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**Briefing Paper**

# China – Sustainability Credentials & Economic Rate of Return at SISSC Marina – 'BREEAM Excellent'

# 中国 --上海国际航运服务中心 "BREEAM 优秀" 建筑的可持续发展资质和经济回报率

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## Introduction

Shanghai International Shipping Service Center's (SISSC) development on the Huangpu River in Shanghai aims to set a new standard in China for green, low carbon, smart and highly efficient buildings. The development has pioneered the use of BREEAM[1], the world's leading design and assessment method for sustainable buildings, in the Chinese market in order to achieve these aspirations. The development includes the first building in China to achieve BREEAM certification at both design and post construction stages. This office building, known as Building 17, is formed of twin towers comprising 13 floors (including 3 floors underground) and has a total floor area of approximately 25,000 $m^2$ (Figure 1 and Figure 2). It achieved a BREEAM 'Very Good' (three stars) rating at the design stage assessment, and an 'Excellent' (four stars) rating at the post construction stage assessment. This case study paper provides an overview of how BREEAM was used to increase the sustainability benefits and value of Building 17.

## 介绍

位于黄浦江畔的上海国际航运服务中心（SISSC）项目，致力于在国内树立绿色、低碳、智能及高效建筑的新标杆。为在中国市场实现这些目标，该项目率先在中国使用了英国建筑研究院环境评估方法BREEAM1,这项世界级领先的建筑设计评估方法。在这个开发项目中包含了达到了中国第一个同时完成BREEAM设计和竣工阶段认证的建筑。 17号办公楼，由双塔组成共13层（含地下3层），总建筑面积约25, 000平方米（见图1和图2），达到了BREEAM设计阶段 "很好"（三星级），以及竣工阶段 "优秀"（四星级）。本文概述了BREEAM如何提高了17号楼可持续发展的益处和价值。

Figure 1 Harbour side view of Building 17,
17号楼港口侧外观

1 BREEAM is an internationally recognised measure and mark of a building's sustainable qualities. Since its launch in 1990 by the UK's BRE (Building Research Establishment), BREEAM has certified over 500,000 buildings and is now active in more than 70 countries around the world. Wherever they are, these buildings are immediately identifiable as having been planned, designed, constructed and operated in accordance with best practice sustainability principles. BREEAM works to raise awareness amongst owners, occupants, designers and operators of the benefits of taking a life cycle approach to sustainability. It also helps them to successfully and cost-effectively adopt solutions, and facilitates market recognition of their achievements. Using independent, licensed assessors, BREEAM examines scientifically based criteria covering a range of issues in sections that evaluate energy and water use, health and wellbeing, pollution, transport, materials, waste, land use, ecology and management processes. Buildings are rated and certified on a scale of 'Pass', 'Good', 'Very Good', 'Excellent' and 'Outstanding'.

1 英国建筑研究院环境评估方法是国际公认的建筑可持续性评价标准。自1990年由英国建筑研究院推出以来， 英国建筑研究院环境评估方法已经认证超过五十万的建筑，现在在全球70多个国家都有项目。无论在哪里，这些建筑在规划、设计和建造期间是根据最佳实践可持续发展的原则运作，非常容易识别。 英国建筑研究院环境评估方法致力于提高业主、住户、设计师和运营商的认识，并采取生命周期的方法提高可持续发展。这也帮助他们采用经济并有效的解决方案，并有利于市场认同他们的成就。英国建筑研究院环境评估方法雇佣独立的、有资格证的评估师，采用以科学为基础的标准，对一系列问题进行评价，包括评价能源和水的使用、健康与舒适、污染、交通运输、材料、垃圾、土地利用、生态和管理流程等。建筑评估等级分为 "及格"、"好"、"很好"、"优秀" 和 "杰出"。

Figure 2 Atrium of building 17
17号楼中庭

The BREEAM principles and methodology align closely with the Chinese Government's policy for green buildings, which promotes sustainability through the efficient use of energy, water, land and materials. Using BREEAM as a design tool, Building 17 has been designed and built to high sustainability performance levels that go beyond current Shanghai and Chinese standards and practices, and has involved the use of a number of state-of-the-art technologies, features and processes. Consequently, Building 17 has achieved the highly regarded BREEAM 'Excellent' rating at the post construction assessment stage, representing performance equivalent to that of the top 10% of new buildings internationally. The following points highlight some examples of where Building 17 has demonstrated best practice in terms of the BREEAM performance requirements and therefore exceeded current Chinese standards.

BREEAM的原则和方法与中国政府的绿色建筑政策保持紧密一致，后者通过有效地利用能源、水、土地和材料促进可持续发展。17号楼使用BREEAM作为设计工具，其设计和建造的可持续性性能达到了高水平，包括采用一些最先进的技术、设备和流程，超越了目前上海乃至中国的标准和惯例。因此，17号楼在竣工评估阶段取得了BREEAM性能表现“优秀”评级，性能表现等同于排名前10%的国际新建建筑。以下内容表明：17号楼按照BREEAM性能的要求，展示出了最佳的性能表现，优于中国的现行标准。

## Energy efficient design

In terms of energy efficiency, Building 17 has achieved a BREEAM 'Outstanding' level of performance, as energy modelling has demonstrated significant improvement over the local building regulations in terms of the building's energy demand, primary energy consumption and associated carbon dioxide emissions. This has been realised by the following design features and technologies:

- A highly insulated building fabric, including the use of low-e glass windows and curtain walls, aluminium anti-thermal bridge windows and inflatable ETFE atrium roof.
- A mixed-mode ventilation system, which maximises the use of natural ventilation during spring and autumn through the exploitation of local wind flows and the stack effect by taking advantage of the site's relatively open riverside setting and prevailing wind directions.
- Connection to a highly efficient district heating and cooling system that is based on a river water source heat pump and ice storage.
- An energy efficient lighting system that maximises the use of daylight through the glass curtain walling and ETFE atrium roof, as well as incorporating sensors to control lighting throughout the building, LED lighting in stairwells and external areas, and light tubes in underground areas.

## Water efficient design

In terms of water consumption, Building 17 has demonstrated a 73% improvement against the BREEAM baseline water consumption performance standard, which meets the minimum performance requirements for a BREEAM 'Outstanding' rating. This has been realised through the specification of water efficient appliances and fittings (e.g. waterless urinals, dual flush toilets, low flow taps) and connection to the site-wide rainwater and greywater storage system, which has been modelled to meet all of the building's WC flushing water demand.

## Low environmental impact materials

The specification of construction materials in Building 17 was informed through the use of a robust tool that assessed the life cycle environmental impact of the various building elements, in accordance with the BREEAM requirements for materials. This led to the specification of materials with a low environmental impact, including a specific focus on materials with a low embodied carbon[1], which makes the building an exemplar low embodied carbon case study in China.

## Construction resource efficiency

By following the BREEAM requirements for construction resource efficiency, the construction waste management plans and procedures implemented by the principal contractor for the project went significantly beyond current Chinese standards. These included setting up dedicated waste recycling locations across the site and all contractors monitoring their construction waste. The plans and procedures ensured that 95% of construction waste generated by the project was diverted from landfill, which ensured the project met the exemplary level BREEAM performance requirements for this issue.

## 节能设计

在能效方面，17号楼取得了BREEAM性能表现 "杰出" 评级。能源模拟证明无论在建筑能源需求、一次能源消费还是相关二氧化碳排放量方面都优于当地建筑法规。17号楼采用的设计特征和技术 包括：

- 高性能建筑围护结构，包括断桥铝合金低辐射中空玻璃幕墙及充气四氟乙烯（ETFE）中庭屋顶。
- 混合模式通风系统，最大程度的在春季和秋季利用自然通风，充分利用当地主导风向和烟囱效应，并利用该项目相对开放的、河边的优势和盛行风的方向。
- 基于江水源热泵和冰蓄冷的高效区域供热和制冷系统。
- 高效节能照明系统，最大限度地利用日光透过玻璃幕墙和四氟乙烯（ETFE）中庭屋顶，以及使用传感器控制整个楼宇照明，楼梯间和外部区域的LED照明以及导光管在地下区域的照明。

## 节水设计

基于BREEAM基准用水量的性能标准，17号楼水资源利用率提升了73%，满足了BREEAM性能表现 "杰出" 评级的性能要求。17号楼不仅使用了节水器具和配件（如无水小便器，双冲水马桶，低流量水龙头），还加入了整个项目雨水和中水储存系统网络，能满足所有卫生间的冲洗用水需要。

## 低环境影响材料

17号楼使用的建筑材料采用建筑材料全生命周期工具对建筑材料的环境影响进行了评定，与BREEAM对材料的要求一致。这促使项目采用低环境影响的建筑材料，并侧重于材料的低隐含碳，这对中国的建筑市场具有标志性的意义。

## 建设资源效率

主要承包商对建筑垃圾管理计划和流程的实施遵循BREEAM对建设资源效率的要求，这远远高于于现行中国标准。这包括建立整个项目的专用废物回收地点和监督所有承包商的建筑垃圾。这些计划和流程确保95%的项目产生的建筑垃圾不再进入垃圾填埋场，保证了项目在这一问题上满足BREEAM性能要求的示范水平。

1 Embodied carbon is a measure of the carbon emissions associated with the materials used in the construction of the building, which includes the total carbon emitted in relation to sourcing and processing of raw materials, the manufacturing process, transportation, and assembly on site to form the building.

隐含碳是衡量建筑物中使用的材料相关的碳排放量，其中包括采购和处理原材料、制造过程中、运输以及在工地上装配以形成建筑的总碳排放量。

## Healthy indoor environment

The specification of building materials with low emissions of formaldehyde and volatile organic compound (VOC) was a key aspect of the materials selection that was informed by BREEAM requirements. Post construction indoor air testing for formaldehyde and VOC was performed and the results complied with the internationally recognised best practice health guidelines specified in BREEAM. The building also met the BREEAM health and wellbeing requirements for visual comfort (daylighting, glare control, external views, and lighting levels and controls), thermal comfort (thermal modelling and temperature control) and acoustic performance (indoor noise levels and sound insulation), which all involve compliance with international standards and best practice.

## Construction management improvements

Following the design stage assessment a number of management related issues were identified that could improve the BREEAM rating and construction process at low or zero cost. This led to the implementation of integrated design process principles (e.g. enhanced collaboration between the client, design team and contractor; a schedule of training for building occupants and facilities managers) and the commissioning of all building services. Such measures will help to ensure that the building's operational performance is in accordance with the design expectations.

## Savings and payback

Achieving these higher levels of sustainability has incurred some additional capital costs compared to standard Chinese approaches (see Table 1). The investment in sustainability technologies represents an uplift of less than 5% of the total capital cost for the project. Analysis has shown that the additional capital cost of the energy efficiency features will payback in under 7 years. This is based on an electricity price of 1.05 CNY per kWh and a modelled 79 kWh per $m^2$ per year primary energy consumption saving compared to local building regulations requirements. In addition the water efficiency features will payback in approximately 6 years. This is based on water price of 5.0 CNY per $m^3$ and a saving of 33,600 $m^3$ per year compared to the design standards of 50 litres per person per day for offices and 8 litres per $m^2$ per day for businesses as stipulated in GB 50015-2003 'Code for design of building water supply and drainage'. Figure 1 shows the savings and payback that the investment in the energy and water saving technologies will generate over the first 15 years of the building. Experience in other countries in implementing BREEAM has shown that uplifts in capital costs usually drop significantly with increased understanding and economies of scale.

## 健康的室内环境

选择甲醛和挥发性有机化合物（VOC）排放量低的建材是BREEAM要求中的一个重要方面。竣工后室内空气甲醛和挥发性有机化合物（VOC）的检测结果符合BREEAM国际公认的最佳实践的健康指标。该大楼还达到了BREEAM健康与舒适要求中对视觉舒适度（日光、眩光控制、外部景观、照明水平和控制），热舒适性（热模型和温度控制）和声学舒适度（室内噪音水平和良好的绝缘）的要求，这都符合国际标准和最佳实践。

## 建设管理改进

继设计阶段评估之后，在低成本或零成本的情况下，改进了一些管理的相关问题并提高了BREEAM等级和施工工艺，促进了一体化设计过程原则的实施（加强客户、设计团队和承包商之间的合作；建立培训建筑使用者和设施管理人员的计划），以及建筑设备系统调试。这些措施将有助于确保建筑的运营情况，并达到设计预期效果。

## 节约和投资回报

达到更高水准的可持续发展设计 所需要的资金成本比使用中国当地标准设计的成本费用略高 （见表一）。此项目的资金成本分析表明，采用可持续发展技术的花费仅占小于5%投资总数。通过进一步的分析表明，这些能效功能附加的资本成本回收期不到7年， 这是以1.05元/千瓦时的电价和当地建筑法规要求的79千瓦时/平方米/年 为基准的一次能源消费可节省的费用。此外，提高用水效率设备的投资回收期约6年， 这是基于水价5.0元/立方米，相对于并采用 “建筑给水排水设计规范” GB 50015-2003 条款规定中的办公室里每人每天50升水 ，商业建筑每平方米每天8升水节省33,600立方米/年来计算的。图表一显示了水资源和能源绩效在新近的15年建筑物使用寿命中的节约和投资回报。其他国家运用BREEAM的经验表明，增量成本通常随社会认同的增加和经济规模的扩大而显著下降。

Figure 1: Savings and payback of energy and water saving technologies 表一： 水资源和能源的节省和投资回报

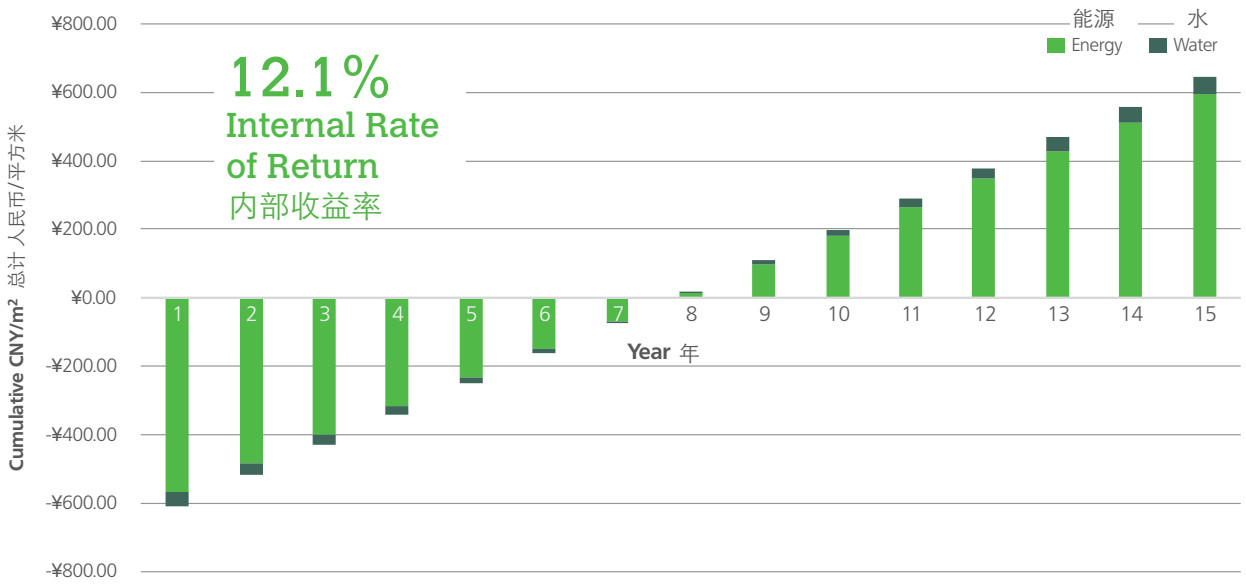

**Table 1: Capital cost analysis**

| Sustainability technologies used in Building 17 | Investment for standard Chinese technology (CNY/m$^2$) | Investment for Building 17 technology (CNY/m$^2$) | Capital Uplift for Building Technologies only (CNY/m$^2$) | Uplift to total capital costs of Building 17 |
|---|---|---|---|---|
| Energy sub-metering | 28.55 | 95.15 | 66.6 | 0.24% |
| River water source heat pump* | 1.85 | 4.87 | 3.02 | 0.01% |
| Ice storage cooling system* | 0 | 83.96 | 83.96 | 0.31% |
| Energy efficient lighting | 25.00 | 42.97 | 17.97 | 0.07% |
| Energy efficient lighting control systems | 13.50 | 32.20 | 18.7 | 0.07% |
| External shading system | 140.00 | 190.00 | 50 | 0.18% |
| Sun pipe/light tube system | 0 | 12.67 | 12.67 | 0.05% |
| Low-e glass and aluminium anti-thermal bridge windows | 73.33 | 138.70 | 65.37 | 0.24% |
| Low-e glass curtain wall | 0 | 48.00 | 48 | 0.18% |
| Inflatable ETFE atrium roof | 11.00 | 28.13 | 17.13 | 0.06% |
| Highly insulated external wall | 48.00 | 97.00 | 49 | 0.18% |
| Exhaust heat recovery system* | 0 | 133.42 | 133.42 | 0.49% |
| Water efficient appliances | 12.96 | 16.00 | 3.04 | 0.01% |
| Rainwater harvesting system* | 0 | 15.16 | 15.16 | 0.06% |
| Greywater recovery system | 0 | 16.00 | 16 | 0.06% |
| Water efficient irrigation system* | 1.50 | 9.59 | 8.09 | 0.03% |
| Wireless water meter | 0.49 | 0.66 | 0.17 | 0.001% |
| Intelligent systems* | 123.45 | 516.38 | 392.93 | 1.44% |
| Indoor air quality monitoring system | 0 | 2.98 | 2.98 | 0.01% |
| Permeable ground | 135.00 | 452.21 | 317.21 | 1.16% |
| Green roof | 0 | 29.03 | 29.03 | 0.11% |
| | | | Total | 4.94% |

* Site wide systems. Investment based on the proportion of Building 17's floor area relative to the total floor area of all buildings using the system.

After the BREEAM post construction certificate was issued and the sale of Building 17 completed, Mr Binwu He (Managing Director, Executive Director and Executive Vice President of the Franshion Group Shanghai International Shipping Center) stated: "BREEAM is the world's leading sustainable building assessment method, and we found that it is suitable for use in China. Designing Building 17 in accordance with the BREEAM principles, not only saves land, water, energy and materials, and is environmentally friendly, but also meets world-class indoor environmental and health standards. As a result, the sale price of this building is significantly higher than similar non-BREEAM certified buildings in Shanghai."

This case study has demonstrated that BREEAM can drive best practice sustainability performance in China for the design and construction of green buildings. The BREEAM 'Excellent' rated Building 17 provides a best practice example for China in terms of meeting internationally recognised standards for energy, water and resource efficiency, low carbon materials and healthy indoor environments. BREEAM has also been used to improve construction management practices that will help to ensure that the building's operational performance is in accordance with the design expectations. Achieving these enhanced levels of sustainability performance has only increased the project's capital cost by about 5%. Additionally, the resulting savings on energy and water bills are projected to pay back the additional investment in energy and water efficient technologies in less than 7 years and approximately 6 years respectively. Building 17 has set a benchmark for green building projects in China using the BREEAM methodology, which will enable future projects in China to use BREEAM to push performance even further.

表 1 资金成本分析

| 17号楼可持续技术清单 | 相应标准技术投资 (CNY/m²) | 投资 (CNY/m²) | 仅房屋技术采用的资本提升 (CNY/m²) | 增量 % |
|---|---|---|---|---|
| 能耗分项计量 | 28.55 | 95.15 | 66.6 | 0.24% |
| 江水源热泵* | 1.85 | 4.87 | 3.02 | 0.01% |
| 冰蓄冷* | 0 | 83.96 | 83.96 | 0.31% |
| 节能灯具 | 25.00 | 42.97 | 17.97 | 0.07% |
| 节能照明控制系统 | 13.50 | 32.20 | 18.7 | 0.07% |
| 外遮阳系统 | 140.00 | 190.00 | 50 | 0.18% |
| 导光筒系统 | 0 | 12.67 | 12.67 | 0.05% |
| 断桥铝合金低辐射中空玻璃窗 | 73.33 | 138.70 | 65.37 | 0.24% |
| 低辐射玻璃幕墙 | 0 | 48.00 | 48 | 0.18% |
| 中庭屋顶天窗四氟乙烯（ETFE）充气膜 | 11.00 | 28.13 | 17.13 | 0.06% |
| 高度绝缘外墙 | 48.00 | 97.00 | 49 | 0.18% |
| 排风热回收系统* | 0 | 133.42 | 133.42 | 0.49% |
| 节水器具 | 12.96 | 16.00 | 3.04 | 0.01% |
| 雨水收集、利用系统* | 0 | 15.16 | 15.16 | 0.06% |
| 中水回用系统 | 0 | 16.00 | 16 | 0.06% |
| 节水灌溉系统* | 1.50 | 9.59 | 8.09 | 0.03% |
| 远传水表 | 0.49 | 0.66 | 0.17 | 0.001% |
| 智能化系统* | 123.45 | 516.38 | 392.93 | 1.44% |
| 室内空气质量监控系统 | 0 | 2.98 | 2.98 | 0.01% |
| 透水地面（透水砖） | 135.00 | 452.21 | 317.21 | 1.16% |
| 屋顶绿化 | 0 | 29.03 | 29.03 | 0.11% |
| | | | 合计 | 4.94% |

*用于整个开发项目的体系，根据17号楼的建筑面积相对于所有使用该系统总建筑面积的比例计算 。

17号楼在运用BREEAM竣工并取得证书及销售完成后，贺斌吾先生（董事总经理，执行董事，原方兴地产集团上海国际航运中心的执行副总裁）说：“BREEAM是全球领先的可持续建筑评估方法，我们发现它是适用于中国。按照BREEAM原则设计17号楼，不仅节约了土地、水资源、能源、材料，而且环保，并却同时达
到了世界顶尖水平的的室内环境和健康标准。因此在上海，这栋建筑的销售价格
显著高于同类非BREEAM认证的建筑”。

本案例研究表明，BREEAM能在中国推动绿色建筑设计和施工的可持续发展的最佳实践绩效。评级达到BREEAM“优秀”的 17号楼提供了一个达到能源、水、资源效率、低碳材料和健康的室内环境等方面国际公认标准的中国最佳实践范本。BREEAM也被用来提高施工管理实践，这将有助于确保建筑运营业绩符合设计目标。要实现可持续发展绩效的资本增量只有不到5%，此外，在能源和水方面的节约分别在不到7年和6年内即可偿还能源和节水技术的额外投资。 17号楼树立了在中国采用BREEAM的标杆，这将有利于中国的项目在未来运用BREEAM，从而进一步推动中国绿色建筑项目的业绩。

Further details on the BREEAM criteria can be found in the relevant scheme manuals. Copies of the manuals can be downloaded free of charge from **www.breeam.com**



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