BROAD A/C
远大空调

2020
TECHNICAL APPLICATION OF BROAD AIR CONDITIONING

远大空调技术应用方案 2020年版

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BROAD A/C
远大空调

WASTE HEAT FOR DISTRICT HEATING

废热区域供热

Banwol EcoPark, Anshan, Korea

韩国安山伴月生态园

Project Background

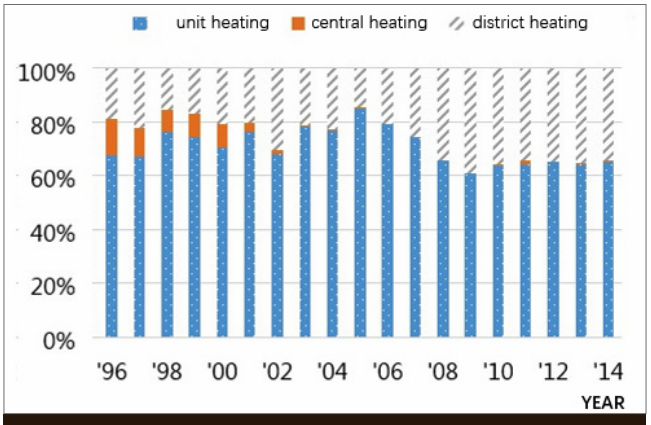
From government to the populace, the South Koreans have a strong consciousness of energy efficiency because of its limit land and insufficient natural resource. South Korea has a long winter with low temperature because of its geographical location. The heating season is from each November to April. In South Korea, the main heating modes are unit heating and district heating. Unit heating is the most common method, accounting for more than 60%, district heating currently accounts for about 30%, and also some building central heating exists, which is replaced gradually in recent years. District heating has a large initial investment due to the network construction, but the operation cost advantage and environmental benefits are obvious, so it is strongly supported and promoted by the government.

District heating resources mainly include steam heat exchange from power plant (CHP), gas boilers, garbage incineration, waste heat recovery etc. Main income of heating company is heating charge from a defined area, and the heating area is quite stable as soon as it is defined, so the company's income is also predictable yearly. To pursuit more profit, heating companies try every possible means to reduce their cost, such as using low cost heat sources like waste incineration, recycling waste heat, and minimize the usage of steam and gas boiler. The Korean government also vigorously advocates energy saving and emission reduction, provides funds and technologies to promote energy-saving equipment and green energy, and introduces laws and regulations to stipulate emission reduction obligations of enterprises. If enterprises fail to fulfill their obligations, they must procure emission reduction quotas from other enterprises.

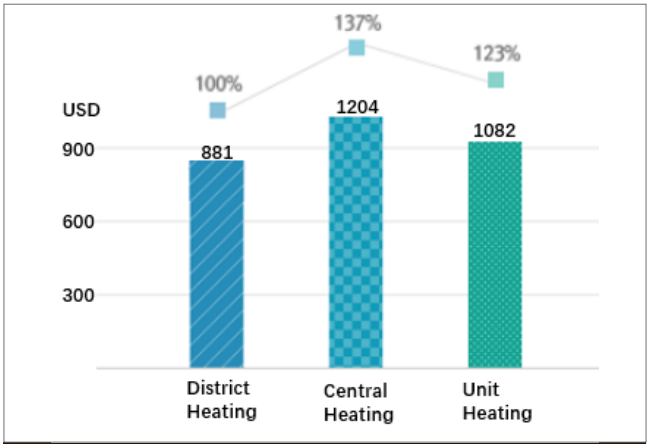
项目背景

韩国国土面积有限，自然资源相对不足，政府和民众的节能意识非常强。韩国冬季气温低、时间长，采暖季一般为每年的11月到次年4月，主要供热方式为单独供热和区域热网供热。单独供热应用最为普遍占60%以上；区域供热目前占30%左右；另有少量的楼宇集中供热，近年逐渐被替代。区域供热由于管网铺设等初期投资较大，但运行成本低、环境效益显著，因而得到政府大力推广。

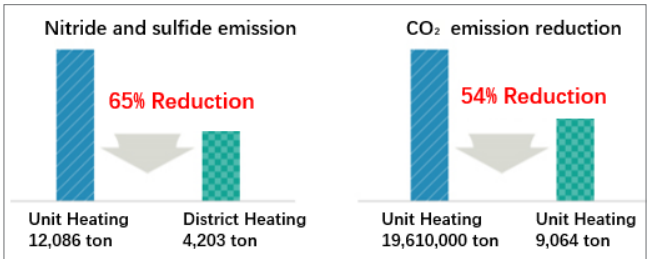
区域供热主要热源有电站蒸汽换热 (CHP)、燃气锅炉、垃圾焚烧、废热回收等，热力公司的主要营业收入是特定区域内的采暖费。供热区域一经划定基本不变，因而营业收入比较稳定。为了扩大利润，各热力公司均想方设法来降低能源成本,如采用垃圾焚烧、回收废热等低成本供热方式，减少蒸汽换热和燃气锅炉的使用。韩国政府也大力推进节能减排工作，提供资金和技术鼓励节能设备和绿色能源的使用，并出台多项法令规定各类企业的硬性减排义务。如企业不能完成，则必须向其他企业购买减排量指标。



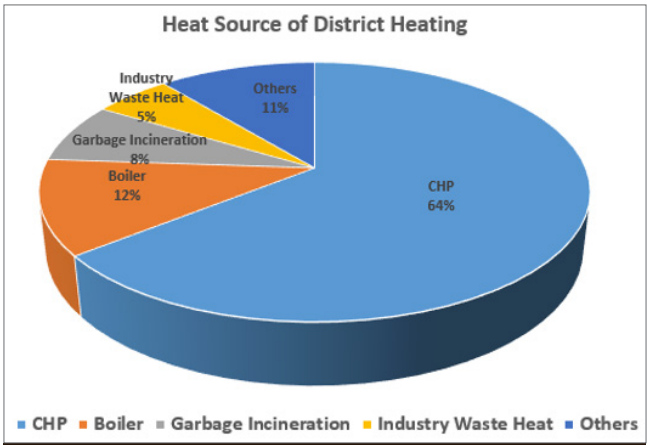
Heating modes and their proportion in Korea from 1996 to 2014.
www.r114.com, www.mk.co.kr
韩国1996~2014年供热方式及其占比



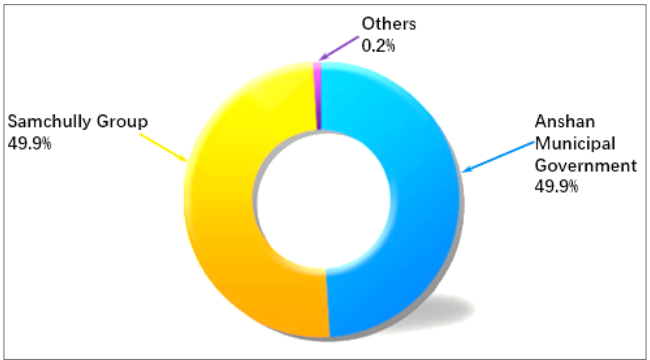
Average yearly household heating expense in Korea www.kdhc.co.kr
韩国年均家庭采暖费支出



Comparison of yearly emission caused by heating (equivalent calculation) www.kdhc.co.kr
韩国全年供暖产生的排放物对比 (折算)



Proportion of heat source of district heating from Ministry of Environment and Korea Energy Agency
韩国区域供热各热源占比



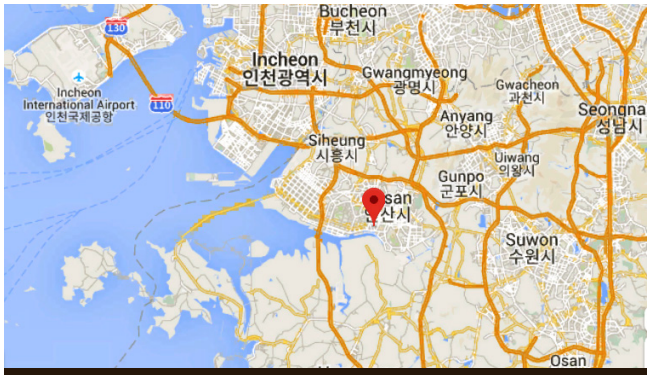
Shareholders of Ansan Urban Development Inc.
安山都市开发股东

Ansan Urban Development Inc. is a local heating supply company, founded in 1995, mainly owned by Sumchully Group and Ansan municipal government (49.9% share each). It is located in Ansan Banwol ECO Park, about 30 km away from downtown Seoul, the main business is heating and power generation with a installed power generation capacity 62.6MW, and a heating capacity 102Gcal/h. The main revenue comes from district heating, and there are around 60,000 users in defined supply area. Renewable energy sources (mainly garbage incineration), steam heat exchange (CHP) and peak load boiler are heating sources, among which garbage incineration has the lowest cost while cost of peak load boiler is the highest, even higher than heating charge. From late-November to mid-February, peak load boiler should be operated to cover high heating load, and that is very costly.

So as a heating supply company, the most important method to create profit is increasing use of low cost heat source and reducing peak load boiler operation time. In this project, BROAD absorption heat pump is used to recycle zero cost waste heat from dyeing factories for heating, primary energy consumption is decreased, so substantial economic profit is created. Meanwhile it is a positive response to government's call to save energy and decrease CO_2 emission, significant contribution to the society is also achieved.

安山都市开发是韩国定山市一家热力公司，成立于1995年，主要由三千里和安山市政府持股 (各49.9%)，位于安山伴月生态产业园区内，距离首尔市中心约 30 公里。公司主营业务为供热和发电，发电装机总容量 62.6MW，供热能力 102Gcal/h，主要收益来自于供热，目前划定区域内用户约 6万家。供热能源来自可再生能源 (垃圾焚烧)、蒸汽换热 (CHP) 和调峰锅炉，其中垃圾焚烧产热成本最低，调峰锅炉成本最高 (高于采暖收费)。在采暖季高峰11月下旬至次年2月中旬，需要开启调峰锅炉应对高负荷，使公司利润大打折扣。

因此增加低成本热源比例，减少调峰锅炉运行时间，是创造利润的最重要手段。本项目利用远大热泵回收零成本的印染废热用于区域供热采暖，降低一次能源消耗，既创造了可观的经济收益，也响应了政府号召，实现节能减排，做出重大的社会贡献。



Ansan Urban Development Inc.on google map
安山都市开发在地图上位置

Ansan Urban Development Inc.
安山都市开发

Heat pump machine room
热泵机房

Heat pump machine room
热泵机房

Project Introduction

BROAD Korea Distributor GS Power is responsible for the design, construction, commissioning and operation management of this project. Four units of BROAD BDS1000 heat pumps are installed, with low-pressure steam as the heat source, waste heat from dyeing factory waste water through heat exchanger is recycled to provide heating for the residential areas and other public places of Ansan city. Dyeing factory waste water is cooled down from 34.5℃ to 27℃, and heating return water is heated up from 55℃ to 83℃, and then further heated up to 103℃ before supplying to the heating net. Heating capacity of a single heat pump reaches 14MW when operates at full load.

Installation and commissioning work were completed in 2012, since no record of so huge heat pump operation in South Korea before, the customer required two BROAD engineers to support. The commissioning was completed successfully, all the performance indexes reached or exceeded designed data. After two years operation, the primary investment has been recycled, which provided powerful force for the company's development.

项目简介

该项目由远大韩国经销商 GS Power 承担设计、施工、调试及运营管理任务，采用四台远大 BDS1000 热泵，以低压蒸汽作为热源，回收印染厂经换热器后得到的废水中的热量，向安山市居民区及其他公共场所供热。印染厂废水从 34.5℃ 降至 27℃，采暖水回水则从 55℃ 提高到 83℃，再经蒸汽热交换器升温至 103℃ 后输入热水管网。设备满负荷运行时，单台热泵供热能力达到 14MW。

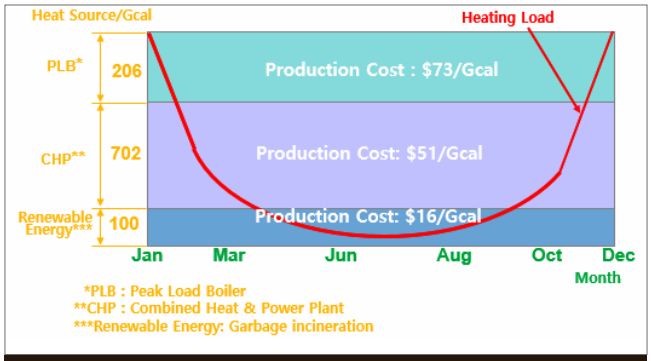
热泵系统于2012年底调试，由于在此之前从未有如此大的同类设备在韩国运行，远大派工程师全程指导协助客户调试并取得圆满成功，所有的指标都达到或者超过设计参数。不到两个采暖季，项目就已全部收回初投资，热泵的运行为安山都市开发公司的发展提供了强大的助力。

Project Value

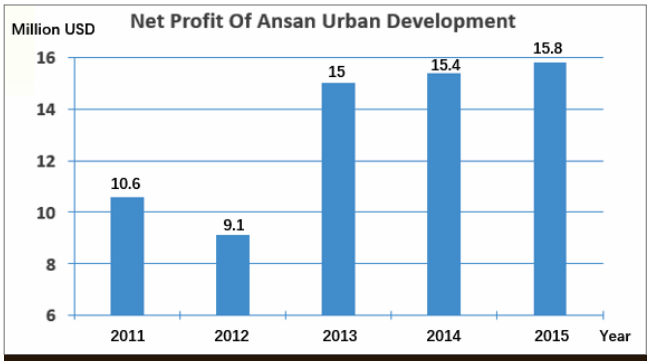
1. For Banwol Dyeing, waste water is cooled down to 27℃, treatment cost is decrease, and no need to operate cooling tower, operation cost is reduced, and no complaint from local citizens about the smells.
2. Zero-cost 19.8Gcal/h waste heat is recycled for heating, so for Anshan Urban Development Inc., cost of heating supply is decreased, and actual yearly payback is around $5 million.
3. Waste heat from factory is recycled for heating supply, primary energy consumption is decreased, economic profit is obtained, meanwhile huge contribution to the society is created, which makes this project a show case of energy saving and emission reduction.

项目价值

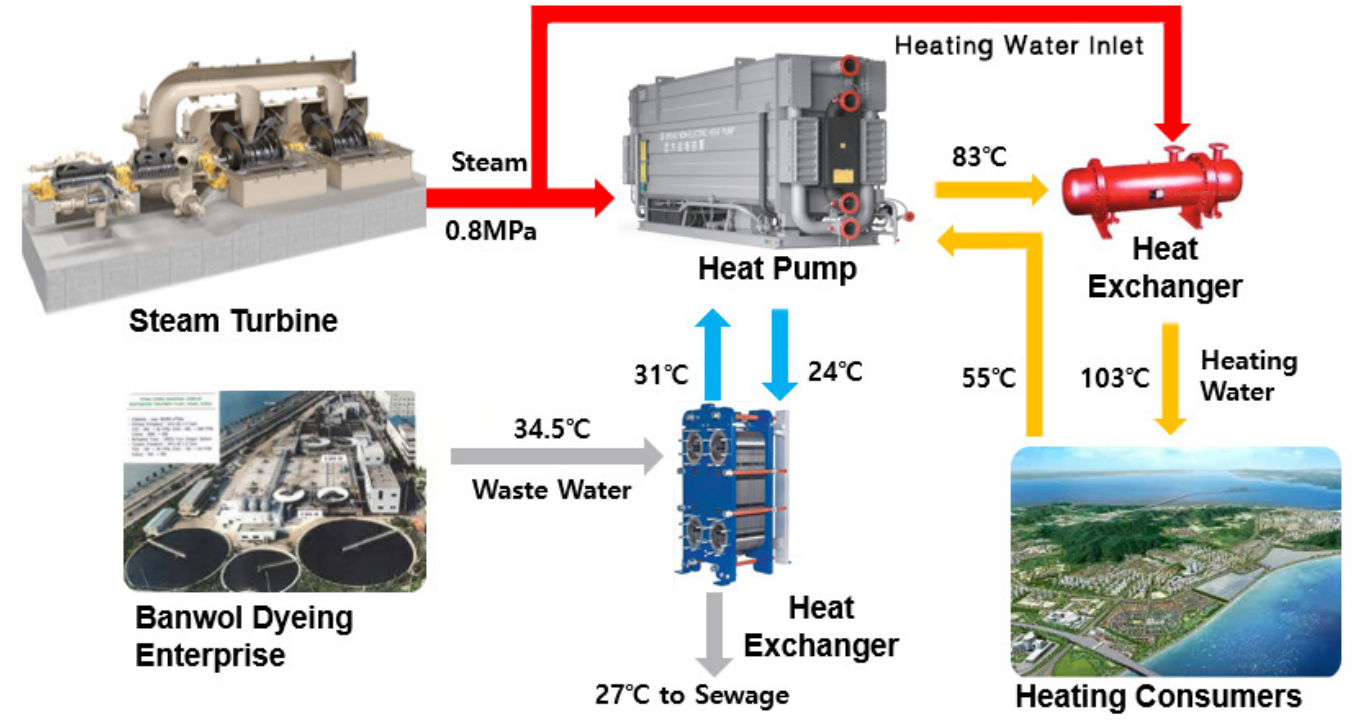
1. 伴月印染厂废水降到 27℃ 再处理，冷却塔无需再运行，降低了污水的处理费用和工厂运营成本，同时也减少了周围居民对气味的投诉。
2. 零成本的废热回收量达到 19.8Gcal/h，减少调峰锅炉的运行时间，供热成本降低。安山都市开发通过此项目的实际年收益达到 500 万美元。
3. 项目回收了工业废热用于区域供暖，降低一次能源消耗，创造经济收益的同时做出重大的社会贡献，成为当地节能减排项目的典范。



Heating load, source and production cost of Ansan Urban Development Inc.
安山都市开发供热负荷，热源以及成本



After the heat pump installed in 2013, net profit of Ansan Urban Development Inc. increased obviously.
安山都市开发2011~2015年度净利润，自2013年项目完成后利润增长显著



System diagram 项目系统简图

BROAD A/C
远大空调

HOT WATER DRIVEN DISTRICT ENERGY

远程热水区域能源

CEPM Dominica

多米尼加 CEPM

Project Background

The Consorcio Energé tico Punta Cana - Macao (CEPM) is a privately own utility company that generates, transmits, distributes and commercializes energy in the touristic areas of Punta Cana, Bá varo and Bayah í be in the Dominican Republic, with an available capacity of more than 300 MW. As the pioneer in the country, CEPM set the first wind energy project in the Dominican Republic (8.25 MW), it's the first distribution company to introduce prepaid energy and implement first waste heat district energy in the Caribbean area.

This DE project is in the eastern tourist area of Punta Cana. BROAD provided 8 units single stage hot water chiller, using waste heat from power generation. The total cooling capacity is 19MW.

项目背景

CEPM是多米尼加共和国一家民营电力公司，为蓬塔卡纳、巴瓦罗和巴亚希比旅游区生产、输配和销售电力，有能力满足 300 MW的电力需求。CEPM作为多米尼加能源先驱，在能源领域取得了诸多成就，例如多米尼加的第一个风能项目(8.25MW)，第一家引入预付费模式的电力公司以及建设加勒比地区第一个废热区域能源项目。

该区域能源项目位于多米尼加东部旅游胜地蓬塔卡纳。远大为其提供了 8 台利用发电废热驱动的热水型非电空调，总制冷量 19MW。

Project Location
项目地点

Project Introduction

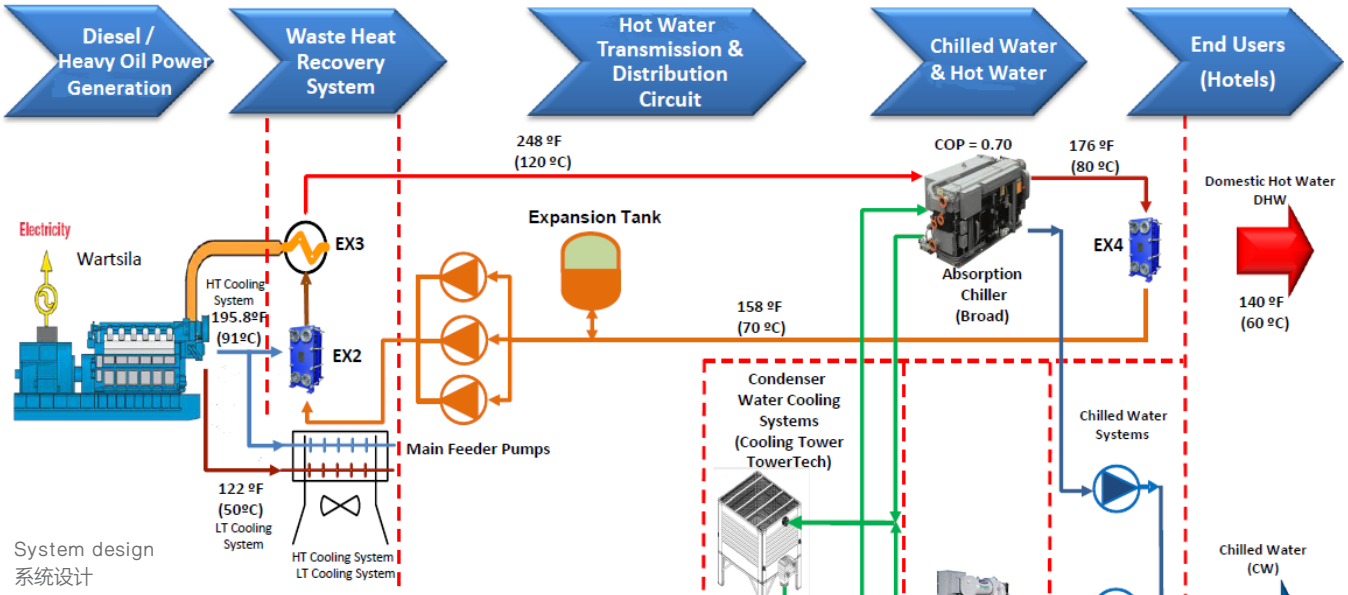
CEPM's available generation infrastructure is 63.8MW. It has 17 active units, 17 reserve units and keep two in maintenance (8.2MW). The District Energy Project oriented to expanding energy services and optimizing clean energy production, thus enabling the company to guarantee a reliable operation and sustained development. Highlighted among Its main objectives are:

- Recovery of residual heat from the electric generating units from the CEPM plant in Bá varo to produce pressurized hot water for distribution through a closed circuit that feeds the absorption chillers for cooling.
- In addition, to generate Domestic Hot Water (DHW) following the Chilled Water (CHW) generation process.
- Significantly reduce exhaust gas temperature discharged through the plant's smoke stacks and, thus, environmentally improving the operations of CEPM, and reducing environmental impacts derived from the production of SHW and CHW in resort hotel facilities which are in the scope of this project.

项目介绍

CEPM发电装机容量为 63.8MW， 拥有 17 台常用机组和 17 台备用机组，并保持 2 台左右的维修机组 (8.2 MW)。区域能源项目旨在扩大能源服务和优化清洁能源生产，从而使公司能够保证可靠的运作和持续的发展。
其主要目标重点是：

- 从巴瓦罗CEPM电厂发电机组中回收余热并生产加压热水，热水通过一个闭式循环输送给吸收式制冷机组提供空调
- 另外，驱动制冷机之后的热水继续换热制取卫生热水
- 显著降低电厂烟囱排放的废气温度，从而在环境上改善CEPM的运行，并减少本项目范围内度假酒店设施中生产冷水和卫生热水所产生的环境影响



System design
系统设计

This system provides 5,000 RT of CW and DHW to hotels located near to CEMP's power plant. The system is powered by waste heat comes from the exhaust gas and cooling water of 5 units of diesel engines (6 MW each) in the power plant which consume heavy fuel oil (HFO).

The waste heat from the power plant generates 120℃ High Temperature Hot Water (HTHW) which then is distributed to nearby 4 hotels via 4kM long piping. The absorption chillers located in the hotels utilize HTHW as the heat source to produce CHW.

The HTHW after being used to provide cooling via the absorption chillers is then connected to an additional set of heat exchangers to produce DHW, and the "spent" HTHW is sent back to the power plant with a temperature of ±70℃.

In this way a large delta T 50℃ can be effected by using the single loop to serve two purposes, first high quality heat to run the chillers, and second the lower temperature resulting water out of the chillers used for all or part of domestic hot water generation. Energy was used in cascade with high efficiency.

该系统为CEPM电厂附近的酒店提供 5,000 冷吨的供冷需求和卫生热水需求。电厂内5台重油发电机 (每台 6 MW)的高温烟气和缸套水提供该系统所需的驱动能源。

电厂发电废热生产出 120℃ 高温热水经过 4 公里管道输配到附近 4 个酒店。酒店内吸收式制冷机组以高温热水作为驱动热源进行制冷。

高温热水在经过吸收式制冷后再经过一个换热器来制取卫生热水，最终降温至 70℃ 送回电厂。

这样，通过高达 50℃ 的供回水温差可以通过一套管路实现供冷、供热的双重目标。首先，高品味的热源用来驱动空调，其次空调出来的中品位热源用来全部或部分制取卫生热水，从而实现了能源的梯级高效综合利用。

Project Value

Reduction of 25% of the electrical energy (kWh) consumed by the hotels versus the option of conventional design, since the hotels consumed 34% of the electrical bill to produce chilled water before the district energy project was implemented. This implies that the utility consume 25% less fuel to supply electric power to these hotels and can reduce the expansion investment of electrical transmission and distribution networks.

The base demand for chilled water of the hotels was covered by BROAD absorption chillers plus reuse of limited amount of existing peak cooling with the existing electric chillers.

All demand for domestic hot water was supplied to the hotels by the district energy, therefore the fuel consumption in the domestic hot water boilers was reduced to zero. This is meaningful given that all of it were operated from Diesel or GLP, which is very expensive.

This project demonstrated that we can use waste energy to produce thermal energies (chilled water and domestic hot water) required in the hotels for the comfort of its customers, in such a way that both the hotels benefit through total cost reduction as compared to the previous all electric load case, and the utility wins through actually increasing net revenues in a cost effective way which helps to cement a long term relationship with large key customers. This then becomes truly a win-win situation for all, which is one of the avowed goals of any third party cogeneration project.

With this cogeneration approach, about 25% of thermal energy is recovered to drive absorption chillers and DWH heat exchangers and reduce the Fuel consumption by 35,740 Bbl/year of HFO and 32,881 Bbl/year of LPG. The Greenhouse gas emission is reduced by over 28,872 tons CO_2/year.

HVAC scheme 空调主机参数

Model 机型	Absorption chiller 热水型吸收式制冷机组
Quantity 数量	8 units 台
Capacity 发电量	6MW/unit 台×5
Brand 品牌	BROAD 远大
Heat input 能源输入	Hot water 热水
Origin 原产地	China 中国

项目价值

相较于传统模式，冷热电联产使酒店用电量减少25%，用于制冷的电费减少了34%。这也意味着电厂因用电量下降燃料消耗减少了25%，同时节省电力输配网络的投资。

酒店的基础制冷负荷由远大吸收式制冷机组来提供，已有的电冷机仅作为调峰备用。

酒店所有的卫生热水的需求都由区域能源系统提供，不再需要使用锅炉。由于供锅炉的燃料：柴油或液化气价格昂贵，更使得该系统意义非凡。

该项目向人们展示了废热能够用来给酒店客户提供制冷和卫生热水，也使得酒店经营方和能源提供方双双受益。相比之前全部用电力承担负荷，酒店方面通过整体运营费用降低产生更多利润。同时，费用的节省使得能源提供方实际净利润增加，从而进一步巩固了和大批重要客户的长期合作关系。最终，该项目真正实现了多方共赢，这也是所有第三方冷热电联产项目要实现的目标之一。

通过冷热电联产，约 25% 的热能被用来制冷和制取卫生热水，每年减少重油消耗 35740 桶；减少液化石油气消耗 32881 桶；每年减少二氧化碳排放达 28872 吨。

International Recognition

As one of interest DE project in the Caribbean, CEPM project has drawn great international attention and recognition.

As an International District Energy Association (IDEA) member, BROAD shared this case study with global professional via IDEA platform, and wish to inspire more ideas.

On July 18 2019, the former US President Bill Clinton visited the facilities of the CEPM, to learn about the infrastructure and innovative technology supporting the efficient energy supply model in the East of the country, specifically for the tourist area of Bavaro and Punta Cana.

国际认可

CEPM区域能源作为加勒比海地区最有吸引力的项目，受到了国际社会的广泛关注和赞誉。

作为全球最大和最专业的区域能源专业组织——国际区域能源协会（IDEA）的会员，远大在IDEA平台上与全球专业人士分享该项目案例，希望能启发更多思考。

2019年7月18日，美国前总统比尔·克林顿参观考察CEPM区域能源项目，详细了解了该国东部地区（特别是巴瓦罗和蓬塔卡纳旅游区）应用于高效能源供应模式的核心设备和创新技术。

BROAD District Energy Case Study, CEPM

11-15-2018 15:16

District Energy

Summary

In Punta Cana, waste heat from energy company CEMP's power plant is sent to nearby hotels to provide chilled water and domestic hot water. Absorption chillers, provided by BROAD, are used for cooling. A heat exchanger provides domestic hot water. The large delta T, 90 degrees F, was harnessed to serve two purposes, high quality heat to run the chillers and domestic hot water generation. The cogeneration process resulted in a 25% decrease of electricity consumption for the hotels.

Source: https://www.districtenergy.org/viewdocument/broad-district-energy-case-study-c

As a sponsor of Cinton Fund, CEPM always focus in low carbon development
CEPM作为克林顿基金的赞助者之一，一直专注于绿色低碳能源发展

Conclusion

This project represents the most innovative energy arrangement in the Caribbean. The use of the residual thermal energy as well as cascade energy use represents the new development creating of the country.

Comparing with others in this area, the hotels will benefit significantly in operating costs and increasing their competitiveness, moreover, it helps them to forward to environmentally friendly growth.

The optimization and use of the available thermal energy allows having better chance to meet future power demands of the area since the electrical energy which is not consumed by the hotels can be distributed to other new facilities.

The implementation of this project will strengthen the growth of the region that will also maintain a sustainable development in the economic growth of the region.

项目总结

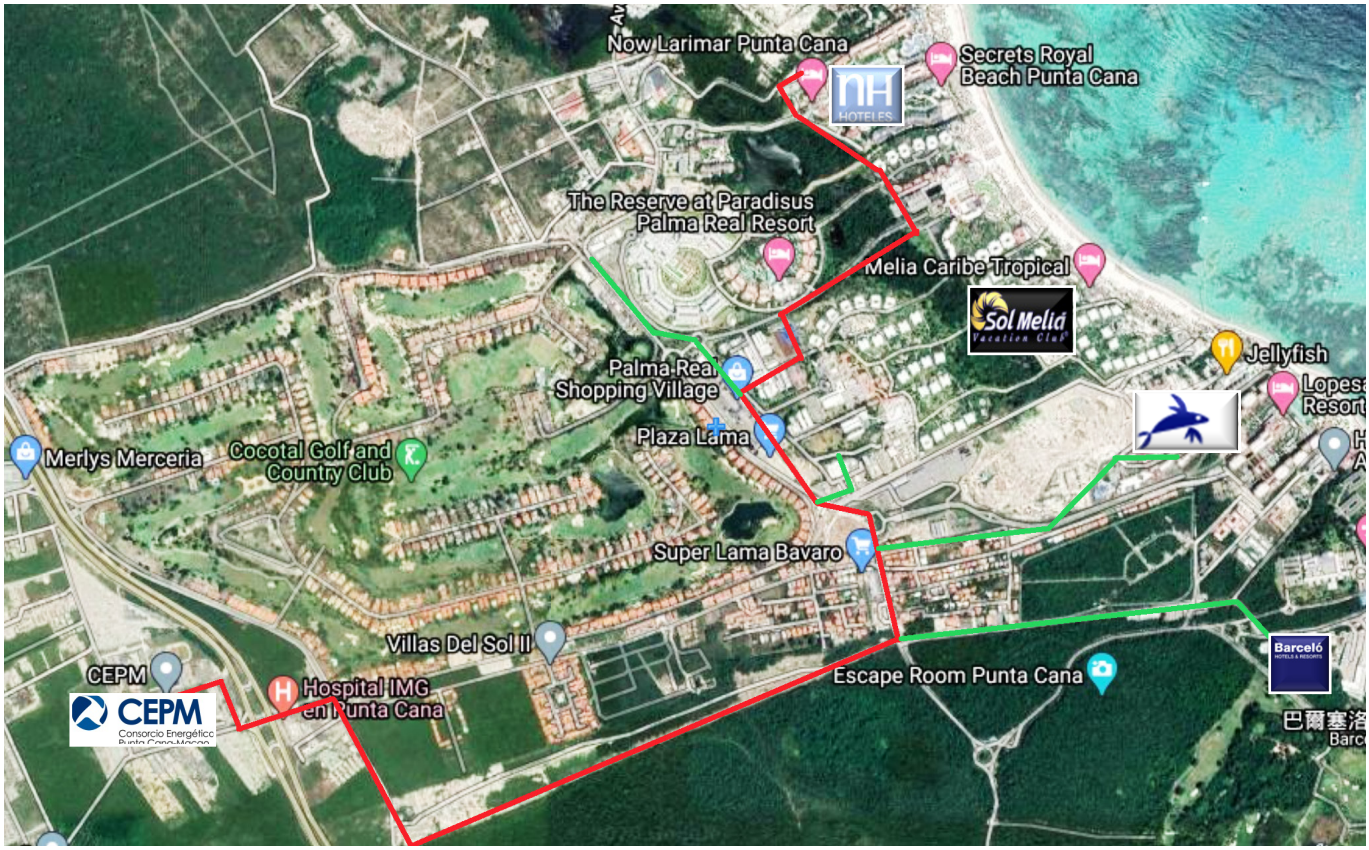
该项目是加勒比海地区最具创新性的能源项目。废热的梯级综合利用代表了多米尼加在能源发展领域的最新开拓。

同该区域其它酒店相比，这些酒店极大降低了运营成本，提升了竞争力，因而酒店获益明显。同时，也有助于他们往环境友好型方向发展。

热能的优化利用有利于更好的满足该地区未来的电力需求，因为那些原本要被酒店消耗的电能可以更好的分配给该地区的其它新增设施。

该项目的实施将巩固该地区的经济增长，并将为维持该地区的经济可持续发展做出贡献。

main hot water pipe 主热水管　　branch 支管



What is District Energy?

District energy systems produce steam, hot water or chilled water at a central plant. The steam, hot water or chilled water is then piped underground to individual buildings or factory for space heating, domestic hot water heating, air conditioning or industrial process use. As a result, individual buildings served by a district energy system don't need their own boilers or furnaces, chillers or air conditioners. The district energy system does that work for them, providing valuable benefits including:

- Improved energy efficiency;
- Enhanced environmental protection;
- Fuel flexibility;
- Ease of operation and maintenance Reliability;
- Comfort and convenience for customers;
- Decreased life-cycle costs;
- Decreased building capital costs;
- Improved architectural design flexibility.

From the data of International District Energy Association (IDEA), It is easy to know that the energy efficiency of a standard power plant is only 40%, and that of 60% is wasted as the waste. However, with the same fuel input, the energy efficiency can be 80% if the power plant combined heat and cooling. Obviously it will benefit a lot not only in saving energy cost but also to the environmental protection.

District energy is the best application of CCHP system, which is widely accepted around the world as it can maximize the energy efficiency.

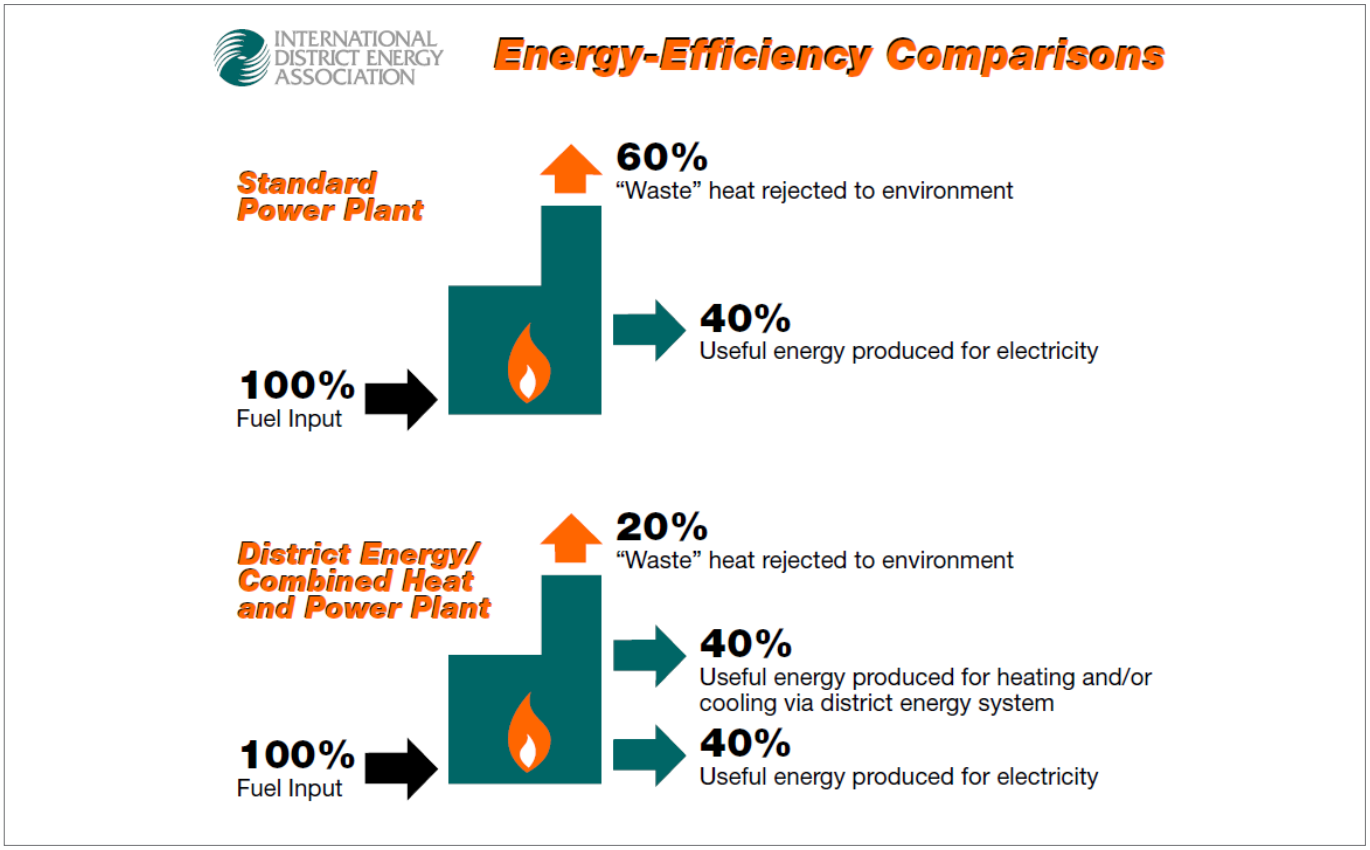
什么是区域能源?

区域能源系统通常是指在某个集中的区域生产蒸汽、热水或者冷水，并通过地下管道将这些蒸汽和冷、热水送至周边的单个建筑或工厂，为其提供冷、热或卫生热水等。因而单个建筑便不需要再安装锅炉或是空调。区域能源系统能够提供所有这些需求，并带来以下好处：

- 提高能源效率
- 加强环境保护
- 燃料更加灵活
- 操作维护简便
- 运行稳定可靠
- 客户舒适方便
- 减少运行费用
- 减少建筑投资
- 建筑设计灵活

从国际区域能源协会公布的数据看，传统发电厂的能效为 40%，而剩余 60% 热量被当作废热直接排放到大气中。然而，相同的能源输入，冷热电三联产的能效可以达到 80% 。无论是在节省能源费用方面，还是在环境保护方面，该系统都将带来巨大的效益。

因为冷热电三联产能最大化提高能源效率，已成为区域能源的最佳应用形式，并得到国际社会广泛认可。



DOUBEL LIFT HEAT PUMP
两级提升式热泵

Hjørring District Heating, Denmark
丹麦约灵区域供暖

Project Background

Denmark, locate at the north of Europe, with long and cold winter, the energy consumption for heating occupies a big portion in the country's energy structure. As one of the World's most efficient country, Denmark has the most advanced heating technologies, according to Danish Energy Agency, the application of district heating and combined heating and power are the main reason that Denmark maintain a high energy efficiency and control carbon emission. It is regarded as the cornerstone of Danish green effective energy system.

Danish population is widely distributed across the country, thus different scale heating centers are built commonly. Hjørring, is one of the examples.

Hjørring biomass heating plant, in order to improve the system energy efficiency, aim to fully recover the 40℃ flue gas waste heat from the boiler stack. BROAD creatively developed the world's first double lift absorption heat pump to provide 10℃ low-temperature water to recover 40℃ flue gas waste heat and supplies 85℃ hot water for district heating, maximized the energy efficiency.

项目背景

丹麦位于欧洲北部，冬季温度低、时间长，供暖所用能源占全国总能源比例大。作为全球能效最高的国家之一，丹麦拥有世界领先的区域供暖技术。丹麦能源署认为区域供热和热电联产的广泛使用，是该国在过去几十年里提高能源效率并减少碳排放的主要原因，是丹麦绿色高效能源体系的基石。

由于人口分散，丹麦各种规模的区域供暖中心极为普遍。约灵，就是一个典型的剪影。约灵区域供暖公司采用木屑生物质锅炉供暖，为了提高整个供暖系统的能源效率，要求将40℃左右的锅炉尾气余热充分回收用于供暖。远大开创性地开发出两级提升式热泵，在提供 10℃ 冷水回收 40℃ 锅炉尾气余热的同时提供 85℃ 的高温热水用于区域供暖，为客户真正做到废热的充分回收和供暖系统能效最大化。

Project Introduction

Hjørring District Heating A.m.b.a. supplies electricity, heating and cooling to commercial industries and private homes in northern Jutland, Denmark. It aims for top reliability and low heating prices. In April 2014, one BROAD double life absorption heat pump was stared up in this plant which made this plant become one of the lowest cost district heating plants in Denmark afterwards.

The heat pump recycles the latent heat from flue gas of biomass boiler and provide 13MW heating water at 85℃ to the DH network. From evaporator 10℃ chilled water directly cool down and recycle the latent heat from the flue gas, decrease its temperature to 9~12℃, to keep the emissions at the lowest level. This special designed heat pump overcome the big challenge of low temperature chilled water and high temperature heating water (75℃) between the evaporator and the condenser.

This is one of the typical cases to utilize the absorption heat pump to recover the flue gas condensate heat and improve the plant efficiency.

项目简介

约灵区域供暖中心为约灵镇周边的商业、工业及住宅提供冷热电服务。2014年4月，远大吸收式热泵机组成功调试运行，实现了高可靠、低成本的区域供暖服务，是丹麦运行成本最低的供暖中心之一。

远大吸收式热泵回收生物质锅炉尾气的废热作为热泵的低位热源（10/20℃），并将此低位废热经热泵提升至 85℃ 供给区域管网，总供热量 13MW。此项目的特点是用吸收式热泵抽取的 10℃以下冷水直接去回收锅炉尾气废热，将尾气降温至 9~12℃，回收尾气中的潜热，同时清洗了尾气，确保排放在最低水平。此项目克服了低温冷水与高温供暖水的大温差(75℃)，同时满足了客户低温热源水侧和中温水侧的高要求。

这是利用吸收式热泵回收锅炉尾气冷凝废热并提高整个供暖中心能源效率的典型案例。

What is Double Lift?

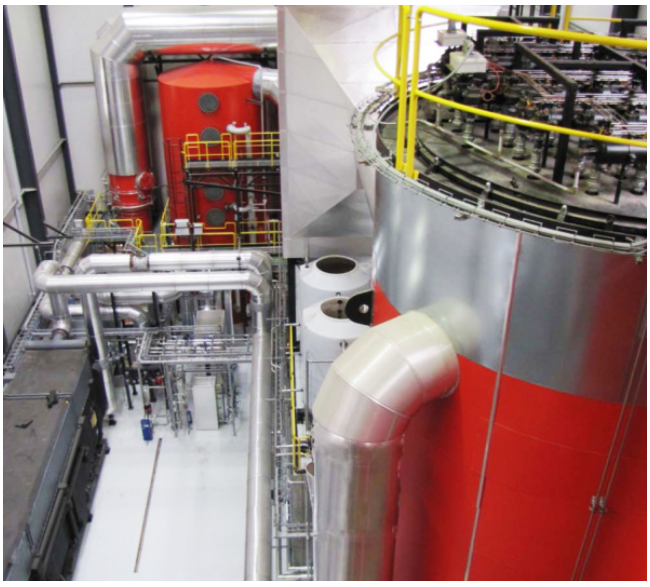
When the temperature difference between the low temperature heat source water outlet and the heating water outlet is very big, for instance 70℃, a standard absorption heat pump with single lift is not possible to achieve this target. BROAD developed a new heat pump which with new evaporators and absorbers structure, and creative flow circle to make sure the heat from low temperature heat source water can be transferred and lifted twice within the machine and delivered to the heating water. This is called double lift heat pump.

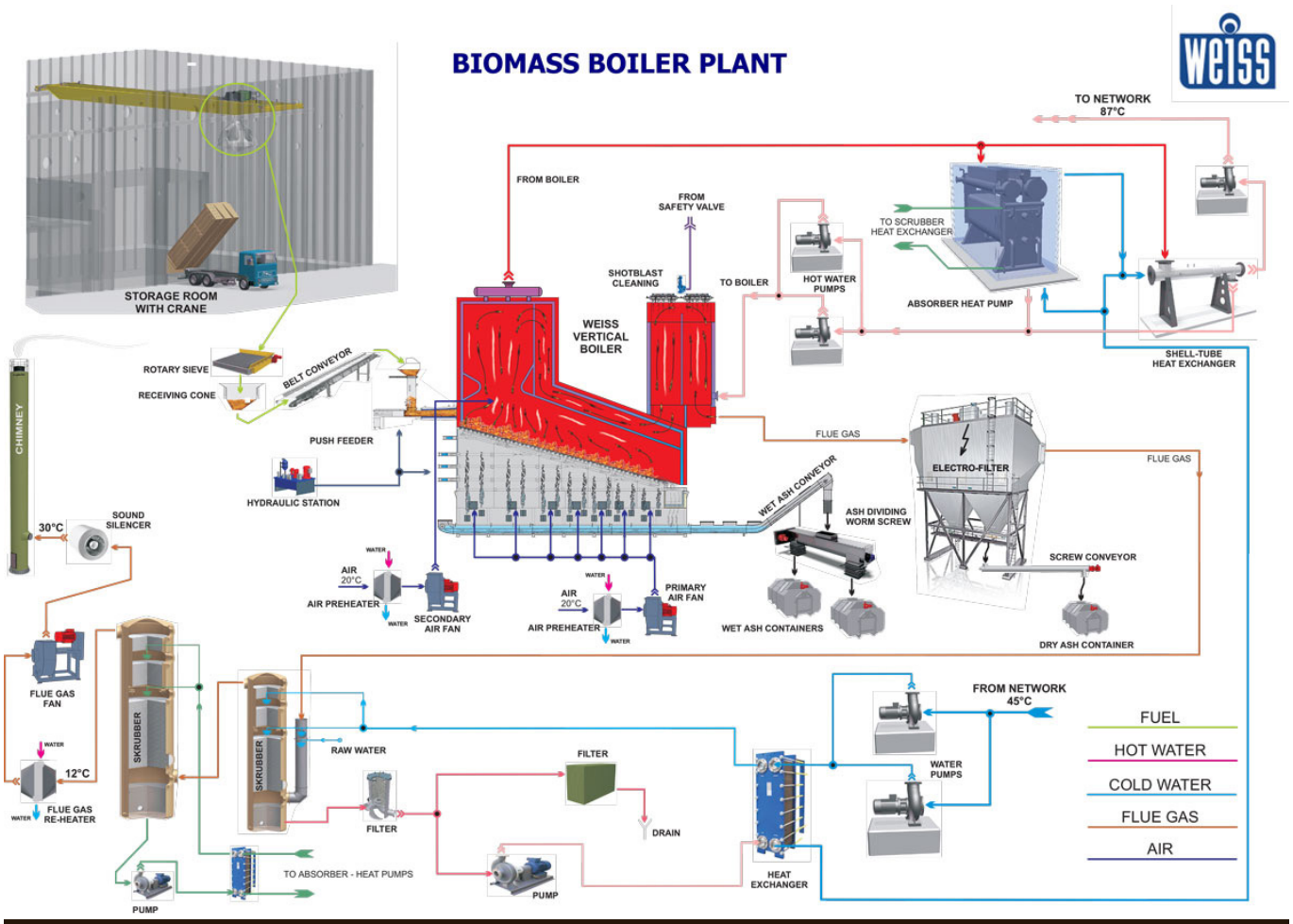
By this technology, big temperature difference between low temperature heat source water outlet and heating water outlet can be very big such as 70℃. In Hjørring, it is remarkably 75℃. During 6 years operation, Hjørring received many visitors from Denmark and other countries for study.

什么是两级提升

当低位热源出口温度和中温水出口温度温差要求非常大时（如 70℃），普通热泵无法满足。远大开发了一种新型热泵来满足这种需求：通过特殊设计蒸发器和吸收器结构以及创新设计的流程，低位热源水侧的热量通过了两次能量传递和提升至中温水侧，我们将这种技术称为两级提升。

通过此项创新，低位热源水出口温度和中温水出口温度温差可以超过 70℃，在约灵项目上更是达到客户要求的 75℃。本项目已运行6年多，接待了众多欧洲客户的考察和交流。

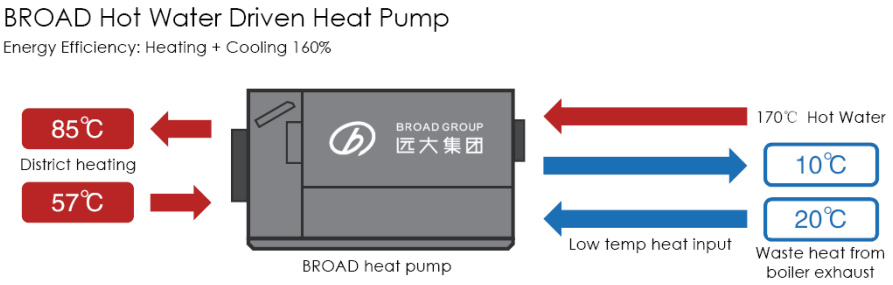




Biomass Heating System Diagram　生物质采暖系统简介

The heat pump parameters
热泵主机参数

Model 机型	BDH1000
Heating capacity 制热量	13MW
Heat input 热源	Hot water 热水
Quantity 数量	1 unit 台
Brand 品牌	BROAD 远大
Origin 原产地	China 中国



Project Value

The heat pump cool the flue gas and recover 3,000kW waste heat from it, help to increase the energy efficiency of the whole plant to 120%, which is the world-class fuel utilization performance. The facilities can dramatically lower their carbon footprint by 1,800 tons/year, while save an operation cost by USD 446,300/year, the payback time is 3 years.

The flue gas emission levels are extraordinarily low. Gas and dust emission are on the lowest level of current permissible limits, and some already meet the planned compliance levels for the year 2022 in Denmark.

项目价值

热泵将 40℃ 的锅炉尾气降低至 9~12℃，可以从中回收 3,000kW废热。同时将整个供暖中心的能源效率提升至 120%，这是世界级的能源利用效率。此套设备每年可以减少碳排放 1800 吨，同时每年减少运行费用约 45 万美元，投资回收期 3 年。

锅炉尾气的排放水平极低。气体和颗粒物排放已经处于目前所容许范围的最低水平，同时部分参数已经达到了2022年丹麦地区容许的排放水平。

URBAN WASTE TREATMENT FOR DISTRICT COOLING

城市废弃物处理与区域空调

Gardens by the Bay, Singapore

新加坡滨海湾花园

Project Background

Gardens by the Bay is an independent organization responsible for developing and managing one of Asia's foremost garden destinations.

The Gardens is led by a multidisciplinary team of professionals who have been involved in the greening of Singapore and had worked alongside international and local experts to develop the Gardens. It has an in-house team of skilled landscape designers, horticulturists, arborists, engineers, plant health, garden and turf management experts, as well as plant research and orchid breeding professionals, who leverage on the extensive global network of plant sources cultivated during the development days, to continuously curate and grow the Gardens.

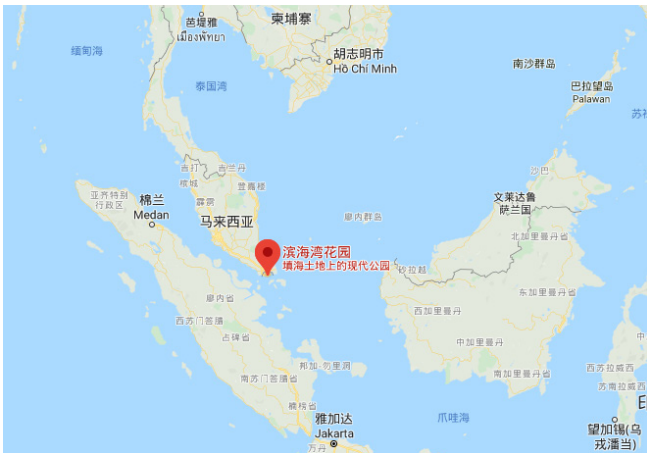
Guided by its vision to be a world of gardens for all to own, enjoy and cherish, Gardens by the Bay has earned numerous awards and accolades including the World Building of the Year in 2012, the President's Design Award (Singapore) in 2013, the Outstanding Achievement Award by the Themed Entertainment Association in 2014, the Largest Glass Greenhouse (Flower Dome) in the Guinness World Records for 2015, and the Trip Advisor Certificate of Excellence in 2016. These achievements are testament to the ongoing excellence of the Gardens and spur the team towards attaining greater success.

项目背景

滨海湾花园是一个负责开发和管理亚洲最著名花园项目的独立组织。

滨海湾花园由一个多学科的专业团队领导，他们参与了新加坡的绿化工程，并与国际和当地的专家合作共同开发滨海湾花园项目。它拥有一支由顶级的景观设计师、园艺师、植物学家、工程师、植物健康管理专家、花园和草坪管理专家以及植物研究和兰花育种专家组成的内部团队，他们借助开发期间建立的全球植物资源网络来持续管理和种植滨海湾花园。

滨海湾花园以成为一个让所有人拥有、享受以及珍爱的花园世界为愿景，使其获得了无数奖项和荣誉，包括：2012年世界建筑奖、2013年新加坡总统设计奖、2014年主题娱乐协会杰出成就奖、2015年吉尼斯世界纪录（最大玻璃温室——鲜花穹顶）、2016年旅行顾问优秀证书。这些成就证明了滨海湾花园的长久卓越，并激励团队取得更大的成功。



A national garden and premier horticultural attraction for local and international visitors, Gardens by the Bay is a showpiece of horticulture and garden artistry that presents the plant kingdom in a whole new way, entertaining while educating visitors with plants seldom seen in this part of the world, ranging from species in cool, temperate climates to tropical forests and habitats.

Gardens by the Bay comprises three distinctive waterfront gardens - Bay South, Bay East and Bay Central.

Bay South, the largest of the three gardens, opened in 2012. With its award-winning cooled conservatories and iconic Super trees, Bay South has placed Singapore squarely on the international map and is a source of national pride. Within Flower Dome, the ever-changing floral displays including crowd favorites such as Tulipmania, Orchid Extravaganza and Blossom Beats bring the beauty and diversity of the plant kingdom to life for all to enjoy.

While plant displays remain the focal point of Gardens by the Bay, engaging programmes and excellent service form key pillars in enhancing the Gardens' overall visitor experience.

The Gardens' calendar - filled with signature festivals, music concerts and movie screenings, sports and community events, and educational workshops and school programmes- draw a wide spectrum of visitors to the Gardens. With more than 50 million visitors to date, Gardens by the Bay continues to refresh and refine its offerings, to make the Gardens a place that everyone can enjoy-a green jewel where wonder blooms.

滨海湾花园是一个国家花园，也是当地和国际游客的首选园艺景点，是园林艺术的展示中心。它以一种全新的方式呈现了植物王国，用世界上珍稀植物（从凉爽、温带气候到热带森林的各类物种）让游客游玩时学到知识。

滨海湾花园是由三个各具特色的滨水花园——南湾，东湾和海湾中心组成。

南湾于2012年开园，是三个花园中最大的一个。南湾凭借屡获殊荣的恒温温室和标志性的巨树，使新加坡成为世界地图上最耀眼的明珠，成为新加坡的民族骄傲。在鲜花穹顶内，变幻无穷的花卉 (包括观众最喜欢的郁金香、兰花等花卉) 展示、植物王国的美丽和多样性让旅客们流连忘返、如痴如醉。

虽然植物展示仍然是滨海湾花园的重点，但引人入胜的节目和优质的服务是提升花园整体游客体验的关键。

滨海湾花园的活动日历上充满了标志性的节日、音乐会和电影、体育和社交活动、学术研讨会和论坛，吸引了众多游客参观、游览。到目前为止，滨海湾花园已经吸引了超过5000万游客，并且仍在不断更新和完善服务内容。滨海湾花园就像一颗绽放奇迹的绿色宝石让每个人乐在其中。

Sustainability in the Gardens

Underlying the concept of Gardens by the Bay are the principles of environmental sustainability. Much effort was made to plan and design for sustainable cycles in energy and water throughout Bay South Garden.

Comprising two glass biomes, the Conservatories replicate the cool-dry climate of the Mediterranean and semi-arid sub-tropical regions and the cool-moist climate of the Tropical Montane region. They house a diverse collection of plants that are not commonly seen in this part of the world and are of high conservation value.

The conservatories are a statement in sustainable engineering and apply a suite of cutting-edge technologies for energy-efficient solutions in cooling. This suite of technologies can help to achieve at least 30% savings in energy consumption, compared to conventional cooling technologies.

1. Minimizing Solar Heat Gain
   The two conservatories are fitted with specially selected glass that allows optimal light in for plants, but reduces a substantial amount of heat. The roof is fitted with a sensor-operated retractable sails that opens automatically to provide shade to the plants when it gets too hot.

2. Cooling only the occupied zones
   The Conservatories apply the strategy of cooling only the lower levels, thus reducing the volume of air to be cooled. This is achieved through thermal stratification - ground cooling by chilled water pipes cast within the floor slabs enabling cool air to settle at the lower occupied zone while the warm air rises and is vented out at high levels.

3. De-humidifying the air before cooling
   To reduce the amount of energy required in the cooling process, the air in Flower Dome is de-humidified by liquid desiccant (drying agent) before it is cooled. This desiccant is recycled using the waste heat from the burning of the biomass.

花园的可持续发展

滨海湾花园以环境可持续性为设计基本原则。南湾花园在能源和水的可持续循环方面做了大量的规划和设计。

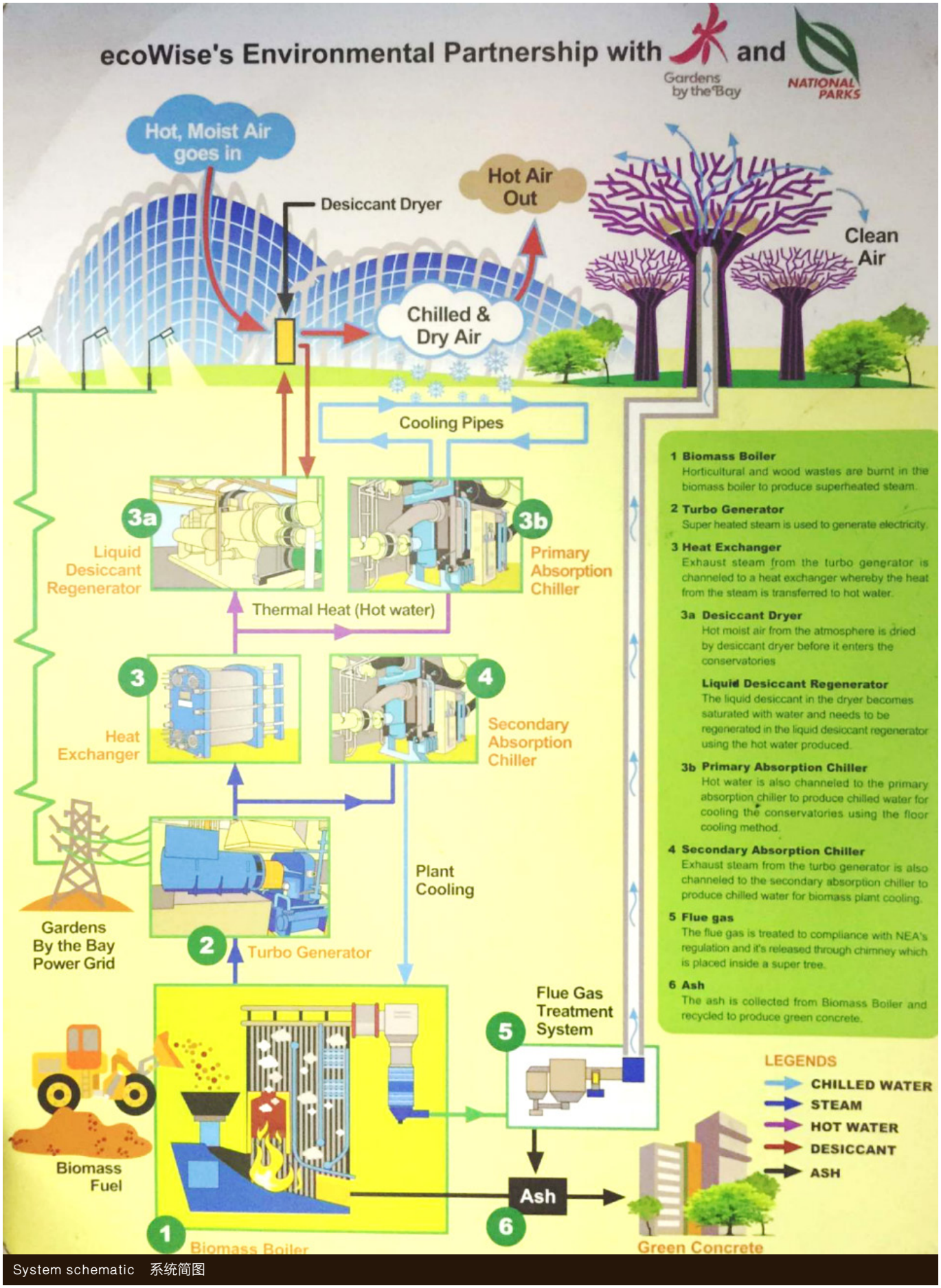
由两个生物群落构成的玻璃温室分别模拟了地中海和半干旱亚热带地区的凉爽干燥气候和热带山地地区的凉爽潮湿气候。温室里面种植了多种世界上濒临灭绝的稀有植物，具有很高的保护价值。

温室是一个可持续的示范工程，应用先进的技术来解决制冷节能问题。和传统的制冷技术相比，滨海湾花园采用的先进制冷技术至少可以节约30%的能源消耗。

1. 尽量减少太阳辐射
   两个温室都装有特制的玻璃，既能为植物提供最佳光照，又大量减少太阳辐射的热量。屋顶装有传感器控制的可伸缩帆，当温度过高时，帆会自动打开，为植物提供荫凉。

2. 只对活动区域制冷
   温室只对底层空气进行冷却，从而大幅减少需要冷却的空气量。这是通过热分层原理实现的，即通过在楼板内安装冷水管道制冷，使冷空气在较低的人流活动区域沉积，而热空气上升并在顶部排出。

3. 制冷前对空气进行除湿
   为了减少制冷过程中所需的能量，在制冷前用液体干燥剂对鲜花穹顶的空气除湿，所使用的干燥剂利用生物质燃烧产生的废热再生。



System schematic 系统简图

BROAD non-electric chiller
远大非电空调

Exterior figure of machine room
机房外景

Project Introduction

- An environmental sustainability concept where horticultural and other wood wastes are utilised as biomass fuel to provide the required energy for daily operations
- Tri-generation power plant which generates electrical power, heating (steam) and cooling services
- The core of the biomass power plant is a highly efficient biomass furnace and boiler system
- Electrical power - produced through a steam turbine generator. Electricity is supplied directly to Gardens by the Bay's power grid
- Heat energy - derived from the steam generated in the boiler system. Heat energy is used by Gardens by the Bay in the regeneration of the liquid desiccant where the latter is utilised to create a dry atmosphere mimicking a temperate climate in the conservatories. Heat energy is also used in the operation of absorption chillers
- Cooling load - generated through absorption chillers. Cooling load is generated for the purpose of plant cooling and conservatories cooling (on demand)
- Sophisticated DCS process control system permits a lean O&M manpower requirement and ensures maximum operating efficiency
- Flue gas post treatment systems, consisting of cyclones and electrostatic precipitators ensures 100% compliance to air pollution control standards set by local authorities
- By-products such as fly ashes and bottom ashes are also repurposed as soil amendments as well as fertilizers.

Values of Project

- BROAD non-electric chiller recovers exhaust steam after turbo generator. The gradient energy application is implemented and system energy efficiency increased dramatically
- The project saves 13,280 tons oil equivalent every year, equivalent to planting 730,000 trees. It becomes a new benchmark of energy-saving and emission reduction in Singapore

项目简介

- 依照可持续发展的理念，利用园艺废枝、废木和其他废木料作为生物质燃料，为日常运营提供能源
- 三联供发电厂提供电力、热（蒸汽）及制冷等服务
- 生物质发电厂的核心是高效的生物质锅炉和锅炉系统
- 发电：蒸汽轮机发电，通过电网直接为滨海湾花园供应电力
- 供热：热能来自于锅炉系统中产生的蒸汽。热能被用于液体干燥剂的再生，干燥剂主要用于为滨海湾花园温室空气除湿来模拟干燥舒适的温带气候和环境。热能也被用于驱动吸收式制冷机制冷
- 冷负荷：通过吸收式制冷机为电厂及温室供冷
- 先进的DCS控制系统不但大幅减少了运行和维护的人工成本，也确保了整个系统的高效运行
- 废气处理系统由旋风除尘器和静电除尘器组成，确保100%符合当地政府所规定的空气污染控制标准
- 副产品如飞尘和底灰也被用为土壤改良剂和肥料

项目价值

- 远大非电空调充分回收发电机废蒸汽，做到能源梯级利用，能源效率大幅提高
- 项目每年节省 13280 吨油当量，相当于种了 73 万棵树，成为新加坡节能减排事业新标杆

主要数据 Key Data

- Biomass fuel: horticultural and wood waste (crushed)
  生物质燃料：园艺废木、废枝和木质废料 (粉碎)
- Model 机型：BDS75
- Electrical power 电力：0.93MW
- Heating power 热能 (Exhaust steam 废蒸汽)：5.4MW
- Cooling load 制冷量：675kW
- Steam production capacity 蒸汽产能：
  9.5 tons/hour 吨/小时
- CO_2 reduction 减少二氧化碳排放：13,280 tons/y 吨/年

EXISTING BUILDING RETROFITTING

既有建筑节能改造

Central Government Korea

韩国中央政府

Project Background

Korean Central Government Complex was built in the Gwacheon zone, Seoul in 1982. It is a vital political center in Korea that contains Department of Energy, Department of Finance, Ministry of Environment, Ministry of Justice, Ministry of Labor etc. After investigation, the aging buildings and the obsolete facilities including the out-of-life-design air conditioning system caused a lot of energy waste.

In 2010, the Korean government building is conducted to energy-saving renovation to achieve the 15% of CO_2 emission reduction goal. Hence, it becomes the first governmental project of GREEN KOREA, including the procedures of regional waste heat air conditioning, window heat insulation, roof insulation, layer energy management etc.

项目背景

韩国政府办公楼位于韩国首尔果川区，建于1982年，集国家能源部、财政部、环境部、法务部、劳动部等韩国最高国家机关于一体，是韩国极为重要的政治中心。经详细能耗调查发现，建筑老化严重，内部设备使用年代长，冷热设备已大大超出了寿命范围，由此造成严重的能源浪费。

2010年，为响应韩国政府二氧化碳年减排 15% 的目标，提出对政府办公区进行建筑节能改造，该项目成为打造“绿色韩国”的首个政府项目，包括区域废热空调、窗体隔热、屋顶保温 (天空花园)、能源分级管理等节能改造措施。

ESCO Business Model

Korea is energy scarce country. Reliance on energy imports makes the government to ask for the perfection of energy using by enterprises and individuals. In spite of that, the Korean government support a efficient energy management mode: ESCO.

Introduction of ESCO

ESCO: ENERGY SERVICE COMPANY, certified and approved by government that is qualified as a professional energy-saving company.

ESCO invests in energy saving equipment to ensure its business when the customer needs to change or repair the equipment to save energy. ESCO model started from US and applied by many countries today.

ESCO Business Scope

- Invest on energy saving equipment.
- Manage and service on energy usage facility for energy saving purpose.
- Energy management diagnosis and other energy saving business.

Features of ESCO

- Invest by the third party.
- ESCO responsible for the initial investment of the energy saving facilities installation.
- Allocate the energy saving achievement.
- Share the saved cost as per contact between ESCO and customers.
- The Invested facilities should be returned to customers after ESCO reclaim the investment cost.

能源服务公司 (ESCO) 商务模式

作为能源稀缺国，韩国对进口能源的依赖促使政府要求企业及个人在能源利用方面都必须做到极致。除此之外，韩国政府推行了有效的能源管理模式：能源服务公司。

ESCO介绍

ESCO：ENERGY SERVICE COMPANY，是政府认可且具备资质的专业节能企业。

当用户为了节能，需要更换或维修设备时，由ESCO投资节能设备以保证节能效果。ESCO模式始于美国，至今已有许多国家采用这种能源投资模式。

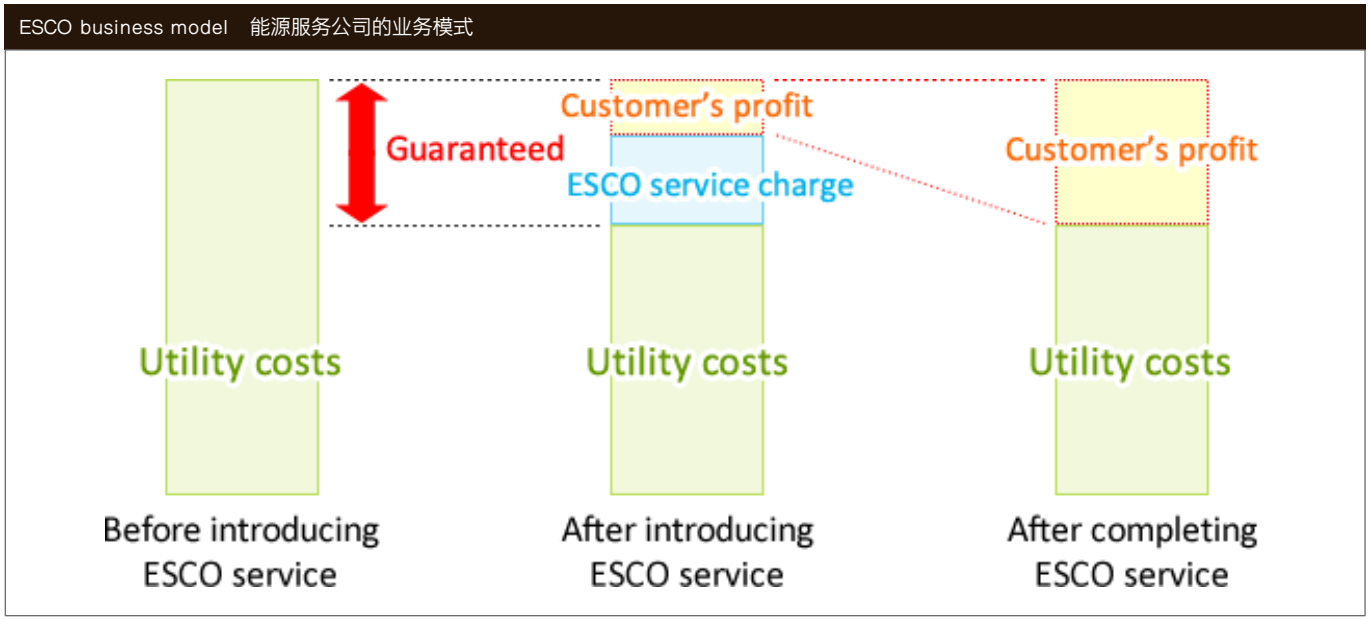
ESCO的业务范围

- 投资节能设备
- 以节能为目标，对用能设备进行管理及服务
- 能源管理诊断及其他节能业务

ESCO的特点

- 由第三方进行投资
- ESCO负责节能设备安装的初期投资
- 分享节能成果
- 根据ESCO与用户的合同，约定分配设备投资的节能效益
- ESCO回收投资后，已投资的节能设备归客户所有

ESCO business model 能源服务公司的业务模式



Business Process of ESCO

ESCO has three stages as following table and detailed process:

First stage: investment negotiation
Make arrangements with customers and companies that need to reduce investment

Second stage: energy management diagnosis
- Research on usage condition of heat and electricity
- Analyze energy efficiency and operation condition
- Understand investment fee and expected saving amount of energy saving projects
- Draft contract proposal for energy user

Third stage: check proposals of energy users (customers)
Check and deliberate the proposal of saving investment

Fourth stage: contract signing
- Confirm total investment amount
- Negotiate about the allocation of reduction amount due to the saving facilities investment
- Negotiate about basic terms of energy saving amount measurement

Fifth stage: construction of energy saving facilities

Sixth stage: afterwards management
- Checkout operational condition of facilities
- Checkout the saving amount
- Training for best operation time

Seventh stage: terminate recovery of investment cost in contract

Advantages of ESCO
- Update old equipment to add the value of user's substantial assets
- Energy consumption reduced by energy saving innovation
- Reduce CO_2 emission
- Provide professional service to reduce the user's economic risk
- Specifically set for Korea, 10% of the energy saving equipment purchasing expense will be deducted from Individual or enterprise income tax.

ESCO的业务流程

ESCO分为三个阶段，具体流程如下：

第一阶段：投资洽谈
- 与有节能需求的客户及公司安排洽谈

第二阶段：能源管理诊断
- 热力和电力使用情况调查
- 分析能源效率和运行状况
- 了解节能项目的投资额及节能预期
- 为客户制定合同方案

第三阶段：能源方案论证（客户）
- 审议节能投资方案

第四阶段：合同签订
- 确认投资总额
- 商定节能收益的分配方式
- 协商节能量的界定方式

第五阶段：建设施工

第六阶段：后期管理
- 检查设备运行状态
- 检查节能量
- 最佳的运作实施

第七阶段：合同投资的最终收回

ESCO优势
- 更新老旧设备，提升用户固定资产价值
- 通过节能改造减少能源费用
- 减少二氧化碳排放
- 通过提供专业的服务降低用户经济风险
- 适应韩国国情，10%的节能设备采购费用可以从个人或企业所得税中得到减免

Who is the ESCO in this project: GS Power (BROAD South Korea Distributor)
What we do?

Comparison of System Renovation

Original cooling equipments before renovation:

- Cooling: electricity and natural gas as input energy.
- Administrate office machine room: electricity chiller ×4, direct-fired absorption chiller ×1
- Subsidiary building machine room: single stage hot water chiller×2

Original heating equipments before renovation:

- Heating: Natural gas as boiler's energy
- Administrate office machine room: boiler×5
- Subsidiary building machine room: boiler×3

系统改造对比

系统改造前的制冷设备:

- 制冷能源：电、燃气
- 管理楼机房：电冷机 4 台，直燃机 1 台
- 附属机房：单效热水机 2 台

系统改造前的采暖设备

- 采暖能源：燃气
- 管理楼机房：热水锅炉 5 台
- 附属楼机房：热水锅炉 3 台

According to the analysis of the Korea energy distribution, we adopt the following plan:

我们针对项目和韩国能源分布进行分析，采取以下方案:

Type 类别	Before renovation 改造前
Heating 制热	Gas boiler heating 燃气锅炉制热
Cooling 制冷	Electricity 电制冷

Type 类别	After renovation 改造后
Heating 制热	Regional heating 区域集中供暖
Cooling 制冷	Cooling by district heating 用集中供暖水制冷

Due to the equipments ageing problem and lack of system management, we calculate the energy cost (based on the A/C application of 2007) as follow:

由于设备的老化以和缺乏系统管理，根据2007年使用情况，能源费用如下:

Energy 能源	Section 区域	Energy consumption 能耗	Cost 费用
Electricity 电力 (kWh)	Administrate Office 管理楼	997,300	USD 169,541
	Subsidiary Building 附属楼	11,102	USD 1,887
	Total 合计	1,008,402	USD 171,428
Natural gas 燃气 (Nm^3)	Administrate Office 管理楼	945,471	USD 482,190
	Subsidiary Building 附属楼	63,306	USD 32,286
	Total 合计	1,008,777	USD 514,476

According to the 2007 A/C application condition, the energy cost after renovation are as follows:

按照2007年的使用时间和工况，改造后的能源费用如下:

Energy 能源	Section 区域	Energy consumption 能耗	Cost 费用
Electricity 电力 (kWh)	Administrate Office 管理楼	231,310	USD 39,323
	Subsidiary Building 附属楼	31,037	USD 5,276
	Total 合计	262,347	USD 44,599
Regional heating 区域集中供暖	Administrate Office 管理楼	/	USD 239,000
	Subsidiary Building 附属楼	/	USD 10,000
	Total 合计	/	USD 249,000


Chiller Machine Room
制冷机房

Area saved for machine room
节省机房面积

Section 区域	Before renovation 改造前	After renovation 改造后	Differences 差距
Office 管理楼 (m^2)	2,690	2,367	-323
Subsidiary building 附属楼 (m^2)	1,156	379	-777
Total 合计 (m^2)	3,846	2,746	-1,100

Building energy efficiency retrofitting

- Change the original roof to a sky park to make roof insulation.
- Change the single layer window to double layer.
- With regional waste heat absorption chiller, A/C operation cost will be deducted significantly, and more important to realize the CO_2 emission reduction.
- After renovation of the whole system, the central government building is not only a public service centre, but also a glaring Green Building of Seoul area.

建筑节能改造

- 将原有的普通屋顶改为屋顶花园，进行屋顶隔热
- 单层玻璃改为双层玻璃，从建筑本身做到能源节约
- 使用区域废热制冷系统，空调运行成本大幅度降低，更重要的是实现二氧化碳减排
- 经过整个系统的改造，这个办公大楼不仅是为民服务中心更成为首尔地区耀眼的绿色建筑

	Before renovation 改造前	After renovation 改造后
CO_2 emission 二氧化碳排放	2,021 ton/year 吨/年	84 ton/year 吨/年
Equals plant more 相当于多植树		105,850 trees per year 棵/年

FUEL CELL CCHP

燃料电池 CCHP

University of California San Diego

加州大学圣地亚哥分校

About UCSD

The University of California, San Diego is a public research university located in the La Jolla neighborhood of San Diego, California, in the United States. The university occupies 2,141 acres (866 ha) near the coast of the Pacific Ocean with the main campus resting on approximately 1,152 (466 ha) acres. Established in 1960 near the pre-existing Scripps Institution of Oceanography, UC San Diego is the seventh oldest of the 10 University of California campuses and offers over 200 undergraduate and graduate degree programs, enrolling about 22,700 undergraduate and 6,300 graduate students. UC San Diego is one of America's Public Ivy universities, which recognizes top public research universities in the United States.

关于加州大学圣地亚哥分校

加州大学圣地亚哥分校是一所位于美国加利福利亚州圣地亚哥拉荷亚的研究型公立大学。学校紧邻太平洋海岸，占地 2141 英亩 (866 公顷)，其中主校区占地约 1152 英亩 (466 公顷)。加州大学圣地亚哥分校位于1960年成立的斯克里普斯海洋学院旁，是加州大学 10 个分校中第7个成立的。大学提供超过 200 个本科和研究生学位课程，招收约 22700 本科生和 6300 名研究生。加州大学圣地亚哥分校是美国的“公立常青藤”，也是美国顶尖公立研究型大学之一。

Project Background

With construction plans for the east campus, in order to meet increasing power and cooling demand as well as improve campus's power resiliency with reliable power, reduce operating costs and cut greenhouse emissions.

UCSD decide to install an advanced environmental-friendly power - the fuel cell energy as well as a heat recovery exhaust absorption chiller as a new CCHP energy system.

Fuel cell plant utilizes directed biogas to generate 2.8 MW of renewable power on-site, acts as cornerstone of UCSD microgrid which produces 92% of annual electricity load.

The chiller plant provides chilled water to various buildings on the east campus of UCSD, the new BROAD chiller has a cooling capacity of 374 RT, with existing chillers system, the east campus cooling load are fulfilled.

项目背景

随着东校区的扩建计划，加州大学圣地亚哥分校决定安装先进的环保能源——燃料电池和烟气吸收式制冷机打造新型CCHP能源系统。该系统不但满足了日益增长的电力和制冷需求，提高了校园用电可靠性及负荷弹性，而且大幅降低了运营成本和温室气体的排放。

燃料电池发电站直接利用可再生能源——沼气发电 2.8MW，是加州大学 (UCSD) 微电网可持续发展的基石，每年提供所需电力的 92% 负荷。

远大烟气吸收式制冷机为学校东校区各建筑物提供空调，制冷量为 374 冷吨，加上现有的冷水机组系统，能满足未来建设规划需求。

Project Information & CCHP

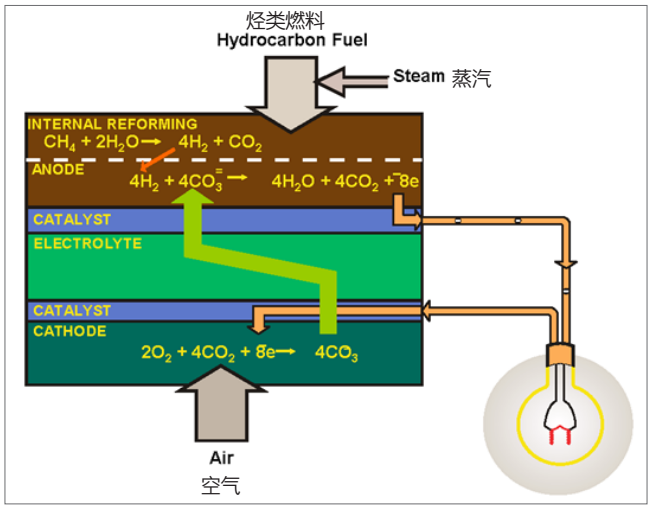
Instead of using a traditional gas generator or turbine, a fuel cell power unit was selected to provide electrical power for San Diego campus University of California (UCSD). Fuel cell technology offers clean, efficient, reliable power generation to almost any device requiring electrical power. This fuel cell with enough capacity to power 2,800 homes in UCSD campus is part of a renewable-energy project with the city of San Diego.

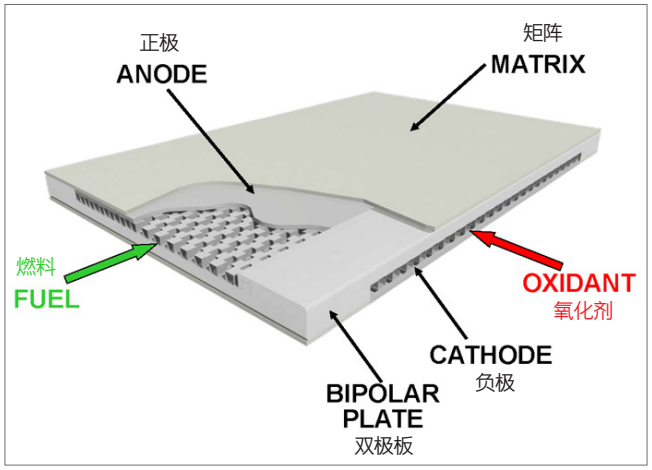
BROAD absorption chiller recycles 371℃ (700 °F) exhaust from fuel cell to provide cooling for campus buildings, in which waste heat can be tapped as a secondary power source, raising the overall net efficiency of energy system to 78%, compared to 30% from traditional power plants.

项目情况及冷热电联供

加州大学圣地亚哥校区 (UCSD) 并未采用传统的燃气内燃发电机或涡轮发电机，而是选择燃料电池这种新技术。燃料电池给该校区所有需要用电的设施提供清洁、高效、可靠的电能。这个发电系统足够给UCSD校区 2800 户提供电力，是圣地亚哥市可再生能源项目的一部分。

远大吸收式空调回收燃料电池 371℃ (700 °F) 的废烟气热量来给校园建筑供冷，其废热作为二次能源，将系统整体的能源效率提高至 78%，而传统发电厂仅仅只有 30% 左右。





About Fuel Cell

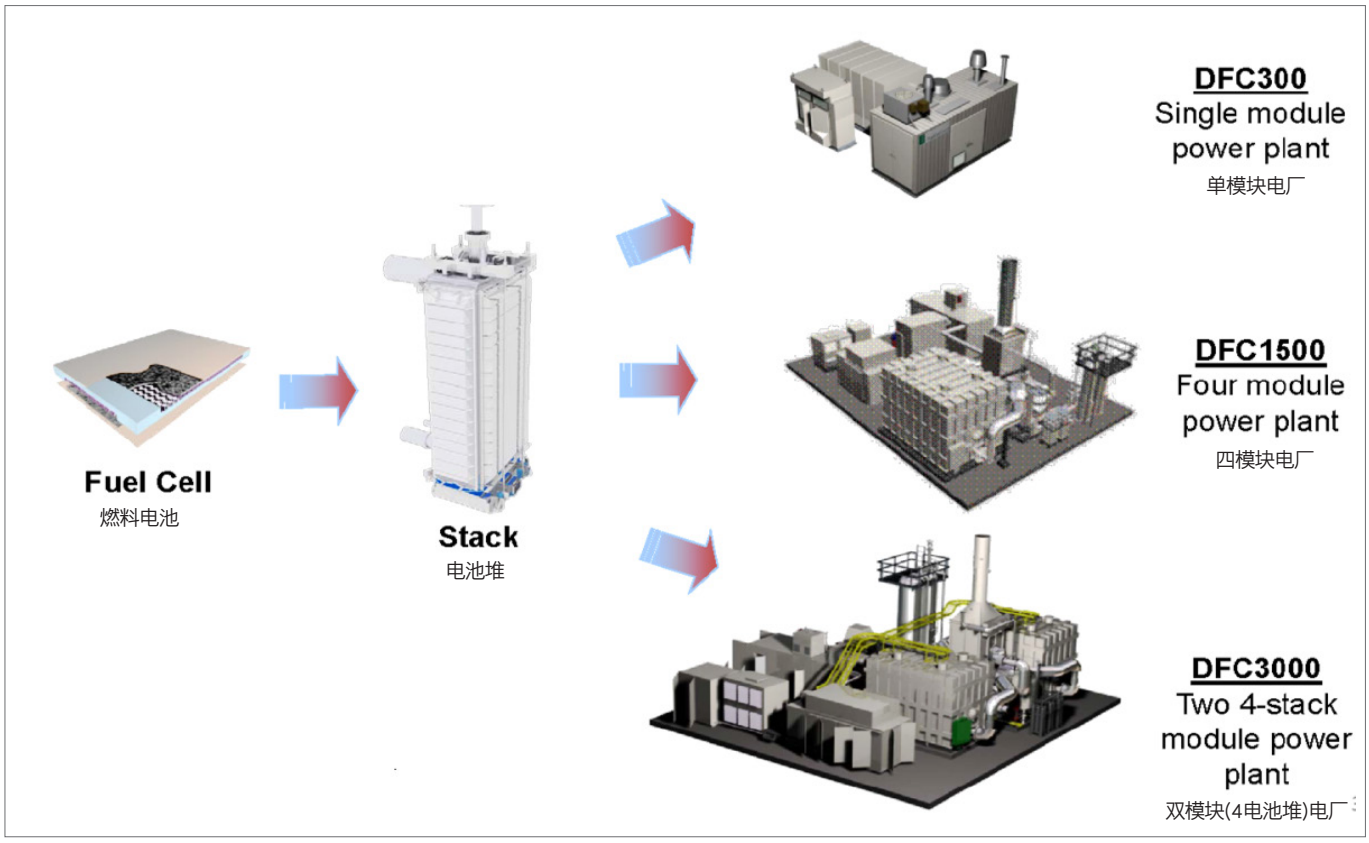
A fuel cell is a device that converts the chemical energy from a fuel into electricity through a chemical reaction of positively charged hydrogen ions with oxygen or another oxidizing agent. Fuel cells are different from batteries in that they require a continuous source of fuel and oxygen or air to sustain the chemical reaction, whereas in a battery the chemicals present in the battery react with each other to generate an electromotive force (emf). Fuel cells can produce electricity continuously for as long as these inputs are supplied.

The fuel cell is to get electricity directly from chemical energy without intermediate combustion process. The energy conversion rate is high and the electrical energy conversion efficiency can be as high as 45~60%.

关于燃料电池

燃料电池是通过带正电荷的氢离子与氧或其它氧化剂的化学反应，将存在于燃料中的化学能转化为电能的装置。燃料电池区别于普通电池在于它们需要持续的燃料和氧气或空气的化学反应来维持，而普通电池靠电池中的化学成分间的相互作用来产生电动能。只要有燃料输入，燃料电池就能持续发电。

燃料电池直接将燃料的化学能转化为电能，中间不经过燃烧过程，能量转化率高，电能转换效率在 45~60% 。



The module for UCSD is DFC3000, specifications are as below.
该项目采用 DFC3000 模块电厂，参数如下

Power plant rating 电厂容量	2,800 kW
Standard output AC voltage 额定输出电压	13,800 V
Standard frequency 额定频率	60 Hz
Efficiency (LHV) 净热效率	47%±2%
Exhaust temperature 排气温度	371±10℃
Exhaust flow rate 排气量	36,600 lb/h
Available heat for recovery 可回收热能	
(to 250 °F) (至 250 °F)	4,433,000 BTU/h
(to 120 °F) (至 120 °F)	7,460,000 BTU/h
Natural gas consumption (930 Btu/ft) 天然气耗量	362 scfm
Heat rate, LHV 低位热值	7,260 BTU/kWh
Average water consumption 平均水耗量	79gpm
Average water discharge 平均排水量	4.5 gpm
CO_2 emissions 二氧化碳排放	980 lb/MWh
CO_2 emissions (with waste heat recovery) 热回收后二氧化碳排放	520-680 lb/MWh

The chiller arrangement
空调主机参数如下

Model 机型	BE200 烟气机
Quantity 数量	1 unit 台
Capacity 制冷量	1,315kW/unit 台
Brand 品牌	BROAD 远大
Heat input 热源	Exhaust 烟气
Origin 原产地	China 中国

Chiller Operation Condition

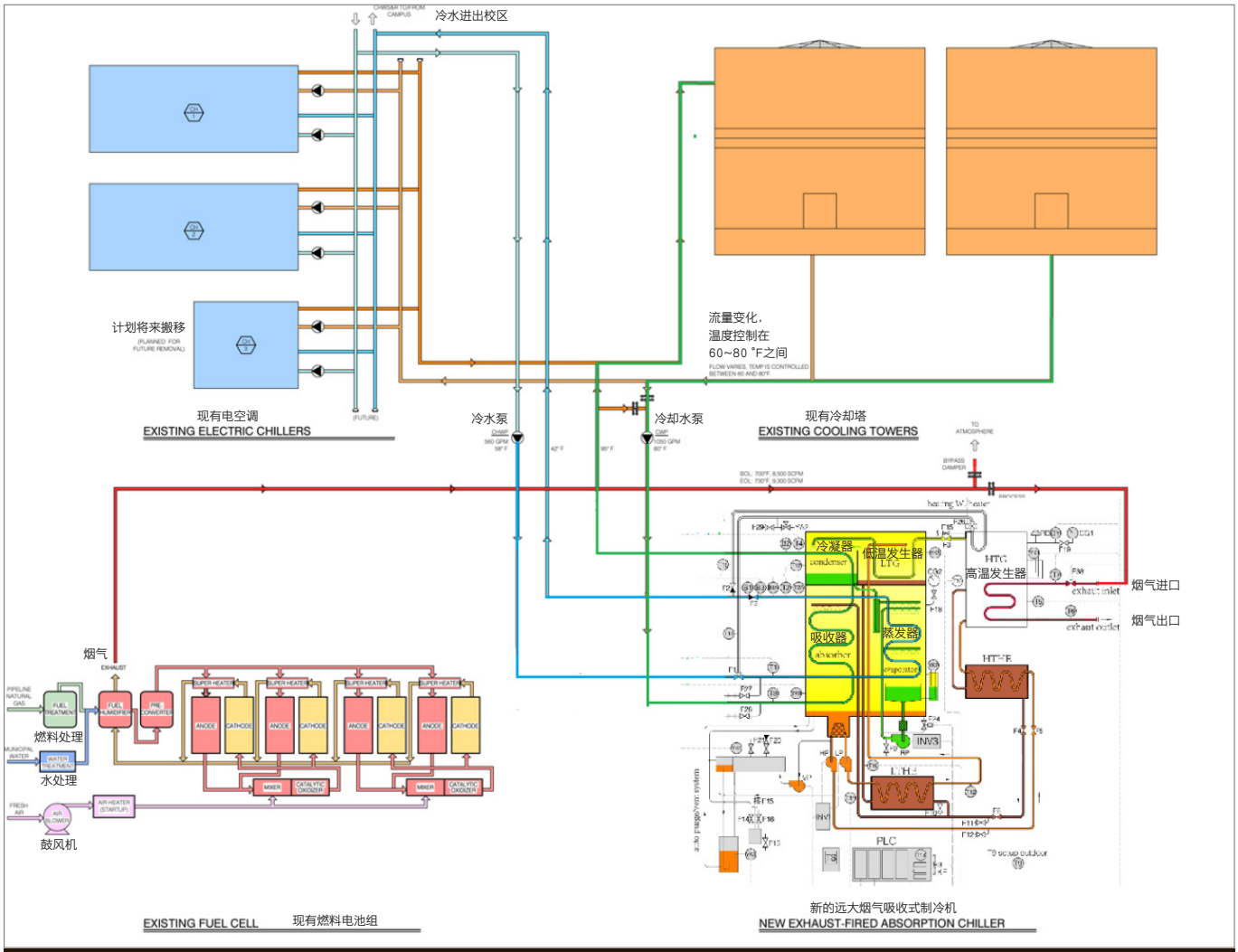
The cooling capacity of BROAD depends on the fuel cell stacks which are replaced periodically. At the beginning of life of the fuel cell stack modules the exhaust gas is near 700 °F and the absorption chiller capacity is at a design value of 311 tons. At the end of life of the stack modules the exhaust gas rises to over 730 °F and the absorption chiller capacity therefore rises due to the higher temperature inlet gas to 374 tons.

制冷机运行情况

远大吸收式制冷机的制冷量取决于定期更换的燃料电池堆。在燃料电池堆组件使用初期，废气接近 371℃，吸收式制冷机的设计冷量为 311 冷吨(1094kW)。在电池模块的运行后期，废气上升到388℃ 以上，吸收式制冷机的制冷量因此上升，由于较高的烟气入口温度，制冷量可达到 374 冷吨(1315kW)。

Feb. 21, 2012, San Diego Gas & Electric presented a check for $2.4 million to UCSD representing energy-efficiency incentives

2012年2月21日，圣地亚哥燃气电力公司为该项目提供240万美元高能效优惠政策 (下图)



Simplified System Schematic　系统简要示意图

Project Value

By directly burning natural gas as opposed to only utilizing grid power for HVAC applications, the facilities can dramatically lower their carbon footprint by 1,331 tons/year, In addition to saving approximately $18 million in annual purchased utilities costs, UCSD saves over $800,000/month from its microgrid, versus buying from the local grid, meanwhile cogeneration reduces:

- Energy loss due to transmission and distribution of electricity over the statewide electrical grid
- Reliance on out-of-state coal-burning power generation
- Regional congestion on SDG&E's grid system
- Reducing the cost of demand charge by USD 330,000/year, the payback period of cooling system is around 3.5 years.

项目价值

与传统采用电网电力的空调系统相反，通过燃料电池CCHP系统，每年可减少碳排放约 1331 吨、节省大约 1800 万美元固定资产购置费。加州大学圣地亚哥分校再也不用在大电网上购电，每月自己微电网发的电就能节省 80 万美元，与此同时冷热电联产还减少：

- 大电网传输和分配电力而造成的能源损失
- 对州外燃煤发电的依赖
- 圣地亚哥燃气电力公司电网系统的区域拥塞
- 降低需求费用成本约 33万美元/年，该项目于 3.5 年内收回制冷机投资

BROAD A/C
远大空调

CCHP IN BUILDING ENERGY RETROFITTING

CCHP 应用于建筑节能改造

Treetops Executive Residence, Singapore

新加坡翠峰园服务公寓

Project Background

Treetops is a luxury serviced apartment managed by Debenham Tie Leung Hospitality Management Services (DTZ). It has 220 sets fresh-holiday apartments with Southeast Asia tropic style. The apartment garden covers an area of 5 acres with as many as 200 kinds of plants. The green area is as high as 60%.

Treetops located adjacently to Singapore's premier shopping center and entertainment center Orchard Road, which was put into use from September 2000. Although it is in the busiest area of Singapore, treetops is just like an oasis in city to provide resort style living space with green environment of quiet and beautiful. All guests here can enjoy the daily life as comfortable as the fresh breeze but without scarifying the city's convenient.

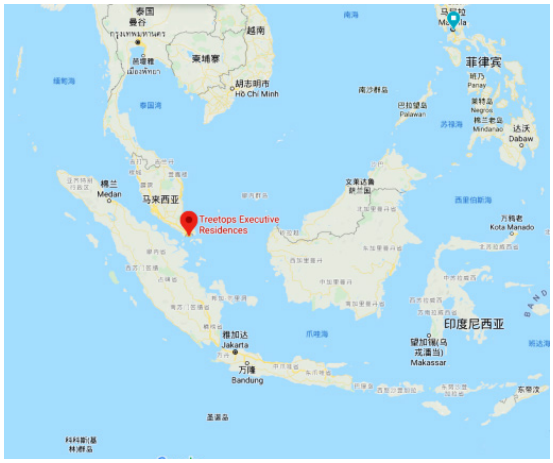
Today, Treetops is the one of the leading serviced apartments in Singapore and has since become a preferred choice of home for senior managers and leisure travelers round the world.

项目背景

翠峰园服务公寓属于豪华服务式公寓，由戴德梁行酒店管理服务部管理，拥有 220 套以新东南亚热带风格为主题的清新假期公寓。园地占地 5 英亩，生长着 200 多种植物，绿化面积高达 60% 。

翠峰园服务公寓于2000年9月投入使用，毗邻新加坡首屈一指的购物、娱乐中心乌节路。虽处于繁华地带，翠峰园却宛如城市中的一片绿洲，以绿意盎然的清幽环境为旅客提供度假村式的生活空间。所有住客能在不舍弃城市便利生活之余，享受舒适安逸生活，使每日心情如清风般舒畅。

如今，翠峰园已成为新加坡顶级服务公寓，是全球高级管理人士和休闲旅客首选的居家之所。




BROAD Seminar
远大应用介绍


ASEAN ENERGY
AWARDS 2014
2014年东盟能源奖

CCHP & BROAD

It is the first CCHP retrofit project in Singapore, by replacing the traditional grid power and electric A/C model with CCHP system. 3 units 200kW diesel generators provide electricity and 1 exhaust & jacket water fired absorption chiller provides cooling (electric A/C as the backup). A variety method was adopted to maximize the system efficiency, for example, using flue gas plate exchanger to control the exhaust temperature below 60℃; recycling the exhaust air of cooling tower to drive a wind turbine to generate the electricity, etc. After the renovation, the system efficiency has improved by 40%, from 0.76kW/RT to 0.45kW/RT, and therefore it was awarded with Greenmark Platinum hotel certification in Singapore.

The total investment of this project is about $2.6million, and about $400,000 of energy cost can be saved after the reformation. Because of the notable economic and environmental benefits, Singapore government beard 50% of the investment as subsidies, that is $1.3million. The payback period is 3.25 years.

The Building and Construction Authority (BCA) attaches particular importance to the project after its reformation, and put it as a case on energy saving. Almost every month there are government team come to visit this project.

There is BROAD Air Purifier in each room improved air quality by 30% which won wide applause from the customers.

The chiller arrangement 空调主机参数

Model 机型	BHE100 热水烟气机
Quantity 数量	1 unit 台
Capacity 发电量	978kW/unit 台
Brand 品牌	BROAD 远大
Heat input 热源	Exhaust & Jacket Water 烟气和缸套水

冷热电联产和远大

这是新加坡第一个 CCHP 改造示范项目，将原传统的市电+电空调模式改造成 CCHP 系统，采用 3 台 200kW 柴油发电机组提供酒店所有电力，远大 BHE100 制冷机提供免费空调 (电空调辅助)。为了最大程度提高系统的能源效率，客户采用了多种方法，比如采用烟气板交将排烟温度控制在 60℃ 以下；利用冷却塔的排风来驱动风力发电等。经过改造后的系统效率提升了 40%，能耗从原来的 0.76kW/RT 减少至 0.45kW/RT，获得新加坡铂金绿色酒店证书。

项目总投资约 260 万美元，改造后每年可节省能源费约 40 万美元。由于良好的经济和环境效益，新加坡政府补贴投资的 50% 即 130 万美元，该项目投资回报期 3.25 年。

新加坡建设局 (BCA) 将其作为既有建筑节能改造的展示案例，经常组织各类参观考察和学习交流。

Green feature: Building "green" insulation
Totally use the natural way to reduce the cooling load. Apartments are surrounded by greenery which reduce the solar heat transmitted to the building.

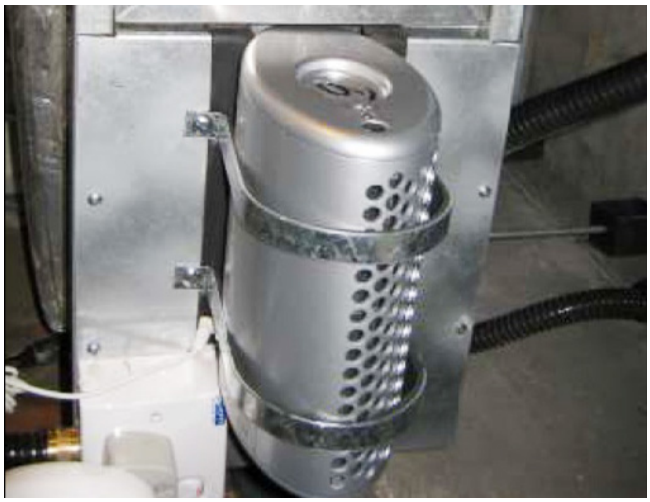
“绿色”酒店之建筑保温
采用纯天然方法来减少制冷负荷。所有公寓均被植被围绕，从而减少传递到建筑上的太阳热量。

Green feature: Cooling tower wind energy recycling
A small wind turbine is installed at cooling tower outlet to capture residue wind energy to produce electricity.

“绿色”酒店之冷却塔排风利用
冷却塔排风口装风力发电机，利用排风余压发电。

Green feature: Water treatment
Install ultraviolet and water filter to improve water quality instead of chemical treatment on the cooling water.

“绿色”酒店之水处理
利用紫外线和过滤技术替代化学方法来提高冷却水质量。



Green feature: Air Purifier
BROAD air purifiers were installed at each apartment to improve air quality.

“绿色”酒店之空气净化
每个公寓都安装了远大空气净化机来提高空气质量。

Economy Analysis

Phase 1

Works mainly focused on the optimization of existing system, including chiller efficiency improvement, water and air balancing, chilled water pump and condenser water pump optimization.

Improved plant efficiency from 1.02kW/RT to 0.76kW/RT, and saved electricity 1,492,028kWh, that is about $ 320,000 if calculated with $ 0.2188/kWh. And treetops was awarded with Green Mark Gold Certificate in 2010.

Phase 2

Works mainly focused on tri-generation system, including produce electricity to building and get cooling and hot water by recycling generator's waste heat.

Improved plant efficiency from 0.76kW/RT to 0.45kW/RT, and saved electricity 2,752,981kWh, that is about $ 600,000. If calculated with $ 0.2188/kWh. And treetops finally achieved Green Mark Platinum Certification in 2012.

经济性分析

第一阶段

该阶段的主要任务是优化已有系统，包括提高空调效率、水和空气的平衡以及冷水泵和冷却水泵的优化。

制冷耗电从 1.02kW/RT 降低到 0.76kW/RT，省电 149万度，按照每度电 0.2188 美元计算，即省钱约 32万美元。翠峰园也因而获得了2010绿色建筑标志奖 (金奖)。

第二阶段

该阶段的主要工作内容聚焦在冷热电三联产系统，包括给建筑供电，然后回收发电机废热来获得冷和卫生热水。

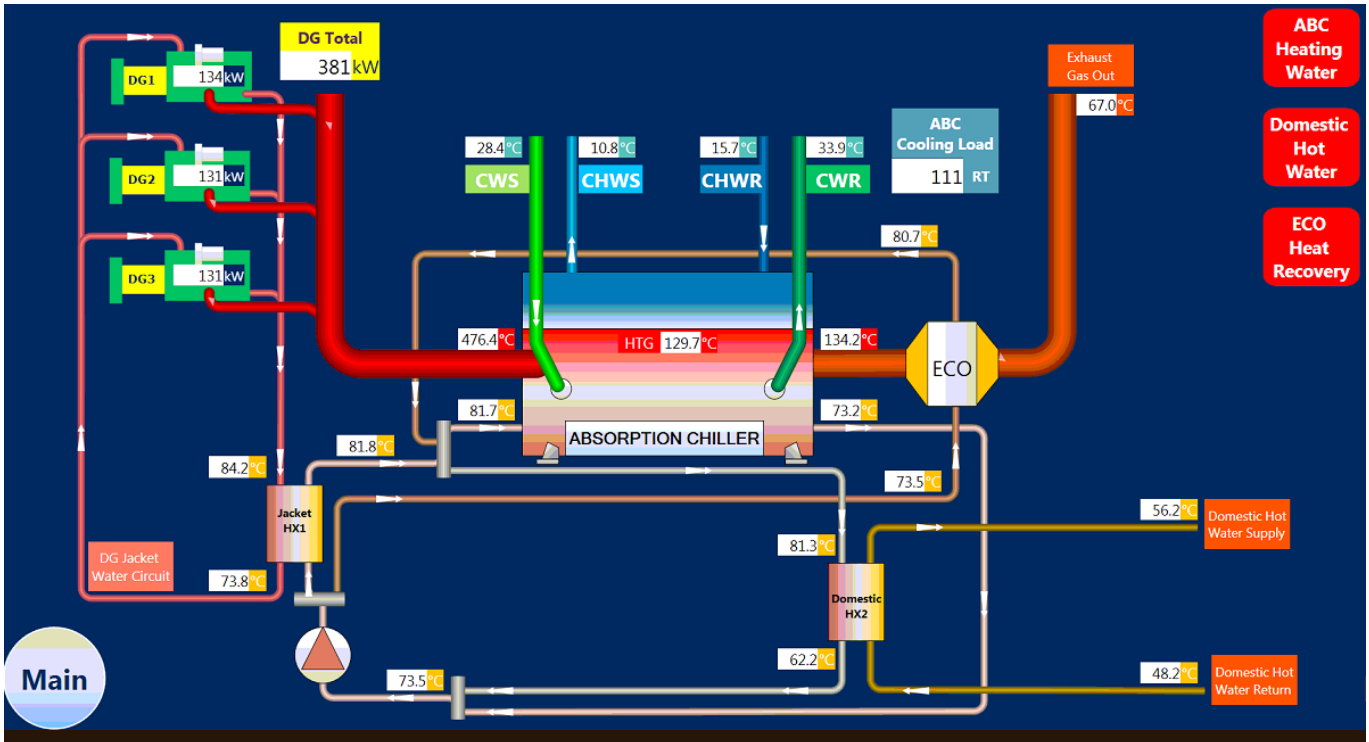
制冷耗电从 0.76kW/RT 降低到 0.45kW/RT，省电 275万度，按照每度电 0.2188 美元计算，即省钱约 60万美元。翠峰园也最终获得了2012绿色建筑标志奖 (铂金奖)。

Treetops & EMC

ESCO provided the EMC (Energy management contract) service for years. The energy and efficiency of ACMV system was tracked on daily and reports submitted monthly.

翠峰园与合同能源管理

多年来，节能服务公司为该酒店提供合同能源管理服务及舒适性服务，追踪空调通风系统的能效并每月提交能源报告。



System schematic & Operating parameters　系统简图与运行参数

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DATA CENTER'S CCHP

数据中心 CCHP

Tencent Data Center, Shanghai

腾讯青浦云数据中心

Project Background

- Location: Qingpu Industrial Park, Shanghai
- Project positioning: a major project of Shanghai's "Yunhai Plan" (Cloud computing industry development plan) and one of the most advanced comprehensive e-commerce bases of Asia-Pacific region.
- Project function: integrate e-commerce platform, electronic trading center, electronic distribution center and electronic testing center, and provide online B2C trading platform and offline service support platform. Mainly for users in East China. it can provide comprehensive cloud platform services for Internet users and companies across the country.
- Project scale: it covers an area of 100 acres with 4 independent data centers, 1 office building, with more than 4000 racks and 100,000 servers.

背景介绍

- 地理位置：上海青浦工业园
- 项目定位：上海市“云海计划”的重大项目，亚太区最先进的综合电子商务基地之一
- 项目功能：集电子商务平台、电子交易中心、电子配送中心和电子检测中心等于一体，同时提供线上B2C交易平台和线下服务支撑平台。以华东地区用户为主，可为全国的互联网用户以及第三方企业提供云平台综合服务
- 项目规模：占地 100 亩，有4栋独立数据中心，1栋办公楼，总计超过 4000 个机架，可容纳约 10 万台服务器

System Design

- The design cooling load of each building is about 9MW.
- System model: multi-energy absorption chiller of CCHP system + water storage + free cooling + centrifugal water-cooled chiller (Note: CCHP system startup time is 06:00-22:00, during the night when the electricity is at low load period, centrifugal chiller is used for chilled water storage, then the storage water is used during the switching period, and cooling tower plates heat exchangers are used in the winter to supply cooling, while centrifugal chiller are used for supplement).
- Energy supply equipment of energy center: conventional system and CCHP system.

系统设计

- 每栋楼设计总冷负荷约为 9MW。
- 采用模式：CCHP烟气热水补燃型溴冷机组+水蓄冷+自然冷却+离心水冷机 (注：CCHP开机时间为 06:00-22:00，夜间低谷电价期间采用离心水冷机蓄冷，切换时段采用蓄冷水制冷，冬季采用冷却塔板换+离心水冷机做补充)。
- 能源中心供能设备：常规系统与CCHP系统。

Conventional System 常规系统

No. 序号	Equipment description 供冷情况	Cooling capacity 容量	Remarks 备注
1	Centrifugal chiller 离心机供冷 4 units for normal operation 4 台正常运行冷水机组	11.3MW	4 centrifugal chillers with 2813 kW/unit 4 台 2813kW 离心机
2	Backup centrifugal chiller 备用离心机供冷 2 units as backup 2 台备用冷水机组	5.6MW	2 centrifugal chillers with 2813 kW/unit 2 台2813kW 离心机
3	Low-temperature plate heat exchanger 低温板换设计供冷 Meet 100% cooling demand 满足用冷100%	9MW	Meet all cooling demand of date center 满足数据中心所有用冷需求
合计	Cooling capacity of date center (4 in use, 2 as backup) 数据中心供冷能力 (4用2备)	16.9MW	6 centrifugal chillers with 2813 kW/unit 6 台 2813kW 离心机

CCHP System 冷热电联产系统

No. 序号	Equipment description 设备名称及规格	Quantity 数量	Installed capacity 装机容量
1	Gas Engines, electricity capacity 2500 kW 燃气内燃发电机 发电功率 2500kW	4	10MW
2	Multi-energy absorption chiller on exhaust, hot water & NG as backup, cooling capacity 3050 kW 带补燃烟气热水溴化锂机组 制冷量 3050kW	4	12.2MW

Black Technology of 5A Certification — CCHP System

What is green level certification?

- Green level certification is jointly launched by the Ministry of Industry and Information Technology and TGG (The Green Grid, a global non-profit organization dedicated to improving the energy efficiency of data centers), and is a comprehensive evaluation certification for data centers around the world.
- "Certification" evaluates and comprehensively scores data centers from the dimensions of energy efficiency, energy-saving technologies, and green management. Based on the scores, the data centers are divided into five levels from "1A" to "5A", with "5A" as the highest level.
- High-temperature exhaust gas and jacket water of gas generators are used by BROAD multi-energy absorption chiller to produce chilled water to meet the cooling demand of the data center.
- The CCHP system greatly improves the primary energy ratio through graded use of energy. At the same time, it also provides energy complementarity for the power grid and realizes off-peak power consumption of the data center, which brings to economic and social benefits.
- This is the first commercial project in China to apply the CCHP in the data center.

Cascade Utilization of Energy

This project uses gas distributed energy system. The gas generators are operated under the model of "grid-connected with no power injection" to provide part of the power for the data center.

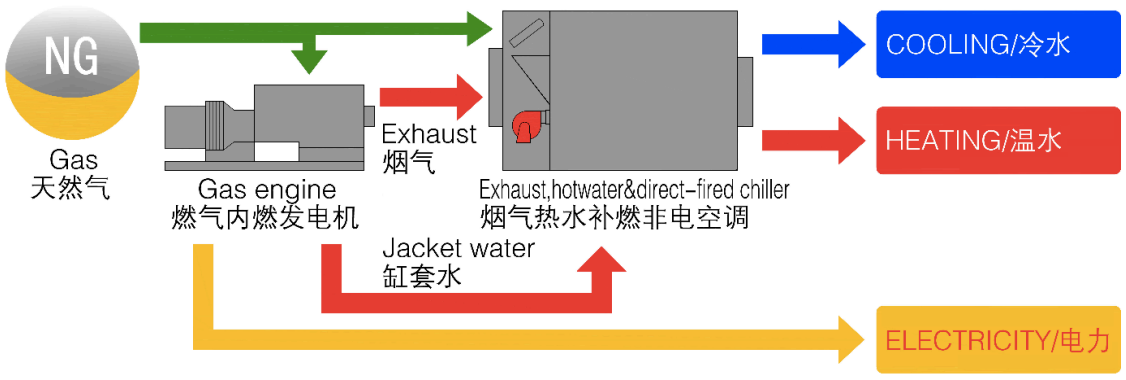
5A黑科技 — CCHP系统

什么是绿色等级认证?

- 绿色等级认证是工信部和 TGG (The Green Grid，是一家致力于提升数据中心能源效率的全球性非盈利机构) 共同推出的，面向全球数据中心的综合评估认证
- “认证”从能源效率、节能技术、绿色管理等维度对数据中心进行评估和综合评分，根据评分将数据中心分为“1A”至“5A”五个等级，“5A”是最高等级
- 燃气发电机组的高温烟气及缸套水，通过远大烟气热水型溴化锂机组生产冷水，满足数据中心冷负荷需求
- 冷热电联产系统通过能源的梯级利用，大大提高一次能源利用率。同时还为电网提供能源互补，实现数据中心部分的错峰用电，具有明显的经济收益及社会效益
- 该项目是国内首个将冷热电联产技术应用到数据中心的商业化项目

能源梯级利用模式

项目使用燃气分布式能源系统，燃气发电机组与市电并联，采用并网不上网的运行方式，为数据中心提供部分电能。



Technical Advantages of BROAD

- The highest COP;
- Condensing heat recovery of exhaust gas to produce hot water and create extra economic value;
- The actual cooling capacity of the chiller exceeds the requirements of the bidding documents;
- Application of rapid start-stop technology.

Project Value

- CCHP power generation effect: 14.81 million yuan
- Waste heat recovery effect: 7.54 million yuan
- CCHP energy costs saving: 22.35 million yuan
- Reduce CO_2 emissions: 30,895 tons/year

远大技术优势

- 机组COP最高
- 回收烟气冷凝热制取卫生热水，创造额外经济价值
- 机组实际制冷量超过招标文件要求
- 快速启停机技术的应用

项目价值

- CCHP发电收益：1481 万元
- 余热收益：754 万元
- CCHP节省能源费用：2235 万元
- 减少碳排放：30895 吨/年

Technical solution 技术方案	Conventional system 常规方案	CCHP system CCHP方案
Equipment composition 设备配置	Centrifugal chiller, cooling capacity 2,813 kW/unit (4 in use + 2 backup, power: 454kW, COP: 6.2) 离心式冷水机组 4 用 2 备，制冷量 2813kW，功率 454kW，COP：6.2	Gas generator 10MW (2.5MW×4) + Indirected fired absorption chiller (3,050kW×4) 发电机满负荷配置 10MW (4 台 2.5MW) + 4 台 3050kW 余热非电空调
Power consumption (kW) 消耗功率 (kW)		
IT equipment IT 设备	7,000	7,000
UPS + distribution cabinet UPS + 配电柜	700	700
Lighting facility 照明	240	240
Chiller 冷水机组	1816	0
Chilled water pump, cooling water pump, cooling tower 冷冻水泵、冷却水泵、冷却塔	1,140	1,200
Air conditioning terminal 空调末端	600	600
Self-consumption of generator 发电机自耗电	0	300
Total power consumption 总功耗	11,496	10,040
PUE	1.64	1.43
Power generation effect, CCHP system runs 12h/d (million yuan) 发电收益，CCHP一天运行12h (百万元)	14.81	
Waste heat recovery effect (million yuan) 余热收益 (百万元)	7.54	
CCHP energy costs saving (million yuan) CCHP节省能源费用 (百万元)	22.35	
Carbon emission reduction (t/year) 减少碳排放 (t/年)	30,895	

BROAD A/C
远大空调

CCHP IN HOSPITAL

医院 CCHP

Royal Children Hospital, Australia

澳大利亚皇家儿童医院

Project Background

The Royal Children's Hospital (RCH) established in 1870 and located at Parkville in Melbourne, Australia since 1963. RCH has been providing outstanding care for Victoria's children and their families for 150 years. They are the major specialist pediatric hospital in Victoria and their care extends to children from Tasmania, southern New South Wales and other states around Australia and overseas. With a passionate, highly skilled and committed staff campus wide of close to 4,000, they provide a full range of clinical services, tertiary care and health promotion and prevention programs for children and young people.

Project name: Royal Children's Hospital
Location: Melbourne, Australia
Building area: 114,198m^2

项目背景

墨尔本皇家儿童医院（RCH)成立于1870年，从1963年一直位于墨尔本 Parkville 地区。RCH创立 150 年来致力于为维多利亚地区的儿童及其家庭提供卓越的医疗服务。它是维多利亚地区最著名的儿科医院，服务范围覆盖了塔斯马尼亚州，新南威尔士州南部以及澳大利亚其他地区。医院拥有 4,000 多名热情、高水平和有责任心的工作人员，为儿童和年轻人提供全套的临床服务、健康和疾病防护服务。

项目名称：皇家儿童医院
项目位置：澳大利亚，墨尔本
占地面积：11.4 万平方米

Why CCHP?

By natural of their function, hospitals are major users of power and water, not to mention historically being major emission contributors, Melbourne's new Royal Children's Hospital (RCH) is not only regarded as a world class facility by virtue of its design and cutting edge medical technology, but it also incorporates the very latest building services technology and sustainability initiatives such as CCHP as the key of their energy solution. The new RCH site is located in Parkville residences, which provide even greater incentives to ensure that the new world class complex qualified as being as "Green" a neighbor as possible.

Sustainable Targets

Significant environmentally sustainable design (ESD) targets were defined at the outset for the new RCH by the Victorian government in relation to the reduction of energy, carbon dioxide and portable water use. This strategy ensures that this new healthcare facility significantly raises the sustainability bar for other planned major healthcare facilities. The two key RCH initiatives implemented include a black water treatment plant (a hospital first) and secondly tri-generation. With both systems playing a significant role in meeting and exceeding ESD targets.

CCHP Advantages

Apart from the Carbon reduction benefits provided, it will also produce electricity and heat energy with a system efficiency of around 78%. This higher efficiency is far in excess of the 35 to 40% system efficiency of grid power is largely due the traditional coal-fired generation plant currently employed as well as transmission and distribution losses which account for merely around 8 %.

为什么选择冷热电联产系统

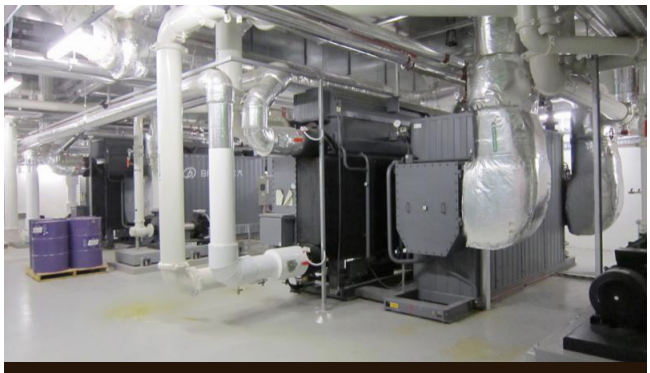
医院历来就是水和电的消耗大户，同时也是碳排放主要贡献者之一。墨尔本皇家儿童医院不仅因其世界级的设计和医疗技术而闻名，也是因为它融合最先进的建筑科技及可持续能源方案，比如冷热电联产系统作为关键的能源解决方案。新的医院大楼坐落于Parkville居民生活区，新建筑技术和能源方案使得医院更加容易被当地居民认可为“绿色的”邻居。

可持续发展目标

新的医院在设计之初，维多利亚政府就将环境可持续性设计作为目标，必须减少能源消耗、二氧化碳排放和用水量。新的可持续性节能方案对其它医院的改造带来示范性意义。皇家儿童医院采用了两套系统，一套是污水处理系统，另外一套是冷热电联产系统，这两套系统满足了设计要求，达到可持续性发展的目标。

冷热电联产系统的优点

冷热电联产系统不仅减少了二氧化碳的排放，而且将系统的总效率从 35~40% 提高到 78% (澳大利亚大部分的电力源自传统的火力发电厂，火力发电后的输配电损失占总发电效率的 8% 左右)。



Heart of CCHP, Absorption Chiller
冷热电联产的心脏，吸收式空调

RCH Machine Room, Gas Generator
医院机房，燃气发电机

System Installation

Electricity Part

The power generation arrangement as follows:

Model: gas engine
Quantity: 2 units
Capacity: 1,160 kW/each
Origin: United States

The system generates 25 percent of the RCH base building electrical demand. The two tri-generation engines also contribute to the 100 percent overall standby capacity which operates in the event of grid power failure.

Absorption Chiller Part

The chillers arrangement as following:

Model: BHE125
Quantity: 2 units
Capacity: 1,276KW/each
Brand: BROAD
Origin: China
Heat input: 470℃ exhaust and 95℃ Jacket water

The system is plan to supply chilled water and heating hot water for air conditioning and heating to contribute domestic hot water.
There are significant environment gains from the on-site generated electrical contribution which offsets the need for the equivalent capacity in much less than efficient grid power and effectively reduces the electrical demand by 25%. Further benefits accrue from the recovery of otherwise wasted heat for use in space heating and cooling which means that the equivalent capacity of heating and cooling is saved from needing to be generated via gas fired boilers and electrically powered chillers.

系统安装

电力系统部分

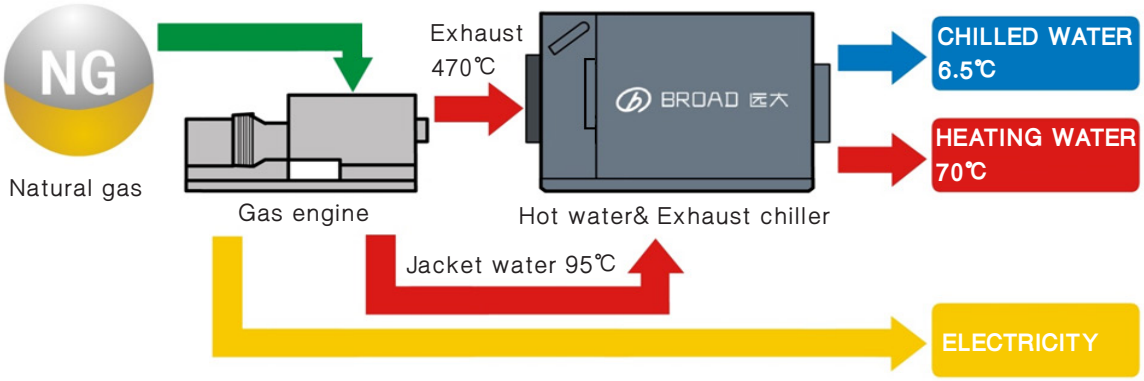
发电机数据如下所示：
机型：燃气发电机
数量：2台
发电量：1160 kW/台
原产地: 美国

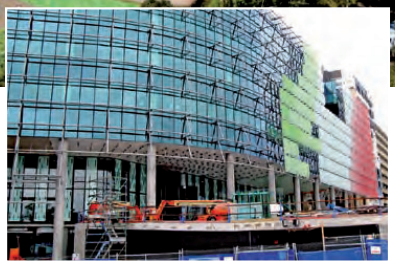
发电机系统的发电量占整个医院项目总的设计用电量的25%，发电机系统也是做为整个医院的备用电源，在主电网出现故障的时候使用。

吸收式空调部分

吸收式空调数据如下所示：
机型：BHE125
数量：2台
制冷量：1276 kW/台
品牌：远大
原产地：中国
输入热源：470℃ 烟气和 95℃ 的缸套水

系统将提供医院的空调冷、热水，以及部分的卫生热水，减少锅炉的容量。
相比电空调，吸收式空调系统将非常显著地减少因巨大耗电而带来的能源浪费，减少 25% 的医院用电量。同时，因为采用了远大的空调，发电的废热部分被二次有效利用，用来产生空调水和部分卫生热水，降低了对燃气锅炉的需求。





Trigeneration at the new Royal Children's Hospital

Rapid developments in medical technology, the paradigm shift to patient and family-centred care, and the inability of ageing hospitals to accommodate the latest models of care, have all contributed to the current worldwide boom in hospital redevelopment, writes Keith Davis.

The evolving 'new breed' of hospital is welcoming, less threatening to patients, integrates sympathetically with the local community, and embraces evidence-based design principles. These new hospitals are now more integrated into their local communities than ever before, and with this attitudinal change comes new pressures for our 'new-look' hospitals to become exemplary neighbours.

Taking a lead in implementing sustainability initiatives is fundamental to this new image, and correlates strongly with the principles of evidence-based design that focuses on stakeholder wellbeing.

By nature of their function, hospitals are major users of power and water, not to mention historically being major environmental polluters. Melbourne's new Royal Children's Hospital (RCH) is not only regarded as a world-class facility by virtue of its design and cutting edge medical technology, but it also incorporates the very latest building services technology and sustainability initiatives.

The new RCH site is located in parkland and directly across the road from Parkville residences, which provided even greater incentives to ensure that the new complex qualified as being as "green" a neighbour as possible.

Significant ESD targets were defined at the outset for the new RCH by the Victorian government in relation to the reduction of energy, carbon dioxide and potable water use. This strategy has ensured that this new healthcare facility significantly raises the sustainability bar for other planned major healthcare facilities. The two key RCH initiatives implemented include a blackwater treatment plant (a hospital first) and secondly trigeneration, with both systems playing a significant role in meeting and exceeding ESD targets.

The trigeneration plant and technology engineered by Norman Disney & Young (NDY) is undoubtedly one of the cornerstone ESD initiatives implemented for the new RCH. Apart from the carbon reduction benefits provided, it will also produce electricity and heat energy with a system efficiency of around 78 per cent.

This higher efficiency level is far in excess of the 35 to 40 per cent system efficiency associated with grid power. The poor efficiency of grid power is largely due to the traditional coal-fired generation plant currently employed as well as transmission and distribution losses which account for around eight per cent.

RCH has a heat-led trigeneration system comprising of two 1160kW gas reciprocating engines and two 1267 kWr 2-stage absorption chillers. The system generates 25 per cent of the RCH base building electrical demand, plus a contribution to chilled water and heating hot water for air conditioning, and a heating contribution to domestic hot water. Carbon reduction from the trigeneration system is around 37 per cent, with a further 10 per cent reduction in carbon emissions from the use of a renewable technology biomass boiler (burning compressed timber pellets from forestry waste) and solar pre-heating of domestic hot water serving the inpatient unit. The two trigeneration engines also contribute to the 100 per cent overall standby capacity which operates in the event of a grid power failure.

There are significant environmental gains from the on-site generated electrical contribution which offsets the need for the equivalent capacity in much less efficient grid power and effectively reduces the electrical demand by 25 per cent. Further benefits accrue from the recovery of otherwise wasted heat for use in space heating and cooling which mean that the equivalent capacity of heating and cooling is saved from needing to be generated via gas fired boilers and electrically powered chillers.

ENERGY UPGRADE IN UNIVERSITY CAMPUS

大学校园能效升级

Bucknell university campus 巴克内尔大学校区

Bucknell University, USA
美巴克内尔大学

Project Background

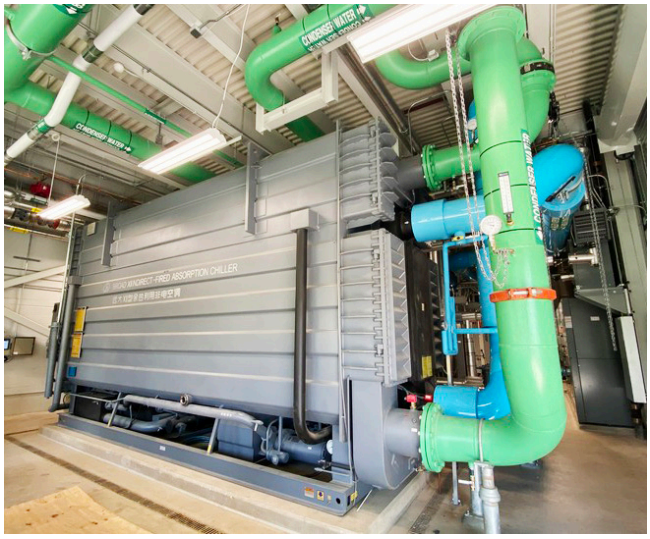
The Bucknell University is located in Lewisburg, PA. Bucknell’s power plant was built in 1998, it allowed the university to produce and manage its own electricity on site. 2018，The campus began the process of replacing their aging coal-fired campus power plant with a cogeneration system. Apart from the environmental challenges which the coal plant presented, it placed additional running costs which was not feasible on a rapidly developing。

The cogeneration plant needed to serve the campus steam load growth for the next 20 years, satisfy the current electrical load with some reserve, and have emergency power capability, all in a cost- effective manner. Improved emissions and energy efficiency were also required for this project to be a success.

项目背景

该项目位于宾夕法尼亚州路易斯堡。巴克内尔的发电厂建于1998年，大学可以就地生产和管理自用电。2018年校园开始能源升级——用冷热电联产系统替换老化的燃煤热电联产系统。燃煤电厂除带来严重的环境污染外，还带来额外的运营成本的增加，这与快速发展的理念背道而驰。

改造的目标是采用最经济的方法，使新的冷热电联产系统满足未来 20 年的校园蒸汽负荷增长需求，满足现有用电需求并保留一定余量，满足紧急用电需求。提高能源效率及改善排放是项目取得成功的重要因素。



With a campus size of 450 acre campus with > 150 buildings, totaling 2.4 million sq. ft. Student population over 3,300, in 1996 the university installed its first CHP. The campus load as of 2002 was 42,000 MWh per year 7.5 MW peak demand 70,000 lbs per hour steam, this was expected to grow by 30% by 2018. Bucknell University's campus is about three million square feet. Providing electricity and heat to the campus in Lewisburg was a large scale project.
Currently the campus is powered by Prime Movers: Solar Taurus 60 combustion turbine 70k lb/hr HRSG with redundancy Murray KG4 steam turbine and begun operation in 1997.
BROAD has since embarked replacing these outdated models and have a guaranteed to improve efficiency and energy usage by at least 35%.

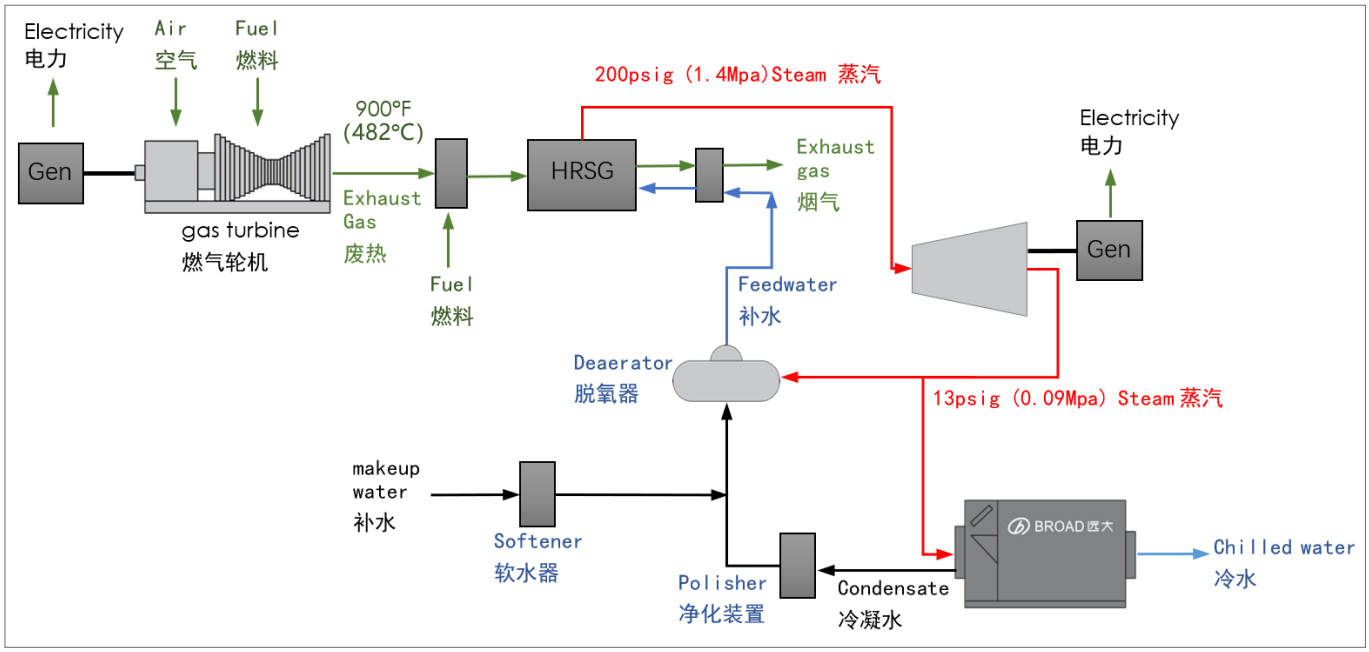
学校占地 450 英亩 (182公顷)，拥有 150 多栋建筑，总面积 24 万平方米，学生人数超过 3300 人，1996年，该校安装了第一套热电联产系统。
2002年，校园的总能耗为 4.2 万MWh, 峰值电力负荷为 7.5MW，蒸汽负荷为 31.78 吨/小时；到2018年这些数据均增长 30% 。巴克内尔大学的校园大约有 30 万平米，为路易斯堡的校园提供电和热是一项大规模的工程。
目前，校园的动力系统为：索拉金牛座 60 燃气轮机、31.78 吨/小时余热锅炉和备用的 Murray KG4 蒸汽轮机，系统于1997年开始运行。
远大参与此项目，替换旧的制冷机组，并确保至少提高35%的能效。

BROAD Cooling System

As a part of the chilled water plant expansion project, a new single effect steam driven absorption chiller was installed. Recovering exhaust steam from campus cogeneration plant nearby to provide district cooling. It increases the campus energy efficiency and dramatically reduces the peak electric demand in the hot summer season. In addition the cost to the environment is significantly reduced.

远大制冷系统

作为制冷中心扩建工程的一部分，客户选择了一台新的单效蒸汽吸收式冷水机组，回收热电厂排出的蒸汽，提供区域制冷。它提高了校园的能源效率，大大降低了炎热夏季的用电高峰，也大大降低了环境成本。



BROAD Chiller Information

Cooling capacity: 3,317 kW
Model: BDS285XII0.08-37.8/29.4-5.6/12.1-400
Heat source: exhaust steam from campus cogeneration plant

Project Values

Customized machine design including marine type water box for both ends of evaporator, and titanium tubes for the evaporator. Superior performance and reliable operation of BROAD chillers created a name amongst other institutions of the region, which make many Universities across the States selected BROAD.

Energy efficiency figures:

- 50% reduction in campus cooling costs
- 2,450 RT of cooling capacity added
- The project was installed in December 2018
- BROAD utilized existing methods decreasing the complete overhaul cost to the university in the short term, in addition to saving the University money for future energy necessities.

远大主机信息

制冷量：3317 kW
机型：BDS285XII0.08-37.8/29.4-5.6/12.1-400
热源：校区联合循环系统废蒸汽

项目价值

机组根据客户需求定制，蒸发器内换热管采用钛管，蒸发器两端均采用船型水室等。远大冷水机组的卓越性能、良好的服务以及在北美地区可靠运行的口碑，使美国多所大学选择了远大。

能源效率：

- 校园制冷费用降低 50%
- 新增制冷量 2450 冷吨
- 项目安装于2018年12月
- 远大运用成熟技术，在短期内降低了大学的项目总成本，另外也为大学节省了未来能源需求的投资

BROAD A/C
远大空调

DIRECT FIRED CHILLER IN DATA CENTER

数据中心直燃机

Yandex Data Center, Russia

俄罗斯 Yandex 数据中心

Project Background

- In total, Yandex has seven data centers in Russia and abroad. The main task of data centers is to provide access to Yandex services. Data centers are working around the clock.
- The data center of Yandex in Sasovo city is one of the most innovative and advanced projects implemented in the Ryazan Region recently. The data center occupies part of the former workshops of machine tool plant "SASTA".
- It is the largest data center in Russia. The project is implemented in four stages from 2012 to 2020. The volume of investments amounts to 2.7 billion rubles (about 38 million USD).

项目背景

- Yandex在俄罗斯和国外共拥有七个数据中心，主要任务是提供对Yandex服务的访问，数据中心全天候工作
- 位于萨索沃市的Yandex数据中心是最近在梁赞地区实施的最具创新性和先进性的项目之一,数据中心使用了机床制造厂“SASTA”的部分既有厂房
- 这是俄罗斯最大的数据中心，项目从2012年到2020年分四个阶段实施，投资额达 27 亿卢布 (约合 2.7 亿人民币)

Customer Profile

Yandex is Russia's largest search engine, not only reaching 96% of customers in Russia, but also covering many CIS countries, with more than 80% of netizens from more than a dozen Russian-speaking countries such as Belarus, Ukraine, and Kazakhstan. In addition, Yandex is also conducting a search business in Turkey.

客户简介

Yandex是俄罗斯最大的搜索引擎，不仅在俄罗斯客户覆盖率达到 96%，还覆盖整个独联体国家，拥有白俄罗斯、乌克兰、哈萨克斯坦等十几个俄语系国家 80% 以上的网民。此外，Yandex还在土耳其开展搜索业务。

Chiller Information

- Cooling capacity: 12MW
- Model: BZ400×3
- Heat source: natural gas
- Shipment date: February, 2012

机组配置

- 制冷量：12MW
- 机型：BZ400×3
- 热源：天然气
- 发货日期：2012年2月

BROAD Advantages

- Reliability: just rely on regular maintenance, almost no need to repair; with effective preventive after-sales service "zero failure operation" of whole life cycle can be realized;
- Long life: easy to operate and maintain; as a heat exchange equipment without high-speed rotating parts, the life span is more than 30 years;
- Environmentally friendly: using lithium bromide solution as working fluid, non-toxic, odorless and no pollution to the environment;
- Safety: the chiller operates in negative pressure, with inside pressure lower than atmospheric pressure, no risk of explosion;
- Value-added services: forewarning failure self-diagnosis, life-long internet monitoring, annual solution sampling analysis, centralized technical training for operators and free on-site training.

远大优势

- 可靠性：只需靠定期的维护保养，几乎不需维修，通过有效的预防性售后服务可实现全生命周期“零故障运行”
- 长寿命：机组运行操作、维护简便；主机为换热设备，无高速旋转部件，寿命长达 30 年以上
- 环保性：以溴化锂溶液为工质，无毒、无臭，对大气环境无污染
- 安全性：机组处于负压运行状态，机内压力低于大气压，无爆炸危险
- 增值服务：预警式故障自诊，终身联网监控，每年溶液采样分析，作业员集中技术培训与现场免费培训

Project Value

Transform idle industrial plants into data centers — a paragon of industrial transformation and upgrading

IDC construction is a huge and complex system project. Under the completely self-built model, the long construction period is far from meeting the growing demand for IDC business.

Yandex made full use of the existing energy supply facilities and infrastructure of the industrial plant, and transformed it into IDC without the need of huge investment, making it possible to revitalize and reuse idle plant resources.

This renovation and construction model is not only benefit for data center operators to seize market opportunities, shorten construction period and save construction investment, but also serves as a self-transformation of industrial structure upgrade and economic benefit improvement.

Green, high efficiency and energy saving — the first application of non-electric absorption chiller in Russian IDC

The main component of IDC infrastructure is the cooling system. Yandex comprehensively considered the existing energy supply facilities, energy price conditions and equipment operation reliability and chose non-electric chiller for IDC cooling.

This project used the existing gas supply infrastructure of the factory, using natural gas as driving energy for 3 non-electric chiller BROAD to provide 12MW of cooling capacity for the data center.

This is the first project in Russia that uses non-electric chiller to provide cooling for data centers, and has good economic and social effects.

项目价值

闲置工业厂房变身数据中心 — 产业转型升级典范

IDC数据中心建设是一项庞大而复杂的系统工程，在完全自建模式下，漫长的建设周期，远远无法满足日益增长的IDC业务需求。

Yandex充分利用了工业厂房已有的能源供应设施和基础设施，在无须投入大量资金的前提下，将其改造成为IDC数据中心，实现对闲置存量厂房资源的盘活再利用。

这种改造建设模式，不仅有利于数据中心运营商抢占市场先机、缩短建设周期、节省建设投资，同时还有利于产业结构升级、经济效益提升的自我转型。

绿色、高效、节能 — 非电空调在俄数据中心的首次应用

数据中心基础设施的主要组成部分是制冷系统，Yandex综合考虑既有能源供应设施、能源价格条件、设备运行可靠性，选用非电空调为数据中心制冷。

项目利用厂房既有的燃气供应基础设施，采用天然气为3台远大非电空调供能，为数据中心提供 12MW 制冷量。

这是俄罗斯首个使用非电空调为数据中心提供制冷的项目，具有良好的经济、社会效益。

ANTI-EXPLOSION CHILLER IN CHEMICAL FACTORY

化工厂防爆机组


BASF-YPC 扬子巴斯夫

BASF-YPC
扬子巴斯夫

Project Introduction

BASF-YPC Company Limited (BASF-YPC), a 50:50 joint venture between two FORTUNE 500 companies - BASF and SINOPEC. It is located in Nanjing Jiangbei New Materials High-Tech Park. BASF-YPC sells about 3 million tons of high-quality chemicals and polymers per year to cater the rapidly growing Chinese market.

BASF-YPC's products are multiple basic industrial materials with flammable and explosive chemical features, and the safety requirement such as anti-explosion is very harsh, the requirement to site equipment is also at the world's top level.

In September 2009, BASF-YPC initiated the second phase development, cooling is mandatory in some of the process. After a careful and strict global vendor selection process, BASF-YPC selected it's first BROAD hot water fired absorption chiller. Now, after 10 years operation, the chiller still gives full capacity and ensured the uninterrupted production of its process 24/7 which gained solid appreciation from the customer.

In 2020, when there is a new expansion from BASF-YPC, a new BROAD BDH600 machine is ordered again.

项目简介

扬子石化-巴斯夫有限责任公司由两个世界五百强企业中国石化和德国巴斯夫以 50：50 的股比合资成立。公司位于南京江北新材料科技园，每年为迅速增长的中国市场提供约三百万吨高质量的化学品和聚合物.

由于生产多种化工基础原料，安全防爆要求极为苛刻，对设备可靠性有着极高的要求。2009年，扬子巴斯夫启动一期项目，其中很多工艺必须有制冷需求。经过对全球制冷设备厂家的严格筛选，2010年该公司采用第一台远大单效热水机组。迄今为止，该 BDH800 热水机组已经运行十年，制冷出力十年如一日，有力保证了生产线全年 365 天的不间断运行，获得扬子巴斯夫的高度认可。

2020年新改造项目上马，扬子巴斯夫采购了第二台远大 BDH600 热水制冷机。

BASF-YPC's products　扬子巴斯夫的各类产品

BROAD Chiller
制冷主机

Model 型号	BDH602X-88/98-38/33-16/20-800 BDH344XII87/95-41/33-11/15.5-600-Fa-Ma (Phase II)		
Energy source 使用能源	Waste hot water 废热水 (98℃ , 95℃)	Application 用途	Process cooling for EOEG devices 巴斯夫 EOEG 装置工艺制冷
Shipment date 发货日期	Dec.2010 2020 (Phase II)	Operation date 使用日期	June 2011 2021 (Phase II)
Explosion-proof level 防爆等级	The products are compound explosion-proof product which can be used in zone 2 of class IIB , and the surface temperature of the equipment do not exceed 135 ℃ “Exdeib II BT4”本防爆产品为可用于 IIB 类气体的二区，设备表面温度不超过 135℃的隔爆增安本安复合型防爆产品		

Project Features

Safe, reliable, and investment saving

BROAD hot water chiller designed in full accordance with the standards of BASF special anti-explosion requirements. It is installed in chemical explosion-proof area and provides process cooling for BASF EOEG devices.

Because of the high reliability of the BROAD products, only one hot water chiller with no back-up equipment serves the respective process 24/7, which saved a lot of initial investment. Since the startup, BROAD chiller has been operating with zero fault and fully meet the cooling demand.

Energy-saving, Environment-friendly

BROAD chiller is driven by hot water which is generated by means of waste heat. By recycling waste heat, the annual energy cost savings is more than USD 2.5million which benefits customer a lot.

项目特点

安全可靠、省投资

远大热水机完全按照巴斯夫标准进行特殊防爆要求设计，安装在化工防爆区域，为巴斯夫 EOEG 装置提供工艺制冷。

由于远大产品的高可靠性，相应工艺流程只使用了远大设备而无备用机组，全年 24 小时不间断运行，大幅节省了初投资。设备投入运行 10 年来零故障满出力，完全满足巴斯夫严格的工艺控制要求。

节能环保

远大热水机所需能源由装置废热提供，通过回收利用废热，年节省能源费 1600 余万元，经济效益巨大。

Six Typical Features

- The most stringent requirements of material - specified by customer
  Most electrical components and other materials for the chiller are specified by BASF-YPC. This means a entirely special design. Hundreds of components and materials must be re-tested, which bring a big challenge to the supplier.
- The most stringent document control - hundreds of documents approval
  BASF-YPC hired a construction engineering company - Fluor (China) for documents checking and approval. The participants are internationally renowned consultants and engineers. Hundreds of documents including design, procurement, manufacturing and performance test have been reviewed and approved.
- The most stringent manufacturing requirement-standards specified by customer
  BASF-YPC applied Germany Petrochemical standards to manufacture the chiller, it almost represents the highest requirements in the world. Chiller core manufacturing processes are required to comply with BASF-YPC specifications and approved by them.
- The most stringent quality control- Third-party supervision &inspection
  BASF-YPC hired world famous consultancy Moody (Shanghai) as the third-party supervision & inspection at BROAD factory for the entire processes including welding, PMI, non-destructive testing, tube expansion, leak detection, helium inspection, hydrostatic testing, shot blasting and performance testing etc.. Specially for electrical devices testing and performance testing which are the most critical among processes, BASF-YPC organized more than ten experts to witness.
- The most harsh working conditions for chiller
  Chiller works under the most harsh conditions, like cooling operation under ambient temp. -14~43℃, 25 years lifespan with only once maintenance yearly, cooling output tolerance less than 4% under both working conditions (hot water 88/98℃ & cooling water 33/38℃ + hot water 95/105℃ & cooling water 35/40℃), cooling water fouling factor 0.35m^2K/kW with corrosive contents, anti-explosion level ExdeibⅡBT4, IP55, etc.
- The most demanding after - sales service
  Chiller canned pumps should be replaced in any failure cases without discharge solution out; Service response time less than 4 hours; Easily worn-out spare parts and key components parts should be available in BROAD local office.

六个“最”

- 最苛刻的选材要求——业主自选
  机组使用的大部分电气元件和其它材料必须出自扬子-巴斯夫的材料库。这意味着机组需依据客户要求重新设计，几百个变更的元件和材料都要重新测试，这和重新开发新机组没什么区别
- 最严格的文件控制——审批数百份文件
  扬子-巴斯夫有限公司聘请全球知名建筑工程公司——福陆(中国) 对机组相关资料进行审核，参与文件审批的都是国际上知名的设计师和工程师。从设计、采购、制造到最后的性能测试先后审批通过数百份文件
- 最严格的生产要求——按业主规范制造
  扬子-巴斯夫要求按照德国石化相关标准规范制造制冷机组，比国内的标准要求要高很多，代表了世界制造业的最高水平。机组制造过程中的核心工艺必须按照扬子-巴斯夫的规范制造，并通过过程审查
- 最严格的质量控制——第三方监检
  扬子-巴斯夫有限公司聘请世界著名咨询机构——摩迪 (上海) 咨询公司进行第三方驻厂监检。机组生产过程中的质量控制点：焊接、材料成分 (PMI)、无损检测、胀管、检漏、氦检、水压测试、抛丸以及性能测试都是在第三方监检人员在场的情况下完成。另外，对于其中最关键的机组电气测试和性能测试，扬子巴斯夫组织十几位专家进行现场测试
- 最苛刻的现场运行环境
  机组露天摆放，仅做防雨棚，没有专门的机房；机组工作环境温度为 -14~43℃，低温下机组仍需开机；机组每年仅允许停机保养一次，运行寿命须达到 25 年；机组双工况运行时 (工况1：热源水温度 88/98℃，冷却水 33/38℃；工况2：热源水温度 95/105℃，冷却水 35/40℃) 机组制冷量偏差不大于 4%；冷却水水质差 (污垢系数 0.35m^2K/kW)，是国家标准的 4 倍且带有腐蚀性；机组安装在防爆区，防爆等级 ExdeibⅡBT4，电气防护等级要达到 IP55……
- 最高要求的售后服务
  机组的泵组如出现问题，在确保不对系统进行排放的条件下进行更换，出现异常时，服务人员必须 4 小时内赶到现场维修。所有的易损件和关键部件在当地服务部都有备件

Operation Management

BASF YPC professional engineer team takes daily operation. Chiller is under 100% load operation 24/7 (except regular maintenance time).

The cooling water is from communal cooling towers, which is managed by dedicated department including regular water quality inspection, testing, dosing management.

运行管理

由巴斯夫专业工艺设备工程师进行日常操作管理，全年 24 小时满负荷不间断使用(巴斯夫装置定期检修时间除外)。

冷却水来自公用大型冷却塔，有专门的水处理部门从事水质化验，检测、加药管理，制度完善。

Project Values

- High reliability: 24/7 running and zero faults for 10 years.
- Cost effective: annual energy savings by USD 2.5million.
- Management worry-free: maintained by BROAD and monitored by BROAD Internet Monitor Service.
- CO_2 emission annual cutting by 15,000 tons. Benefit both the enterprise and the society.

项目价值

- 高可靠性：全年不间断运行，运行 10 年多零故障
- 节能省钱：直接为用户降低了生产成本，每年可节省能源费 1600 余万元
- 管理省心：关键设备远大热水机完全由远大进行维护及远程监控服务
- 社会减排：年减排CO_2 1.5万吨，实现了社会效益与企业利益的双赢

BROAD Chillers and Packaged Water Distribution System are CE, UL, ETL, ASME Certified

远大空调主机及输配系统均通过了 CE、UL、ETL、ASME 等国际认证

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