SUPPORTING INFORMATION

FOR

Characterizing Hydrogen Storage Potential in U.S. Underground Gas Storage Facilities

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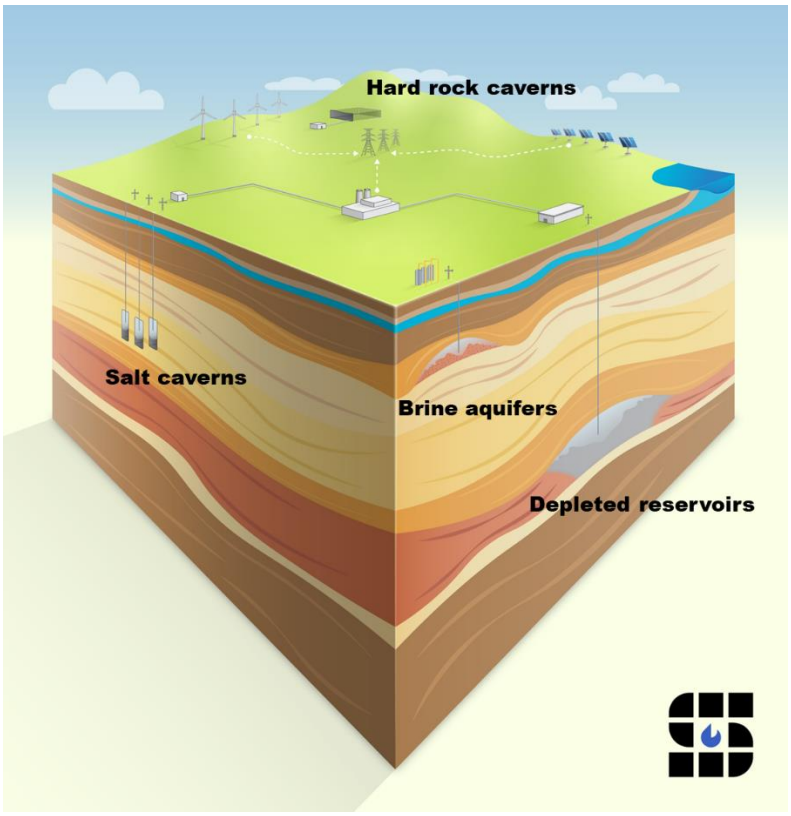

Figure S1. Schematic showing underground storage of H_2 in depleted reservoirs, brine aquifers, salt caverns, and hard rock caverns in association with power generation and H_2 production (modified from [1]).

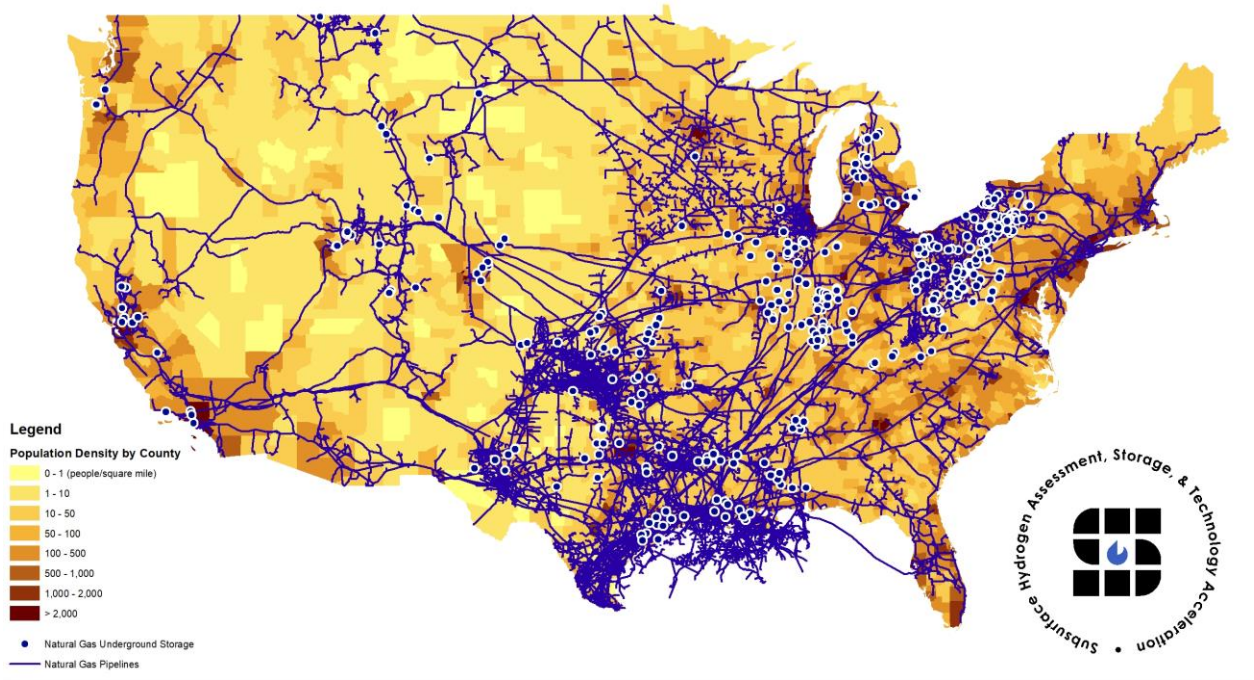

Figure S2. Distribution of existing UGS storage fields (blue circles with white outlines), NG distribution pipelines (blue lines), and proximity to major population densities (shaded from yellow to orange). (modified from [1]).

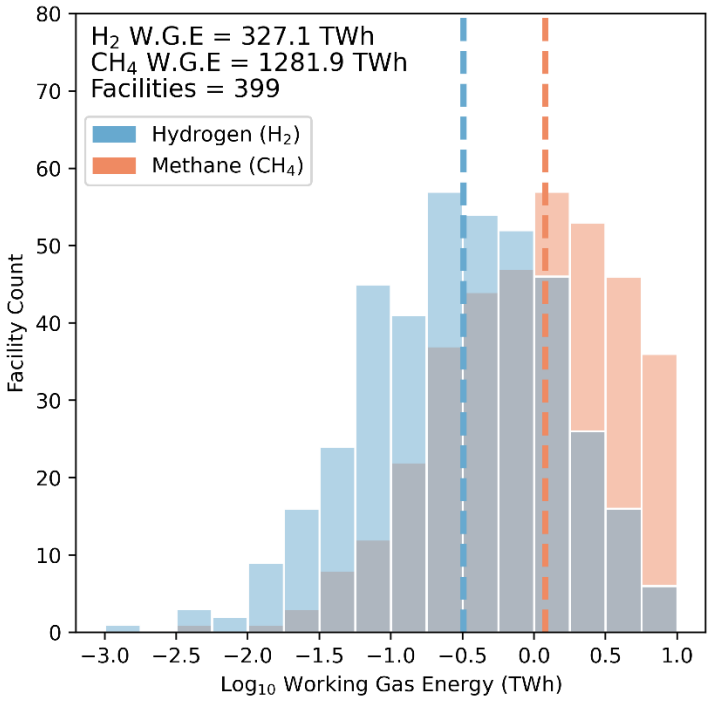

Figure S3. Histograms comparing the working gas energy (W.G.E) of individual U.S. UGS facilities for pure methane (CH_4) and pure hydrogen (H_2) storage scenarios. The median of each histogram is also shown as a dashed line. Overlap between the two histograms is shown in gray. A log base 10 scale is used for clarity of presentation.

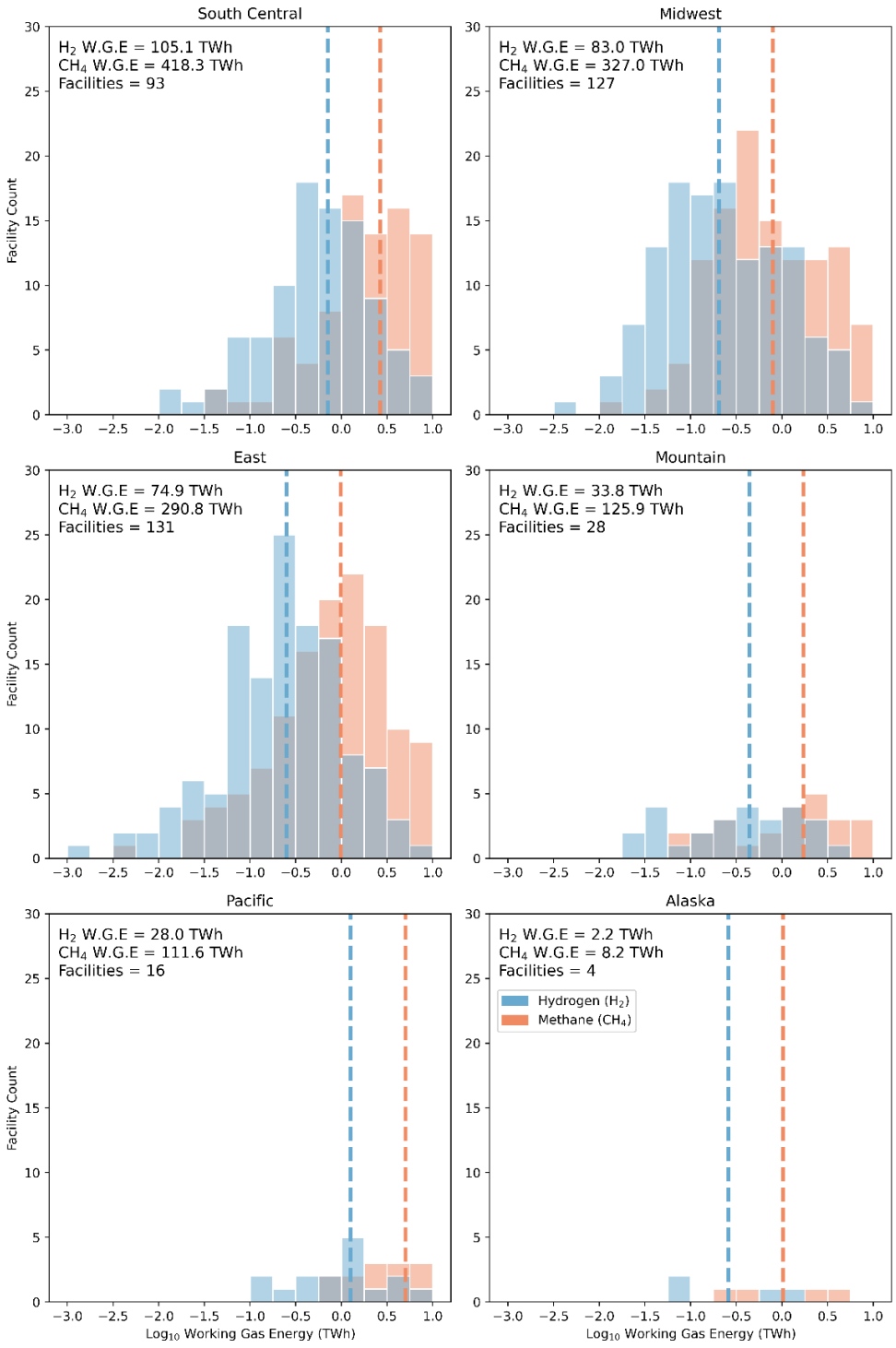

Figure S4. Histograms comparing the working gas energy (W.G.E) of individual U.S. UGS facilities for pure methane (CH_4) and pure hydrogen (H_2) storage scenarios categorized by U.S. Energy Information natural gas storage region. Overlaps between the histograms are shown in gray. The median of each histogram is also shown as a dashed line. A log base 10 scale is used for clarity of presentation.

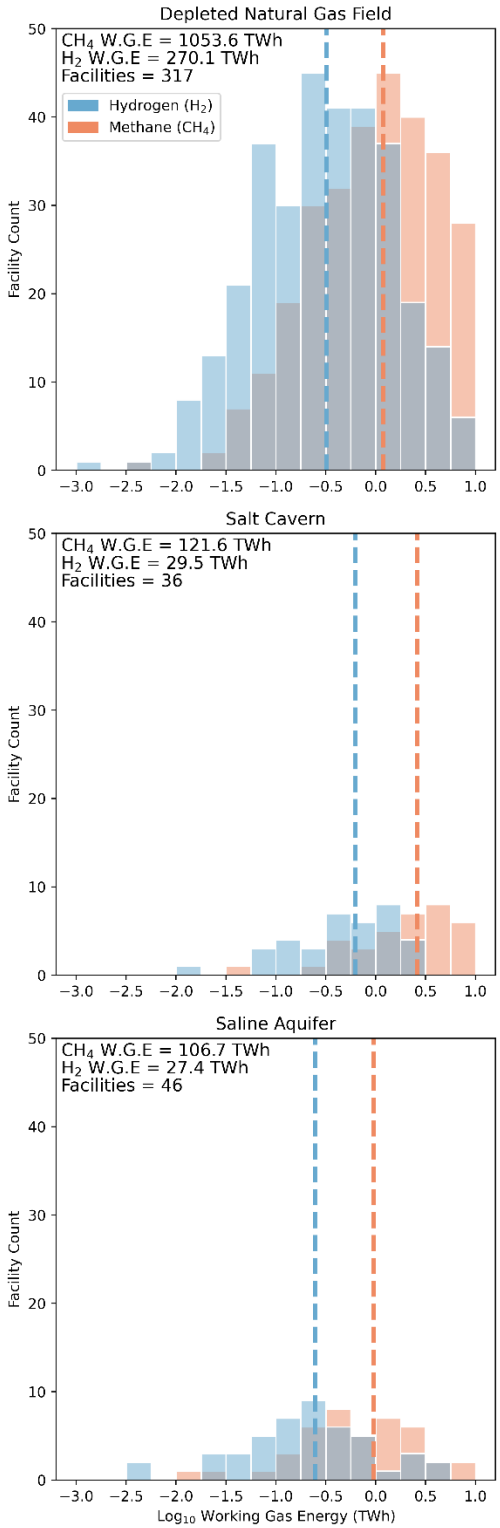

Figure S5. Histograms comparing the working gas energy (W.G.E) of individual U.S. UGS facilities for pure methane (CH_4) and pure hydrogen (H_2) storage scenarios categorized by storage reservoir type. Overlaps between the histograms are shown in gray. The median of each histogram is also shown as a dashed line. A log base 10 scale is used for clarity of presentation.

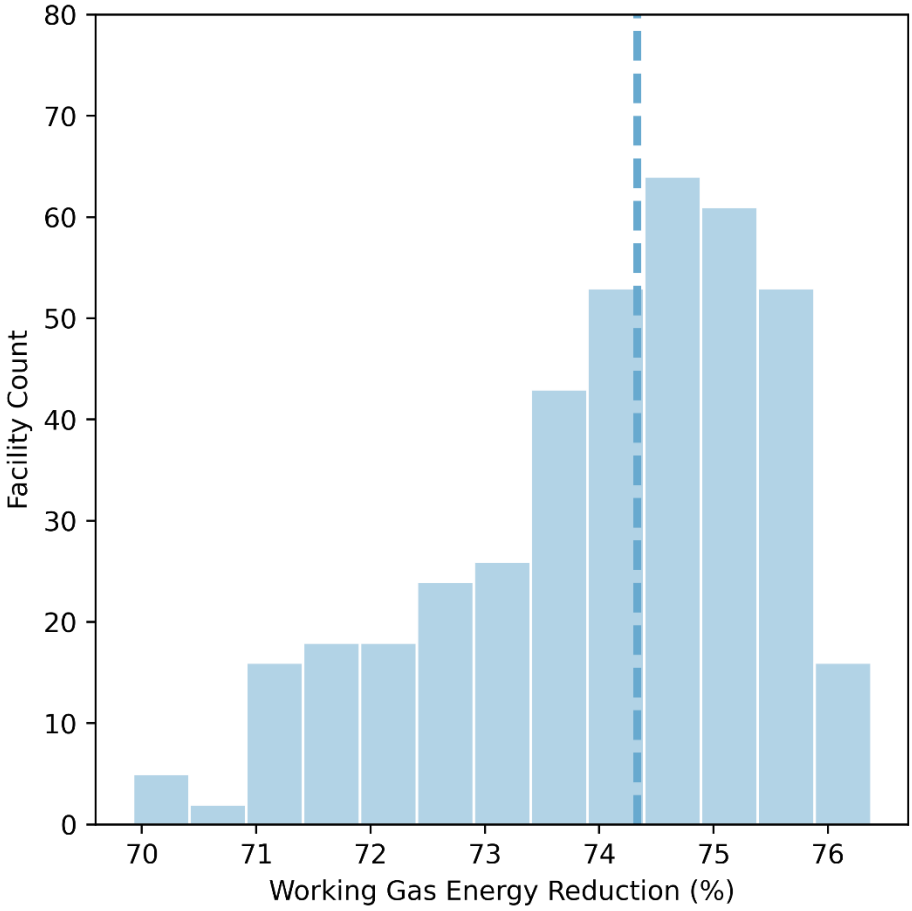

Figure S6. Histogram showing the percent reduction in working gas energy of individual U.S. UGS facilities that results from a transition to pure hydrogen (H_2) storage. The median of the population is shown as a dashed line.

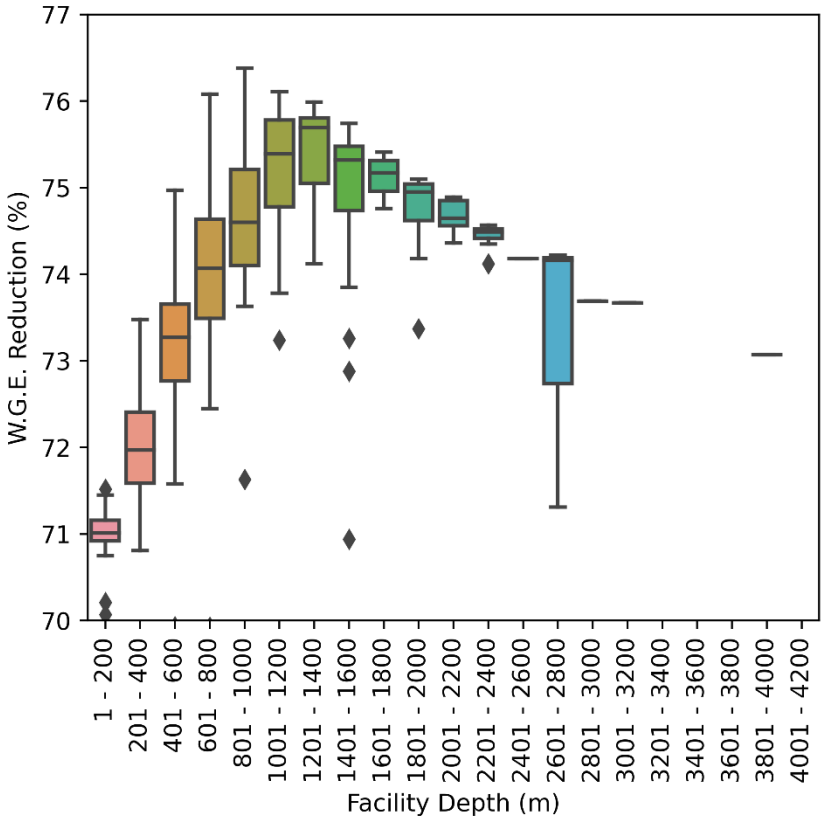

Figure S7. Box plots showing the distribution of the percent reduction in working gas energy of U.S. UGS facilities that results from a transition to pure hydrogen (H_2) storage grouped by reservoir depth.

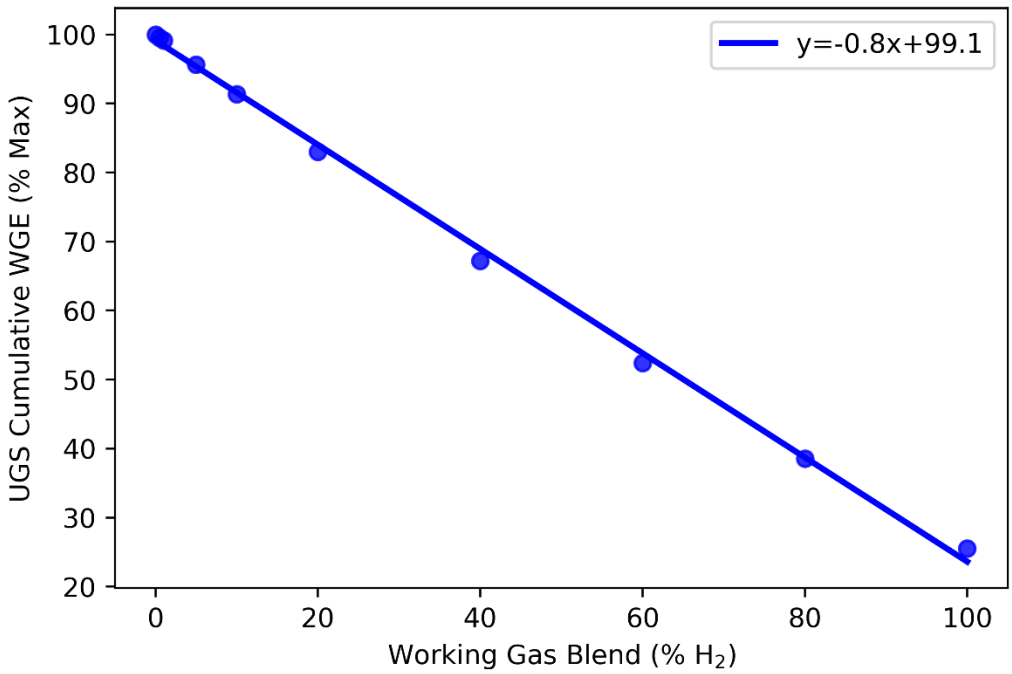

Figure S8. Total U.S. UGS Facility working gas energy (WGE) as a percentage of the maximum U.S. UGS facility WGE vs. the % H_2 in working gas.

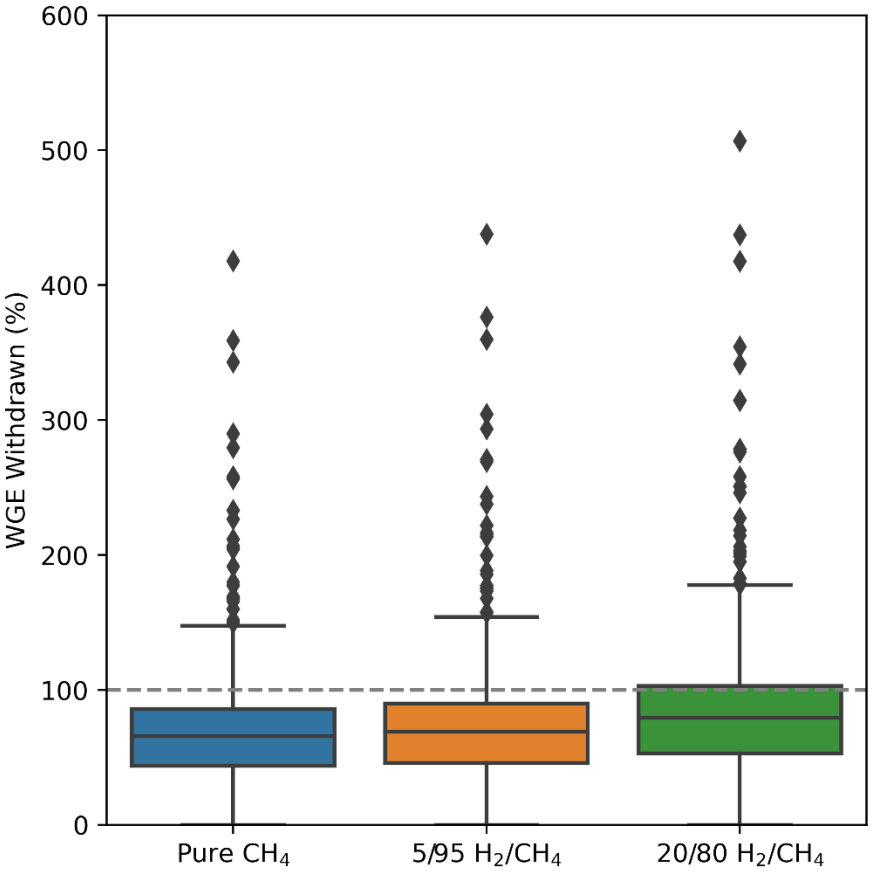

Figure S9. Box plots showing the distribution of the percentage of working gas energy (WGE) withdrawn from individual UGS facilities for pure CH_4, 5/95 H_2/CH_4, and 20/80 H_2/CH_4 working gas scenarios.

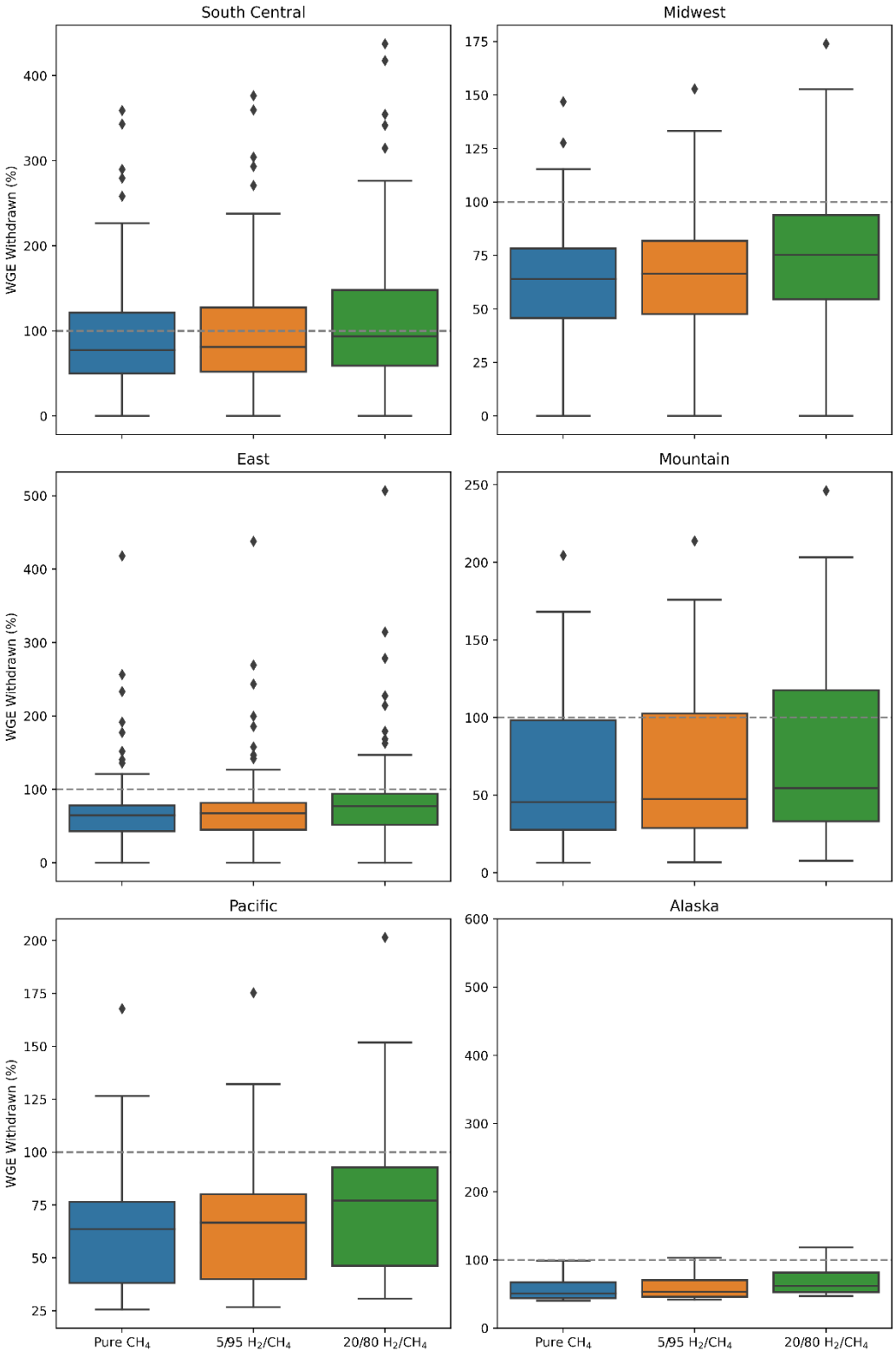

Figure S10. Box plots showing the distribution of the percentage of working gas energy (WGE) withdrawn from individual UGS facilities for pure CH_4, 5/95 H_2/CH_4, and 20/80 H_2/CH_4 working gas scenarios grouped by region.

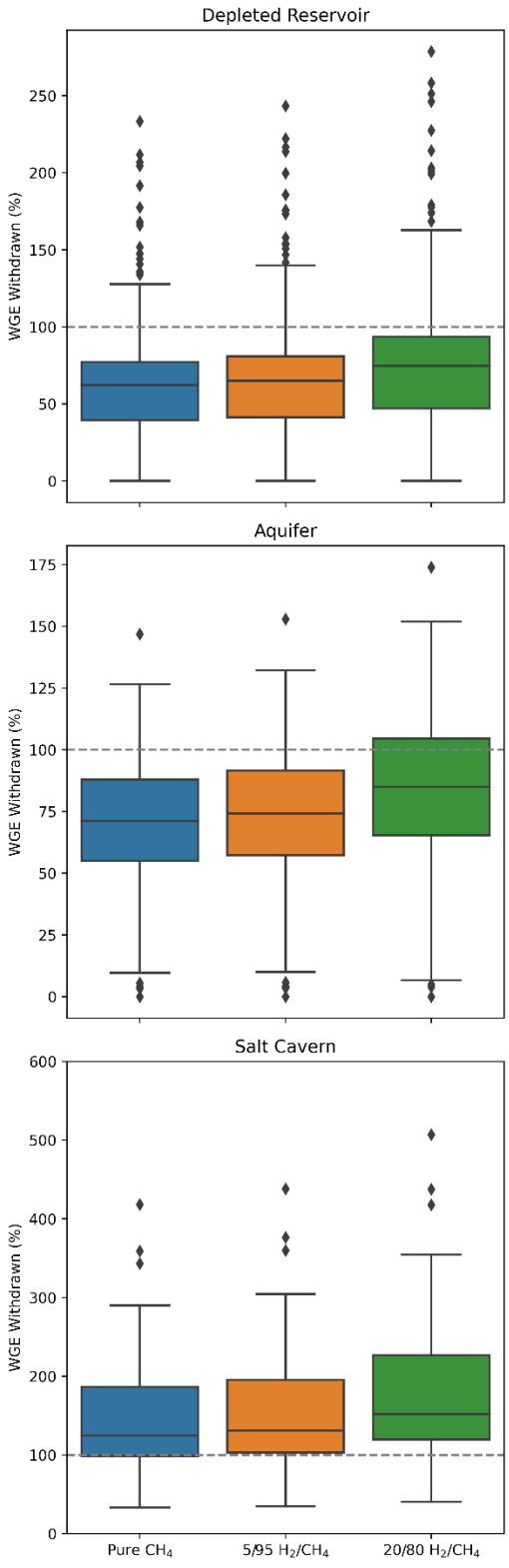

Figure S11. Box plots showing the distribution of the percentage of working gas energy (WGE) withdrawn from individual UGS facilities for pure CH_4, 5/95 H_2/CH_4, and 20/80 H_2/CH_4 working gas scenarios grouped by storage reservoir type.

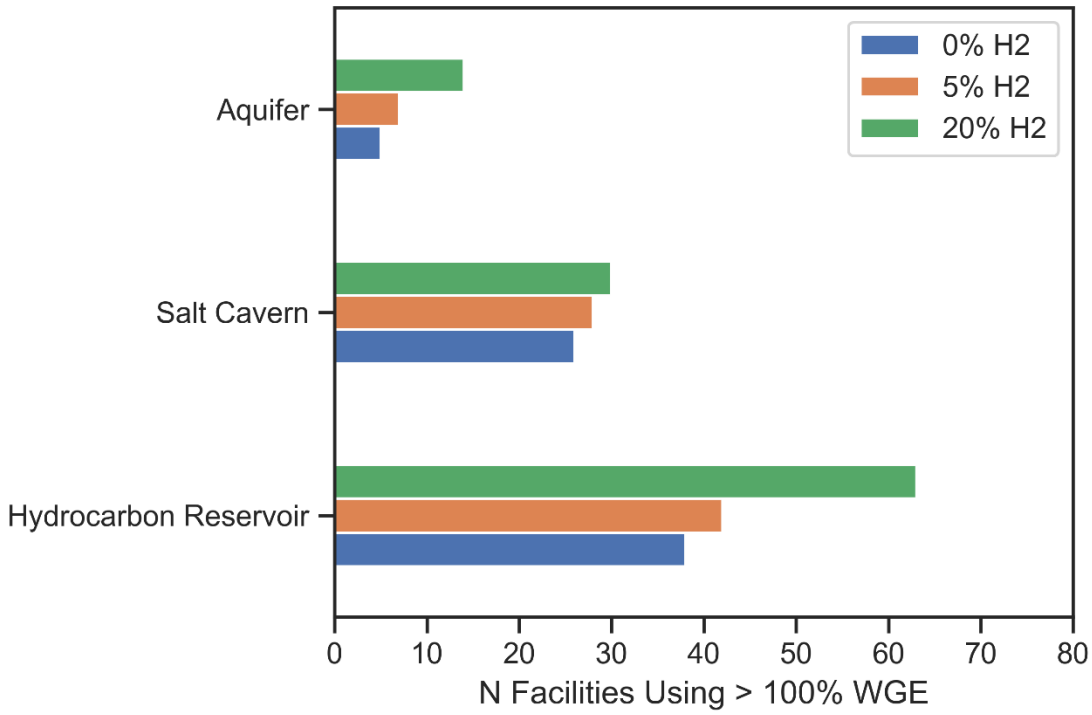

Figure S12. The number of UGS facilities with an energy demand greater than 100% of their working gas energy for pure CH_4 (0% H_2), 5/95 H_2/CH_4 (5% H_2), and 20/80 H_2/CH_4 (20% H_2) storage scenarios grouped by reservoir type.

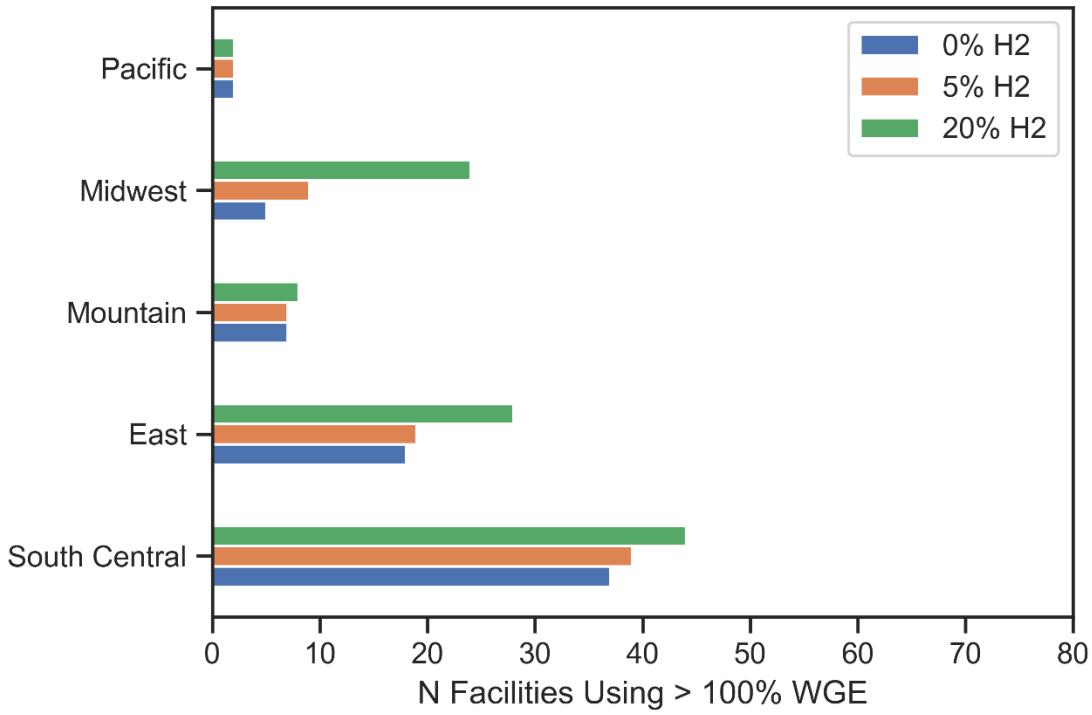

Figure S13. The number of UGS facilities with an energy demand greater than 100% of their working gas energy for pure CH_4 (0% H_2), 5/95 H_2/CH_4 (5% H_2), and 20/80 H_2/CH_4 (20% H_2) storage scenarios grouped by U.S. EIA natural gas storage region.

Table S1. Statistical summary of the percentage of working gas energy reduction from a transition to pure H_2 storage at U.S. UGS facilities grouped by depth.

Depth Range	count	mean	std	min	25%	50%	75%	max
1 - 200	13	71.0	0.4	70.1	70.9	71.0	71.2	71.5
201 - 400	43	72.0	0.6	70.8	71.6	72.0	72.4	73.5
401 - 600	56	73.1	0.9	69.9	72.8	73.3	73.7	75.0
601 - 800	75	74.0	1.0	69.9	73.5	74.1	74.6	76.1
801 - 1000	49	74.7	0.9	71.6	74.1	74.6	75.2	76.4
1001 - 1200	39	75.2	0.7	73.2	74.8	75.4	75.8	76.1
1201 - 1400	26	75.4	0.5	74.1	75.1	75.7	75.8	76.0
1401 - 1600	39	74.9	1.0	70.9	74.7	75.3	75.5	75.7
1601 - 1800	14	75.1	0.2	74.8	75.0	75.2	75.3	75.4
1801 - 2000	14	74.8	0.5	73.4	74.6	75.0	75.0	75.1
2001 - 2200	17	74.7	0.2	74.4	74.6	74.7	74.9	74.9
2201 - 2400	7	74.4	0.2	74.1	74.4	74.5	74.5	74.6
2401 - 2600	1	74.2		74.2	74.2	74.2	74.2	74.2
2601 - 2800	3	73.2	1.7	71.3	72.7	74.2	74.2	74.2
2801 - 3000	1	73.7		73.7	73.7	73.7	73.7	73.7
3001 - 3200	1	73.7		73.7	73.7	73.7	73.7	73.7
3201 - 3400	0							
3401 - 3600	0							
3601 - 3800	0							
3801 - 4000	1	73.1		73.1	73.1	73.1	73.1	73.1
4001 - 4200	0							

Table S2. Statistical summary of the percentage of working gas energy currently withdrawn at U.S. UGS facilities.

% WGE Withdrawn	N facilities	Mean	Std	min	25%	50%	75%	Max
0% H2	399	72.1	51.9	0.0	43.9	65.9	85.9	418.2
5% H2	399	75.4	54.4	0.0	45.9	69.0	89.9	438.0
20% H2	399	86.8	63.0	0.0	53.0	79.4	103.1	507.0

Table S3. Statistical summary of the percentage of working gas energy currently withdrawn at U.S. UGS facilities grouped by U.S. EIA natural gas storage region.

Region	N facilities	Mean	Std	min	25%	50%	75%	Max
WGE Used (0% H2)								
Alaska	4	60.2	26.6	40.2	43.8	50.9	67.3	98.8
East	131	68.3	50.8	0.0	43.1	64.7	78.2	418.2
Midwest	127	61.0	27.2	0.0	45.7	64.0	78.3	146.9
Mountain	28	64.6	51.8	6.4	27.6	45.5	98.2	204.5
Pacific	16	67.4	36.8	25.6	38.1	63.6	76.4	167.8
South Central	93	96.3	71.9	0.0	49.9	77.4	121.5	359.1
WGE Used (5% H2)								
Alaska	4	62.9	27.9	41.7	45.8	53.3	70.4	103.2
East	131	71.4	53.2	0.0	45.0	67.5	81.7	438.0
Midwest	127	63.7	28.4	0.0	47.6	66.5	81.9	152.9
Mountain	28	67.6	54.2	6.7	28.8	47.5	102.6	213.8
Pacific	16	70.6	38.5	26.7	39.9	66.6	80.1	175.3
South Central	93	100.8	75.4	0.0	52.0	81.0	127.4	376.5
WGE Used (20% H2)								
Alaska	4	72.3	32.2	47.1	52.7	61.8	81.4	118.6
East	131	82.1	61.4	0.0	51.8	77.2	94.0	507.0
Midwest	127	73.0	32.5	0.0	54.5	75.3	93.9	173.9
Mountain	28	77.7	62.6	7.7	33.2	54.5	117.6	246.2
Pacific	16	81.4	44.2	30.7	46.3	77.1	92.8	201.5
South Central	93	116.5	87.7	0.0	59.2	93.6	148.0	437.4

Table S4. Statistical summary of the percentage of working gas energy currently withdrawn at U.S. UGS facilities grouped by storage reservoir type.

Reservoir Type	count	mean	std	min	25%	50%	75%	max
% WGE Withdrawn (0% H2)								
Aquifer Reservoir	46	69.1	32.1	0.0	55.0	71.1	87.9	146.9
Hydrocarbon Reservoir	317	63.2	37.7	0.0	39.5	62.3	77.3	233.3
Salt Cavern	36	154.6	93.8	33.3	98.5	124.9	186.3	418.2
% WGE Withdrawn (5% H2)								
Aquifer Reservoir	46	72.2	33.5	0.0	57.3	74.2	91.6	152.9
Hydrocarbon Reservoir	317	66.0	39.4	0.0	41.4	65.0	81.0	243.4
Salt Cavern	36	162.1	98.4	34.9	103.2	131.0	195.3	438.0
% WGE Withdrawn (20% H2)								
Aquifer Reservoir	46	82.8	38.6	0.0	65.4	85.0	104.5	173.9
Hydrocarbon Reservoir	317	75.8	45.3	0.0	47.1	74.8	93.6	278.6
Salt Cavern	36	188.4	114.3	40.4	119.7	152.0	226.7	507.0

Table S5. The number of UGS facilities that will have a demand that exceeds 100% of their WGE if a 5/95 H_2/CH_4 or 20/80 H_2/CH_4 blend is used grouped by region and reservoir type.

Region	Reservoir Type	5% H2	20% H2
Alaska	Hydrocarbon Reservoir	1	1
East	Hydrocarbon Reservoir	1	10
Midwest	Aquifer Reservoir	2	9
Midwest	Hydrocarbon Reservoir	1	9
Midwest	Salt Cavern	1	1
Mountain	Hydrocarbon Reservoir	0	1
South Central	Hydrocarbon Reservoir	1	4
South Central	Salt Cavern	1	3
Total		8	38

SI References

1 Goodman, A. *et al.* Subsurface Hydrogen and Natural Gas Storage: State of Knowledge and Research Recommendations Report 77 (National Energy Technology Laboratory: Morgantown, WV, 2022).