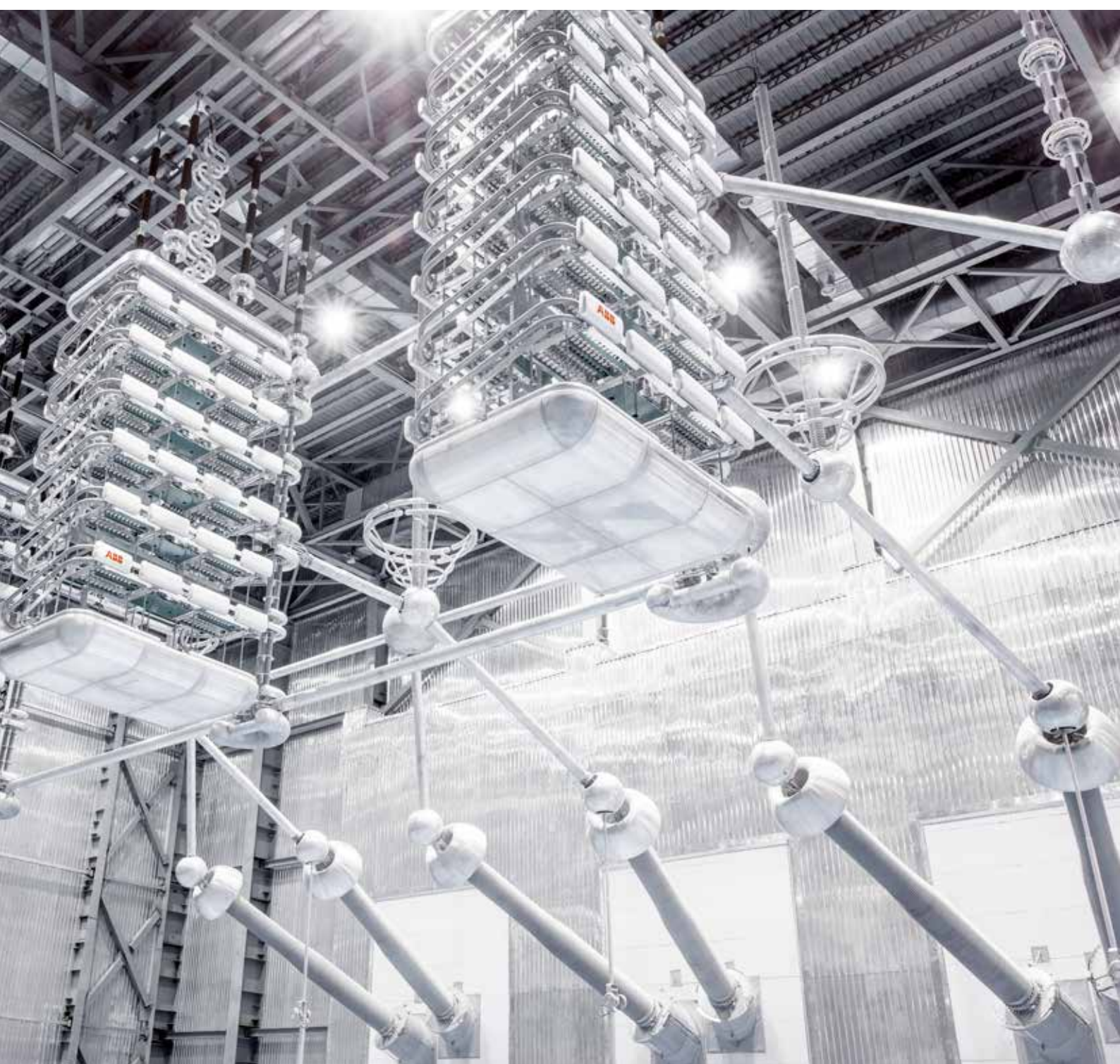


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REFERENCE LIST

# **HVDC Classic**

## Thyristor valve projects



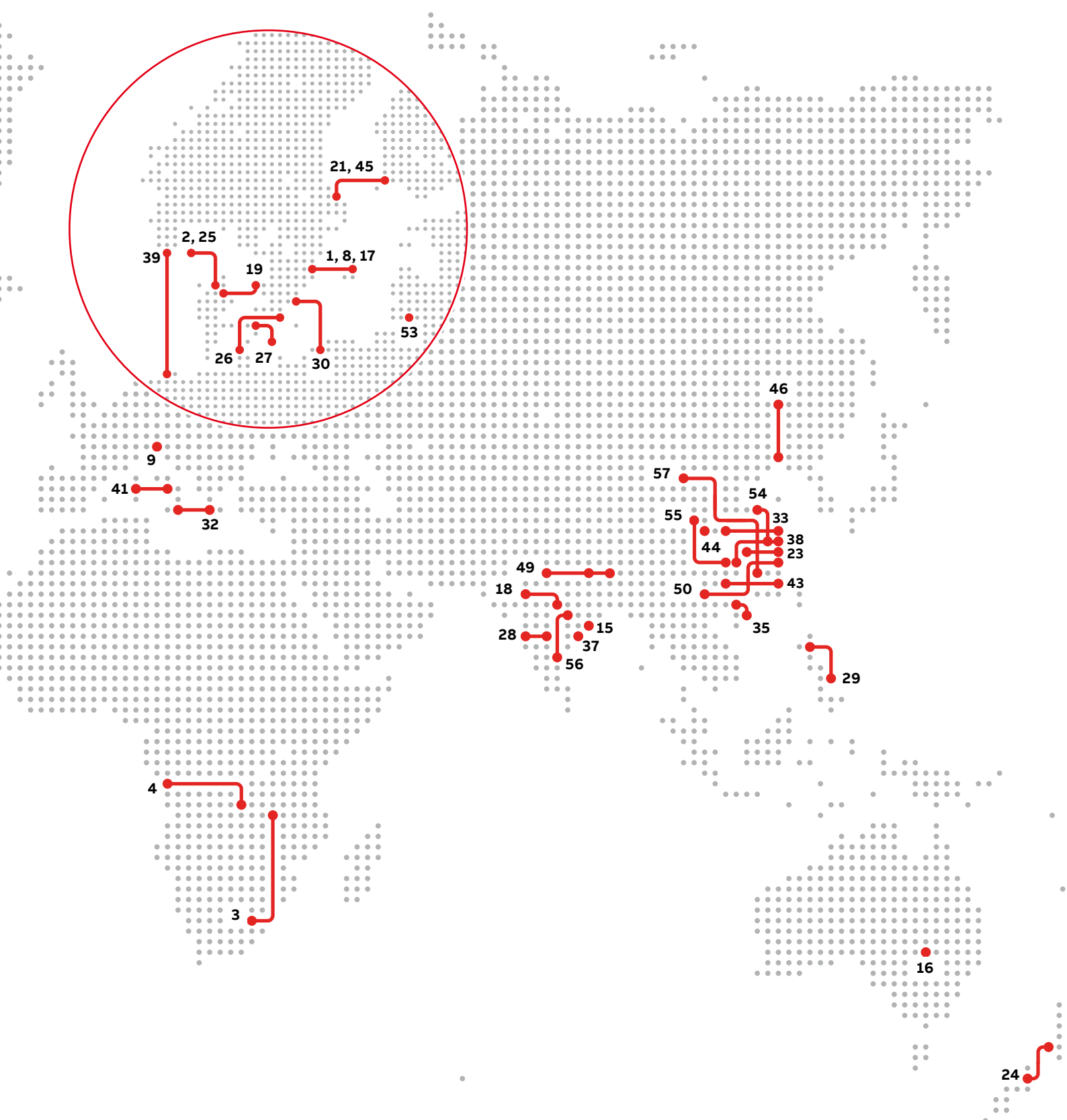
# ABB HVDC Classic

## Projects worldwide

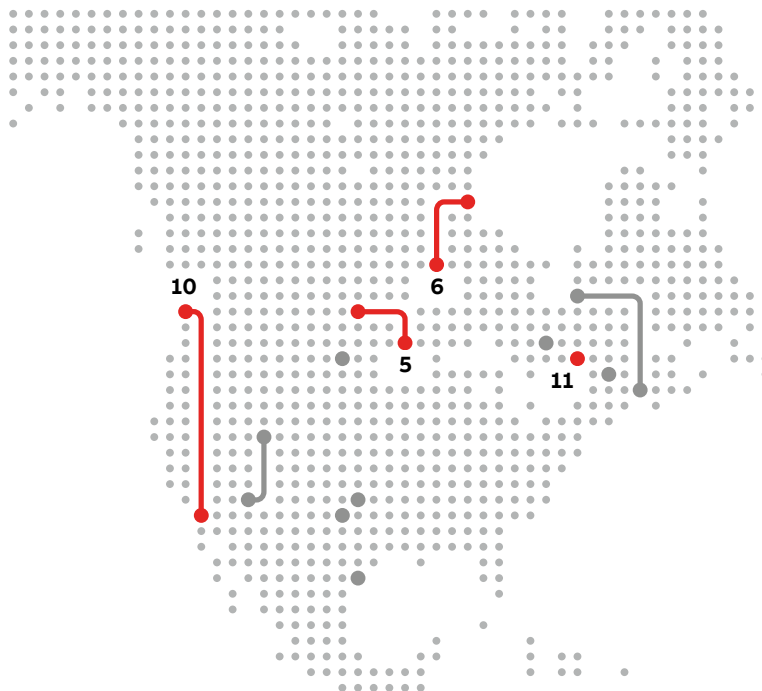
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For more information about the  
projects visit: [www.abb.com/hvdc](http://www.abb.com/hvdc)



# North America



Scheme	5. CU-Project	6. Nelson River 2	10. Pacific Intertie	11. Châteauguay
Commissioning year	1979	1978-1985	1970	1984
Owner/Original customer/Country	CPA, USA and UPA, USA	Manitoba Hydro, Canada	Bonneville Power Administration, USA and The Department of Water and Power of the City of Los Angeles, USA	Hydro-Quebec, Quebec, Canada
Main reason for choosing HVDC system	Connecting remote generation, Environment, Stability benefits	Interconnecting grids, Connecting remote generation	Connecting remote generation Stability benefits	Interconnecting grids
Power Transmitted, MW	1000	2000	1440	2 x 500
Direct voltage, kV	±400	±500	±400	2 x 140.6
Converters per station	2	4	6	2 + 2
Direct voltage per converter, kV	400	250	133	140.6
Direct current, A	1250	2000	1800	2 x 3600
Reactive power supply	Capacitors Power generator	Capacitors	Capacitors	Capacitors and SVC
Converter station location and AC grid voltage	Coal Creek, 235 kV Dickinson, 350 kV	Henday, 230 kV Dorsey, 230 kV	Celilo, 230 kV Sylmar, 230 kV	Hydro-Quebec side, 315 kV U.S. side, 120 kV
Length of overhead DC line, km	687 km	940 km	1360 km	Back-to-back
Cable arrangement	-	-	-	-
Cable route length, km	-	-	-	-
Grounding of the DC circuit	For full current in two ground electrode stations (intermittent)	For full current in two electrode stations	For full current in one ground and one sea electrode station (intermittent)	One point grounded
AC grids at both ends	Synchronous	Asynchronous	Synchronous	Asynchronous
Control	Constant power, damping control	Constant power	Constant power in either direction and small signal modulation	Constant power
Emergency change of power flow	-	-	On manual or automatic order to preset values	-
Main supplier of converter equipment	ABB	ABB/Siemens/AEG	ABB/GE	ABB/Siemens

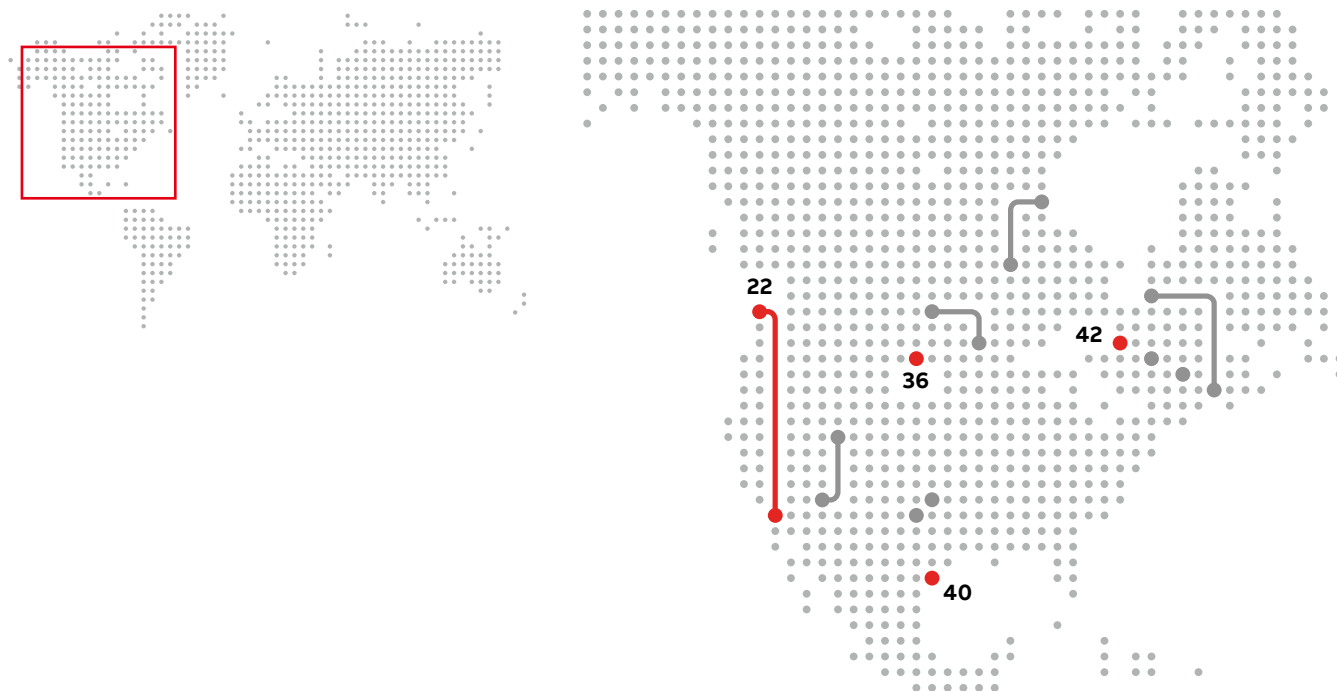


# North America



Scheme	12. Intermountain	13. Highgate	14. Blackwater	20. Quebec-New England
Commissioning year	1986	1985	1985	1990-1992
Owner/Original customer/Country	Intermountain Power Agency, USA. Agent: The Department of Water and Power of the City Los Angeles, USA	Vermont Electric Power Company Inc., USA	Public Service Company of New Mexico, USA	Hydro Quebec, Quebec, Canada and New England Hydro Transmission Electric Company Inc., USA
Main reason for choosing HVDC system	Connecting remote generation	Interconnecting grids	Interconnecting grids	Connecting remote generation, Interconnecting grids
Power Transmitted, MW	1920	200	200	2000 (Multiterminal)
Direct voltage, kV	±500	57	56.8	±450
Converters per station	2	2	2	2
Direct voltage per converter, kV	500	57	56.8	450
Direct current, A	1920	3600	3600	2200
Reactive power supply	Capacitors	Capacitors	Capacitors	Capacitors
Converter station location and AC grid voltage	Intermountain, 345 kV Adelanto, 500 kV	Highgate North, 120 kV Highgate South, 115 kV	New Mexico side, 345 kV Texas side, 230 kV	Radisson, 315 kV Sandy Pond, 345 kV Nicolet, 230 kV
Length of overhead DC line, km	785 km	Back-to-back	Back-to-back	1480 km
Cable arrangement	-	-	-	-
Cable route length, km	-	-	-	-
Grounding of the DC circuit	For full current in two ground electrode stations (intermittent)	One point grounded	One point grounded	All stations grounded by totally three electrode stations
AC grids at both ends	Synchronous	Asynchronous	Asynchronous	HQ synchronous NEH asynchronous
Control	Constant power, damping control	Constant power	Constant power, reactive power control	Multiterminal, constant power control, frequency control
Emergency change of power flow	-	-	-	Isolation of Radisson from the AC system at severe AC disturbances
Main supplier of converter equipment	ABB	ABB	ABB	ABB

# North America



Scheme	22. Pacific Intertie Expansion	36. Rapid City	40. Sharyland	42. Outaouais
Commissioning year	1989	2003	2007	2009
Owner/Original customer/Country	Bonneville Power Administration, USA and The Department of Water and Power of the City of Los Angeles, USA	Basin Electric Power Cooperative and Black Hills Power & Light, USA	Sharyland Utilities, USA	Hydro Quebec, Quebec, Canada
Main reason for choosing HVDC system	Connecting remote generation, Interconnecting grids, Rapid control	Interconnecting grids	Interconnecting grids, Trading	Interconnecting grids
Power Transmitted, MW	1100	2 x 100	150	2 x 625
Direct voltage, kV	±500	±13	±21	±87.5
Converters per station	(8) + 2	2 + 2	2	2 + 2
Direct voltage per converter, kV	500	26	42	175
Direct current, A	1100	3930	3600	3600
Reactive power supply	Capacitors	Capacitors	Capacitors	Capacitors
Converter station location and AC grid voltage	Celilo, 500 kV Sylmar, 230 kV	Rapid City, South Dakota, USA, 230 kV both sides	Mission, Texas, USA, 138 kV both sides	Outaouais, Quebec side, 315 kV Ontario side, 240 kV
Length of overhead DC line, km	1360 km	Back-to-back	Back-to-back	Back-to-back
Cable arrangement	-	-	-	-
Cable route length, km	-	-	-	-
Grounding of the DC circuit	For full current in one ground and one sea electrode station (intermittent)	Midpoint grounded no ground current	Midpoint grounded no ground current	Midpoint grounded no ground current
AC grids at both ends	Synchronous	Asynchronous	Asynchronous	Asynchronous
Control	Constant power in either direction and small signal modulation	Power Control, emergency power control, voltage control	Constant power	Constant power. Frequency dependant power control. Power swing damping control.
Emergency change of power flow	On manual or automatic order to preset value	-	-	Runback control.
Main supplier of converter equipment	ABB	ABB	ABB	ABB

# North America



Scheme	51. Oklaunion	52. Railroad DC Tie
Commissioning year	2014	2014
Owner/Original customer/Country	American Electric Power (AEP), USA	Sharyland Utilities, USA
Main reason for choosing HVDC system	Interconnecting grids	Interconnecting grids
Power Transmitted, MW	220	150
Direct voltage, kV	$\pm 31$	$\pm 21$
Converters per station	2	2
Direct voltage per converter, kV	31	21
Direct current, A	3600	3600
Reactive power supply	Capacitors	Capacitors
Converter station location and AC grid voltage	Oklaunion, 345 kV	Mission, Texas, USA, 138 kV both sides
Length of overhead DC line, km	Back-to-back	Back-to-back
Cable arrangement	-	-
Cable route length, km	-	-
Grounding of the DC circuit	Midpoint grounded no ground current	Midpoint grounded no ground current
AC grids at both ends	Asynchronous	Asynchronous
Control	Constant power	Constant power
Emergency change of power flow	-	-
Main supplier of converter equipment	ABB	ABB

# South America



Scheme	7. Itaipu	31. Brazil-Argentina Interconnection 1	34. Brazil-Argentina Interconnection 2	47. Rio Madeira
Commissioning year	1984-1990	2000	2002	2012
Owner/Original customer/Country	Furnas, Brazil	CIEN a company of the Endesa Group, Chile	CIEN a company of the Endesa Group, Chile	Eletronorte, Brazil
Main reason for choosing HVDC system	Interconnecting grids, Connecting remote generation	Interconnecting grids	Interconnecting grids	Connecting remote generation
Power Transmitted, MW	3150 + 3150	2 x 550	2 x 550	3150
Direct voltage, kV	±600	±70	±70	±600
Converters per station	4 + 4	2 + 2	2 + 2	2
Direct voltage per converter, kV	300	70	70	600
Direct current, A	2610	3930	3930	2625
Reactive power supply	Capacitors Synchronous condensers	Capacitors	Capacitors	Capacitors
Converter station location and AC grid voltage	Foz do Iguaçu, 500 kV Ibiuna, 345 kV	Garabi, Brazil, 525 kV Argentina, 500 kV	Garabi, Brazil, 525 kV Argentina, 500 kV	Port Velho, Rondonia Araraquara, São Paulo 500 kV
Length of overhead DC line, km	785 and 805 km, respectively	Back-to-back	Back-to-back	2500 km
Cable arrangement	-	-	-	-
Cable route length, km	-	-	-	-
Grounding of the DC circuit	For full current in two ground electrode station per bipole	Midpoint grounded no ground current	Midpoint grounded no ground current	For full current in two electrode stations
AC grids at both ends	Foz do Iguaçu, 50 Hz Ibiuna, 60 Hz	Brazil, 60 Hz Argentina, 50 Hz	Brazil, 60 Hz Argentina, 50 Hz	Asynchronous
Control	Constant power, damping control	Constant power	Constant power	Constant power, frequency control
Emergency change of power flow	-	On automatic order to preset values	On automatic order to preset values	On automatic order
Main supplier of converter equipment	ABB	ABB	ABB	ABB

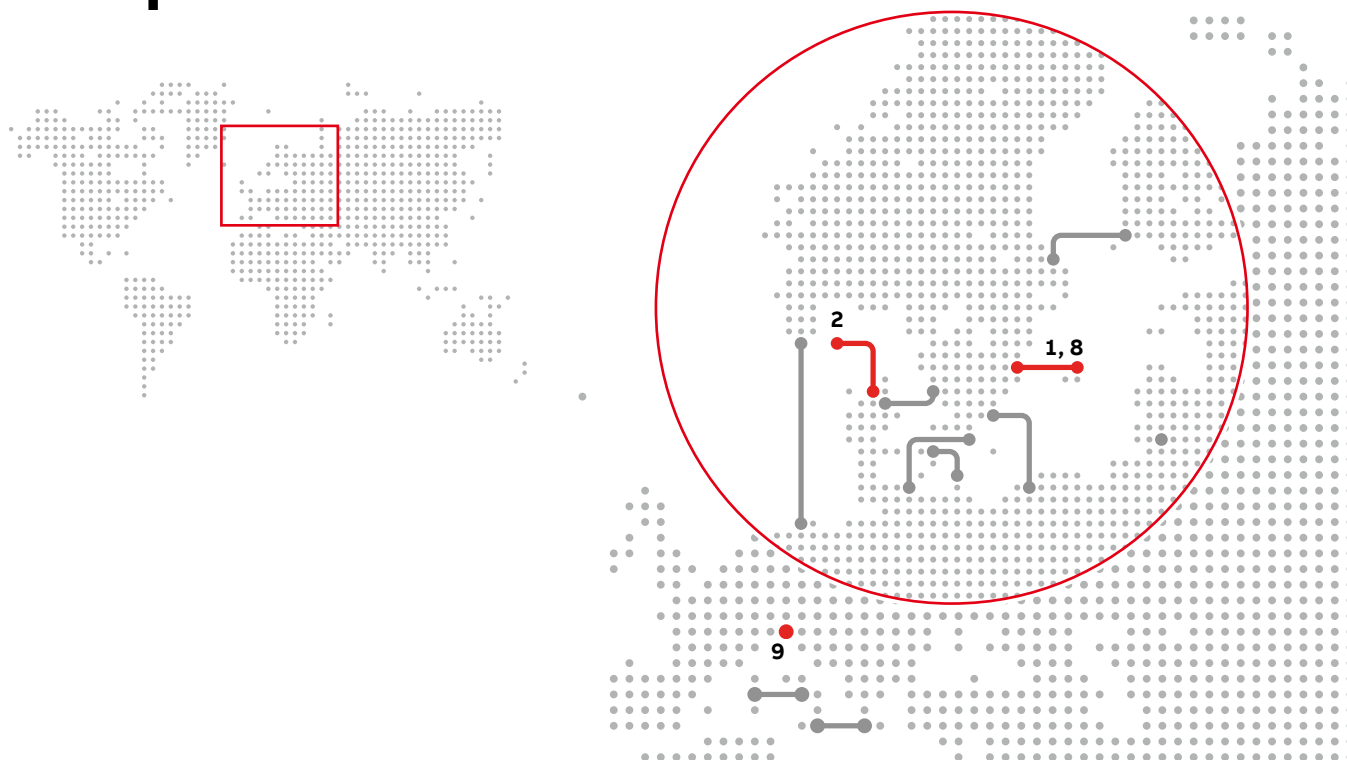


# South America



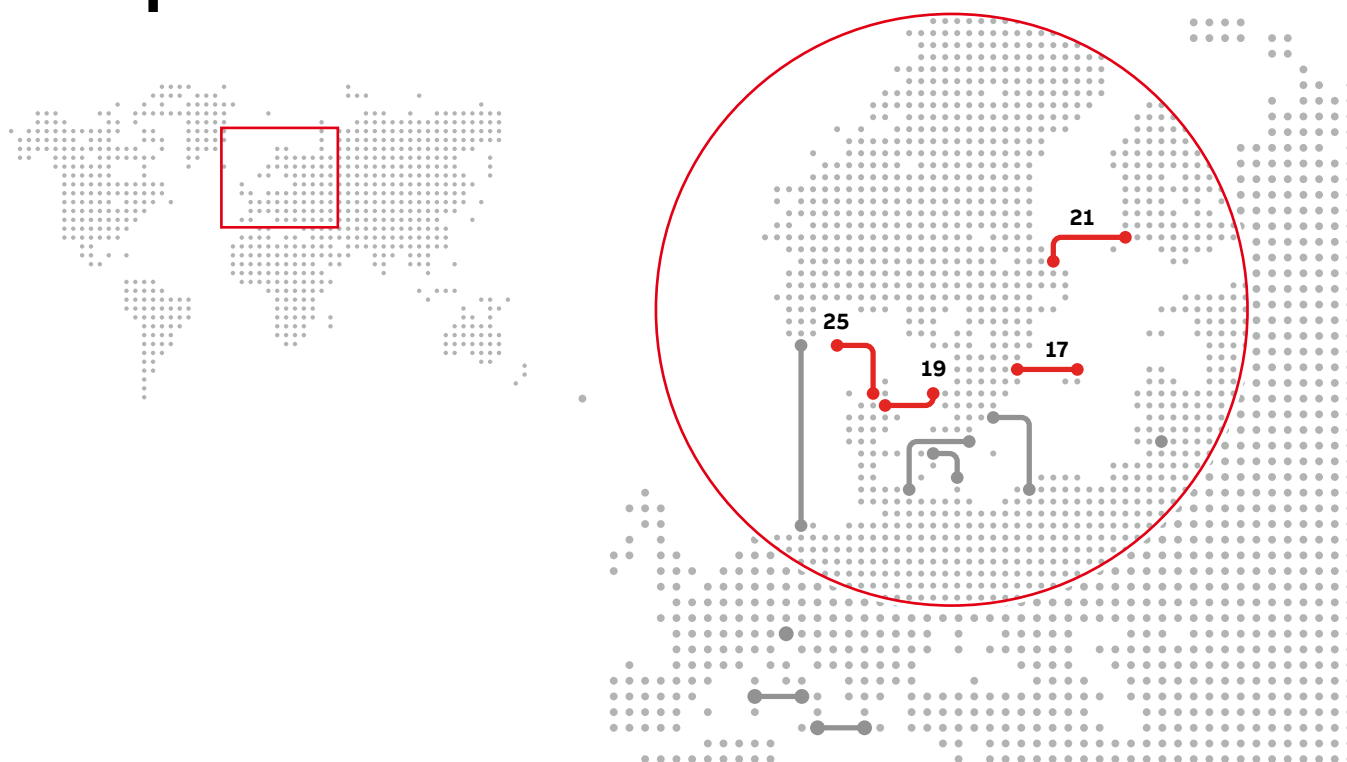
Scheme	48. Rio Madeira Back-to-back
Commissioning year	2013
Owner/Original customer/Country	Eletrosul, Brazil
Main reason for choosing HVDC system	Interconnecting grids
Power Transmitted, MW	2 x 400
Direct voltage, kV	±51
Converters per station	2
Direct voltage per converter, kV	102
Direct current, A	3930
Reactive power supply	Capacitors
Converter station location and AC grid voltage	Port Velho, Rondonia 500 kV/230 kV
Length of overhead DC line, km	Back-to-back
Cable arrangement	-
Cable route length, km	-
Grounding of the DC circuit	Midpoint grounded no ground current
AC grids at both ends	Asynchronous
Control	Constant power, frequency control, AC voltage control 230 kV side
Emergency change of power flow	On automatic order
Main supplier of converter equipment	ABB

# Europe



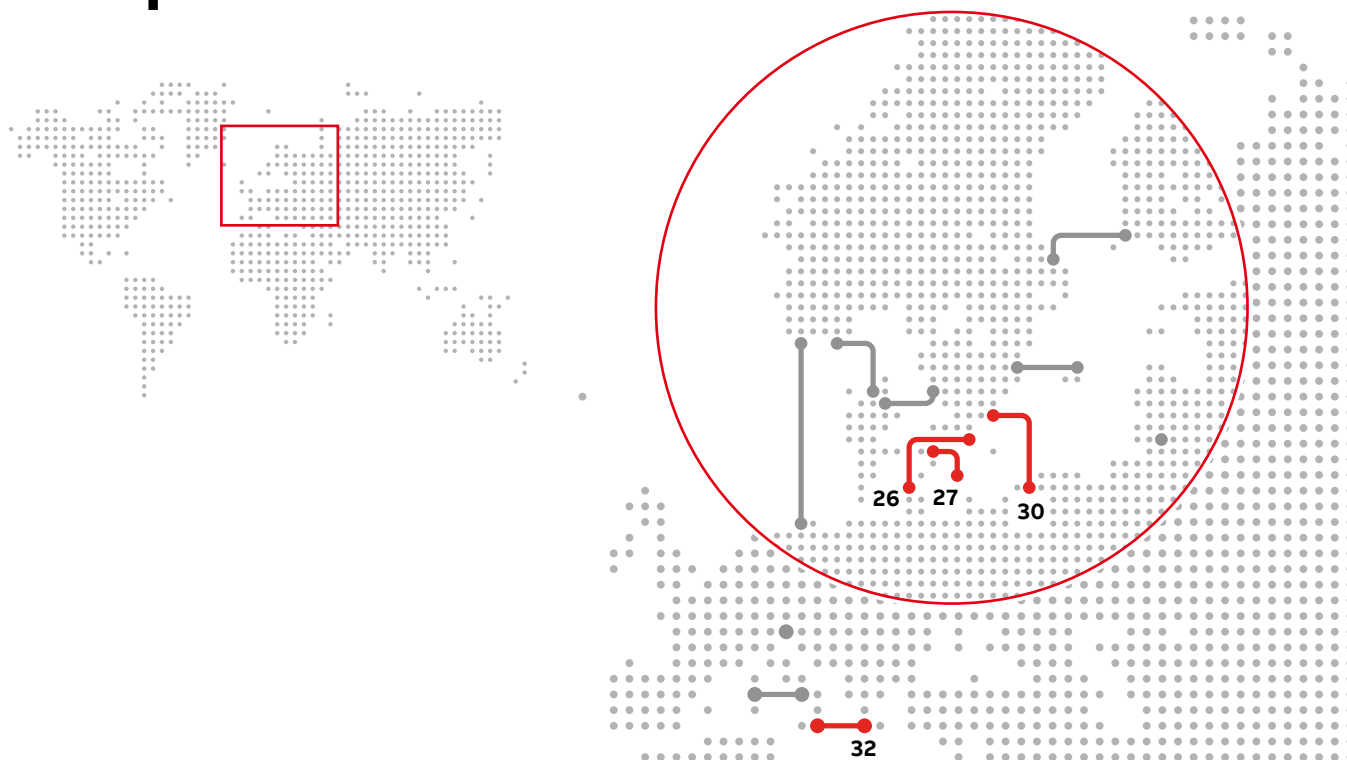
Scheme	1. Gotland	2. Skagerrak 1 & 2	8. Gotland 2	9. Dürnrohr
Commissioning year	1970	1976-1977	1983	1983
Owner/Original customer/Country	Statens Vattenfallsverk, Sweden	Statkraft, Norway and Elsam, Denmark	Statens Vattenfallsverk, Sweden	Österreichische Elektrizitäts-wirtschafts AG, Austria
Main reason for choosing HVDC system	Interconnecting grids, Island connection, Long sea crossing, frequency control	Interconnecting grids, Sea crossing	Interconnecting grids, Island connection, Long sea crossing, frequency control	Interconnecting grids
Power Transmitted, MW	(20) + 10	500	130	550
Direct voltage, kV	(100) + 50	±250	150	145
Converters per station	(2) + 1	2	1	2
Direct voltage per converter, kV	50	250	150	145
Direct current, A	200	1000	914	3790
Reactive power supply	Capacitors Synchronous condensers	Capacitors Synchronous condensers	Capacitors Synchronous condenser	Capacitors
Converter station location and AC grid voltage	Västervik, 130 kV Visby, 70 kV	Kristiansand, 275 kV Tjele, 150 kV	Västervik, 130 kV Visby, 70 kV	Dürnrohr, 420 kV both sides
Length of overhead DC line, km	-	113 km	7 km	Back-to-back
Cable arrangement	1 cable, ground return	1 cable per pole	1 cable, ground return	-
Cable route length, km	96 km	127 km	96 km	-
Grounding of the DC circuit	For full current in two sea electrode stations	For full current in two ground electrode stations	For full current in two sea electrode stations	One point grounded
AC grids at both ends	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Control	Constant frequency on Gotland	Constant power in either direction	Constant frequency on Gotland	Constant power in either direction
Emergency change of power flow	-	On manual or automatic order to preset value	-	-
Main supplier of converter equipment	ABB	ABB	ABB	ABB/Siemens/AEG

# Europe



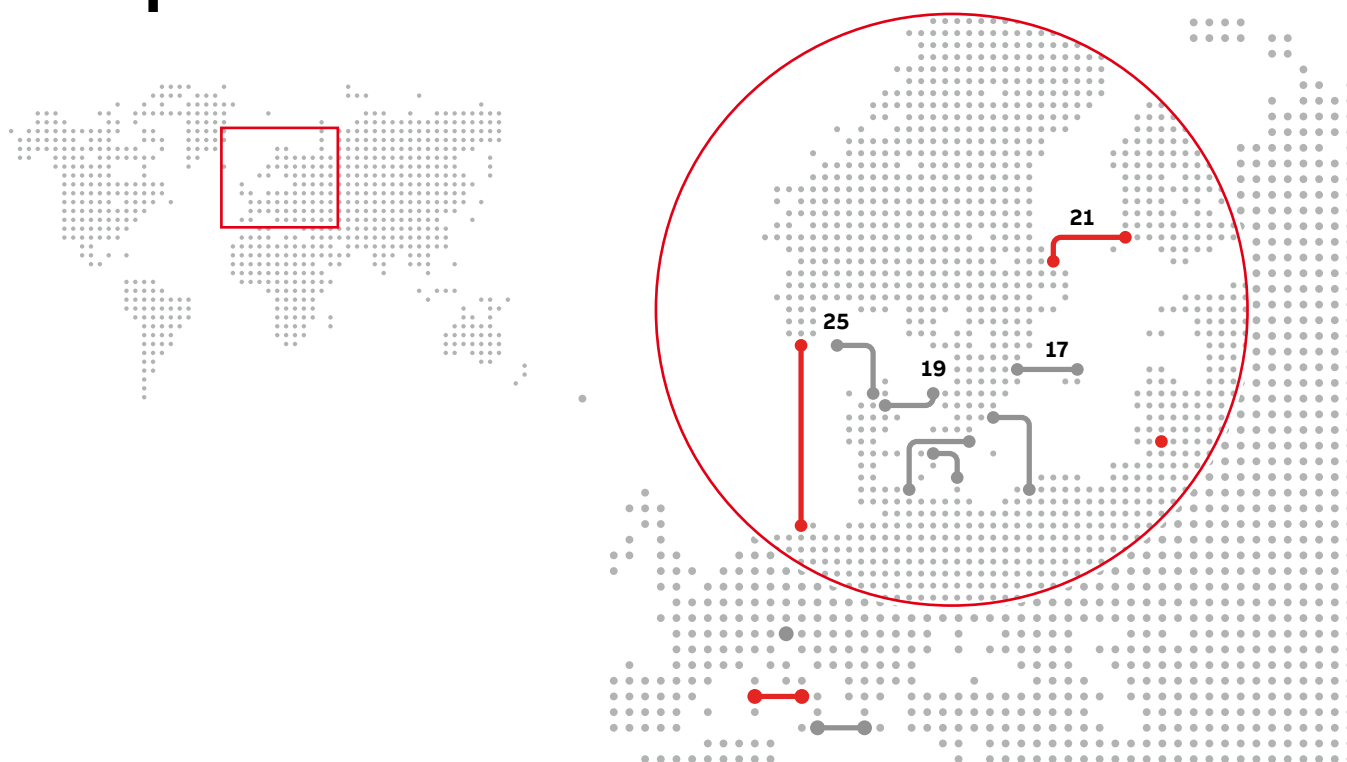
Scheme	17. Gotland 3	19. Konti-Skan 2	21. Fenno-Skan	25. Skagerrak 3
Commissioning year	1987	1988	1989	1993
Owner/Original customer/Country	Statens Vattenfallsverk, Sweden	Statens Vattenfallsverk, Sweden and Elsam, Denmark	Statens Vattenfallsverk, Sweden and Imatran Voima Oy, Finland	Statnett, Norway and Elsam, Denmark
Main reason for choosing HVDC system	Interconnecting grids, Island connection, Long sea crossing	Interconnecting grids, Sea crossing	Interconnecting grids, Sea crossing	Interconnecting grids, Sea crossing
Power Transmitted, MW	130	300	500	440
Direct voltage, kV	150	285	400	350
Converters per station	1	1	1	1
Direct voltage per converter, kV	150	285	400	350
Direct current, A	914	1050	1250	1260
Reactive power supply	Capacitors Synchronous condenser	Capacitors	Capacitors	Capacitors Synchronous condensor
Converter station location and AC grid voltage	Västervik, 130 kV Visby, 70 kV	Lindome, 130 kV Vester Hassing, 400 kV	Dannebo, 400 kV Rauma, 400 kV	Kristiansand, 300 kV Tjele, 400 kV
Length of overhead DC line, km	7 km	61 km	33 km	113 km
Cable arrangement	1 cable	1 cable	1 cable	1 cable
Cable route length, km	96 km	88 km	200 km	127 km
Grounding of the DC circuit	For full current in two sea electrode stations	For full current in two sea electrode stations	For full current in two sea electrode stations	For full current in two ground electrode stations
AC grids at both ends	Asynchronous	Asynchronous	Synchronous	Asynchronous
Control	Constant frequency on Gotland	Constant power in either direction	Constant power, damping control	Constant power in either direction
Emergency change of power flow	-	On manual or automatic order to preset value	-	On manual or automatic order to preset value
Main supplier of converter equipment	ABB	ABB	ABB	ABB

# Europe



Scheme	26. Baltic Cable	27. Kontek	30. SwePol	32. Italy-Greece
Commissioning year	1994	1995	2000	2000
Owner/Original customer/Country	Baltic Cable AB, Sweden	Elkraft, Denmark VEAG, Germany	SwePol Link AB, Sweden	ENEL, Italy and PPC, Greece
Main reason for choosing HVDC system	Interconnecting grids, Sea crossing	Interconnecting grids, Sea crossing	Interconnecting grids, Sea crossing	Interconnecting grids, Sea crossing
Power Transmitted, MW	600	600	600	500
Direct voltage, kV	450	400	450	400
Converters per station	1	1	1	1
Direct voltage per converter, kV	450	400	450	400
Direct current, A	1364	1500	1330	1250
Reactive power supply	Capacitors	Capacitors	Capacitors	Capacitors
Converter station location and AC grid voltage	Kruseberg, 400 kV Herrenwyk, 380 kV	Bjæverskov, 400 kV Bentwisch, 400 kV	Stärnö, 400 kV Slupsk, 400 kV	Galatina, 400 kV Arachthos, 400 kV
Length of overhead DC line, km	12 km	-	-	110 km
Cable arrangement	1 cable	1 cable	1 cable + 2 cables for the return current	1 land and 1 sea cable
Cable route length, km	261 km	170 km (120 km under ground)	230 km	200 km (40 km + 160 km)
Grounding of the DC circuit	For full current in two sea electrodes	For full current in two sea electrodes	Metallic ground return with cable. No ground current.	For full current in two sea electrode stations
AC grids at both ends	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Control	Constant power, frequency and damping control	Constant power, frequency and damping control	Power control, emergency power control	Constant power
Emergency change of power flow	On manual or automatic order to preset value	On manual or automatic order to preset value	On automatic order to set values	Frequency control
Main supplier of converter equipment	ABB	ABB	ABB	ABB

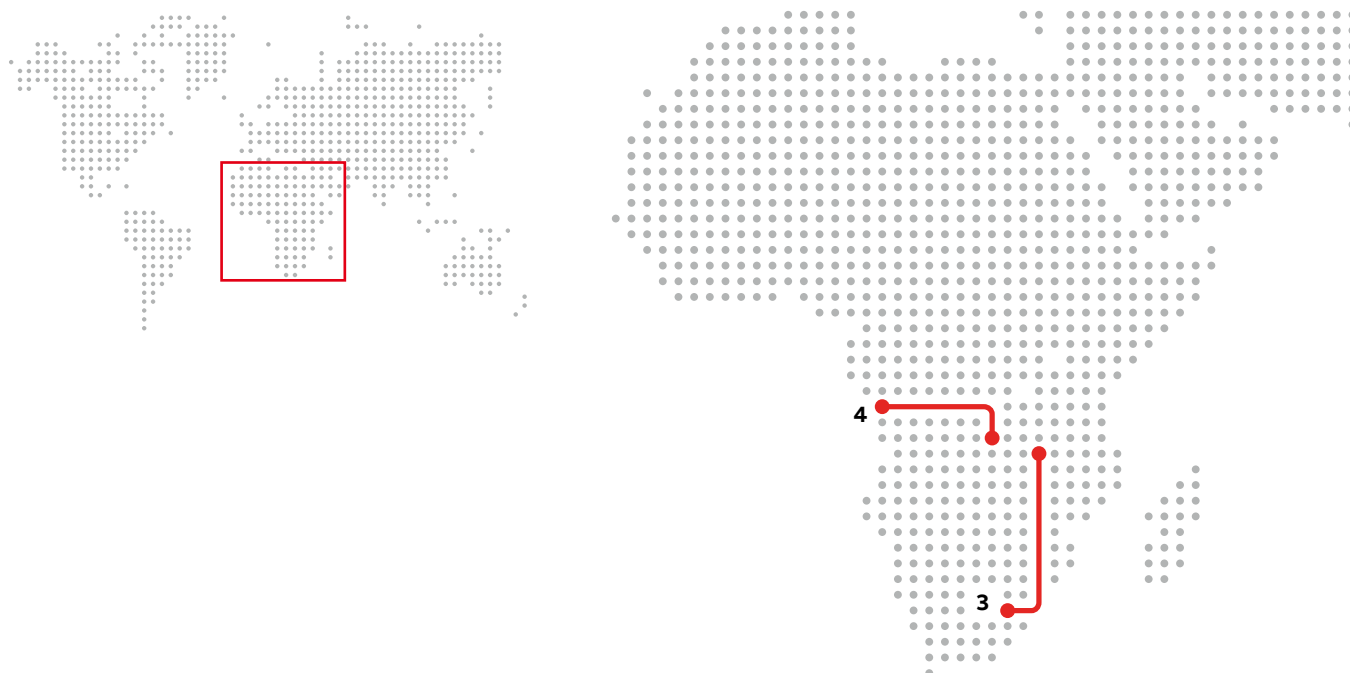
# Europe



Scheme	39. Norned	41. SAPEI	45. Fenno-Skan 2	53. LitPol
Commissioning year	2008	2011	2011	2015
Owner/Original customer/Country	Statnett, Norway TenneT, The Netherlands	Terna, Italy	Fingrid, Finland and Svenska Kraftnät, Sweden	Litgrid AB, Lithuania
Main reason for choosing HVDC system	Interconnecting grids, Sea crossing, Trading	Interconnecting grids, Sea crossing	Interconnecting grids, Sea crossing	Interconnecting grids
Power Transmitted, MW	700	1000	800	500
Direct voltage, kV	±450	±500	500	± 70
Converters per station	1	2	1	2
Direct voltage per converter, kV	450	500	500	70
Direct current, A	780	1000	1600	3600
Reactive power supply	Capacitors	Capacitors	Capacitors	Capacitors
Converter station location and AC grid voltage	Eemshaven, 400 kV Fedaa, 300 kV	Fiume Santo, 400 kV Latina, 400 kV	Finnböle, 400 kV Rauma, 400 kV	Lithuanian side, 330 kV Polish side, 400 kV
Length of overhead DC line, km	-	-	70 km (Swedish side) 33 km(Finnish side)	Back-to-back
Cable arrangement	2 x 450 kV cables	2 cables	-	-
Cable route length, km	560 km	420 km (sea) + 15 km (land)	200 km	-
Grounding of the DC circuit	Midpoint grounded 12-pulse converter in Eemshaven. No ground current.	For full current in two sea electrode stations.	Grounded neutral. Common neutrals and electrodes with Fenno-Skan 1.	Midpoint grounded no ground current
AC grids at both ends	Asynchronous	Asynchronous	Synchronous	Asynchronous
Control	Constant power. Reactive/AC voltage control. Frequency dependant power control. Power swing damping control.	Frequency control on Sardinia	Constant power, damping control	Constant power, frequency control, AC voltage control
Emergency change of power flow	-	-	On manual order to preset value	On manual or automatic order
Main supplier of converter equipment	ABB	ABB	ABB	ABB

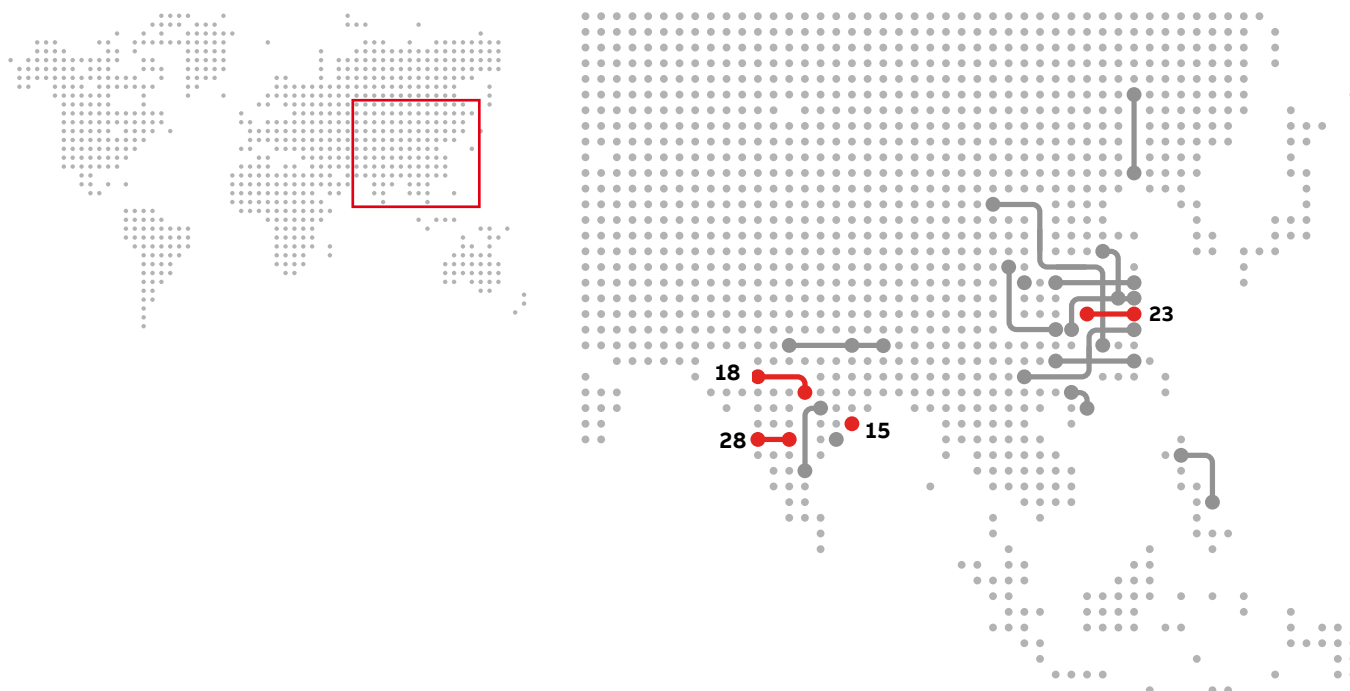


# Africa



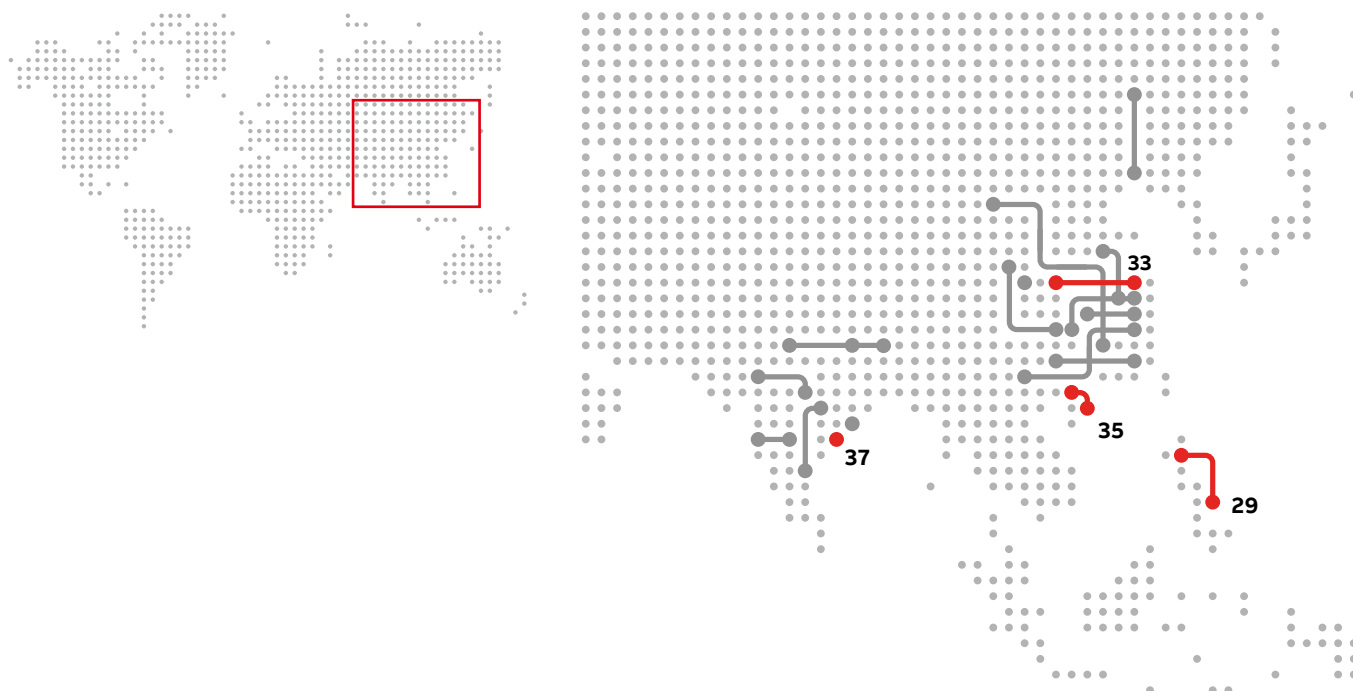
Scheme	3. Cahora Bassa	4. Inga-Kolwezi
Commissioning year	1977-1979	1982
Owner/Original customer/Country	Hidroelectrica de Cahora Bassa, Mocambique and Electricity Supply Commission, South Africa	SNEL, DR Congo
Main reason for choosing HVDC system	Connecting remote generation, Interconnecting grids	Connecting remote generation, Interconnecting grids
Power Transmitted, MW	1930	560
Direct voltage, kV	±533	±500
Converters per station	8	2
Direct voltage per converter, kV	133	500
Direct current, A	1800	560
Reactive power supply	Capacitors	Capacitors Synchronous condensers
Converter station location and AC grid voltage	Songo, 220 kV Apollo, 275 kV	Inga (Zaire River), 220 kV Kolwezi (Shaba), 220 kV
Length of overhead DC line, km	1420 km	1700 km
Cable arrangement	-	-
Cable route length, km	-	-
Grounding of the DC circuit	For full current in two ground electrodes	For full current in two ground electrode stations
AC grids at both ends	Asynchronous	Asynchronous
Control	Constant power	Constant power or constant frequency in Shaba
Emergency change of power flow	-	-
Main supplier of converter equipment	ABB/Siemens/AEG	ABB

# Asia



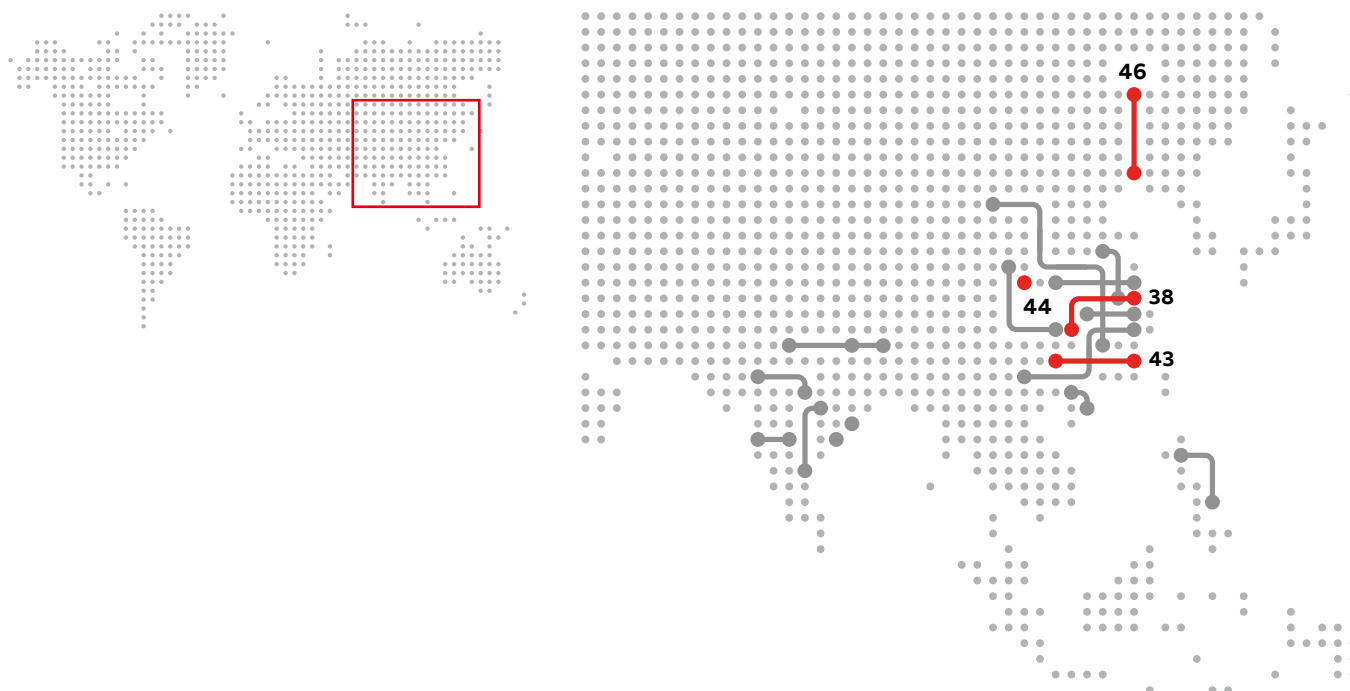
Scheme	15. Vindhyachal	18. Rihand-Delhi	23. Gezhouba-Shanghai	28. Chandrapur-Padghe
Commissioning year	1989	1990	1989	1998
Owner/Original customer/Country	National Thermal Power Corporation, India	National Thermal Power Corporation, India	Central China Electric Power Administration, China and East China Electric Power Administration, China	Maharashtra State Electricity Board, India
Main reason for choosing HVDC system	Connecting remote generation	Connecting remote generation, Stability	Connecting remote generation, Interconnecting grids, Stability benefits	Connecting remote generation, Stability benefits
Power Transmitted, MW	2 x 250	1568	1200	1500
Direct voltage, kV	70	±500	±500	±500
Converters per station	2 + 2	2	2	2
Direct voltage per converter, kV	70	500	500	500
Direct current, A	3600	1568	1200	1500
Reactive power supply	Capacitors	Capacitors	Capacitors	Capacitors
Converter station location and AC grid voltage	Northern system, 400 kV Western system, 400 kV	Rihand, 400 kV Dadri, 400 kV	Gezhouba, 500 kV Nan Qiao, 230 kV	Chandrapur, 400 kV Padghe, 400 kV
Length of overhead DC line, km	Back-to-back	814 km	1000 km	736 km
Cable arrangement	-	-	-	-
Cable route length, km	-	-	-	-
Grounding of the DC circuit	One point grounded	For full current in two ground electrode stations (intermittent)	For full current in two ground electrode stations	For full current in two electrode stations
AC grids at both ends	Asynchronous	Synchronous	Asynchronous	Synchronous
Control	Constant power in either direction, damping control	Constant power, damping control	Constant power, reactive power control	Constant power, frequency and damping control
Emergency change of power flow	Automatic power reduction triggered by AC signal	On manual or automatic order	On manual or automatic order to preset value	On manual or automatic order
Main supplier of converter equipment	ABB	BHEL, India, main contractor ABB subcontractor to BHEL under licence agreement	ABB/Siemens	ABB/BHEL

# Asia



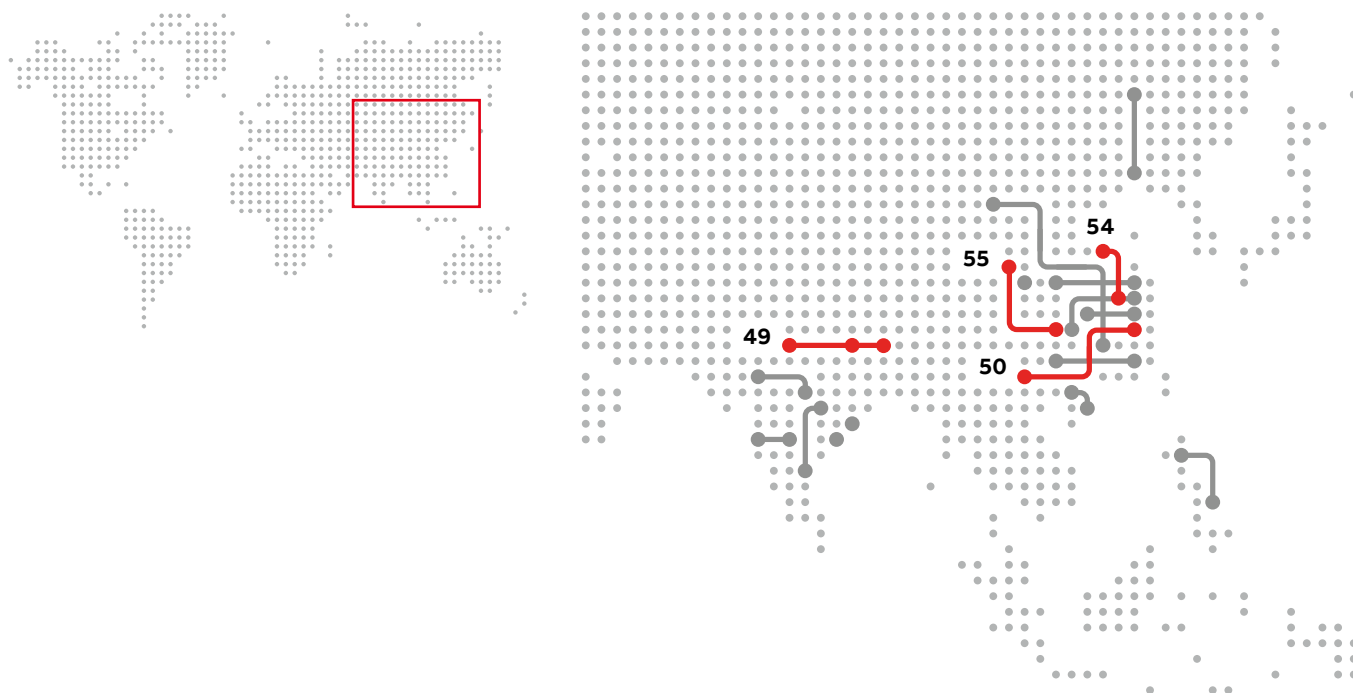
Scheme	29. Leyte-Luzon	33. Three Gorges-Changzhou	35. Three Gorges-Guangdong	37. Vizag II
Commissioning year	1997	2003	2004	2005
Owner/Original customer/Country	National Power Corporation, Manila, Philippines	China Power Grid Development Co Ltd, China	State Power Corporation of China, China	Powergrid Corporation of India Ltd. India
Main reason for choosing HVDC system	Interconnecting grids, Sea crossing	Connecting remote generation	Connecting remote generation	Interconnecting grids
Power Transmitted, MW	440	3000	3000	500
Direct voltage, kV	350	±500	±500	±88
Converters per station	1	2	2	2
Direct voltage per converter, kV	350	500	500	176
Direct current, A	1260	3000	3000	2860
Reactive power supply	Capacitors	Capacitors	Capacitors	Capacitors
Converter station location and AC grid voltage	Ormoc, 230 kV, Naga, 230 kV	Longquan, 500 kV Zhengping, 500 kV	Jingzhou, 500 kV Huizhou, 500 kV	Visakhapatnam, India, 400 kV both sides
Length of overhead DC line, km	433 km	890 km	940 km	Back-to-back
Cable arrangement	1 cable + 1 spare	-	-	-
Cable route length, km	19 km	-	-	-
Grounding of the DC circuit	For full current in two sea electrodes	For full current in two ground electrode stations (intermittent)	For full current in two ground electrode stations (intermittent)	Midpoint grounded no ground current
AC grids at both ends	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Control	Constant power, frequency control	Constant power	Constant power	Power Control, frequency control, voltage control
Emergency change of power flow	On manual or automatic order to preset value	-	-	-
Main supplier of converter equipment	ABB	ABB	ABB	ABB

# Asia



Scheme	38. Three Gorges-Shanghai	43. Xiangjiaba-Shanghai	44. Lingbao II Extension Project	46. Hulunbeir-Liaoning
Commissioning year	2006	2010	2010	2010
Owner/Original customer/Country	State Grid Corporation of China, China	State Grid Corporation of China, China	State Grid Corporation of China, China	State Grid Corporation of China, China
Main reason for choosing HVDC system	Connecting remote generation	Connecting remote generation	Interconnecting grids	Connecting remote generation, Interconnecting grids
Power Transmitted, MW	3000	6400	750	3000
Direct voltage, kV	±500	±800	168	±500
Converters per station	2	4	2	2
Direct voltage per converter, kV	500	400	168	500
Direct current, A	3000	4000	4500	3000
Reactive power supply	Capacitors	Capacitors	Capacitors	Capacitors
Converter station location and AC grid voltage	Yidu, 500 kV Huaxin, 500 kV	Fulong: 525 kV Fengxian: 515 kV	Huazhong: 500 kV Xibei: 330 kV	Yimin: 500 kV Mujia: 500 kV
Length of overhead DC line, km	1059 km	2071 km	Back-to-back	920 km
Cable arrangement	-	-	-	-
Cable route length, km	-	-	-	-
Grounding of the DC circuit	For full current in two ground electrode stations (intermittent)	For full current in two electrode stations	One point grounded	For full current in two ground electrode stations (intermittent)
AC grids at both ends	Asynchronous	Synchronous	Asynchronous	Asynchronous
Control	Constant power	Constant power, frequency and damping control	Constant power, frequency control	Constant power
Emergency change of power flow	-	On manual or automatic order	-	-
Main supplier of converter equipment	ABB - Chinese consortium	ABB/Siemens	ABB/XPR/XJ/CEPRI/TBEA/ XB/Sifang	ABB/XPR/XJ/TBEA/NARI

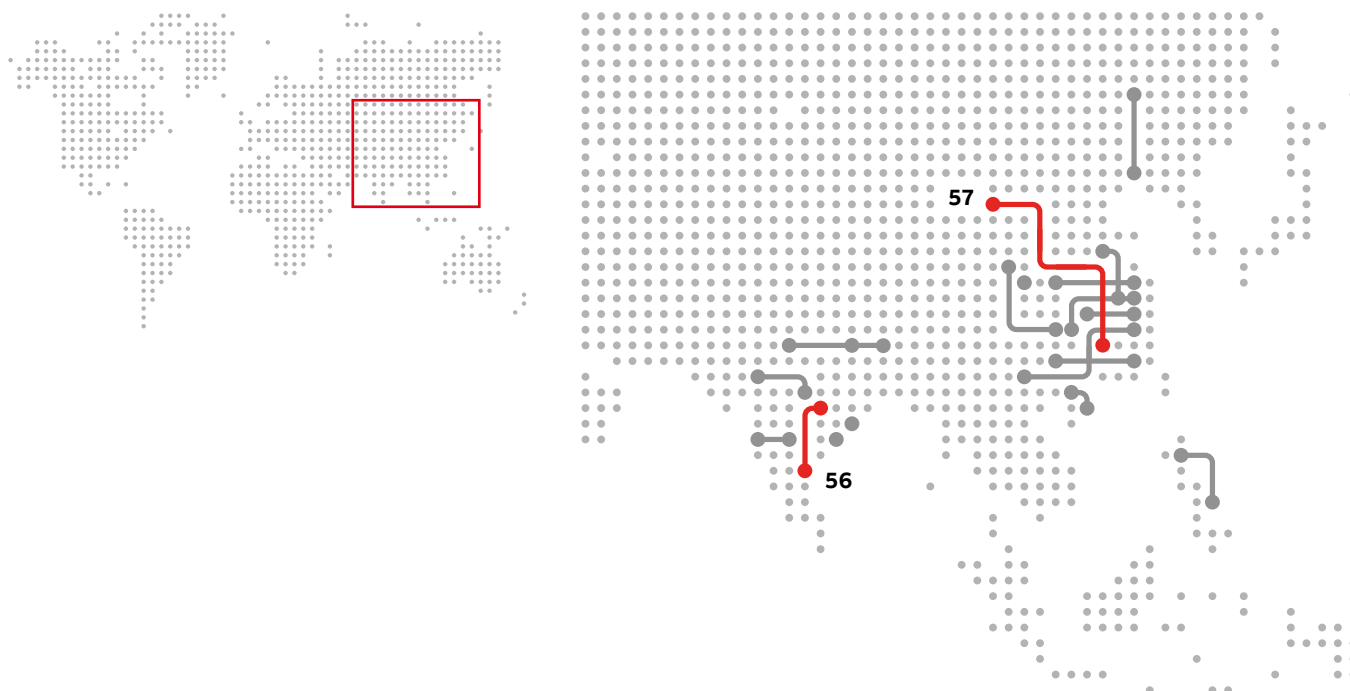
# Asia



Scheme	49. North-East Agra	50. Jinping-Sunan	54. Jinbei-Nanjing	55. Jiuquan-Hunan
Commissioning year	2017	2013	2017	2017
Owner/Original customer/Country	Power Grid Corporation of India Ltd. India	State Grid Corporation of China, China	State Grid Corporation of China (SGCC)	State Grid Corporation of China (SGCC)
Main reason for choosing HVDC system	Connecting remote generation, Interconnecting grids	Connecting remote generation	Connecting remote generation, Interconnecting grids	Connecting remote generation, Interconnecting grids
Power Transmitted, MW	6000 (Multiterminal) 4 x 2000 (Converters)	7200	8000	8000
Direct voltage, kV	±800	±800	±800	±800
Converters per station	2 + 2 + 4	4	4	4
Direct voltage per converter, kV	800	400	800	800
Direct current, A	2500 + 2500	4500	5000	5000
Reactive power supply	Capacitors	Capacitors	Capacitors	Capacitors
Converter station location and AC grid voltage	Biswanath Chariali: 400 kV Alipurduar: 400 kV Agra: 400 kV	Yulong: 535 kV Tongli: 505 kV	Jinbei: 500 kV Nanjing: 500 kV	Jinquanbei: 750 kV Hunan: 500 kV
Length of overhead DC line, km	1728 km	2090 km	1118 km	2390 km
Cable arrangement	-	-	-	-
Cable route length, km	-	-	-	-
Grounding of the DC circuit	For full current in three electrode stations	For full current in two electrode stations	For full current in two electrode stations	For full current in two electrode stations
AC grids at both ends	Synchronous/ Asynchronous	Synchronous	Synchronous	Synchronous
Control	Multiterminal, constant power, damping control, frequency control	Constant power, frequency and damping control	Constant power frequency and damping control	Constant power frequency and damping control
Emergency change of power flow	-	On manual or automatic order	On manual or automatic order	On manual or automatic order
Main supplier of converter equipment	ABB/BHEL	ABB/XD/XJ/NARI	ABB/XD/XJ/NARI	ABB/XD/XJ/NARI



# Asia



Scheme	56. Raigarh - Pugalur	57. Changji-Guquan
Commissioning year	2017-2019	2017-2018
Owner/Original customer/Country	Power Grid Corporation of India Ltd.	State Grid Corporation of China (SGCC)
Main reason for choosing HVDC system	Connecting remote generation	Connecting remote generation, Interconnecting grids
Power Transmitted, MW	6000	12000
Direct voltage, kV	±800	±1100
Converters per station	4	2
Direct voltage per converter, kV	800	1100
Direct current, A	1875 + 1875	5454
Reactive power supply	Capacitors	Capacitors
Converter station location and AC grid voltage	Raigarh 400 kV Pugalur 400 kV	Changji Guquan
Length of overhead DC line, km	1830 km	3000 km
Cable arrangement	-	-
Cable route length, km	-	-
Grounding of the DC circuit	Dedicated Metallic Return	For full current in two electrode stations
AC grids at both ends	Synchronous/Asynchronous	Synchronous
Control	Multiterminal, constant power, damping control, frequency control	Constant power, frequency and damping control
Emergency change of power flow	-	On manual or automatic order
Main supplier of converter equipment	ABB/BHEL	ABB/XD/XJ/NARI

# Australia and Oceania



Scheme	16. Broken hill	24. New Zealand DC Hybrid Link
Commissioning year	1986	1991-1992
Owner/Original customer/Country	Southern Power Corporation, Australia	Trans Power New Zealand Ltd., New Zealand
Main reason for choosing HVDC system	Interconnecting grids, Frequency control	Interconnecting grids, Sea crossing
Power Transmitted, MW	40	560
Direct voltage, kV	8.3	-350
Converters per station	2	1
Direct voltage per converter, kV	8.3	350
Direct current, A	2400	1600
Reactive power supply	Capacitors Synchronous condenser	Capacitors Synchronous condensor
Converter station location and AC grid voltage	Broken Hill 22 kV and 6.9 kV	Benmore, 220 kV Haywards, 220 kV
Length of overhead DC line, km	Back-to-back	575 km
Cable arrangement	-	2 cables + 1 spare
Cable route length, km	-	42 km
Grounding of the DC circuit	Mid-point grounded	For full current in one ground and one sea electrode station
AC grids at both ends	Asynchronous	Asynchronous
Control	Constant 40 Hz frequency	Constant power, frequency and damping control
Emergency change of power flow	-	Frequency control of isolated Wellington area
Main supplier of converter equipment	ABB	ABB



## Notes

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