NEWS ALERT

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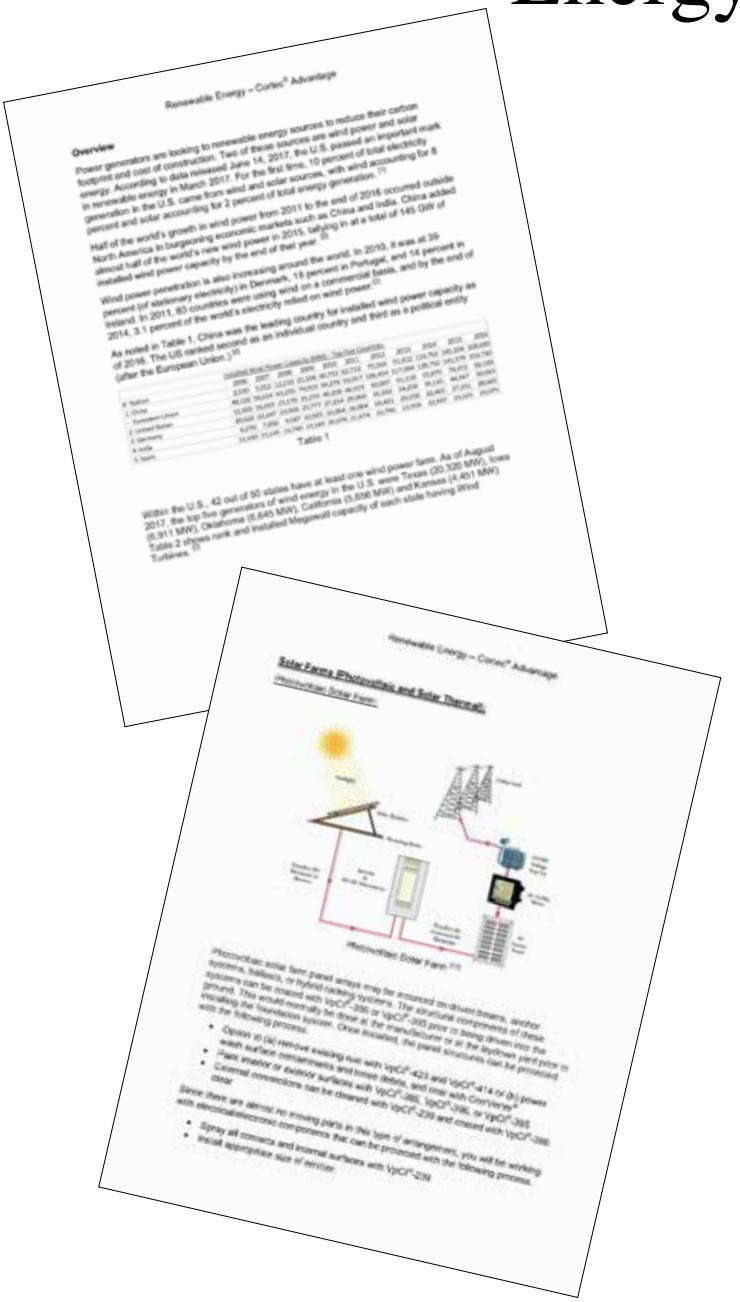
New White Paper Discusses Cortec's Role in the Expanding Renewable Energy Market



Cortec® has released a new white paper on the "Cortec® Advantage" for the renewable energy market. The paper gives an overview of the renewable energy market, with statistics on the growth of wind energy and solar power around the world. As these sources of power generation experience significant expansion, Cortec® is prepared to offer solutions for the corrosion that can attack solar and wind power equipment. The white paper goes into detail about specific VpCI® products that can be used for maintenance and corrosion protection on particular components of these new systems. It is an excellent resource for anyone looking to introduce corrosion solutions to the renewable energy market.

To see the full white paper, please continue.

Overview

Power generators are looking to renewable energy sources to reduce their carbon footprint and cost of construction. Two of these sources are wind power and solar energy. According to data released June 14, 2017, the U.S. passed an important mark in renewable energy in March 2017. For the first time, 10 percent of total electricity generation in the U.S. came from wind and solar sources, with wind accounting for 8 percent and solar accounting for 2 percent of total energy generation. [1]

Half of the world's growth in wind power from 2011 to the end of 2016 occurred outside North America in burgeoning economic markets such as China and India. China added almost half of the world's new wind power in 2015, tallying in at a total of 145 GW of installed wind power capacity by the end of that year. [2]

Wind power penetration is also increasing around the world. In 2010, it was at 39 percent (of stationary electricity) in Denmark, 18 percent in Portugal, and 14 percent in Ireland. In 2011, 83 countries were using wind on a commercial basis, and by the end of 2014, 3.1 percent of the world's electricity relied on wind power.[2]

As noted in Table 1, China was the leading country for installed wind power capacity as of 2016. The US ranked second as an individual country and third as a political entity (after the European Union.) [2]

	Installed Wind Power Capacity (MW) - Top Five Countries										
#	Nation	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	China	2,599	5,912	12,210	25,104	44,733	62,733	75,564	91,412	114,763	145,104	168,690
–	European Union	48,122	56,614	65,255	74,919	84,278	93,957	106,454	117,384	128,752	141,579	153,730
2	United States	11,603	16,819	25,170	35,159	40,200	46,919	60,007	61,110	65,879	74,472	82,183
3	Germany	20,622	22,247	23,903	25,777	27,214	29,060	31,332	34,250	39,165	44,947	50,019
4	India	6,270	7,850	9,587	10,925	13,064	16,084	18,421	20,150	22,465	27,151	28,665
5	Spain	11,630	15,145	16,740	19,149	20,676	21,674	22,796	22,959	22,987	23,025	23,075

Table 1

Within the U.S., 42 out of 50 states have at least one wind power farm. As of August 2017, the top five generators of wind energy in the U.S. were Texas (20,320 MW), Iowa (6,911 MW), Oklahoma (6,645 MW), California (5,656 MW) and Kansas (4,451 MW). Table 2 shows rank and installed Megawatt capacity of each state having Wind Turbines. [3]

Wind Energy Facilities - Installed Capacity - Ranked by State/Territory [3]

(Largest to Smallest Capacity for the Year Ending 2016)

Rank	State	Installed Capacity (MW)
1	Texas	20,320
2	Iowa	6,911
3	Oklahoma	6,645
4	California	5,656
5	Kansas	4,451
6	Illinois	4,026
7	Minnesota	3,499
8	Oregon	3,163
9	Washington	3,075
10	Colorado	3,026
11	North Dakota	2,746
12	Indiana	1,897
13	New York	1,827
14	Michigan	1,611
15	Wyoming	1,489
16	Pennsylvania	1,369
17	Nebraska	1,328
18	New Mexico	1,112
19	South Dakota	977
20	Idaho	973
21	Maine	901
22	Montana	695
23	West Virginia	686
24	Missouri	659
25	Wisconsin	648
26	Ohio	545
27	Utah	391
28	Arizona	268
29	Hawaii	203
30	Maryland	190
31	New Hampshire	185
32	Nevada	152
33	Puerto Rico	125
34	Vermont	119
35	Massachusetts	115
36	Alaska	62
37	Rhode Island	52
38	Tennessee	29
39	New Jersey	9
40	Connecticut	5
41	Delaware	2
42	Guam	less than 1
	United States Total	82,143

Table 2

According to *The Guardian*, the growth of solar power last year outpaced the growth of any other form of power generation, "leading experts to hail a 'new era'." Among the renewable sources that made up two-thirds of 2016 power gen growth, as identified by the International Energy Agency (IEA), solar technology was the most notable. Thanks to government policies and falling prices in China, where close to half of the new solar panels were installed, growth of solar capacity effectively caught up with coal energy growth. [4]

Signifying the growing scope for solar energy in the U.S., a Solar Energy Industries Association (SEIA) database lists almost 6,000 major solar projects. These projects represent about 70 GW of capacity either in operation, under construction, or in development. More than 20.5 GWac of major solar projects are already active, while a massive capacity of over 49 GW of photovoltaic (PV) and concentrated solar power (CSP) is in the construction or development stage. The list is not comprehensive but provides insight into the growth of ground-mounted solar projects. [5]

According to the IEA, solar power is expected to dominate future power growth worldwide with maximum growth in China, India, and the U.S. The IEA projects that within five years the global growth in solar power will exceed the 2016 capacity of India and Japan. [4]

As of 2017, there were 53 operating PV solar farms worldwide, with 29 in planning or under construction. [6] Additionally, there were 44 solar power thermal stations operating worldwide. [7] The major difference between these is that PV equipment converts solar energy directly to electrical energy; whereas the solar thermal plant concentrates the sun's energy to a single point to heat a fluid, which in turn heats water to make steam.

Wind power plants, PV solar farms, and Solar Thermal Collectors (STCs) are all susceptible to corrosion due to their locations, materials, and maintenance feasibility. The two major designs requiring maintenance and corrosion protection at solar thermal power plants are the parabolic trough (Figures 1 and 2) and the concentrating linear Fresnel reflector (Figure 3). STC solar farms also include a steam plant system that is at risk for corrosion as in any traditional power plant.

Figure 1 - Parabolic Trough [8]

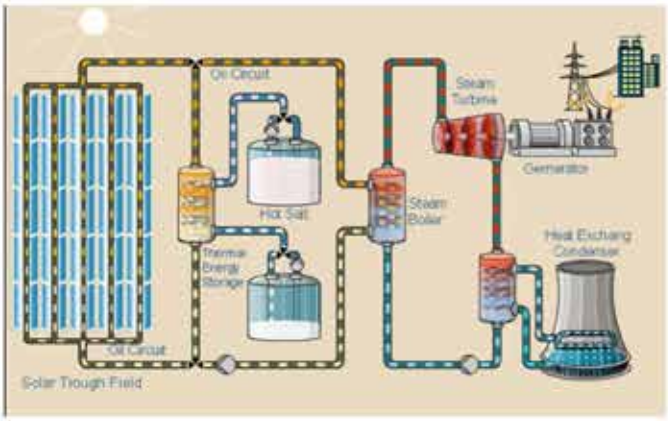


Figure 2 -Schematic of a Parabolic Trough with Thermal Storage System [9]

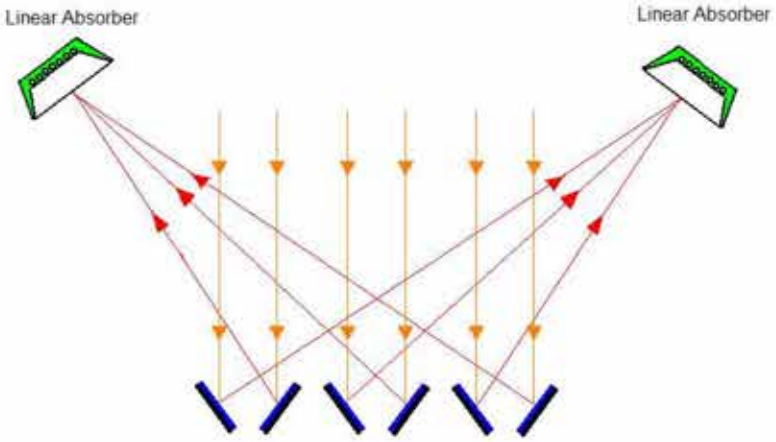
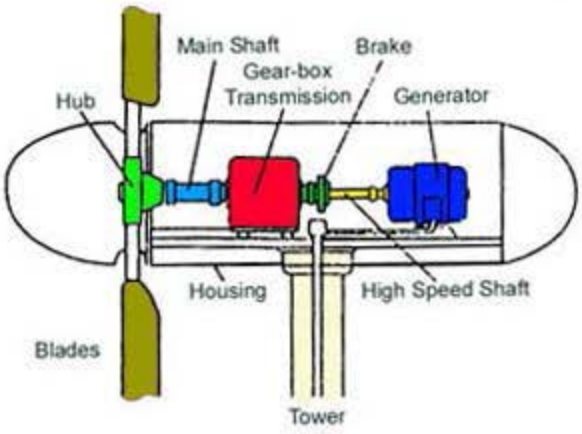


Figure 3 - Concentrating Linear Fresnel Reflector [10]

Corrosion Remediation and Prevention for Operating Wind and Solar Farms

NOTE: The following recommendations are applicable for installed systems. Contact a Cortec® representative to discuss Cortec® applications during the manufacture of individual components.



A diagram of the inner workings of a wind turbine [11]

Wind Turbine:

A wind turbine consists of the following major components that are susceptible to rusting.

- Gearbox (various carbon steels)
- High speed and low speed shaft (various carbon steels)
- Brake (various carbon steels and non-metallic pads)
- Generator and motors (carbon steel, copper, stainless steel, insulation)
- Drive mechanisms (various carbon steels)
- Electric/electronic controls (carbon steel, copper, stainless steel, insulation)
- Tower (pre-stressed concrete or steel)
- Base/foundation (steel-reinforced concrete)
- Nacelle
- Blades

The following treatments are recommended.

Gearbox:

- M-531 as an additive to run in oil or as a fogging application (1 oz/ft^3 (1 l/m^3))
  - NOTE: Not to be used in operating oil
- VpCI®-391 or VpCI®-386 clear for all exposed machined surfaces
- VpCI®-386, VpCI®-396, or VpCI®-395 for coating of exterior surfaces

- VpCI®-422 and VpCI®-414 for removing any internal rust
- VpCI®-423 or VpCI®-422 with VpCI®-414 to remove any external rust

High Speed and Low Speed Shaft:

- VpCI®-391 or VpCI®-386 clear for all exposed machined surfaces
- VpCI®-423 or VpCI®-422 with VpCI®-414 to remove any external rust

Brake:

NOTE: For metallic surfaces only – Do not apply VpCI® product to non-metallic surfaces.

- VpCI®-391 or VpCI®-386 clear for all exposed machined surfaces
- VpCI®-423 or VpCI®-422 with VpCI®-414 to remove any external rust

Generators and Motors:

- VpCI®-239 for fogging into the generator and motor core (ensure the generator and motor are not energized)
- VpCI®-391 or VpCI®-386 clear for all exposed machined surfaces
- VpCI®-423 or VpCI®-422 with VpCI®-414 to remove any external rust
- VpCI®-101 placed in junction boxes
- VpCI®-386, VpCI®-396, or VpCI®-395 for coating of exterior surfaces

Drive Mechanism:

- VpCI®-391 or VpCI®-386 clear for all exposed machined surfaces
- VpCI®-423 or VpCI®-422 with VpCI®-414 to remove any external rust

Do not apply any Cortec® product to the non-metallic brake pads.

Electric/Electronic Controls:

- Spray all internal surfaces with VpCI®-239
- Install appropriate sized emitter
    - VpCI®-101
    - VpCI®-105
    - VpCI®-111
    - VpCI®-308 pouch

Tower (Steel):

- Option to (a) remove existing rust with VpCI®-423 and VpCI®-414 or (b) power wash to remove surface contaminants and loose debris, and coat with CorrVerter®
- Coat interior or exterior surfaces with VpCI®-386, VpCI®-396, or VpCI®-395

Renewable Energy – Cortec® Advantage

Tower (Pre-Stressed Concrete):

- Power wash to remove surface contaminants and loose debris
- Apply Migrating Corrosion Inhibitors to cleaned surface
- Apply Cortec® sealer to treated surface
- Contact Cortec® Migrating Corrosion Inhibitor™ specialists for proper selection and application technique
- NOTE: Migrating Corrosion Inhibitors can be added to the concrete during the construction phase to protect the steel rebar reinforcement to extend tower life

Base/Foundation:

- Power wash to remove surface contaminants and loose debris
- Apply Migrating Corrosion Inhibitors to cleaned surface
- Apply Cortec® sealer to treated surface
- Contact Cortec Migrating Corrosion Inhibitor™ specialists for proper selection and application technique
- NOTE: Migrating Corrosion Inhibitors can be added to the concrete during the construction phase to protect the steel rebar reinforcement and extend tower life

Nacelle:

- Option to (a) remove existing rust with VpCI®-423 and VpCI®-414 or (b) power wash to remove surface contaminants and loose debris, and coat with CorrVerter®
- Paint interior or exterior surfaces with VpCI®-386, VpCI®-396, or VpCI®-395

Blades (metallic):

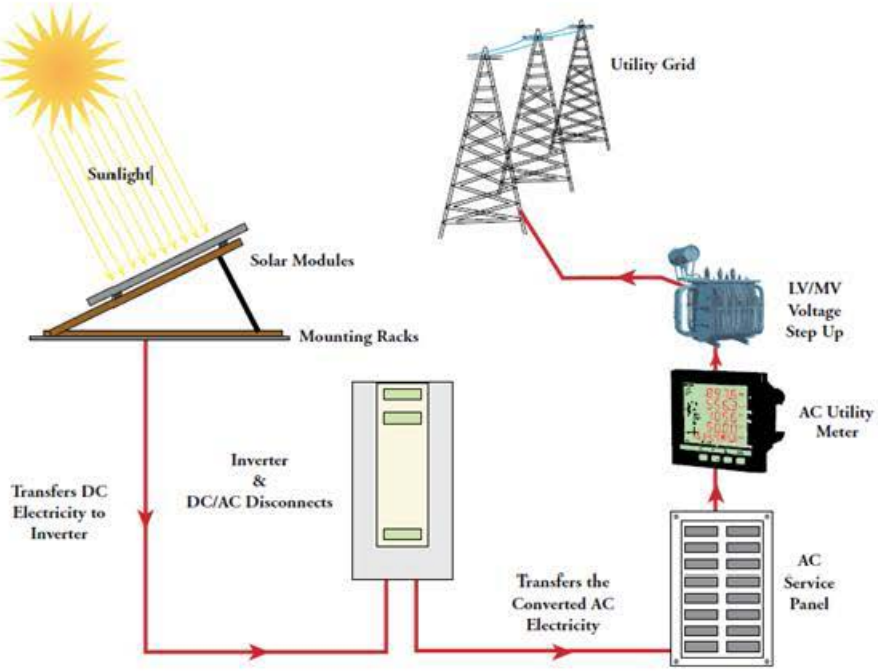
- Clean with VpCI®-414
- Coat with VpCI®-391
- Shrink wrap with either MilCorr® or VpCI®-126 HPUV

Blades (non-metallic):

- Hub
    - Clean with VpCI®-414
    - Coat with VpCI®-391
    - Shrink wrap with either MilCorr® or VpCI®-126 HPUV

Solar Farms (Photovoltaic and Solar Thermal):

Photovoltaic Solar Farm:



Photovoltaic Solar Farm [12]

Photovoltaic solar farm panel arrays may be mounted on driven beams, anchor systems, ballasts, or hybrid racking systems. The structural components of these systems can be coated with VpCI®-396 or VpCI®-395 prior to being driven into the ground. This would normally be done at the manufacturer or at the laydown yard prior to installing the foundation system. Once installed, the panel structures can be protected with the following process.

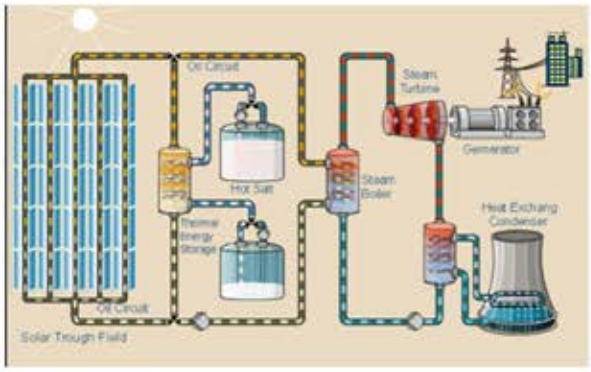
- Option to (a) remove existing rust with VpCI®-423 and VpCI®-414 or (b) power wash surface contaminants and loose debris, and coat with CorrVerter®
- Paint interior or exterior surfaces with VpCI®-386, VpCI®-396, or VpCI®-395
- External connections can be cleaned with VpCI®-239 and coated with VpCI®-386 clear

Since there are almost no moving parts in this type of arrangement, you will be working with electrical/electronic components that can be protected with the following process.

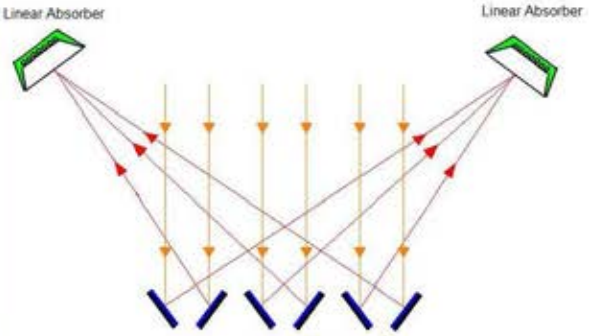
- Spray all contacts and internal surfaces with VpCI®-239
- Install appropriate size of emitter:

  - VpCI®-101
  - VpCI®-105
  - VpCI®-111
  - VpCI®-308 pouch
- In addition, Cortec's M-236 can be added to the transformer oil for extra protection

Parabolic Trough with Thermal Storage System and Concentrating Linear Fresnel Reflector:



Parabolic Trough [11]



Fresnel Reflector [10]

Both the solar trough field and Fresnel reflector provide focused concentrated heat to a fluid which is used to heat water into steam to drive a steam turbine. The structure and components for the solar side of each system would be handled in the same manner as the photovoltaic solar structure and components. The power plant side, which includes the piping for the heat transfer fluids, storage tanks, and traditional power plant equipment would be protected and preserved following Cortec's recommended procedures for power plants.

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