



**Shanghai Electric Power Generation  
Environment Protection Engineering Co., Ltd.  
Corporate Brochure**

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DEDICATED TO RECOVERING CLEAR WATER  
AND BLUE SKY FOR A BETTER FUTURE

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# I. COMPANY OVERVIEW



## COMPANY PROFILE

Shanghai Electric Power Generation Environment Protection Engineering Co., Ltd, as the subsidiary of Shanghai Electric Group Co., Ltd, is among the earliest high-tech enterprise in Shanghai that set up general contracting businesses of desulphurization, denitration and dust removal system engineering as well as sewage treatment, garbage incineration, resource utilization of biomass, solid waste treatment, resources recycling, ecological restoration, energy and chemical industry, comprehensive utilization of energy etc.

At the beginning of the company establishment, it has signed a complete set of technology transfer contracts with Ishikawajima-Harima Heavy Industries (IHI) and owns in series the desulphurization technologies, SCR denitration technologies (independently developed SNCR and low NOx combustion technologies), low-temperature electric precipitation technologies and white smoke-plume controlling technologies. The company has continuously maintained joint research offices and technical alliances together with many famous scientific research institutions and famous universities; it has also accumulated experience through independent R&D and engineering design; the company also owns the technologies of sewage treatment, solid waste treatment, biomass recycling, ecological restoration, improving quality of energy, as well as energy and chemical engineering. The company is an engineering company engaged into R&D, design, engineering and service.



## II. COMPANY DEVELOPMENT HISTORY

2018

Clean energy production and ecological restoration

Gansu Jiuquan Hazardous Waste Disposal Co., Ltd.  
(The first hazardous waste disposal project of the Company)

Environmental Protection Project of Rizhao Steel Co., Ltd.

Caprolactam Expansion Project and Auxiliaries of Risun Chemical Co., Ltd.

2017

Wastewater and sludge disposal



1x1350MW Unit of Pingshan Phase II Project  
(The largest desulphurization and denitration unit in China)

2013

Share right change of the company

Shanghai Electric Power Generation Environment Protection Engineering Co., Ltd.



2x1000MW Unit of Zhejiang Zheneng Electric Power Co., Ltd.  
(China's first retrofit project of low-low temperature electrostatic precipitation)

2014

Self-developed wet electric precipitation technology



Yangxi 2x1240MW Unit  
(The largest environmental protection island in China)

2012

Acquiring the technology transfer of low-low temperature electrostatic precipitation technology

2005

Name change of the Company

Shanghai Ishikawajima-Harima Power Station Environmental Protection Engineering Co., Ltd.



Vietnam Quang Ninh 2x300MW Unit  
(undertaking its first overseas desulphurization project)

2004

Acquiring the technology transfer of denitration



Fujian Songyu 2x300MW Unit  
(the first homemade denitration equipment)

2000

Foundation of the Company

Shanghai Electric Ishikawajima-Harima desulfurization Engineering Co., Ltd.  
(Technology transfer of desulphurization technology from IHI of Japan)



## III. BUSINESS MODE

# E-P-C-S-F

Engineering design,  
Complete equipment,  
General contracting of engineering,  
O&M and financing,  
Solution provider for the whole system

# E

Engineering consultation  
Equipment design  
Project engineering

# P

Equipment procurement  
Equipment surveillance  
Complete set of equipment

# C

General contracting of project  
Construction management of project  
General contracting of environmental protection island

# S

Commissioning and operation of system  
Training and after-sales service  
Energy management  
Financing service  
Operation and maintenance of project

# F

Solution provider for the whole system

## IV. QUALIFICATION AND HONORS



**Registered capital:** RMB 102.63 million RMB

**Founded in:** 2000

**Company orientation:** industrial environmental protection and cyclic economy

**Fields:** electricity, metallurgy, building materials, petrochemical engineering, mine, non-ferrous metal and marine equipment etc.

**Business:** flue gas desulphurization, denitration, dust removal, zero liquid discharge, smoke plume elimination, VOCs control, environmental protection island, reclamation and recycling of solid waste and hazardous waste, energy and chemical engineering, clean energy production and comprehensive utilization of energy

**Core competencies:** research and development technology, overall design, process package, core equipment, management and control of project, operation and maintenance, etc.

**Company qualification:**

Special Class-A environmental engineering (air pollution control engineering)

Special contracting Class-I environmental engineering

Special contracting Class-II water-proof, anticorrosion and insulation engineering

General contracting Class-III municipal public engineering

Special contracting Class-III construction electromechanical installation

Special contracting Class-III steel structure engineering

Top 100 Environmental Protection High-Tech Enterprises in China

Award of Excellent Enterprise of Competition Zone of Meritorious Race

Equipment of Important Engineering of Shanghai Municipality during 2001-2003 and 2009-2013

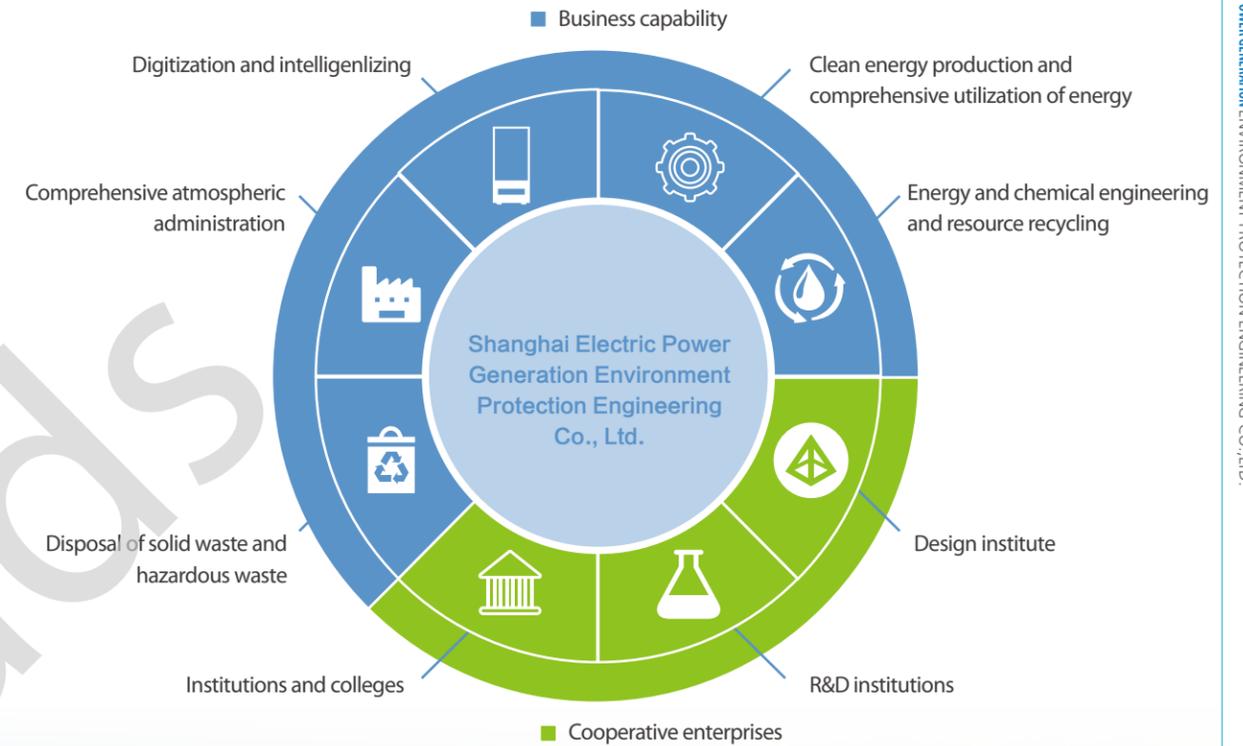
ISO9001 Quality Management System Certification

ISO14001 Environmental Management System Certification

OHSAS18001 Occupational Health and Safety Management System

Certification

## V. TECHNICAL CAPACITY



**Personnel structure of the company**

At present, the company has more than 100 people in core technology team, which includes more than 30 people with senior title or master's degree, and has strong engineering design and technology R&D capacity. Besides, the company has more than 150 people in engineering management team, project manager and professional registered engineers. Dozens of projects are carried out annually in recent years, which brings rich engineering experience, impeccable management and strong engineering capability for the company (as of the end of 2018)

**List of qualified personnel**

The company has more than 50 registered staff, in which there are 8 Registered HVAC Engineers, 3 Registered Water Supply and Drainage Engineers, 5 Registered Structural Engineers, 5 Registered Electrical Engineers (power supply and distribution), 6 Registered Cost Engineers, 18 Class-I Registered Architects, 3 Class-II Registered Architects and 3 Registered Safety Engineers. Moreover, the company has 5 Professor-level Senior Engineers, 27 Senior Engineers and 72 people with intermediate title. (As of the end of 2018)



## Scientific research

The company constantly enlarges R&D teams and attaches importance to talent cultivation at the same time. Experts and scholars in this industry will be regularly invited for professional training for R&D personnel and R&D personnel will be arranged for field study in relevant industry to constantly enrich professional knowledge and innovation ability of R&D teams.

The company attaches great importance to R&D of new products, constantly increase R&D input into new products and thus makes great achievements. In R&D of new products, the company will enhance communication and cooperation with domestic scientific research institutes according to technology development and market demands. Moreover, scientific achievements will be gradually transformed into productivity by means of technology introduction and cooperative R&D to create value for the society and the Company.



Research Center Jointly Established with Shanghai University of Electric Power



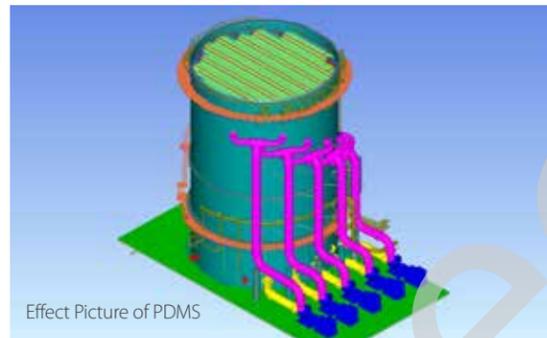
Joint R&D Center of Environmental Engineering with Zhejiang University



Joint R&D Environmental Engineering with Shanghai Jiaotong University



3MW Experimental Platform



Effect Picture of PDMS



Sampling and Assay Laboratory



Experiment Platform of Flow Field Simulation

## Patents and awards

(Statistics as of October 2018)

76 proprietary patents including 37 inventions and 39 utility models; 22 joint patents including 7 inventions and 15 utility models.

The company has won 5 awards in Shanghai, 4 provincial and ministerial awards, 9 awards of Shanghai Electric Group Co., Ltd. and 15 awards of Shanghai Electric Power Generation Group.



### Projects of Shanghai Municipal Commission of Economy and Informatization (excerpt)

Project name	Project nature	Start time	End time	Cooperation with academic institutions	Project name
Desulphurization Project of 2x1000MW Unit in Phase II of Xinmi Power Plant	Special Fund for Guidance in Total Integration and General Contracting Project in 2011 (2nd Batch)	2011	2013	Independent research and development	Shanghai Municipal Commission of Economy and Informatization (Service Center)
Flue Gas Desulphurization and EPC Project of 2x660MW Expansion Project in Phase II of Dabieshan Power Plant	Special Fund for Development of Production Service Industry in 2017 (Total Integration and General Contracting)	2017	2019	Independent research and development	Shanghai Municipal Commission of Economy and Informatization (Service Center)
System integration and optimization for Flue Gas Desulphurization Project of Millions of Unit	2007 Absorption and Innovation Plan of Introduced Technology in Shanghai	20070530	20081230	Shanghai University of Electric Power	Shanghai Municipal Commission of Economy and Informatization
Flow State Simulation, Cold Mold Verification and Optimal Control Demonstration Project of Coal-fired and Thermal Power Flue Gas Denitration Equipment	2007 Absorption and Innovation Plan of Introduced Technology in Shanghai	20070930	20081230	Shanghai Jiaotong University	Shanghai Municipal Commission of Economy and Informatization
Research and Development Platform for Key Technologies of Desulphurization for Environmental Protection Equipment in Power Plant	2008 Absorption and Innovation Plan of Introduced Technology in Shanghai	20081230	20100630	Shanghai University of Electric Power	Shanghai Municipal Commission of Economy and Informatization
Research and Development of Environmental Protection Island and Devices Based on Low-temperature Dust Removal System	2012 Absorption and Innovation Plan of Introduced Technology in Shanghai	20120901	20140930	Shanghai Jiaotong University and Shanghai University of Electric Power	Shanghai Municipal Commission of Economy and Informatization
Research, Development and Application of Key Technologies of Efficient and Wet-type Electrostatic Dust Collector for Boiler in Coal-fired Power Plant	Special Fund for Enterprises' Independent Innovation in Shanghai-Theme of Industry-College-Institute Cooperation	20130930	20150930	Shanghai University of Electric Power	Shanghai Municipal Commission of Economy and Informatization
Research, Development and Industrialization of Large Thermal Power Equipment for Reduction of PM2.5 Emission	2014 Special Project of Research and Development of Key Technical Equipment in Shanghai	20140910	20161230	Independent research and development	Shanghai Municipal Commission of Economy and Informatization
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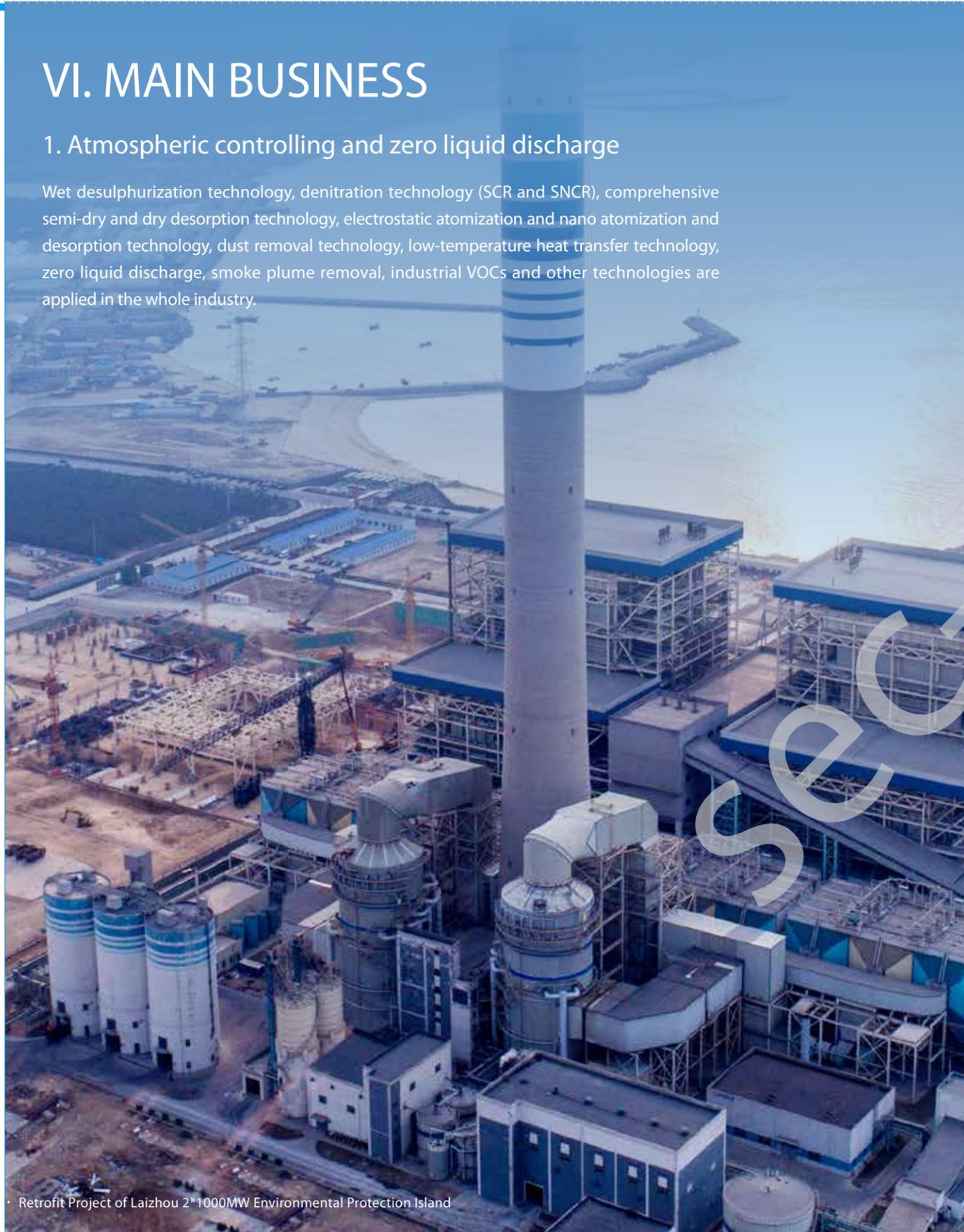
### Projects of Science and Technology Commission, Shanghai Municipality (excerpts)

Project name	Project nature	Start time	End time	Cooperation with academic institutions	Project name
Research and Application of Wet-process Flue Gas Desulphurization and Denitration Technology Based on WFGD System	2010 Energy Conservation and Emission Reduction Subject of Science and Technology Commission, Shanghai Municipality	20100701	20120630	Shanghai University of Electric Power and Shanghai University	Science and Technology Commission, Shanghai Municipality
Shanghai Engineering Research Center of Power Generation and Environmental Protection	2011 Project of Newly-built Shanghai Engineering Research Center	20110101	20131230	Shanghai University of Electric Power	Science and Technology Commission, Shanghai Municipality
Integration Technology Development and Demonstration of Boiler of Coal-fired Power Plant and Environmental Protection Island Based on Denitration, Efficient Electric Precipitation and Desulphurization	2014 Project of Scientific Research Plan	20140701	20160630	Shanghai University of Electric Power	Science and Technology Commission, Shanghai Municipality
Research on PM2.5 Emission Laws of Large Thermal Power Environmental Protection Equipment of Flue Gas	2014 Project of Scientific Research Plan	20150101	20160630	Independent research and development	Science and Technology Commission, Shanghai Municipality
Research on Zero Liquid Discharge Technology of Desulphurization Waste Water in Coal-fired Power Plant	2014 Project of Scientific Research Plan	20180701	20210630	Independent research and development	Science and Technology Commission, Shanghai Municipality
.....	.....	.....	.....	.....	.....

# VI. MAIN BUSINESS

## 1. Atmospheric controlling and zero liquid discharge

Wet desulphurization technology, denitration technology (SCR and SNCR), comprehensive semi-dry and dry desorption technology, electrostatic atomization and nano atomization and desorption technology, dust removal technology, low-temperature heat transfer technology, zero liquid discharge, smoke plume removal, industrial VOCs and other technologies are applied in the whole industry.



· Retrofit Project of Laizhou 2\*1000MW Environmental Protection Island

### Product portfolio in the field of atmospheric controlling

Main business	Process type	Thermal power	Metallurgy	Chemical industry	Building materials	Waste incineration power generation
Desulfurization	Limestone/gypsum technology	●	●	●	●	●
	Ammonia technology	○	●	●	○	○
	Magnesium technology	○	○	●	○	○
	Seawater technology	○	□	□	□	□
	Sodium technology	○	○	●	○	○
	Circulating fluidized bed semi-dry technology	□	●	●	●	○
	Rotary spray semi-dry technology	□	○	○	●	●
	Active coke adsorption	○	●	○	○	●
	Dry technology	□	○	●	○	○
Denitrification	Low-nitrogen combustion	●	●	●	●	●
	Selective non-catalytic reduction	●	○	●	●	●
	Active coke catalytic reduction	○	○	○	○	○
	Ozone oxidation	○	□	●	○	○
	High-temperature selective catalytic reduction	●	●	●	●	●
	Medium-temperature selective catalytic reduction	○	●	○	○	●
Dust precipitation	Low-temperature selective catalytic reduction	○	●	○	○	○
	Bag precipitation	●	●	●	●	●
	Low-low temperature electric precipitation	●	○	●	○	□
	Electric bag precipitation	●	○	●	○	○
	Wet electric precipitation	●	●	●	●	○
Smoke plume elimination	High-temperature electric precipitation	□	○	□	●	□
	Direct heating type	●	●	●	●	●
	Condensation heating type	●	●	●	●	●
Zero liquid discharge	Rapid condensation type	○	○	○	○	○
	Membrane concentration + crystallization (optional)	●	●	●	□	●
	Thermal concentration + crystallization (optional)	●	●	●	□	○
VOCs	Flue evaporation crystallization	●	○	○	□	○
		*				

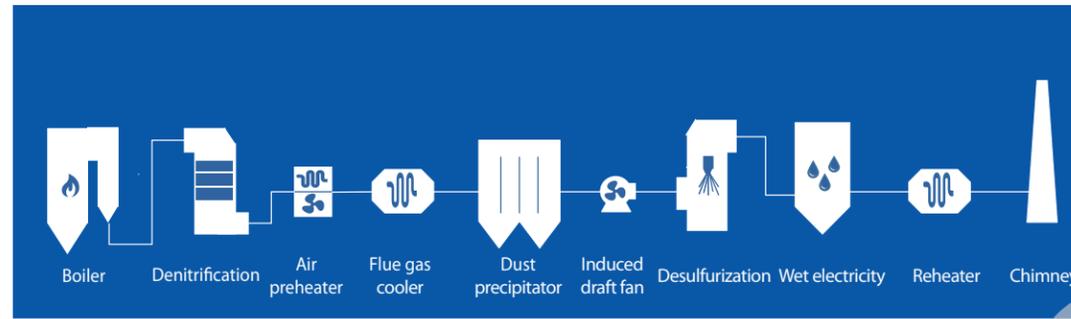
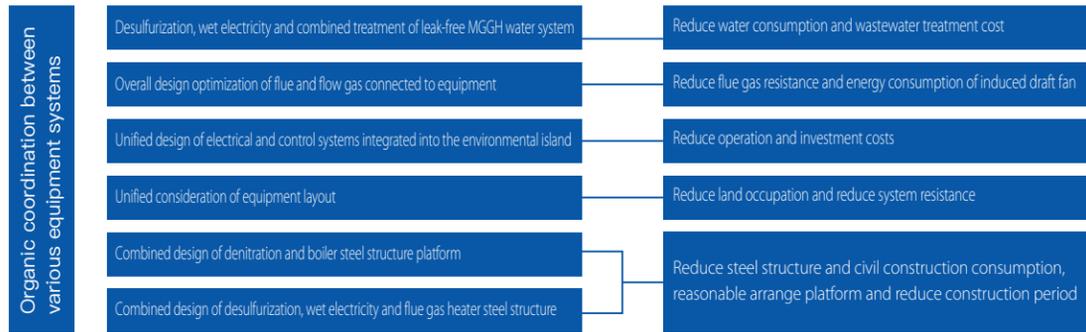
Note: "●" recommended, "○" applicable, and "□" carefully use.

#### \* Schedule volatile organic compounds (VOCs) treatment

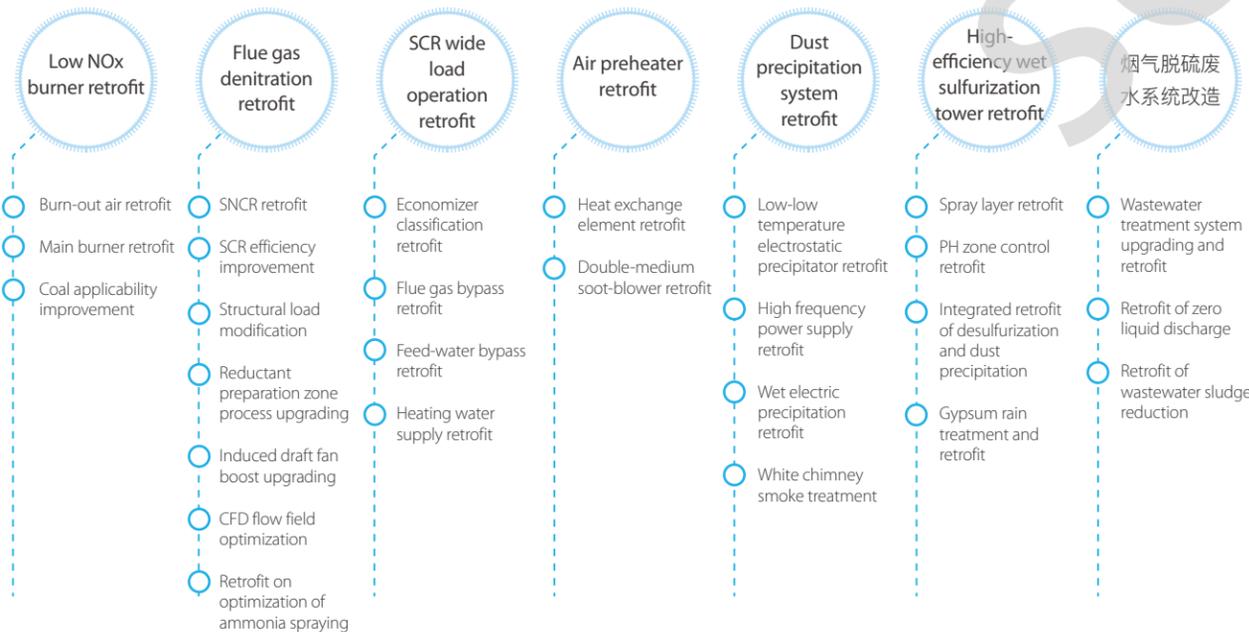
Main business	Process type	Applicable industry type
VOCs	Adsorption concentration method	Printing, painting, papermaking, semiconductor, lithium battery, etc.
	Catalytic photolysis method	Tobacco, chemical, rubber, oil refining, electroplating, pharmaceutical, printing and dyeing, coking, metallurgy, food, etc.
	Low temperature plasma method	Chemical, fertilizer, rubber, oil refining, electroplating, pharmaceutical, printing and dyeing, coking, metallurgy, food, etc.
	Regenerative (catalytic) combustion method	Painting, costing, printing and dyeing, chemical, petrochemical, etc.
	Efficient washing method	Electroplating, pharmaceuticals, etc.
	Biological method	Solid waste treatment, leachate treatment, sewage treatment, etc.

## (1) Flue gas environmental protection island

The environmental protection island is the environmental protection equipment complex used to achieve the harmless comprehensive treatment of flue gas discharged from the boiler after leaving from the boiler body through a series of pollution control process so that the flue gas pollutant emission indexes exceeds the super-clean standards to overall, systematic, integrated and intensive treatment of various pollutants in the boiler island.



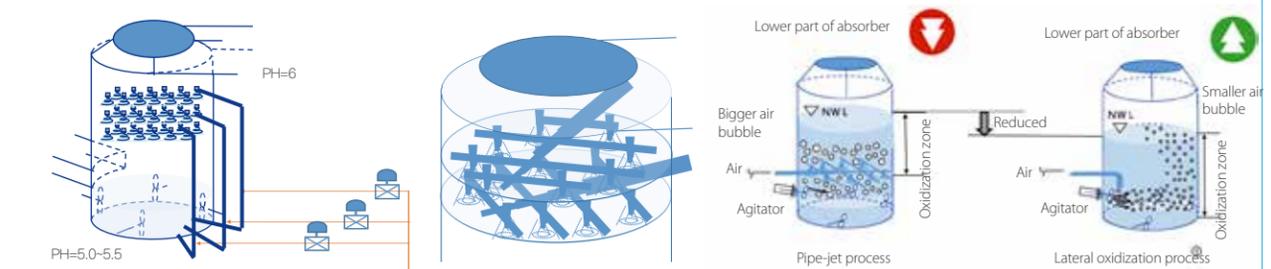
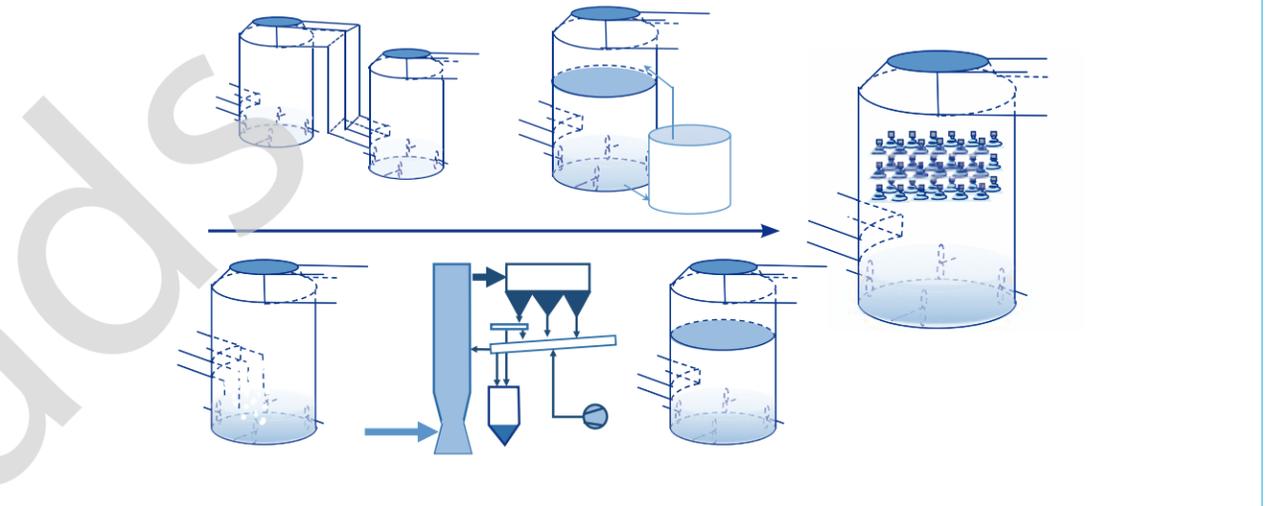
### Schematic diagram of environmental protection island retrofit menu



## (2) Flue gas desulfurization system

### Wet method

Install the grading ring at the inlet of absorption tower to make the smoke flow field more uniform, adopt the spray layer control technology and the high-performance low-power consumption spiral nozzle with three cutting directions, 100-degree coverage, and particle diameter less than 1000 $\mu$ m to strengthen the gas-liquid mass transfer, and finally achieve more than 99.5% desulfurization efficiency and more than 75% synergistic dust removal efficiency after repeated defogging.



### Process characteristics-1 PH level control

1. Higher pH value, which is conducive to SO<sub>2</sub> absorption
2. Lower pH value, which is conducive to gypsum growth
3. This process is our patented technology (National Patent No.: ZL201520108899.9)

### Process characteristics-2 High-efficiency spiral nozzle and angle optimization

1. Nozzle type: optimized spiral nozzle with low pressure loss.
2. The slurry particle size is optimized to reduce the atomized particle size to below 1000 $\mu$ m.
3. The angle between the spray layers is optimized to reduce the dead angle and evenly spray.

### Process characteristics-3 Lateral atomization

1. Smaller oxidation fan pressure head
  2. Better gypsum quality
  3. No blocking, no maintenance
- Note 1: This figure only shows the oxidation effect that can be achieved by a single mixer. Each mixer can form the bubble trajectory as shown in the figure to achieve full oxidation

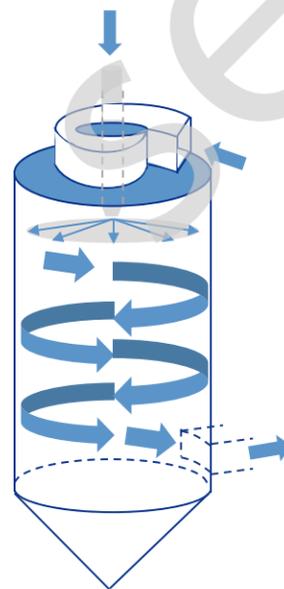


### Characteristics of semi-dry technology

1. The desulfurization efficiency is high, up to 95%, and the desulfurization efficiency can be adjusted to a high degree;
2. It adopts the empty tower structure, the resistance of absorption tower does not exceed 800Pa, saving the operation costs;
3. Flexible adjustment, more adaptable to load changes;
4. The dust concentration at the inlet of dust precipitator is low, which can reduce the dust precipitator load and operating resistance and increase the dust precipitator service life;
5. With the mechanism of wet desulfurization and the characteristics of dry technology, the system does not require anti-corrosion treatment;
6. The desulfurization by-product is dry ash, which can be easily ;
7. No wastewater discharge and small system operation and maintenance work amount.

### Characteristics of dry technology

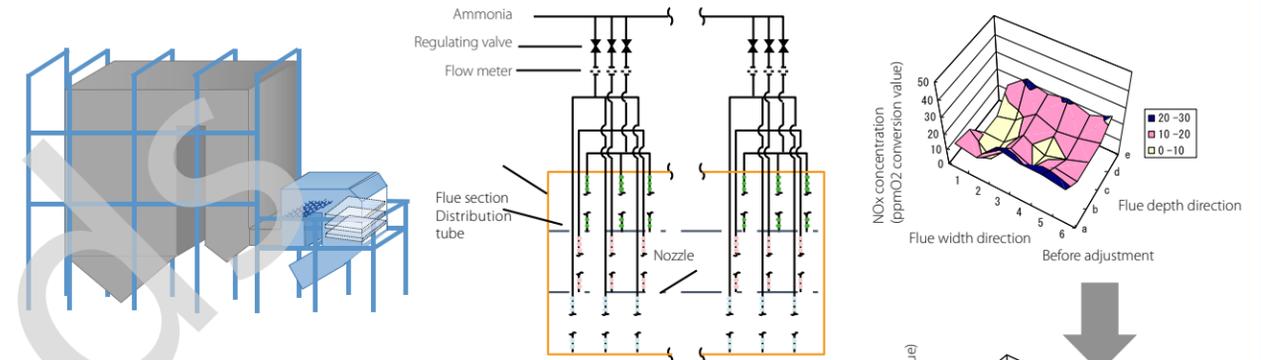
The initial investment is small, the desulfurization efficiency is high; the desulfurization system has no temperature drop and no water consumption; the desulfurization product is dry ash which can be easily transported and treated; the system has low resistance; the occupied space is small; the product generated from the sodium-based dry technology has high added value and wide industrial use.



## (3) Flue gas denitration technology

### Advantages of SCR

The company mainly adopts the following flue gas denitration technologies including: low-nitrogen combustion, selective non-catalytic reduction SNCR, selective catalytic reduction SCR, and the optimized combination of the above denitration processes. The company has undertaken the projects with the unit capacity of 7MW at minimum and of 1350MW at maximum.

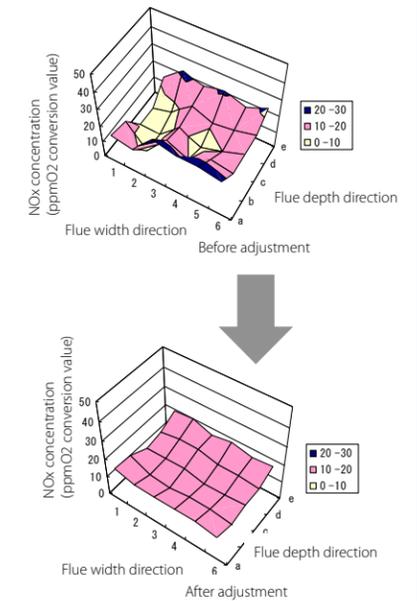


### Combined design with the boiler plant

SCR can implement full-load design more easily, has more reasonable arrangement and layout, and can effectively reduce investment cost; in CFD simulation, the boundary is clearer, the model is more complete, which is closer to the actual project conditions, and ultimately achieve better flow field uniformity.

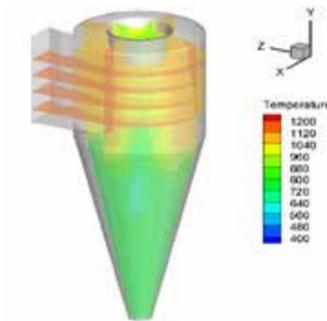
### Adjustment and optimization of NH<sub>3</sub> injection volume

To obtain a more uniform NH<sub>3</sub>/NO<sub>x</sub> concentration distribution, the NH<sub>3</sub> injection volume can be slightly adjusted in the commissioning stage according to the flow field simulation results and site conditions.

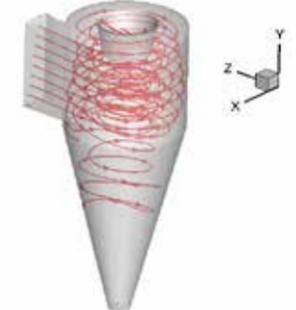


### Advantages of SNCR

1. It closely cooperates with the boiler, the flow field simulation accuracy is higher, and the design is more integrated.
2. With a variety of reductants and process performance, such as urea method SNCR, urea method SNCR + SCR (pyrolysis), ammonia water method SNCR, ammonia water method SNCR + SCR, etc.
3. SNCR process can reach the denitration efficiency up to 30%-80% in the coal power boiler.
4. The ammonia-nitrogen molar ratio can be as low as 1-1.3 and the ammonia escape rate can be as low as 5ppm, greatly reducing the reductant consumption.
5. With the characteristics of adapting to all loads
6. With rich engineering and field experience



Type A cyclone temperature profile



Type A cyclone flue gas flow line diagram



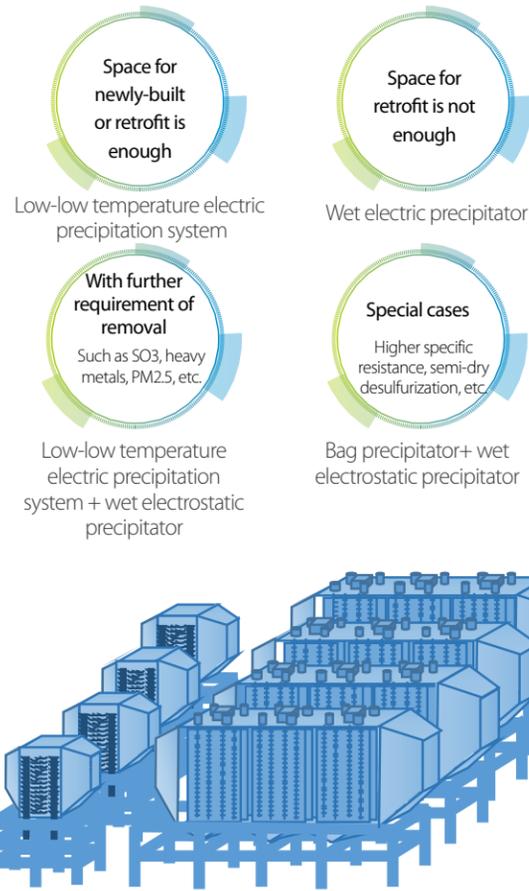
## (4) Dust precipitation

### High-efficiency precipitation

Under the severe atmospheric environment and increasingly strict emission standards, it is urgent to control dust in accordance with the higher requirements. The company's existing dust precipitation technologies include the low-low temperature electric precipitation system, wet electrostatic precipitation and some other conventional precipitator technologies. The company can provide the most suitable design route combination selections according to the different boundary conditions.

### Low-low temperature electric precipitation system

The core equipment of the low-low temperature electric precipitation system consists of low-low temperature economizer and electrostatic precipitator. After the flue gas passes through the low-low temperature economizer, the temperature is reduced below the acid dew point temperature (generally around 90°C), so that the most of SO<sub>3</sub> from flue gas is condensed to form the sulfuric acid mist, adhering to the dust and neutralized by the alkaline substance, thus to greatly reduce the dust specific resistance, avoid the back corona phenomenon, thereby improving the dust prediction efficiency, and saving the coal consumption for power generation and power plant consumption at the same time.



### Wet electrostatic precipitator

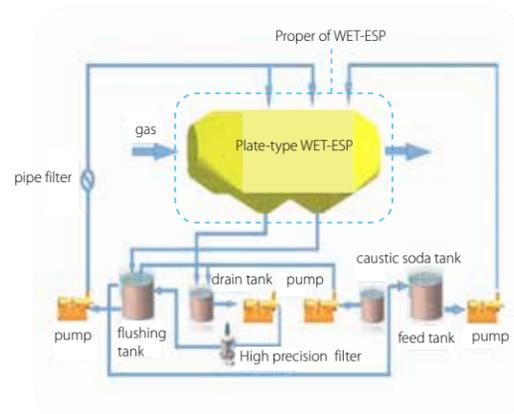
The wet electrostatic precipitator (WESP) can be used as the terminal precision treatment equipment for efficient dust precipitation. It has the powerful function of controlling composite pollutants and the good effects of collecting fine, viscous or high specific resistance dust, flue gas, acid mist, aerosol and mercury, heavy metals and dioxins, etc. At present, most coal-fired power plants use wet desulfurization systems, which also create favorable conditions for application of WESP in power plant. It is a forward-looking and reliable technology that can meet extremely low emission standards and control composite pollutants.

#### Horizontal wet electrostatic precipitator

Combine the continuous spraying with intermittent spraying to form continuous water film at stable operating voltage; circulating water system, "zero" water consumption; combined with desulfurization, optimized overall layout and system, reducing energy consumption and investment cost.

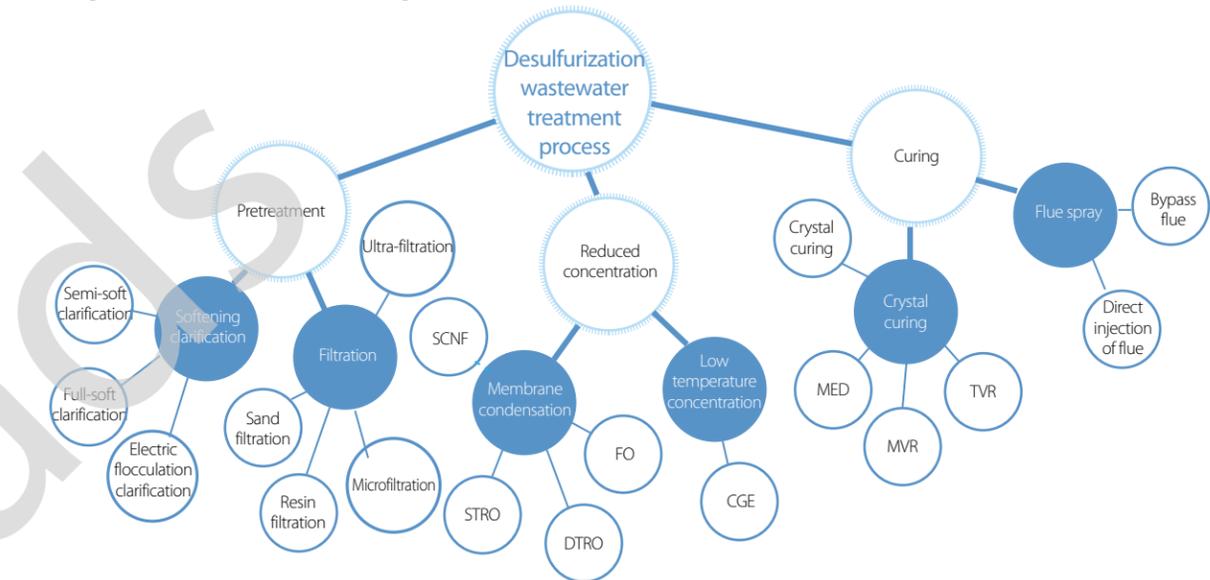
#### Vertical wet electrostatic precipitator

Intermittent spraying, low washing frequency, low water consumption, drainage for desulfurization recycling; integrated layout with desulfurization absorption tower, sharing water tank and water pump, reducing investment cost.



## (5) Zero liquid discharge system

Zero liquid discharge means that after reuse of industrial water, the wastewater containing salt and pollutants is further concentrated and further recycled so that finally no waste liquid is discharged from the factory. The salt and contaminants in the water are discharged into the waste treatment plant after being concentrated or crystallized or the filter press residue is discharged into the waste treatment plant in the solid form or recycled as the useful chemical raw material. There are many menu process route combinations for zero liquid discharge, which can be selected according to the end customers' needs.



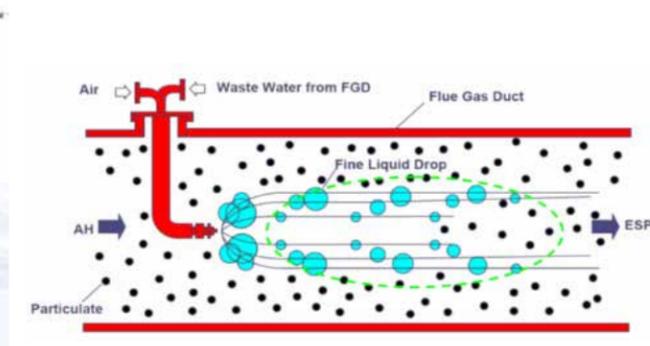
The combination of forward osmosis + flue atomization spray evaporation scheme is generally recommended for the zero-discharge system for desulfurization wastewater. The high-concentration desulfurization wastewater generated after forward osmosis of wastewater is transported to the special spray gun by a high-pressure pump, sprayed into the flue after atomization by using the spray gun, evaporated by the residual heat from the outlet of air preheater to convert the pollutants in the wastewater into solids such as crystals, chlorides, and eventually collected by the dust precipitator along with the fly ash in the flue gas.

### Flow chart of OsmoBCTM Process



### Advantages of forward osmosis membrane concentration technology

- (1) Pressure or even no-pressure operation, reduced energy consumption;
- (2) many pollutants completely intercepted, good separation effect;
- (3) low membrane pollution characteristics;
- (4) simple process and equipment



### Advantages of flue jet evaporation process

- (1) Small liquid drop size
- (2) Short complete vaporization time of wastewater
- (3) Reasonable selection of injection position
- (4) With independently researched and developed spray gun

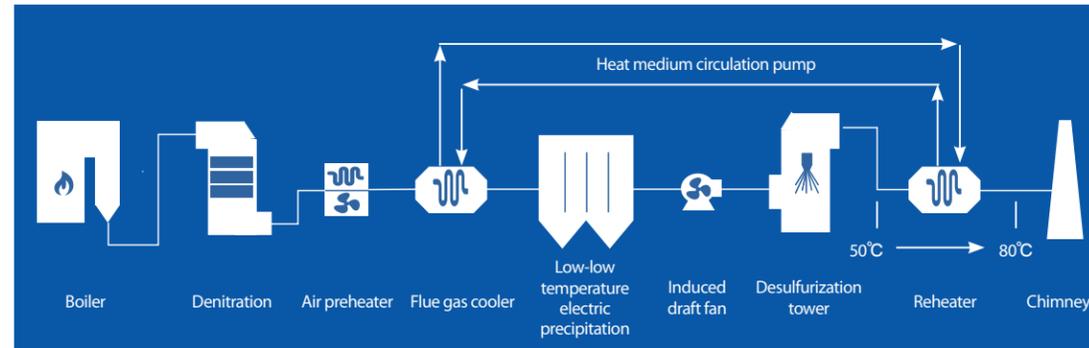
## (6) "Plume elimination" technology

As the flue gas is discharged from the chimney to the atmosphere, some of the vapor water and pollutants in the flue gas will condense because of temperature drop, forming the misty water vapor at the chimney and the misty water vapor will have slight color change because of sky background color, sky illumination, observation angle and other reasons, forming the "colored plume", usually in white, grey white, blue or other colors. The plume elimination technology mainly achieves the plume elimination effects by changing the temperature and humidity of flue gas discharged from the chimney.

### Direct heating technology route

The heat is recovered by the flue gas cooler, and the tail flue gas is heated by using the circulating water as heat exchange medium. If the unit has been equipped with the low-low temperature electric precipitation system, the low-low temperature economizer can be directly transformed into the flue gas cooler to constitute a leak-free flue gas heat exchange system (MGGH).

The technical route system is simple and can generate the obvious plume elimination effect. Under the working conditions in winter, the auxiliary steam can be simultaneously input to further increase the flue gas discharge temperature due to the low outdoor temperature.



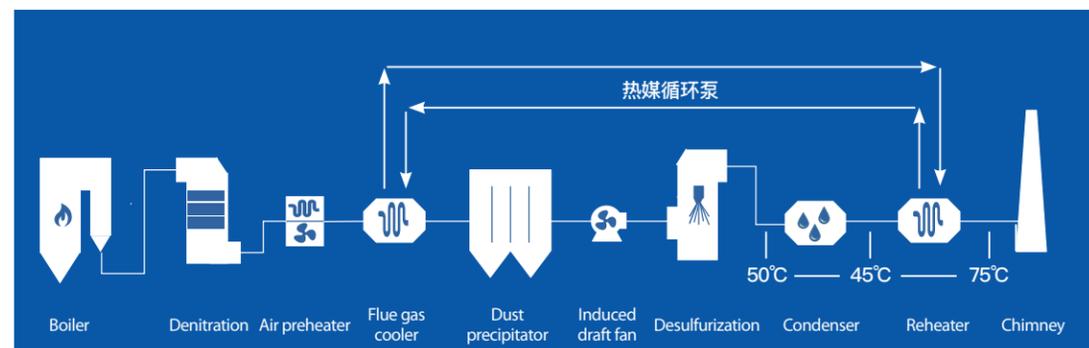
### Condensation heating technology route

The flue-gas temperature is lowered again by using the flue gas condenser and then the combined flue gas application is heated to achieve the optimal elimination effects by changing the moisture content and temperature (two factors affecting the formation of plume), which can reduce the demand for auxiliary steam in winter conditions.

Compared with the direct heating MGGH system, it only requires adding one flue gas condenser in front of the original flue gas heater to greatly improve the plume elimination effects. It is especially suitable for the northern low-temperature area already equipped with the MGGH system without obvious plume elimination effects generated in winter.

Project	Unit	Quantity
PH		3.2
COD	mg/l	543
CL <sup>-</sup>	mg/l	825
Suspended matter	mg/l	31
Conductivity	μs/cm	1310

Note: Condensed water recovery quality analysis

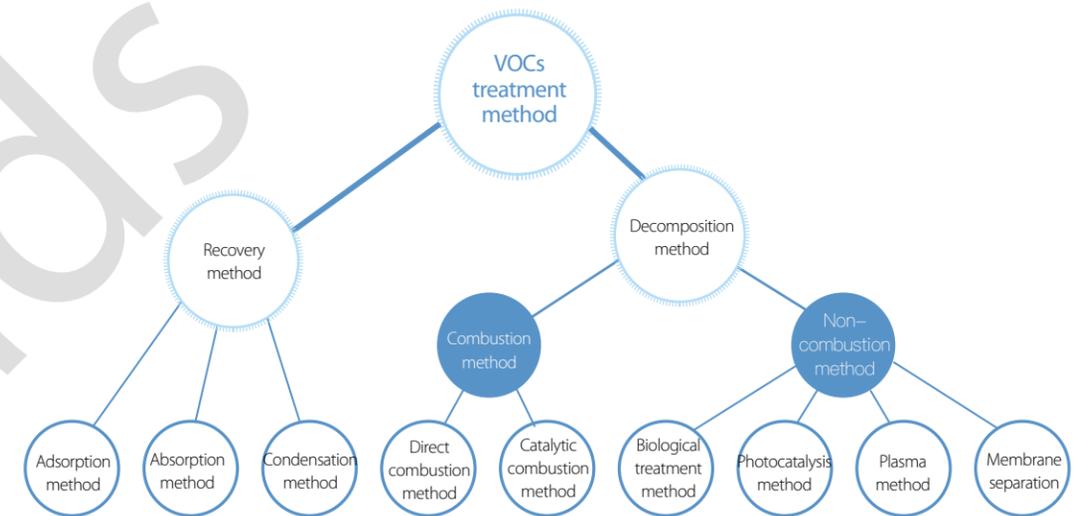


## (7) Volatile organic compounds (VOCs) treatment

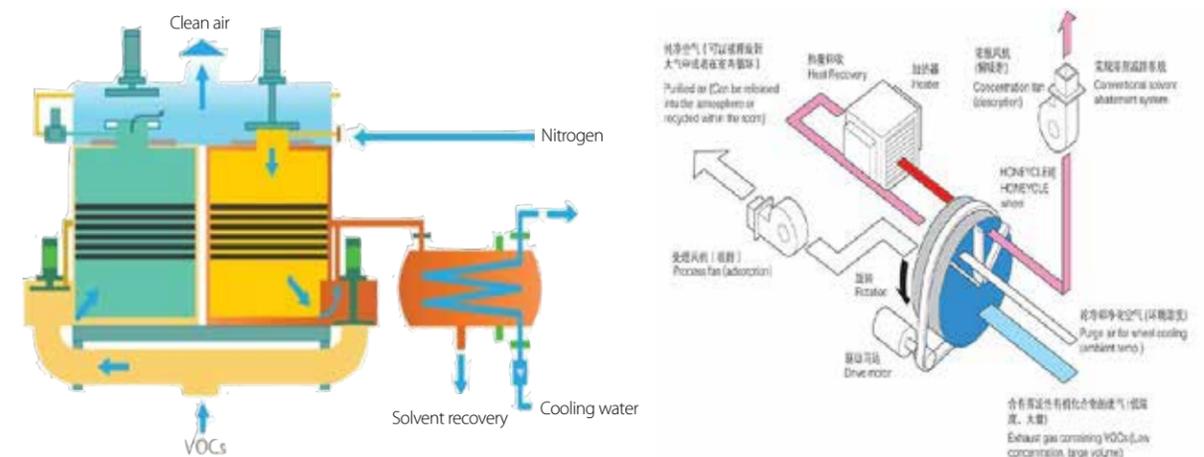
Shanghai Electric Power Generation Environment Protection Engineering Co., Ltd. provides environmental protection measures such as desulfurization, denitrification and dust removal for macro-atmosphere control technology. It also provides more comprehensive treatment including non-electrical industry from the microscopic perspective and develops towards mercury removal, arsenic removal, VOCs treatment and flue gas treatment in the steel, chemical, ship and other industries.

### Graphical representation of application range of different treatment technologies

The company will recommend the optimal technology combination based on the project situation.



### Treatment device of adsorption concentration



## 2. Solid waste and hazardous waste resource recycling

Collection, pretreatment, storage, transportation and resource treatment of sludge, oil sludge, biomass, livestock manure, domestic waste (including home appliances and electronic products), industrial waste (including batteries), etc.

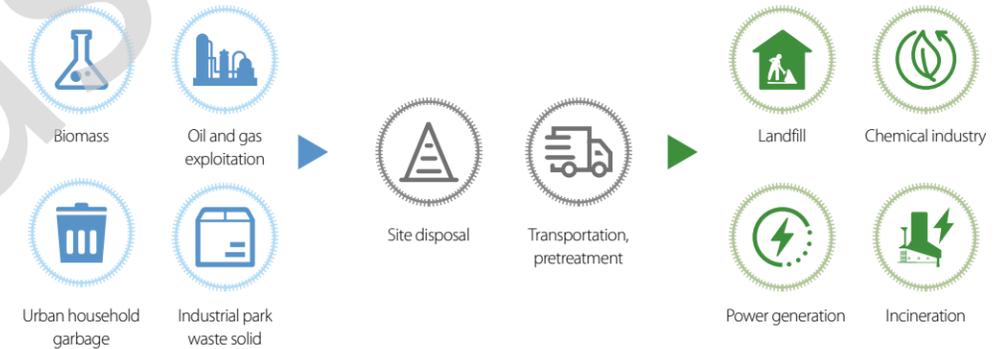


## Solid waste and hazardous waste recycling

### Technical advantages:

Shanghai Electric Power Generation Environment Protection Engineering Co., Ltd. has experience in design, engineering and installation of clean small power generation business located in waste heat power generation, waste incineration, biomass power generation, distributed energy stations, etc. At the same time, the company and Shanghai Electric Power Generation Engineering Company form an echelon to complement each other; providing EPC capability output to Shanghai Electric Environmental Protection Group for investment projects such as PPP and BOT, truly making use of the advantages of Shanghai Electric Group and complementing each other; achieving energy conservation and emission reduction from the source.

Collection, pre-treatment, storage and transportation, fuel rod manufacturing and recycling of sludge, oil sludge, biomass, livestock and poultry manure.



overall-process recycling solutions of biomass, hazardous waste and sludge



## Provide the fully systematic solutions — "collection, pretreatment, recycling"

### (1) Solid waste transportation and pretreatment

Have super-large and super-strong operation function; meet the highest energy conservation and environmental protection requirements; have unique energy conservation, emission reduction and environmental protection advantages; comply with a series of policy guidelines such as smart city, environmental protection and emission reduction strongly advocated by the state; create new highlights for environmental sanitation and environmental protection work in large cities.



Equipped with multi-function equipment used for emergency rescue, dredging and cleaning operations.

#### The biggest advantages:

- Comply with the terrain requirements for different operation environments: 4-wheel drive
- Convenient operation: small size, short wheelbase, intuitive and simple operating system
- Multi-function: slag removal, cleaning, descaling, suction
- Large volume trunk convenient for classification of operation tools
- Custom-made as required

### (2) Hazardous waste transportation

Medium-sized pipe network cleaning and high-pressure cleaning, as well as hazardous waste transportation.



#### ECOLOGICAL

- Extract water for cleaning from the sewage sludge
- Achieve continuous operation without water makeup around the clock

#### ECONOMICAL

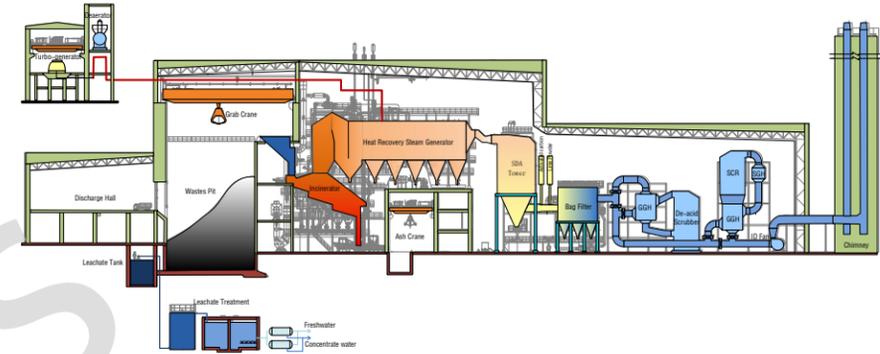
- Reduce the quantity unloaded
- Automated operation
- Fast and automatic maintenance

#### INNOVATIVE

- Finer filter design makes the filtered water more clear
- GVI system: intelligent rotating speed system, ensuring the maximum performance during operation

### Garbage recycling

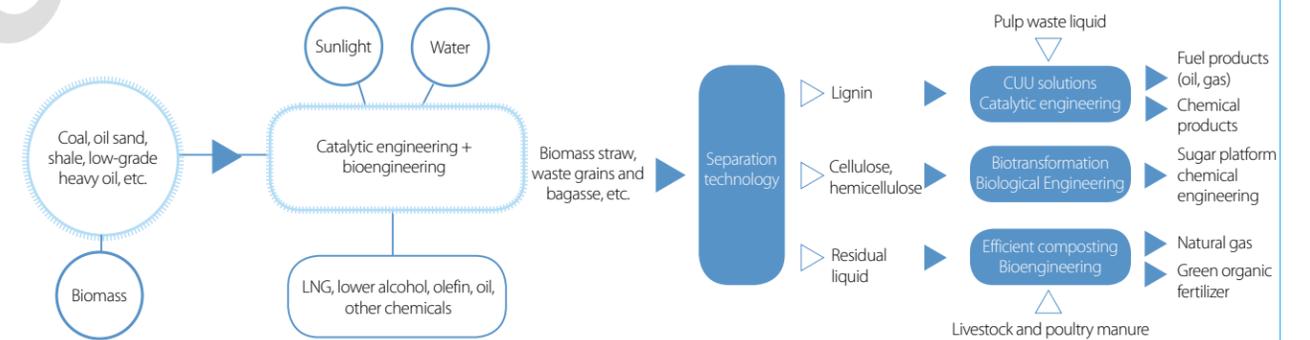
In the waste incineration power generation project, the company can provide customers with complete sets of technical equipment solutions for waste incineration, waste heat utilization, steam turbine power generation, flue gas purification, leachate treatment, ash treatment etc.



### Resource utilization of biomass

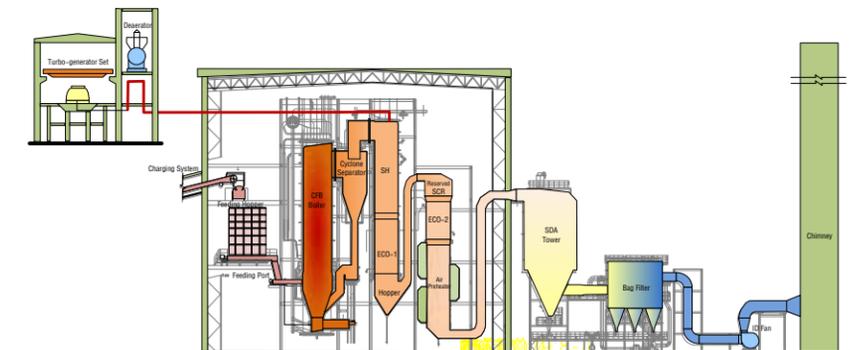
The company's biomass processing solutions combine a multi-dimensional coupling technology system of "catalytic engineering" and "bioengineering". The raw materials include fossil raw materials, biomass raw materials, etc.:

Such solution is not limited to the processing of plant stems and leaves such as straw, but can be extended to all biomass, including the waste residue from traditional food processing industry such as waste grain and bagasse, waste residue from the biomass processing such as pulp mill waste liquid and bioorganic waste such as livestock and poultry manure, kitchen waste, etc.:



At the same time, it can also provide the biomass power generation system EPC.

The biomass power plant engineering EPC service adopts domestic advanced biomass feeding system according to the specificity of biomass fuel to ensure smooth feeding; the circulating fluidized bed boiler with low bed temperature combustion can ensure the wide fuel adaptability; the high-parameter technology can improve the overall efficiency of the power plant, and the mature environmental protection technology is reasonably configured to achieve the super-clean flue gas emission standards. The unit is the double pumping type to realize cogeneration of heat and power, which greatly improves the economic benefits of the power plant.



### 3. Energy and chemical industry, clean energy creation and comprehensive utilization of energy

Quality upgrade, comprehensive conversion and utilization of inferior energy materials, complete sets of energy and chemical equipment and engineering, three-waste treatment of energy and chemical industry, comprehensive renovation of energy environment; waste heat utilization, industrial tail gas utilization, coal to gas (electricity), triple generation, integration and comprehensive utilization of regional energy resources etc.; establishment of energy quality improvement center, energy resource recycling center, energy resources comprehensive utilization and distribution center.

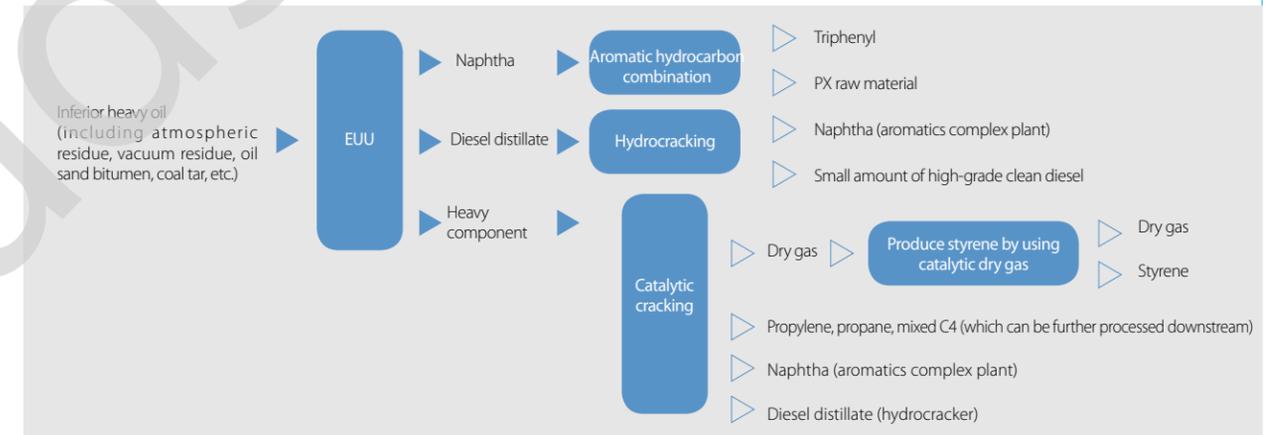


### Energy Quality Improvement Center

Use the low-grade heavy oil processing technology independently researched and developed by the company to convert the low-grade heavy oil into the "artificial oil" with the same quality as the light crude oil, thus increasing the utilization rate of low-grade heavy oil by 20%-25%; use the environmental-friendly inferior coal classification and quality processing technology to convert the inferior coal into high-quality clean coal and produce about 40% of high-value products, thus improving the quality and utilization rate of energy resources, greatly reducing emission and achieving the large environmental protection goals.

### Comprehensive utilization of low-grade heavy oil

EUU technology and NUHC-60 series catalysts are specially produced for low-grade heavy oil, and can process the petroleum-type low-grade heavy oil such as low-grade heavy oil crude oil, atmospheric residue, vacuum residue, coking wax oil, catalytic oil slurry as well as unconventional oils such as coal tar, shale oil and oil sand bitumen oil. The process realizes the online loading and unloading of the catalyst and can continuously operate for three years, which ensures the "safe, stable, long-time, full and excellent" operation of device. Taking medium and low temperature coal tar as an example, the removal rate of sulfur and nitrogen distilled from the boiling bed is greater than 80%, the conversion rate of resin and asphaltene is greater than 90%, and the liquid product yield is greater than 95%.

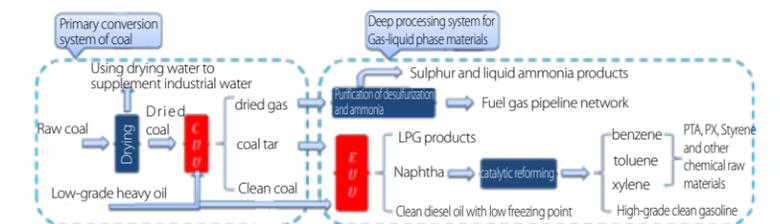


- The raw material costs are reduced by nearly 40% by using the company's optimized solutions.
- Almost no refined oils such as gasoline and diesel are produced.
- No catalytic oil slurry is produced (return to EUU for conversion)
- The ethylene (styrene) products with high added value can be obtained without steam cracking of naphtha.
- The aromatic hydrocarbon products have high added value and no consumption tax.
- It can provide stable raw material supply for downstream chemical enterprises in the park and becomes a leading enterprise in the park.

### Classification and comprehensive utilization of inferior coal

#### Primary transformation of coal

CUU (Coal Upgrading Unit) is the coal processing technology independently developed by the company. This process technology is to treat the pulverized coal that cannot be utilized by the traditional dry distillation technology, the oil and gas yield is up to 40%, and the oil yield is up to 25% or above. CUU is the primary processing technology for coal with the highest yield and the best comprehensive benefit among the current high value products. The obtained intermediate products can be further processed into high-value fuel products or high-value chemical raw materials, the processing process is clean and environmentally friendly, and the product quality is good.

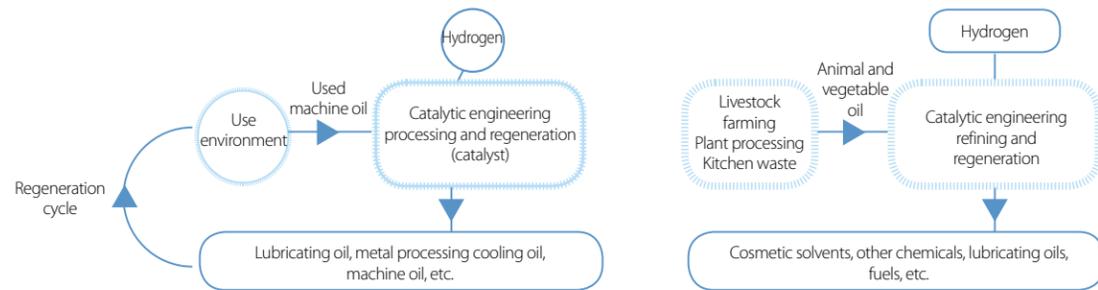


## Energy Resource Recycling Center

Use the company's technology, including

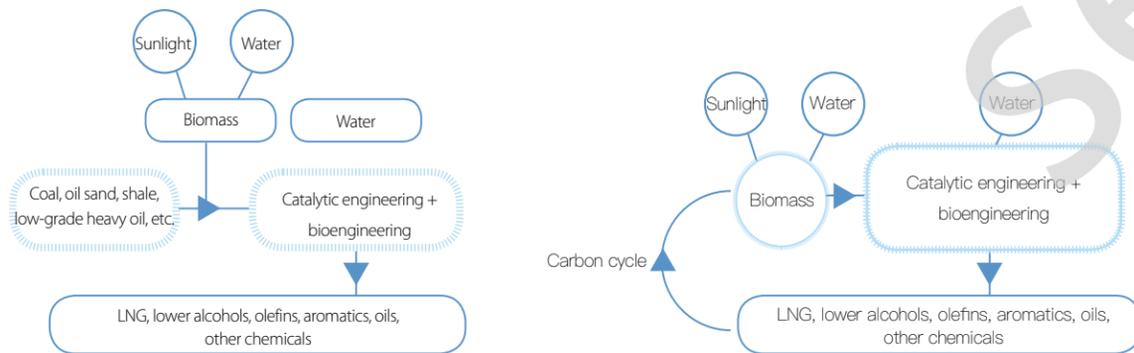
1. Use waste machine oil, waste mineral oil, waste lubricating oil, animal and plant waste oil and other hazardous waste oils as raw materials to regenerate the second-class and above lubricating oil base oil.
2. After recycling of waste plastics, waste rubber, white home appliance casings and plastic components of electronic components, regenerate the olefins, aromatics and other basic chemical raw materials that can be processed into materials.

### Waste oil recycling



- Use hydrogenation technology to re-adjust the proportion of carbon and hydrogen atom in the oil and remove impurities to obtain the high-quality products.
- Waste oil processing equipment should rely on existing energy chemical plants to save investment and reduce finished products.
- Relatively lightweight assets can be more easily connected with the capital market.

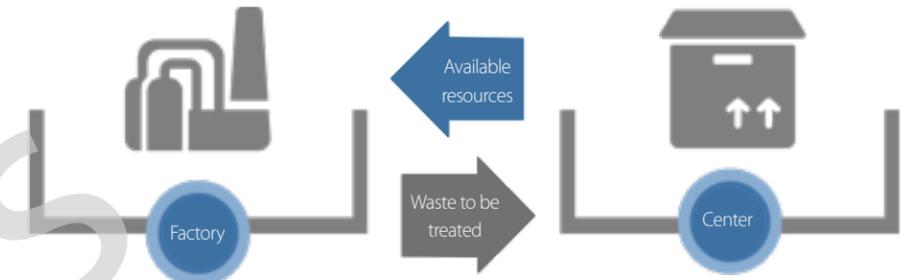
### Recycling utilization of biomass



- In the long term, the fossil energy will be completely abandoned.
- Use biomass as a carrier, use carbon dioxide as cycling medium and use solar energy to achieve carbon cycle and create the green energy industry.
- Recycled products can be uniformly sold through the existing energy and chemical factories with tax subsidy to obtain the considerable profits.
- Animal and vegetable oil processing products are green energy products with high selling price and without tax and can be directly exported to Europe and the United States. It is also the future energy direction in China.

## Comprehensive utilization of energy resources

The cold, heat, and kinetic energy produced by the above-mentioned energy quality improvement center and energy resource recycling center are distributed to the distribution center for full utilization. The distribution center can also supply industrial gases such as oxygen, nitrogen and hydrogen. The centralized processing is conducive to reducing gas costs and reducing the burden on enterprises. It can transform the assets of main processing enterprises into light assets, and the capital connection difficulty is relatively low.



### Energy factory

The processing plant of low-grade heavy oil and inferior coal will transport the low-temperature heat, solid waste, low calorific value fuel gas and wastewater to the resource comprehensive utilization and distribution center.

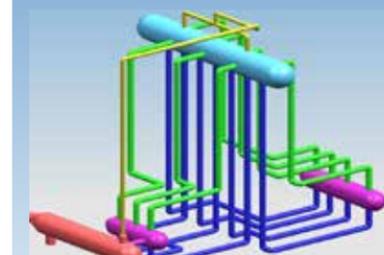
### Distribution center

Treat the low temperature heat, solid waste, low calorific value fuel gas and wastewater transported from the factory and send back the available industrial gases, cold, heat and electricity to the factory after recycling.



### Gasification island core equipment

Hot-wall gasifiers, such as multi-nozzle coal water slurry, multiple raw material slurry, Texaco, etc.; cold-wall gasifiers, such as Shell gasifier, Dongfang furnace, Huaneng two-section, Yingde Qingda, etc.; key biomass coupling technologies and equipment for power generation, such as SG-CFB gasifier and SG-cyclone technology.



### Energy recovery system

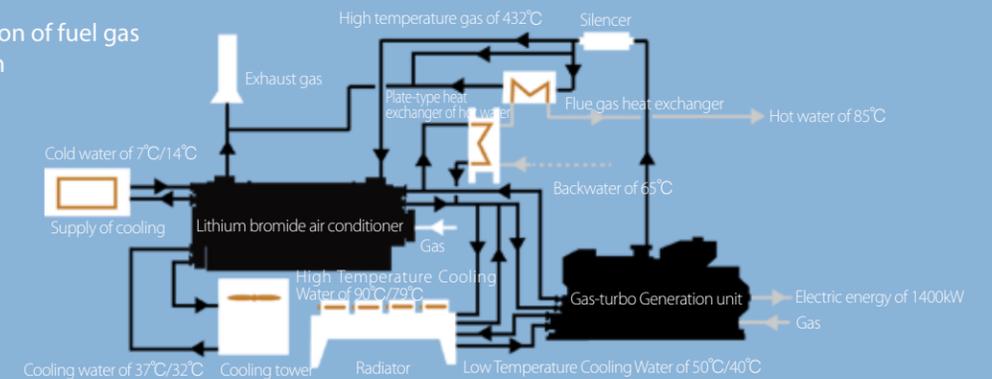
The energy recovery system with waste heat boiler as the core includes waste heat boiler, superheater, steam drum and steam water pipe etc., such as key equipment for coal-based natural gas project, including molten salt storage tanks of methanation waste heat boiler system and solar thermal system.



### Other chemical process vessels

Coal gasification, coal liquefaction and petrochemical medium and high-end equipment, such as hydrocracking reactor, catalytic reactor, disproportionation reactor, tower, converter, separator and other products. Pressure vessels used for military industry, such as gas storage tanks, gas cylinders, space capsules, etc.

### Typical application of fuel gas triple generation



## VII. TYPICAL PERFORMANCE

### Environmental protection island



**Laizhou Power Generation Co., Ltd.**  
Unit capacity: 2×1050MW  
Desulphurization efficiency: 98.89%  
Efficiency of dust removal: 98.9%  
Dust content at outlet: 5mg/m<sup>3</sup>



**Huaxia Yangxi Power Generation Co., Ltd.**  
Unit capacity: 2×1240MW  
Desulphurization efficiency: 97.9%  
Denitration efficiency 85.7%  
Dust content at outlet: 5mg/m<sup>3</sup>

#### Performance excerpts of the environmental protection island:

Xinjiang Tianfu Power Plant Phase-I 2×660MW Unit, Anhui HuaiBei Pingshan Power Plant 2×660MW Unit, Shanghai Wujing No.2 Co., Ltd. 2×660MW Unit, Shanghai Waigaoqiao No. 2 Power Plant 2×900MW Unit, Baosteel Power Plant 3×350MW Unit, Shanxi Lingshi Qiguang Power Generation Co., Ltd. 2×350MW Unit and Liaoning Nenggang Power Generation Co., Ltd. 2×200MW Unit.

### Desulphurization



**Pingshan Phase II Co., Ltd.**  
Unit capacity: 1×1350MW  
Desulphurization efficiency: 99.04%  
Scale of unit: world's biggest



**Vietnam Than Quang Ninh Power Generation Co., Ltd.**  
Unit capacity: 2×300MW  
Desulphurization efficiency: 90%  
First overseas desulfurization project

#### Desulfurization performance excerpts:

Japan Hitachinaka 1×1000MW Unit, Taiwan Taichung 2×550MW Unit, Shanghai Waigaoqiao Power Plant Phase I 2×300MW Unit, Shanghai Baosteel Power Plant 1×350MW, Guangdong Yangxi Power Plant Phase I 2×600MW, Zhengzhou Xinmi Power Plant Phase II 2×1000MW Unit, Huadian Laizhou Power Plant Phase II 2×1000MW Unit, Xinjiang Tianfu Power Plant Phase I 2×600MW Unit, Inner Mongolia Zhujiaping Power Plant 2×660MW Unit and Dabieshan Power Plant Phase II 2×660MW Units.

### Denitration



**SDIC Meizhou Bay No.2 Power Plant Denitration Project**  
Unit capacity: 2×1000MW  
Outlet NO<sub>x</sub>: 45mg/m<sup>3</sup>



**Vietnam Vinh Tan Phase-II Unit**  
Unit capacity: 2×600MW  
Outlet NO<sub>x</sub>: 136.5mg/m<sup>3</sup>

#### Denitration performance excerpts:

Xiamen Songyu Power Plant 4×300MW Unit, Turkey IZDEMIR Power Plant 1×350MW Unit, Suzhou Qianyingzi Low-calorific-value Coal Power Generation Project 2×350MW Unit, Jinneng Xiaoyi Low-calorific-value Coal Power Generation Project 1×350MW Unit, Huanggang Dabieshan Power Generation 2×660MW Unit, Guangdong Shajiao A Power Plant Phase III Extension 2×1000MW Units and China Resources Power Hubei Co., Ltd. 2×1000MW, etc.

### Waste water treatment



**Huaxia Yangxi Power Generation Co., Ltd.**  
Unit capacity: 2×1240MW  
Handling capacity: 68t/h  
Technical route: DTRO reverse osmosis membrane decrement + slag flushing with concentrated water



**Shanghai Wujing No.2 Power Generation Co., Ltd.**  
Unit capacity: 2×600MW  
Supporting waste water flue evaporation plant  
Technical route: forward osmosis + flue evaporation

#### Performance excerpts of waste water treatment:

Jingneng Ningxia Shuidonggou Power Plant 2×660MW Unit, Xinjiang Jiarun Co., Ltd 2×350MW Unit, Baosteel Zhanjiang Iron and Steel Co., Ltd 2×350MW Unit, Shanxi Lingshi Qiguang Power Generation Co., Ltd 2×350MW Unit and Dabieshan Power Plant Phase II 2×660MW Unit, etc.

### Dust removal



**Zhejiang Zheneng Jiahua Phase III Project**  
Unit capacity: 2×1000MW  
Efficiency of dust removal: 99.94%  
Form of dust removal: low-low temperature - spiral finned tube



**Haimen Power Plant Flue Gas Waste Heat Recovery System**  
Unit capacity: 2×1000MW  
Efficiency of dust removal: 99.94%  
Form of dust removal: low-low temperature - spiral finned tube

#### Dust removal performance excerpts:

Guangdong Wanglong Power Plant 2×125MW Unit, Hubei Energy Group Ezhou Power Plant Phase II 2×650 MW Unit, Erdos Power No.3 Company 2×330MW Unit, Zhujiaping Power Plant Phase I 2×660MW Low & Saving Project, Huaneng Jinling Power Plant 2×1040MW Unit WGGH Renovation Project, Haimen Power Plant Pipe WGGH and Flue Gas Waste Heat Recovery System 4×1000MW Unit, Zhejiang Energy Zhenhai Power Plant 2×600MW Unit, etc.

### Comprehensive utilization of energies and resources



**Germany Erfurt Project**  
Installed capacity of project: 1×1560kW  
Fuel source: biogas



**Cuxhaven Sewage Treatment Plant Project**  
Installed capacity of project: 2×527kW  
Fuel source: biogas

#### Performance excerpts of comprehensive utilization of energies and resources:

Schroder Biogas Plant Extension Project, Rauschenberg Biogas Plant Extension Project, Sancha Biogas Plant Project, C. Oldenburg Biogas Plant Extension Project, Chile No.6 District Biogas Plant Project, Soltau Swimming Pool Heating Project, Oldenburg University Project, Bart Heating Project, Rottenburg Heating Project, etc. (Partly in the joint construction with AGG).

### Petrochemical industry



**Jilin Hongtai New Energy Company**  
Raw material: coal tar  
Job content: EPC

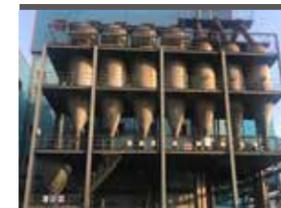


**Kenli Baoyuan Compound Additives Plant**  
Raw material: naphtha reforming and aromatics extraction  
Job content: technology, design and catalyst

#### Performance excerpts of petrochemical industry:

China Risun Coal Chemicals Group, Hebei Zhongjie Petrochemical Group, Hebei Xinqiyuan Energy Co., Ltd., Shandong Heze Yuhuang Chemical Co., Ltd., Sichuan Shengma Chemical Industry Stock Co., Ltd., Shandong Huidong New Energy Co., Ltd., Shanghai New-Unity Energy Technology Co., Ltd., Xinjiang Tianyu Coal Chemical Co., Ltd. and Xinjiang Guanghui Group, etc. (partly in joint construction with Junming Chemical).

### Metallurgy and building materials



**Ningxia Shengyan Energy Circular Economy Project**  
Blast volume of workshop: 80000m<sup>3</sup>/h  
Exhaust emission concentration: 30mg/m<sup>3</sup>  
Smoke exhaust outside the workshop: no obvious in-organized emission of smoke and dust

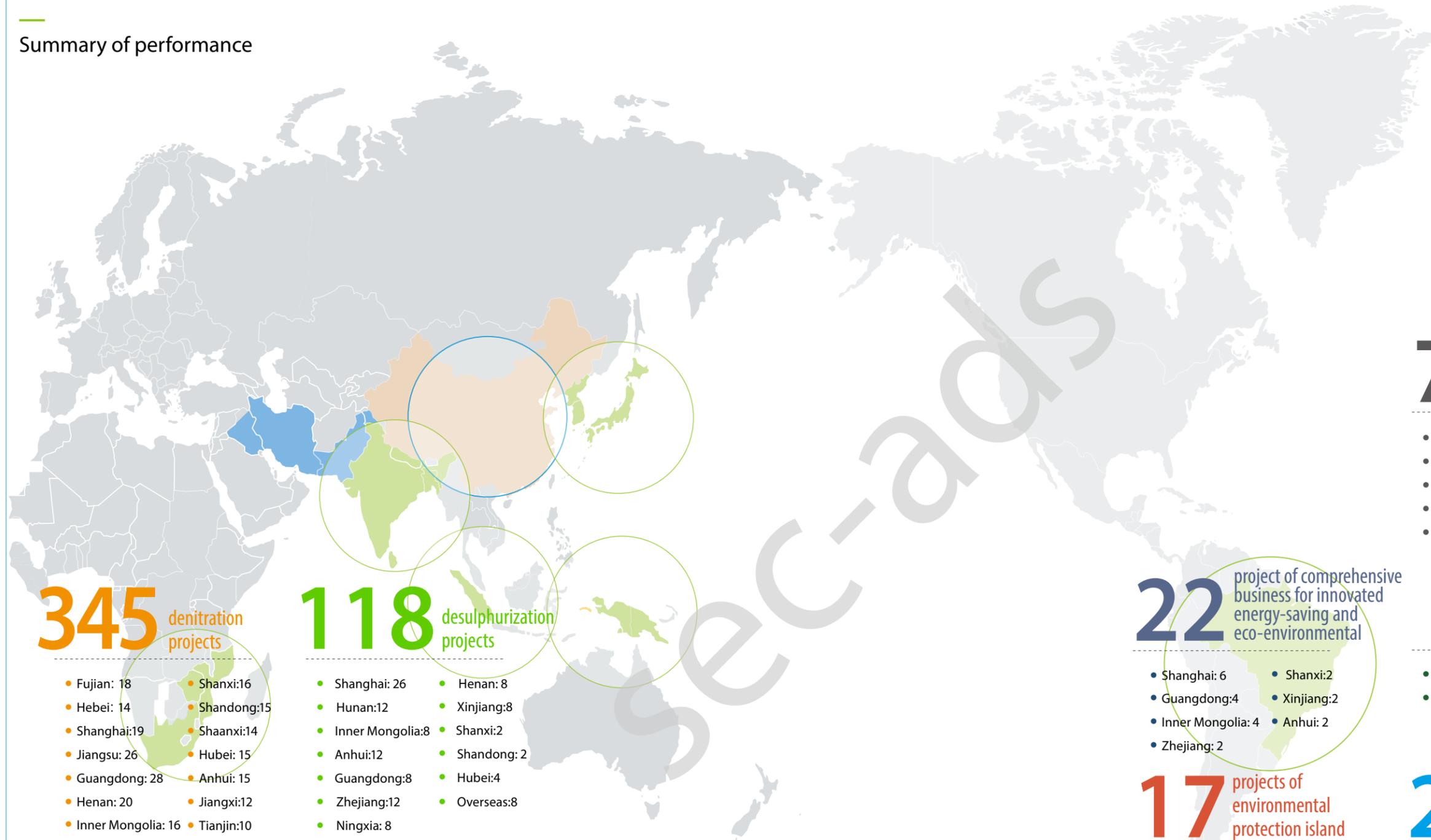


**Shandong Rizhao Steel Sintering Project**  
Size of unit: 500m<sup>2</sup>  
Dust emission concentration: 3mg/m<sup>3</sup>  
NO<sub>x</sub> concentration at outlet: 60mg/m<sup>3</sup>

#### Performance excerpts of metallurgy and building materials:

Baosteel Group Corporation, HBIS Group, Shandong Rizhao Steel, Nippon Steel and Conch Group, etc. (partly in joint construction with the associate company within Shanghai Electric Group).

## Summary of performance



### 345 denitration projects

- Fujian: 18
- Hebei: 14
- Shanghai: 19
- Jiangsu: 26
- Guangdong: 28
- Henan: 20
- Inner Mongolia: 16
- Xinjiang: 30
- Ningxia: 18
- Zhejiang: 8
- Qinghai: 6
- Shanxi: 16
- Shandong: 15
- Shaanxi: 14
- Hubei: 15
- Anhui: 15
- Jiangxi: 12
- Tianjin: 10
- Liaoning: 6
- Guangxi: 14
- Hunan: 15
- Overseas: 10

### 118 desulphurization projects

- Shanghai: 26
- Hunan: 12
- Inner Mongolia: 8
- Anhui: 12
- Guangdong: 8
- Zhejiang: 12
- Ningxia: 8
- Henan: 8
- Xinjiang: 8
- Shanxi: 2
- Shandong: 2
- Hubei: 4
- Overseas: 8

### 18 projects of hazardous waste and solid waste, or energy chemical industry

- Gansu: 2
- Hebei: 2
- Inner Mongolia: 2
- Shanghai: 4
- Fujian: 4
- Shaanxi: 2
- Overseas: 2

### 22 project of comprehensive business for innovated energy-saving and eco-environmental

- Shanghai: 6
- Guangdong: 4
- Inner Mongolia: 4
- Zhejiang: 2
- Shanxi: 2
- Xinjiang: 2
- Anhui: 2

### 17 projects of environmental protection island

- Shanghai: 6
- Guangdong: 4
- Shanxi: 2
- Xinjiang: 2
- Overseas: 3

### 79 projects of ultra-clean dust removal

- Jiangsu: 9
- Zhejiang: 12
- Shanghai: 10
- Guangdong: 6
- Inner Mongolia: 10
- Xinjiang: 12
- Ningxia: 8
- Shandong: 10
- Overseas: 2

### 8 projects of zero liquid discharge

- Guangdong: 2
- Shanghai: 4
- Ningxia: 2

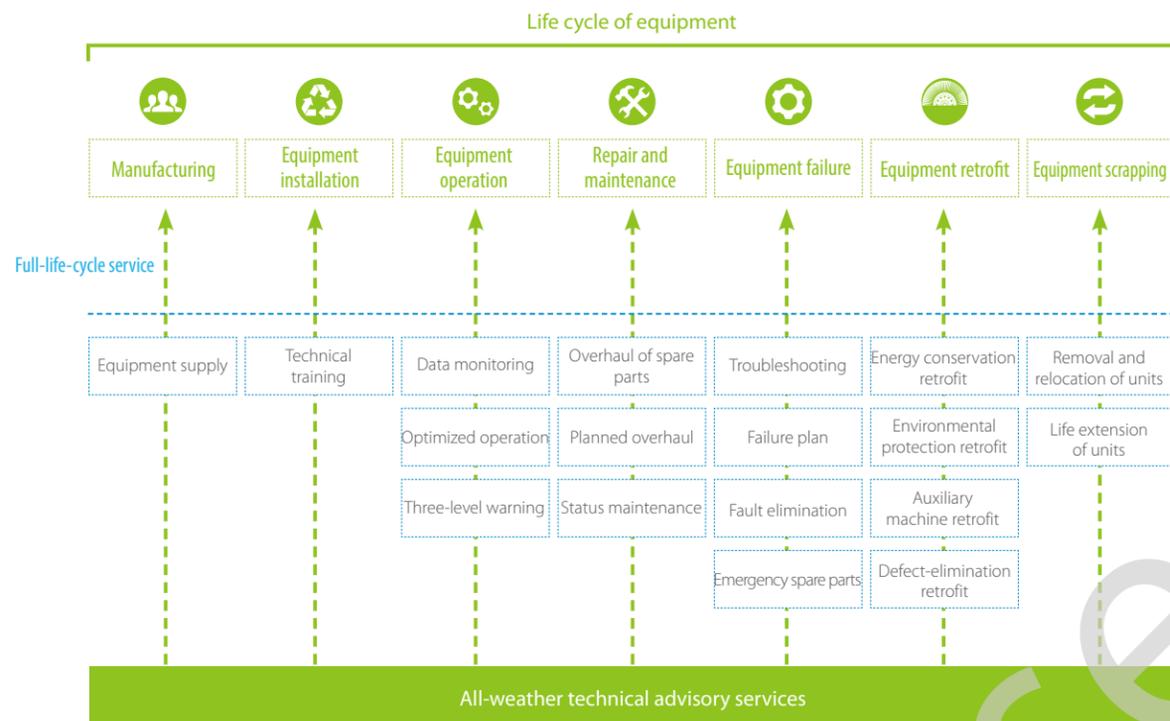
### 25 overseas projects

- Vietnam: 4
- Turkey: 1
- Japan: 5
- Korea: 2
- India: 3
- Singapore: 2
- Africa: 5
- Indonesia: 3

\* Note: Statistics as of the end of 2018

## VIII. CUSTOMER SERVICE

Relying on powerful equipment manufacturing ability and matured EPC engineering experience, Shanghai Electric Power Generation Environment Protection Engineering Co., Ltd. improves the traditional power project service business, treatment of waste water, treatment of solid waste, resource utilization of biomass , ecological restoration and other different fields to the all-round, whole-course and full life circle service facing the entire equipment system, to provide the overall solution, long-term operation, maintenance and overhaul for equipment, property upgrading and optimization, and equipment retrofit and recycle service in the entire service life of the equipment.



# SERVICES



Shanghai Electric Power Generation Environment Protection Engineering Co., Ltd. offers all-weather 24h response customer service. Relying on more than 30 domestic branches and 20 overseas branches of Shanghai Electric Group, the company provides personalized nanny-type service to the satisfaction of customers.



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