MODULAR HYDROGEN ANALYSIS

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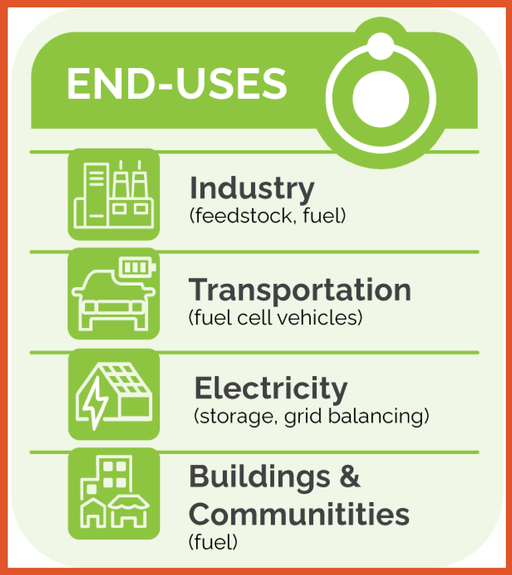
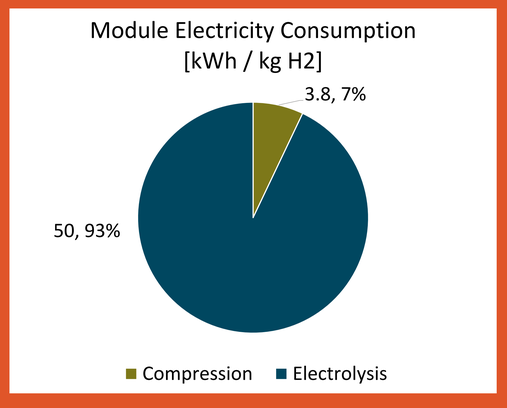
HYDROGEN AS ENERGY

- High Energy Content per kilogram (about 120 MJ/kg)
- Clean Energy alternative to fossil fuel-based sources
- Produced from splitting water, biomass, and steam reformation

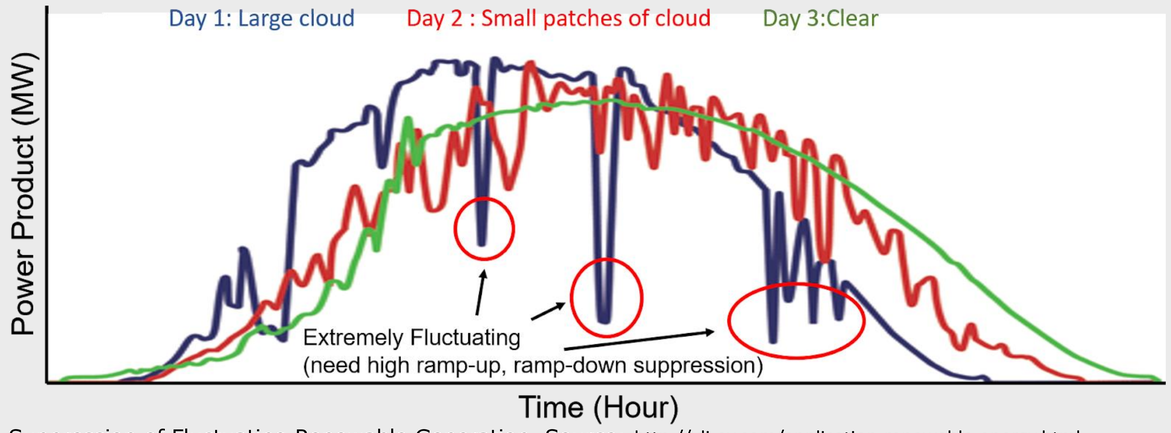


Uses of Hydrogen. Source: https://www.ontario.ca/page/low-carbon-hydrogen



HYDROGEN CHALLENGES

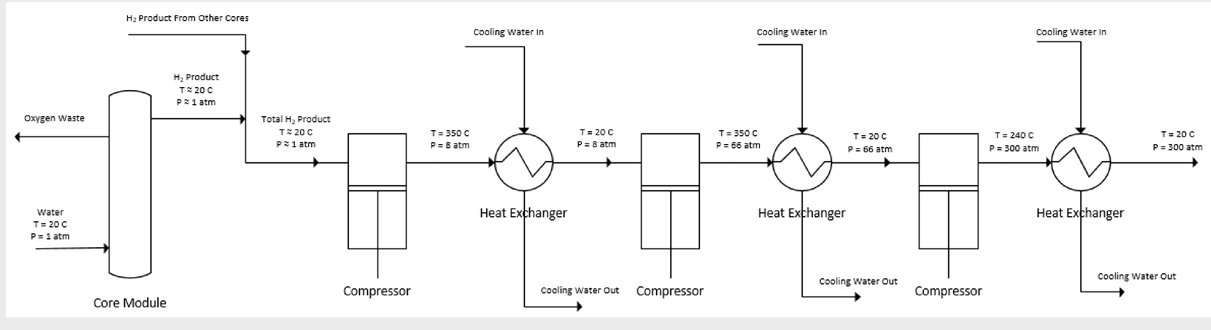
- Hydrogen compression requires special pumping and multiple thermal cycles
- High Temperature Hydrogen Attack (HTHA) can embrittle many metals far below the temperature of self-combustion
- Power fluctuations, due to green energy, create difficulty in turn-down of compressors, pumps, cores, and other auxiliary equipment



Suppression of Fluctuating Renewable Generation. Source: http://vli-ev.com/application-renewable-energy.html

COMPRESSION DESIGN

- Core Modules
  - Proprietary electrolyte and hydrogen coalescing chambers
  - All core product streams are mixed before compression
- Compressors
  - Reciprocating piston compressors
  - Three-stage polytropic adiabatic compression cycle reaches 300 atm
- Heat Exchangers
  - Counter-current shell-and-tube exchangers using water coolant
  - Prevents hydrogen stream from auto-ignition during compression
- Piping
  - Material: A387 Steel (~2.25% Cr & 0.5% Mo)



MODULAR HYDROGEN

- Hydrogen generation in a container the size of a shipping container
- Hydrogen easily able to be generated from water alone via electrolysis
- Easily scalable, but extremes are inefficient and expensive

MODULE OPERATING CONDITIONS

- Water Flow Rate: 0.2 GPM per pod
- 121 kg H_2 gas per day per pod
- 200 kW per pod
- Maximum Temp Allowed: 350 °C
- 536 Cores per pod

FUTURE WORK

- Refine core design
  - Closer to optimal 1.23V for electrolysis
  - Less hydrogen in the oxygen exit side
- Prototyping
  - Cassettes, blades, and pods need to be made
  - Small scale compression

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