



Washington State

Energy and Lithium-Ion Battery Symposium

Addressing Energy in Residential Capacity



EV 2 G



Energy Hazards at R-3

RECEOVS

R - Rescue victims

E - Exposures

C - Confine to smallest footprint

E - Extinguish

O - Overhaul

V - Ventilation

S - Salvage



Electrical Utilities - Residential

Securing utilities

Primary AC Feed*

PV / Solar

ESS

Generator

EV2G



PV – Photovoltaic Systems



Solar / Photovoltaic Energy

Single Solar Cell

Each cell captures solar energy and converts to DC current

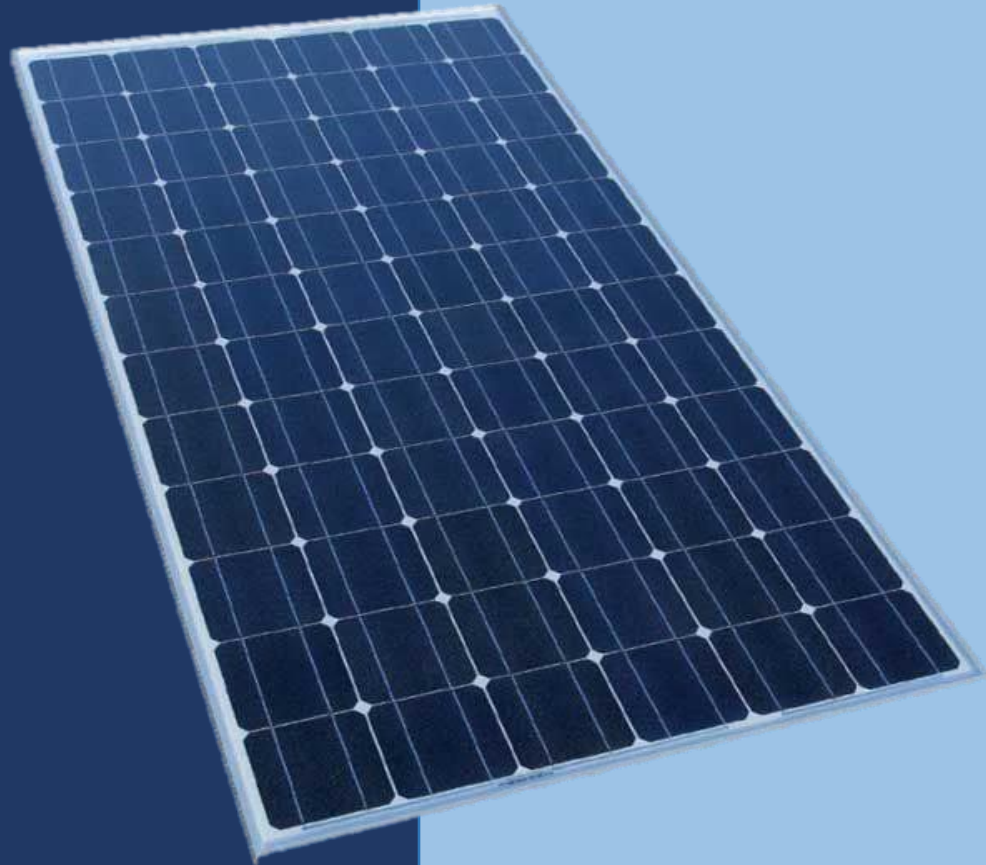
If there is light on this cell, then consider it to be energized.



You cannot turn this thing off



Solar / Photovoltaic Energy



Solar Module

Multiple of cells connected and wired in series

Light weight

Glass does not burn, backing material will burn

You cannot turn this thing off



Voltage Limits



600 Vdc



1000 Vdc



1500 Vdc



Solar / Photovoltaic Energy



Solar Array System

Multiple modules used to increase system capacity

PV Array Panels/Modules do not have a Capacitance...they are not designed to STORE energy.



Solar / Photovoltaic Energy

Fire Damaged panels are likely still making DC energy.

If there is light on them, they should be considered energized.



Solar / Photovoltaic Energy

An inverter converts DC current to AC Current

The inverter is a critical component of the PV Array System

Generally located near the electrical meter



Solar / Photovoltaic Energy

PV Disconnect
Solar Disconnect
DC Disconnect



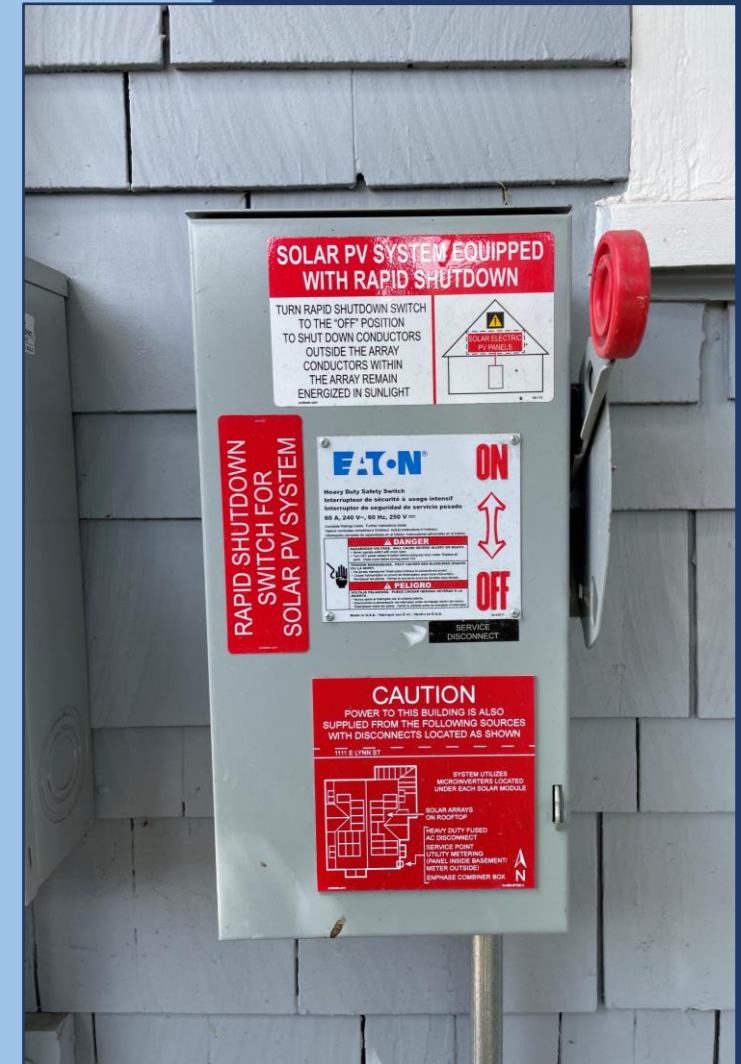
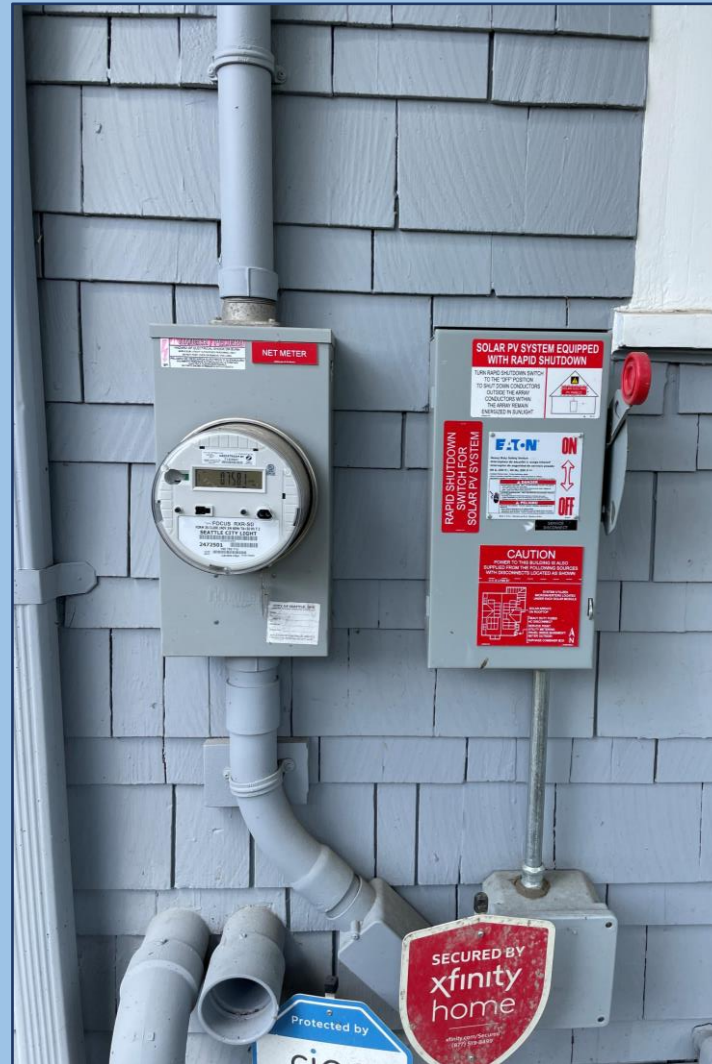
Rapid Shut Down

Rapid shutdown is an electrical safety requirement that was originally introduced in the United States by the National Electrical Code (NEC). This requirement applies to solar PV systems and requires a way to de-energize, or reduce the voltage, of the solar modules on the roof by adding an “on or off” switch, so to speak.

Section 690.12(B)(2)(2) of the 2023 NEC, as in the 2020 NEC, will still require those direct-current PV conductors that lay inside the array boundary to be controlled to not more than 80 Volts within 30 seconds of rapid shutdown initiation



Rapid Shut Down Indicators



Early Recognition

Rooftop PV System

Isolation Switch
Location



Locate Isolation Switch

PV Isolation boxes are often located near the meter

Locate the Weather head



Operational Safeguards

Identify PV hazard
Radio Information
Solar Disconnect
Roof Package



Hose lines and PV

Hose stream pattern should be adjusted to at least a 10 degree fog pattern if possible.

Safe from 20 feet with a broken/straight/sold streams



UL-FSRI 2011 PV Report



Energy Storage Systems: Fire Service Response

Hunter Clare (President Local 493 Peoria Chapter)

Paul Rogers (Retired FDNY/IAFF REP. NFPA 855)

Adam Barowy (Research Engineer, UL FSRI)

Sean DeCrane (IAFF Standards and Codes Director)

A Safe Response to Renewable Energy Hazards



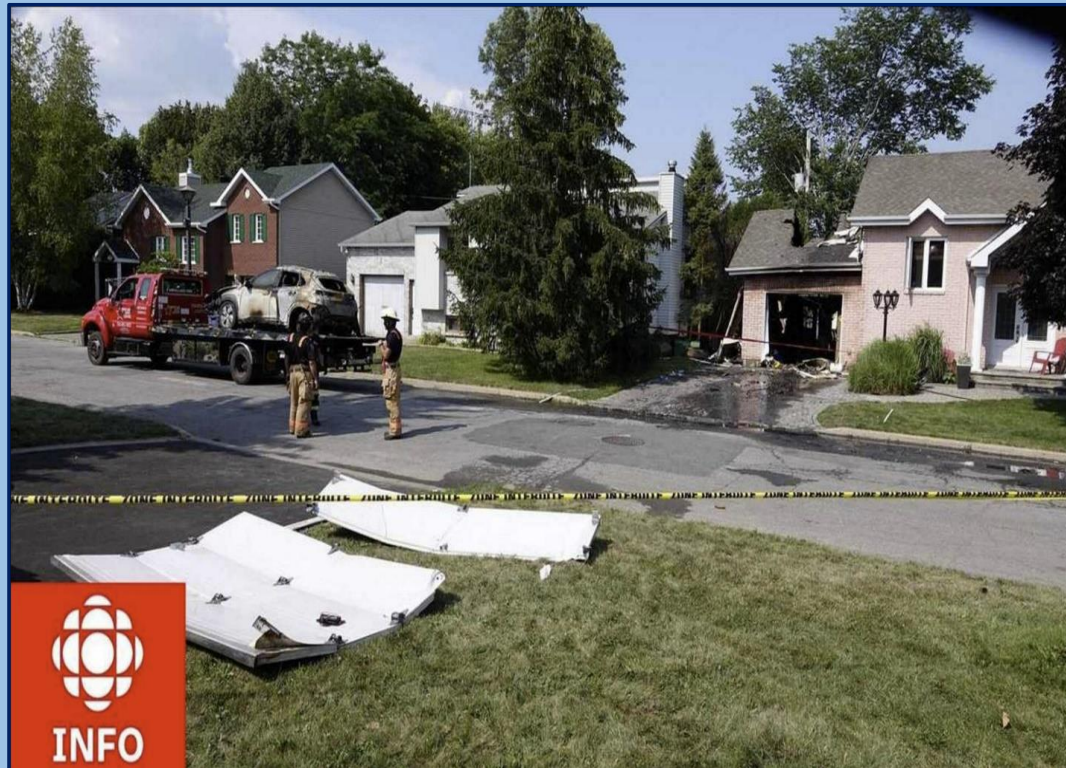
Deflagration and ESS

- March 3, 2022
- Bodnegg, Germany
- ESS in basement, PV on roof
- Pressure wave “pushed several windows and doors open” and “lifted the entire roof structure”
- No injuries



Field Incidents with Li-ion Batteries in Residences

Montreal, Canada – July 27, 2019



Erie, CO, USA – April 11, 2023

Video courtesy of Mountain Video Fire Department



Size-up and Tactical Considerations

Without active fire, lithium-ion battery pack thermal runaways may be recognizable by white/gray battery gas leaking from the structure and forming low-hanging clouds.



DOE Test #2



DOE Test #3



Surprise, AZ



Unanswered Questions

How to approach if battery involvement is suspected?

How much battery gas is needed before the structure present explosion hazards?

What is the nature of the explosion hazards?
(e.g., direction, distance, fragmentation, etc.)



Size-up and Tactical Considerations

During size-up, additional indicators for residential energy storage system installation should be considered beyond smoke appearance.

- Response area – Know your running district
- Presence of Photovoltaic System
- Meter altering – Additional connections
- Labeling
- Presence of EV
- Sounds and Smells
- Dispatch, interviews



Comparison to Mountain View Incident

Simulated ESS battery gas buildup (FSRI)



- Battery gas buildup from Hybrid Jeep
- Video courtesy of Mountain View Fire Department



Size-up and Tactical Considerations

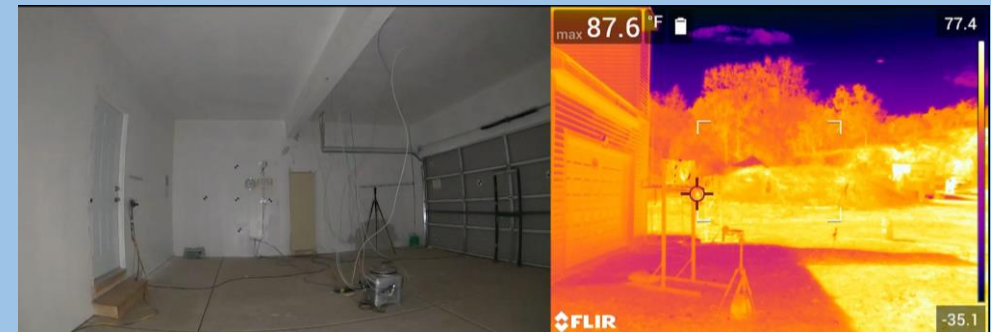
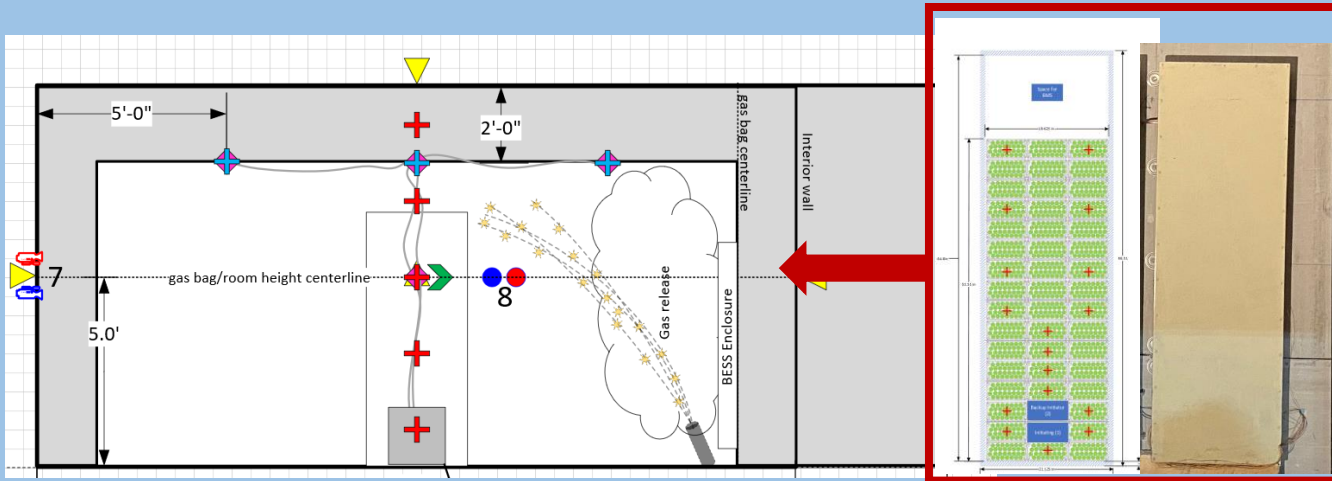
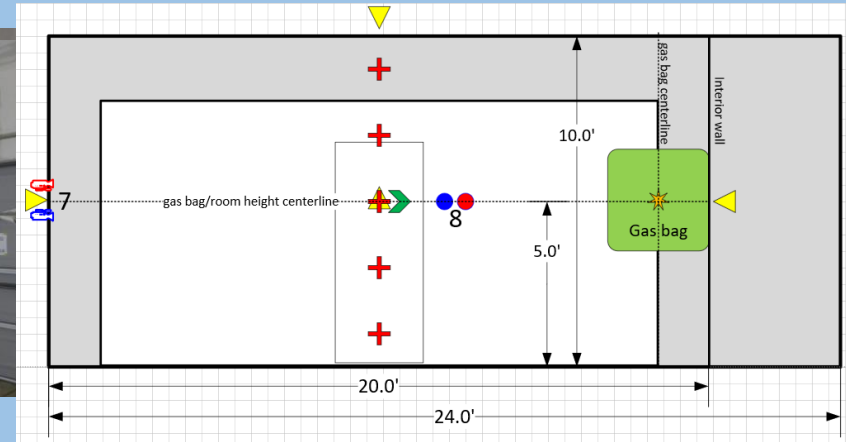
When li-ion batteries undergo thermal runaway without burning, an explosion hazard begins to develop.



Test Scenarios

1. Partial volume deflagrations
2. Battery gas release simulations
3. Repeat of DOE test series, Test #2

Scenario 1



Energy Hazard Training

Chris.greene@eht4responders.com

206-877-2128

