

Outdoor Exposure Testing for Glass-to-Glass PV module for Building Application in Korea

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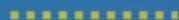
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RELIABILITY TEST



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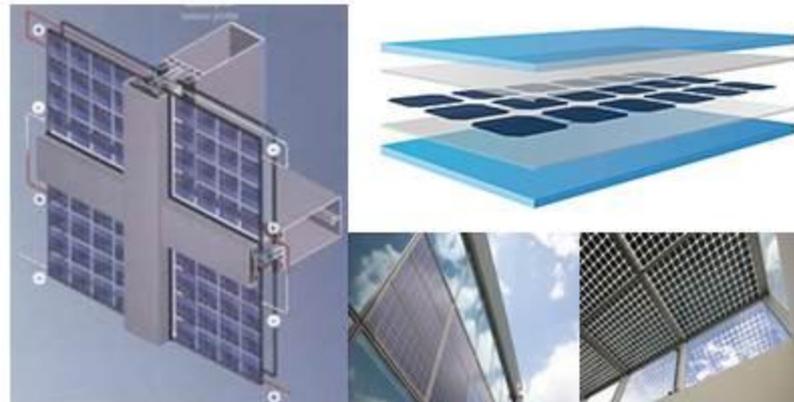
INTRODUCTION

Glass-to-Glass PV Module for Building

Conventional PV Module



Glass-to-Glass(G2G) PV Module



- Glasses on both sides of the module; **strong for severe environment, great thermal insulation performance.**
- G2G module transparency **creates a new aesthetic value of building.**
- System efficiency and output energy depends on the **module encapsulating materials.** [1]
- Development of life reliability test of G2G module as building materials is needed.

INTRODUCTION

OBJECTIVE



PV module



Glass(Curtain wall)



GtoG PV module

Performance
Test

- IEC 61215(c-Si)
- IEC 61646(a-Si)

Reliability
Test

- Accelerated life test
- Outdoor exposure test

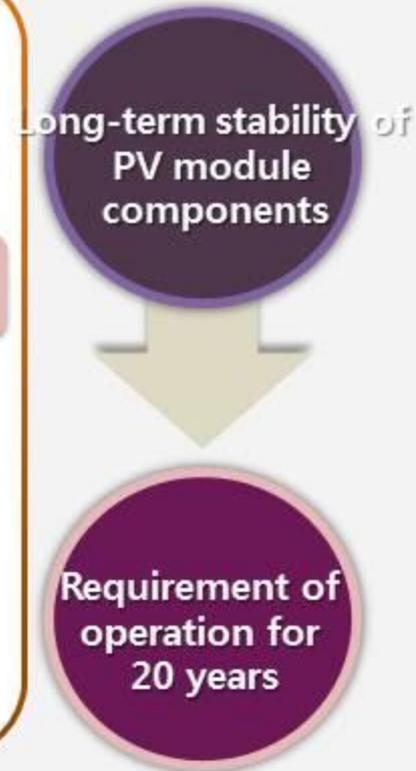
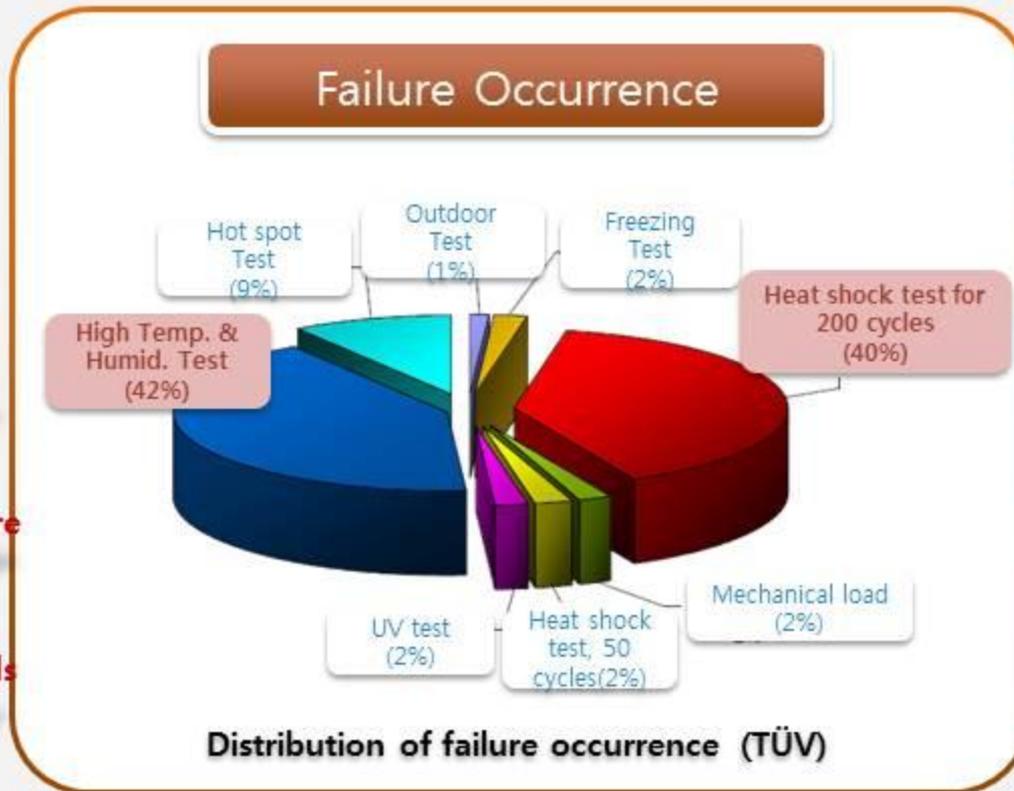
- **Glass :**
 - KS L 2002 (Tempered glass)
 - KS L 2004 (Laminated glass)
- **Building Materials**
 - ASTM E 283-04 (Air Leakage)
 - ASTM E 331-00 (Water Penetration)
 - ASTM E 330-02 (Structural Performance)

**“Performance and Reliability
Evaluation Method for G2G
PV module**

; Through Exterior Windows,
Curtain Walls and Doors”

RELIABILITY TEST

Major Failures of Modules

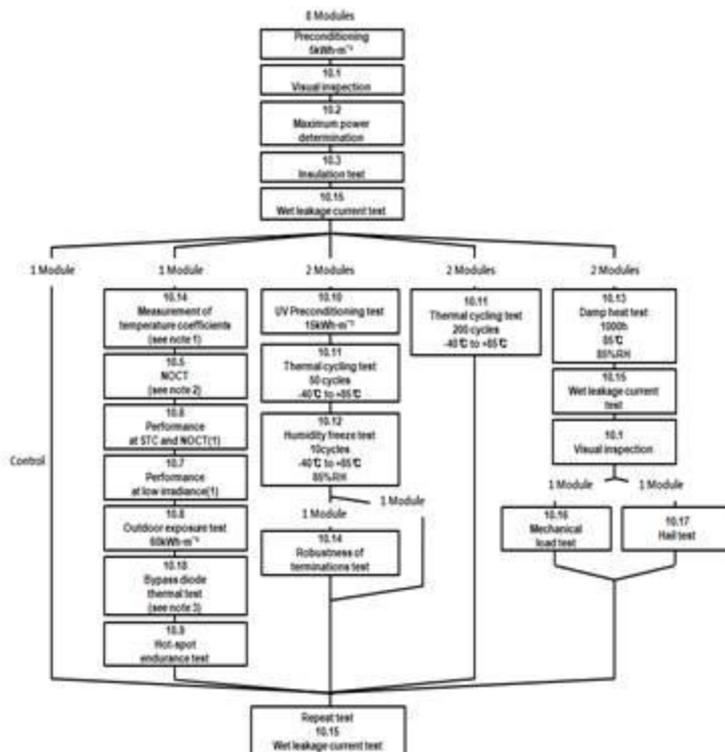


RELIABILITY TEST

Development Process

- ✓ IEC 61215/61646(c-Si, a-Si terrestrial PV module) + Construction Standards
- ➔ Degradation factor : **Irradiation, Temperature, Humidity.**

IEC 61215



Construction Standards

Glass Standards

- ✓ **Shot Back**
- ✓ **Bends & Curves**

Building materials Standards

- ✓ **Air Leakage**
- ✓ **Water Penetration**
- ✓ **Structural Performance**

Mock-up test

- ✓ **Application (Curtain Wall)**



INFRASTRUCTURE

Test Apparatuses in KCL

Building Materials Test

Mock-up Test of large scale BIPV Total performance test of Weathering

▶ **Energy Environment Technology Center**

- Energy Efficiency and Insulation Test
- Air Leakage/Water penetration/ Wind pressure Test
- Fire Safety Test
- Insulator Test
- etc.

▶ **Outdoor Experimental Test Center**

- Weathering Test
- Outdoor Exposure test
- Curtain Wall Mock-up Test



▶ Curtain Wall
Mock-up



▶ Fire Test



▶ Thermal
Transmittance

PV Performance Test

PV performance Test KS C IEC 61215, 61646

▶ **Outdoor Experimental Test Center**

Photovoltaic Performance Test equipment



Solar Simulator



Mechanical Test



Hail Test



Outdoor exposure



I-V Curve



Bypass Diode

INFRASTRUCTURE

Outdoor Exposure Site

Outdoor Test Facility



Seosan in west sea, Korea (48,000 m²)
Area for PV module (5,200 m²)
Max Power : 500 kW (usable area)

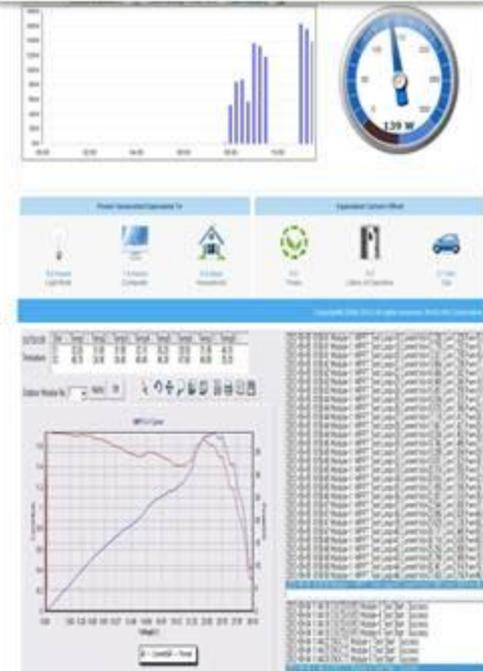
Outdoor NOCT Testing



Field Failure Testing



Reliability D/B



Weathering data
(T, humidity, irradiation,
etc.)
Electrical data
(I-V, Power, etc.)

INFRASTRUCTURE

Environment Monitoring Site

| Weathering Environment Monitoring Equipment |

Real-time Data acquisition of temperature, humidity, rainfall, solar irradiance



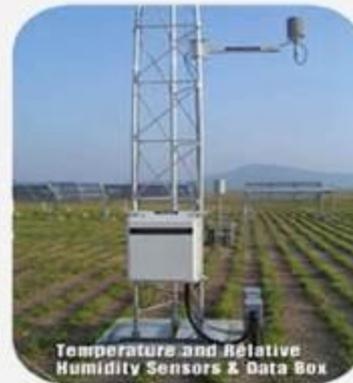
UV Pyranometer
- Angle : 5, 30, 37, 45°



Total Pyranometer
- Angle : 5, 30, 37, 45°



Static Radiometer Rack



Temperature and Relative Humidity Sensors & Data Box



< Salt measurement system >



Under Glass Pyranometer(UV&Total)
- Angle : 5, 30, 37, 45°



White Panel Temperature



Black Panel Temperature



Wet Time (젖음 시간)



< Acid rain measurement system >

FUTURE WORKS

Performance Comparison

| Module Performance |

Performance comparison between conventional PV module and G2G PV module

1

| Module Performance Testing |



Conventional PV module



Glass-to-Glass PV module

2

| Outdoor Exposure Testing |



c-Si G2G PV module

a-Si G2G PV module

FUTURE WORKS

Performance Comparison

| Building Application |

Performance simulation for building application



Curtain Wall

- Installation angle : 90°



Roofing

- Installation angle : 45°



CONCLUSION

Summary and Conclusion

- ① **Main failure factors** that examined by outdoor exposure test are **solar irradiation** and **temperature**, which could be degradation factors of G2G module reliability test.
- ② Especially for G2G PV module, the test for laminated glass(KS L 2004) will be carried out as building materials.
- ③ Comparison tests ; ① module performance, ② installation type, have been implemented for building application.
- ④ As a result, standard '**Performance and Reliability Evaluation Method for G2G PV module**' will be crystallized in KOREA.