Energy Efficiency Technologies in Building Sector

欧洲建筑能效技术

People's Republic of China - Zhengzhou, 3 July 2008

中国 - 郑州， 二〇〇八年七月三日

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ENEA is the Italian National Agency for New Technologies, Energy and the Environment

ENEA:意大利国家新技术能源及环境研究院

ENEA is a public research body operating in the fields of energy, environment and new technologies to support Country's competitiveness and sustainable development.

ENEA是一家能源，环境和新技术领域的，支持国家竞争力和可持续发展的公共研究机构。

ENEA mainly operates: ENEA主要开展以下活动:

- to promote and carry out basic and applied research and innovation technology activities, also through prototypes and product industrialization;
  推广和开展基础和应用研究及创新技术活动,建立技术原型,以及产品的工业化
- to disseminate and transfer technologies, encouraging their use in productive and social sectors;
  技术传播和转让,鼓励其在生产和社会领域的应用
- to provide high-tech services, studies, tests and evaluations to both public and private bodies and enterprises.
  为公共和私人机构以及企业提供高技术服务,研究,测试和评估.

ENEA research activities are carried out by **five Departments**:

ENEA的研究活动由五个部门开展:

- **Advanced physical technologies and new materials 先进物理技术及新材料**
- **Biotechnologies, agro-industry and health protection 生物技术,农工和健康防护**
- **Energy Technologies, Renewables and Energy Saving Department 能源技术,可再生能源和节能**
- **Environment, global change and sustainable development 环境,全球变化及可持续发展**
- **Nuclear Fusion and Fission, and related Technologies 核聚变及裂变及相关技术**

ENEA has set up several **new projects** in the fields of energy and the environment. These Project are:

ENEA已经在能源和环境领域开展了多个新项目,包括:

Clean energy 清洁能源

(Distributed power generation and renewable sources, Clean coal, Bio-fuels, Concentrated solar power generation) 分布式发电和可再生能源，清洁煤，生物燃料，集中太阳能发电

Energy, the environment and territory 能源,环境与领土

(Sustainable use of the energy and territory, Global change and Kyoto, Sustainable waste management, Energy efficiency and eco-building, Sustainable mobility and transports, Management and safety of technology and energy networks) 可持续利用能源和领土，全球气候变化和京都议定书，可持续废物管理，能源效率和生态建设，可持续发展交通与运输，技术管理和安全以及能源网络

Emerging technologies 新兴技术

(New-generation photovoltaic energy, New energy materials, Hydrogen and fuel cells, Nuclear fusion, Superconductivity) 新一代的光伏能源，新能源材料，氢气和燃料电池，核聚变，超导

ENEA's technologies spin-offs ENEA 的技术衍生活动

(Technologies for cultural heritage, Health technologies, Food quality and safety technologies) 保护文化遗产的技术，卫生技术，食品质量和安全技术

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Wide range of expertise, advanced facilities and tools, are located at ENEA Research Centres: they operate in support of ENEA's programmes and also at the service of the Nation's scientific and productive system.

ENEA各个研究中心均具备广泛的专长,先进的设施和工具:它的运做支持着ENEA的项目，以及国家的科学与生产体系

ENEA 的研究中心

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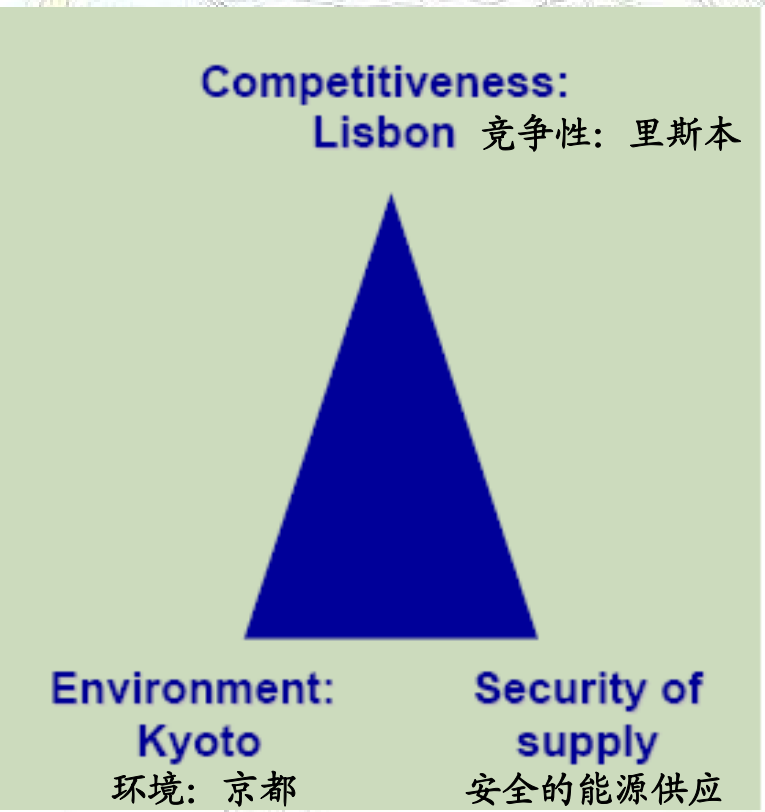
Website : www.enea.it

Energy efficiency in Europe 欧洲的能源效率 - 1

- EU Green paper on energy efficiency (2005): “Doing more with less”
  欧盟能效绿皮书（2005）：以少做多
  http://ec.europa.eu/energy/efficiency/doc/2005_06_green_paper_book_en.pdf
- Green paper on energy efficiency on a European strategy for sustainable, competitive and secure energy” (EC – DGTREN, 2006):
  欧洲可持续，竞争性及安全能源战略绿皮书（ EC – DGTREN, 2006 ）
  http://ec.europa.eu/energy/green-paper-energy/index_en.htm



- **Competitiveness:** internal market, competition, interconnections (TEN-T), European electricity grid, research & innovation (clean coal, carbon sequestration, alternative fuels, energy efficiency, nuclear)
- **Environment:** renewable energy, energy efficiency, nuclear, innovation & research, emission trading
- **Security of Supply:** international dialogue, European stock management (oil/gas), refining capacity and storage of energy, protection against terrorism

竞争性：内部市场，竞争，互联互通，欧洲电力网格，研究与创新（洁净煤，固碳，替代燃料，能源效率，核能）

环境：可再生能源，能源效率，核能，创新与研究，排放权交易

安全能源：国际对话，欧洲油/气储备管理，炼油能力和能源的储备，防备恐怖主义

Energy efficiency in Europe 欧洲的能源效率 -2

- The European Council Action Plan (2007 – 2009) Energy Policy for Europe (EPE) - Brussels *8-9 March 2007*

  欧洲理事会行动计划（2007 – 2009) 欧洲能源政策(EPE) – 布鲁塞尔 *2007.3.8-9*

  http://register.consilium.europa.eu/pdf/en/07/st07/st07224-re01.en07.pdf

  The Action Plan contains priority actions, which may contribute to the objectives of EPE, concerning:
  该行动计划包括的优先行动有助于达到欧洲能源政策(EPE)所设定的目标, 包括:

  - **internal market for gas and electricity** (technical standards, unbundling, investments in infrastructures, etc.);
    天然气和电力的内部市场(技术标准, 分拆, 基础设施投资等)

  - **security of supply** (diversification of energy sources and transport routes, a more effective crisis response mechanism, an Energy Observatory within the Commission);
    供应保障 (能源和运输路线的多样化, 更有效的应急机制, 欧委会的能源观察部门)

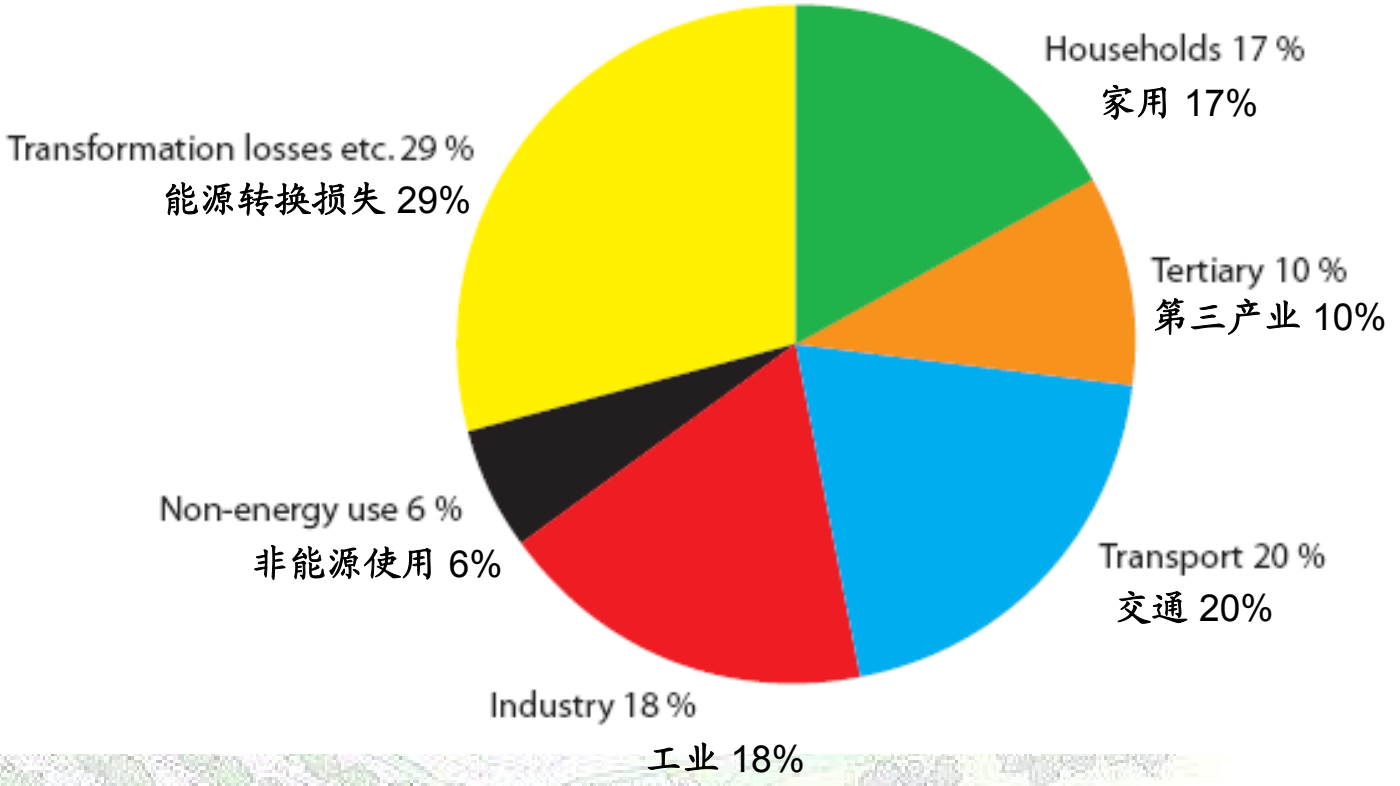
  - **international energy policy** (a common approach to external energy policy, relationship and partnership between EU and Oil producer Countries);
    国际能源政策(共同的对外能源政策, 欧盟与产油国之间的关系和合作)

  - **energy efficiency and renewable energies** (objectives 20% of energy saving in 2020 EU's energy consumption projections, a binding target of 20% share of RES in overall EU energy consumption by 2020 to be achieved with a minimum binding target of 10% of biofuels in transport consumption);
    能效与可再生能源(2020年欧盟能源的节能目标为20%，加之2020年的使用可再生能源捆绑目标：即欧盟总能源消费中20%来自可再生能源，且交通能耗中至少10%来自生物燃料）。

  - **energy technologies** (support in energy research to accelerate the competitiveness of sustainable energies).
    能源技术（支持能源研究，提升可持续能源技术的竞争力）。

- Directive 2002/91/EC on **Energy Performance of Buildings** (EPBD);
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0091:EN:NOT
- Directive 2005/32/EC on **Eco-design of energy-using products**
  http://ec.europa.eu/enterprise/eco_design/dir2005-32.htm
- Directive 2006/32/EC on **energy end-use efficiency and energy services**
  http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/oj/2006/l_114/l_11420060427en00640085.pdf

Estimated gross energy consumption (1.725 Mtoe) by sector in 2005 (EU-25)
欧盟25国2005年各部门的能源总消耗（17.25 亿吨标油）



Source: European Commission “Green paper on energy efficiency: Doing more with less” (2005)
Estimate based on Eurostat energy balances
资料来源：欧洲委员会“能源效率绿皮书：以少做多”(2005年)。预计工作基于欧洲能源平衡数据

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Estimated gross energy consumption to 2020 (EU-25)
欧盟25国2020年的能源预计

If the current trend continues, gross energy demand could increase by 10 % by 2020. Growth in electricity demand could also reach 1.5 % per year.
如果持续目前的趋势, 2020年的总能源需求可能增加10％。电力的需求可增长1.5％ 。

Today's consumption in the EU could reach 1,900 Mtoe within 15 years (2020), compared with 1,725 Mtoe in 2005.
15年内(2020年) 欧盟的能源消费(17. 25亿吨标油, 2005年数据)可达到19亿吨标油。

These predictions are made under the assumption of an average growth of GDP as foreseen to be 2.4 % per year.
预计的假设条件：国民生产总值平均每年增长2.4 %

Estimated for full energy saving potential in end-use sectors at 2020
估计2020年终端消费领域的节能潜力

领域	2005年 能耗	预计2020 年的能耗	预计2020 年的节能量	预计2020 年的总节能潜力
Sector	**Energy consumption (Mtoe) 2005**	**Energy Consumption (Mtoe) 2020 (Business as usual)**	**Energy Saving Potential 2020 (Mtoe)**	**Full Energy Saving Potential 2020 (%)**
Households (residential) 居住	280	338	91	27%
Commercial buildings (Tertiary) 商业建筑	157	211	63	30%
Transport 运输	332	405	105	26%
Manufacturing Industry 制造	297	382	95	25%

Source: Action Plan for Energy Efficiency: Realising the Potential (2006)
European Commission, EU-25 Baseline Scenario and Wuppertal Institute 2005
资料来源：能源效率行动计划：实现潜力（2006年）
欧洲委员会，欧盟25国基准情景和伍珀塔尔研究所2005年

How save energy in building design, Energy refurbishment and construction

如何在建筑设计，改造和建造中节能

A correct energy efficiency building design must respect the following features:

正确的节能建筑设计必须尊重以下原则：

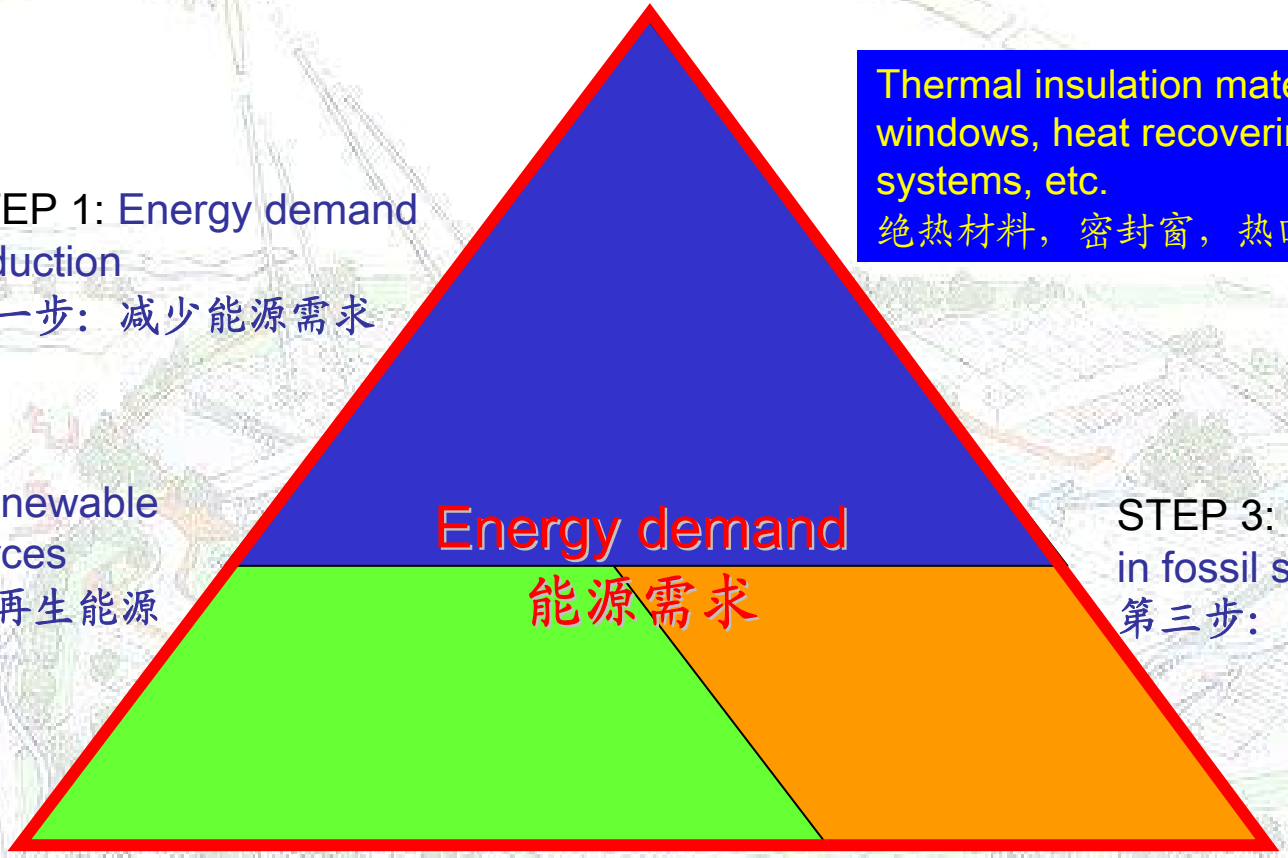
- **integrated approach in energy design**: in defining the energy demand we must consider the building envelope together with the heating&cooling systems;
  整体能源设计：在确定能源需求时，将建筑围护体与供热/制冷系统放在一起考虑
- **correct construction works**, according to energy design;
  根据能源设计，正确地开展建筑施工
- **high quality and performances** of materials, components and systems.
  材料，部件和系统的高质量和高性能

Eco-building: high efficiency building design approach
生态建筑：高效建筑设计方法

STEP 1: Energy demand reduction
第一步：减少能源需求

Thermal insulation materials, air-proof windows, heat recovering, shading systems, etc.
绝热材料，密封窗，热回收，遮阳系统等

STEP 2: Renewable energy sources
第二步：可再生能源



STEP 3: High en. efficiency in fossil sources employ
第三步：高效使用化石资源

Solar energy (thermal, PV), heat pumps, wind, biomass
太阳能（热利用，光电利用），热泵，风能，生物质能

High efficiency boilers, lighting and electrical household appliances
高效锅炉，照明和家用电器

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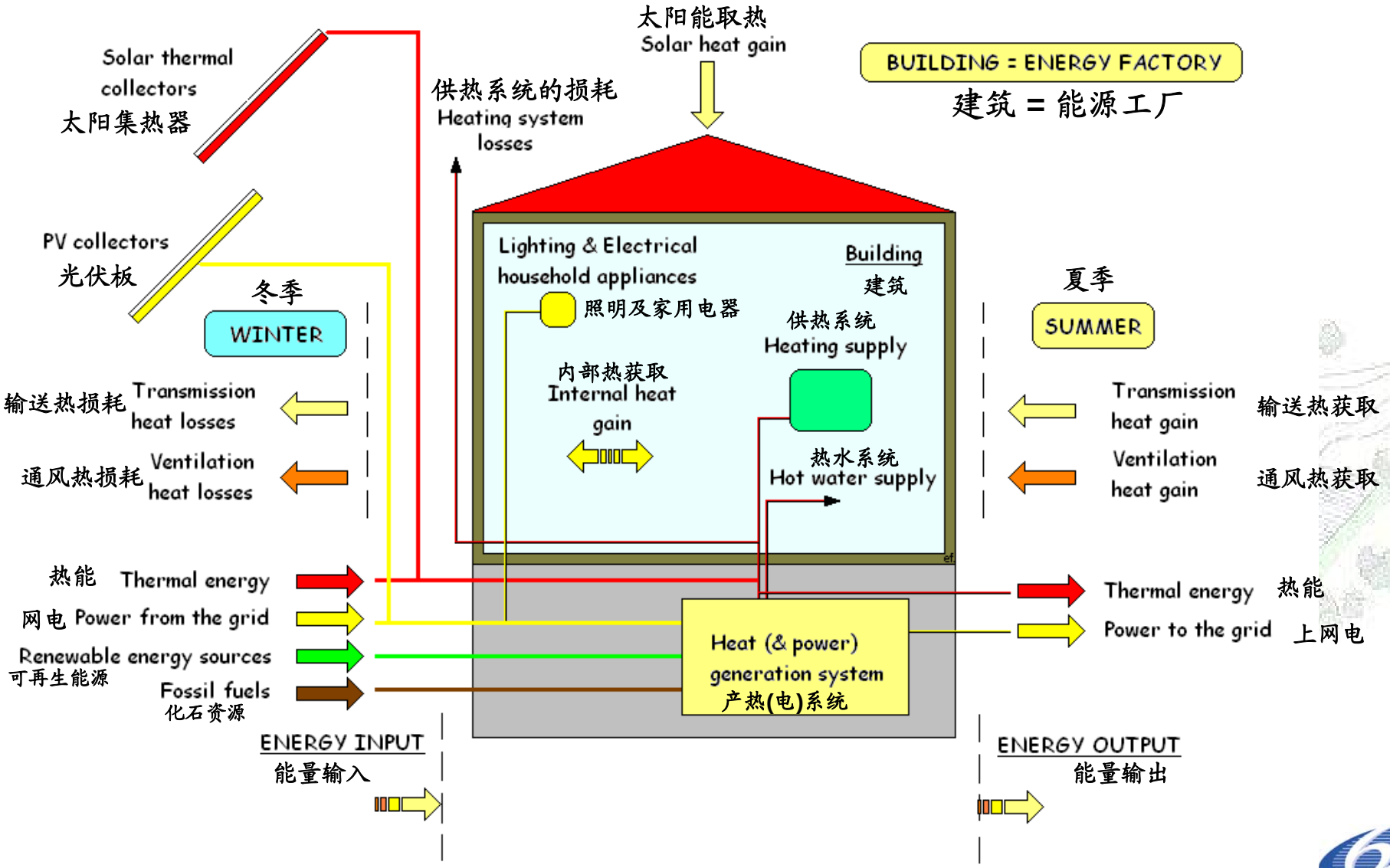
Buildings becomes energy factories
建筑物成了能源工厂



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Eco-building technological solutions:
生态建筑技术方案 (1)

- Integrated approach to the building design 集成式建筑设计:
  - envelope (opaque façade and transparent components);
    围护结构（不透明面墙和透明部件）;
  - heating/cooling systems 供热/供冷系统;
  - solar heat gain (natural and hybrid ventilation, passive cooling, etc.);
    太阳能取热（自然与混合通风，被动式制冷，等等）;
  - Information and Communication Technologies in and around the home (domotics).
    围绕家庭可应用的信息与通信技术（家用自动化控制系统）
- High efficiency components, systems and materials:
  高效部件，系统和材料
  - high performance doors and windows 高性能门窗;
  - high efficiency paints 高效涂料;
  - Innovative and high performance bricks 新型高性能砖;
  - high performance insulating systems 高性能隔热系统;
  - Intelligent envelope 智能围护结构。
- High efficiency technologies integrated with RES:
  高效技术与可再生能源的综合利用
  - thermal & PV systems integration 太阳热及光电系统综合利用;
  - solar cooling systems 太阳能制冷系统;
  - high efficiency heating systems (i.e. high efficiency boilers, heat pumps).
    高效供热系统（即高效锅炉，热泵）。

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Eco-building technological solutions:
生态建筑技术方案 (2)

- Innovative and high efficient light systems
  新型高效照明系统
  - Light Emitting Diode (LED) technology and sun tunnel tubular skylights, etc.
    LED（发光二极管）技术和太阳隧道管状天窗 天光，等
  - Lighting systems design based on natural and artificial integration concepts
    基于自然和人工整合理念的照明系统设计
- Smart Building devices
  智能建筑设备
  - Innovative software tools for rational and efficient management of energy consumptions and environment control
    创新的软件工具，合理和有效的能源消耗管理和环境的控制
- Electrical household appliances
  家用电器

The criteria for energy efficiency technology choice
节能技术选择判据

No absolute criteria for energy efficiency technology choice

→we have to compare the technologies which are available, reliable and applicable considering the restrictions' framework defined by the features:

没有选择节能技术的绝对判据，必须在以下特定条件下就可用，可靠且可应用的技术进行比较：

Technical: heat demand profile, plant components dimensions compared to available spaces, availability of fuels or energetic vectors (i.e. H_2);

技术上：热需求的状况，设备尺寸与可用空间，燃料或其它能源(如氢气)的可供性？；

Economical: installation and operation costs, particularly fuel cost and taxation applied;

经济上：安装和运行成本，特别是燃料成本和相关税收；

Financial: specific financings (grants, credit facilitations, guarantee/revolving funds);

资金上：专门的资金情况(赠款，信贷，保证金/周转金)；

Political: laws and technical requirements at local, regional and national level;

政策上：地方，地区和国家层面的法律和技术要求

Specific **end-users' needs/requirements**.

终端用户的特殊需要/要求。

Eco-Building technology areas
生态技术领域

The Project “ECO-BUILDING CLUB” covers three areas related to the Thematic Promotion and Dissemination of:

项目“生态建筑俱乐部”覆盖三个领域的推广与转播:

1. **Eco-buildings** 生态建筑

materials, components, systems, eco-building design concept, etc.

材料，部件，系统，生态建筑设计理念等。

2. **Renewable heating & cooling technologies** 可再生能源供热/制冷技术

energy technologies using renewable energy sources (solar thermal and PV, biomass, etc.)

使用可再生能源的能源技术（太阳能热利用，光电利用，生物质能，等）

3. **Poly-generation** 多联产

energy technology to produce power, heating, cooling and other energy service, also with integrated systems and distributed (decentralised) generation

生产电力，热力，制冷和提供其他能源服务的能源技术，包括集成系统和分散式联产系统

Innovative energy efficiency technology for building envelope
新型建筑围护结构节能技术

- transparent insulation (aerogel, geometric media)
  透明隔热（气溶胶，几何介质）
- electrochromic glazing systems
  电致变色玻璃
- solar filter glazing units
  滤光玻璃单元
- cool material and coatings
  冷材料及涂膜

Transparent insulation 透明隔热

Objective of the technology: 技术目标

produce glazing systems transparent to the solar radiation but with high insulation level.

生产玻璃系统，全透明太阳辐射且具有良好的隔热性

Function of the technology: 技术功用

solar gains, building insulation, daylighting, passive and active solar

获取太阳能，建筑隔热，日光照明，被动式和主动式太阳能利用

State of the technology: 技术状态

commercial but research still needed

已商用，但仍需进一步研发

Applications: 应用

tertiary and (partly) residential buildings, heating dominated climates, unfavorable orientations (north or shaded facade)

服务业和（部分）住宅建筑，以供暖需求为主的气候条件，不佳的朝向（北向或阴面立面）

Electrochromic glazing systems
电致变色玻璃

Objective of the technology: 技术目标

produce glazing systems able to switch their colour and optical/solar properties as a function of a small voltage potential.

生产可以随着小电压变化变换颜色和光性能的玻璃

Function of the technology: 技术功能

dynamic solar control, daylighting, visual and thermal comfort.

动态太阳光控制，日光照明，视觉和热觉舒适度

State of the technology: 技术状态

commercial but lot of research still needed

已商用，但仍需大量研发

Applications:应用

tertiary and buildings, all climates (excluded very cold ones), un-shaded facades

服务业和建筑，所有的气候(除了极冷气候), 未被遮挡的立面

Solar filter glazing units 太阳能滤过玻璃

Objective of the technology: 技术目标

produce static glazing systems with high insulation level and advanced solar control

生产具有高隔热水平和先进太阳光控制性能的玻璃

Function of the technology: 技术功能

solar control, building insulation

太阳光控制, 建筑隔热

State of the technology: 技术状态

commercial

商用

Applications:应用

tertiary and residential buildings, mild climates (where cooling and heating demand are significant)

服务业和住宅建筑,适用温和气候 (制冷和供暖需求都比较大)

Cool materials and coatings 冷材料和涂膜

Objective of the technology: 技术目标

produce opaque envelope components with high solar reflectance to reduce cooling demand and urban heat island effect

生产不透明的，具有高太阳能反射度的围护部件，以减少制冷需求和城市热岛效应

Function of the technology: 技术功能

solar control, thermal comfort 太阳光控制，热舒适性

State of the technology: 技术状态

commercial but research needed 已商用，但仍需研究

Applications:应用

tertiary and residential buildings, mild climates (where cooling demand is significant), urban area affected by heat island effect

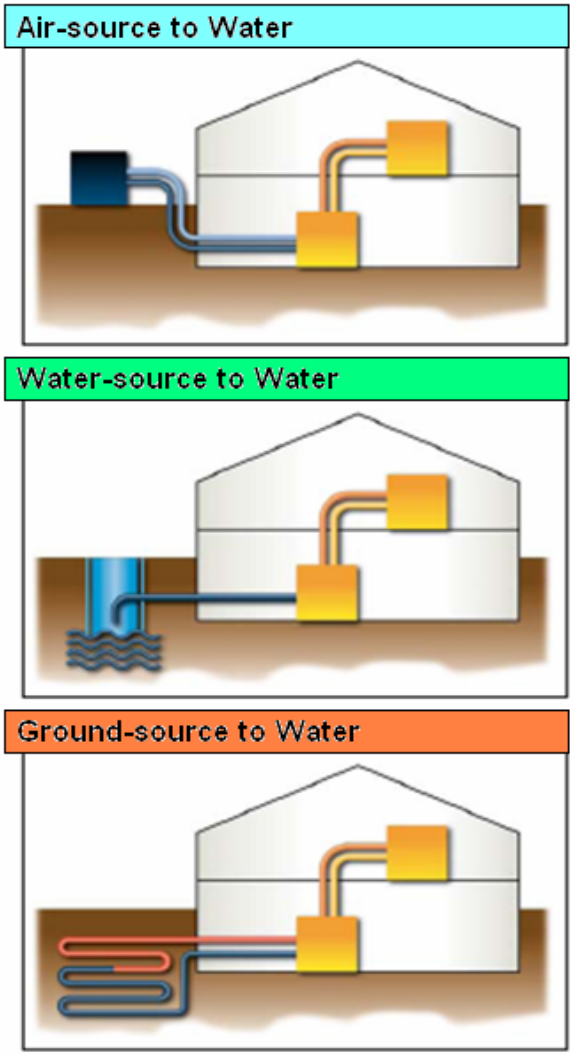
服务业和住宅建筑，适用于对制冷和供暖需求都比较大的温和气候，以及受热岛效应影响的城市区域

High efficiency heating systems 高效供热系统

- Condensation boilers 冷凝锅炉
- Heat pumps 热泵
- Combined Heat & Power (Micro-CHP ⩽ 50 kWe) 热电联产
- Integrated systems (CHP & heat pumps)
  集成式系统（热电联产和热泵）
- District heating / cooling 集中供热/制冷
- Renewable heating & cooling technologies
  可再生能供热/制冷技术

Heat pumps 热泵

- residential sector: heating/cooling, hot water supply
  住宅领域：供热/制冷，热水供应
- business sector: air conditioning, hot water supply
  经营领域：空调，热水供应
- commercial sector: heating/cooling (air conditioning)/drying, hot water supply
  商业领域：供热/制冷(空调)/干燥，热水供应



Coefficient Of Performance

性能系数

$$COP = \frac{\text{供热}}{\text{电力 (及天然气) 用量}}$$

Energy Efficiency Ratio

能效比

$$EER = \frac{\text{制冷}}{\text{电力 (及天然气) 用量}}$$

供热

制冷

电力 (及天然气) 用量

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Distributed generation 分散式发电/供热 -1

Potential advantages of distributed generation in building
分散式发电应用于建筑的潜在优势

- Save of primary energy combining electrical & thermal generation (CHP)
  通过热电联产节约一次能源
- Increasing of global energy efficiency 提高整体能源利用效率
- Reduction energy bill by reducing energy costs
  通过减少能源成本降低能源支出
- Contribution to environment preservation, mainly through CO_2 emissions reduction 通过CO_2减排对环保做出贡献
- Reducing of transmission and distribution electricity losses
  减少输配电损耗
- Reliability and high quality in electrical energy supply (possible use of Standby power, Peak shaving/Load levelling, etc.)
  电能供应的可靠性和高质量得到保证（可利用备用电力，调峰等等）

Distributed generation 分散式发电 -2

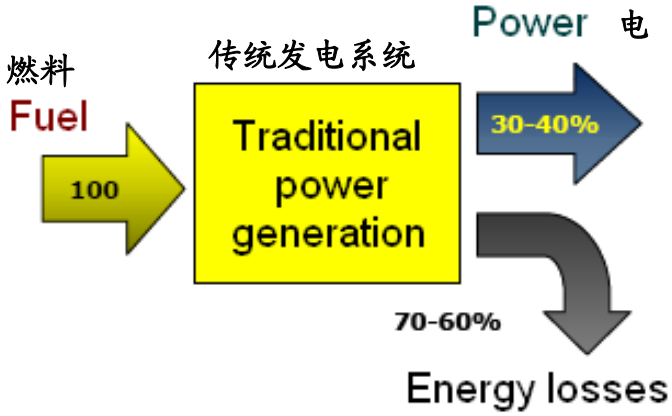
Technological barriers of distributed generation in building
分散式联产在建筑业中应用的技术障碍

- Low electrical efficiency in small size generation units (prime motors, micro-turbines, etc.)
  小型发电单元的低发电效率（原动机和微型涡轮，等等）
- High cost of generation units 高成本发电设备
- Operating life of some technologies tested for limited time (micro-turbines, fuel-cells)
  一些技术的运行期仅经过较短时期的检验（微型涡轮和燃料电池）
- need of electrical grid modification, from passive to active grid
  需要进行电网改造
- technologies not yet commercially available or completive (FC)
  技术尚未商用或不完善

Combined heat & power generation 热电联产 -1

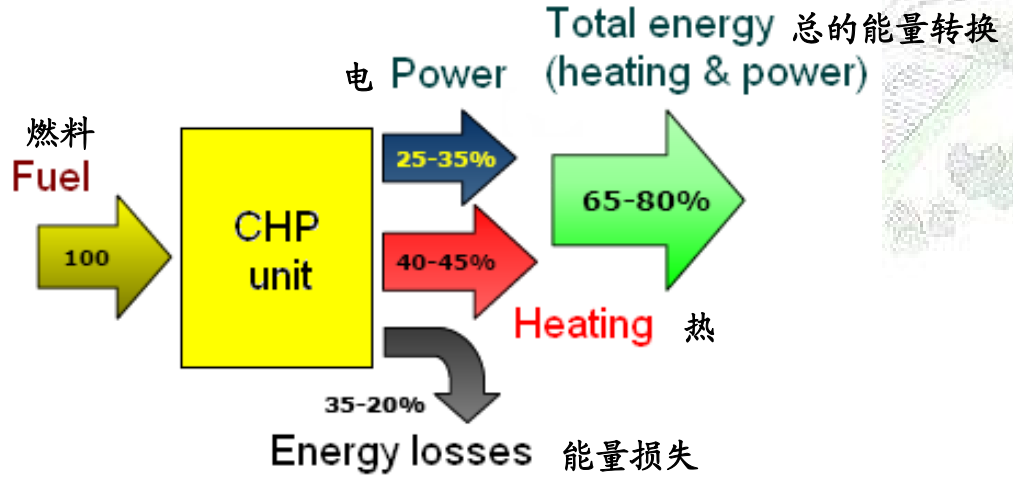
Cogeneration or Combined Heat and Power (CHP) is the simultaneous production of electrical (or mechanical) and thermal energy, from a system using a single fuel source.
热电联产：使用单一燃料的系统同时生产电力（或机械力）和热能

传统系统



Energy efficiency
能源效率

热电联产系统



Combined heat & power generation 热电联产 -2

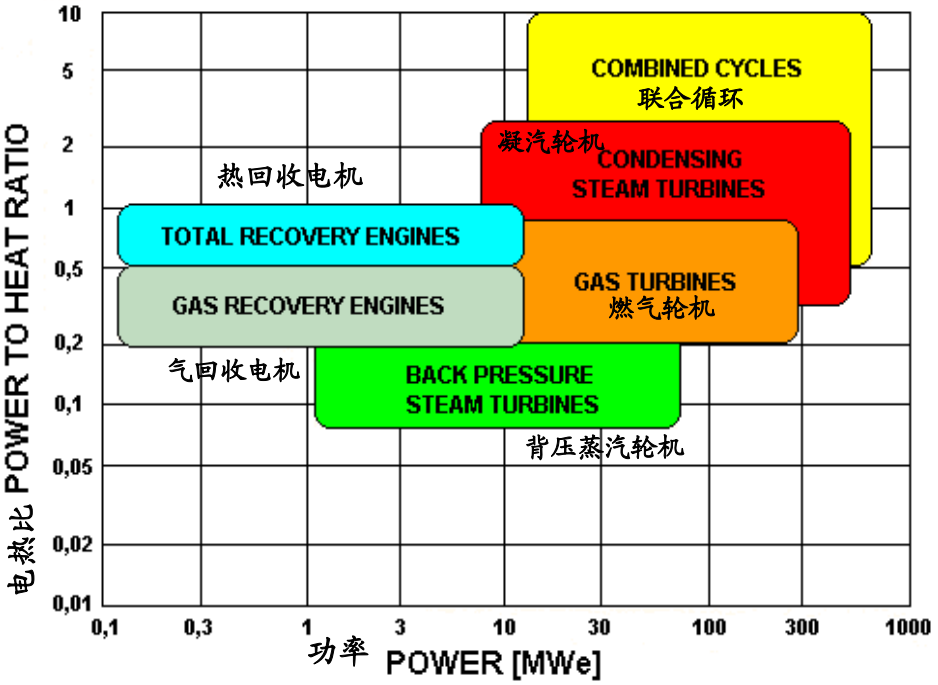
Traditional CHP technologies 传统热电联产技

- reciprocating engines: Diesel & gas (MCI) 往复式内燃机
- gas turbines (TG) 燃气轮机
- steam turbines (TV) 汽轮机
- combined cycles: gas & steam t. (CCC)
- 联合循环：气，汽

New CHP technologies:新型热电联产技术:

- micro-turbines 微型涡轮
- fuel cells (FC) under demonstration and field trials for stationary (residential) applications 示范和试验性固定式（住宅）燃料电池应用
- Stirling engines 斯特林内燃机
- organic Rankine cycle (ORC)有机朗肯循环

Electrical power 发电功率	Technology 技术
P_e < 1 MW	MCI, TG, FC
1 MW < P_e < 10 MW	MCI, TG, TV
P_e > 10 MW	TG, TV, CCC



CHP technologies applications fields
热电联产技术的应用领域
(Source: Libro Bianco sulla cogenerazione – White paper on CHP – ATIG, 1997)
资料来源：热电联产白皮书， ATIG, 1997

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Combined heat & power generation 热电联产 -3

In terms of energy efficiency, when is a (micro) CHP generation system profitable in a building?

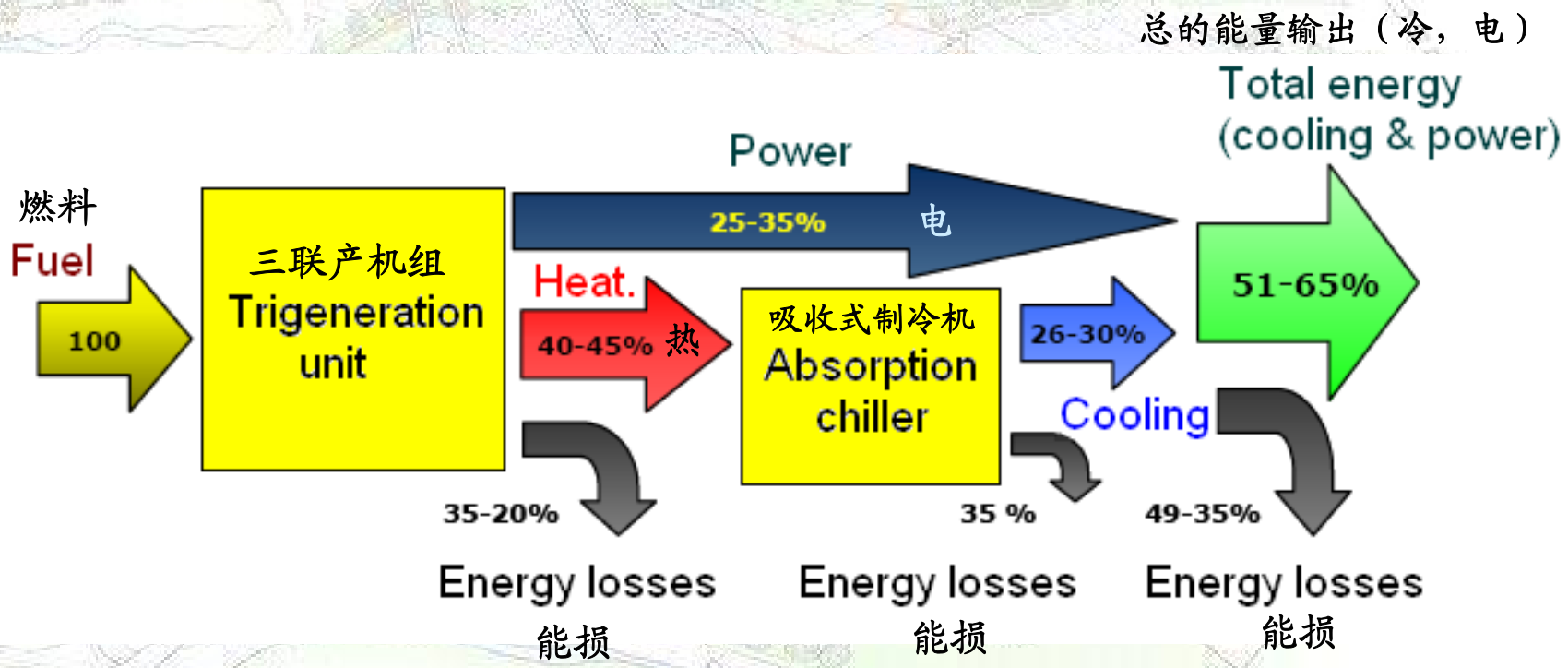
关于能源效率，何时（微型）热电联产系统在建筑业的应用可以有经济效益？

- ✓ Demands for both power and heating (&/or cooling)
  同时存在电和热（或冷）的需求
- ✓ Power to Heat Ratio of CHP generation system is similar to Power load to Heat load Ratio of the end-user
  热电联产系统的电热比与终端拥护的电/热负荷比接近
- ✓ commercial CHP generation units are available in order to optimize energy efficiency by using power units similar to power calculated
  有热电联产商业机型，以便使用相近功率的机组

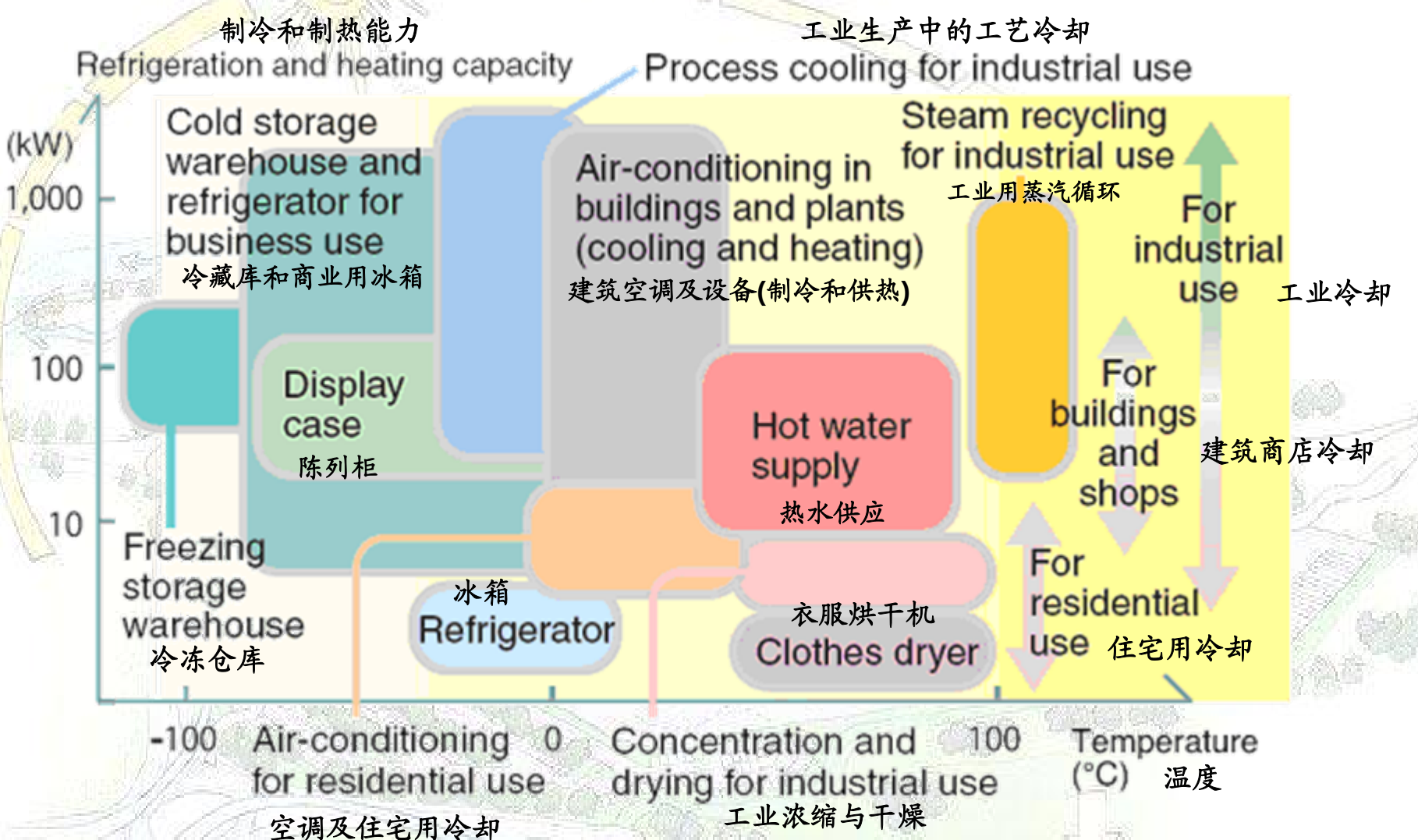
Trigeneration technologies 三联产技术

Trigeneration is the simultaneous production of power (electrical or mechanical), heat and cooling from a system using a single fuel source.

三联产：使用单一燃料的系统同时生产电(或机械力), 热和制冷



Typical cooling-heating technologies 典型的制冷-供热技术



(source: www.hptcj.or.jp)

Cooling technologies combined with CHP
制冷技术与热电联产结合

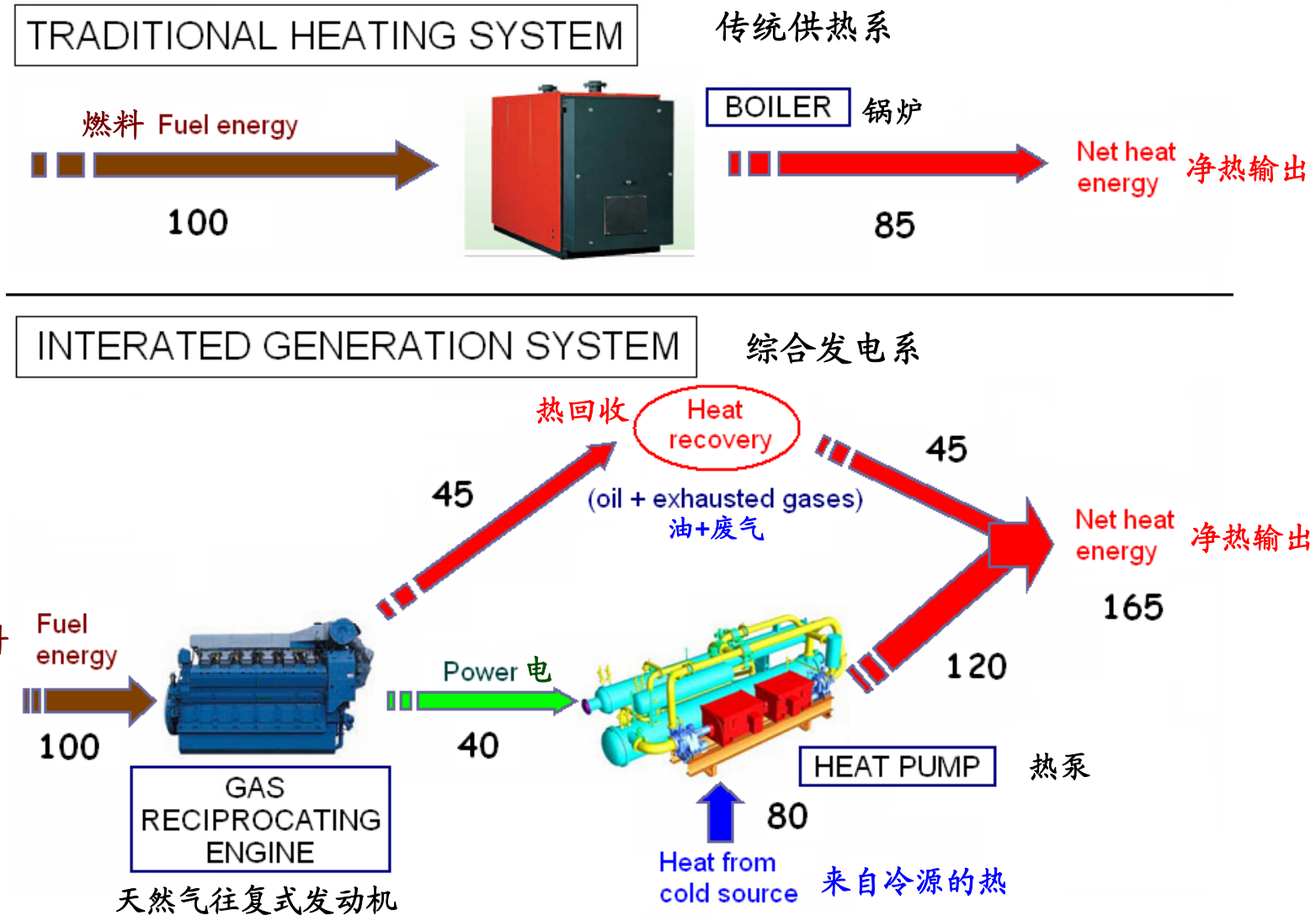
- Absorption chillers: 吸收式制冷机
  - H_2O/LiBr chillers driven by hot water 热水驱动的水/溴化锂制冷机，
  - H_2O/LiBr chillers driven by exhaust gases 废气驱动的水/溴化锂制冷机
  - Ammonia/ H_2O absorption chillers 氨/水吸收式制冷机
- Adsorption chillers 吸附式制冷机

the adsorption chillers are driven by thermal energy (like absorption chillers), but a solid medium works as sorbent instead of a liquid

吸附式制冷机由热能驱动（这一点与吸收式制冷机相同），但是吸收剂是固体而非液体介质

- Desiccant cooling systems 干燥剂制冷系统

Integrated systems 集成系统



谢　谢

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Transparent insulation 透明隔热

Objective of the technology: 技术目标

produce glazing systems transparent to the solar radiation but with high insulation level.

新型玻璃系统，即可全面透入太阳辐射又具有良好的隔热性

Function of the technology: 技术功能

solar gains, building insulation, daylighting, passive and active solar

获取太阳能，建筑隔热，日光照明，被动式和主动式太阳能利用

State of the technology: 技术研发状态

commercial but research still needed

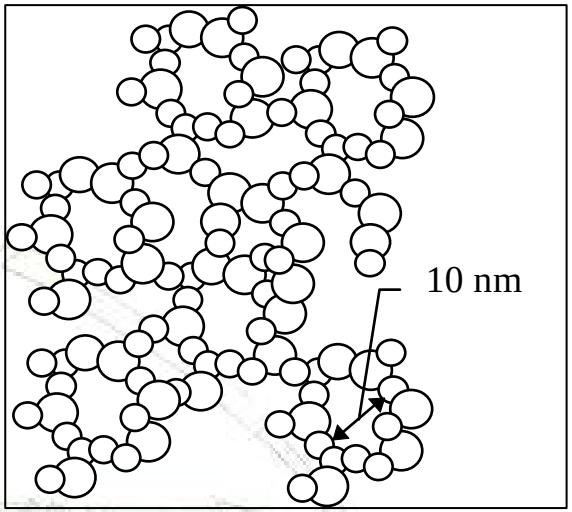
已商用，但仍需进一步研发

Applications: 应用

tertiary and (partly) residential buildings, heating dominated climates, unfavorable orientations (north or shaded facade)

服务业和（部分）住宅建筑，以供暖需求为主的气候条件，不佳的朝向（北向或立面被遮挡）

Aerogel 气凝胶



Aerogels are a class of open celled micro porous solids with a density ranging from 1 to 150 kg/m3 and are typically 90–99.8% air.

气凝胶是一类微观组织开放且含无数微孔的固体，密度范围在1到150 kg/m3之间，通常含90-99.8％的空气。

They can be formed from a variety of materials including Silica (by far the most used), alumina, transition and lanthanide metal oxides, organic and inorganic polymers and carbon.

他们可采用各种材料来制成，包括硅 (迄今为止最常用的)，氧化铝，过渡和镧系金属氧化物，有机和无机高分子材料和碳.

Aerogel, as an insulation material was originally developed for military application and is the lowest density solid known, often called solid air.

气凝胶，作为绝缘材料的开发原本是为了在军事上的应用，是众所周知的密度最低的固体，通常被称为固体空气

The thermal conductivity is 15-20 mW/ m K at atmospheric pressure. The air encapsulated in porous structure remains. The thermal exchange is by conduction and, in small part, radiation.

在大气压下的热导率是15-20毫瓦/米k; 空气包覆在多孔性结构中。热交换通过传导和小区域辐射进行

Aerogel 气凝胶

The dimension of the porous is lower than visible wavelength hence it is possible to view though with minor chromatic distortion.
孔的大小多低于可见光的波长，因而所观景物有可能略带轻微色失真.

Aerogel can be monolithic (a real aerogel *brick*) or granular (few millimeters aergel balls assembled together in a pane). The latter does not permit the vision through, since the little balls cause the scattering of the light.
气凝胶可单片（一个真正的气凝胶砖）或颗粒（几毫米直径的气凝胶球组装在同一个窗格). 后者因小球散射光作用而呈不透明状态。

Excellent thermal, solar, and luminous properties, as an example a 25 mm granular pane has:
优异的隔热，隔太阳能和遮光特性，例如， 一块 25毫米厚的颗粒窗板具有:

U = 0.57 $W/m^2 K$

g = 0.43

t_V = 0.45

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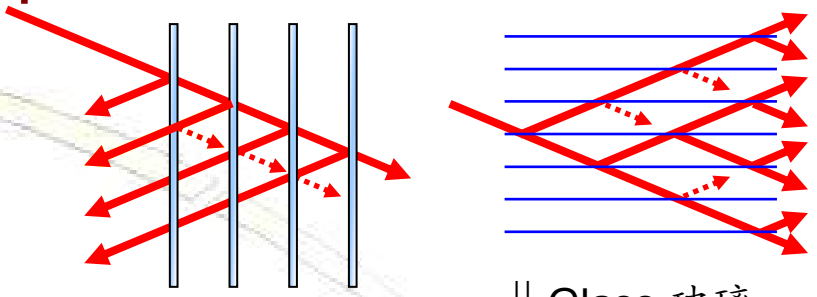
Geometric media 几何介质 -1

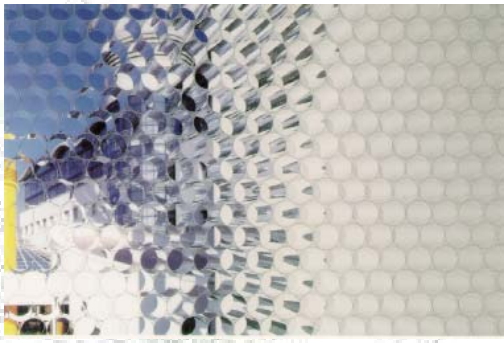
Production of geometric structures of various materials (polycarbonate, PMMA(Polymethilmetacrylate), glass - still research): honeycomb, capillary, small cylinder with different section geometries.
生产各种材料的几何结构（聚碳酸酯，聚甲基丙烯酸甲酯，玻璃，仍处研究状态）：蜂窝，毛细管，具有不同几何区的小柱体。

The product is a compact element to be placed in the gap of a glazing unit, improving its thermal properties, by radiant and convection reduced losses.
该类产品通常是一个紧凑的元素，被放置在两块玻璃板的空隙内，通过辐射和对流而改善玻璃的隔热性能，减少损失。

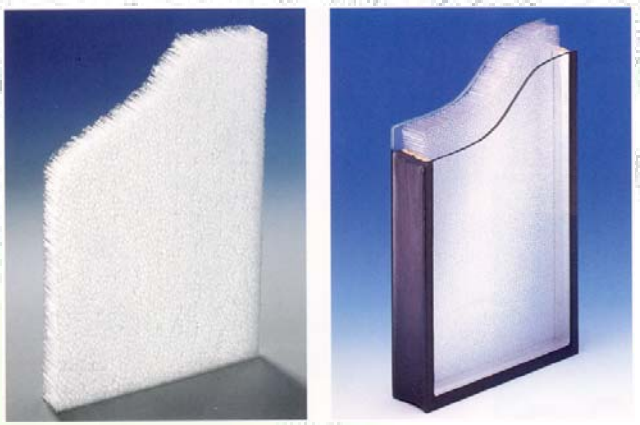
The plastic sheet, the structure is made of, has an almost negligible solar absorption: the solar radiation impinging the surface passes through units by direct transmission or successive reflections, see figure in the right high corner.
该类塑料片材的太阳吸收几乎可以被忽略：辐射到表面上的太阳受到每个单元的直接传送或连续反射，见右图。



⇓ Glass 玻璃



Polycarbonate 聚碳酸酯



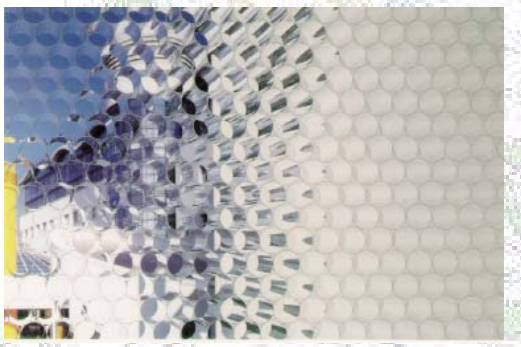
Geometric media 几何介质 -2

The thickness of the geometric element is several centimeters (generally from 3 to more than 10 centimeters) and it influences the insulation level: the thicker it is, the lower the U-value.

几何元件的厚度为几个厘米**(**一般由3至10多个厘米**),** 对绝缘水平的影响为：越厚**U**值越低。

These products give the conventional glazing units U-values by far lower than 1 W/m^2 K, while solar and luminous transmittance are not significantly affected (above 0.7).

这些产品的**U**值远远低于1 W/m^2**K**，而对阳光和发光透过率没有显着影响**(**0.7以上**).**



Glass 玻璃

Polycarbonate 聚碳酸酯

Electrochromic glazing systems
电致变色玻璃

Objective of the technology 技术目标:
produce glazing systems able to switch their colour and optical/solar properties as a function of a small voltage potential.
生产可以随着(小)电压变化而变换颜色和光性能的玻璃

Function of the technology 技术功用:
dynamic solar control, daylighting, visual and thermal comfort.
动态太阳控制，日光照明，视觉和热觉舒适度

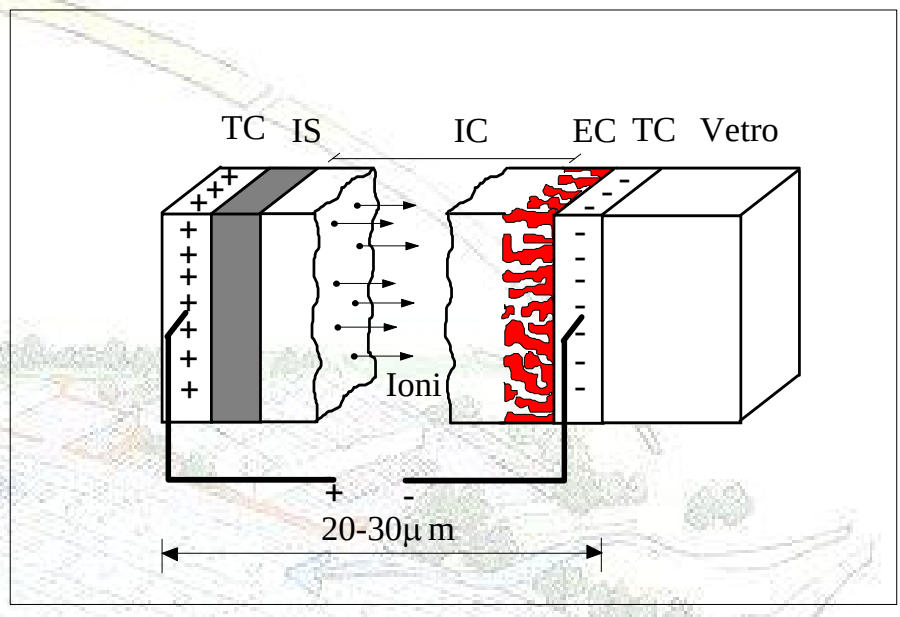
State of the technology 技术研发状况:
commercial but lot of research still needed
已商用，但仍需大量研究

Applications 应用:
tertiary and buildings, all climates (excluded very cold ones), un-shaded facades
服务业和建筑，适用于所有的气候条件（除了极冷气候），未被遮挡的立面）

Electrochromic glazing systems 电致变色玻璃

How it works: when a few volt potential is applied between the transparent conductor sheets (TC), part of the ions in the ion storage layer (IS) pass through the separation zone (IC) and reach the electrochromic layer (EC) where a chemical reaction causes the colour change.

工作原理：当一定伏特的电压施加在透明导体板**(TC)**之间时，离子储存层（**IS**）的部分离子通过分离区**(IC)**并达到电致变色层**(EC)**，在电致变色层内因化学反应导致颜色变化。



Several chemical elements can be used in process, W is generally used. Inverting the voltage, the process is inverted too.

不同的化学元素可用来产生电致变色，普遍采用钨**(W)**。倒施电压，过程将随之倒转。

Very complex technology: 5 layers to be deposited in few hundred microns total thickness.

非常复杂的技术：**5**层必须叠放在总厚度为几百个微米的导体板中。

Solar filter glazing units 太阳过滤玻璃

Objective of the technology 技术目标:
produce static glazing systems with high insulation level and advanced solar control
生产具有高隔热水平和先进太阳控制性的玻璃系统

Function of the technology 技术功用:
solar control, building insulation
太阳控制, 建筑隔热

State of the technology 目前的技术状态:
commercial
商用

Applications 应用:
tertiary and residential buildings, mild climates (where cooling and heating demand are significant)
服务业和住宅建筑, 适用温带地区 (制冷和供暖需求都比较大)

Solar filter glazing units 太阳过滤玻璃

Special low-e coating cut all the transmitted component of the solar radiation but the part falling into the visible range of the solar spectrum. The double silver layer is the most used solar filter.

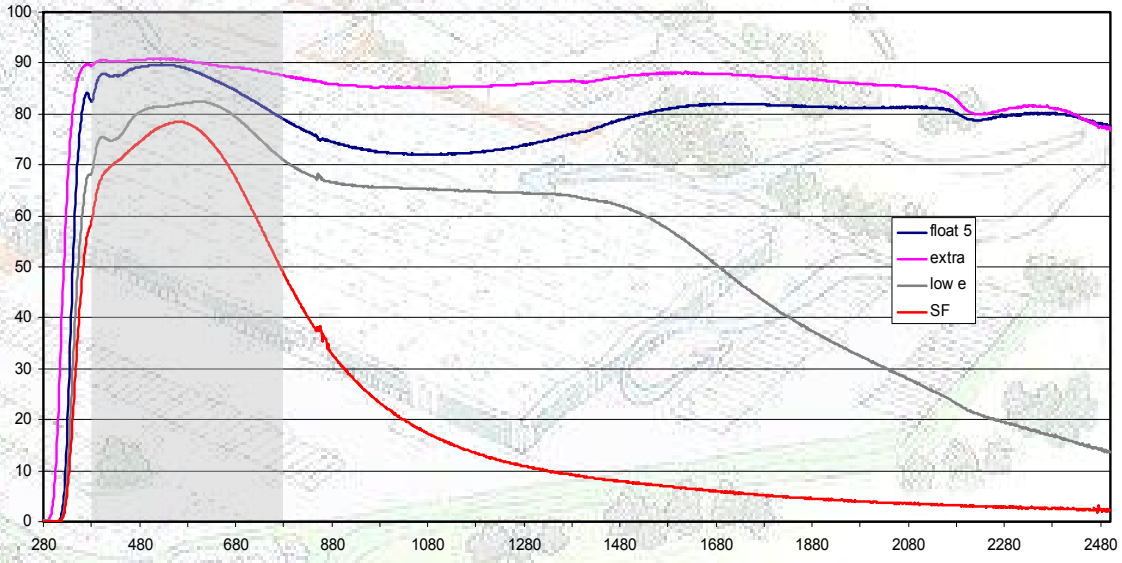
特殊的**e-**涂料可将大部分太阳辐射过滤掉，只有部分落入太阳光谱的可见区。

双银层是最常用的太阳光过滤器。

The advantage is an high performing glazing unit with high luminous transmittance and low solar factor and thermal losses coefficient.

太阳过滤玻璃的优点是光透射率高而太阳因子低，热损失系数小。

Glazing unit (4-12-4)	t_v	g	Uc
Double glazing unit (DGU)	0.81	0.76	2.9
DGU low-e	0.80	0.75	1.8
DGU solar control	0.40	0.40	2.9
DGU solar filter	0.70	0.40	1.8



Reduced U value is the advantage respect to the old solar control glazing units.

与老的太阳控制玻璃装置相比， **U** 值低是太阳过滤玻璃的优势。

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Cool materials and coatings 冷材料和涂膜

Objective of the technology 技术目标:

produce opaque envelope components with high solar reflectance to reduce cooling demand and urban heat island effect

生产不透明的,具有高太阳反射度的立面部件，以减少制冷需求和城市的热岛效应

Function of the technology 技术功用:

solar control, thermal comfort

太阳控制, 热舒适性

State of the technology 目前的技术状态:

commercial but research needed

已商用,但仍需研究

Applications 应用:

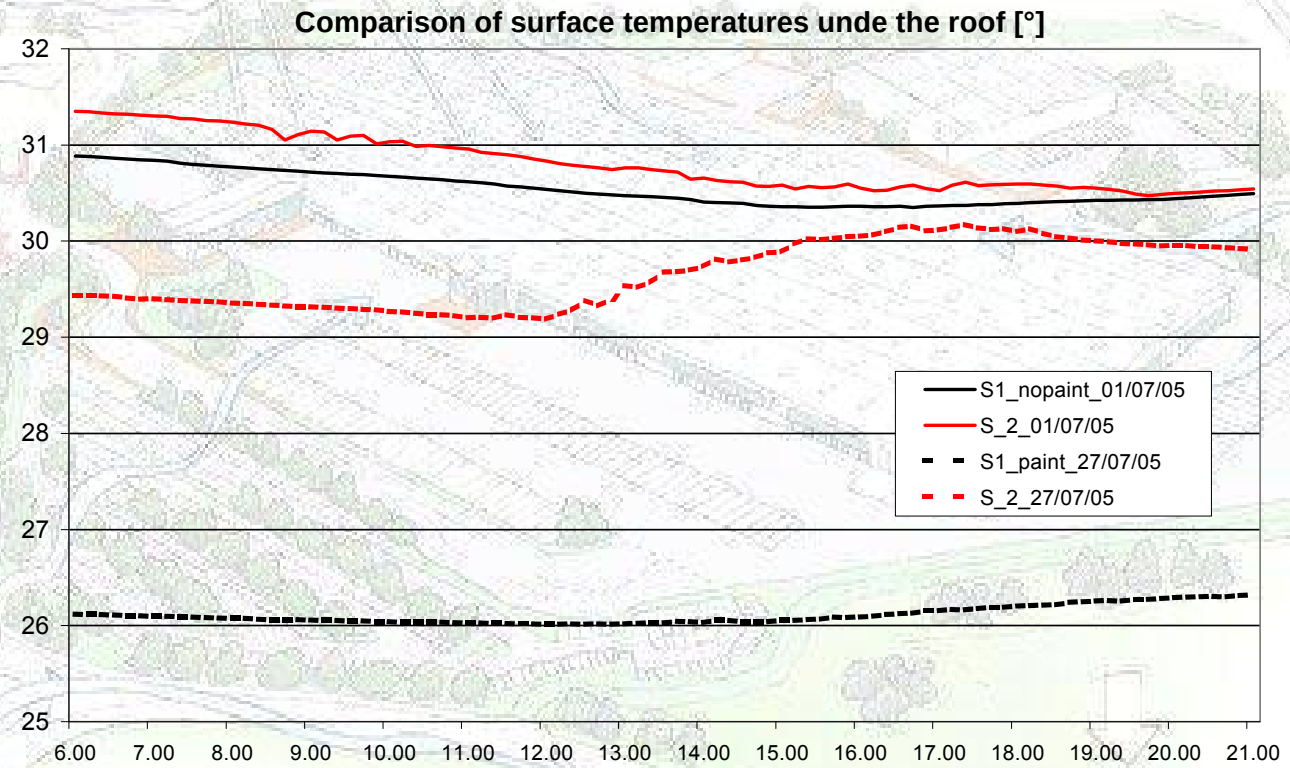
tertiary and residential buildings, mild climates (where cooling demand is significant), urban area affected by heat island effect

服务业和住宅建筑,适用温带气候区域 (制冷和供暖需求都比较大)，以及受热岛效应影响的城市区域

Cool materials and coatings 冷材料和涂膜 -1

The effect of solar radiation absorbed by the opaque envelope, especially the roof, on the cooling loads of building is not negligible. Left figure show how different is the surface temperature on the ceiling when a clay tiles roof is coloured with a reflective paint.

不透明立面结构，特别是屋顶，吸收的太阳辐射对建筑制冷负荷的影响是不可忽略的。图中显示了黏土瓦屋顶涂上反光涂料后天花板表面温度的差异。



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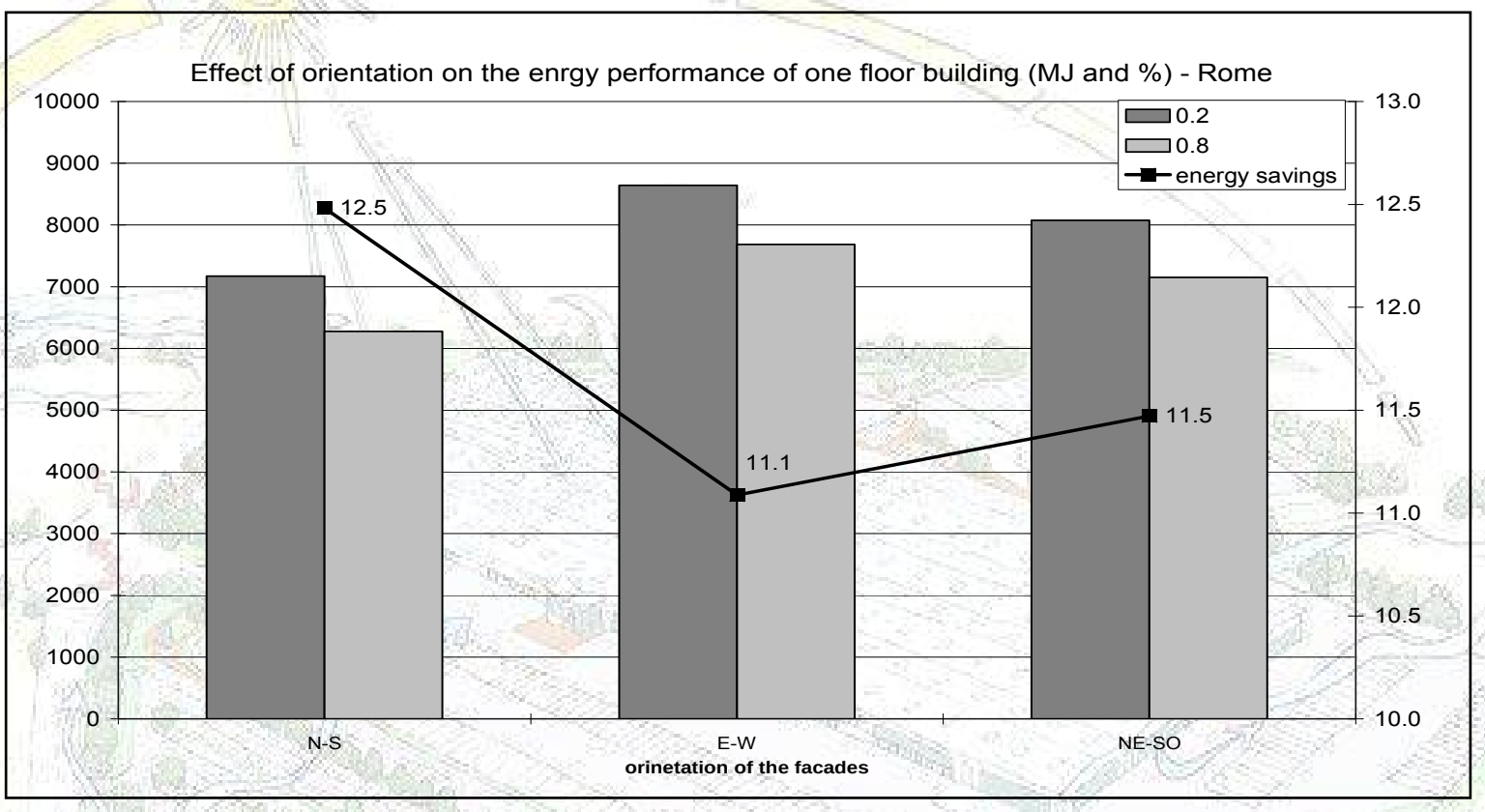
Cool materials and coatings 冷材料和涂膜 -2



The effect in terms of energy consumption is in the figure below, showing the reduction in total primary energy in a history office building in Rome when the roof reflectance passes from 0.2 to 0.8

对能耗的影响见上图。图中表明当屋顶反射度从**0.2**变化到**0.8**时，罗马的一个古老办公建筑的一次能源消费量减少情况。

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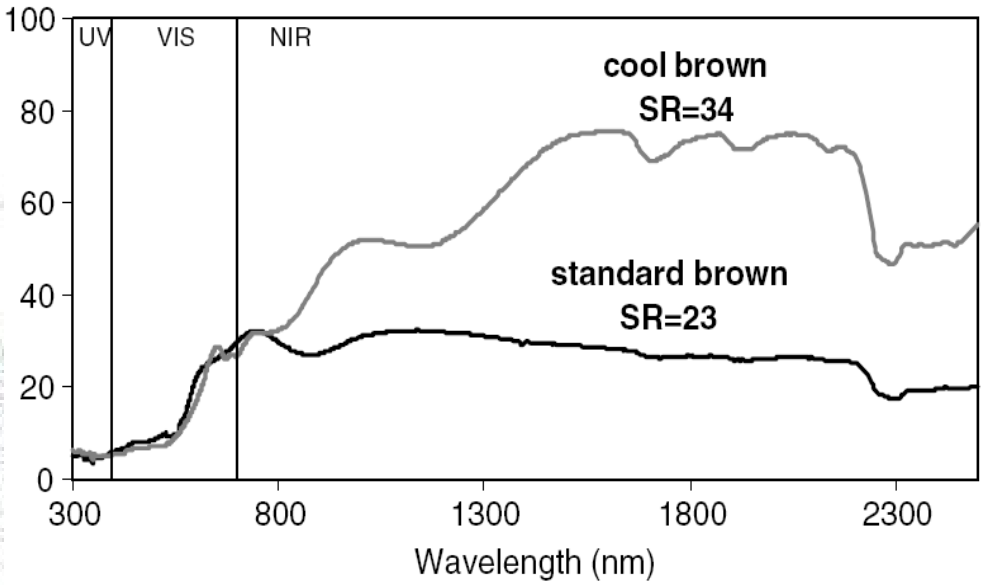
SIXTH FRAMEWORK PROGRAMME

Cool materials and coatings 冷材料和涂膜 -3

Cool materials can be: plasters, paints, membranes, plastic sheets and so on.
冷材料可以是：石膏，涂料，膜，塑料片，等等
Beside white coating, also coloured materials are used:
除了白色涂层外，也可以使用彩色材料



- High reflectance can be achieved with natural light pigments, even if some additional durability issues are needed.
  可采用天然的光亮颜色获得高反光度的材料，但有可能需解决提高耐久性的问题。
- Cool pigments can be also used. They increase the solar reflectance in the near infrared respect to normal pigments. See the comparison between two browns.
  可使用冷颜料，与常规颜色相比这些冷颜料在近红外区的阳光反射度增加，见上图的比较结果。
- Chromogenic cool materials are in the research phase up to now.
  目前显色冷材料正处在研究阶段

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Cooling technologies 制冷技术 -1

- Absorption chillers 吸收式制冷机
  - H_2O/LiBr chillers driven by hot water 热水驱动的水/溴化锂制冷机
  - H_2O/LiBr chillers driven by exhaust gases 废气驱动的水/溴化锂制冷机
  - Ammonia/ H_2O absorption chillers 氨/水吸收式制冷机
- Adsorption chillers 吸附式制冷机

the adsorption chillers are driven by thermal energy (like absorption chillers), but a solid medium works as sorbent instead of a liquid

吸附式制冷机由热能驱动（这一点与吸收式制冷机相同），但是吸收剂是固体而非液体介质

- Desiccant cooling systems 干燥剂制冷系统

Cooling technologies 制冷技术 -2

Process 工作方式	Closed cycles Chilled water Production 封闭式循环系统生产冻水		Open Cycles Air Conditioning 开放式循环系统用于空调	
Type Sorbens 吸附剂	Solid 固体	Liquid 液体	Solid 固体	Liquid 液体
				
Typical material 典型的吸附材料	Water/silica-gel Ammonia-salt	Water/LiBr Ammonia/Water	Water/silca-gel Zeolithe	Water(calciumchloride Water - Lithumcloride
Available technology 目前的技术	Adsorption Chiller	Absorption Chiller	DEC System	coming soon
Available capacity 可达的功率	50 – 430 kW	35 – 5,000 kW	20 – 350 kW	-
Manufacturer 制造商	2 jap. Man.	USA, Asia (only few with small cap.)	~ 5 Rotor Manuf. many units	1 german
COP 性能参数	0.3 – 0.7	0.6 – 0.75 (single eff.) <1.2 (double eff.)	0.5 up to >1	up to >1
Typical Temperature 典型温度	60 – 95°C	80 – 110°C (single) 130 – 160°C (double)	45 – 95°C	45 – 70°C

(信息来源 source: Alberto Coronas - CREVER)

Desiccant cooling 干燥剂制冷 -1

Basically, desiccant cooling systems are open cycle systems for cooling interior air by removing the humidity using a rotating dehumidification wheel and a solid sorbent.

从原理上讲，干燥剂制冷系统一般是开放式循环系统，通过使用固体吸附剂和转轮除湿机除湿制冷

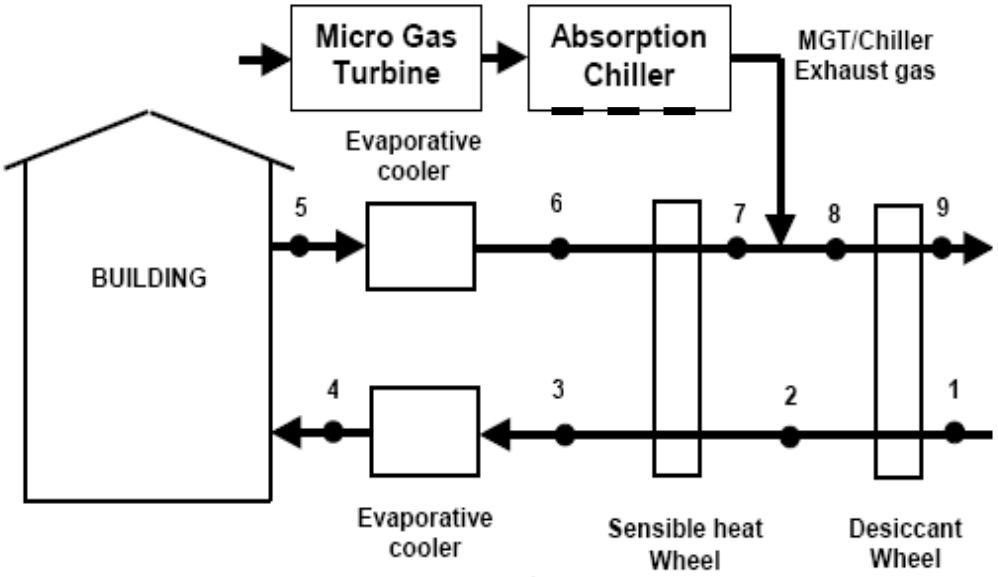
(信息来源 source: Alberto Coronas - CREVER)

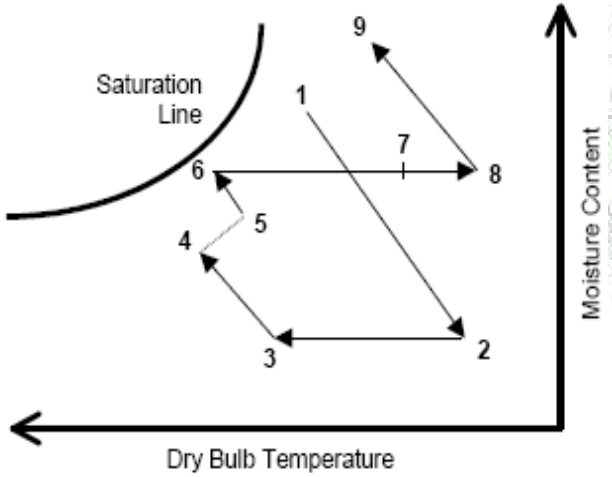
Desiccant cooling 干燥剂制冷 -2

In residential sector, desiccant is being explored in conjunction with energy recovery ventilation, by using of ventilators. The energy recovery ventilator (ERV) is designed to provide energy recovery in a mechanical ventilation system during the heating season. ERV systems recover heat and humidity from indoor air to preheat and humidify incoming fresh air. Desiccant cooling is designed to dehumidify incoming fresh air in the summer.

Desiccant cooling systems can be also driven by solar thermal heat or other heat sources, like recovery from exhaust gas.

目前在住宅建筑领域中干燥剂的采用常与通风设备的能源回收相结合。能源回收通风设备 (ERV)的设计是为了在供暖季节能将在机械通风系统所回收的能量进行供暖。 ERV系统回收的热和室内空气的湿度，以预热和湿润由室外进入的新鲜空气。除湿冷却设计则为了在夏季将由室外进入的新鲜空气除湿。除湿冷却系统，也可以用太阳能或其他热源驱动，如烟气中回收的热。





(信息来源 source: Alberto Coronas - CREVER)