Utility Connections, Safety & Code Issues
Agenda

1. Grid Interconnection & Relationship to the Utility
2. Permitting Challenges
3. Codes and Standards Related to PV Systems
Grid Interconnection and Relationship to the Utility
Relationship & connection to the electrical utility grid

Photo credit: NREL
Solar PV Energy Flow

- Building Load
- Service Panel
- Utility Meter
- DC Disconnect
- Inverter
- AC Disconnect

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Advantages to grid connection

Net metering and value-of-solar tariffs can offset a customer’s electricity usage costs
Advantages to grid connection

Grid-connected PV systems do not require a battery system

Photo credit: CSE
Inverter: Speaking the grid’s language
Inverter: Speaking the grid’s language
Anti-islanding
Anti-islanding

Building Load → DC Disconnect → Inverter

AC Disconnect ← Service Panel ← Utility Meter

Anti-islanding

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Solar PV Energy Flow with Battery Bank

- DC Disconnect
- Charge Controller
- Battery Bank
- Backup AC Circuits
- Inverter
- AC Disconnect
- Building Load
- Service Panel
- Utility Meter

Anti-islanding X

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Permitting Challenges
What makes SOLAR permitting unique?

• Impacts multiple disciplines/areas of the building
• Most frequently retrofits
• Inexperience of code officials
• Rooftop access needed for inspection
• Wide variation in local permitting requirements

• Local laws and ordinances addressing solar
• Scale and pace of solar installs
• Unique financing and marketing of systems
• Multiple inspections
• Applicability nationwide, on most types of structures, new and existing construction
Permitting Challenges

1 in 3 solar installers avoid selling in an average of 3.5 jurisdictions because of permitting difficulties.

Resubmissions of plans occur in 24% of all installations and rework in 16% of installations.

An average installation requires nearly 8 weeks to be processed by all the relevant jurisdictions.


Slide & photo credit: IREC and ICC. Image Source: https://solarpermit.org/
The Problem from Both Perspectives

**Installer’s Perspective**

- Varying requirements across AHJs create confusion, rework, and frictional costs
- Requirements within the same AHJ suffer from inconsistent application.
- Requirements are not readily accessible and can be updated without notice.
- Inconsistent processing and cycle times disrupt sales and operations flows (e.g. scheduling staff time, routing crews, and site visits to customers)

**AHJ’s Perspective**

- Installer errors and incomplete/inconsistent paperwork (e.g. design doesn’t match documents) creates extra work and delays.
- AHJs often operate in sub-optimal conditions - strained budgets, under-resourced, staff turnover.
- No channel to communicate updates or simplification of processes to installers.
- Solar installations are uncommon; AHJs are unaware of existing best practices or that a problem even exists.

“I find myself having to educate the city staff on their own requirements”

“AHJs can change their interpretations of existing codes and you only find out after you are about to submit your paperwork…”

“Perhaps a fifth of submittal packages are poorly organized and may require hours of red-lining.”

“This is a matter of safety, not red tape.

Slide credit: IREC and ICC.
PV’s Overlapping Permitting Approval Processes

**Code Approvals**
- Submit permit application
- Permit application, plan review & approval
- Construction of solar PV system
- Site inspection & final approval

**Grid-Tie Approval**
- Submit “request to interconnect” to the local electrical grid
- Utility site inspection
- Interconnection approval

**Incentive Approval**
- Submit incentive application
- Incentive program inspection
- Incentive program approval and payout.
What is “expedited permitting”? 

- Definition: An organized permitting process by which a majority of small PV systems can be permitted quickly and easily (Brooks).

- Simple eligibility checklist to determine eligibility.
  - 10-15 kW maximum power output
  - Simplified structural and electrical review
  - Minimize the need for detailed engineering studies
  - Not intended to apply to all PV systems
  - Widespread use of expedited permitting and growing.

Slide & photo credit: IREC and ICC. Source credit: Solar ABCs?: Expedited Permit Process for PV Systems
Solar Training for Code Officials is Happening

• Strong growth of the solar industry is expected to continue
• Many code officials recognize the need to improve knowledge of solar
• Focus is now on reducing non-hardware costs
Ask AHJ if they have a solar checklist

BENEFITS TO DESIGNERS

• Helps you prepare plans for application / inspections
• Helps you establish client/subcontractor expectations

BENEFITS TO AHJs

• Increase consistency of inspections
• Consolidate material from different depts/trades

BENEFITS TO CONTRACTORS

• Advance preparation for inspection
• Set expectations for subcontractors

Credit: IREC and ICC.
Some AHJ Offer Expedited Permitting

Eligibility requirements may include:

- A limit on system capacity and complexity
- Limit applicability to certain building types
- Installation by licensed solar contractors
- Utilize listed/certified components
- Exclude sites with special zoning, historical and architectural requirements
Codes and Standards Related to PV Systems
The ICC codes are the basis for the code ordinances adopted by most jurisdictions.
Int’l Solar Energy Provisions (ISEP)

• ALL code requirements for PV in one place!
  – Building code
  – Mechanical code
  – Plumbing code
  – Energy code
  – Fire code
  – Electrical code
International Building Code (IBC) and International Residential Code (IRC)

- Fire Classifications
- Roof Coverings
- Structural:
  - Wind
  - Seismic
  - Gravity
Fire Classification is based on:

- Type of construction: Yes
- Required fired rating: Yes
- Existing roof: No
Fire Classification

IBC 1505.8

• Building Integrated PV Products
Fire Classification

IBC:
PV Panels and Modules
UL 1703

Inverters
UL 1741
The dead load of rooftop PV systems, which includes the racking support systems, must be identified on the construction documents.
Structural - Design Roof Loads

**Dead loads**

**Live loads**

Graphic credit: NREL
Structural - Snow Loads
Structural - Wind loads
International Plumbing Code (IPC) and International Mechanical Code (IMC)

- Label information
- Building envelope penetrations
- Allowable locations
- Roof access
- Roof anchors for fall protection
- Many more provisions applicable to solar thermal
International Energy Conservation Code (IECC)

- Minimum energy considerations
- References ASHRAE Standard 90.1
- Mandatory and enforceable language
- C406.5 On-site renewable energy
- Solar-ready appendices
IgCC and ASHRAE 189.1

- Total building sustainability guidance
- High performance green buildings
NEC & Solar PV:

• Art. 690 Solar Photovoltaic (PV) Systems
• Art. 705 Interconnection of Electric Power Production Sources
• Art. 250 Grounding and Bonding
International Fire Code (IFC)

- Fire department access
- Fire safety requirements
- Requires clear space on roof for:
  - Access paths
  - Ventilation
NEC requires rapid shutdown of PV systems
Rapid Shutdown

Building Load → DC Disconnect → Inverter

Utility Meter ↔ AC Disconnect ↔ Service Panel

Rapid Shutdown

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Access and Ventilation

IFC: Access

• 6 ft. wide clear perimeter at edges of roof
• Pathways provided in both axes
Access and Ventilation

IFC: Smoke Ventilation

- Max. 150' x 150' array
- Min. 4' pathway with venting cutouts
Access and Ventilation

IFC:
Smoke Ventilation

Photo credit: Greentech Media
Testing and Commissioning

Importance:
• Ensures safe installation
• Minimum procedures
• Output and performance
Quiz & Discussion
If the grid goes down and the sun is shining, the building will still receive energy from the PV system.

a) True
b) False
Which is the best reference document for finding all code requirements for PV installations?

a) International Building Code (IBC)
b) National Electric Code (NEC)
c) International Solar Energy Provisions (ISEP)
d) International Energy Conservation Code (IECC)
The maximum size for a roof-mounted PV array is 150’ x 150’ due to:

a) **Firefighter access**
b) **Structural loading considerations**
c) **Electric utility restrictions**
d) **Capacity of inverters**