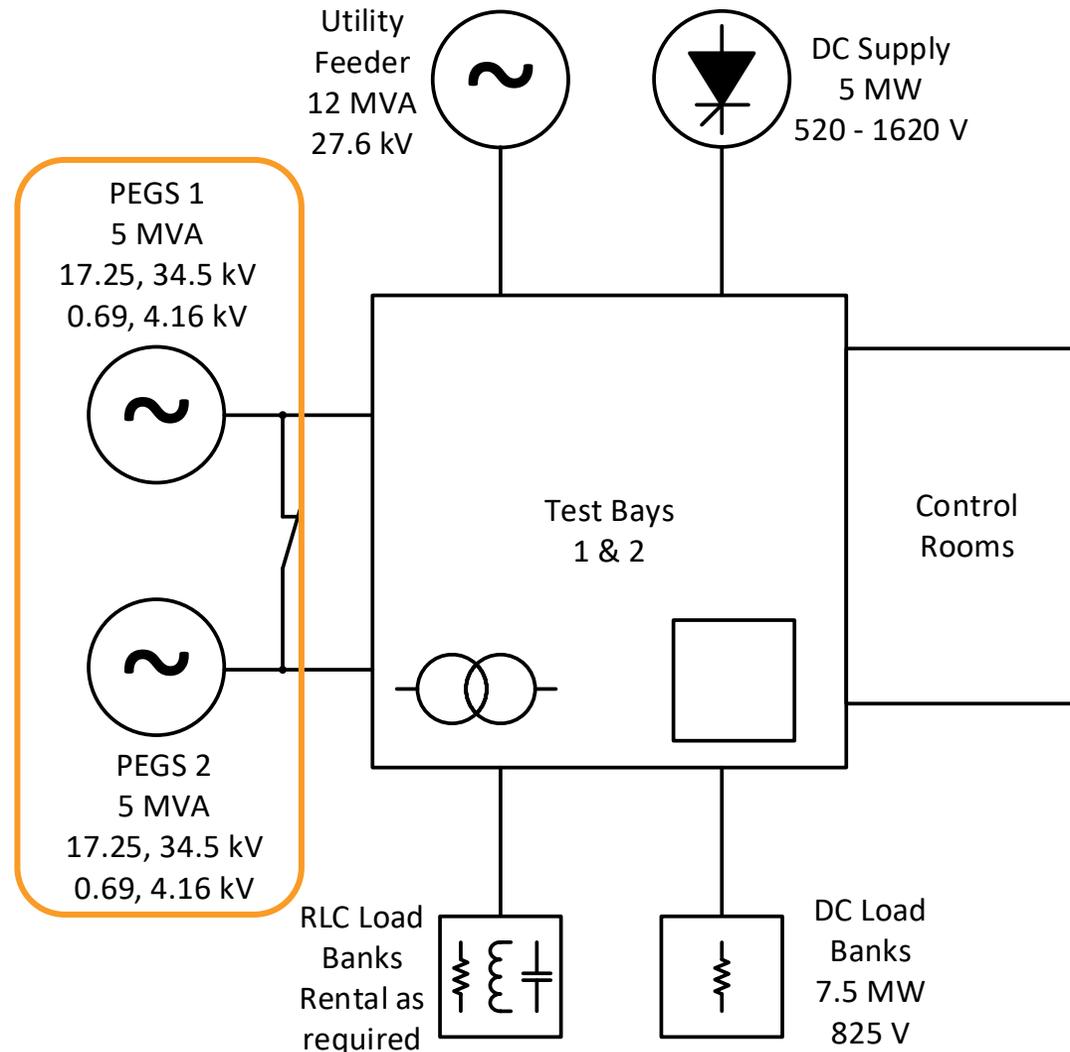
Technical Overview



Power Electronics Grid Simulator

ACS6000

- 10 MVA continuous
- 4 quadrant
- Dual-bay design
- Independent phase control
- Dedicated feeder circuit breaker
- Input 3 winding transformer
- Liquid cooled system with external fin fan
- Output configurable MV transformer
- Output configurable MV RC filter
- Cable connection point panels for EUTs



Power Electronics Grid Simulator

ACS6000 – internal and external views



Power Electronics Grid Simulator

ACS6000 – North Switchyard with Input Transformer



Power Electronics Grid Simulator

ACS6000 – Fin Fan, Output Filter, Output Transformer

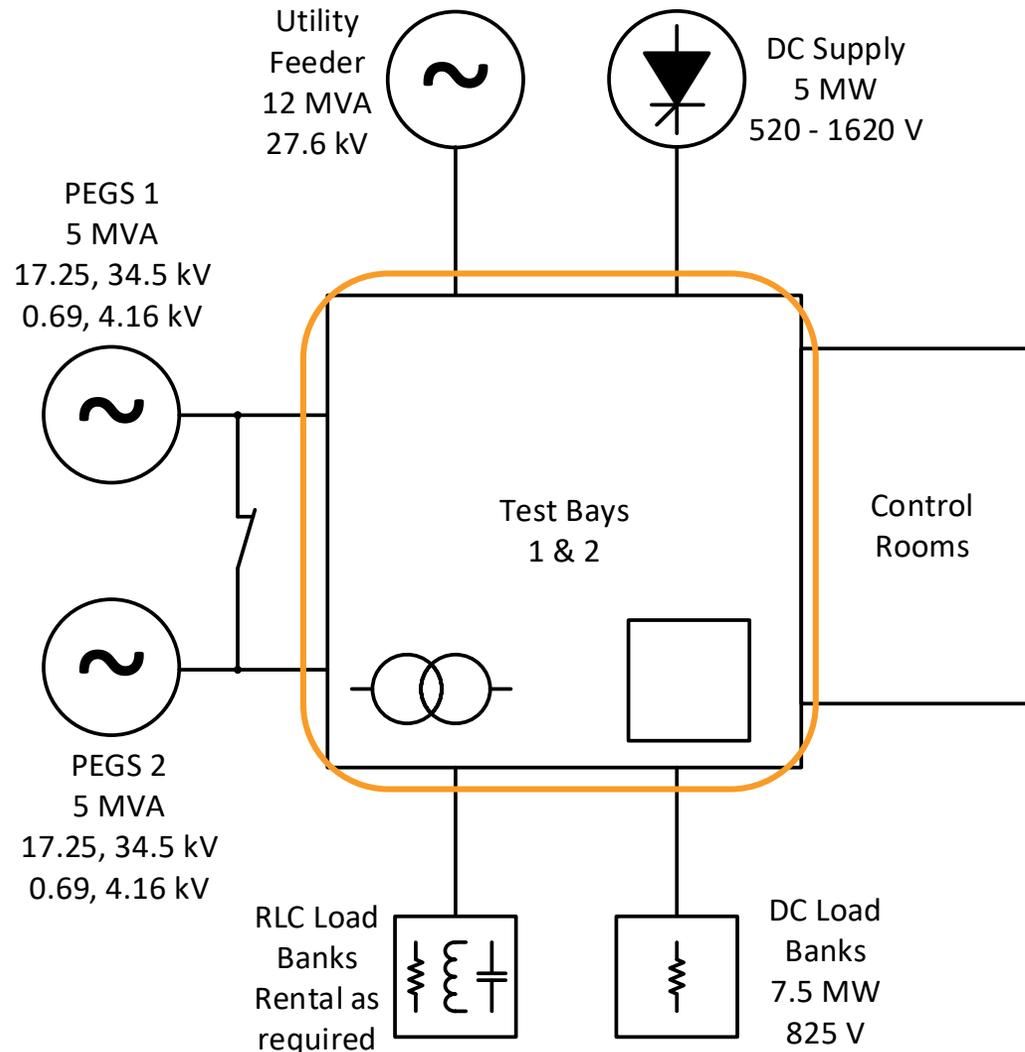


				Momentary	Continuous	Momentary	
AC Grid Simulator	20 - 42 kV	45 - 67 Hz	10,000 kVA	12,000 kVA for 60 s 13,000 kVA for 30 s 14,000 kVA for 15 s 15,000 kVA for 5 s	210 A		<ul style="list-style-type: none"> - Independent control of phase voltage magnitudes, Phase angle, frequency - Voltage changes 20 pu / cycle - Frequency changes 20 Hz / cycle - 4-quadrant source/sink - Virtual grid impedance emulation - Transformer voltage drop compensation - Harmonic injection
AC Grid Simulator	10 - 21 kV		10,000 kVA				
AC Grid Simulator	2.5 – 5.0 kV		5,000 kVA	N/A	1,200 A		
AC Grid Simulator	400 - 830 V		5,000 kVA	N/A	6,000 A		
DC Supply	520 - 1,620 V	DC	5000 kW	9,500 kW for 60 s 14,000 kW for 15 s	8,000 A		

Test Bays 1 & 2

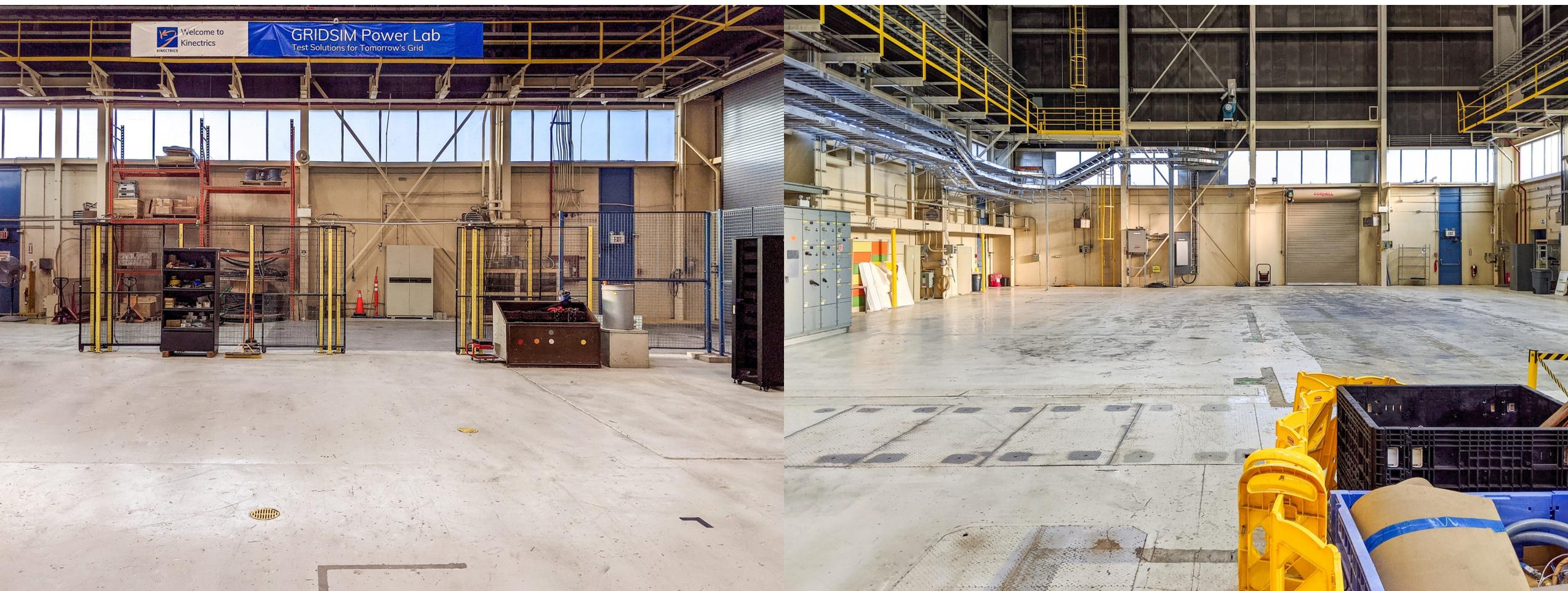
Key Features

- 2 test bays
- North & south truck accessible roller doors
- 4,000 ft² test floor with ground grid
- 72 ft working height
- 15/75 ton dual-hoist bridge crane
- 120 / 208 / 240 / 347 / 400 / 480 / 600 V auxiliary power to 800 kVA
- Coordinated protections using IEC61850
- Safety interlocked access to MV areas



Test Bays 1 & 2

KG South Loading Door and North Loading Door



Test Bays 1 & 2

2000 kW Traction Inverter Unit (2021)

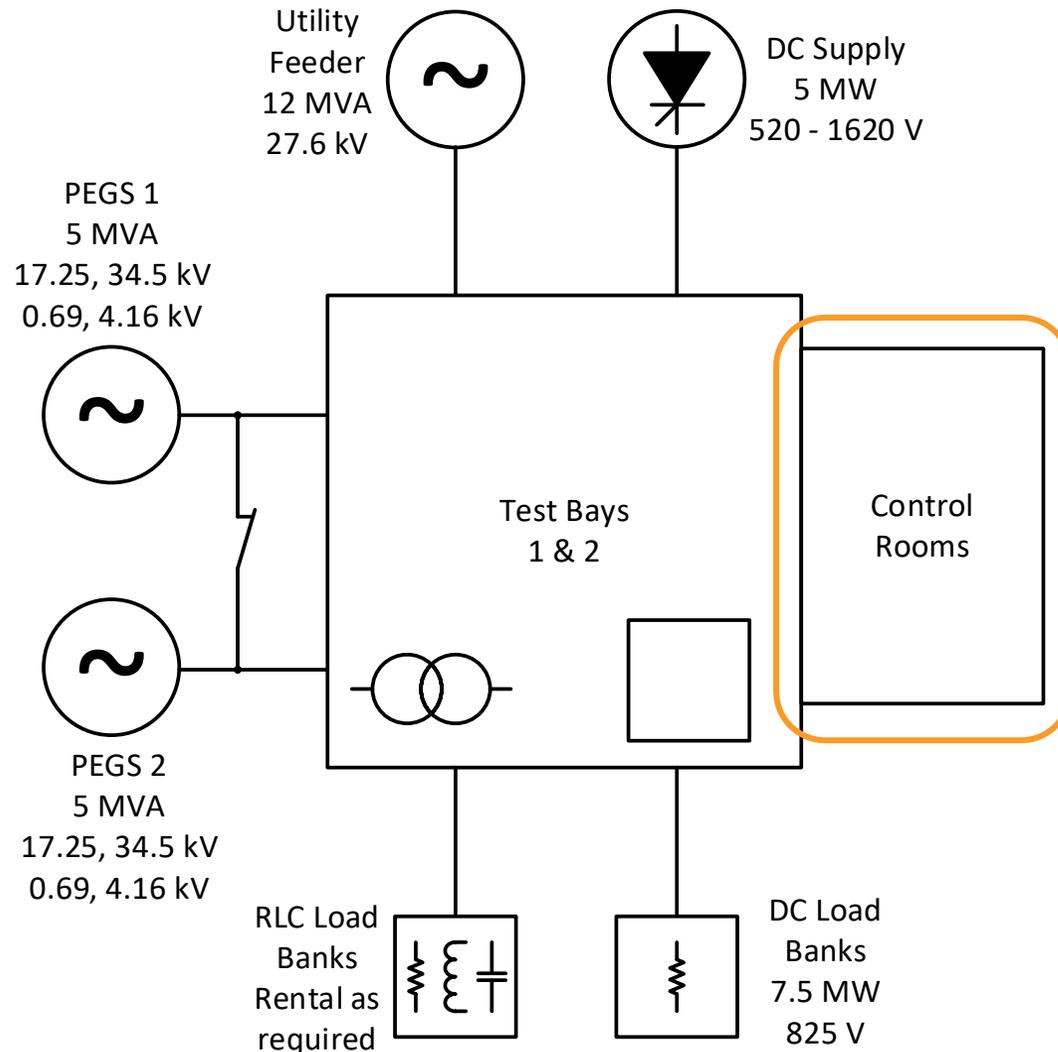


Control Rooms & Instrumentation

Key features

- 2 control rooms
 - Air-conditioned and sound insulated
 - Estops available
 - Multiple video feeds
 - Supports witness testing
 - Dedicated HMI and DAQ stations
 - In-house developed HMIs (profiles)

- Full suite of instrumentation
 - Voltage, current, advanced meters, temperature
 - Traceable calibrations
 - RTU and PLC I/O for EUT controls
 - DAQ system with data backups



Control Rooms & Instrumentation



Control Rooms & Instrumentation

Connection panel, CT, DAQ



IEEE 1547.1-2020

UL 1741 (Sept. 2021)



Standards Landscape

Standards Governing DER Interconnection

- IEEE 1547-2003 → IEEE 1547-2018
 - Standard for Interconnection and Interoperability of DER with Associated Electric Power Systems Interfaces
- IEEE 1547.1-2005 → IEEE 1547.1-2020
 - Standard Conformance Test Procedures for Equipment Interconnecting Distributed Energy Resources with Electric Power Systems and Associated Interfaces
- UL1741 (2010) → UL1741 SA (2016) → UL1741 SA/SB (2021)
 - Standard for Safety – Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources, Supplement A
- IEEE P2800 & P2800.1
 - Standard for Interconnection and Interoperability of Inverter-Based Resources Interconnecting with Associated Transmission Electric Power Systems

Standards Landscape

Standard Interactions

- Distribution (and transmission currently?)
 - Without Grid Support:
 - Safety: UL 1741
 - Interconnection: IEEE 1547-2003 -> IEEE 1547.1-2005 -> UL 1741
 - Certification: UL 1741
 - With Grid Support:
 - Safety: UL 1741
 - Interconnection (SB): IEEE 1547-2018 -> IEEE 1547.1-2020 -> UL 1741 SB
 - Interconnection (SA): Source Requirement Document (i.e. Rule 21) -> UL 1741 SA
 - Certification: UL 1741 SA/SB
 - CSA C22.2 No. 107.1 is similar to IEEE 1547.1-2005 and includes safety
- Transmission (near-future)
 - Safety: UL 1741 (assumed)
 - Interconnection: IEEE 2800 -> IEEE 2800.1
 - Certification: ?

GridSim Power Laboratory

UL1741 SA/SB & IEEE 1547.1 Testing Capabilities

- *Temperature Stability*
- Test for response to voltage disturbances
 - Test for overvoltage trip
 - Test of undervoltage tip
 - Low voltage ride-through tests
 - Test for voltage disturbances within continuous operating region
 - High voltage ride-through tests
- Test for response to frequency disturbances
 - Test for overfrequency trip
 - Test for underfrequency trip
 - Test for low frequency ride-through
 - Test for high frequency ride-through
 - Test for rate of change of frequency (ROCOF)
 - Test for voltage phase-angle change ride-through
- Enter service
- Synchronization
- Interconnection integrity
 - *Protection from electromagnetic interference (EMI) test (subcontract)*
 - *Surge withstand performance test (subcontract)*
 - Paralleling devices test
- Limitation of dc injection for inverters
- Unintentional islanding
 - Balanced generation to load unintentional islanding test
 - Powerline conducted permissive signal test
 - Permissive hardware-input test
 - Reverse or minimum import active-power flow
- Open phase
- Current distortion
- Limit active power
- Voltage regulation
 - Constant power factor mode
 - Voltage-reactive power (volt-var) mode
 - Active power-reactive power (watt-var) mode
 - Constant reactive power mode
 - Voltage-active power mode (volt-watt)
- Frequency support
 - Frequency droop (frequency-power or frequency-watt) mode
- Test for prioritization of DER responses
- Limitation of overvoltage contribution
 - Ground fault overvoltage (GFOV) test
 - Load rejection overvoltage (LROV) test
- Fault current tests
- Persistence of DER parameter Setting
- Various other tests

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Traction Testing Capabilities

- Power factor
- Efficiency
- Voltage regulation
- Harmonics
- Acoustic noise
- Current balance
- Temperature rise
- Commutating reactance
- Surge testing
- Short circuit
- Conducted EMC
- Full voltage or reduced voltage testing

GridSim Power Lab Experience

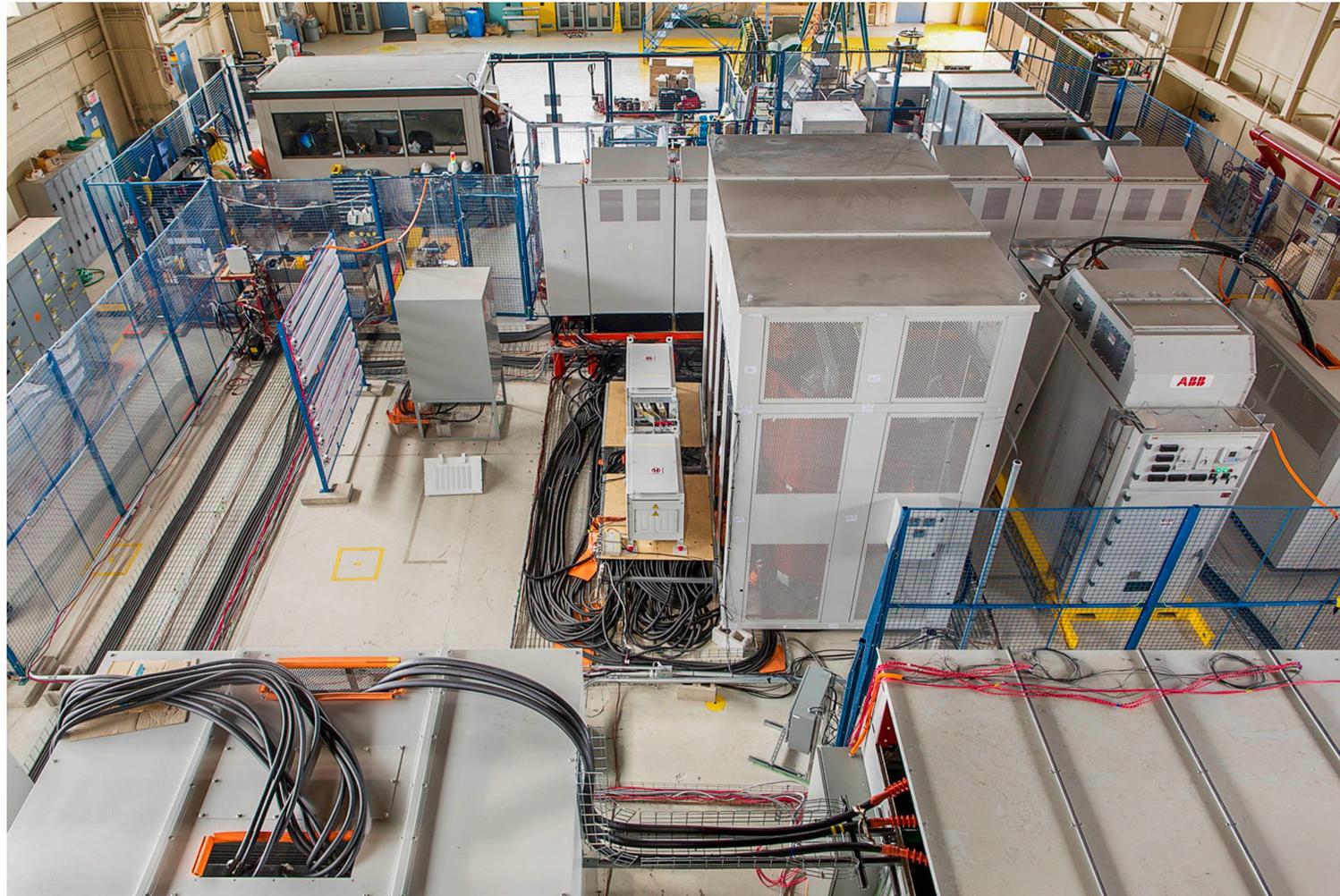
Traction and IEEE 1547.1-2020 Testing

- Bi-directional traction converter (2016)
 - 1,200 kW, 750 V, Class 7
- Bi-directional traction converter (2017/2018)
 - 4,000 kW, 1500 V, Class 6
- Bi-directional traction converter (2019/2020)
 - 2,000 kW, 750 V, Class 6
- Traction Inverter Unit (TIU) (2021)
 - 2,000 kW, 750 V, custom duty cycle
- Synchronous Generator UL 1741 SB / IEEE 1547.1-2020 Certification (2021 – Present)
 - 2500 kW, 13,200 V
 - 2000 kW, 4,160 V
 - 750 kW, 480 V



GridSim Power Lab Experience

4000 kW Class 6 bi-directional traction converter (2017/2018)



GridSim Power Lab Next Steps

Future targets

- Continue client testing
- Execute developed maintenance procedures
- DC Load bank HMI integration
- DC Power supply installation and HMI integration
- To be ISO 17025-accredited for UL 1741 & IEEE 1547.1 tests inline with other on-site labs
- PHIL integration with closed loop control – including RLC load bank emulation
 - Advice welcomed
- General lab and system continuous improvements
 - Advice welcomed
- New opportunities?

Questions?



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