



Abstract

The state of Texas produces the most wind energy in the US by a significant margin, generating more than the next three highest-producing states combined. This shouldn't surprise you if you've ever taken a roadtrip across the western plains of Texas; it's a sea of giant wind turbines.

The wind farm engineers have decided to build an 80 MW wind farm in Marfa, TX, enough to power 35,000 homes!

Let's hope they find a grid interconnection out there, because somehow that power needs to get to the large cities nearby (El Paso & Odessa). By the end of this poster, you'll know exactly how to turn this barren plot of land into a clean-energy generating machine.

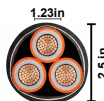
Electrical Infrastructure

The SWT-2.3-108 turbine output voltage specs:

Grid Terminals (LV)		
Nominal Power	2,300 kW	$I = \frac{P}{\sqrt{3}V}$ $I = \frac{2,300,000}{1.732 \times 690} = 1,925 \text{ A}$
Voltage	690 V	
Frequency	50 Hz or 60 Hz	

In-turbine transformer effect on wind farm grid

Without transformer

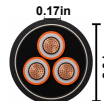


1,925A @ 690V

Cable cost: \$552/ft

Losses: 30.0W/ft

With transformer

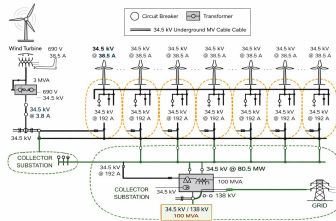


34.5kV @38.5A

Cable cost: \$24/ft

Losses: 0.9W/ft

This wind farm will connect to the Alamito Creek 69/138 kV substation, just 1 mile from the Marfa city center.



Cost Estimation / Break Even

Engineering & Project Management: **\$4.5M**

Electrical Infrastructure: **\$7M**

Concrete Foundations: **\$11.5M**

Turbines (35 SWT-2.3-108s): **\$105M**

Assembly & Installation: **\$10M**

Permits, Insurance, Construction Financing: **\$12M**

Turbine Transportation: **\$20M**



*Marfa is a remote town, so the electricity & turbines transportation costs are considerable

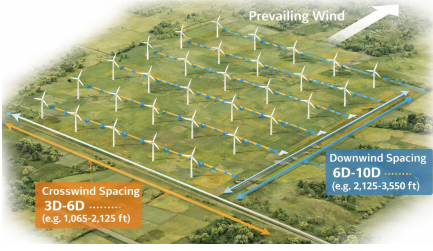
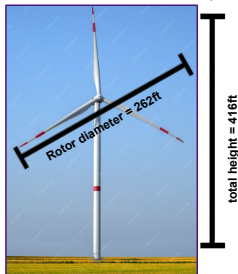
The rough cost estimation of this 80 MW wind farm **totals \$170M**. At this price, it will take the wind farm **48 years** to pay for itself, assuming a modest 35% capacity factor, average spot ERCOT prices, & standard tax credits. Wind farms generally last 25 years and are considered investable if their break-even is >15 years. So, this wind farm would be a poor financial investment.

Wind Farm Layout

Let's see how much land we'll need for this wind farm. There are 35 turbines and generally the downwind spacing is 6 - 10 diameters and the crosswind is 3 - 6 diameters. @D = 354m, the side-to-side distance is 1,400ft and the front-to-back is 2,500ft, any closer than this and the turbines will begin to "steal" their neighbors wind. 2,000 Acre wind farm.



Siemens SWT-2.3-108 (~\$3M)



Wind Data Analysis

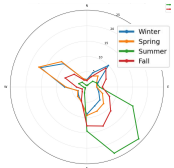
A 3 year sample of wind data has been collected from the Wind Resource Database (wrdp.nrel.gov). At 330ft, the average wind speed is 12mph, max is 54mph, & 90th percentile is 24mph. Good news since the SWT-2.3-108's cut-out wind speed of 25m/s.

Air density: 1.02kg/m³

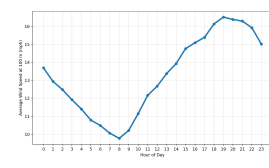
Wind power density: 238W/m²

Operational data	
Cut-in wind speed	3 - 4 m/s
Nominal power at	11 - 12 m/s
Cut-out wind speed	25 m/s

Wind direction per season



Wind speed throughout the day



Why Marfa, TX? Because 2 of my favorite movies were filmed there.



Can you name these 2 movies?