CleanEnergyGroup

Solar+Battery Storage Fire Safety Part 2: Utility-Scale Projects and EVs

July 8, 2025

www.cleanegroup.org

Webinar Logistics

We are now using Zoom Webinars!
Thank you for your patience as we get used to this platform. We encourage you to provide feedback in the post-webinar survey or via email.

All attendees are in “listen only” mode – your webcam and microphone are disabled.
The Chat function is also disabled.

Submit questions and comments via the Q&A panel 

Automated captions are available 

Speaker bios will be made available in the Chat

This webinar is being recorded. We will email you a webinar recording within 48 hours. This webinar will be posted on CEG’s website at www.cleanegroup.org/webinars

Clean Energy Group

Affordable, reliable, clean energy for all.

Climate Resilience and Community Health

Distributed Energy Access and Equity

Energy Storage and Flexible Demand

Fossil Fuel Replacement

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Resilient Power Project

Building the foundation for energy resilient communities.

USDN urban sustainability directors network

footprintproject.org™

AMERICAN MICROGRID SOLUTIONS

ELEVATE

GEMINI ENERGY SOLUTIONS

Rooftop solar installation in Dorchester, MA. Credit: Resonant Energy

www.resilient-power.org

CleanEnergyGroup

Technical Assistance Fund

Providing technical support to build local resilience.

GEMINI ENERGY SOLUTIONS

footprintproject.org™

ELEVATE

AMERICAN MICROGRID SOLUTIONS

Clean Coalition

USDN urban sustainability directors network

Solar installation in Puerto Rico. Credit: Solar Responders

www.cleanegroup.org/initiatives/technical-assistance-fund

The Resilient Power Project Impact: 2013 - 2024

$2 million in Grants Awarded

200 Community Service Partners

380 Community Facilities

www.cleanegroup.org

Webinar Speakers

Solar+Battery Storage Fire Safety Part 2: Utility-Scale Projects and EVs

Olivia Tym

Project Manager,
Clean Energy Group
(Moderator)

Richard Birt

Retired Captain, Las Vegas Fire & Rescue
Founder, Solar and Fire Education (SAFE)

CleanEnergyGroup

Upcoming Webinars

Community Storage: SMUD's Energy StorageShares Program (July 17)

Load Growth: What States Are Doing to Accommodate Increasing Electric Demand (July 21)

Read more and register at www.cleanegroup.org/webinars

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First Responder Safe Response for Solar + Energy Storage Systems (ESS)

Presented by:

Captain Richard Birt, (Ret)

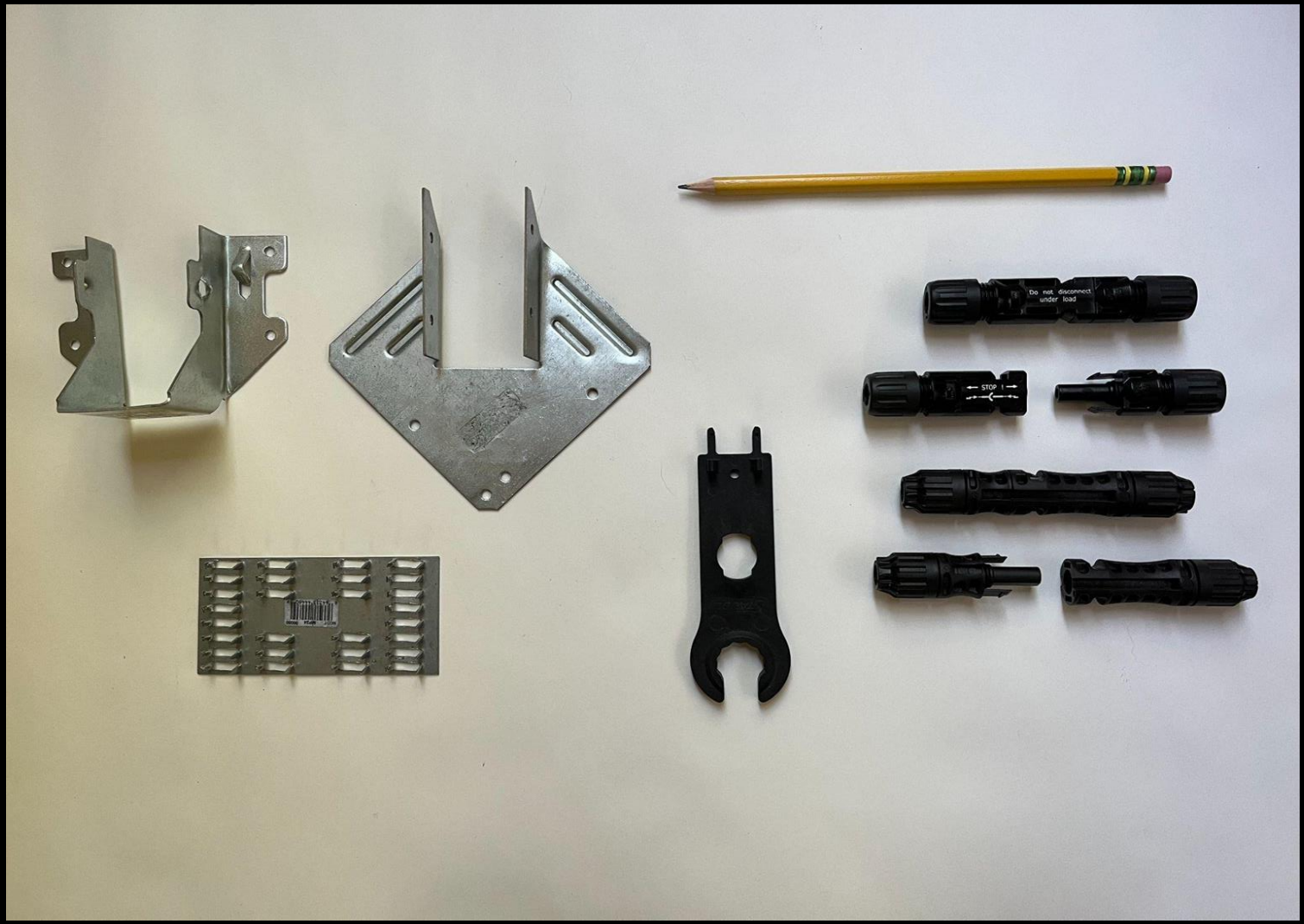
Las Vegas Fire & Rescue.

Founder of Solar And Fire Education.

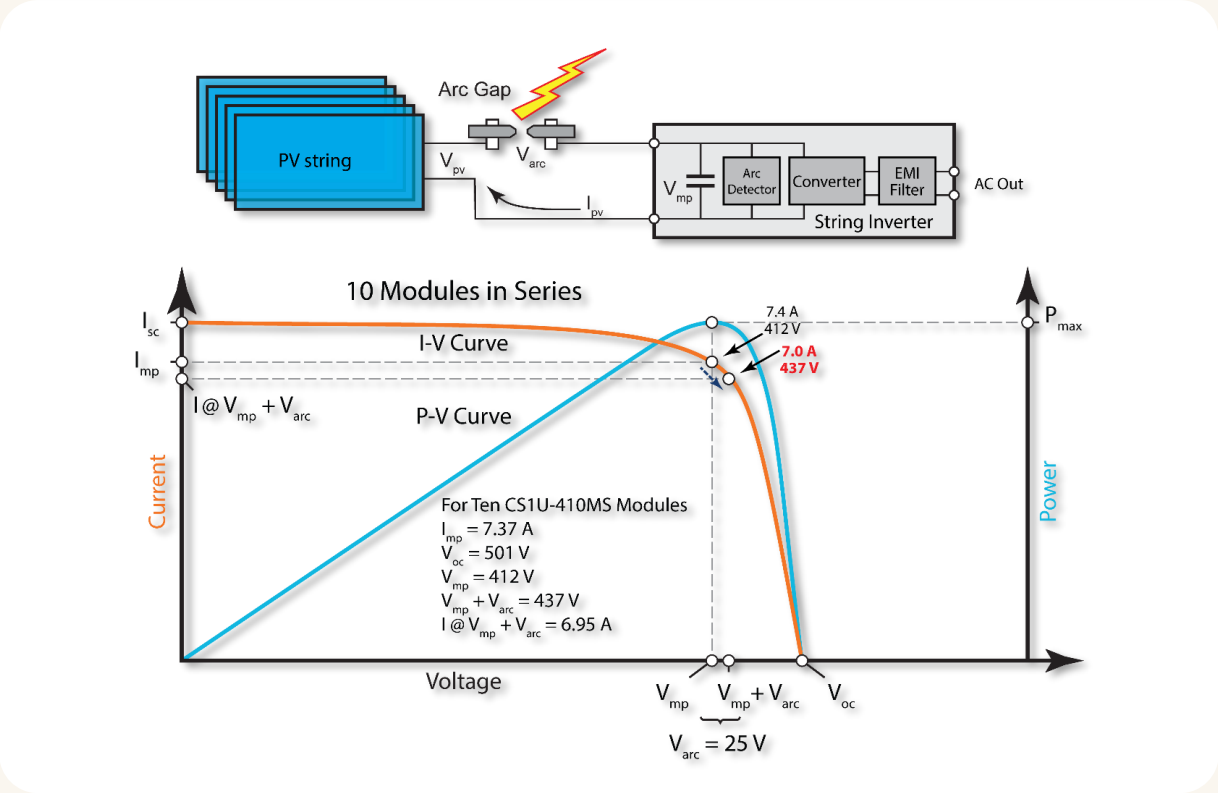

LAS VEGAS
T-1
BRING BACK
SOLAR
BRINGBACKSOLAR.COM

Rapid Shutdown Effects 4 Safety Benchmarks used by Firefighters Across the World

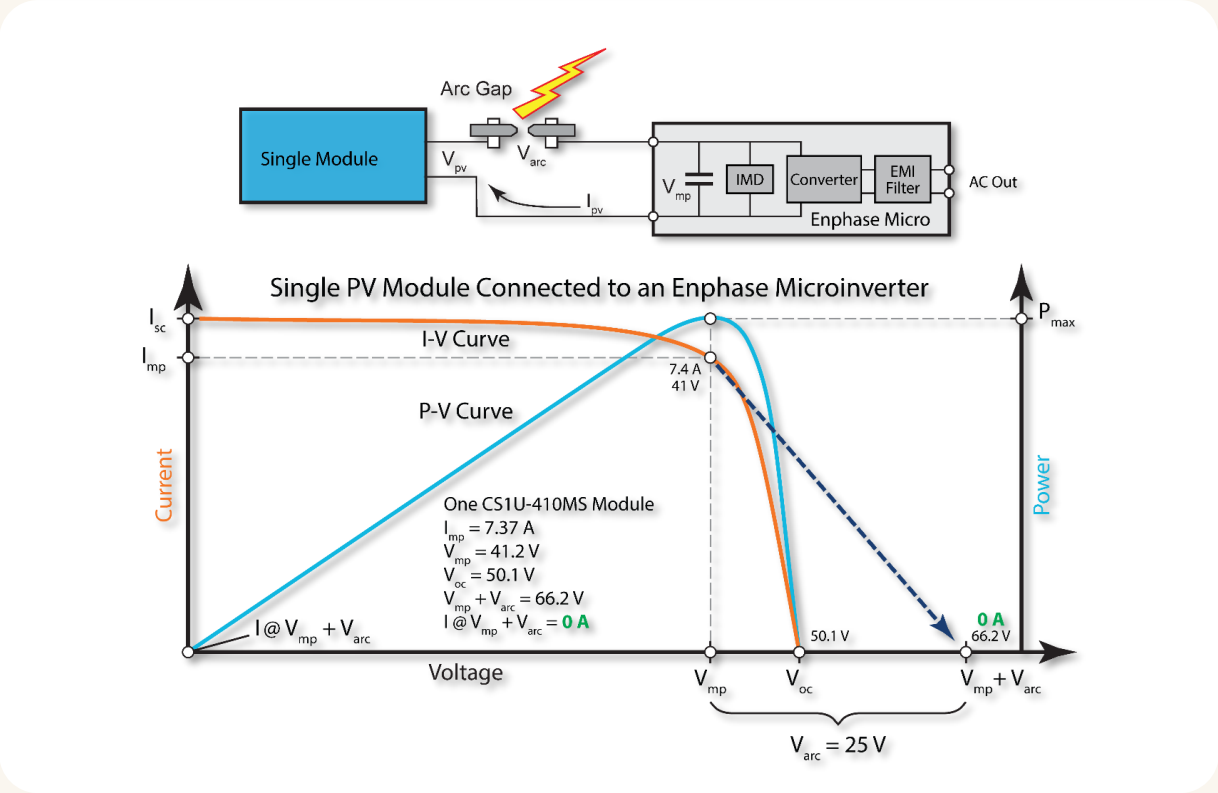
1. Firefighter Safety
2. Civilian Life Safety
3. Incident Stabilization
4. Property Conservation


Do not disconnect
under load
STOP

Arc-Fault within a String Array

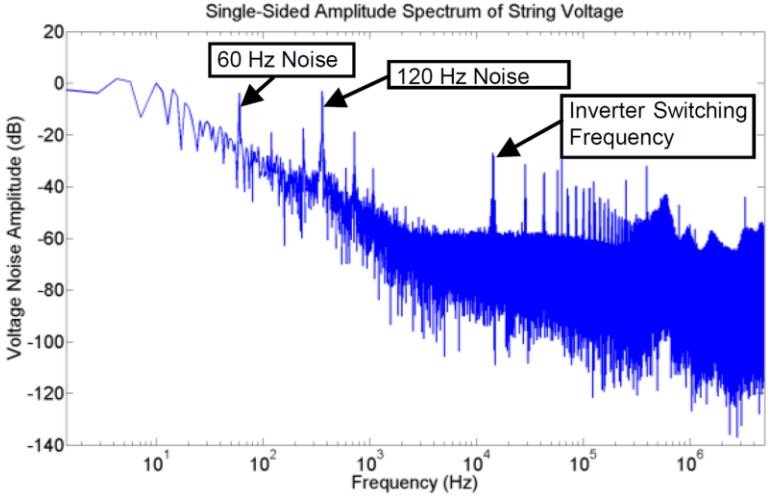


Arc-Fault within a Single Module and Enphase Microinverter



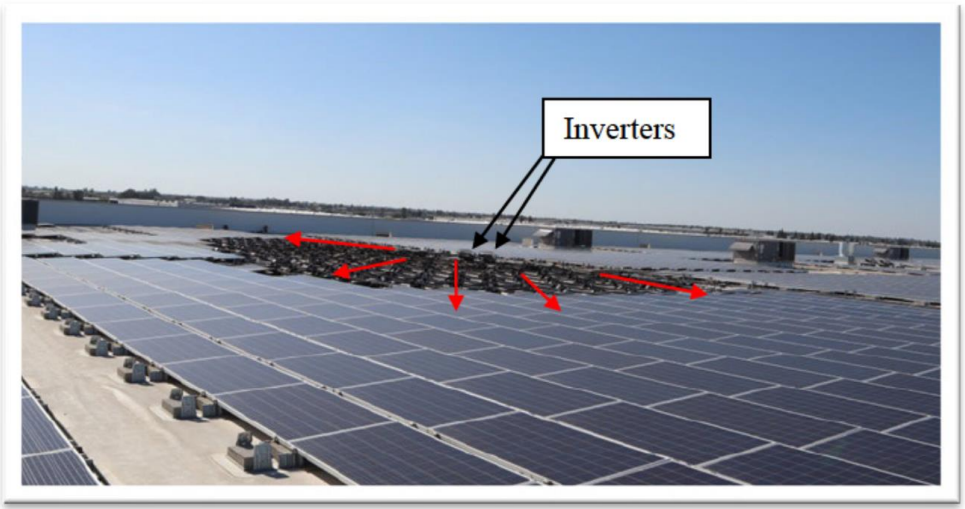
Arc-Fault Detection Issues

- Arc-Fault detectors have faults
- Arc-Faults create an RF, wide band signal with frequency content similar to Pink Noise
- Sandia National Labs
  - Using PV Module and Line Frequency Response Data to Create Robust Arc-Fault Detectors
  - Differentiating Series and Parallel Photovoltaic Arc-Faults
- Ideal detection range 1000 Hz to 100kHz
- RF detection methods act as a receiver and are very susceptible to masking if other noise sources couple into the circuits
- Long Cable runs (homeruns) desensitize the detectors
- There is a better way



Drone footage


25’ X 25’ area and fire direction of travel identified by CAPT PERKINS


Inverters

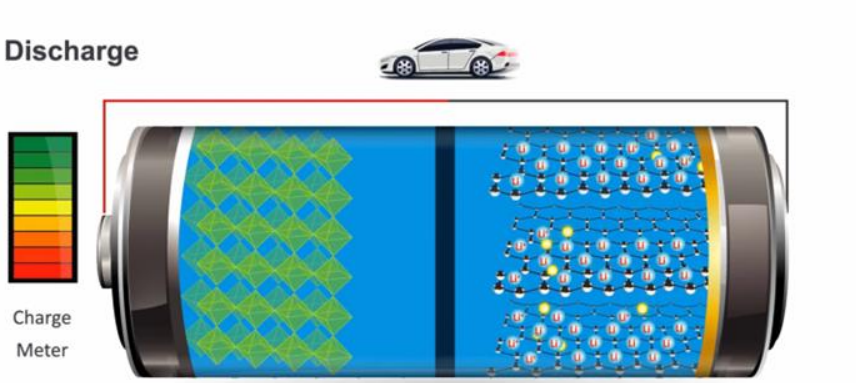
The use of Lithium batteries

Examples of common electronic devices containing lithium cells or batteries

Video cameras	Walkie talkies (2 way radio)	GPS devices	Radio controlled toys
			
Cameras	**Scanner**	**Cellular Phones**	**MP3 players**
			
Bluetooth headsets	**Smartphones/mobiles**	**Laptop computers**	**Shavers**
			
Power Drills	**Tablets**	**Portable DVD players**	**Measuring equipment**
			

How do Lithium-Ion Battery cells work?

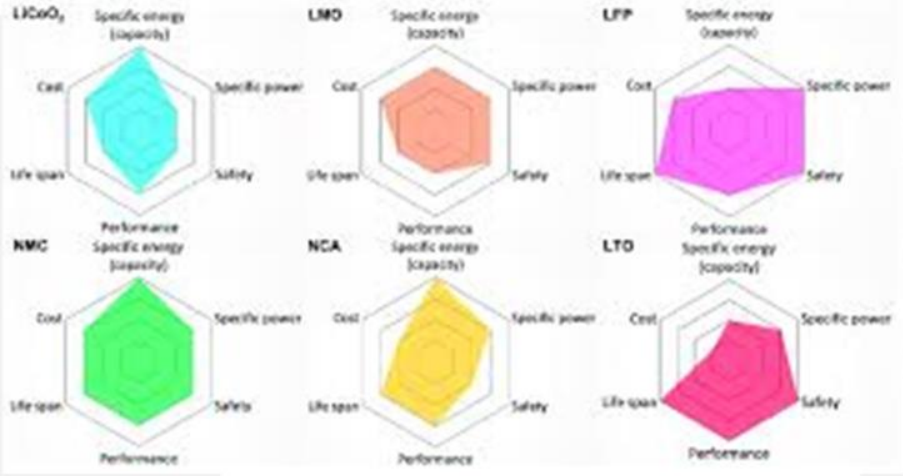
The anode (Negative) and cathode (Positive) store the lithium. The electrolyte carries positively charged lithium ions from the anode to the cathode and vice versa through the **separator.** The movement of the lithium ions creates **free electrons** in the anode which **creates a charge at the positive current collector**.



FIRECONTAINERS
LIMITED

Types of Lithium Ion cells

- Lithium cobalt oxide
- Lithium manganese oxide
- Lithium iron phosphate
- Lithium nickel manganese cobalt oxide
- Lithium nickel cobalt aluminium oxide
- Lithium titanate



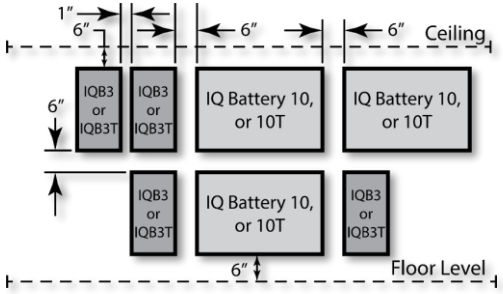
Battery Chemistry

	LG CHEM	Enphase IQ Battery	TESLA Powerwall
Battery Chemistry	Lithium Nickel Manganese Cobalt Oxide	Lithium Iron Phosphate	Lithium Nickel Cobalt Aluminum Oxide
Thermal Runaway Temperature	210°C	270°C	150°C
Products of Combustion	Carbon Monoxide (CO) & Hydrogen (H)	Carbon Monoxide (CO) & Hydrogen (H)	Carbon Monoxide (CO) & Hydrogen (H)

Tests have shown that battery cells start degrading at as low as 150°C. At this temperature, there is the potential to off-gas hydrogen and carbon monoxide which can create an explosive atmosphere in a contained area. **Ventilation is key!**

UL 9540A – Enphase Unit Level Testing

- Results of large scale fire testing is guidance on spacing between units when installed.
- Criteria
  - Target wall temperature rise < 97 °C (175 °F)
  - Indoor wall mount - No flame beyond outer unit dimensions
- Enphase IQ Batteries have been evaluated by UL Solutions to Standard UL 9540A for outdoor and non-habitable indoor residential installations.



Horizontally

- 3/3T to 3/3T = 1 inch
- 3/3T to 10/10T = 6 inch
- 10/10T to 10/10T = 6 inches

Vertically

- 3/3T to 3/3T = 6 inches
- 3/3T to 10/10T = 6 inches
- 10/10T to 10/10T = 6 inches
- All units to ceiling and floor = 6 inches

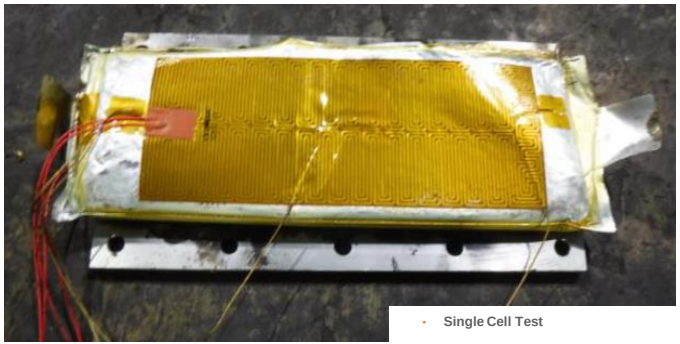
Setup with cover over initiating unit and covered by cheesecloth.

ENPHASE.

UL 9540A – Cell and Module Level Test

- **Single Cell or Module test**
- **Chemistry – $LiFePO_4$, NMC, other**
- **Gas Volume**
- **Burning velocity**
- **Gas Composition**
- **Observations for Enphase**
  - ✓ External Flaming: No External Flaming
  - ✓ Flying Debris: No flying debris
  - ✓ Re-ignition: No re-ignition

Gas		Measured %
Carbon Monoxide	CO	6.91
Carbon Dioxide	CO_2	16.19
Hydrogen	H_2	63.75
Methane	CH_4	4.65
Ethylene	C_2H_4	3.20
Ethane	C_2H_6	1.07
Propylene	C_3H_6	2.20
Others, each less than 1%		2.03



- Single Cell Test

- Module Test

ENPHASE.

Smoke??

- Toxic & flammable gases
- Explosive atmosphere
- Vapour produced (500-6000L per KW/Hr)
- Both lighter than air and heavier than air

'Black vapour' – particles of heavy metals from cathode material (Nickel, Manganese, Cobalt)

'White vapour' –

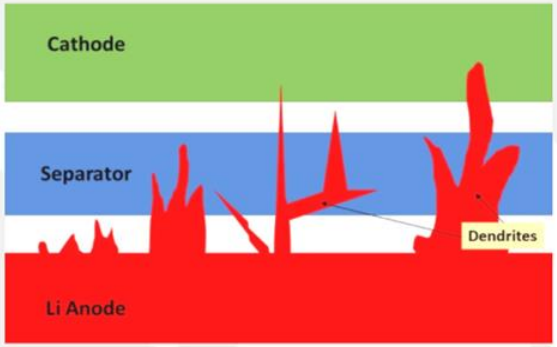
- 30-50% Hydrogen
- 10-20% CO
- Hydrogen Cyanide
- Hydrogen Fluoride
- Hydrogen Chloride
- 2-15% Methane/Ethane
- Small droplets organic solvents

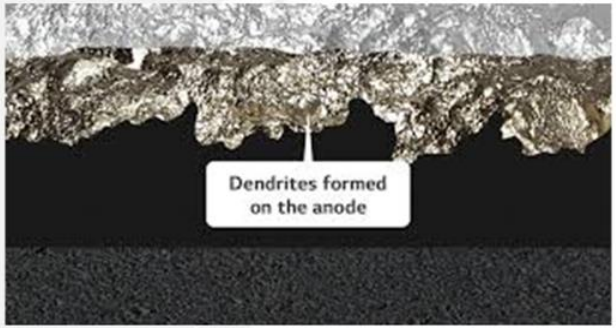
What is Thermal Runaway?

Thermal runaway describes a process that is accelerated by increased temperature, in turn releasing energy that further increases temperature. Thermal runaway occurs in situations where an increase in temperature changes the conditions in a way that causes a further increase in temperature, often leading to a destructive result.

Non-energetic failures

- **Manufacturing defects**
- **Short circuits**
  Water
  Li Dendrite growth





Thermal Runaway

Explosibility

BURNING VELOCITY (cm/s)

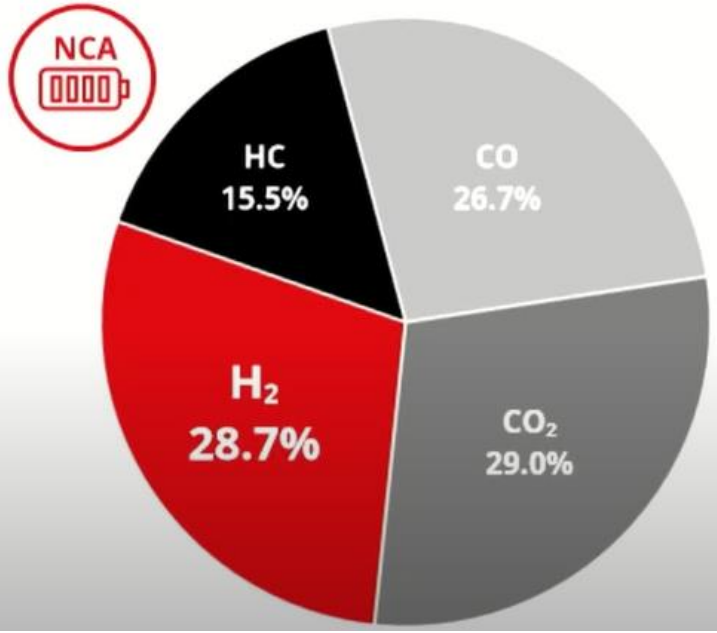
PROPANE	NCA	ETHYLENE	LFP	ACETYLENE
46	51	80	112	166

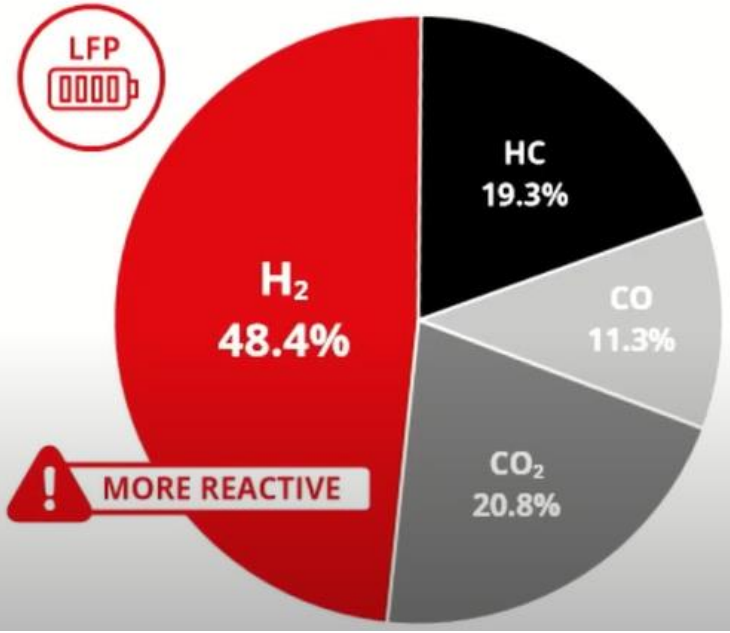
MAXIMUM CLOSED VESSEL DEFLAGRATION PRESSURE (psi-g)

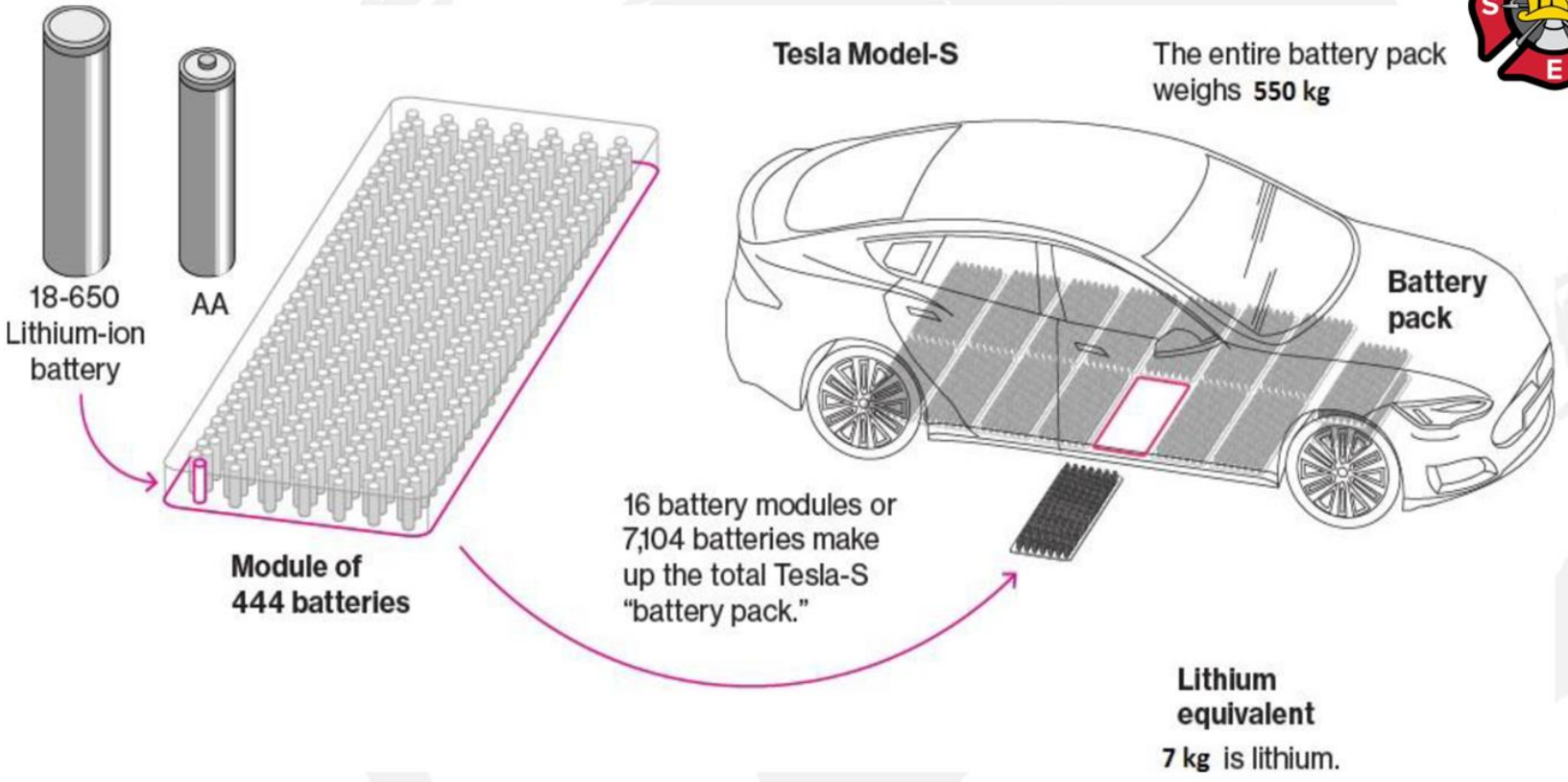
PROPANE	NCA	ETHYLENE	LFP	ACETYLENE
115	113	116	122	154

Thermal Runaway

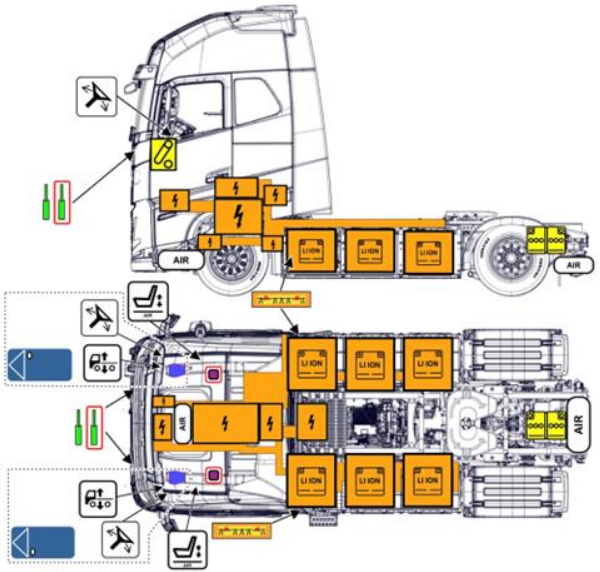
Gas Concentration






18-650
Lithium-ion
battery
AA
Module of
444 batteries
16 battery modules or
7,104 batteries make
up the total Tesla-S
"battery pack."
Tesla Model-S
The entire battery pack
weighs 550 kg
Battery
pack
Lithium
equivalent
7 kg is lithium.

Electric Lorries




FIRE FIGHTERS