

Performance-Based Design for Truly Green and Energy Efficient Buildings-
Cases of Large Scale Shopping Malls in Hot and Humid Climate

性能化设计成就真正的绿色与节能建筑

-以热湿气候下的大型商场为例



大型商业与文化建筑的节能运行与监管论坛
第十一届国际绿色建筑与建筑节能大会暨新技术与产品博览会
24~25 Mar 2015, 北京

By **Gregers Reimann**, managing director
Sun Hansong, director-China



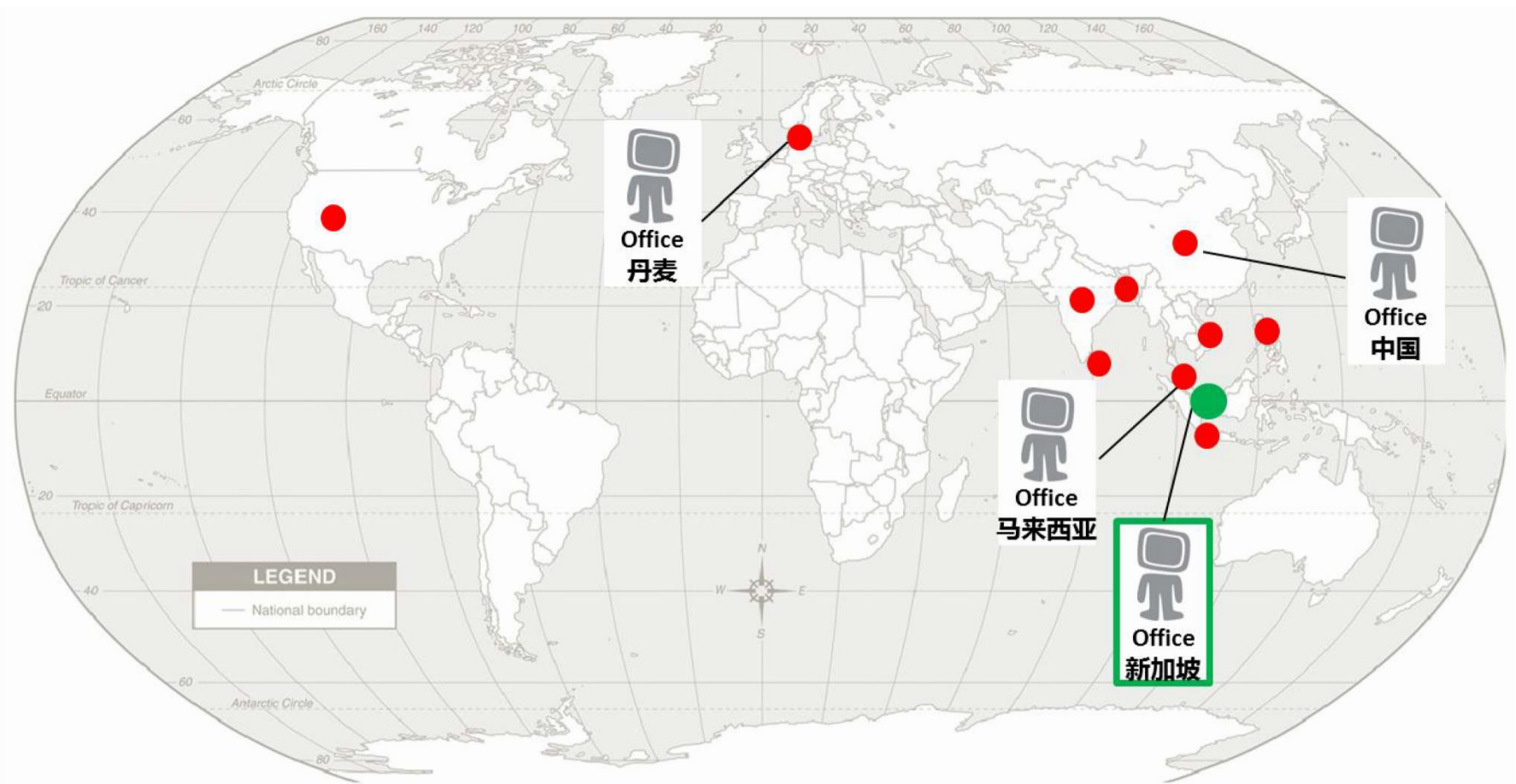
绿色建筑咨询 | 节能与环境设计及改造 | 可持续城镇规划 | 区域能源规划

Green Building Consultancy | Energy & Environment Design Retrofit | Sustainable Urban Planning | District Energy Planning

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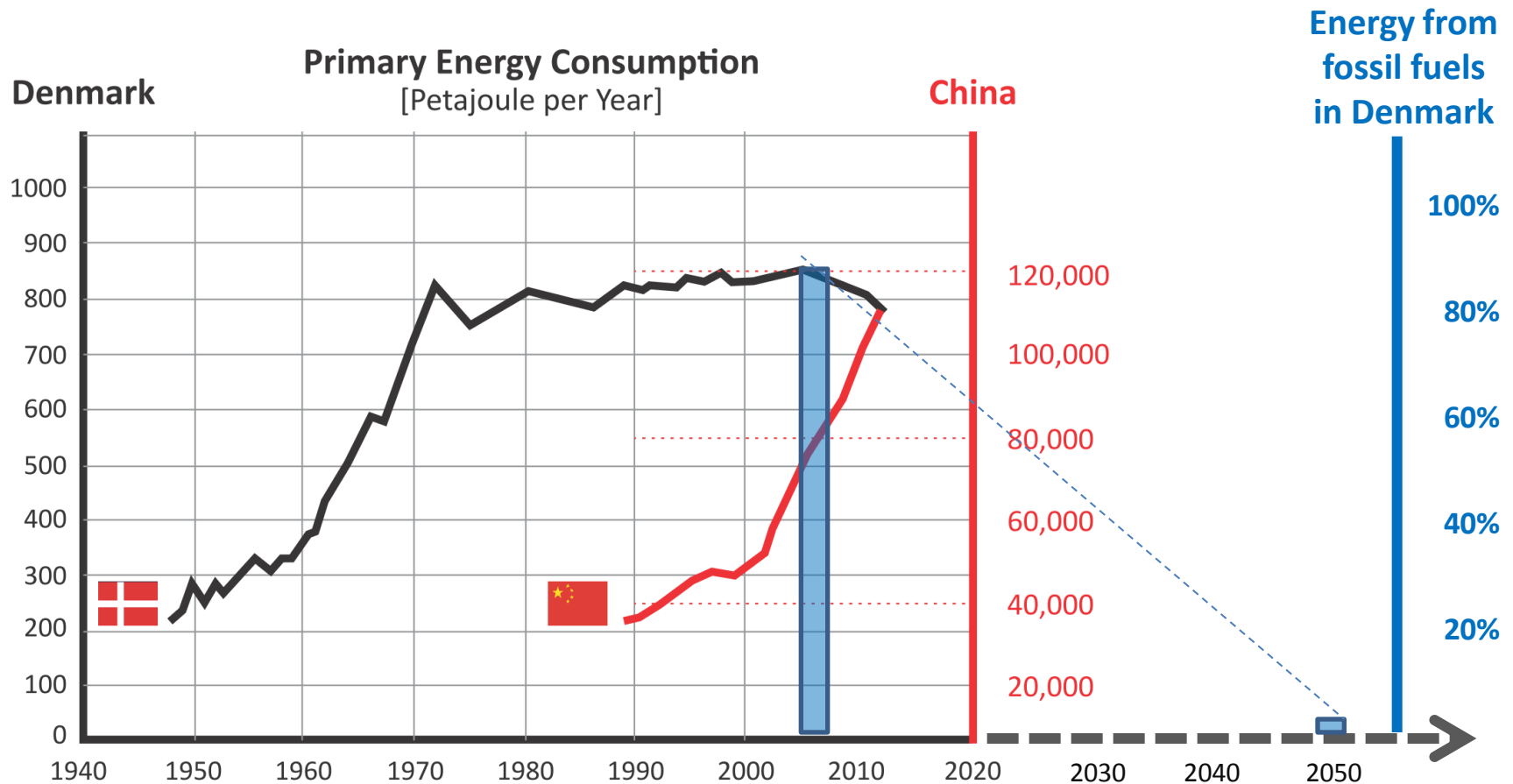
3.2 Million Square Meters of Green Building Space in Asia

320多万平米在亚洲的绿色建筑项目



CHINA & DENMARK: National Energy Development

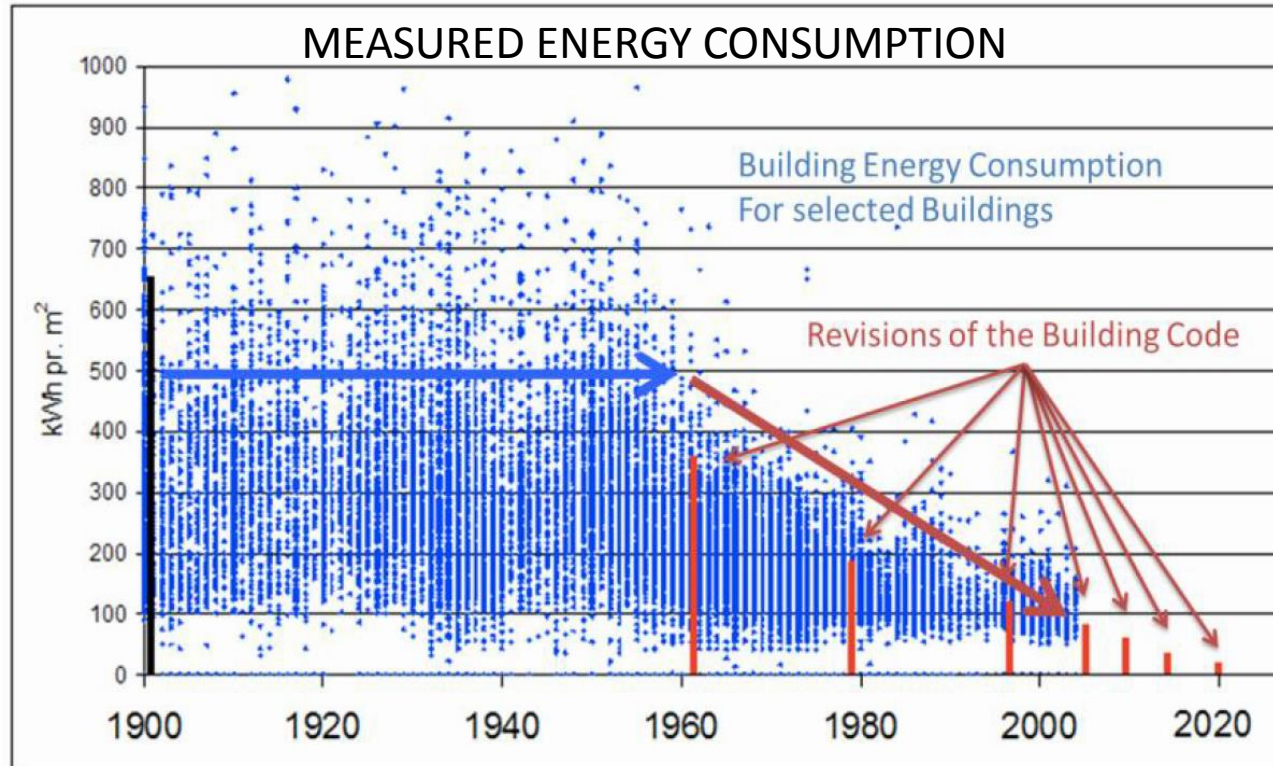
丹麦与中国能源发展历程



IPCC says: Green house gas emissions must reduce to by year 2100

CASE of DENMARK: 50% Energy Savings for Building Stock

丹麦的实例：实测建筑整体能耗降低50%



Energy Efficiency

- Energy codes
- Energy labels
- Energy efficiency incentives



能源标识
源于丹麦，现被
全世界使用

Is Green Expensive?

绿色贵吗？

Expensive Not to Go Green!

不做绿色才贵

"If you're involved in a new project and you are not making it as green and low energy as possible, it will be functionally obsolete the day it opens and economically disadvantaged for its entire lifetime"

"假如你在做一个新项目，而你没有使它尽可能地做到绿色与低能耗，那么从开业运行的第一天起，它就将功能过时，并在整个生命周期经济性上落后。"

Mr. Jerry Yudelson (2008)

国家董事会成员
美国绿色建筑理事会

Overdesign of buildings will add unnecessary initial cost and reduce efficient operations

15 kg too heavy

- Food for **12 days**
- Water for **10 days**
- Clothing for **8 days**



©The Star Graphics by FADZUL YUSOF

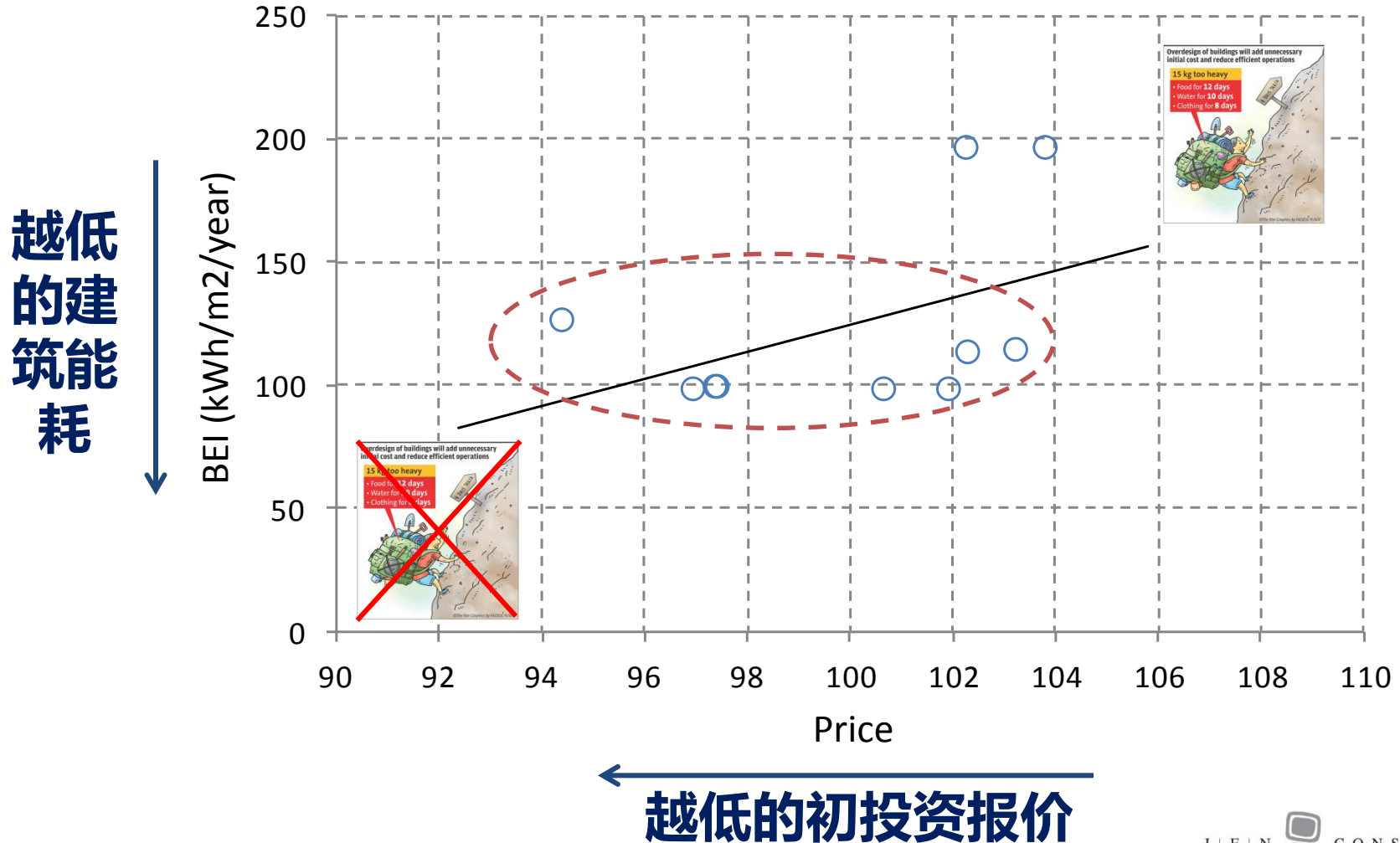
Cartoon by IEN Consultants / The Star newspaper (2014)



Expensive Not to Go Green!

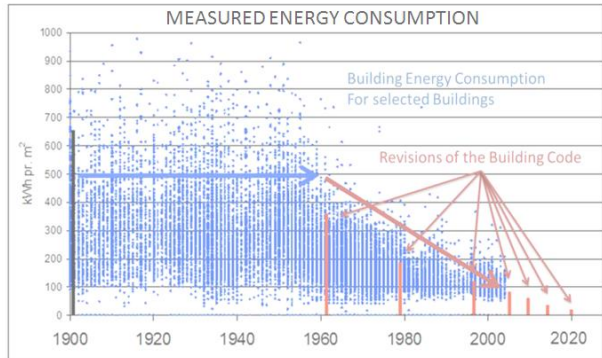
不做绿色才贵

1. 开发商明确在施工招标文件中提出建筑能耗指标要求，100 kWh/m²/yr
2. 公开招标结果表明：更合理的节能设计同时也是投标方总报价成本最低的。



CASE of IEN CONSULTANTS: 50% Energy Savings or More for Our Building Projects

IEN的实例：实测建筑能耗降低50%~80%



Annual energy bills show

- 50-80% energy savings
- 3 year pay-back time

IEN Core Values

- Effective design solutions
- Ensure long-term benefit to client, occupant and environment



The First Green Certified Shopping Mall in Malaysia

马来西亚第一座获得绿色认证的大型商场



Night falls at Setia City Mall

项目名称：Setia City Mall
建筑类型：大型商场
总建筑面积: 107,000 m²（停车场除外）
可出租面积：72,000 m²
开业年份: 2012年7月
主要功能：零售、超市、餐饮、影院、体育娱乐
绿色星级: GBI 银级，Green Mark 金级
能耗数据对比：303 kWh/m²/年，相比同类建筑节能30%。



Tenancy Mix

租户构成

Type of Tenant

Retail 零售

F&B / Restaurants 餐饮

Cinema 影院

Bowling

Gym / Fitness Center

Supermarket

Karaoke

Others

TOTAL NLA

Area [m²]

45,000

12,000

4,000

3,000

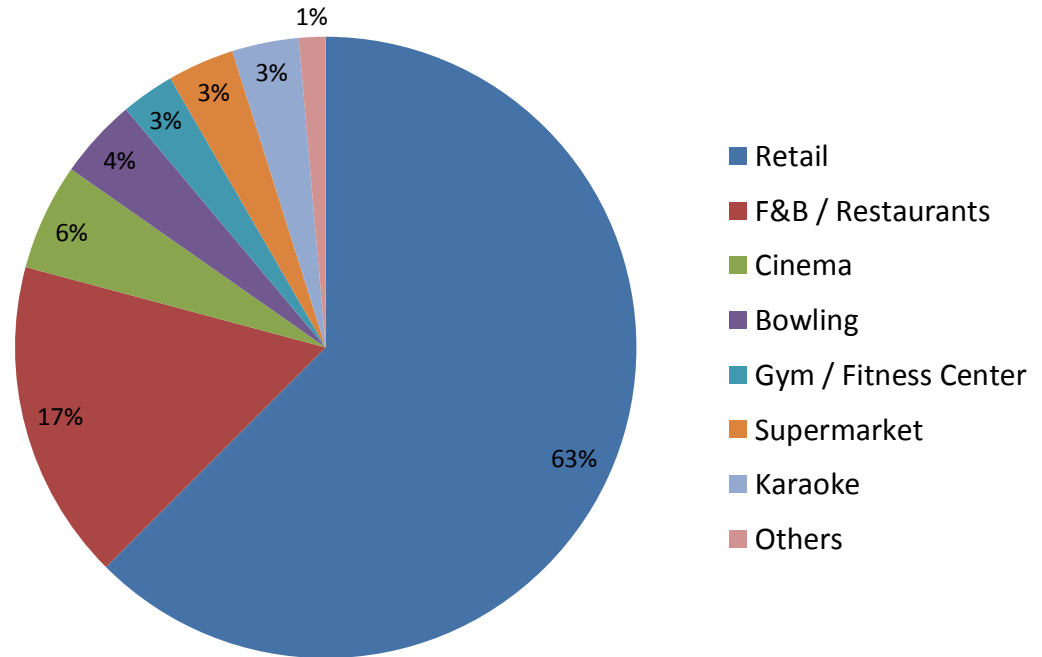
2,000

2,500

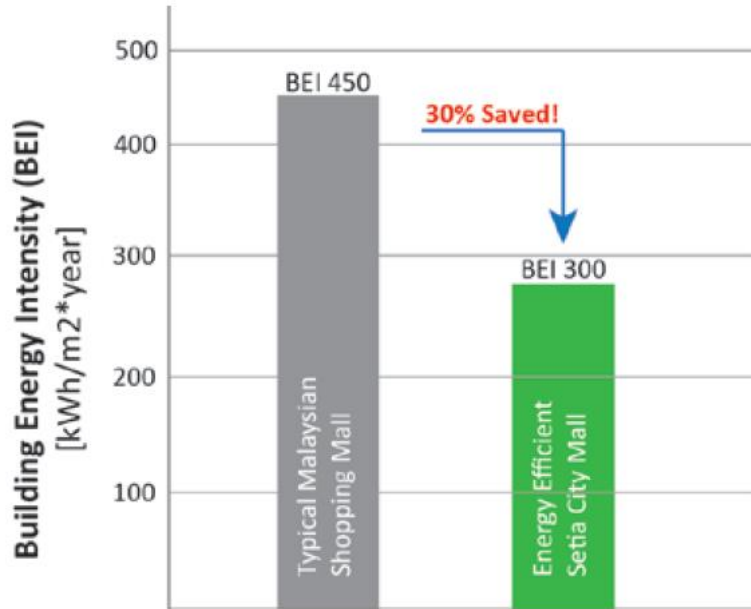
2,500

1,000

72,000

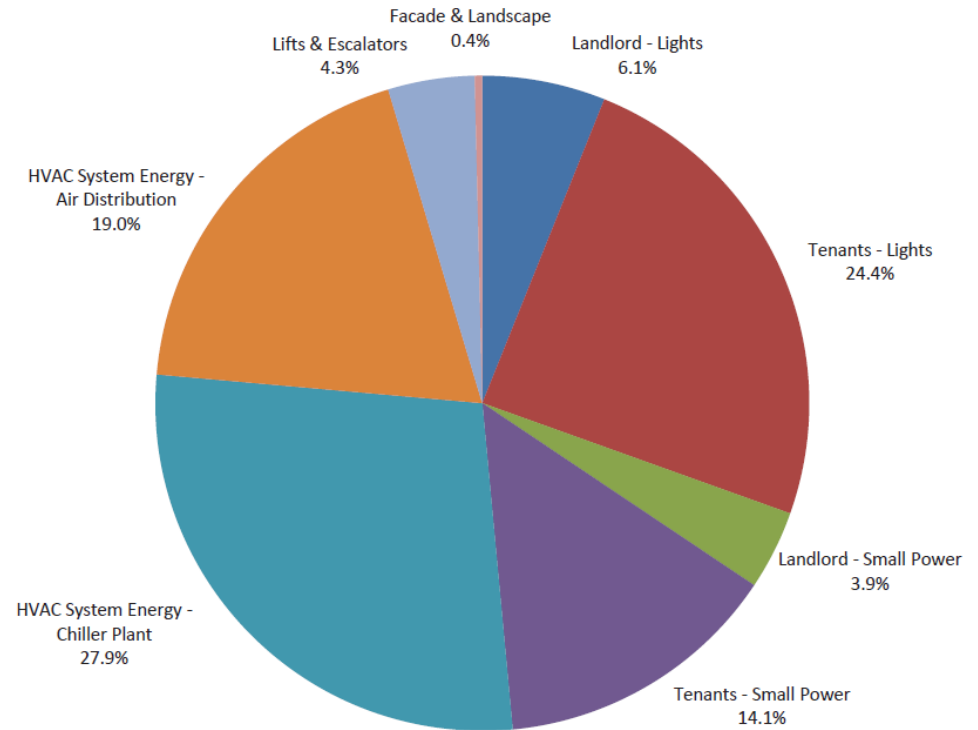


Measured Energy Saving Potential 实测节能潜力



Energy Comparison- Typical Mall vs Setia City Mall

各类系统与设备能耗



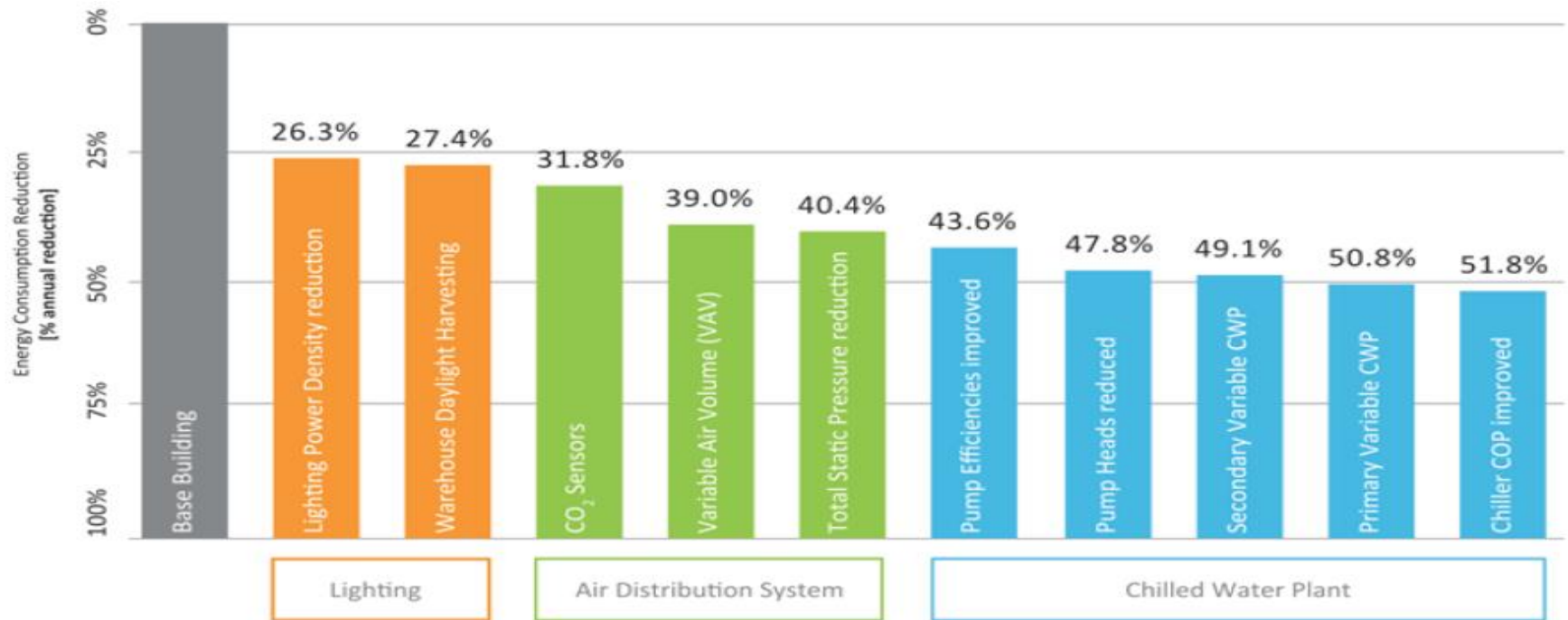
节省

30% 能耗

每年1200万人民币

Technical Feasibility Analysis for Energy Saving Measures – Based on Energy Simulations

基于动态能耗模拟的节能措施技术经济性分析



Traditional Cooling Plant Sizing Methodology

传统上，确定制冷机房装机选型的方法

1. Define Worst Case Conditions for Internal Load (No. of People, Equipment, Lights)
基于最不利工况，定义内部负荷（人员数量，设备插座功率，照明功率）
2. Assume worst case conditions on external conditions (hot sunny day, atmospheric clarity at 1.0)
假设最不利外部条件（炎热夏日，大气透明度为1.0）
3. Estimate Peak Cooling Load over 1 typical year
基于一个典型年，估算峰值负荷
4. Allow Safety Factor (ranging from 10% to 15%) on top of Peak Cooling Load
在峰值负荷以上，给予安全系数（10% 至15%）
5. Select Cooling Plant configuration based on Peak Cooling Load + Safety Factor
制冷机房选型基于确定的峰值负荷与安全系数
6. Allow additional at least 1 spare chiller + pump + cooling tower as backup to cater for breakdowns
为应对突发停机故障，设置至少一套备用冷机+水泵+冷却塔

Cooling Plant Design– Common “Rule of Thumb”

一般情况下，制冷机房装机选型遵循“经验法则”

- 典型空调冷负荷假设: **220-252 W/m²** (大型商场)
- 建筑面积107,074 m², 其中空调面积约占70%
- 预计峰值冷负荷: **4700 RT - 5400 RT (16530 kWc – 18992 kWc)**

本项目的制冷机房装机配置

- 主制冷机: **4台 x 1000 RT** 水冷离心冷机
- 小冷机: **2台 x 500 RT** 水冷离心冷机
- 制冷机房总装机: **5000 RT**

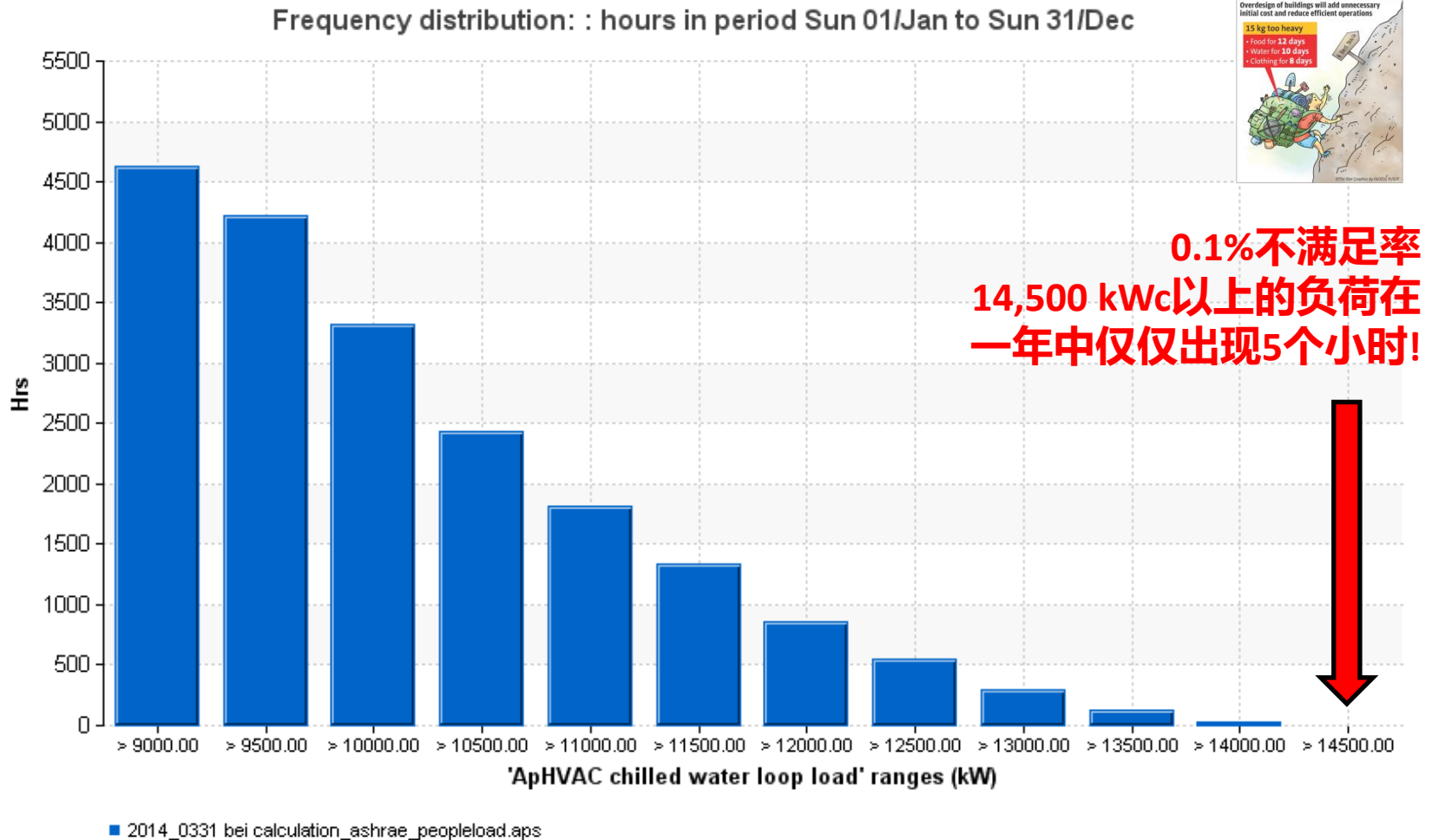
IEN Proposed Cooling Plant Sizing Methodology

IEN推荐的确定制冷机房装机选型的方法

1. Define Internal Load (No. of People, Equipment, Lights) based on data collected from similar projects
基于类似建筑项目的数据，定义内部负荷（人员数量，设备插座功率，照明功率）
2. Utilize weather data based on TRY (Test Reference Year)
利用基于TRY（参考年）的气象数据
3. Estimate Peak Cooling Load based on TRY
基于TRY，估算峰值负荷
4. Review Frequency of Load Occurrence and Risk Acceptability Assessment with Owner
与业主一起，评估负荷出现的频率与风险可接受度
5. Select Cooling Plant configuration based on acceptable risk level
基于可接受的风险水平，确定制冷机房装机选型
6. Repeat steps 1 -5 when Lighting Design & External Envelope material selection has been confirmed
重复以上1至5步，当照明系统设计与外围护结构材料选择被确定时

Cooling Load Profile – Energy Simulation Model

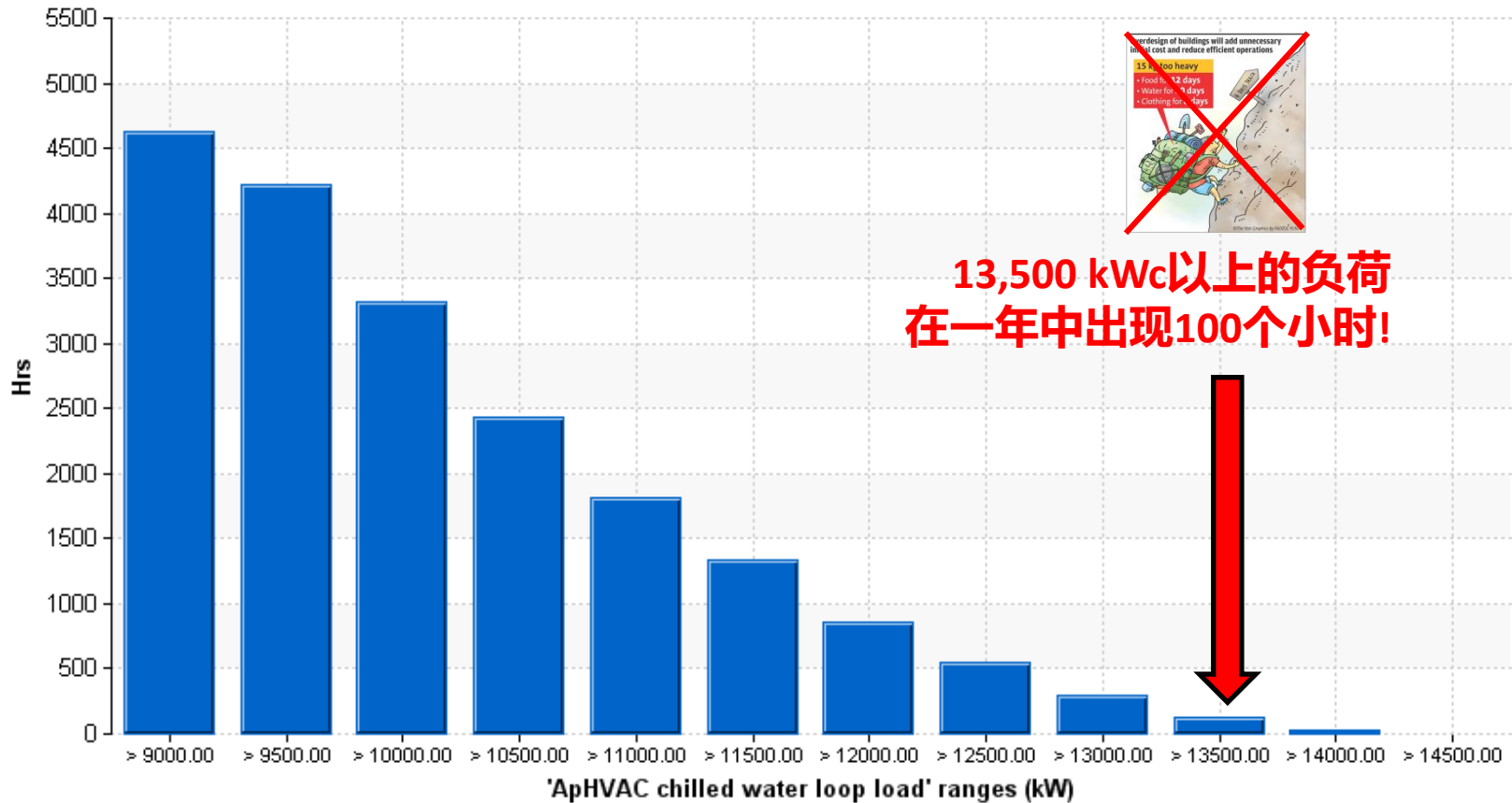
能耗模拟预测全年冷负荷分布，0.1%不满足率



Recommended Cooling Plant Capacity 推荐的制冷机房规模

需要考虑的点 - 什么是可以接受的风险水平?

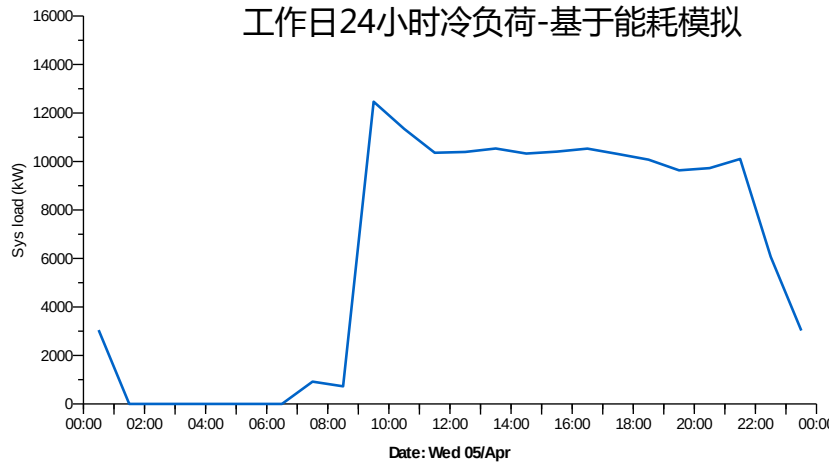
Frequency distribution: : hours in period Sun 01/Jan to Sun 31/Dec



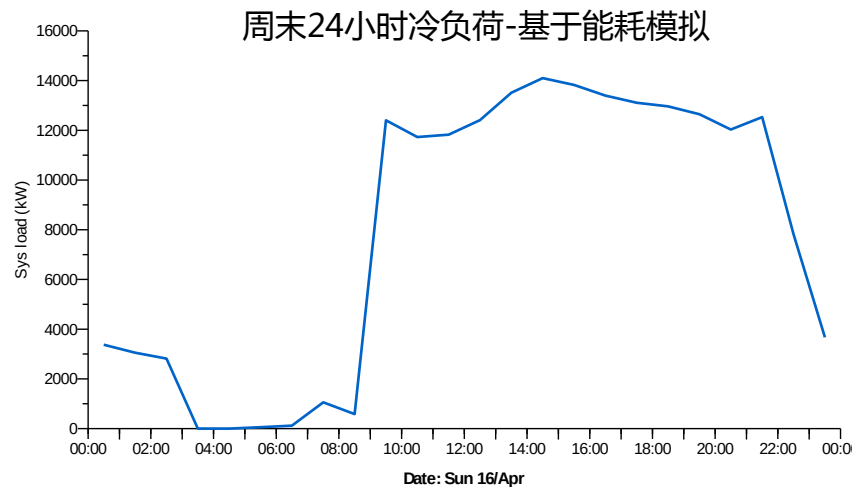
■ 2014_0331 bei calculation_ashrae_peopleload.aps

Measured Cooling Load Profile Almost Identical to Energy Model

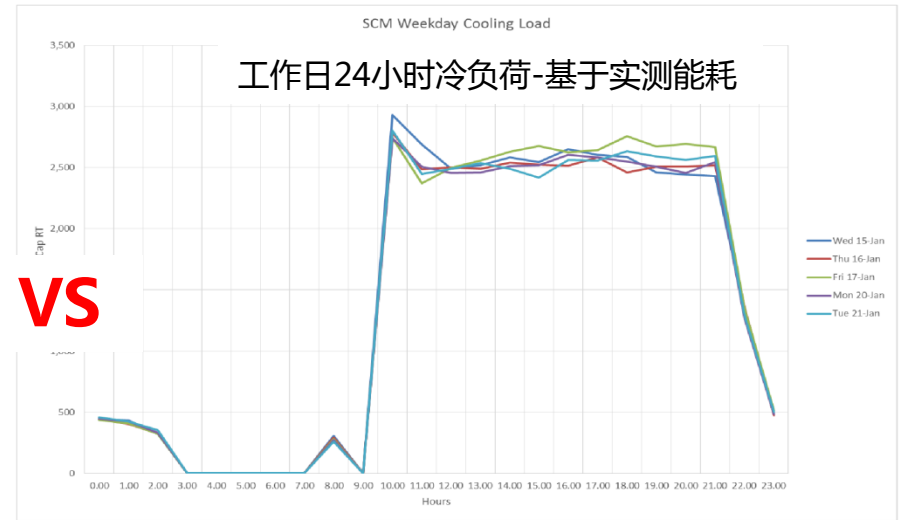
实测冷负荷几乎与能耗模拟结果吻合



— ApHVAC chilled water loop load: (2014_0331 bei calculation_ashrae_peopleload.aps)

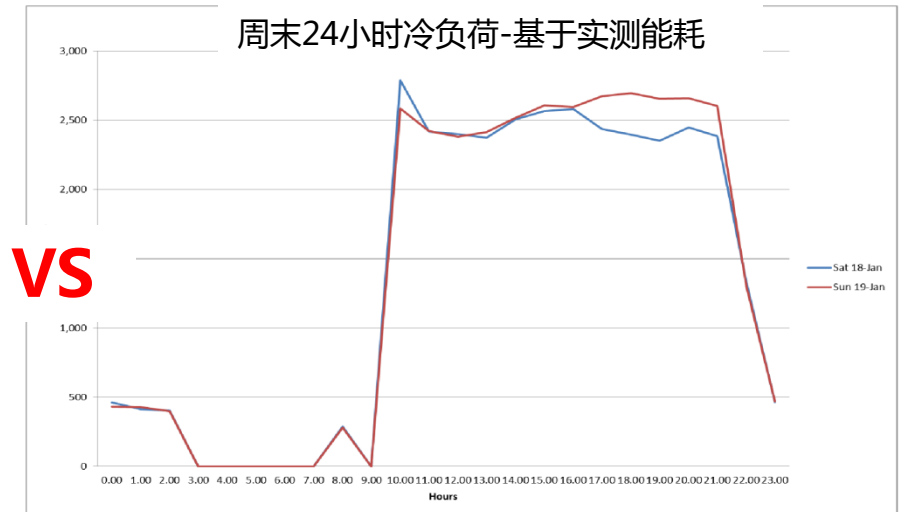


— ApHVAC chilled water loop load: (2014_0331 bei calculation_ashrae_peopleload.aps)



VS

Chart 1a : Weekday Cooling Load Profile Line Diagram

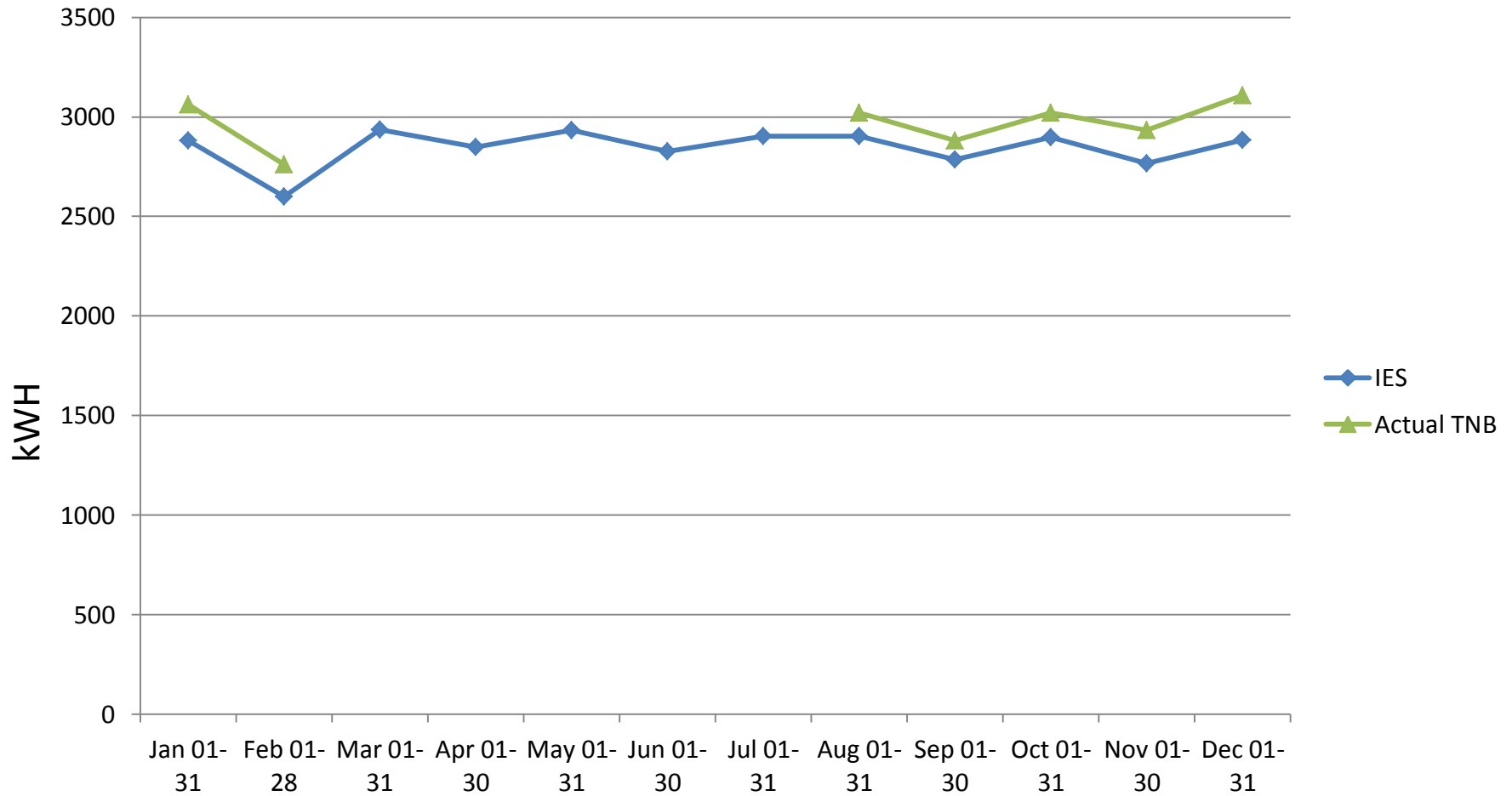


VS

Chart 1b : Weekend Cooling Load Profile

Utility Energy Bill vs. Energy Modeling

建筑整体能耗账单与能耗模拟结果对比



Measured Peak Cooling Load Profile (Weekday vs. Weekend)

实测峰值负荷与装机负荷对比

现有机房内，一台1000RT + 1台500RT的制冷机，
几乎从来没有开机过，转化成备用/闲置设备的初投资接近600万人民币！可以足够提供多一个Setia City Mall的日常空调运行！

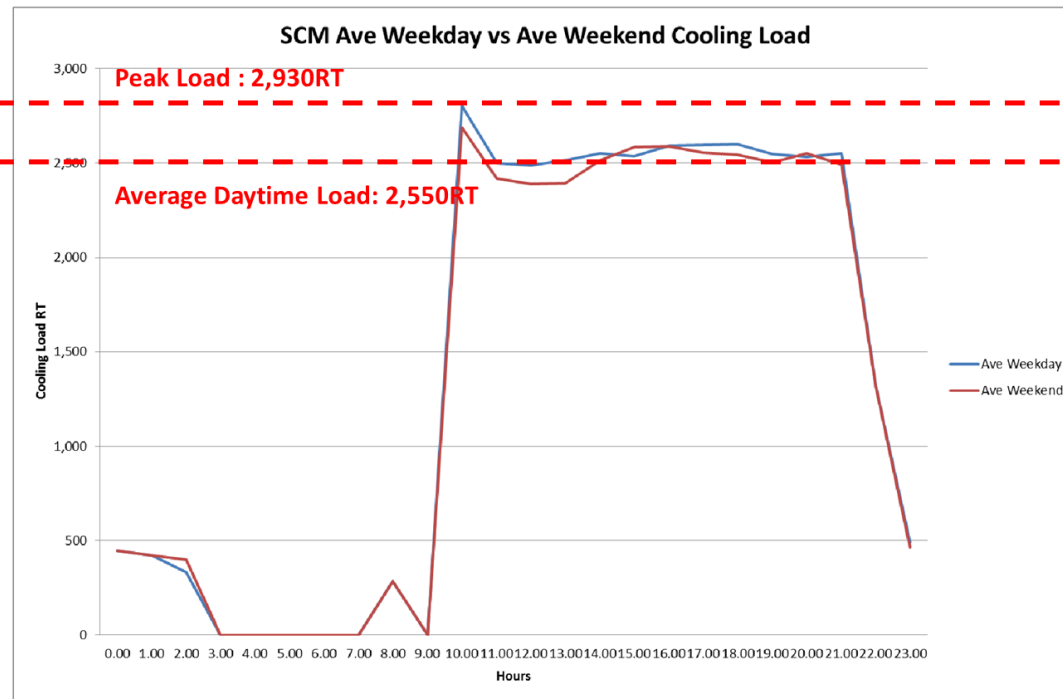


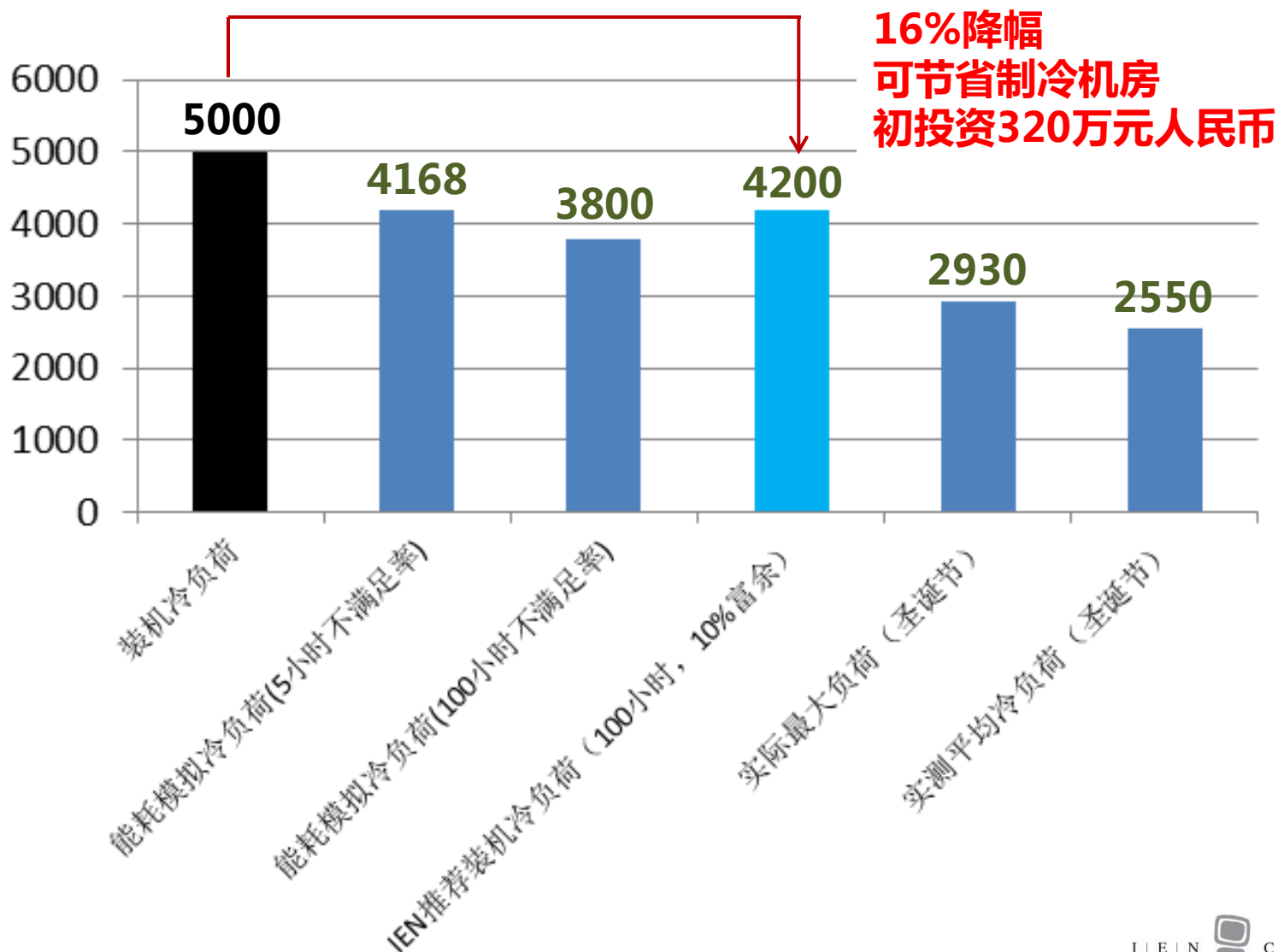
Chart 1c : Comparison Ave Weekday vs Ave Weekend Cooling Load Profile

实际装机负荷
5000 冷吨

实测峰值负荷
2930 冷吨

IEN Proposed Cooling Plant Sizing

IEN推荐的制冷机房规模



IEN Proposed Cooling Plant Sizing

IEN推荐的制冷机房配置

如果100小时负荷不满足率可以被接受：

设计峰值冷负荷 = **13500 kWc (3800RT)**

建议的制冷机房配置为：

- 4台 x 800 RT 大制冷机
- 2台 x 500 RT 小制冷机
- 制冷机房总装机 = 4200 RT

风险评估 (Risk Assessment)

1. 制冷机房可以满足预测的峰值冷负荷吗？

可以

2. 如果一台大冷机故障停机了，影响有多大？

只有在一年中，当总空调冷负荷大于3400 RT（小于10%的可能性）的时候，商场的温度可能会提高1至2度

2. 对于这种风险水平，我将节省多少初投资？

将降低800 RT的装机容量，相当于约320万人民币！

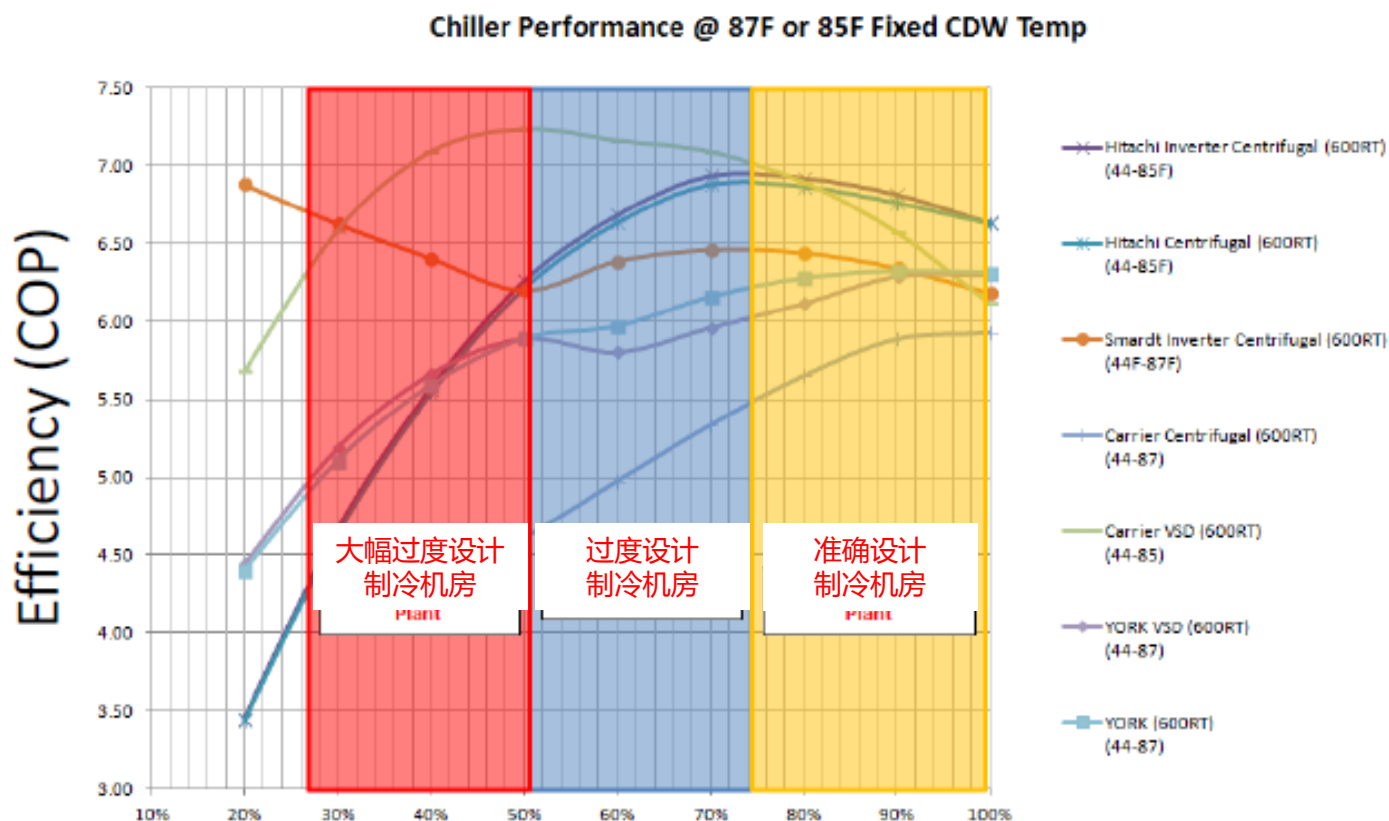
Dual Penalties of Over Sized Chiller Plants

制冷机房设计规模过大的双重惩罚

较高的初投资：
多320万人民币

+

较高的运行费用：
每年多180万人民币



Tenants Energy Use & Green Lease

租户能耗控制与绿色租赁

Energy Verification Report for Setia City Mall Ten Months Upon Completion

2013

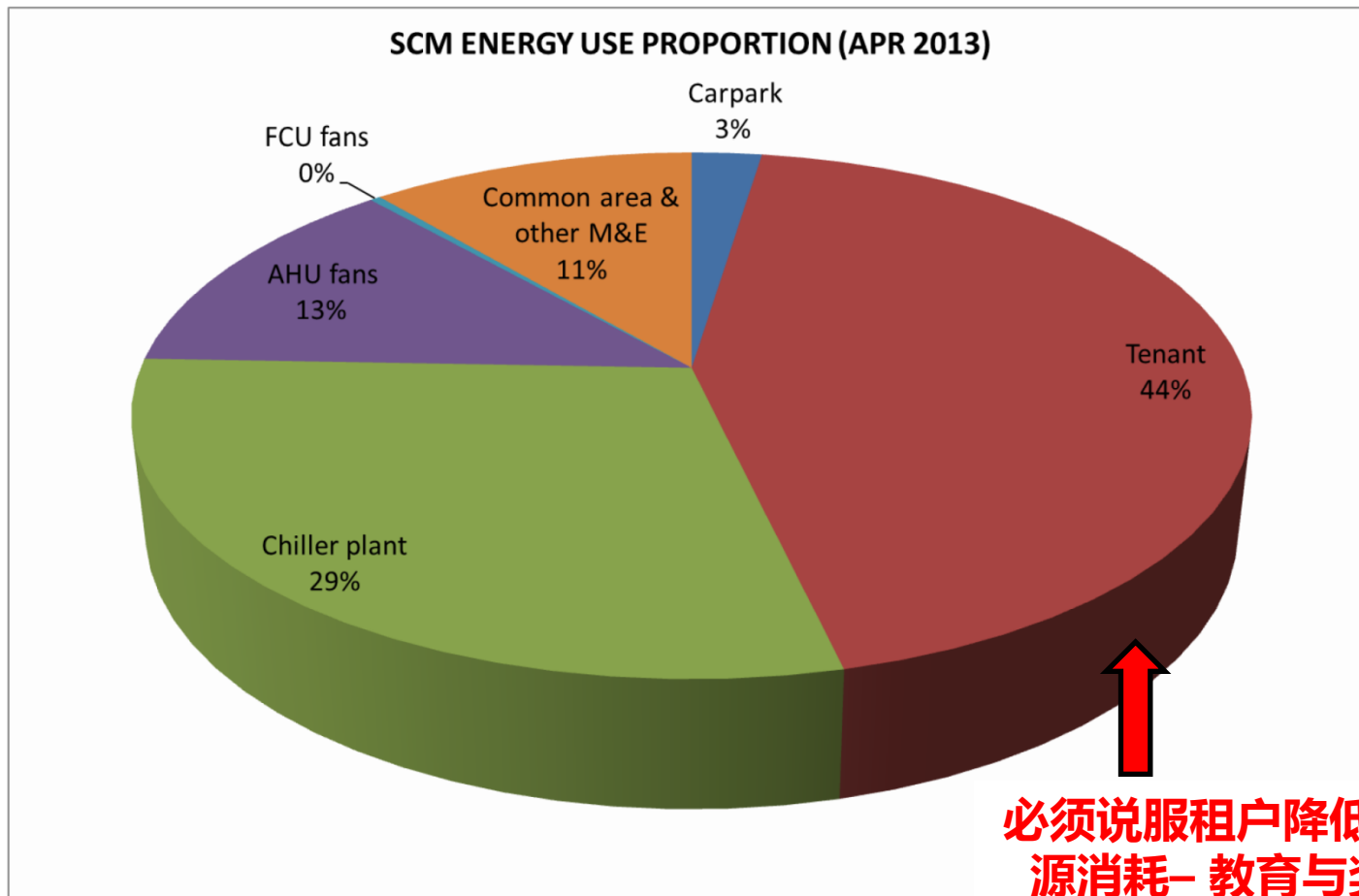


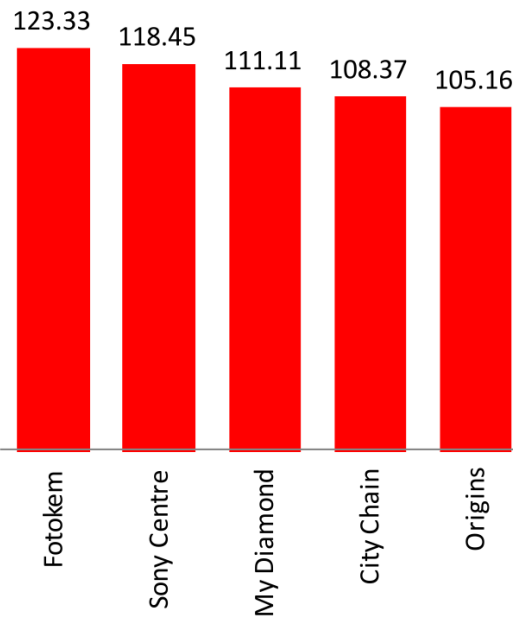
Chart 1 : Energy Proportion for SCM Month of April 2013

Tenants Energy Use & Green Lease

租户能耗控制与绿色租赁

**Retail Average Power Density [W/m²]
for SETIA CITY MALL (based on Aug 2012 consumption)**

Top 5 Highest Small
Power Density



41.50

Weighted Average

35

IEN Assumption

Lowest Small
Power Density

14.11

D'Rias

11.37

Get Crafty

10.87

Z Gen

9.93

Uptown Playaz

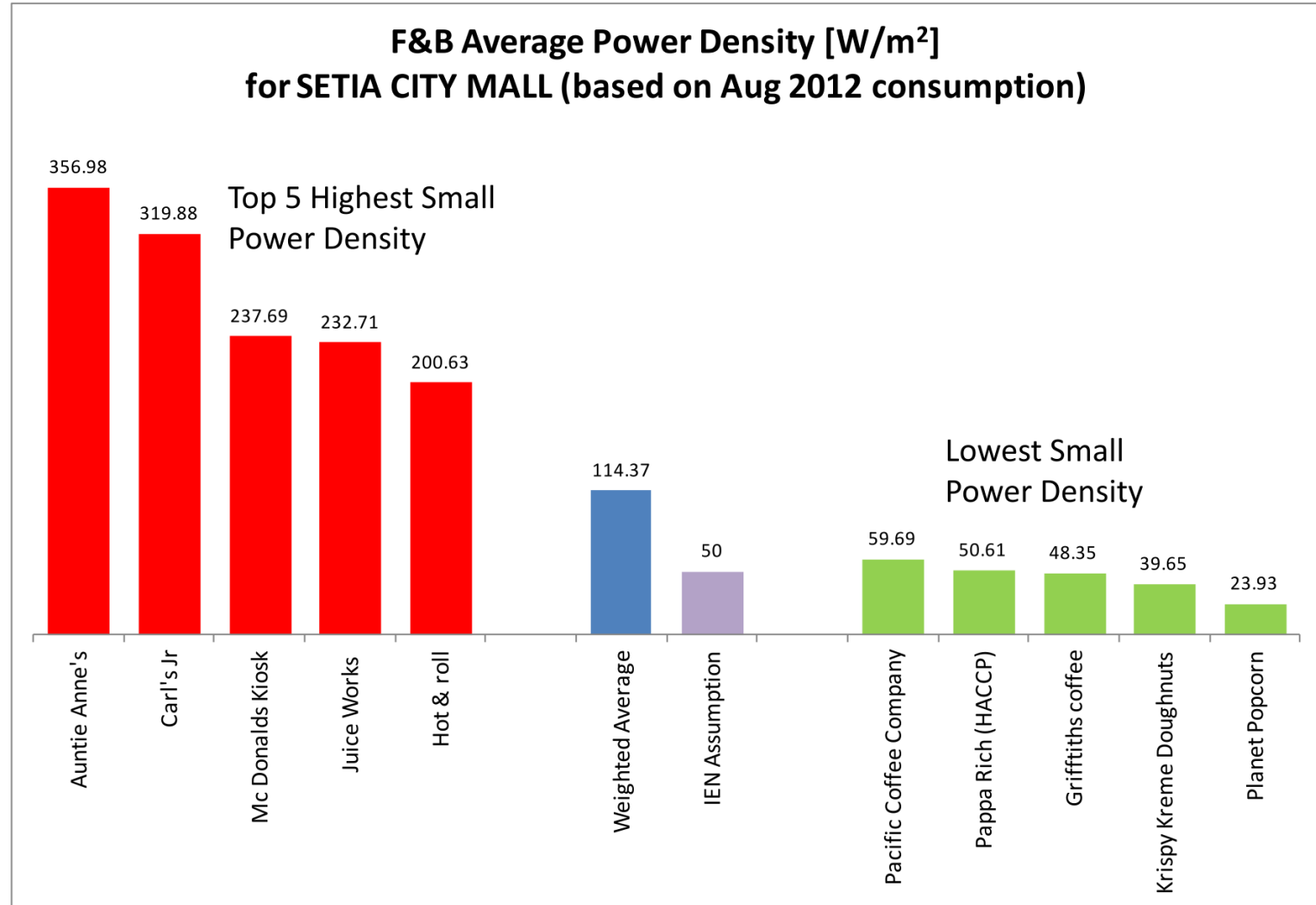
5.95

Ellui Accessories



Tenants Energy Use & Green Lease

租户能耗控制与绿色租赁



Tenants Energy Use & Green Lease

租户能耗控制与绿色租赁



Retailer: Origins

Type: Cosmetics / Apothecary

Lighting: Halogen Downlights and Spotlights

Electrical Equip: 1 PC for Point of Sale (POS) System

Average Power Density: 100W/m²

Estimated Electricity Cost per 100m²: **RM16,600per annum***

*Based on 13hrs per day, 365days per year, RM0.35/kWH

100 W/m²



Retailer: Machines

Type: Apple Computers and Accessories

Lighting: LED Downlights and Spotlights

Electrical Equip: >10 computers

Average Power Density: 27W/m²

Estimated Electricity Cost per 100m²: **RM4,500per annum***

*Based on 13hrs per day, 365days per year, RM0.35/kWH

27 W/m²

The First Green IKEA Mall in Malaysia

IKEA KL2 宜家家居

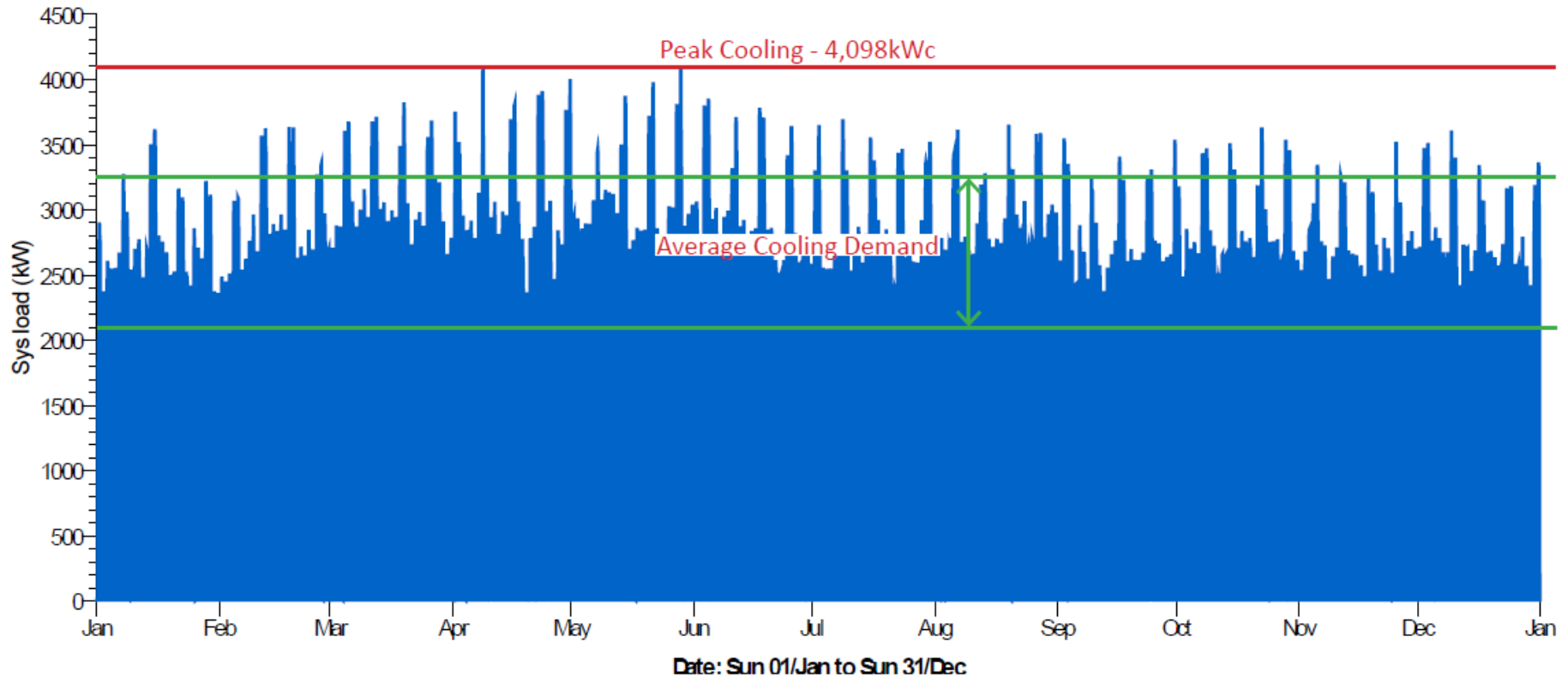


项目名称：IKEA KL2
建筑类型：家居超市 (IKEA)
总建筑面积：41,000 m² (停车场除外)
可出租面积：35,000 m²
开业年份：2015年9月
主要功能：仓储式家居超市，餐厅
绿色星级：GBI 金级，LEED 金级



Cooling Load Profile- Based on Energy Simulation

基于动态能耗模拟的空调冷负荷概况



AphVAC chillers load: (ikea comfort_coils.aps)

Cooling Load AC Hours Distribution- Based on Energy Simulation

基于动态能耗模拟的空调冷负荷小时数分布

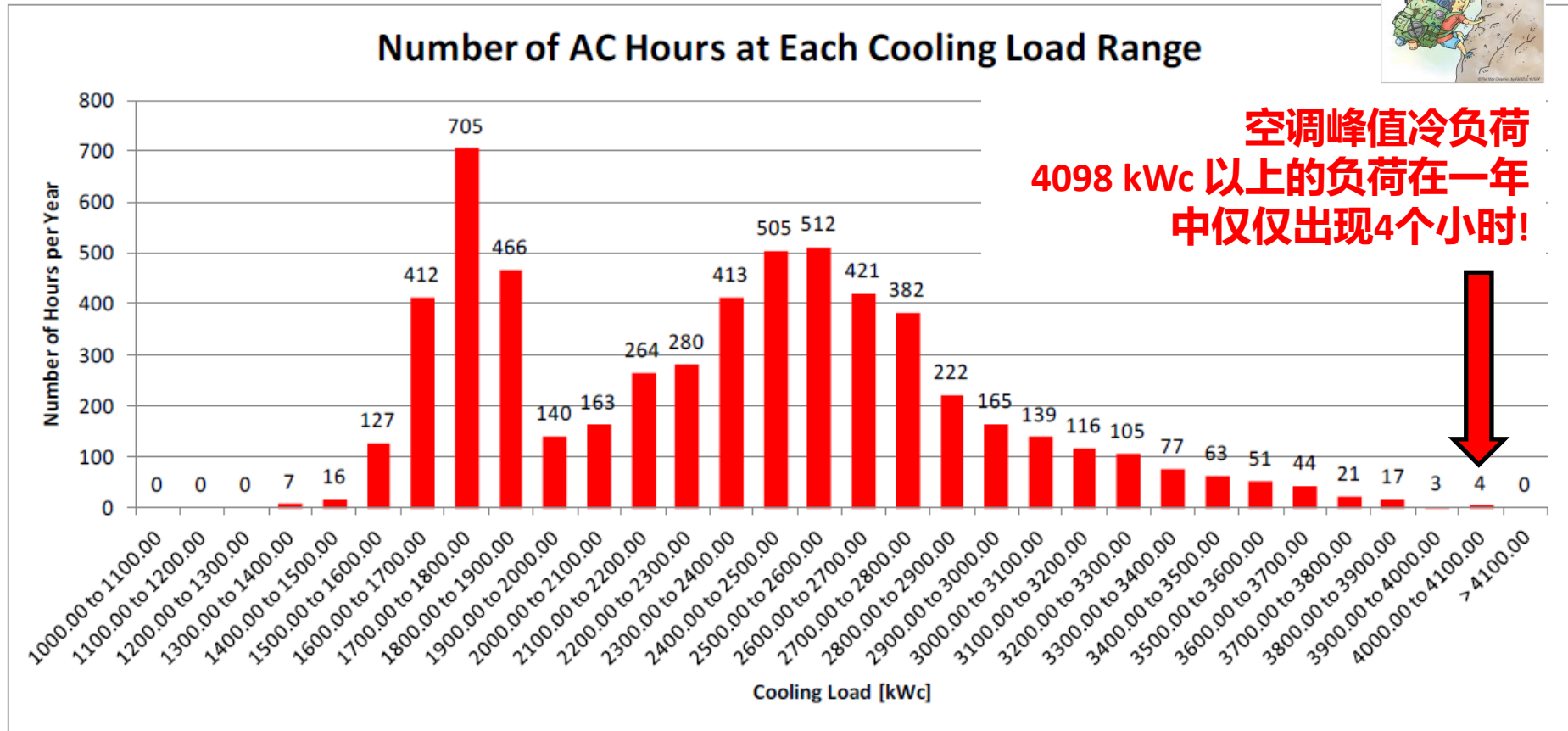
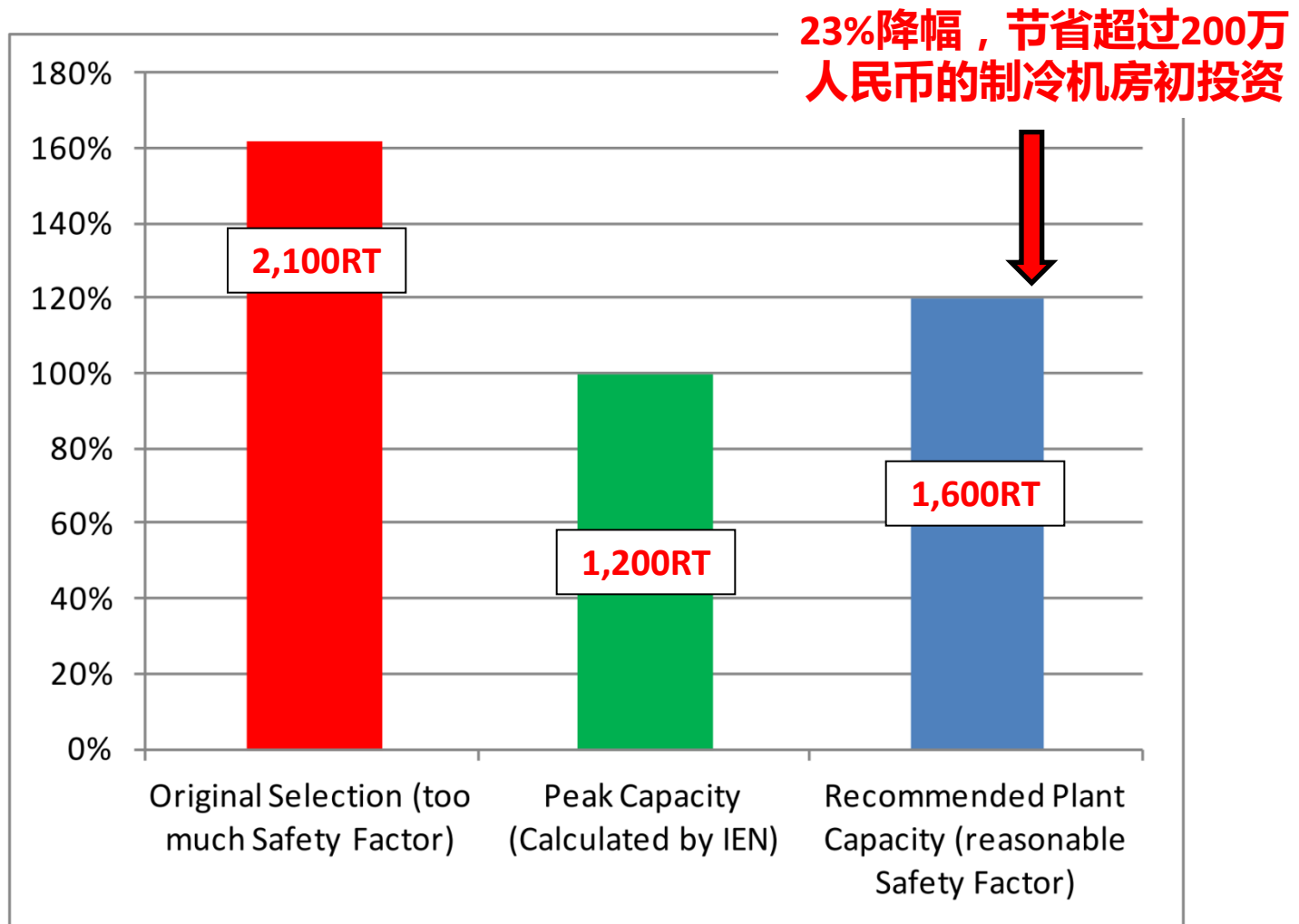


Figure 4.2 Chart showing the number of AC hours per year the store Total Cooling Demand will be between the specified range

大部分冷负荷出现在1600 kWc 至3000 kWc之间！

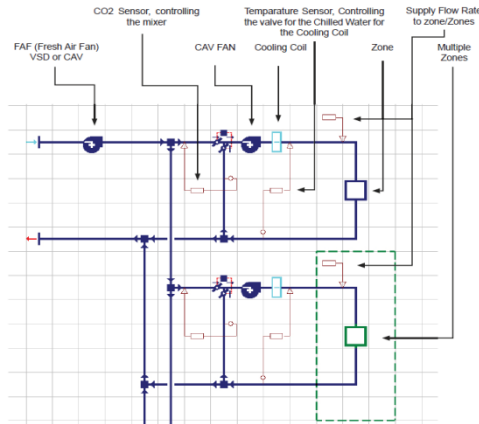
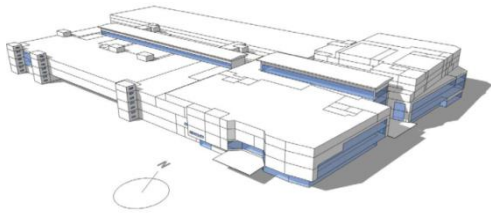
Proposed Chiller Plant Configuration

IEN推荐的制冷机房配置



Lessons Learned

学习到的经验总结



1. 在大多数项目中，机电系统通常存在**过度设计**的问题，这是因为它们通常是基于经验法则或简化模拟被设计出来。这类方法不适用于建筑空间与外形复杂，内部负荷大且波动幅度大的建筑，例如商场。一些商场的实测峰值冷负荷(137 W/m^2) 仅为装机冷负荷(254 W/m^2) 的一半！
2. 能耗模拟基于细致的三维电脑模型，全年逐时气象数据，详细HVAC系统建模，详细的内部负荷与系统运行时间设定，以及动态负荷与能耗模拟，可以更准确地确定空调**冷热负荷在一年中如何发生**，从而显著优化并降低供热与制冷系统设备选型的大小，从而给客户节省大量初投资与运行费用。
3. 制冷机房的选型配置不应该仅仅基于峰值负荷，同样重要的是，要考虑提供需要冷量时的效率。
4. 动态负荷与能耗模拟可以帮助大型商场的**制冷机房选型降低达20%以上**，从而平衡掉整座建筑的绿色增量成本！真正做到：“**不做绿色才贵！**”
5. 同样重要的是，50%以上的建筑能耗与**使用者的行为**习惯有关，比如照明、空调末端、办公设备，通风方式，生活热水，节水，电梯等。应该通过充分地沟通教育与奖励计划，鼓励商场租户参与**绿色租赁**，降低他们的能耗水平。

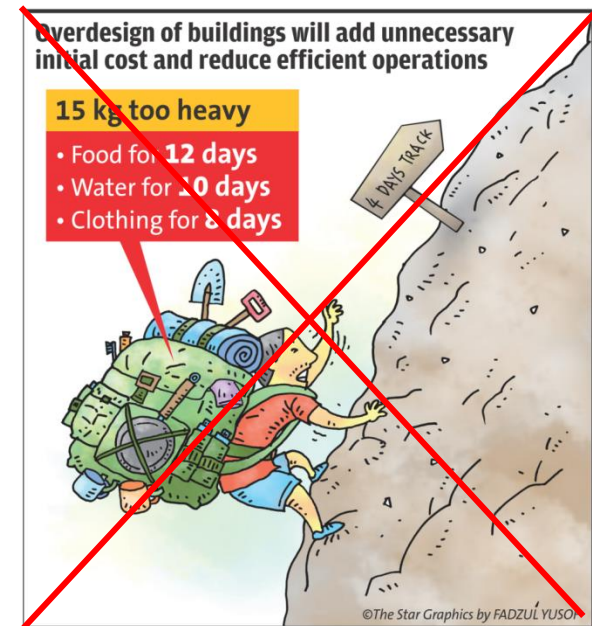
CONCLUDING REMARK

总结陈词

Plug the holes
堵上能耗漏洞



Don't overdesign
不要过度设计



+

要求建筑节能优化设计，节约初投资与运行成本

Request for Energy Optimization

- and save money!



谢谢！ THANK YOU!

提供您的名片，我们将把演讲通过电子邮件发给您。



绿色建筑咨询 | 节能与环境设计及改造 | 可持续城镇规划 | 区域能源规划

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