Developing Codes and Standards for BIPV and Integrated Systems

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Removing Barriers to Photovoltaic Technology Adoption: Reliability, Codes/Standards, and Market Acceptance

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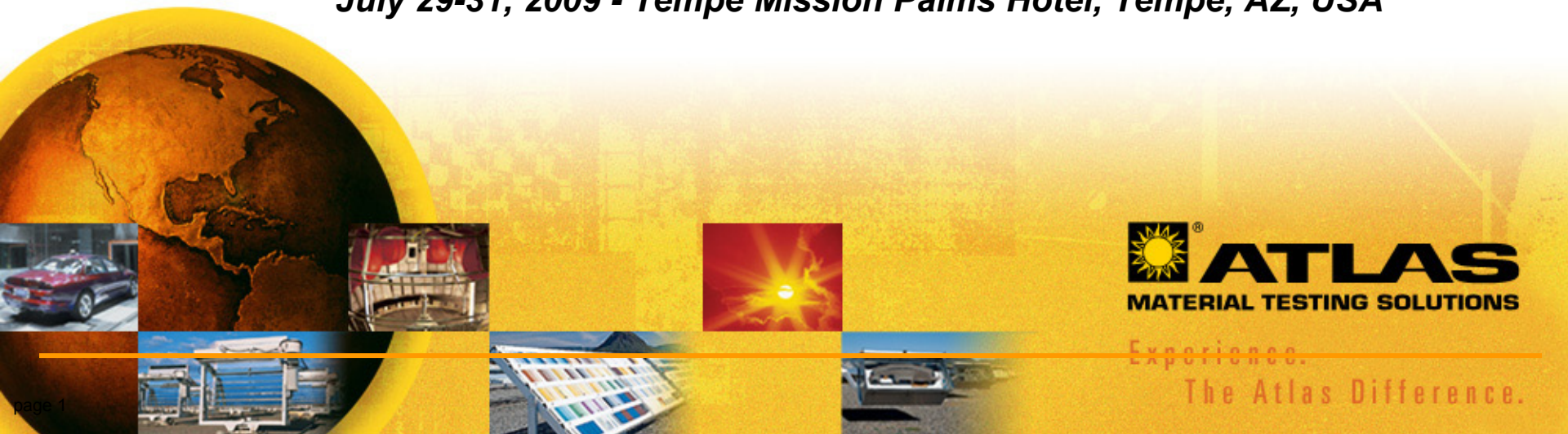

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Outline:

Why standards are needed
- Preaching to the choir?

What are BIPV? - Their Special Needs
- Building material

- Architectural
  - Aesthetics
  - Functionality

- PV requirements
  - Electrical Performance Issues
  - Safety

Types of standards needed
- Qualification
- Durability

Path forward

BIPV are PV components that replace the look and function of a primary building material, and are provided as a single integrated unit

An example of BIPV, which is installed at an REI store in Boulder, CO. (Photo: Scott Dressel-Martin)

BIPV products act as the weather-resistant skin of the building envelope.

Photo: BIPV Facade, Melbourne University Private (photo: S.Troman)

BIPV Building Integrated Photovoltaic

BIPV products must conform separately to ***both*** PV and building product standards. There are essentially no integrated standards specifically for BIPV products

Photo source: Inhabitat

BAPV Building Applied PhotoVoltaic

BAPV encompass a broader class of building-mounted photovoltaics and include some traditional roof-mounted PV systems, usually applied post-construction.

Photo source: Sunpower Corporation

From a standards perspective, should direct-adhered PV products be considered part of the building product *or* as a stand-alone PV, e.g., safety (flammability) issues?

Photo: United Solar Ovonics

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There is a need for standards and regulations:

- Safety issues
- Quality
- Durability

Rooftop BAPV, Mali

Source: Bart de Boer, Energy Center of the Netherlands, Performance BIPV Workshop, Nice, 30 October, 2008

Necessary for end-user confidence & to facilitate trade..

"Unfortunately, BIPV use faces critical barriers in *standardization*, services, and materials, as well as formidable competition from building-applied photovoltaics."

"BIPV is nearing a crossroads . . . it will either continue to grow slowly as a highly specialized, aesthetic niche market, or bridge the gap between the PV and building industries. The latter path will require *industry standards*, as well as innovation and investment. But it also offers genuine growth opportunities for well positioned parties."

Source: "Laying the Foundation for Building Integrated Photovoltaics," Lux Research report

The issue in a nutshell……..

Architectural & building codes

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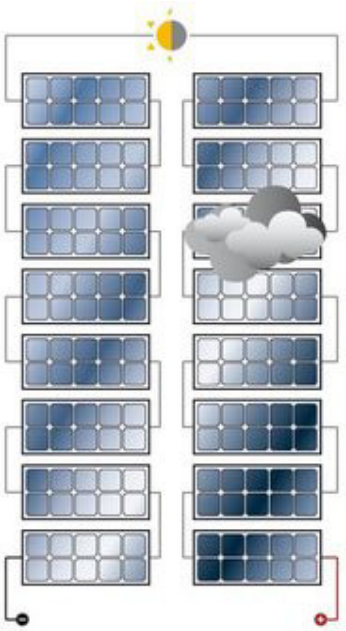
- Building materials
  - Fire codes
  - Prevention of electrical fires
  - non-enhancement - fire-resistant materials

  -Mechanical
    - Stability
    - Wind resistance
    - Hail resistance
    - Dirt pick-up
    - Organic pollutants

- Building design considerations
  - Noise protection
  - Energy economy
  - Heat retention
  - Health & environment
  - Means of egress

BIPV standards are very important

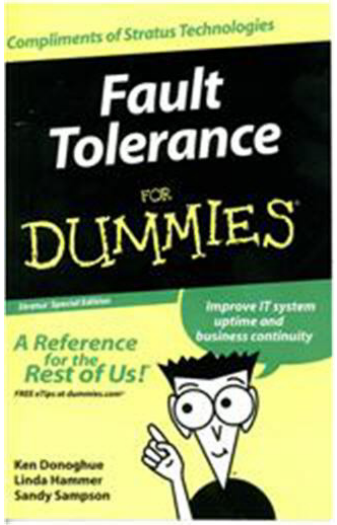


- Grid-connected BIPV systems feed energy back into the grid, a function previously managed by electricity authorities and large generation plants.
- Grid protections - designed for a small number of stations feeding down through a network of high, medium and low voltage systems to the consumer. BIPV inverts this concept.
- Utilities are responsible for the safety and quality of the supply; BIPV must be proactive in helping set standards to gain market acceptance, but not so restrictive or expensive to stifle the market.

An issue: US v. Euro DC grounding requirements

Electricity production issues…..

BIPV standards are very important



- BAPV/BIPV generators do not inherently have high fault tolerance
  - **Output is not easily turned off and is dependent on a variable source**
- Contains cells connected to circuits with potentially dangerous voltages
- Inverter grid-connected systems have different characteristics than electro-mechanical systems.

Standards need to address these potential safety issue without draconian measures that would stifle the industry.

Electricity production issues…..

PV has been around a while. Haven't durability issues all been resolved?

30-yr experience with traditional framed Si PV-modules does not transfer to:

new form factors such as flexible roofing materials or curtain wall systems

Silicon thin-film devices

Non-silicon photovoltaics

Durability issues are significant….

Major PV standards

Major safety and performance issues are generally addressed by IEC, UL, CE, EU standards, national standards and electrical codes

Solar Modules & Panels	
Standards	**Description**
UL 1703	Flat-Plate Photovoltaic Modules and Panels
IEC 61215	Crystalline Silicon Terrestrial Photovoltaic Modules — Design Qualification and Type Approval
IEC 61646	Thin-film Terrestrial Photovoltaic Modules — Design Qualification and Type Approval
IEC 61730	Photovoltaic Module Safety Qualification
Other Major Parts and Components of Photovoltaic Systems	
Standards	**Description**
UL 1741	Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
UL 4703	Outline for Photovoltaic Wire

Table 1. Key UL and IEC Standards for Photovoltaic Parts and Components

Source: Underwriters Laboratories

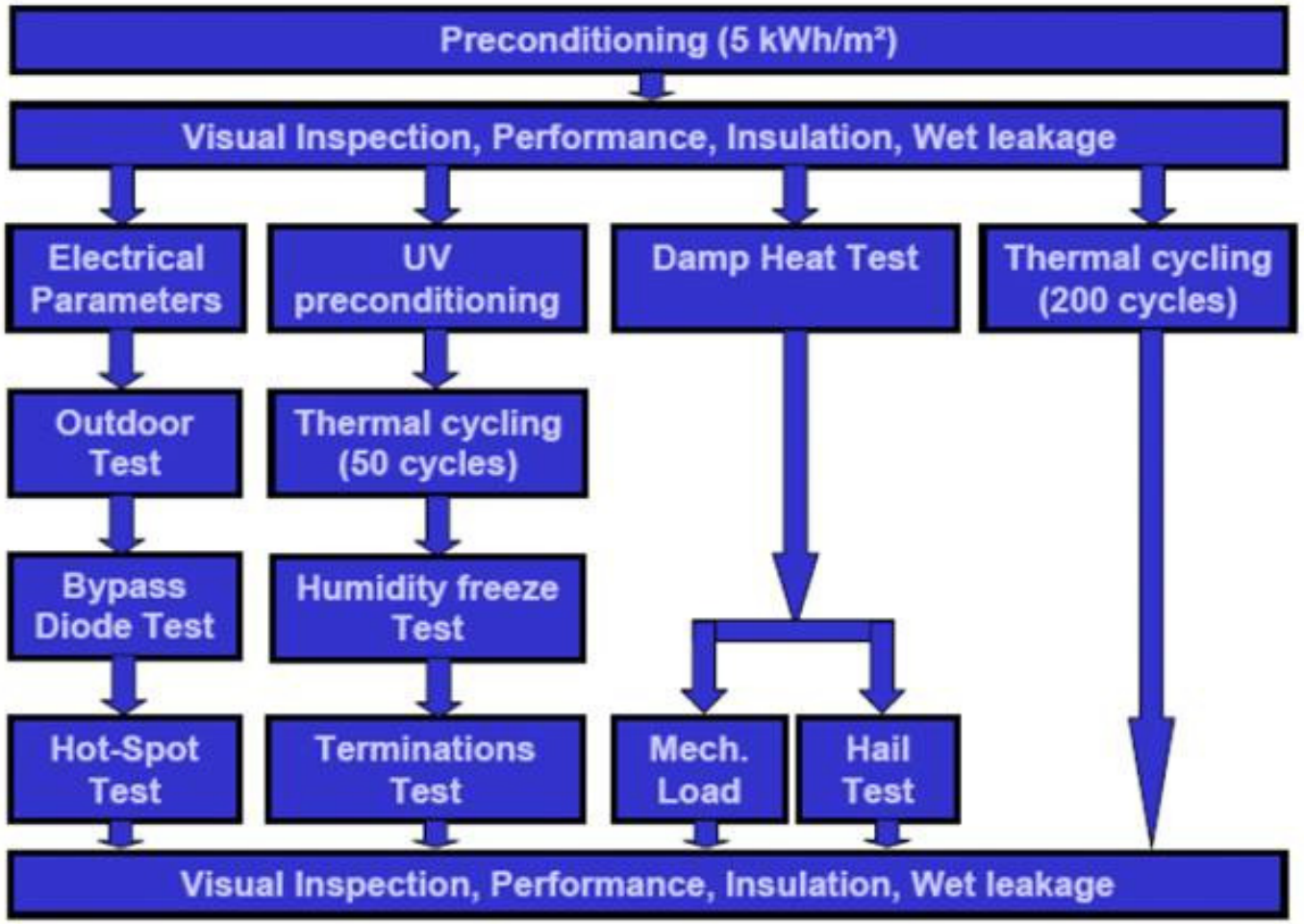
Current BIPV-related standards primarily address some specific safety and electrical issues but not long term performance as either a PV or building material.

BIPV Products	Additional Assessments/ Standards
Replacing roofing materials	UL 790
Used as facades or building glass	ANSIZ97.1-1984
Used in locations traditionally employed glazing materials, such as building facades, skylights and solarium roof	Mounting and wiring methods must be evaluated with the PV modules for impact resistance and must comply with Part IV of Article 690 in the NEC.
IEC 61730	Photovoltaic Module Safety Qualification

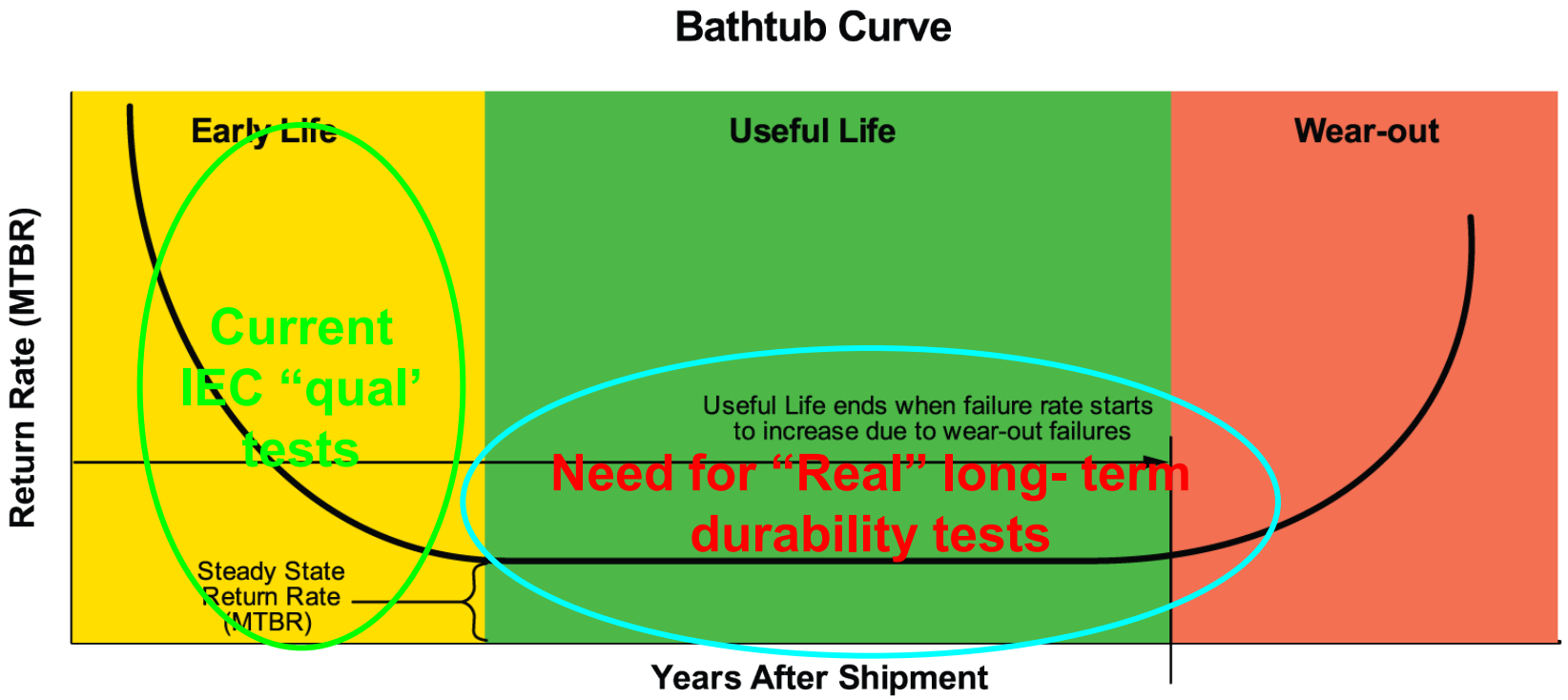
Table 2. Additional Assessments/ Standards for BIPV Products

Source: Underwriters Laboratories

IEC 61215 Test Sequence

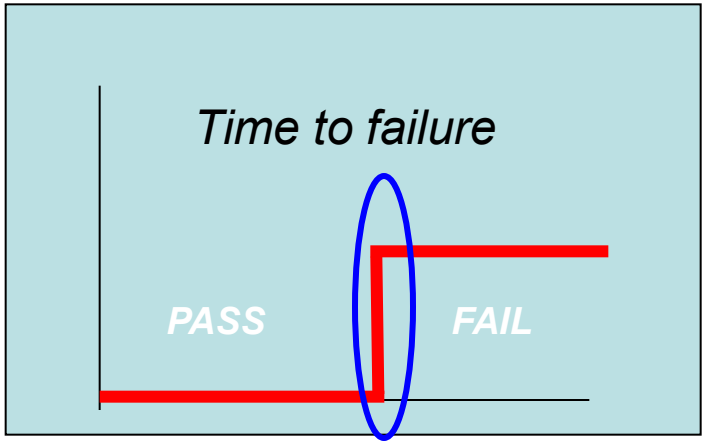


Initial qualification vs. durability tests

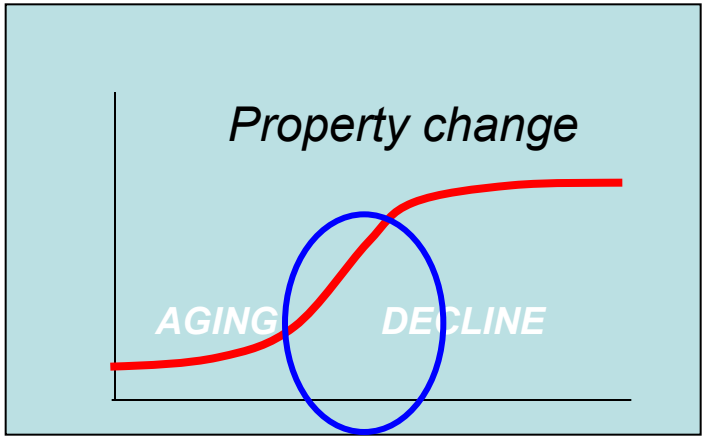


BIPV standards should ideally address both…

Reliability vs. Durability



Reliability

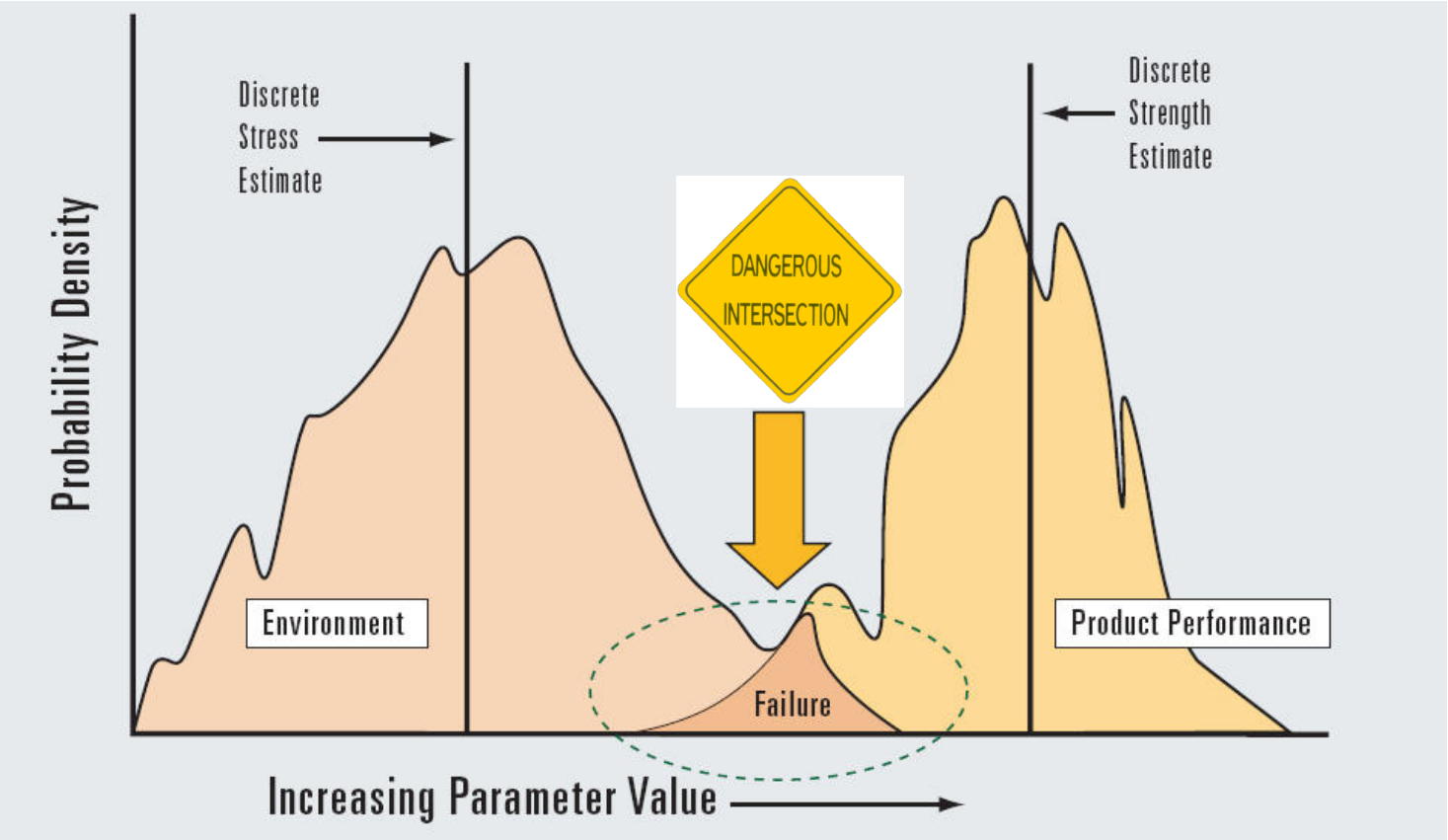


Durability

In very general terms, reliability **analysis is concerned with measuring discrete,** absolute failures

Durability **involves the** route to failures **(mechanisms), the property** rate of change **(kinetics), degree of** robustness, **etc.** ***These may not cause failure but result in declining performance and shortened service lifetimes.***

Design for Reliability/Durability



Becomes convoluted when looking at multiple criteria sets……

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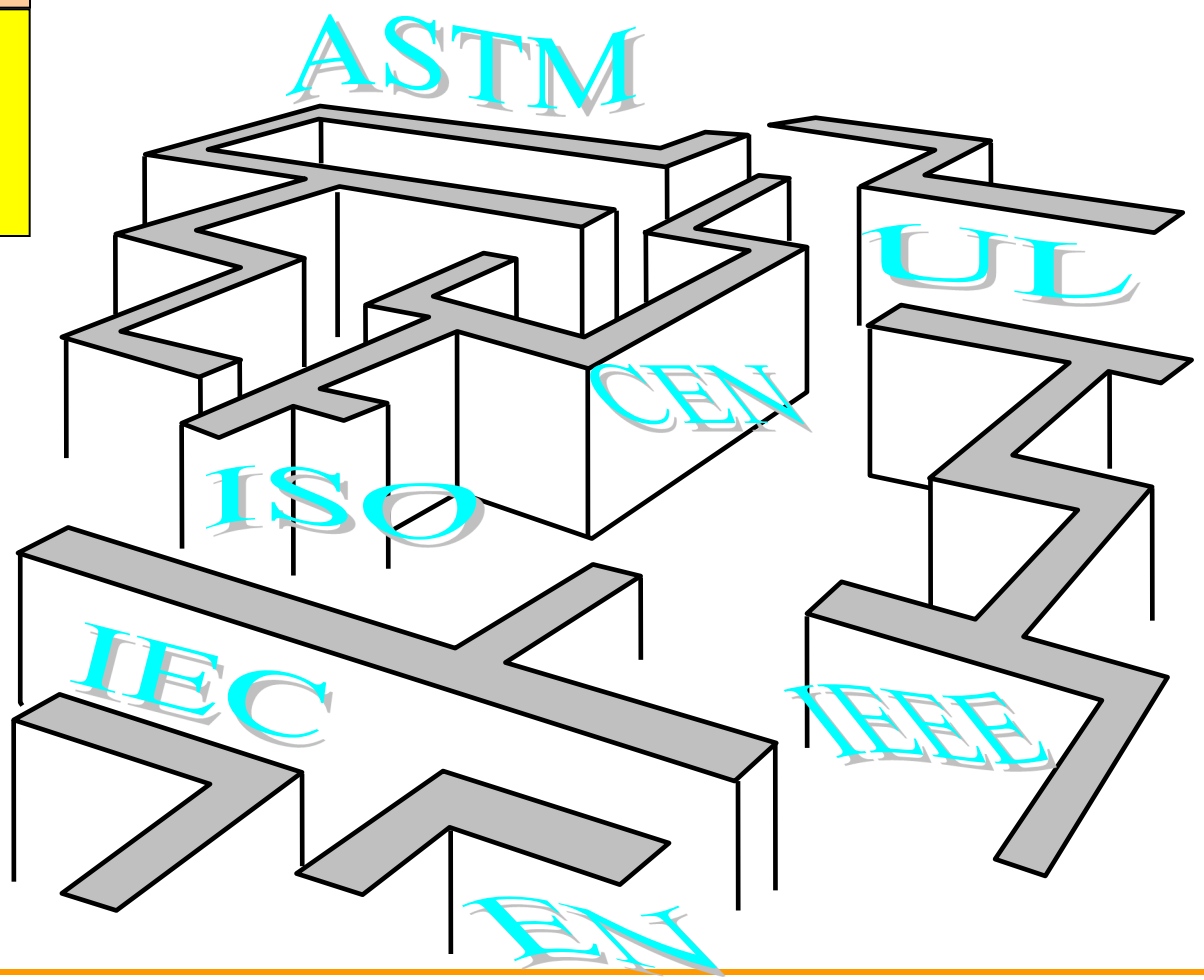
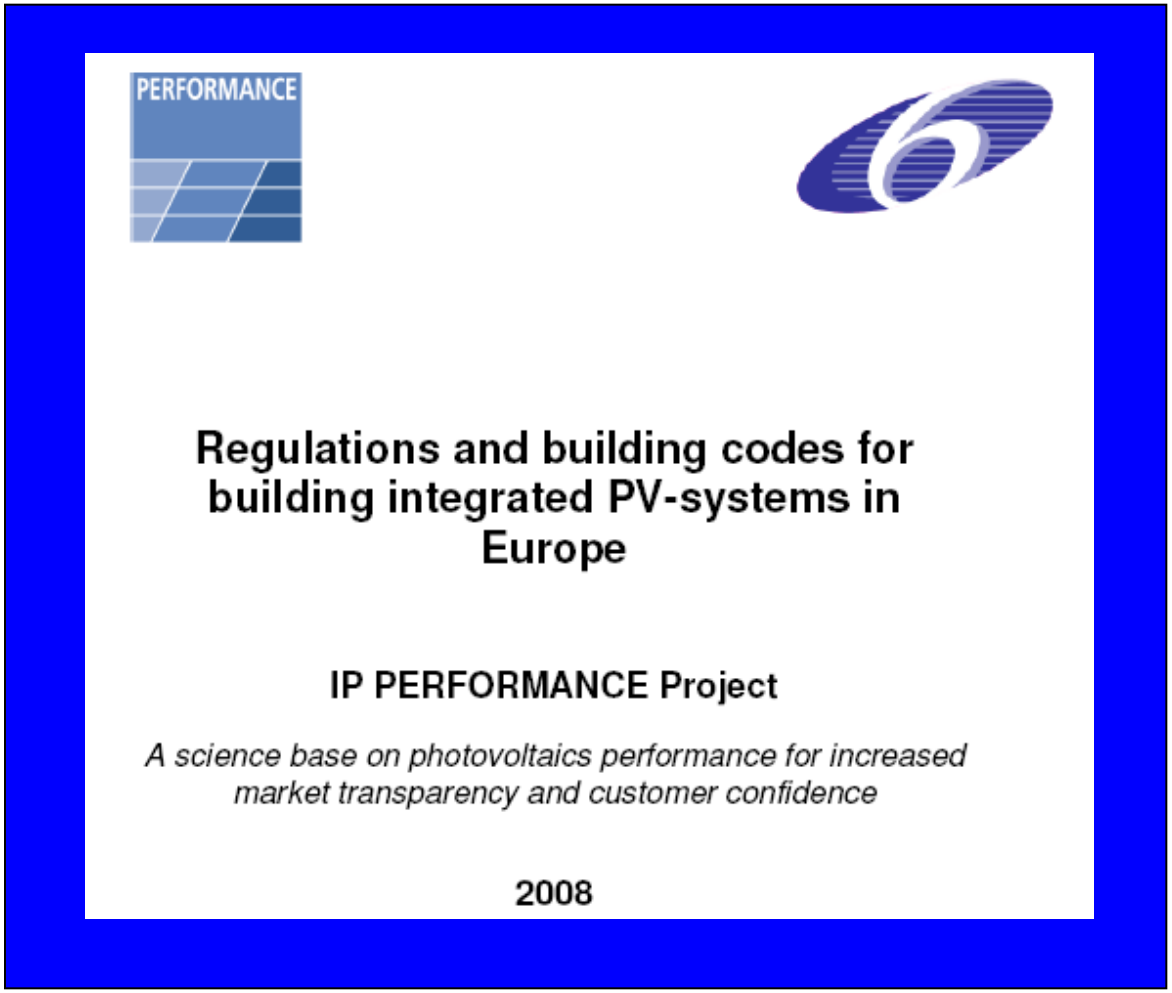
BIPV Issues:

- Building materials
- Architectural
- Electrical performance
- Safety



Where does an integrated standard belong????

BIPV standards - progressing in Europe



Source: www.pv-performance.org

Much good work has been done….

Missing from standards

- **BIPV products such as curtain walls and others *must* retain appearance properties in addition to building functionality (envelope)**

- **Additionally, BIPV products must retain their safety and electrical performance throughout their rated lifetimes (at a minimum)**

- **Conventional PV testing:**
  - Current IEC, UL, etc., qualification tests are performed on new or near-new modules and not weather-aged products
  - IEC, UL, etc., qualification tests – Have their own issues – do not test long term durability

- **Current IEC, UL, etc., qualification tests are performed on new or near-new modules - not repeated on weather-aged products. Therefore, their property retention characteristics are unknown.**

- **Current IEC, UL, etc., qualification tests are primarily ALT tests for "infant mortality" and initial pass/fail reliability, and do not test or assure long-term durability or aging characteristics.**

- **BIPV products often must conform to "other" building product codes and standards not familiar to PV manufacturers:**

  -ICC Evaluation Services ***"Acceptance Criteria for Building-Integrated Photovoltaic (BIPV) Roof Panels" (2007)*** which contains provisions for wind resistance, wind-driven rain, accelerated weathering, etc.
  -Miami-Dade County (FL) building codes for hurricane protection
  - Some municipal fire departments are developing their own BIPV codes.

  Others . . . .

Summary

- From 1992 BIPV – hailed as the next high - growth sector
  - **Remains an underperforming – small niche sector**

- Reasons:
  - **Boon in standard silicon crystalline demand**
    - Demand greater than supply

- Manufacturers without incentive to move towards more complex BIPV production– too many barriers to entry

- Lack of appropriate standards – a significant hurdle

- For BIPV to fulfill promise – the complicated integration of standards (PV & Building materials) must be undertaken

- Many efforts undertaken and later abandoned

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Summary

- Effective standards development really be done ***only*** with leadership of entity (or entities) with interest, funding, gravitas, expertise.
- Standards development is difficult
- Especially for BIPV - spans a number of disciplines: architecture, engineering, device physics, structural & electrical engineering and building trades. Sectors traditionally lacking in standards working committees
- Standards take a long time to develop.
- Standards are necessary to improve quality and reliability of early systems and prevent failures & to instill confidence and foster market growth
- Standards which are overly restrictive, inadequate, or non-existent, early in product technology can significantly limit market growth; very difficult to overcome later on.

A more aggressive role for Solar ABCs?

PV

Standards

Building
Codes

Thank You!

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