Expensive
not to go green
绿色节能更经济

Gregers Reimann

Managing Director, IEN Consultants

www.ien-consultants.com

Denmark | Singapore | Malaysia | China

丹麦　新加坡　马来西亚　中国

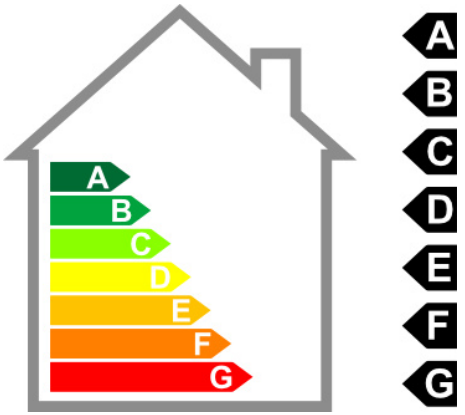
Contents 汇报内容

”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。”

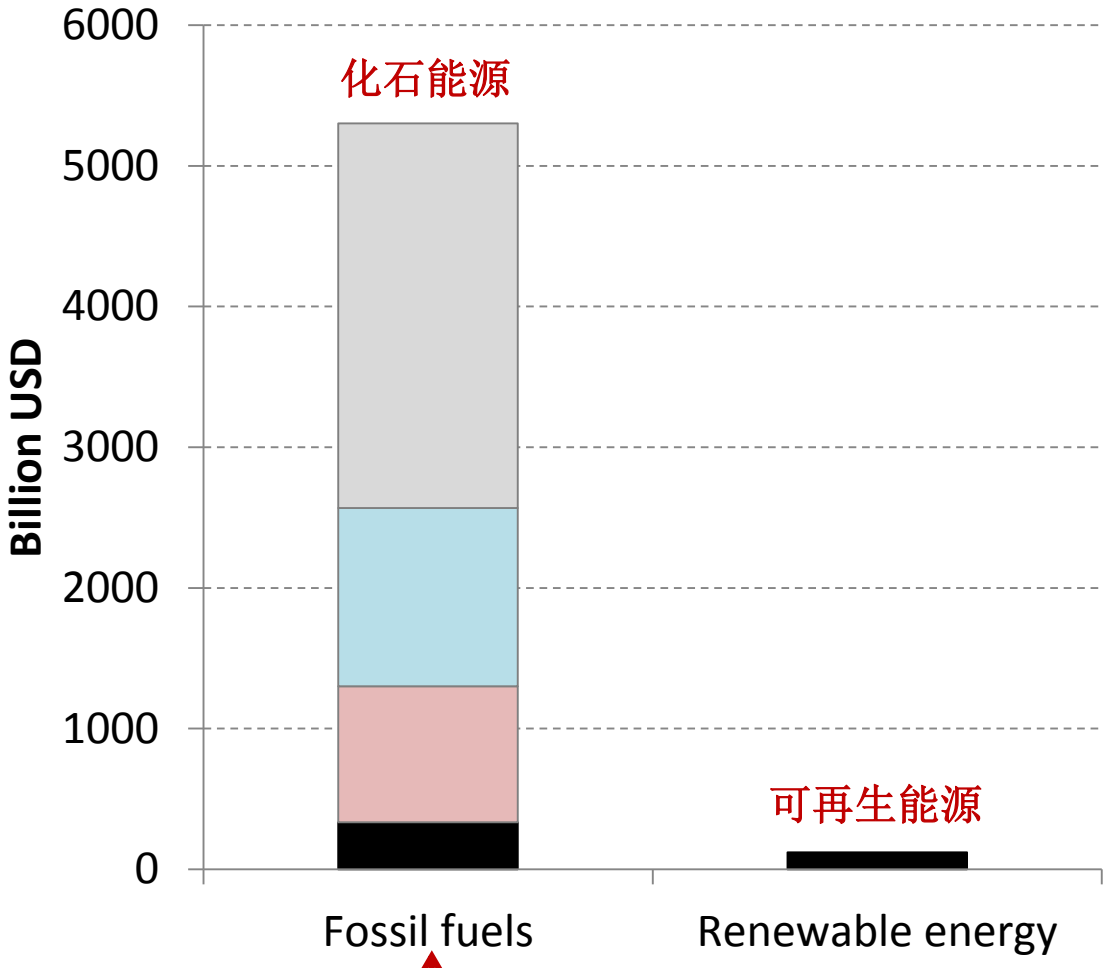
I. Three fundamental observations
三个基本观察
II. The economic argument for energy efficiency
节能的经济性讨论
III. Energy efficient and daylight solutions for new & retrofitted buildings
节能与采光解决方案：新建与既有
IV. Energy Efficient Building Case Studies & Innovations
节能建筑案例与创新

”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”

Mr. Jerry Yudelson (2008)
national board member
US Green Building Council



True Cost of Energy
能源的真实价格



- Health costs from air pollution
  空气污染造成的健康成本
- Damage from extreme weather
  极端气候造成的毁坏成本
- Traffic congestion, accidents, reduced sales tax
  交通堵塞，意外与减少税收造成的成本
- Subsidy
  政府补贴

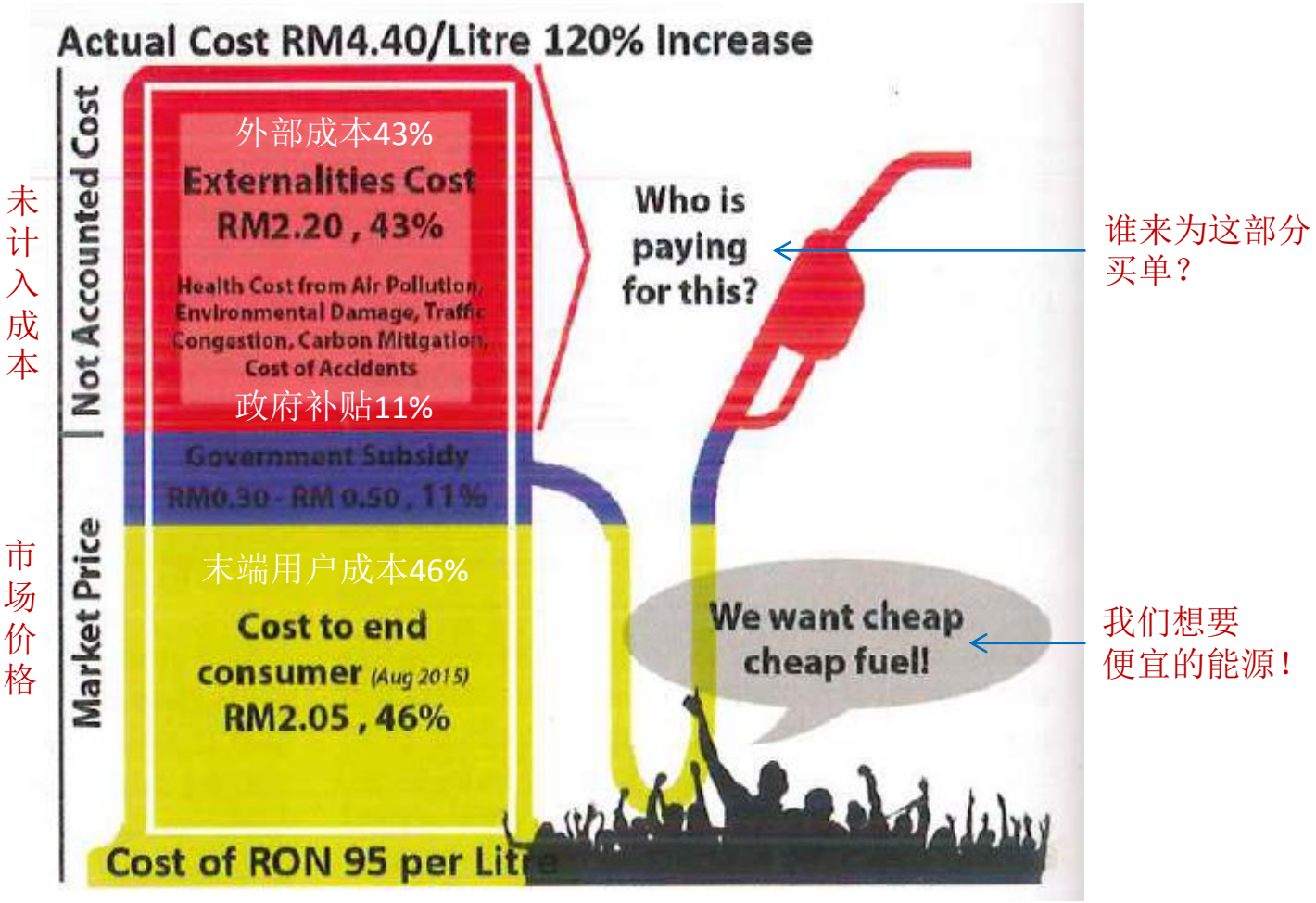
Source：How Large Are Global Energy Subsidies? The International Monetary Fund (IMF), 2015

来源：全球能源补贴有多大？国际货币基金组织（IMF），2015

每年5.3万亿美元的补贴，相当于全球GDP的6.5%！

USD5.3 trillion per year - or 6.5% of the global GDP!

True Cost of Energy
能源的真实价格，以马来西亚为例

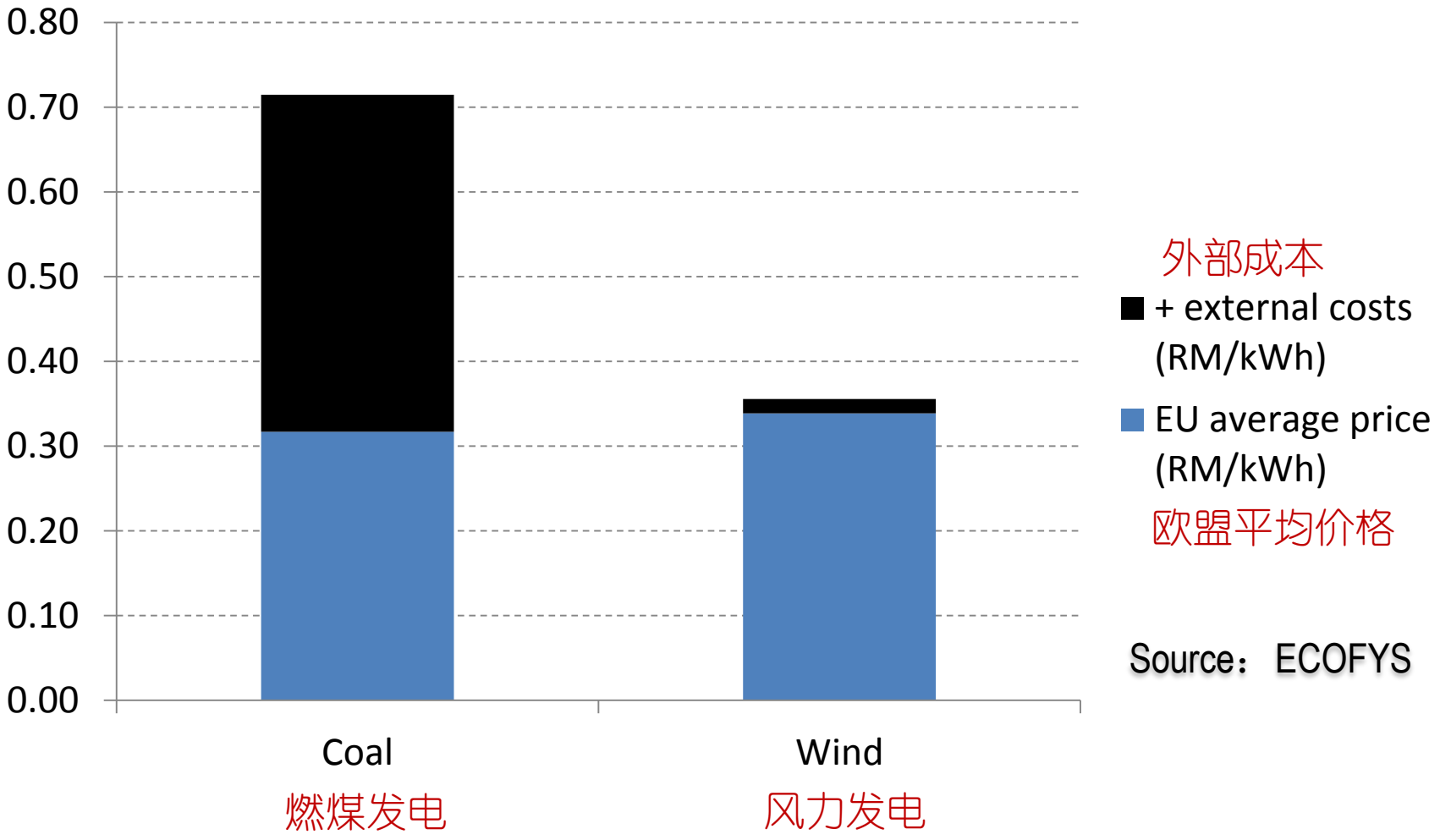


Source： Calling Energy Price Right by the International Monetary Fund (IMF), 2014

来源：正确能源报价，国际货币基金组织（IMF），2014

True Cost of Energy

能源的真实价格，以欧洲为例



极端气候变化的威胁

DENMARK complies to

IPCC recommendation

and

EU short term targets and **EU 2050 roadmap**

for Green House Gas Emission Reductions (80-95% reductions)

为了避免由于温度提升超过2 oC，引发全球灾难性的气候变化

全球最多只能允许5650亿吨的碳排

已探明的全球化石能源碳排量为27950亿吨

Max. global warming to avoid catastrophic climate change

Max. allowed additional global CO_2 emissions

CO_2 emissions from known fossil fuel reserves

Latest status (April 2015):
World heading for 2.9 – 4.2°C

Reached in less than 20 years in a BAU scenario (!)

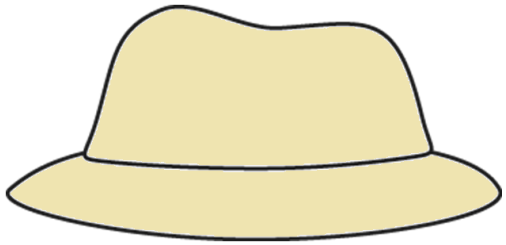
80%的化石能源应被留在地下！

ENERGY EFFICIENCY 节 能

Three Fundamental Observations 三个基本观察

得到一个帽子

GET A HAT



因地制宜的解决方案

LOCAL SOLUTIONS

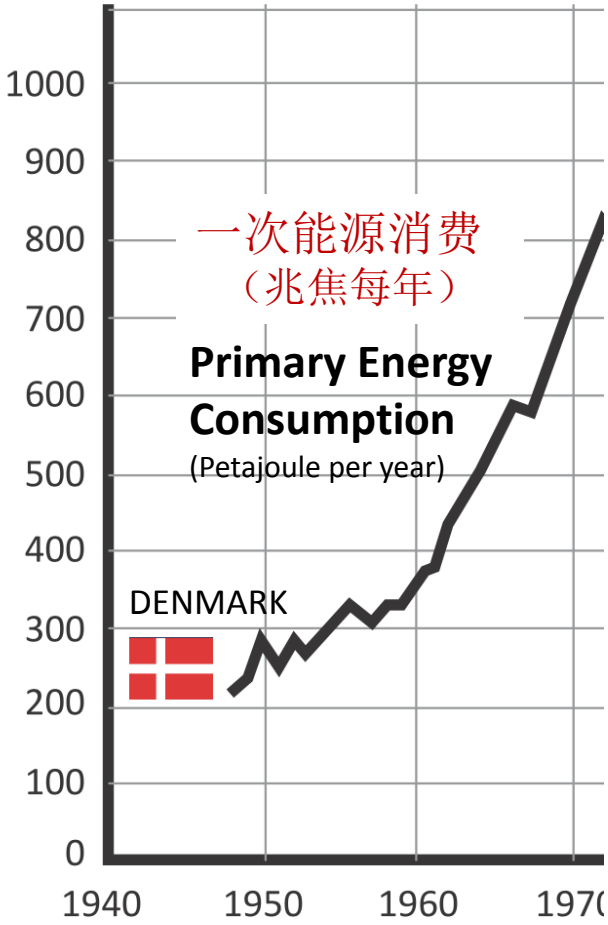
不要带太多的东西

DON'T OVER-PACK

ENERGY EFFICIENCY

Three Fundamental Observations

节 能，三个基本观察



ENERGY EFFICIENCY

Three Fundamental Observations

节 能，三个基本观察

Oil crisis 石油危机

一次能源消费
（兆焦每年）

Primary Energy Consumption
(Petajoule per year)

DENMARK

1973
95% of Danish energy consumption covered by imported oil

1985
Electricity and heating from coal and natural gas
Increased energy efficiency
Oil and gas from the North Sea

2011
High energy efficiency
Large share of renewable energy
Net exporter of energy

2050
Denmark is independent of fossil fuels

Note: The graph excludes energy consumption for international shipping and flights, as well as embodied energy of imported goods

50% energy reduction of the entire building stock (heating per m^2)

降低建筑整体能耗50%（每平米采暖）

Fossil fuels 化石能源

1000
900
800
700
600
500
400
300
200
100
0

1940 1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050

化石能源所占比例：

Fossil fuel fraction: 97% 80% 0%

ENERGY EFFICIENCY

Three Fundamental Observations

节 能，三个基本观察

Oil crisis 石油危机

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Fossil fuels 化石能源

1000 900 800 700 600 500 400 300 200 100 0

1940 1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050

化石能源所占比例：

Fossil fuel fraction: 97% 80% 0%

Case DENMARK: What happened?

丹麦的实例：发生了什么？

Energy Efficiency

- Energy codes
- Energy labels
- Energy efficiency incentives

建筑节能

- 建筑节能标准
- 建筑能耗标识
- 节能激励政策

Green Transportation

- Walkable City
- Fast & Safe Cycling
- Expensive to Drive

绿色交通

- 步行的城市
- 完善的自行车系统
- 开车、停车很贵

Renewable Energy

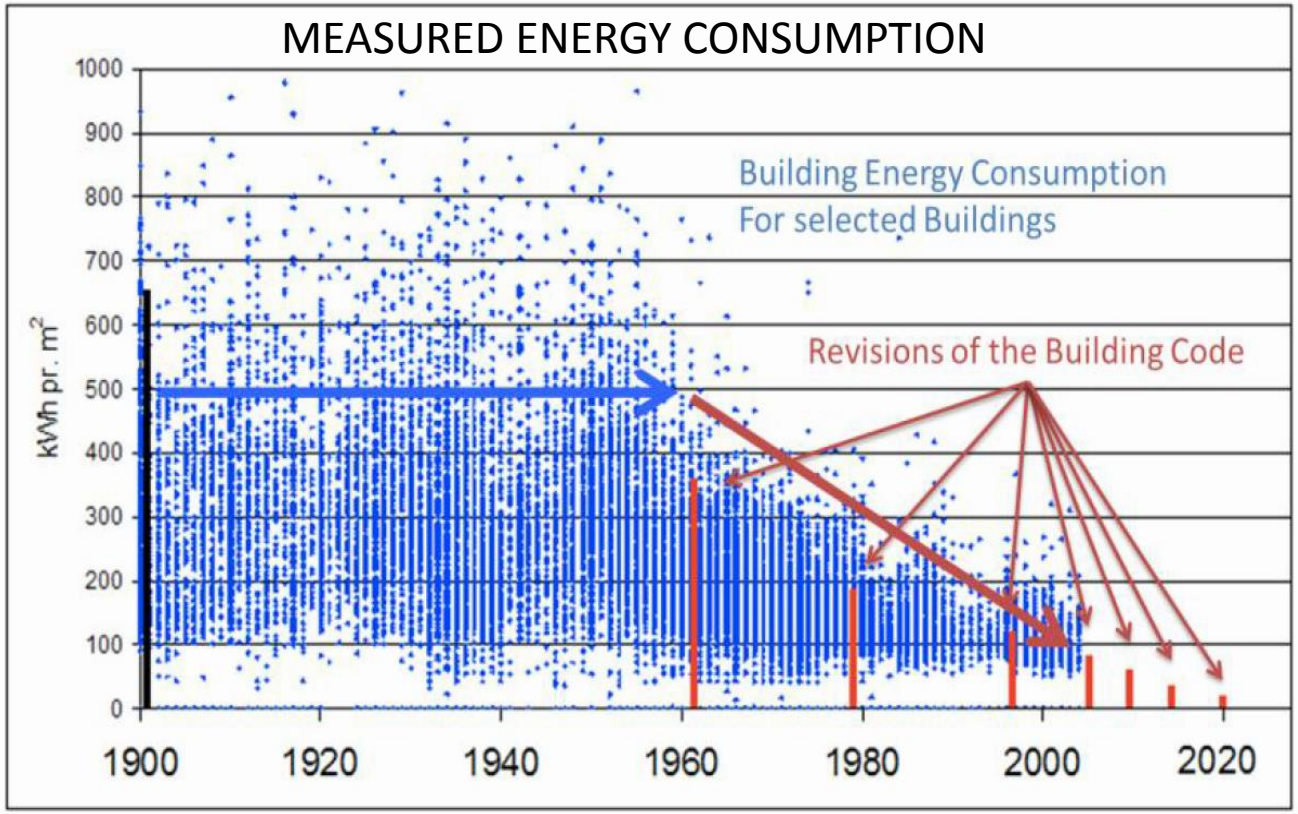
- Wind, Solar and Biomass
- No Nuclear
- Waste to Energy

可再生能源

- 风能、太阳能与生物质能
- 反对发展核能
- 变废物为能源

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%



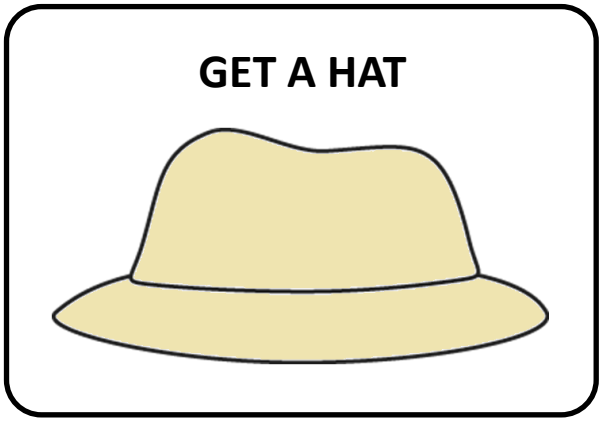
每隔5年颁布未来10年的强制执行新的建筑能耗限值，kWh/m2/year

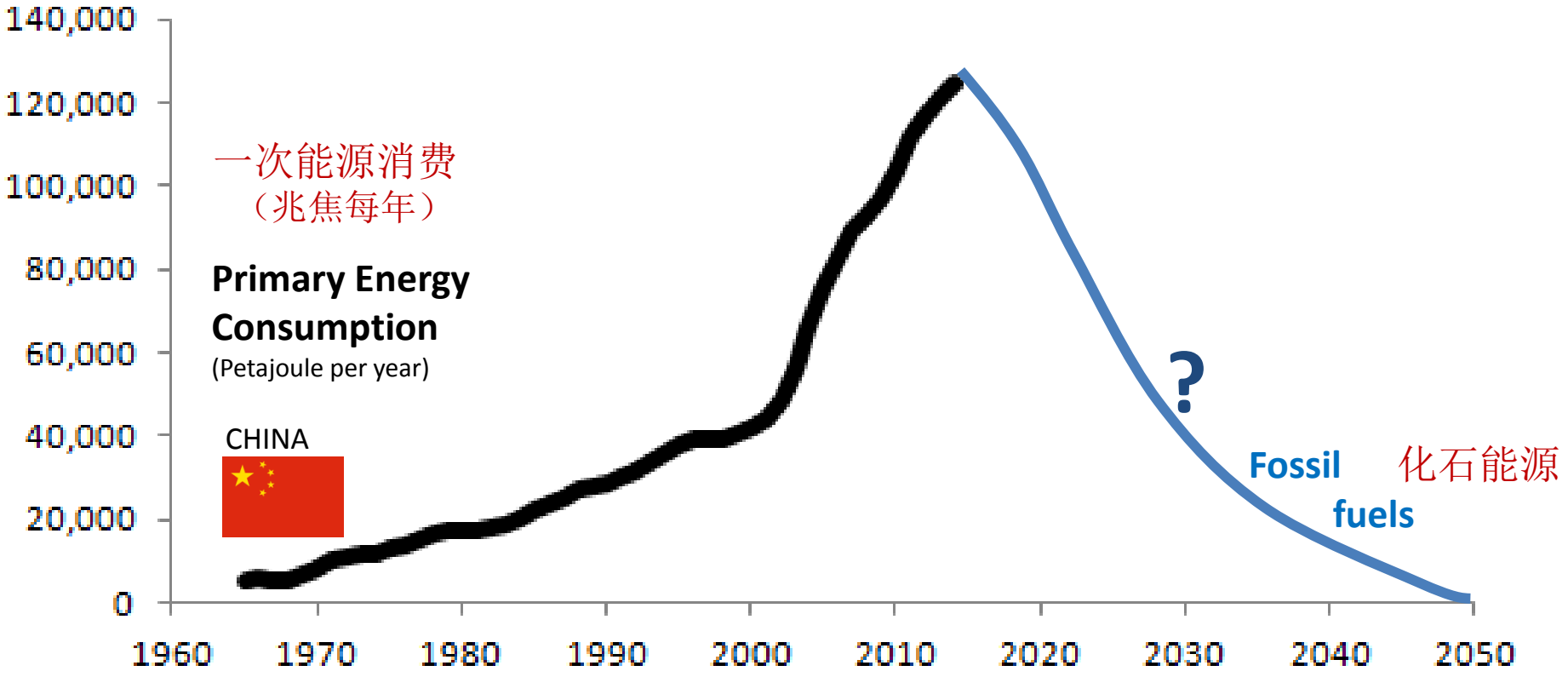
Mandatory energy efficiency building codes that were made stricter approximately every five years and announced ten years ahead.

ENERGY EFFICIENCY

Three Fundamental Observations

节 能，三个基本观察





化石能源所占比例：

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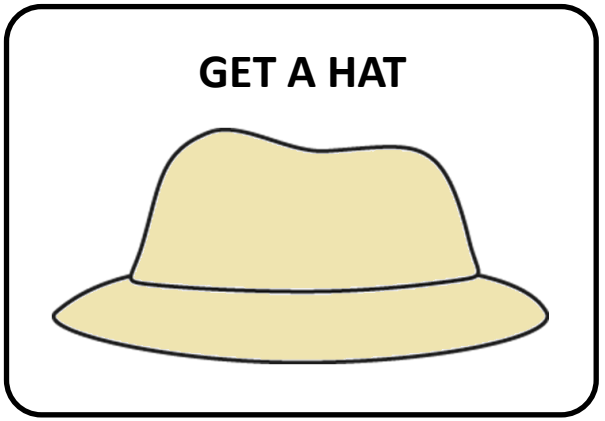
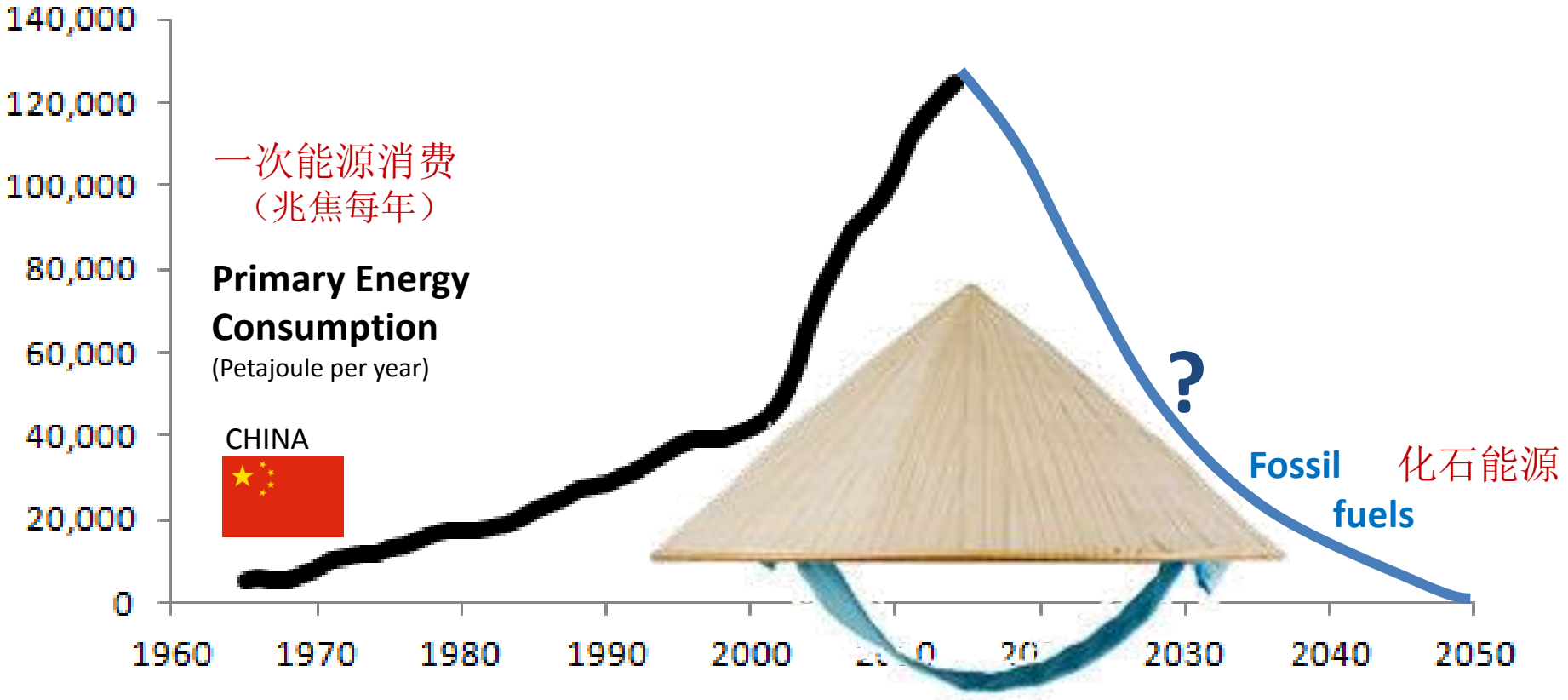
ENERGY EFFICIENCY

Three Fundamental Observations

节 能，三个基本观察



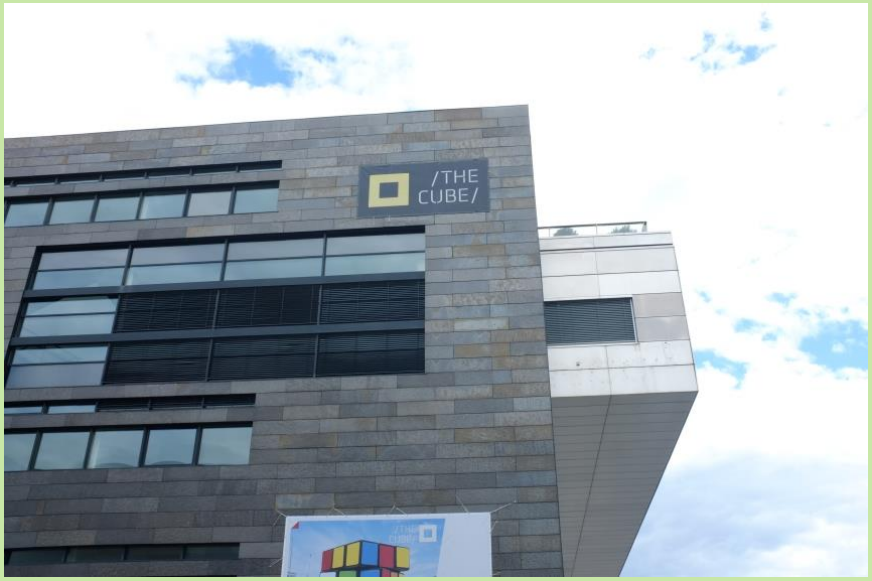


化石能源所占比例：

Fossil fuel fraction: 90% 0%

Case study no. 1　参考案例一

首个依靠自动控制自然通风的办公建筑



Passive Low Energy Building case study

CUBE/THE NCC BUILDING

COPENHAGEN DENMARK, 2000

哥本哈根，丹麦，2000

Image courtesy of SHL (architects for the project)

LOCAL SOLUTIONS

CUBE/The NCC Building

Pioneering office building to be fully naturally ventilated with window automation

首个依靠自动控制自然通风的办公建筑

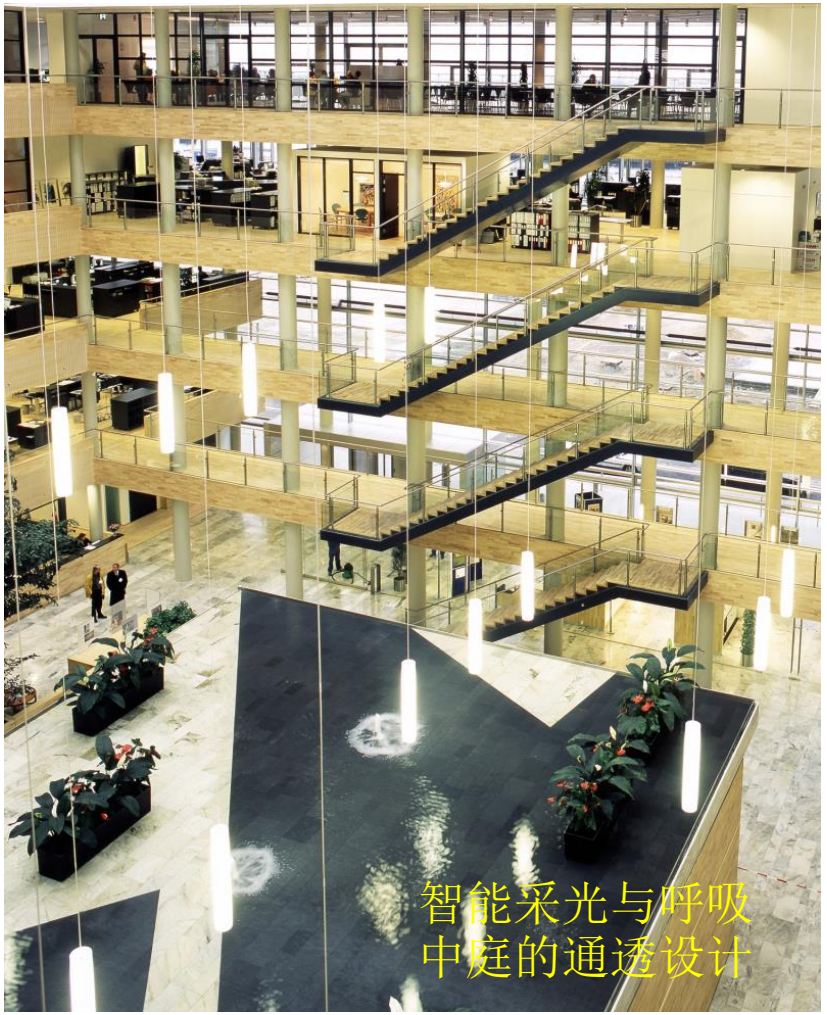


Image courtesy of SHL (architects for the project)

CUBE/The NCC Building

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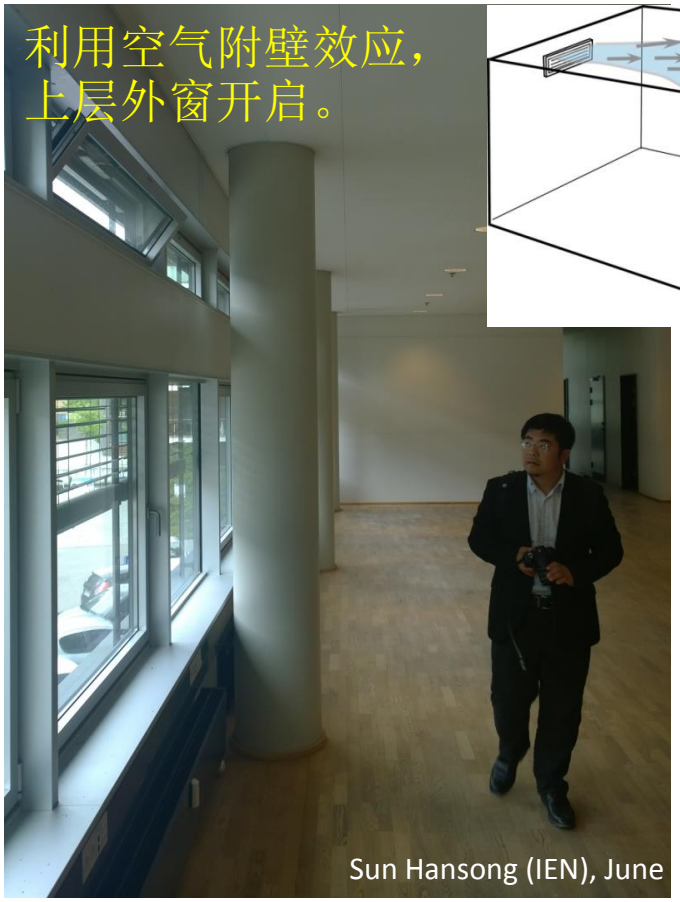

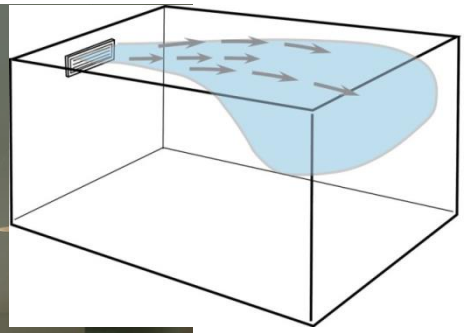

Coanda Effect

for natural ventilation where the air clings to the ceiling surface and discomfort from draught is avoided

Window & External Blind Automation

The top windows are opened automatically for temperature and fresh air regulation.
The external blinds automatically block direct sun light and have manual override.
Both automation systems are still operating after 15 years

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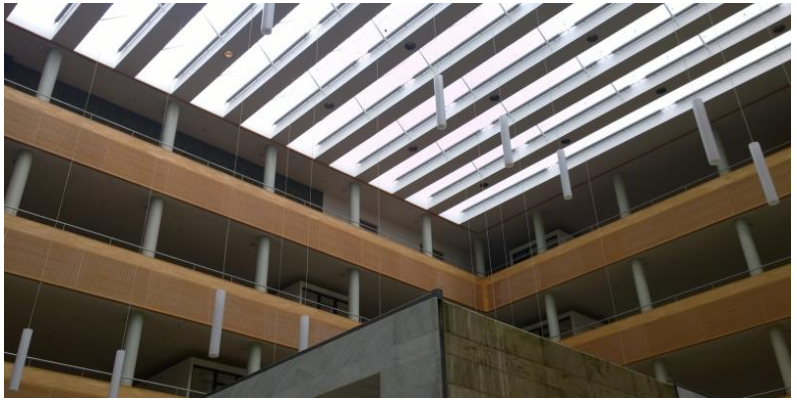
CUBE/The NCC Building

Pioneering office building to be fully naturally ventilated with window automation

首个依靠自动控制自然通风的办公建筑

Image courtesy of SHL (architects for the project)



White Noise from Fountain & Air Storage

Splashing water stops voices across the atrium. Atrium is filled with fresh air at summer nights, so windows can be kept closed during hot days and still meeting the fresh air requirements

Diffuse daylight from North facing skylights

The skylight windows face North away from the sun and the daylight in the atrium becomes diffuse, soft and pleasant.

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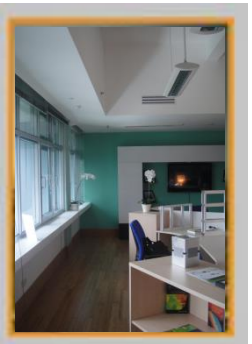
Low Energy Buildings with Good Payback time
低能耗建筑具有良好的回收期

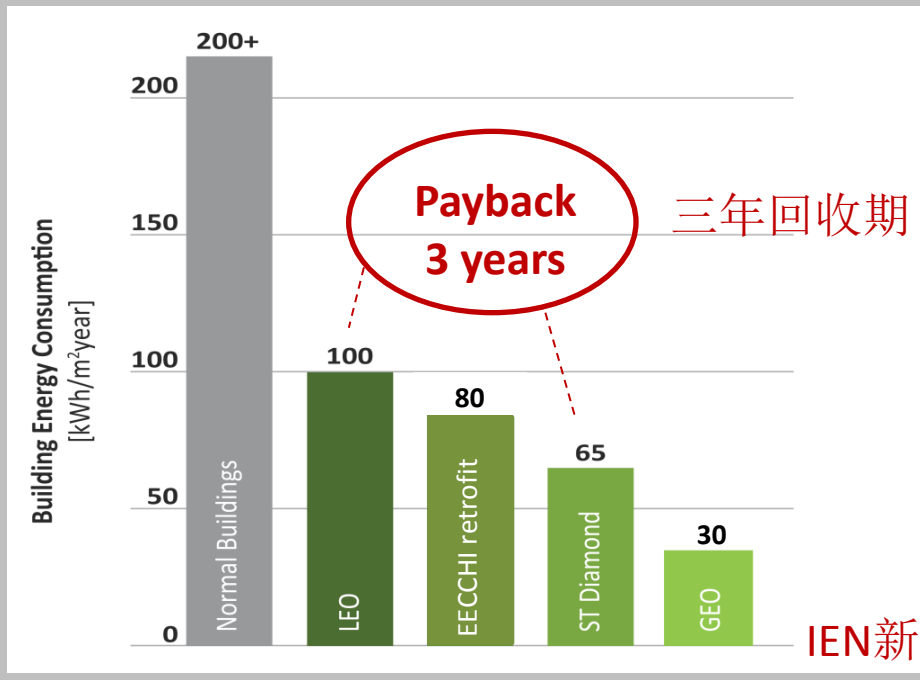
LEO Building

GEO Building

ST Diamond Building



EECCHI retrofit



Energy Consumption of Green Office Buildings

Measured data for New and Retrofitted Buildings by IEN Consultants

IEN新建与既有建筑项目的实测能耗数据对比

Completion year	-	2004	2010	2010	2007

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CONCLUSION　结论

”Expensive NOT to go green”

Plug the holes

堵上能耗漏洞

统筹规划，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!

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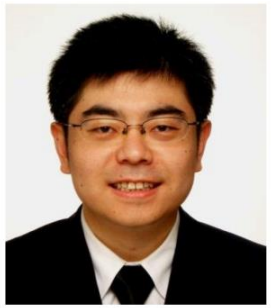
谢 谢！
THANK YOU!

请联系我们

Gregers Reimann,
Managing Director
M +60 122755630
gregers@ien-consultants.com

Kevin Sullivan
Director, Singapore
M +65 92710067
kevin@ien-consultants.com



Sun Hansong
Director, China
M +86 15210220818
hansong@ien-consultants.com

IEN CONSULTANTS

www.ien-consultants.com

Visit us at exhibition booth no. 2141

Appendix slides

ENERGY EFFICIENCY

Three Fundamental Observations

节 能，三个基本观察

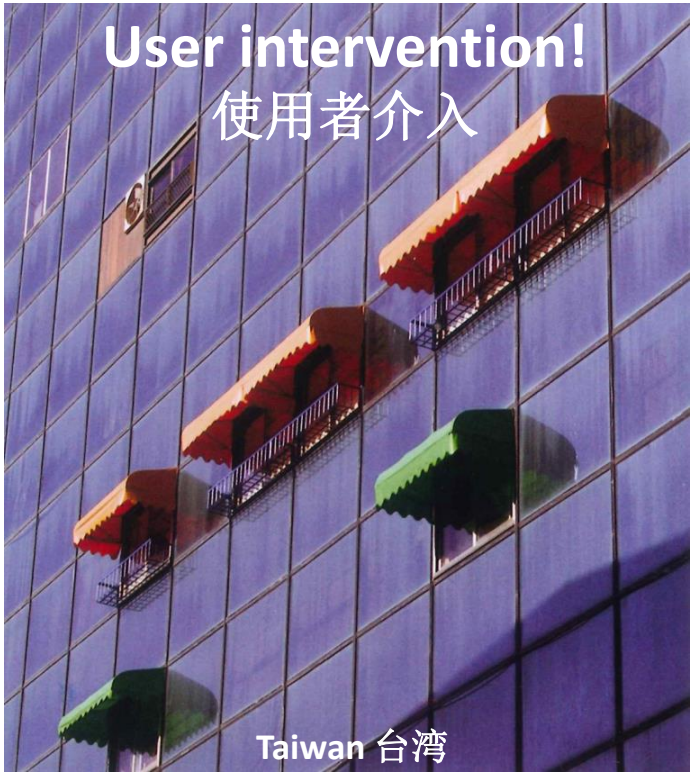
LOCAL SOLUTIONS

Full height glass
Wonderful design!?

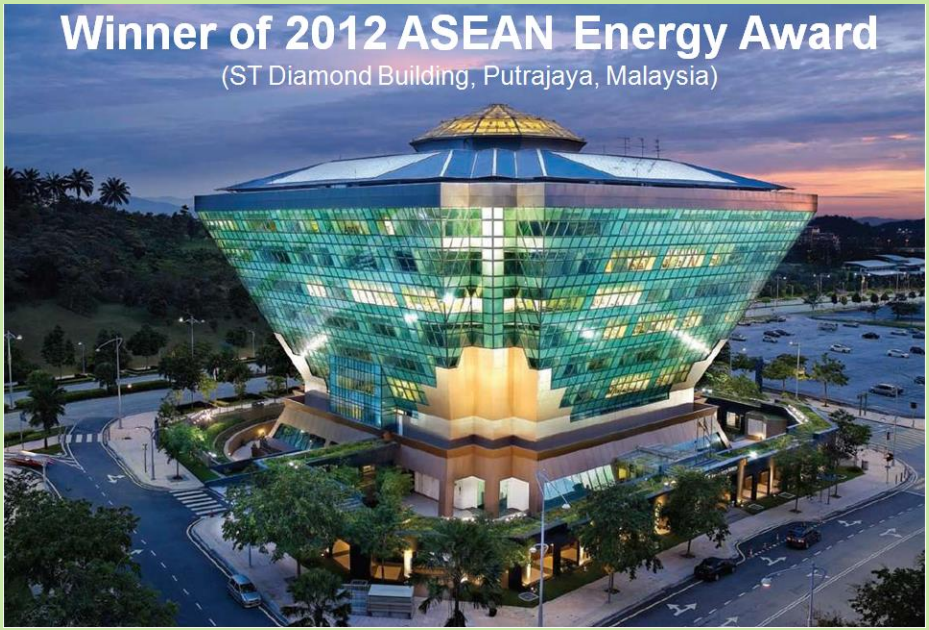
全玻璃幕墙

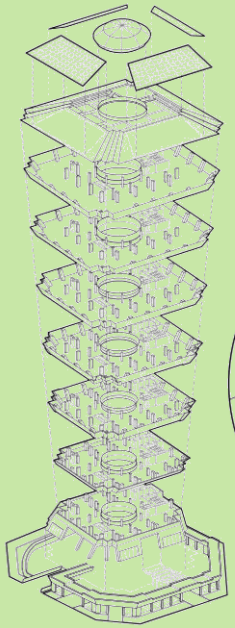
Glary & hot Blinds
everywhere

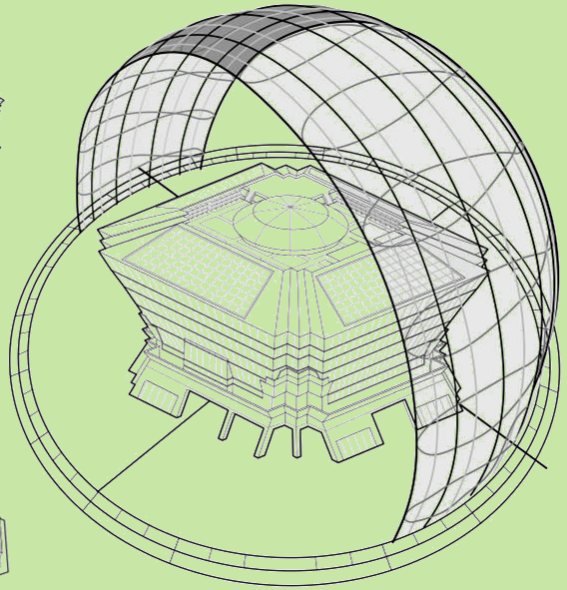
到处都是
眩光、热、窗帘



Case study no. 2　参考案例二







Energy Efficient Office case study

DIAMOND BUILDING

(SURUHANGJAYA TENAGA, 2010)

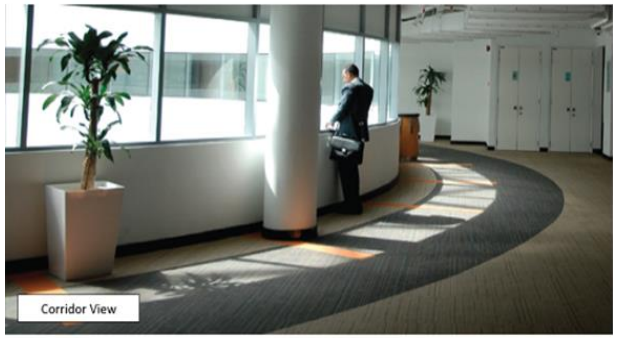
钻石大厦，马来西亚，2010

LOCAL SOLUTIONS

1/3 Energy Consumption

(Measured 4 years of data)

三分之一的能耗，基于四年的实测数据



Key Data

Gross Floor Are: 14,000sqm

Year of Completion: 2010

Building Energy Intensity: 69kWh/m2*year

Total Construction Cost: RM60mil

Additional EE Cost: 3.2%

Payback Period: **< 3years**

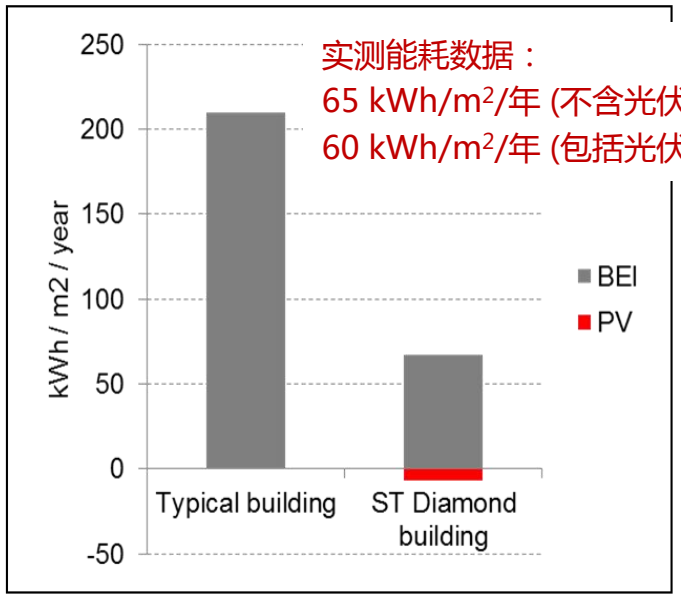
IRR: 34% (based on 7year Lease Term)

GBI **Platinum**

Green Mark **Platinum**

2012 ASEAN energy award **Winner**

东盟能源大奖



实测能耗数据：

65 kWh/m²/年 (不含光伏),

60 kWh/m²/年 (包括光伏),

2013 ASHRAE Technology Award (2nd place)

美国暖通工程师协会技术大奖（第二名）

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Similar design with Sarawak Longhouse

(in the book “The Cooperation”, 2012)

钻石大厦外形与当地土著居民的长屋类似

Examples and Initiatives

Malaysia and Denmark's, commitment to the field of

Green Energy in Architecture

as well as in cooperation and capacity building within the field, can be illustrated by the mutually beneficial involvement of IEN Consultants with the development of this field in Malaysia over the years. IEN Consultants was originally a proprietorship established by a Danish Chief Technical Advisor involved in the identification of energy projects in Malaysia. When the company took on the LEO Building projects it gained recognition in Malaysia and IEN Consultants managed to build up a team of consultants, most of them Malaysian, who with their experience on the LEO Building, became known further afield. This helped gain further commissions on such projects as the Green Tech Building and what has become known as The Diamond Building in Putrajaya.

“Green Buildings” are perceived to be expensive, both because of the costs of employing the expertise necessary to develop and refine the building and system designs, and because of the relatively high capital costs of green technology items. It takes time for reduced operating costs, which come with reduced energy usage, to counterbalance the increased capital investment and this has been a significant brake on development worldwide. However, given that approximately 40% of worldwide carbon emissions come from buildings, it is clear that the there is a need for the “greening” of buildings to make a significant contribution to carbon reductions.

As a result much effort has gone into the dissemination of green ideas to the Malaysian building industry, including the idea that the advantages of reduction of whole life costs of buildings as opposed to just capital costs are worthwhile. The fact that some “green” input to building design in Malaysia has moved from a subsidised base, using for example Danish funding for the LEO Building and European Union funding for the Green tech Office Building, to a fully Malaysia funded base in the case of the so-called “Diamond Building” indicates some success in changing attitudes to operating costs vs capital costs ascribed to “Green Buildings”.

Improved energy efficiency is already recognised by the Malaysian government to be more important than mere certification under the Green Building Index (GBI) scheme. That scheme therefore carries tax and stamp duty benefits to encourage the real application of green ideas in the design and operation of buildings.

Beyond this, IEN Consultants is now involved with a UNDP funded project, with the Ministry of Works, to promote low carbon buildings in Malaysia. It is hoped, amongst other things that it will lead to a building code by 2015 specifying much lower carbon footprints even than the LEO Building or the Diamond Building.

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Modern sunshade
Diamond Building in festive season lighting

Traditional sunshade
Rungus Longhouse, Sabah

Another major area of involvement was in

Capacity Building for Malaysian Industry and Academia in EE Building design.

The objective of the scheme, which was implemented by the Ministry of Energy, Communications and Multimedia (now Ministry of Energy, Green Technology and Water), was to develop capacity in the optimisation of energy efficient building design. This was done through training sessions, seminars, specific analysis of existing buildings and design development of new buildings. A key partner in this endeavour was the Public Works Department (JKR) and there was close cooperation with Schools Division and Healthcare Division, so the lessons learned were comprehensive, and the dissemination of the results widespread.

The project produced reports outlining design strategies for new buildings, making lessons learned from the LEO Building described above available to practitioners and academics across Malaysia. The project also produced reports on “Energy Efficiency Promotion: Lessons Learned and Future Activities”, and undertook an evaluation of JKR design standards.

The project certainly raised awareness and improved the country's knowledge base regarding energy efficiency in buildings and made recommendations to Ministry of Energy, Green Technology and Water and JKR to set up demonstration offices, a very successful example of which was in Wisma Damansara.

Examples and Initiatives

047

Result of many SIMULATIONS

许多电脑模拟的结果

Result of many GENERATIONS

许多代人努力改进的结果

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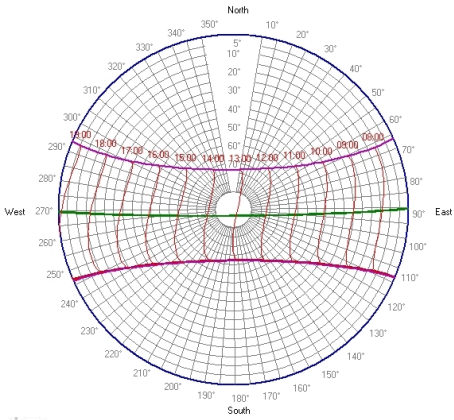
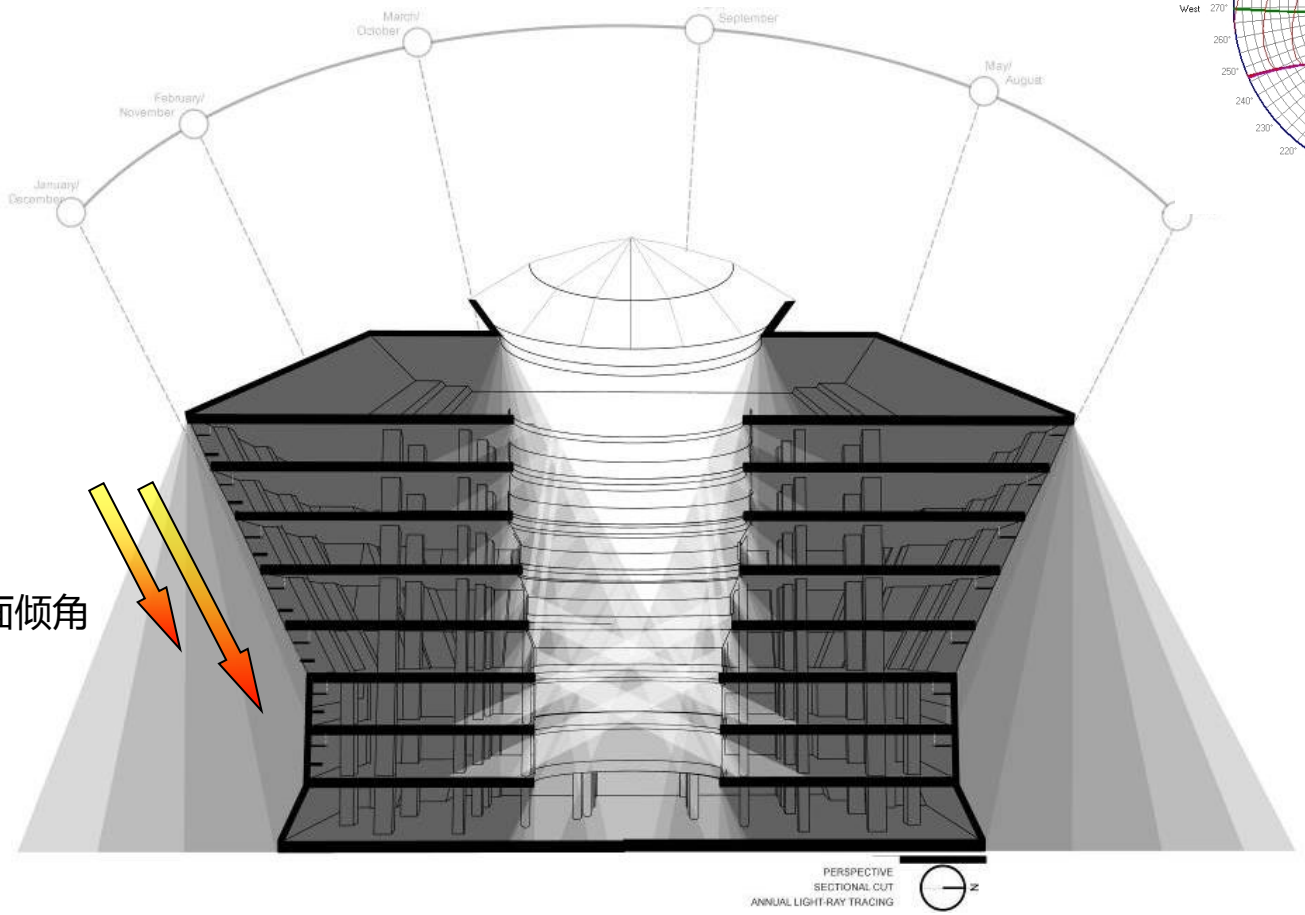
Book available free online:

http://um.dk/da/~/media/Malaysia/Documents/Other/Book%20Finalist%20LR.ashx



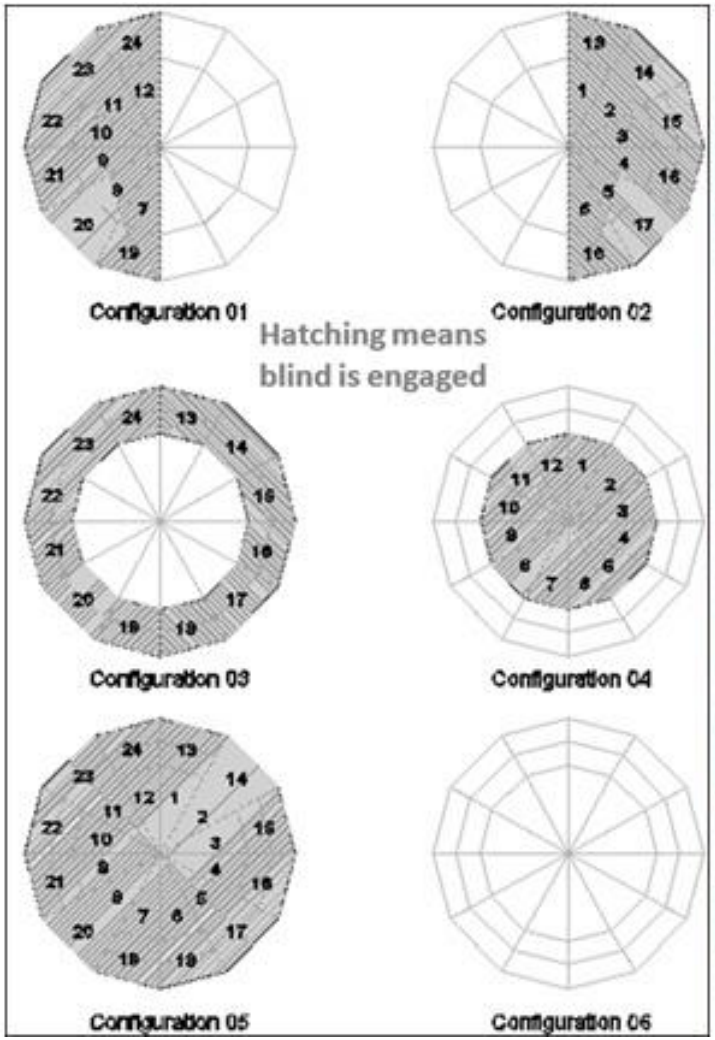


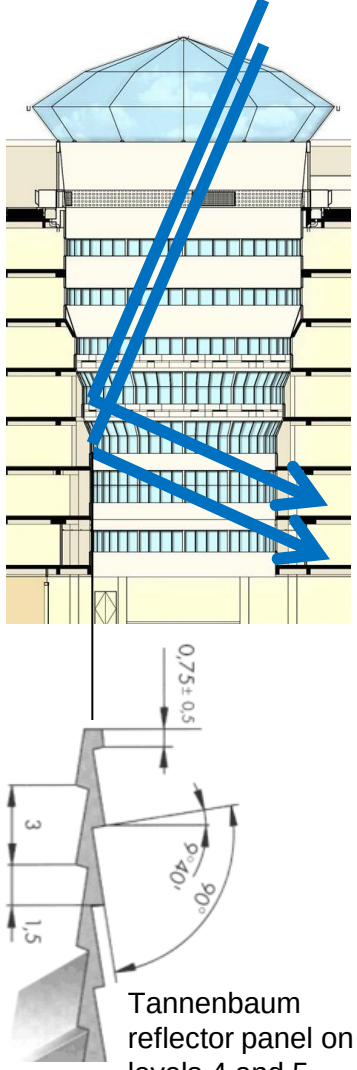
25° 外立面倾角

The building design allows for ample internal daylighting via the atrium and self shading on the north and south facades.

建筑的中庭设计允许充分的建筑内区自然采光，同时建筑巧妙的体型设计允许建筑南北立面自己给自己遮阳。


智能采光与呼吸中庭





Tannenbaum reflector panel on levels 4 and 5

Atrium Daylight Design

The atrium has been carefully designed optimize daylight utilization for each floor employing the combin strategies:

新型反光材料，增强反光率，去除眩光，并改变光线方向至最最要阳光的低层办公区域

1. Automated blind with six different configuration to maintain the appropriate daylighting levels at all times. The blinds v adjusted every 15 minutes and follow a three different control strategies for morning, mid-day and evening
2. The windows size becomes larger deeper into the atrium to cater for lower daylight levels
3. A band of Tannenbaum reflector panels are applied to 4th and 5th floor to deflect daylight across the atrium to 1st and 2nd floor where daylight levels are the lowest. The 'christmas tree' profile reflectors have an inclination of 10° and reflect about 85% of the light in semi-diffuse manner, hence, avoiding visual glare issues for the building occupants.

Diffuse light deflected into room by lightshelf and window sill

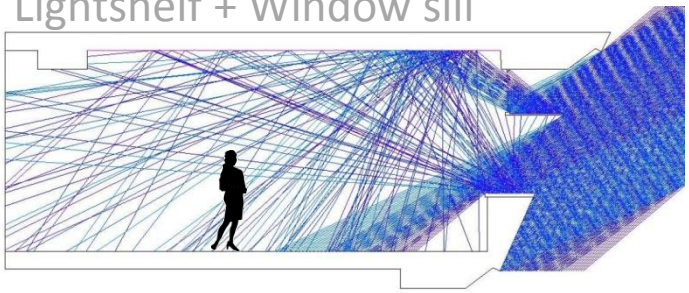
漫射光通过导光板与窗台斜射入室内

建筑自遮阳防止太阳直射入室内

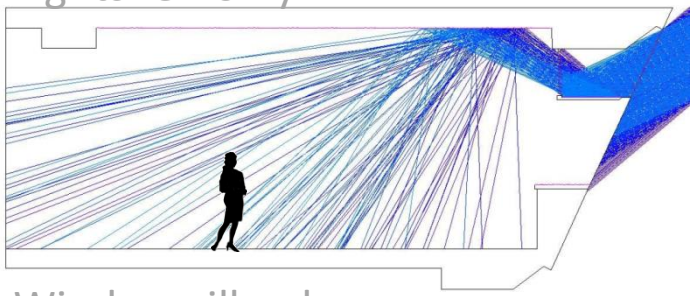
Self-shaded facade from direct sun

LIGHT REFLECTIONS FROM:

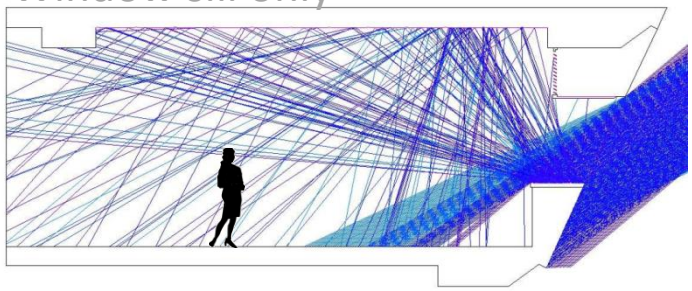
Lightshelf + Window sill



Lightshelf only



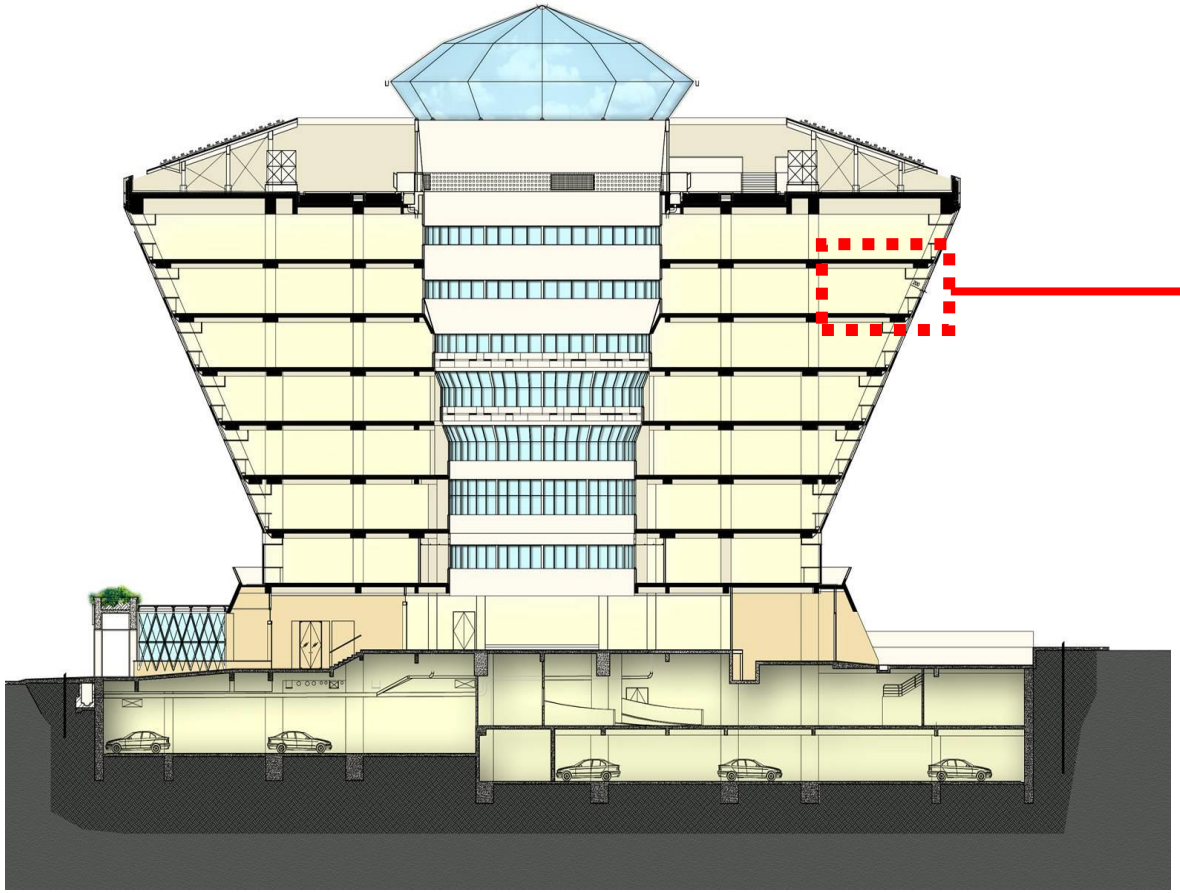
Window sill only



自然采光模拟方案对比

Façade Daylight Design

The building is 50% daylit. The façade daylighting system consists of a mirror lightshelf and a white painted window sill. Both deflect daylight onto the white ceiling for improved daylight distribution until 5 meters from the façade + 2 additional meters of corridor space. Installed office lighting is 8.4 W/m2, but 1-year measurements show consumption of only **0.9 W/m2** showing high reliance on daylighting



Mirror lightshelf

镜面导光板

Fixed blinds for glare control

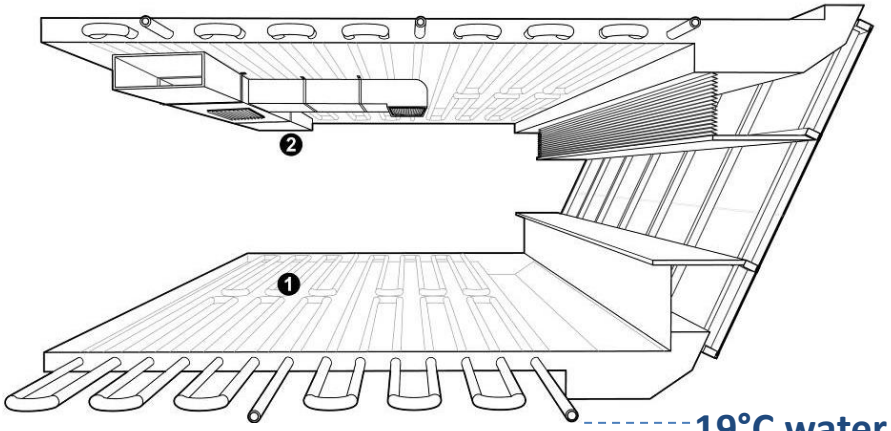
特定角度的固定百叶控制眩光

Daylight reflected onto ceiling

自然光被反射到天花板

Floor Slab Cooling in Diamond Building
结构埋管辐射制冷系统（TABS）

Floor slab cooling system embedded in RC slab



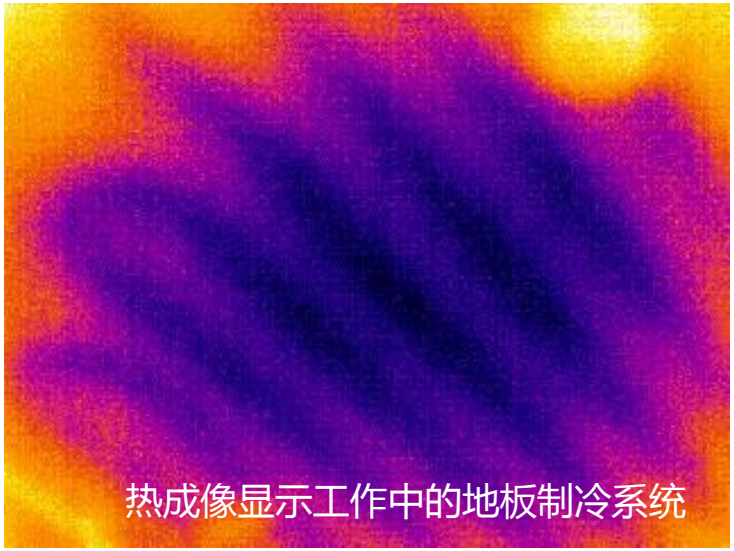
19°C water

COP of 16 possible!

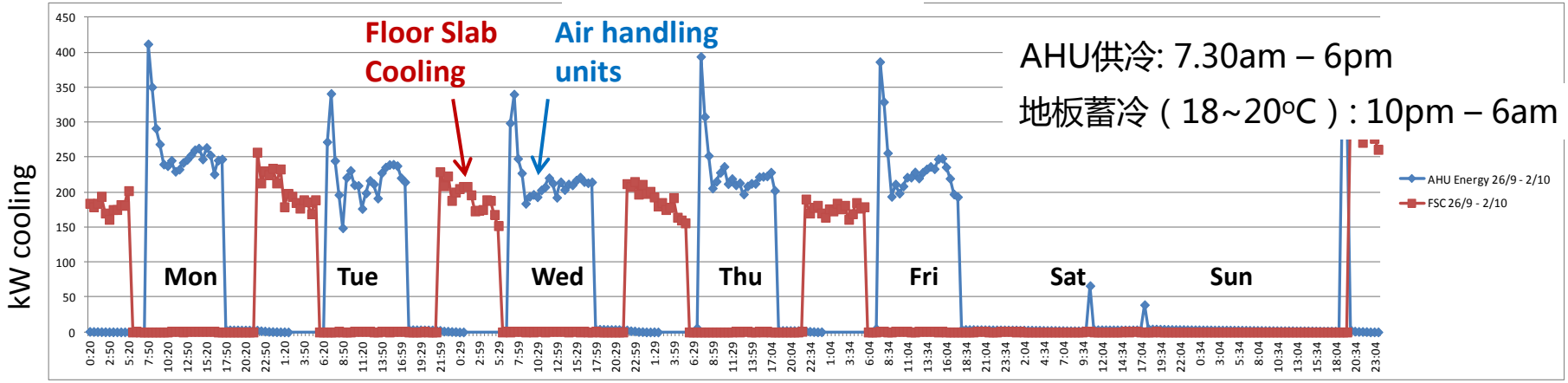
冷冻水温度19度，

COP最大可以达到16！

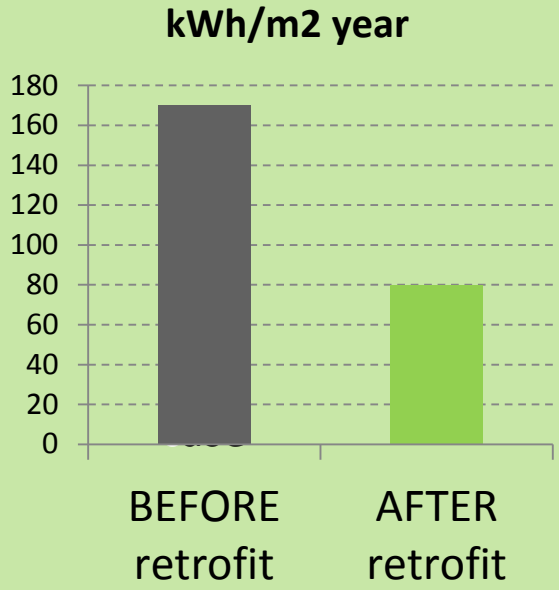
Illustration courtesy of:
Greening Asia – Emerging Principles for Sustainable Archi
Copyright: Nirmal Kishnani, 2012. Publisher: FuturArc



ermographic image of floor slab cooling in ST Diamond
cture courtesy of: PS Soong, Pureaire



Case study no. 3　参考案例三



Energy Efficient Retrofit case study

EECCHI OFFICE RETROFIT

办公室节能与环境改造

(JAKARTA, 2011)

雅加达，印尼，2011

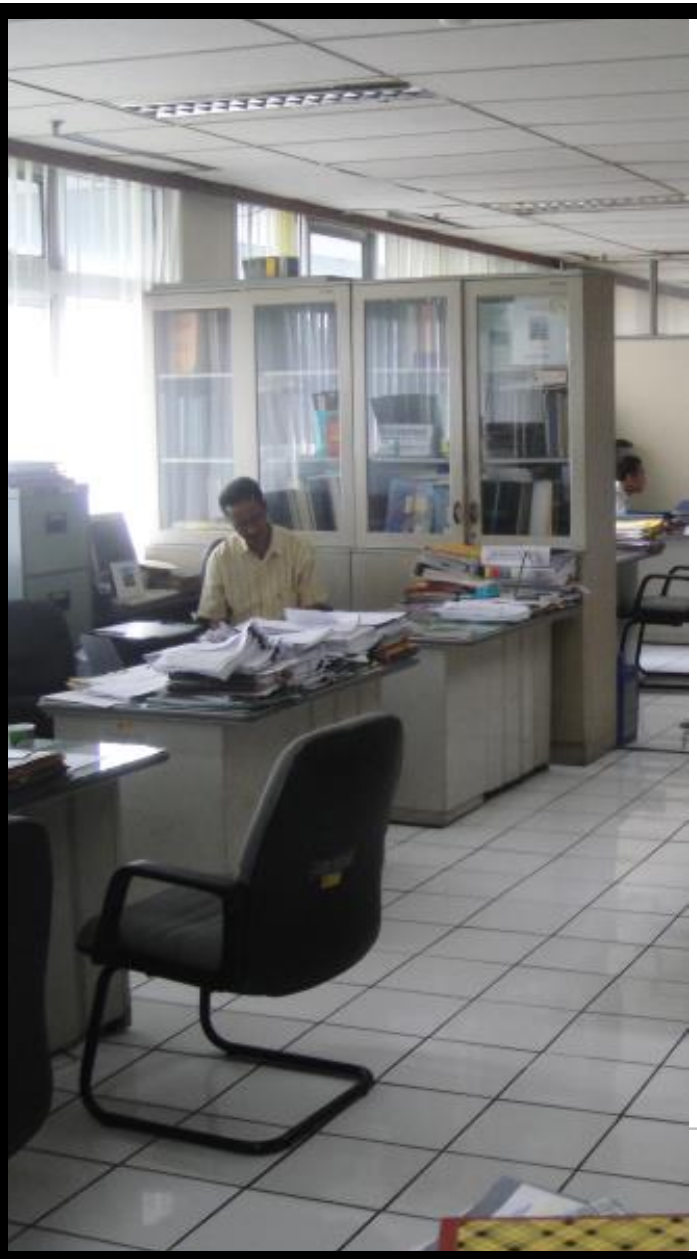
LOCAL SOLUTIONS

改造前

BEFORE

改造后

AFTER



Energy 能耗

170	80
kWh/m² yr	kWh/m² yr

Comfort 舒适

26-31	24-26
temp (°C)	temp (°C)
75	55
RH (%)	RH (%)

Noise 噪声

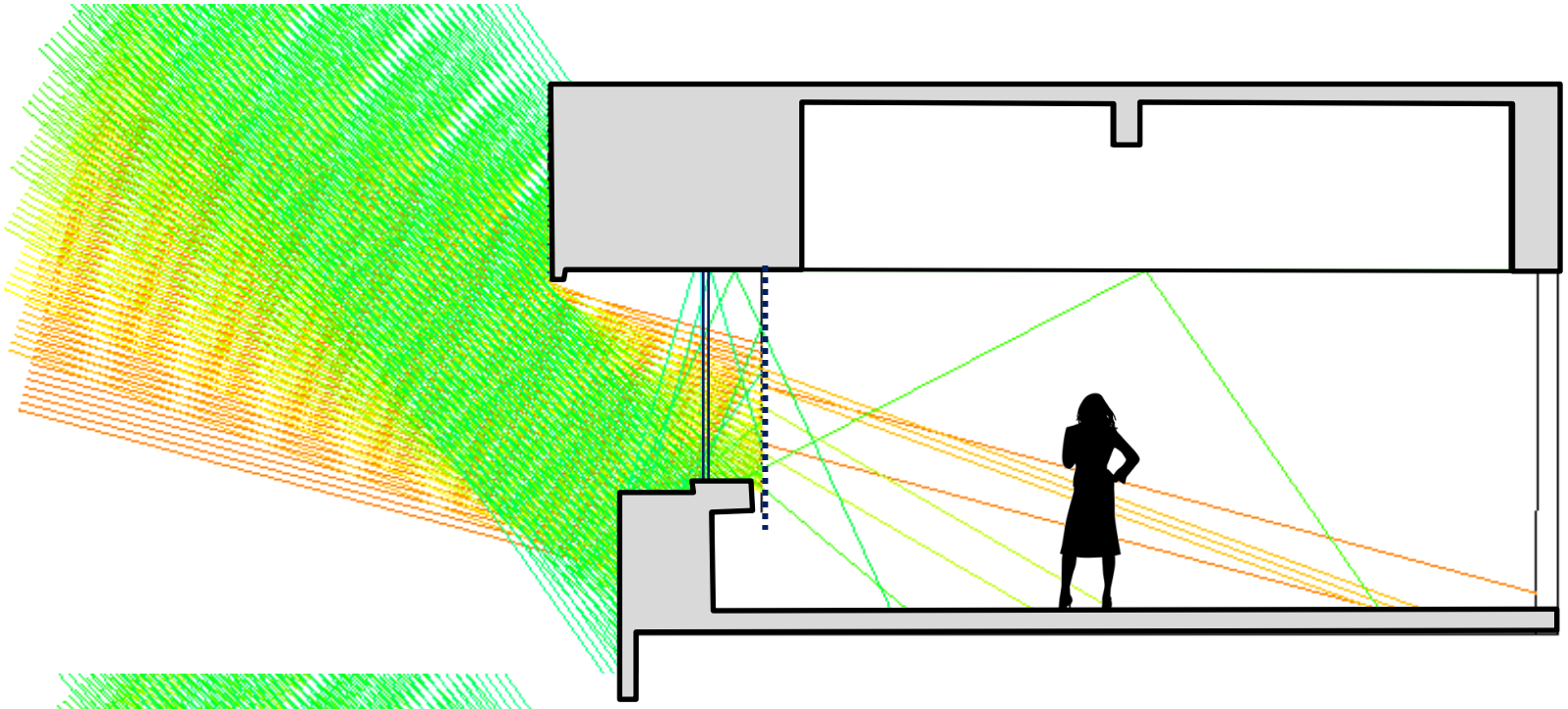
57	53
dB	dB

Daylight 采光

No	Yes

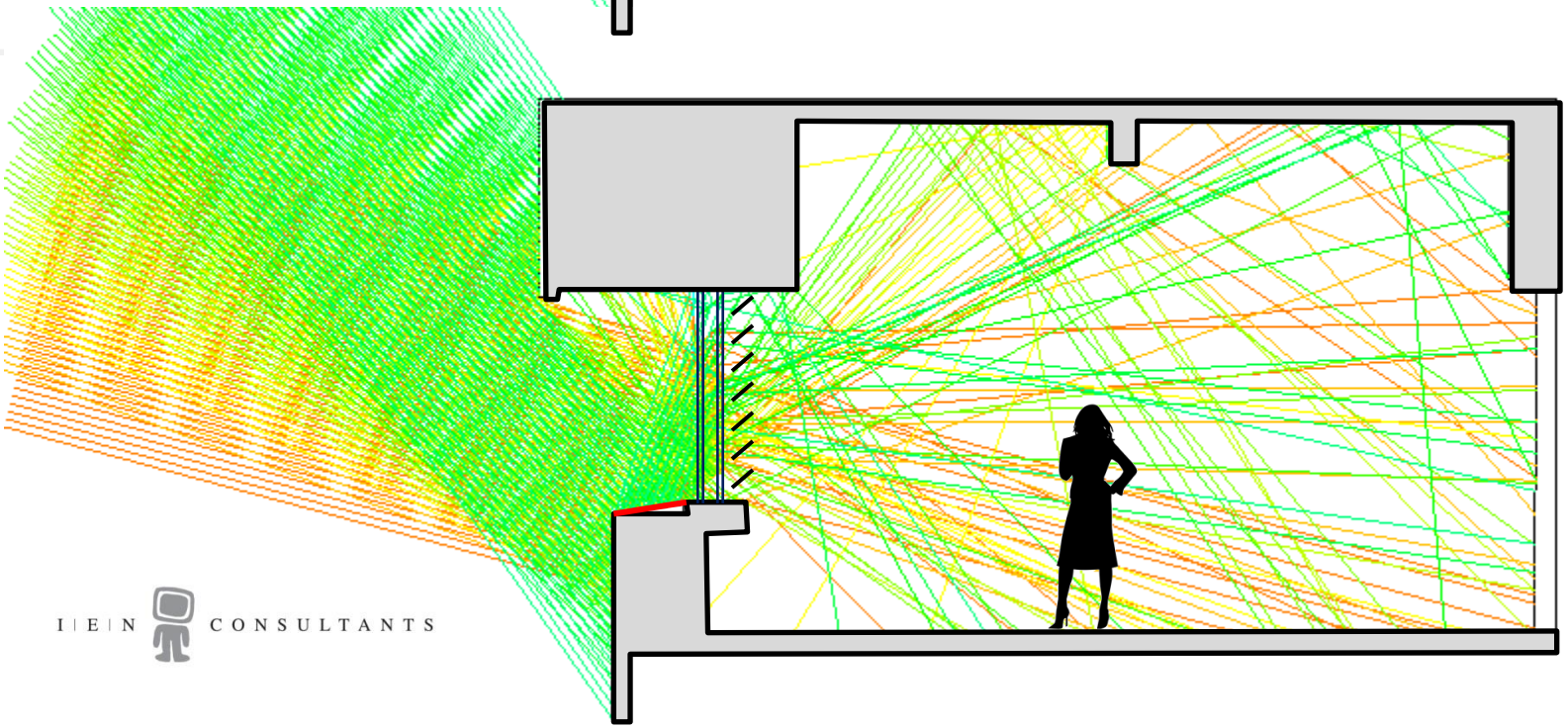
View out 视野

No	Yes



BEFORE RETROFIT

- Vertical blinds blocking most of the daylight
- Suspended ceiling
- Central air-conditioning
- Leaky windows

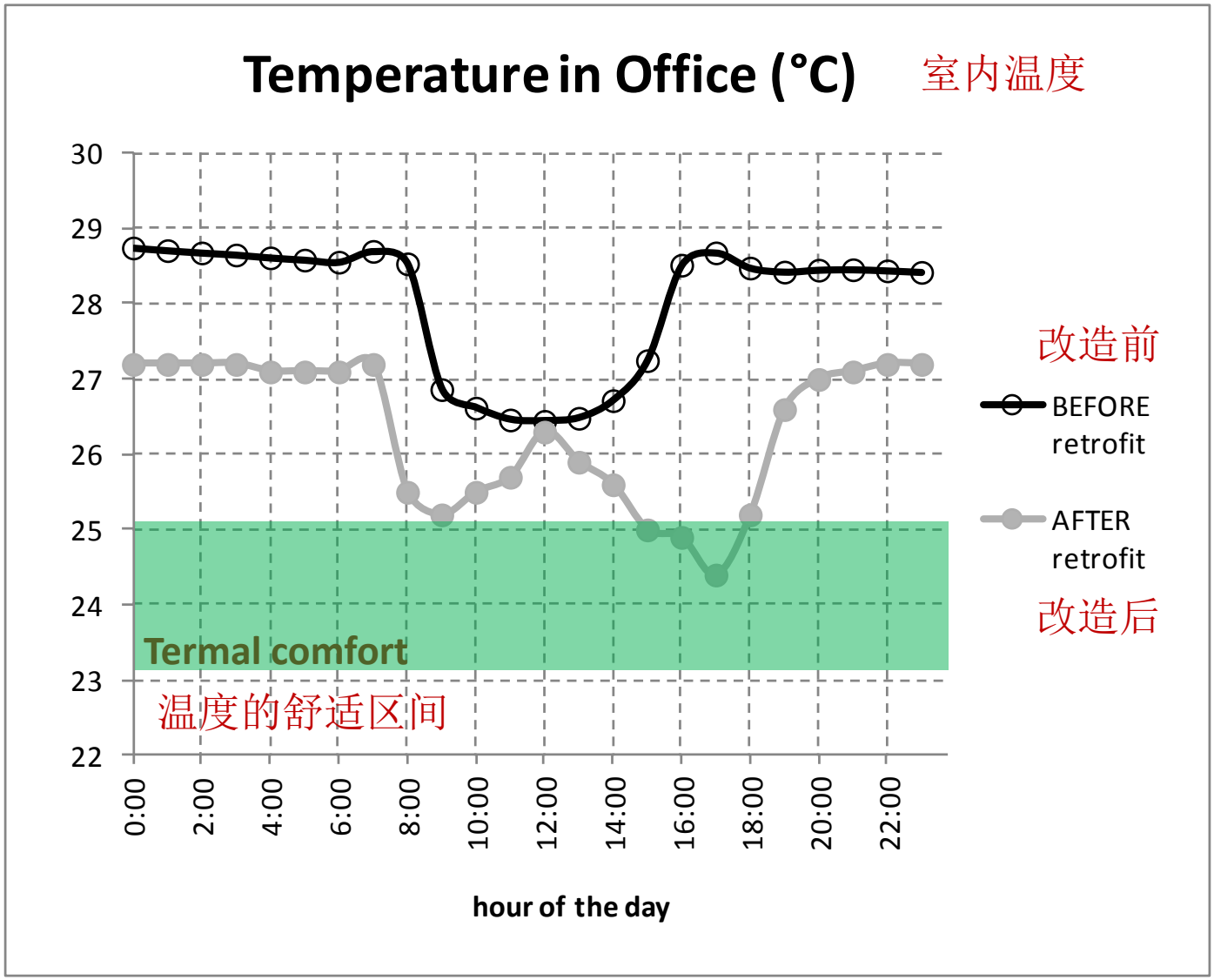


AFTER RETROFIT

- Mirror lightshelf on external ledge reflecting diffuse daylight onto the high ceiling (suspended ceiling removed)
- Perforate venetian blinds
- Extra window pane
- VRF air-con with CO_2 sensor

I | E | N CONSULTANTS

Measured indoor climate: Before vs. After



Case study no. 4　参考案例四

ZERO Energy Bungalow

EARTH BERM HOUSE

零能耗别墅

(KUALA LUMPUR, 2015)

吉隆坡，马来西亚，2015

LOCAL SOLUTIONS

INNOVATION: Night Sky Cooling

Bungalow 100% natural cooling, no air-conditioning

技术创新：夜晚天空制冷

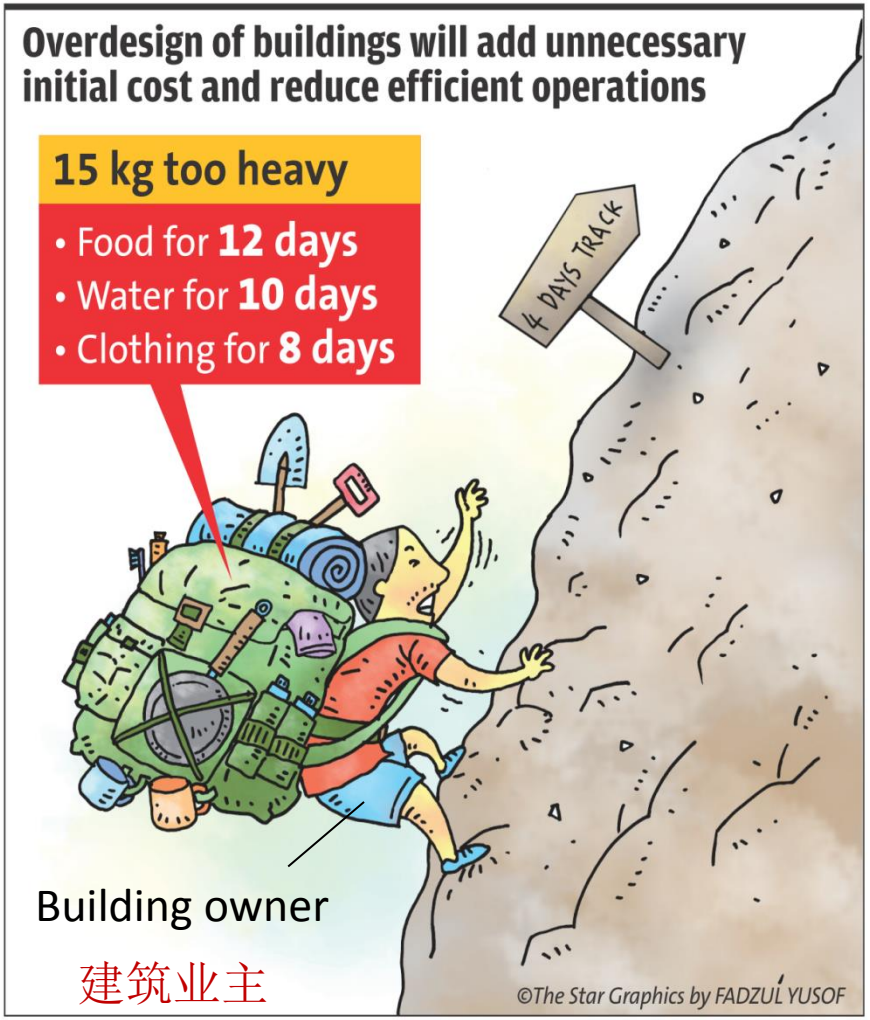
建筑100%自然冷却，不需要空调

To be completed end of 2016

Similar design by Design Unit Sdn. Bhd.

ENERGY EFFICIENCY

Three Fundamental Observations



DON'T OVER-PACK

Building owners get double-penalty of: 过渡设计对业主的双重惩罚：

- Higher CAPEX 高设备装机容量，高初投资
  (higher construction cost)
- Higher OPEX 高设备运行能耗与水耗
  (higher operating cost)

Cartoon by IEN Consultants. The Star newspaper (2014)

Case study no. 5　参考案例五

设计+施工
Design & Build

Highrise Office Avoiding Overdesign case study

KKR2 超高层办公楼

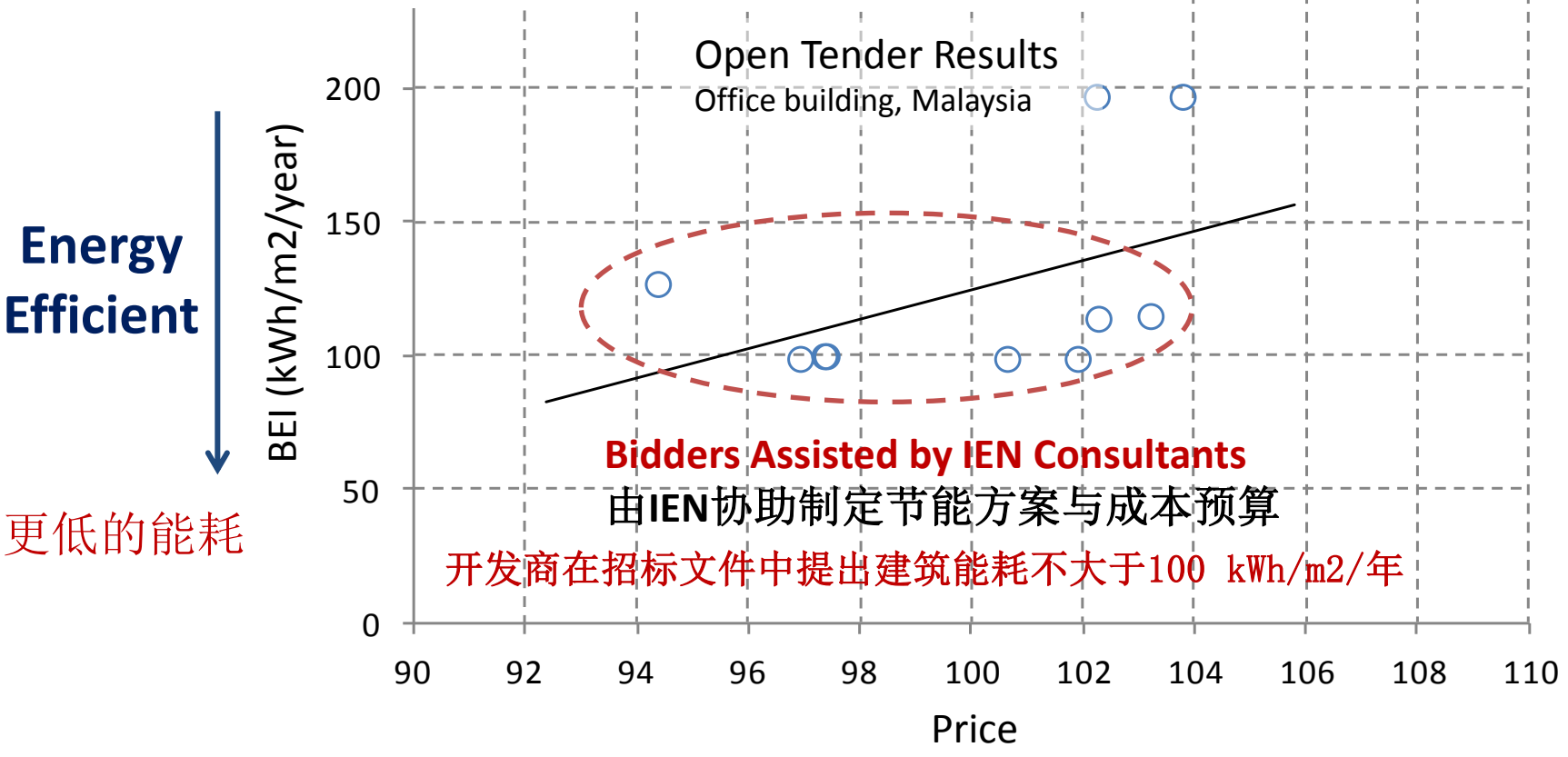
(KUALA LUMPUR, 2014)
吉隆坡，马来西亚，2014

DON'T OVER-PACK

Lowest Construction Cost

Energy Efficient Office Building also the Cheapest

更合理的节能设计同时也是投标报价中最低的！



Case study no. 6　参考案例六

Shopping Mall Avoading Overdesign case study

IKEA　宜家商场

(Kuala Lumpur, 2016)

吉隆坡，马来西亚，2016

DON'T OVER-PACK

Cooling Load Profile – Energy Simulation

基于动态能耗模拟预测建筑设计冷负荷

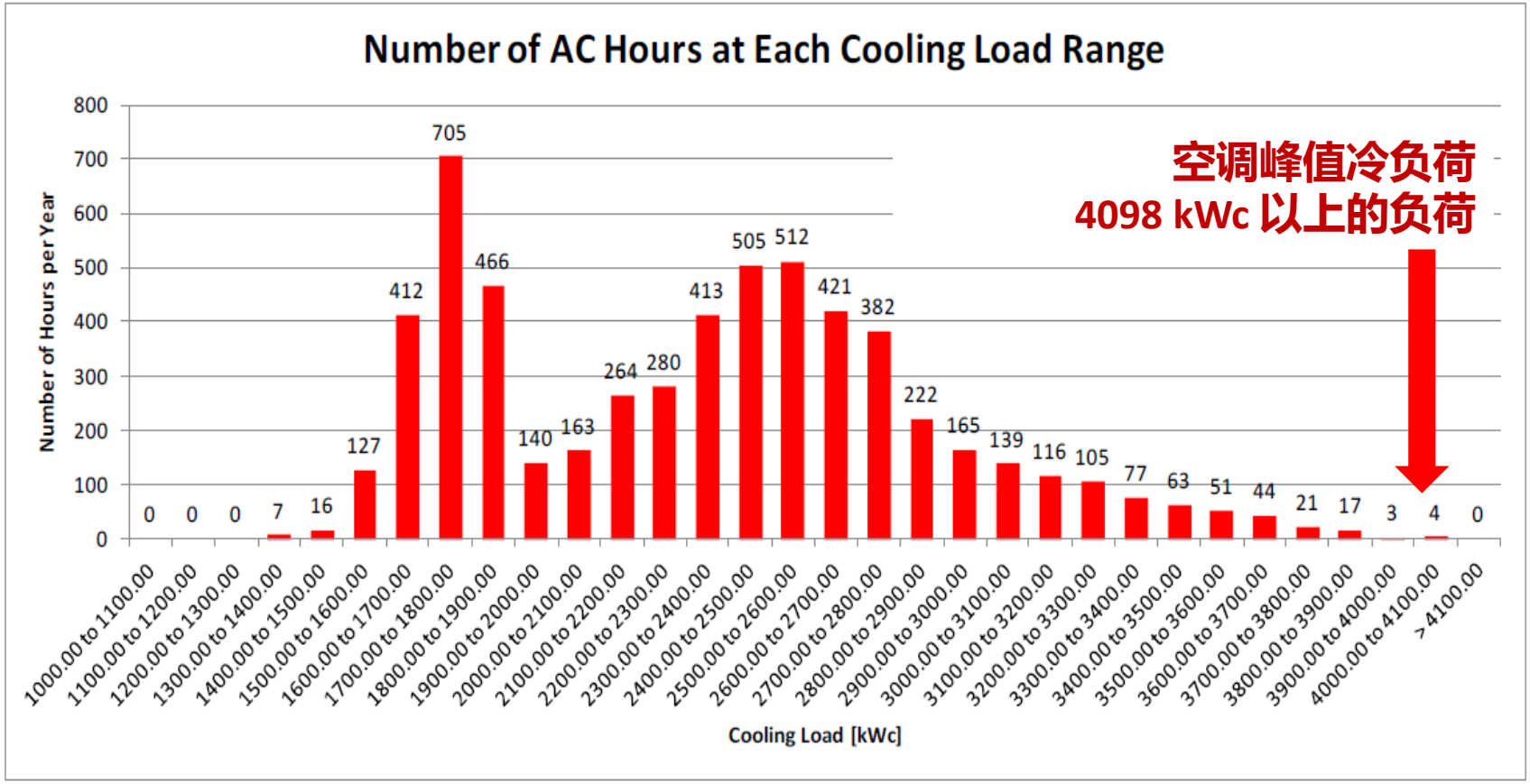
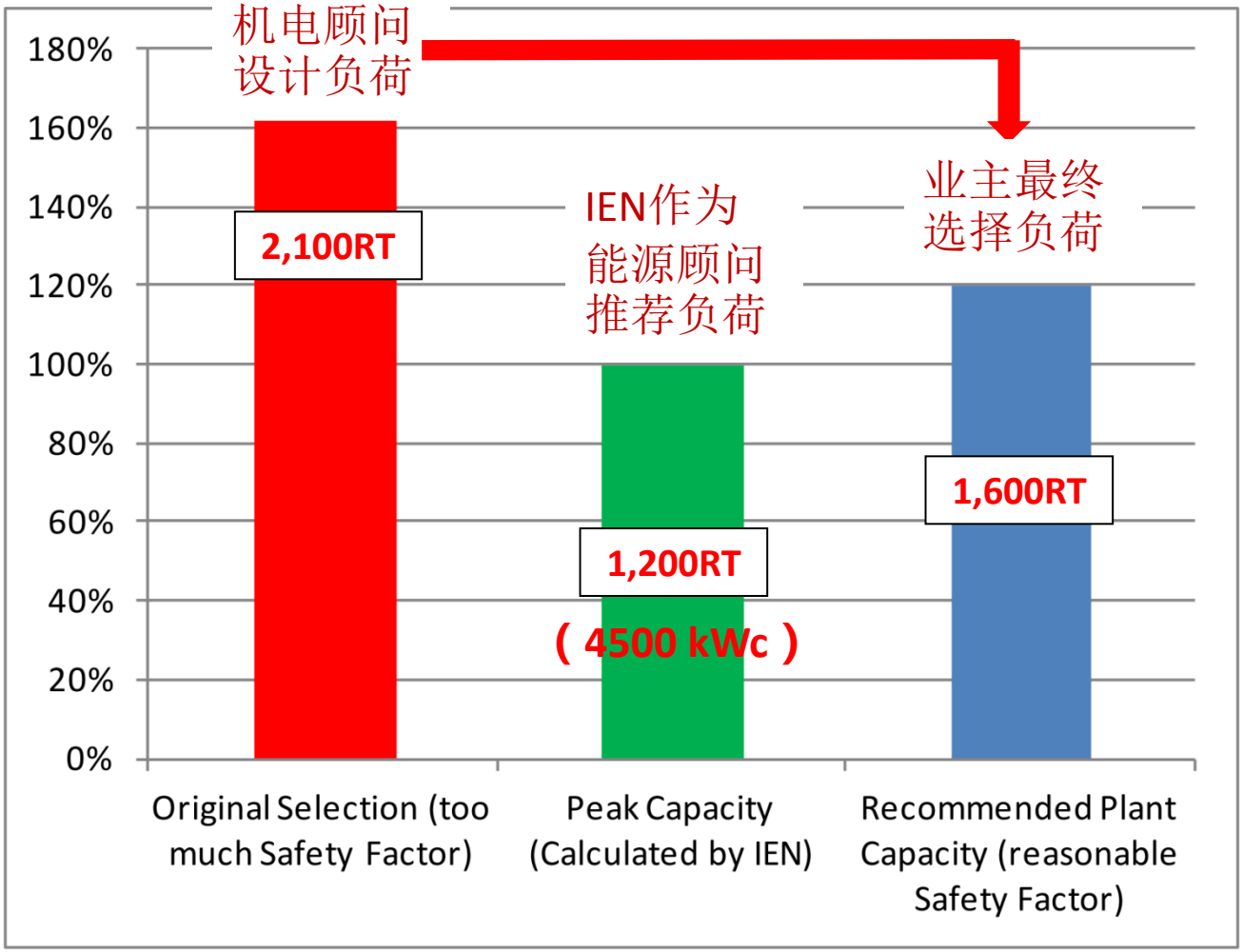


Figure 4.2 Chart showing the number of AC hours per year the store Total Cooling Demand will be between the specified range

大部分冷负荷出现在1600 kWc 至3000 kWc之间！

23%降幅，节省超过200万人民币的制冷机房初投资



Initial cost saving by avoiding overdesign!

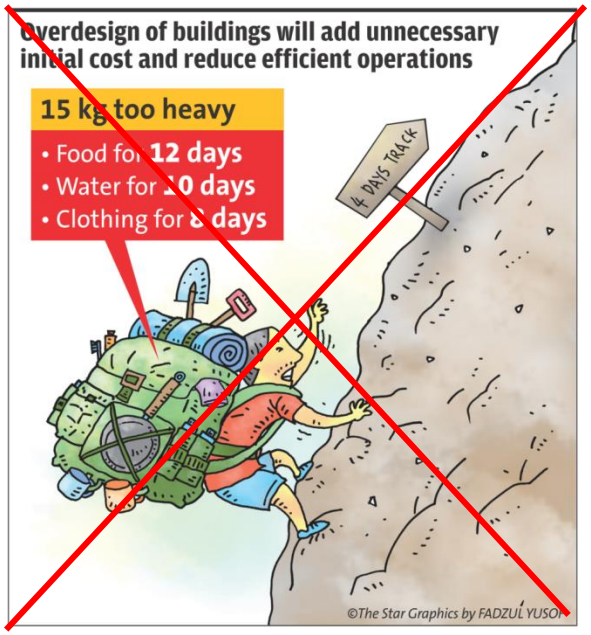
CONCLUSION 结论

”Expensive NOT to go green”

Plug the holes
堵上能耗漏洞

+

Don’t overdesign
不要过度设计



统筹规划，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!

哥本哈根2025，第一个实现零碳(碳中和)的首都

- 哥本哈根过去与现在同样面对着世界上其他城市面临的碳排，交通拥挤和废弃物等挑战。
- 可持续的城市也是宜居的城市。
- 为使哥本哈根成为一座宜居的城市，不能忽视可持续的解决方案必须与持续的经济增长与提高的居民生活水平的最终发展目标相结合。

CPH 2025 Climate Plan

75%的碳排来自建筑
50%的人骑自行车上下班

CITY CLIMATE
LEADERSHIP
AWARDS

Energy Efficient Building Stamp Series

建筑节能系列邮票 (全部是IEN的作品)

IEN Consultants Expert Staff

IEN Consultants

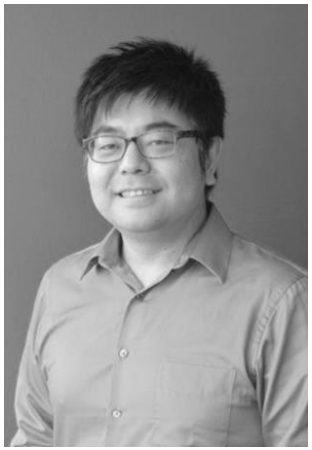
Hover the cursor over a person's head to see a short presentation and click to see a detailed personal description or click on a name in the list below.

We are a diverse group of individuals

5 different degrees
6 different nationalities
5 LEED AP
8 GBI Facilitators

Green Building Certification

Senior Consultant curriculum



Nationality: Chinese
Language Skills: EN | CH
Based in: Beijing, China

Education:

- Building Science (National University of Singapore)
- Heating, Ventilation and Air-Conditioning (Tianjin University)

SUN Hansong

Roles: **Energy & Environment Consultant**

Sun Hansong is the Director of IEN Consultants (China). He has worked for several international design consultancy companies including Surbana, ARUP, AECOM and Walton Design, before he joined IEN in 2013. Hansong graduated in 2000 from Tianjin University as an building services engineer and obtained master degree in building science from the National University of Singapore (NUS) in 2004. He has worked in Singapore and China delivering integrated energy and environmental solutions in building and sustainable urban planning sectors.

Key project references include the Singapore Pavilion at Shanghai Expo 2008, Marina Bay Sands Integrated Resort in Singapore, Civic and Culture Development in Singapore (CCRC), TDIC Permanent Head Quarter in Abu Dhabi, Philips R&D Centre in Shen Zhen, TEDA H2 Low Carbon Demonstration Building in Tianjin and Vanke Botanic Garden in Dongguan.

Sustainable urban planning and energy planning projects include Yongwai Morden Commercial District in Beijing, Beijing University of Chemical Technologies New Campus in Beijing, Caofeidian Eco-Industrial Park in Tangshan and Vanke Green Building Park in Beijing. Hansong was also the key project researcher and coordinator for EC-ASEAN Energy Facility (EAEF) project.

Energy Efficiency Consultancy

Senior Consultant curriculum

Nationality: Danish
Language Skills: EN | DA
Based in: Kuala Lumpur, Malaysia

Education:
•MSc Energy Engineering (Technical University of Denmark)

Gregers REIMANN

Roles: **Energy Efficiency Consultant**

Gregers is the managing director of IEN Consultants, the pioneering green building consultancy in Malaysia, with offices in Singapore as well as China. He specialises in building designs that have good daylighting, are highly energy efficient and have excellent thermal and visual comfort.

Key project references during his 10 years of working in Asia include the Setia City Mall (first green certified shopping mall in Malaysia), the new IKEA in Kuala Lumpur (ongoing), ST Diamond Building (2012 ASEAN Energy Award winner) and the GEO Building designed to be a zero energy office building. Other green projects include the KLIA2 airport terminal, the KL Eco City, the Pertamina Energy Tower – the first skyscraper designed to be ZERO energy – and energy efficiency building retrofit works incl. daylight retrofitting of the Asian Development Bank in Manila.

Gregers has also been a technical reviewer for the EU Energy-Efficiency Buildings project and is newly appointed Chairman of the “Energy Efficient Buildings” committee under the EU-Malaysian Chambers of Commerce and Industries (EUMCCI).

Gregers regularly contributes to green building articles and frequently guest lectures at universities internationally. He has a keen interest to pursue innovative and integrated design solutions bridging the gap between architects and engineers. Gregers is also ‘walking the talk’ with respect to green living habits, which includes commuting to work by a foldable electric bicycle that combines easily with public transport.

Green Building Consultancy

Senior Consultant curriculum

Nationality: American
Language Skills: EN | FR
Based in: Singapore

Education:
• MCP in Urban Planning (MIT)
• MA in Urban History (Columbia University)

Kevin SULLIVAN

Roles: **Green Building Consultant**

Kevin has been a carpenter, community organizer, educator, and environmental entrepreneur. Since 2008 he has founded and led two leading sustainability consulting firms in India and Singapore. Kevin has been a design consultant on more than one hundred building projects across the United States, Middle East, India and Asia.

An expert on green schools, Kevin has developed energy-efficiency strategies and educational tools to teach and engage students in green design concepts for top international K-12 schools across Asia. In 2006 he served as a Fulbright Scholar at India's premier environmental think tank, The Energy and Resources Institute in New Delhi. Before moving to India, Kevin was a Policy and Project Director for one of the largest US community-based housing NGOs, where he pioneered the first low-cost urban green homes. Kevin was an Adjunct Professor in the Urban Environment at Queens College as the City University of New York.

Kevin is trained as an architect and urban planner and writes and speaks widely on urban and environmental issues. He has an MCP in Urban Planning from the Massachusetts Institute of Technology and an MA in Urban History from Columbia University. He lives with his family in Singapore.