HVDC Systems
Presentation for the PJM Emerging Technologies Forum

Rob Stupar – Senior Manager, Regulatory Affairs - Invenergy

Carlos A. Rodriguez – SVP, Interconnections & Grid Analysis - Invenergy

Rob Taylor – Director, Transmission New Markets - Invenergy

Dan Kell - Senior Director, Power System Studies and HVDC - Hatch

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World's Leading Privately Held Sustainable Energy Company

CORE BUSINESS

Invenergy

Our Foundation
Developing and operating sustainable energy projects around the world

Wind
110 projects
17,600 megawatts

Solar
50 projects
6,205 megawatts

Storage
18 projects
1,537 megawatt hours
486 megawatts

Natural Gas
13 projects
5,964 megawatts

DIVERSIFIED SOLUTIONS

Invenergy Services

Award-winning asset management and operations with an owner's mindset

Invenergy Transmission

Experience developing 4,100+ miles of transmission and distribution infrastructure to bring power to market

Invenergy Clean Water

Tackling the next sustainability challenge with an emerging water desalination business

ENERGIZE VENTURES

Investing in digital solutions that drive affordability, reliability and security for energy and industry

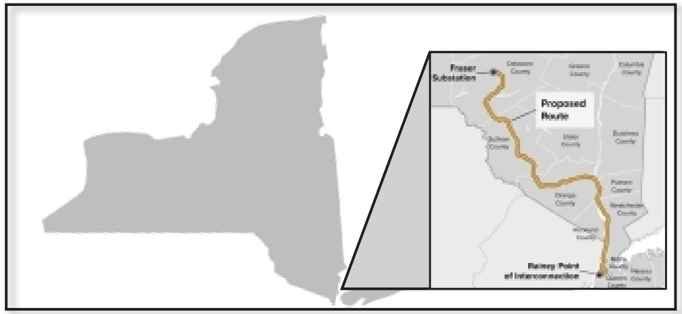
Invenergy Transmission

Invenergy Transmission is building transmission infrastructure to meet critical energy needs for all Americas – from consumers and communities, to grid operators and governments.

Powered by state-of-the-art HVDC technology, Invenergy Transmission projects will:

- Deliver **billions of dollars in customer cost savings**
- **Power economies** for entire states and regions through job creation and payments to local governments and landowners
- Enhance America's **grid reliability** and **energy independence**
- Unlock new renewables to **support climate and clean energy goals**

CLEAN PATH NEW YORK

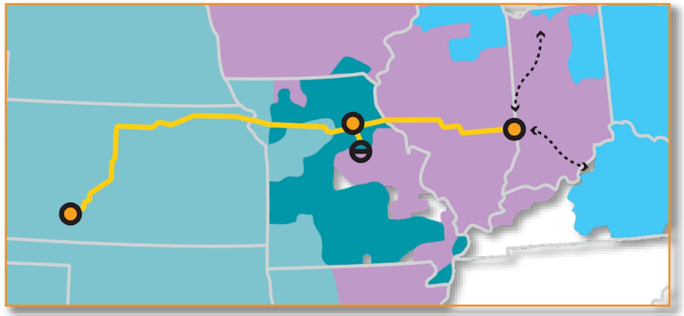


Solving the "Tale of Two Grids"

Underground HVDC | 175 miles | 1,300 megawatts

- **$11B investment** in new renewable generation and transmission entirely located in New York state
- **Public private partnership** with New York Power Authority and energyRe (Related Companies)
- **2,000MW** of new wind, **1,800MW** of new solar, and **1,160MW** existing pumped hydro storage to be delivered into NYC via new transmission line as well as available to Upstate
- **39M tons CO2 avoided** over 25 years statewide; **22% reduction** in statewide fossil fuel generation
- **8,300 construction jobs** supported for NY workers
- **$270M community investment** fund supporting

GRAIN BELT EXPRESS

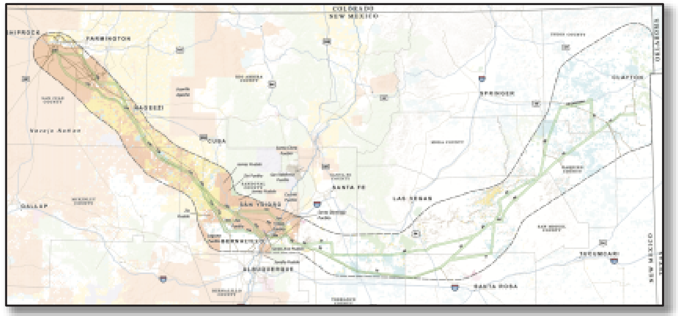


Connecting 4 of America's largest grids

Overhead HVDC | 800 miles | 5,000 megawatts

- **Up to $20B investment** in new transmission and an associated 5GW+ buildout of renewable energy in southwest Kansas
- **$8.5B+ customer cost savings** over 15 years for KS, MO, IL
- **Two-way power flow** and **blackstart capability** will significantly enhance grid reliability for SPP, MISO and PJM, which serve 25 U.S. states
- **12,000 construction jobs** supported annually for three years across Kansas, Missouri and Illinois for transmission plus renewable generation buildout
- **3.2M American homes powered** with clean energy

NEW MEXICO NORTH PATH



Renewing New Mexico's role as an energy supplier

Overhead HVDC | 225 miles | 4,000 megawatts

- **$2B transmission investment** with up to $5B in additional expected renewable energy investment
- **Opening access** to Union County renewables, which is #1 county in NM for wind and #6 for solar
- **Public private partnership** with New Mexico Renewable Energy Transmission Authority
- **3,500 construction jobs** supported for transmission buildout
- Supports NM's **50% renewables by 2030 goal**

Hatch Overview

9,500
+
Staff

Power Sector Experience since
1924

70+
Offices

1,200+
Power Sector Professionals

Power Business Unit - What we Do

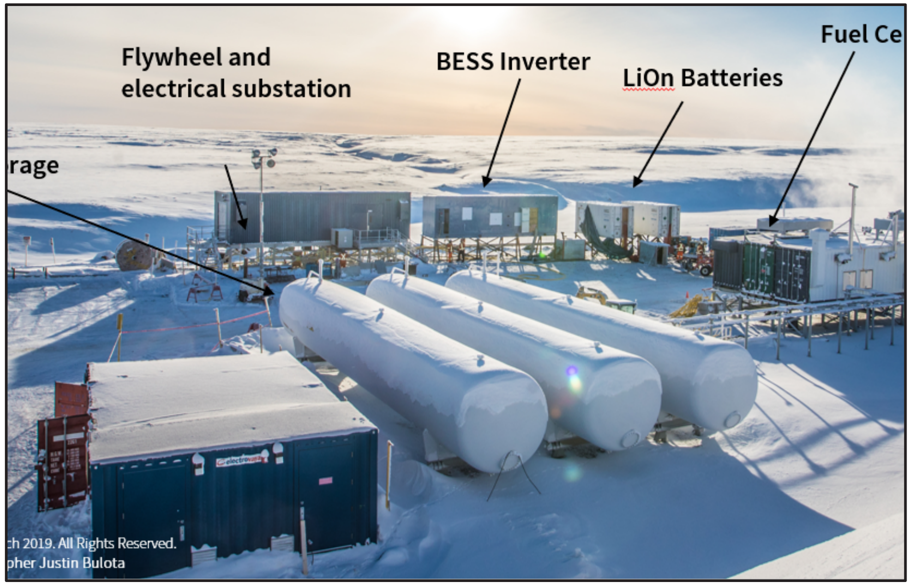
Hydropower & Dams

Thermal

Nuclear

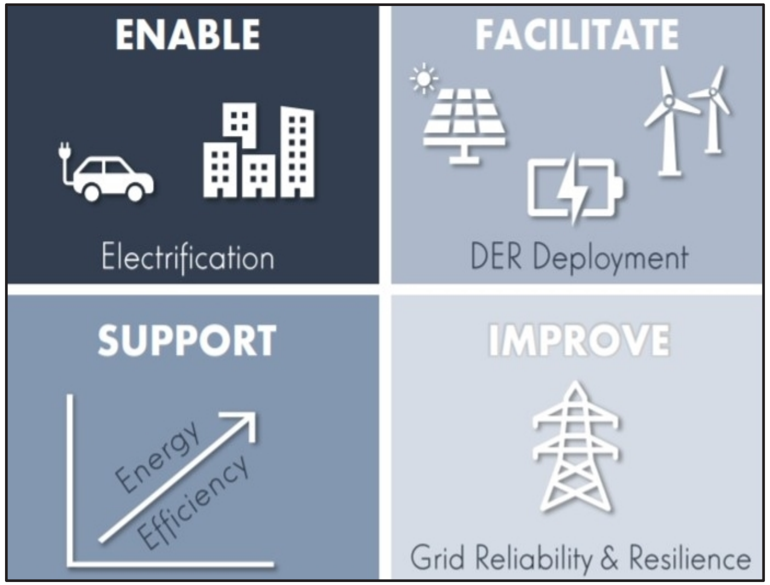
eGRID

Renewables



Hybrid Systems

Transmission



Grid Modernization

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- What is a High Voltage Direct Current (HVDC) system?
- HVDC applications
- Existing and planned HVDC projects in North America
- HVDC past growth and projected growth.
- Some HVDC technology history
- HVDC technologies fundamentals (LCC, VSC)
- HVDC configurations (monopoles, bipoles)
- HVDC facilities (voltages, sizes, applications)
- Ancillary services that HVDC can provide today
- Reliability services that HVDC can provide. Grain Belt Express Project example

What is a HVDC System?

Conversion from AC to DC → HVDC Converter

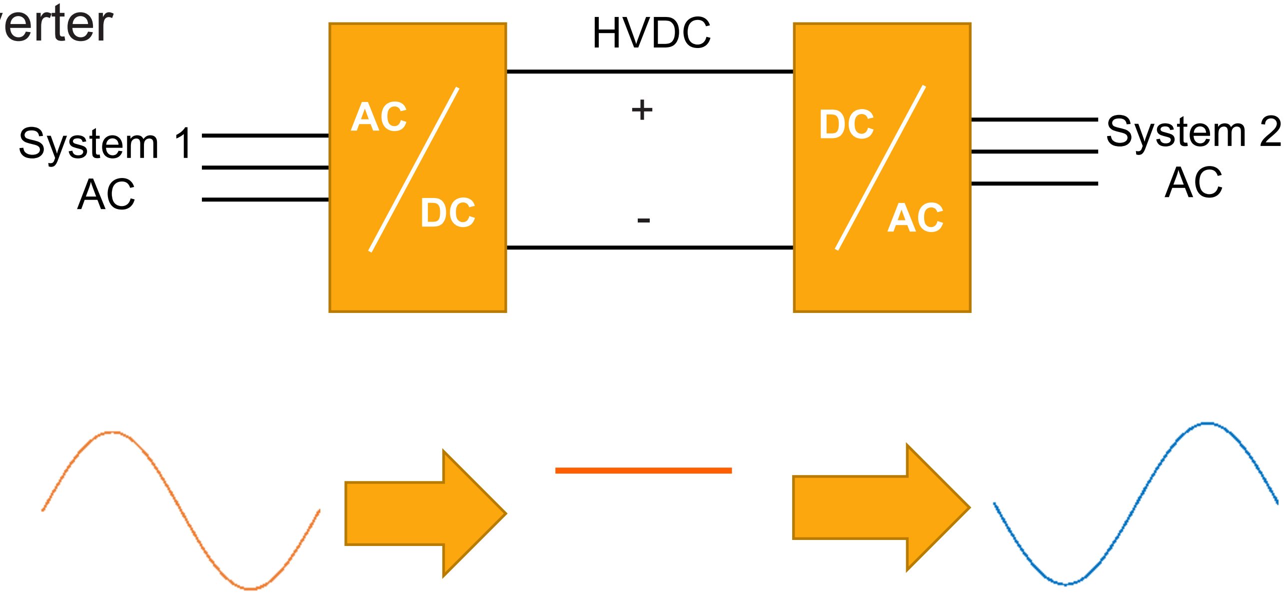
DC link can be:

Overhead lines

Cables

Mixed Cables / Lines

Busbar (back-back)

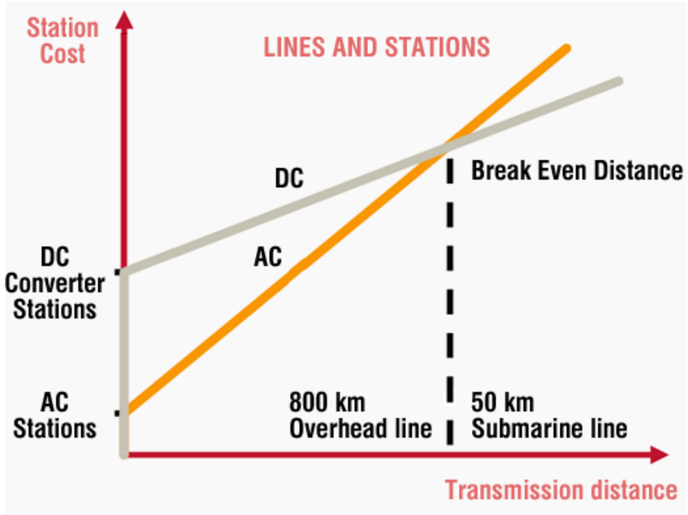


When Do We Use HVDC instead of HVAC?

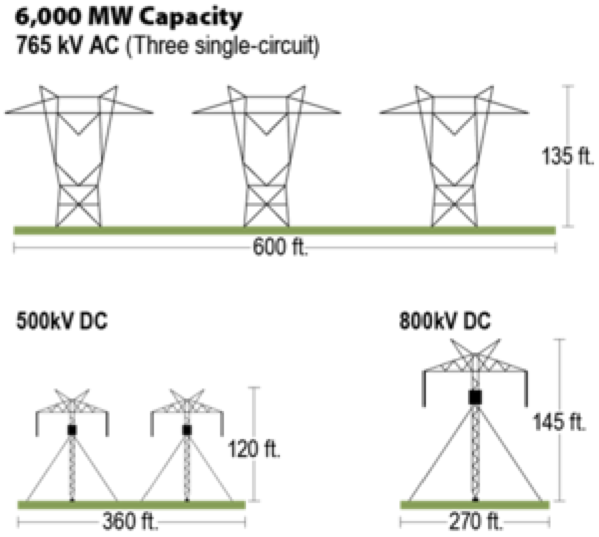
- One of the main reasons to use HVDC is that transmitting power with HVAC over a distance of about 350-400 miles or more gets very complicated and costly
- Therefore, HVDC should be considered for distances longer than about 350-400 miles
- Over very long distances, transferring power with HVAC is very complicated, due to voltage control, voltage stability, expensive reactive compensation equipment, potential sub-synchronous resonance issue if series compensation is used, and other issues
- In addition, an HVDC line's investment cost is lower than an HVAC line beyond the critical distance of about 350-400 miles, it has a smaller right of way requirement (due to one less conductor) and lower losses
- Another application of HVDC is to move power between asynchronous systems or systems with different frequencies

HVDC Technology Application

Moving power overland long distances



Congested Corridors



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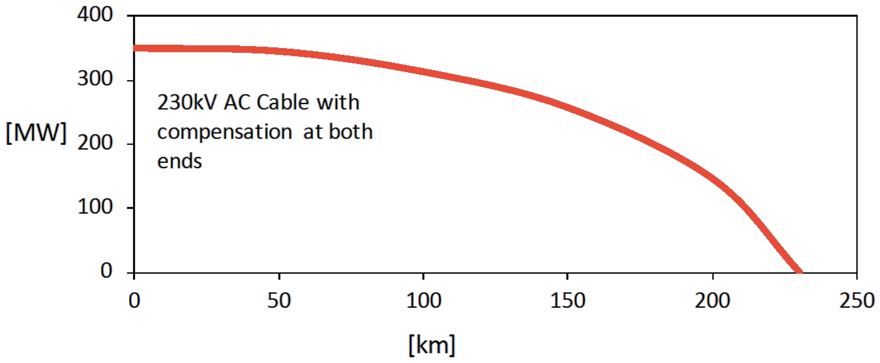
HVDC Technology Application

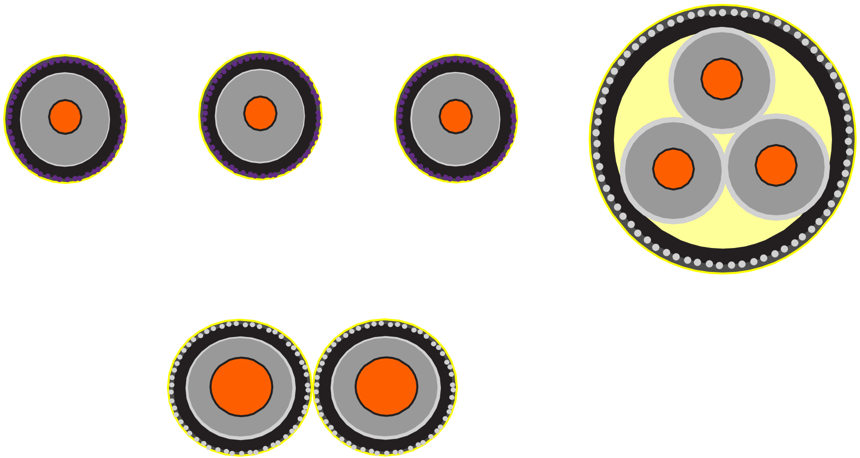
Moving power via sub-sea cable

DC has theoretically no distance limit



AC

DC



Power Level	DC	AC
1000MW	2 x 320kV DC cables	3 x 3ph 220kV AC cables 9 x 1ph 220kV AC cables
1300MW	2 x 320kV DC cables 2 x 400kV DC cables	4 x 3ph 220kV AC cables 12 x 1ph 220kV AC cables
2000MW	2 x 500kV DC cables	5 x 3ph 220kV AC cables 15 x 1ph 220kV AC cables

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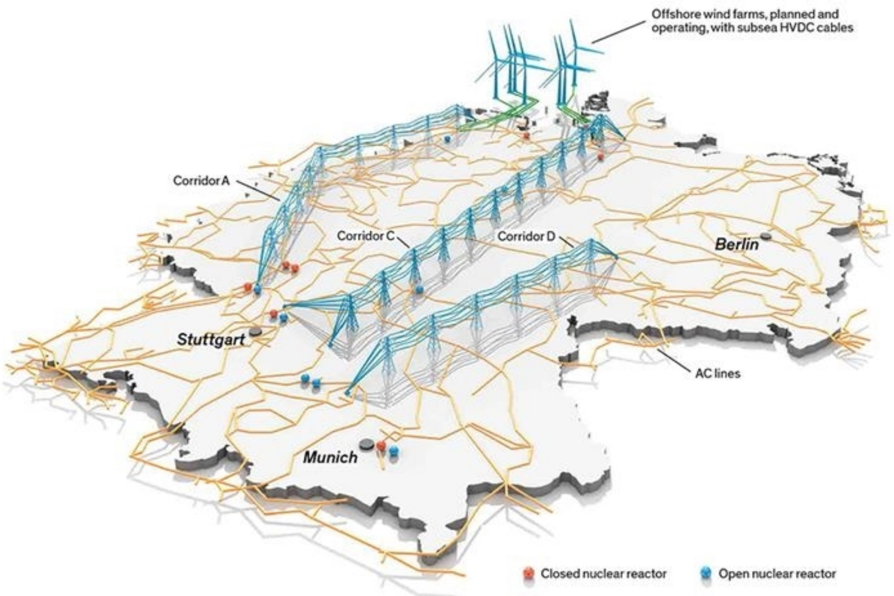
HVDC Technology Application

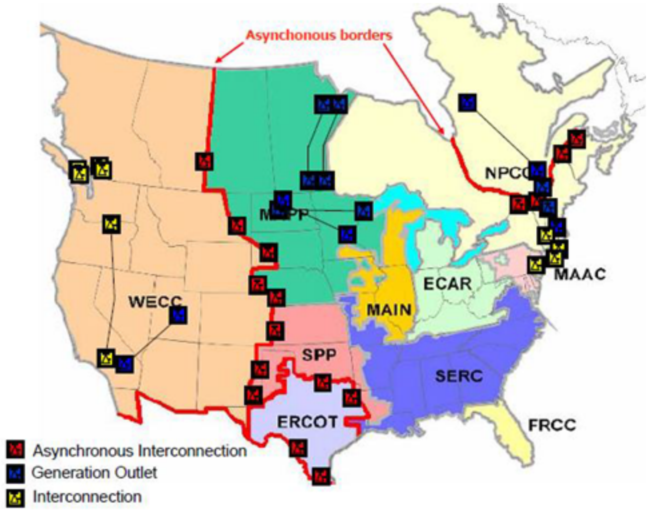
Germany are using HVDC to move Wind energy from off-shore
And then HVDC to load centers



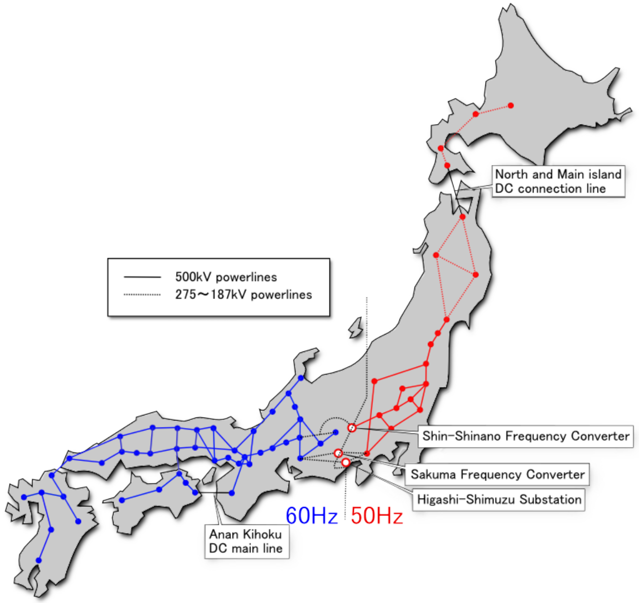
[Germany Takes the Lead in HVDC (ieee.org)]

HVDC Technology Application

Moving power between asynchronous systems



Connecting systems with different Frequencies



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Existing HVDC Projects in North America

	Vendor	Name	country	type	rating	Technology
1	GE	McNeil	Canada	BtB	150MW	LCC
2	GE/Siemens	BP1	Canada	OHTL	1650MW	LCC
3	GE	LCP	Canada	OHTL/Cable	900MW	LCC
4	GE	Eddy County	USA	BtB	200MW	LCC
5	GE	Mile City	USA	BtB	200MW	LCC
6	ABB	CU	USA	OHTL	1000MW	LCC
7	GE/Siemens/ABB	BP2	Canada	OHTL	2000MW	LCC
8	ABB	Pacific Intertie	USA	OHTL	3800MW	LCC
9	ABB/Siemens	Chateauguay	Canada	BtB	1000MW	LCC
10	ABB	Intermountain	USA	OHTL	1920MW	LCC
11	ABB	Highgate	USA	BtB	200MW	LCC
12	ABB	Blackwater	USA	OHTL	200MW	LCC
13	ABB	Quebec-NE	USA/Canada	OHTL	2000MW	LCC
14	ABB	Rapid City	USA	BtB	200MW	LCC
15	ABB	Sharyland	USA	BtB	150MW	LCC
16	ABB	Outaouais	Canada	BtB	1250MW	LCC
17	ABB	Oklaunion	USA	BtB	220MW	LCC

	Vendor	Name	country	type	rating	Technology
18	ABB	Railroad DC Tie	USA	BtB	150MW	LCC
19	ABB	Cross Sound	USA	Cable	330MW	VSC
20	ABB	Mackinac	USA	Btb	200MW	VSC
21	ABB	Maritime Link	Canada	OHTL/Cable	500MW	VSC
22	ABB	Eagle Pass	USA	BtB	36MW	VSC
23	GE/ABB	Eel River	Canada	BtB	350MW	LCC
24	Siemens	Virginia Smith	USA	BtB	200MW	LCC
25	Siemens	Welsh Link	USA	BtB	600MW	LCC
26	Siemens	Lamar	USA	BtB	210MW	LCC
27	Siemens	Neptune RTS	USA	Cable	660MW	LCC
28	Siemens	Hudson	USA	Cable	660MW	LCC
29	Siemens	EATL	Canada	OHTL	1000MW	LCC
30	Siemens	WATL	Canada	OHTL	1000MW	LCC
31	Siemens	BP3	Canada	OHTL	2000MW	LCC
32	Siemens	TransBay Cable	USA	Cable	400MW	VSC
33	GE	Madawaska	Canada	BtB	350MW	LCC

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Total US: 11.5GW
Total Canada: 14.2GW

Total (US + Canada) : 25.7GW

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A Few Notable Planned HVDC Projects in The US

Name	Location	Type	Rating	Technology
Clean Path New York	NY - NY	Cable	1300 MW	VSC
Champlain Hudson Power Express	Quebec - NY	Cable	1250 MW	VSC
Sun Zia	NM - AZ	Overhead Line	3000 MW	VSC
Grain Belt Express	KS – MO – IL -IN	Overhead Line	5000 MW	VSC

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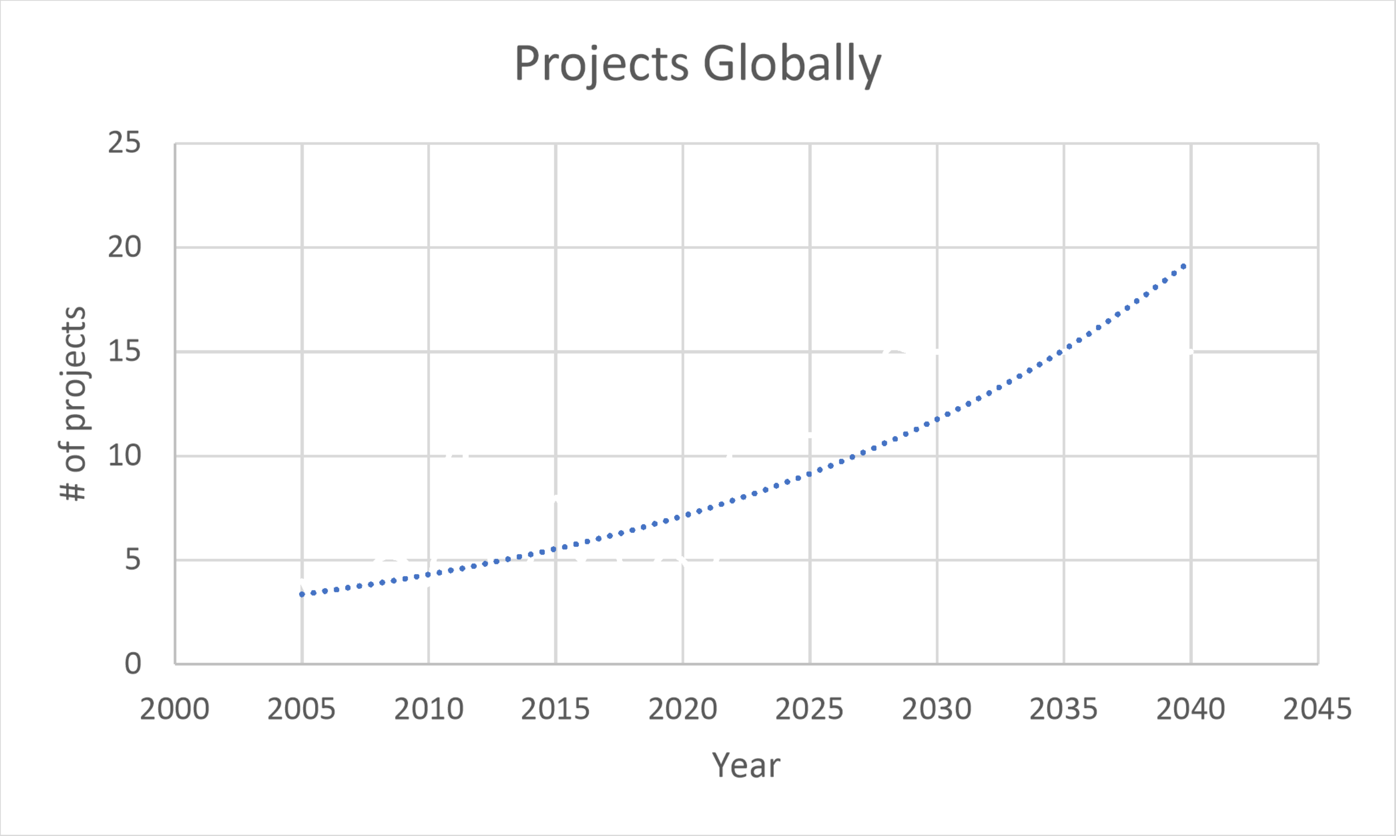
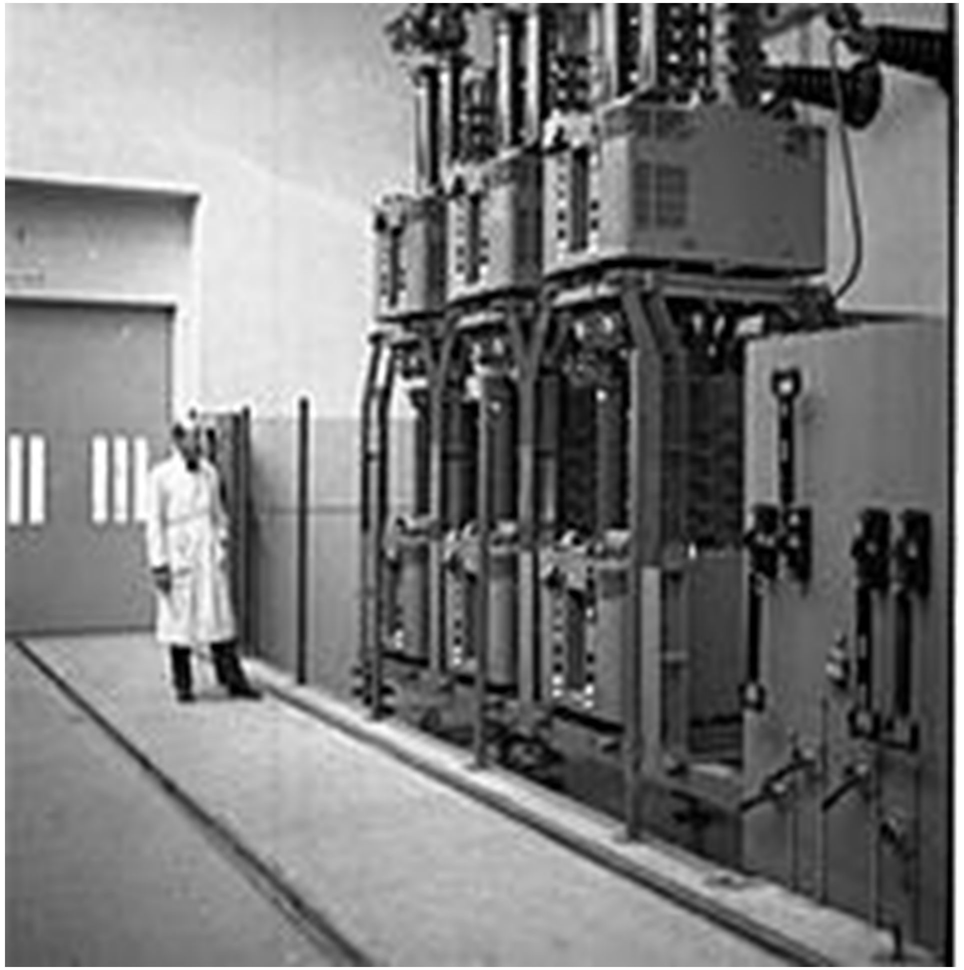
HVDC Past and Future Growth



Some HVDC Technology History

- HVDC was introduced in 1954 with the Gotland HVDC link 2 x 6 pulse converters (LCC)
- 10 MW, 50 kV, 96 km



Some HVDC Technology History

- First Thyristor based system in the world was a back to back HVDC station between New Brunswick and Quebec (Eel River) - 1972
- 320 MW, 80 kV

Source: l-eel-river-2 (720×424) (hitachienergy.com)

Some HVDC Technology History

- In 1979, the 1920 MW, 533 kV Cahora Bassa was brought in service. Connecting Mozambique to South Africa
- 1920 MW, +/-533 kV
- Oil filled valves
- Currently undergoing refurbishment
- After this a few more developments (water cooled valves) for Nelson River

Some HVDC Technology History

- In 1997, the experimental Hellsjön–Grängesberg VSC HVDC system was put in service (Sweden). 3 MW, 10 kV, 10 km

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[Hallsjon the first hvdc light transmission | Hitachi Energy]

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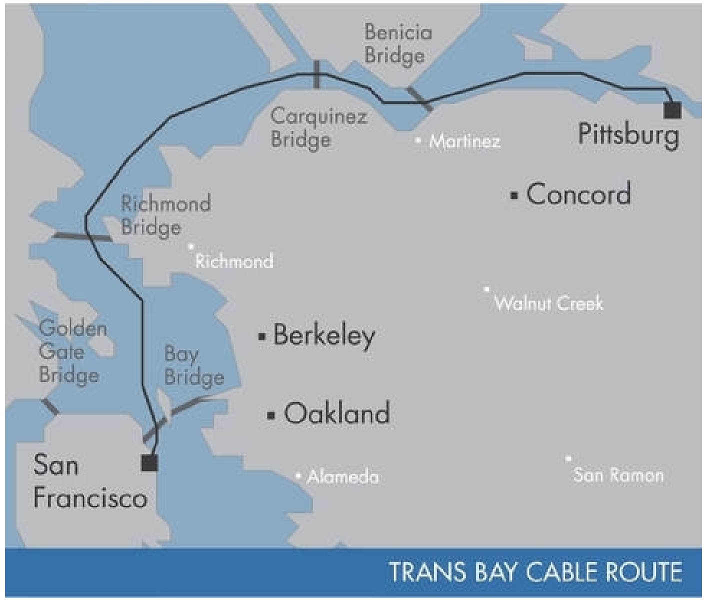
Some HVDC Technology History

- Technology grew very quick from here and by 2010, the Transbay cable was in service
- 400 MW, 200 kV, 85 km
- Transbay uses the multi-module converter (MMC) which is the basis of VSC technology



[Siemens black-start technology to provide critical back-up for San Francisco's power grid | Press | Company | Siemens]()

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Why HVDC

- Moving large amounts of power long distances
- Moving power by cable over moderate to long distances
- Moving power between asynchronous systems
- Forcing power into an area (e.g., loop flow)
- Congested corridors
- Limitation of short circuit currents through system segmentation

HVDC Technology Fundamentals

Two Prominent Technologies:

Line Commutated Converters

Voltage Sourced Converters

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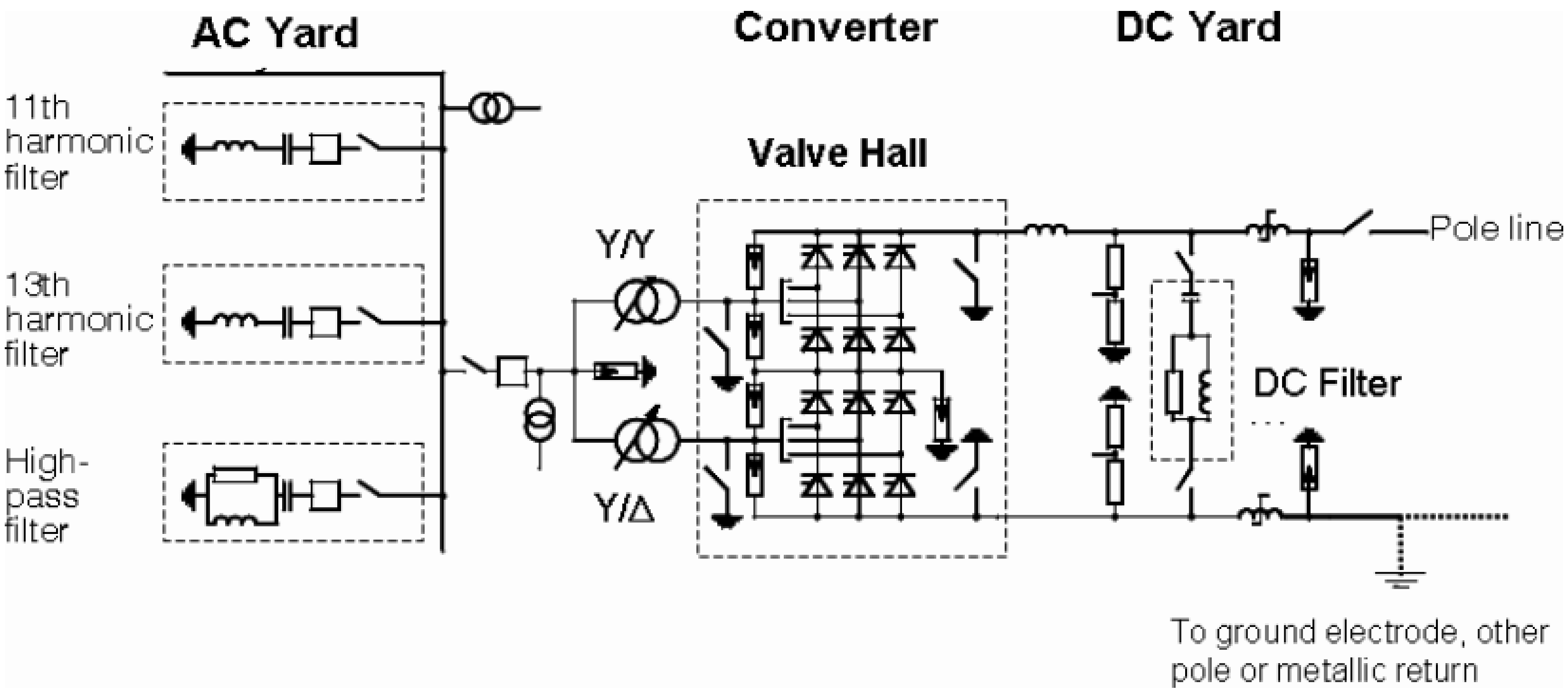
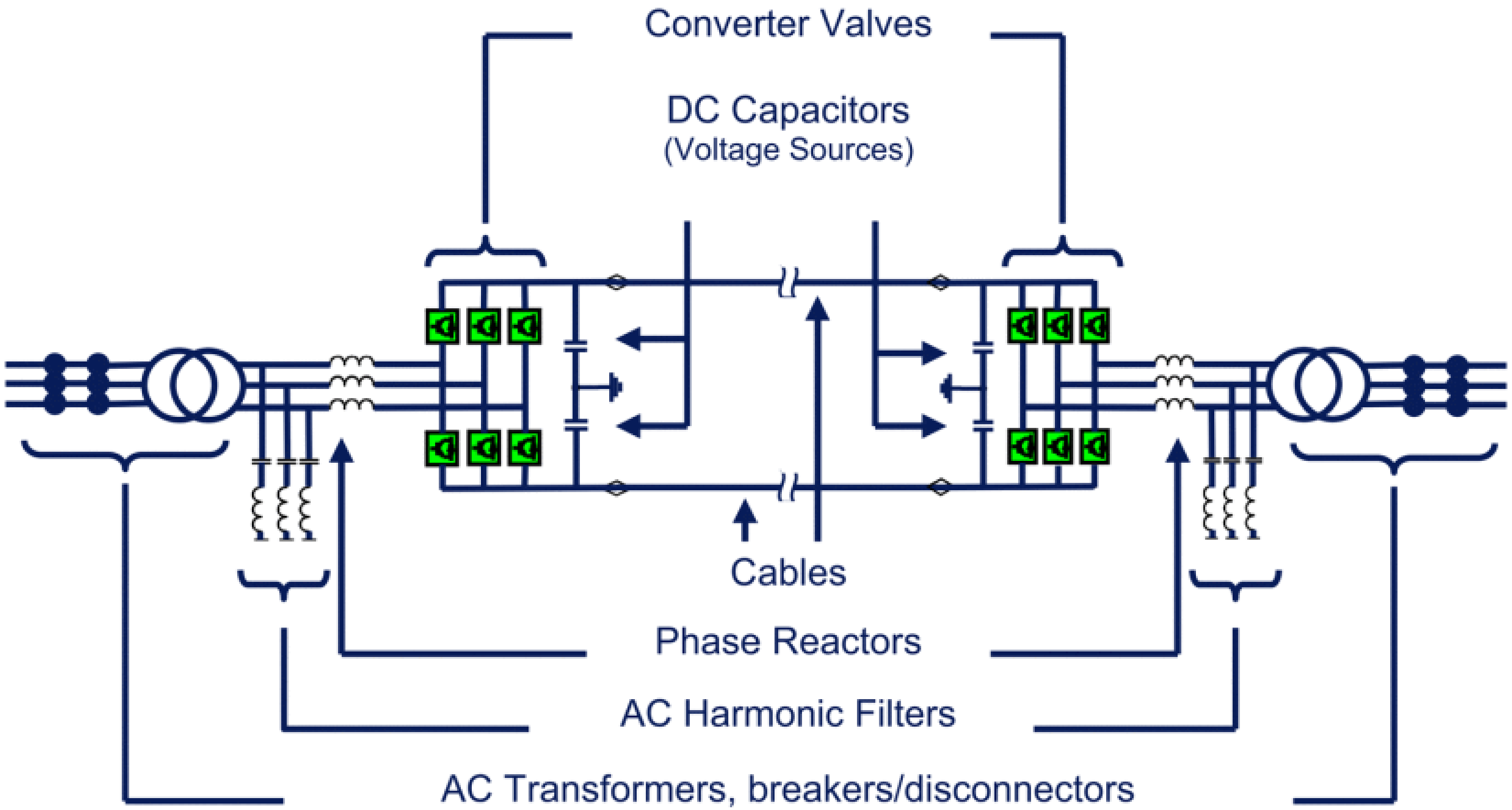
HVDC Technology Fundamentals



HVDC Technology Fundamentals



HVDC Technology Fundamentals

Line Commutated Converter (LCC)

- AC ← → DC
- Semiconductor: Thyristor
- Active Power Control
- Large AC Filters
- Minimum Short Circuit Ratio required
- DC power flow reversal with momentary interruption

Voltage Source Converter (VSC)

- AC ← → DC
- Semiconductor: Transistor (IGBT, BIGT)
- Active/Reactive power control
- Small (or zero) AC Filters
- Very low short circuit ration (incl. black start capability)
- Fast DC power flow reversal

HVDC Technology Fundamentals

Line Commutated Converter (LCC)

- Overload Capacity
- Power up to 12,0000 MW with =/- 1,100 kV
- Losses in range of 0.7%/Converter
- Large footprint
- Excellent DC Line Fault Performance

Voltage Source Converter (VSC)

- No inherent overload capability
- Power now in the range of: 3,400 MW with +/- 600 kV
- Losses now in range of 0.7%/Converter
- Compact Design
- Excellent DC Line Fault Performance (for a price) or "good" DC Fault Performance

HVDC Technology Fundamentals

Moyle Interconnector (LCC) 500MW +/-250kV
~6.2acres

Transbay Cable (VSC) 400MW +/-200kV
~3.3acres

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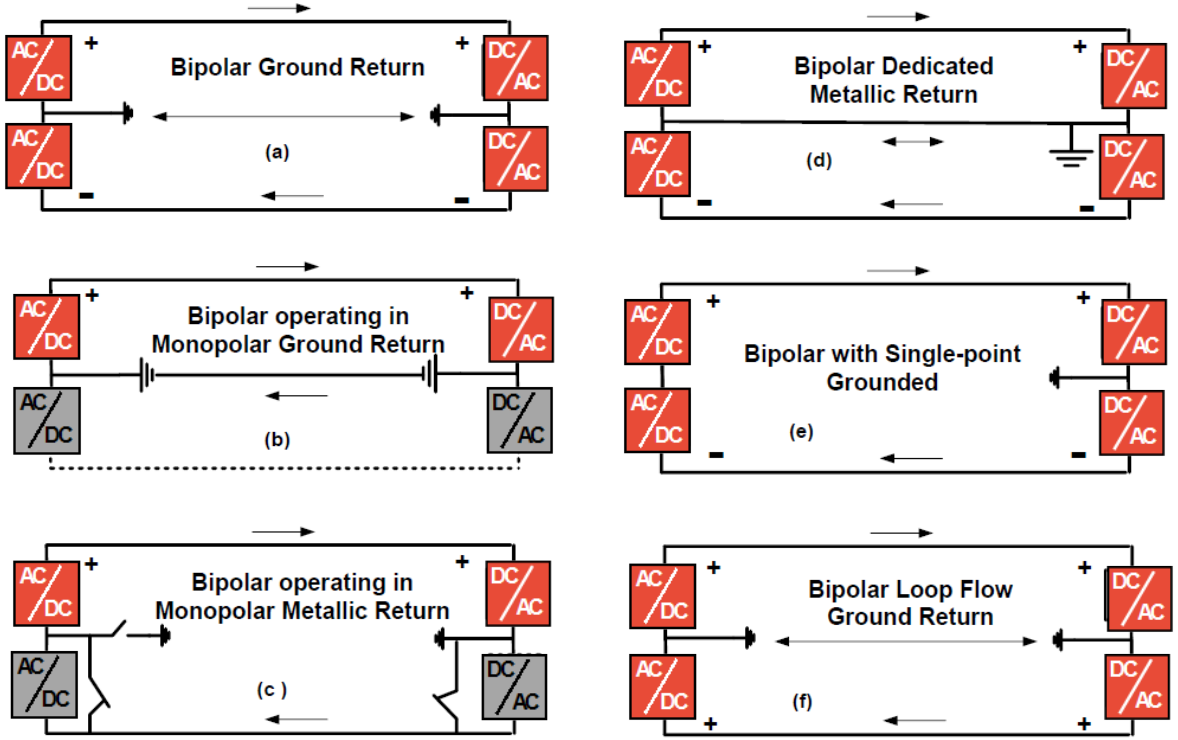
HVDC Technology Configurations

Bipole

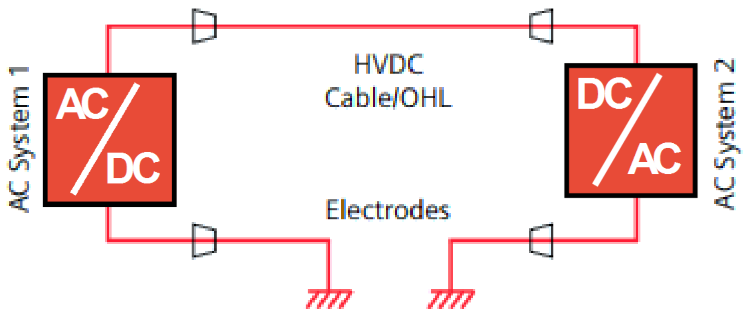
- +/- DC voltage
- Two converters per end

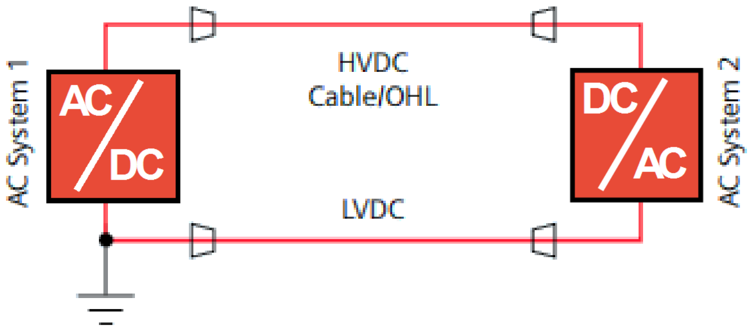


HVDC Technology Configurations

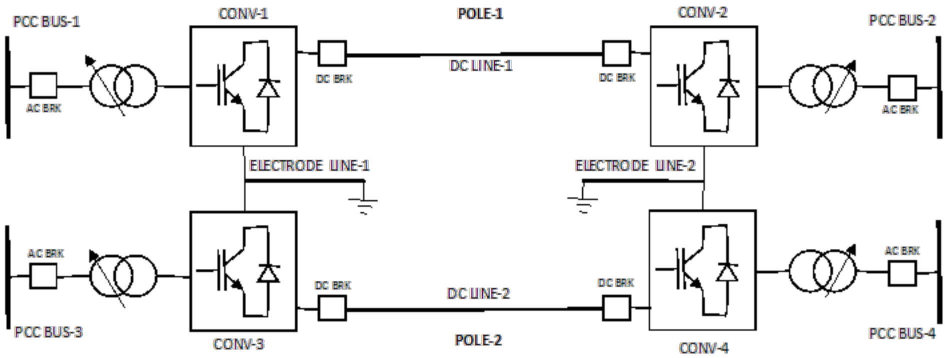
Monopole

- 0/+ DC voltage

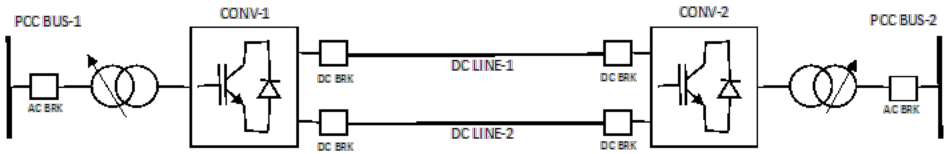




HVDC Technology Configurations



Bipole VSC



Symmetrical Monopole VSC

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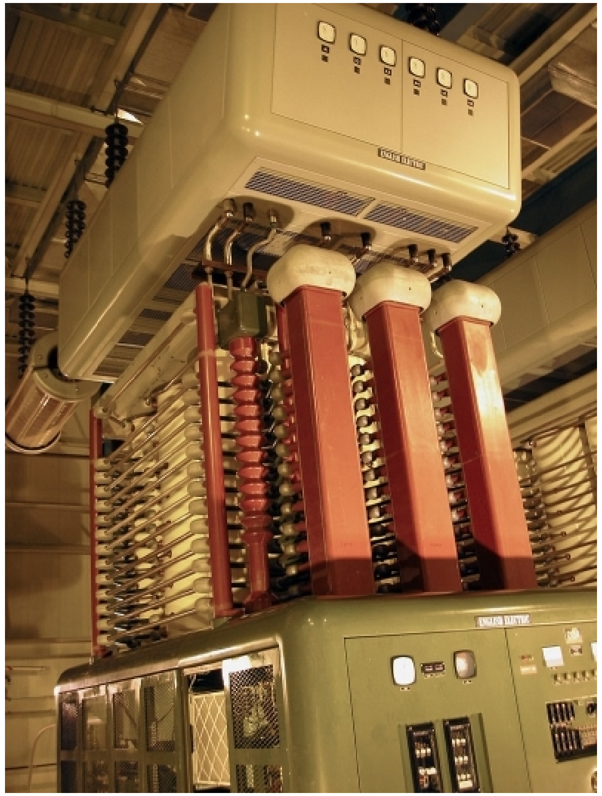
HVDC Technology Configurations

[TRANS BAY CABLE — Dolmen Consulting Engineers (dolmen-engineers.net)]

HVDC Technology Configurations



Mercury Arc Valve, Radisson Converter Station, Gillam MB - Nelson River DC Transmission System - Wikipedia

Manitoba Hydro-BipoleII Valve - Nelson River DC Transmission System - Wikipedia

HVDC Technology Configurations

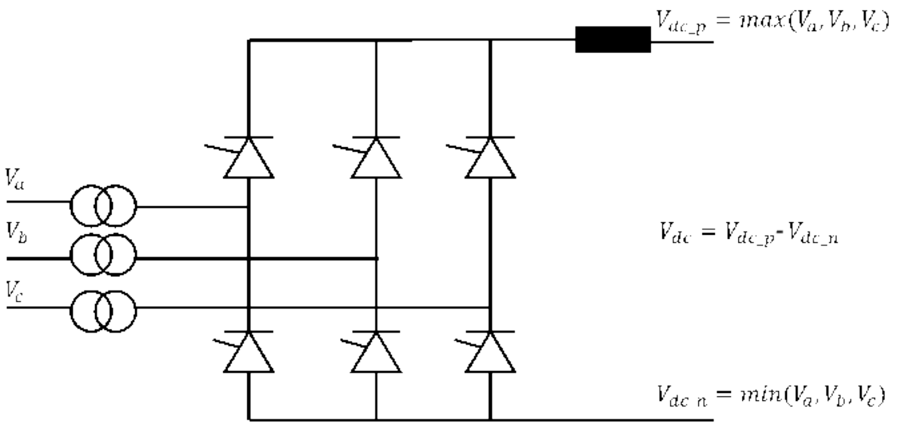
Celilo Converter Station

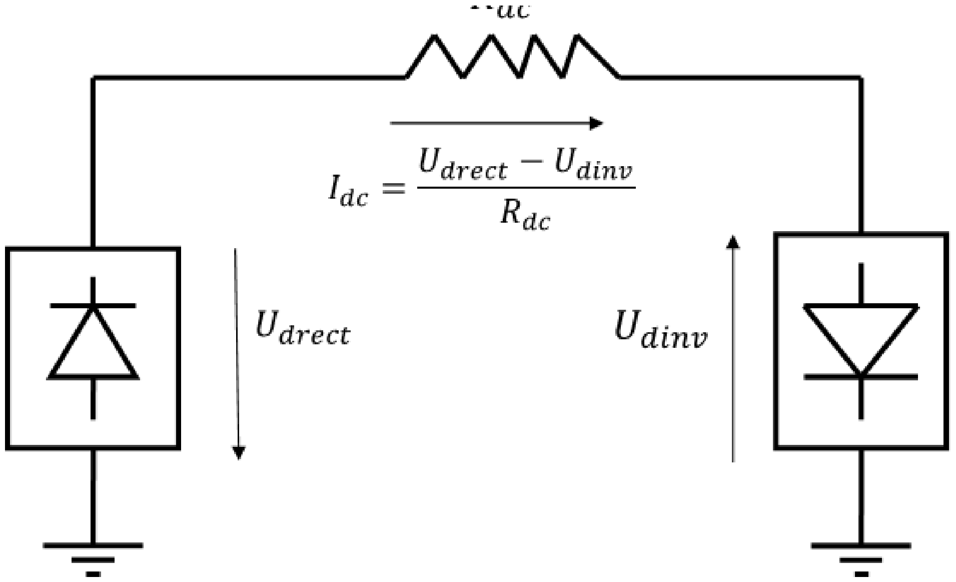
HVDC Lines

Line Commutated Converters

- LCC Operation is quite complex
- Can control real power very Precisely, reactive power 50%-60% of real power
- Weak system issues
- For Cables, require Mass-impregnated Cable type

Line Commutated Converters



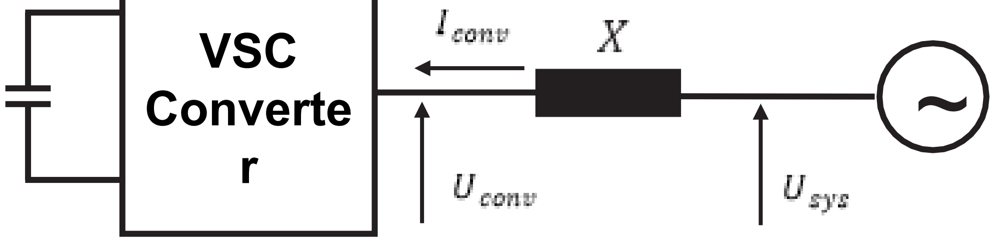


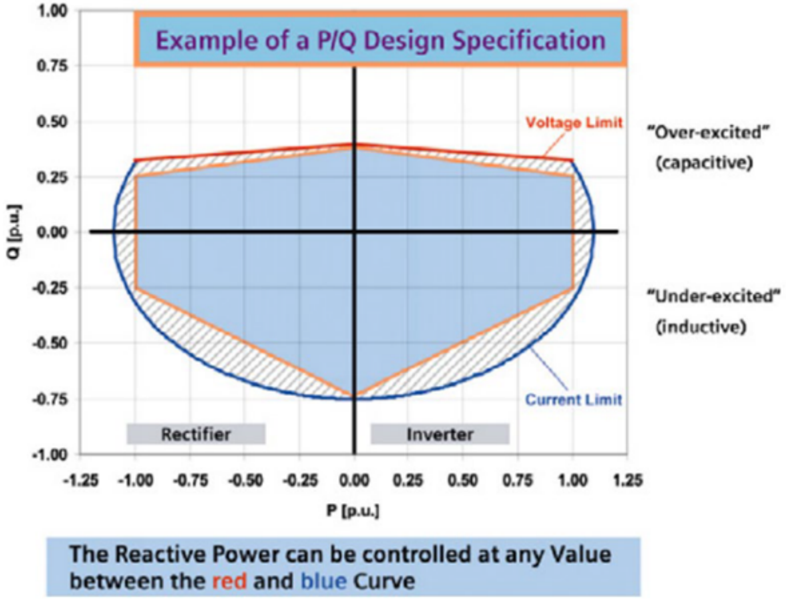
Voltage Sourced Converters

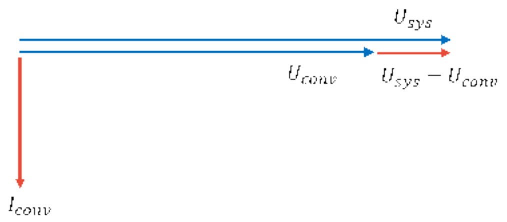
- VSC operation is very similar to a synchronous machine
- Provides active and reactive power control (4-Quadrant control!)
- Can use a cheaper XLPE cable
- Works well in weak, even “dead” systems

Voltage Sourced Converters

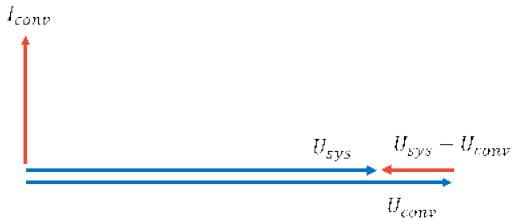
$$I_{conv} = \frac{U_{sys} - U_{conv}}{jX}$$





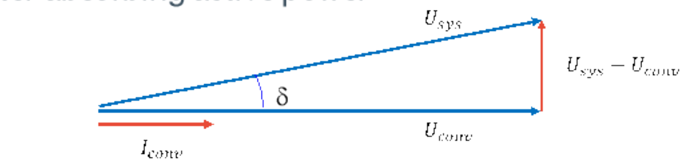


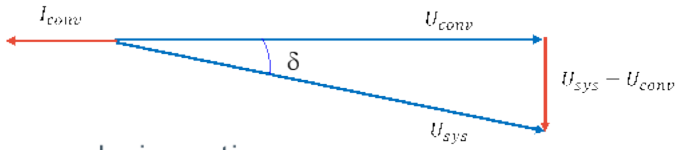
Converter absorbing reactive power



Converter producing reactive power

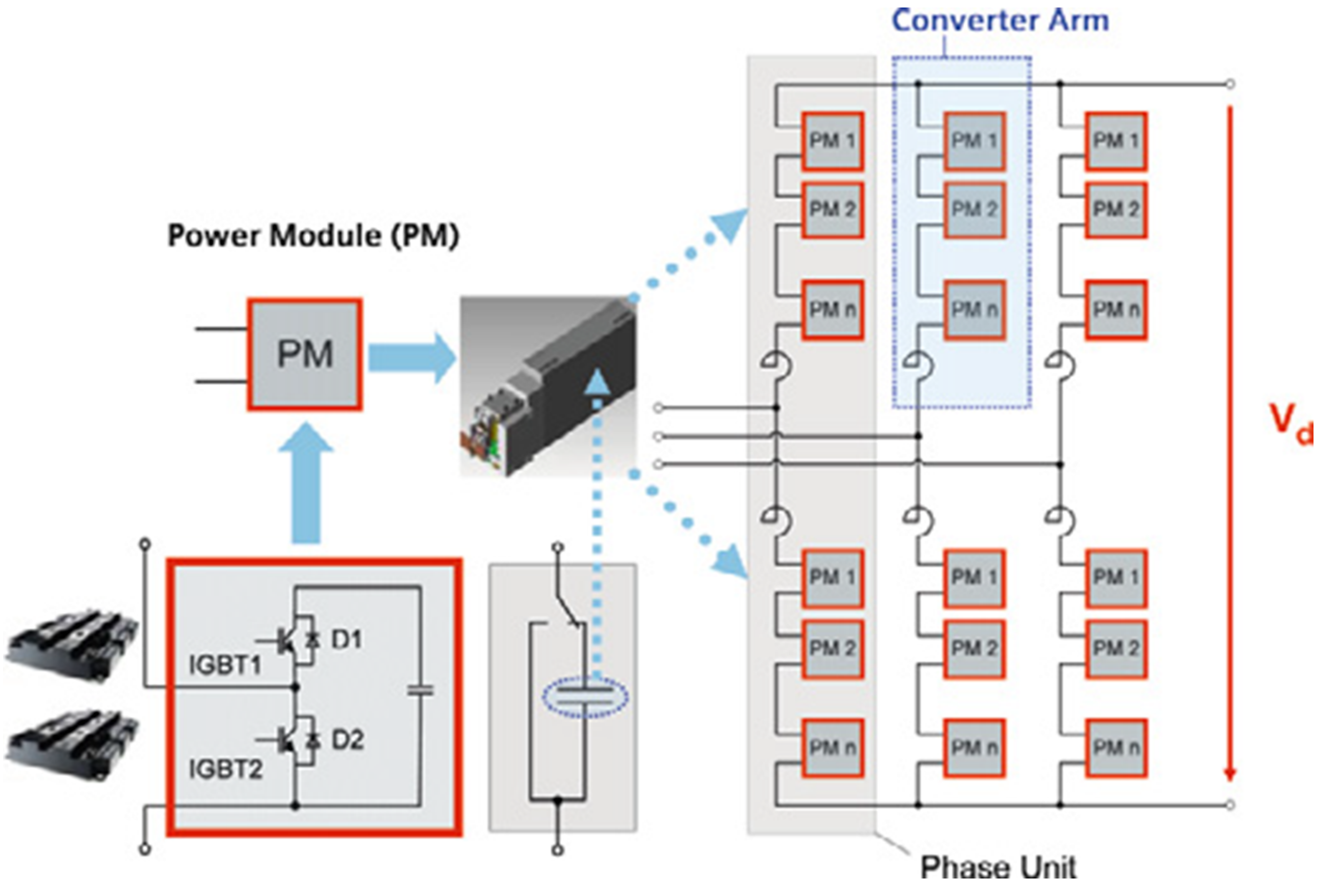
Converter absorbing active power





Converter producing active power

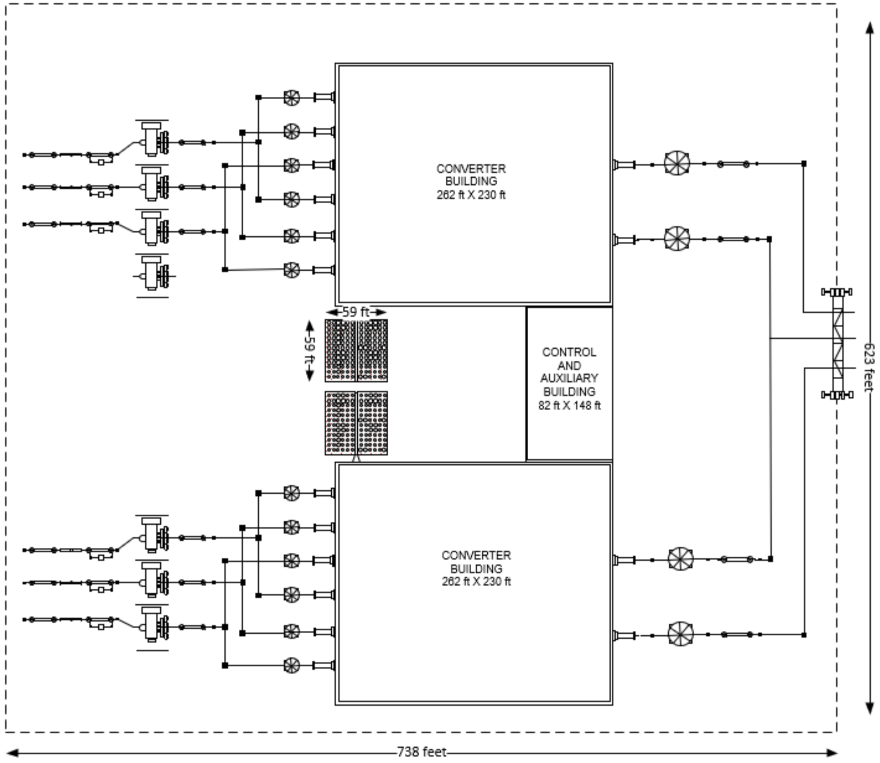
Voltage Sourced Converters



Ref: Siemens

HVDC Station Overview

- VSC 2000MW +/- 525 kV
- Footprint: 625 ft x 740 ft
- 10-11 acres
- Layout optimization possible



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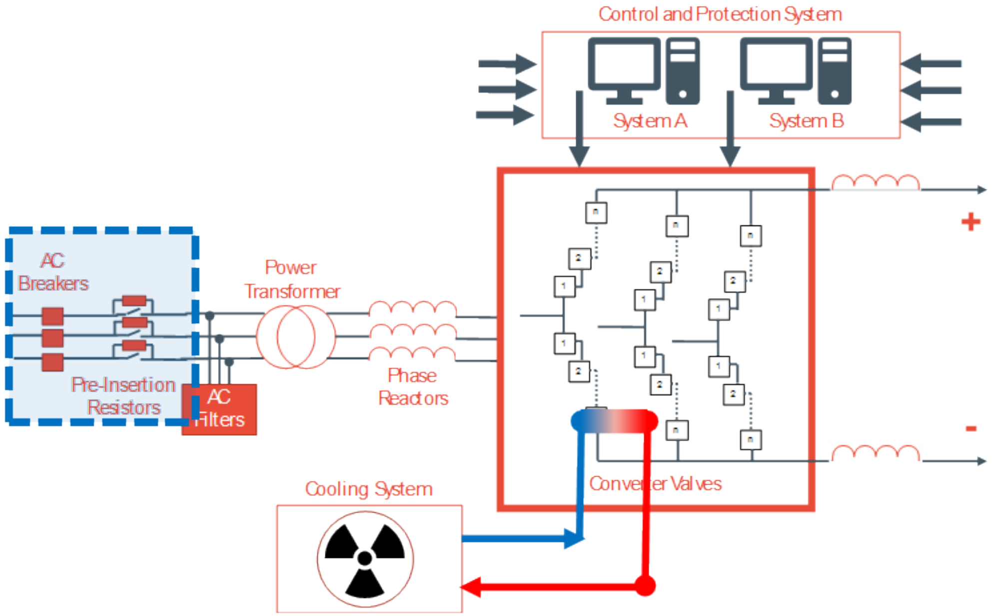
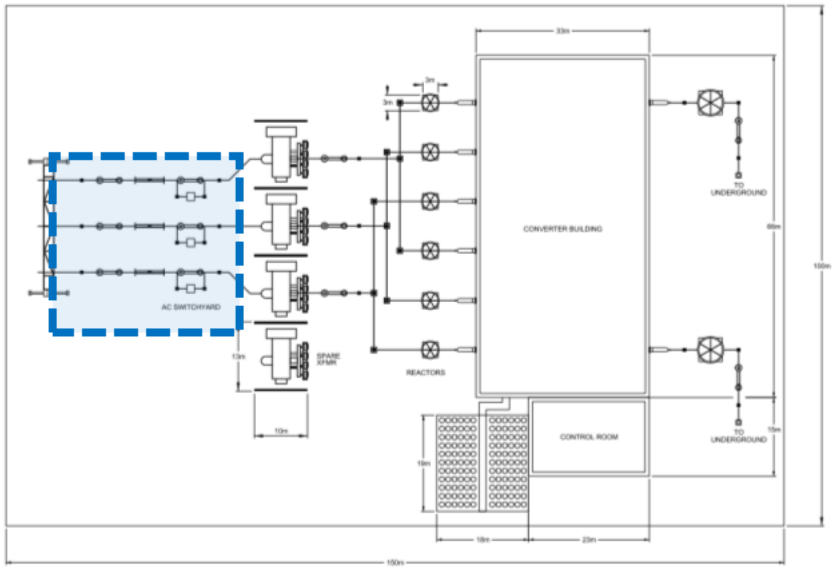
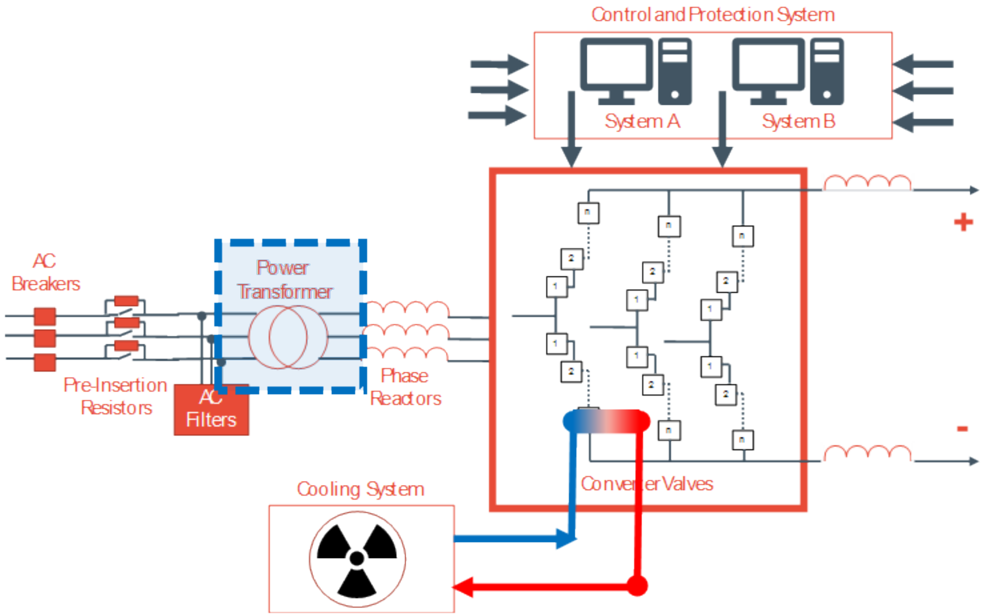
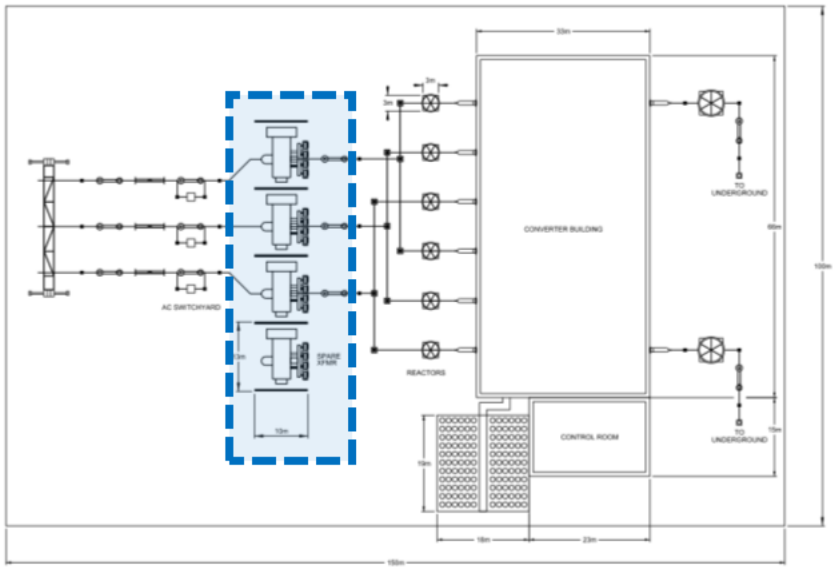
HVDC Station Overview



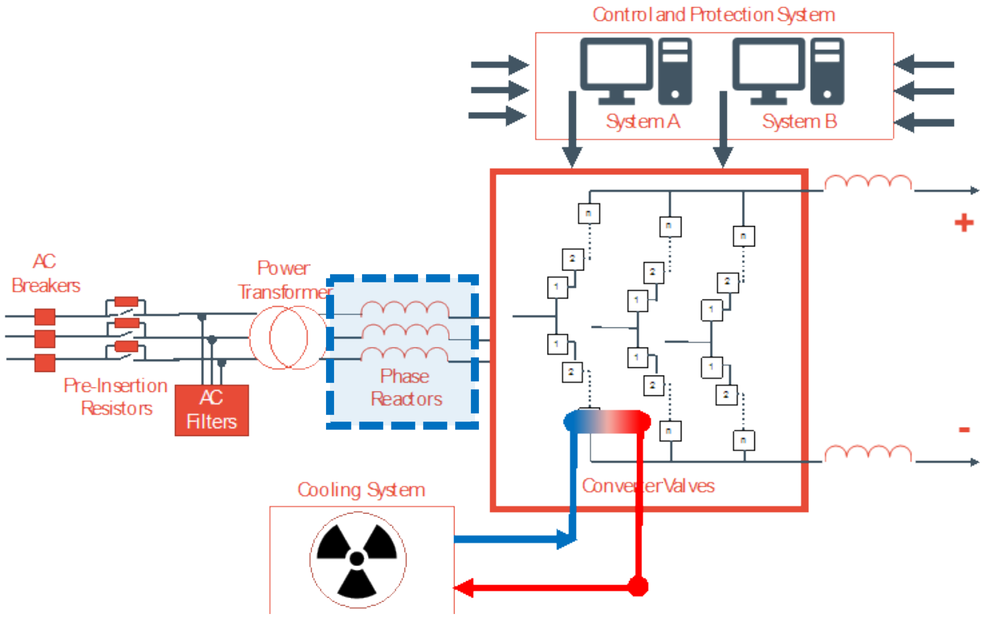


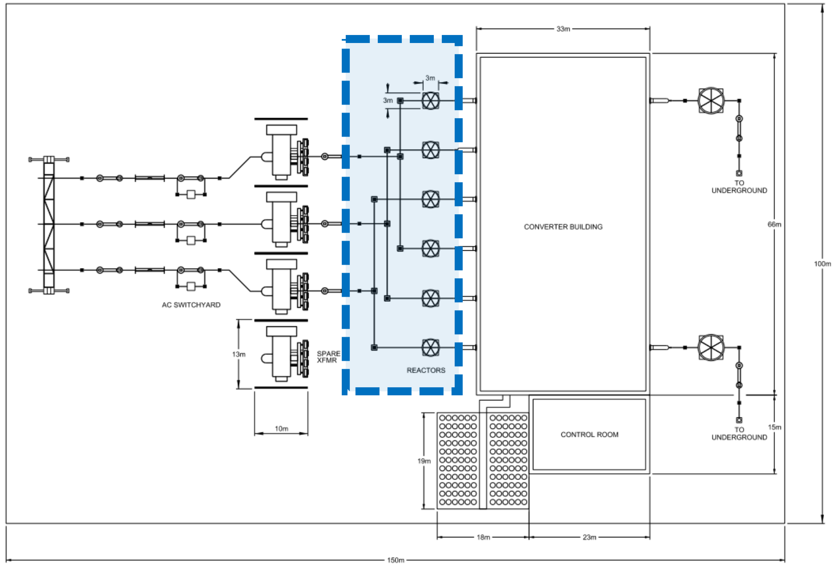
HVDC Station Overview



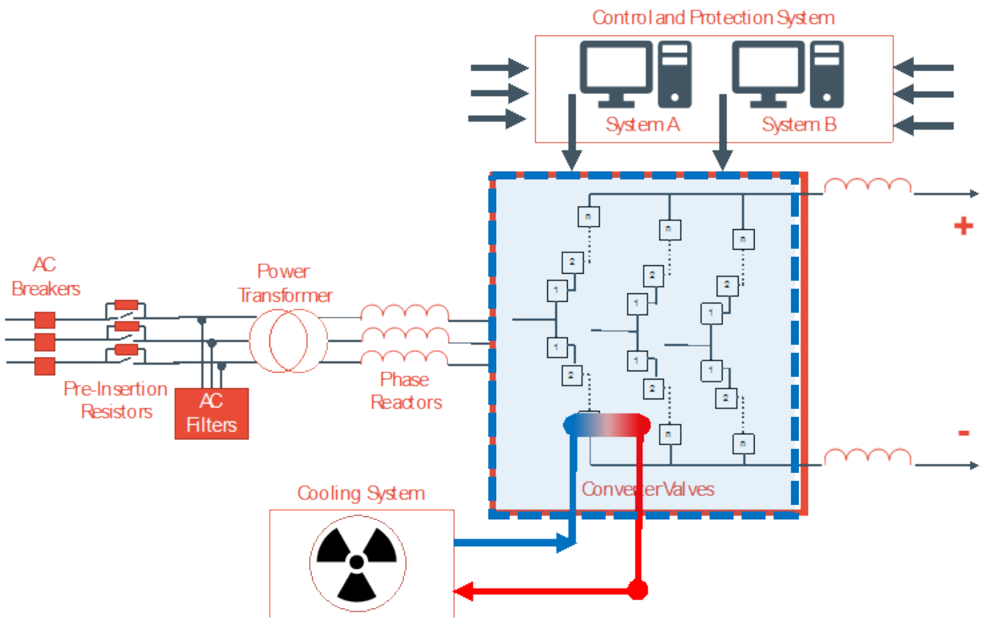


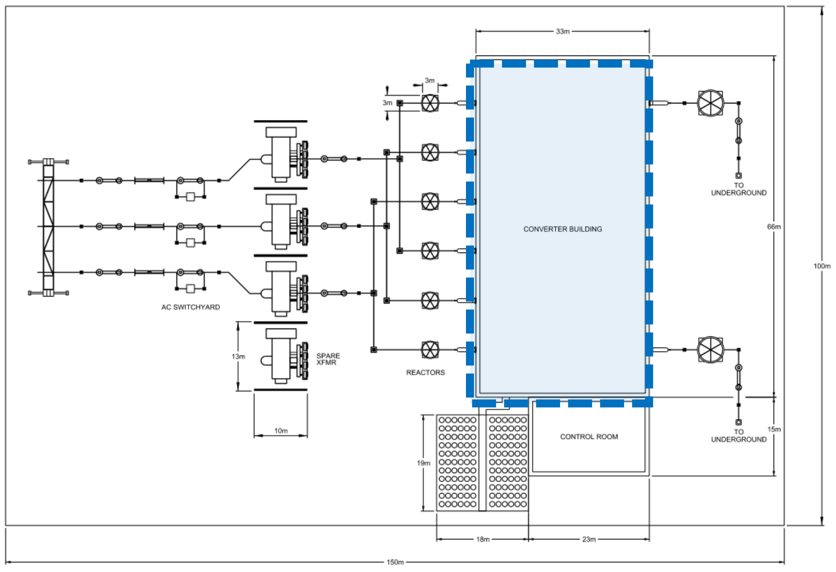
HVDC Station Overview



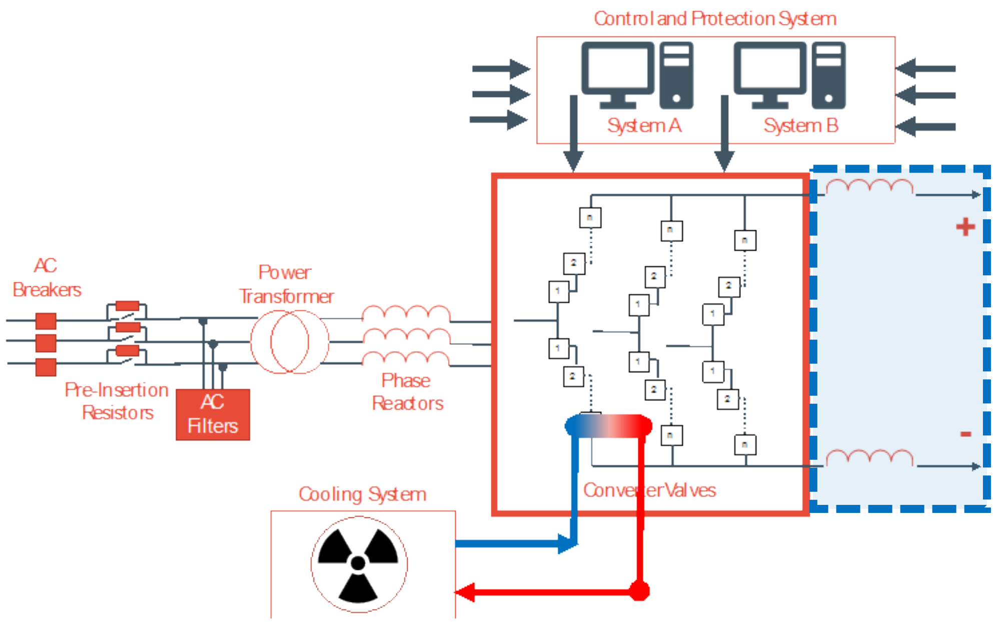


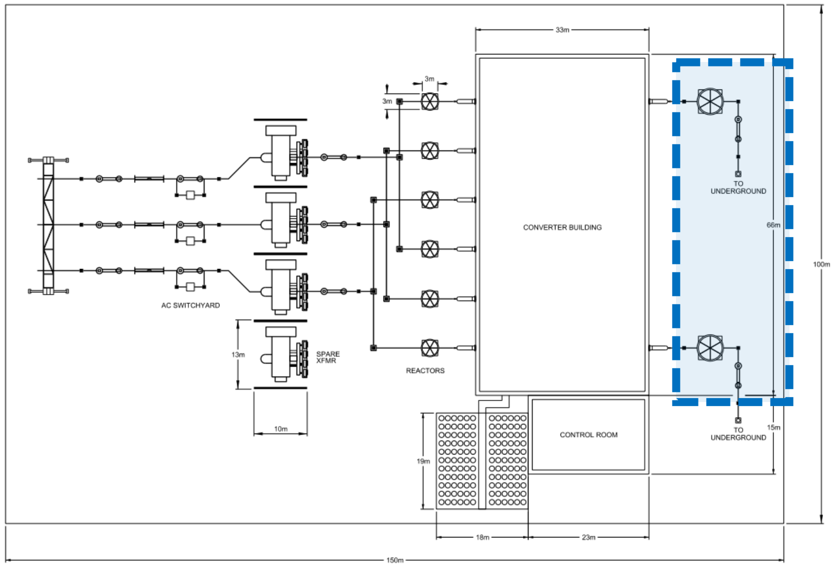
HVDC Station Overview



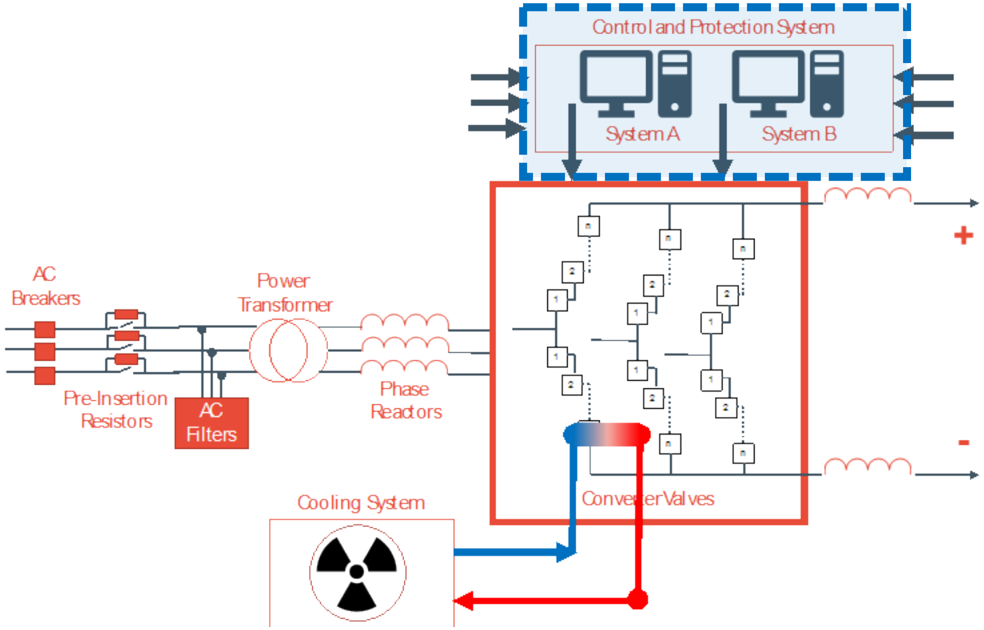


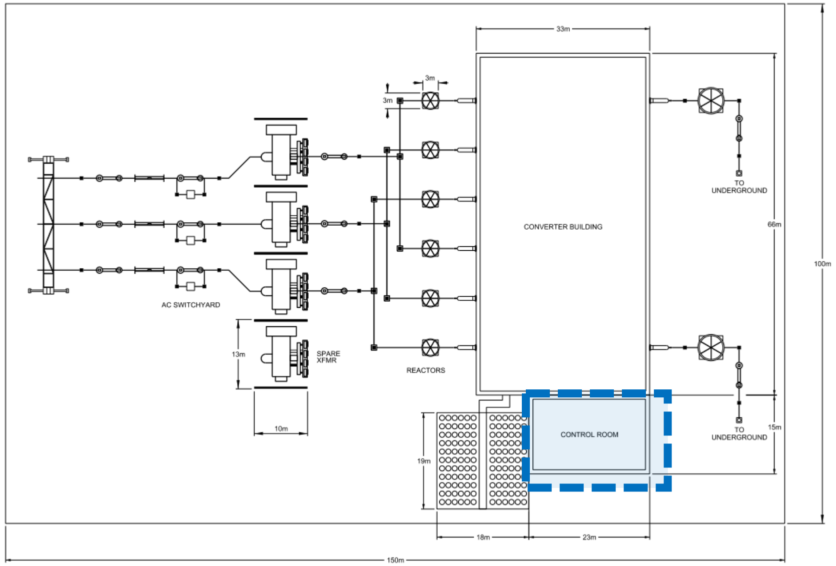
HVDC Station Overview



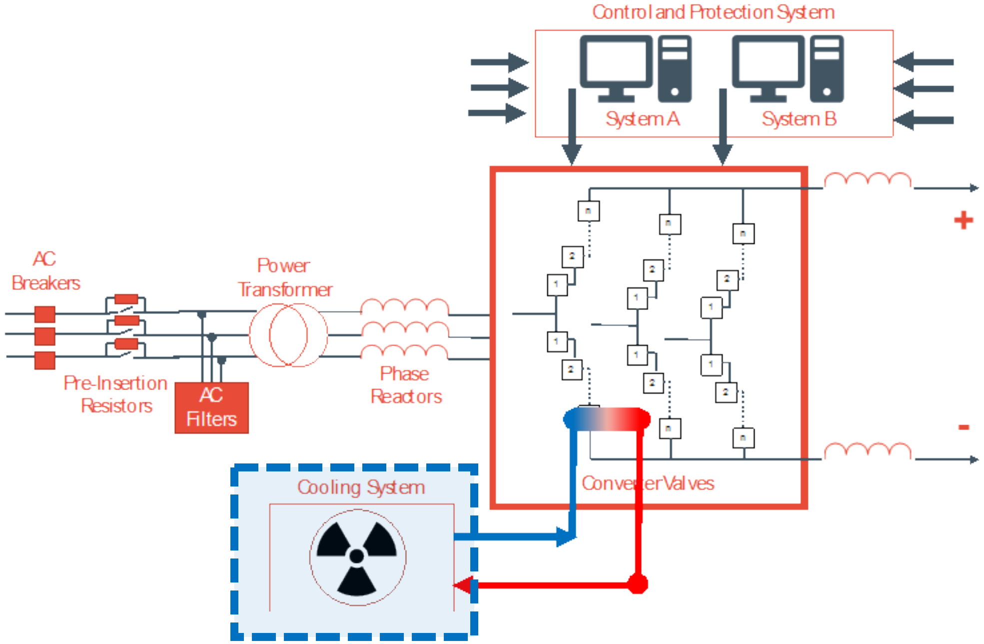


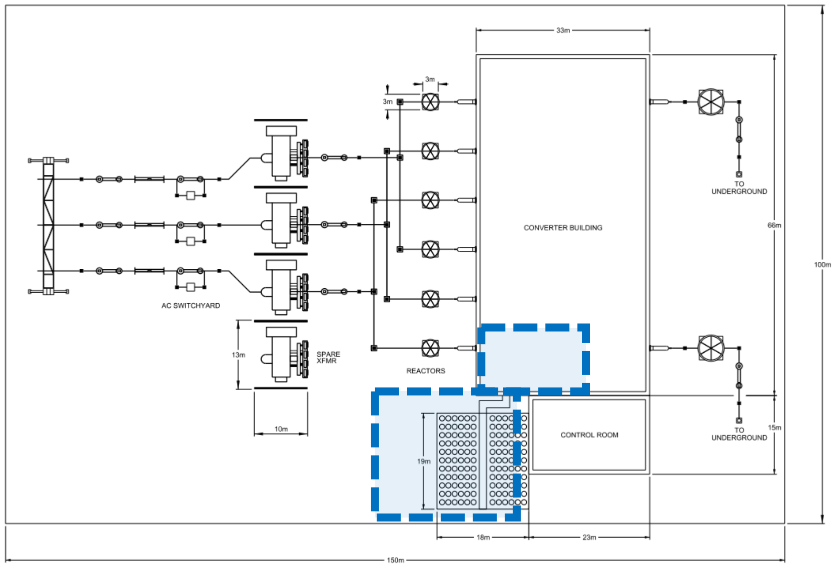
HVDC Station Overview





HVDC Station Overview





Major HVDC Vendors with Significant Experience

Vendor	Head Office	Notable North American Projects
GE	Stafford, UK	Lower Churchill McNeil BtB Nelson River Pole 1
Hitachi	Ludvika, Sweden	Maritime Link Cross Sound Cable Mackinac Pacific Inter-tie Intermountain Quebec-New England CU Project
Siemens	Erlangen, Germany	Neptune RTS Transbay Cable Hudson EATL WATL Nelson River BP3

Reliability Ancillary Services HVDC and Connected Generation Can Provide Today

Reliability Service	Description	Can HVDC Provide?	HVDC Eligible for Compensation?
Primary Frequency Response	Inherent response of resources and load to locally detect and arrest changes in frequency. FERC Order 842 requires generators to be capable of providing PFR and operating with PFR controls enabled.	Yes, instantaneously.	Not currently
Primary Reserve (Spinning)	Able to increase output or decrease load within 10 minutes	Yes, and can be scheduled for whatever is required.	Not currently
Secondary Reserve (Short-Term)	Able to increase output or decrease load within 30 minutes	Yes, and can be scheduled for whatever is required.	Not currently
Reactive Capability and Supply	The mechanical capability for a generator to supply reactive support to the grid and the actual supply of reactive as needed. FERC requires generators to have reactive capability if built after 2017.	Yes, and will inherently provide +/- 0.95PF at the POI	Not currently
Ramping	Ramping is upward or downward control by resources over a period of time needed to maintain load-generation balance	HVDC can provide and can meet any ramp rate	Not currently
Regulation	Regulation is the requirement of generators to control Area Control Error (ACE) and frequency deviations.	Through the frequency controller, the HVDC system can provide ACE functionality	Not currently
Black Start	Necessary to restore the transmission system following a system-wide blackout	Yes	Not currently

Additional HVDC Reliability Benefits

Reliability Service	Description	Can HVDC Provide?	Do RTOs Provide Compensation for this Service?
Inertia	The energy stored in large rotating generators and is a factor in helping to minimize a frequency drop if/when a sudden loss of generation occurs.	Yes	No
Flexibility	Measures the ability of a unit to turn on and off quickly and frequently in a single operating day. Three characteristics that commonly determine a resource's flexibility are cycling capability, quick start time and low minimum run times	HVDC can be scheduled anywhere w/in its rating, can emulate functionality of quickly turning on/off a unit.	No
Fuel Assurance	Fuel assurance considers the ability of a balancing authority to withstand disruptions to fuel supply chains and delivery mechanisms that hinder generator performance.	HVDC is not fuel dependent	No
Energy Assurance	The concept of managing energy assurance to account for variability in solar irradiance and wind speed.	HVDC can do this when paired with storage	No
System Stability	System Stability refers to: 1) transient (angular) stability, 2) small signal stability, and 3) voltage stability.	HVDC can provide a wide range of system stability functions and can provide transient, small signal and voltage stability	No
Load Following & Dispatchable	The ability for a generator to receive and respond, in real time, to a dispatch signal to adjust the MW output of the resource.	Yes, and can respond in real-time to any dispatch signal	No
Extreme Weather Performance	The ability for generators to perform under extreme weather conditions such as extreme heat, cold, high wind, icing, etc.	Can perform under extreme events by utilizing reduced voltage and can be designed to mitigate icing events by operating in loop power mode.	No

Interregional HVDC Projects Have Significant Reliability and Resiliency Value in the Face of Extreme Weather

- A 2021 SPP study found that increased transmission would provide substantial reliability benefits during severe weather events by reducing:
  - Generation outages
  - Transmission losses
  - Congestion
  - Load uncertainty
  - Cost of cycling power plants, operating reserves and other ancillary services
- A 2021 Grid Strategies Report found that during Winter Storm Uri in February 2021, the savings associated with an extra GW of transmission ties from ERCOT to the Southeast, during the event alone, could have fully covered the cost of the lines.
- The value of 1 GW of additional transmission ties between SPP and PJM, SPP and MISO and SPP and the Southeast during Winter Storm Uri similarly would have paid for a significant share of the cost of building the transmission lines

When cold winter events move from region to region, interregional HVDC projects can enable regions to move supply to where it is most needed by load. Regions can switch between importing and exporting as the most extreme cold or heat migrates.

Sources: *Transmission Makes the Power System More Resilient to Extreme Weather*, Grid Strategies LLC, Prepared for American Council on Renewable Energy (July 2021); *The Value of Transmission*, A Report by Southwest Power Pool (March 31, 2022).

Invenergy Transmission

LBNL Study: Regional and Interregional Transmission is Being Undervalued

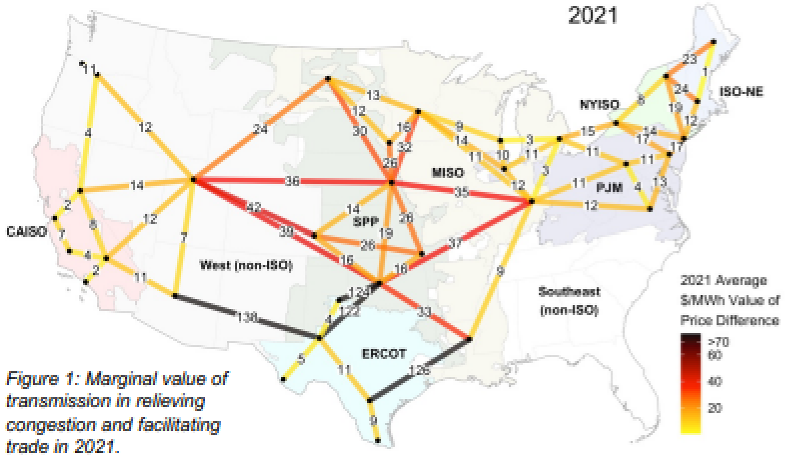


Figure 1: Marginal value of transmission in relieving congestion and facilitating trade in 2021.

- Many regional and interregional transmission links have significant potential economic value in reducing congestion and expanding opportunities for trade
- Extreme conditions and high-value periods (which are difficult to model) **play an outsized role in the value of transmission**, with 50% of transmission's congestion value coming from only 5% of hours
- Transmission planners run the risk of **understating the benefits** of regional and interregional transmission if extreme conditions and high-value periods are not adequately considered.
    - In recent years, there has been little deployment of interregional transmission. Most transmission studies focus on a limited set of values (e.g., reliability) that can lead to a systematic undervaluation of transmission
    - Transmission studies use normalized weather profiles, which are based on deterministic hourly simulations that do not account for uncertainty in load and generation, do not consider fuel price volatility, include only limited representation of infrastructure outages (e.g., do not explicitly model correlated outages across multiple generators or model outages of existing transmission lines), and do not represent other processes that contribute to the geographic price volatility observed in wholesale markets.
- **Interregional links may have higher value** due to more diversity of weather, load profiles, and generator resources than is found within regions
- One lens with which to view transmission value **is that of 'insurance' against the high costs of faced during extreme grid conditions, extreme events, or other factors** (such as unexpected deviations from forecasted conditions).

Invenergy Transmission

Federal Discussions on Transmission Policy Reform

Building for the Future Through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection, RM21-17

- NOPR to reform regional transmission planning to build out a **more cost effective, long-term, regional planning framework**. No significant reforms for interregional.

Transmission System Planning Performance Requirements for Extreme Weather, RM22-10/Information Reports on Extreme Weather Vulnerability Assessments Climate Change, Extreme Weather, and Electric System Reliability, RM 22-16

- Reliability standard to require planning cases for **extreme heat and cold weather,** require that TPs conduct studies of extreme heat and cold conditions
- Directs transmission providers to submit one-time informational reports re: extreme weather vulnerability assessments and mitigating identified extreme weather risks.

Reliability Technical Conference, AD21-11

- Discusses role of additional regional and interregional **transmission capacity in avoiding or resolving** issues surrounding extreme weather conditions
- Asks whether the current approach to how services and products are procured needs to be revised in order to ensure reliable operation of the Bulk-Power System and whether **new services or products should be considered**

Technical Conference Request Concerning Interregional Merchant HVDC Transmission, AD22-13

- Argues interregional merchant HVDC can improve grid reliability and resiliency by instantaneously making available capacity and energy from a region with surplus power to a region of need, **particularly during system emergencies** (extreme grid conditions).
- Argues **merchant transmission can provide these benefits at a significant cost savings** compared to lines paid entirely on a traditional cost-of-service basis.
- Urges FERC to explore development of a framework to identify **and unlock reliability and resiliency benefits on behalf of electricity consumers** in RTO footprints
- Requests FERC **remove barriers** to the deployment of interregional MHVDC

Workshop Establishing Interregional Transfer Capability Transmission Planning and Cost Allocation Requirements, AD23-3

- Explore whether and how to establish a **minimum requirement for Interregional Transfer Capability**
- Discuss criteria/standard setting and cost allocation

Building Back a Better Grid Initiative

- Administer Transmission Facilitation program and loans under IRA to **support nationally significant transmission lines**, conduct national transmission planning study, support OWS transmission, all in support of increasing economic, energy and national security in the face of physical and cyber attacks and extreme weather.

Grain Belt Express Project

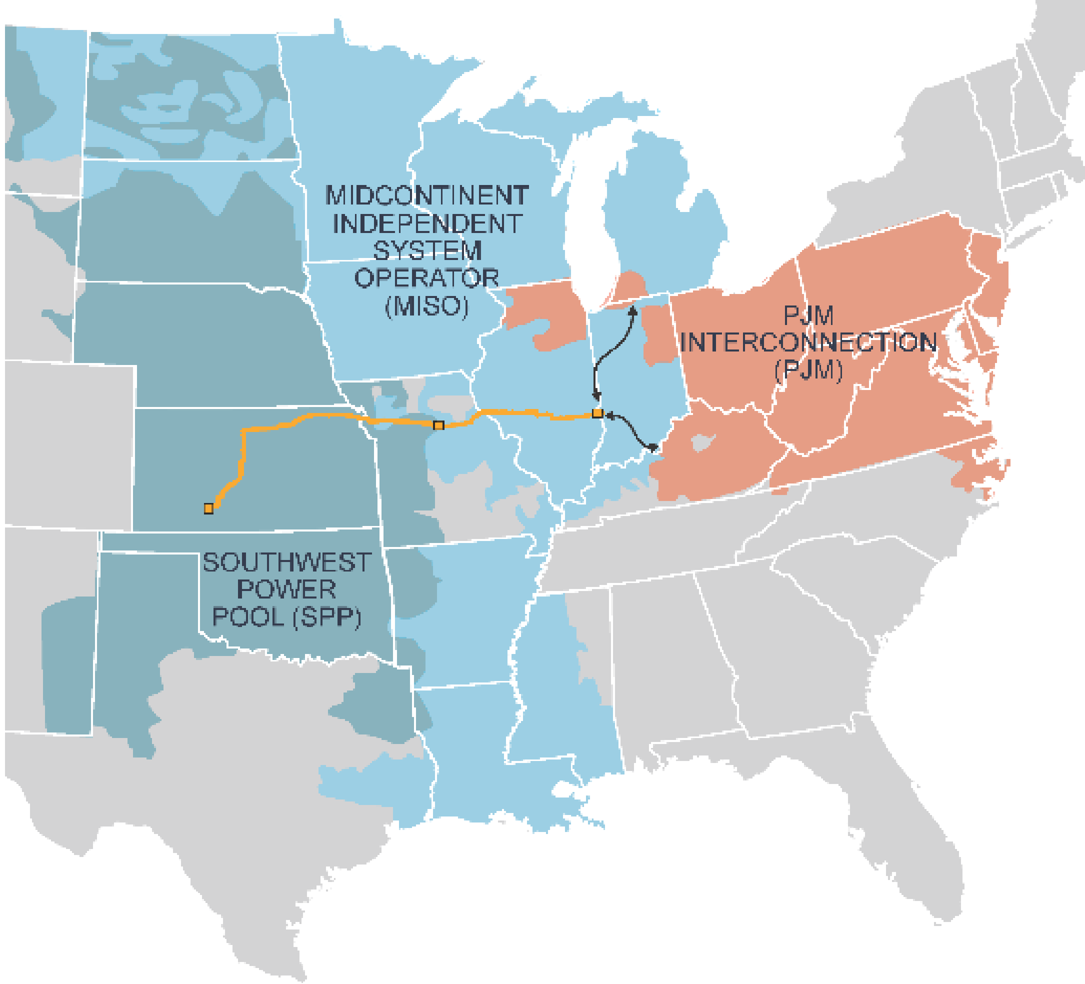
- Approximately 800 miles
- 600kV High Voltage Direct Current (HVDC)
- 5,000 megawatts (MW)
- Low-cost sustainable power

- **Power Source:** Western Kansas and surrounding area
- **Customers:** Missouri and other states in the region

Grain Belt Express will be a reliability and resilience backbone for the U.S.

By directly linking three of the largest U.S. power markets—SPP, MISO and PJM—Grain Belt Express will increase electric system reliability for each region including through:

- **Emergency two-way power flow between regions**
- **Black start capability (ability to "jump start" outage-affected regions using power from another region)**
- **Greater geographic diversity of renewables**



Grain Belt Project Technical Capabilities and Impact on Reliability as an Interregional Line

Increasing reliability during severe weather events

- **February 2021 Winter Storm Uri —** Each additional 1 GigaWatt (GW) of transmission ties between the Texas power grid (ERCOT) and the Southeastern U.S. **could have saved nearly $1 billion, while keeping the heat on for hundreds of thousands of Texans**. *
- With stronger transmission ties, other parts of the Central U.S. also could have avoided power outages while saving consumers hundreds of millions of dollars. In particular, consumers in the Great Plains, served by the Southwest Power Pool (SPP), and those in the Gulf Coast states, served by the southern part of the Midcontinent Independent System Operator (MISO), **each could have saved in excess of $100 million** with an additional 1 GW of transmission ties to power systems to the east. *
- **The Grain Belt Project could have provided up to 5 GW of power to SPP during winter storm Uri, via a combination of local generation and transfers of power from the other RTOs.**

** Source: "Transmission makes the Power System Resilient to Extreme Weather", Grid Strategies July 2021*

Grain Belt Project Technical Capabilities and Impact on Reliability as an Interregional Line

TABLE 1. *Value of 1 GW of additional transmission by region for each event*

Receiving region – delivering region	Savings per GW of additional transmission capacity (millions of $)
WINTER STORM URI, FEBRUARY 2021	
ERCOT – TVA	$993
SPP South – PJM	$129
SPP South – MISO IL	$122
SPP South – TVA	$120
SPP S – MISO S (Entergy Texas)	$110
MISO S-N (Entergy Texas - IL)	$85
MISO S (Entergy Texas) – TVA	$82

The Grain Belt Project could have enabled direct power transfers between PJM - SPP South, MISO IL – SPP South, saving hundreds of millions of dollars during winter storm Uri

Source: "Transmission makes the Power System Resilient to Extreme Weather", Grid Strategies July 2021

Innovators building a sustainable world

Rob Stupar – Senior Manager, Regulatory Affairs – Invenergy - RStupar@invenergy.com

Carlos A. Rodriguez – SVP, Interconnections & Grid Analysis – Invenergy - CRodriguez@invenergy.com

Rob Taylor – Director, Transmission New Markets – Invenergy - RTaylor@invenergy.com

Dan Kell - Senior Director, Power System Studies and HVDC – Hatch – Dan.kell@hatch.com

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