

## Flexible DC Transmission Solution



**TBEA Xi'an Flexible Transmission and Distribution Co., Ltd.**

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**TBEA Xi'an Flexible Transmission and Distribution Co., Ltd.**





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## About Us

Founded in 2010, TBEA Xi'an Electric Technology Co., Ltd. is a trusted provider of high-performance energy solutions, with expertise in solar power generation, battery energy storage systems (BESS), power conversion systems (PCS), advanced power distribution, flexible HVDC transmission, and intelligent operation & maintenance (O&M) platforms. The Company emphasizes reliability, safety, and long-term value in global energy infrastructure. Its comprehensive portfolio includes grid-connected solar inverters, PCS, high-voltage STATCOM, energy routers for microgrids, flexible HVDC converter valves, and more.

In the solar sector, TBEA Xi'an Electric Technology offers a complete lineup of grid-connected inverters ranging from 8 kW to 9,000 kW, with a cumulative global installation capacity exceeding 100 GW. For energy storage, TBEA Xi'an Electric Technology has delivered BESS solutions with a total installed capacity of 5 GWh, and over 55 GVar of static var generators (SVG). As one of the pioneers in China, the Company provides integrated solutions spanning BESS, microgrids, HVDC systems, SCADA platforms, and the TB-eCloud intelligent O&M system.

TBEA Xi'an Electric Technology maintains a strong international footprint, with operations in more than 20 countries across Asia, Europe, Latin America, and the Middle East. Guided by its mission of "Green Energy for a Better Life", TBEA Xi'an Electric Technology is dedicated to driving the sustainable development of global society through intelligent, efficient, and eco-friendly energy solutions.

**38<sup>+</sup>**GW  
Total designed capacity of  
PV and wind power

**20<sup>+</sup>**  
Countries and  
regions

**20<sup>+</sup>**GW  
Total access of  
TB-eCloud

**5<sup>+</sup>**GWh  
Cumulative global shipments  
of energy storage system

**55<sup>+</sup>**Gvar  
Cumulative global  
shipments of TSVG

**100**GW  
Cumulative global  
shipments of PV inverters

**TBEA 特变电工**





## TBEA Xi'an Electric Technology Flexible Transmission and Distribution Co., Ltd.

TBEA Xi'an Electric Technology Flexible Transmission and Distribution Co., Ltd. is a wholly-owned subsidiary of TBEA Sunoasis Co., Ltd., mainly engaged in the R&D, manufacturing, and sales of onshore flexible DC converter valves, offshore wind power flexible DC converter valves, high-voltage high-power reactive power compensation devices, and new power electronic equipment.

The Company creatively proposed the flexible DC transmission DC fault non-blocking ride-through control technology, solving the difficult problem of DC fault isolation in the industry. In the future, under the global context of energy structure transformation and upgrading, with the continuous increase in the proportion of clean energy, and the demand for a more flexible and controllable power grid, TBEA Xi'an Electric Technology Flexible Transmission and Distribution Co., Ltd. will inherit TBEA Xi'an Electric Technology's historical accumulation in major electrical equipment development for more than 70 years. It is committed to the safe and efficient transmission of clean energy and strives to promote the development and transformation of transmission and distribution solutions in China and even the world.

Onshore Flexible DC  
Converter Valve

Offshore Wind Power Flexible  
DC Converter Valve



HV High Power Reactive  
Compensation Device

New Power  
Electronic Equipment

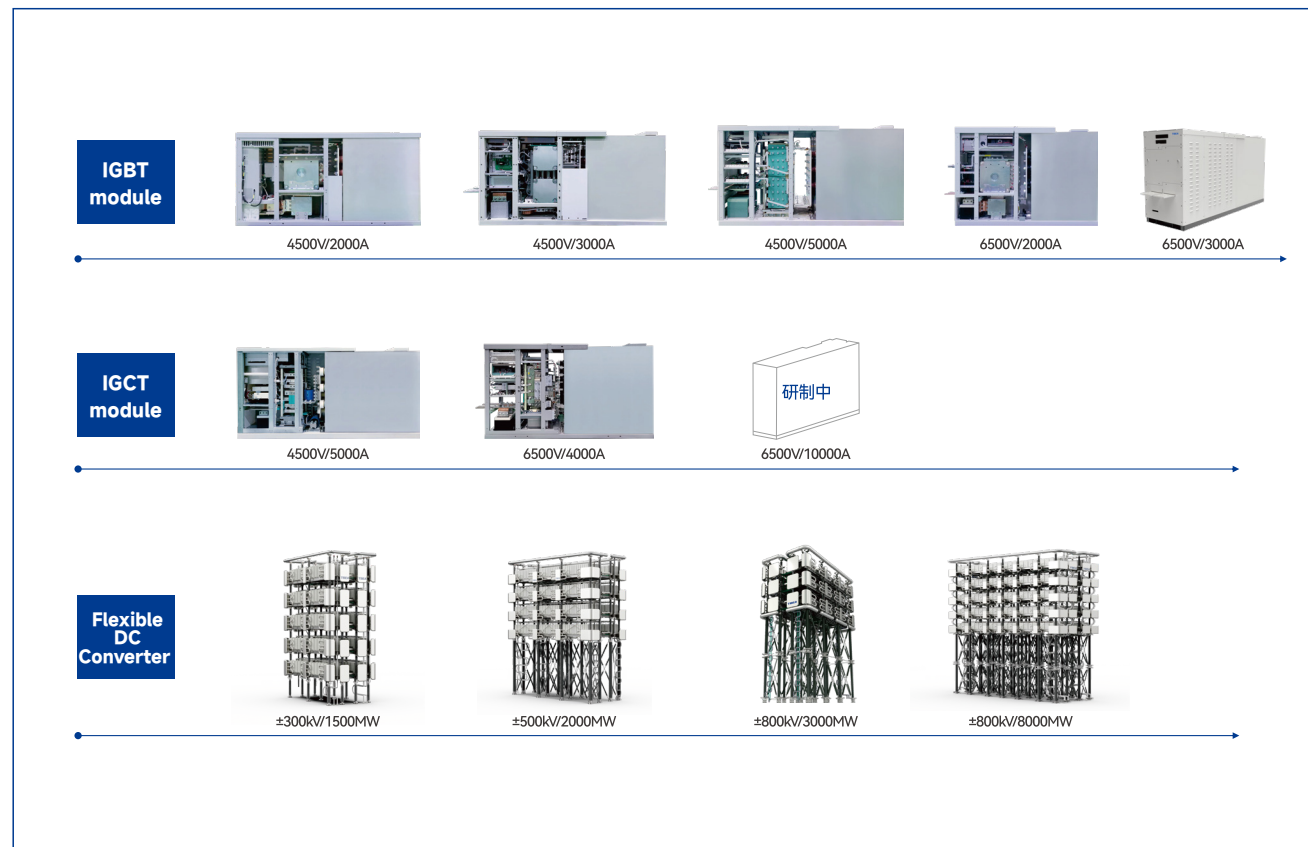


## Milestones in TBEA Xi'an Electric Technology's Flexible DC

- 2013** Established flexible DC transmission business
- 2015** Participated in the R&D of the UHV Flexible DC Project
- 2016** Successfully overcame the core technology challenges of  $\pm 800\text{kV}/5000\text{MW}$  non-blocking overhead flexible DC systems
- 2017** Developed the world's first  $\pm 800\text{kV}/5000\text{MW}$  flexible DC converter valve
- 2018** Won the bid for  $\pm 800\text{kV}/3000\text{M}$  UHV Kunliulong Flexible DC Converter Valve
- 2021** Jointly developed the Zhangbei Low-Frequency Transmission Project M3C Device with China Electric Power Research
- 2022** Jointly completed the development of the 6.5kV IGCT converter valve with Tsinghua University
- 2023** Developed a 5kA IGBT high-capacity converter valve and overcame the core technology of the Modular Commutated Converter (MCC)
- 2024** Won the bid for the Yuhuan 220kV/300M flexible low-frequency converter valve project, developed a new domestically produced 4.5kV/2kA flexible DC converter valve, and a 6.5kV IGBT/IGCT flexible DC converter valve. Delivered the first MCC Qinghai demonstration project.



# TBEA Xi'an Electric Technology flexible DC converter valve product roadmap



## Application Scenario

Long-distance DC transmission of clean energy, offshore wind power DC delivery, and flexible interconnection of power grids

## Product Series

Developed converter valve products based on 4.5kV to 6.5kV devices, catering to the market from 120kV to ±800kV and systems ranging from 1GW to 10GW.

## Applications

±800kV Wudongde Hydropower Station Transmission to Guangdong and Guangxi UHV Multi-terminal DC Project (Kunliulong DC), Yuhuan Offshore Wind Power Low-frequency Transmission Project, and the Qinghai Modular Commutated Converter (MCC) Project.

## Development Trends of Flexible DC Converter Valves

High Voltage High Capacity  
Domestic Production Intelligitization

## Core Values

High Reliability High Efficiency High Power Density



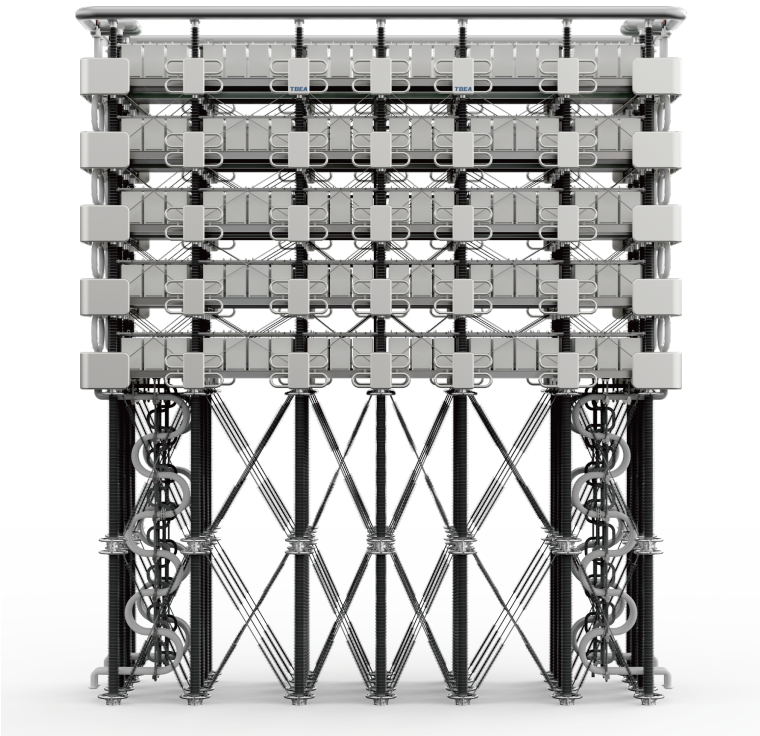
# Large Capacity 5000A IGBT converter valve



UHV flexible DC technology breaks through the bottlenecks of traditional DC transmission, effectively addressing key challenges in conventional DC technology such as the high requirements for integration with AC systems, susceptibility to commutation failures, and difficulties in constructing multi-terminal DC systems. It has become the core solution for large-scale, long-distance transmission of renewable energy. The 4.5kV/5-kA IGBT flexible DC converter valve, independently developed by TBEA Xi'an Electric Technology, along with its digital driver, reduces power loss by approximately 10% compared to traditional analog solutions, further advancing flexible DC technology towards ultra-high voltage and large capacity. The 5kA converter valve solution marks China's entry into the 8GW era of flexible DC, providing critical technical support for scenarios such as offshore wind power development and desert photovoltaic power transmission under the "carbon peak and carbon neutrality" goals, and leading the green transition in the power transmission sector.

## Technical parameters

Name	±800kv/8GW converter valve parameters
Connection type	High-low valve groups in series
Single valve DC voltage (kV)	400
Single valve rated power (MW)	2000
Bridge arm current RMS (A)	3800
Power module rated voltage (V)	2100
Converter valve topology	"Half-bridge + Full-bridge" hybrid structure
Number of Submodules per single valve bridge arm	200 units (including 10 redundant)
IGBT Specification	4500V/5000A
DC capacitors (mF)	24mF (3 units of 8mF in parallel), ±5%



±800kV/8GW High-end Valve Tower Diagram



## HV 6.5kV/ 4kA IGCT converter valve



With the further increase in transmission capacity, particularly the application of flexible DC transmission for offshore wind power integration, traditional IGBT-based converter valve technology faces limitations in large-scale engineering applications, such as large size, heavy weight, high costs, and the "bottleneck" problem of the critical IGBT component. The "6.5kV domestically produced split-drive IGCT converter valve component for flexible DC", jointly developed by TBEA Xi'an Electric Technology and Tsinghua University, completely solves the commercialization challenges of IGCTs. It has passed authoritative appraisal, with product performance meeting engineering application conditions. and is currently operating at the  $\pm 800$ kV Liuzhou converter station in the Wudongde project.

Taking the  $\pm 500$ kV/2000MW transmission system as an example, the number of power modules is reduced by 30%, the size of the valve hall is reduced by 25%, the area is reduced by approximately 25%, the weight of the converter valve is reduced by 15%, and the total platform cost is reduced by 20%.

**30%**

Reduction in the number of power modules

**25%**

Reduction in the volume of the valve hall

**25%**

Reduction in the area by about

**15%**

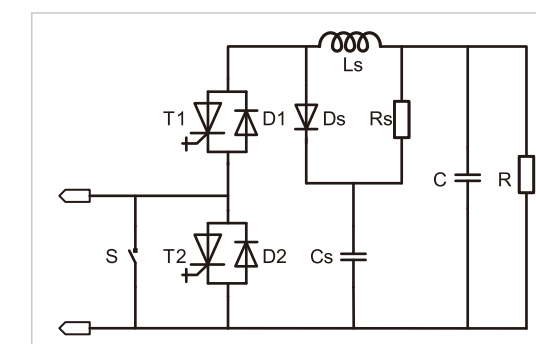
Reduction in the weight of the converter valve

**20%**

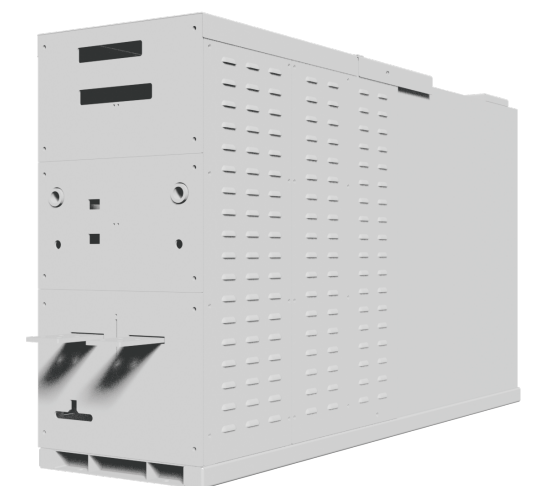
Reduction in the total platform cost

### Technical parameters

Name	IGCT power module parameters
Rated voltage	3000V
Overvoltage operation	4000V
Rated current	1422A
Maximum operating current	1.05p.u (1493A) long-term operation 1.1p.u (1564A) Operation for 10s
Current withstand capability	Valve component overcurrent cut-off capability: 4000V/4000A Power module single pulse overcurrent cut-off capability: 4500V/4000A
Switching frequency	<100Hz
IGCT Specification	6500V/4000A
DC capacitor	4000V/8.6mF (2 pieces of 4.3mF in parallel), 0~ $\pm 5\%$
Bypass switch	5.5kVac/2.0kA, main contact closing time <5ms, auxiliary contact response time <10ms
Draw-out power supply	Operating voltage 400Vdc-6500Vdc; output 400V, 35V



IGCT power module topology

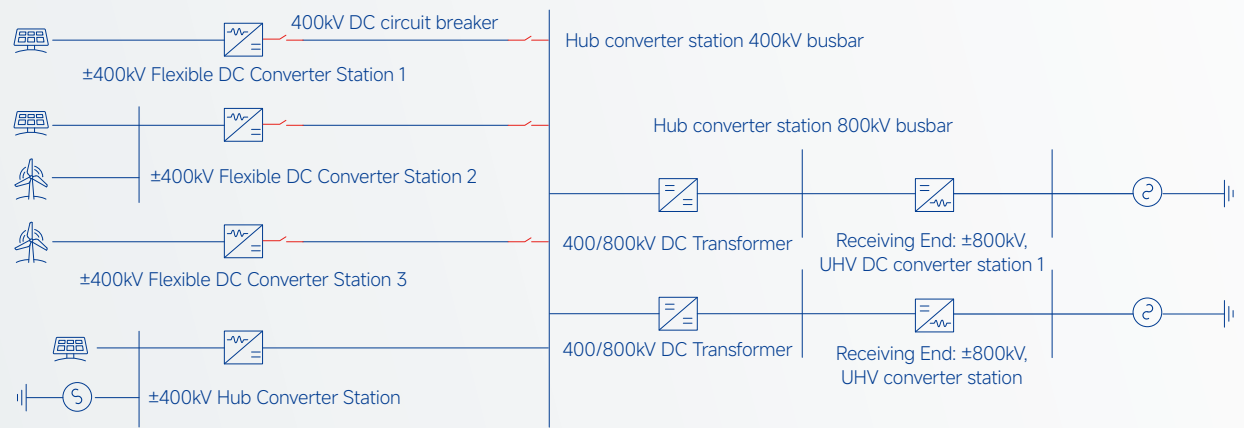




# Energy self-balancing flexible DC converter valve

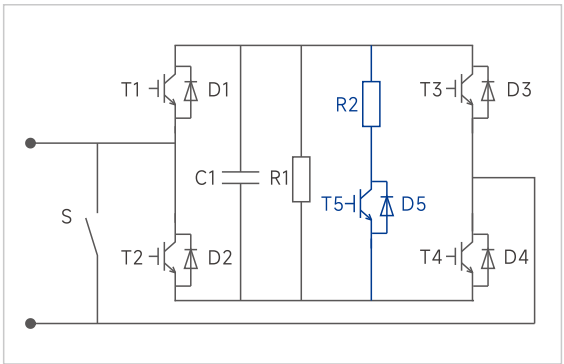


To address the issue of transient surplus power absorption after faults in flexible transmission projects, TBEA Xi'an Electric Technology and the CSG Electric Power Research Institute have jointly developed the first energy-self-balanced flexible DC converter valve. It successfully passed on-site testing by an expert group from the CSG Electric Power Research Institute and full-type testing certification by an authoritative third-party organization. This solution addresses the direct threat of excess surplus power to the operational safety of converter stations, which could potentially cause equipment burnout and project shutdowns. This achievement marks another significant breakthrough for China in the field of flexible DC transmission technology and is of great importance for improving grid operation efficiency and optimizing energy allocation.

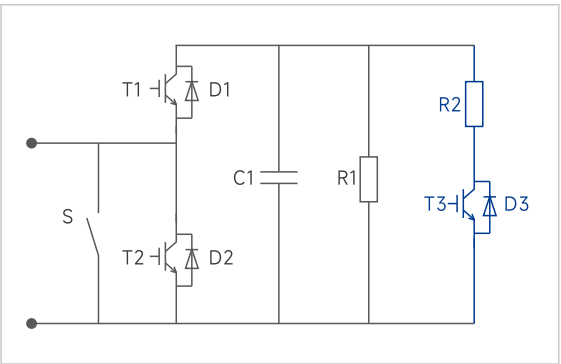


## Technical parameters

Name	Energy Self-Balancing Power Module Specifications
Rated voltage	2203V
Overvoltage operation	3200V
Rated current	1345Arms
Maximum operating current	1.1p.u (1478A) long-term operation1.2p.u (1614A) Operation for 10s
Current withstand capability	Valve component overcurrent cut-off capability: 3200V/4000A Power module single pulse overcurrent cut-off capability: 3400V/4000A
Switching frequency	<100Hz
IGBT Specification	4500V/2000A
DC capacitor	2800V/10mF (2 pieces of 5mF in parallel), 0~±5%
Bypass switch	3.6kVac/1.6kA, main contact closing time <3ms, auxiliary contact response time <10ms
Draw-out power supply	Operating voltage 350Vdc-4500Vdc; output 400V, 15V;
Discharge IGBT	4500V/1000A
Discharge Resistor	2Ω/400kJ



Full-Bridge IGBT Power Module Topology



Half-Bridge IGBT Power Module Topology

Key components of the power module include IGBT, diode, DC capacitor, bypass switch, draw-out power supply, power board, discharge IGBT, and discharge resistor.



# Next-generation Domestically Produced Onshore Flexible DC Converter Valve



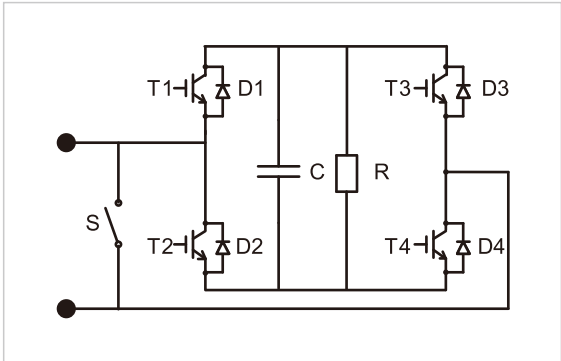
To address the "bottleneck" issue of domestic production for critical components of flexible DC transmission converter valves, TBEA Xi'an Electric Technology has successfully developed the "Fully Domestically Produced 4.5kV/2kA IGBT Flexible DC Converter Valve Assembly". The converter valve power circuit is entirely designed with domestically produced components, solving reliability issues for domestic devices in engineering applications. The product has passed the new product technology appraisal organized by the China Machinery Industry Federation, with performance on par with imported converter valves. This achievement ensures that key components of flexible DC converter valves are autonomously controllable. It is now operating at the  $\pm 800\text{kV}$  Liuzhou converter station in the Wudongde project.

## Technical parameters

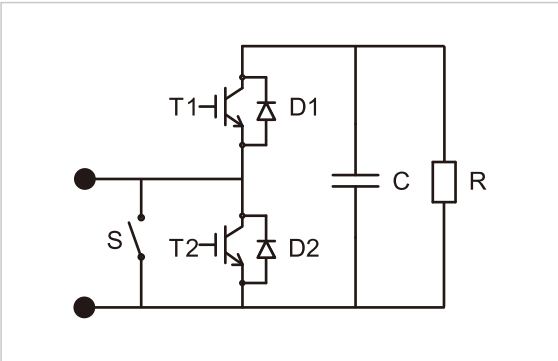
Name	Value
Rated voltage	2203V
Overvoltage operation	3200V
Rated current	1237Arms
Maximum operating current	1.05p.u (1299A) long-term operation 1.2p.u (1484A) Operation for 10s
Current withstand capability	alve component overcurrent cut-off capability: 3200V/4000A Power module single pulse overcurrent cut-off capability: 3600V/4000A
Switching frequency	<100Hz
IGBT Specification	4500V/2000A
DC capacitor	2800V/12mF (2 pieces of 6mF in parallel), 0~ $\pm 5\%$
Bypass switch	3.6kVac/1.6kA, main contact closing time <3ms, auxiliary contact response time <10ms
Draw-out power supply	Operating voltage 350Vdc-4500Vdc; output 400V, 15V;

The power module is subject to version 2.0 of CRRC' s compression-type IGBT devices. The power module features long-term short-circuit current capability, redundant draw-out power supply design, paired module interactive redundancy communication, highly reliable multi-level redundant bypass design, bypass link redundancy design, and high electromagnetic interference resistance design.

CRRC' s version 2.0 compression-type IGBT devices are equipped with the short-circuit failure current capability, eliminating the need for additional overvoltage bypass thyristor devices.



Full-Bridge IGBT Power Module Topology

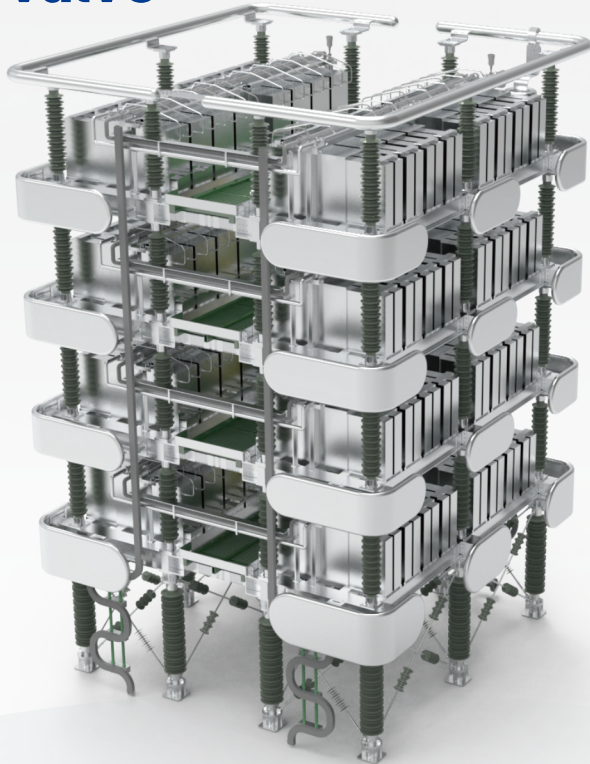


Half-Bridge IGBT Power Module Topology

Key components of the power module include IGBT, diode, DC capacitor, bypass switch, energy recovery power supply, and power board.

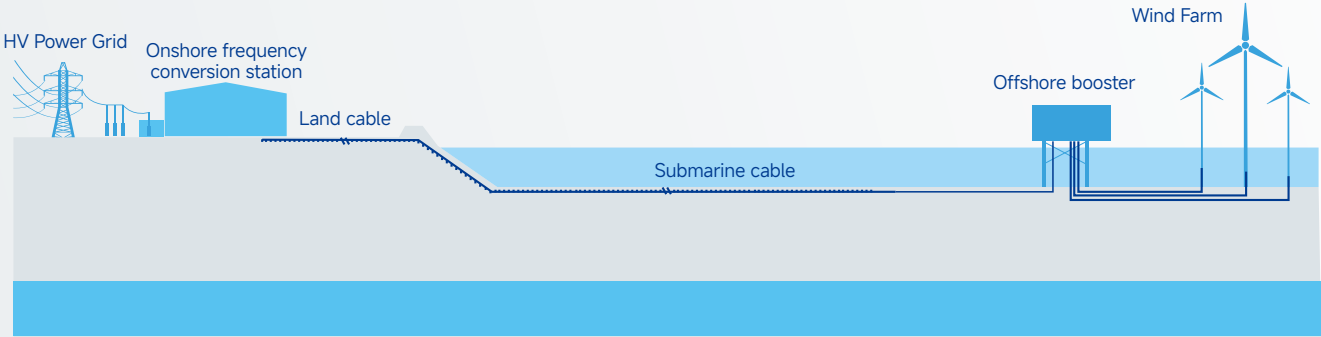


# Flexible low-frequency ACtransmission converter valve



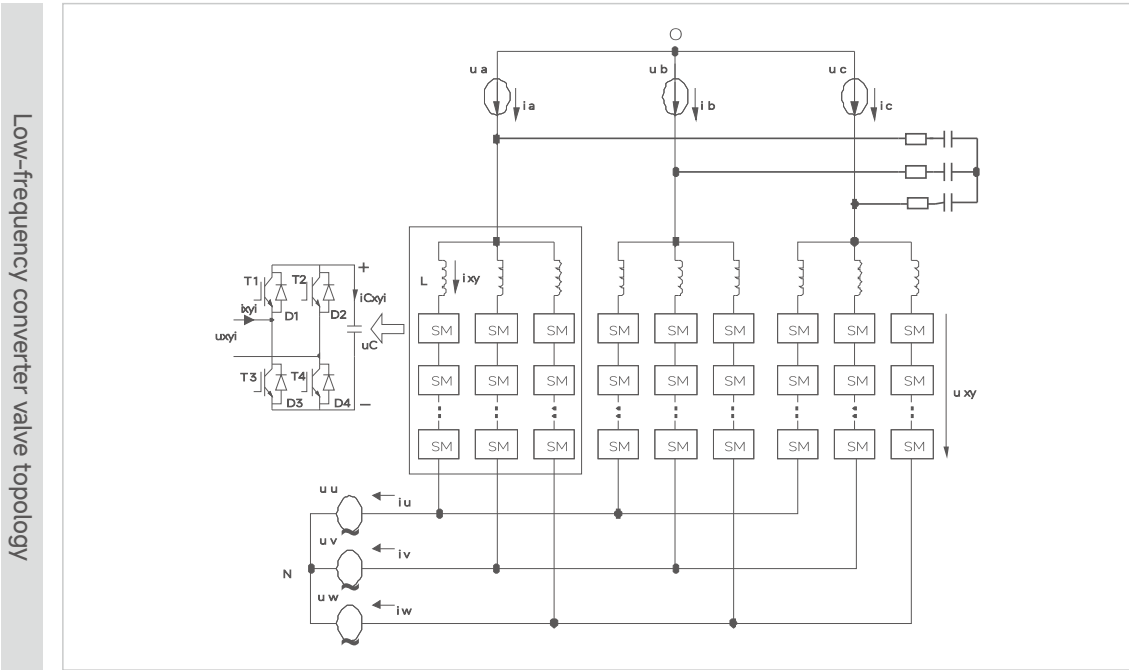
Compared with power frequency transmission systems, flexible low-frequency transmission helps increase line transmission capacity, reduce voltage loss and fluctuation, decrease cable charging reactive power, and provide flexible power support to the grid. It has significant economic advantages in scenarios such as mid-to-long distance offshore wind power transmission, multi-island interconnection, urban grid partition interconnection, and large-scale wind and photovoltaic power base transmission in areas like “deserts, gobi, and wilderness” . The flexible low-frequency transmission technology will lay an important foundation for the development and utilization of new energy in China, the safe, economical, and stable operation of the power system, and the construction of a new type of power system. It has broad social, economic, and ecological benefits.

Compared with traditional DC transmission systems, it does not require DC circuit breakers, offers easy voltage transformation, and provides convenient networking capabilities, with significant economic advantages in the 70km to 200km range. It also eliminates the need for offshore converter stations, simplifies operation and maintenance, reduces construction and maintenance costs, and delivers high reliability without bottlenecks in primary equipment.



## Technical parameters

Name	Parameter	Parameter value
M3C inverter	Rated capacity/MVA	304
	Submodule capacitor voltage/kV	2.1
	Submodule capacitor value/mF	14
	Number of submodules per bridge arm	64
Low-frequency input	Frequency/Hz	20
	Line voltage RMS/kV	64
Power frequency output	Input AC system frequency/Hz	50
	Line voltage RMS/kV	64
Product power	Rated voltage	2150V
	Rated current rms	1800A
	Maximum operating current	Long-term operation at 1.05 p.u., 10 seconds at 1.2 p.u.
	Current withstand capability	Valve component overcurrent cut-off capability: 3200V/4000A Power module single pulse overcurrent cut-off capability: 3400V/4000A
	Capacitor voltage sampling range and accuracy	Sampling range: 400V ~ 4500V; Sampling accuracy: 0.5% @ (400V ~ 4500V)
	Draw-out power supply	Operating voltage 350Vdc-4500Vdc; output 400V, 15V;
	Power supply power-off retention time	After the power input is disconnected, the single board maintains power for 20ms without dropping.
	Bypass switch	3.6kVac/2.5kA, main contact closing time < 3ms Auxiliary contact response time < 10ms



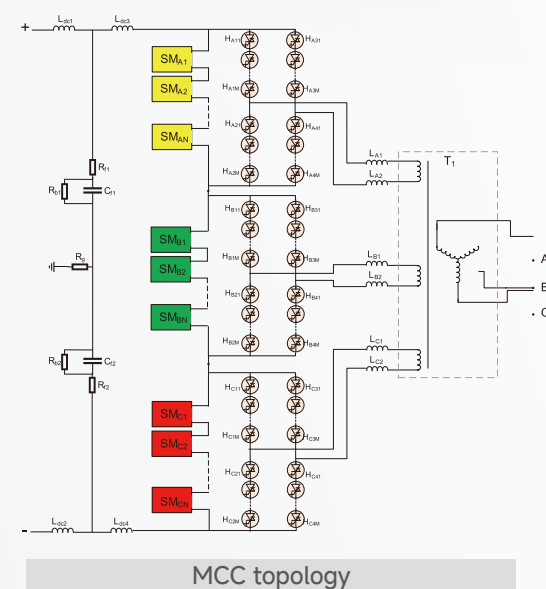


# Modular Commutated Converter (MCC)



## Advantages compared to traditional MMC converters:

- Module capacitor usage is reduced by 80%;
- Number of semiconductor devices is reduced by 25%;
- The H-bridge part of the device, due to its zero-voltage switching characteristics, reduces overall machine loss by 50%;
- Overall solution cost is reduced by over 30%.



This product can be applied in scenarios such as medium-voltage photovoltaic DC grid connection and long-distance offshore wind power transmission, significantly enhancing conversion efficiency and increasing new energy power generation.

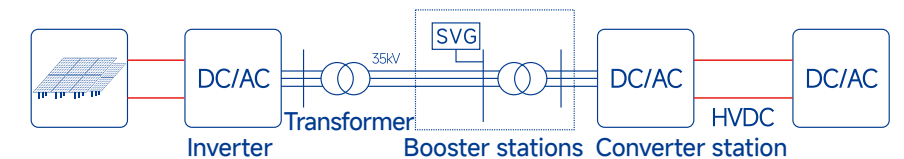
## Technical parameters

Name	±50kV/200MW MCC parameters
Active power	200MW
Reactive Power	50MVar, configured at 25% active power
Apparent power	206MVA
DC voltage	±50kV
Direct current	2000A
Rated AC voltage on grid side (phase, rms)	66kV phase, 115kV line voltage
Rated AC current on grid side	1034A
Maximum AC current on grid side (phase, rms)	1138A, 1.1 p.u long-term operation
Rated AC voltage on valve side (Phase, rms)	33kV
AC current on valve side (phase, rms)	2082A
Maximum AC current on valve side	2290A, 1.1 p.u long-term operation

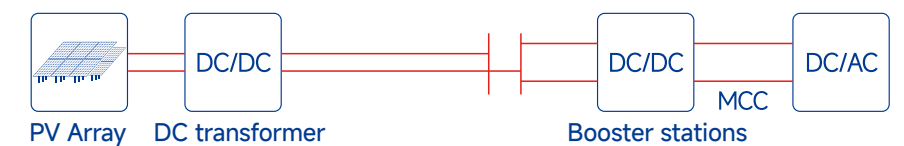
## Solution

## Topology diagram and pros and cons

AC collection DC transmission scheme



DC collection DC transmission scheme

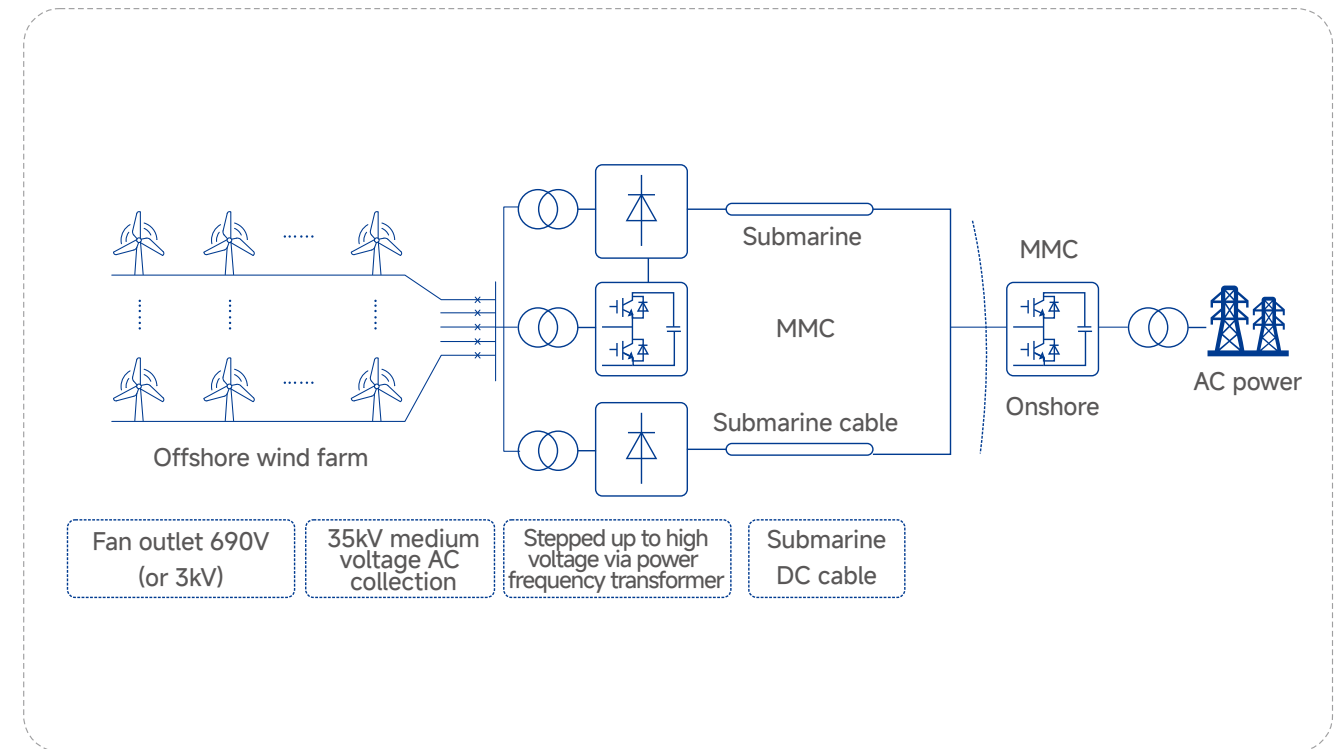




## Flexible diode hybrid unidirectional valve Key technology



To address the issues of the large number, size, and weight of full-power modular multilevel converter (MMC) submodules in offshore applications, which result in high investment costs and construction difficulties for the converter station and its associated platforms, TBEA Xi'an Electric Technology has innovatively proposed a hybrid transmission scheme that combines offshore low-capacity MMC with high-capacity diode valves in series. By employing full-power range capacity optimization design technology for hybrid valves, active and passive flexible reactive dynamic compensation technology, and rapid smooth black start technology for hybrid valves, TBEA Xi'an Electric Technology significantly reduces the size, weight, and cost of converter valves, offering a cost-effective, highly reliable, and efficient new solution for offshore wind power transmission.



**50%** ↓

Reduction in converter valve cost



**45%** ↓

Reduction in weight



**45%** ↓

Reduction in volume



## R&D and testing capability



### R&D team

After years of development and accumulation, TBEA Xi'an Electric Technology flexible transmission industry is equipped with a well-configured, professionally advanced, experienced, and highly creative team of talents, covering many fields such as power electronics, power systems, mechanical design, high voltage and insulation, thermal magnetic and fluid simulation, computer science, and automation. The team consists of over 150 professional R&D personnel, with doctors as innovation leaders and senior power electronics product development engineers as technical backbones. Among them, there are 47 PhD/Master's degree holders, 21 personnel with senior/associate senior titles, and a total of 195 patents obtained.



Power electronics



Power systems



Mechanical design



High voltage and insulation



Thermal magnetic and fluid simulation



Computer



Automation

**47** people

PhD/Master's degree holders

**21** people

Senior/associate senior titles

**195** items

Total number of patents obtained

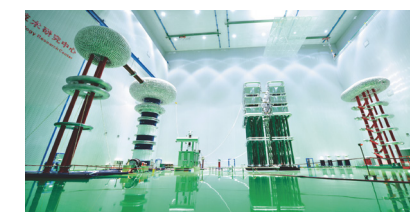
The Company has a CNAS-accredited advanced energy internet and power electronics laboratory in China. The laboratory is composed of more than ten development platforms, including the HVDC back-to-back system platform, the overhead flexible DC system platform, the RTDS real-time digital simulation laboratory, the flexible DC transmission converter valve component operation and short-circuit test platform, the converter valve power unit test platform, the AC/DC joint test platform, the energy router test platform, the SVG full-performance test platform, the photovoltaic grid-connected inverter comprehensive test platform, the environmental reliability test platform, the EMC test platform, and the TBEA Xi'an Electric Technology smart eCloud platform. It is equipped with the technical development and full-performance testing capabilities for products such as VSC-HVDC converter valve sets, energy routers, high-voltage SVGs, and photovoltaic inverters, and is the largest high-power power electronics product development laboratory in the Northwest China region.



RTDS Real-Time Digital Simulation System



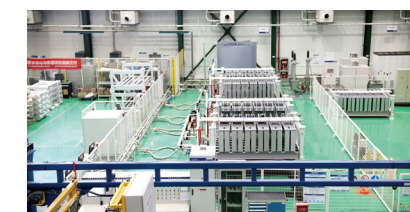
Valve Component Short-Circuit Test Platform



±1100kV UHV AC and UHVDC Insulation Test Hall



IGBT Dynamic Testing Platform



Valve Section Aging Platform

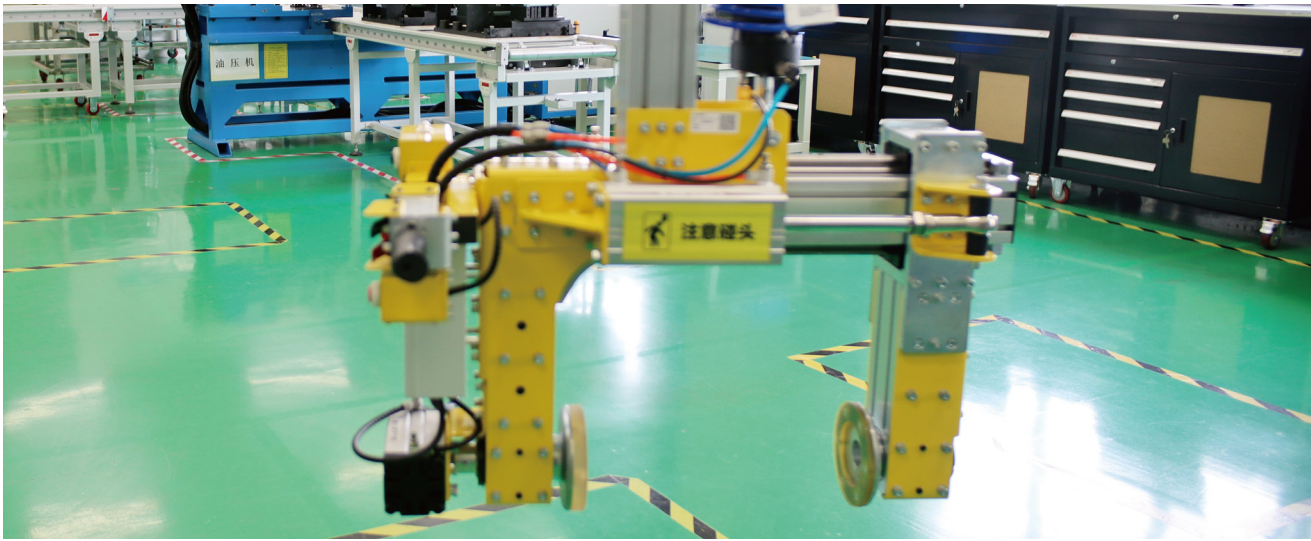


Flexible DC Converter Valve Control Test Platform



# Production and Delivery Capability

The company has a secure and reliable workshop information network infrastructure. It has established industrial software systems such as ERP, MOM, ELM, WMS, and SCM, enabling a shift from "manual operations" to a "digital, networked, and flexible" manufacturing model. Networking capabilities are implemented across all production stages, allowing for the real-time collection of data from intelligent equipment and timely uploading of production data. The company also operates a 4,000 m<sup>2</sup> clean production facility, specifically designed for high standards, with a 100,000-level IGBT compression room. The cleanliness of the workshop is maintained within the range of 100,000 to 1,000,000 class, with temperature control between 5°C and 35°C. In addition, the company is equipped with flexible automated compression tooling, as well as dedicated automated assembly lines for single boards and power modules, intelligent lifting equipment, ATLAS intelligent tightening wrenches, and other smart devices. The company also possesses internationally advanced flexible DC converter valve sub-modules and semi-automated production lines for valve sections. The annual production capacity exceeds 12,000 flexible DC sub-modules and 2,000 valve sections, capable of meeting the delivery requirements for four ultra-high voltage monopolar converter valves.



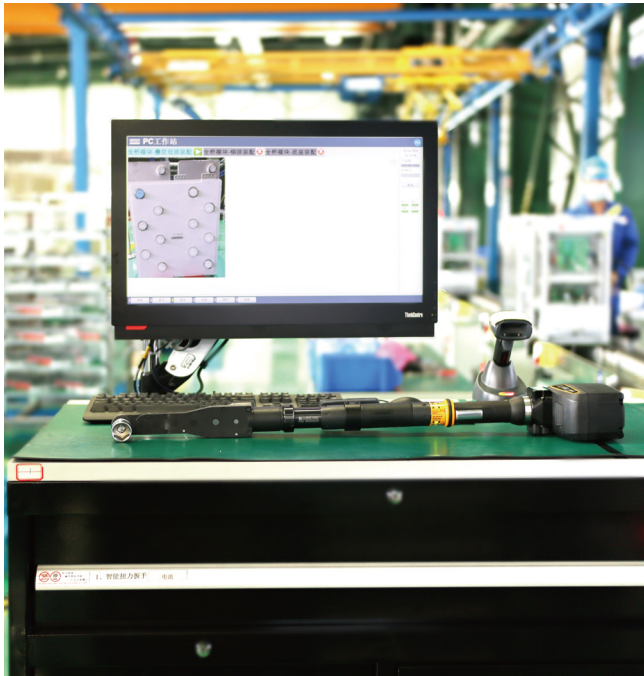
IGBT intelligent assembly line



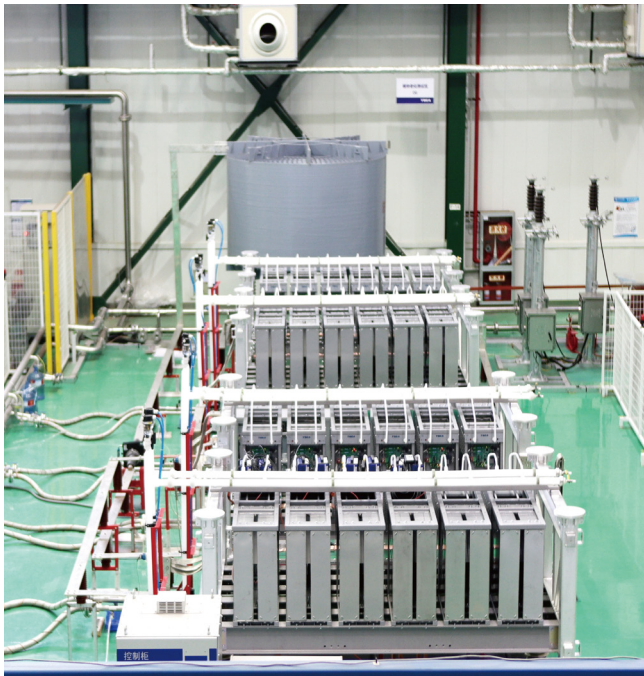
Module production line



Valve unit assembly line



Intelligent torque wrench integrated with the MOM system



Valve component aging platform



Partial discharge withstand voltage testing platform

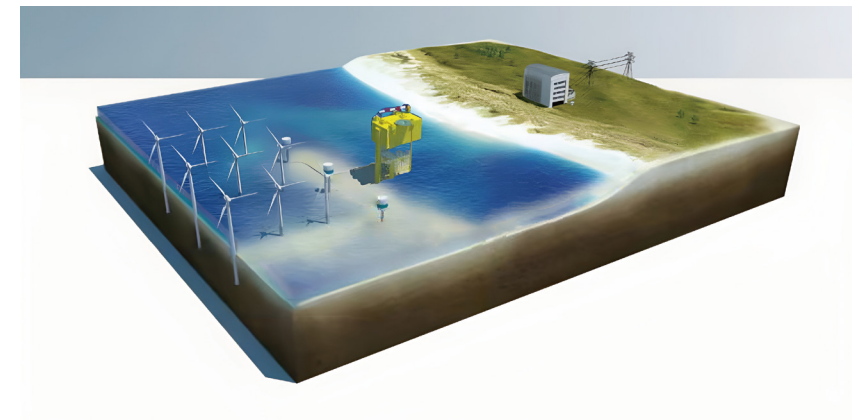


## Engineering performance



### Product delivered to Wudongde Hydropower Station

On December 25, 2020, products were delivered to the Wudongde Power Station for the UHV Multi-Terminal DC Demonstration Project of Power Transmission to Guangdong and Guangxi.



### Key R&D Program

“Flexible Low-Frequency Transmission Key Technology” demonstration project—Yuhuan No.2 Offshore Wind Power Project.

### Product delivered to China Electric Power Research

In August 2022, products were delivered for the demonstration application at the Zhangbei New Energy Base of China Electric Power Research Institute.



### Energy Storage in Qinghai Province

“Top-Runner” Liquid Compressed Air Energy Storage Demonstration Project



## Main Clients



地方电网





# Honors and Awards



2022 China Industrial Award Commendation Award



2022 First Prize of the China Machinery Industry Science and Technology Award



2022 Second Prize of the China Machinery Industry Science and Technology Award



2023 First Prize of the China Electrotechnical Society Science and Technology Department



2022 First Prize of the Electric Power Construction Science and Technology Progress Award



2021 First Prize of the China Electric Power Science and Technology Progress Award



2021 China Good Design Silver Award



2022 First Prize of the China Machinery Industry Science and Technology Award



2022 First Prize of the Engineering Construction Science and Technology Progress Award



2022 Guangdong Science and Technology Progress First Prize



# Contributing TBEA Xi'an Electric Technology strength to the innovative development of China's UHV industry.

Providing comprehensive flexible DC solutions according to customer needs and grid characteristics, combined with specific application scenarios. Relying on the comprehensive industrial chain advantages of TBEA Xi'an Electric Technology to provide complete equipment support, enabling customers to experience timely, high-quality, and efficient "one-stop" and "turnkey" services.

## Consultation Services

Telephone Q&A, email information, fax notifications, on-site presentations, and program communication

No matter where the user is, he/she can always call our hotline at 400-669-8866 to learn about our products and services. We have professional engineers available 24 hours a day to listen to users' questions and patiently provide answers.

## Training Services

On-site lectures, company lectures, production line observations, brand displays, and case introductions

No matter what product knowledge users want to understand, we will formulate professional training programs to help you learn about our products.

## On-site Services

Installation guidance, wiring guidance, grid connection debugging, operation and maintenance, and trouble-shooting

No matter what product issues users encounter, TBEA Xi'an Electric Technology after-sales service engineers are on standby 24 hours a day. Upon receiving your feedback, we will respond quickly within 2 hours and arrive at the project site within 24 hours to resolve your issues. Reliable service means that regardless of the time, day or night, or the bad weather, we will always meet users' needs and protect their interests.

