Solar Panels (Photovoltaic Systems)

The purpose of this guide is to provide the fire service a roadmap on how to conduct a safe and informative familiarization of photo voltaic system.

This is meant to supplement and not replace training from a recognized source.

Solar Panels (Photovoltaic Systems)

Familiarization Focus Areas

System Layout: Layout of rooftop and ground-mounted solar panel systems.

Shutoffs: DC disconnects, inverters, and other shutoff mechanisms.

Fire Suppression: Fire suppression operations involving or near solar arrays.

Roof Operations: Roof ventilation and structural stability.

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Photovoltaic Systems (PV)

PV Systems are becoming more common.

Understanding the types of systems in your response area will enhance your safety if called to respond to one.

Photovoltaic Systems (PV)

Introduction

- Increased demand for electrical power requires additional alternate sources
- Provides more economical and secure power, saving utility costs
- More environmentally friendly
- PV is a silent generator, changes where the power comes from
- PV indicators could point out the presence of ESS and vise-versa
- Firefighters are more likely to encounter PV than ESS

It is important to identify generators on scene and shut down

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Photovoltaic Systems (PV)

PV Systems can be found in varied locations. Where they are located will influence their design and accessibility to firefighters.

Solar Panels (Photovoltaic Systems)

System Locations - Residential

Residential locations are very common.

Are you familiarizing yourself with a residential location?

System Locations – Residential

Photovoltaic Systems

- Most often on south side of roof and may not be visible from street
- Systems may or may not have ESS
- Voltages up to 600 V
- 3 kW – 15 kW size ranges

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System Locations - Rooftop Commercial

Rooftop commercial systems tend to be on larger, commercial structures.

Are you familiarizing yourself with a roof top commercial location?

System Locations – Rooftop Commercial

Photovoltaic Systems

- Often flat roof, system may not be visible
- Covering large portions of roof
- Up to 1,000 Vdc
- Disconnect locations may be confusing.
- 50 kW – 2 MW sizes

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System Locations - Covered Parking

Covered parking areas can host PV systems.

Are you familiarizing yourself with a covered parking area?

System Locations – Covered Parking

Photovoltaic Systems

- May be as low as 9 feet
- Car fires may damage components
- Disconnect locations may be remote or local
- Up to 1,000 Vdc

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System Locations - Utility Scale

Are you familiarizing yourself with a utility scale location?

System Locations – Utility Scale

Photovoltaic Systems

- Large fenced facilities
- Treat as power plant
- Farms, landfills, brownfields
- Up to 1,500 Vdc and 35,000 Vac
- 1-500 MW sizes

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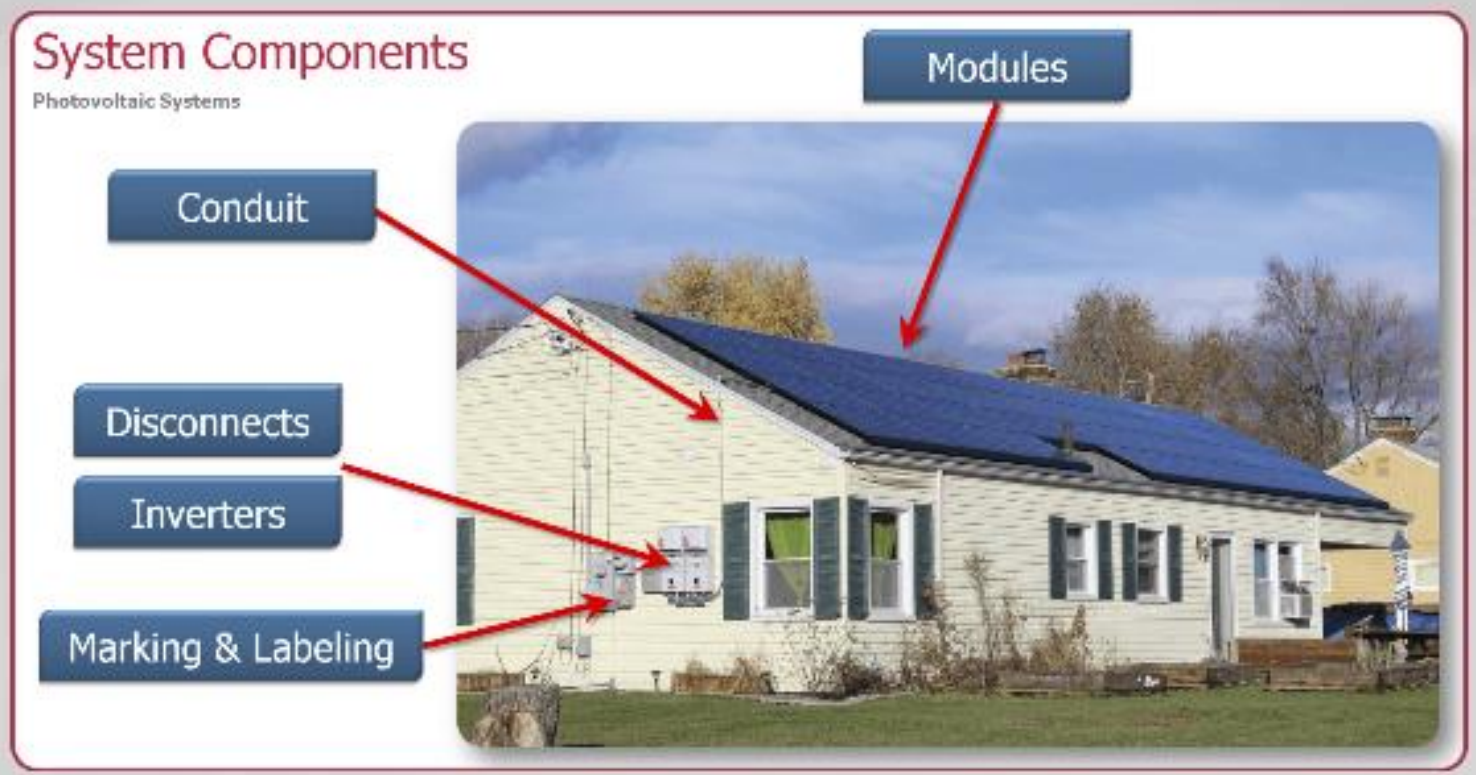
System Components

Once you identify the location of the PV system, look for the main components as you familiarize yourself with it.

Use this to guide your search at a residential location.



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PV Modules

Looking closer at residential roof top PV modules, which you will need a way to access from the ground.

System Components

Photovoltaic Systems

PV Modules

- Rack mounted
- BIPV (Building integrated)

- Does not store power
- Turns light into electricity
- Typically, 20-40 Vdc
- BIPV may be hard to identify
- Snow will challenge roof operations

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PV Modules

Roofing shingles can have solar panels integrated into their design.

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PV Modules

Rooftop and covered parking area locations also have the same components as residential locations.

If you are familiarizing yourself with one of these locations, pay attention to means of access and safe area for response operation.

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Inverters

All systems will have inverters.

Newer systems utilize them to shut down the flow of current at the module level.

System Components

Photovoltaic Systems

Inverters

- Changes DC into AC (and reverse to charge batteries)
- Shut off to stop flow of AC power into building
- Microinverters shut down at module level (safer)

Three Types:

Microinverter

Central

String

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PV Inverters

Inverters may be enclosed in cabinets.

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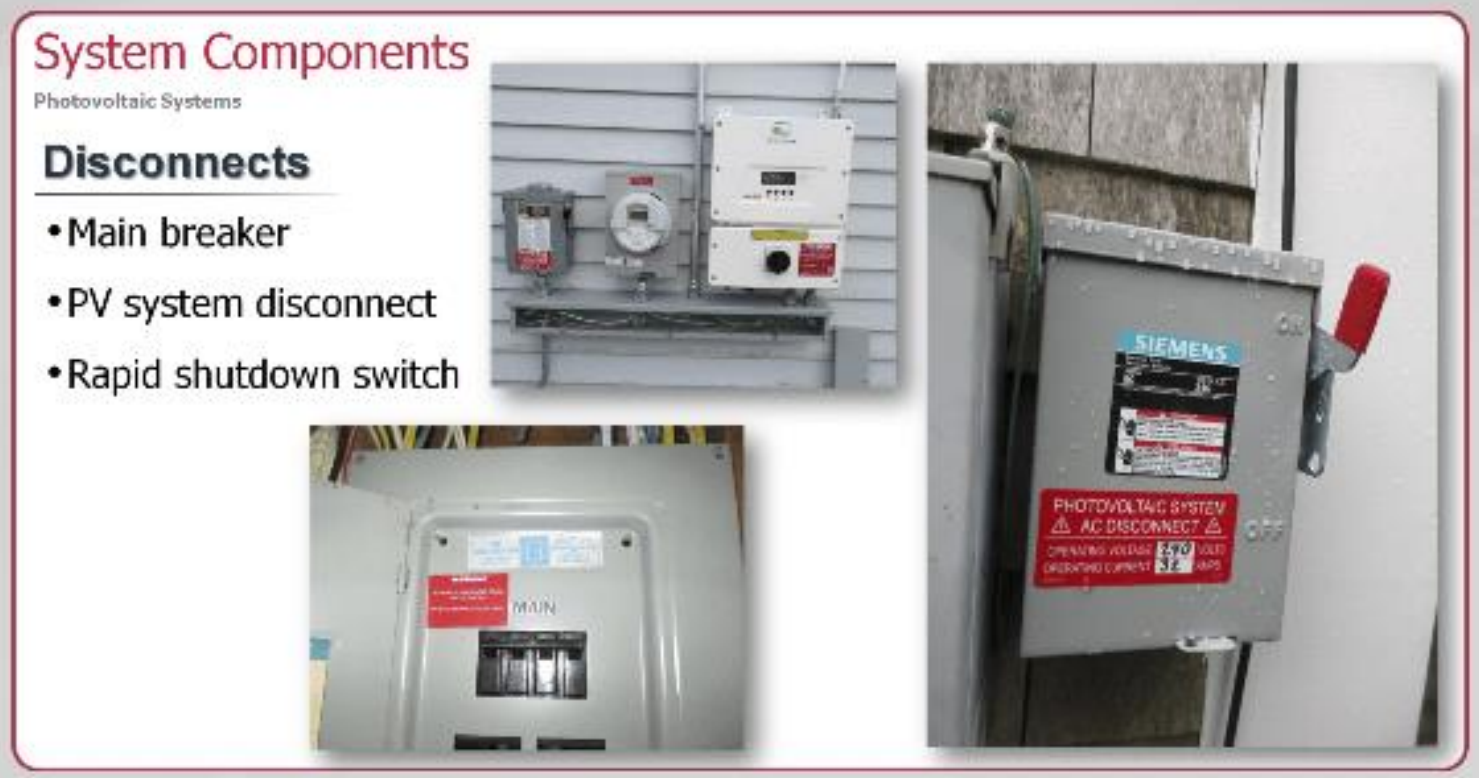
Disconnects

Locate the disconnects for the location you are familiarizing yourself with.

Understand exactly what each disconnect does and how it controls/isolates current flow.



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PV Disconnects - Commercial

Are you familiarizing yourself with a commercial location system? The PV disconnects might look like these.

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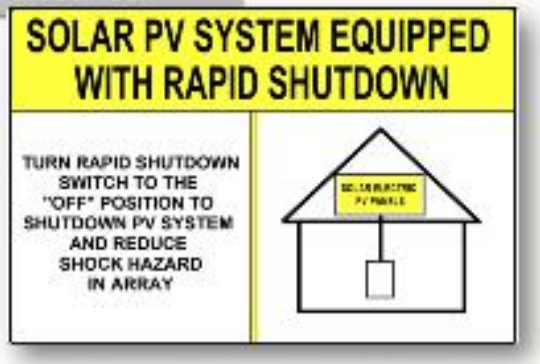
PV System Shutdown - Rapid Shutdown

Does this system have Rapid Shutdown capability?

PV System Shutdown – Rapid Shutdown

Emergency Response Operations

Conductors more than 3 feet in length inside a building, or more than 1 foot from a PV array must reduce to < 30Vdc within 30 seconds



The area within the 1' boundary of the array is reduced voltage

690.12 Rapid Shutdown of PV Systems on Buildings (2017)

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Marking & Labeling

Local building and electrical codes may require component be labeled.

Read each label you find during your familiarization and develop an understanding of the role of the labeled component.

System Components

Photovoltaic Systems

Marking & Labeling

- Dependent on code cycle
- May or may not be present
- Used to identify system presence and locate disconnects
- May be confusing with many labels

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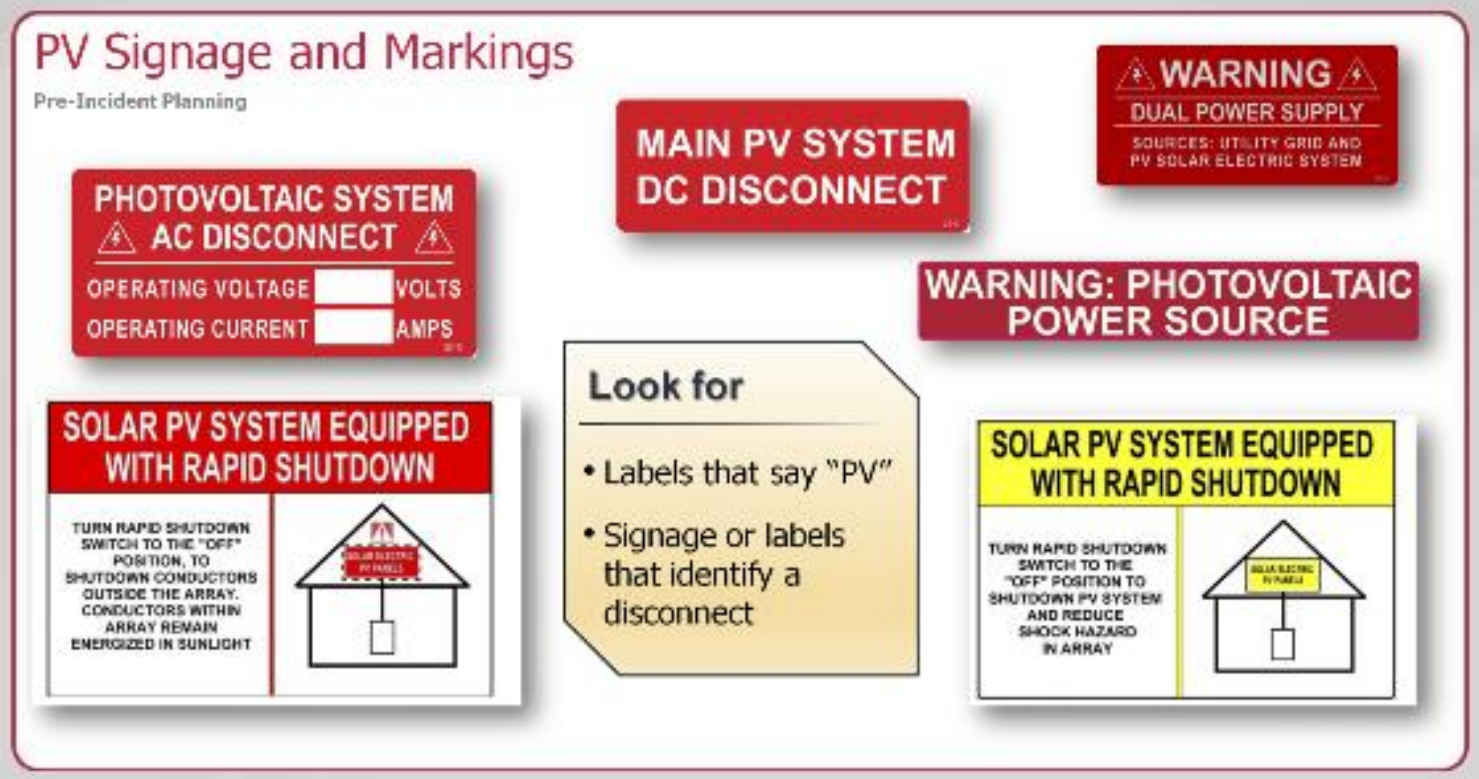
PV Signage and Markings

Read each label you encounter. It provides important information to help you understand the PV system you are familiarizing yourself with.



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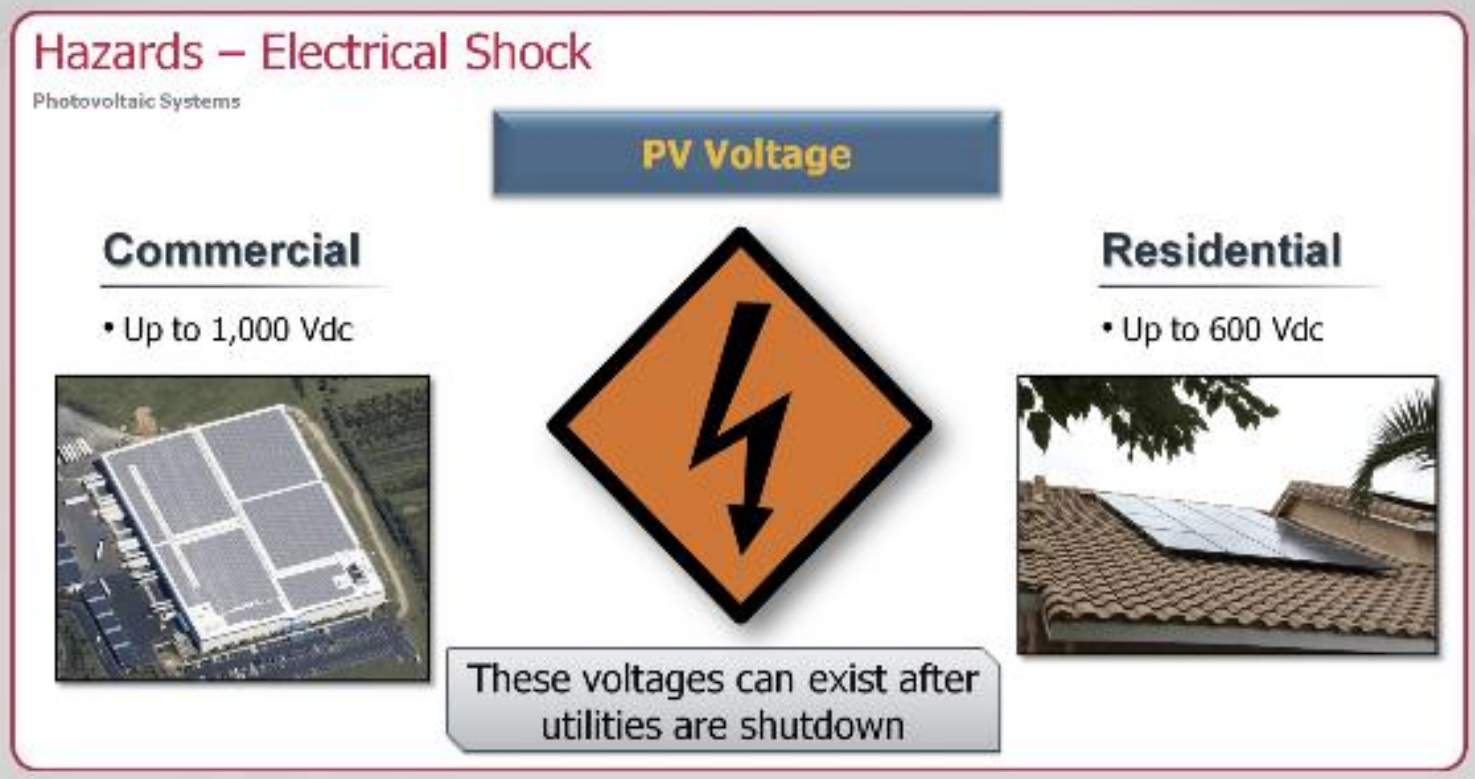
Hazards - Electrical Shock

Electrical shock is a hazard in all PV systems.

As you do your familiarization visit, the primary goal is understanding how to keep responding personnel safe and prevent electrical shock.



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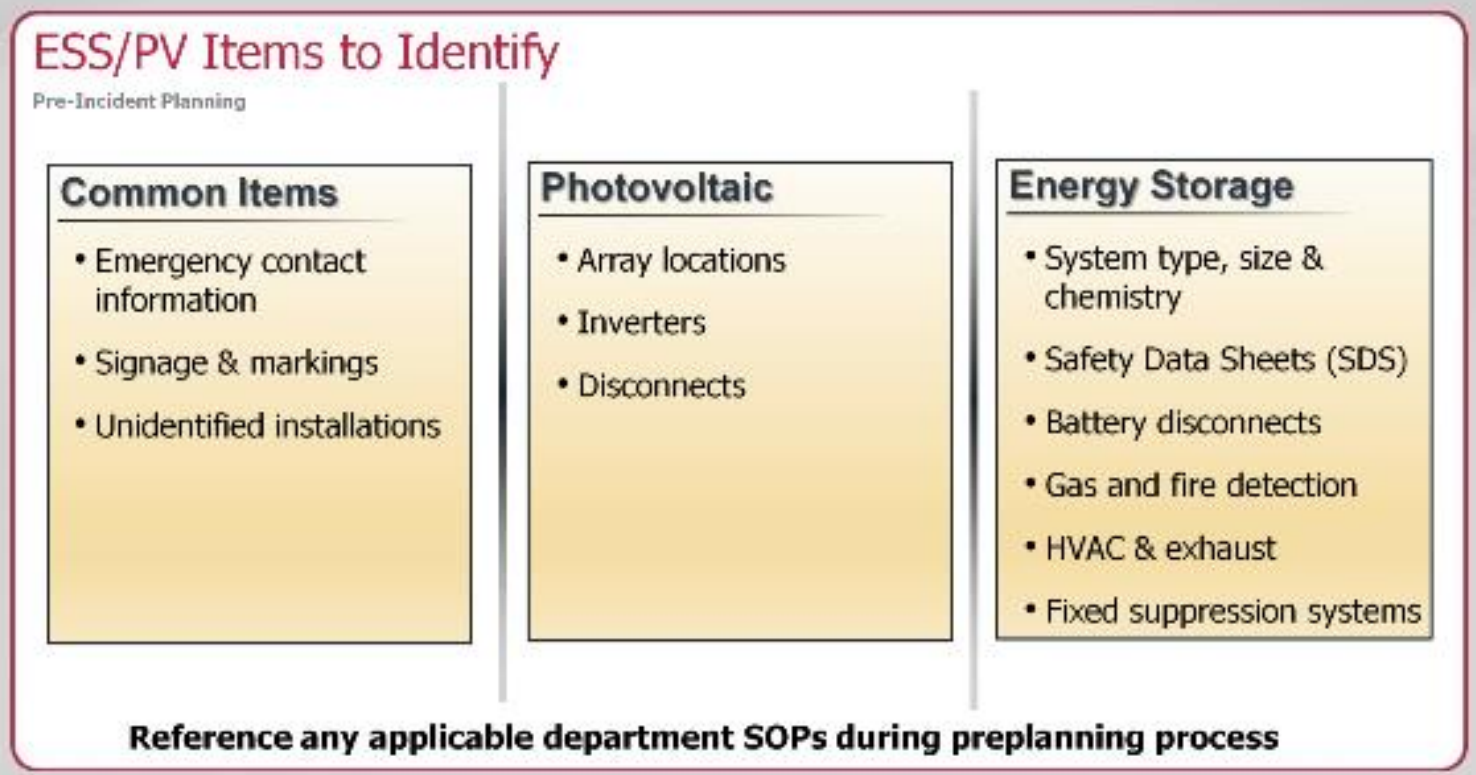
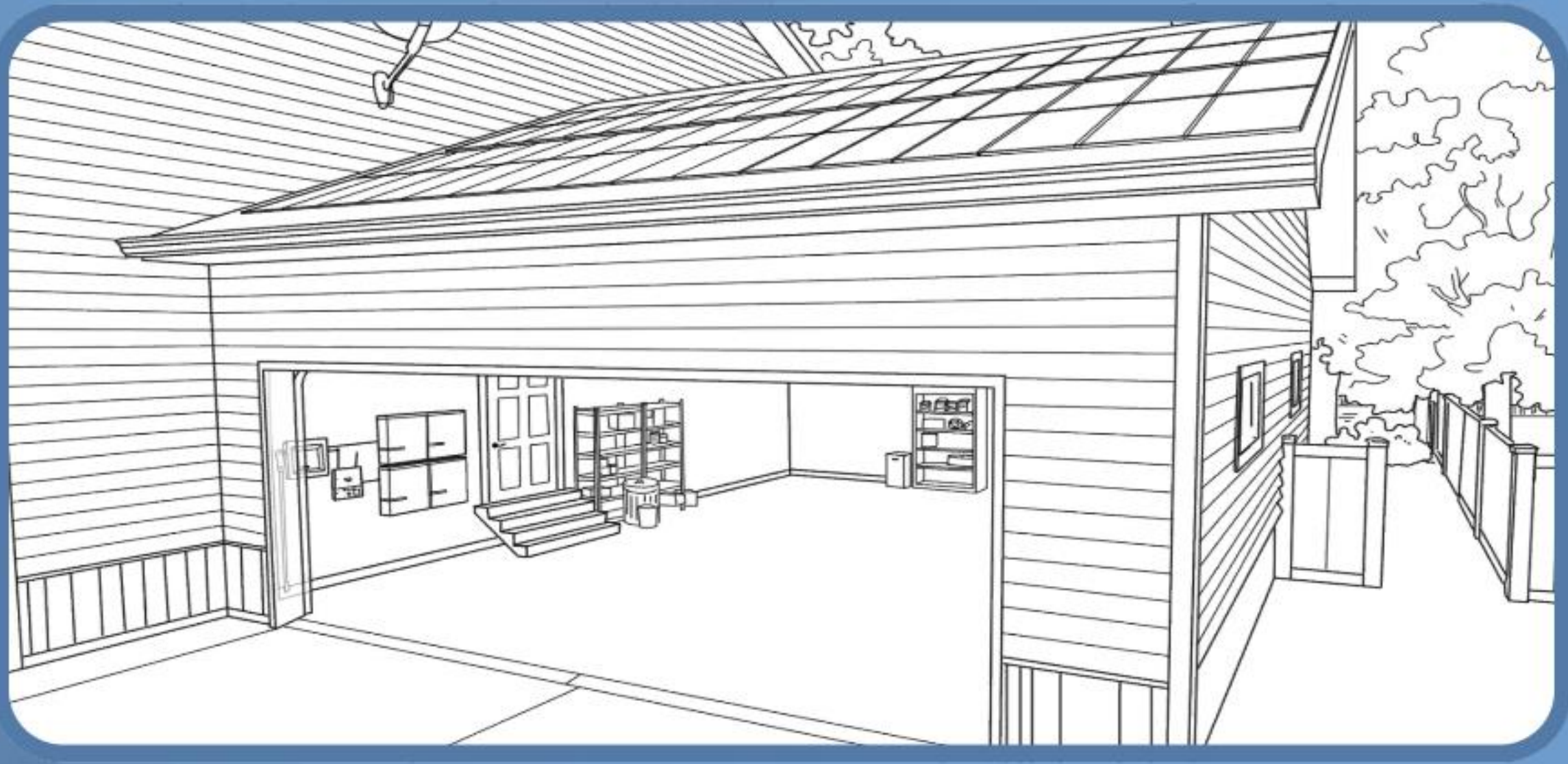
ESS/PV Items to Identify



Congratulations!

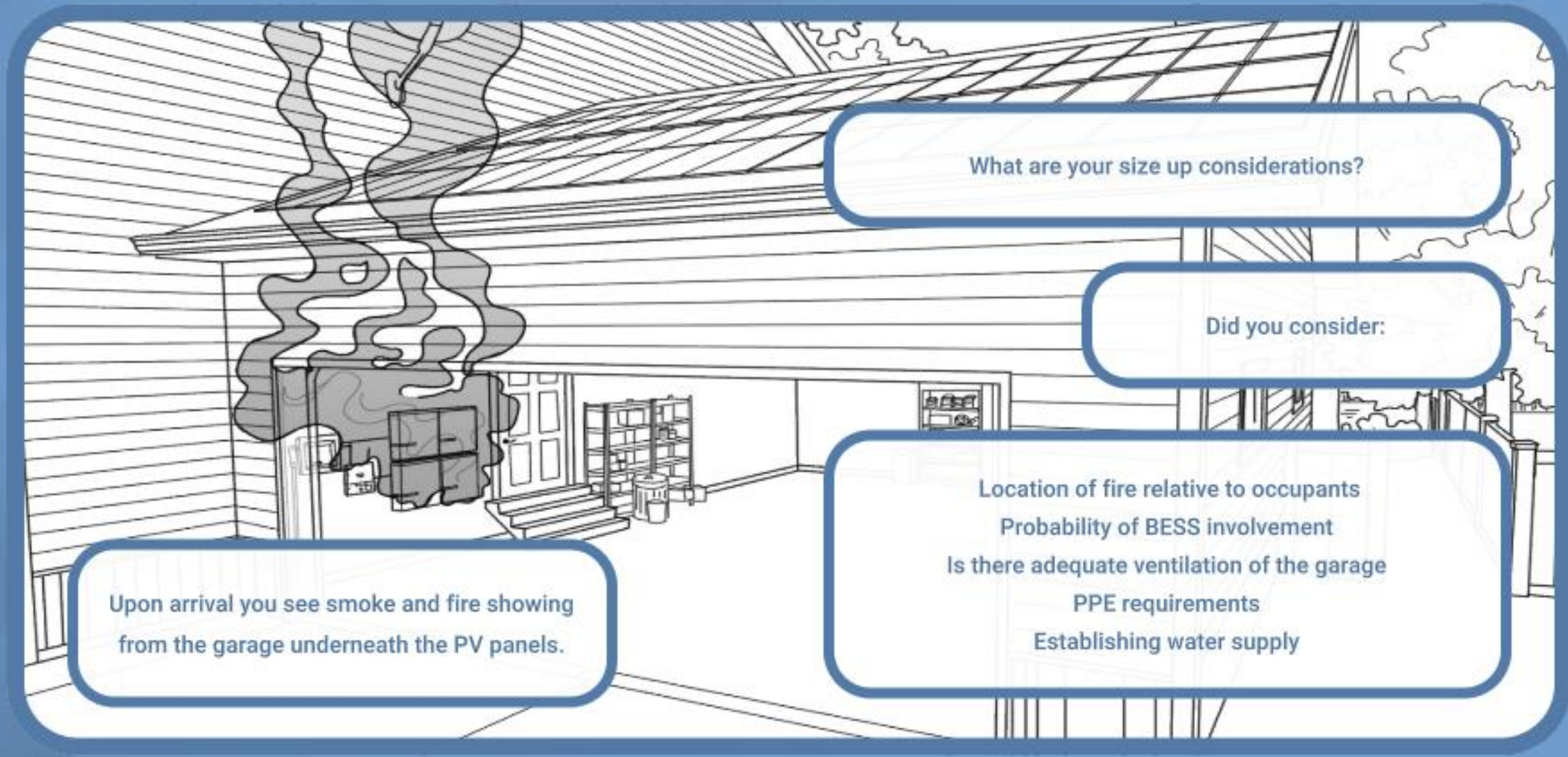
You have completed the PV module. Let's explore an incident scenario.

CONTINUE



Let's explore an incident scenario.

You are dispatched to a residential property for a reported garage fire.
Enroute, you are advised the caller reports there is a PV system and BESS at the residence.



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Upon arrival you see smoke and fire showing from the garage underneath the PV panels.

What are your size up considerations?

Did you consider:

Location of fire relative to occupants
Probability of BESS involvement
Is there adequate ventilation of the garage
PPE requirements
Establishing water supply

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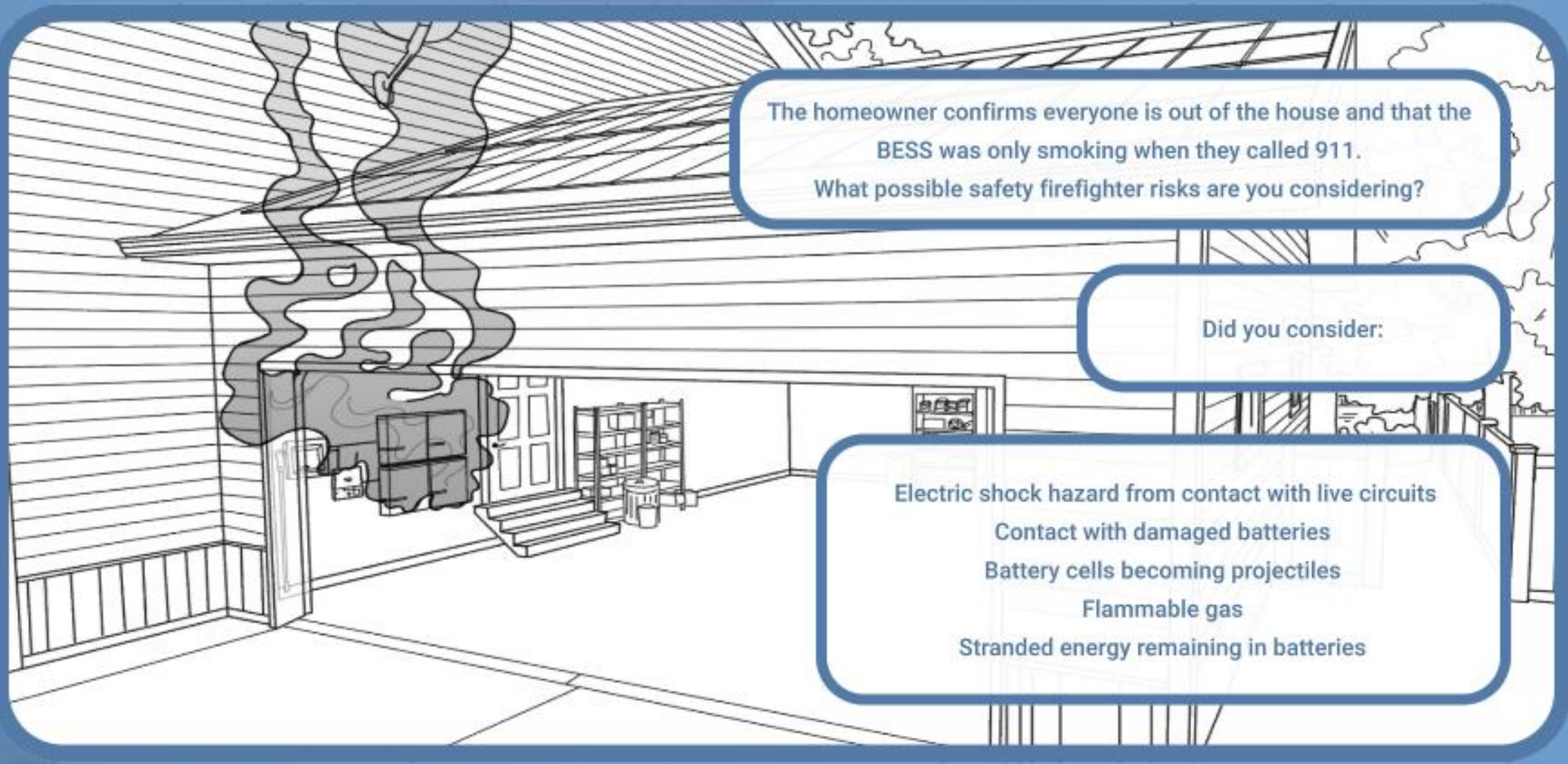

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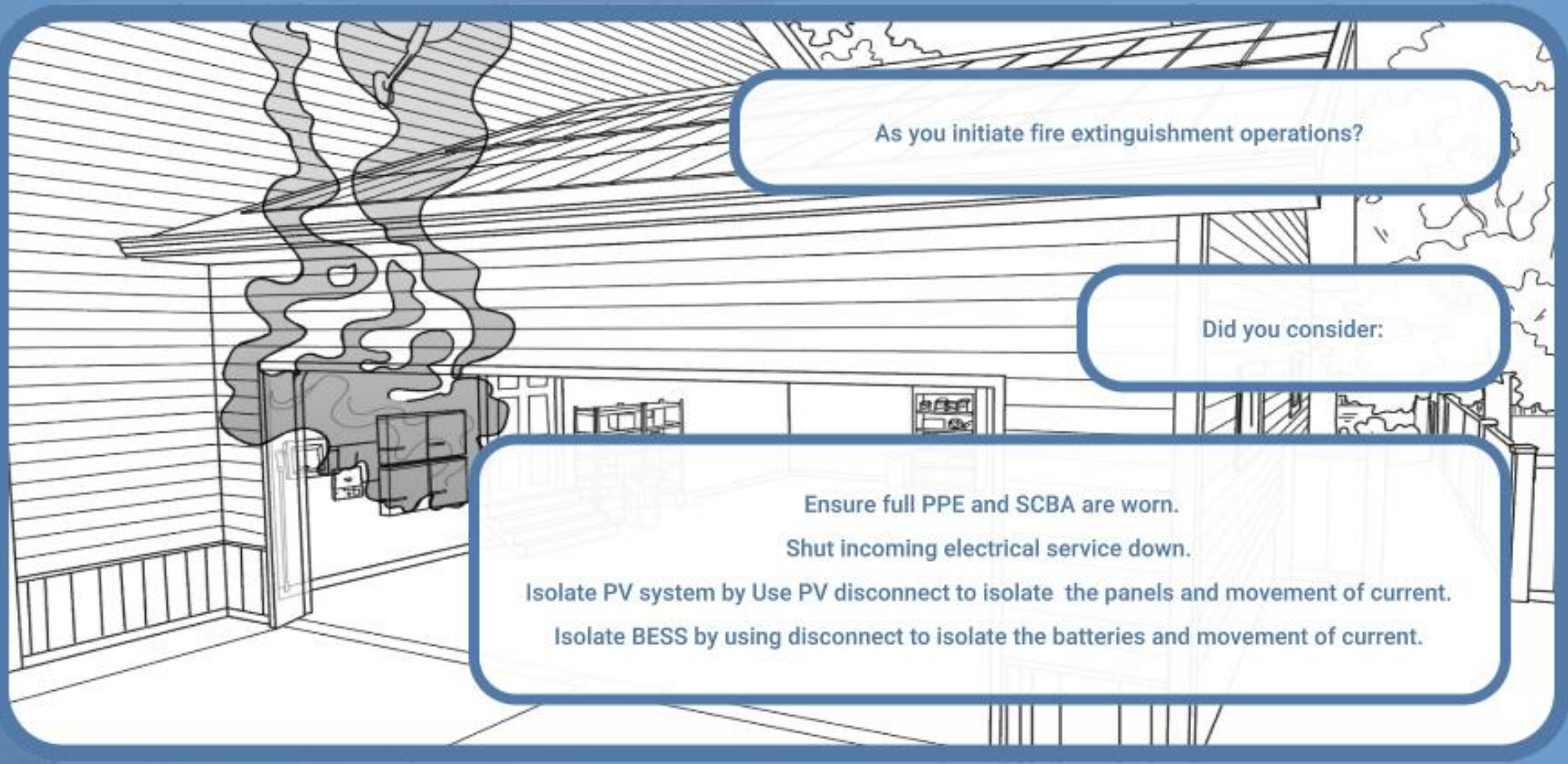

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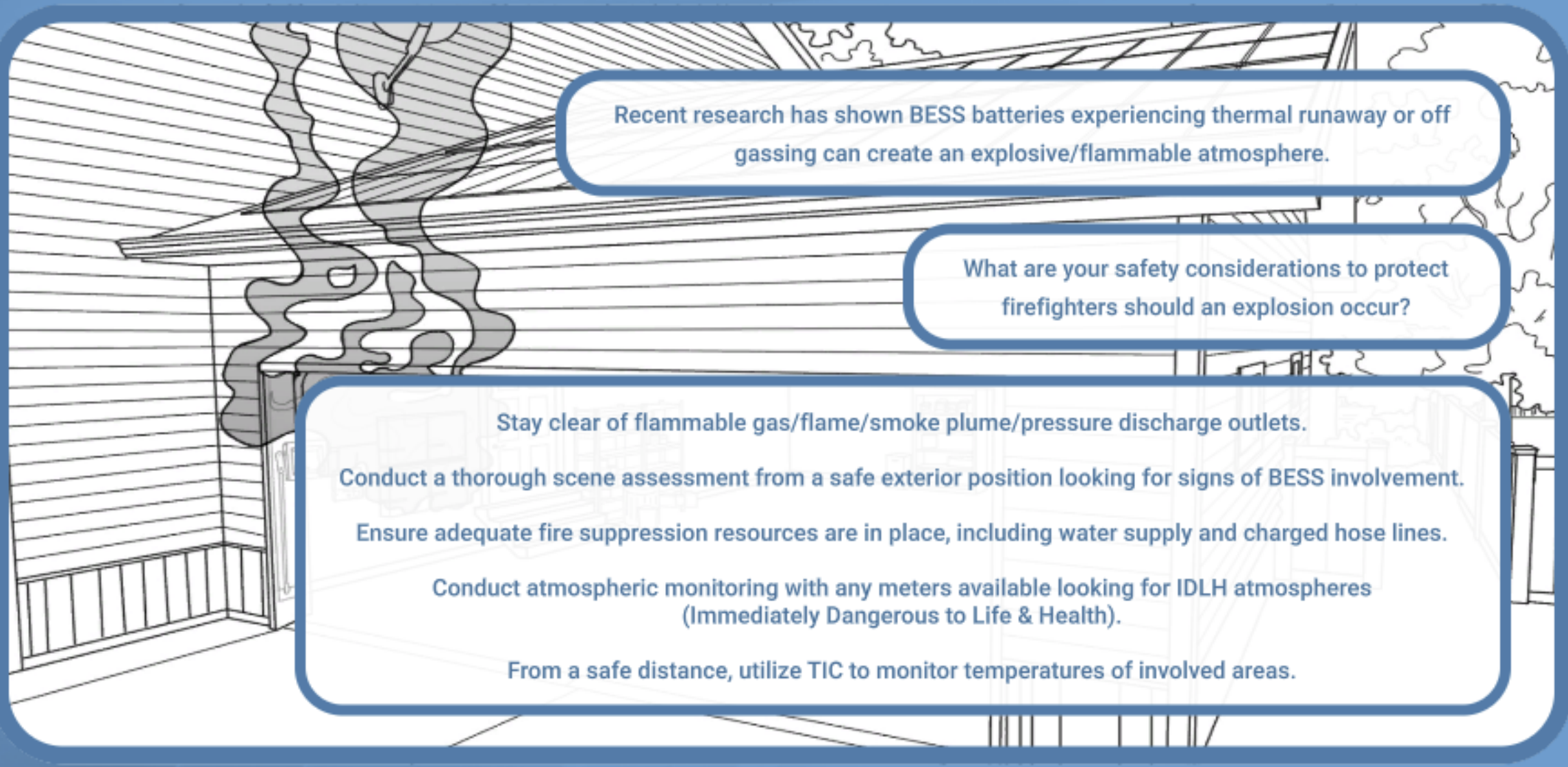

Recent research has shown BESS batteries experiencing thermal runaway or off gassing can create an explosive/flammable atmosphere.

What are your safety considerations to protect firefighters should an explosion occur?

Stay clear of flammable gas/flame/smoke plume/pressure discharge outlets.

Conduct a thorough scene assessment from a safe exterior position looking for signs of BESS involvement.

Ensure adequate fire suppression resources are in place, including water supply and charged hose lines.

Conduct atmospheric monitoring with any meters available looking for IDLH atmospheres (Immediately Dangerous to Life & Health).

From a safe distance, utilize TIC to monitor temperatures of involved areas.

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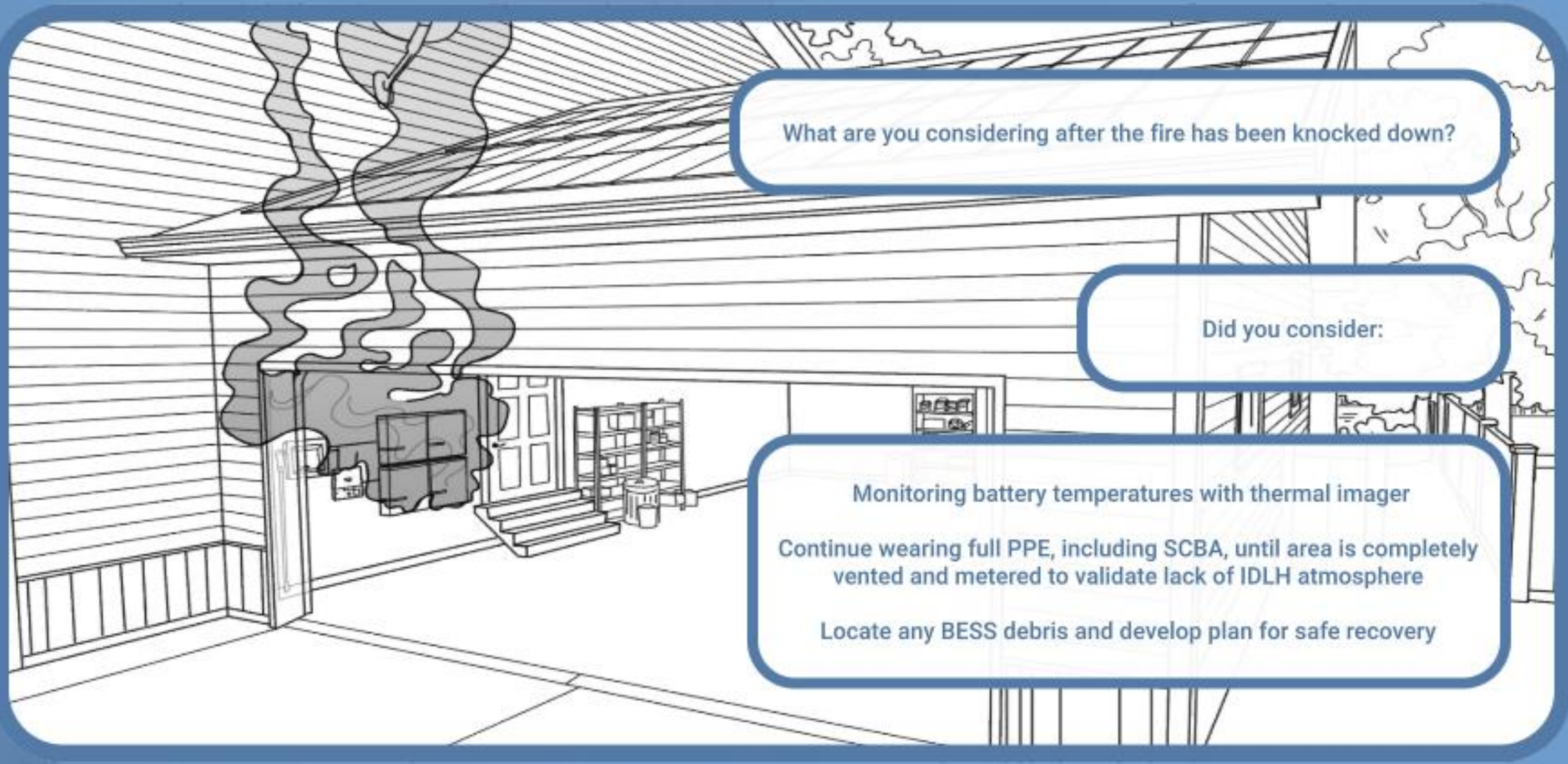

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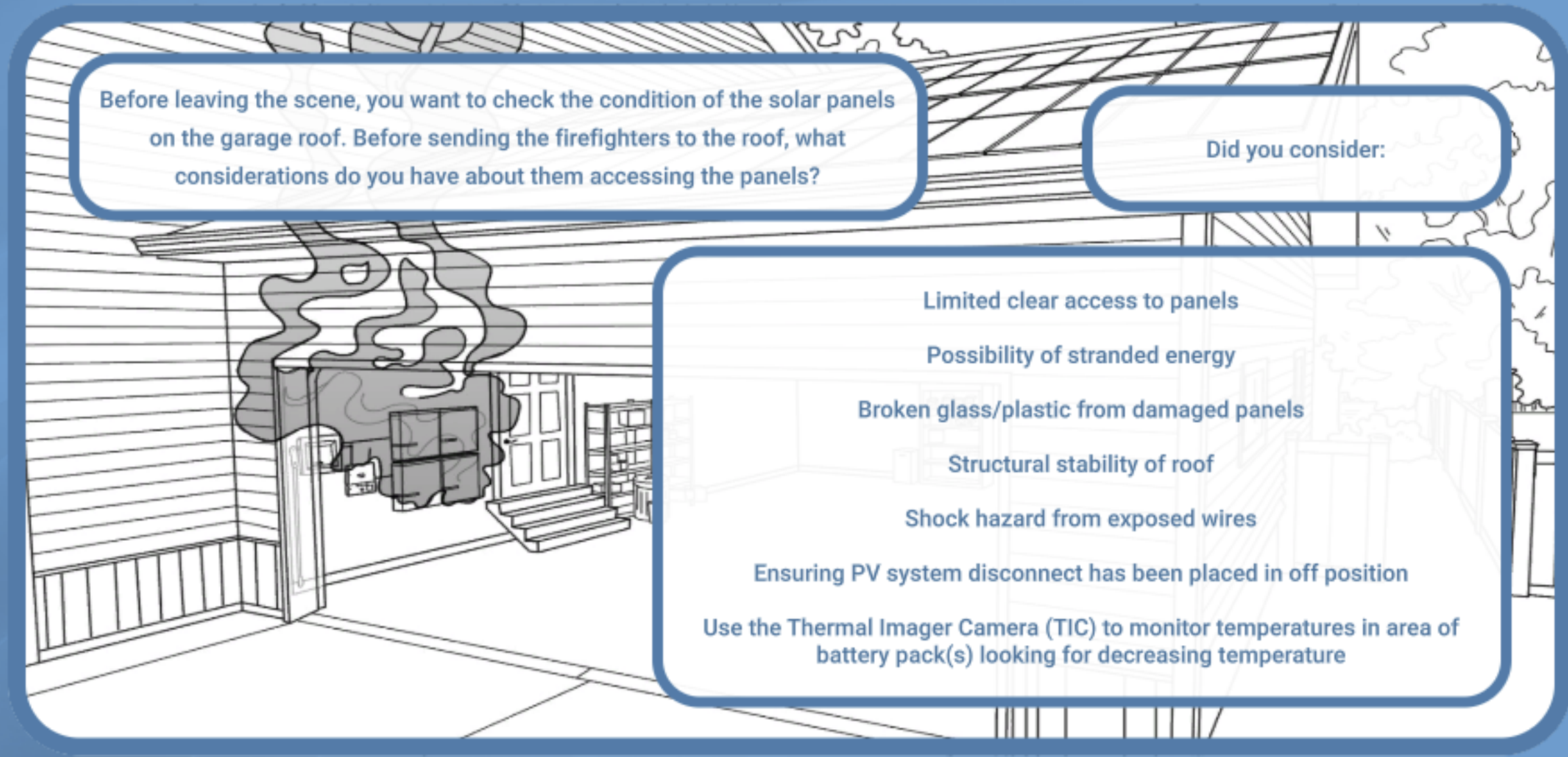

Before leaving the scene, you want to check the condition of the solar panels on the garage roof. Before sending the firefighters to the roof, what considerations do you have about them accessing the panels?

Did you consider:

Limited clear access to panels

Possibility of stranded energy

Broken glass/plastic from damaged panels

Structural stability of roof

Shock hazard from exposed wires

Ensuring PV system disconnect has been placed in off position

Use the Thermal Imager Camera (TIC) to monitor temperatures in area of battery pack(s) looking for decreasing temperature

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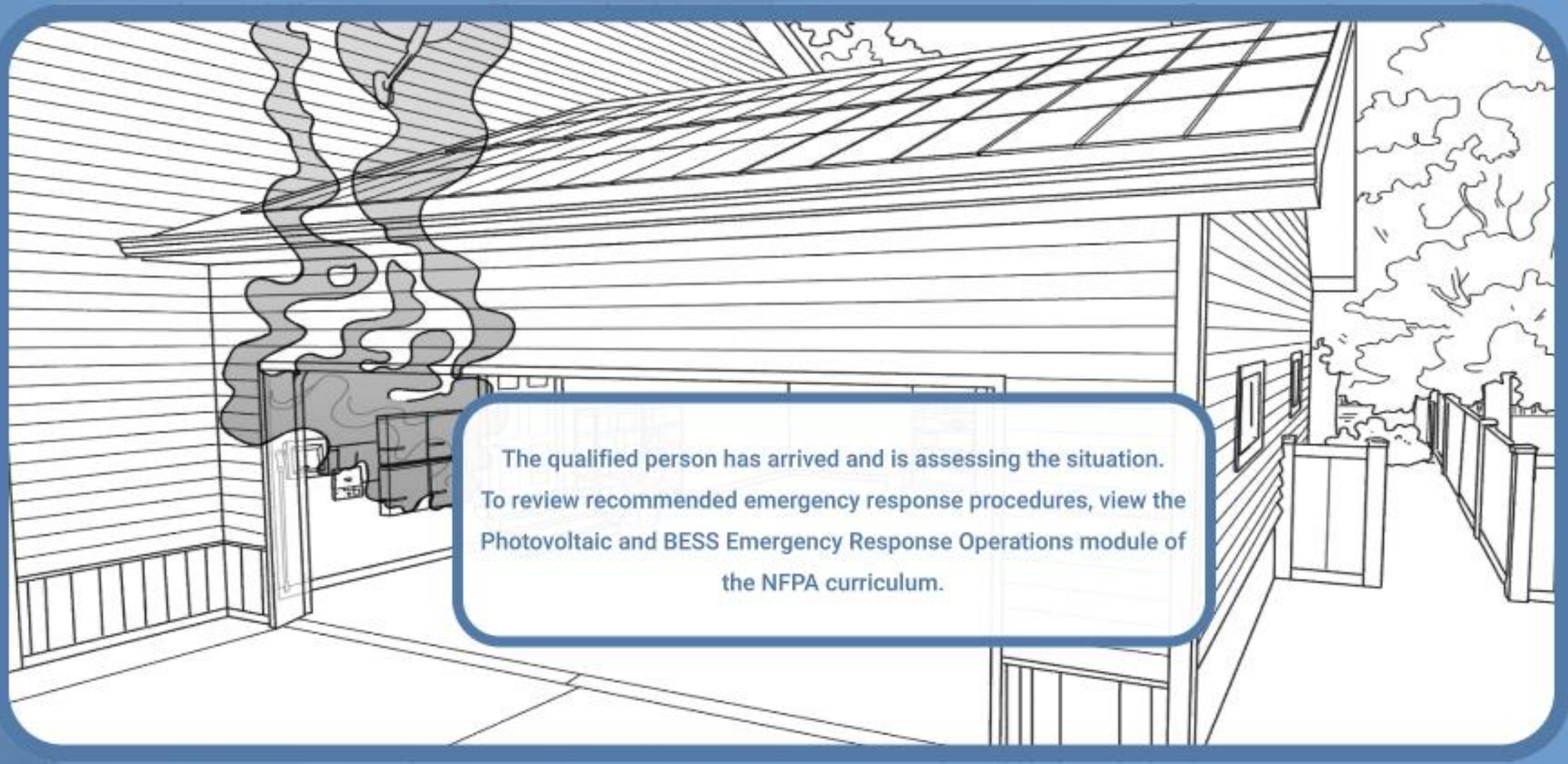
The qualified person has arrived and is assessing the situation.
To review recommended emergency response procedures, view the Photovoltaic and BESS Emergency Response Operations module of the NFPA curriculum.