



HYDROGEN STORAGE IN THE WILLISTON BASIN



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AGENDA

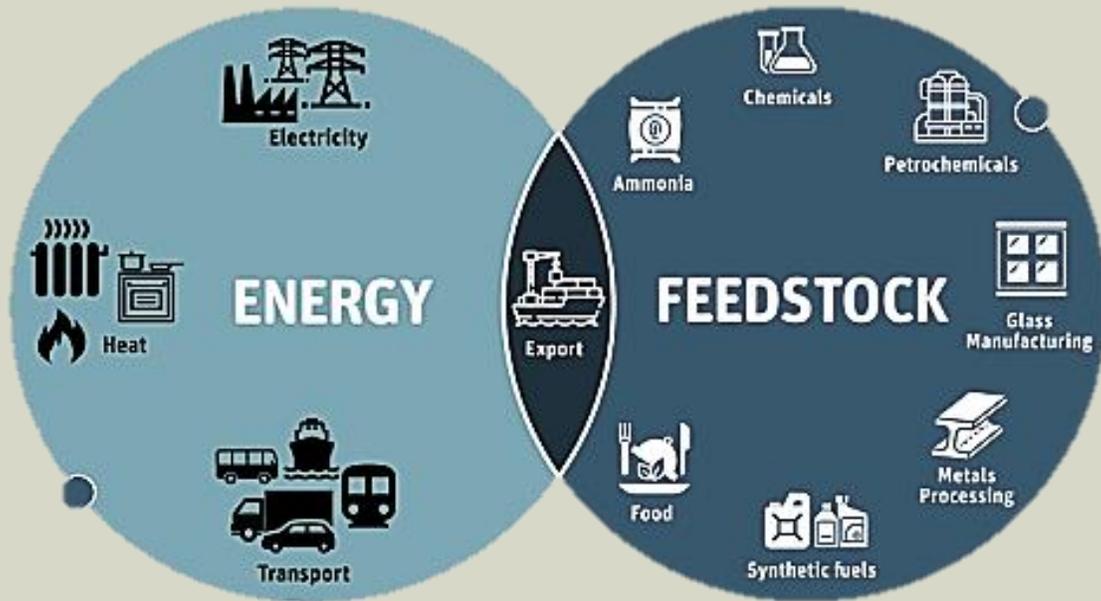
- / WHY HYDROGEN?**
- / WHY UNDERGROUND STORAGE?**
- / THE WILLISTON BASIN**
- / SUMMARY**

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WHY HYDROGEN?

Applications for Hydrogen

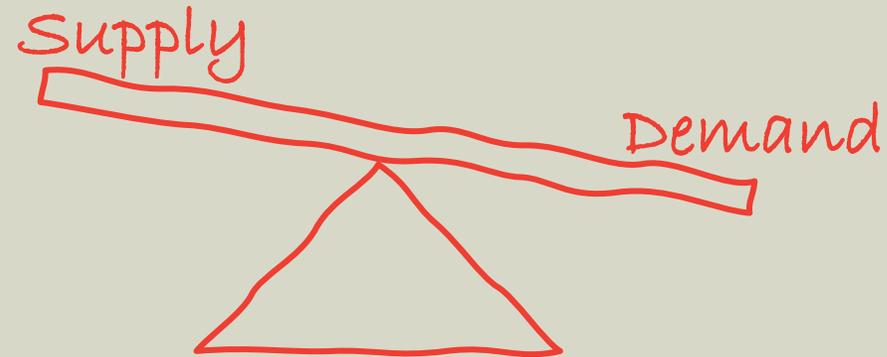


Source: CSIRO

- › Carbon emissions free
- › Significant interest in hydrogen to meet net-zero carbon goals
- › Integration with renewable energy
- › New fuel for the oil and gas industry

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Alleviate
supply and demand
issues

Unique interest
in renewable
energy integration
"power to gas"

Short and long-term
storage to balance
intermittent renewable
energy (wind / solar)

LOW DENSITY

Hydrogen has **3x** more energy per pound than hydrocarbons (natural gas, gasoline, etc.)

BUT...

Hydrogen has a low density

HIGHER VOLUME

Hydrogen has $\frac{1}{3}$ the energy compared to natural gas on a per cubic foot basis.

More storage volume to equal the same energy content



Compared to natural gas, we will need **4x the storage volume for hydrogen**



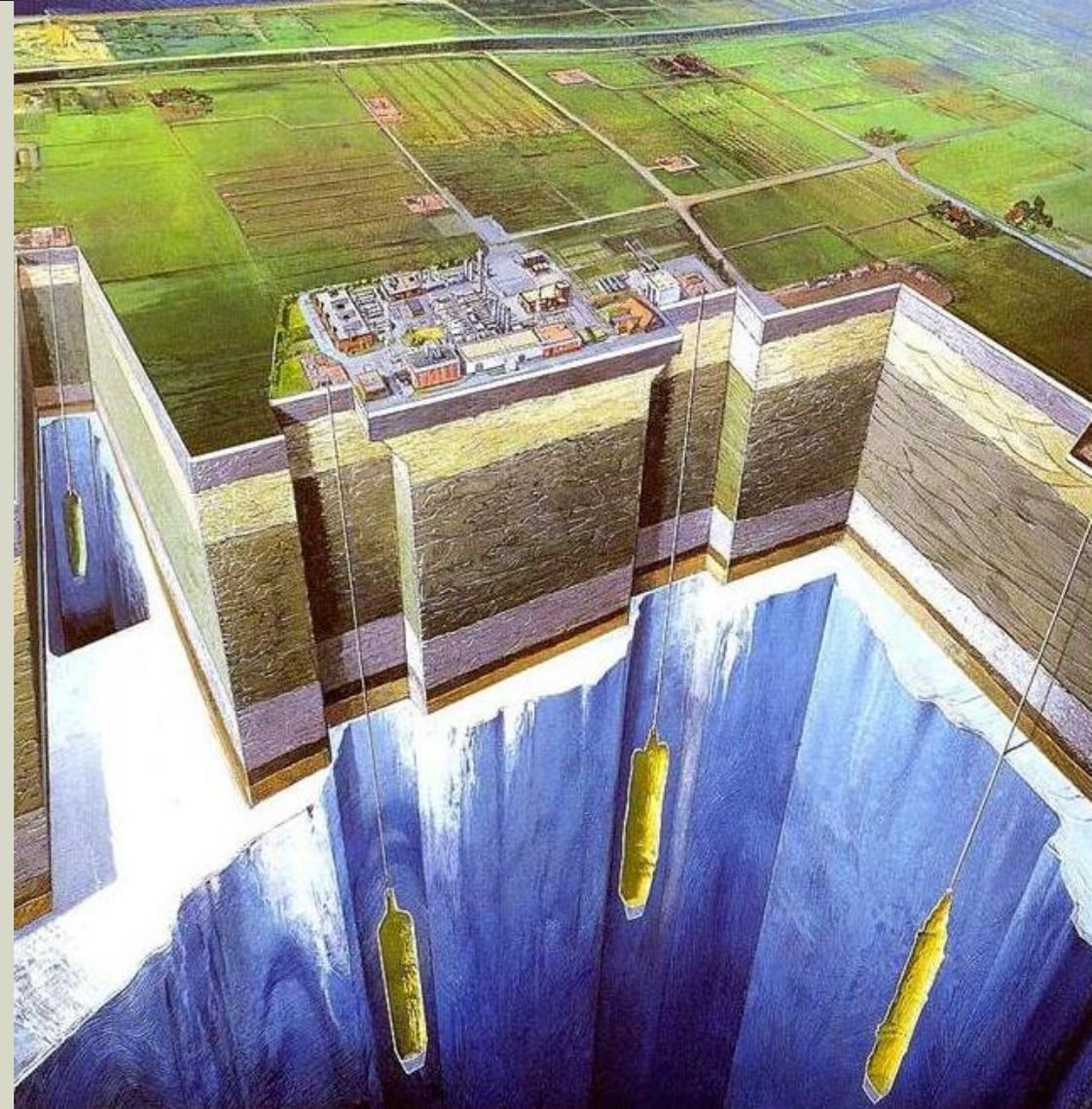
Bulk surface storage is difficult



Underground storage is the immediate target for hydrogen

HYDROGEN STORAGE

- › **Solution: Underground Salt Cavern Storage**
- › Geologic salt formations have many unique properties
 - / Impermeable
 - / Inherently stable
 - / Self healing
- › These properties make salt a great media for underground storage of liquids and gasses (NGLs, natural gas, etc.)
- › 1000's of salt caverns used for storage during the past 70+ years
- › Massive bulk storage... >30 MMbbls liquid and >20 bcf gas (>500 MMscm)



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WILLISTON BASIN — HYDROGEN STORAGE

- › We need salt resources to be able to store hydrogen
- › The Williston Basin has excellent salt resources!
- › Existing caverns in the basin used for natural gas storage
- › Need to be diligent with geologic siting



HYDROGEN STORAGE CAVERN DESIGN AND DEVELOPMENT ASPECTS

GEOLOGIC SITING

- › Salt depth, thickness, and quality
- › Core well
- › Geophysics

H2 STORAGE DESIGN

- › Laboratory testing
- › Cavern leach design
- › Thermodynamic assessment
- › Geomechanical evaluation

CAVERN DEVELOPMENT

- › Drill disposal well
- › Drill cavern well
- › Build surface facilities
- › Leach cavern

STORAGE OPERATIONS

- › Convert well to storage completion
- › Mechanical integrity test
- › Begin gas injections and withdrawals



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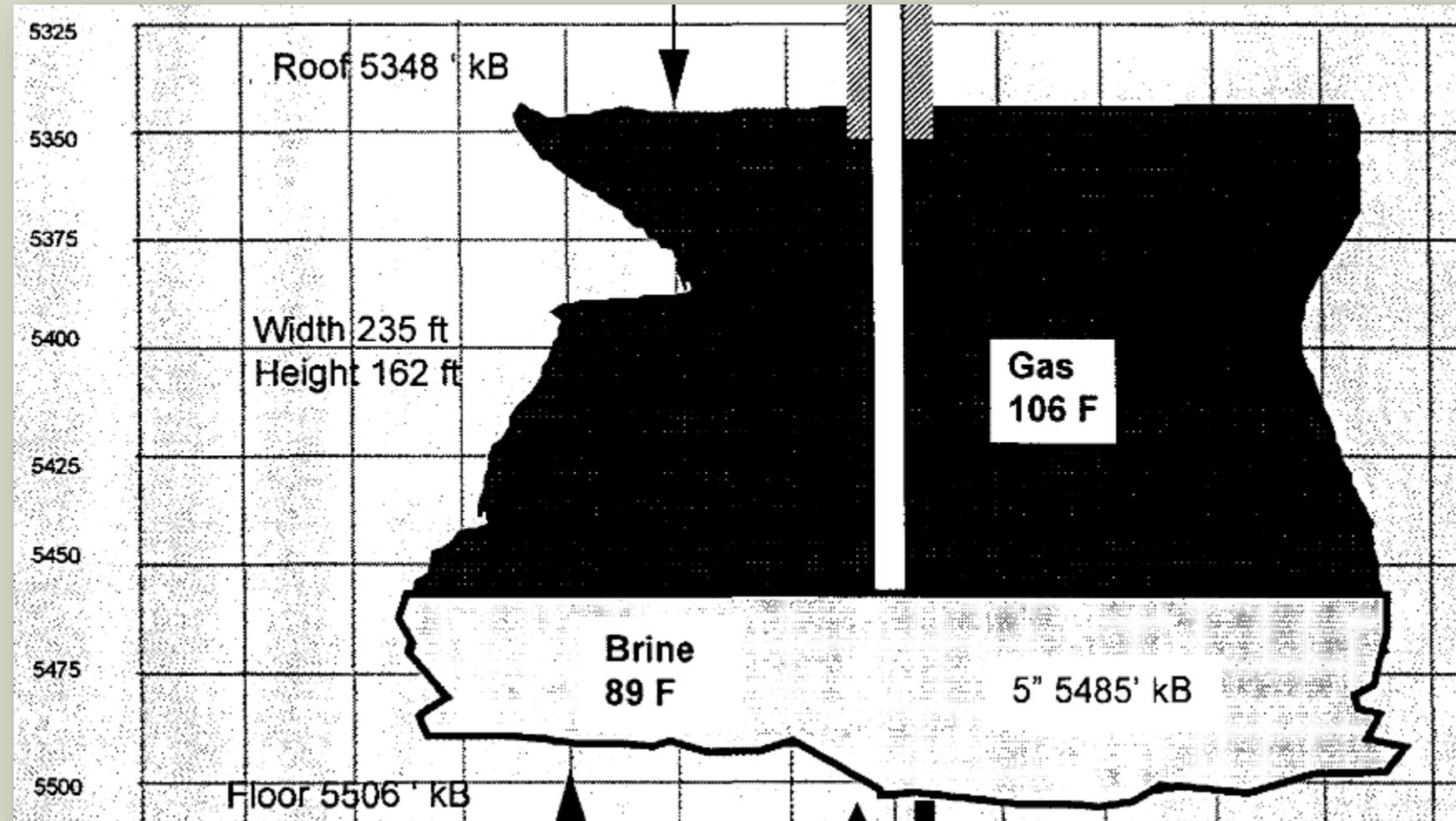
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WILLISTON BASIN — HYDROGEN STORAGE

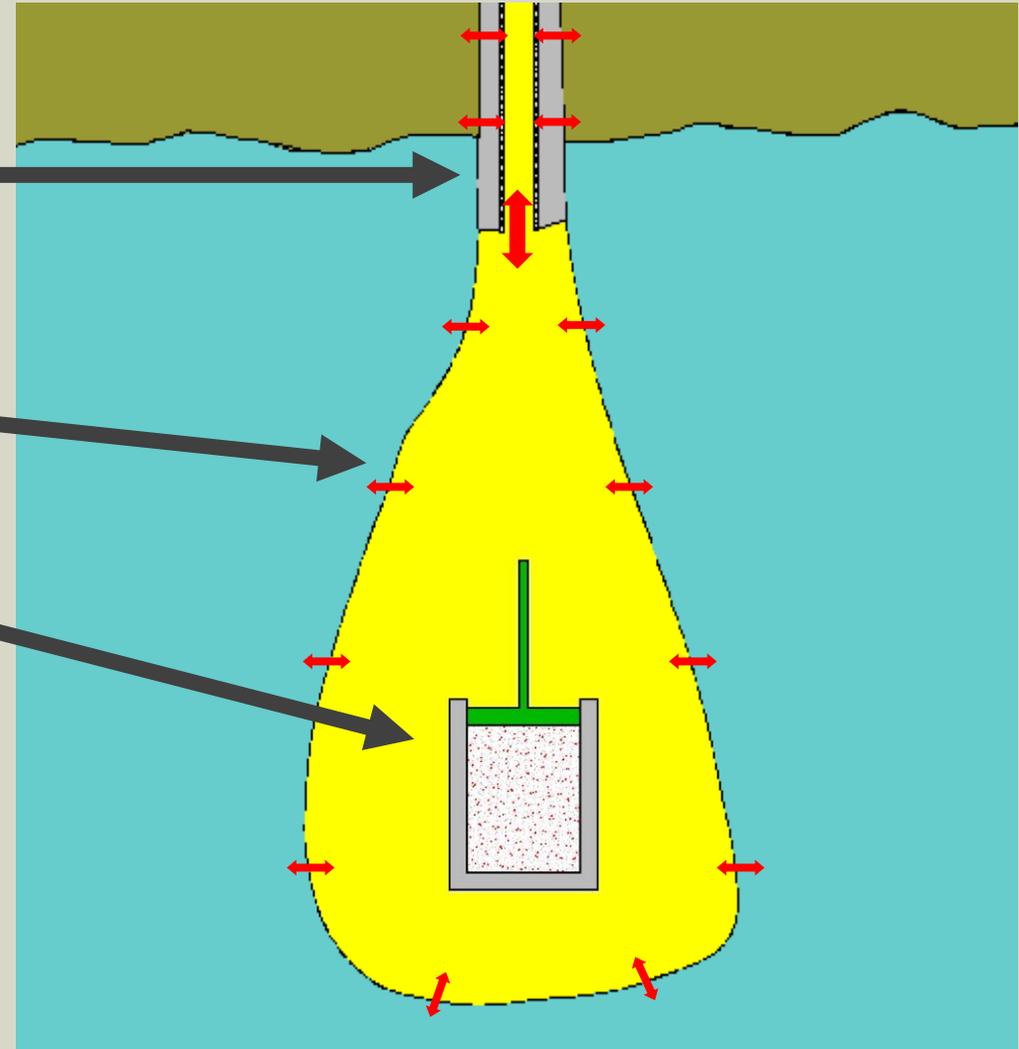
- › Example of a storage cavern near Regina
- › About 5,300 ft deep (1,600 m)
- › Approximately 1 MMbbls of storage volume
- › How much hydrogen could we store in this Williston Basin cavern?



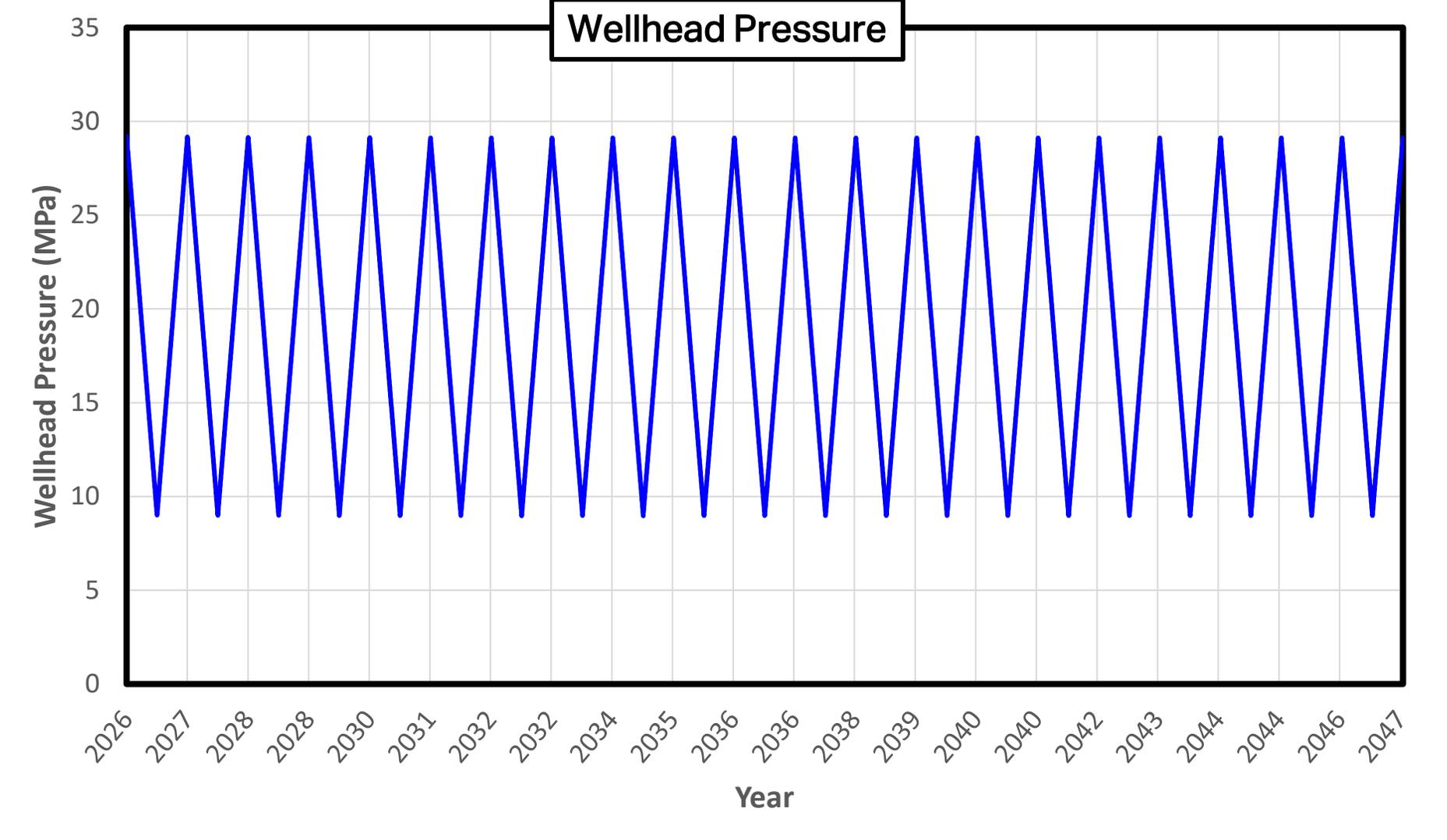
Source: Crossley [1996]

HYDROGEN THERMODYNAMICS

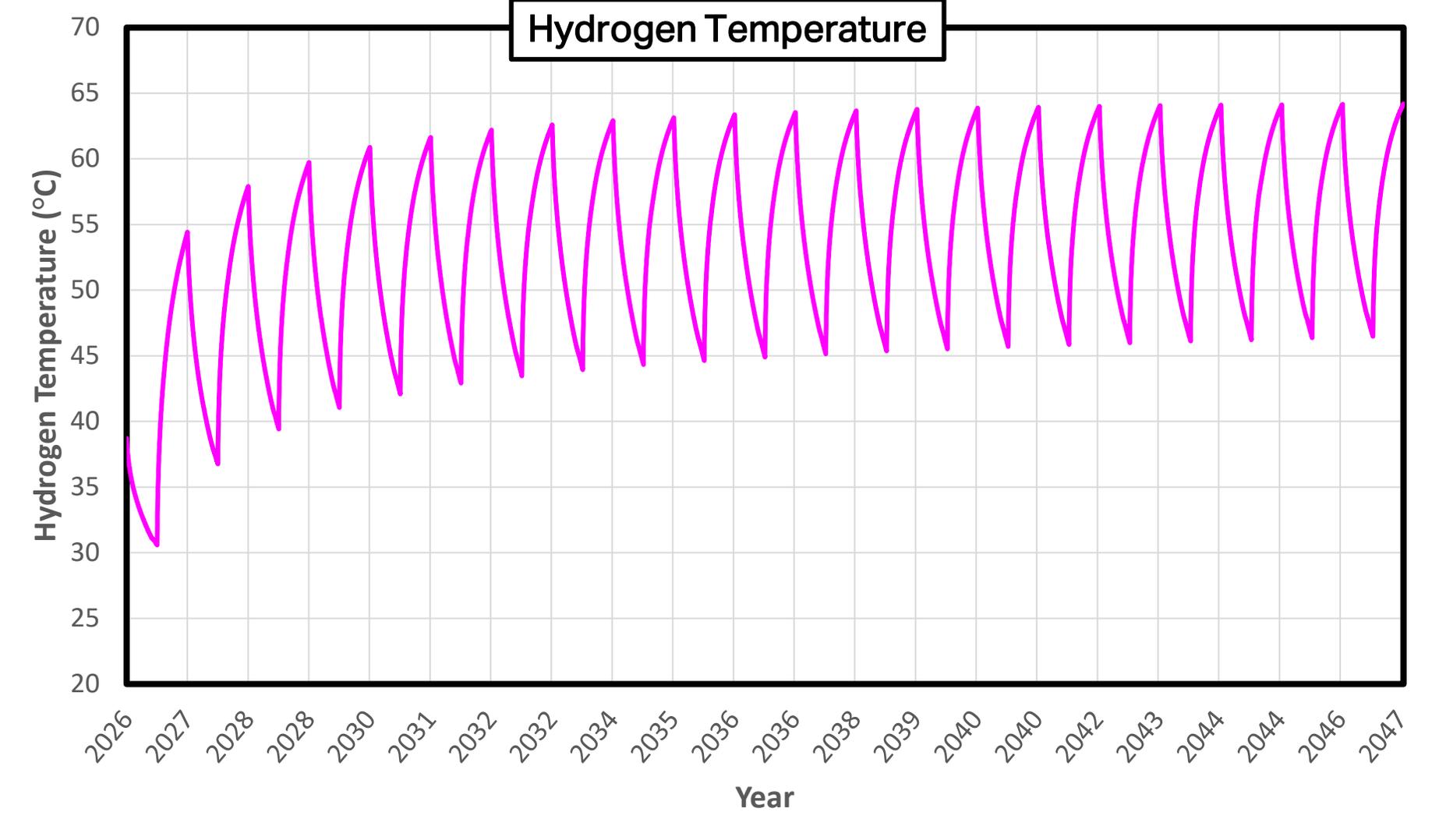
- › Heat Gain/Loss due to Mass Flow in and out of Cavern
- › Heat Transfer with Surrounding Salt
- › Compression/ Decompression of the Gas



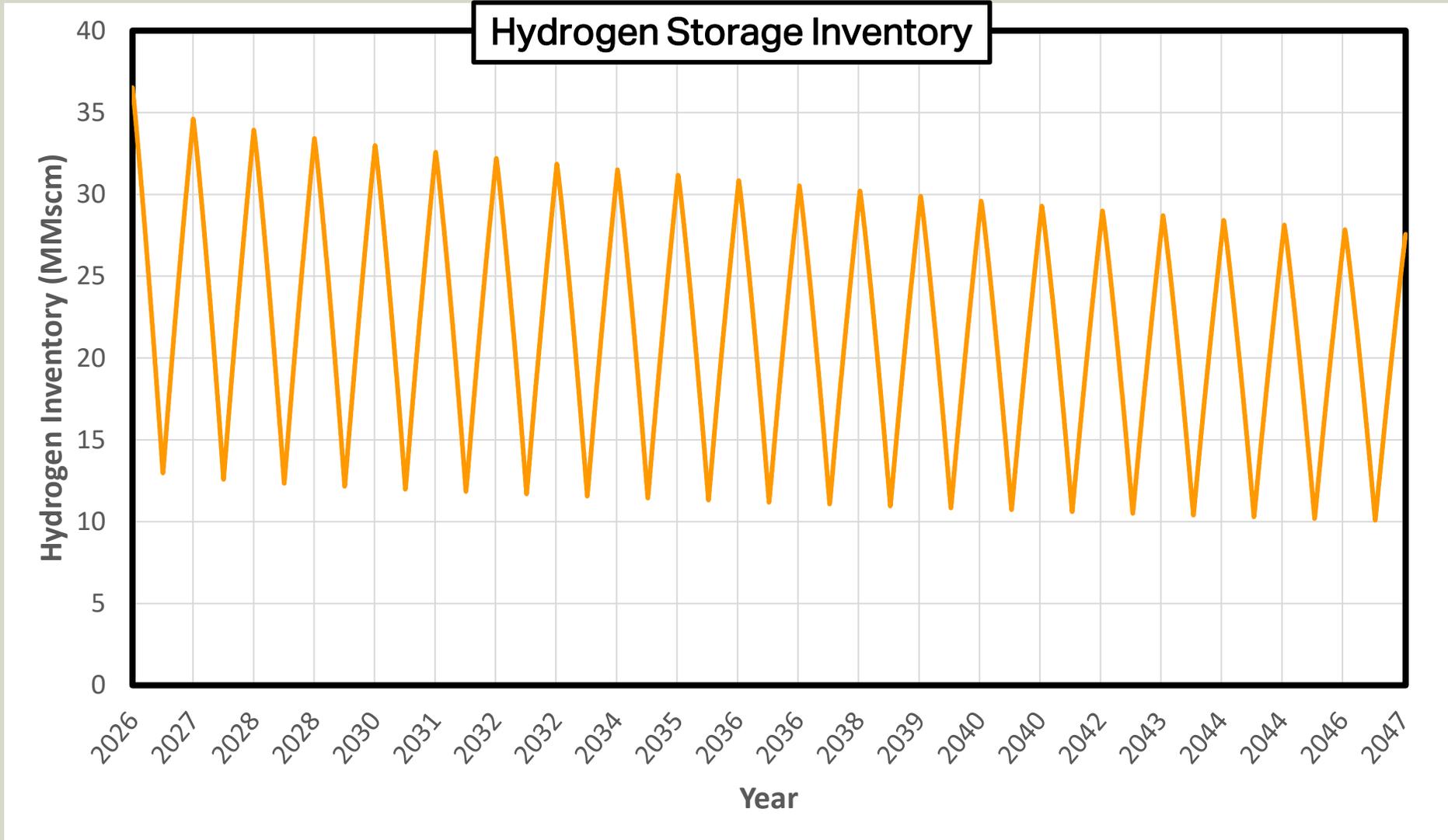
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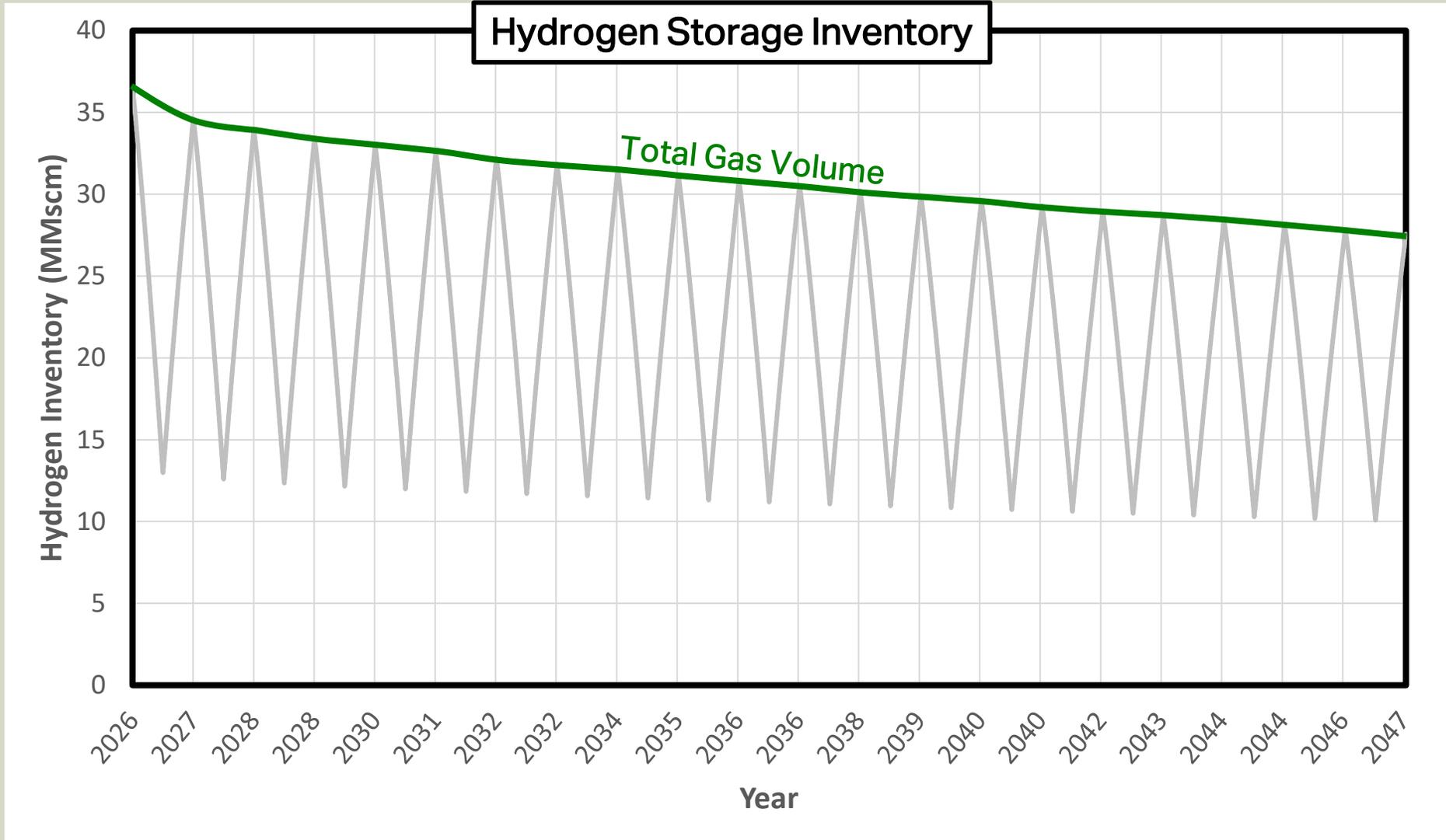
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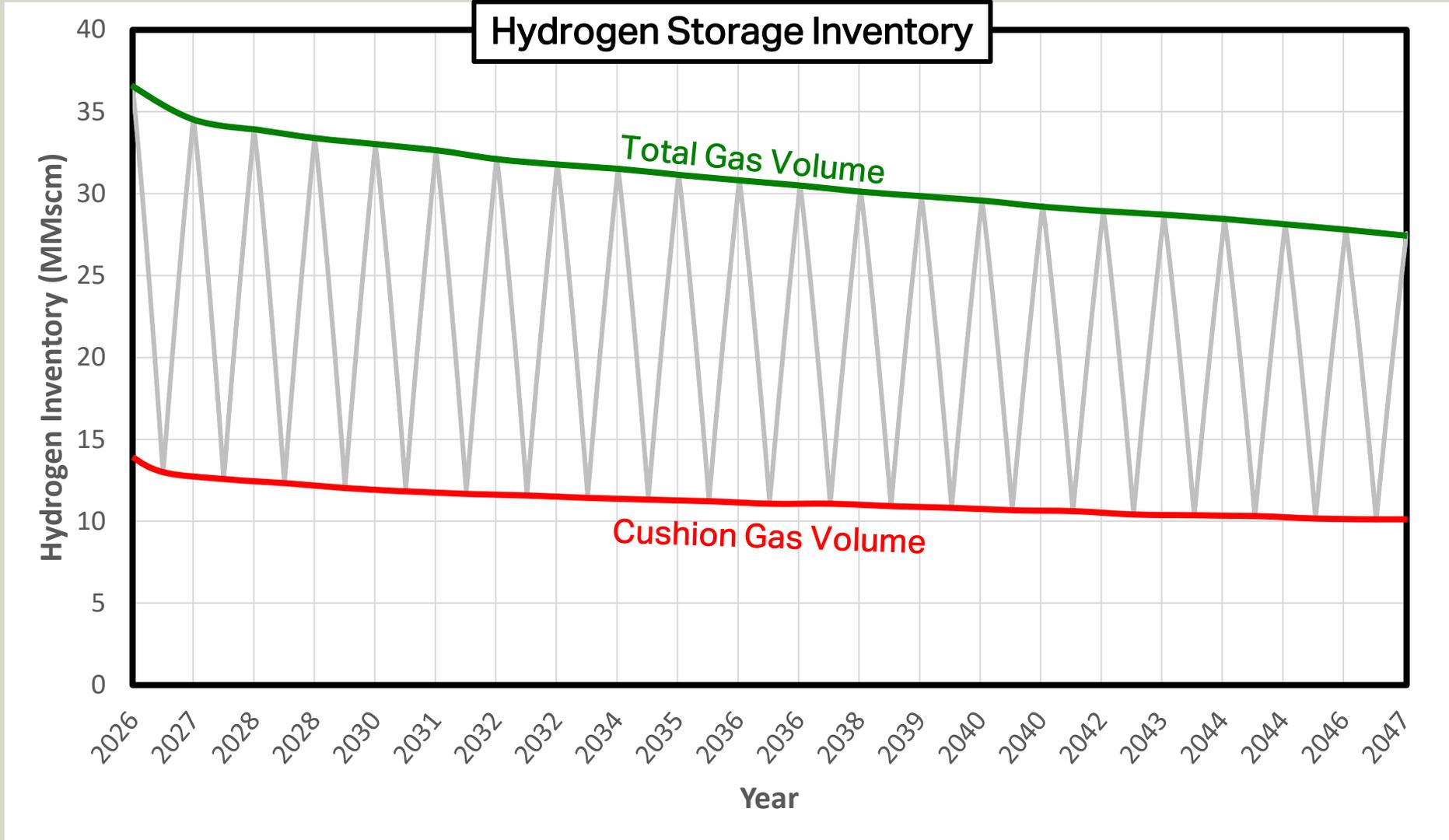
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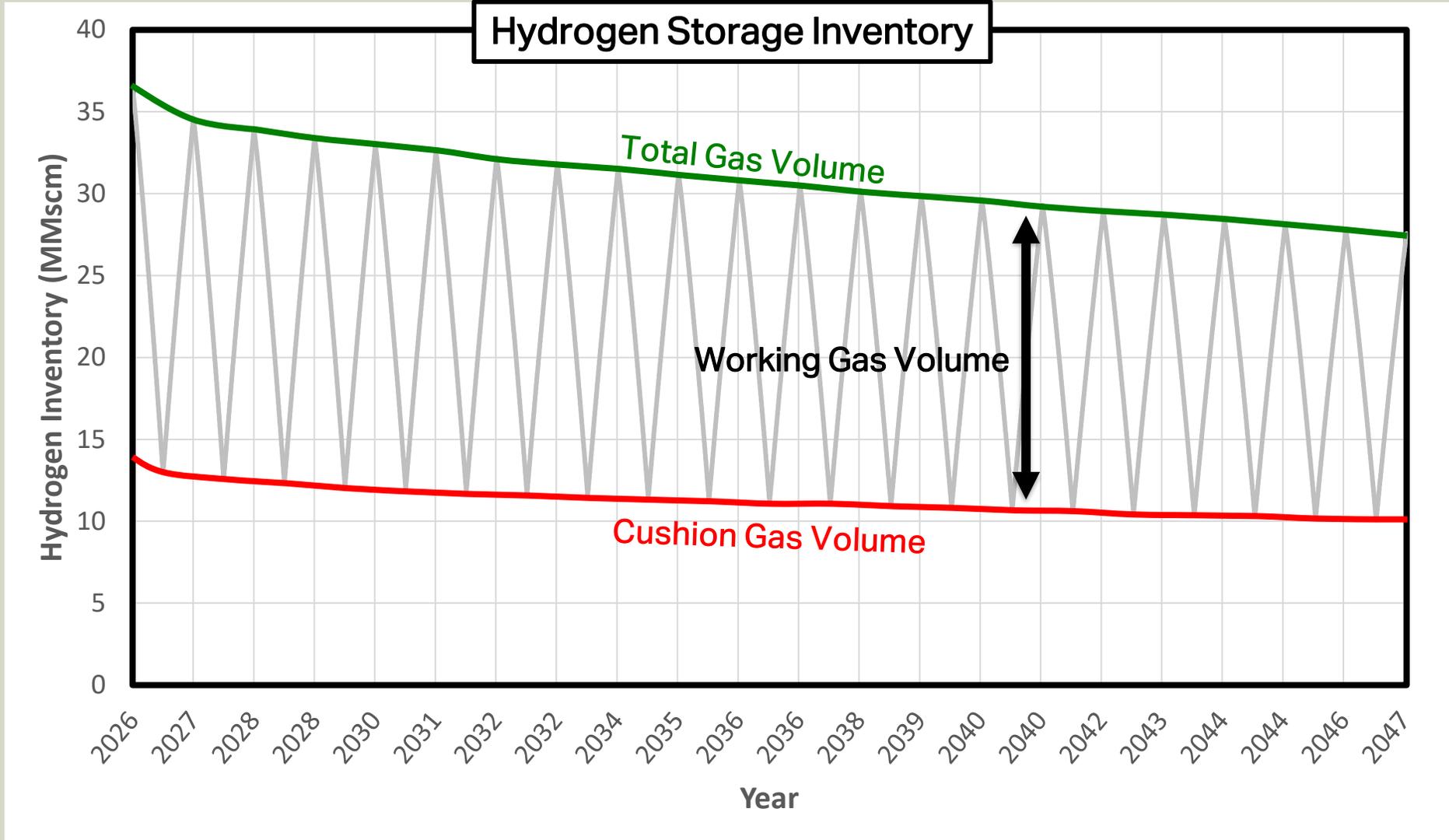
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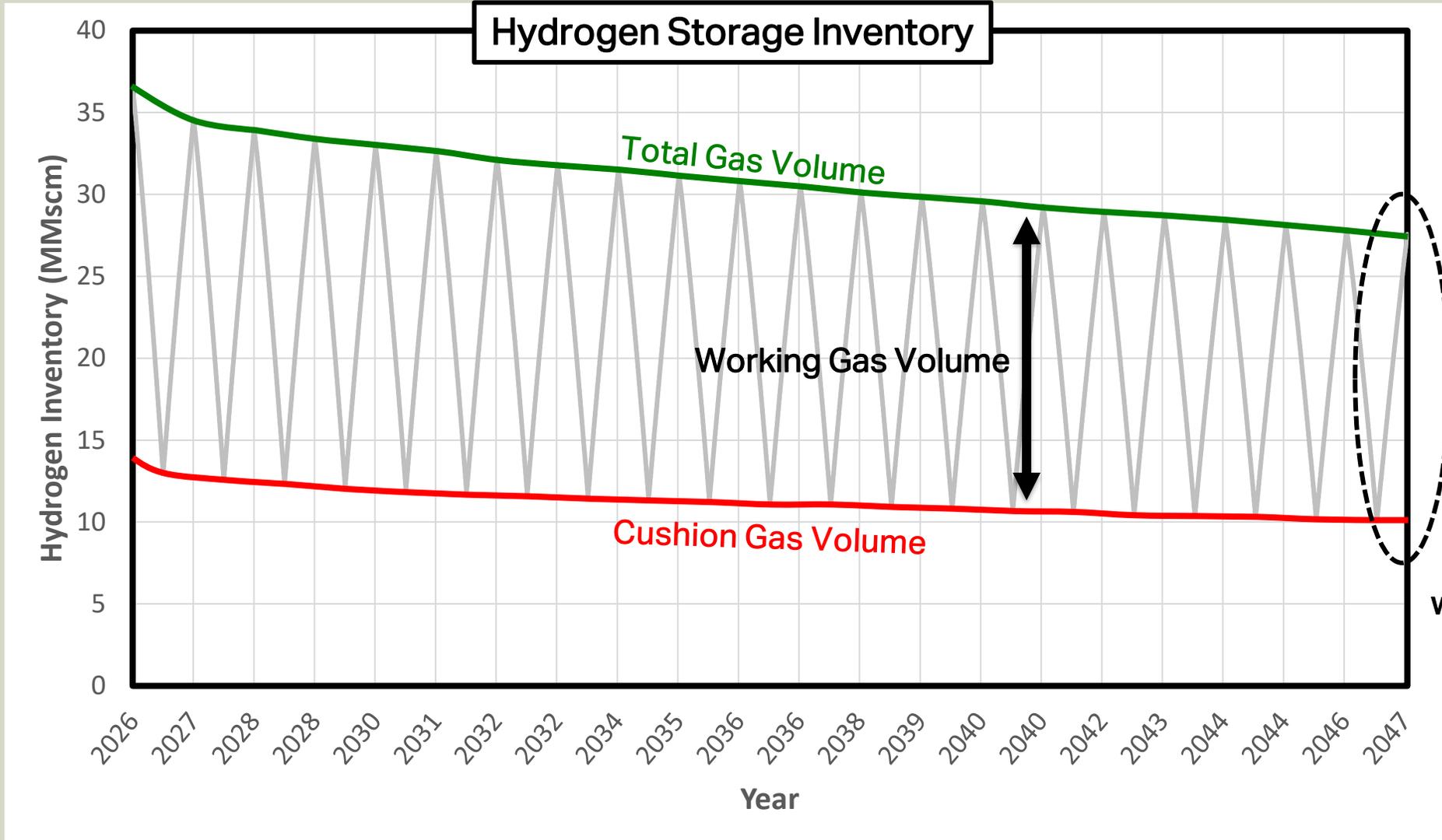
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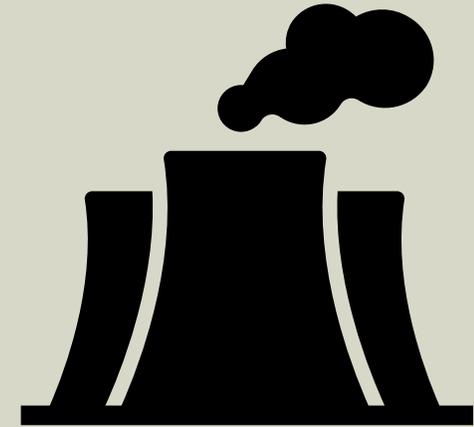
WILLISTON BASIN – HYDROGEN STORAGE



18 MMscm of working hydrogen storage volume

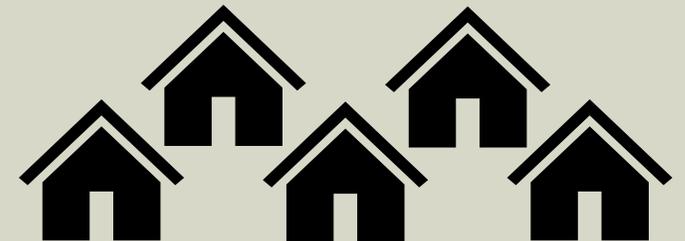
WILLISTON BASIN — HYDROGEN STORAGE

- › For this SK cavern, we can store roughly 18 MMscm of hydrogen
- › This equates to about 200 MDth of energy



Or in other words...

- › Approximately 3 days of supply for a typical natural gas power plant
- › Enough for 25,000 homes for a month



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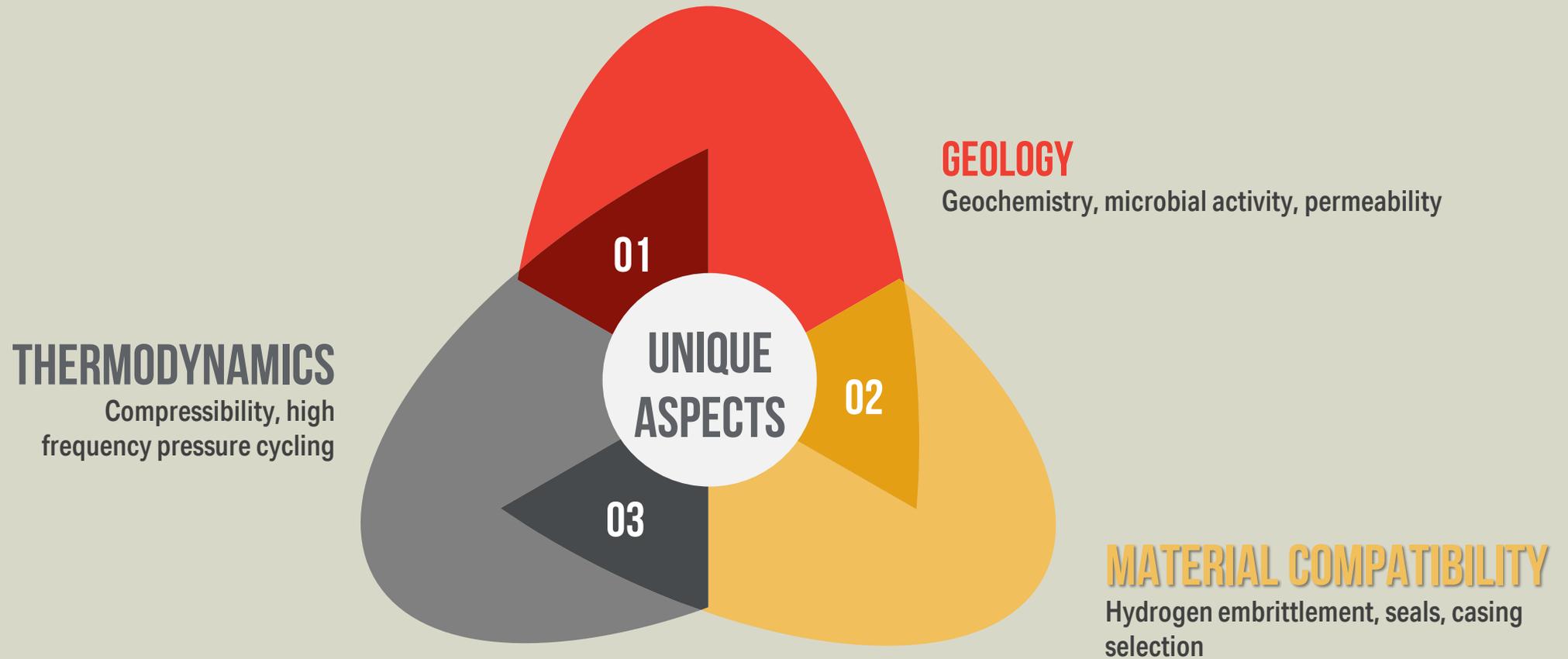
- › A clean fuel for the oil and gas industry
- › Integrates with existing resources and know-how
- › A valuable tool in our toolbox of energy solutions

WHY UNDERGROUND STORAGE?

- › Alleviate supply and demand issues
- › We will need 4x the storage volume for hydrogen
- › Underground storage in salt caverns is economical and safe

WHY THE WILLISTON BASIN?

- › The Williston Basin has significant salt resources for hydrogen cavern storage
- › Regional infrastructure and hydrocarbon feedstocks for hydrogen
- › Unique opportunity for both hydrogen production and storage, creating a hydrogen hub





THANK YOU

QUESTIONS?

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