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/m²)

Increasing Renewable Energy

Decreasing Energy Consumption

Zero Energy Buildings (ZEB)

trend
What is the menu of solution?
Solution

Zero Energy Buildings

Increase Renewable Energy Supply

Decrease Energy Consumption
How to reach the target?
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
Sunny day 4/4/2014 Taiwan

Temperature Difference 14.7°C
Cooling testing

Total energy saving 48%

Ordinary glass house

HISG house

Energy consumption (kWh)

Date

Only by fan ventilation
Reach comfortable indoors
Unique in the world

2017/01/04(06:00~18:00)
Energy Saving Analysis of Two Different Glass Test House

Solar Power + Cooling saving

10.07 kWh from grid

1.19 kWh send back to grid
ENERGY EFFICIENCY TEST of houses
The Best Performance

2017/02/16 (06:00~18:00)
Energy Saving Analysis of Three Different Glass Test Houses

Solar power generation | Air Conditioner | Fan | Heater | Total consumption | Energy needed

Normal Glass
-3 kWh from grid

Low-E Glass
0 kWh from grid
-2.01 kWh from grid
0.32 kWh send back to grid

HISG
1.66 kWh from grid
From Jan. 2017 to July 2017

Power from grid

Savings 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.

<table>
<thead>
<tr>
<th>date</th>
<th>12:00 (°C)</th>
<th>14:00 (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/11/2009</td>
<td>36.8</td>
<td>38</td>
</tr>
<tr>
<td>5/12/2009</td>
<td>35.2</td>
<td>38.8</td>
</tr>
<tr>
<td>5/13/2009</td>
<td>30.8</td>
<td>30.5</td>
</tr>
<tr>
<td>5/14/2009</td>
<td>32</td>
<td>31.2</td>
</tr>
<tr>
<td>5/15/2009</td>
<td>35.3</td>
<td>36.6</td>
</tr>
<tr>
<td>5/16/2009</td>
<td>34.9</td>
<td>37.5</td>
</tr>
<tr>
<td>5/17/2009</td>
<td>30.3</td>
<td>30.9</td>
</tr>
</tbody>
</table>
Use curtain for insulation
### Cooling consumption (one sunny day)

<table>
<thead>
<tr>
<th>Items</th>
<th>Normal Glass</th>
<th>HISG</th>
<th>Normal PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>圖示</td>
<td><img src="image1.jpg" alt="Normal Glass" /></td>
<td><img src="image2.jpg" alt="HISG" /></td>
<td><img src="image3.jpg" alt="Normal PV" /></td>
</tr>
<tr>
<td>Cooling load (kWh)</td>
<td>5.3</td>
<td>3.4</td>
<td>6.0</td>
</tr>
<tr>
<td>Reason</td>
<td>High heat penetration</td>
<td>Heat insulation</td>
<td>High temp. on the normal PV</td>
</tr>
<tr>
<td>Testing condition</td>
<td>Outdoor 35°C, Cooling setting 26°C 06:00 A.M. – 18:00 P.M.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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

Visible light at 12:00 noon

Lux

Outdoor
Normal glass indoors
PV insulation glazing indoors

Too bright
Comfortable visible light

58964
40086
2960
All day Zero UV to protect human skin to prevent cancer attack
PV insulation glazing
Skylight
Decreasing CO2
Building in Taipei 1876 m²
Solar power simulation
98137 kWh/year
Cooling consumption

Normal glass
124,100 kWh/year

HISG
31,600 kWh/year

Saving 92,500 kWh/year

Saving 74%
Heating consumption

**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

<table>
<thead>
<tr>
<th>Feed back year</th>
<th>4.23</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROI</td>
<td>18 %</td>
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</table>
Applied on vertical facade
Within 20 years

<table>
<thead>
<tr>
<th>Feed back year</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROI</td>
<td>7.6 %</td>
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</table>
Japan JIS wind testing

Up to 8000 Pa
No damage

<table>
<thead>
<tr>
<th>加圧ステップ</th>
<th>圧力 (Pa)</th>
<th>開発状況</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>900</td>
<td>異常なし</td>
</tr>
<tr>
<td></td>
<td>1800</td>
<td>異常なし</td>
</tr>
<tr>
<td></td>
<td>2700</td>
<td>異常なし</td>
</tr>
<tr>
<td></td>
<td>3600</td>
<td>異常なし</td>
</tr>
<tr>
<td></td>
<td>-900</td>
<td>異常なし</td>
</tr>
<tr>
<td></td>
<td>-1800</td>
<td>異常なし</td>
</tr>
<tr>
<td></td>
<td>-2700</td>
<td>異常なし</td>
</tr>
<tr>
<td></td>
<td>-3600</td>
<td>異常なし</td>
</tr>
</tbody>
</table>

加圧ステップ1

|          | 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|

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|

0 (加圧ステップ1終了) 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

試體安裝完成 ← 感測器銜接至接收器 ← 黏貼溫度感測器
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

<table>
<thead>
<tr>
<th>situation</th>
<th>Ordinary glass</th>
<th>HISG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor fire</td>
<td>30 seconds</td>
<td>19 mins</td>
</tr>
<tr>
<td>Outdoor fire</td>
<td>30 seconds</td>
<td>27 mins</td>
</tr>
</tbody>
</table>
Real Application
EAG HOUSE

www.hisg.com.tw
Skylight

www.hisg.com.tw
MRT STATION
GREEN HOUSE USA
SKYLIGHT, SCHOOL
Glass Curtain Wall
Green House
International cooperation
Development of Heat Insulation Solar Glass for Low Carbon Buildings
UNIVERSITY OF NOTTINGHAM
TAIWAN TECH HISG TESTING HOUSE
Application of HISG on conservatory in UK

Solar power + Saving heating

Only 1/5 Power required

Comparison of electricity from grid

<table>
<thead>
<tr>
<th></th>
<th>energy consumption(kwh)</th>
<th>solar power generation(kwh)</th>
<th>energy needed from grid(kwh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Insulation Glazing</td>
<td>-4775.7</td>
<td>2016</td>
<td>-2960.0</td>
</tr>
<tr>
<td>Normal</td>
<td>-14759.3</td>
<td>0</td>
<td>-14799.318</td>
</tr>
</tbody>
</table>
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)

Dubai: 71851
Tokyo: 44204
London: 36678
Sydney: 59529
Cooling + heating consumption

- Saving 69%
- Saving 47%
- Saving 52%
- Saving 56%

Energy consumption (kWh/year)

- Normal glass (10mm)
- Double Low-E glazing
- HISG

Locations:
- Dubai
- Tokyo
- London
- Sydney
Power needed from grid
(energy consumption – solar power)

Dubai  |  Tokyo  |  London  |  Sydney
--- | --- | --- | ---
532,648 kWh | 445,448 kWh | 604,678 kWh | 252,459 kWh

- Saving 82%  
- Saving 57%  
- Saving 58%  
- **Saving 86%**
Many small power plants in Australia
All day Zero UV to protect human skin to prevent cancer attack
Vertical city power plant in Sydney
A New style Zero Energy House for Australia
Zero Energy Building Design in Tainan Taiwan

9,152 kWh/year send back to grid
Zero Energy Buildings all over the world

www.hisg.com.tw

www.hisg.com.tw  young@mail.ntust.edu.tw