MAZZETTI

Hydrogen Fuel Cells:

The answer to Healthcare's **back-up power** challenges?

Green Hydrogen Summit

October 1, 2025

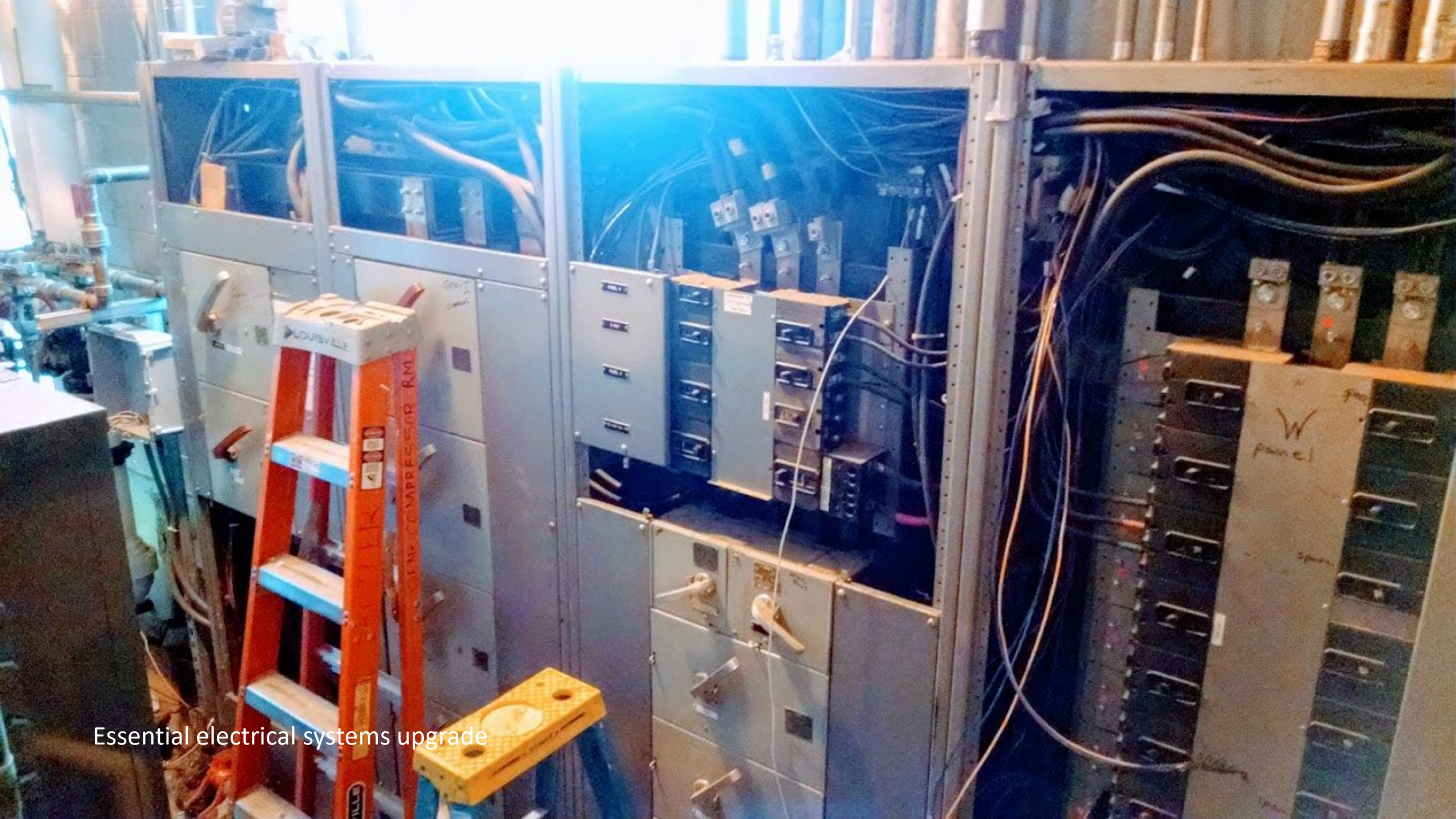
Hydrogen Fuel Cells in Rural Healthcare

A Case Study

Jonathan Lewis,
Klickitat Valley Health


Klickitat Valley
HEALTH

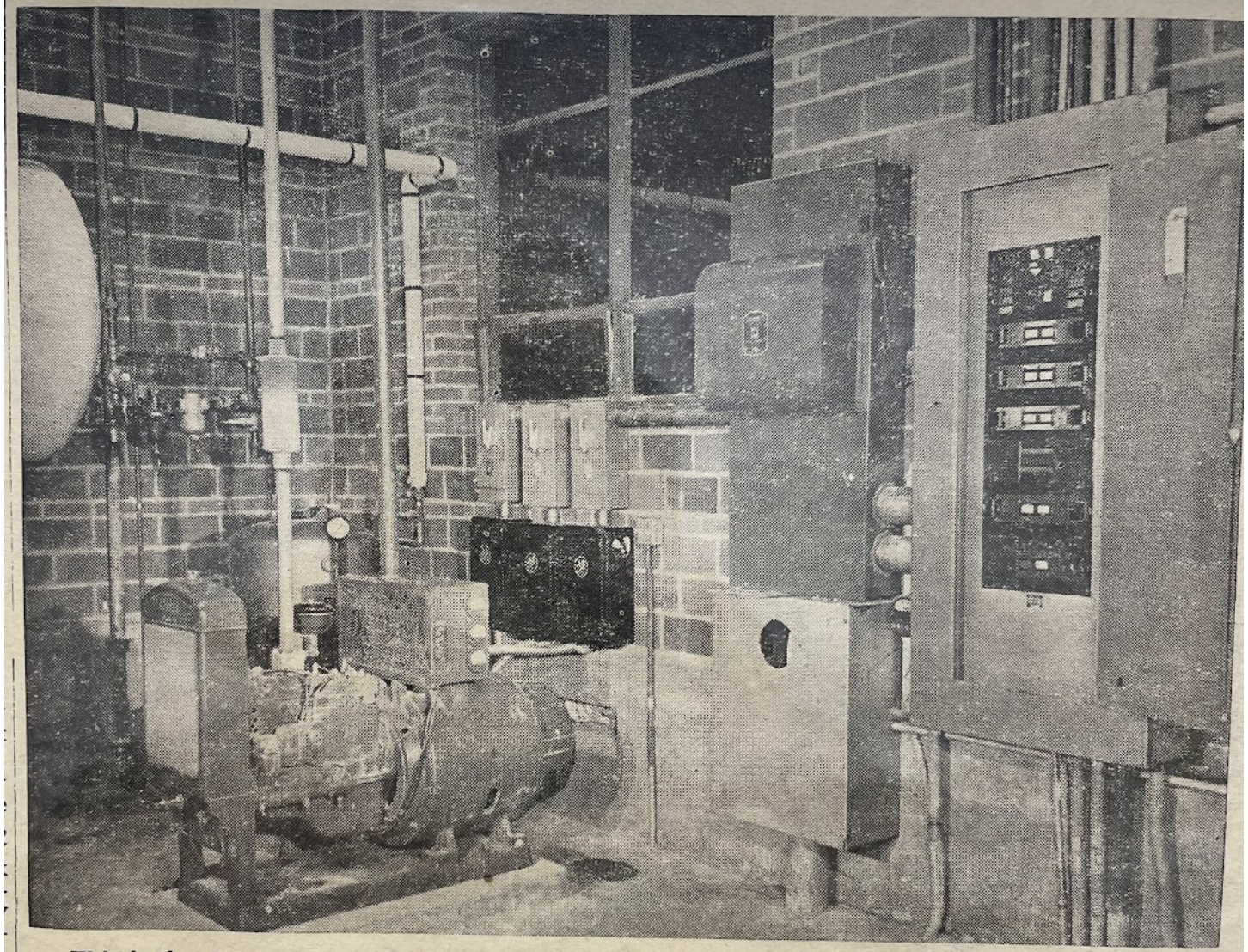
WWII era generator set backing up the hospital



Essential electrical systems upgrade


TWO WAY FEED
DANGER

No Power Outage At New Hospital; Has Auxiliary Plant



This is the electrical core of the New Klickitat Valley Hospital. The main distribution panel (right) is the primary power entrance to the building. There are no worries, from the standpoint of power failure, for in this room (left) is the emergency power plant, which will provide power to delivery room, the surgery, heating plant and to several other strategical locations. Extreme rear is shown the 100KW steam generator which will provide high and medium pressure steam to the sterilizing apparatus and to the laundry and dishwasher.

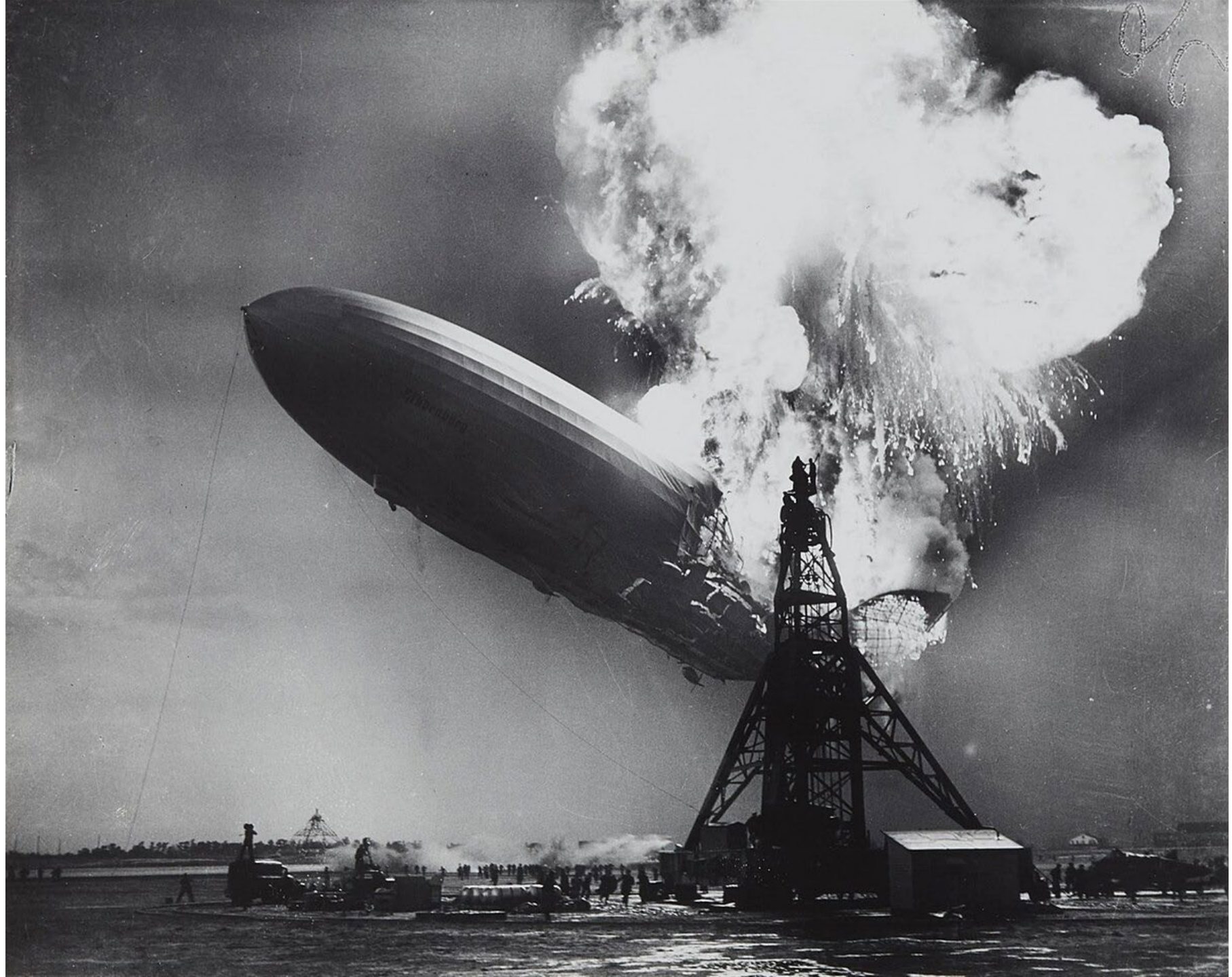

JUNK
TRUNK
AGEN
FIRST AID & SAF


Hydrogen
WASHINGTON GREEN HYDROGEN ALLIANCE


WASHINGTON STATE
HOUSE OF
REPRESENTATIVES


HYDRO

Example Kohler Fuel Cell Power System

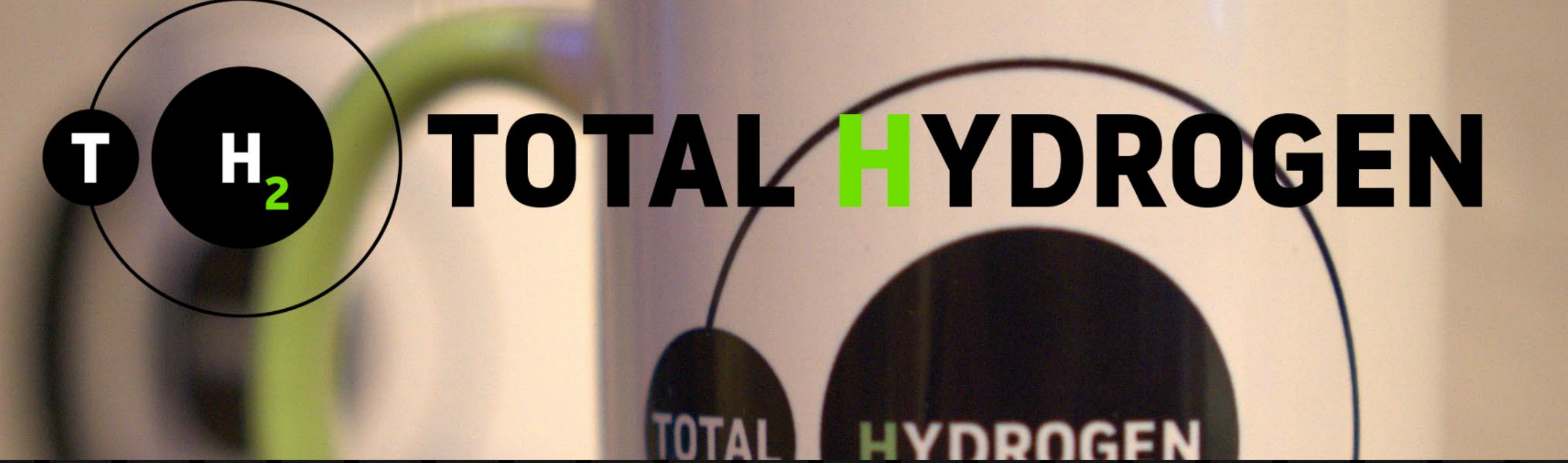



PRODUCTS


CENTER FOR
Hydrogen™
SAFETY
Connecting a Global Community


OVERSIZE LOAD
RX No. 5
RX No. 6
RX No. 7
RX Local
KVH PHARMACY
KVH


rehlko



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Storage Information		
Cylinder Type	CGA 350T	
Number of Cylinders	48	
Amount of Gas Per Cylinder	261	SCF
Total Amount of Hydrogen	12528	SCF
Density of Hydrogen	423	SCF/Kg
Total Amount of Hydrogen	29.61702128	Kg
Storage Pressure	2400	PSI

Next Steps at KVH

Hydrexia Metal Hydride Safety Features

HYDREXIA

Storage Subsystem Features

- H2 Leak detectors with rapid response safety protocol
- Flow orifices
- Pressure relief valves for > 40 bar with purge pipes
- Hydrogen temperature and pressure switches
- E-Stop protocol and buttons
- Explosion-proof fan with flow sensors
- Multiple response safety chain protocols
- All necessary lightning, electrical, grounding, and smoke detection equipment
- Optional passive ventilation

Thermal Management Subsystem Features

- Glycol flow switch and flow orifices
- Glycol temperature, pressure sensors and switches
- Glycol pressure relief valves with purge pipes
- PLC with safe operating boundary conditions
- All necessary lighting, electrical, grounding, and smoke detection equipment
- Non-static materials for non-metal componentry

Safety Compliance

- Compliance with NFPA and NEC codes and standards

Low Pressure Storage

- 30 bar (435 PSI)
- Fraction of high-pressure tubes

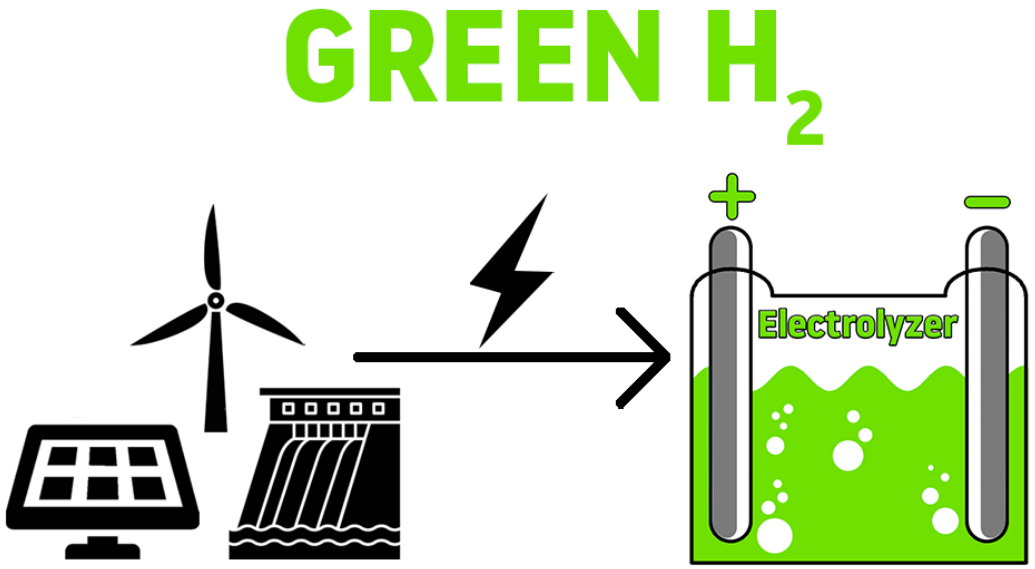

This guy's Crazy! :)
Thank You!
~jlewis@kvhealth.net

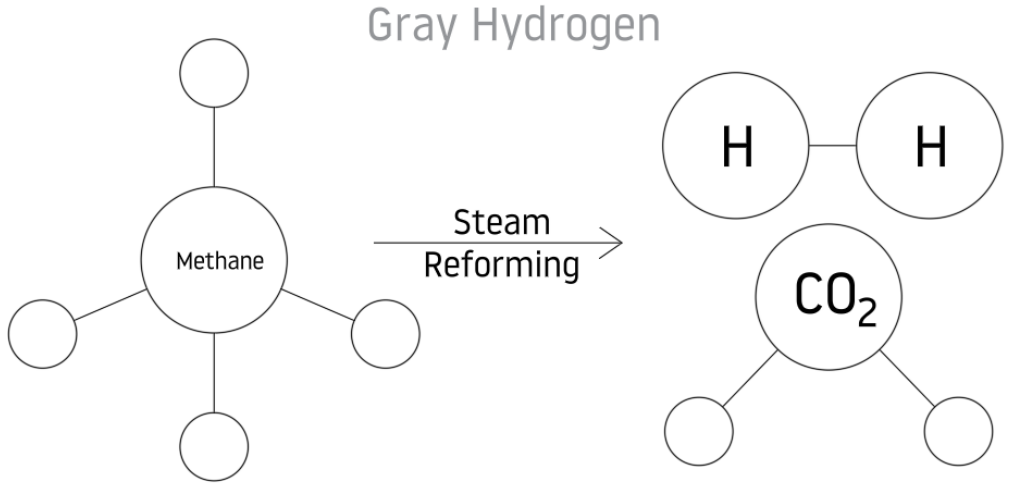
Hydrogen Storage Systems for Healthcare Facilities

Carl Rivkin,
National Renewable Energy Labs, retired
Total Hydrogen

Why Hydrogen?

- Hydrogen is primarily a way to store energy
- Hydrogen can be produced from renewable technologies such as wind and solar
- The energy source used to produce hydrogen determines the “color”:





Backup Power Options

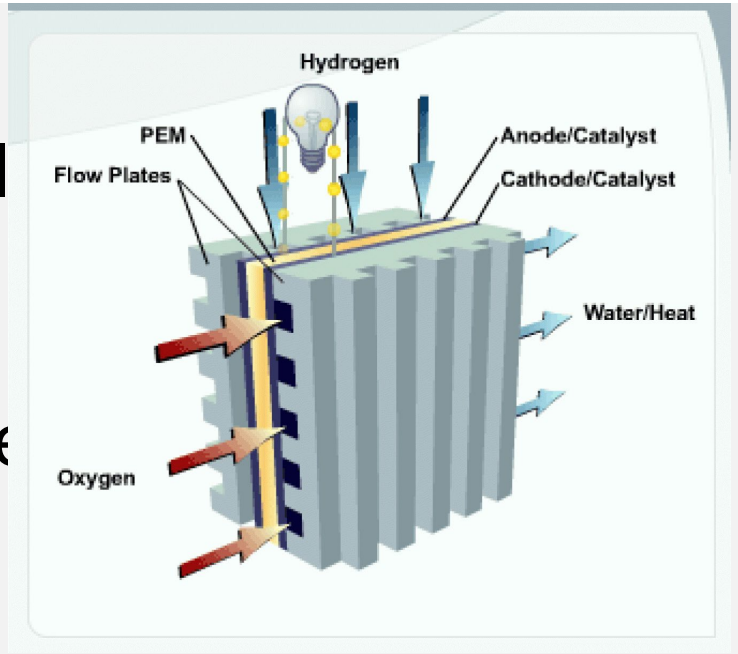
	Fuel Cell	Diesel	Battery
Reliability	+	–	+
Capital cost ($/kW)	–	+	++
Extended run time	++	++	– –
Emissions	++	–	++
Noise	+	–	++
Weight	+[a]	+	+
Efficiency	+	–	++
Annual fuel cost	–[b]	–	+[c]
Annual maintenance cost	+	–	++
Maintenance frequency	++	–	~
Refurbishment	+	+	– –
Remote conditioning and check	+	–	~
Operation lifetime	+	++	– –
Ambient conditions	+	+	–

[a] Fuel cell system only without the weight of hydrogen storage.
[b] Current cost of hydrogen (2016) is still high.
[c] Cost can be worse if batteries were added for air conditioning.

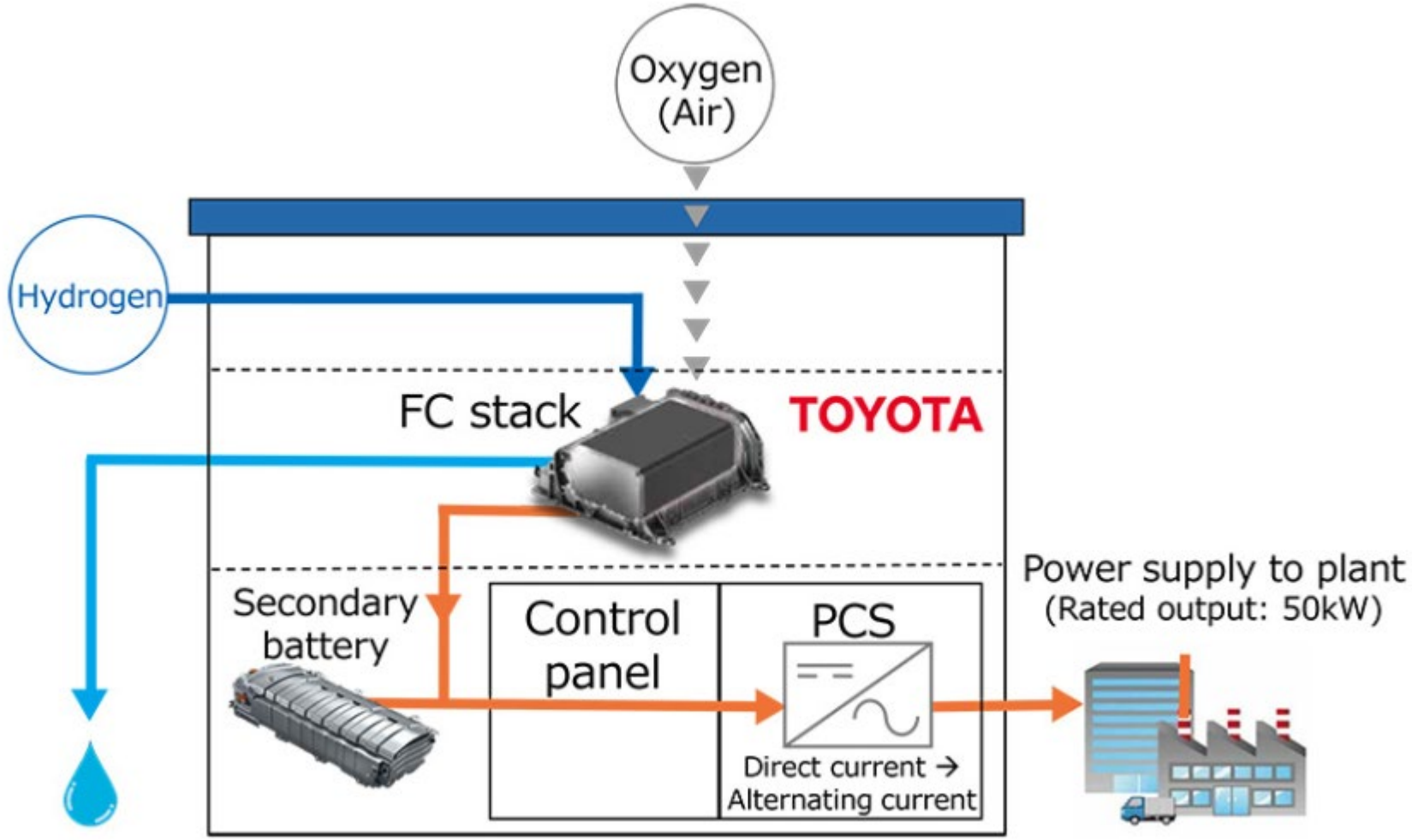
From NREL Technical Report
NREL/TP-5400-67408 March 2017

Basics of Fuel Cell Technology

- Backup power fuel cells often use proton electrolyte membrane (PEM) technology to provide DC power.
- PEM fuel cells are fueled directly by hyd temperatures, are smaller than other fuel and have a short warm-up time.
- Most PEM fuel cells have integral batterie to provide immediate power.



Fuel Site Schematic



- **Width x Depth x Height**
  2.9 x 1.5 x 2.7 m
- **Weight**
  Approximately 3.5 tons
- **Rated output**
  50 kW
- **Rated voltage / number of phases / frequency**
  AC 210 V / three-phase three-wire / 50/60 Hz
- **Fuel cell type**
  Solid polymer electrolyte
- **Hydrogen purity**
  Pure hydrogen (99.97 percent)
- **Start-up time**
  40 seconds (time to reach rated output)

https://global.toyota/en/newsroom/corporate/32732488.html

Regulations, Codes, and Standards for Hydrogen Infrastructure

The Regulatory Landscape

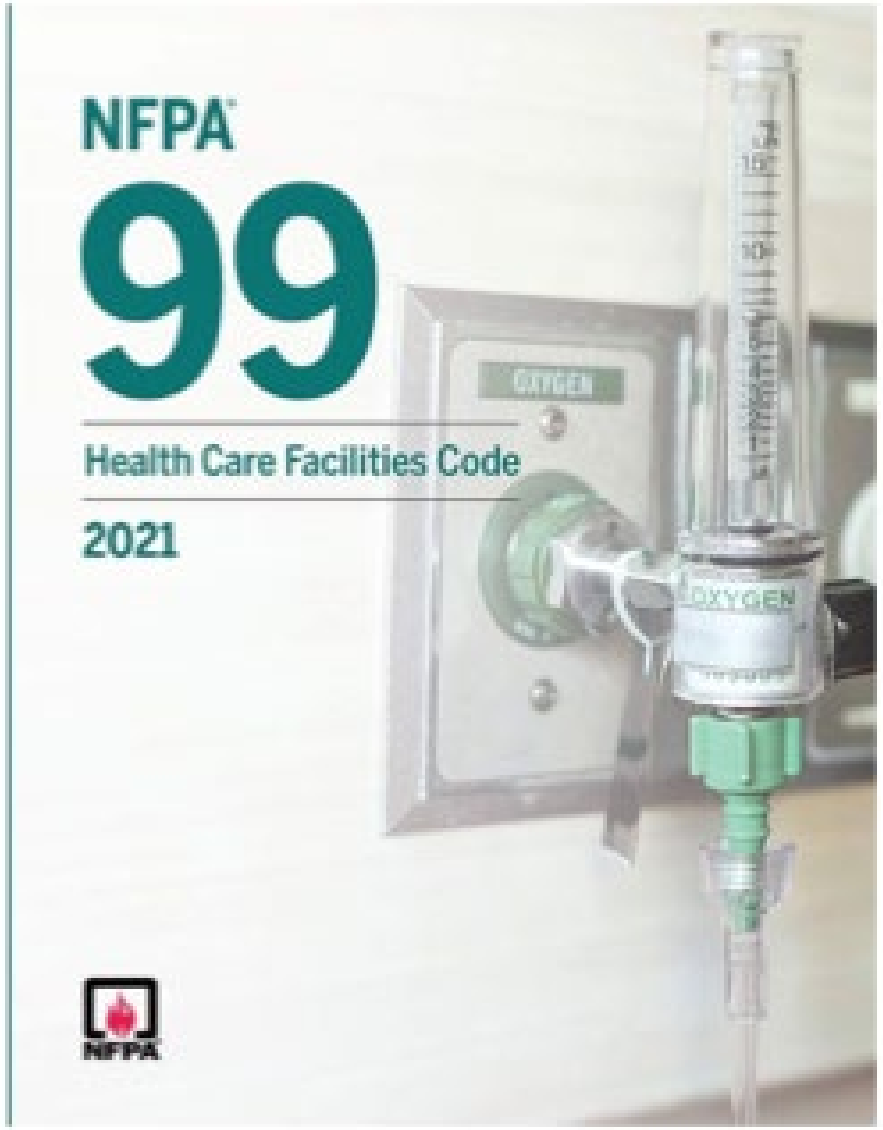
- Federal regulations- OSHA Process Safety Management (PSM) and EPA Risk Management Plan (RMP) - both triggered by 10,000 lb. storage- not likely to apply to fuel cell storage
- OSHA 29 CFR § 1910.103 Hydrogen- hydrogen safety
- State Regulations- for example California CUPA for hazardous materials and State Health Department
- Local Permitting Jurisdiction- regulatory requirements start with the adopted Building and Fire Code
- Most Jurisdictions in the US adopt an edition of the International Building Code (IBC) and International Fire Code (IFC) -(“the Fire Code”)
- The IBC and IFC reference NFPA codes including NFPA 2 Hydrogen Technologies

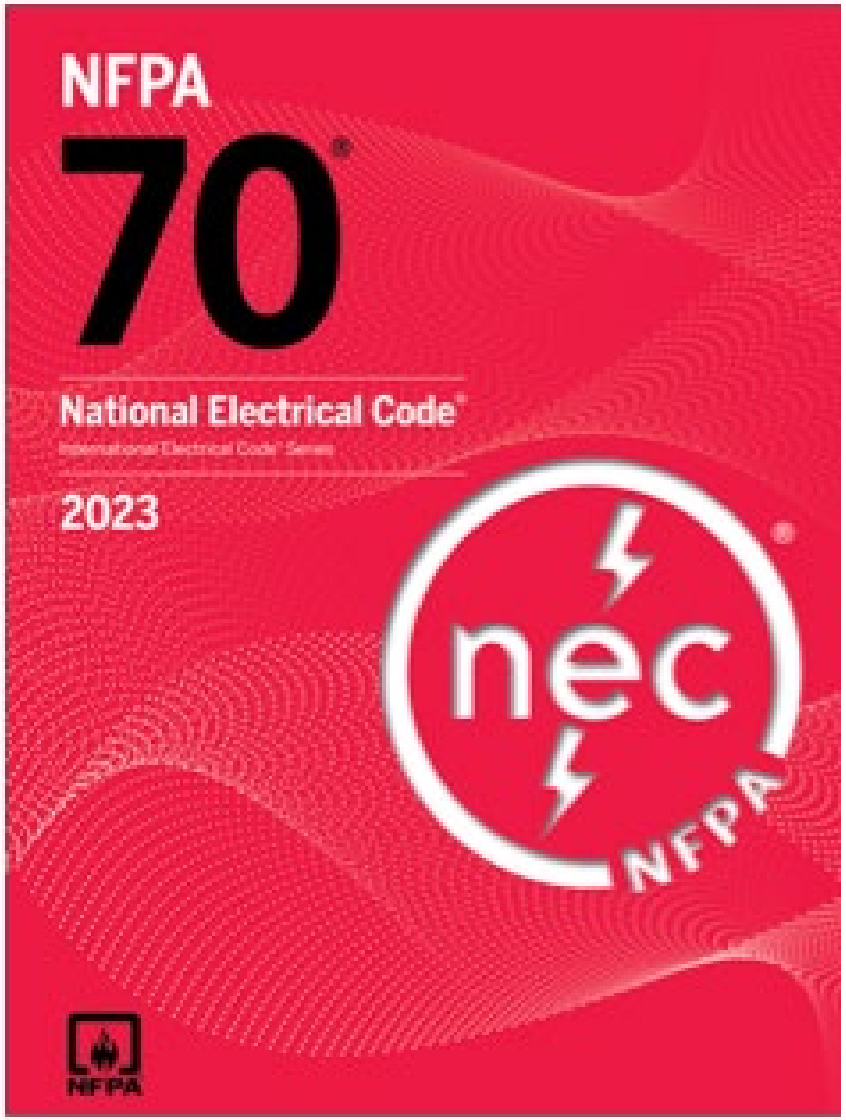
NFPA 2 Hydrogen Technologies 2023 edition

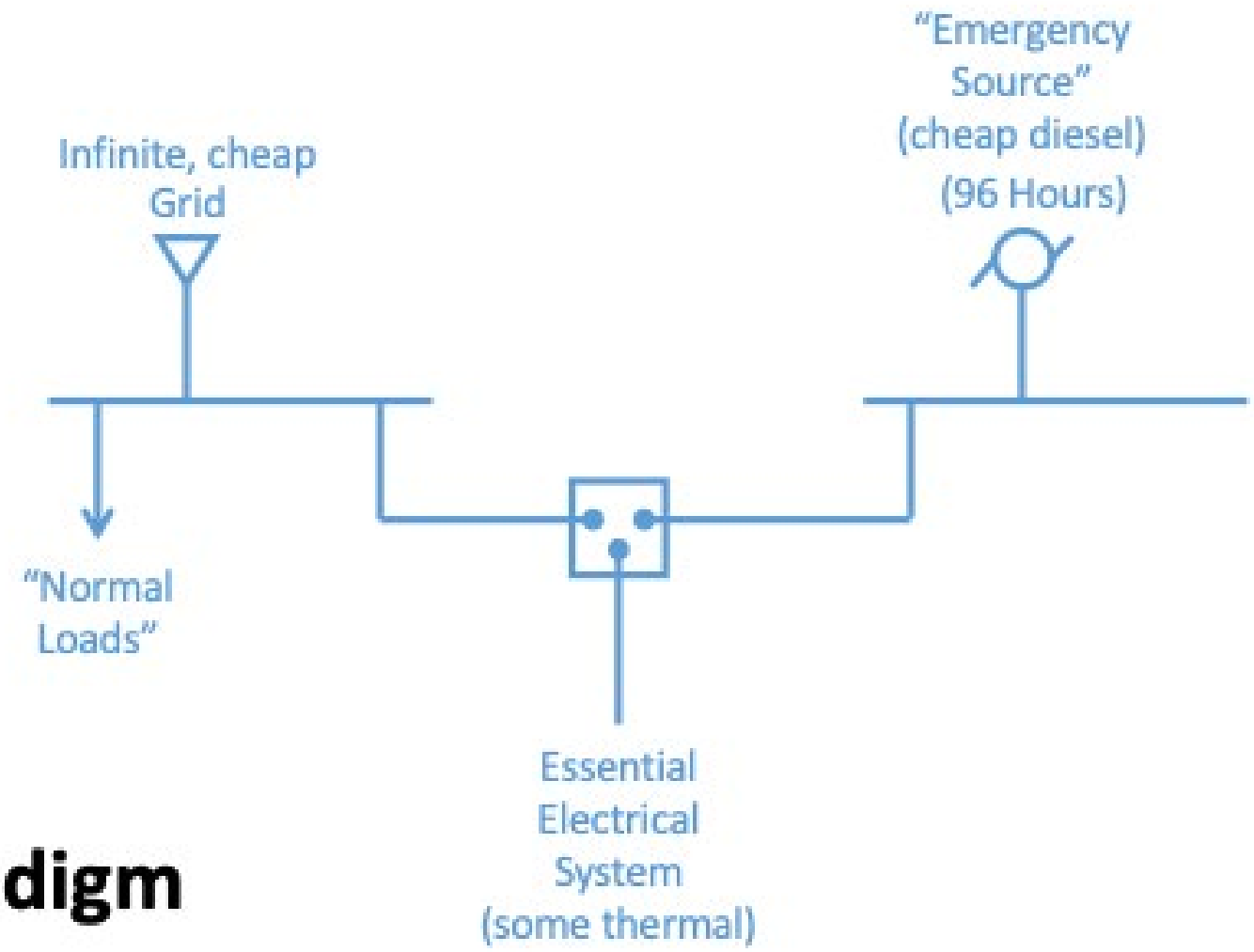
- NFPA 2 is the national code for hydrogen safety
- NFPA 2 is referenced in the fire code and directly in certain state legislation
- NFPA 2 covers the safe operation and design of hydrogen infrastructure
- NFPA 2 references standards that address all system components
- NFPA 2 extracts portions of NFPA 853 Standard for the Installation of Stationary Fuel Cell Power Systems

Evolution of Healthcare Codes, and Role of hydrogen in the future

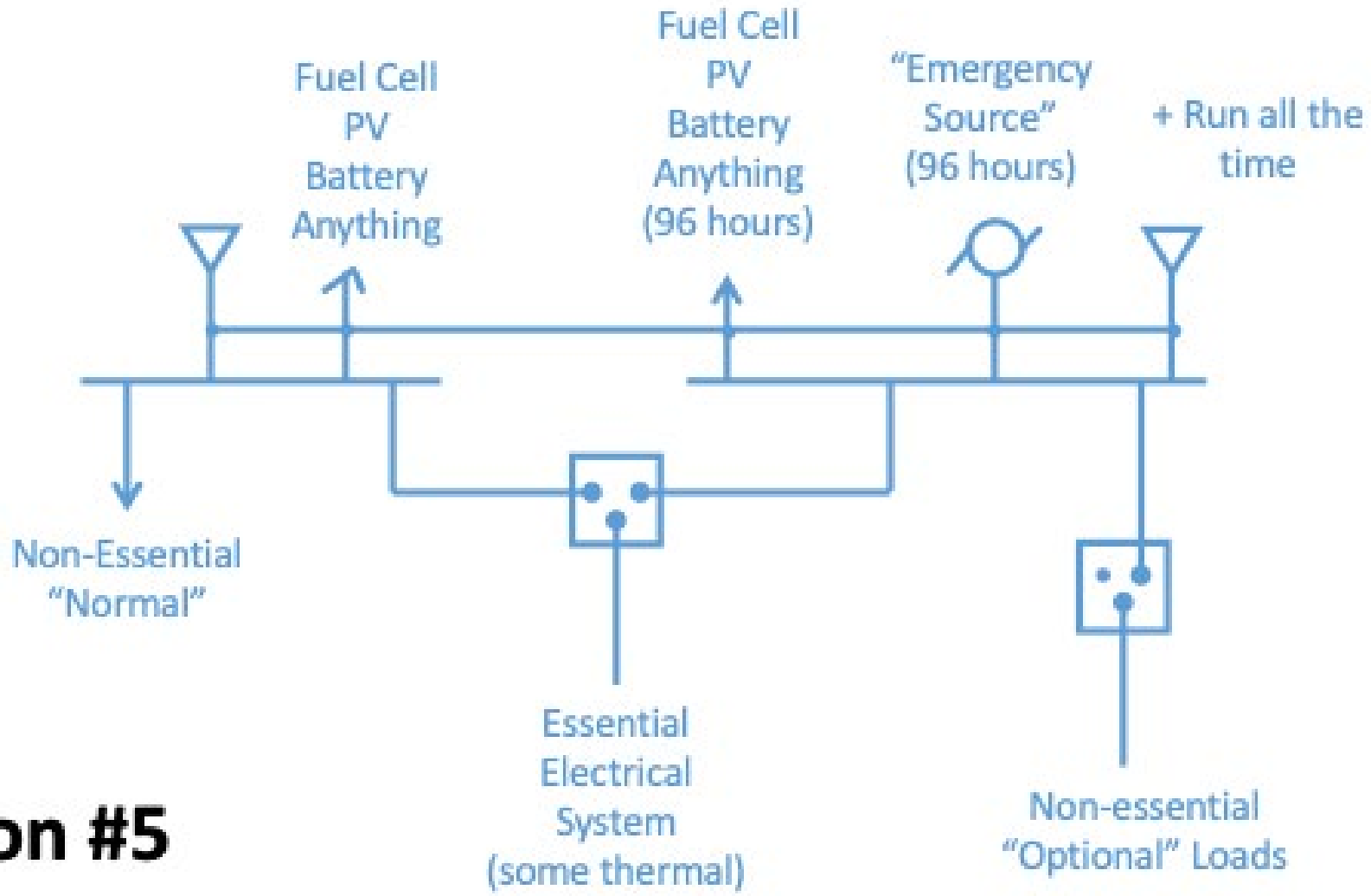
Walt Vernon,
Mazzetti, Sextant Foundation


NFPA
99
Health Care Facilities Code
2021
OXYGEN
NFPA

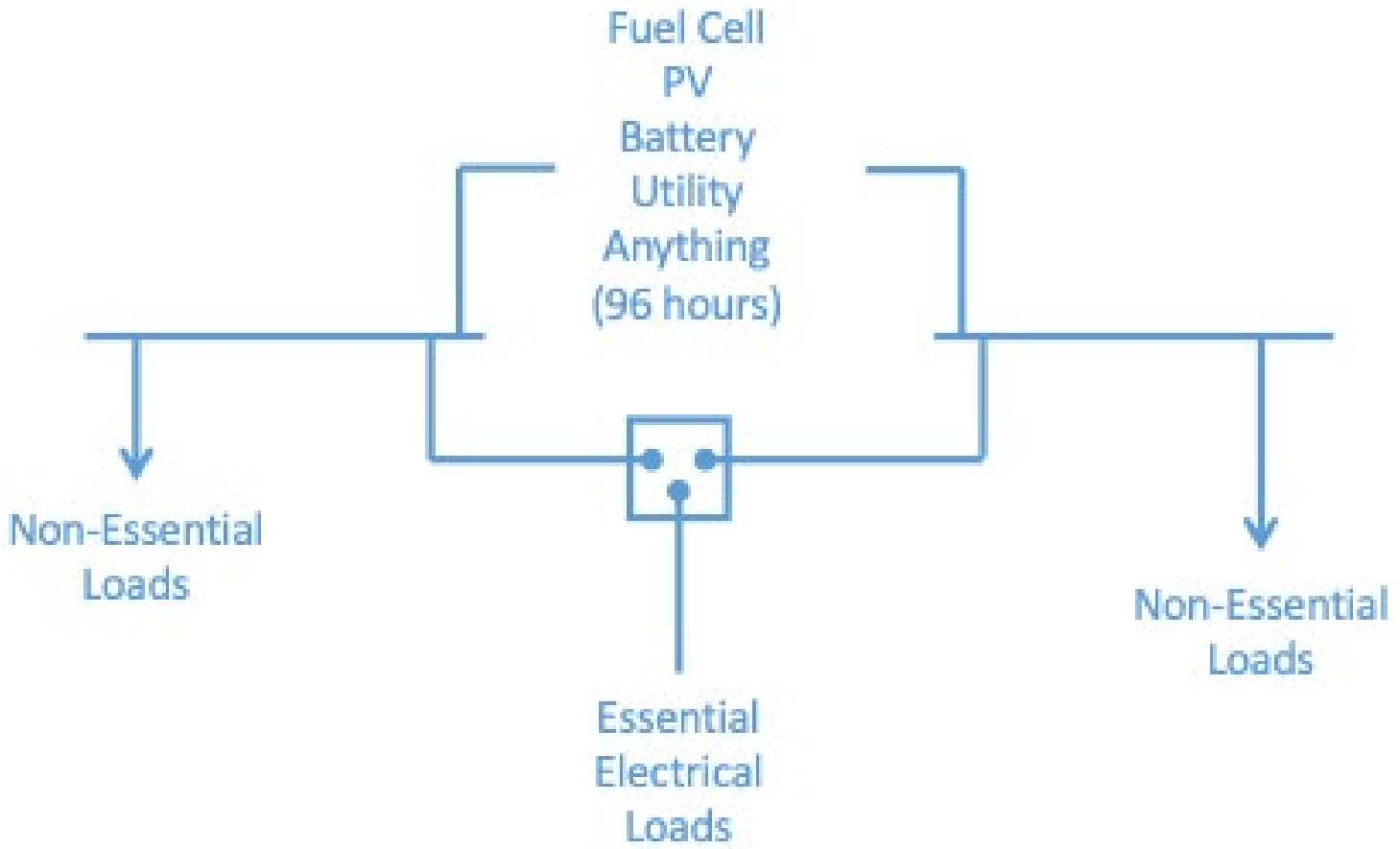

NFPA
70
National Electrical Code
2023
nec
NFPA
NFPA



Old Paradigm


Fuel Cell
PV
Battery
Anything
Fuel Cell
PV
Battery
Anything
(96 hours)
"Emergency
Source"
(96 hours)
+ Run all the
time
Non-Essential
"Normal"
Essential
Electrical
System
(some thermal)
Non-essential
"Optional" Loads

Evolution #5


Fuel Cell
PV
Battery
Utility
Anything
(96 hours)
Non-Essential
Loads
Non-Essential
Loads
Essential
Electrical
Loads

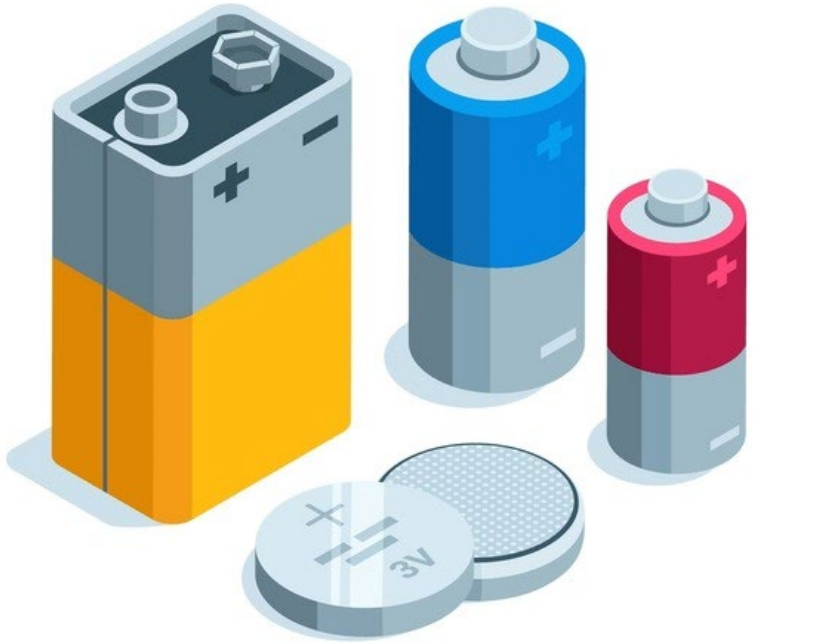
2029??

Sizing?

Categorical Waiver – Health Care Microgrid Systems (HCMSs)

Title	Categorical Waiver – Health Care Microgrid Systems (HCMSs)
Memo #	QSO-23-11-LSC
Posting Date	2023-03-31
Fiscal Year	2023
Title	Various CMS regulations governing certain providers and certified suppliers require compliance with the 2012 edition of the National Fire Protection Association (NFPA) Health Care Facilities Code (NFPA 99). • 2012 edition of NFPA 99 requires emergency power for an essential electric system (EES) to be supplied by a generator or battery system. • 2021 edition of the NFPA 99 permits emergency power for an EES to be supplied by sources other than a generator or battery system, including a health care microgrid system (HCMS) • HCMSs are small-scale electrical grids where the sources of electricity can be provided by clean energy technologies (e.g., fuel cells, solar, wind, energy storage, etc.). • Except as noted below, CMS is issuing a categorical waiver permitting new and existing health care facilities subject to CMS requirements

What’s left after The One Big Beautiful Bill?



Thought Experiment:
375 kw; 200 hours per year; 30 years, 7%

Item	Diesel generator	Battery (w/tax)	Methane Fuel Cell (w/tax)	Hydrogen Fuel Cell (w/tax)
Installed Cost	$382,500	$6,720,000	$787,500	$1,268,750
Annual Fuel Cost	$18,165	$13,000	$3,071	$18,018
Annual O&M Cost	$6,500	$7,225	$8,250	$8,250
Total Annual Cost	$24,655	$20,725	$11,321	$26,268
Total Life Cycle Cost	$1,216,688	$12,354,000	$2,568,122	$3,859,706
NPV	$716,754	$8,286,249	$1,376,203	$2,137,416
Cost/kwh	$0.54	$5.49	$1.14	$1.72

517.31(D)

The on-site power source(s) required in 517.30 shall have the capacity and rating to meet the demand produced by the load at any given time. Demand calculations for sizing of the on-site power source(s) shall be based on any of the following:

1. Prudent demand factors and historical data
2. Connected Load
3. Feeder Calculations

The BIG One -

- 517.4 Electrical Service
- (B) Capacity of Systems
- Systems shall have the capacity and rating to meet the maximum actual demand likely to be produced by the connected load on the system. Demand calculations for sizing of the systems shall be based on one or more of the following:

1. Prudent demand factors and historical data
2. Connected loads
3. Feeder calculations

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National Renewable Energy Labs, retired
Total Hydrogen

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