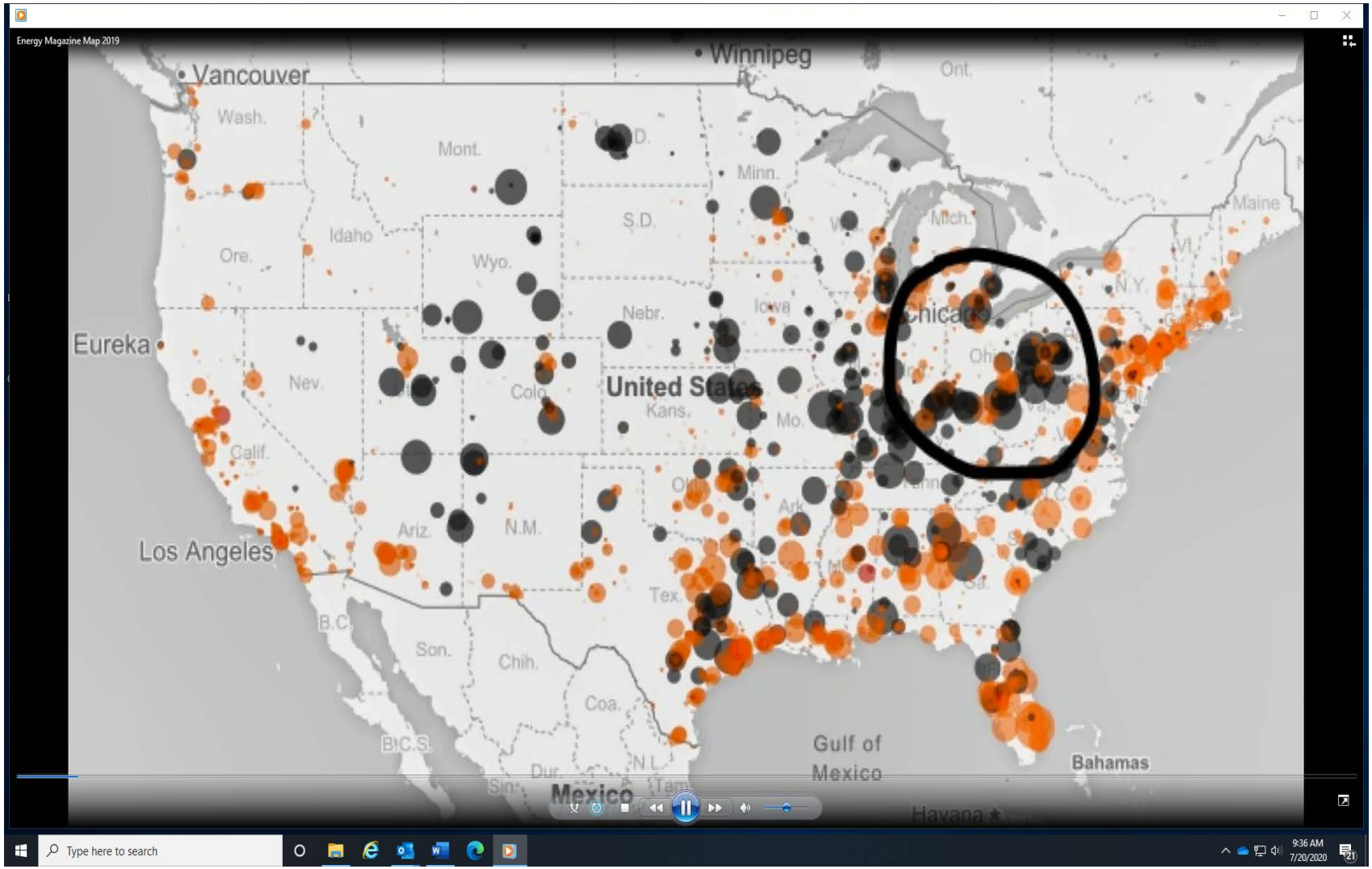
Energy Magazine Map 2019
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# Areas of industrial wind facilities*

| facility | capacity/area† | acres/MW |
|---|---|---|
| Mojave Co., Ariz. | 425 MW/24,527 acres | 58 |
| Snowflake, Ariz. | 99 MW/7,000 acres | 71 |
| Altamont Wind Resource Area, Calif. | 580 MW/50,000 acres | 86 |
| Fountain Wind, Shasta Co., Calif. | 347 MW/37,436 acres | 108 |
| Montezuma Hills, Calif. | 180 MW/6,800 acres | 38 |
| Pine Tree Wind Farm, Tehachapi Hills, Calif. | 135 MW/8,000 acres | 59 |
| Tule Wind Project, East County, Calif. | 131.5 MW/12,000 acres | 91 |
| Cheyenne Ridge Wind Project, Colo. | 500 MW/100,000 acres | 200 |
| Colorado Green, Lamar | 162 MW/11,840 acres | 73 |
| Prairie Wind, Colo. | 69 MW/7,000 acres | 101 |
| Twin Buttes, Colo. | 75 MW/9,000 acres | 120 |
| Winergy offshore, Del. | 1,101 MW/67 $mi^2$ | 40 |
| Cassia County, Idaho | 200 MW/4,500 acres | 23 |
| Boone County, Ill. | 27 MW/800 acres | 30 |
| Baileyville Wind Farm, Ogle County, Ill. | 80 MW/5,000 acres | 62 |
| Big Sky, Ill. | 75 MW/10,000 acres | 133 |
| Bishop Hill, Ill. | 400 MW/25-30,000 acres | 62-75 |
| Crescent Ridge, Ill. | 54.5 MW/2,200 acres | 40 |
| LaSalle Country, Ill. | 384.5 MW/25,000 acres | 65 |
| Mendota Hills, Ill. | 50.4 MW/3,500 acres | 69 |
| Rail Splitter, Ill. | 100.5 MW/11,000 acres | 109 |
| Twin Groves Wind Farm, McLean County, Ill. | 396 MW/21,000 acres | 53 |

| | | |
|---|---|---|
| Walnut Ridge, Bureau County, Ill. | 225 MW/14,000 acres | 62 |
| Jordan Creek Wind Farm, Warren County, Ind. | 300 MW/27,000 acres | 90 |
| Cerro Gordo, Iowa | 42 MW/2,110 acres | 50 |
| Franklin County, Iowa | 200-300 MW/40,000 acres | 133-200 |
| Pomeroy Wind Farm, Pocahontas County, Iowa | 198 MW/8,200 acres | 41 |
| Elk River, Kan. | 150 MW/8,000 acres | 53 |
| Ford County, Kan. | 100.5 MW/5,000 acres | 50 |
| Smoky Hills, Kan. | 100.8 MW/20,000 acres | 198 |
| Spearville, Kan. | 100 MW/10 $mi^2$ | 64 |
| Cape Wind (off shore), Mass. | 420 MW/24 $mi^2$ | 37 |
| Harvest Wind Farm, Mich. | 53 MW/3,200 acres | 60 |
| Huron County, Mich. | 48 MW/4,700 acres | 98 |
| Muskegon, Mich. | 31.5 MW/8,000 acres | 254 |
| Goodhue Wind Project, Minn. | 78 MW/32,700 acres | 419 |
| Grand Meadow Wind Farm, Dexter, Minn. | 100.5 MW/10,000 acres | 100 |
| Palmer's Creek Wind Farm, Minn. | 44.6 MW/6,150 acres | 138 |
| Pleasant Valley Wind Farm, Minn. | 300 MW/80 $mi^2$ | 171 |
| Trimont Area Wind Farm, Minn. | 100.5 MW/8,900 acres | 89 |
| Bluegrass Ridge, Mo. | 56.7 MW/7,000 acres | 123 |
| Judith Gap, Mont. | 135 MW/8,300 acres | 61 |
| Pierce County, Mont. | 150 MW/72 $mi^2$ | 307 |
| Ainsworth, Nev. | 59 MW/11,000 acres | 185 |
| Colfax County, N.M. | 20 MW/800-1,200 acres | 20 |
| Grant County, N.M. | 2150 MW/25 $mi^2$ | 64 |
| Cherry Valley, N.Y. | 60 MW/1,200 acres | 40-60 |
| Fenner, N.Y. | 30 MW/1,500 acres | 50 |

| | | |
|---|---|---|
| Gore Mountain, N.Y. | 27.5 MW/1,700 acres | 62 |
| High Sheldon, N.Y. | 112.5 MW/10,000 acres | 89 |
| Long Island Sound, N.Y. | 140 MW/8 $mi^2$ | 37 |
| Pasquotank and Perquimans Counties, N.Car. | 208 MW/34 $mi^2$ | 105 |
| Pierce County, N.Dak. | 150 MW/72 $mi^2$ | 307 |
| Velva, N.Dak. | 12 MW/3 $mi^2$ | 160 |
| Wilton Wind Energy Center, N.Dak. | 49.5 MW/8,000+ acres | 162 |
| Black Fork Wind Farm, Ohio | 201.6 MW/46,000 acres | 228 |
| Blue Canyon V, Okla. | 99 MW/12 $mi^2$ | 78 |
| Arlington, Ore. | 104 MW/14,000 acres | 135 |
| Biglow Canyon, Ore. | 350-450 MW/25,000 acres | 56-71 |
| Elkhorn Valley, Ore. | 101 MW/10,000 acres | 99 |
| Shepherds Flat, Ore. | 750 MW/32,000 acres | 43 |
| Forkston Twp., Pa. | 75-125 MW/7,400 acres | 59-99 |
| Block Island, R.I. | >1,000 MW/>260 $mi^2$ | 166 |
| Titan I, Hand County, S. Dak. | 25 MW/7,500 acres | 300 |
| Galveston Offshore, Texas | 150 MW/11,355 acres | 76 |
| Desert Sky, Texas | 160.5 MW/15 $mi^2$ | 60 |
| Horse Hollow, Texas | 735 MW/47,000 acres | 64 |
| Pampa Wind Project, Texas | 4,000 MW/400,000 acres | 100 |
| Stanton, Texas | 100 MW/12,000 acres | 120 |
| Wildorado Wind Ranch, Texas | 161 MW/16,000 acres | 75 |
| Milford Wind Corridor, Utah | 300 MW/40 $mi^2$ | 85 |
| Sheffield, Vt. | 52 MW/3,000 acres | 58 |
| Big Horn, Wash. | 200 MW/15,000 acres | 75 |

| | | |
|---|---|---|
| Desert Claim, Wash. | 180 MW/5,237 acres | 29 |
| Hopkins Ridge, Wash. | 150 MW/11,000 acres | 73 |
| Kittitas Valley, Wash. | 181.5 MW/6,000 acres | 34 |
| Klondike II, Sherman County, Wash. | 75 MW/6,400 acres | 98 |
| Linden Wind Farm, Wash. | 50 MW/1,800 acres | 36 |
| Lower Snake River, Wash. | 1,250 MW/94,900 acres | 76 |
| Nine Canyon, Kennewick, Wash. | 63.7 MW/5,120 acres | 80 |
| Wild Horse, Wash. | 64 MW/7,500 acres | 118 |
| Mountaineer, W.V. | 66 MW/4,400 acres | 67 |
| Bent Tree, Freeborn County, Wis. | 200 MW/32,000 acres | 160 |
| Forward Wind Energy Center, Wis. | 200 MW/32,400 acres | 162 |
| Kewaunee County, Wis. | 11 MW/603 acres | 54 |
| Monroe County, Wis. | 80 MW/10,000 acres | 125 |
| Evanston, Wyo. | 144 MW/7,800 acres | 54 |
| Campbell County, Wyo. | 199.5 MW/14,000 acres | 70 |
| Converse County, Wyo. | 200 MW/17,000 acres | 85 |
| Naikun Offshore, Hecate Strait, Br. Col. | 396 MW/100 $km^2$ | 62 |
| Blue Highlands, Ont. | 49.5 MW/4,500 acres | 91 |
| Sederglan Wind Farm, Alb. | 70.5 MW/3,900 acres | 131 |
| St. Joseph Wind Farm, Man. | 138 MW/125 $km^2$ | 224 |
| Prince I & II Wind Energy Project, Ont. | 189 MW/10,000 hectares | 55 |
| Thunder Bay, Ont. | 100 MW/8,000 acres | 80 |
| Anse-a-Valleau, Que. | 100.5 MW/4,800 hectares | 118 |
| Stanstead Station, Que. | 62 MW/920 hectares | 37 |
| Eurus wind park, Juchitán, Oaxaca | 250.5 MW/6,178 acres | 25 |
| Codrington, Australia | 18.2 MW/240 hectares | 33 |

| | | |
|---|---|---|
| Dollar Wind Farm, Australia | 79.2 MW/2,000 hectares | 62 |
| East Otago, Australia | 650 MW/300 $mi^2$ | 295 |
| Macarthur, Australia | 334 MW/5,500 hectares | 47 |
| Ruševo-Krmpotsko, Croatia | 90 MW/27 $km^2$ | 74 |
| Horns Rev (off shore), Denmark | 160 MW/24 $mi^2$ | 96 |
| Horns Rev II (off shore), Denmark | 209 MW/35 $mi^2$ | 107 |
| Butendiek (off shore), Germany | 240 MW/35 $km^2$ | 36 |
| Duddon Sands (off shore), U.K. | 500 MW/66 $km^2$ | 33 |
| London Array, Thames Estuary (off shore) | 1,000 MW/245 $km^2$ | 61 |
| Walney (off shore), U.K. | 450 MW/74.5 $km^2$ | 41 |
| Walney Extension (off shore), U.K. | 659 MW/145 $km^2$ | 54 |
| E. Ayrshire, Dumfries, Galloway, Scotland | 300 MW/8,000 hectares | 67 |
| Beinn Ghlas, Scotland | 8.4 MW/300 hectares | 88 |
| Braes of Doune, Scotland | 72 MW/1,000 acres | 14 |
| Lewis, Scotland | 600 MW/45 $mi^2$ | 50 |
| Novar, Scotland | 17 MW/300 hectares | 44 |
| Sutherland, Scotland | 50 MW/2,731 hectares | 135 |
| Windy Standard, Scotland | 21.6 MW/350 hectares | 40 |
| Carno, Wales | 33.6 MW/600 hectares | 44 |
| Makara Hills, New Zealand | 210 MW/55 $km^2$ | 65 |
| Quartz Hill, New Zealand | 210 MW/3,000 hectares | 35 |
| Egypt (off shore) | 2200 MW/1,600 $km^2$ | 180 |

* The data are gathered mostly from news articles, some from government and company documentation. The list includes proposed (and possibly rejected) as well as operating facilities. Ridgeline facilities described only by length instead of the whole area taken are not included. An August 2009 study for the National Renewable Energy Laboratory

examined land-use data for 172 projects, representing about 80% of the installed and targeted wind capacity in the U.S., and found an average area of 85 acres/MW.

According to "Permitting setbacks for wind turbines and the blade throw hazard," by Scott Larwood, presented at the 2004 California Wind Energy Collaborative Forum, University of California, Davis, the distance that turbines should be from each other for minimal wind interference is 3 rotor diameters when aligned perpendicular to the wind and 10 rotor diameters when parallel to the wind. This is also the spacing described by the New York State Energy Research and Development Authority and others. The minimum area required (where d is the rotor diameter) around each turbine in a single line where the wind is generally from one direction would therefore be 13d (10d fore and 3d aft) × 3d, with an extra 1.5d at each end. The minimum area in an array would be 10d × 10d, with an extra 5d border.

For a stand-alone turbine, the area required would be a 13d × 6d oval at a site where the wind is generally from one direction and up to a 20d-wide circle to use the wind from any direction. Depending on surrounding features, very tall towers allow reducing the area for a stand-alone turbine or a single line to some extent.

The GE 1.5-MW turbine, with a 70.5-m rotor span, therefore requires at least 38 acres per tower in a single line perpendicular to the wind (25 acres/MW) or 96 acres per tower in an array (64 acres/MW). Each Vestas V90 1.8-MW turbine, with a 90-m rotor diameter, requires 61-157 acres (34-87 acres/MW). Tom Gray of the American Wind Energy Association has written, "My rule of thumb is 60 acres per megawatt for wind farms on land."

That may still not be enough for maximum efficiency. More recent research at Johns Hopkins University by Charles Meneveau suggests that large turbines in an array need to be spaced 15 rotor diameters apart, increasing the above examples to 145-197 acres required per installed megawatt in an array.

Note that larger turbines are not substantially more efficient than small ones, because they require proportionally more space.

† ***Remember that capacity is different from actual output.*** Typical average output is only 25% of capacity, so the area required for a megawatt of actual output is four times the area listed here for a megawatt of capacity. And because three-fifths of the time wind turbines produce power at a rate far below average, even more (2.5×, perhaps, for a total of 10×) -- dispersed across a wide geographic area -- would be needed for any hope of a steady supply.

*back to* "A Problem With Wind Power"

# Impacts if Pennsylvania Joins RGGI

- CO2 emissions would be reduced by 3 million tons per year (source: PA DEP modeling).
- This equates to an insignificant reduction of 0.05% in U.S. emissions and a 0.006% reduction in global emissions (source: EPA).
- This trivial level of emissions reduction would not produce any climate change benefits.
- Power prices for Pennsylvania and other RGGI states that are members of PJM would increase by as much as 13.2% (source: PJM modeling).
- Premature coal retirements are likely, with a resulting loss of resilience and fuel security.