Public Research Seminars

Development of heat insulation solar glass and application on zero energy buildings

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National Taiwan University of Science and Technology

What is Heat Insulation Solar Glass?

HISG
(Heat Insulation Solar Glass)

10% see through

50% see through

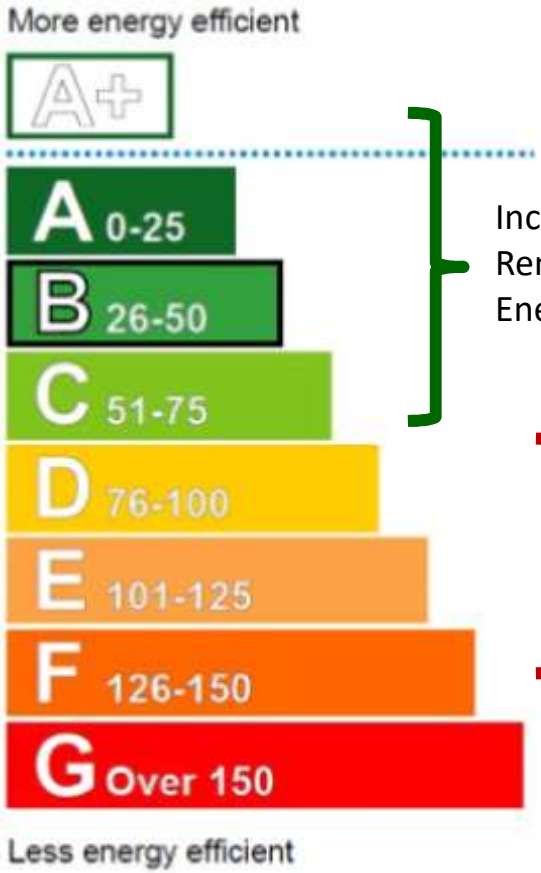
What different?

(demonstration)

For roof
(not see through)

For window
(see through)

Traditional power required (kWh/m^2)



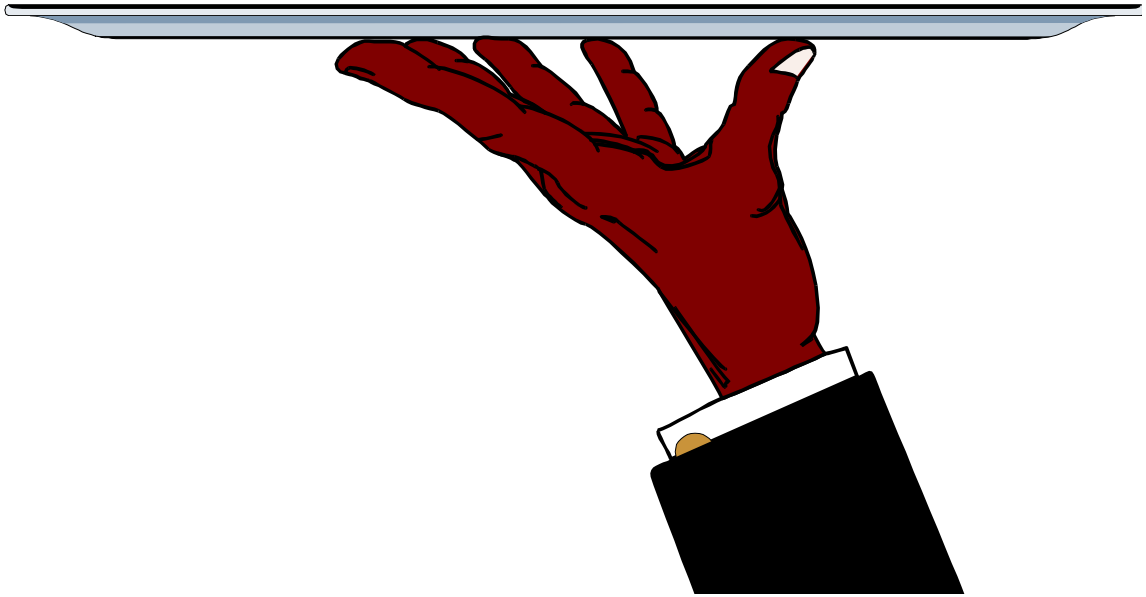
Increasing Renewable Energy

Decreasing Energy Consumption

Zero Energy Buildings (ZEB)

tendency

What is the menu of solution?



Solution

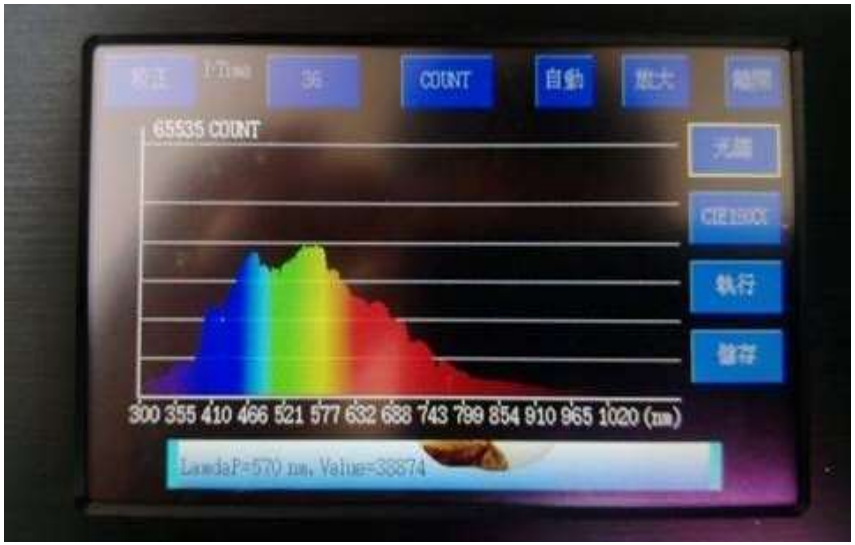
Zero Energy Buildings

Increase Renewable Energy Supply

+

Decrease Energy Consumption

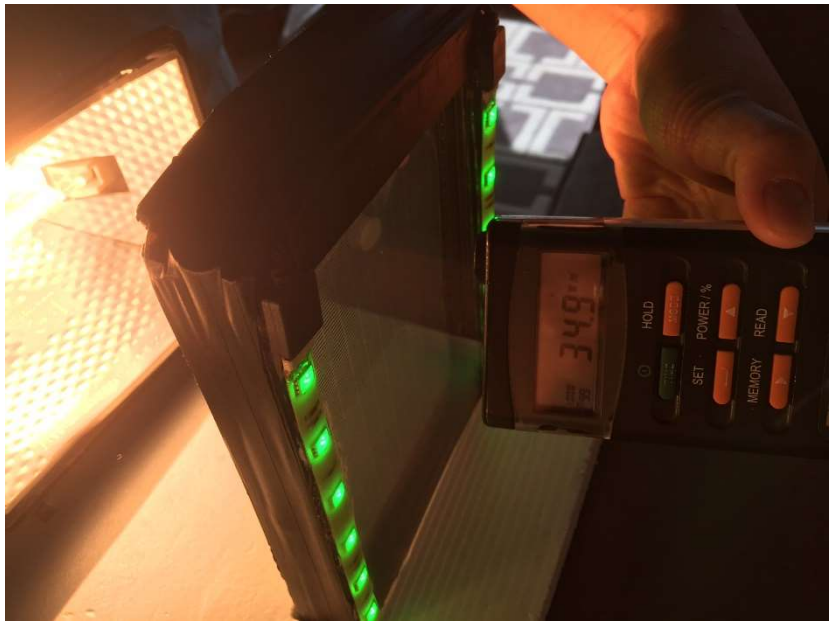

How to reach the target?


COUNT
自動
放大
65535 COUNT
執行
儲存
300 355 410 466 521 577 632 688 743 799 854 910 965 1020 (nm)
LamdaP=570 nm, Value=38874


校正
I-Time
36
COUNT
自動
放大
關閉
65535 COUNT
光譜
CIE1931
執行
儲存
300 355 410 466 521 577 632 688 743 799 854 910 965 1020 (nm)
LamdaP=469 nm, Value=5268

Demonstration

High Power generation + Heat Insulation

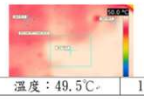
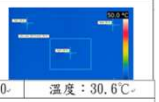
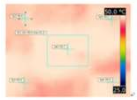
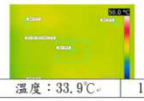
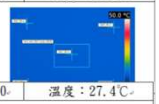


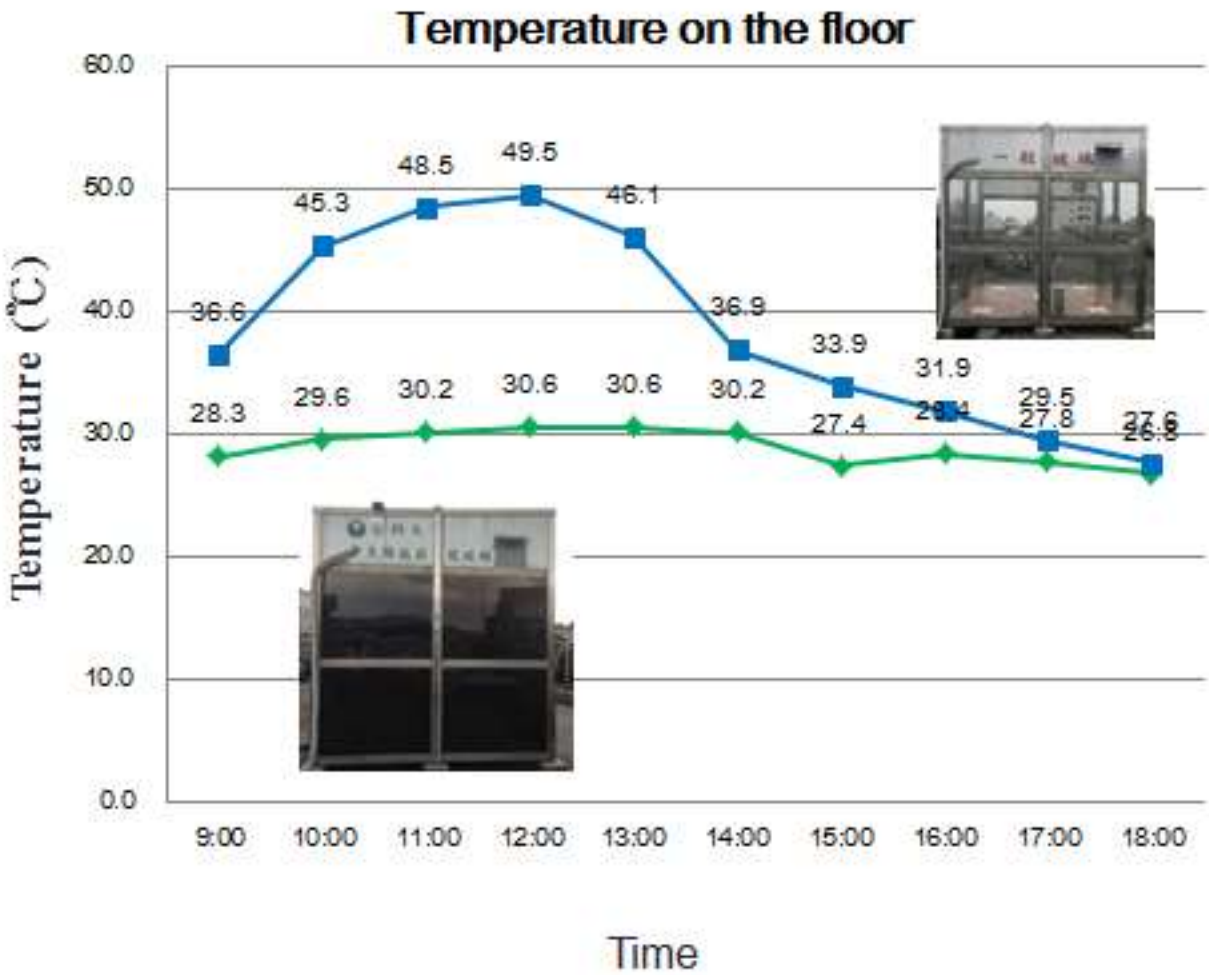
824.2 W/m2

34.9 W/m2

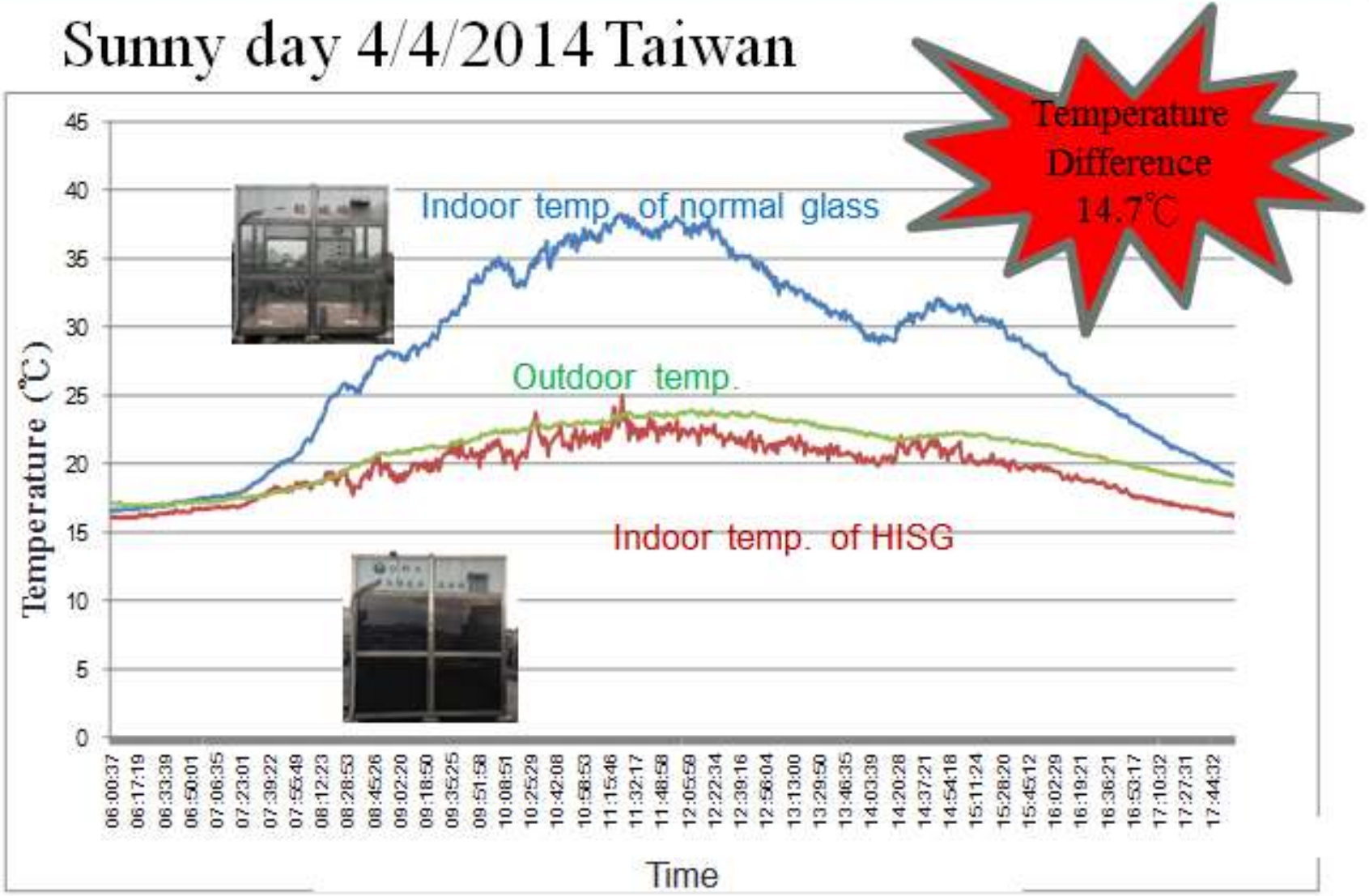
ENERGY EFFICIENCY TEST of Glass House

Energy saving
During summer time

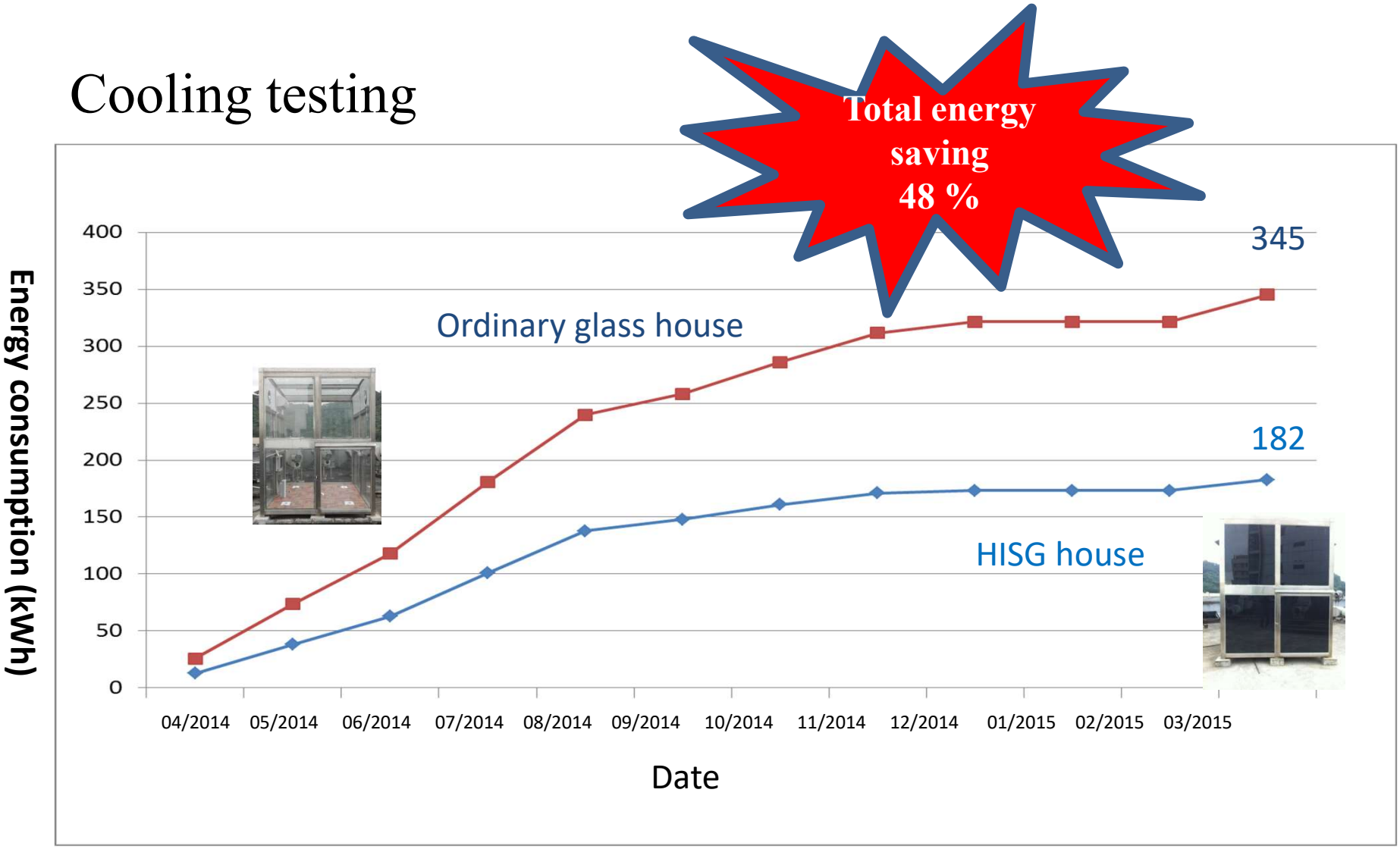
	一般帷幕		節能帷幕
時間	溫度：36.6℃	09:00	溫度：28.3℃
試驗照片			
時間	溫度：45.3℃	10:00	溫度：29.6℃
試驗照片			
時間	溫度：48.5℃	11:00	溫度：30.2℃
試驗照片			
時間	溫度：49.5℃	12:00	溫度：30.6℃
試驗照片			
時間	溫度：46.1℃	13:00	溫度：30.6℃
試驗照片			
時間	溫度：36.9℃	14:00	溫度：30.2℃
試驗照片			
時間	溫度：33.9℃	15:00	溫度：27.4℃
試驗照片			
時間	溫度：31.9℃	16:00	溫度：28.4℃
試驗照片			
時間	溫度：29.5℃	17:00	溫度：27.8℃
試驗照片			



Sunny day 4/4/2014 Taiwan



Cooling testing

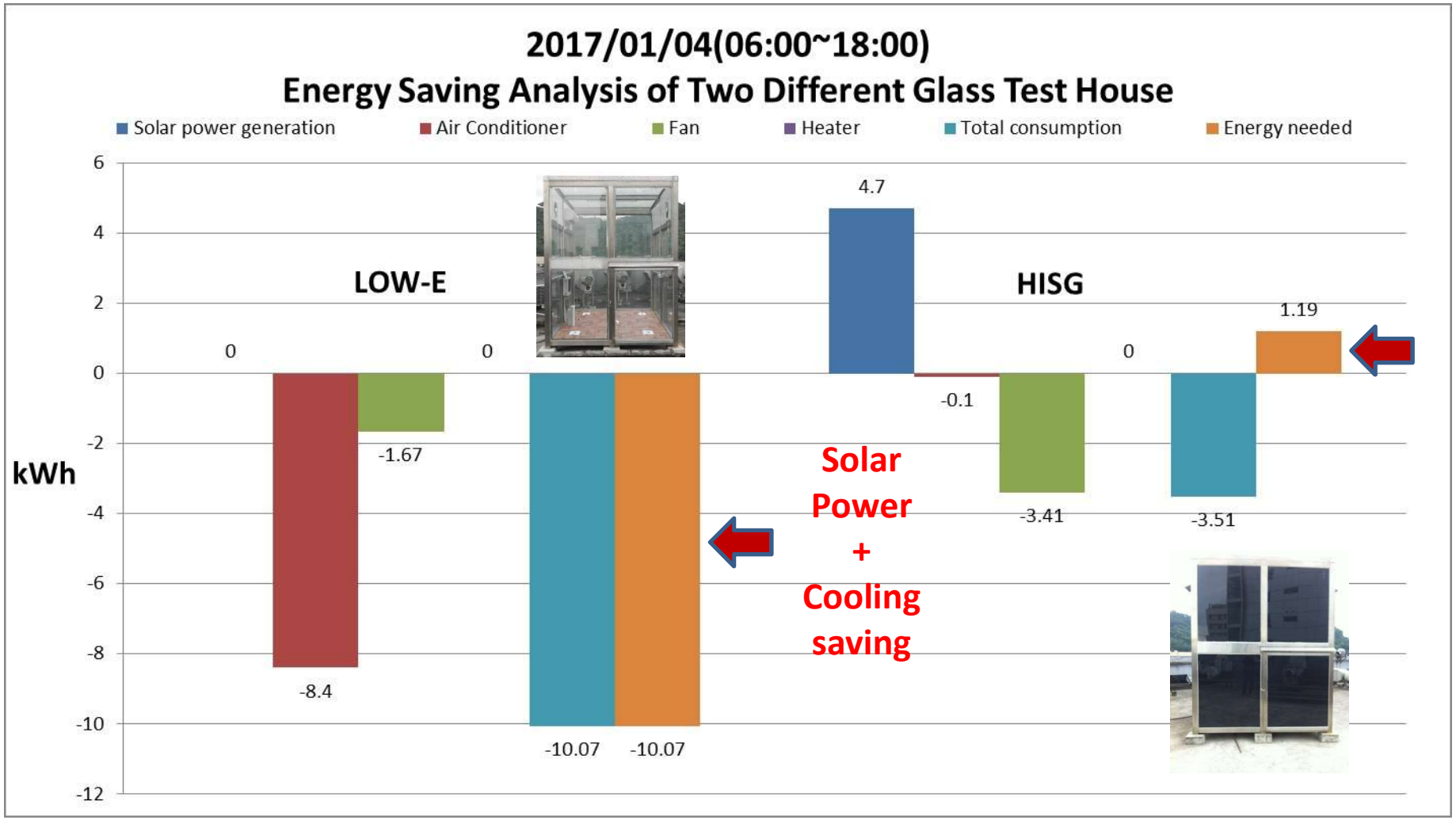


Only by fan ventilation
Reach comfortable indoors

Fan ventilation

Air condition

Unique in the world

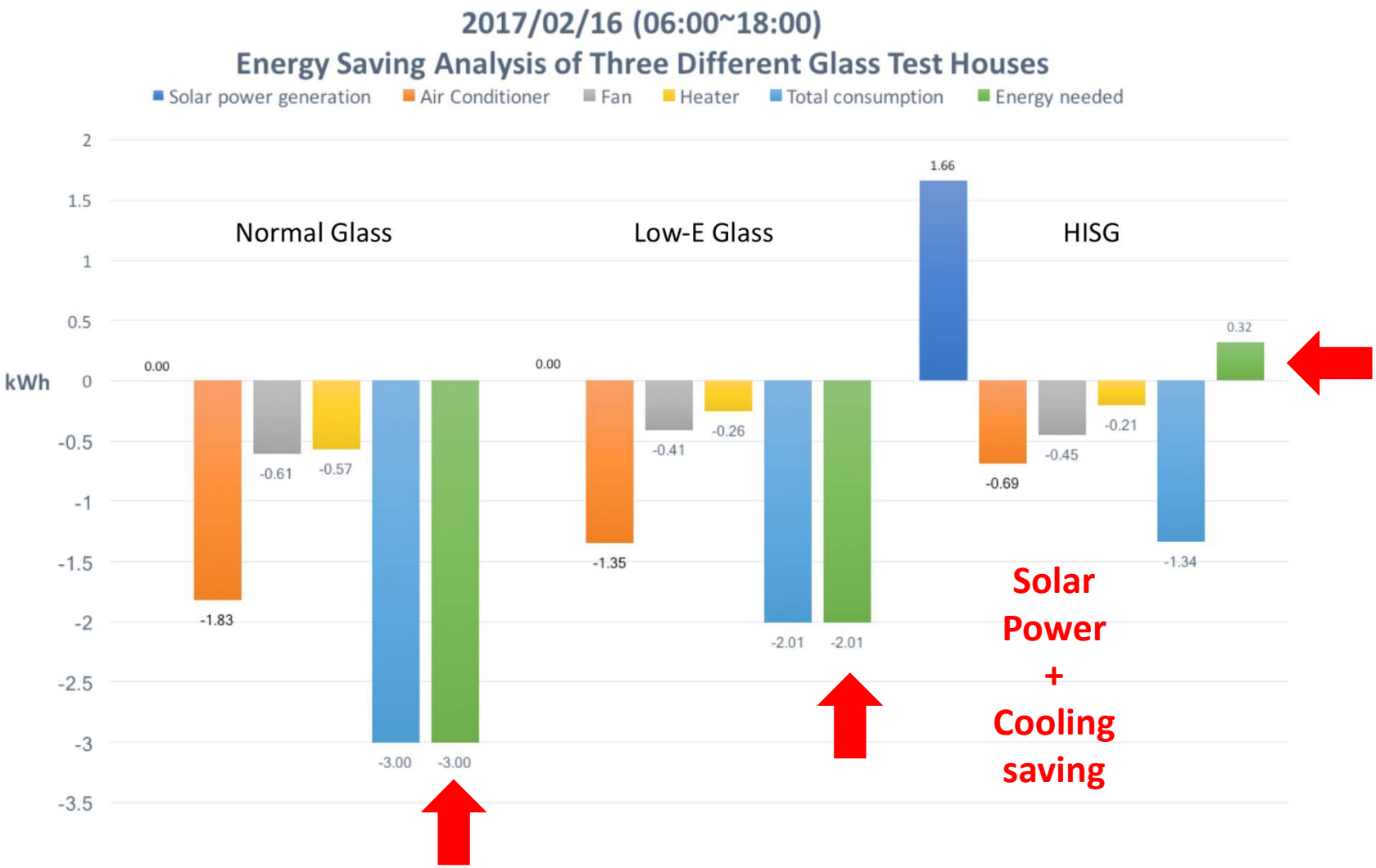


10.07 kWh from grid

1.19 kWh send back to grid

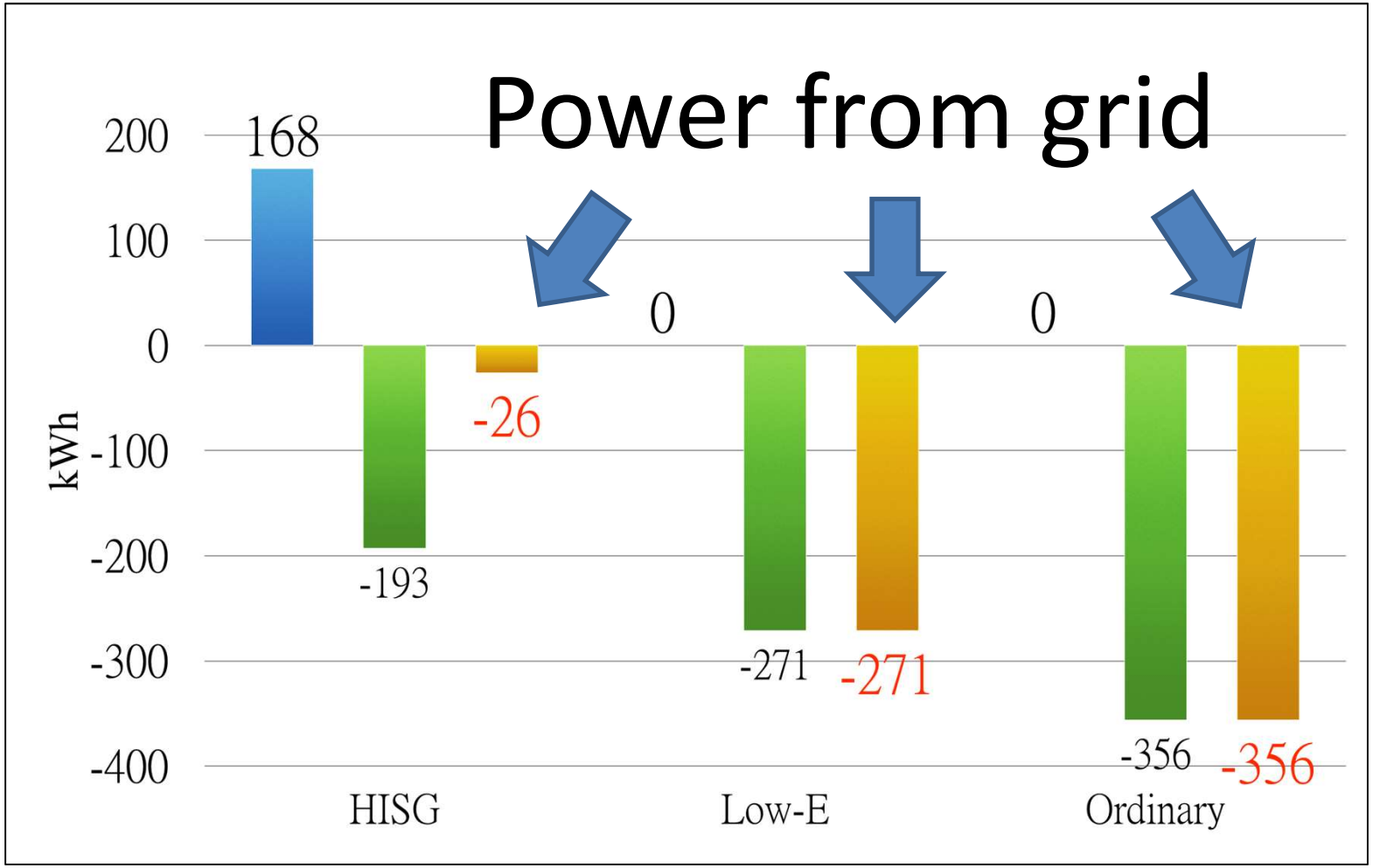
ENERGY EFFICIENCY TEST of houses

The Best Performance



3 kWh from grid **2.01 kWh from grid** **0.32 kWh send back to grid**

From Jan. 2017 to July 2017



Saving 93 %

Compare with other Normal PV

Zero Energy Building in Singapore

See through effect

Shanghai

Taipei

Not see through

See through

Too hot during summer time

C-Si panel skylight

Indoor temp.

date	12:00 (°C)	14:00 (°C)
5/11/2009	36.8	38
5/12/2009	35.2	38.8
5/13/2009	30.8	30.5
5/14/2009	32	31.2
5/15/2009	35.3	36.6
5/16/2009	34.9	37.5
5/17/2009	30.3	30.9

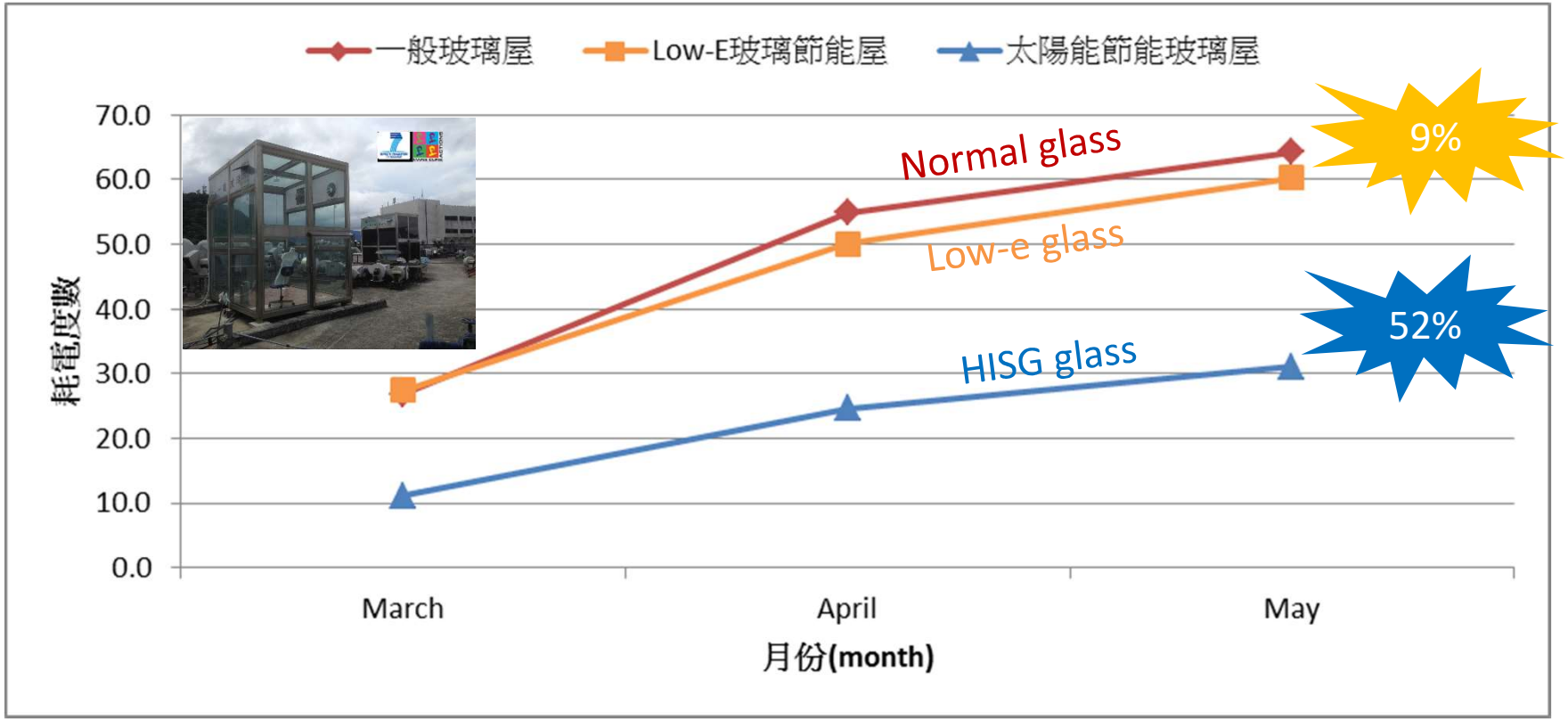
Use curtain for insulaiton

Cooling consumption (one sunny day)

Items	Normal Glass	HISG	Normal PV
圖示			
Cooling load (kWh)	5.3	3.4	6.0
Reason	High heat penetration	Heat insulation	High temp. on the normal PV
Testing condition	Outdoor 35℃ , Cooling setting 26℃ 06:00 A.M. – 18:00 P.M.		

Compare with Low-e glass

Cooling consumption comparison



資料來源:羅偉2015

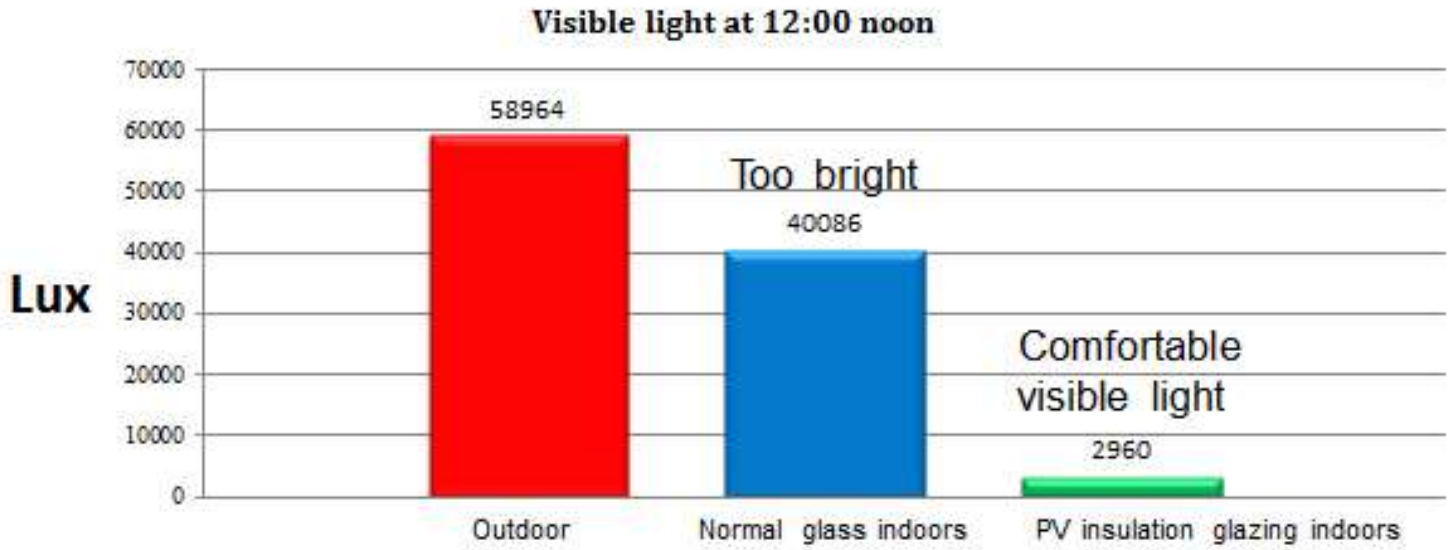
Lighting-Saving at Day time

Shading effect of PV Insulation Glazing

Indoor visible light testing

Normal glass indoors

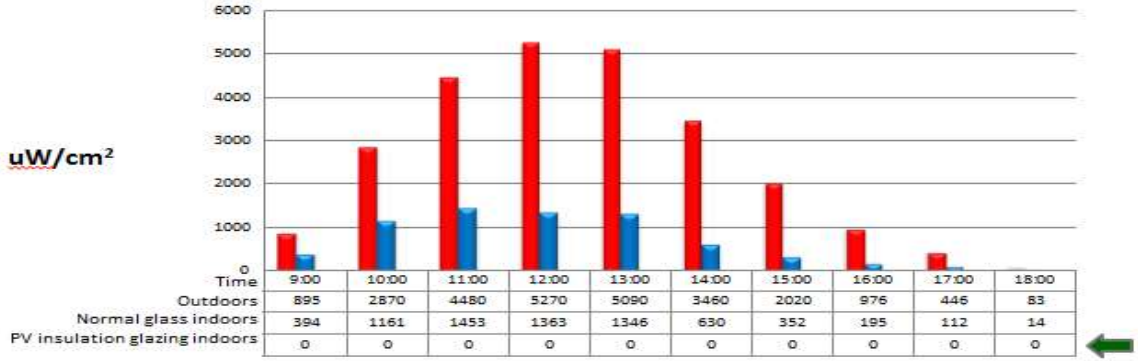
PV insulation glazing indoors



All day Zero UV to protect human skin to prevent cancer attack

UV testing

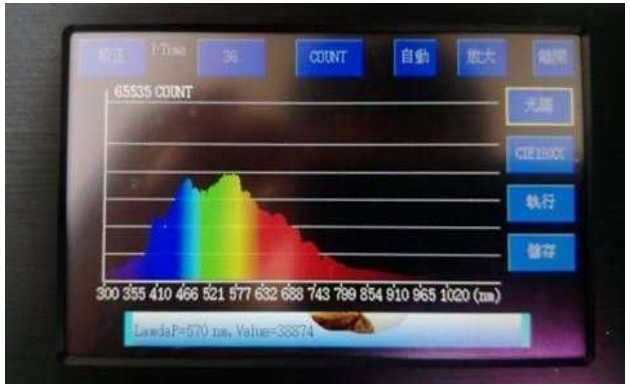
All the day zero UV at the indoors of PV Insulation Glass house



Time	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
Outdoors	895	2870	4480	5270	5090	3460	2020	976	446	83
Normal glass indoors	394	1161	1453	1363	1346	630	352	195	112	14
PV insulation glazing indoors	0	0	0	0	0	0	0	0	0	0

Normal glass indoors

PV insulation glazing indoors



Zero UV

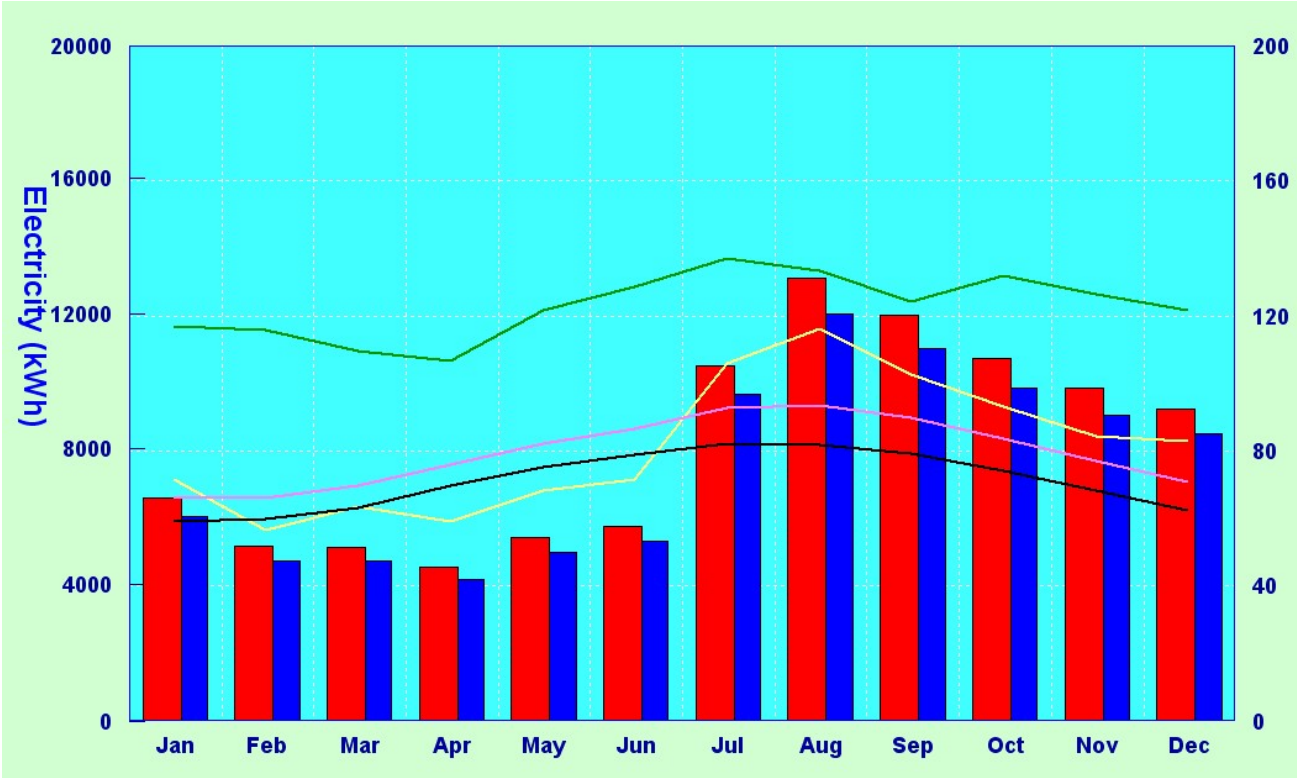
PV insulation glazing Skylight

Decreasing CO2

Building in Taipei 1876 m^2

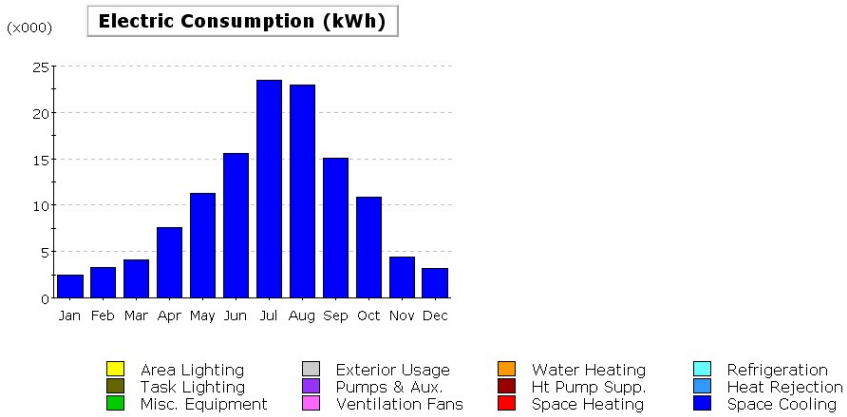
Solar power simulation

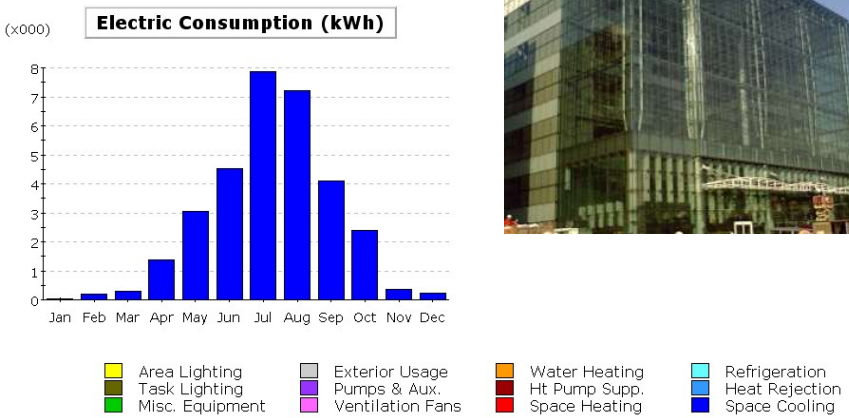
98137 kWh/year



Date	PV Energy
Month	kWh
Jan	6601.75
Feb	5179.37
Mar	5141.24
Apr	4549.01
May	5436.75
Jun	5785.82
Jul	10506.51
Aug	13104.41
Sep	12011.15
Oct	10722.07
Nov	9858.57
Dec	9240.68
Sum Value	98137.34

Cooling consumption





Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	2.50	3.30	4.10	7.57	11.29	15.58	23.42	22.91	15.02	10.89	4.38	3.15	124.10

Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.04	0.18	0.29	1.36	3.05	4.53	7.86	7.22	4.09	2.40	0.37	0.21	31.60

Normal glass

124,100 kWh/year

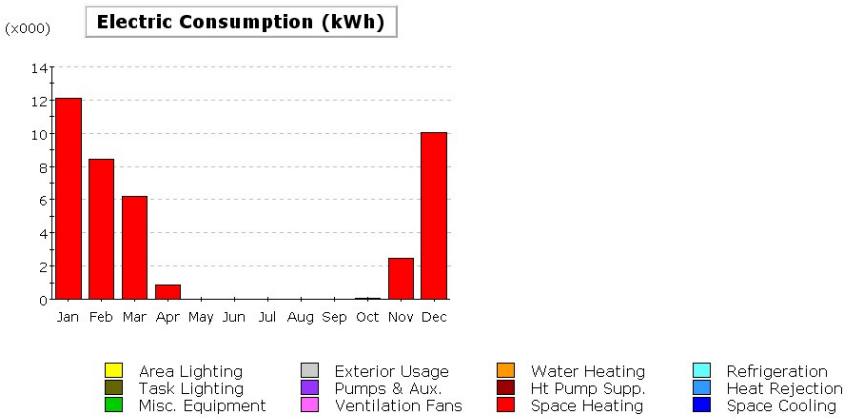
HISG

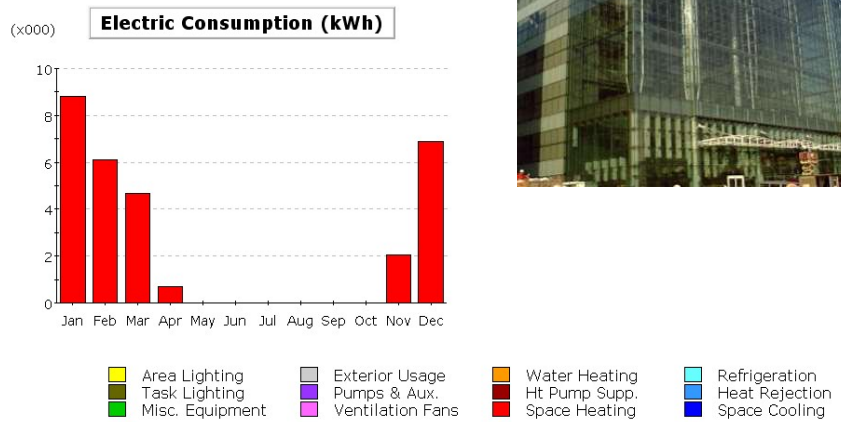
31,600 kWh/year

Saving 92,500 kWh/year

Saving 74%

Heating consumption





Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	12.13	8.42	6.22	0.86	-	-	-	-	-	0.03	2.46	10.03	40.16

Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	8.80	6.13	4.68	0.70	-	-	-	-	-	0.01	2.04	6.90	29.27

Normal glass

40,160 kWh/year

HISG

29,270 kWh/year

Saving 10,890 kWh/year

Saving 27.12%

Energy Efficiency Assessment

Solar power

Generating 98,137 kWh/year

Energy consumption

Saving 103,390 kWh/year

Environmental

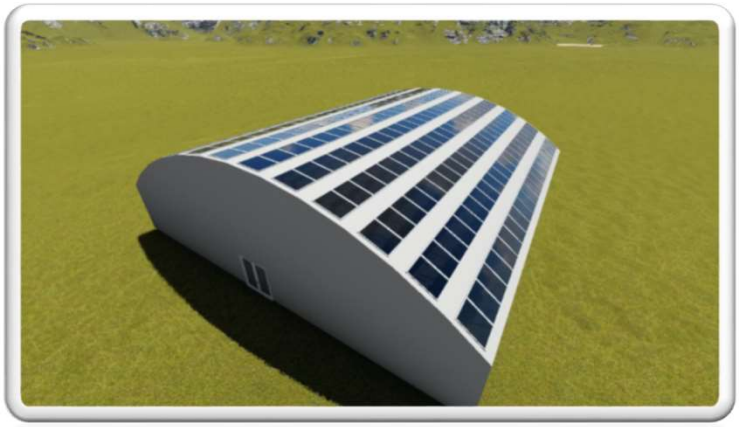
Energy efficiency
201,527 kWh/year

CO2 decreasing
141,068 kg/year

Economic assessment

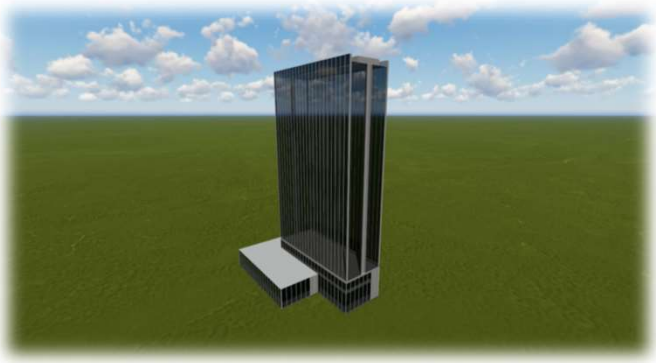
Applied on Skylight
Within 20 years

Feed back year	**4.23**
ROI	18 %



Applied on vertical facade
Within 20 years

Feed back year	**8**
ROI	7.6 %

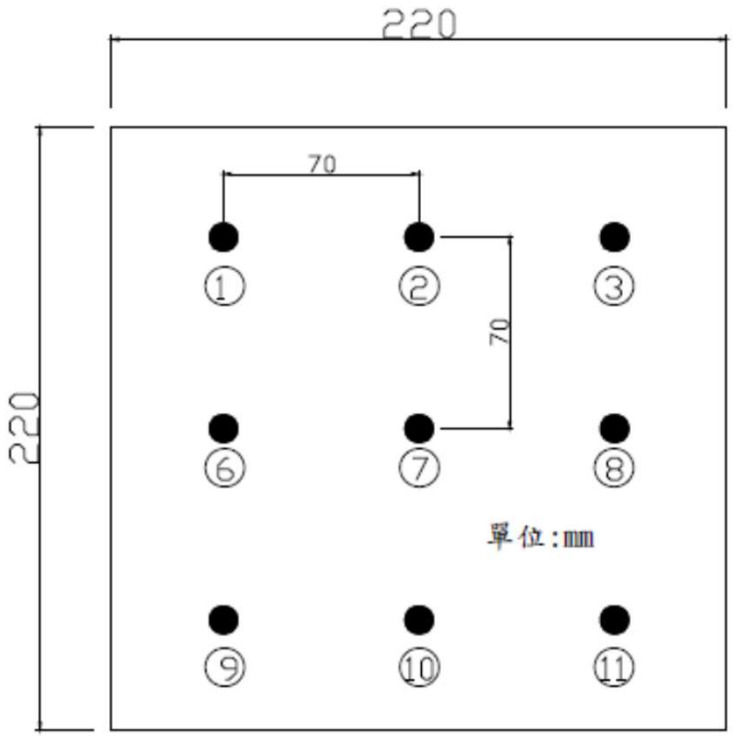


Japan JIS wind testing

Up to 8000 Pa
No damage

加圧ステップ	圧　力（Pa）	観　察　状　況
加圧ステップ１	900	異　常　な　し
	1800	異　常　な　し
	2700	異　常　な　し
	3600	異　常　な　し
	-900	異　常　な　し
	-1800	異　常　な　し
	-2700	異　常　な　し
	-3600	異　常　な　し
	0（加圧ステップ１終了後）	異　常　な　し
加圧ステップ２	1000	異　常　な　し
	2000	異　常　な　し
	3000	異　常　な　し
	4000	異　常　な　し
	5000	異　常　な　し
	6000	異　常　な　し
	7000	異　常　な　し
	8000	異　常　な　し
	-1000	異　常　な　し
	-2000	異　常　な　し
	-3000	異　常　な　し
	-4000	異　常　な　し
	-5000	異　常　な　し
	-6000	異　常　な　し
	-7000	異　常　な　し
	-8000	異　常　な　し
	0（加圧ステップ２終了後）	異　常　な　し

Fire testing



試體熱電偶位置圖

Test configuration

加熱爐封艙板安裝 →

試體光電板安裝 →

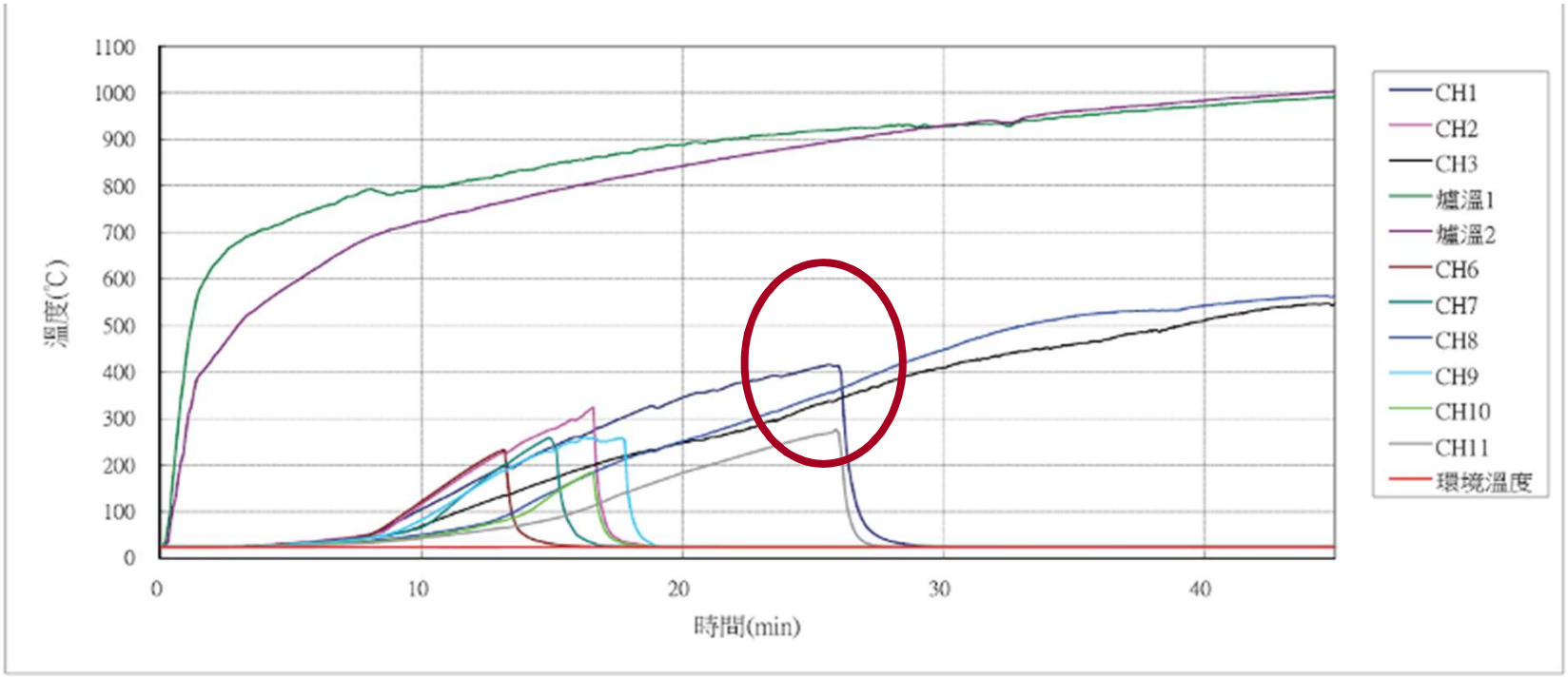
填塞防火綿 ↓

黏貼溫度感測器 ←

感測器銜接至接收器 ←

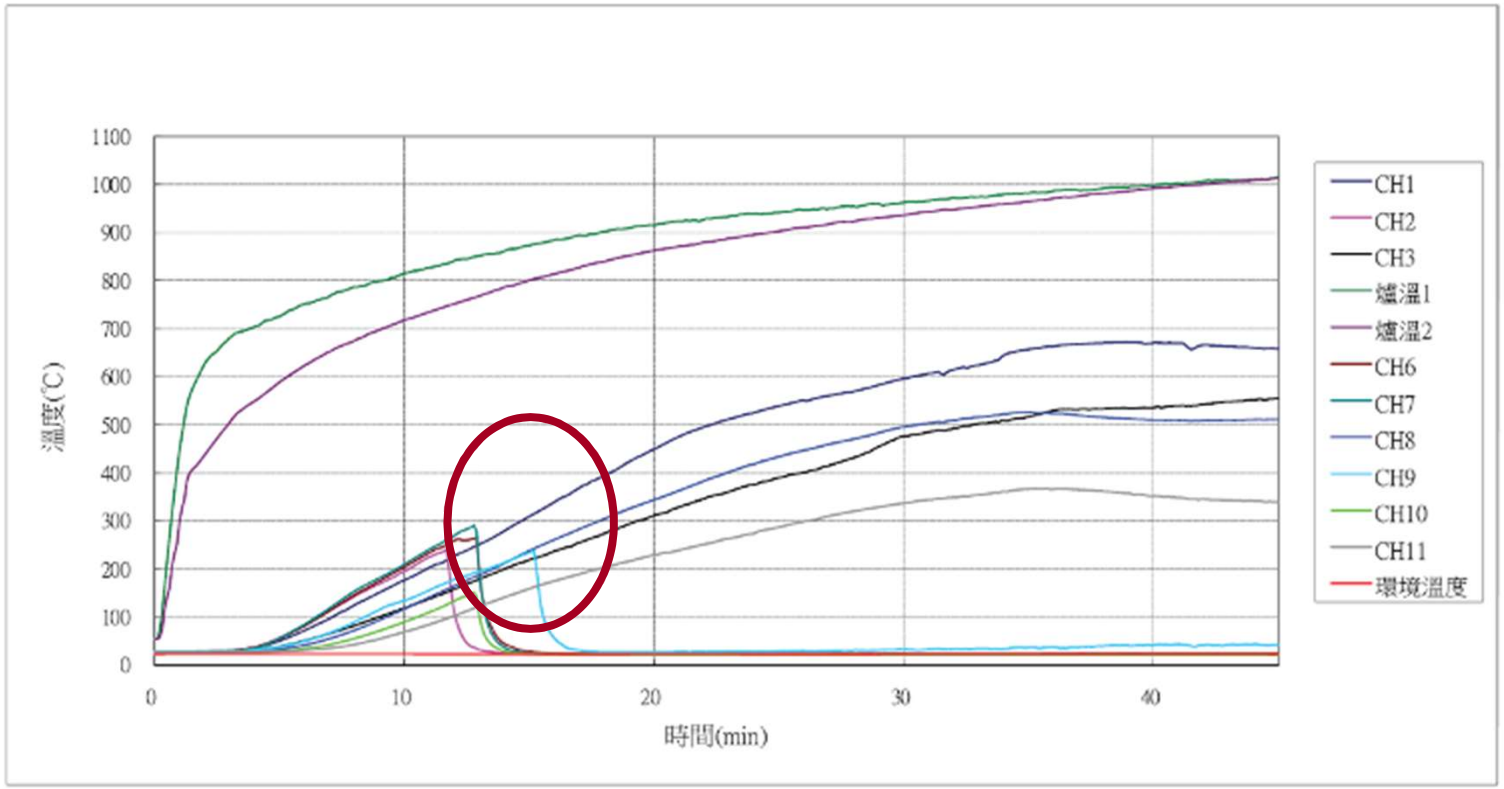
試體安裝完成

Outdoor file



爐內溫度與時間關係圖(太陽能板側)

Indoor fire



爐內溫度與時間關係圖(普通玻璃側)

Collapse time

situation	Ordinary glass	HISG
Indoor fire	30 seconds	19 mins
Outdoor fire	30 seconds	27 mins

Real Application

EAG HOUSE

Skylight

MRT STATION

GREEN HOUSE USA

SKYLIGHT, SCHOOL

Glass Curtain Wall

Green House

International cooperation

Development of Heat Insulation Solar Glass for Low Carbon Buildings

European Commission

Brussels, 16/10/2015

Certificate of Award

Chin-Huai Young

was awarded in *2014* a

MARIE CURIE Fellowship

as part of the EU-funded project

Development of Heat Insulation Solar Glass for Low Carbon Buildings (DHISGLCB)

Alessandra Luchetti
Head of Department 'Excellent Science'
Research Executive Agency

MCFA Marie Curie Fellows Association

Marie Curie Fellows Association

Certificate of Membership

2015

Awarded to

Chin-Huai Young

Grant Number: 326917

Grant Period: 2014-01-01 – 2015-12-31

Host Institution: University of Nottingham

Host Country: UK

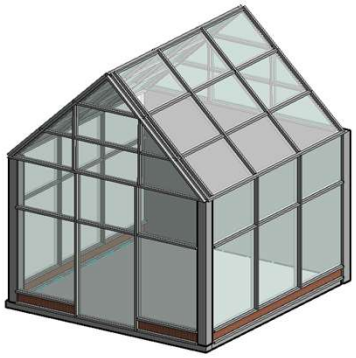
Eric Buchlin
Treasurer of the Association

The Marie Curie Fellows Association is the Association of scientists who have been awarded a Marie Curie fellowship or other individual European Community research grant. The MCFA works to improve the conditions for recipients of European Commission Fellowships, as well as for mobile researchers in the European Community and Associated Countries in general. The MCFA provides advice for Fellows, organizes yearly national meetings for members in individual countries, and works politically on several levels to improve the working conditions for all mobile researchers in Europe. MCFA actively participated in the preparation of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers.

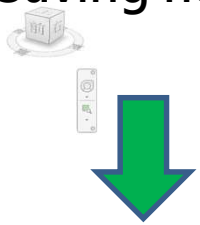
The Marie Curie Actions are a collection of funding schemes provided by the European Union, currently through its Framework Programmes for Research and Technological Development. The Marie Curie Fellowships are individual driven actions, which provide an applicant with funding for several years of research. Grants can be awarded to European Union nationals to carry out research at any research institution in the world, as well as to international researchers to join a European research institution. The highly prestigious grants are awarded after a rigorous scientific peer evaluation in a competitive selection procedure.

UNIVERSITY OF NOTTINGHAM
TAIWAN TECH HISG TESTING HOUSE

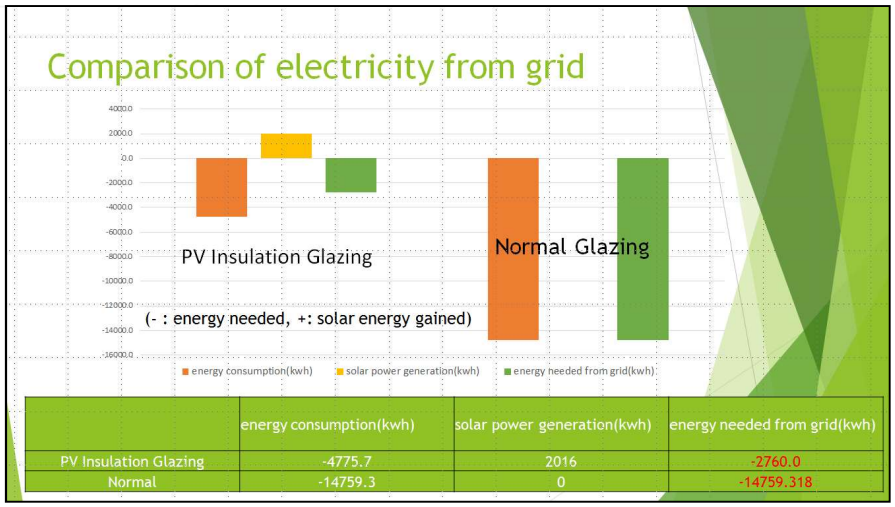
Application of HISG on conservatory in UK



Solar power +
Saving heating



Only 1/5
Power required



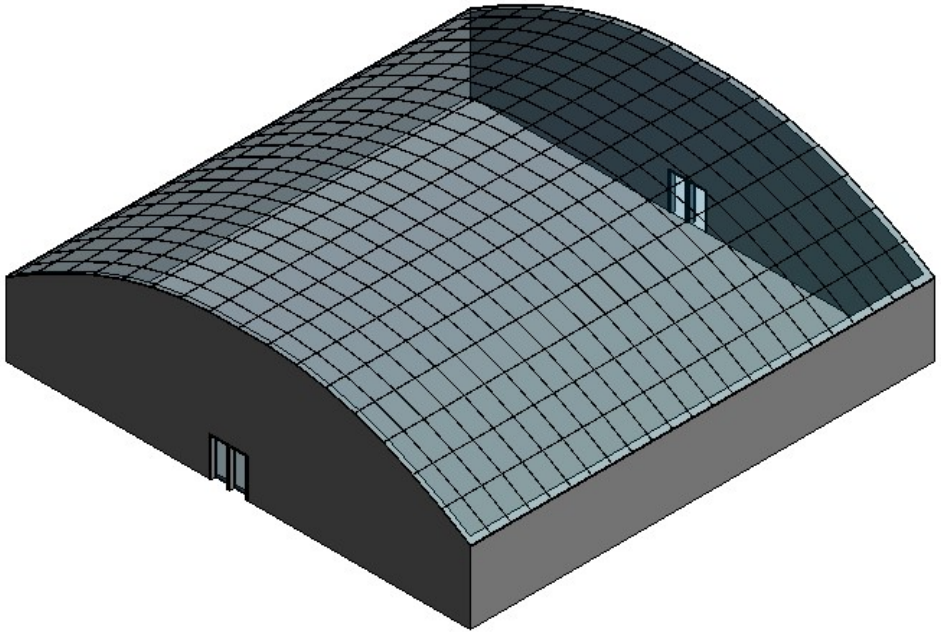
	energy consumption(kwh)	solar power generation(kwh)	energy needed from grid(kwh)
PV Insulation Glazing	-4775.7	2016	-2760.0
Normal	-14759.3	0	-14759.318

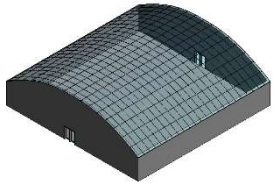
Low carbon demo house in China

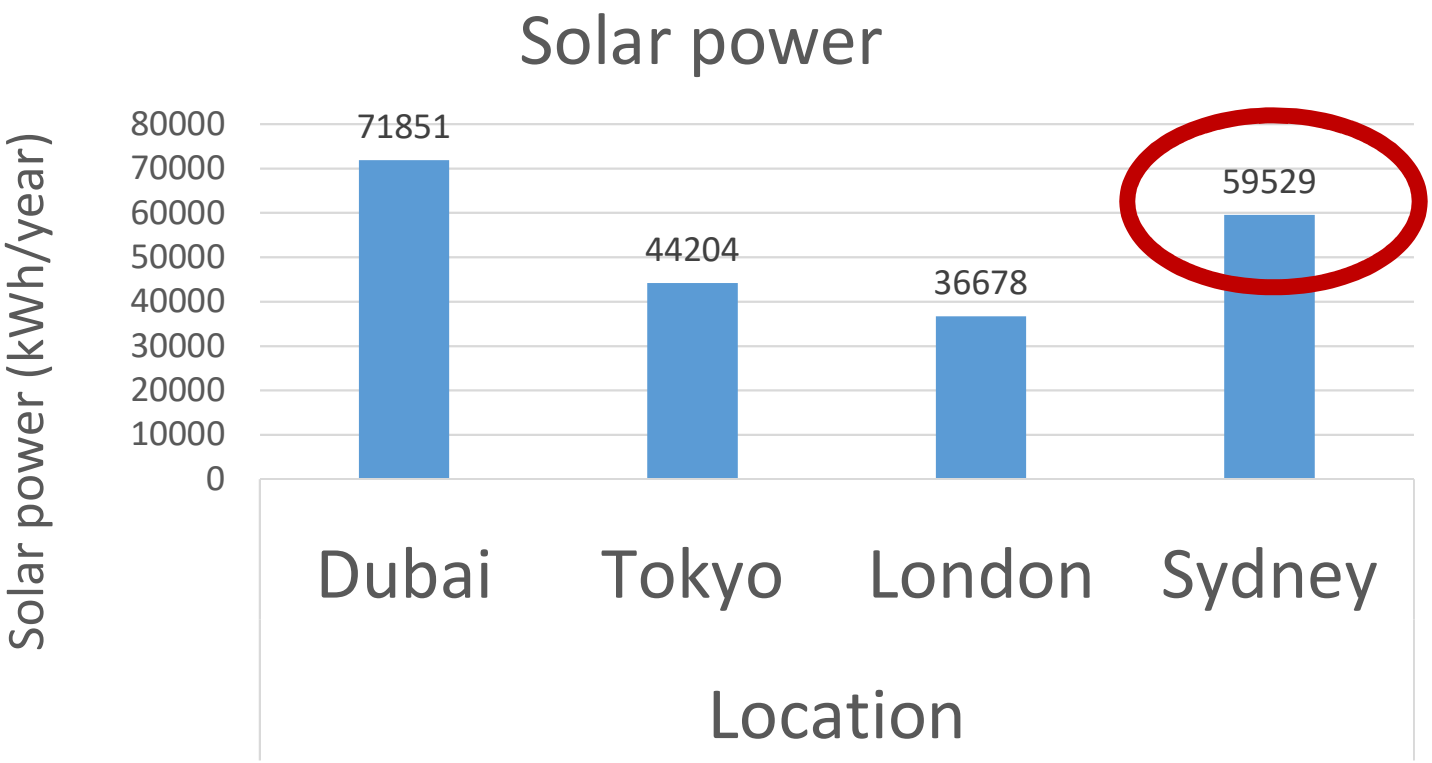
Proposed for Australia

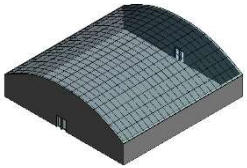
Energy efficiency assessment

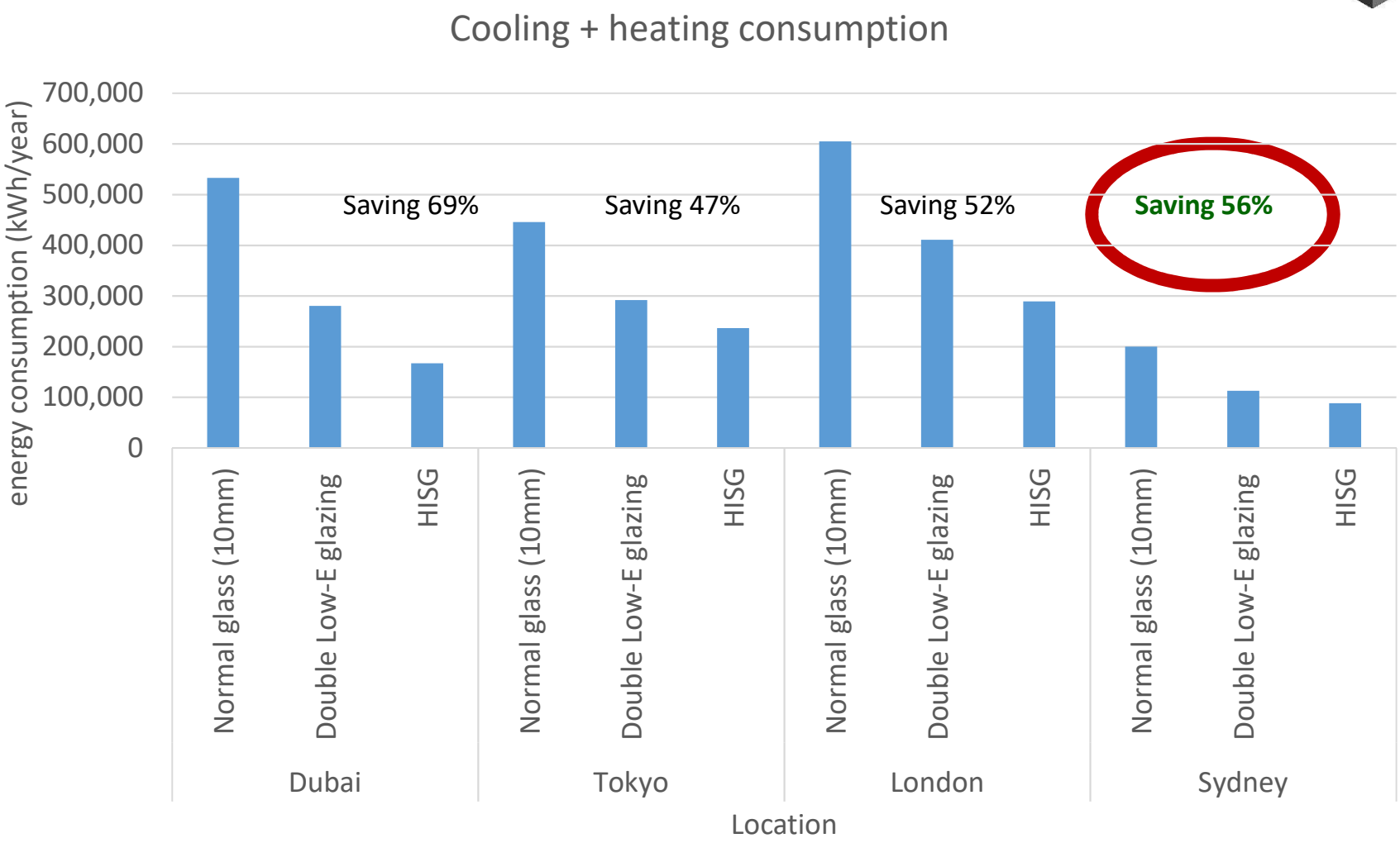
25.7m x 25.7m skylight
3.7 m high in the middle



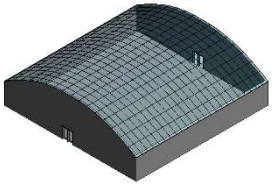


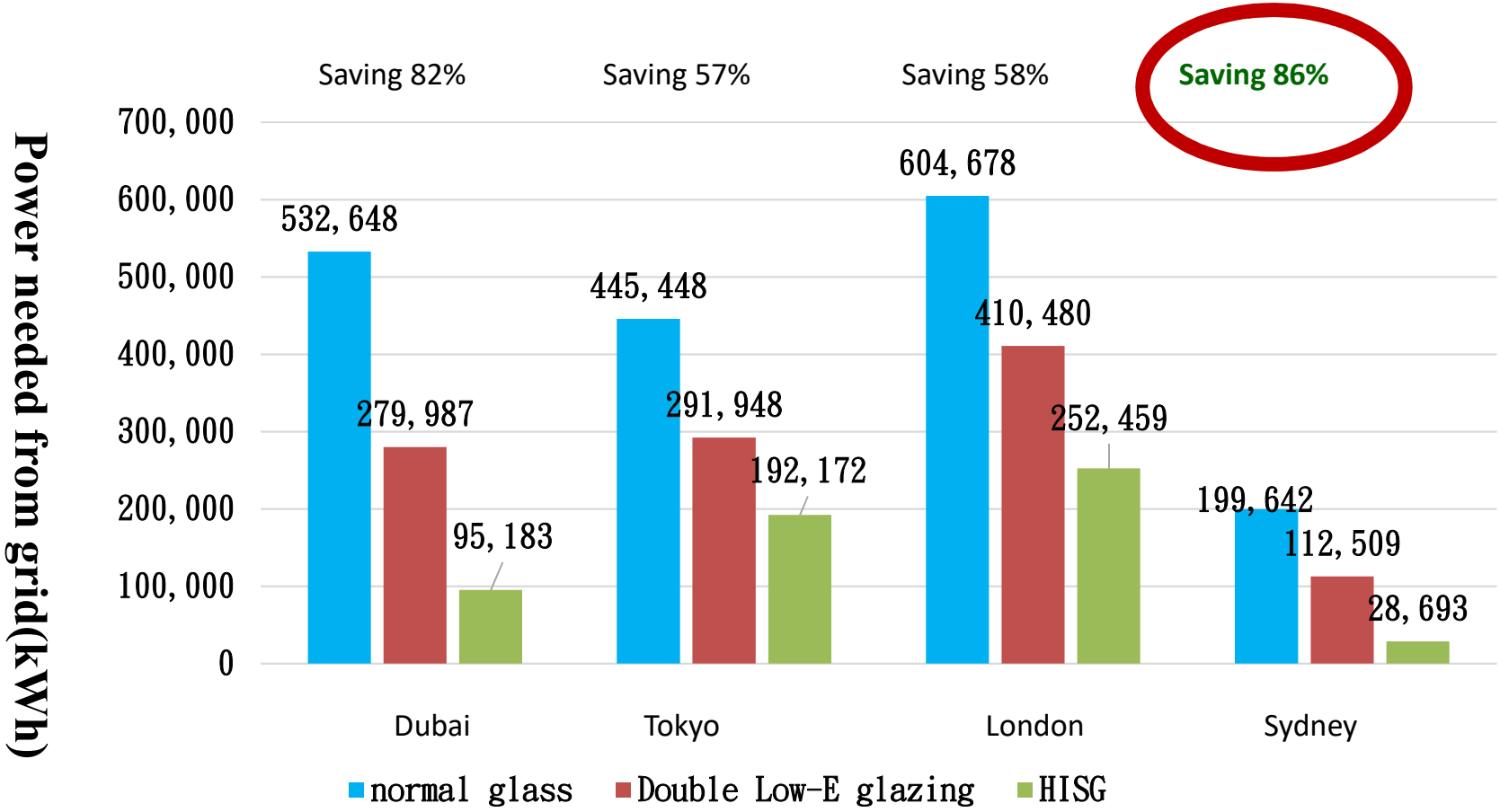

Solar power
Solar power (kWh/year)
80000
70000
60000
50000
40000
30000
20000
10000
0
71851
44204
36678
59529
Dubai
Tokyo
London
Sydney
Location




Cooling + heating consumption
energy consumption (kWh/year)
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Saving 69%
Saving 47%
Saving 52%
Saving 56%
Normal glass (10mm)
Double Low-E glazing
HISG
Normal glass (10mm)
Double Low-E glazing
HISG
Normal glass (10mm)
Double Low-E glazing
HISG
Normal glass (10mm)
Double Low-E glazing
HISG
Dubai
Tokyo
London
Sydney
Location

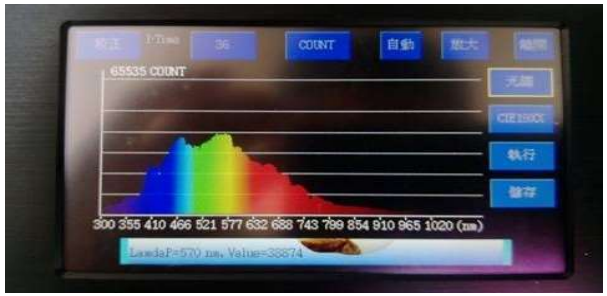
Power needed from grid
(energy consumption – solar power)





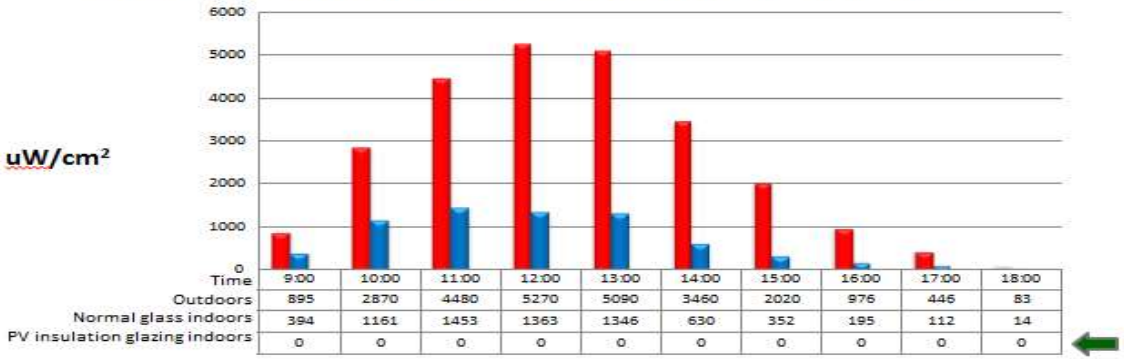
Many small power plants in Australia

All day Zero UV to protect human skin to prevent cancer attack



UV testing

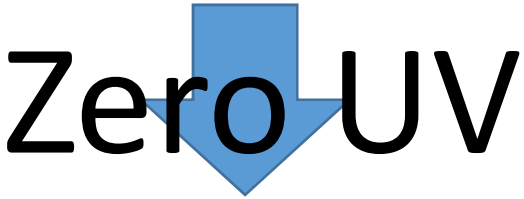
All the day zero UV at the indoors of PV Insulation Glass house



Time	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
Outdoors	895	2870	4480	5270	5090	3460	2020	976	446	83
Normal glass indoors	394	1161	1453	1363	1346	630	352	195	112	14
PV insulation glazing indoors	0	0	0	0	0	0	0	0	0	0

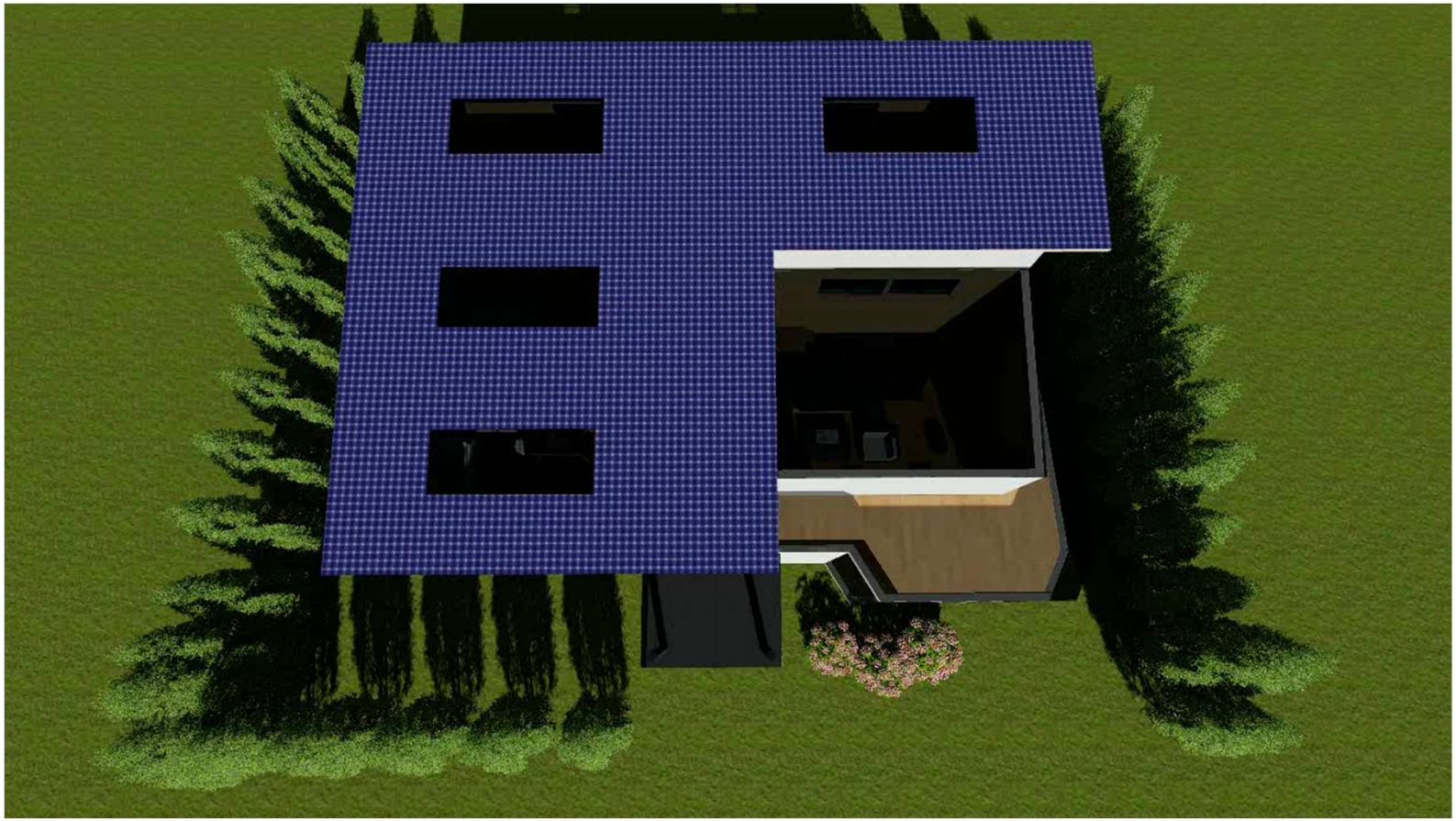
Normal glass indoors

PV insulation glazing indoors

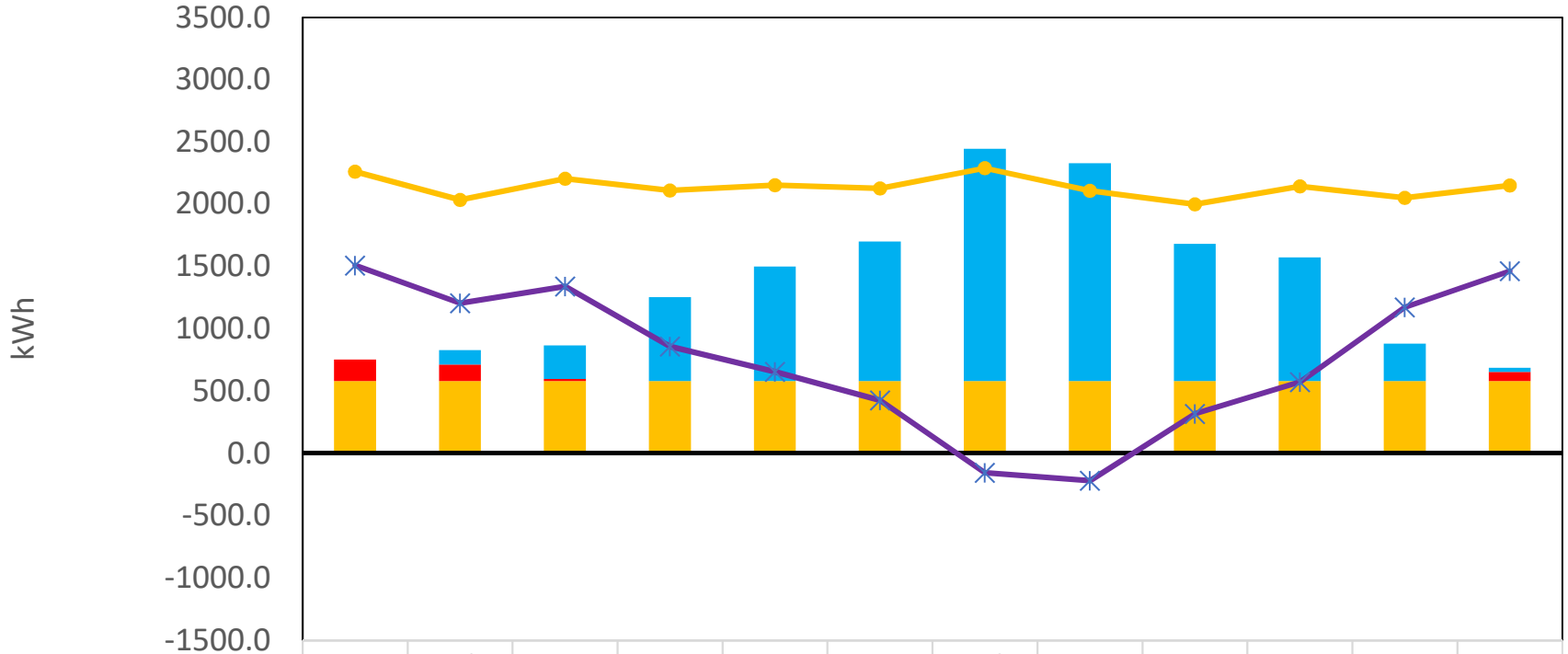


Vertical city power plant in Sydney

A New style Zero Energy House for Australia



Zero Energy Building Design in Tainan Taiwan



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cooling	0.0	117.1	268.1	672.9	918.7	1121.0	1864.4	1749.3	1102.8	993.2	300.7	33.5
Heating	173.0	132.2	17.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	73.5
Others	579.6	579.6	579.6	579.6	579.6	579.6	579.6	579.6	579.6	579.6	579.6	579.6
Solar	2262.0	2034.5	2205.8	2112.1	2153.2	2127.9	2289.7	2109.9	2000.1	2145.2	2053.1	2151.5
Remain	1509.4	1205.7	1340.7	859.6	654.9	427.3	-154.4	-218.9	317.7	572.3	1172.8	1465.0

9,152 kWh/year send back to grid

Zero Energy Buildings all over the world

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young@mail.ntust.edu.tw

UNSW SYDNEY

NEP II

TAIWAN TECH
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