Filing Receipt

Filing Date - 2025-03-06 05:22:49 PM

Control Number - 55718

Item Number - 83

Public Utility Commission of Texas

Memorandum

TO: Interested Parties

FROM: Julia Wagner PE, Market Analysis Division
John Poole PE, Infrastructure Division

DATE: March 6, 2025

RE: Project No. 55718 – Reliability *Plan for The Permian Basin Under PURA §39.167*
Tentative **Timelines for March 7, 2025 Public Workshop**

Please find attached vendor presentations Staff received in the order they will be presented.

Tentative start times for the workshop agenda topics are also listed below.

Start: **9:30 am**

Opening Remarks Staff **5 minutes**

Part 1: ERCOT **15 minutes** **9:35**

Part 2a: Vendor presentations **105 minutes** **9:50**

Siemens, HICO, Hyundai, Hitachi, GE Vernova, Quanta, Burns and McDonnell, Mitsubishi

Part 2b: Q&A **60 minutes** **11:35**

Break: **30 minutes** **12:35 –1:05**

Part 3: 7 Questions **120 minutes** **1:05**

Closing Remarks **Staff 5 minutes** **3:05**

End: **3:10**

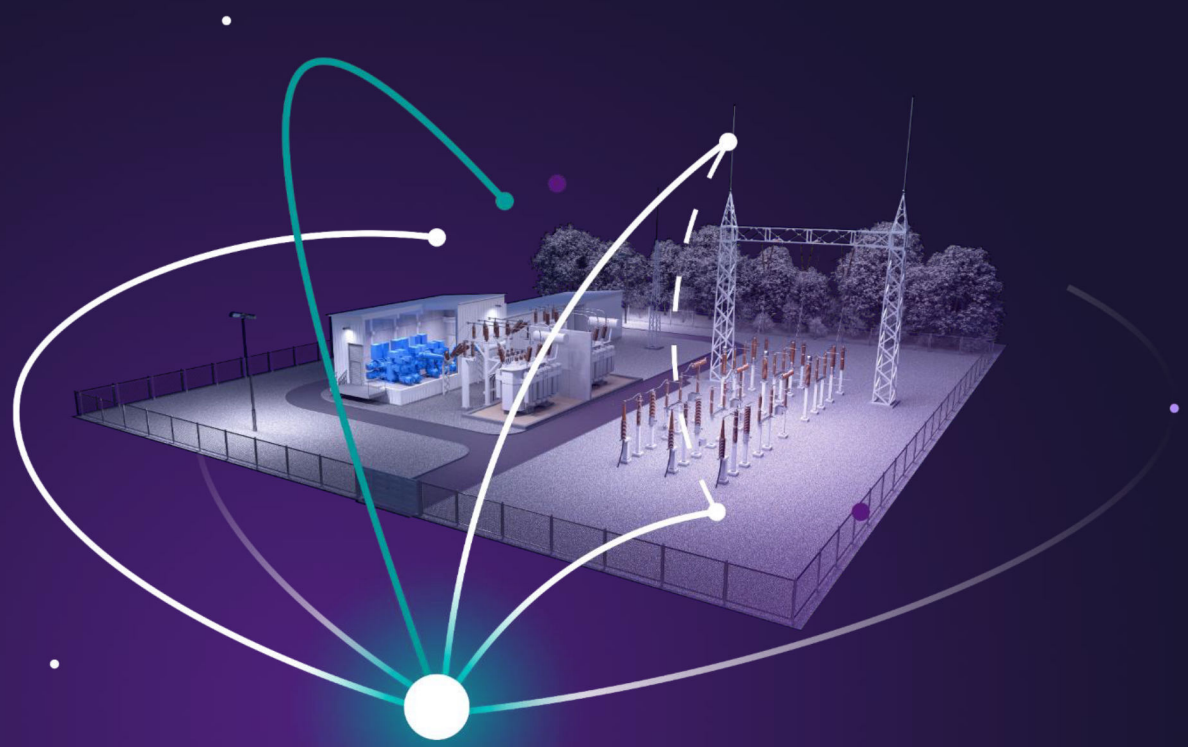
Siemens Energy

PUCT Workshop – March 7, 2025

Comparing 345 kV and 765 kV Transmission

- Supply Chain and Cost Concerns

Siemens Energy
345kV and 765kV Equipment



EHV Circuit Breakers

Siemens Energy EHV Capabilities
High Voltage Circuit Breakers

345kV Dead Tank Breaker

765kV Live Tank Breaker

Siemens Energy EHV Capabilities
345kV vs 765kV Circuit Breakers

Comparison of 345kV vs 765kV Circuit Breakers
Basic technologies such as interrupter and mechanism are identical

Only differences are the:

- 345kV breaker is dead tank vs 765kV breaker is live tank
- 765kV live tank will use approx. only 8% SF6 compared to dead tank breaker.
- Insulators are different between the two ratings
- Current Transformers are provided with dead tank breakers. Current transformers for live tank will need to be free standing design and sourced separately.
- Clearance distances and phase spacing
- 345kV dead tank breaker are built and tested in Richland, MS.
- 765kV live tank breaker are be built and tested in Siemens Energy Jundiaí, Brazil factory. All quotation, project management, engineering, warranty processes will be handled in Richland MS factory.

345kV Dead Tank Circuit Breaker

765kV Live Tank Circuit Breaker

Siemens Energy EHV Capabilities
345kV vs 765kV Circuit Breakers

The main materials are generally the same for both 345kV and 765kV circuit breakers and generally come from the same main suppliers. Items such as frames and cabinets are sourced from local suppliers dependening upon where the circuit breakers are assembled.

The following tables contain a list of the various main material components, comments on the similarities/differences, and the current rough lead-times for the materials for each of the two voltage classes:

Component	Comments	Current 345kV Leadtime	Current 765kV Leadtime
Interrupter Components	Same material, manufacturing requirements, and suppliers for both voltage classes	14 months	14 months
Aluminum Tank Housings/Sections	Same material, manufacturing requirements, and suppliers for both voltage classes	14 months	14 months
Porcelain Live Tank Interrupter Heads	Only applicable for live tank circuit breakers	Not Applicable	12 months

Siemens Energy EHV Capabilities
345kV vs 765kV Circuit Breakers

Component	Comments	Current 345kV Leadtime	Current 765kV Leadtime
Mechanism	Same material, manufacturing requirements, and suppliers for both voltage classes	1 year	1 year
Pre-Insertion Resistors (Optional)	Same material, manufacturing requirements, and suppliers for both voltage classes	2 years	2 years
Cabinets	Same material and manufacturing requirements for both voltage classes	3 months	6 months
Steel Structures	Same material and manufacturing requirements for both voltage classes	3 months	3 months
Current Transformers	Tape wound current transformers only provided with dead tank circuit breaker design	12 months	Not Provided With Live Tank Breaker
Controls and Accessories	Same material, manufacturing requirements, and suppliers for both voltage classes	12 months	12 months

Siemens Energy EHV Capabilities
345kV vs 765kV Circuit Breakers

Cost Volatility Comparison

The risk factors that might impact the cost of EHV circuit breakers are almost 100% identical for units of both voltage classes. The aluminum housings, insulators, and pre-insertion resistors for both ratings are the most significant components that could see increased cost pressure due to supply/demand imbalances that might develop due to the expected demand increase over the next few years.
But we see this risk as rather low, and we are working closely with our suppliers to ensure that they are increasing their capacities to match the increase in global circuit breaker manufacturing capacity, ensuring that new bottlenecks/scarcity issues do not arise.

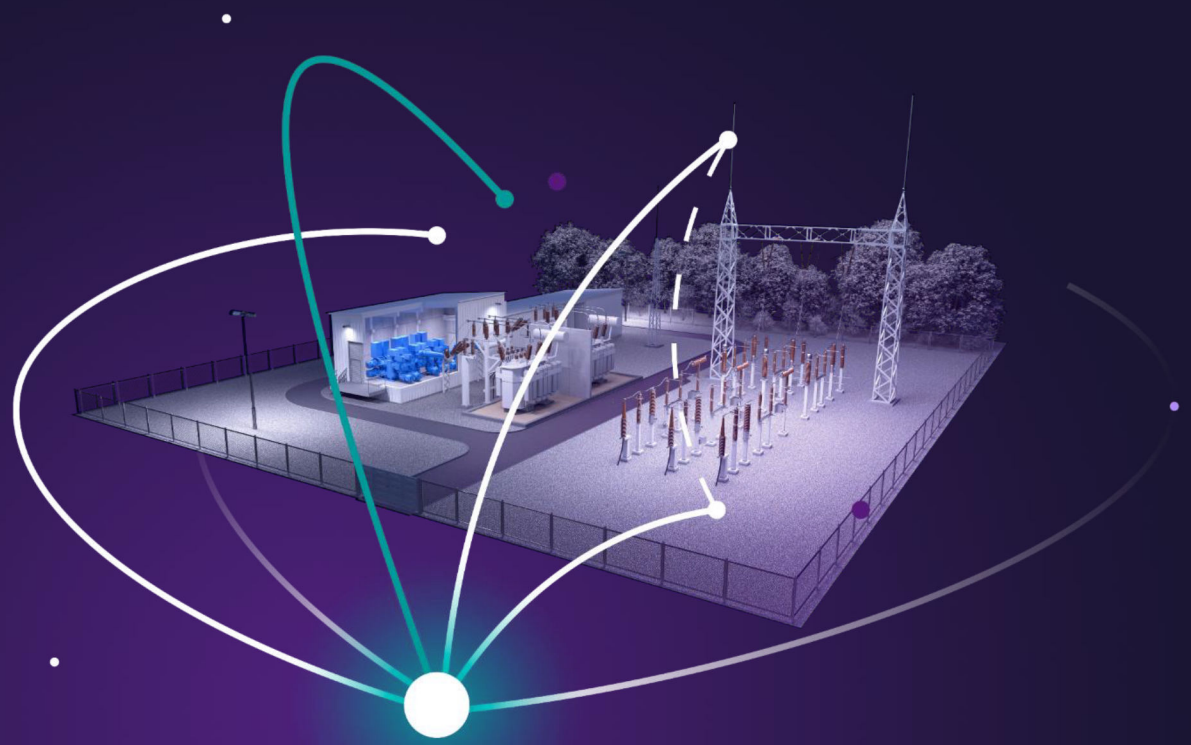
Siemens Energy EHV Capabilities
345kV vs 765kV Circuit Breakers

Other concerns

Transportation and Logistics

765kV breakers will be shipped via container to site due to import from Siemens Energy Brazil factory. Longer shipment times due to shipment from Brazil. However, due to large capacity at Brazil manufacturing site and open capacity, lead time including shipment to site is far shorter than dead tank breaker from Richland, MS.

Siemens Energy
345kV and 765kV Equipment



Power Transformers

Siemens Energy EHV Capabilities
345kV vs 765kV Power Transformers

Comparison of 345kV vs 765kV Power Transformers
Technologies Involved are Identical

Significant differences are the:

- Technical design capability
- insulation levels of the HV lead exits
- shielding and lead supports
- HV bushings
- Clearance distances
- Care, quality, and cleanliness of the manufacturing facilities and processes must be of the highest levels
- Test facility capabilities

345kV Autotransformer

765kV Autotransformer

Siemens Energy EHV Capabilities
345kV vs 765kV Power Transformers

The main materials are generally the same for both 345kV and 765kV transformers, and generally come from the same main suppliers.

The following tables contain a list of the various main material components, comments on the similarities/differences, and the current rough lead-times for the materials for each of the two voltage classes:

Component	Comments	Current 345kV Leadtime	Current 765kV Leadtime
Main Tank	Same material, manufacturing requirements, and suppliers for both voltage classes – only differences are size due to increased oil volume and clearance distance required by 765kV	1 year	1 year
Conservator Tank	Same material, manufacturing requirements, and suppliers for both voltage classes – only differences is size due to increased oil volume of main tank	1 year	1 year
Structural Steel	No differences	5 months	5 months

Siemens Energy EHV Capabilities
345kV vs 765kV Power Transformers

Component	Comments	Current 345kV Leadtime	Current 765kV Leadtime
Core Steel	Same material, manufacturing requirements, and suppliers for both voltage classes	1 year	1 year
Conductors	Same material, manufacturing requirements, and suppliers for both voltage classes	1 year	1 year
Main Insulation	Same material, manufacturing requirements, and suppliers for both voltage classes	5 months	5 months
Cooling Equipment	Same material, manufacturing requirements, and suppliers for both voltage classes	5 months	5 months
765kV Bushings	Slightly longer leadtimes ***today*** for 765kV bushings, but new capacity is coming online	24 months	30 months
Remaining Bushings	Same material, manufacturing requirements, and suppliers for both voltage classes	24 months	24 months
Controls and Accessories	Same material, manufacturing requirements, and suppliers for both voltage classes	1 year	1 year

Siemens Energy EHV Capabilities
345kV vs 765kV Power Transformers

Other concerns

Transportation and Logistics

While 765kV units need to be physically larger due to the additional internal and external clearances (leading to a bigger tank), which could present serious logistical concerns in transporting the units from the factory to the site, this issue is mitigated by the fact that the 765kV unit for the large power ratings needed for these type of projects are usually built as single-phase units instead of three-phase units, limiting the transport dimensions.

Siemens Energy EHV Capabilities
345kV vs 765kV Power Transformers

Cost Volatility Comparison

The risk factors that might impact the cost of EHV transformers are almost 100% identical for units of both voltage classes.
The 765kV bushing is the one component that could see some increase cost pressure due to supply/demand imbalances that might develop due to the expected demand increase over the next few years.
But we see this risk as rather low, and we are working closely with our suppliers to ensure that they are increasing their capacities to match the increase in global transformer manufacturing capacity, ensuring that new bottlenecks/scarcity issue do not arise.

Thank you!

HICO America: Supporting a 765kV Future

Presented by: HICO AMERICA

HICO AMERICA
HYOSUNG HEAVY INDUSTRIES CORPORATION

AGENDA

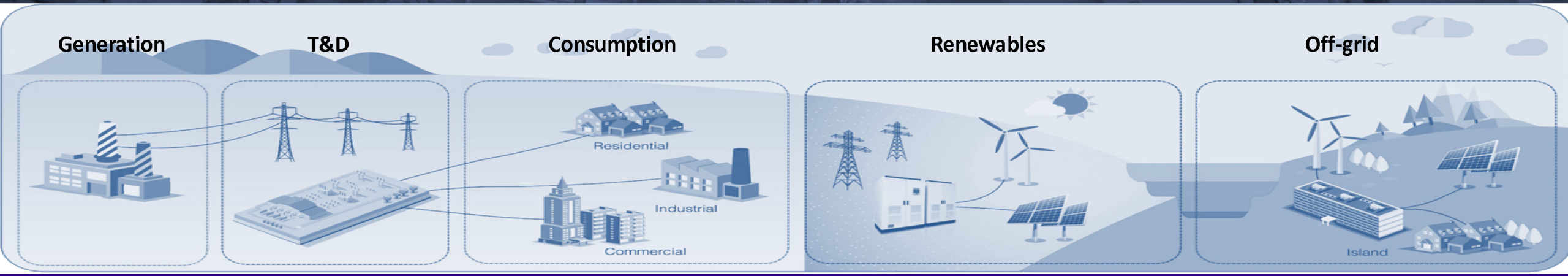
- HICO Overview
- Comparing 345kV And 765kV
  - Cost Variability
  - Availability
- 800kV Breaker Impacts
- MISO Cost Estimate
- Summary & Key Points

HICO AMERICA
HYOSUNG HEAVY INDUSTRIES CORPORATION

HICO - Product Lines and Services

HICO AMERICA
HYOSUNG HEAVY INDUSTRIES CORPORATION

- Power Transformers and Shunt Reactors – Small, Medium & large Power to 765kV
- High Voltage GIS – 72.5kV to 800kV
- High Voltage Gas Circuit Breakers – 72.5kV to 800kV
- FACTS (STATCOM/HVDC/MVDC)
- Medium Voltage GIS – Up to 38kV
- Full Engineering, Procurement & Construction Services



Experience and Capabilities to 765kV

- Power Transformer Manufacturing
  - 3000MVA, 765kV, 500T
- Manufacturing experience and capabilities including 765kV

- 350,000 Square Feet

- 400+ Employees

HICO AMERICA
HYOSUNG HEAVY INDUSTRIES CORPORATION

Comparison of 345kV and 765kV Cost Variability and Availability

Risk Factor	345kV	765kV
Raw Material and Component Price Variability (Copper, Steel, Insulation)	765kV does not have any greater price variability than 345kV. In terms of components, there are a few differences in key components such as the 765kV bushing and the DETC.	
Supplier Capacity & Expansion	Suppliers are expanding capacity, mitigating risks. Core & Insulation: similar availability for both voltage levels. Tank & Conservator: Suppliers expanding capacity (some more than 40%) in terms of tanks/conservators both voltages have similar risk.	Challenging capacity constraints w/ HV bushings and OLTC currently. Bushing suppliers are localizing and expanding capacity of 765kV that should ease constraints. Additional production of Tap Changer starting in 2026 should also ease constraints.
Transportation/Installation and Related Services	Service capability and availability for 345kV and 765kV are similar and the risk is the same.	1ph 765kV transformers in general are easier to transport vs 3ph 345kV large capacity transformers.

Comparison of 345kV and 765kV Cost Variability and Availability

Risk Factor	345kV	765kV
Tariff Impact & Geopolitical Risk	Ongoing geopolitical shifts: Some exposure with specific components, but broader supplier base at 345kV provides more alternatives.	765kV dependent upon select suppliers for certain components, making tariff changes a potential risk. Availability and reduced risk will come with added capacity and US manufacturing.
Technology & Customization Requirements	More standardized components reduce variability.	Specialized components like 765kV bushings and insulation may have longer lead times and higher costs but will be improved w. added capacity
Market Demand & Project Pipeline	In general, 345kV is more prevalent in the US including and grid expansion projects, providing stable demand.	Large-scale 765kV transmission projects historically can create bursts of demand, leading to periodic cost spikes. With stable demand, and increased capacity it is expected that this stabilizes.
Demand & Lead Time Risks	More established production, lower near-term risk.	Component supplier expansions over the next few years will stabilize costs, and lower variability risks.

800kV Breakers -

Cost Variability and Lead Time

- 800kV Breaker is roughly 3x cost of 362kV (illustrated in MISO cost tables)
- 800kV Breaker lead time is roughly 50% longer than lead time of a 362kV breaker
- Key components driving lead time – Internal resistors needed to limit the current or assist in arc extinction. Required for both 362kV And 800kV with higher quantity required at 800kV
- Standard resistor values will help manufacturers to improve lead time:

Voltage Class	Options
800KV Dead Tank Breaker	300/3500ohm
362KV Dead Tank Breaker	520ohm

[800kV GCB]

[362kV GCB]

- 800kV Resistor lead times 28-32 months, 362kV 26-28 weeks
- Standardizing ratings helps with lead time and cost – also has significant benefits for spare equipment and parts, enhancing resiliency

HICO AMERICA
HYOSUNG HEAVY INDUSTRIES CORPORATION

About MISO Transmission Cost Estimation Guide MTEP24

- HICO Opinion on costs included in the MISO estimate is that they are accurate – price levels may have changed since that point but the comparison of 345kV and 765kV is accurate
- Additional considerations on cost should include 1ph 765kV vs 3ph 345kV
  - Table below highlights cost comparison when spare strategies are considered – 765kV and 345kV cost delta shrinks more when this is considered

	Power Transformers - Cost Comparison			
Capacity	765-kV [3 x 1ph]	345-kV [1 x 3ph]	765-kV [4 x 1ph]	345-kV [2 x 3ph]
600 MVA	175%	100% (base)	-	-
1200 MVA	-	-	120%	100% (base)

HICO AMERICA
HYOSUNG HEAVY INDUSTRIES CORPORATION

765-kV Cost Variability and Availability Takeaways

- 765-kV transformers and reactors will benefit from upcoming supplier expansions which will stabilize costs and reduce variability risks.

  ERCOT decision on 765kV will give more confidence to suppliers and drive further investment!

  - Insulation material supply is increasing which is especially beneficial for 765kV due to its more complex insulation needs.
  - Radiator supplier capacity is set to increase significantly, ensuring a steady supply for both 345kV and 765kV transformers, reducing future bottlenecks.
  - US production of HV bushings may begin in 2026, lowering reliance on overseas imports, which should significantly decrease long-term price uncertainty for 765kV and minimize tariff risk.
  - Steel and copper availability is improving with major suppliers expanding capacity, making long-term pricing for both voltage levels more stable for both voltages

- Despite initial higher exposure to variability, 765kV transformers could see cost normalization within 5 years as domestic and global suppliers ramp up.

HICO AMERICA
HYOSUNG HEAVY INDUSTRIES CORPORATION

HICO - Key final points on 765kV in the ERCOT territory

- With current as well as planned capacity additions, considering the timeframe of projects there will be little to no difference in cost variability or availability for 765kV equipment vs 345kV
- Standardization of design provides significant benefits to lead time and cost. Standardization has long term benefits including system resiliency, spare standardization
- Local facilities in the US are capable of manufacturing 765kV equipment as well as provide maintenance, repair and service enhance resiliency of the system
- ERCOT deliberation on 765kV is already driving addition of capacity to 765kV equipment market

HICO and our supply base is ready to serve the 765kV buildout in ERCOT from our domestic facilities and overseas facilities

HICO AMERICA
HYOSUNG HEAVY INDUSTRIES CORPORATION

HICO America: Supporting a 765kV Future

THANK YOU – QUESTIONS?

Presented by: HICO AMERICA

HICO AMERICA
HYOSUNG HEAVY INDUSTRIES CORPORATION

HD Hyundai Electric

perspectives on supply chain timelines and any cost variability between 345 kV and 765 kV transmission

March 7, 2025

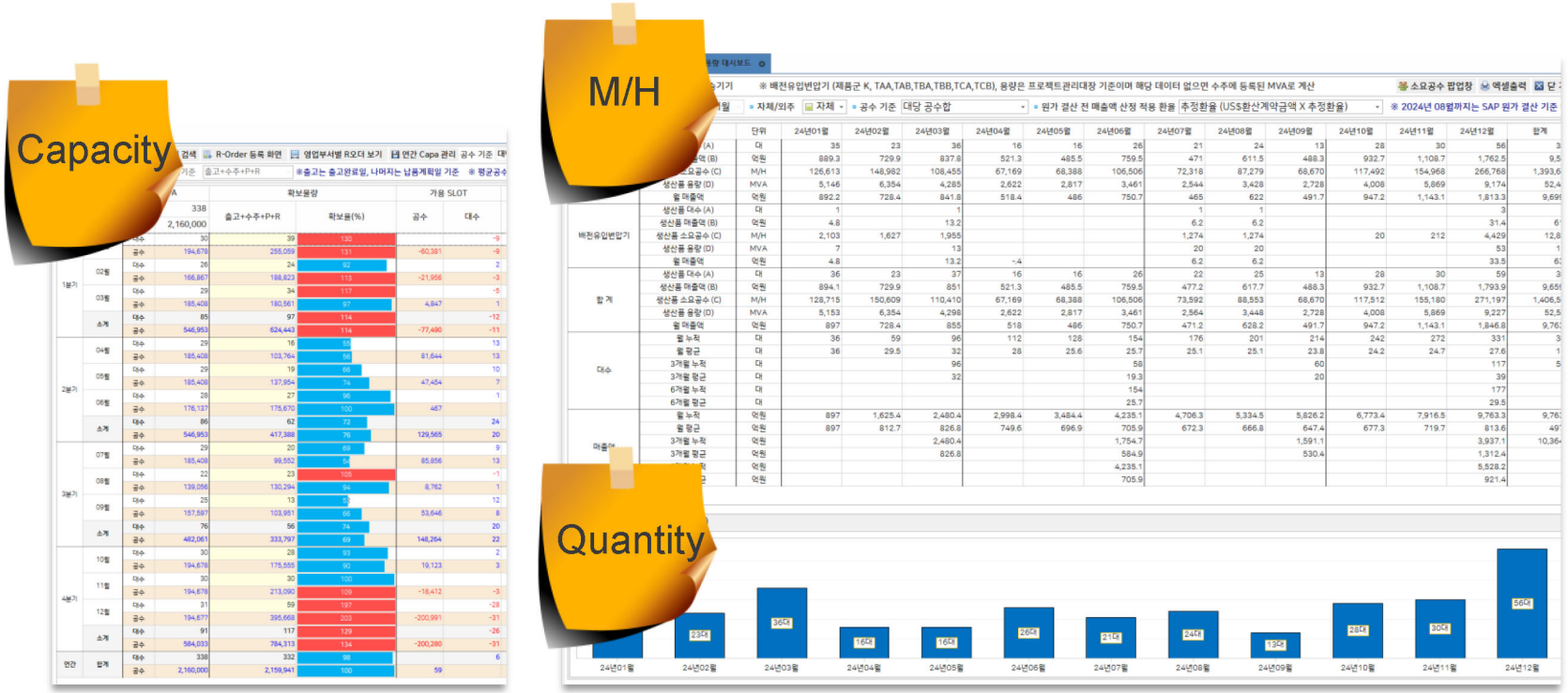
Timeline

- 765kV production timeline
  - : one or two certified suppliers available for RIP bushing, T/C, key insulation materials

- 345kV production

Timeline

- 765kV production requires more 1.6 times M/H than 345kV



Specialized *Materials* for 765kV

RIP Bushing

- Environmentally friendly, **No oil leakage**
- Higher **fire resistance**
- **No broken porcelain.**

Long Leadtime Items

- Longer Leadtime of **Bushings, OLTC, insulation materials**
- Need to be **pre-reserved**

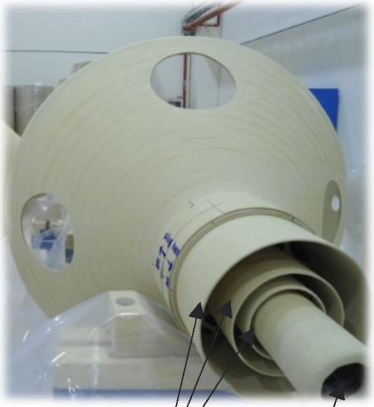
Specialized Items

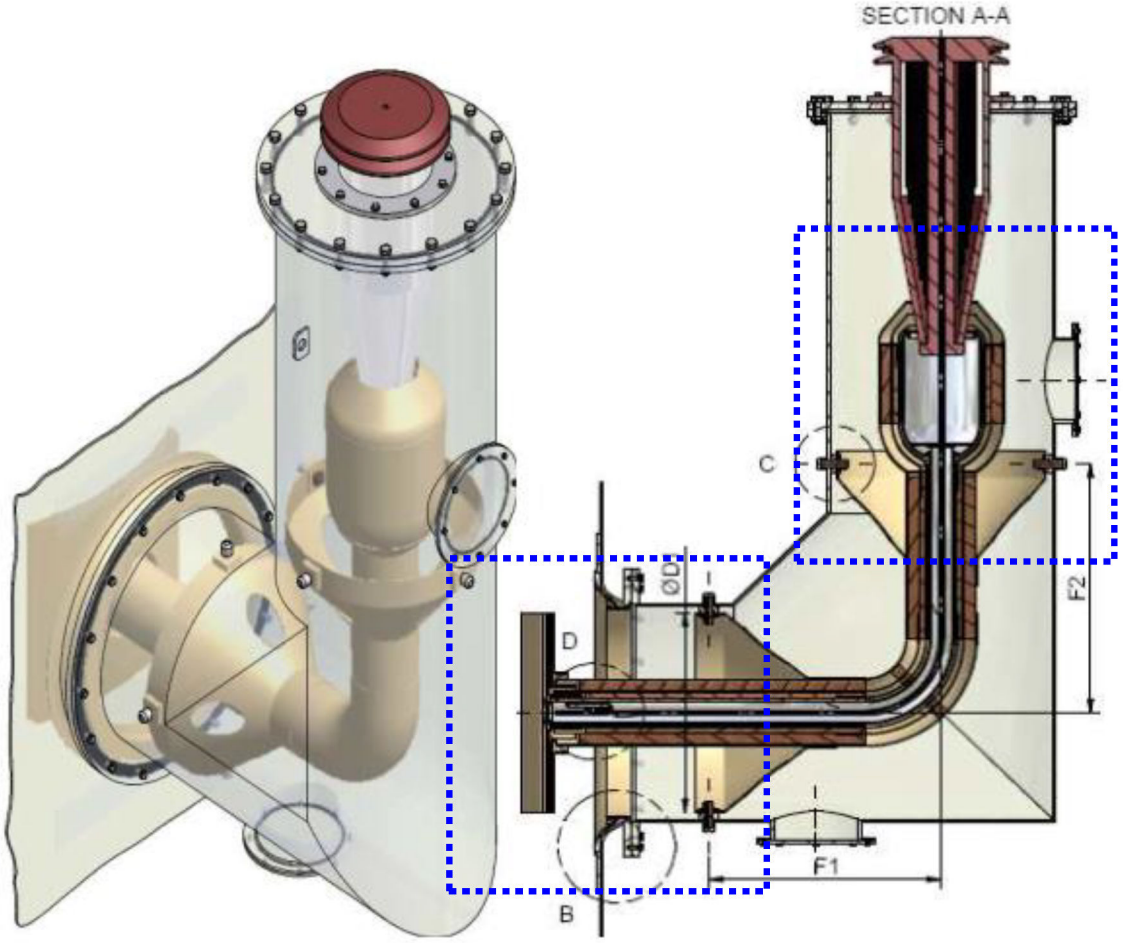
- Critical items **Specialized at 765kV**
- **Limited resource availability** from a few suppliers.

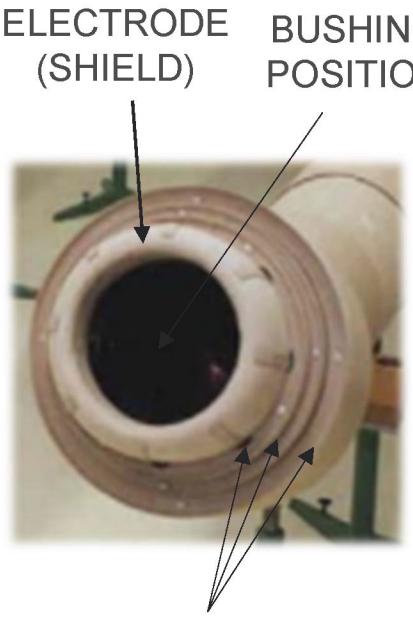
Design

Molded insulation materials are used to increase **THE DIELECTRIC STRENGTH**

- Connection points between winding and lead exit as well as between bushing and lead exit



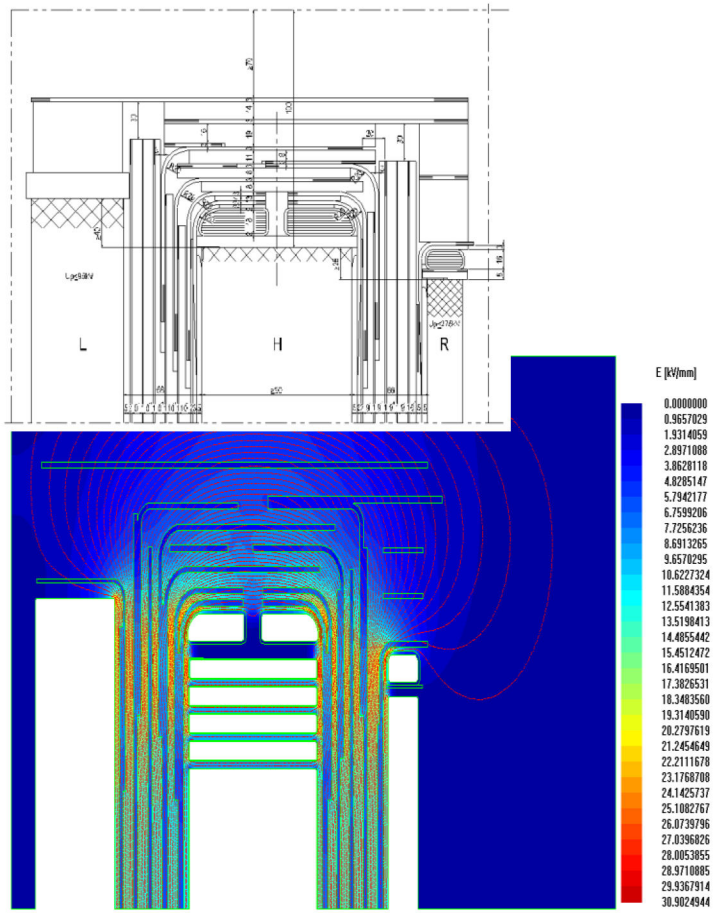




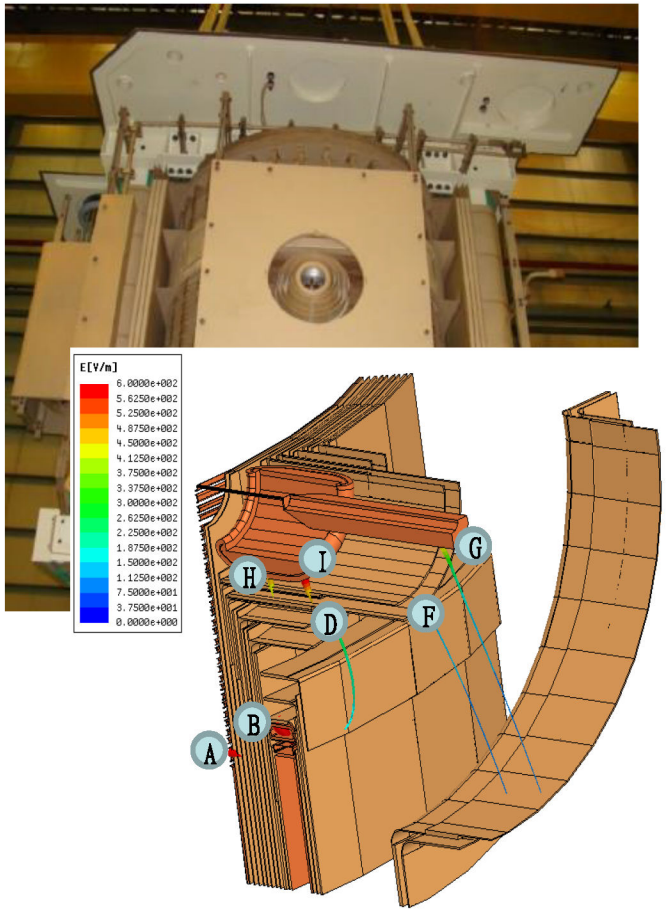
Design(Electric Field Analysis)

ELECTRIC FIELD ANALYSIS between windings, lead exits and HV bushing turret

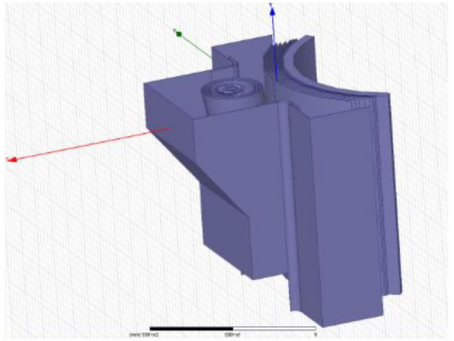
2D electric field analysis for windings

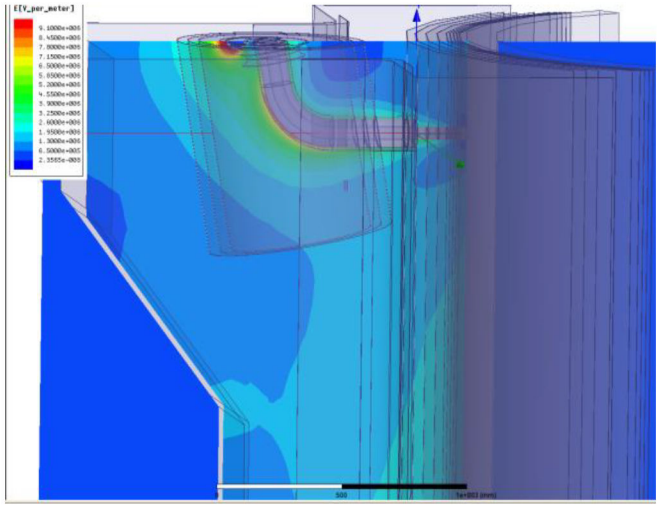


3D electric field analysis for winding lead exit



3D electric field analysis for bushing turret

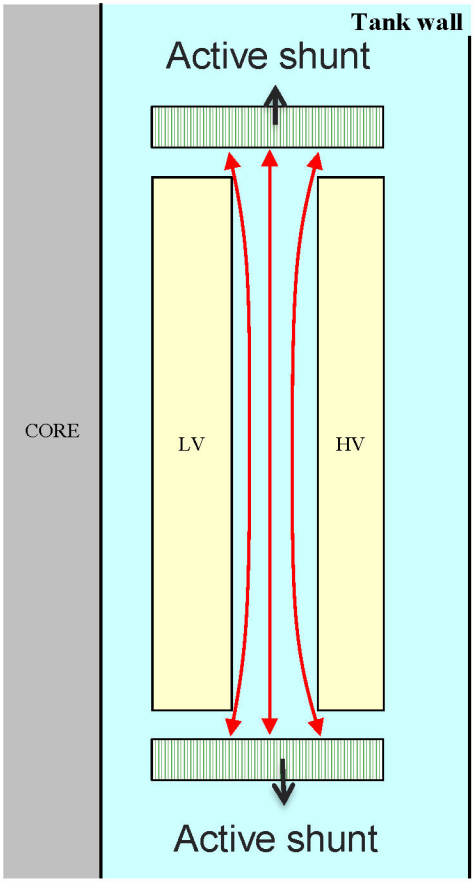




Design(Magnetic Field Analysis)

ACTIVE SHUNT for 765kV to prevent a high leakage flux from overheating clamp structure

- The leakage flux causes a temperature rise in structure
- Install active shunt to mitigate this increase in temperature



[Bottom Shunt]

[Top Shunt]

Processing: Moisture & Particle count control

Drying time is 123% Longer : 765kV vs 345kV

- Insulation system and material sensitive to moisture
- Moisture control is related to performance, reliability, and long-term operation

Strict Particle Count Control regulations based on NAS 1638

- BDV 65kV/mm for 765kV which is more than 56kV/mm from ASTM.
- 765kV[class 3- 63/100ml] vs 400kV [class 4 – 126/100ml] 25um to 50um

	Criteria for insulating oil				Remark
	<230kV	>230kV	>400kV	>765kV	
Breakdown Voltage (kV) [min]	50	60	60	65	
Particle Count (Class) [max.]	6	6	4	3	NAS 1638


THANK YOU
http://www.hd-hyundaielectric.com

Reliability Plan for The Permian Basin - Public Workshop

Public Utility Commission of Texas, William B. Travis Building, located at 1701 N. Congress Avenue, Austin, TX

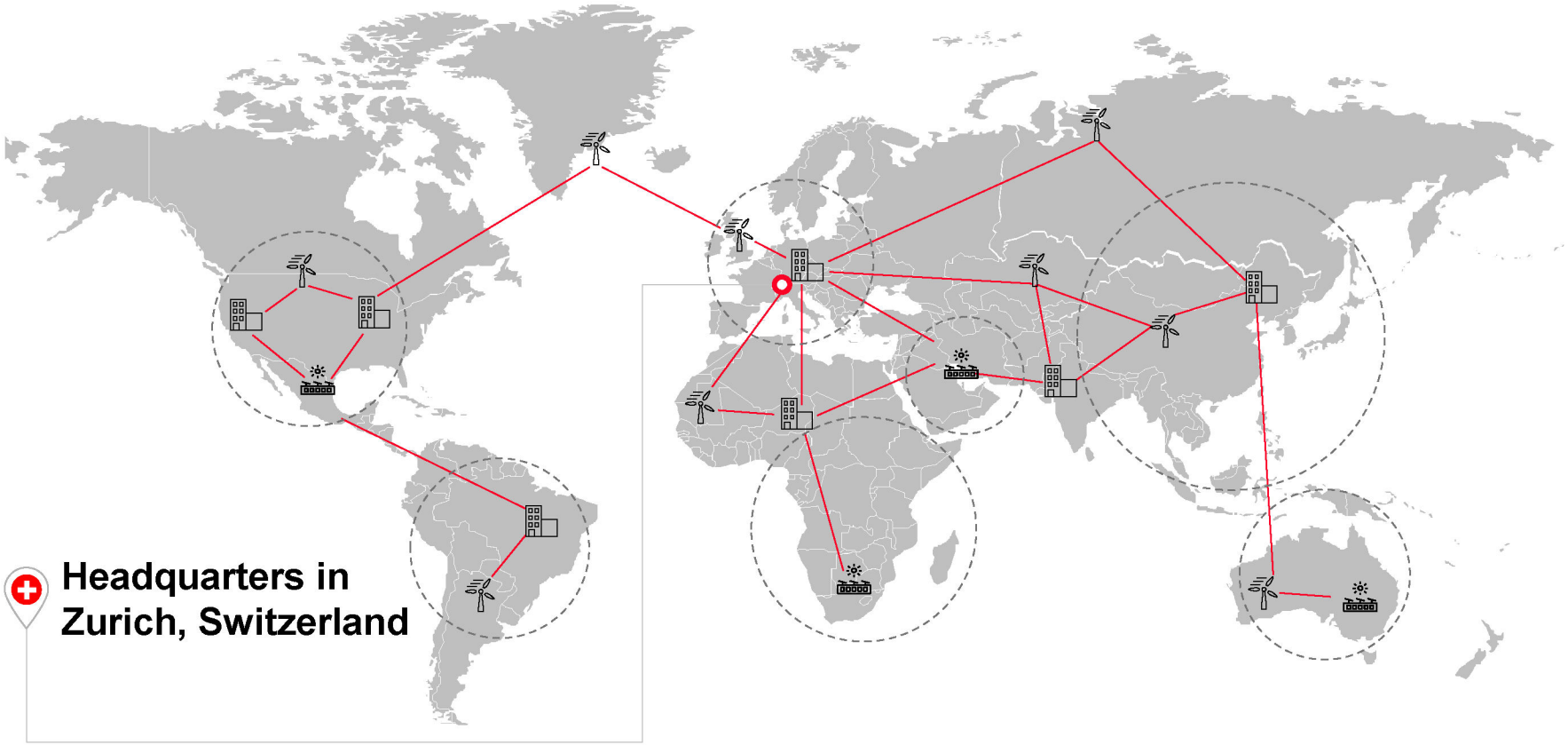
Pradeep Chaudhary, Darby Shoemaker, Jerzy Kazmierczak

2025-03-06

Hitachi Energy

About Hitachi Energy

HITACHI
Inspire the Next



Headquarters in Zurich, Switzerland

45,000 employees

90+ countries with 200 offices

~250 years' heritage combined

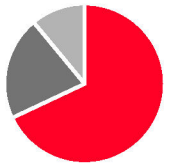
5,500 sales employees & field engineers

2,000 engineers & scientists in R&D

4 Business Units

Grid Automation	**High Voltage Products**
Grid Integration	**Transformers**

Customers



- Transport & Infrastructure
- Utilities
- Industry

Offering

- Services
- Software & Automation
- Systems
- Products

Geographies

- Asia, Middle East & Africa
- Americas
- Europe

Hitachi Energy

Power Transformers

HITACHI
Inspire the Next

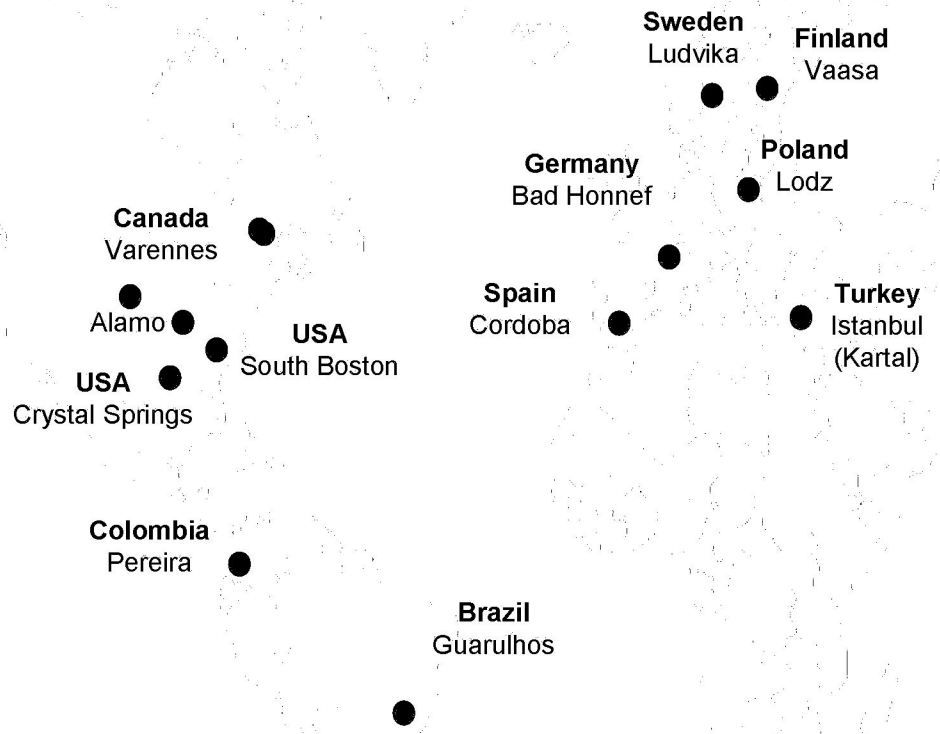
Production and service units

Americas
- Brazil, Canada, Colombia, USA

Europe
- Finland, Germany, Poland, Spain, Sweden,

AMEA
- Turkey

Global sales network in about 100 countries



Hitachi Energy Is Investing

HITACHI
Inspire the Next

Hitachi Energy to invest additional $1.5 billion to ramp up global transformer production by 2027

•Capacity expansion will increase speed to market to meet accelerating global demand, address long-term customer investments and create over **4,000 jobs.**

•Investments span across Europe, the Americas, and Asia leveraging existing global footprint.

Hitachi Energy today revealed investments of over $1.5 billion to ramp up its global transformer manufacturing capacity to keep pace with the growing demand and support the long-term plans and electrification efforts.

Hitachi Energy to invest additional $1.5 billion to ramp up global transformer production by 2027

Hitachi Energy to invest additional $4.5 billion by 2027 to accelerate the clean energy transition

Hitachi Energy will invest an additional $4.5 billion in:

- manufacturing,
- engineering,
- digital, R&D and partnerships by 2027,
- HVDC & HV products
- doubling the investments done in the last three years

6000 new jobs

Hitachi Energy to invest additional $4.5 billion by 2027 to accelerate the clean energy transition

Hitachi Energy

History and Experience of 765 kV Transformers

HITACHI
Inspire the Next

- The first 765kV units were produced in the 1970s, legacy of Westinghouse and ASEA
- Over 500 units of 735-765kV AC transformers have been delivered
- All production facilities utilize a single TrafoStar design and manufacturing technology since mid 1990's.

- Hitachi Energy's 765kV transformers are designed and manufactured across major power transformer plants worldwide
- Our 765kV technology is the result of our own research, development, and manufacturing, which makes us unique in the industry
- Factory in Varennes, Canada built over 100 units with the HV rated 735-765kV

History and Experience of 765 kV Reactors

HITACHI
Inspire the Next

- Since 1960, we have delivered more than 3,000 shunt reactors to 70 countries worldwide
- All Hitachi Energy factories utilize the common design platform giving us best-in-class experience, consistency, and repeatability

Most oil-immersed shunt reactors manufactured by Hitachi Energy are based on the so-called gapped core concept. This technical concept is based on the core type of technology that has been used within Hitachi Energy since the beginning of the 1970s. Over 200 units rated for voltage of 735-800kV

Product scope

	1-phase	3-phase
Reactive power*	150 Mvar	300 Mvar
Voltage*	Up to 800 kV	Up to 800 kV

* only as a reference, limitations on voltage and reactive power may vary according to the capabilities of the test facilities

Hitachi Energy

Takeaways

HITACHI
Inspire the Next

Hitachi Energy is prepared to support manufacturing and supply chain requirements of 765kV. Common manufacturing factories used for both 345 kV & 765 kV.

Manufacturing and Transportation Lead Times will be extended for 345kV, 750MVA 3-phase vs 765kV with similar power rating

Industry and Manufacturing have +50 years experience in development and execution

Same factories produce HDVC, Reactors and Transformers, long term partnership, forecast and reservation of production capacity

Supply factory capacities are calibrated to support the ERCOT, MISO and NAM regions 765kV transmission demand.


Hitachi Energy

HITACHI

Inspire the Next

GE VERNOVA

HIGH VOLTAGE EQUIPMENT (345KV/800KV) PUCT WORKSHOP

Divjot Singh, Commercial Director (AIS)
Todd Irwin, Business Development Manager (HV Circuit Breakers)

March 7, 2025

GE VERNOVA Edge: Single Supplier for Circuit Breakers, Disconnects and Instrument Transformers

ComEd,AEP, Hydro Quebec

ComEd & AEP

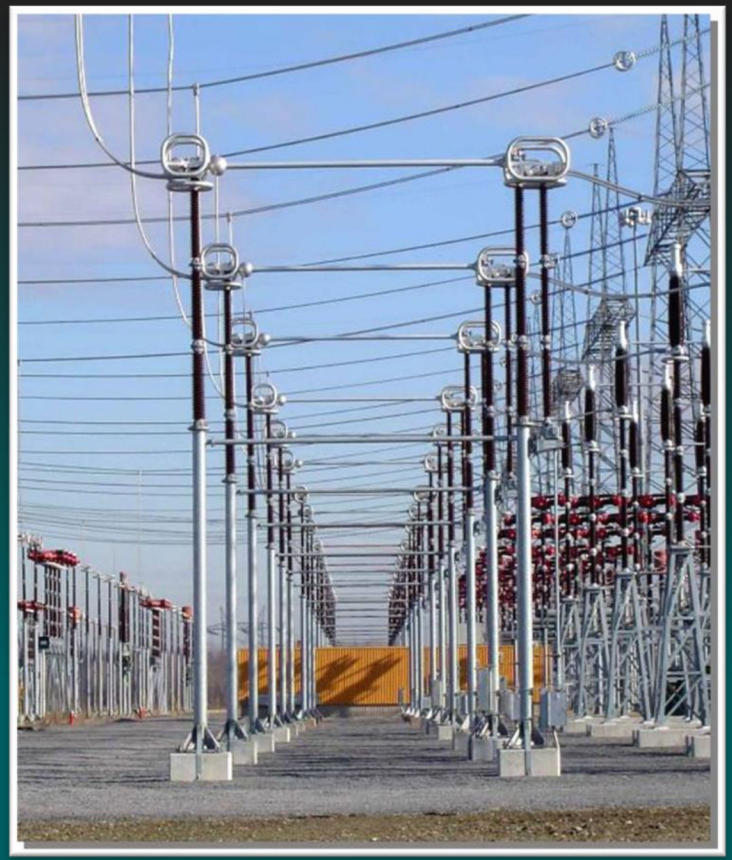
AEP & NYPA

Supplier of 765kV products with references in NAM and Globally on EHV Networks

Source:https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/investing-in-the-rising-data-center-economy#/

GE VERNOVA

765kV Disconnect Switches



Noventa di Piave, Italy Site - More than 50 years of history

1963
CEME founded in Noventa di Piave

1965
First 735kV Disconnect Switch installed in Canada

1969
First 765kV Disconnect Switch installed in USA

1985
First 1100kV Disconnect Switch installed in Russia

1988
First co-operation with GEC ALSTHOM

1998
Flotation and implementation of the name ALSTOM

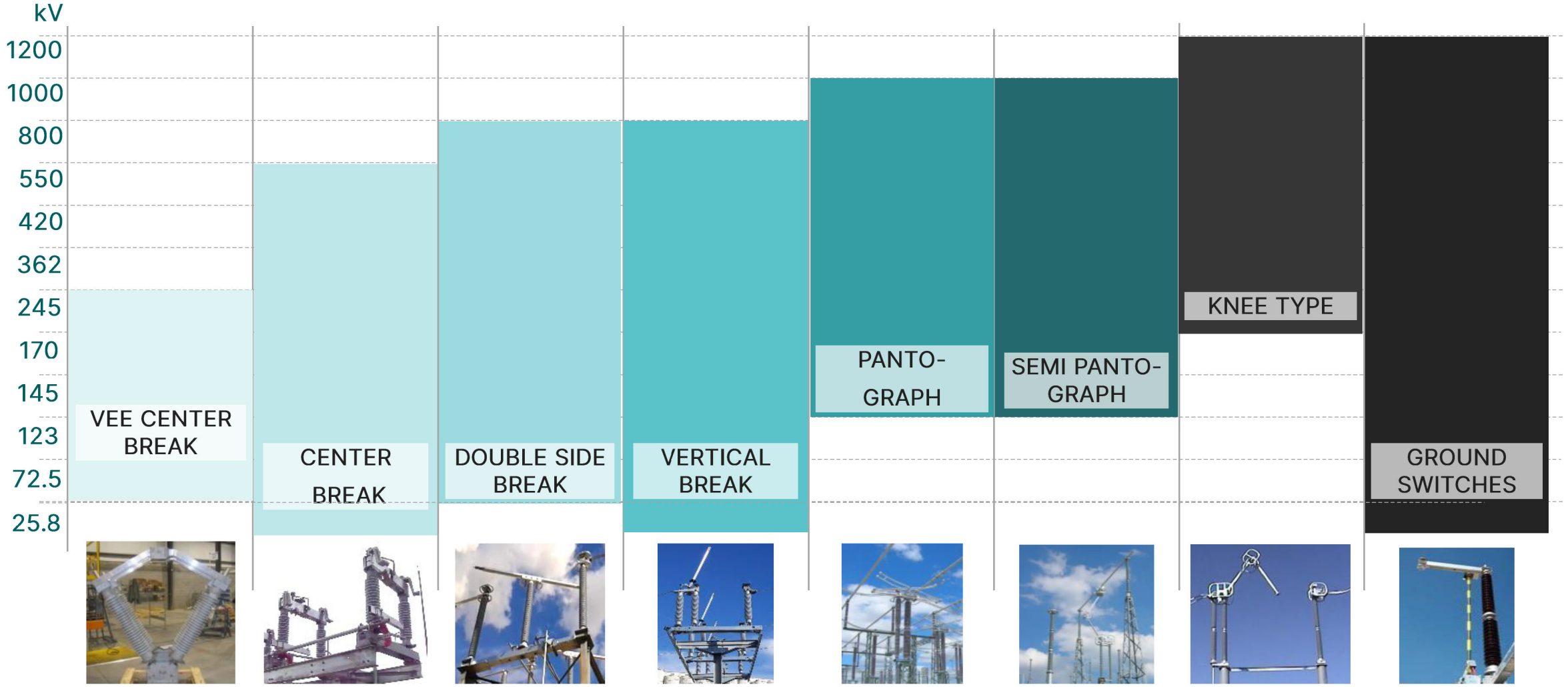
2004
T&D Group purchased by AREVA

2010
ALSTOM acquires the transmission activity of AREVA T&D

2015
GE acquires the energy activity of ALSTOM

Product Portfolio: AC Disconnects

43-45 week lead time on all switches, optimizations on a case-by-case basis.



800kV DSC References List

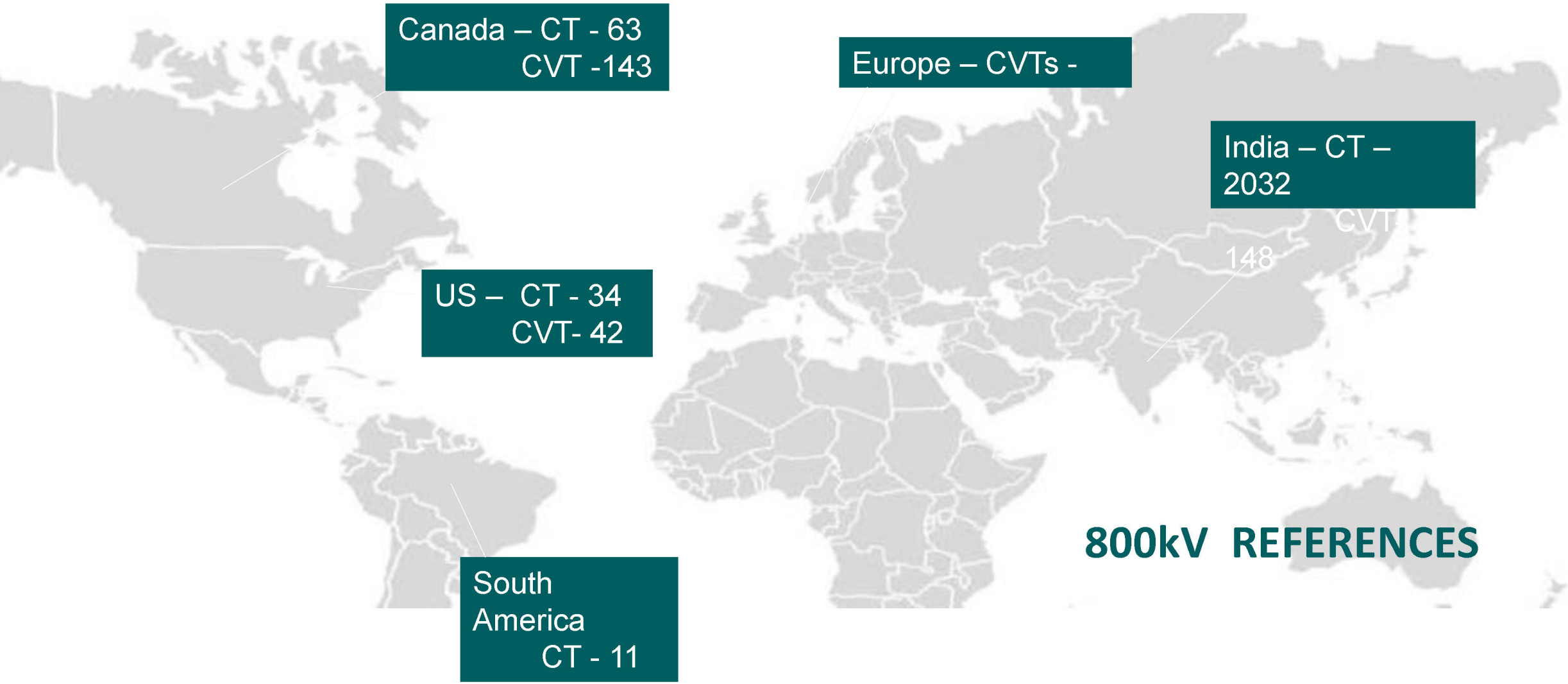
GE VERNOVA

800kV Capacity
CVT and CT

HV ITR MANUFACTURING LOCATIONS

High Voltage Instrument Transformers

Activity	Equipment	Product type	Voltages (kV)										
			72,5	123	145	170	245	362	420	550	800	1200	other
Conventional Instrument Transformer	CVT (Capacitor Voltage Transformer)	CCV OTCF	■	■	■	■	■	■	■	■	■	■	
	CT (Current Transformer)	OSKF	■	■	■	■	■	■	■	■	■		
	VT (Voltage Transformer)	OTEF	■	■	■	■	■	■	■				
	CMU (Combined Metering Unit)	KOTEF	■	■	■	■	■	■					



North American References: Nalcor, Hydra Quebec, AEP, COMED

GE VERNOVA

HIGH VOLTAGE CIRCUIT BREAKERS 362KV AND 800KV

Todd Irwin
Business Development Manager (US West)
GE Senior Expert, IEEE Senior Member
March 7, 2025

GE's Grid Solutions Manufacturing Footprint - HVCB

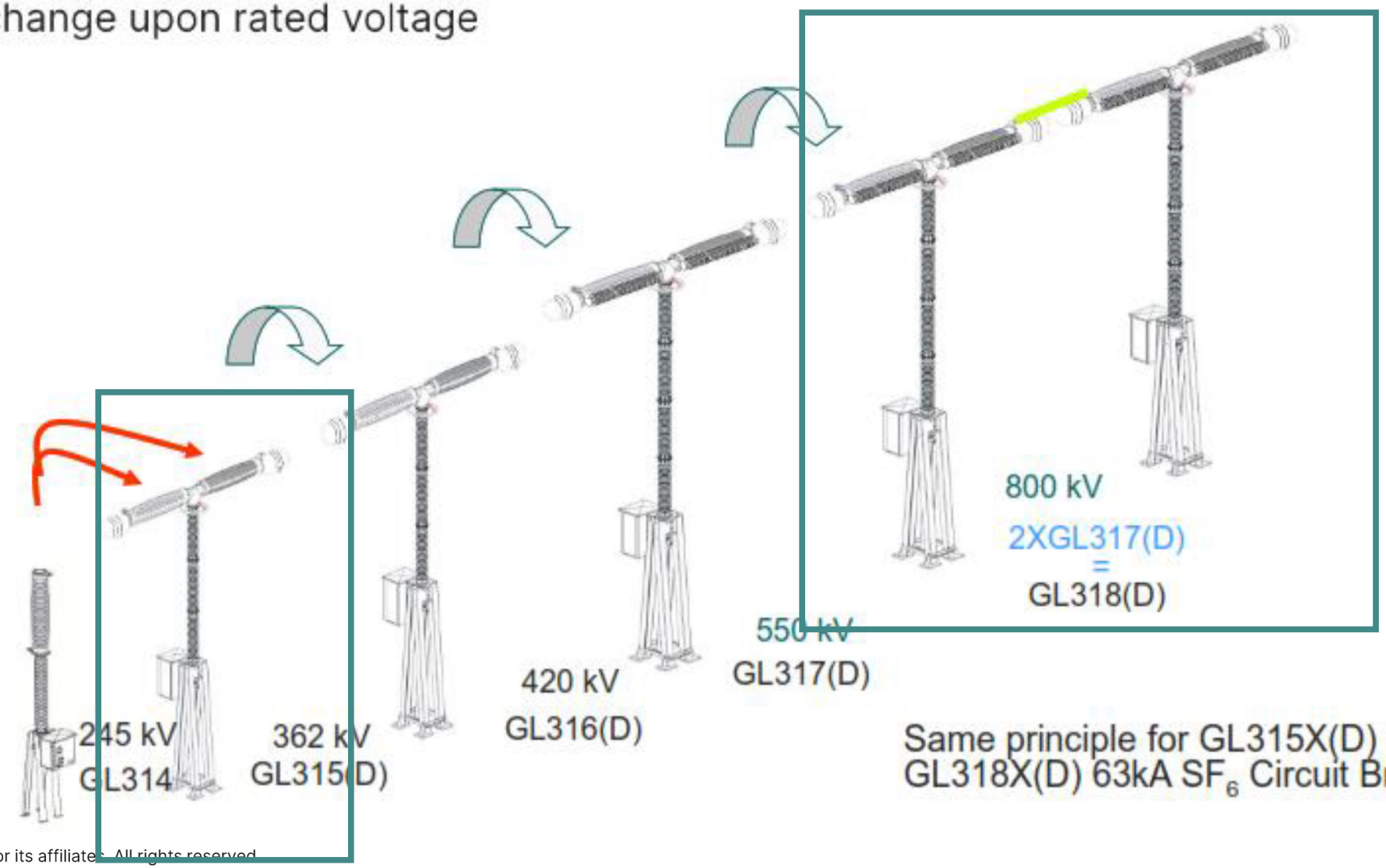
Charleroi, PA DTCB Competence Center

Villeurbanne, France LTCB Competence Center

Reference

Live Tank CB – 362kV and 800kV

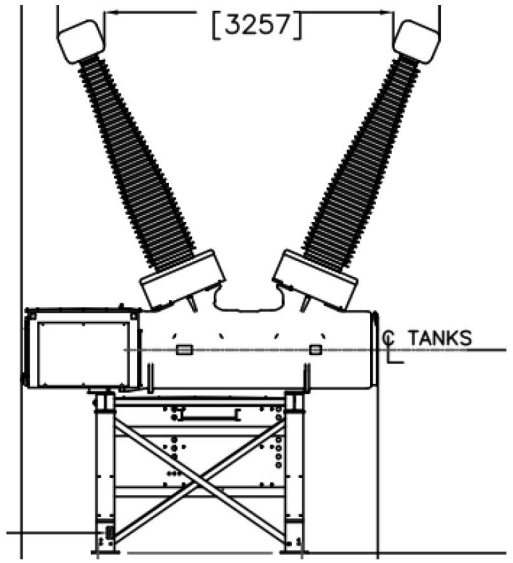
Same breaking chamber-internal parts used across SF6 LT range. Only length of insulator change upon rated voltage

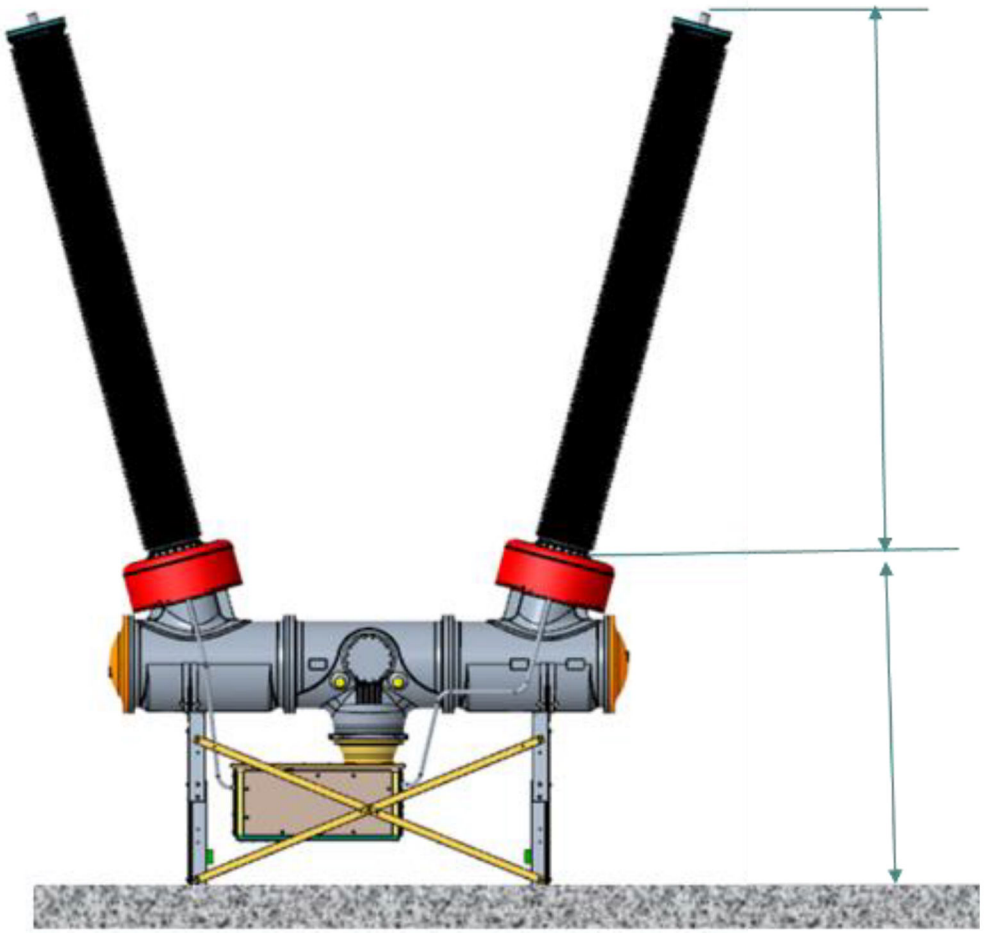


Same principle for GL315X(D) to GL318X(D) 63kA SF_6 Circuit Breaker

Dead Tank CB – 362kV and 800kV

- **Same Breaking Chamber Parts**
- **Operating mechanisms shared with other products.**





Risk Factors

GE VERNOVA

Timeline/Schedule 🕗 and Cost ($)

	345kV	800kV
Production Capacity	$ 🕗	$ 🕗🕗
Supply Chain	$ 🕗	$$ 🕗
Market Demand	$ 🕗	$ 🕗
Transportation (In/Out)	$ 🕗	$ 🕗
Environmental Regulation (SF6)	$ 🕗	$ 🕗
Inflation	$ 🕗	$ 🕗
Tariffs	$	$
Labor (Factory)	$	$
Labor (Field Service)		$
Domestic Content Regulation	$ 🕗	$ 🕗

Questions?


GE VERNOVA

GE VERNOVA

HIGH VOLTAGE CIRCUIT BREAKER 800KV LIVE TANK BACKUP

GE VERNOVA

800KV HIGH VOLTAGE CIRCUIT BREAKER FACTORIES AND EXPERIENCE

CENTER OF EXCELLENCE
FOR LIVE TANK CIRCUIT BREAKERS & GENERATOR CIRCUIT BREAKERS

VILLEURBANNE, FRANCE

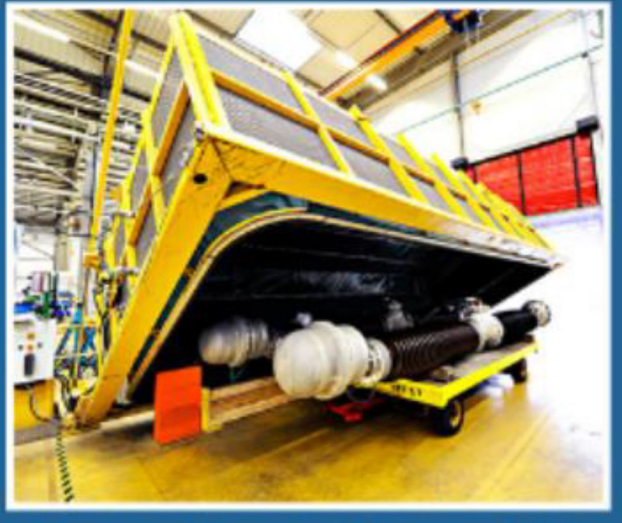
- Research and development (R&D) for circuit breakers and generator circuit breakers
- Manufacturing of live tank circuit breakers from 245 kV up to 1,100 kV
- Manufacturing of generator circuit breakers for 50 MW to 2,000 MW power plants
- Certified to ISO 9001, ISO 14001 and OHSAS 18001
- Value-added services and customer support

INSTALLED BASE OF 120,000+ live tank circuit breakers and **3,000+** generator circuit breakers

Villeurbanne site includes R&D activities, switchgear manufacturing, test labs and service activities

Live tank circuit breakers assembly complying with latest quality and EHS standards

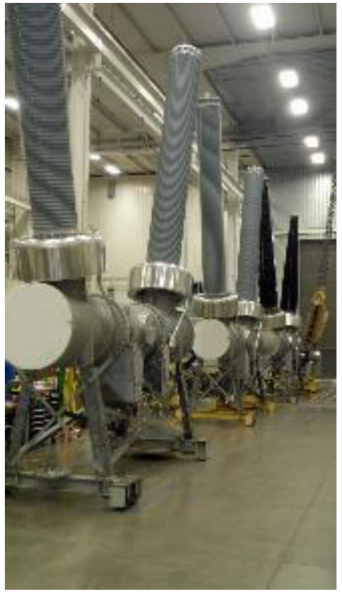
High voltage testing laboratory for internal routine testing according to international standards



Circuit breakers are tested fully assembled for SF_6 gas tightness

High Voltage Circuit Breakers
Charleroi, PA (USC) – Site Overview

GE VERNOVA



- Worldwide Center of Excellent for Dead Tank Circuit Breakers
  - Manufacturing, Quality, Customer Care (Worldwide Mobility)
  - Clean room assembly, automated testing, panel shop
  - Capacity 2000~3000 CB per year (DT and LT)
  - Interrupter Assembly: 72.5kV – 550kV
  - Labs - 2R&D, 2FAT
  - ~400 employees
  - ISO 9001, ISO 14001, ASME/NB/U-stamp
  - ISO 17025 A2LA Lab Accreditation

Dead Tank Circuit Breakers

MANUFACTURING SITES

HV CIRCUIT BREAKERS

Padappai, INDIA

- Padappai site (HVM) includes R&D activities, Engineering, Project Management, Switchgear manufacturing, Erection, Test labs, Service and Training activities.
- Live tank breaker assembly and testing complying with latest quality and EHS standards.

KEY FACTS & FIGURES

- **16,000+** circuit breakers from 72.5 to 800 kV delivered and export base of over 40 countries
- Value-added services and customer support.
- 40 years of presence in India

Management Certificates

ISO 9001	Quality Management
ISO 14001	Environment Mgmt
OHSAS 18001	Health & Safety Mgmt

Factory

Live tank breaker assembly and testing complying with latest quality and EHS standards

Technical Institute

MANUFACTURING FACILTIES

HV CIRCUIT BREAKERS

ITAJUBA, BRAZIL

- Itajubá site (AIB) includes Design, Engineering, Project Management, Manufacturing, Testing, Erection, Commissioning, Technical Training and Services.
- Live tank breaker assembly and testing complying with latest quality and EHS standards

KEY FACTS & FIGURES

- 8,000+ circuit breakers from 72.5 to 550 kV delivered in Brazil and Latina America countries
- Value-added services and customer support
- 40 years' experience and complete portfolio in High Voltage products

Management Certificates

ISO 9001	Quality Management
ISO 14001	Environment Mgmt
OHSAS 18001	Health & Safety Mgmt

Factory

Circuit Breaker Assembly and testing

QUANTA

MARCH 07, 2025

TX PUCT EHV WORKSHOP

KENNETH MERCADO:
EVP Commercial Excellence

MICHAEL FOSTER:
VP Engineering

ALEX PHILLIPS:
TRANSMISSION TECHNICAL ADVISOR

QUANTA IS READY NOW

To build the required high voltage transmission to support Texas

- EHV Transmission Investment is happening across the country
  - SPP Announces Investment in 765 kV
  - PJM Approves 765 kV Investment
  - MISO Invests EHV Expanding 765 kV Backbone

  → **Investment needs to start now. Let's lead the energy transition to show investors Texas has the Power**

- Quanta has invested over a **Quarter Billion** in development and continued education, providing a world class workforce

  → **We have the experience and trained workforce and ready to build 345 kV or 765 kV to support Texas's needs**

- Quanta has developed strategic relationships with OEMs, including those here today, to lock-in slots for manufacturing for long lead time equipment to support EHV investment

  → **Equipment can be built for 345 kV or 765 kV and will face similar challenges and tariff risks**

- Quanta owns **Sherman & Reilly** world leader in providing innovative construction equipment (6-bundle technology), PTTI, and Niagara to support EHV construction

  → **USA based equipment manufacturing of key construction equipment to support EHV**

IN SUMMARY: ***765 kV is a 12-lane super-highway compared to a 4-lane 345 kV, both will get traffic from Point A to Point B. However, is it expensive and painful to expand the 345-kV highway when more lanes required.***

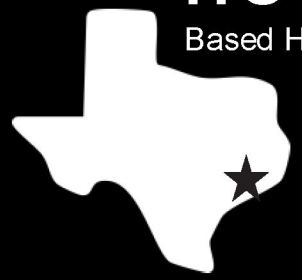
QUANTA BY THE NUMBERS

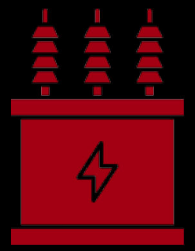
62,000

Largest highly trained craft skilled labor force

HOUSTON

Based Headquarters





USA

MANUFACTURING:

Key Transmission Line Construction Equipment, Transformers, Breakers,

300

More than 300 strategic operating centers across U.S., Canada & Australia

74,000

Unmatched specialized equipment resources: approximately 74,000 pieces of equipment

85%

self-perform work to ensure the lowest risk and highest quality across industries

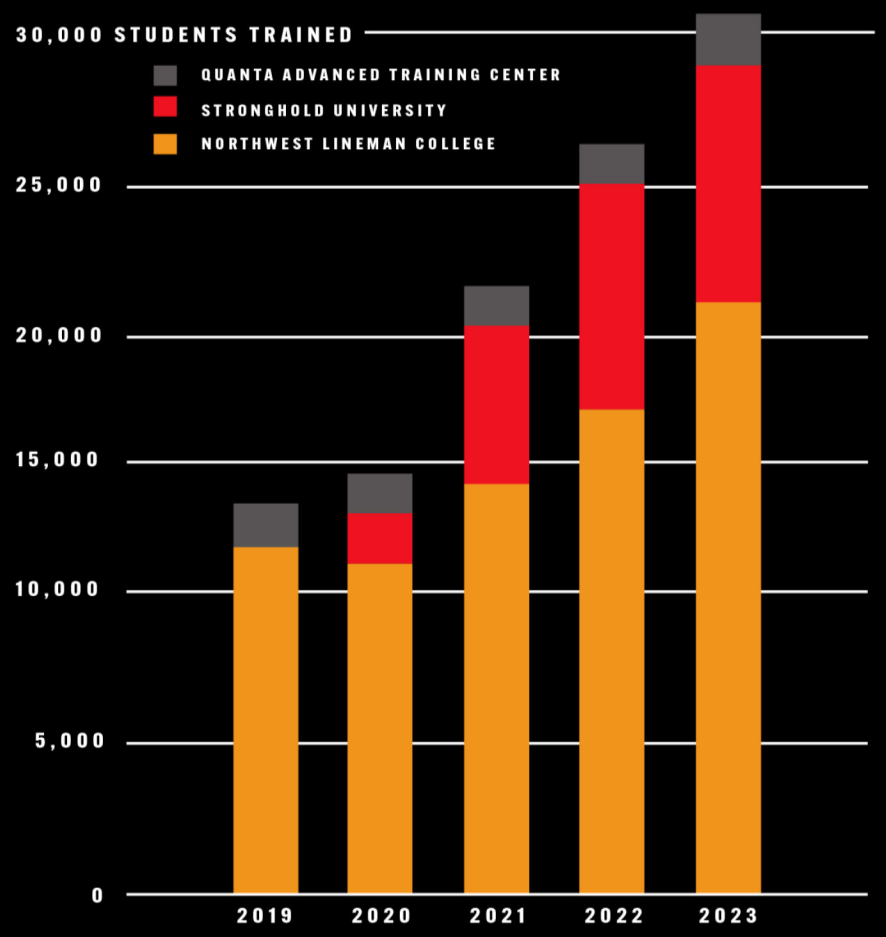
#1

Largest procurer of line trucks in North America – and 3rd largest private fleet in North America

46+

Quanta's Life-Saving AED Program has saved 46+ lives including 15 of the general public.

WORKFORCE INVESTMENT



NORTHWEST LINEMAN COLLEGE (NLC) – Post secondary education institution with a **DENTON, TX** campus. Provided world-class electric training curriculum for +25 years.

QUANTA ADVANCED TRAINING CENTER – World-class 2,300 acre training facility in **LA GRANGE, TX**. The Quanta Advanced Training Center performed a total of 26,137 training days in 2023, a 50% increase since 2019.

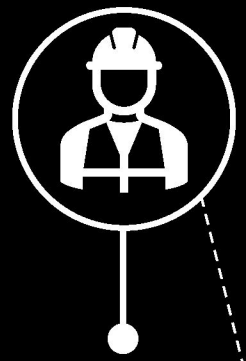
SAM HOUSTON STATE UNIV. PARTNERSHIP – Workforce Development Program

TEXAS STATE UNIV. PARTNERSHIP – Workforce Development Program

MILITARY VETERAN RECRUITING

END-TO-END INFRASTRUCTURE SOLUTIONS

Solutions tailored to your project needs



INTEGRATED SERVICES

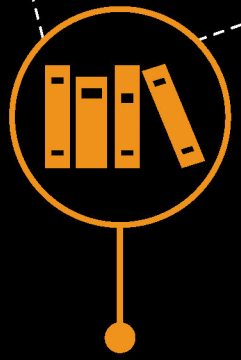
- Complete engineering services for turnkey projects
- Substation and switchyard design
- Overhead & underground electric distribution and transmission design
- Specialty foundation designs
- Professional Land Survey, geospatial & GIS services
- Full-service pipeline and facility design for Oil, Gas, and LDC market
- Service lines
- And more

PROCUREMENT

- Procurement Management
- Preferred Suppliers
- Buying
- Expediting
- Shipping/freight forwarding
- Coordination of factory inspections and tests
- Warehousing
- Logistics
- And more

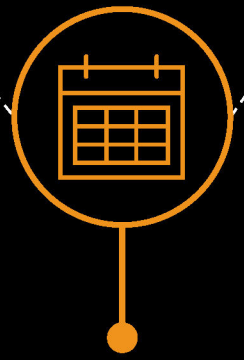
CONSTRUCTION

- Largest infrastructure provider across the electric power, pipeline and industrial and communications sectors in North America
- Largest, most highly trained and skilled workforce in the industries served
- On time, on budget world-class execution – delivered at a local level
- And more



ENIVIRONMENTAL PLANNING & MANAGEMENT

- Project-specific environmental planning
- Environmental Site Assessments
- AHJ Permitting
- Monitoring & Compliance
- In-depth knowledge of federal, state and local environmental regulations
- And more



PROJECT MANAGEMENT

- Single-source responsibility and accountability with one-team approach
- Seamless, integrated transitions through project phases
- Optimized budgets and schedules
- And more

765 kV CAPABILITIES

Quanta has built more high-voltage electric transmission Infrastructure in North America than any other specialty contractor

PROJECT	STATE	VOLTAGE	TOWER TYPE
Jefferson	IN	765	Steel Tower
Sullivan	IN	765	Steel Tower
Jackson Ferry	WV, VA	765	Steel Lattice
Rolling Hills	PA	765	Steel Tower
Celilo-Sylmar	OR	750	Guyed

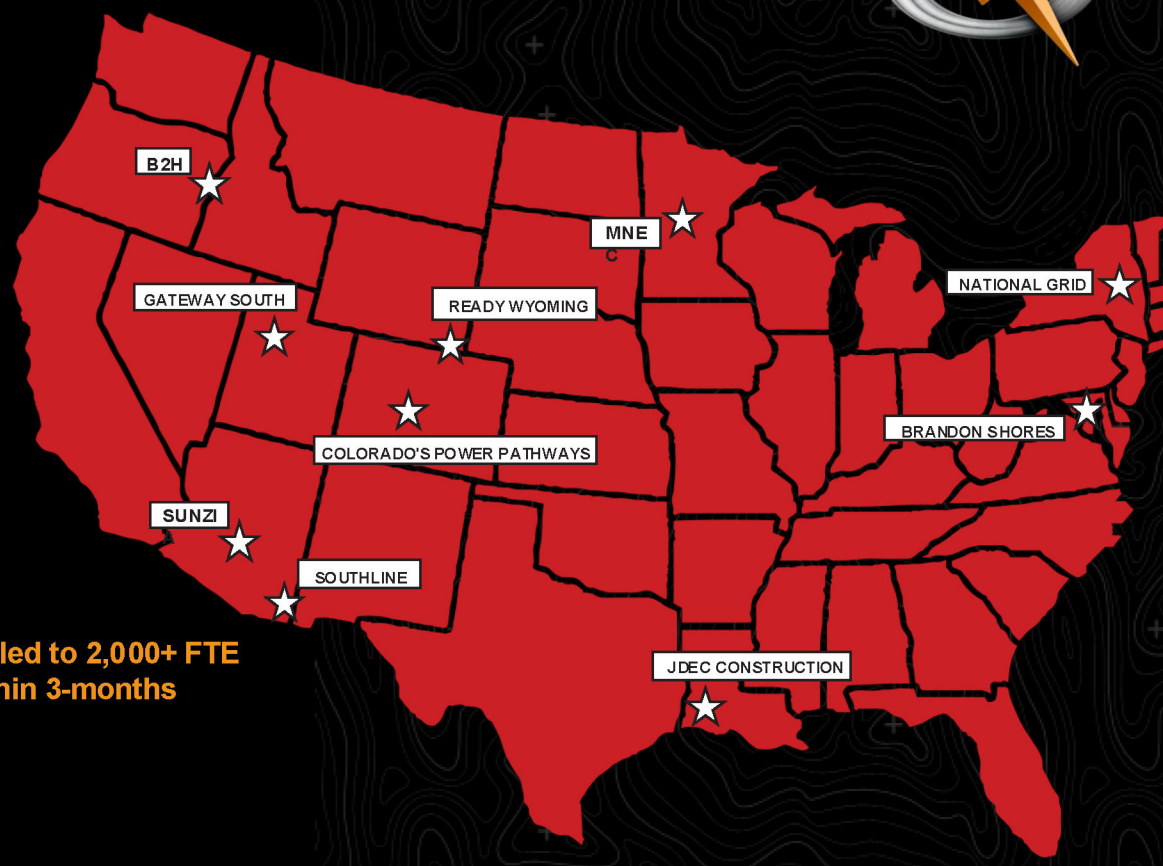
750-765kV - 25+ PROJECTS - OVER 2,000 MILES

CURRENT PLATFORM PROGRAMS

500kV - 150+ PROJECTS - OVER 5,000 MILES

PROJECT	OWNER	LENGTH	SIZE (KV)	SUBSTATIONS
B2H	Idaho Power	260 miles/ single circuit	500	
Gateway South	PacifiCorp	416 miles/ single circuit	500	
Ready WY	Black Hills Energy	263 miles/ single circuit	115/230	6
Colorado Power Pathways	Xcel Energy	610 miles/ double circuit	345	8
SunZia	Pattern Energy	550 miles/ single circuit	525 HVDC	2 converter stations
Southline	Grid United	278 miles/ double circuit	345/500	4
Gateway West	PacifiCorp	145 miles/ single circuit	500	4
MNEC	Xcel Energy	170 miles/ double circuit	345	
Brandon Shores	Exelon (BGE)	60 miles/ single circuit	345/500	5 (6 new pending)
National Grid	National Grid	170 miles/ nine circuits	230	

Scaled to 2,000+ FTE Within 3-months

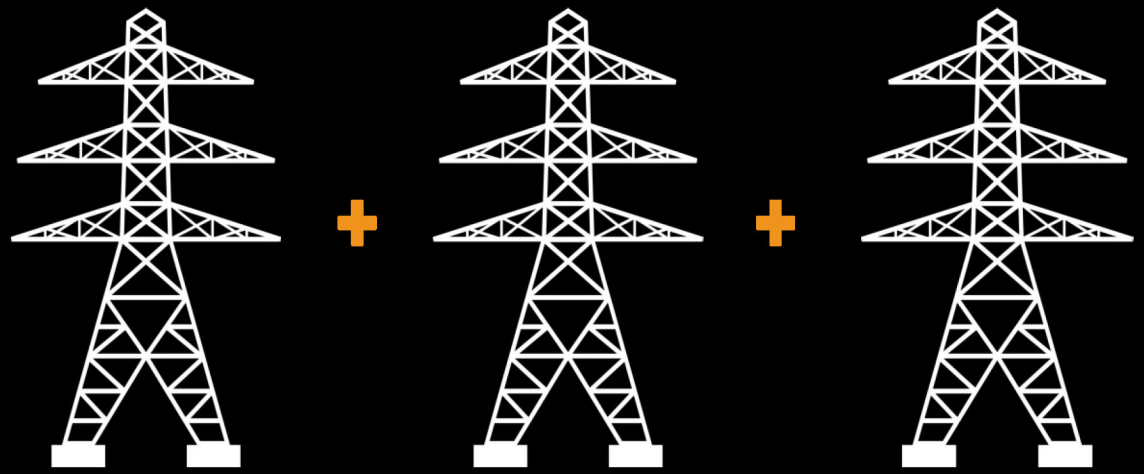


OUR KEYS TO SUCCESS

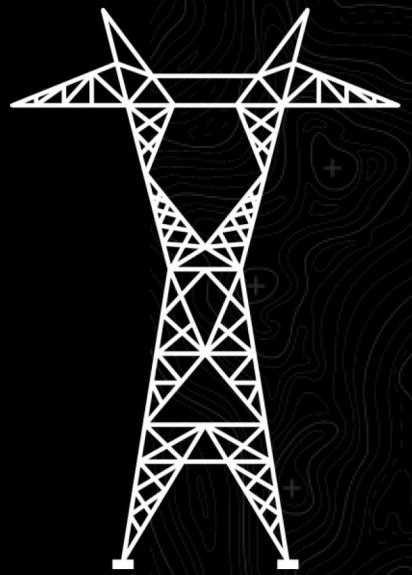
- ✓ Foster a transparent, collaborative partnership aimed at solving problems.
- ✓ Engage early in construction to streamline engineering, permitting, material procurement, scheduling, and labor use.
- ✓ Leverage collaboration for schedule reliability, value engineering, enhanced safety, quality, and cost savings over traditional methods.

LABOR & EQUIPMENT RESOURCES

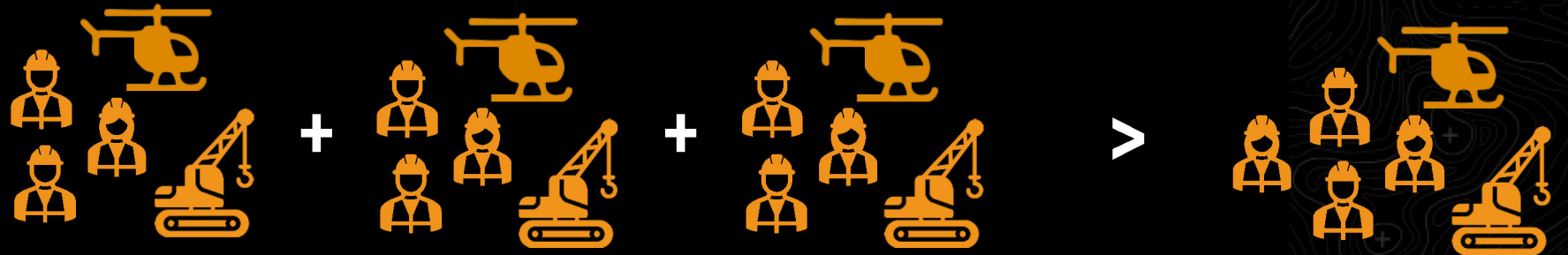
DOUBLE CIRCUIT 345 kV



SINGLE CIRCUIT 765 kV



LABOR & EQUIPMENT REQUIRED



QUANTA

QUANTASERVICES.COM

THANK YOU

QUANTIFYING RISK IN THE DESIGN AND PLANNING OF 765KV TRANSMISSION LINES

Cornelius Henderson
cjhenderson@burnsmcd.com
817-570-0084
777 Main Street, Suite 2500 \ Fort Worth, TX 76102

03/07/2025

Agenda

01 // QUANTIFYING RISK, EXAMPLES

02 // COMMERCIAL OFF THE SHELF ITEMS (COTS)

03 // MATERIAL QUANTITIES

04 // LABOR QUANTITIES

05 // PRELIMINARY HAZARD ANALYSIS (PHA)

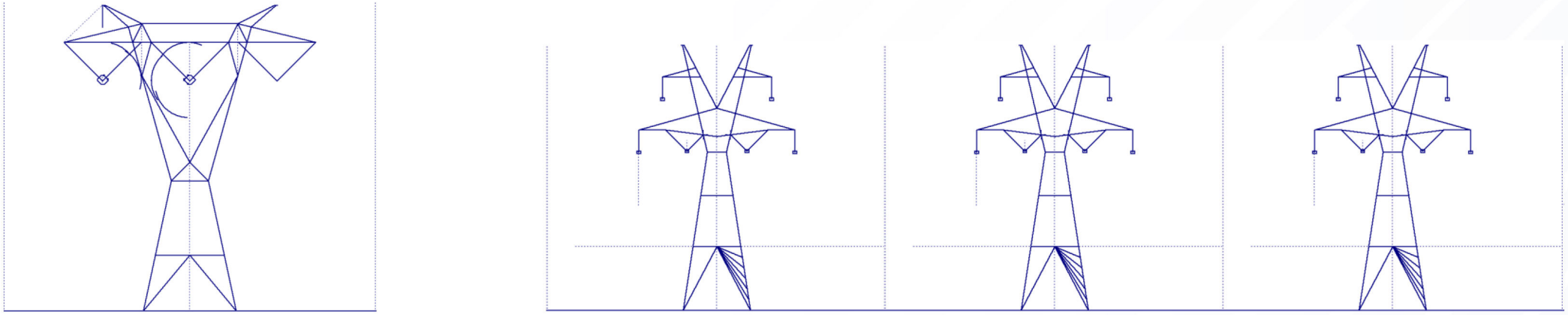
- Quantifying risk using the Unit Risk model is a well-established principal used by U.S. Dept. of Defense, ISO 31000: Risk Management, OSHA & NIOSH, and fault tree analysis.
- The **Unit Risk Model** defined as:

$$Unit\ Risk = Frequancy\ of\ Occurrence \times Severity\ of\ Outcome \times Exposure$$

To be able to compare 345kV and 765kV it should be assumed that the SIL be ignored, and the same length be used from station A to B (200 miles).

- Further assumptions using MISO common design (765kV) and Texas common design (345kV DC).
- 765kV – 6x ACSR “Tern”, Ruling Span = 1200 ft, right-of-way = 200 ft.
- 345kV Double Circuit – 2x ACSR “Falcon”, Ruling Span = 1200 ft, right-of-way = 160 ft.

765kV Single Circuit vs. 3x 345kV Double Circuit



- Further assumptions using MISO common design (765kV) and Texas common design (345kV).
- 765kV – 6x ACSR “Tern”, Ruling Span = 1200 ft, right-of-way = 200 ft.
- 345kV Double Circuit – 2x ACSR “Falcon”, Ruling Span = 1200 ft, right-of-way = 160 ft.

Quantifying Risk// Unit Risk Examples

$$Unit\ Risk = Frequency\ of\ Occurrence \times Severity\ of\ Outcome \times Exposure$$

Item	Frequency		Severity	Exposure 765kV	Exposure 3x 345kV	UR 765kV	UR 345kV
Suspension clamp installation	0.001	Incidents / defect	$100,000.00	15,840	31,680	$1,584,000/year	$3,168,000/year

*Clamps are for different diameter cables, but it has negligible impact.

$$Unit\ Risk = Frequency\ of\ Occurrence \times Severity\ of\ Outcome \times Exposure$$

Item	Frequency		Severity	Exposure 765kV	Exposure 3x 345kV	UR 765kV	UR 345kV
Transformer $	0.5	Tariff / Inflation	$100,000.00	6	12	$300,000/year	$600,000/year

*Inflation or tariff causes an increase in price of x%.

**Same power transfer requires double the quantity of production slots, double the quantity of bushings.

Quantifying Risk// Unit Risk during Engineering & Procurement

$$Unit\ Risk = Frequency\ of\ Occurrence \times Severity\ of\ Outcome \times Exposure$$

Item	How Likely		Severity
LiDAR	0.0001	faults per acre	$30,000
SUE	0.003	colocations per mile	$50,000
Engineering	0.01	estimate/spotting/clearance	$30,000
Testing	0.01	test center availability	$60,000
Steel	0.01	steel price tariff / test center availability	$1,000,000
Insulator	0.1	failures / 100 miles / year	$120,000
Hardware	0.1	failures / 100 miles / year	$120,000
Conductor	0.1	failures / 100 miles / year	$120,000
Spacer Damper	0.3	failures / 1000 dampers / year	$10,000
Clamps	0.3	failures / 1000 dampers / year	$25,000
Concrete	0.1	availability / price increase	$1,000,000
Landowner dispute	0.05	flags / 100 acres	$100,000
Endangered species	0.05	flags / 100 acres	$75,000
FAA	0.01	flags / 100 miles	$15,000

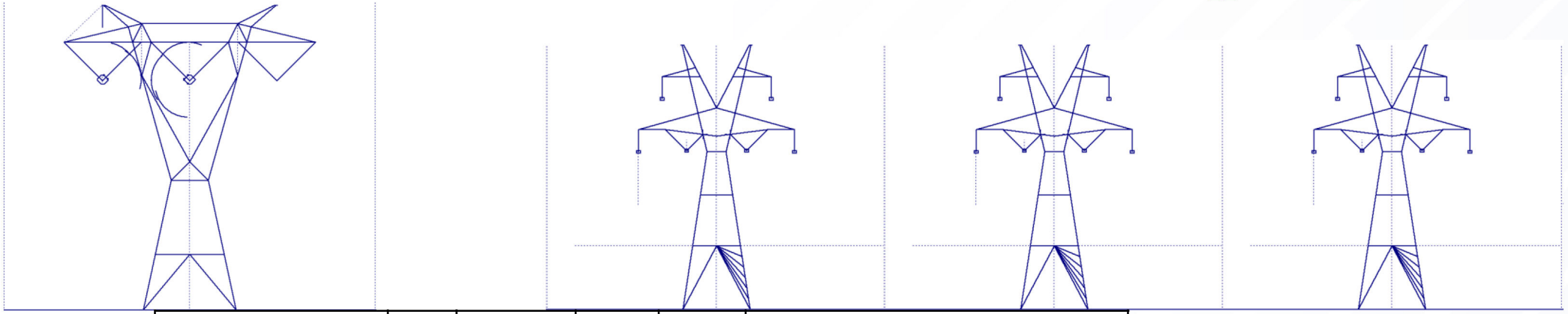
Quantifying Risk// Unit Risk during Construction

$$Unit\ Risk = Frequency\ of\ Occurrence \times Severity\ of\ Outcome \times Exposure$$

Item	How Likely		Severity
Lifting tackle fails	0.0001	per use	$ 100,000.00
Crane breaks	0.003	per use	$ 10,000.00
Weather delays	0.015	per event	$ 1,000.00
Winch causes collapse of hardware during dressing	0.001	per use	$ 100,000.00
Temporary stay collapses	0.0001	per use	$ 50,000.00
Bolts not tightened causing part of structure collapse	0.0025	per event	$ 20,000.00
Worker falls from structure	0.001	times per climb	$ 100,000.00
Tools fall on worker	0.01	times per climb	$ 10,000.00
Worker falls into hole	0.01	times per drill	$ 10,000.00
Bad batch of concrete	0.01	times per pour	$ 10,000.00

Quantifying Risk// Unit Risk - Exposure

$$Unit\ Risk = Frequency\ of\ Occurrence \times Severity\ of\ Outcome \times Exposure$$



Item	765kV		345kV		*Odds are the same, exposure drastically increases
Length A-B	200	miles	200	miles	
Ruling Span	1200	ft	1200	ft	
Towers	880		2640		Odds of a tower getting hit by storm?
Foundations / tower	4		12		
Foundations total	3520		10560		
Drill operations	3520		10560		
QYD of concrete	52800		158400		Odds of a bad batch / odds of delays / odds of foundation re-design?
HW Assemblies	2640		15840		
Rig/Lift operations	2640		15840		Odds of a winch failing, tool falling
Stringing operations	3		18		
Conductor circuit miles rate of installation	1	mile/hr	1	mile/hr	
Conductor stringing time	600	eq. hours	3600	eq. hours	Odds of bullwheel / tensioner failure?
Stringing blocks	2640	blocks	15840	blocks	Odds of stuck block during stringing?
Backstay operations @ 1 per 12miles	50	operations	300	operations	
Acres	4849	acres	11636	acres	

QUESTIONS?

Thank You