

Sea Level Rise Threats to Energy Infrastructure

A Surging Seas Brief Report by Climate Central • April 19, 2012

Ben Strauss
Remik Ziemlinski

Summary

Sea level rise from global warming is well on the way to doubling the risk of coastal floods 4 feet or more over high tide by 2030 at locations nationwide. In the lower 48 states, nearly 300 energy facilities stand on land below that level, including natural gas infrastructure, electric power plants, and oil and gas refineries. Many more facilities are at risk at higher levels, where flooding will become progressively more likely with time as the sea continues to rise. These results come from a Climate Central combined analysis of datasets from NOAA, USGS and FEMA.

Rising seas

Global warming has raised sea level about 8 inches since 1880, and the rate of rise is accelerating. Scientists expect 20 to 80 more inches this century, a lot depending upon how much more heat-trapping pollution humanity puts into the atmosphere. In the near term, rising seas will translate into more and more coastal floods reaching higher and higher, as sea level rise aggravates storm surges. These increases threaten widespread damage to the nation's energy infrastructure. This brief analyzes the potential risk.

Multiplying risk

Based on peer-reviewed research, Climate Central's March 2012 report, *Surging Seas* (surgingseas.org/NationalReport), made local sea level rise and coastal flood risk projections at 55 water-level stations distributed around the lower 48 states. At the majority of these sites and across the U.S., according to the projections, climate change more than doubles the odds of near-term extreme flooding, compared to a hypothetical world without warming. Across sites, median odds for floods reaching at least 4 feet above local high-tide lines are 55 percent by 2030. Median odds for floods exceeding 5 feet are 41 percent by 2050. Odds vary regionally, but generally rank highest along the Gulf of Mexico. However, warming *multiplies* odds the most along the Pacific and then Atlantic coasts. Numbers are detailed in Table 2 of *Surging Seas*.

Energy infrastructure exposed

A great number of coastal energy facilities lay below these elevations, exposed to increasing risk of floods. This analysis identifies 287 facilities less than 4 feet above the high-tide line, spread throughout the 22 coastal states of the lower 48. More than half of these are in Louisiana, mainly natural gas facilities. Florida, California, New York, Texas, and New Jersey each have 10-to-30 exposed sites, mainly for electricity in the first three states, and for oil and gas in the last two. All told, this brief catalogs 130 natural gas, 96 electric, and 56 oil and gas facilities built on land below the 4-foot line. Below the 5-foot line, the total jumps to 328 facilities with similar geographic and type distribution.

Figure 1 shows a map of coastal facility locations below 4 feet. Table 1 presents total energy facilities below 1-to-10 feet, state by state. Tables 2-4 break out natural gas, electric, and oil and gas facilities.

Analysis methods

To arrive at the values presented here, we overlay point coordinate data for energy facilities from the Federal Emergency Management Agency HAZUS Database / MH (version 1.1), against previously developed flood-risk zones. *Surging Seas* documents the methodology for developing these zones, which are based on the elevation of land relative to local high-tide lines (as opposed to standard elevation). The *Surging Seas* analysis employed national datasets from NOAA and USGS.

The HAZUS database breaks down energy facilities into several classes. We lump “Oil / Gas Refinery” and “Oil / Gas Storage Facility / Tank Farm” together with “Oil / Gas Facility”; the database includes only two sites in the first two categories less than 10 feet, vs. 118 for the last category. Similarly, we lump “Substation” (1 below 10 feet) together with “Electric Facility” (201).

Limitations

The results presented here should be presented with certain limits in mind. For example, the FEMA source data used includes only point coordinate values for each energy facility. Actual facilities cover larger areas that may include higher or lower elevations. This analysis uses the best publicly available elevation data covering the entire coast of the lower 48 states. However, like most datasets, the elevation dataset includes errors, so any point may be higher or lower than the value provided. These factors mean that results for any individual facility should be

viewed cautiously. We therefore do not present results at the individual level. However, averaged over many facilities, potential errors should cancel out, making the aggregate findings presented more reliable.

This analysis simply tallies facilities under different elevations. It does not account for levees, seawalls, or other features that may offer protection. However, areas depressed below a sea-flood level, even if isolated from the ocean, may be more subject to flooding from rainwater during storms, as drainage would be impeded.

The *Surging Seas* report presents more thorough and detailed limits that all apply for this brief as well.

Figure 1. Low-lying coastal energy facilities map.

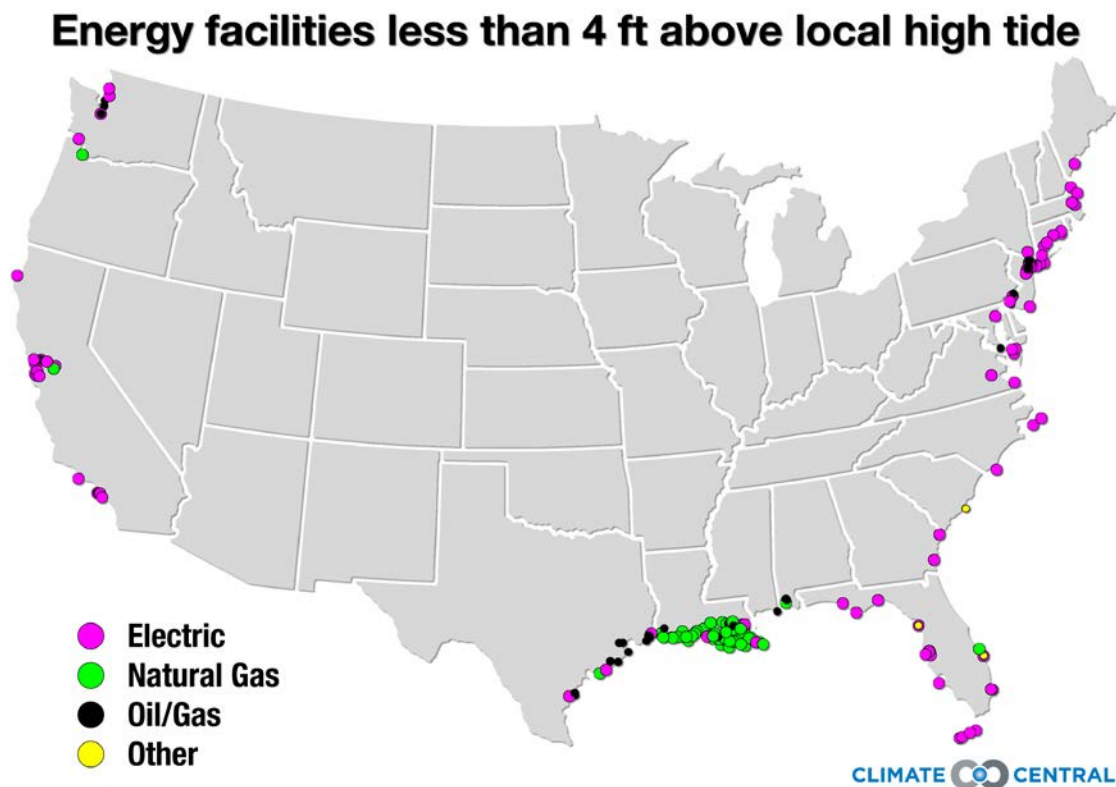


Table 1. Total energy facilities on land less than 1-to-10 feet below local high tide. Includes oil and gas, natural gas, and electric facilities, as well as other facilities.

State	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft	9 ft	10 ft
Alabama	0	0	1	3	3	3	5	6	8	8
California	8	12	19	22	24	27	29	34	40	42
Connecticut	5	5	5	5	5	5	6	7	7	7
Delaware	0	0	0	0	0	3	4	4	4	5
Florida	6	12	19	26	30	33	34	44	47	49
Georgia	2	2	5	5	5	7	8	9	10	10
Louisiana	101	114	131	148	163	170	182	184	203	206
Maine	1	1	1	1	1	1	1	1	1	1
Maryland	1	2	3	4	5	5	6	7	10	11
Massachusetts	2	2	2	3	6	9	11	11	12	12
Mississippi	0	0	0	1	1	2	2	2	2	2
New Hampshire	2	2	2	2	2	2	2	2	3	3
New Jersey	10	12	15	17	21	22	34	40	46	50
New York	7	8	11	13	14	15	16	20	23	27
North Carolina	3	3	5	5	5	5	5	5	5	5
Oregon	1	1	1	1	2	2	2	2	2	2
Pennsylvania	1	1	1	1	1	2	4	6	7	7
Rhode Island	0	0	0	0	0	1	2	2	2	2
South Carolina	1	1	1	1	2	2	3	3	3	3
Texas	4	5	5	17	23	25	27	29	33	35
Virginia	1	1	2	3	5	5	6	8	13	14
Washington	6	6	6	9	10	12	14	14	14	18
Total	162	190	235	287	328	358	403	440	495	519

Table 2. Natural gas facilities on land less than 1-to-10 feet below local high tide.

State	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft	9 ft	10 ft
Alabama	0	0	1	1	1	1	1	2	2	2
California	0	0	1	1	1	1	1	1	1	1
Connecticut	0	0	0	0	0	0	0	0	0	0
Delaware	0	0	0	0	0	0	0	0	0	0
Florida	1	1	1	1	2	2	3	3	3	3
Georgia	0	0	1	1	1	1	1	1	1	1
Louisiana	84	96	110	123	135	140	150	151	165	166
Maine	0	0	0	0	0	0	0	0	0	0
Maryland	0	0	0	0	0	0	0	0	0	0
Massachusetts	0	0	0	0	0	1	1	1	1	1
Mississippi	1	1	1	1	1	1	1	1	1	1
New Hampshire	0	0	0	0	0	0	0	0	1	2
New Jersey	0	0	0	0	0	0	0	0	0	0
New York	0	0	0	0	0	0	0	0	0	0
North Carolina	0	0	0	0	0	0	0	0	0	0
Oregon	0	0	0	0	0	0	0	0	0	0
Pennsylvania	0	0	0	0	0	0	0	0	0	0
Rhode Island	1	1	1	1	2	2	2	2	3	3
South Carolina	0	0	0	0	1	1	1	2	2	2
Texas	1	1	1	1	1	2	2	2	2	3
Virginia	1	1	2	3	5	5	6	8	13	14
Washington	6	6	6	9	10	12	14	14	14	18
Total	88	100	117	130	145	152	163	166	182	185

Table 3. Electric facilities on land less than 1-to-10 feet below local high tide.

State	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft	9 ft	10 ft
Alabama	0	0	0	0	0	0	2	2	3	3
California	5	9	12	15	17	19	20	23	27	28
Connecticut	5	5	5	5	5	5	5	6	6	6
Delaware	0	0	0	0	0	3	4	4	4	5
Florida	3	8	15	22	25	27	27	34	36	38
Georgia	1	1	3	3	3	4	5	5	6	6
Louisiana	6	6	8	8	9	10	10	10	14	14
Maine	1	1	1	1	1	1	1	1	1	1
Maryland	1	2	2	3	4	4	4	5	8	9
Massachusetts	2	2	2	3	6	9	10	10	11	11
Mississippi	0	0	0	0	0	0	0	0	0	0
New Hampshire	1	1	1	1	1	1	1	1	1	1
New Jersey	3	4	6	7	10	10	17	19	23	24
New York	6	7	10	12	13	14	15	17	18	21
North Carolina	3	3	5	5	5	5	5	5	5	5
Oregon	1	1	1	1	2	2	2	2	2	2
Pennsylvania	0	0	0	0	0	1	2	4	5	5
Rhode Island	0	0	0	0	0	1	2	2	2	2
South Carolina	0	0	1	1	1	1	2	2	2	2
Texas	0	0	0	3	3	3	3	3	3	4
Virginia	1	1	2	3	4	4	4	4	8	8
Washington	2	2	2	3	4	5	6	6	6	7
Total	42	54	76	96	113	129	147	165	191	202

Table 4. Oil and gas facilities on land less than 1-to-10 feet below local high tide.

State	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft	9 ft	10 ft
Alabama	0	0	0	2	2	2	2	2	3	3
California	2	2	5	5	5	6	7	9	11	12
Connecticut	0	0	0	0	0	0	1	1	1	1
Delaware	0	0	0	0	0	0	0	0	0	0
Florida	0	0	0	0	0	0	0	3	4	4
Georgia	1	1	1	1	1	2	2	3	3	3
Louisiana	11	12	13	17	19	20	22	23	23	25
Maine	0	0	0	0	0	0	0	0	0	0
Maryland	0	0	1	1	1	1	2	2	2	2
Massachusetts	0	0	0	0	0	0	1	1	1	1
Mississippi	0	0	0	1	1	1	1	1	1	1
New Hampshire	0	0	0	0	0	0	0	0	1	1
New Jersey	6	7	8	9	10	11	15	18	20	23
New York	1	1	1	1	1	1	1	2	3	3
North Carolina	0	0	0	0	0	0	0	0	0	0
Oregon	0	0	0	0	0	0	0	0	0	0
Pennsylvania	1	1	1	1	1	1	2	2	2	2
Rhode Island	0	0	0	0	0	0	0	0	0	0
South Carolina	0	0	0	0	1	1	1	1	1	1
Texas	3	4	4	13	18	20	22	24	27	28
Virginia	0	0	0	0	0	0	1	2	3	3
Washington	3	3	3	5	5	5	6	6	6	7
Total	28	31	37	56	65	71	86	100	112	120

Licensing

You may republish this brief report and/or its tables and graphics online, in their original form, provided you cite Climate Central and provide a link to sealevel.climatecentral.org. You must seek prior permission for print republication. You may also not sell or edit our content without permission. Contact us with questions or for permissions at republish@climatecentral.org. For more detailed information on our policy, see climatecentral.org/about/republish-our-content.

About Climate Central

Climate Central is an independent, non-profit journalism and research organization. For more information, visit climatecentral.org/what-we-do.

Disclaimer

All content found herein is provided solely for personal informational purposes and is provided "AS-IS." You acknowledge and agree that your use and possession of this content is subject to, and you agree to the provisions set forth in, Climate Central's Terms of Use (http://www.climatecentral.org/about/legal#terms_of_use), Privacy Policy (http://www.climatecentral.org/about/legal#privacy_policy) and Disclaimer (<http://sealevel.climatecentral.org/about/disclaimer>).