

STORING SOLAR POWER

- Battery storage array as intermittent power storage
- Batteries arranged to give necessary power, amperage and voltage for electrolyzer cores
- Battery Problems: Discharge and lack of movability

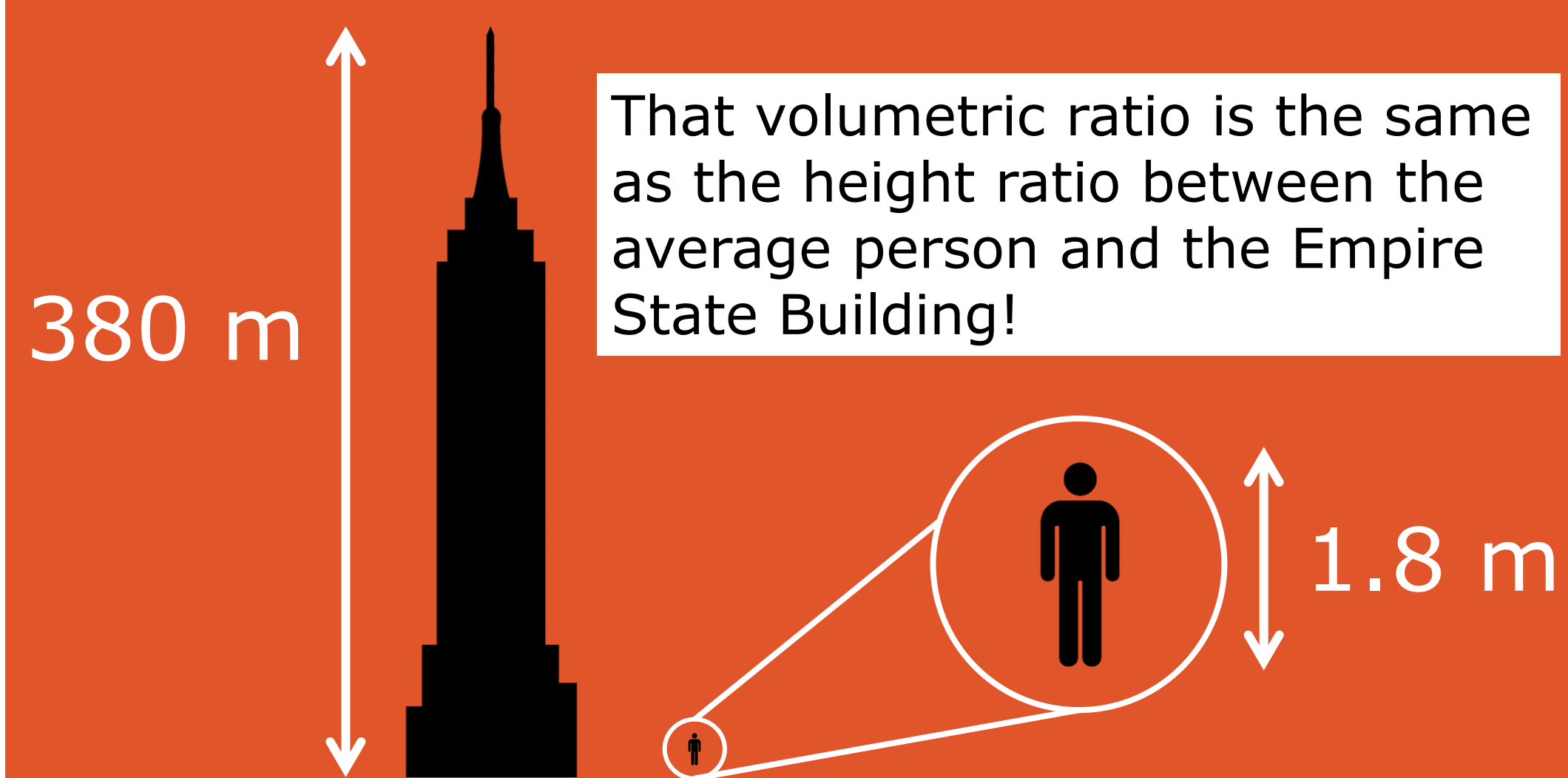


Image source: Solar Integration: Solar Energy and Storage Basics. <https://www.energy.gov/eere/solar/solar-integration-solar-energy-and-storage-basics> (accessed 2023-05-12)

STORING HYDROGEN

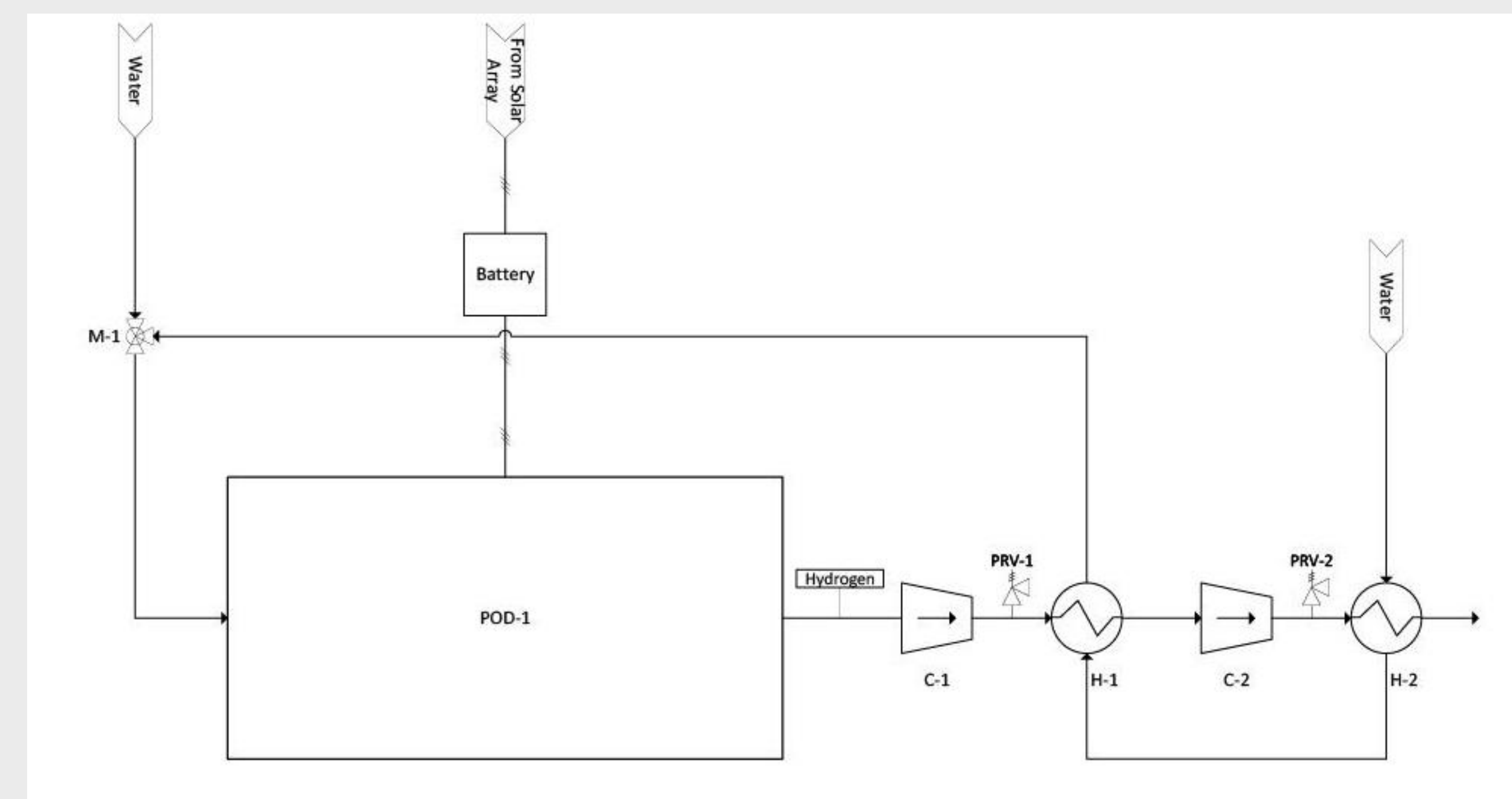
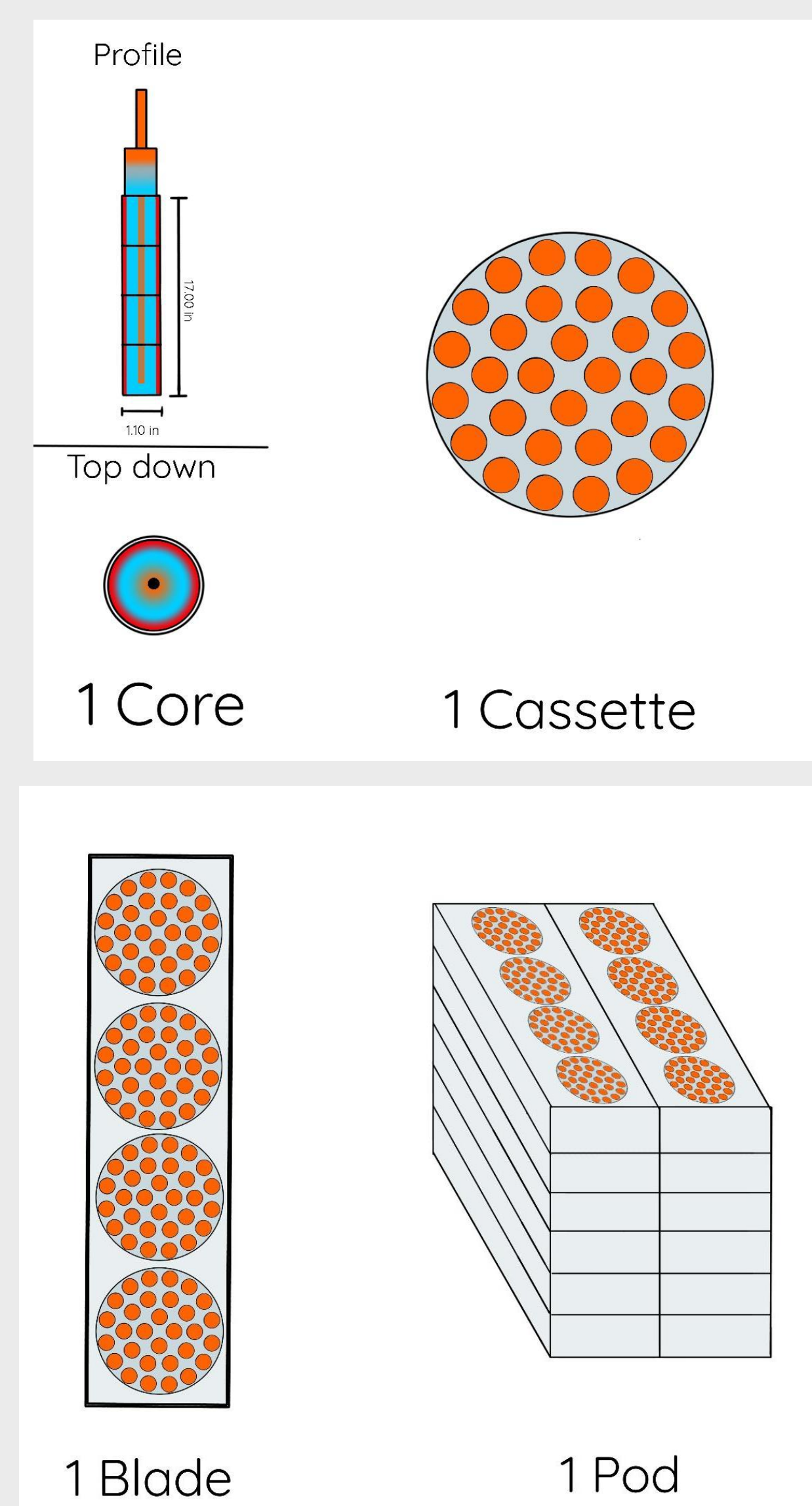
Hydrogen fuel must be stored at high pressures to make efficient use of space. For example:

- 1 kg of H<sub>2</sub> stored at 1 atm would require a container of 11 m<sup>3</sup>
- 1 kg of H<sub>2</sub> stored at 296 atm would require a container of 0.05 m<sup>3</sup>



# COMPRESSION SOLUTIONS: PAVING THE WAY FOR GREEN HYDROGEN FUEL

Compressing hydrogen from a membraneless electrolyzer powered by renewable energies



WHY HYDROGEN?

Renewable energy

- The electrolysis process produces hydrogen from water by separating the hydrogen atoms from the oxygen atom. When hydrogen is combusted as fuel, the resulting product is... water!
- Zero carbon emissions when electrolysis is performed from renewable energies.

Three times the energy density of gasoline

- When stored cryogenically or at high pressure

Can be produced by domestically available resources

- Domestic water sources
- Solar energy, wind and biomass

THE CHALLENGES OF HYDROGEN FUEL

Low density

- Hydrogen is an extremely small molecule! Because of this, hydrogen has an incredibly low density at atmospheric pressure. To make it possible to make hydrogen transportable in standard-sized containers, it must be compressed to 300 to 700 atmospheres!

Corrosive

- Hydrogen atoms transfers through the interstitial sites in steel's iron, carbon matrix and corrodes metal

EXPLOSIVE!

- Leaks and damaged machinery can lead to disastrous results. Careful consideration must be given to all materials that contact hydrogen and routine maintenance is essential.

COMPRESSION TYPES

Method	Benefits	Downsides
Reciprocating (Piston)	<ul style="list-style-type: none"> <li>• Wide market availability</li> <li>• Adaptable to a range of flow rates</li> <li>• High discharge pressures</li> </ul>	<ul style="list-style-type: none"> <li>• Embrittlement</li> <li>• Noise</li> <li>• Heat transfer</li> <li>• Oil contamination</li> </ul>
Reciprocating (Ionic Liquid)	<ul style="list-style-type: none"> <li>• High efficiency (70%)</li> <li>• Low energy con.</li> <li>• Low contamination</li> </ul>	<ul style="list-style-type: none"> <li>• Corrosion</li> <li>• Leakage</li> <li>• Cavitation</li> </ul>
Diaphragm	<ul style="list-style-type: none"> <li>• Low power consumption</li> <li>• Less cooling req.</li> <li>• Less contamination</li> </ul>	<ul style="list-style-type: none"> <li>• Complex design</li> <li>• Diaphragm failure</li> </ul>
Centrifugal	<ul style="list-style-type: none"> <li>• High flow/throughput</li> <li>• High efficiency</li> </ul>	<ul style="list-style-type: none"> <li>• Noise</li> <li>• Extreme spin spins leads to wear and tear</li> </ul>
Electrochemical	<ul style="list-style-type: none"> <li>• No moving parts</li> <li>• Purifies product gas</li> <li>• Quiet</li> </ul>	<ul style="list-style-type: none"> <li>• Immature tech,</li> <li>• Loses efficiency at high discharge pressures</li> </ul>

MEMBRANELESS ELECTROLYSIS HYDROGEN PRODUCTION

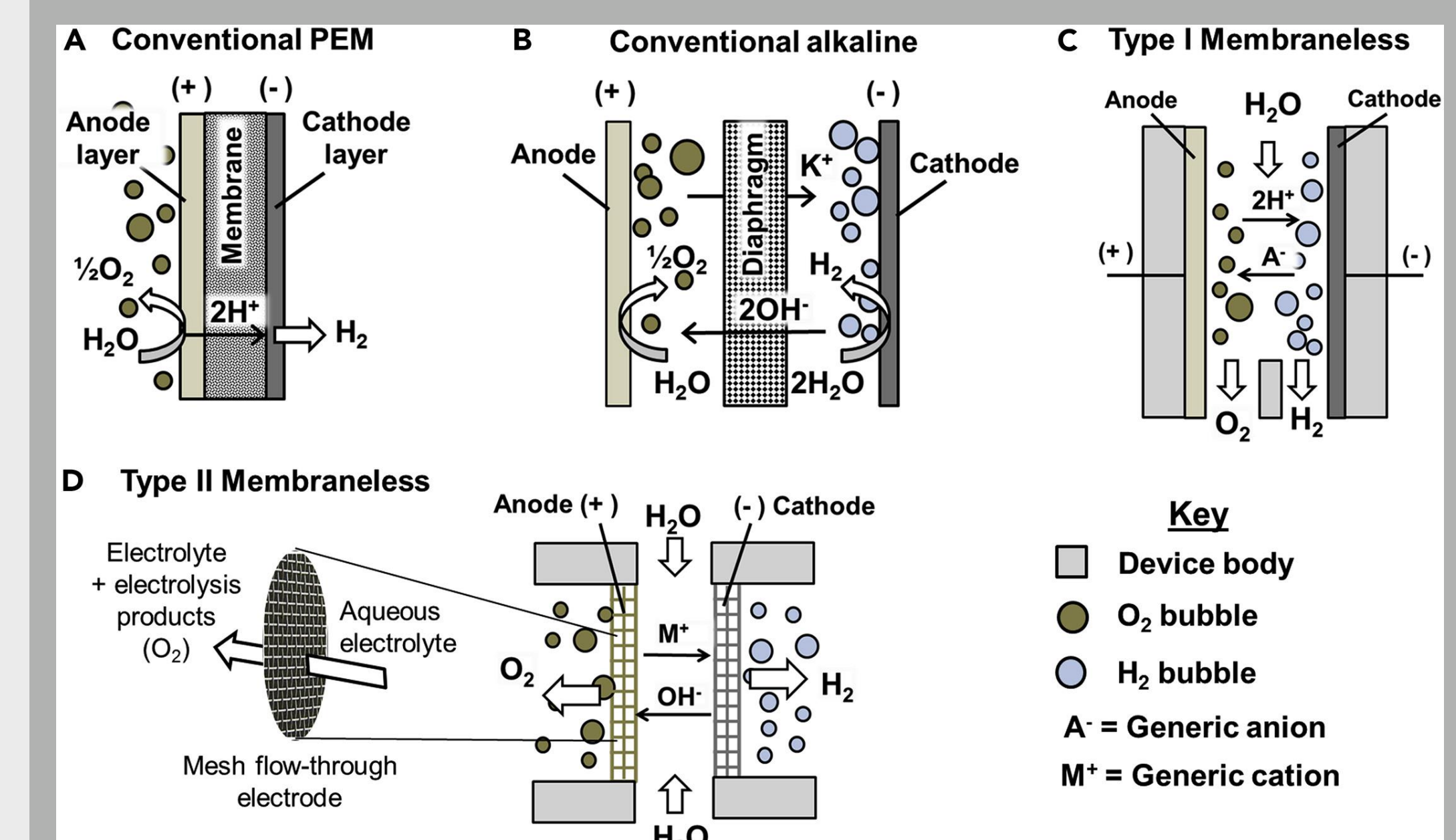


Image source: Esposito, D. V. Membraneless Electrolyzers for Low-Cost Hydrogen Production in a Renewable Energy Future. *Joule* 2017, 1 (4), 651-658. <https://doi.org/10.1016/j.joule.2017.07.003>

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