Green Buildings and Renewable Heating and Cooling Concepts in China

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POLYCITY
EXCURSION AND FINAL CONFERENCE, CITYNET WORKSHOP

Contents

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CO2 emission of the world

Total GHG Emissions in 2004 (excludes land use change) CO2					
Country	MtCO2	Rank	% of World Total	Tons CO2 Per Person	Rank
United States of America	5,888.7	(1)	19.80%	20.1	(7)
China	5,204.8	(2)	17.50%	4.0	(73)
European Union (25)	4,017.1	(3)	13.51%	8.8	(37)
Russian Federation	1,575.3	(4)	5.30%	11.0	(24)
Japan	1,304.2	(5)	4.39%	10.2	(28)
India	1,199.0	(6)	4.03%	1.1	(122)
Germany	856.6	(7)	2.88%	10.4	(27)
United Kingdom	551.3	(8)	1.85%	9.2	(35)
Canada	549.1	(9)	1.85%	17.2	(10)
Korea (South)	507.0	(10)	1.71%	10.5	(26)

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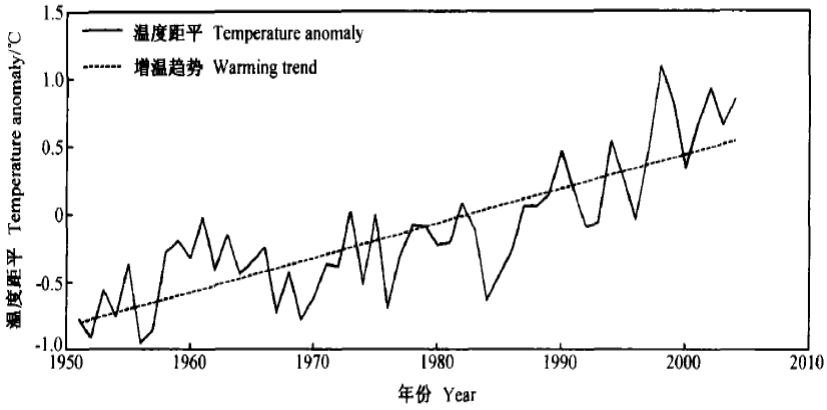
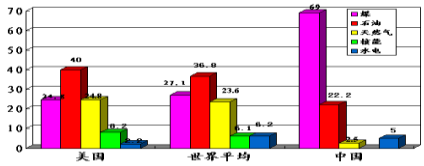
Warming trend of China in 50 years

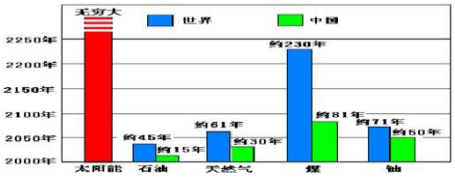


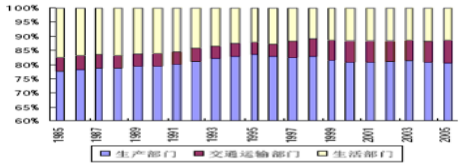
In the past 50 years, the average temperature of the china's mainland increases by about 0.68℃.

Energy supply Comparison

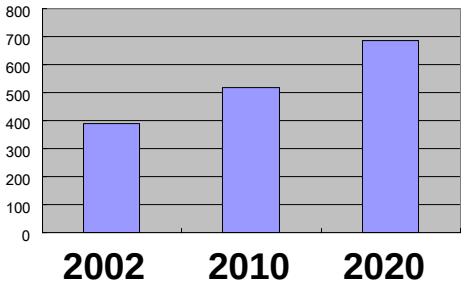
- Different from the other countries, in China, **almost 70% energy supply comes from Coal**.
- **Energy consumption in building** section occupies about **1/3 of the total**.
- **Optimizing the energy supplying structure** and clean energy, **renewable technologies are important.**
- …



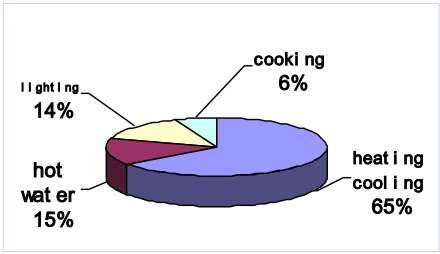


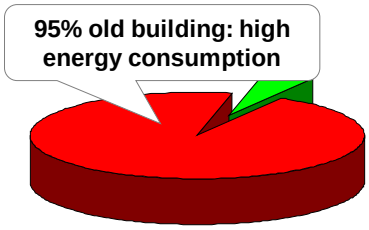


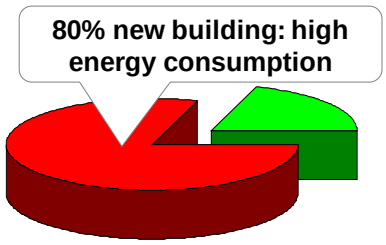
Challenges



Construction area (billion*0.1m^2)







Only 10 - 15% meet the national standards

Changing of Shanghai

陆家嘴竹园商贸区1993-2008

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- Solar thermal industry in China
- Development of solar cooling and heating technologies
- Application of solar energy in buildings
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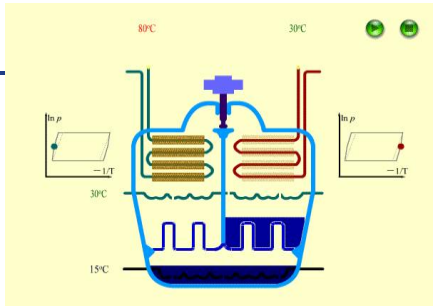
Major technologies in China

- Silica-gel water adsorption chiller
- Two stage LiBr-water absorption chiller
- Novel configuration of desiccant cooling system
- Small size single effect absorption chiller
- ……



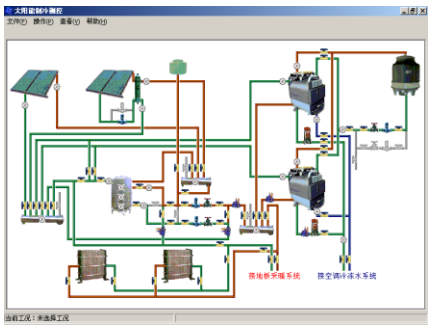
➢ Solar adsorption Chiller

- Powered by 55 - 85°C hot water ;
- Suitable to be driven by solar water heater or waste heat from other sources ;
- Small mass production
- 10 kW, 20kW,50kW,100kW,200kW

Parameters	Performance	Unit
Cooling power	8.5	kW
Chilled water	10	°C
Chilled water flow rate	1.5	t/h
Cooling water inlet	32	°C
Cooling water flow rate	5	t/h
Hot water inlet	85	°C
Hot water flow rate	3.6	t/h
COP	0.4	
Weight	1.5	t
Power AC	2Φ-220V-50Hz	

5kW silica-gel adsorption chiller

Solar cooling, heating hybrid system in a Green Building

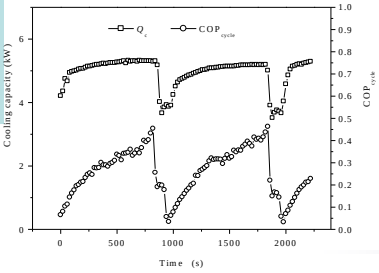


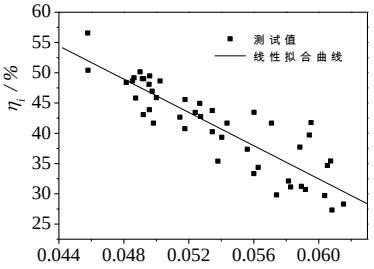
- 2 silica gel water chillers
- 150 m^2 of U-type ETC;
- $T_{Ger.}$ = 55-85 °C
  $\Rightarrow Q_C$ = 15 kW, Solar COP=0.15

Solar cooling used to cool a grain depot in China(2004)

- **Solar powered water-heating unit:**
- **50 m² of evacuated tube collectors**
- **5kW cooling**

10kW adsorption chiller

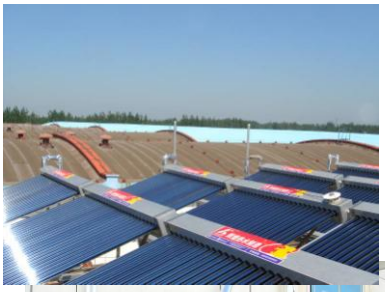




Solar grain cooling (adsorption chiller) (2005) (almost the same as last year)

Solar adsorption cooling in grain depot(2006)

Yangzhou (2006)



Suqian (2006)

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Pavilion of National state power company

2 adsorption chillers are used

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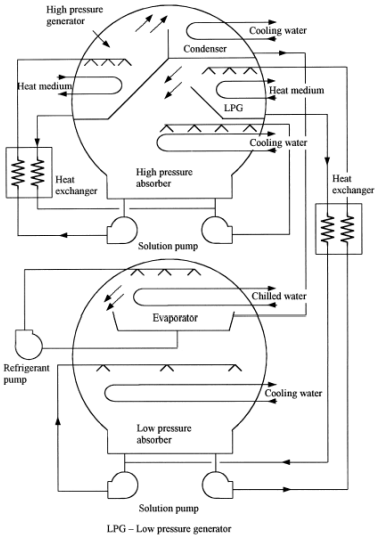
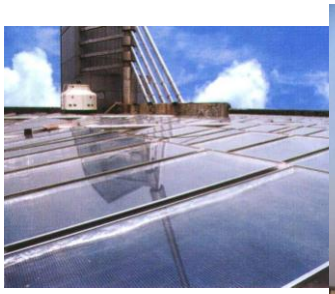
Two-stage LiBr water absorption chiller



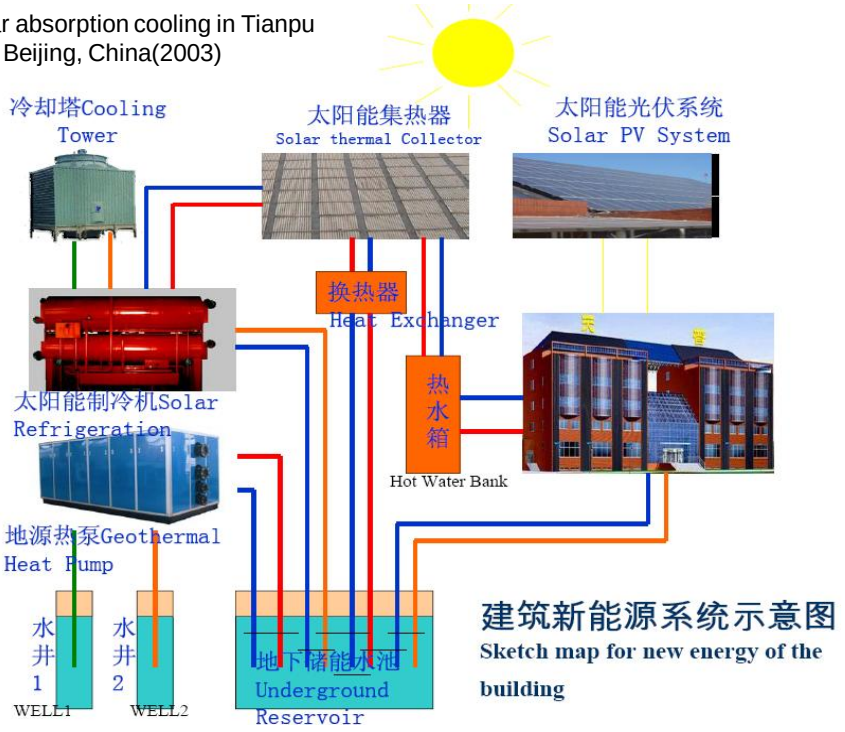
70kW two stage absorption chiller
(Guangzhou, China,1994)

Solar driven two stage absorption cooling project in Jiangmen, Guangdong, China(1997)



- solar flat plate collectors: 500m^2
- Hot water: 75℃;
- chilled water: 9 ℃
- Cooling capacity: 100kW
- Auxiliary heat source: Oil boiler

Solar absorption cooling in Tianpu Co., Beijing, China(2003)



Solar absorption cooling in Beijing Solar energy institute

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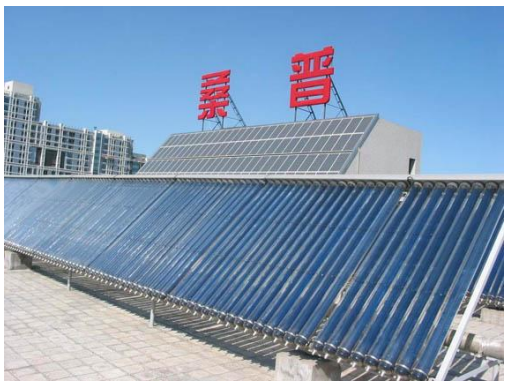
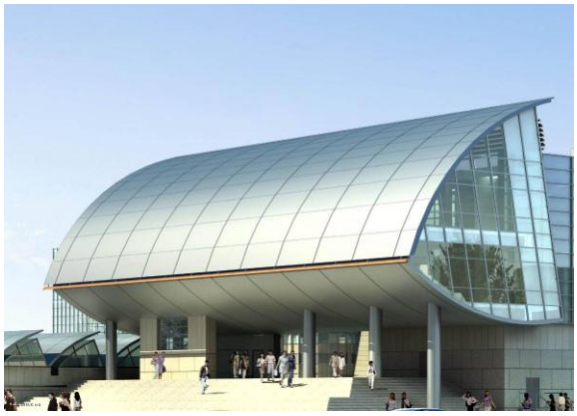


360kW solar cooling project (heat pipe solar collector)

Solar cooling Project in Qingdao

Solar +waste heat absorption cooling project in QingDao Olympics center



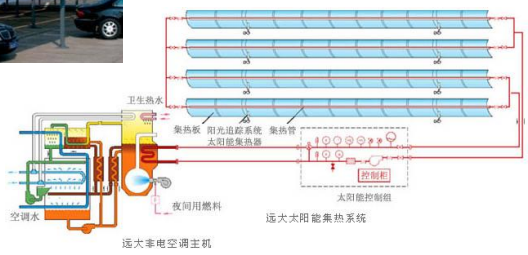
- solar flat plate collectors: 600 m^2
- Hot water: 75-90 ℃;
- chilled water: 12-15 ℃
- Cooling capacity: 600 kW
- Auxiliary heat: waste heat from power station

Solar air conditioning in Himing Group

Collector area: 9188m^2

Absorption chiller

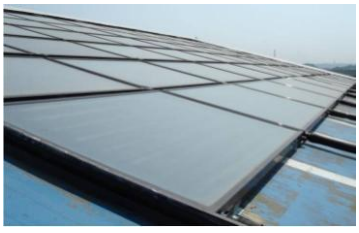
HaiTai Information Plaza, Tianjin
天津市新技术产业园区海泰信息广场

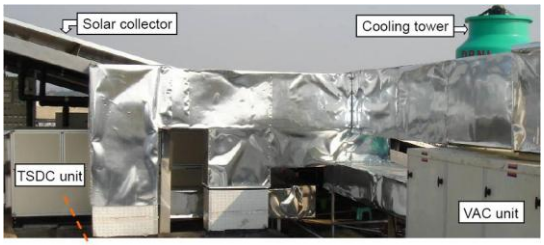


It is not so successful and stopped till now.

Broad solar absorption cooling

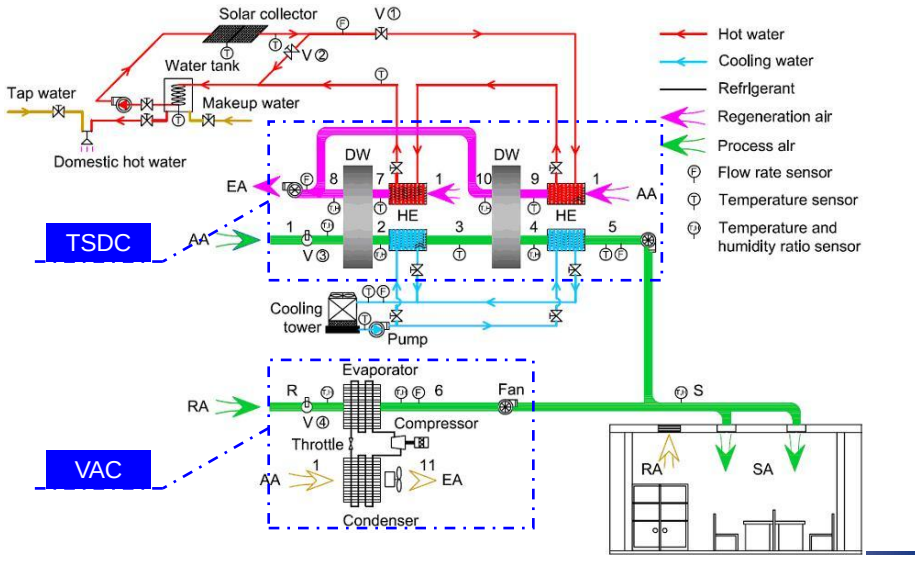
Hybrid VCS/Two-stage desiccant cooling driven by solar flat plate water collector





- Cooling capacity of TSDC: 10 kW
- Flat plate solar collector
- Collector area: 90 m^2 (72m^2 was used during test)

Two-stage Solar DCS Installed in Jiangsu, China



(DW: Desiccant wheel; HE: Heat exchanger; V: Valve; AA: Ambient air; SA: Supply air; RA: Return Air; EA: Exhaust air)

Two-stage Solar DCS using air collector in Shandong, China

- Cooling capacity: 20 kW
- Solar air Collector
- Collector area: 140 m^2

Solar driven ORTS desiccant cooling

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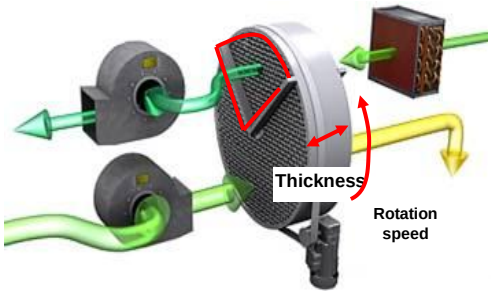
regeneration

50℃ ~ 90℃ heat resource



- Thermal COP > 1
- Convert more than 50% solar radiation to capability of dehumidification

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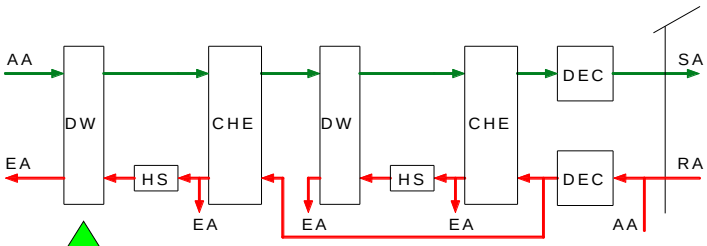
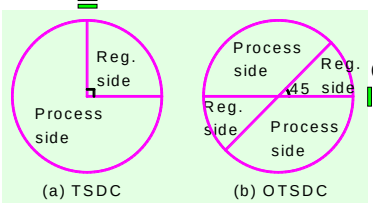
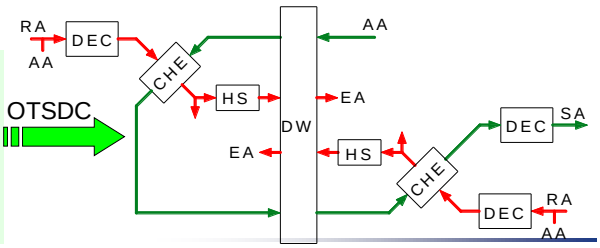
System Design



TSDC



OTSDC



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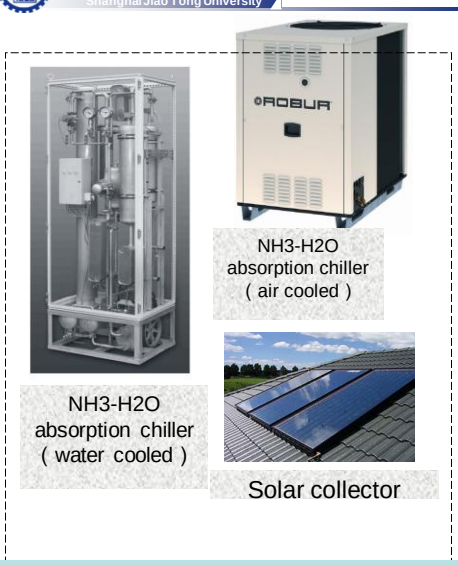
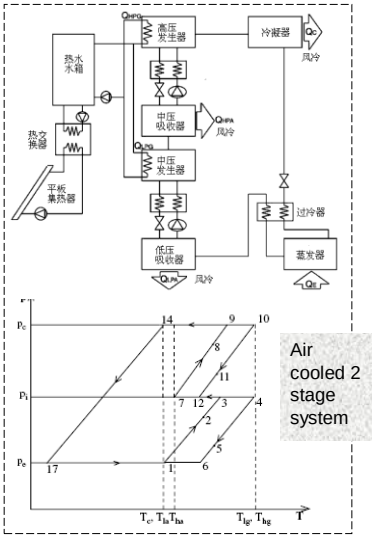
Small size solar absorption chiller

17kW single effect absorption chiller

Solar NH3-H2O absorption chiller





The two stage NH3-H2O absorption chiller can be driven by 85ºC heat resource，COP=0.4, chiller water temperature is about 15℃.

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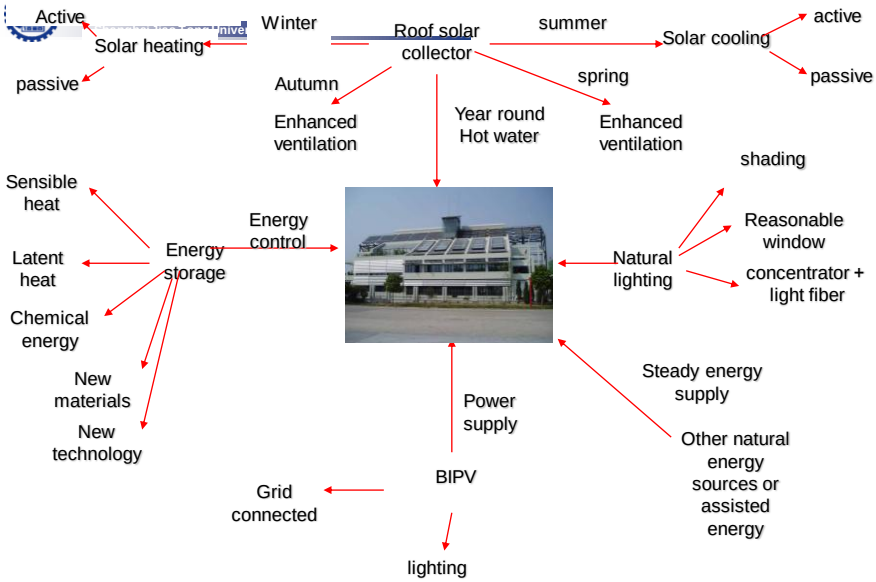
Building integrated solar energy utilization



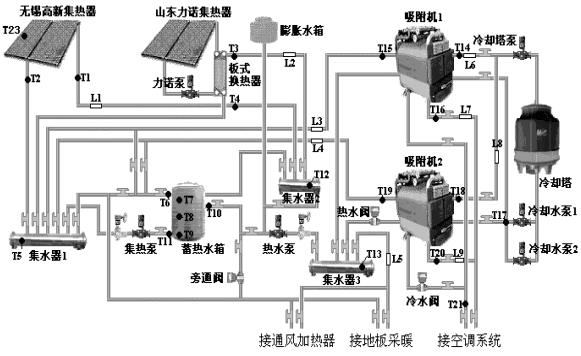
The green building in Shanghai (2004)

The solar cooling project in green building has been listed in “Wisions of sustainability “ in Germany

Use of solar thermal

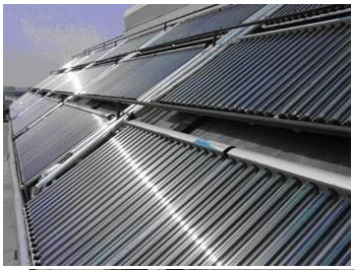
Functions

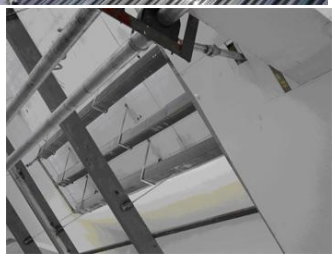
- Air conditioning in summer
- Floor radiation heating in winter
- Hot water supply for the whole year
- Natural ventilation in spring & autumn



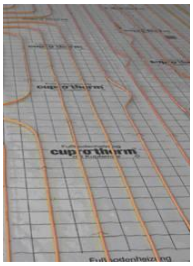
To solar chimney To floor heating To AC terminals

In Shanghai, our experience shows that the solar fraction of this system is about 60%.





Solar heating, cooling hot water supplying and enhanced natural ventilation system



- Heating area 390 m2, heating capacity 25kW, cooling capacity 15kW。
- Solar collector：150 m^2
- Adsorption chiller：SWAC-10 **（SJTU）**
- **Year round solar fraction is about 60%;**

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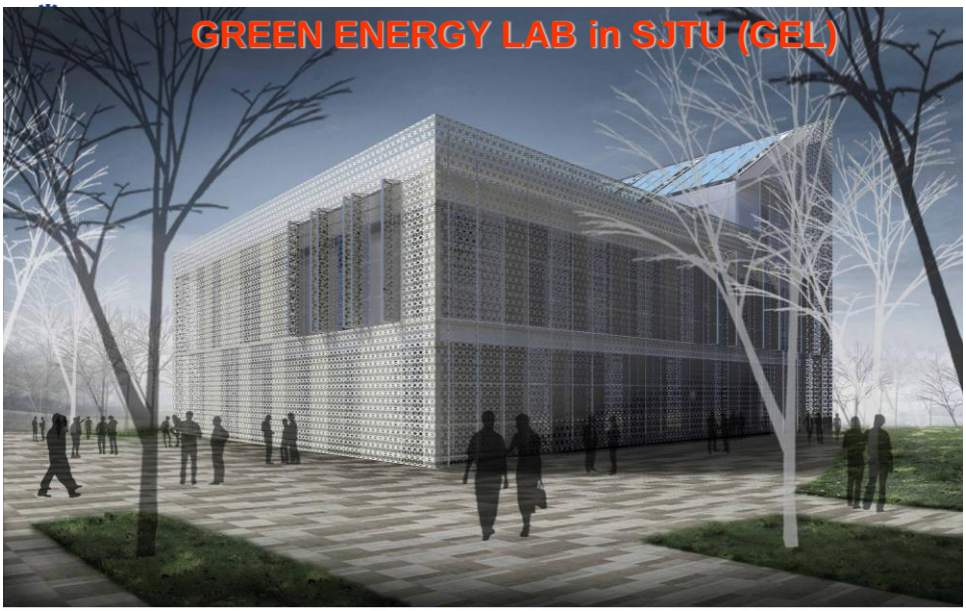

GEL outside look

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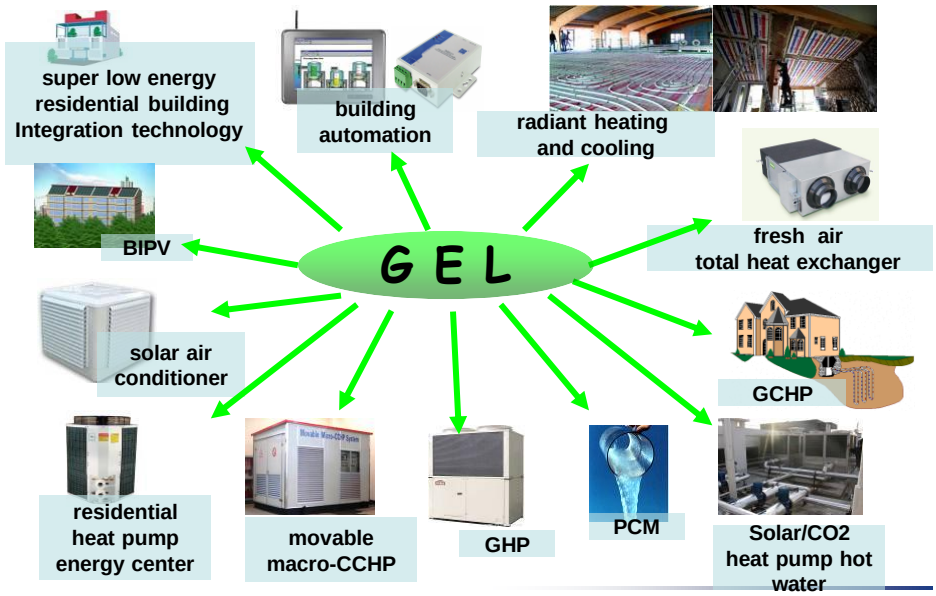
12 key technologies in GEL



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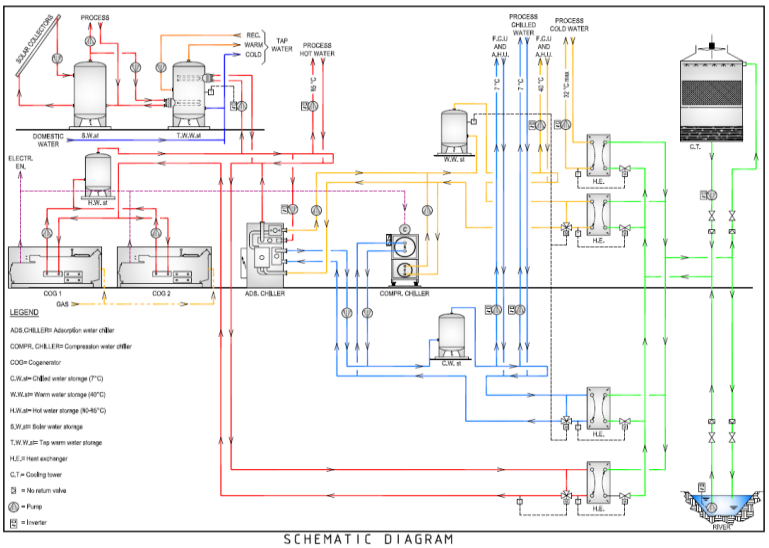
Heating and cooling in GEL



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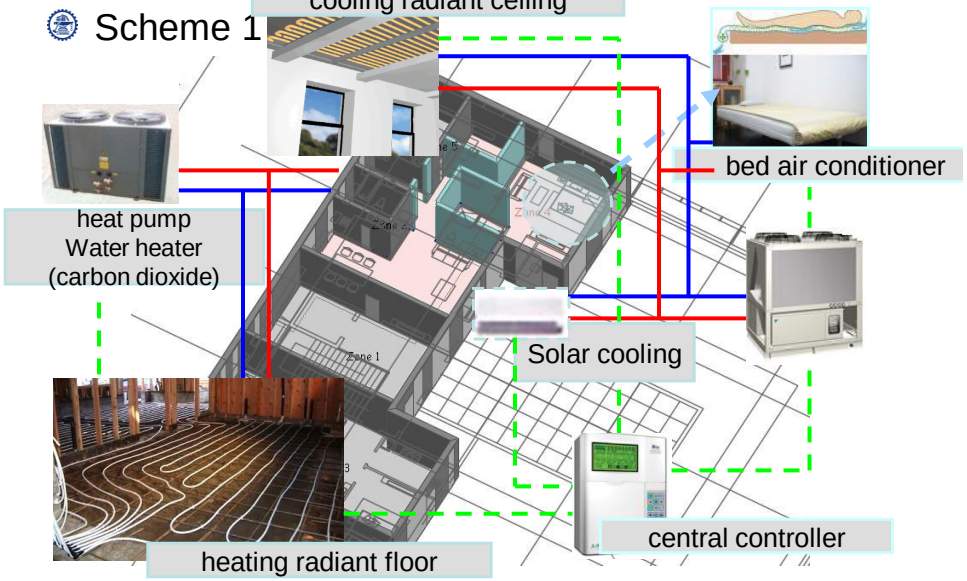
Zero energy house (third floor)

Scheme 1



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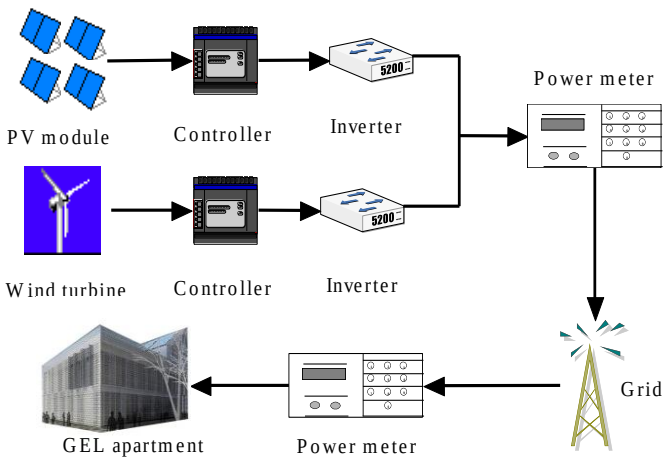
Power control



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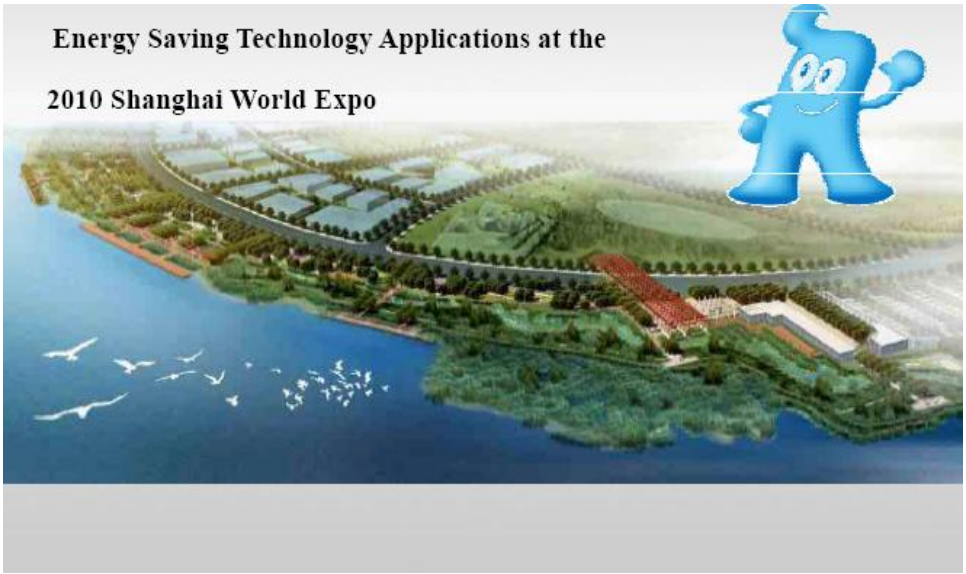
Use in World Expo'2010



Sustainable energy technologies

- **Solar PV and thermal**
- New energy car
- Semiconductor lighting
- Ecological planting
- **River water source and ground source heat pump**
- Non-hazardous disposal, minimization and resource recovery technologies for waste treatment
- …

❑中国馆 China Pavilion

Solar PV, rain water recovery, Ice cold storage technologies

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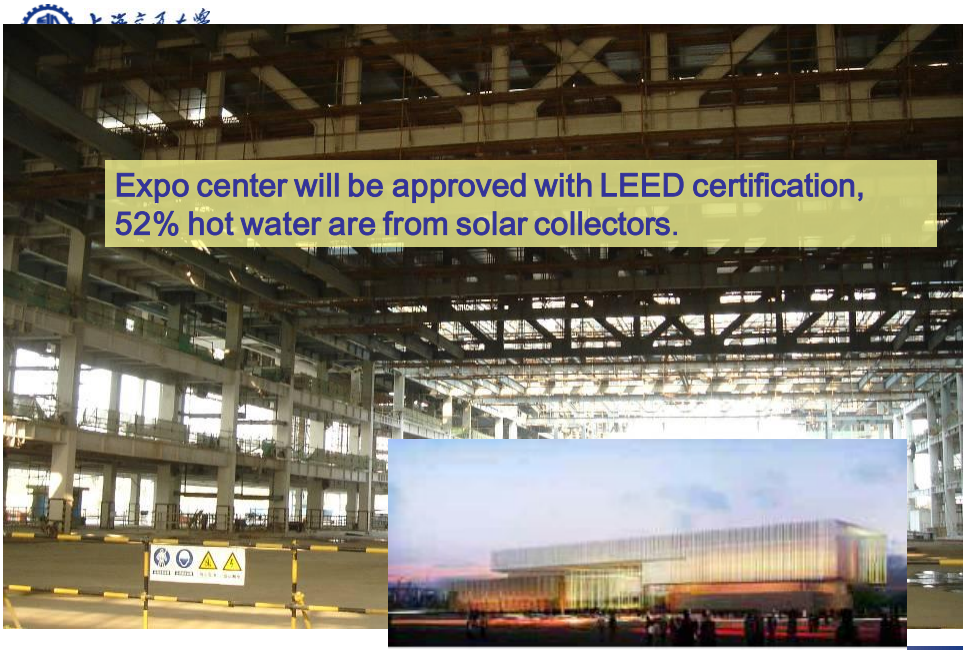

Expo center will be approved with LEED certification, 52% hot water are from solar collectors.

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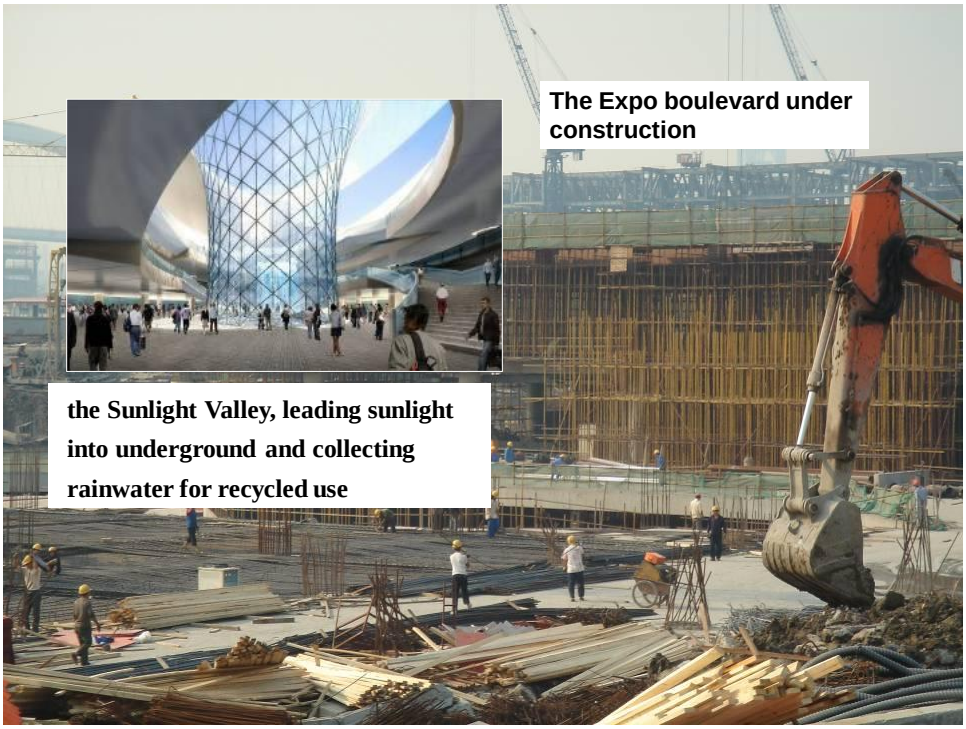

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- River source heat pump cooling and heating
- Natural lighting
- Water & heat recovery
- ……

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Performance center

2007年12月30日开工建设，预计2009年12月底完工。

世博演艺中心采用了江水源冷却系统、气动垃圾回收系统、空调凝结水与屋面雨水收集系统、程控绿地节水灌溉系统等多项环保节能技术，注重可再生材料的使用，其目标是成为一座“绿色生态建筑”。

Being built as a green ecological building, the performance center has integrated many environmental technologies including the river water cooling, the pneumatic waste collection, collection system for condensing water from air conditioners and rainwater, program control water-saving irrigation system, and use of renewable materials

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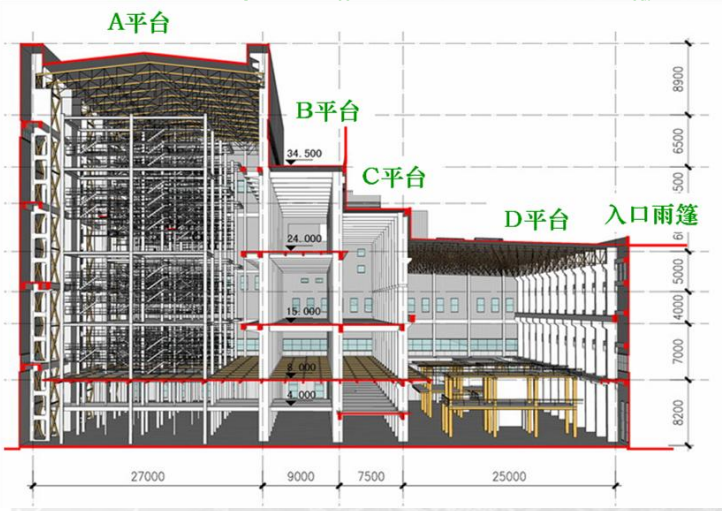
南市发电厂主厂房和烟囱改建工程

Comprehensive Renovation Project of the Nanshi Power Plants

- Solar PV
- Wind turbine
- Water resource heat pump
- Active natural lighting
- Natural ventilation
- Green materials
- Water recovery
- LED lighting

1. 太阳能光伏发电技术实施方案

Implementing scheme of Solar PV technology



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Roadmaps of solar air conditioning technologies

- Objectives in the near future
  - Solar cooling units suitable for use of solar hot water supply and heating system;
  - Development of small capacity solar cooling units;
  - Integration with building energy systems.
  - Cost and size reduction…
- Long term plan
  - Low cost and high efficiency;
  - Developed industry for solar cooling products and services;
  - Important role among the sustainable cooling technologies.

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Application prospect

- If the solar collectors can be used efficiently for cooling, 0.2 billion ㎡ solar collector can produce cooling with technology advancement is shown in the table below. (I=700W/㎡)

Time (solar collector , 80℃)	COP_{solar}	Cooling capacity (kW)	Daily cooling time (sunny day) (h)	Number of AC unit (1.5HP) COP = 3	Conditioned area (AC load=100W/m²)
present	0.15	21 million	5 ~ 8 h	6 million	0.21 billion ㎡
After 5 years	0.25	35 million	6 ~ 8 h	10 million	0.35 billion ㎡
After 10 years	0.35	49 million	7 ~ 8 h	14 million	0.49 billion ㎡

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Summary

- Undergoing a process of industrialization and urbanization, **China faces huge pressure on the environment**.
- Being one of the biggest developing Country, China **has to pave its way towards sustainable development**, especially in the energy supplying field.
- **Energy consumption** in building section is huge for China, and **must be transferred towards sustainable development** ASAP.
- **Building integrated solar energy** utilization is **a good way towards sustainables** in the coming future.

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Thank You
for Your Attention!