

Land Area Occupied by the Fossil Fuel and Nuclear Industries in California and the U.S.

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Contact: Jacobson@stanford.edu; Twitter @mzjacobson

Table 3.3. Estimated land areas required for the fossil fuel and nuclear infrastructure in California and the United States circa 2018.

	Area per installation (km ²)	California		United States	
		Number	Area (km ²)	Number	Area (km ²)
^a Active oil and gas wells	0.05	105,000	3,327	1.3 million	65,000
^b Abandoned oil wells	0.00005	225,000	6.6	2.6 million	128.5
^b Abandoned gas wells	0.000025	48,000	0.7	550,000	13.8
^c Coal mines	50	0	0	680	34,000
^d Oil refineries	7.28	17	124	135	983
^e Kilometers of oil pipeline	0.006	4,800	29	258,000	1,550
^e Kilometers of gas pipeline	0.006	180,000	1,080	2.62 million	15,700
^f Coal power plants	1.74	1	1.74	359	626
^f Gas power plants	0.12	37	4.5	1,820	221
^f Petroleum power plants	0.93	0	0	1,080	1,007
^f Nuclear power plants	14.9	1	14.9	61	911
^f Other power plants	0.93	0	0	41	41
^g Fueling stations	0.0018	10,200	18	156,000	275
^h Gas storage facilities	12.95	10	130	394	5,102
Total			4,736		126,000
Percent of CA or U.S.			1.2		1.3

^aNumber of active oil and gas wells, compressors, and processors from Oil and Gas (2018). The area of each is calculated from the 3 million ha of well pads, roads, and storage facilities required for 600,000 new wells from 2000 to 2012 (Allred et al., 2015).

^bThe number of abandoned U.S. oil and gas wells is from U.S. EPA (2018), slide 11. The California number is calculated as the U.S. number multiplied by the California to U.S. ratio of active wells. The area of each abandoned oil well is estimated as 50 m², and of each gas well, 25 m² from Jepsen (2018).

^cThe number of coal mines is from EIA (2018a). The area per mine is estimated from the total area among all mines from Sourcewatch (2011) divided by number of mines here.

^dThe number of oil refineries is from EIA (2018b). The area of each refinery is based on the area of the Richmond, California refinery.

^eKilometers of oil and gas pipeline for the U.S. were from BTS (2018); for California were estimated. The area needed for each 1 km of pipeline is estimated to be 6 m (3 m on each side of the pipe) multiplied by 1 km.

^fThe numbers of coal, gas, petroleum, nuclear and other power plants are from EIA (2018c). The areas for each coal, gas, and nuclear plant is derived from Strata (2017). For coal, the area includes those for the plant and waste disposal (mining is a separate line in this table). For gas, the area is just for the plant. For nuclear, the area includes the areas required for uranium mining, the plant itself, and waste disposal. The areas required for petroleum and other are an average of that for a coal and gas plant.

^gThe number of retail fueling stations in the U.S. is from AFDC (2014) for 2012 and in California, from Statistica (2017) for 2016. The area of a fueling station is estimated from the area of a typical gas station.

^hThe number of gas storage facilities is from FERC (2004). The area of a gas storage facility is estimated as that of the Aliso Canyon storage facility.

References

- AFDC (Alternative Fuels Data Center), Public retail gas stations by year, 2014, https://afdc.energy.gov/files/u/data/data_source/10333/10333_gasoline_stations_year.xlsx, (accessed January 3, 2020).
- Allred, B.W., W.K. Smith, D. Twidwell, J.H. Haggerty, S.W. Running, D.E. Naugle, and S.D. Fuhlendorf, Ecosystem services lost to oil and gas in North America, *Science*, 348, 401-402, 2015.
- BTS (Bureau of Transportation Statistics), U.S. oil and gas pipeline mileage, 2018, <https://www.bts.gov/content/us-oil-and-gas-pipeline-mileage> (accessed December 3, 2018).
- EIA (U.S. Energy Information Administration), Table 1. Coal production and number of mines by state and mine type, 2017 and 2016, 2018a, <https://www.eia.gov/coal/annual/pdf/table1.pdf> (accessed December 3, 2018).
- EIA (U.S. Energy Information Administration), Frequently asked questions, 2018b, <https://www.eia.gov/tools/faqs/faq.php?id=29&t=6> (accessed December 3, 2018).
- EIA (U.S. Energy Information Administration), Table 4.1. Count of electric power industry power plants by sector, by predominant energy sources within plant, 2007 through 2017, 2018c, https://www.eia.gov/electricity/annual/html/epa_04_01.html (accessed December 3, 2018).
- FERC (Federal Energy Regulatory Commission), Current state of and issues concerning underground natural gas storage, 2004, <https://www.ferc.gov/EventCalendar/Files/20041020081349-final-gs-report.pdf> (accessed December 3, 2018).
- Jepsen, K., Ramboll Oil and Gas Operations Team (personal communications), 2018.
- Oil and gas, Threat map, 2018, <https://oilandgasthreatmap.com/threat-map/> (accessed December 3, 2018).
- Statista, Number of retail fuel stations in California from 2009 to 2016, by type, 2017, <https://www.statista.com/statistics/818462/california-fueling-stations-by-type/> (accessed December 3, 2018).
- Strata, The footprint of energy: Land use of U.S. electricity production, 2017, <https://www.strata.org/pdf/2017/footprints-full.pdf> (accessed December 3, 2018).
- U.S. EPA, Revision under consideration for the 2018 GHGI: Abandoned wells, 2017, https://www.epa.gov/sites/production/files/2017-06/documents/6.22.17_ghgi_stakeholder_workshop_2018_ghgi_revision_-_abandoned_wells.pdf (accessed December 3, 2018).