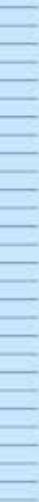




South-South Cooperation on Science and Technology to Address Climate Change  
Applicable Technology Manual Renewable Energy



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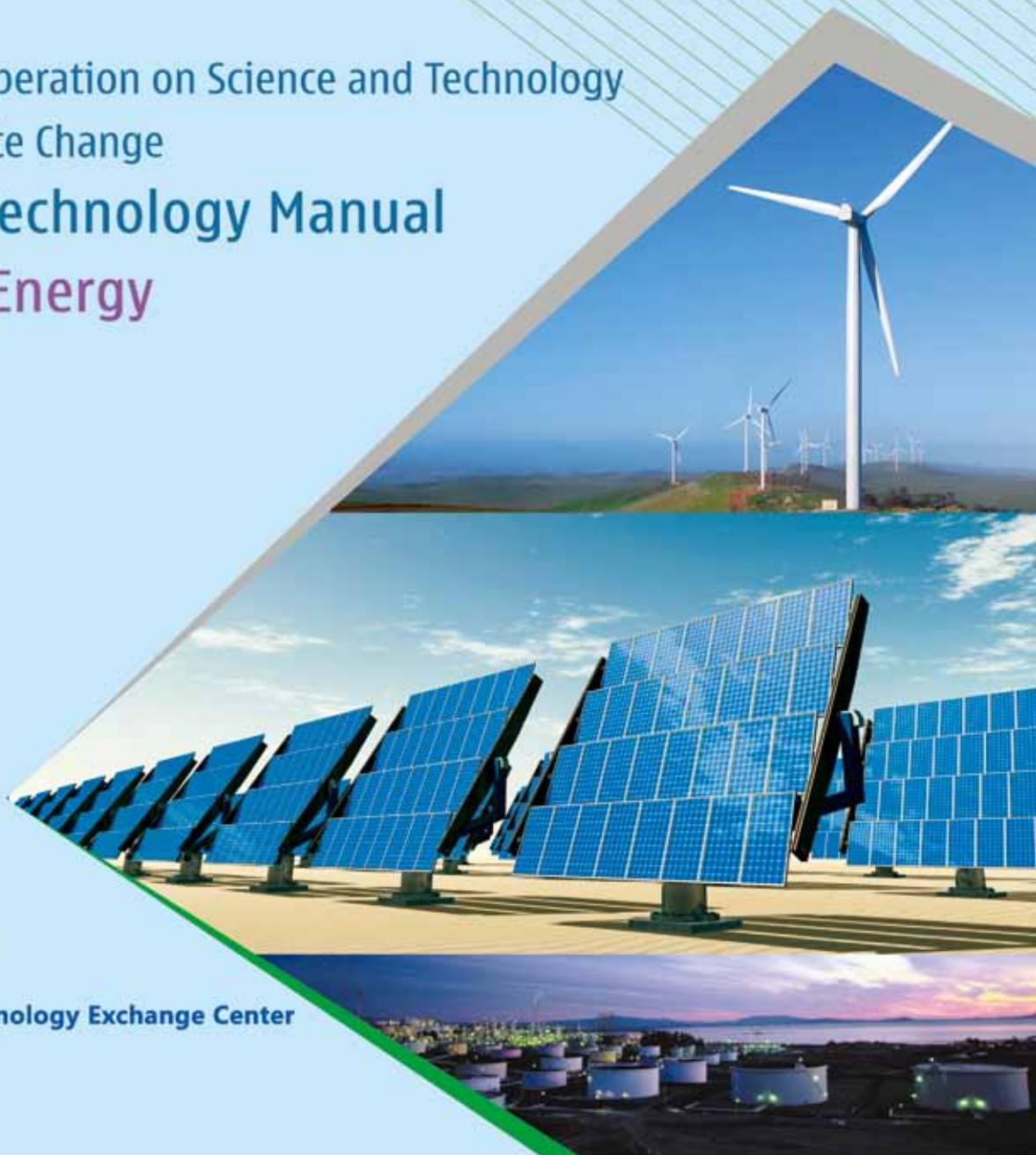
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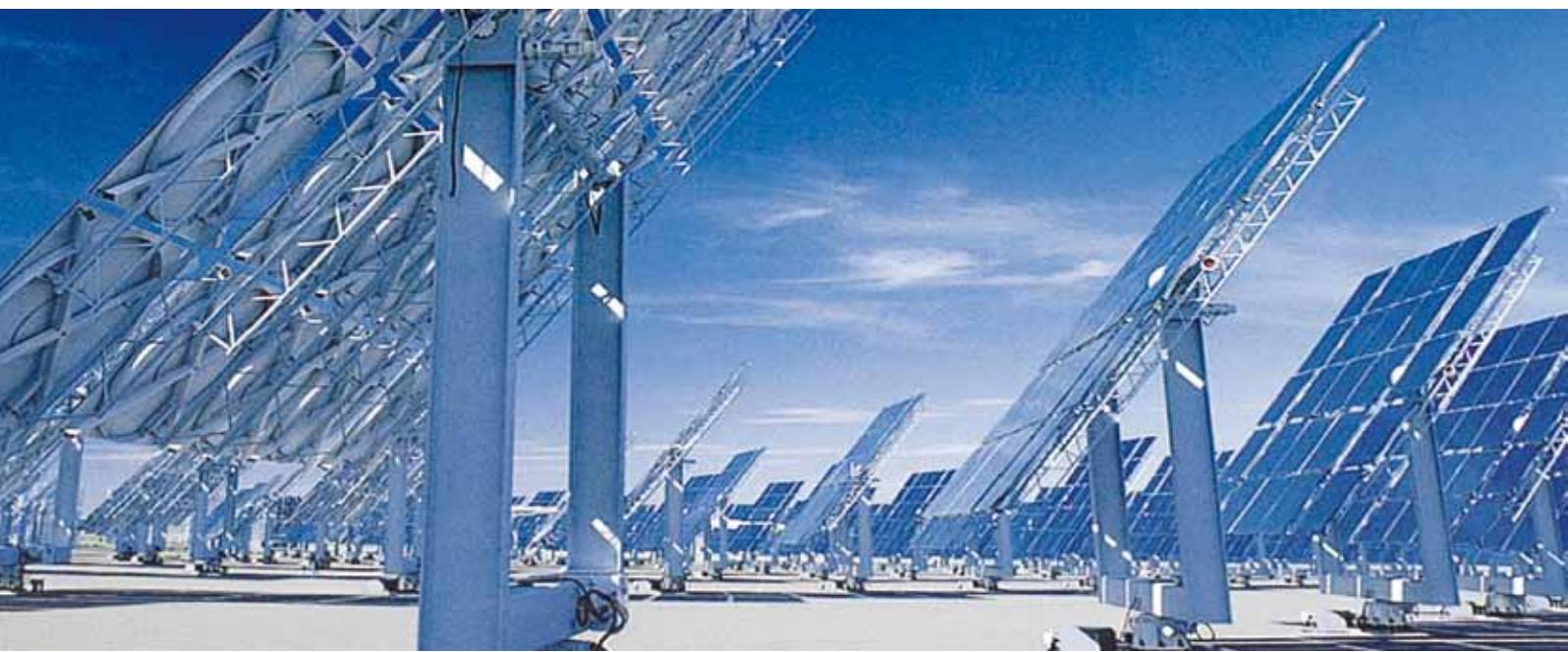
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South-South Cooperation on Science and Technology  
to Address Climate Change  
**Applicable Technology Manual**  
**Renewable Energy**



China Science and Technology Exchange Center





3<sup>rd</sup> Edition



South-South Cooperation on Science and Technology  
to Address Climate Change

**Applicable Technology Manual**  
**Renewable Energy**

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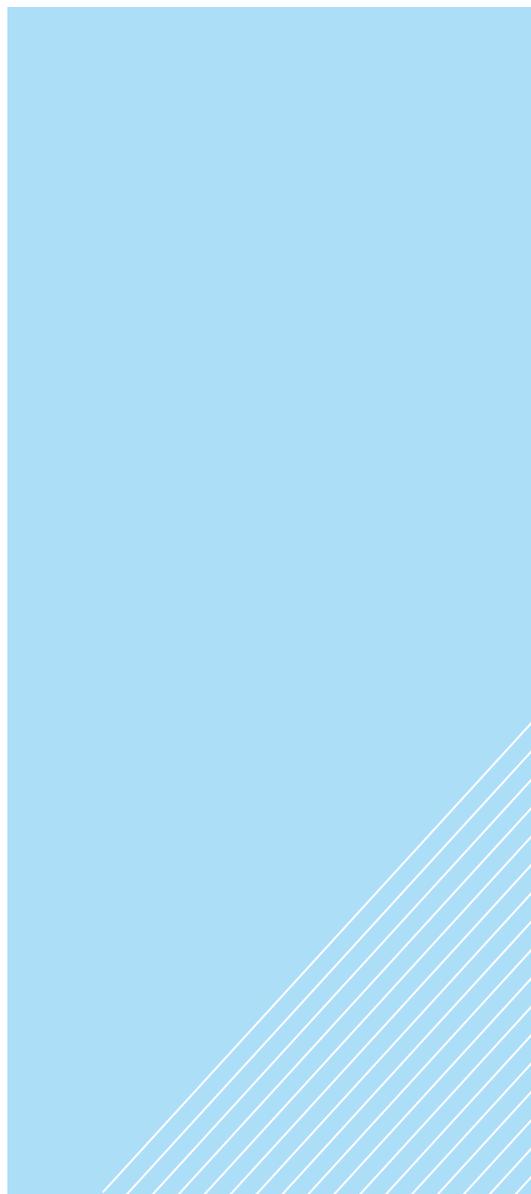
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## Introduction

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This Manual provides the information of applicable technologies to address climate change, aiming at facilitating cooperation among developing countries in addressing climate change through joint research and development, technology transfer and dissemination, training, building indigenous technological capability.

The editorial board released 1st edition of the Manual at UNFCCC COP16/CMP6 in Cancun, 2010, and released the 2nd edition at UNFCCC COP17/CMP7 in Durban, 2011. The released editions are the comprehensive volume, consisting of about 140 technologies in different areas. According to users' feedback, the editorial board has revised the 3rd edition and released the compact disc instead of paper. The 3rd edition consists of three volumes in the field of renewable energy, agriculture and forestry, water resources and environmental protection respectively. Each volume covers about 100 technologies.

Hard copies, either CD or printed brochures, could be distributed only to limited readers, while it is made more accessible to wider audience by be published on the network/website. In order to contribute to further improving the capacity of developing countries in addressing climate change and promoting sustainable development, Ministry of Science and Technology, China has launched the Network/Platform for International Science and Technology Cooperation: Address Climate Change and Achieve Sustainable Development. With the goal of promoting knowledge diffusion, technology development and transfer, information sharing, the Network/Platform is an open, non-profit Platform to facilitate international science and technology cooperation for the benefit of all users from the world. The PDF version of the Manuals is available for download from the website (<http://www.actc.org.cn>) of the Network/Platform.

Partners from developing and developing countries, international organization and other stakeholders are warmly welcome to join us in building up this Network/Platform.

More information, please visit <http://www.actc.org.cn>.

### Contact

China Science and Technology Exchange Center

Tel: +8610- 68528432, +8610-68526771

Fax: +8610- 68515808

Email: [jhc@ctestc.org.cn](mailto:jhc@ctestc.org.cn)

Address: 54 Sanlihe Road, Xicheng District, Beijing, P.R.C. 100045

### Disclaimer

Technology providers are responsible for factuality and accuracy of respective technological descriptions outlined in the Manual. MOST, UNDP, UNEP, UNESCO, the South Center, the Third World Network, CSTEC and the Editorial Board does not hold any responsibility for the factuality or accuracy of materials in the manual.

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South-South Cooperation on S&T to Address Climate Change

**Applicable Technology Manual Renewable Energy**

## **Renewable energy technologies**

Energy is highly important for the economic development of a nation and the improvement of its people's living standard. The major source of GHG comes from the burning of fossil fuels, and the use of renewable energy technologies such as solar power, hydro power, wind power and biomass can effectively reduce GHG and other pollutants, offering important substitutes for traditional fossil fuels and key solutions for energy mix optimization. Low-cost, mature and applicable renewable energy technologies are crucial to the energy revolution in developing countries.

## 1. Solar photothermal technology



### Technology overview

Functions and use: Adopts active and passive solar heating and cooling technologies and in combination with building roof photovoltaic power generation systems, solar water heating systems, water source heat pump technology and energy-saving LED lighting technology, provides households with hot water, heating and electric power and effectively reduces energy consumption in buildings.



Technical information: Average annual solar energy assurance rate: 50%~70%. In combination with active and passive solar heating and cooling, grid-connected/disconnected roof photovoltaic power generation, solar water heating system, water source heat pump, energy-saving LED public lighting, attached solar air heat collector technologies and corresponding indicators.

Scope of application: Suitable for countries and regions with rich solar energy resources.



Technological features: Lowers energy consumption in buildings maximally uses solar energy and reduces conventional energy consumption.

### Status of application

Has been promoted and applied; ready for use after simple training; high initial input cost but low subsequent use cost; and users can perform their own maintenance, low maintenance cost.



### Technology Provider

Organization: Gansu Natural Energy Research Institute/UNIDO International Solar Energy Center for Technology Promotion and Transfer

Contact: Jia Lingping

Tel: +86-931-8386635

E-mail: [jjialingping@unido-isec.org](mailto:jjialingping@unido-isec.org)

Address: 20 Renmin Road, Lanzhou, Gansu Province, P.R.C. Postcode: 730000

## Solar energy

### 2. Solar photothermal technology



#### Technology overview

Functions and use: Depending on user requirements, this product technology can provide 45-95°C hot water to meet the water needs for domestic, partial industrial and solar air conditioning purposes.

Technical information: Household-use solar products vary from 75L to 230L in volumetric capacity.

Scope of application: Meets water needs for domestic, partial industrial and solar air conditioning purposes.

Technological features: The product comes in 2 forms: a vacuum tube heat collector and a flat panel heat collector.

Based on user demand, optimal water use solutions can be provided.

#### Status of application

Has been promoted and applied; can be put into industrial production in developing countries; mature product; no training is needed; low use cost; and users can perform their own maintenance.

#### Technology Provider

Organization: Qingdao Economic and Technical Development Zone Haier Water Heater Co., Ltd

Contact: Zhuang Changyu

Tel: +86-532-88937605

E-mail: zhuangcy@haier.com

Address: Haier Industrial Park, 1 Haier Road, Qingdao, Shandong Province, P.R.C.

Postcode: 266109



### 3. Solar cooker

#### Technology overview

Functions and use: For heating water and cooking, and suitable for rural and livestock households or small insitutions.

Technical information: Power: 800W-1100W; light interception area:  $\leq 2\text{m}^2$ ; cooking frame height: 1.2m-1.4m.

Scope of application: Suitable for rural and grazing regions, frontier regions and islands.

Technological features: Simple structure, easy access to materials and scale production; minimal amount of manufacturing equipment, small investment, mature technology and technical support is available.



#### Status of application

Has been promoted and applied; can be put into commercial production in developing countries; mature product; ready for use after simple training; low user cost; and users can perform their own maintenance, low maintenance cost.

#### Technology Provider

Organization: Gansu Natural Energy Research Institute/UNIDO International Solar Energy Center for Technology Promotion and Transfer

Contact: Jia Lingping

Tel: +86-931-8386635

E-mail: [jjialingping@unido-isec.org](mailto:jjialingping@unido-isec.org)

Address: 20 Renmin Road, Lanzhou, Gansu Province, P.R.C.

Postcode: 730000



## Solar energy

# 4. Solar PV power generation system products and technologies



### Technology overview

Functions and uses: Engineering design, consulting, supervision of solar photovoltaic systems; general contracting of stand-alone, grid-connected, stand-alone + grid connected, and BIPV systems; supporting engineering systems and undertaking of sub-divisional work of the system; industry chain related before-sale consulting services and after-sale maintenance/upgrade services.

Technical indicators: PV array: Including solar modules and devices; energy storage components: storage battery; control section: including the DC controller. Have the capability to produce 4500 tons of electronic grade polysilicon /year, 500MW of solar cells and 500MW solar module per year. Has formed an independent entire-industry chain service model that integrates material and product manufacturing, equipment R&D, technology R&D, engineering design and contract.

Features: mostly R & D and manufacturing of polysilicon and downstream products; solar cells and related products; solar cell modules and photovoltaic power generation system-related products. Have core technology and independent intellectual property rights; can carry out a complete industrial chain services including systematic application of solar modules, system integration, installation, BIPV, photovoltaic power plant construction.

### Status of application

Has been promoted and applied; can be put into industrial production in developing countries; mature product; no training is needed; low use cost; high initial input cost but low subsequent use cost; maintenance free.

### Technology Provider

Institution: China Great Wall Industry Corporation

Contact: Zhao Chunchao      Tel: +86-13601218937

E-mail: chunchao@cgwic.com

Add: C412, Building 2, A18 Xingshikou Road, Haidian District, Beijing, P.R.C.      Postal Code: 100195

# 5. Solar photovoltaic power generation products

### Technology overview

Functions and uses: PV power generation using solar energy.

Monocrystalline silicon module efficiency of not less than 15%, polycrystalline silicon module efficiency of not less than 14%, service life of modules of not less than 25 years.

Application scope: all types of building roofs, stand-alone PV systems.

Features: have research, development, manufacturing and installation and commissioning capabilities of solar systems developed over the years and experience in undertaking a number of solar energy demonstration projects.

### Status of application

Has been promoted and applied; no training is needed; high initial input cost but low subsequent use cost; users can carry out their own maintenance.



### Technology Provider

Institution: Wanxiang Group Corporation

Contact: Chen Guizhang

Tel: +86-571-82832999

E-mail: cgz@wanxiang.com

Add: Xiaoshan Economic and Technological Development Zone, Hangzhou, P.R.C.

Postal Code: 311215

## Solar energy

# 6. Household-use photovoltaic power generation system



### Technology overview

**Functions and use:** This system is especially designed for solar photovoltaic generation. It is mainly used to meet the daily power needs of households in remote regions with little or no electricity. The system consists of 5 main parts; an outdoor solar cell component, a standing column, an outdoor photovoltaic cable, a maintenance-free lead acid battery and an integrated control inverter. The outdoor solar cell component is fixed outdoors using a standing steel column. It converts sunlight into DC power, which is transmitted via the outdoor photovoltaic cable into the indoor integrated control inverter. The maintenance-free lead acid battery is placed inside an integrated control internet cabinet. A control circuit is used to store the electric power transmitted from the outdoor photovoltaic cables in a battery.

**Technical information:** Open circuit voltage: 42V; maximum working voltage: 35.5V; maximum working current: 4.79A; short circuit current: 5.36A; weight: 15.5kg; maximum overcurrent: 10A, maximum system voltage: 1000V DC; number of battery plates: 72 series. Test conditions: light intensity: 1000W/m<sup>2</sup>; temperature: 25°C; and AM: 1.5.

**Scope of application:** Regions without electricity or with power shortages, pastoral regions, islands, frontier outposts and other regions which public grids cannot reach. This system is a low-power system for household use. Its total load power does not exceed 240W.

**Technological features:** The outdoor solar cell component of the system has received authoritative TUV certification and has a service life of over 25 years and a protection class of over Ip65. It can withstand the impact of D25mm hail at a speed of 23m/s. The integrated photovoltaic control inverter has a unique looking structural design and an integrated control/inversion design, which give the system such features as economy, practicality, ease of installation, reliability, and low consumption with high efficiency. The system converts low voltage DC power into 220 V/50Hz domestically useable AC power.

### Status of application

Mature product; ready for use after simple training; high initial input cost but low subsequent use cost; and maintenance personnel need to be trained or a maintenance station needs to be established.

### Technology Provider

Organization: CETC International Co., Ltd.

Contact: Tian Yaobin

Tel: +86-10-82209138

E-mail: tianyaobin@cetci.com.cn

Address: Room 706, Dianhe International Mansion, 5 North Wulutong Road, Xicheng District, Beijing, P.R.C.

Postcode: 100120

# 7. Solar photovoltaic power generation technology

## Technology overview

Functions and use: (1) Solar off-grid generation system solves the problem of electricity usage for farmers and herdsmen in remote regions in developing countries, improves the standard of living and livelihood of residents. (2) Solar grid-connected generation system generates renewable energy in developing countries that meets the required sunlight conditions. And (3) Solar photovoltaic water pump is especially useful in arid and semi-arid regions and can meet the domestic, livestock and irrigation needs of farmers and herdsmen.

Technical information: (1) Solar cell efficiency: >17%; (2) solar inverter efficiency: >95%; and (3) household-use solar power generation equipment will continue to maintain the normal power supply for at least 3 consecutive cloudy days.

Scope of application: Solar photovoltaic generation technology has been widely used in agriculture, industry, energy and other fields.

Technological features: Europe, Oceania and a number of developing countries are the main markets for grid-connected generation systems.

Among other countries and regions household-use systems and photovoltaic pumps have been widely used in Tibet, Guangxi and Inner Mongolia of China and in Nigeria, South Africa and Pakistan.

## Status of application

The technology has already been put into use; can be put into industrial production in developing countries; is a mature product; ready to use after simple training; has high initial input cost, but later-stage cost of use is low and users can carry out their own maintenance.



Cooperation agreements have been signed with Pakistan, Egypt, Madagascar and other countries to provide them with solar photovoltaic generation technology, and assist local enterprises in building up solar photovoltaic businesses. Related products and services are already in use in Egypt, South Africa, Nigeria, Pakistan and other developing countries.

## Technology Provider

Organization: CEEG

Contact: Luo Tao

Tel: +86-25-52095699

E-mail: jallty@ceeg.cn

Address: No.6, Shuige Road, Jiangning Economic and Technological Development Zone, Nanjing, Jiangsu Province, P.R.C.

Postcode: 211153

## Solar energy

# 8. High-efficiency, low-cost crystalline silicon solar cell



### Technology overview

Functions and use: crystalline silicon solar cells for use in photovoltaic power generation, in the interest of energy conservation and environmental protection.

Technical information: Monocrystalline silicon solar cells have a conversion efficiency of over 17%, while polycrystalline silicon solar cells achieve over 15%.

Scope of application: Widely used in photovoltaic power generation systems (solar power plants, BIPV, household-use solar systems and other application products and facilities) of different forms and different sizes.

Technological features: Innovation, high efficiency and low cost -- large-scale use of self-made core equipment and independently developed processes and technologies. Among them, the cost of self-made core equipment is only 1/3-1/2 of that of similar equipment.



### Status of application

Has been promoted and applied; can be put into industrial production in developing countries; mature product; ready for use after simple training; high up-front cost but low cost of use; and easy self maintenance.

Has been used as a domestic home appliance in remote regions in Uganda. Such application has not only met power demand of households in the region but also advocated the low carbon, green ideas and facilitated the use of the product.



### Technology Provider

Organization: Leshan Xintianyuan Solar Power Co., Ltd

Contact: Feng Jiabao

Tel: +86-833-3515021

E-mail: fengjiabao@126.com

Address: 9 Jianye Avenue, Hightech Development Zone, Leshan, Sichuan, P.R.C.

Postcode: 614000

# 9. Solar photovoltaic and photothermal utilization and integrated solar building technology and equipment



### Technology overview

**Functions and use:** This equipment is used for solar photovoltaic power generation and water-heating. It can be used to provide domestic water and assistant heating in winter.

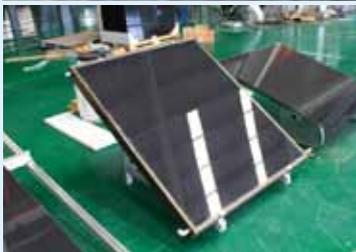
**Technical information:** For photovoltaic and photothermal utilization: photovoltaic conversion efficiency: 8.5%; photothermal conversion efficiency: 35%-45%. Equipment dimensions:  $1400 \times 1200 \times 100\text{mm}$  (L  $\times$  W  $\times$  T). For solar buildings: power generation efficiency: 8.5%; light penetration rate: opaque-30% transparent, adjustable; dimensions:  $2.6 \times 1.1\text{m}$ ,  $1.3 \times 2.2\text{m}$ ,  $1.1 \times 1.3\text{m}$ , and  $1.1 \times 0.65\text{m}$ .

**Scope of application:** Can be installed on roofs or in sunny areas on the ground, and combines solar power generation with building materials. The generated power can be used with storage cells for off-grid or on-grid usage.

**Technological features:** Effectively combines buildings with photovoltaic power generation to meet the needs of buildings, produces the desired visual effect and connects to grids. It is an efficient product for energy conservation and emission reduction. In addition, it uses solar energy to generate power and heat and improves the overall utilization rate of solar energy. While generating heat, it also lowers solar cell panel temperature and improves the efficiency of power generation.

### Status of application

Can be put into commercial production in developing countries; mature product; no training is needed; low use cost; high initial input cost but low subsequent use cost; and users can perform their own maintenance .



### Technology Provider

Organization: Enn Solar Co., Ltd

Contact: Xingbo Huang Tel: +86-316-2596329 E-mail: huangxingbo@enn.cn

Address: No.106 Huaxiang Road, Economic and Technological Development Zone, Langfang, Hebei Province, P.R.C. Postcode: 065001

## Solar energy

# 10. Polycrystalline silicon solar cell manufacturing technology



### Technology overview

Functions and use: The technology is used for solar photovoltaic generation. Polycrystalline silicon is the main material used in the making of solar cells. Polycrystalline silicon solar cells are the mainstream product in the international photovoltaic market at present. Such products can partially replace mainstream fossil energy and provide clean electric energy.

Technical information: Polycrystalline silicon solar cells achieve an average photoelectric conversion efficiency of 16.5%, with a product range of 1W~350W, which can be flexibly adjusted according to market demand.

Scope of application: Suitable for residential

use, oil transmission pipe cathode protection and independent power supply in remote regions. Among these, the widest and the fastest-developing application involves the use of integrated photovoltaic buildings (including roof solar cell panels, solar cell tiles and solar cell glasses for commercial buildings) on building roofs to establish household-use or public photovoltaic systems. In addition, large-scale outdoor solar photovoltaic off/on-grid power plants have entered a stage of large-scale promotion and application.

Technological features: Solar photovoltaic power generation is now a mature technology, offering such advantages as safety, reliability, noise-free operation, non-polluting, wide energy availability, no geographical restrictions, no fuel consumption, no mechanical transmission components, low equipment fault rate, simple maintenance, unattended operation, short construction cycle, choice of size, no need for power transmission line and blends in well with architectural surroundings. These advantages are unrivaled by conventional power generation technologies.

### Status of application

Has been promoted and applied; can be put into industrial production in developing countries; mature product; special training is needed; high initial input cost but low subsequent use cost; and users can perform their own maintenance .

### Technology Provider

Organization: Yingli Green Energy Holding Company Limited

Contact: WangYu

Tel: +86-312-8631968

E-mail: wangyu@yinglisolar.com

Address: Science & Technology Industry Parks, No.3399 North Chaoyang Road, Baoding, Hebei Province, P.R.C. Postcode: 071051

# 11. High-efficiency, photovoltaic DC water lifting system

### Technology overview

Functions and use: The whole system consists of 3 parts: a solar power generation system, a control system and a water making system. The solar cell array consists of several serial solar cell components. It absorbs solar radiation and converts it into electric power. With conversion, it can directly drive high-efficiency, photovoltaic DC water pumps to work. Maximum lift: 200m; and flow: 0.3m<sup>3</sup>--20m<sup>3</sup> (high flows can be achieved by connecting several pumps in parallel).

Technical information: Maximum lift: 200m; flow: 0.3m<sup>3</sup>--20m<sup>3</sup>.

Scope of application: Desert control, seawater desalination, agricultural irrigation, domestic water, forest irrigation, urban waterscape, landscape fountain water, grazing grassland, island water supply and water treatment work.

Technological features: DC motors feature high thermal energy conversion efficiency and reduce the usage of solar photovoltaic panels by 30%. Piston pump efficiency can reach 85%. Other features include easy installation, flexible operation and minimal maintenance.

### Status of application

Can be put into industrial production in developing countries; ready for use after simple training; high initial input cost but low subsequent use cost; and users can perform their own maintenance, low maintenance cost.

### Technology Provider

Organization: Gansu Natural Energy Research Institute/UNIDO international Solar Energy Center for Technology Promotion and Transfer

Contact: Jia Lingping

Tel: +86-931-8386635

E-mail: [jialingping@unido-isec.org](mailto:jialingping@unido-isec.org)

Address: 20 Renmin Road, Lanzhou, Gansu Province, P.R.C. Postcode: 730000



## Solar energy

# 12. Solar Receiver—coated steel tube



### Technology overview

**Functions and use:** It is a kind of solar selective absorbing coating product able to be applied in medium and high-temperature (300-350°C) air. The coating absorbs the sunlight and heats the heat transfer working fluid inside the pipe to 300°C, to directly or indirectly drive the turbine to produce electricity or steam.

**Technical information:** The absorption ratio of such tube can be greater than 95%, and the emission ratio lower than 8% when in 300°C. Moreover, the coating has shown excellent performance in long-term operation,

almost has no attenuation.

**Scope of application:** Has been promote and applied in Fresnel thermal power generation or industrial steam system.

**Technological features:** Himin solar receiver has intellectual property rights. The selective coating film has shown stable performance during 1500h age testing when in 300-350°C air.

### Status of application

mature product; special training is required;before use; high initial input cost but low subsequent use cost, maintenance personnel need to be trained or a

maintenance station needs to be established.

Himin solar receiver has been applied in Fresnel thermal power generation all over the world. The 1.4MW system operated in 2009, and 30MW is under construction, will operate in 2012 in Spain. The pilot systems in Italy, France, Australia and India shows good test result.

Himin built a 2.5MW Fresnel solar thermal power demonstration project in China Solar Valley, which was the first MW-level Fresnel solar thermal power station and worked well.

### Technology Provider

Organization: Himin Solar Co.,Ltd.

Contact: Emily

Tel: +86-534-5089347

E-mail: trade@himin.com

Address: Sun-Moon Mansion, Solar Valley Road, Economic-development Zone, Dezhou, Shandong, P.R.C.

Postcode: 253000

### 13. Phenolic foam

#### Technology overview

Functions and uses: Improve the insulation performance of the solar water heaters insulation and extend their service life.

Technical indicators: Good insulation properties, thermal conductivity coefficient :0. 025w / m • k; wide operating



#### Status of application

The product has been put into use, and is mature. No training is needed. The initial investment is large. The subsequent use cost is low. The product is maintenance free.

temperature range and strong heat resistance: may be operated at -196 °C to 150 °C (can accommodate transient temperature of 250 °C); environmentally friendly due to the use of CFC-free foaming technology and generate no toxicity and odor during production and use; durable, corrosion and aging resistant, and free from obvious aging after long-term exposure to sunlight. acid and salt corrosion-resistant.

Application scope: Flat plate solar collectors, solar water heater insulation tank.

Features: Phenolic foam can withstand high temperature and offers good insulation properties. It can provide thermal insulation performance on the flat plate solar collectors and simplify the production process. On the insulation tank, it can solve issues such as polyurethane aging /contraction.

#### Technology Provider

Organization: Qingdao Economic and Technical Development Zone Haier Water Heater Co., Ltd

Contact: Zhuang Changyu

Tel: +86-532-88937605

E-mail: zhuangcy@haier.com

Address: Haier Industrial Park, 1 Haier Road, Qingdao, Shandong Province, P.R.C.

Postcode: 266109



## Solar energy

# 14. A new type of AZO coated glass for thin film solar cells

### Technology overview

Functions and uses: Applied to silicon thin film solar cell manufacturing and can make various transparent conductive films on a variety of different materials according to the requirements. The silicon thin-film solar cell has become the world's most active area of photovoltaic research as it significantly reduces the cost of solar cells and help solve the energy and environmental issues.

Technical indicators: New ZnO: AlAZO is a typical n-type semiconductor film whose band gap is close to 3.3 eV, delivers high transmittance and low resistivity in the visible range, cheap, abundant, non-toxic. Moreover, under high temperature conditions, its composition is less likely to inter-diffuse with hydrogen and deposited on the glass to become the front pole of the cell. Hence, the new silicon AZO coated glass has become the main direction of development of thin film solar cells.

Features: have a full set of production process technology and production equipment manufacturing capability of the new AZO coated glass, may carry out new AZO coated glass technology services according to the needs of the developing countries, provides new AZO coated glass production equipment, and be responsible for training local technicians to allow them

to finish the maintenance, servicing of their equipment and other work independently.

### Status of application

The product may be industrialized in the developing countries. Special training is needed. The initial investment is large. The subsequent use cost is low. Maintenance by the customers is permitted.

### Technology Provider

Institution: China National Building Materials Group Corporation

Contact: Zhi Xiao

Tel: +86-10-88423159

E-mail: zhx@cnbm.com.cn

Add: 2 Zizhuyuan South Road, Haidian District, Beijing, P.R.C.

Postal Code: 100048

### 15. Production process of solar water heater



#### Technology Provider

Institution: Guangdong Rongsheng Electric Holding Co., Ltd.  
Contact: Shi Dongjing  
Tel: 26936962  
E-mail: 522237164@qq.com  
Add: 8 Rongguiqiao East Road, Shunde District, Foshan, P.R.C.  
Postal Code: 528303

#### Technology overview

Functions and uses: Use of solar collector technology to heat water for showers, cleaning, etc

Technical indicators: Vacuum tube solar collector production technology, water storage/insulation technology, water heater production process

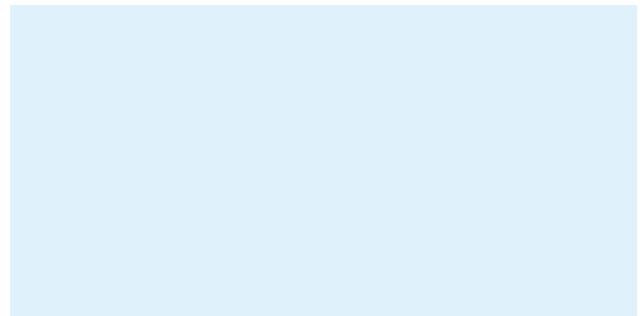
Applications: Shower, water heating, etc

Application scope: Shower, water heating, etc.

Features: high heat collection efficiency, long holding time, ability to achieve effective heat collection under low-temperature weather, rainy weather conditions.

#### Status of application

The product may be industrialized in the developing countries. Special training is needed. The initial investment is large. The subsequent use cost is low. Training of the maintenance personnel or establishment of maintenance points is needed.



## Solar energy

# 16. Stand-alone solar photovoltaic generation system



### Technology overview

**Functions and uses:** This product combines the solar photovoltaic cells and battery energy storage technology to provide the residents in remote areas or other residents without power supply with steady and continuous power supplies, meet the demands of local people for power supply without building a power grid, and may reduce the once-off investment cost of the government significantly.

**Technical indicators:** Output power: 100W; 500W, 1kW, 3kW and 5kW, etc.; single-phase 220V/11V AC power supply can be achieved; maximum power tracking efficiency of photovoltaic cells higher than 99.8%; maximum system efficiency: 96.5%; a variety

of over /under voltage, over current / short circuit protection and detection and other functions are available; back-up battery voltage: 12V/24V/48V/96V (optional).

**Application scope:** may be used in areas without power supplies in the developing countries that abound in solar energy resources to meet the demands of local residents for power supplies without building a power grid.

**Features:** Advanced digital control technology, highly efficient solar cell maximum power tracking capability and perfect protection / monitoring measures; high overall efficiency of the system, small footprint, and high reliability.

### Status of application

The technology has been put into use, may be industrialized in the developing countries. Simple training is needed. The use cost is low. The initial investment is large. The subsequent use cost is low. Maintenance by the customers is permitted.

### Technology Provider

Institution: College of Electrical Engineering, Zhejiang University

Contact: Li Wuhua

Tel: +86-571-87952416

E-mail: woohualee@zju.edu.cn

Add: College of Electrical Engineering, Zhejiang University, 38 Zheda Road, Xihu District, Hangzhou, P.R.C.

Postal Code: 310027

### 17. Solar cell



#### Technology overview

Functions and uses: Solar power generation, used for power plants connected to the grids or independent power plants.

Technical indicators: Electrical standards

Application scope: power grids and electrical appliances

Features: Green, clean

#### Status of application

The technology has been put into use, may be industrialized in the developing countries and is mature. Simple training is needed. The initial investment is large. The subsequent use cost is low. Maintenance by the customers is permitted.

#### Technology Provider

Institution: Northwest China Office, Yingli Green Energy

Contact: Kang Jian

Tel: +86-931-8738168

E-mail: [yingli@yinglisolar.com](mailto:yingli@yinglisolar.com)

Add: 4-6 Guangchang South Road, Chengguan District, Lanzhou, Gansu Province, P.R.C.

Postal Code: 730000

## Solar energy

# 18. Solar cell modules

### Technology overview

Functions and uses: the solar cell modules are solar power generation devices that convert the sunlight directly into DC power. They may be used individually, in series or in parallel to obtain different power. The modules consist of monolithic high-efficiency solar cells, EVA film, low-iron tempered glass and the back membrane.

Technical indicators: Power of the modules: 5W to 300W; service life: 25 years.

Application scope: independent solar power plants or grid-connected power plants; coastal aids to navigation, communications, road transport, building lighting, street lights (including wind and solar street lights).

Features: High area ratio power, long life and high reliability. The input-output ratio of production of energy used for solar cell modules reaches up to 10-15 times, the return on investment is high. The modules can be used as buildings materials on building roofs and facades so that the building is integrated and are easy to install.

### Status of application

The product is mature. Special training is needed. The initial investment is large. The subsequent use cost is low. Training of the maintenance personnel or establishment of maintenance points is needed.



### Technology Provider

Institution: Shanghai Solar Energy S&T Co., Ltd.

Contact: Wen Jie

Tel: +86-21-64895099

E-mail: tywmm@sohu.com

Add: 555 Shennan Road, Minhang District, Shanghai, P.R.C.

Postal Code: 201108

# 19. Solar photoelectric/photothermal building integrated system/module

### Technology overview

Functions and uses: to produce heat using solar power and replace part of the structural layer of the buildings as building blocks.

Technical indicators: the product is sized 1200 \* 800mm (hereinafter referred to as "modules"; size to be adjusted depending on the building requirements); condenser focal length = 11.3652mm, height = 49.9149mm, opening = 40mm, silicon surface = 16.25mm, condensation multiplication: 2.462; each module (2) Supply voltage: 12 volts, inverter voltage : 220 volts; peak power: 250 watts ; electricity that may be supplied each day: 1000 watt-hours; domestic hot water provided: provide 60 kg /day; with drainage, cold, anti- rain and other functions, its configuration and installation fully meet the requirements for integration with the buildings.

Application scope: building walls, roofs (the north side is ok), balcony, sun-shade, doors and windows, etc.

Features: the annual power generation performance is more stable than that of common PV modules. Moreover, heat may be generated, the degree of concentration of the product is high, and the cost-performance ratio is good.

### Status of application

The product may be industrialized in the developing countries. Simple training is needed. The use cost is low. Training of the maintenance personnel or establishment of maintenance points is needed.

### Technology Provider

Institution: Nanjing Nanzhou New Energy R&D Co., Ltd.

Contact: Luo Junjie

Tel: +86-15251811539

E-mail: nanzhounewenergy@126.com

Add: 39 Yinhu Road, Science Park, Jiangning District, Nanjing, Jiangsu Province, P.R.C.

Postal Code: 211112

## Solar energy

### 20. Solar PV inverter



#### Technology overview

Functions and uses: Use the PV inverter to convert the DC electricity collected by the solar cell panel into AC electricity to supply the grid or household appliances directly. Suitable for home application or power-plant type solar power generation systems.

Technical indicators: Single phase inverter, power: 3kw, 4kw, 5kw; three phase inverter: 10kw, 17kw, 20kw, 30kw, 50kw, 100kw, the maximum conversion efficiency reaches 98%.

Application scope: used for the roof power generation systems, PV building integration, large-scale photovoltaic power plants and other solar power generation systems to convert DC

electricity into AC electricity.

Features: Stable performance, complete product line, can be used in series, high conversion efficiency, unattended operation, remote monitoring, and operation according to the program automatically.

#### Status of application

The technology has been put into use, may be industrialized in the developing countries and is mature. No training is needed. The use cost is low. Maintenance by the customers is permitted.

#### Technology Provider

Institution: Shanghai Macsolar Power Co., Ltd.

Contact: Li Chengrong

Tel: +86-21-50720537

E-mail: jason.li@macsolar-power.com

Add: Building 9, 590 Ruiqing Road, Zhangjiang Hi-tech Park (east side), Pudong, Shanghai, P.R.C.

Postal Code: 201201

# 21. Solar water heater



### Technology overview

Functions and uses: To heat water using solar power.

Application scope: households and institutions.

### Status of application

The product may be industrialized in the developing countries. No training is needed. The use cost is low. The product is maintenance-free.

### Technology Provider

Institution: Shandong Jude Solar Technology Co., Ltd.

Contact: Xu Changhe

Tel: +86-632-7798885

E-mail: sddfjgs@yahoo.com.cn

Add: 266 Zhongxing Avenue, Yicheng District, Zaozhuang, Shandong Province, P.R.C.

Postal Code: 277300

## Solar energy

# 22. Solar water heater

### Technology overview

Functions and uses: Household hot water supply, central heating.

Application scope: provide the solar collector system for households, schools, hotels, staff quarters, bathrooms and other areas.

Features: Timing control, fully automatic replenishment functions, automatic monitoring of water tank, high collector efficiency, high heat transfer efficiency, long service life.

### Status of application

The product has been put into use, may be industrialized in the developing countries and is mature. Simple training is needed. The initial investment is large. The subsequent use cost is low. The product is maintenance free.

### Technology Provider

Institution: Xinjiang New Energy Research Institute  
Contact: Reziwang  
Tel: +86-991-3680725  
E-mail: xjxnyys@xj.xninfo.net  
Add: 40 Beijing South Road, Urumqi, Xinjiang, P.R.C.  
Postal Code: 830011



# 23. Solar water pump products and systems

### Technology overview

Functions and uses: Use solar power generated to drive the water pump system to work; can be used for crop irrigation, drinking water for humans and animals, fish breeding, drainage and other purposes.

Technical indicators: Photoelectric conversion efficiency: 8.5%. Panel Size: 1.1 \* 1.3m, 2.2 \* 2.6m and so on.

Application scope: suitable for areas that abound in solar resources, especially for remote areas that lack power supply or have no power supply.

Features: Solar photovoltaic power direct drive DC motor; the system is reliable, safety, noise-free, easy to install and requires little post-maintenance.

### Status of application

The product is mature. Simple training is needed. The use cost is low. The initial investment is large. The subsequent use cost is low. Maintenance by the customers is permitted.

### Technology Provider

Institution: Center for Integrated Technologies of ENN Solar Energy

Contact: Huang Xingbo

Tel: +86-316-2596329

E-mail: huangxingbo@enn.cn

Add: 106 Huaxiang Road, Langfang Economic & Technological Development Zone, Hebei Province, P.R.C.

Postal Code: 065001



## 24. Grid-PV inverter

### Technology overview

Functions and uses: used for solar grid power generation.

Technical indicators: rated AC output power: 5KW/100KW; largest array open circuit voltage: 900Vdc; maximum array input current: 500A; maximum power point tracking range: 450-820Vdc; rated voltage:  $380V \pm 7$  (GB); total current waveform distortion rate: <3% (rated power); power factor:  $\geq 0.99$  (rated power); maximum efficiency: 97%

Application scope: Solar grid power generation systems

Features: 1, high-efficiency power conversion technology 2, high-performance inverter SVPWM technology to improve power quality 3, stable and reliable 3-phase inverter control technology 4, advanced MPPT technology to achieve maximum energy capture 5, minimum non-detection area island detection and protection technology 6, highly adaptable, robust software PLL technology of grid voltage.



### Status of application

The product has been put into use, may be industrialized in the developing countries and is mature. Simple training is needed. The initial investment is large. The subsequent use cost is low. The product is maintenance free.

### Technology Provider

Institution: The 36th Research Institute of China Electronics Technology Group Corporation

Contact: Cheng Xiaoguang

Tel: +86-573-83671230

E-mail: cyb@jecor.com.cn

Add: Building 13, 1369 Chengnan Road, Jiaxing, Zhejiang Province, P.R.C.

Postal Code: 314001

# 25. Stainless steel ceramic liner solar water heater replacement technology - ceramic liner solar water heater

### Technology overview

Functions and uses: an important component of the solar water heaters that replaces the ordinary stainless steel liner.

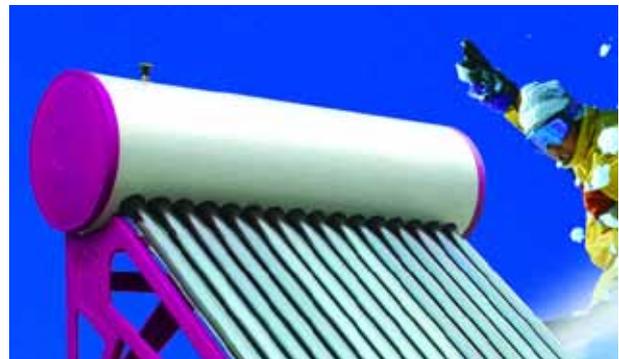
Technical indicators: Mechanical strength, hardness, wear resistance superior to those of steel, plastic and other materials; the acidity of the non-axial part is usually no more than 95, and the alkali resistance is generally 79-88. The thermal conductivity is 1.5W/MK, the thermal stability is good, and the product can withstand exchange of hot and cold at 250 °C to 20 °C while remaining in good condition, and can store considerable heat.

Application scope: Solar water heaters

Features: strong corrosion resistance, high mechanical strength, double insulation, hygiene, clean and safe, long service life.

### Status of application

The product has been put into use, and may be industrialized in the developing countries. Simple training is needed. The initial investment is large. The subsequent use cost is low. The product is maintenance free.



### Technology Provider

Institution: Zibo Jianci Optical-thermal Technology Co., Ltd.

Contact: Zhang Fengqiao

Tel: +86-15964663564

E-mail: xiaomam.2007@163.com

Add: Unit 10, #8 China Fortune Earthenware Market, Zibo, Shandong, P.R.C.

Postal Code: 255100

## Small hydropower

# 26. Cost-effective small hydropower electromechanical technology

### Technology overview

Functions and use: Small hydropower is China's richest renewable energy at present, accounting for 98% of the total national renewable energy. Small hydropower is particularly suitable for rural regions in developing countries. Cost-effective small hydropower electromechanical technology is applicable to regions with small hydropower resources. It can improve returns from project investment, promote small hydropower development and meet power needs in rural regions and reach those not covered by large grids.

Scope of application: Various products have been exported to dozens of countries and regions and successfully applied there. The technology can be used in inland, mountainous, forest, tropical, subtropical and temperate regions rich in water resources.

Technological features: Simple structure, reliability and easy maintenance. Technology and product standardization has become an essential means for lowering construction cost, speeding up small hydropower building and promoting small hydropower technology transfer and equipment trade. Self-maintenance equipment is adopted to

reduce cost and improve performance. Unattended or less-attended automatic equipment is used, offering simple and reliable performance.

### Status of application

Has been promoted and applied; mature product; ready for use after simple training; low user cost; and maintenance personnel need to be trained or a maintenance station needs to be established.

The technology is under the Light up Africa Program. It has been used to build 100 village-level micropower plants in 10 countries including Cameroon, Ethiopia, Kenyan and Liberia and one 1MW small hydropower demonstration plant each in Zambia and Sierra Leone.

### Technology Provider

Organization: International Center on Small Hydro Power (ICSHP)

Contact: : Wei Jianghui

Tel: +86-571-87132785

E-mail: [weijianghui@icshp.org](mailto:weijianghui@icshp.org)

Address: 136 Nanshan Road, Hangzhou, Zhejiang Province, P.R.C.

Postcode: 310002

# 27. Small hydropower/micro hydropower technology and equipment



### Technology overview

Functions and use: Small hydropower can increase energy supply, improve energy structure, protect the ecological environment and reduce greenhouse gas emissions. Small hydropower has the advantages of distributed power supply and can rapidly resume power supply. Micro hydropower is a type of renewable energy that is economical and offers large development output. It is suitable for installation and use in remote mountainous regions with insufficient power supply.

Technical information: small hydropower: 100KW – 50,000KW; and micro hydropower: <100KW.

Scope of application: rural areas, remote regions and populated regions with rich hydropower resources.

Technological features: China has built 45,000 small hydropower plants, with a total installed generating capacity of over 51 million KW and an annual power output of over 160 billion KW. Both the technology and equipment are mature. The Asia and Pacific Small Hydropower Training Center has trained more than 1,000 students from over 100 countries.

### Status of application

Has been promoted and used; can be put into industrial production in developing countries; ready for use after simple training; low operating costs; and users can carry out their own maintenance. Through short- and long-term cooperation projects between the Chinese and Vietnamese science and technology ministries, the two countries have strengthened technological cooperation. More than 3,000 sets of small hydropower/micro hydropower equipment have been used in Viet Nam.

### Technology Provider

Organization: Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power

Contact: Lin Ning

Tel: +86-13064710512

E-mail: nlin@hrcshp.org

Address: 122 Xueyuan Road, Hangzhou, Zhejiang Province, P.R.C.

Postcode: 310012

## Small hydropower

### 28. Small hydropower automatic control technology

#### Technology overview

Functions and use: The application of small hydropower automatic control systems can improve the operational reliability of hydropower plants as well as the quality of power output, reduce both the number of operating personnel required and their workload, raise the operational stability of the grid and optimize plant operations.

Technical information: System MTBP:  $\geq 17,000$ h; usability:  $\geq 99.9\%$ ; and maintainability (with spare parts on site):  $\leq 0.5$ h

Scope of application: The SDJK High Voltage Unit Smart Microcomputer Automatic Control System is applicable to 6.3KV and  $< 50,000$ KW high voltage units in small rural hydropower plants, while the DZWX Low Voltage Smart Control System is suitable for 400V and  $< 630$ KW low voltage units used in small rural hydropower plants.

Technological features: Flexible system combinations, and high applicability. Based on power plants' different needs and actual configuration of the equipment, a total computer control system may be designed or used with conventional equipment to achieve varying degrees of automatic control. The systems are applicable in both newly-built power plants and as part of the renovation of old power plants.

#### Status of application

Has been installed and used; can be put into industrial production in developing countries; mature product; ready for use after basic training; inexpensive to use; high initial input cost, but low subsequent use cost; and users can carry out their own maintenance.

The system has been successfully operating at TAISHIR Hydropower Plant (with an installed generating capacity of  $3 \times 3450$ KW+ $1 \times 650$ KW) for 3 years.

#### Technology Provider

Organization: Hangzhou Yatai Hydropower Equipment and Technology Co., Ltd.

Contact: Xu Wei

Tel: +86-13957111096

E-mail: xuw2000@163.com

Address: No.122 Xueyuan Road, Hangzhou, Zhejiang Province, P.R.C. Postcode: 310012

# 29. Micro hydropower technology

## Technology overview

Functions and use: Micro hydropower generation technology converts micro hydropower resources from small rivers and creeks into civilian power. Micro hydropower plants are unattended plants which generate power mainly from runoff, operate off-grid and require no transformer equipment. Their power output can be directly used as the power source for lighting, home appliances and small agricultural byproduct processing equipment. It can meet the needs of several dozens households.

Technical information: Output power: 0.1-100 KW; output voltage: single phase 110/230V, 3 phases 230/400V and 400/690V; and output frequency: 50/60 Hz.

Scope of application: Micro hydropower generating units are serial products whose design is based on the distribution of local micro hydropower resources and the power demands of rural households. Users simply select generating units according to the local micro hydropower resources and power use demand. There are rich micro hydropower resources in hilly regions in China, Southeast Asia, Africa and Latin America.

Technological features: Micro hydropower plants involve very little installation work. Their operation, maintenance and repair have been kept simple to facilitate users. Only small ditches are needed to channel water to micro hydropower plants and this has no adverse affect on the local ecological environment.

## Status of application

Has been promoted and applied; can be put into industrial production in developing countries; mature product; simple training is needed; low use cost; and users can perform their own maintenance .

### Technology Provider

Organization: Nanjing Research Institute for Agriculture Mechanization

Contact: Liu qin

Tel: +86-25-84346211

E-mail: kjc211@163.com

Address: 100 Liuying, Zhongshanmenwai, Nanjing, Jiangsu Province, P.R.C. Postcode: 210014

## Biogas and other biomass energies

### 30. Biogas production of organic waste utilization



#### Technology overview

**Functions and use:** This technology can reduce waste generation, perform harmless treatment and turn waste into energy. While disposing of waste, it also generates clean renewable energy.

**Technical information:** Widely applicable raw materials, highly mechanized and automated, specific gas output capacity:  $> 1 \text{ m}^3/\text{m}^3\cdot\text{d}$ ; and biogas' methane concentration:  $>55\%$ .

**Scope of application:** Industrial organic wastewater (waste) treatment, livestock breeding waste treatment, domestic waste and sewage, sludge treatment and agricultural waste treatment.

**Technological features:** Wide range of raw materials, mature technology, no secondary pollution, low operating cost and recoverable clean energy.

#### Status of application

Has been promoted and applied; can be put into industrial production in developing countries; mature product; special training is required before use; inexpensive to use; and maintenance personnel need to be trained or a maintenance station needs to be established.

It has been used in Guyana. In a pilot scheme in two Egyptian provinces, a total of 5 Chinese-style household-use biogas systems have been built for middle-income households.

#### Technology Provider

Organization: Guangzhou Institute of Energy Conversion (GIEC), Chinese Academy of Sciences (CAS)

Contact: Zhou Zhouyu

Tel: +86-20-87057400

E-mail: zhouzy@ms.giec.ac.cn

Address: No.2, Nengyuan Rd, Wushan, Tianhe District, Guangzhou, P.R.C. Postcode: 510640

### 31. Soft household-use biogas-generating pit

#### Technology overview

**Functions and use:** This product is a new type of biogas production equipment developed to meet the biogas development needs of rural areas. It has 3 volume specifications: 6m<sup>3</sup>, 8m<sup>3</sup> and 10m<sup>3</sup> (which are specified in accordance with the National Rural Household-Use Digester Standard). When fermentation process conditions are met, the biogas generated by one biogas digester can meet the basic cooking needs of one rural household. It is suitable for application and use in rural areas.

**Technical information:** The product has been awarded a national patent in China and also passed (CQC) ISO9001:2000 certification. It has 3 volume specifications: 6m<sup>3</sup>, 8m<sup>3</sup> and 10m<sup>3</sup> (which are specified in accordance with the National Rural Household-Use Biogas Digester Standard). The soft cover has a service life of 8-10 years.

**Scope of application:** Household-use biogas digester in rural areas.

**Technological features:** (1) The product employs a combined structure of a fixed brick pit (the pit wall part) plus a hanging active soft cover. (2) High durability, with a long service life in normal use of 6-8 years. If additional cover material is added to the digester surface, the service life of the soft cover can be extended to 8-10 years. (3) A barostat may be installed at the end of the biogas transmission pipe to improve the biogas stove's operation and efficiency. (4) The hanging soft cover is easy to lift and install. It facilitates safe material



feeding and discharge and can prevent accidents. (5) Simple to maintain. If the hanging soft cover wears out while in use, it can be quickly repaired without affecting the performance of the biogas digester. (6) Simple structure, easy construction, short construction time (usually 2-3 days), and good gas sealing. Compared with traditional digesters, this new digester can cut construction cost by over 20%. And (7) this new biogas digester is suitable for factory and large-scale production.

#### Status of application

Has been promoted and applied; can be put into industrial production in developing countries; mature product; ready for use without training, inexpensive to use, and users can carry out their own maintenance.

500 sets of these digesters have been transferred to Canada, South Africa and other countries.

#### Technology provider

Organization: Chengdu Datangren Biogas Technology Development Co., Ltd.

Contact: Tang Bing

Tel: +86-13060078422

E-mail: bdy001@163.com

Address: 70 Wuhou Avenue Shuangnan Section, Chengdu, P.R.C.

Postcode: 640041

## Biogas and other biomass energies

### 32. Rural household-use biogas technology

#### Technology overview

**Functions and use:** This technology improves upon traditional household-use biogas pool in China. It can convert human and livestock excrement and crop straws into household-use biogas and thus constitutes an ideal biomass energy for energy conservation and emission reduction.

**Technical information:** An improved version based on China's national biogas production standard. Each biogas pool has a capacity of 8-10m<sup>3</sup>. The biogas pool can be built into a "Three-in-One" or "Four-in-Four" compound biogas production base along with the water closet, the kitchen and the green house.

**Scope of application:** Tropical, subtropical and temperate rural regions with conditions for livestock breeding in Africa and Asia.

**Technological features:** Good heat preservation and high gas output. Biogas liquids and biogas

residues can be recycled and reused to replace pesticides and fertilizes and increase crop yield; can protect the ecological environment; biogas liquids can improve seed budding rate; reduce the intensity of women's work; and promote the fattening of livestock.

#### Status of application

Has been promoted and applied; can be put into industrial production in developing countries; ready for use after simple training; high initial input cost but low subsequent use cost; and users can perform their own maintenance .

#### Technology Provider

Organization: Lanzhou University

Contact: Dr. Ding Wenguang

Tel: +86-931-8915589

E-mail: wgding@lzu.edu.cn

Address: Lanzhou University Center for Western Environmental and Social Development, 222 Tianshui Nanlu, Lanzhou, Gansu Province, P.R.C.

Postcode: 730000



### 33. Household-use biogas generator

#### Technology overview

Functions and use: Uses modified plastics as the main material and the injection molding technique to achieve the large-scale, standardized production of gas generators. The technology fills a niche in the rural household-use biogas device market where there is currently no mature industrialized product.

Technical information: Volume: 6m<sup>3</sup>; gas leakage: <1%/24h when pressure is ≤8kPa; daily average gas output (effective volume): 0.3~0.5m<sup>3</sup>; and strength safety coefficient (k): ≥2.65.

Scope of application: Rural households of 3-6 persons.

Technical features: Polypropylene, the modified plastic used in the generator, is an environment-friendly, recyclable and reusable material, with good mechanical, anti-seismic, pressure-resistant, air-tight, water-resistant, heat-preserving, corrosion-resistant, anti-aging, non-toxic and non-polluting properties. Product features include industrial production, stable quality, simple construction, easy installation, split production, on-site assembly, easy transportation, self-releasing pressure, self-draining liquid and slag, simple management and high pool construction rate and a service life of over 20 years.

#### Status of application

Has been promoted and applied; can be put into industrialized production in developing countries; ready for use after simple training; low use cost; and free from maintenance.

#### Technology provider

Organization: Biogas Scientific Research Institute, Chinese Ministry of Agriculture

Contact: Zheng Shixuan

Tel: +86-13808016899

E-mail: shixuanz@126.com

Address: 4-13, South Renmin Road, Chengdu, Sichuan Province, P.R.C.

Postcode: 610041



## Biogas and other biomass energies

### 34. Biogas project



#### Technology overview

**Functions and use:** Through biological fermentation, domestic and livestock waste is turned into biogas. Biogas can be used for heating and power generation. It effectively disposes waste and provides new energy.

**Technical information:** corrosion-proof reactor, concealment and safety of the gas storage system, reliable purification system, and gas output rate.

**Scope of application:** Large-scale biogas projects for household use, large-scale breeding farms and plantations.

**Technological features:** Use of advanced materials for the reactor and gas storage films. Rich experience in design, installation and construction; and qualified for large-scale biogas project construction.

#### Status of application

Has been promoted and used; mature product; special training is required before use; high initial input cost but low subsequent use cost; maintenance personnel must be trained or a maintenance station should be set up.

Has cooperated with Kenyan in household-use biogas equipment and technology projects.

#### Technology Provider

Organization: Hubei Jinwei New Energy Science & Technology Co., Ltd

Contact: Ruan Wei

Tel: +86-13554321178

E-mail: [jwenergy@163.com](mailto:jwenergy@163.com)

Address: 626 Gexin Avenue, Dongxi Lake District, Wuhan, P.R.C.

Postcode: 430040

### 35. Flat spherical modified plastics biogas pool

#### Technology overview

Functions and use: This technology solves a wide range of problems in the construction of currently widely-adopted concrete biogas pools, including heavy materials, difficult transportation, varying construction quality and hard to carry out factory-based, mechanical and standardized production.

Technical information: Biogas pools made of modified plastics can fully bear the operating load at maximum working air pressure. The modified plastic is buried underground and has a long service life, which experts believe can last for over 20 years. Sealing performance meets China's national standard requirements; and gas output rate reaches  $0.3-0.5 \text{ m}^3/\text{m}^3\cdot\text{d}$ .

Scope of application: Suitable for new energy use in rural households

Technological features: Mechanical batch production; light weight and convenient transportation; convenient and fast installation; good sealing performance and free from most existing problems facing concrete biogas pits; long service life; and feeding/exit material pipes, fermentation chamber and water pressure chamber are designed to facilitate Three-in-One construction and integrated utilization.

#### Status of application

Has been promoted and applied; can be put into industrial production in developing countries; mature product; ready for use after simple training; low user cost; high initial input cost but low subsequent use cost; and users can perform their own maintenance .

#### Technology Provider

Organization: Kunming HongBiao Science and Technology Co., Ltd.

Contact: Zheng Yunfang

Tel: +86-18987173016

E-mail: zhwj4170791@163.com

Address: 2nd Floor, Unit 1, Building 7, 421 Xiyuan Road, Kunming, Yunnan Province, P.R.C.

Postcode: 650032



## Biogas and other biomass energies

### 36. Combined heat, power and manure generation technology



#### Technology overview

Functions and use: The technology uses livestock and fowl (cattle, pig, chicken and etc) excrement, crop straws, organic waste and organic waste water as raw materials to generate biogas from anaerobic fermentation. The generated power is brought into grids (or for self-use); residue heat from the power generator can not only keep the system itself warm but also be used for heating purposes in winter; generated biogas residues and biogas liquids can be used as superior quality organic manure, eventually achieving a large-scale biogas engineering technology model of zero pollutant emission, zero methane leakage and resource recycling and reuse.

Technical information: Fermentation concentration TS: 8%~12%; fermentation at medium temperature (38°C); volumetric gas output:  $\geq 1.5 \text{ m}^3/(\text{m}^3 \cdot \text{d})$ ; and power generator use efficiency: 80%.

Scope of application: Applicable to biogas projects of various sizes in different regions and climate environments.

Technological features: Achieves zero pollutant emission, zero methane leakage and resource recycling and reuse

#### Status of application

Has been promoted and applied; can be put into industrial production in developing countries; mature product; ready for use after special training; low use cost; and maintenance personnel need to be trained or a maintenance station needs to be established.

This mature technology has been widely used in China and produced dual energy and environmental benefits. The technology provider is now designing a biogas project for a chicken farm in Bangladesh and a waste water treatment and biogas project in Pakistan, and will provide key set equipment and technical services to both.

#### Technology Provider

Organization: Hangzhou Energy & Environmental Engineering Co., Ltd. (HEEE)

Tel: +86-571-86041861-8703

Address: 703, No. 118 East Fengqi Road, Hangzhou, Zhejiang Province, P.R.C.

Contact: Jing Tan

E-mail: heee-gm@163.com

Postcode: 310020

### 37. Biogas power generation engineering technology



#### Technology overview

Functions and use: Compound anaerobic digestion technology is used to generate electrical power from the treatment of biogas from cattle farms, chicken farms, waste, straw, sisal and domestic sewage.

Technical information: (1) Breeding waste-generated biogas. Near average-temperature gas output capacity:  $0.35 \text{ m}^3/\text{kgTs}$ ; (2) plantation waste-generated biogas. Near average-temperature gas output capacity:  $0.85 \text{ m}^3$ .

Scope of application: agricultural breeding waste, plantation waste, garbage and domestic sewage.

Technological features: High feeding concentration, high gas output rate, small device size, less investment, and wide scope for application.

#### Status of application

Has been promoted and used; mature product; special training is required before use; high initial input cost but low subsequent use cost, and users can carry out their own maintenance.

Sisal biogas power generation project in Tanzania: Daily sisal sewage treatment capacity: 50 tons; biogas output:  $1,200\text{m}^3$ ; digestion device capacity:  $1,700\text{m}^3$ ; generating capacity: 150kw; daily power output: 1,800kwh. Hawala domestic waste biogas project in Cuba: Daily domestic waste treatment capacity: 30 tons; biogas output:  $1,000\text{m}^3$ ; generating capacity: 60kw; daily power output: 500kwh, and the rest is supplied as gas.

#### Technology Provider

Organization: Biogas Scientific Research Institute, Ministry of Agriculture

Contact: Zheng Shixuan

Tel: +86-13808016899

E-mail: shixuanz@126.com

Address: 4-13, South Renmin Road, Chengdu, Sichuan, P.R.C. Postcode: 610041

## Biogas and other biomass energies

### 38. Complete biomass power generation technology and equipment

#### Technology overview

Functions and uses: make use of the biomass fuels power generation technology and equipment, including biomass fuels power generation boilers, biomass conveying technology and equipment, biomass collection and processing technology and equipment, sand energy forest and ecological recycling projects for biomass power generation.

Technical indicators: 12MW, 25MW, 30MW and other direct-fired biomass power generation technology, enabling power generation or cogeneration

Application scope: Industrial energy applications of agricultural/forestry residues; ecological restoration and recycling economic development of water containing sand.

Rated combustion efficiency higher than 90%, overall biomass power generation efficiency of 30%.

#### Status of application

Has been promoted and applied; can be put into industrial production in developing countries; mature product; special training is needed; high initial input cost but low subsequent use cost; maintenance personnel need to be trained or a maintenance station needs to be established.

#### Technology Provider

Institution: National Energy Group Company Limited

Contact: Zhuang Huiyong

Tel: +86-13910883668

E-mail: hyzhuang@163.com

Add: 5 Xiwu Street, Sanlitun, Chaoyang District, Beijing, P.R.C.

Postal Code: 100027

### 39. Household pulse-type biogas digester

#### Technology overview

Functions and uses: the pulse-type biogas digester may be used extensively for processing the crushed high-concentration residue containing organic wastes, for instance, man/livestock manure, crop residues, various organic wastes, wastewater and sludge, the biogas produced through anaerobic fermentation is used for cooking and lighting, and the biogas residue and the slurry are used for agriculture.

Technical indicators: (1) the main technical indicators and design parameters of the digester conforms to GB/T4750 requirements. (2) average daily gas production per unit of effective pool capacity  $\geq 0.35$  cubic meters. (3) normal storage volume  $\geq 50\%$  of daily gas production. (4) strength safety factor  $K \geq 2.86$ . (5) volume of independent household biogas digester  $\geq 1$  cubic meters, volume of combined household biogas digester  $\geq 3$  cubic meters.

Application scope: farmers and specialized livestock breeding households.

Features: Small footprint, fast pool construction, environmentally friendly materials, and low cost. Easy material charge/discharge, temperature-controlled tanks, good gas production gas-tight performance.



#### Status of application

The technology has been put into use, may be industrialized in the developing countries and is mature. Simple training is needed. The use cost is low. Maintenance by the customers is permitted.

#### Technology Provider

Institute: Nanjing Hydraulic Research Institute

Contact: Fan Baokang

Tel: +86-25-85828238

E-mail: bkfan@nhri.cn

Add: 225 Guangzhou Road, Nanjing, Jiangsu Province, P.R.C.

Postal Code: 210029

## Biogas and other biomass energies

### 40. Biomass briquette fuel technology

#### Technology overview

Functions and uses: The use of biomass (agricultural and forestry wastes and energy crops) for heating.

Technical indicators: Net

Density: 1.0 kg / m<sup>3</sup> -1.2

kg / m<sup>3</sup>; Bulk density: ≥ 600kg / m<sup>3</sup>; moisture content: ≤ 10%; size (diameter): 6mm, 8mm :length; calorific value: ≥ 4.3kwh/kg; ash content: ≤ 10; mechanical strength (quantity of less than 3mm crushed materials) ≤ 3.

Application scope: hotels, hospitals, schools and peri-urban and rural areas not covered by central heating.

Features: available for commercial, residential, industrial uses, low cost, low pollutant emission, high resource conversion rate, and high thermal efficiency of combustion.

#### Status of application

The technology has been put into use. Special training is needed.

The use cost is low. Maintenance by the customers is permitted.



#### Technology Provider

Institution: Huinan Hongri New Energy Co., Ltd.

Contact: Ms. Zhou

Tel: +86-10-82601957

E-mail: hongripublic@163.com

Add: Jiefang Street, Huinan Township, Huinan County, Jilin Province, P.R.C.

Postal Code: 135102

# 41. Biomass briquette fuel burning/utilization equipment forming

### Technology overview

Functions and uses: Biomass formed (particles) as fuel for cooking stoves, hot water boilers and steam boilers that burn biomass briquette (particles) to provide the rural residents with heat source for cooking and heating, the community residences and public buildings with heat source for heating, and the enterprises with steam heat source, alternative coal, liquefied gas, fuel oils and other petrochemical fuels.

Technical indicators: (1) cooking stove: Heating power: 2.2kW, thermal efficiency  $\geq 50\%$ , fuel consumption: 1kg / h; concentration of smoke emission  $< 8\text{mg} / \text{m}^3$ , flue gas blackness  $< \text{Ringelmann Class I}$ , CO concentration  $< 400\text{ppm}$ , NOx concentration  $< 100\text{mg} / \text{m}^3$ . (2) Hot water boiler: Thermal power :200kW-2.3, flue gas darkness  $< \text{Ringelmann Class I}$ , SO<sub>2</sub> concentration  $< 20\text{mg}/\text{m}^3$ , NOx concentration  $< 150\text{mg}/\text{m}^3$ . Automatic feeding. (3) steam boiler: Thermal power :200kW-2.3, flue gas darkness  $< \text{Ringelmann I}$ , SO<sub>2</sub> concentration  $< 20\text{mg}/\text{m}^3$ , NOx concentration  $< 150\text{mg}/\text{m}^3$  Automatic feeding.

Application scope areas with the supply of biomass briquette (particles) fuels and power supply.

(2) Features: (1) cooking stove: adopt the semi-gasification from the top down method, equipped with a micro-fan; ability to adjust the primary and secondary air; special hearth materials. (2) Hot water boilers and steam boilers: Advanced burner and furnace structure featuring high degree of mechanization.

### Status of application

The technology has been put into use, may be industrialized in the developing countries and is mature. Simple training is needed. The use cost is low. Maintenance by the customers is permitted.

### Technology Provider

Institution: Beijing Shengchang Bioenergy S&T Co., Ltd.

Contact: Cao Xiurong

Tel: +86-10-60215442-8024

E-mail: cxrustb@163.com

Add: 12 Guangmao Avenue, Daxing Industrial Development Zone, Beijing, P.R.C.

Postal Code: 102600

## Biogas and other biomass energies

### 42. Biomass (mostly straw) gasification

#### Technology overview

Functions and uses: Biomass (mostly straw) gasification is a biomass thermochemical conversion technology that converts the biomass into clean gas, which is piped to the home of the residents as heat source for cooking or to the gas fired power plants for power generation.

Technical indicators: Gas calorific value: 4200-5500kJ/Nm<sup>3</sup> ; gasification efficiency: 68% -72%; content of gas, tar and ash produced : ≤20mg/Nm<sup>3</sup>.

Application scope: rural areas that abound in biomass resources and remote hilly areas.

Features: 1. Using the downdraft gasification structure, part of the tar can be cracked in the hot coke layer to reduce the tar content of gas; 2. Simple structure, easy to install, maintain and operate; safe and reliable operation

#### Status of application

The technology has been put into use and is mature. Simple training is needed. The initial investment is large. The subsequent use cost is low. Maintenance by the customers is permitted.

Cambodia 300KW gasification power generation project has been put into operation; Burma 300KW and 60KW gasification projects have been put into operation.



#### Technology Provider

Institution: Liaoning Energy Research Institute  
 Contact: Ren Yongzhi  
 Tel: +86-13050682217  
 E-mail: xny1@lnsnys.com  
 Add: 3 Kefei Road, Yingkou, Liaoning Province, P.R.C.  
 Postal Code: 115000

### 43. Biomass gasification and combustion technology



#### Technology overview

Functions and uses: to use the combustible gas generated through gasification of the solid biomass to replace oil, heavy oil, diesel and petrol.

Technical indicators: Thermal efficiency of biomass gasification System: 80% -90%

Installed capacity of thermal output:50000 KWt

Application scope: industrial boilers, industrial furnaces

Features: Low-carbon, high efficiency, environmental protection, low emission, broad application prospects, low cost.

#### Status of application

The technology has been put into use, may be industrialized in the developing countries and is mature. Special training is needed. The use cost is low. Training of the maintenance personnel or establishment of maintenance points is needed.

#### Technology Provider

Institution: GuangZhou Institute of Energy Conversion, Chinese Academy of Science

Contact: Zhou Zhouyu

Tel: +86-20-87057400

E-mail: zhouzy@ms.giec.ac.cn

Add: Department of Science and Technology, the Complex Building, 2 Nengyuan Road, Wushan, Tianhe District, Guangzhou, P.R.C.

Postal Code: 510640

## Wind power

### 44. Small size wind generator

#### Technology overview

Functions and use: Only using wind energy, small size wind generator can be utilized to provide off-grid electric power supply to the remote area such as rural area, pastoral area, mountainous area and sea coast. The user could be individual householder farmer or a village.

Technical information: Rotor Diameter: 2~7.5m; Number of Blade: 3; Working Wind Speed: 3~25 m/s; Cut in Speed: 3 m/s; Rated Wind Speed: 8~12 m/s; Survival Wind Speed: 50 m/s; Rated Output Power: 0.3~5KW; Max Output Power: 0.44~5.8KW; Rated Output Voltage: 230~460V; Speed Regulation: Yaw regulating, Electromagnetic brake and passive stall controlling.

Scope of application: The small size wind generator can be utilized in plain area, pastoral area, mountainous area, sea coast, intertidal zone, island and ship, where is not typhoon and annual average wind speed is within 3~50m/s.

Technological features: Apply clean & environmental-friendly energy resource; Stand alone system can provide electric power to the off-grid area; Simple & compact structure; Easy to operation and maintenance.

#### Status of application

Has been promoted and applied; can be put into commercial production in developing countries; mature product; special training is required before use; high initial input cost but low subsequent use cost; maintenance personnel must be trained or a maintenance station should be set up.

#### Technology Provider

Organization: Chinese Academy of Agricultural Mechanization Sciences

Contact: Zhao Xiaopeng, Yang Dong

Tel: +86-10-64883347, 0086-10-64882244

E-mail: zhaoxp@caams.org.cn, yangd@caams.org.cn

Address: 1 Beishatan, Deshengmen Wai, Beijing, P.R.C. Postcode: 100083



# 45. Carbon fiber composite material wind turbine impeller blade

### Technology overview

Functions and uses: to be used for more than 3MW (excluding 3MW) wind turbines to form the complete wind power generating set that converts wind energy into electricity.

Technical indicators: wind energy utilization coefficient greater than 0.47

Application scope: to be used for more than 3MW wind turbines.

Features: As the carbon fiber is expensive than glass fiber, the designer, out of consideration of the use cost, design the large blades using glass fiber / carbon fiber hybrid composite structure and the main load-bearing parts using the carbon fiber composite material, therefore giving full play to the effects of the high-strength lightweight carbon fiber . After the

carbon fiber used as a reinforcing material in large wind turbine blades, the performance parameters of the blades see remarkable improvements, which are mainly manifested as follows: As the stiffness increases, the weight decreases; 2 . The power output of the wind turbine is more smooth and stable; 3. The manufacturing, transportation and installation costs of the wind turbines are reduced

### Status of application

Has been promoted and applied; can be put into industrial production in developing countries; simple training is needed. high initial input cost but low subsequent use cost; maintenance personnel need to be trained or a maintenance station needs to be established.



### Technology Provider

Institution: China National Building Materials Group Corporation

Contact: Zhi Xiao

Tel: +86-10-88423159

E-mail: zhx@cnbm.com.cn

Add: 2 Zizhuyuan South Road, Haidian District, Beijing, P.R.C.

Postal Code: 100048

## Wind power

# 46. Switched reluctance variable speed wind generator system



### Technology overview

Functions and uses: used for wind power generation.

Technical indicators: 60KW or less.

Application scope Off-grid stand-alone wind power systems, wind power generation system

operates while connected to the DC power grid.

Features: a kind of switched reluctance variable speed wind power generation system that features high reliability, fewer failures, little maintenance, long service life, strong fault-tolerance, low startup wind speed required, longer effective annual generation time, larger effective annual generating capacity, and low power generation cost.

### Status of application

The product is mature. No training is needed. The use cost is low. The product is maintenance free.

### Technology Provider

Institution: China University of Mining and Technology

Contact: Chen Hao

Tel: +86-13013993107

E-mail: [chenhaocumt@tom.com](mailto:chenhaocumt@tom.com)

Add: 3-1-402, Experts Apartment, China University of Mining and Technology (Wenchang Campus), Xuzhou, Jiangsu Province, P.R.C.

Postal Code: 221008

### 47. Manufacture of large-scale wind turbine impeller blades using the resin vacuum infusion molding technology



#### Technology overview

Functions and uses: use the vacuum resin infusion molding technology to produce large-scale megawatt blades with high molding accuracy of outline dimensions, therefore increasing the utilization ratio of wind energy of the entire unit.

Technical indicators: wind energy utilization coefficient of the blade :greater than 0.47.

Application scope: used for 1. 5MW and above wind turbines.

Features: Low-cost manufacturing process, suitable for large product manufacturing. Excellent product performance, high yield, stable product quality and weight, high precision products and low production losses. Low volatile organic materials and environmentally friendly.

#### Status of application

The product has been put into use, may be industrialized in the developing countries and is mature. Simple training is needed.

The initial investment is large. The subsequent use cost is low. Training of the maintenance personnel or establishment of maintenance points is needed.

#### Technology Provider

Institution: China National Building Materials Group Corporation

Contact: Zhi Xiao

Tel: +86-10-88423159

E-mail: zhx@cnbm.com.cn

Add: 2 Zizhuyuan South Road, Haidian District, Beijing

Postal Code: 100048

## Wind power

### 48. Small wind/solar power generation system

#### Technology overview

Functions and uses: Make the best use of wind and solar resources to solve the problem of power supply of the customers.

Technical indicators: 1KW-30KW

Application scope: Remote areas, populated areas without electricity.

Features: adopt permanent magnet wind turbine that is safe and reliable.

#### Status of application



The product may be industrialized in the developing countries and is mature. No training is needed. The use cost is low. Maintenance by the customers is permitted.

#### Technology Provider

Institution: Hangzhou Silu Energy Technology Co., Ltd.

Contact: Zhang Wei

Tel: +86-13336185392

E-mail: wzhang@hrcshp.org

Add: Jiulian Xincun, Hangzhou, Zhejiang Province, P.R.C.

Postal Code: 310012

## 49. QD128 gas turbine, QD70 gas turbine

### Technology overview

Functions and uses: applicable to natural gas power generation, cogeneration, combined cycle, mechanical drive and many other uses.

Technical indicators: QD128 gas turbine power: 11500 kW, thermal efficiency: 27%

QD70 gas turbine power: 7000 kW, thermal efficiency: 30.5%

Application scope: the QD128, QD70 gas turbine generating units can be used for power generation, thermoelectric cooling supply, pipelines booster stations and other power plants. Also they can be used by the telecommunication systems, modern residential quarters, oil and gas sectors to establish their own independent power system.

Features: make reasonable use of natural gas, low heat value fuel and other resources to solve the problems of peak regulation insufficient power supply in the remote areas. AVIC Liming is presently China's largest independent gas turbine manufacturer, has produced 7 models of gas turbine products, has a professional installation,

commissioning, operation and maintenance team.

### Status of application

The product has been put into use, may be industrialized in the developing countries. Special training is needed. The initial investment is large. The subsequent use cost is low. Training of the maintenance personnel or establishment of maintenance points is needed.

### Technology Provider

Institution: AVIC Shenyang Liming Aero-engine (Group) Corporation Ltd.

Contact: Zhao Luming

Tel: +86-24-24384413

E-mail: maochacha2003@yahoo.com.cn

Add: 6 Dongta Street, Dadong District, Shenyang, Liaoning Province, P.R.C.

Postal Code: 110043



中国科学技术交流中心

China Science and Technology  
Exchange Center

## **China Science and Technology Exchange Center (CSTEC)**

Founded in 1982, CSTEC is a national independent legal entity in China. Through international science and technology exchanges, CSTEC aims to push forward cooperation between China and the world and propel China's socio-economic progress. It has already established partnership with more than 130 organizations and famous enterprises in about 30 countries and regions worldwide. It is playing an important role in scientific communication with countries in America, Oceania, Europe, Asia and Africa, and regions like Hong Kong, Macao and Taiwan. One of CSTEC's major tasks is to push forward South-South S&T cooperation on climate change, and support technology R&D, transfer and training activities among developing countries in this aspect.

[www.cstec.org.cn](http://www.cstec.org.cn)



## Gansu Natural Energy Research Institute (GNERI)/ UNIDO International Solar Energy Center for Technology Promotion and Transfer (UNIDO -ISEC)



GNERI founded in 1978, is mainly engaged in the studies and application of new and renewable energies, and solar energy techniques in particular, national and international technical cooperation and trainings, technical consultation and exchange. It is an Associated Institution of United Nations University within the overall framework of the UNU Environment and Sustainable Development Program, as well as UNIDO international solar energy agency for technology promotion and transfer (UNIDO -ISEC). The GNERI-developed solar water heaters, solar cookers and photovoltaic products also hold an important share in the domestic and international market. By the end of 2010, about 230 world famous experts have paid visits and given lectures or had technical exchanges at GNERI, and 3200 ambassadors, scientists and governors in total from more than 110 countries (including 9 Presidents and Prolocutors, more than 100 Ministers) have visited GNERI.

1. Outdoor Solar Collector
2. Technology of Passive Solar Building: the appropriate choice of building orientation and the surrounding environment building materials, structures to contribute building heating and cooling. The passive solar building is low cost and easy maintenance.
3. An Auto-controlling Mode of the Active Solar Heating System: It can

discriminate variations of the weather automatically, also is able to control the active solar heating system established in various areas.

4. Heat Pipe Evacuated Tubular Solar Collector: the collector possesses characteristics such as, no water in the vacuum tube, tube never broken. anti-precipitation, anti-freezing.

5. Solar street lights, garden landscape lamp, lawn lamp, solar power station integrated construction project design, construction

6. Solar Photovoltaic Power Generation Component of Oblique / Flat Single Axis Tracking Device

7. Semitransparent Air Interlayer Insulation Photovoltaic Component: both lighting and power, and can be widely used for building walls and roofs.

8. Solar Cooker: Boil water, cooking and fit for farmhold and small-size agencies, may be used in the scale of production, small investment.

9. Photovoltaic DC Pumping Systems

10. Solar Drying System

Tel: +86-931-8386635

Fax: +86-931-8386011

E-mail: [jjialingping@unido-isec.org](mailto:jjialingping@unido-isec.org);

[mazheng@unido-isec.org](mailto:mazheng@unido-isec.org)

Web: <http://www.unido-isec.org>

Address: N0.20 Renmin Road, Lanzhou, P.R.C



## International Center on Small Hydro Power (ICSHP)



ICSHP is a public and non-profit institution directly under auspices of United Nations Industrial and Development Organization (UNIDO), China's Ministry of Water Resources (MWR) and Ministry of Commerce (MOFCOM), as well as, ICSHP is headquarters of International Network on Small Hydro Power (INSHP), which is an international organization with more than 300 members from 70 countries. ICSHP established 4 pilot bases on SHP in China, and 3 sub-centers in India, Nigeria and Colombia.

ICSHP aims at the promotion of global SHP development through triangular technical and economic cooperation among developing countries, developed countries and international organizations, hence to supply the rural areas in developing countries with environmentally sound, affordable and adequate energy, which will lead to the increase of employment opportunities, improvement of ecological environment, poverty alleviation, energy security, improvement of local living and cultural standards and social-economic sustainable development in rural areas.

Since it was established in 1994, ICSHP has trained over 700 engineers from 50 countries, provided technical consultations, feasibility study, design, equipment supply and installation on SHP in over 30 developing countries, organized more than 30 international conferences/workshops both in China and abroad, and successfully compiled the first SHP Clean Development Mechanism (CDM) project in China. Through the international cooperation activities, China's practice and experience in SHP have been widely disseminated world wide.

Contact: Prof. Liu Heng

Tel: +86-571-87132796

E-mail: [hliu@icshp.org](mailto:hliu@icshp.org)

Fax: +86-571-87023353

Web: <http://www.icshp.org>

Address: Nanshan Road 136, 310002, Hangzhou, Zhejiang, P.R.C

## China Solar Valley-World Future Valley



- First auto.solar water heater & vacuum tube production line in the world,
- The largest demonstration project of linear Fresnel solar thermal power station in Asia,
- The largest solar air-conditioning system in the world,
- Five solar water heater factories and eight vacuum tube production lines,
- 20 million vacuum tubes,over 3 million square meter solar collectors are produced here.

In the implementation of the Future Ark Project,China Solar Valley is now being built into an exemplary town and city for the world for the next 50 years.UTOPIA GARDEN is being built into a global human habitat model for 30 years to come.And the nine huge centers of China Solar Valley are being built into the future operation model of emerging industries in the next 100 years.

The nine centers include a word-class tourism center for renewable energy,world-class renewable energy R&D and test center,renewable energy international conference and exchange center,logistics center for renewable energy production,education and training center for renewable energy,solar popular science exhibition center,word-class exhibition center for low carbon science and technology,low-carbon human habitat demonstration center and low-carbon international business center.

Contact: +86-534-5089838  
Email:secretary@himin.com

## Yunnan Academy of Scientific and Technical Information

YASTI's major service covers the scientific and technical literature resource development, the technology transfer and international cooperation in science and technology, the climate change and CDM development service, the research for S&T policy and developing strategy, the S&T project consulting and evaluation and so on. In the decade, YASTI has endeavored in the technology transfer and international cooperation careers of new and renewable energy technology with its products to combat climate change. The worldwide



cooperation relationships have been set up with related international organizations in Southeast Asia, South Asia, United States, United Kingdom, France and Japan, such as ASEAN Secretariat, Asia-Pacific Center for Technology Transfer of United Nation (UNAPCTT), Council of Renewable Energy in Great Mekong Region (CORE), by which to push the regional activities for combating climate change and to accelerate the new and renewable energy technology transfer career. With the effect of YASTI, the China-ASEAN Scientific and Technical Forum mechanism has been built up. Targeting at the new and renewable energy, agricultural technology application and other areas, YASTI has carried out 12 activities as international scientific and technical cooperation forum, project implementation and training. Nowadays, YASTI is collaborating with APCTT of UN and ASEAN Secretariat to construct the "International Technology Transfer Platform in New and Renewable

Energy for Asian and Pacific Region", which aims to provide supports and services as technology research, product promotion and application, regional technology transfer for developing countries in the progress of combating climate change.

1. YASTI has cooperated with Ayutthaya University to build up a Sino-Thai building integrated solar energy system demonstration base in Thailand. This construction has greatly pushed the demonstration and promotion of China's solar energy technology with its product in Southeast Asian countries, to improve the solar energy utilizing ability and standard in the region.

2. Successfully held China-ASEAN Scientific and Technical Forum, which focuses on combating climate change by science and technology, to accelerate the promotion and application of new and renewable energy technology and its product in developing countries. Under the topics of new and renewable energy, agricultural new technology promotion and application, energy-saving technology and application, many activities have been carried out as forum, project implementation and training.

3. YASTI is collaborating with APCTT of UN and ASEAN Secretariat to construct the "International Technology Transfer Platform in New and Renewable Energy for Asian and Pacific Region", to enhance the promotion and application of new and renewable energy technology with its product in the region.

Contact: Shang Xiaohui

Tel: +86-871-3113686

Fax: +86-871-3177291

E-mail: Shangxiaohui2000@163.com Web: <http://www.istiy.yn.cn>

Address: No.246 Renming Rd. Kunming, Yunnan province, P.R.C

# Small Hydropower and Application

## International Center on Small Hydro Power

### 1. General Introduction

The Cost-effective Small Hydropower Electromechanical Technology is for the purpose of small hydropower development to meet demand of power supplying for off-grid rural areas with developable small hydropower potentials. The technology will improve the pay-back benefits of projects and has been universally accepted and promoted include standardization, serialization, manufacturing and refurbishment technologies etc.

### 2. Application and Effect

#### 1) Specification

(i.) *Openness*. It is very suitable for vast rural development means that its technology should be open to and adopted by the local people for large-scale development in rural areas. It is only through the utilization of locally available raw materials, technology, potential, labor and funds, self-development and self-management of SHP that the problem of rural electrification can be solved.

(ii.) *Appropriateness*. SHP technology should be appropriate and suitable for the local conditions and its socio-economic development level. It should be suitable for technological transfer. SHP technology needs to be unpacked into different economic levels and conditions of a particular area, which can help those areas to select appropriate technologies. That will guarantee the reliability and reduce the manufacturing cost by great margin in the meantime.

(iii.) *Cost-Effectiveness*. For large-scale development of SHP, a cost-effective technology is highly needed. It is important to optimize the planning and design, to the utilization of local materials and indigenous manufacturing and also to adapt some specific technologies and tools in all process of SHP development from the planning to operation.

#### 2) Technical Specification and advantages

(i) *Simplification*. The design and structure for the equipment is simple. This is not only for the sake of reducing cost, but also for improving reliability. For example, the use of computers and other IT technologies have made SHP equipment to be more efficient and simple.

(ii) *Standardization*. These have helped to reduce the cost, shorten construction period, and promote the technology transfer and equipment trade. Therefore, simplified and standard equipment and technology will be surely further developed.

(iii) *Automation*. In order to reduce the operation cost, most of the SHP stations, especially in remote area, are now using automatic control systems, which always requires SHP stations with "no one on duty", simple equipment and easy controlling method unlike large hydropower stations.

### 3. Range of Application

This cost-effective technology has got successful application at home and abroad in SHP industry. This cost-effective technology has made a great contribution in realizing rural electrification in China. In recent years, the SHP equipment produced by adopting this cost-effective technology has reached about 1/6 of new SHP installed capacity of all nations. Meanwhile, the produced equipment by cost-effective technology has been exported to several countries also.

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# Biomass resources and utilization technology

## Guangzhou Institute of Energy Conversion, Chinese Academy of Science

Commercial application of biomass energy is of important significance in coping fossil fuel shortage and environment pollution. Biomass energy is abundant in China, data show that in 2009, the available biomass as energy resources is about 236.73 million tons of standard coal.

### The Current Situation and Trend of biomass energy

The biomass-to-energy conversion technologies mainly include biodiesel, anaerobic fermentation for biogas, biomass gasification and power generation, biomass combustion and CHP, municipal waste incineration and biomass briquette technologies.

#### 1) Biodiesel

Biodiesel refers to a fuel produced by the transesterification of the vegetable oil or animal fat feedstock and can be used in internal combustion engine. The available feedstocks for biodiesel production are waste vegetable oil and animal fats, oil plant and oleaginous microalgae etc. The production technologies mainly are acid and base catalysis and enzyme catalysis. The wide used technology in biodiesel production is chemical transesterification using liquid catalyst (KOH) to remove content of water and free fatty acids strictly. In China, biodiesel technology is in demonstration stage with annual production capacity of 100 million tons. However due to the feedstock shortage, the current annual output is only about 30 million tons. Started from 2000 to 2009, there are over 100 biodiesel companies in China. For instance, Longyan Zhuoyue New Energy Co., Ltd (annual output 50000 tons), Xiamen Zhuoyue New Energy Co., Ltd (annual output 50000 tons), Sichuan Gushan Environmental Energy Limited (annual output 30000 tons).

#### 2) Biogas

Biogas typically refers to a gas produced by breakdown of organic matter in the absence of oxygen which containing mainly CH<sub>4</sub> (55~75wt%) and CO<sub>2</sub> (25~45wt%). With upgrading, biogas can be used for power generation, central gas supply, substitute for compressed natural gas, vehicle fuel and biogas fuel cells. The mainstream technologies for biogas fermentation are UASB, USR and CSTR. The livestock farms in China mainly use UASB and USR for waste water treatment, in other countries usually use CSTR.

#### 3) Biomass gasification and power generation

Biomass gasification technology is converting biomass into combustible gases. Gasification and power generation technology includes three processes: biomass gasification, gas purification and power generation. Generally, it is considered that plants output less than 500KW are small-sized, the ones with output over 3000KW and including IGCC are large-scale and the ones in-between are medium-scale. System efficiencies of small and medium scale plants are 12-30%, for large-scale ones, reach to 30-50%.

International biomass gasification and power generation technologies are still in the exploitation and demonstration stage. For instance, in Italy, the investment for the 12MW biomass IGCC project is up to

25000 Yuan/KW, generation cost is 1.2 Yuan/KWh, therefore is just a research demonstration with no commercial operation.

In China, there are over 20 megawatt biomass power generation systems. During the 'eleventh five year plan', with the support from state '863' projects, 4MW biomass power generation demonstration has been built. By now, 5.5MW biomass IGCC demonstration has been built, and 28% system efficiency has been reached. It is also the first commercially operated agriculture waste IGCC plant.

#### 4) Biomass combustion and power generation

In the end of 2006, the total installed capacity for biomass power generation reached to 2.2 million KWh, with 1.7 million KWh from Bagasse based CHP, 0.5 million KWh from agricultural and forestry waste, agriculture and industry biogas, waste combustion and landfill gas power generation.

Due to the quickly raising investments, insufficient experiences, lack of accurate estimation of feedstock obtaining and acquisition cost, there are problems existing in the industry such as over-sized single project, over-dependent on imported equipments and high cost for feedstock collection.

#### 5) Waste disposal and power generation

There are many kinds of incinerator applied in the MSW disposal, including grate furnace, fluidized bed incinerator and rotary furnace.

Grate furnace technology is most widely used in MSW incineration plants, account for about 80% of the total market, with advantages of mature technology, stable operation, wide applicability and simple maintenance. It is feasible for large scale central treatment of garbage.

The advantages for fluidized bed incinerator are completely combustion of garbage as well as completely destroying the hazardous substances, which is suitable for waste sludge with high water content. The representative fluidized bed incinerator in China is the combined grate-circulating fluidized bed incinerator developed by Tsinghua University. Rotary furnace can be used for combustion of MSW and other solid waste, and also liquid waste with the incineration temperature of 650-980°C. Normally, the rotary furnaces are placed after the mechanical grate furnace to improve the burn-out rate.

The first phase of Likeng refuse incineration plant in Guangzhou went online in 2006, with two 520t/d garbage incinerators, installation of two 47.46t/h waste heat boilers and one 22MW turbo generator.

#### Conclusion

The new frontier technology of biomass energy conversion include Biomass Gasification for Liquid Fuel Synthesis, Biomass Pyrolysis for Bio-oil Production, biomass Deoxy-liquefaction for Bio-petroleum, biomass gasification and fuel cell power generation, Microbial Fuel Cells, syngas ethanol fermentation, Oleaginous microorganism for biodiesel production etc.

## Acknowledgement

Supported by the United Nations Development Programme (UNDP) in China, United Nations Environment Programme (UNEP), United Nations Educational, Scientific and Cultural Organization (UNESCO), South Centre, Third World Network, the revision and compilation of the Manual is completed with strong support and professional suggestions by the Department of International Cooperation and the Department of Social Development of the Ministry of Science and Technology, China, Department of Climate Change of the National Development and Reform Commission, China and the Administrative Center for China's Agenda 21.

The applicable technologies in this Manual are selected on the basis of extensive field surveys and the needs of developing countries, with the support of the scientific and technological administrative departments of relevant ministries and commissions, relevant enterprises, universities and research institutes of China, as well as local science and technology administrative authorities. We would like to express our gratefulness to all the officials, experts and editing staff involved.

Editorial Board for the Manual of Applicable Technologies to Address Climate Change  
July 2013.

\* The Manual is funded by

- The National Key Technology Support Program of China (project code: 2012BAC20B09)
- Special program of Department of Climate Change of the National Development and Reform Commission, China (project code: 2012006)

