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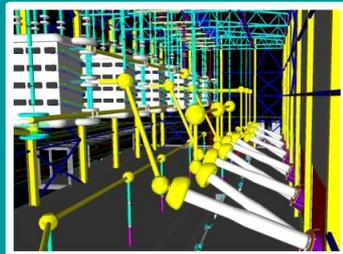
国网智能电网研究院  
STATE GRID SMART GRID RESEARCH INSTITUTE

# HVDC in China

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August, 2013  
[www.cepri.com](http://www.cepri.com)

C-EPRI

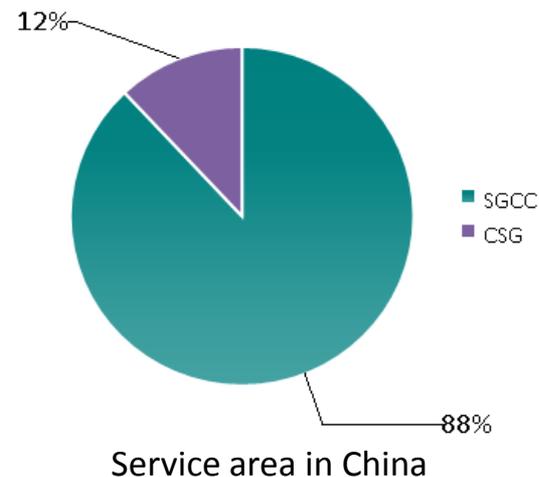




# Introduction of SGCC

## Power Grid Operator in China

- ◆ State Grid Corporation of China (**SGCC**)
- ◆ With 300 billions US\$ revenue & 2 M Employees

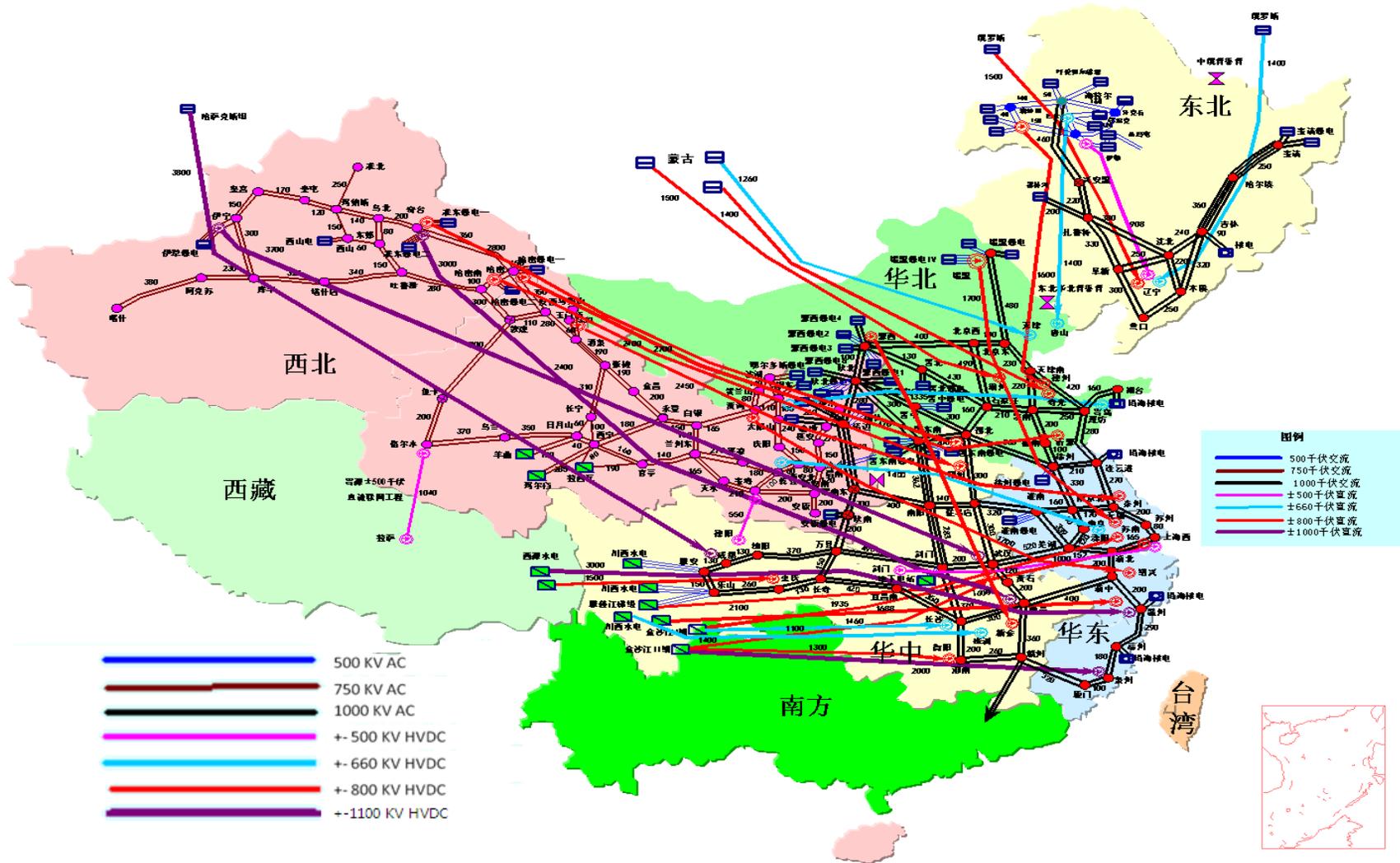


## Key facts about SGCC

- ◆ The largest utility in the world
- ◆ Over 655,131km transmission line (AC up to 1000kV, DC up to  $\pm 800$ kV)
- ◆ Over 2,391,620MVA substation capacity



# China Transmission Grid 2020



New Constructions by 2015

+/-800kV HVDC: 13 lines  
+/-1100kV HVDC: 1 line

Total HVDC (approx.):  
30,000 km, 50 HVDC lines



# HVDC Projects In Operation (1987~2013)

## A young but booming market

No.	Commercial operation	Project name	Voltage (kV)	Capacity (MW)	Distance (km)	EPC/User
1	1987	Zhoushan	-100	50	54	SGCC
2	1990	Gezhouba-Nanqiao	±500	1200	1045	SGCC
3	2001	Tianshengqiao-Guangzhou	±500	1800	980	CSG
4	2002	Shengsi	±50	60	66.2	SGCC
5	2003	Three Gorges-Changzhou	±500	3000	860	SGCC
6	2004	Guizhou-Guangdong I	±500	3000	882	CSG
7	2004	Three Gorges-Guangdong	±500	3000	940	SGCC
8	2005	Lingbao Back-to-Back I	120	360	-	SGCC
9	2006	Three Gorges-Shanghai I	±500	3000	1040	SGCC
10	2007	Guizhou-Guangdong II	±500	3000	1194	CSG
11	2008	Gaoling Back-to-Back I	±125	2x750	-	SGCC
12	2009	Lingbao Back-to-Back II	166.7	750	-	SGCC
13	2010	Deyang-Baoji	±500	3000	534	SGCC
14	2010	Hulunbuir-Liaoning	±500	3000	908	SGCC
15	2010	Xiangjiaba-Shanghai	±800	6400	1907	SGCC
16	2010	Yunnan-Guangdong	±800	5000	1418	CSG
17	2011	Ningdong-Shandong	±660	4000	1335	SGCC
18	2011	Three Gorges-Shanghai II	±500	3000	970	SGCC
• 19	2011	Nanhui wind farm integration	±30	18	8.4	SGCC
20	2012	Sino-Russia Back-to-Back	±125	750	-	SGCC
21	2012	Qinghai-Tibet ( Above 10K ft)	±400	600	1038	SGCC
22	2012	Jinping-Sunan	±800	7200	2093	SGCC
23	2012	Gaoling Back-to-Back II	±125	2x750	-	SGCC

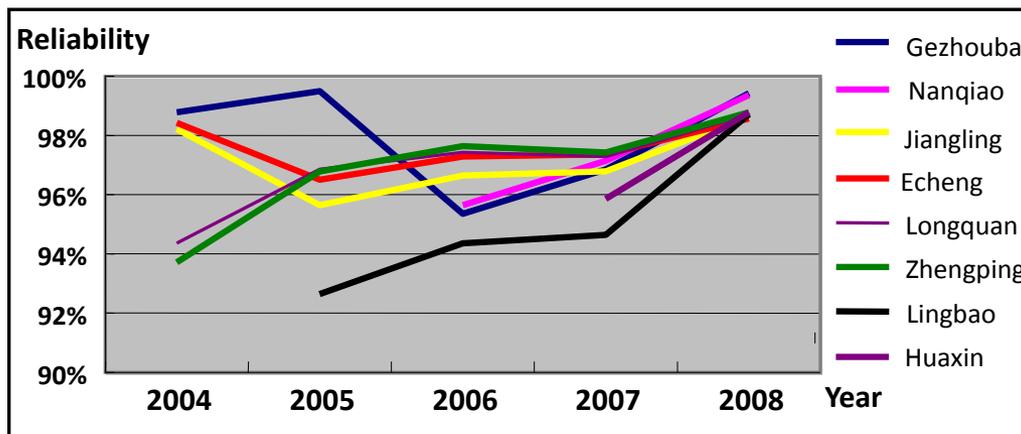


• represents the VSC-HVDC projects



# HVDC Operation Records

Reliability stabilized at around 99%





# New HVDC Projects for (2013~2015)

## Enormous investment in HVDC construction

No.	Commercial operation	Project name	Voltage (kV)	Capacity (MW)	Distance (km)	EPC/User	Remarks
1	2015	Northern Hami-Chongqing	±800	8000	2223	SGCC	Planned
2	2015	Ningdong-Zhejiang	±800	8000	1900	SGCC	Planned
3	2015	Ximeng-Jiangsu (Taizhou)	±800	8000	1690	SGCC	Planned
4	2015	Gansu(Jiuquan)-Hunan	±800	8000	2490	SGCC	Planned
5	2015	Mengxi-Hubei	±800	8000	1400	SGCC	Planned
6	2015	Zhulong-Sichuan	±1100	10000	2600	SGCC	Planned
7	2015	Humeng-Shandong	±800	8000	1600	SGCC	Planned
• 8	2014	Xiamen island in-feed	±320	1000	Approx. 10 Subsea cable	SGCC	Planned
• 9	2014	Zhoushan multi-terminal (5)	±200	1000	141 Subsea cable	SGCC	Ongoing
10	2014	Xiluodu-Zhejiang	±800	8000	1688	SGCC	Ongoing
11	2014	Southern Hami-Zhengzhou	±800	8000	2200	SGCC	Ongoing
• 12	2013	Nan'ao multi-terminal (3)	±160	200	9	CSG	Ongoing
13	2013	Nuozhadu-Guangdong	±800	5000	1451	CSG	Ongoing
14	2013	Xiluodu-Guangdong	±500	6400	1251	CSG	Ongoing
• 15	—	Dalian city in-feed	±320	1000	47.6 Subsea cable	SGCC	Postponed



• represents the VSC-HVDC projects



# ±800, ±1100 HVDCs During (2010 ~2015)

The largest UHVDC market in the world

No.	Commercial operation	Project name	Voltage (kV)	Capacity (MW)	Distance (km)	EPC/User	Remarks
1	2015	Northern Hami-Chongqing	±800	8000	2223	SGCC	Planned
2	2015	Ningdong-Zhejiang	±800	8000	1900	SGCC	Planned
3	2015	Ximeng-Jiangsu (Taizhou)	±800	8000	1690	SGCC	Planned
4	2015	Gansu(Jiuquan)-Hunan	±800	8000	2490	SGCC	Planned
5	2015	Mengxi-Hubei	±800	8000	1400	SGCC	Planned
6	<b>2015</b>	<b>Zhundong-Sichuan</b>	<b>±1100</b>	<b>10000</b>	<b>2600</b>	<b>SGCC</b>	<b>Planned</b>
7	2015	Humeng-Shandong	±800	8000	1600	SGCC	Planned
8	2014	Xiluodu-Zhejiang	±800	8000	1688	SGCC	Ongoing
9	2013	Southern Hami-Zhengzhou	±800	8000	2200	SGCC	Ongoing
10	2013	Nuozhadu-Guangdong	±800	5000	1451	CSG	Ongoing
11	2012	Jinping-Sunan	±800	7200	2090	SGCC	Commissioned
12	2010	Xiangjiaba - Shanghai	±800	6400	1980	SGCC	Commissioned
13	2010	Yunnan - Guangdong	±800	5000	1418	CSG	Commissioned



# HVDC Manufacturing in China

5 Engineering Firms have HVDC experience

C-EPRI HVDC converter valve factory

- ◆ Ultra-clean environment, 10,000m<sup>2</sup>
- ◆ Production capacity: Converter valves for 3 UHVDC schemes and 2 HVDC Flexible schemes per year



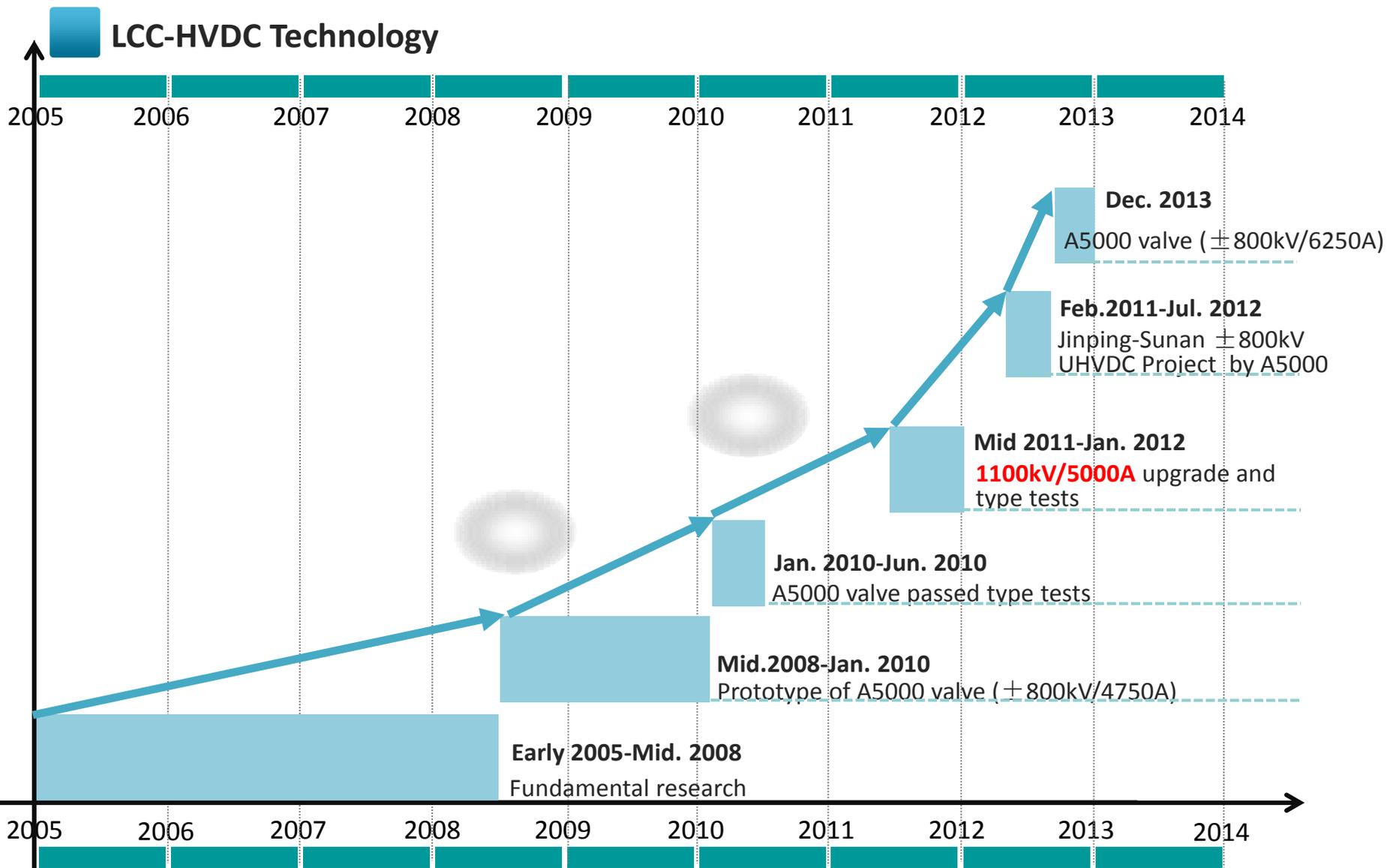
Other facilities

- ◆ 11 converter transformer factories
- ◆ 3 factories for DC yard equipment
- ◆ 3 HVDC Control & Protection factories
- ◆ 3 high voltage submarine cable factories
- ◆ 5 smoothing reactor factories
- ◆ Over 50 transmission conductors and towers factories





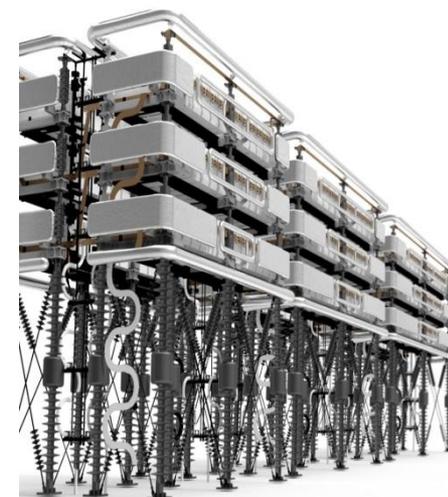
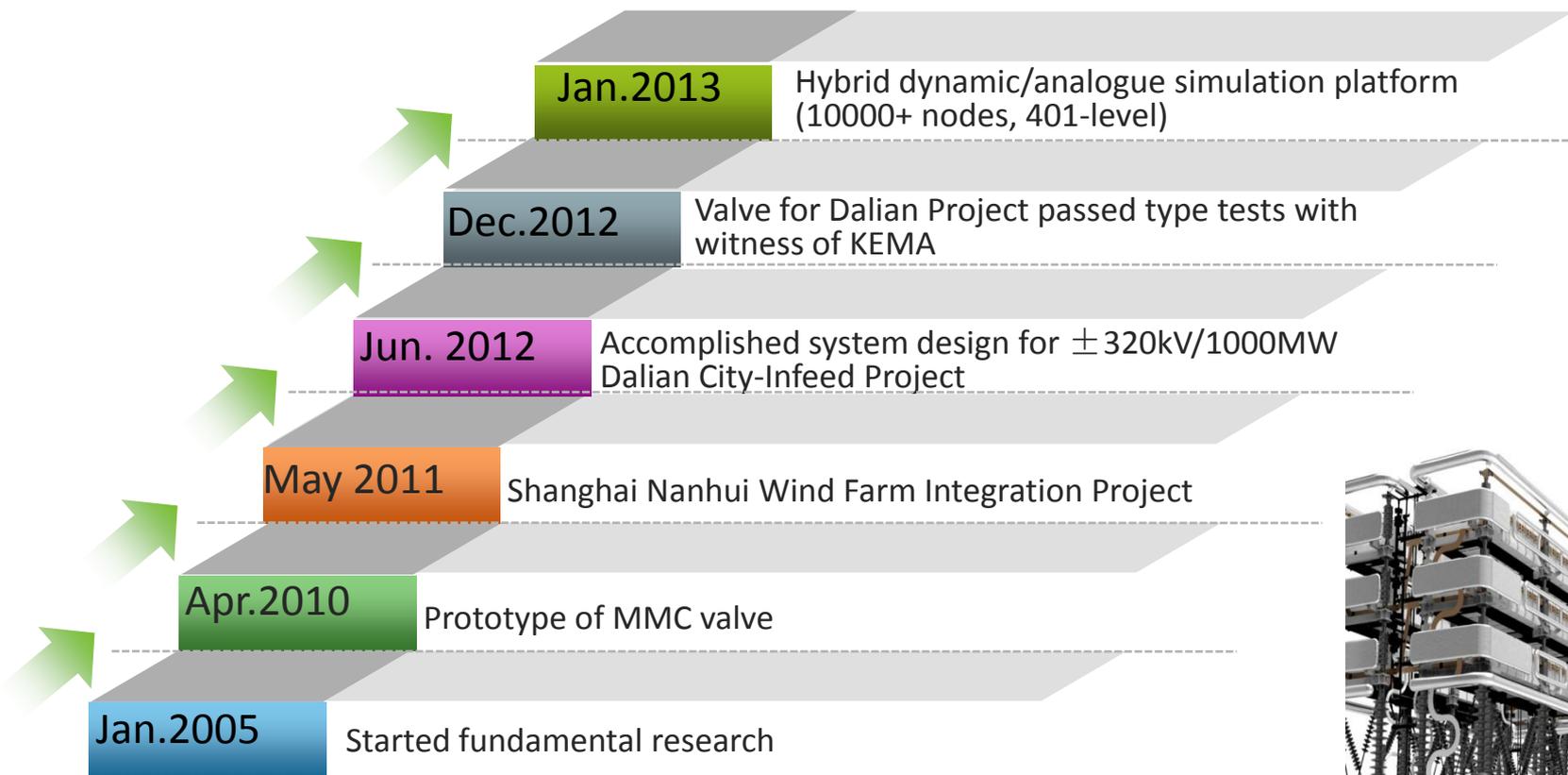
# The HVDC IPR History





# HVDC IPR History

## HVDC Flexible<sup>®</sup> technology - VSC Based





# ±1100kV UHVDC Project

Ratings: 1100kV, 11,000MW / 5000A, 12 pulse, 26000 km

Timeline: Lab: 2007 Aug at CEPRI

Decision: End of 2010

Spec issued: May, 2011

Converter Transformer & Bushings Prototype: June, 2012

Valve prototype: Feb. 2012

Construction Kick-off meeting: July 10, 2013

June 2016 , Low end energized

Dec. 2016 , High end energized

Project Org.

EPC Project Management:

HVDC Construction Division of SGCC

15 main subcontractors

Engineering:

Led by SPERI of SGCC

Zhundong, Xingjiang

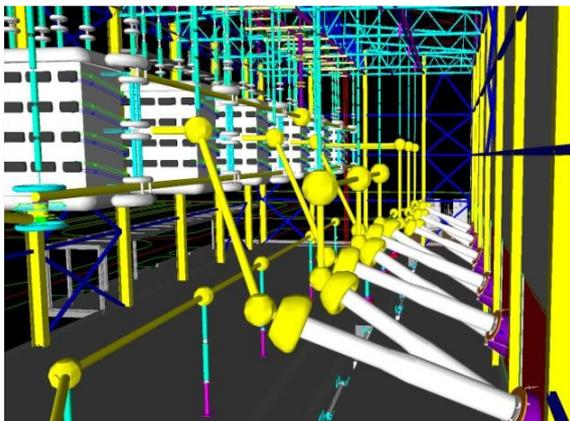
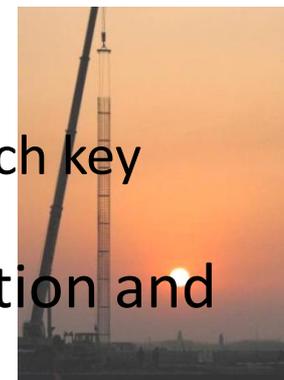
Chengdu, Sichun





# Typical HVDC Project Highlights

- National Central Permit Management
- EPC Prime: SGCC/CSG
- Engineering, SPERI of SGCC
  - Subcontractors
- Mixed Suppliers for key components
  - A couple of Vendors in one converter station for each key components – Transformer, valve, P&C etc
- 2-3 Years for typical 800KV & below HVDC substation and transmission line construction





# Jinping-Sunan $\pm 800\text{kV}$ UHVDC

- ◆ World's largest and longest UHVDC project commissioned
- ◆ Transfer of surplus hydropower from Southwest to Eastern China
- ◆ EPC delivery
  - SGCC as EPC ,did system design, equipment supply and construction
  - All equipment with independent IPR except for 800kV wall bushings
- ◆ Short execution period **2 years**

## Main data

Rated Voltage	$\pm 800\text{kV}$
Rated current	4500A
Rated capacity	7200MW
Transmission distance	2093km
Commissioning year	2012





# Other UHVDC Projects

## UHVDC projects in operation

### Yunnan-Guangdong

Rated Voltage	$\pm 800\text{kV}$
Rated current	4500A
Rated capacity	5000MW
Transmission distance	1418km
Commissioning year	2012

★ *World's first UHVDC project*



### Xiangjiaba-Shanghai

Rated Voltage	$\pm 800\text{kV}$
Rated current	4000A
Rated capacity	6400MW
Transmission distance	1935km
Commissioning year	2010





# Other UHVDC Projects

## UHVDC projects in operation

### Xiangjiaba-Shanghai

Rated Voltage	$\pm 800\text{kV}$
Rated current	4000A
Rated capacity	6400MW
Transmission distance	1935km
Commissioning year	2010



### Jinping-Sunan

Rated Voltage	$\pm 800\text{kV}$
Rated current	4500A
Rated capacity	7200MW
Transmission distance	2093km
Commissioning year	2012

*World's largest UHVDC in service*





# Other UHVDC Projects

## UHVDC projects under construction

### Southern Hami-Zhengzhou

Rated Voltage	$\pm 800\text{kV}$
Rated current	5000A
Rated capacity	8000MW
Transmission distance	2200km
Commissioning year	2013

★ *World's largest UHVDC underway*



### Xiluodu-Zhejiang

Rated Voltage	$\pm 800\text{kV}$
Rated current	5000A
Rated capacity	8000MW
Transmission distance	1688km
Commissioning year	2014

★ *World's largest UHVDC underway*







# Other VSC-HVDC Projects

## Shanghai Wind Farm integration

Commissioning year	2011
Rated capacity	18MW
Rated DC voltage	$\pm 30$ kV
Cable length	8.4km land cable
Type	VSC-HVDC

★ *Asia's first VSC-HVDC project*



## Dalian city in-feed

Commissioning year	2013
Rated capacity	1000MW
Rated DC voltage	$\pm 320$ kV
Cable length	43 km-subsea cable
Type	VSC-HVDC



This scheme has been temporarily postponed for military reasons.



# Other VSC-HVDC Projects

## Zhoushan multi-terminal (5)

Commissioning	2014
Rated capacity	400/300/100/100/100 MW
Rated DC voltage	$\pm 200$ kV
Cable length	134 km-subsea cable
Type	VSC-HVDC



## Nan'ao multi-terminal (3)

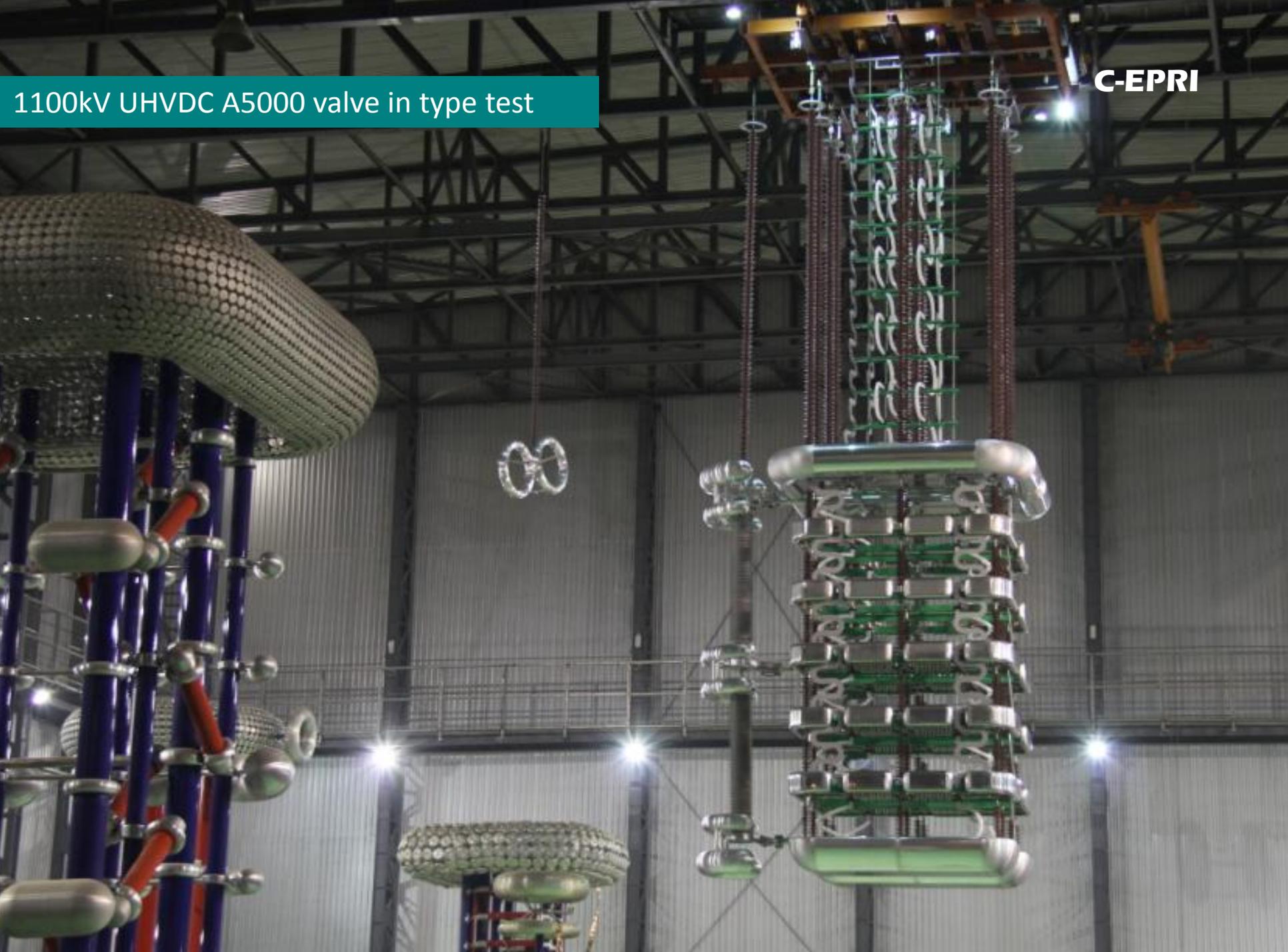
Commissioning	2013
Rated capacity	200MW
Rated DC voltage	$\pm 160$ kV
Cable length	9 km subsea
Type	VSC-HVDC



Valve Hall of Yulong Converter Station  
of Jinping-Sunan +-800KV UHVDC  
Project



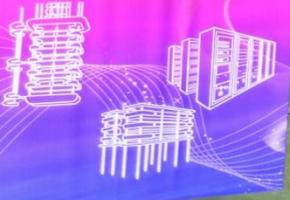
1100kV UHVDC A5000 valve in type test



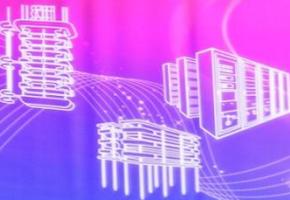
320kV 1000MW VSC HVDC Valve Passed the IEC Type Test



普瑞工程 ±320kV/  
1000MW 柔性直流  
阀及阀控通过 DNV  
KEMA 见证型式实验



C-EPRI self developed  
±320kV/1000MW VSC-  
HVDC Valve success-  
fully passed Type Test  
with witness of  
DNV KEMA





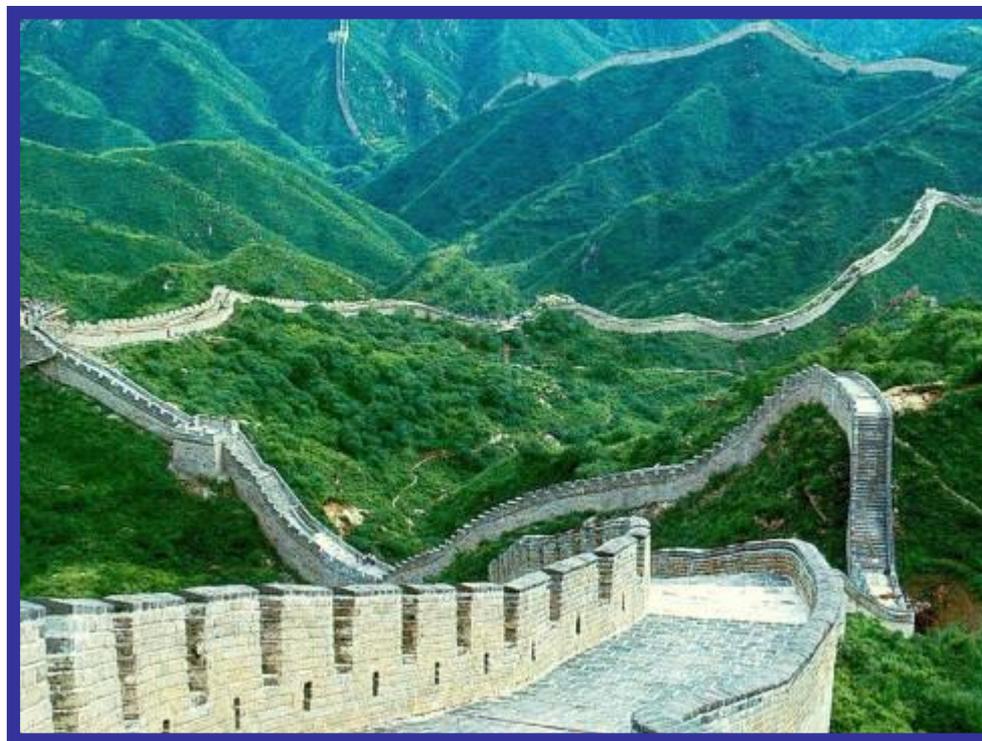
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# Q&A

## Really Appreciate Your Time



Something Built in China Long Time Ago Still Stands

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