

STATEWIDE AIR EMISSIONS CALCULATIONS FROM WIND AND OTHER RENEWABLES

VOLUME I

A Report to the
Texas Commission on Environmental Quality
For the Period January 2021 – December 2021



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ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION



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ENERGY SYSTEMS LABORATORY

July 15, 2022

Mr. David Serrins
Mobile Source Programs Team Leader
Air Quality Division
Texas Commission on Environmental Quality
Austin, TX 78711-3087

Dear Mr. Serrins,

The Energy Systems Laboratory (ESL) at the Texas Engineering Experiment Station of The Texas A&M University System is pleased to provide its annual report, "Statewide Emissions Calculations from Wind and Other Renewables," as required by the 79th Legislature. This work has been performed through a contract with the Texas Commission on Environmental Quality (TCEQ).

In this work, the ESL is required to obtain input from public/private stakeholders, and develop and use a methodology to annually report the energy savings from wind and other renewables. This report summarizes the work performed by the ESL on this project from January 2021 to December 2021.

Please contact me at (979) 845-9213 should you have questions concerning this report or the work presently being done to quantify emissions reductions from renewable energy measures as a result of the TERP implementation.

Sincerely,

A handwritten signature in black ink that reads "David E. Claridge".

David E. Claridge, Ph.D., P.E.
Director

Enclosure

DISCLAIMER

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ACKNOWLEDGMENT

This report cannot be accomplished without the help of many people. Special thanks to Dan Mantena Planning Analyst, Resource Adequacy Department at Electric Reliability Council of Texas (ERCOT), for providing the wind farm power generation data.

SUMMARY REPORT

Statewide Air Emissions Calculations from Wind and Other Renewables

1 EXECUTIVE SUMMARY

The 79th Legislature, through Senate Bill 20, House Bill 2481 and House Bill 2129, amended Senate Bill 5 to enhance its effectiveness by adding 5,880 MW of generating capacity from renewable energy technologies by 2015 and 500 MW from non-wind renewables.

This legislation also requires the Public Utilities Commission of Texas (PUC) to establish a target of 10,000 megawatts of installed renewable capacity by 2025 and requires the Texas Commission on Environmental Quality (TCEQ) to develop a methodology for computing emissions reductions from renewable energy initiatives and the associated credits. Table 1-1 lists the statutory mandates and total wind power generation capacity (including installed and announced) in Texas from 2001 to 2025. It shows that Texas has achieved its milestone of 10,000 MW by the end of 2010 and could reach total 43,224 MW by 2023¹ according to the information from PUC². By the end of 2021, the total installed capacity in Texas is 36,694 MW.

Table 1-1: Installed/Announced Wind Power Capacity and the Statutory Mandates

Texas Wind Summary			SB20 Plan	
Month-Yr	Installed MW	Announced ³ MW	Month-Year	MW
Dec-2001	1,012	-		
Dec-2002	1,091	-		
Dec-2003	1,292	-		
Dec-2005	1,965	-		
Dec-2006	2,786	-	Jan-2007	2,280
Dec-2007	4,438	-		
Dec-2008	8,215	-	Jan-2009	3,272
Dec-2009	9,652	-		
Dec-2010	10,222	-	Jan-2011	4,264
Dec-2011	10,468	-		
Dec-2012	11,737	-	Jan-2013	5,256
Dec-2013	12,302	-		
Dec-2014	14,035	-	Jan-2015	5,880
Dec-2015	17,377	-		
Dec-2016	19,632	-		
Dec-2017	22,937	-		
Dec-2018	24,154	-		
Dec-2019	28,188	-		
Dec-2020	32,413	-		
Dec-2021	36,694	-		
Dec-2022	-	4,028		
Dec-2023		2,502	Jan-2025	10,000

¹ PUC has not announced wind farms for years beyond 2023 in their 2022 announced wind farm list.

² The service date for announced wind farms is searched from PUC (<http://www.puc.texas.gov/industry/electric/reports/Default.aspx>).

³ TBD projects in the announced project list were not included in installed/announced capacity calculations in Table 1-1. Total announced wind power capacity including TBD projects is 6,530 MW by 2023.

In this Legislation, the function of the Energy Systems Laboratory (ESL) is to assist the TCEQ in quantifying emissions reductions credits from energy efficiency and renewable energy programs, through a contract with the TCEQ to develop and annually calculate creditable emissions reductions from wind and other renewable energy resources for the State Implementation Plan (SIP).

The ESL, in fulfillment of its responsibilities under this Legislation, submits its annual report, “Statewide Air Emissions Calculations from Wind and Other Renewables,” to the TCEQ.

The report is organized in several deliverables:

1. A summary report, which details the key areas of work,
2. Volume I report, which includes main document of renewable energy projects and
3. Volume II technical Appendix that includes all information and details about renewables (i.e., wind power, non-utility scale and utility-scale solar PV, solar thermal, biomass, hydroelectric, geothermal, and landfill gas-fired)
4. Supporting data files, including weather data, and wind energy production data are available upon request.

This executive summary provides key areas of accomplishment this year, including:

- Analysis of power generation from wind farms using improved method and 2018 data,
- Analysis of emissions reductions from wind farms,
- Analysis of other renewables, including solar PV, solar thermal, biomass, hydroelectric, geothermal, and landfill gas, and
- Review of electricity generation by renewable sources and transmission planning study reported by ERCOT

1.1 Texas wind power generation (ERCOT and PUCT)

For several years now, Texas has been the largest producer of wind energy in the United States. As of January 2022, the capacity of installed wind turbine totals was 36,694 MW with another 6,530 MW announced for new projects to be completed by 2023. Figure 1-1 shows the growth pattern of the installed wind power capacity in Texas and their power generation in the ERCOT region from September 2005 to December 2021.

In the last few years, the electricity generated by wind has continually shown progressive and substantial increases. However, the wind electricity generation contains a significant seasonal response, which can be observed during the Ozone Season Period⁴ when a dramatic reduction in the power generation can be observed. This reduction is mainly due to the fact that the wind speed in those periods is lower than other times during the year. On the other hand, it is also observed that the peaks of wind electricity generation occur more often during the winter periods when the wind speed also has a higher overall average value.

⁴ Since 2018 the Ozone Season Period (OSP) was changed from the period of July 15 to Sep 15 to the period of May 1 to September 30.

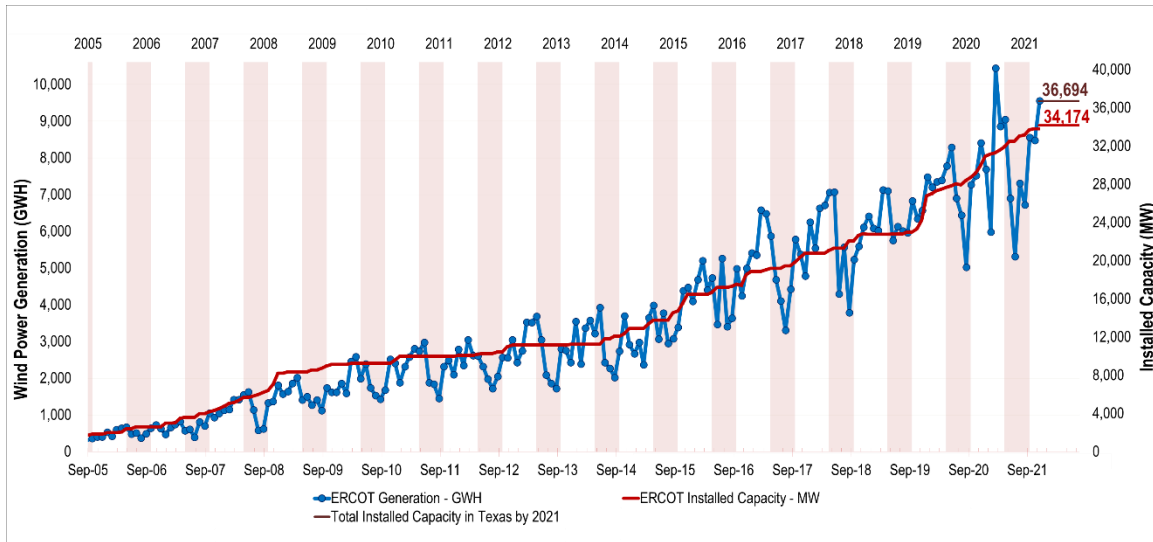


Figure 1-1: Installed Wind Power Capacity and Power Generation in the ERCOT Region from September 2005 to December 2021

1.2 Analysis of wind farms using an improved method and 2021 electricity generation data.

In this report, the weather normalization procedures, developed together with the Stakeholders, were presented and applied to all the wind farms that reported their data to ERCOT during the 2021 measurement period.

In the previous Wind and Renewables reports to the TCEQ, weather normalization analysis methods were reviewed and determined to be appropriate for this report. Therefore, this report used the same analysis method as the previous reports to present the same weather normalization procedure, including:

- the processing of weather and power generation data, modeling of daily power generation versus daily wind speed using the ASHRAE Inverse Model Toolkit (IMT) for two separate periods, i.e., Ozone Season Period (OSP), from May 1 to September 30, and non-Ozone Season Period (non-OSP);
- predicting wind power generation based on 2018 baseline wind speed data, using developed coefficients from 2021 daily OSP and non-OSP models for all the wind farms; and
- the analysis of monthly capacity factors generated using the models.

This report also includes an uncertainty analysis that was performed on all the daily regression models for the entire year and OSP. The detailed analysis for each wind farm is provided in the Appendix A of Volume II of this report.

1.3 Analysis of emissions reduction from wind farms

In this report, the procedure for calculating annual and peak-day, county-wide NO_x reductions from electricity savings from wind projects implemented in the Competitive Load (CL) zones in ERCOT was presented. The calculation of the NO_x emission reductions is based on the 2018 eGRID as modified according to ESL-TR-08-12-04 report (US EPA and ESL, 2008). As shown in Table 1-2 based on the 2021 measured ERCOT data, the total MWh savings for all the wind farms within the ERCOT region are 93,119,496 MWh/yr and 230,679 MWh/day for an average day in the OSP. The total NO_x emissions reductions in 2021 across all the counties amounts are 56,732.0 tons/yr and 132.6 tons/day for the OSP. A comparison of the measured 2021 data and the modeled 2018 data is presented in Section 3.2 of this report.

Table 1-2: Electricity Generation and NO_x Emission Reductions for All the Wind Farms in ERCOT Region in 2020

	Annual	OSP
Measured Electricity Generation in 2021	93,119,496 [MWh/yr]	230,679 [MWh/day]
NO_x Emission Reduction in 2021	56,732.0 [Tons/yr]	132.6 [Tons/day]

Figure 1-2 and Figure 1-3 show the measured annual and OSP NO_x emissions reductions from wind power in each county of Texas in 2021.⁵

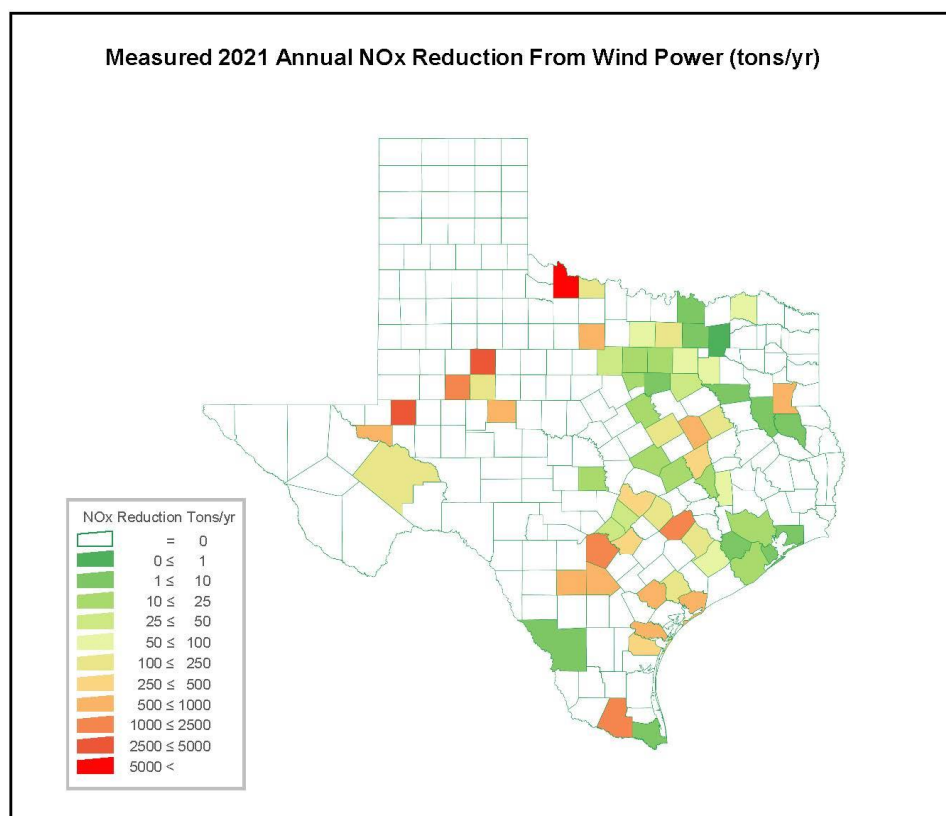


Figure 1-2: Measured 2021 Annual NO_x Reductions from Wind Power in Texas

⁵ The map from Figure 1-2 and Figure 1-3 are designed in simplemaps.com

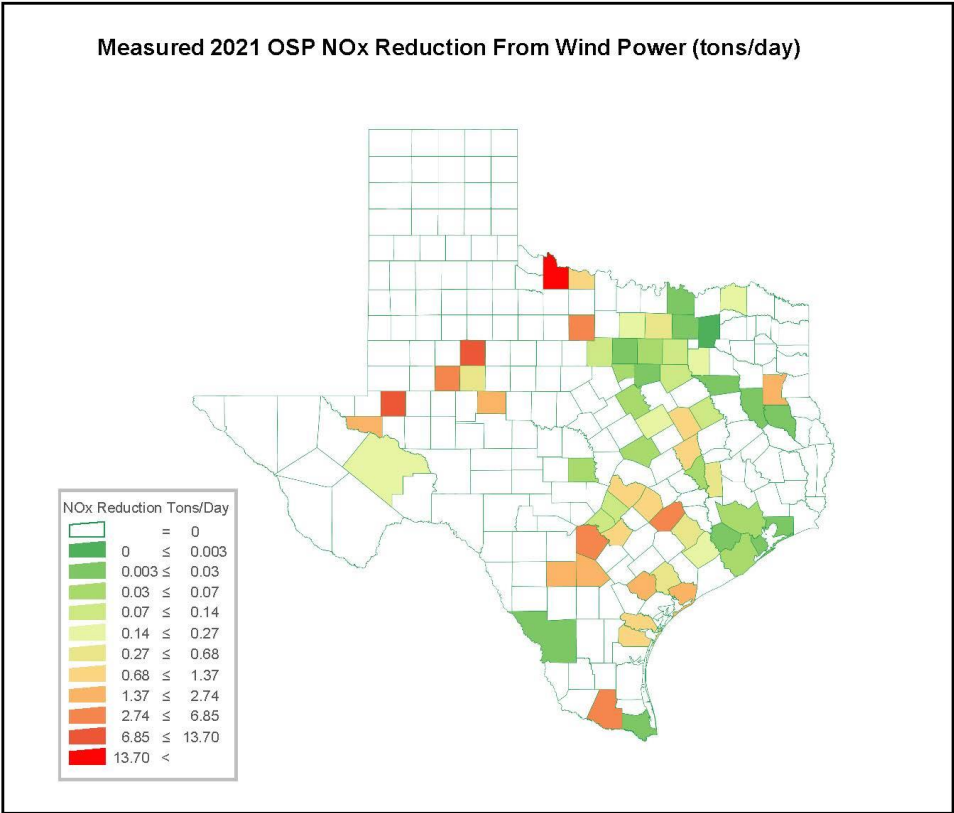


Figure 1-3: Measured 2021 OSP NOx Reductions from Wind Power in Texas

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1.4 Analysis of other renewable sources

Five specific renewable sources were determined: solar, biomass, hydroelectric, geothermal, and landfill gas-fired. To generate/save energy throughout the State of Texas, six types of renewable energy projects were identified: solar photovoltaic (PV) including solar power, solar thermal, biomass power, hydroelectric power, geothermal HVAC, and landfill gas-fired power projects. The solar photovoltaic project accounts for non-utility scale PV installations in Texas whereas the solar power project accounts for utility-scale (solar power plant) constructions. Table 1-3 presents the number of newly located renewable energy projects and total renewable energy projects included in this report.

This report also presents county-wide annual/OSP energy savings for solar photovoltaic including solar power, solar thermal, biomass, and hydroelectric projects. The annual/OSP energy savings calculation for non-utility scale solar photovoltaic was conducted based on the LBNL public dataset. The power generation data for the other utility scale renewable energy projects (solar power, biomass, and hydroelectric), which were obtained from the ERCOT, were used to evaluate the annual/OSP energy generation. The annual/OSP energy savings calculation for solar thermal was conducted based on the project data from various web sources. Then, the annual NO_x emission reductions calculation was conducted with the special version of Texas 2018 eGRID.

In 2021, the total annual energy savings and the OSP daily average energy savings from each renewable projects across all the counties were:

- solar photovoltaic projects (non-utility scale): 607,389 MWh/yr and 1,885 MWh/day; in addition, solar power projects (utility-scale): 15,562,995 MWh/yr and 55,457 MWh/day,
- solar thermal projects: 255 MWh/yr and 0.7 MWh/day,
- biomass projects: 434,278 MWh/yr and 1,663 MWh/day, and
- hydroelectric projects: 597,687 MWh/yr and 2,316 MWh/day.

In 2021, the annual NO_x emission reductions from renewable projects across all the counties were:

- solar photovoltaic projects (non-utility scale): 299.6 tons/yr; in addition, solar power projects (utility-scale): 9,584.4 tons/yr,
- solar thermal projects: 0.1 tons/yr,
- biomass projects: 167.3 tons/yr, and
- hydroelectric projects: 239.2 tons/yr.

Table 1-3: Number of Projects Identified for Other Renewable Sources

Renewable Energy Projects	Number of New Projects in 2021	Total Number of Projects in 2021	Annual Measured/ Estimated Electricity Generation in 2021 [MWh/yr]	OSP Measured/ Estimated Electricity Generation in 2021 [MWh/day]	NO _x Emission Reductions in 2021 [tons/yr] ⁶
Solar Photovoltaic ⁷	5,919	40,700	607,389	1,885.0	299.6
Solar Power	35	117	15,562,995	55,457.0	9,584.4
Solar Thermal	0	41	255	0.7	0.1
Biomass	0	12	434,278	1,663.0	167.3
Hydroelectric	3	33	597,687	2,316.0	239.2
Geothermal ⁸	0	306	-	-	-
Landfill Gas-Fired ^{8,9}	3	35	-	-	-

⁶ The NO_x emissions reductions correspond to the electricity production from solar photovoltaic, solar power, solar thermal, and biomass for each county, based on the appropriate assigned CL zones and the 2018 eGRID.

⁷ This TERP report used the "Tracking the Sun" project dataset of Lawrence Berkeley National Laboratory (LBNL) (<https://emp.lbl.gov/tracking-the-sun/>). The Tracking the Sun project public database included 40,700 projects from 2004 to 2021.

⁸ Annual or OSP electricity savings and NO_x emission reductions from the geothermal and landfill gas-fired could not be estimated due to limited information.

⁹ Landfill gas-fired project information from EPA have seven sub-categories for their status: operational, candidates, potential, construction, shutdown, planned, and others. EPA rearranged/added/removed some projects information within the seven sub-categories. Operational projects were considered for the number of projects.

1.5 Review of electricity savings and transmission planning study reported by ERCOT

In this report, the information posted on ERCOT’s Renewable Energy Credit (REC) Program site (www.texasrenewables.com) was reviewed. In particular, information posted under the “Public Reports” tab was downloaded and assembled into an appropriate format for review. This includes ERCOT’s 2001 through 2021 reports to the Legislature and information from ERCOT’s listing of REC generators.

Each year ERCOT compiles a list of grid-connected sources that generate electricity from renewable energy and report them to the Legislature.

Table 1-4 contains the ERCOT data reported from 2001 to 2021 and Figure 1-4 illustrates the same annual data.

Table 1-4: Annual Electricity Generation by Renewable Resources (MWh, ERCOT: 2001 - 2021)¹⁰

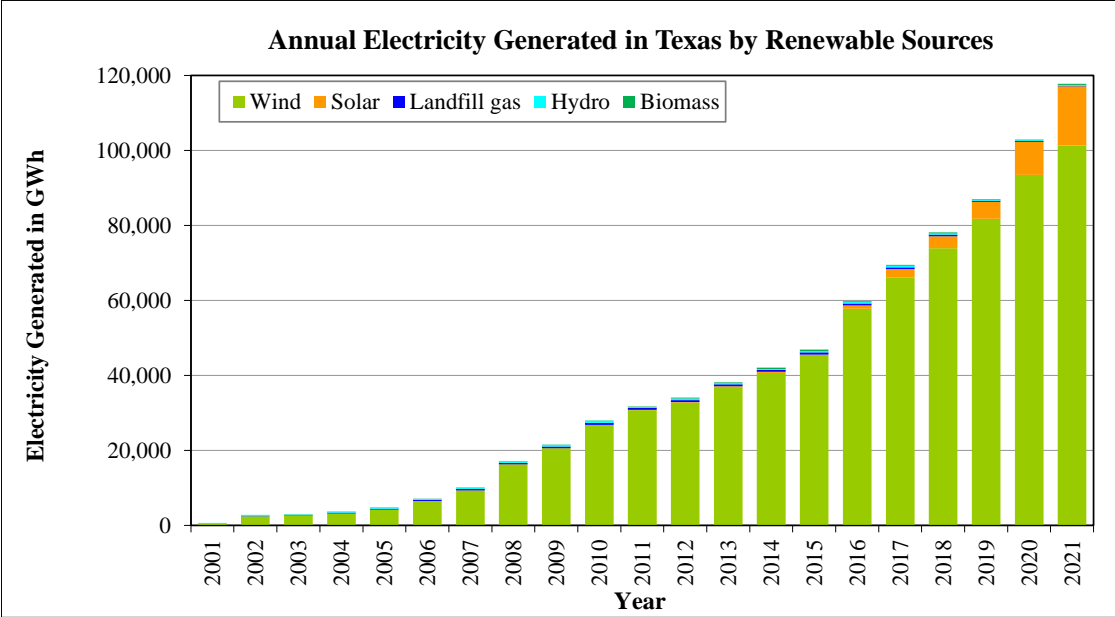
Year	Biomass (MWh)	Hydro (MWh)	Landfill gas (MWh)	Solar* (MWh)	Wind (MWh)	Total (MWh)
2001	0	30,639	0	0	565,597	596,236
2002	0	312,093	29,412	87	2,451,484	2,793,076
2003	39,496	239,684	154,206	220	2,515,482	2,949,087
2004	36,940	234,791	203,443	211	3,209,630	3,685,014
2005	58,637	310,302	213,777	227	4,221,568	4,804,512
2006	60,569	210,077	306,087	470	6,530,928	7,108,131
2007	54,101	382,882	356,339	1,844	9,351,168	10,146,333
2008	70,833	445,428	387,110	3,338	16,286,440	17,193,150
2009	73,364	507,507	412,923	4,492	20,596,105	21,594,390
2010	97,535	609,257	464,904	14,449	26,828,660	28,014,805
2011	137,004	267,113	497,645	36,580	30,769,674	31,708,016
2012	288,988	389,197	549,037	139,439	32,746,534	34,113,195
2013	200,564	294,238	550,845	178,326	36,909,385	38,133,358
2014	343,469	240,792	518,580	312,757	40,644,362	42,059,961
2015	349,600	414,289	561,915	410,318	45,165,341	46,901,462
2016	247,643	393,740	518,403	848,410	57,796,161	59,804,357
2017	216,431	444,453	446,119	2,289,394	66,076,742	69,473,139
2018	287,014	334,460	395,428	3,183,238	73,960,577	78,160,716
2019**	153,531	266,718	335,361	4,492,846	81,770,300	87,018,756
2020**	140,878	222,252	270,377	8,769,838	93,507,058	102,910,401
2021	248,245	222,136	209,019	15,761,965	101,310,613	117,751,978

Note: The REC Program tracks renewable generation in Texas, including non-ERCOT regions of Texas. Not all renewable is eligible for REC credit.

* Solar includes the utility scale solar power only

** 2019 solar and 2020 wind, solar and hydro REC data have been updated after ERCOT’s data changes in this year

¹⁰ <https://sa.ercot.com/rec/public-reports>



Note: In 2021, the unit for the annual electricity generation was revised from MWh to GWh.

Figure 1-4: Electricity Generation by Renewable Resources (ERCOT: 2001–2021 Annual)

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2 INTRODUCTION

2.1 Statement of Work for Calculations of Emissions from Wind and Other Renewables

This summary report covers the Energy Systems Laboratory's work from January 2021 through December 2021. This work is intended to cover the basic work outline included below:

Task 1: Obtain input from public/private stakeholders

Task 2: Develop and maintain a methodology in cooperation with the Texas Commission on Environmental Quality (TCEQ) and the U.S. Environmental Protection Agency (US EPA) for calculating emissions reductions obtained through wind and other renewable energy resources in Texas

Task 3: Calculate annual, creditable emissions reductions for wind and other renewable energy resources for inclusion in the State SIP

Task 4: Include emissions reductions by county from wind and renewable energy resources in the ESL's annual report to the TCEQ

Task 5: Incorporate wind and renewable energy emissions reductions as a component of the ESL's *Texas Energy Summit* to facilitate the technical transfer

2.2 Summary of Progress

The progress toward completing each task is provided in the following section and throughout this report.

Task 1: Obtain input from public/private stakeholders.

Legislation passed during the regular session of the 79th Legislature directed the Energy Systems Laboratory to work with the TCEQ to develop a methodology for computing emissions reductions attributable to renewable energy and for the ESL to quantify the emissions reductions attributable to renewables for inclusion in the State Implementation Plan (SIP) annually. HB 2921 directed the Texas Environmental Research Consortium (TERC) to engage the Texas Engineering Experiment Station for the development of this methodology.

During the period from January 2021 to December 2021, several presentations were done to report the analysis methodology and the results to interested parties.

- November 2021 – Presentation at the Texas Energy Summit about Emissions Reduction Impact of Renewables, Austin, Texas.

Task 2: Develop a methodology in cooperation with the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency for calculating emissions reductions obtained through wind and other renewable energy resources in Texas.

This task is composed of the following subtasks:

- Review existing methodologies for calculating emissions reductions from wind energy and other renewable energy systems with US EPA, TCEQ, and stakeholders.
- Develop acceptable methodologies for wind and renewables.
- Determine how to implement methodologies for Texas, including the accounting of current installations, future sites, degradation, discounting/uncertainty, grid constraints, etc.
- Review methodologies for verifying wind energy production and renewable energy installations with TCEQ, US EPA, and stakeholders.

- Develop acceptable methodologies for verifying installations, including documentation, EPA Quality Assurance Project Plan (QAPP), etc.
- Develop draft State Guidelines for the TCEQ for EE/RE SIP credits

Task 3: Calculate annual, creditable emissions reductions for wind and other renewable energy resources for inclusion in the State SIP.

This task is composed of the following subtasks:

- Calculate annual emissions from wind and other renewable energy projects; verify annual installations of wind and renewable energy systems in Texas;
- Verify ERCOT historical data for wind production and other renewables

Task 4: Include emissions reductions by county from wind and renewable energy resources in the ESL's annual report to the TCEQ.

This task is composed of the following subtasks:

- Report annual emissions from wind and other renewable energy projects;
- Report on verification of installations of wind and renewable energy systems in Texas;
- Develop documentation for all methods developed

Task 5: Incorporate wind and renewable energy emissions reductions as a component of the ESL's Texas Energy Summit to facilitate the technical transfer.

Additional information regarding the ESL's efforts on Tasks 2, 3, 4 and 5 are listed below and presented in detail in the following sections. This work was performed during the period of January 2021 through December 2021.

- Analysis of wind farms using 2021 data
- Analysis of emissions reduction from wind farms
- Updates of the degradation analysis to include more wind farms
- Analysis of other renewables
- Review of electricity savings and transmission planning study reported by ERCOT

3 ANALYSIS ON POWER PRODUCTION FROM WIND FARMS USING 2021 DATA

3.1 Introduction

Texas is the largest producer of wind energy in the United States. As of December 2021,¹¹ the installed wind turbine capacity totals 36,694 MW in Texas, and it has been announced new projects that will add another 6,530 MW of capacity by the end of 2023.¹² The ERCOT region represents 34,174 MW, which accounts for 93% of the 2021 total capacity installed in Texas. Figure 3-1 shows the monthly electricity generation and capacity installed in the ERCOT region from September 2005 to December 2021. Figure 3-3 to Figure 3-5 shows the location and lists of the completed, announced, and retired wind farms based on the information from the PUCT.

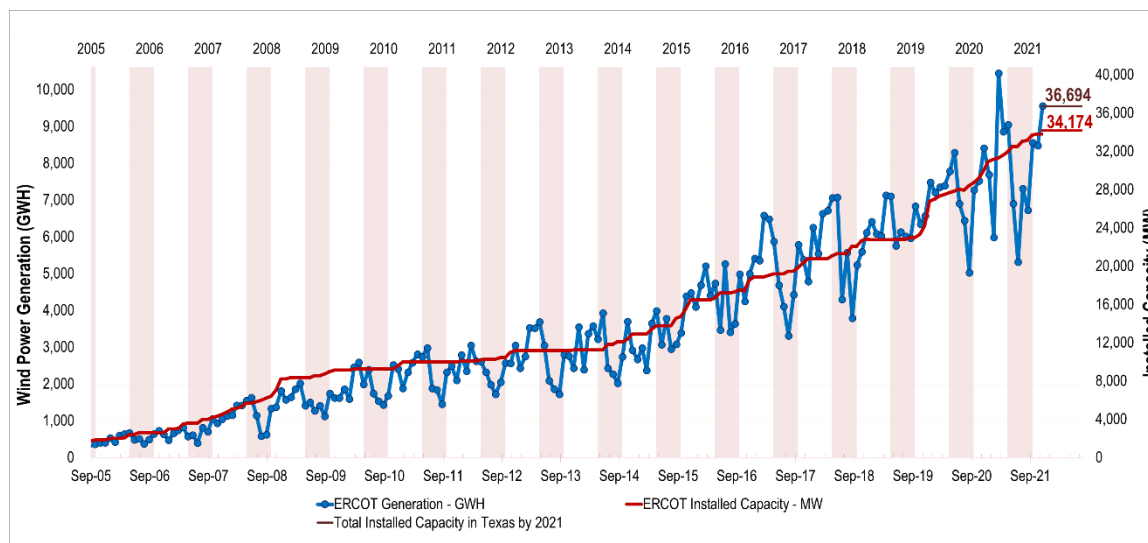


Figure 3-1: Installed Wind Power Capacity and Power Generation in the ERCOT Region from September 2005 to December 2021

In Section 3.2, a summary of wind power production for all wind farms in the Texas ERCOT region is presented. In order to weather normalize the wind power generation of the wind farms, linear regression models are developed for each wind farm that has been in operation in 2021. As shown in Figure 3-2, the model coefficients for each wind farm are obtained from these regression models using the 2021 daily power generation data of the corresponding wind farm and the 2021 daily wind speed data of the most representative ERCOT weather zone among the five ERCOT zones. The model is then used to estimate the wind power generation using the 2018 wind speed data. The weather normalized modeled power generation allows the comparison of the wind power generation of each wind farm in different years. In addition, a comparison between the annual and OSP wind power generation from the previous report and this report is presented.

An uncertainty analysis was also performed on all the daily regression models and included in this report to show the accuracy of applying the OSP and non-OSP linear regression models to predict the wind power generation that the wind farms would have had in the base year of 2018. The detailed analysis for each wind farm is provided in Volume II, Appendix A.

¹¹ Wind project information obtained from the Public Utility Commission of Texas (www.puc.texas.gov) as of 1/15/2022 and the Electric Reliability Council of Texas (ERCOT) as of June 2022.

¹² There are two announced projects in the SPP region, Grand Prairie Wind 2 and Grand Prairie Wind 3 (total 511 MW) that did not have the county identified in the PUCT data. Therefore, these wind farms were excluded from announced projects list in this report.

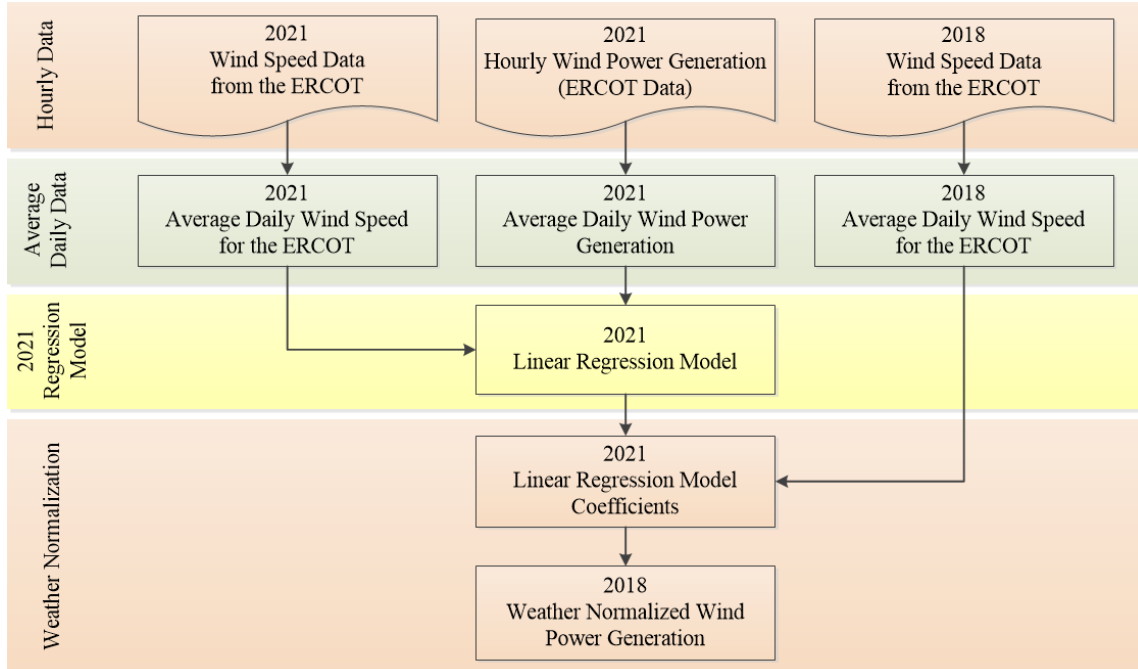


Figure 3-2: Procedure for the 2018 Annual and OSP Weather Normalized Wind Power Generation for Each Wind Farm in Operation in 2021 in Texas ERCOT Region

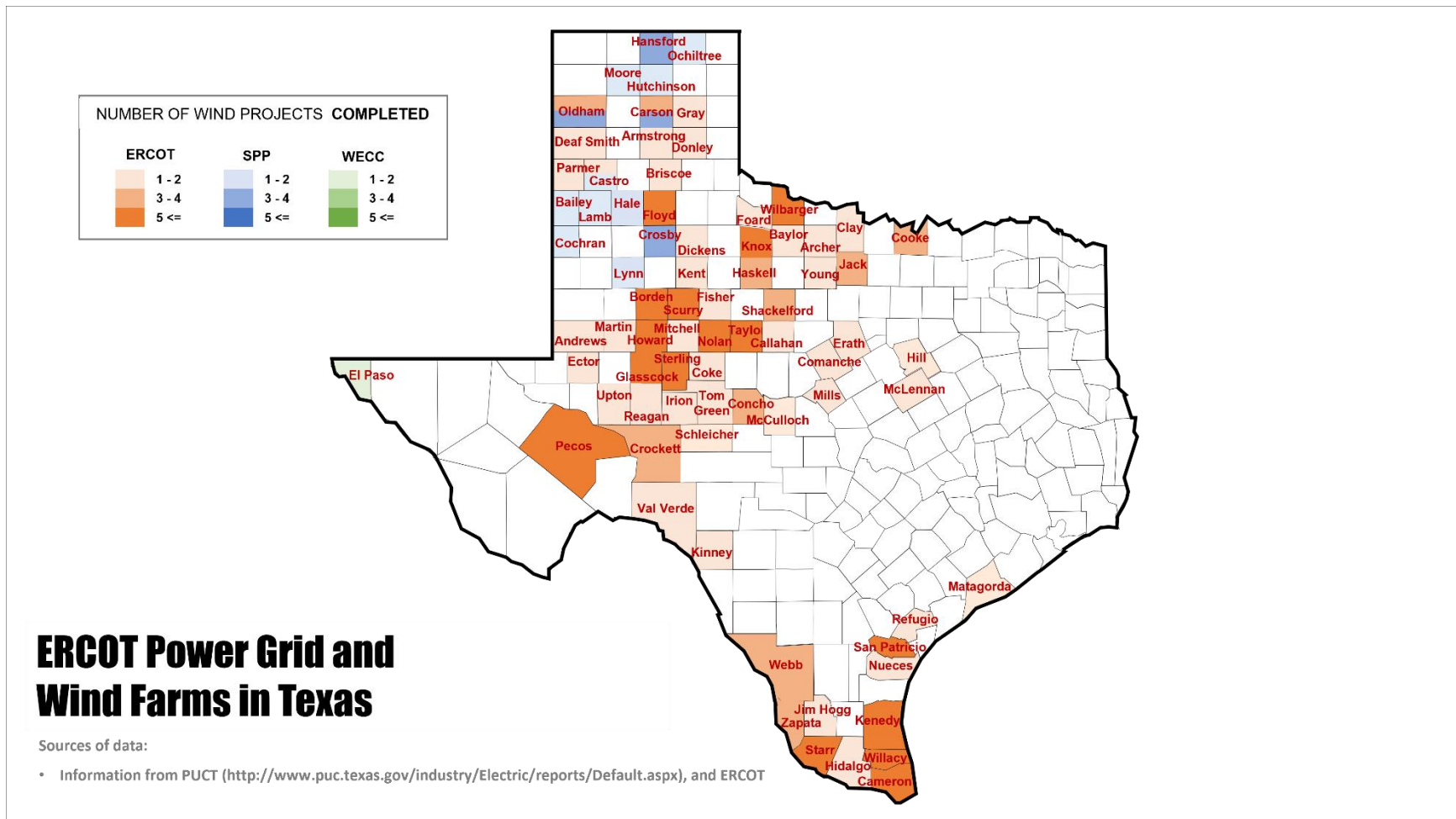


Figure 3-3: Completed Wind Projects in Texas

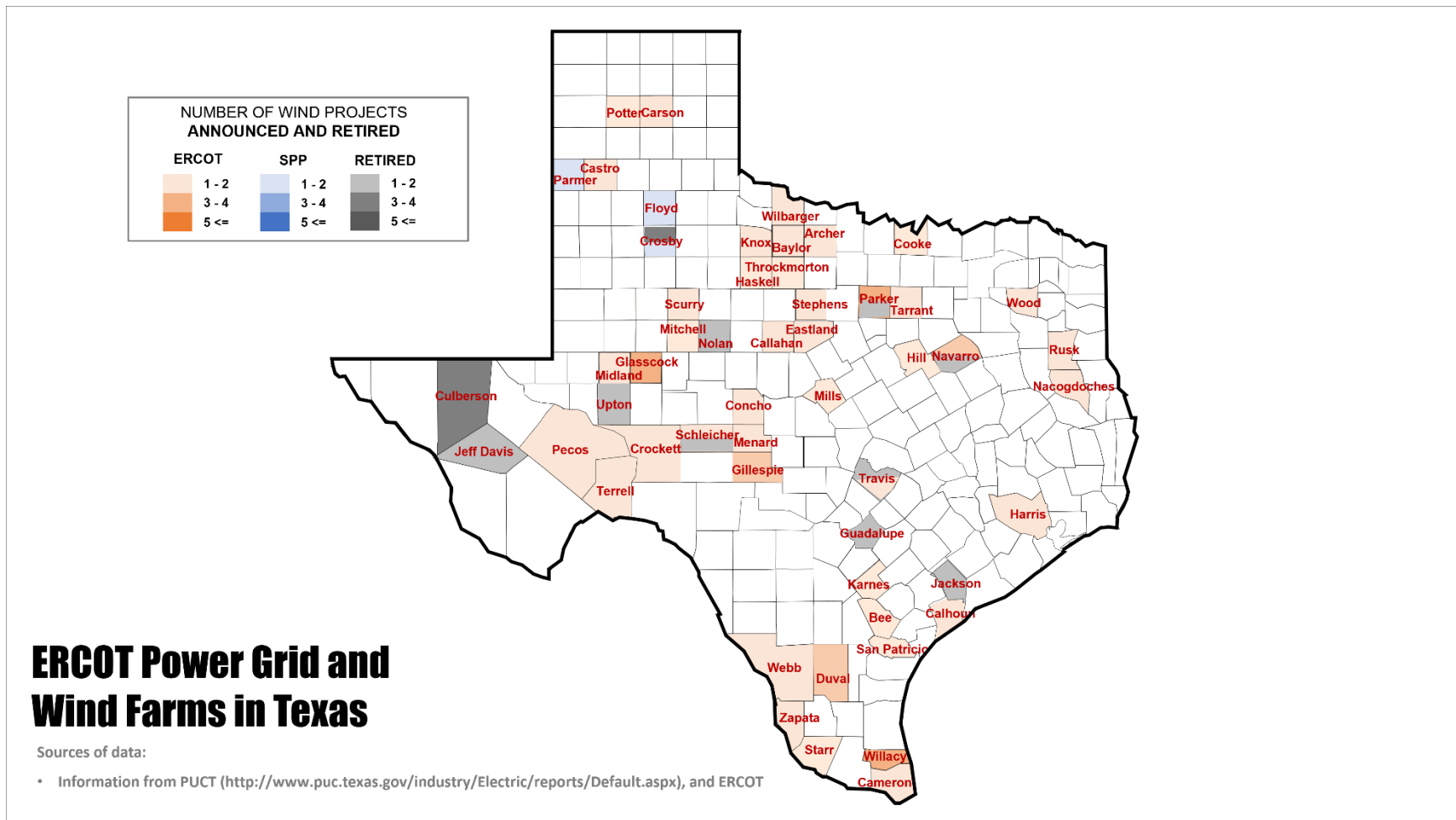


Figure 3-4: Announced and Retired Wind Projects in Texas

WIND PROJECTS COMPLETED :**ERCOT Region - 34,174 MW**

1. Andrews, Barrow Ranch Wind, 160.7 MW, Sep-21
2. Archer, Windthorst 2, 67.6 MW, Dec-14
3. ArmstroGas, Route66 Wind, 150 MW, Aug-15
4. Baylor, S. Hills Wind, 30.2 MW, Aug-19
5. Borden, Red Canyon 1, 89.6 MW, May-06
6. Borden, Bull Creek Wind Plant, 178 MW, Nov-08
7. Borden, Stephens Ranch Wind Phase 1, 211.2 MW, Dec-14
8. Borden, Mesquite Creek W, 211.2 MW, Apr-15
9. Borden, Stephens Ranch Wind Phase b, 164.7 MW, May-15
10. Borden, Gopher Creek Wind, 158 MW, Mar-20
11. Briscoe, LoGashorn Energy Center North, 200 MW, Sep-15
12. Briscoe, Briscoe Wind, 149.8 MW, Nov-15
13. Callahan, Baird North Wind, 345 MW, Feb-22
14. Cameron, Cameron County Wind, 165 MW, Jan-16
15. Cameron, San Roman Wind 1, 95.2 MW, Feb-17
16. Cameron, Palmas Altas Wind, 144.9 MW, Nov-20
17. Cameron, Espiritu Wind, 25.2 MW, Jun-21
18. Cameron, Chalupa Wind, 173.3 MW, Jun-21
19. Carson, Panhandle Wind 1, 218.4 MW, Jul-14
20. Carson, Panhandle Wind 2, 190.8 MW, Nov-14
21. Carson, Grandview Phase 1 (Conway Windfarm), 211.2 MW, Dec-14
22. Carson, Calbeck's Corner, 200.4 MW, May-16
23. Castro, Jumbo Road Wind (Hereford 2), 299.8 MW, Apr-15
24. Clay, Bobcat Bluff, 162 MW, Mar-13
25. Clay, Shannon Wind, 204.1 MW, Dec-15
26. Coke, Aviator Wind, 525 MW, Jun-21
27. Coke, White Mesa 2 Wind, 348.3 MW, Jan-22
28. Comanche, Logan's Gap Wind I, 210.1 MW, Sep-15
29. Comanche, Flat Top Wind I, 200 MW, Sep-18
30. Concho, Panther Creek 3, 199.5 MW, Aug-09
31. Concho, Maverick Creek I Wind, 373.2 MW, Jan-22
32. Concho, Maverick Creek II Wind, 118.8 MW, Jan-22
33. Concho, Cactus Flats Wind, 148.4 MW, Jun-22
34. Cooke, Wolf Ridge Windfarm, 112.5 MW, Oct-08
35. Cooke, Tyler Bluff Wind (Muenster Wind), 125.6 MW, Dec-16
36. Cooke, WILDWIND, 180.1 MW, Dec-21
37. Crockett, Rancho Wind, 300 MW, May-20
38. Crockett, High Lonesome Wind, 449.7 MW, Jul-21
39. Crockett, High Lonesome Wind Phase II, 50.6 MW, Jul-21
40. Crockett, White Mesa Wind, 152.3 MW, Jan-22
41. Deaf Smith, Hereford Wind Project (Hereford 1), 199.9 MW, May-15
42. Deaf Smith, Falvez Astra Wind, 163.2 MW, May-17
43. Dickens, McAdoo Wind Energy, 150 MW, May-08
44. Dickens, Wake Wind, 257.2 MW, Oct-16
45. Donley and Gray, Salt Fork Wind, 174 MW, Dec-16
46. Ector, Notrees Windpower, 152.6 MW, Jan-09
47. Erath, BUCKTHORN WIND, 100.6 MW, Dec-17
48. Erath, Silver Star Phase I, 52.8 MW, Mar-08
49. Fisher, WKN Amadeus Wind, 250.2 MW, Apr-21
50. Fisher, Whitehorse Wind, 418.9 MW, Sep-20
51. Floyd, Whirlwind, 57 MW, Dec-07
52. Floyd, South Plains Wind I, 200 MW, Nov-15
53. Floyd, South Plains Wind II Phase a, 148.5 MW, Jun-16
54. Floyd, South Plains Wind II Phase b, 151.8 MW, Jun-16
55. Floyd, Old Settler Wind, 151.2 MW, Apr-17
56. Floyd, Cotton Plains Wind, 50.4 MW, Mar-17
57. Foard, Foard City Wind, 350.3 MW, Nov-19
58. Glasscock, Forest Creek Wind Farm, 124.2 MW, Dec-06
59. Glasscock, Sand Bluff Wind Farm, 90 MW, Dec-06
60. Glasscock, RattleSnake Wind Ph 1, 207.3 MW, Sep-15
61. Glasscock, Niels Bohr (BearKat Wind A), 196.6 MW, Feb-18
62. Glasscock, Harald (BearKat Wind B), 162.1 MW, Jan-22
63. Gray, Miami Wind 1 Project, 288.6 MW, Dec-14
64. Haskell, Horse Creek Wind, 230 MW, Jan-17
65. Haskell, Willow Sprigass Wind (SALVTION), 250 MW, Dec-17
66. Haskell, SALVTION (Willow Sprigass Wind), MW, Dec-17
67. Hidalgo, Hidalgo & Starr Wind, 250 MW, Dec-16
68. Hidalgo, Hidalgo II Wind, 50.4 MW, Jul-21
69. Hill, Aquilla Lake Wind, 149.3 MW, Jan-22
70. Hill, Aquilla Lake 2 Wind, 150.8 MW, Jan-22
71. Howard, Big SprigGas Wind Power, 27.7 MW, Feb-99
72. Howard, Big SprigGas Wind Power, 6.6 MW, Jun-99
73. Howard, Panther Creek, 142.5 MW, Jul-08
74. Howard, Ocotillo Windpower 1, 58.8 MW, Aug-08
75. Howard, Elbow Creek repower, 121.9 MW, Feb-21
76. Howard, Panther Creek 2, 115.5 MW, Nov-08
77. Howard, Gunsight Mountain, 119.9 MW, Sep-16
78. HOWARD, Panther Creek, 106.9 MW, Jan-00
79. HOWARD, Panther Creek, 108.5 MW, Jan-00
80. Irion, Oveja Wind, 302.4 MW, Oct-21
81. Jack, Barton Chapel Wind 1, 120 MW, Dec-07
82. Jack, Senate Wind Project, 150 MW, Dec-12
83. Jack, Keechi Wind, 110 MW, Jan-15
84. Jim Hogg, Sendero Wind Energy Project, 78 MW, Dec-15
85. Kenedy, Gulf Wind 1, 283.2 MW, Nov-08
86. Kenedy, Penascal Wind Farm, 160.8 MW, Nov-08
87. Kenedy, Penascal Wind Farm 2, 141.6 MW, Mar-10
88. Kenedy, Baffin Wind Farm (Penascal 3), 202 MW, Jun-16
89. Kenedy, Stella 1 Wind, 201 MW, Dec-18
90. KENEDY, Penascal Wind Farm 2, 100.8 MW, Oct-10
91. Kent, Mozart, 30 MW, Dec-12
92. Kinney, Anacacho Windfarm, 99.8 MW, Dec-12
93. Knox, Green Pastures W, 300 MW, Nov-15
94. Knox, Vera Wind V110, 34 MW, May-21
95. Knox, Vera Wind, 208.8 MW, May-21
96. Knox, Griffin Trail Wind, 225.6 MW, Oct-21
97. Knox, TG East Wind, 336 MW, Mar-22
98. Lynn, Tahoka Wind, 300 MW, Mar-19
99. Lynn, Sage Draw Wind, 338.4 MW, Dec-20
100. Martin, Stanton Wind Energy, 120 MW, Jan-08
101. Matagorda, Peyton Creek Wind, 151.2 MW, Jun-20
102. McCulloch, RTS Wind Project, 160 MW, Sep-18
103. McCulloch, RTS 2 Wind, 179.8 MW, May-21
104. McLennan, Prairie Hill Wind, 300 MW, Dec-21
105. Mills, Goldthwaite Wind Energy, 148.6 MW, Jun-14
106. Mills, Pridy Wind, 302.4 MW, Dec-21
107. Mitchell, Loraine Windpark, 148.5 MW, Oct-09
108. Nolan, Trent Mesa, 156.5 MW, Nov-01
109. Nolan, Sweetwater Wind 1, 42.5 MW, Dec-03
110. Nolan, Sweetwater Wind 2, 127.6 MW, Feb-05
111. Nolan, Sweetwater Wind 3 (Cottonwood Creek), 152.2 MW, Dec-05
112. Nolan, Sweetwater Wind 4 (Cottonwood Creek), 237 MW, May-07
113. Nolan, Sweetwater Wind 5, 85 MW, Dec-07
114. Nolan, Inadale, 197 MW, Nov-08
115. Nolan, Turkey Track Energy Center, 169.5 MW, Nov-08
116. Nolan, Maryneal Wind, 182.4 MW, Dec-21
117. Nueces, Chapman Ranch Wind 1, 249 MW, Oct-17
118. Nueces, Shaffer Wind, 226.1 MW, Jun-21
119. Oldham, SpinniGas Spur Wind II, 161 MW, Jun-14
120. Oldham, SpinniGas Spur Wind III, 194 MW, Oct-15
121. Oldham, Canadian Breaks Wind, 210.1 MW, Dec-19
122. Parmer, Mariah Del Notre, 230.4 MW, Mar-17
123. Pecos, Indian Mesa, 91.8 MW, Jun-01
124. Pecos, Woodward Mountain Ranch, 177.7 MW, Jul-01
125. Pecos, Desert Sky (Indian Mesa II), 209.2 MW, Dec-01
126. Pecos, Sherbino Mesa Wind Farm 2, 132 MW, Nov-11
127. Reagan, HICKMAN, 300 MW, May-18
128. Refugio, Cranel Wind, 220 MW, Mar-22
129. San Patricio, Papalote Creek Wind Farm, 179.9 MW, Sep-09
130. San Patricio, Papalote Creek Phase II, 200.1 MW, Jun-10
131. San Patricio, Midway Wind, 162.8 MW, Jun-19
132. San Patricio, Karankawa Wind, 206.6 MW, Dec-19
133. San Patricio, Karankawa 2 Wind, 100.4 MW, Dec-19
134. Schleicher, Wilson Ranch, 199.5 MW, Apr-20
135. Scurry, Brazos Wind Ranch, 160 MW, Dec-03
136. Scurry, Camp SprigGas I, 130.5 MW, Jul-07
137. Scurry, Champion Wind Farm, 126.5 MW, Jan-08
138. Scurry, Roscoe Wind Farm 1, 209 MW, Jan-08
139. Scurry, Camp SprigGas II, 120 MW, Jun-08
140. Scurry, Pyron, 249 MW, Nov-08
141. Scurry, Dermott Wind 1, 253 MW, Aug-17
142. Scurry, Fluvanna Renewable 1, 155.4 MW, Nov-17
143. Scurry, Coyote Wind, 242.6 MW, Dec-21
144. Shackleford, Lone Star - Mesquite Wind, 194 MW, Dec-07
145. Shackleford, Lone Star - Post Oak Wind, 198 MW, May-08
146. Shackleford, Hackberry Wind Farm, 163.5 MW, Nov-08
147. Starr, Los Vientos III, 200 MW, Dec-15
148. Starr, Los Vientos IV, 200 MW, Jun-16
149. Starr, Los Vientos V, 110 MW, Sep-16
150. Starr, Cabezon Wind, 237.6 MW, Dec-19

Figure 3-5: A List of Completed, Announced and Retired Wind Projects in Texas

<p>151. Starr, Venado Wind, 201.6 MW, Dec-21 152. Starr, Mesteno Wind, 201.6 MW, Mar-22 153. Sterling, Capricorn Ridge Wind, 381.2 MW, Sep-07 154. Sterling, Capricorn Ridge Wind (exp), 322.4 MW, May-08 155. Sterling, Goat Wind, 80 MW, Apr-08 156. Sterling, Goat Wind Phase 2, 69.6 MW, Apr-09 157. Taylor, Callahan Divide Wind Energy Center, 123.1 MW, Feb-05 158. Taylor, Buffalo Gap 1, 120.6 MW, Sep-05 159. Taylor, Horse Hollow Phase 1, 230 MW, Oct-05 160. Taylor, Horse Hollow Phase 2, 184 MW, May-06 161. Taylor, Horse Hollow Phase 3, 241.4 MW, Sep-06 162. Taylor, Buffalo Gap 2 (Cirello 1), 232.5 MW, Aug-07 163. Taylor, Buffalo Gap 3, 170.2 MW, Apr-08 164. Taylor, South Trent Wind Farm, 98.2 MW, Oct-08 165. TAYLOR, HORSE HOLLOW WIND 4, 115 MW, May-06 166. Tom Green, LaGasford Wind Power, 160 MW, Oct-09 167. Upton, KiGas Mountain Wind Ranch, 279.6 MW, Dec-01 168. Val Verde, Val Verde Wind , 149.3 MW, Oct-17 169. Webb, Cedro Hill Wind, 150 MW, Oct-10 170. Webb, Whitetail Wind Project, 92.3 MW, Dec-12 171. Webb, Torrecillas Wind, 300.5 MW, Nov-19 172. Wilbarger, Blue Summit Wind, 133.1 MW, Dec-12 173. Wilbarger, Electra Wind, 230 MW, Jan-17 174. Wilbarger, Lockett Wind, 183.7 MW, Sep-19 175. Wilbarger, Blue Summit II, 96.4 MW, Apr-20 176. Wilbarger, Blue Summit III, 195.8 MW, May-20 177. Wilbarger, Ajax Wind, 366.6 MW, Dec-21 178. Willacy, Magic Valley Wind, 203.3 MW, Apr-12 179. Willacy, Los Vientos I, 200.1 MW, Jan-13 180. Willacy, Los Vientos II, 201.6 MW, Jan-13 181. Willacy, BBREEZE (BruenniGas's Breeze), 228 MW, Dec-17 182. Willacy, East Raymond Wind (El Rayo), 194 MW, Jun-21 183. Willacy, West Raymond (Trueno) Wind, 239.8 MW, Oct-21 184. Willacy, Las Majadas Wind , 272.6 MW, Nov-21 185. YouGas, Trinity Hills Wind Farm, 198 MW, Jan-12 186. Zapata, Javelina Wind, 249.7 MW, Dec-15 187. Zapata, Javelina 2 Wind, 200 MW, Feb-17 188. Zapata, Reloj Del Sol Wind, 209.3 MW, Jan-22</p> <p>SPP Region - 2,519 MW</p> <p>WIND PROJECTS COMPLETED :</p> <p>189. Carson, Llano Estacado Wind Ranch, 79 MW, Jan-02 190. Hansford, , 3 MW, Dec-03 191. Oldham, Wildorado Wind Ranch, 161 MW, Apr-07 192. Hansford, Noble Great Plains Windpark, 114 MW, Feb-09 193. Moore, Sunray Wind I, II, III, 49.5 MW, Aug-09 194. Hansford, JD Wind 1-7, 9-11, Wege, 189.8 MW, Dec-09 195. Carson, Majestic Wind, 79.5 MW, Dec-09 196. Hutchinson, Little PriGasle 1, 2, 20 MW, Sep-10 197. Crosby, Ralls Wind Farm, 10 MW, Jul-11 198. Oldham, GS Panhandle Wind Ranch, 78 MW, Sep-11</p>	<p>199. Hansford, Frisco Wind Farm, 20 MW, Feb-12 200. Lynn, Cirrus Wind Energy, 61.2 MW, Dec-12 201. Carson, Majestic Wind II, 79.6 MW, Dec-12 202. Oldham, SpinniGas Spur Wind Ranch, 161 MW, Dec-12 203. Carson, Pantex Wind Farm, 11.5 MW, Jun-14 204. Ochltree, Palo Duro Wind, 250 MW, Dec-14 205. Crosby, Pleasant Hill Wind Energy, 20 MW, Oct-15 206. Castro, Bethel Wind Energy Facility, 276 MW, Jan-17 207. Cochran, Wildcat Ranch Wind Project, 150.5 MW, Dec-18 208. Crosby, Fiber Winds Energy Project, 78.8 MW, Dec-18 209. Bailey and Lamb, Blue Cloud Renewable Energy, 148.4 MW, Dec-18 210. Hale, Hale Community Energy, 478 MW, Jun-19</p> <p>WECC Region - 1 MW</p> <p>211. El Paso, Hueco Mountain Wind Ranch, 1.3 MW, Apr-01</p> <p>WIND PROJECTS ANNOUNCED :</p> <p>ERCOT Region – 6,230 MW</p> <ol style="list-style-type: none"> 1. <i>Sterling, Capricorn I & III repower, 32 MW, Dec-21</i> 2. <i>Young, Trinity Hills Wind repower, -27 MW, Dec-21</i> 3. <i>Pecos, Woodward 2 repower, 0 MW, Dec-21</i> 4. <i>Nolan, Trent repower, 6.4 MW, Jan-22</i> 5. <i>Pecos, Desert Sky repower, 7.2 MW, Jan-22</i> 6. <i>Eastland, Anchor Wind, 114.9 MW, Feb-22</i> 7. <i>Taylor, Horse13 CallD repower, 44 MW, Feb-22</i> 8. <i>Taylor, HHGT repower Horse13+CallD, 44 MW, Feb-22</i> 9. <i>Sterling, Capricorn IV repower, 9 MW, Feb-22</i> 10. <i>Pecos, Indian Mesa repower, 0 MW, Feb-22</i> 11. <i>Pecos, Woodward I repower, 0 MW, Feb-22</i> 12. <i>Haskell, Apogee Wind, 393.24 MW, Mar-22</i> 13. <i>Throckmorton, Vortex Wind, 336.15 MW, Mar-22</i> 14. <i>Nolan, Sweetwater 2 repower, 7.3 MW, Mar-22</i> 15. <i>Nolan, Sweetwater 1 repower, 3 MW, Mar-22</i> 16. <i>San Patricio, El Algodan Alto W, 201 MW, Apr-22</i> 17. <i>Bee, Blackjack Creek Wind, 240.5 MW, Apr-22</i> 18. <i>Eastland, Anchor Wind II, 148.02 MW, Apr-22</i> 19. <i>Willacy, El Sauz Ranch, 301.5 MW, Sep-22</i> 20. <i>Bee, Foxtrot Wind, 268.2 MW, Oct-22</i> 21. <i>Scurry, Canyon Wind, 360 MW, Oct-22</i> 22. <i>Glasscock, Edmondson Ranch Wind, 301.3 MW, Oct-22</i> 23. <i>Navarro, Board Creek WP, 299.2 MW, Nov-22</i> 24. <i>La Salle, Loma Pinta Wind , 200 MW, Dec-22</i> 25. <i>Eastland, Roadrunner Crossing Wind, 200.2 MW, Dec-22</i> 26. <i>Castro, Hart Wind, 151.5 MW, Dec-22</i> 27. <i>Wharton, Crawfish, 163.2 MW, Dec-22</i> 28. <i>Potter, CAROL wind, 169.2 MW, Dec-22</i> 29. <i>Glasscock, Kontiki 1 Wind (ERIK), 250.1 MW, Mar-23</i> 30. <i>Glasscock, Kontiki 2 Wind (ERNEST), 250.1 MW, Mar-23</i> 31. <i>Upton, Appaloosa Run Wind, 175 MW, Mar-23</i> 	<p>32. Midland, Hutt Wind , 336 MW, Apr-23 33. Mitchell, Loraine Windpark Phase III, 100 MW, May-23 34. Armstrong, Goodnight Wind, 506.6 MW, Jun-23 35. Callahan, Sheep Creek Wind , 151.5 MW, Jun-23 36. Throckmorton, Monarch Creek Wind, 209 MW, Dec-23 37. Willacy, Monte Alto I, 223.8 MW, Dec-23</p> <p>SPP Region – 300 MW</p> <p>38. Crosby and Floyd, Cone Renewable Energy Project, 300 MW, Dec-2023</p> <p>WIND PROJECTS RETIRED :</p> <p>ERCOT Region - 417 MW</p> <ol style="list-style-type: none"> 1. Culberson, Delaware Mountain Wind Farm, 30 MW, Jun-05 2. Jeff Davis, Fort Davis Wind Farm, 6.6 MW, Jun-05 3. Pecos, Sherbino 1 Wind, 150 MW, Sep-08 4. Scurry, Snyder Wind, 63 MW, Jun-05 5. Upton, West Texas Wind Farm, 80.3 MW, Jan-00 6. Culberson, Windpower Partners 1994 - Kunitz, 39 MW, Jan-00 7. Hall, Wolf Flats Wind, 1 MW, Jan-00 8. Culberson, Texas Wind Power Project, 35 MW, Oct-95 9. Upton, Southwest Mesa Wind Project, 1.3 MW, Jun-99 10. Nueces, Harbor Wind Project, 9 MW, Mar-12 11. NOLAN, TSTC West Texas Wind, 2 MW, Jul-05 <p>Note:</p> <ul style="list-style-type: none"> The capacity for the “Trinity Hills Wind repower” announced project was reported (-27 MW) in the PUCT list. There are two announced projects in the SPP region that their locations (county) were not identified in the PUCT list. Therefore, these wind farm are excluded from SSP region’s announced list: <ul style="list-style-type: none"> Grand Prairie Wind 2, 210 MW, Dec-2022 Grand Prairie Wind 3, 301 MW, Dec-2022
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Figure 3-5: A List of Completed, Announced and Retired Wind Projects in Texas (Continued)

3.2 Summary of Wind Power Production for All Wind Farms in the Texas ERCOT Region

Table 3-1 shows the summary of the 2021 measured power production for the wind farms that were operating in the year of 2021 in the Texas ERCOT region and the modeled wind power production using daily regression models and wind speed data from 2018 (Volume II, Appendix A). This table includes annual generations, OSP generations, wind power capacity, wind zone, and CL zone for all wind farms operated for more than six months in Texas. The power generation in 2021 of Snyder Wind, Sherbino 1 Wind, and Sand Bluff Wind Farm have been reduced over 50% compared to last year.

Table 3-2 shows the monthly average wind speed across five ERCOT weather zones in 2018 (new base year) and 2021, which are mainly used for the wind modeling analysis. For this year, the average wind speed of ERCOT weather zones was used for data processing.

As shown in Figure 3-6 and Figure 3-7, the modeled annual wind power production using 2018 wind speed data (110,993,597 MWh/yr) is higher by about 16.1% when compared to what was measured in 2021 (93,119,496 MWh/yr)¹³. For the OSP, the modeled average daily power production using 2018 wind speed data is 324,011 MWh/day, which is 28.8 % higher than that measured in 2021 (230,679 MWh/day)¹². This is because, for the modeling analysis of this year, the average wind speed of ERCOT for the year 2021 is used for the analysis of most wind farms and more wind power was produced in the OSP. The OSP in this year's report includes the period from May 1st to September 30th.

Figure 3-8 presents the comparison of the 2021 measured annual wind power production against the modeled annual wind power production using 2018 wind speed data for each wind farm. Figure 3-9 shows the difference between the 2021 measured average daily power production and the modeled average daily wind power production using 2018 wind speed data during the OSP for each wind farm.

¹³ This value reflects the total power generation for all windfarms operated for more than six months in 2021.

Table 3-1: Summary of Annual Power Production for All Wind Farms Operated for more than 6 months in 2021

Wind Unit Name	Facility Name	County	Capacity (MW)	ERCOT Wind Zone	CL Zone	Wind Power for 2018 Predicted		Wind Power for 2021 Measured	
						Annual (MWh/yr)	OSP (MWh/day)	Annual (MWh/yr)	OSP (MWh/day)
AMADEUS1_UNIT1	WKN Amadeus Wind	FISHER	36.7	WEST	W	125,054	332	115,997	252
AMADEUS1_UNIT2	WKN Amadeus Wind	FISHER	35.8	WEST	W	107,702	296	98,307	223
AMADEUS2_UNIT3	WKN Amadeus Wind	FISHER	177.7	WEST	W	636,941	1,664	542,507	1,221
ANACACHO_ANA	Anacacho Windfarm	KINNEY	99.8	SOUTH	S	400,794	1,281	315,312	928
ASTRA_UNIT1	Falvez Astra Wind	DEAF SMITH	163.2	PANHANDLE	W	624,599	2,255	435,258	1,355
AVIATOR_UNIT1	Aviator Wind	COKE	180.1	WEST	W	660,112	1,868	608,179	1,395
AVIATOR_UNIT2	Aviator Wind	COKE	145.6	WEST	W	552,937	1,596	508,373	1,201
BAFFIN_UNIT1	Baffin Wind Farm (Penascal 3)	KENEDEY	100.0	COASTAL	S	250,192	708	219,632	556
BAFFIN_UNIT2	Baffin Wind Farm (Penascal 3)	KENEDEY	102.0	COASTAL	S	251,937	735	220,348	574
BARROW_UNIT1	Barrow Ranch Wind	ANDREWS	90.2	WEST	W	351,786	943	328,306	781
BARROW_UNIT2	Barrow Ranch Wind	ANDREWS	70.5	WEST	W	267,799	691	256,545	587
BBREEZE_UNIT1	BBREEZE (BruenniGas's Breeze)	WILLACY	120.0	COASTAL	S	332,919	805	291,018	621
BBREEZE_UNIT2	BBREEZE (BruenniGas's Breeze)	WILLACY	108.0	COASTAL	S	310,936	768	271,870	594
BCATWIND_WND_1	Bobcat Bluff	ARCHER	162.0	WEST	W	561,290	1,500	517,316	1,120
BLSUMMIT_BLSMT1_5	Blue Summit Wind	WILBARGER	8.8	WEST	W	26,013	83	20,745	65
BLSUMMIT_BLSMT1_6	Blue Summit Wind	WILBARGER	124.3	WEST	W	430,079	1,176	395,970	904
BLSUMMIT_UNIT2_17	Blue Summit Wind 2	WILBARGER	6.7	WEST	W	23,102	75	20,226	58
BLSUMMIT_UNIT2_25	Blue Summit Wind 2	WILBARGER	89.7	WEST	W	371,534	1,071	327,973	826
BLSUMMIT3_UNIT_17	Blue Summit III	WILBARGER	13.4	WEST	W	53,657	157	45,243	120
BLSUMMIT3_UNIT_25	Blue Summit III	WILBARGER	182.4	WEST	W	793,747	2,322	669,584	1,801
BORDAS_JAVEL18	Javelina Wind	WEBB	19.7	SOUTH	S	81,354	252	59,139	162
BORDAS_JAVEL20	Javelina Wind	WEBB	230.0	SOUTH	S	1,167,807	3,558	867,513	2,335
BORDAS2_JAVEL2_A	Javelina 2 Wind	WEBB	96.0	SOUTH	S	492,235	1,492	362,578	965
BORDAS2_JAVEL2_B	Javelina 2 Wind	WEBB	74.0	SOUTH	S	383,201	1,160	281,377	747
BORDAS2_JAVEL2_C	Javelina 2 Wind	WEBB	30.0	SOUTH	S	160,138	484	119,419	319
BRAZ_WND_WND1	Brazos Wind Ranch	SCURRY	99.0	WEST	W	152,433	483	135,843	360
BRAZ_WND_WND2	Brazos Wind Ranch	SCURRY	61.0	WEST	W	116,469	379	103,499	285
BRISCOE_WIND	Briscoe Wind	BRISCOE	149.8	PANHANDLE	W	397,587	1,330	297,393	861
BRTSW_BCW1	Barton Chapel Wind 1	JACK	120.0	NORTH	N	276,239	796	243,670	539
BUCKTHRN_UNIT1	Buckthorn Wind	ERATH	44.9	NORTH	N	170,129	526	147,361	340
BUCKTHRN_UNIT2	Buckthorn Wind	ERATH	55.7	NORTH	N	229,053	700	199,937	466
BUFF_GAP_UNIT1	Buffalo Gap 1	TAYLOR	120.6	WEST	W	305,445	832	279,558	609
BUFF_GAP_UNIT2_1	Buffalo Gap 2 (Cirello 1)	TAYLOR	115.5	WEST	W	267,400	793	240,856	582
BUFF_GAP_UNIT2_2	Buffalo Gap 2 (Cirello 1)	TAYLOR	117.0	WEST	W	258,122	786	231,579	577
BUFF_GAP_UNIT3	Buffalo Gap 3	TAYLOR	170.2	WEST	W	354,449	1,057	315,303	765
BULLCRK_WND1	Bull Creek Wind Plant	BORDEN	88.0	WEST	W	129,666	342	119,583	257
BULLCRK_WND2	Bull Creek Wind Plant	BORDEN	90.0	WEST	W	147,046	402	122,111	300
CABEZON_WIND1	Cabezon Wind	STARR	115.2	SOUTH	S	449,896	1,361	325,041	870
CABEZON_WIND2	Cabezon Wind	STARR	122.4	SOUTH	S	495,033	1,530	360,191	987
CALLAHAN_WND1	Callahan Divide Wind Energy Center	CALLAHAN	114.0	WEST	W	441,026	1,296	406,531	987
CAMWIND_UNIT1	Cameron County Wind	CAMERON	165.0	COASTAL	S	481,000	1,244	417,266	963
CAPRIDG4_CR4	Capricorn Ridge Wind (exp)	COKE	121.5	WEST	W	387,244	1,101	352,813	811
CAPRIDGE_CR1	Capricorn Ridge Wind	STERLING	231.7	WEST	W	776,411	2,197	718,813	1,632
CAPRIDGE_CR2	Capricorn Ridge Wind	STERLING	149.5	WEST	W	455,334	1,339	417,530	990
CAPRIDGE_CR3	Capricorn Ridge Wind (exp)	STERLING	200.9	WEST	W	602,977	1,717	553,225	1,280
CEDROHIL_CHW1	Cedro Hill Wind	WEBB	75.0	SOUTH	S	334,355	1,032	241,930	660
CEDROHIL_CHW2	Cedro Hill Wind	WEBB	75.0	SOUTH	S	305,980	936	217,993	584
CFLATS_U1	Cactus Flats Wind	CONCHO	148.4	WEST	W	468,554	1,319	433,462	1,028
CHALUPA_UNIT1	Chalupa Wind	CAMERON	173.3	COASTAL	S	363,304	848	298,553	724
CHALUPA_UNIT2	Chalupa Wind	CAMERON	25.2	COASTAL	S	52,014	124	42,719	106
CHAMPION_UNIT1	Champion Wind Farm	NOLAN	126.5	WEST	W	342,375	965	313,897	714
CN_BRKS_UNIT_1	Canadian Breaks Wind	OLDHAM	210.1	PANHANDLE	W	1,210,607	3,758	825,558	2,155
COTPLNS_COTTONPL	Cotton Plains Wind	FLOYD	50.4	PANHANDLE	W	273,195	739	193,520	427
COTPLNS_OLDSETLR	Old Settler Wind	FLOYD	151.2	PANHANDLE	W	668,471	2,212	475,022	1,270
COYOTE_W_UNIT1	Coyote Wind Farm	SCURRY	90.0	WEST	W	242,449	728	220,703	541
COYOTE_W_UNIT2	Coyote Wind Farm	SCURRY	26.6	WEST	W	74,717	197	68,086	142
COYOTE_W_UNIT3	Coyote Wind Farm	SCURRY	126.0	WEST	W	364,826	1,153	330,076	858
COTTON_PAP2	Papalote Creek Phase II	SAN PATRICIO	200.1	COASTAL	S	485,789	1,343	421,626	1,045
CRANELL_UNIT1	Cranell Wind	REFUGIO	220.0	COASTAL	S	677,908	1,691	584,131	1,328
CSEC_CSECG1	Camp Springs I	SCURRY	130.5	WEST	W	277,414	829	252,405	652
CSEC_CSECG2	Camp Springs II	SCURRY	120.0	WEST	W	235,347	685	214,015	535
DERMOTT_UNIT1	Dermott Wind 1	SCURRY	126.5	WEST	W	511,110	1,423	467,016	1,047
DERMOTT_UNIT2	Dermott Wind 1	SCURRY	126.5	WEST	W	509,462	1,451	464,295	1,068
DEWOLF_UNIT1	DEWOLF EAST	COKE	199.3	WEST	W	760,972	2,213	674,638	1,671
DIGBY_UNIT1	Electra Wind	WILBARGER	98.9	WEST	W	434,928	1,229	379,191	956
DIGBY_UNIT2	Electra Wind	WILBARGER	131.1	WEST	W	544,023	1,547	488,175	1,197
EL_RAYO_UNIT1	EAST RAYMOND WIND (EL RAYO) U1	WILLACY	98.0	COASTAL	S	377,943	986	333,401	781
EL_RAYO_UNIT2	EAST RAYMOND WIND (EL RAYO) U2	WILLACY	96.0	COASTAL	S	364,156	951	319,784	748
ELB_ELBCCREEK	Elbow Creek Wind	HOWARD	121.9	WEST	W	454,342	1,272	422,572	970
EXGNSND_WIND_1	Sendero Wind Energy Project	JIM HOGG	78.0	SOUTH	S	382,014	1,211	281,353	820
EXGNWTL_WIND_1	Whitetail Wind Project	WEBB	92.3	SOUTH	S	326,436	1,007	235,723	649
FERMI_WIND1	Val Verde Wind	VAL VERDE	121.9	WEST	S	402,567	1,282	372,959	1,050
FERMI_WIND2	Val Verde Wind	VAL VERDE	27.4	WEST	S	105,614	329	98,553	274
FLTCK_SSI	Silver Star Phase I	ERATH	52.8	NORTH	N	240,165	727	210,503	493
FLUVANNA_UNIT1	Fluvanna Renewable 1	SCURRY	79.8	WEST	W	330,747	941	301,839	697
FLUVANNA_UNIT2	Fluvanna Renewable 1	SCURRY	75.6	WEST	W	307,284	865	282,135	652
FOARDCTY_UNIT1	Foard City Wind	FOARD	186.5	WEST	W	712,634	1,928	654,835	1,458

Table 3-1: Summary of Annual Power Production for All Wind Farms Operated for more than 6 months in (Continued)

Wind Unit Name	Facility Name	County	Capacity (MW)	ERCOT Wind Zone	CL Zone	Wind Power for 2018 Predicted		Wind Power for 2021 Measured	
						Annual (MWh/yr)	OSP (MWh/day)	Annual (MWh/yr)	OSP (MWh/day)
FOARDCTY_UNIT2	Foard City Wind	FOARD	163.8	WEST	W	629,177	1,749	573,940	1,305
FTWIND_UNIT_1	Flat Top Wind I	MILLS	200.0	NORTH	N	787,251	2,215	706,350	1,638
GOAT_GOATWIND	Goat Wind	STERLING	80.0	WEST	W	147,094	491	128,756	362
GOAT_GOATWIN2	Goat Wind	STERLING	69.6	WEST	W	138,429	449	121,903	337
GOPHER_UNIT1	Gopher Creek Wind	BORDEN	82.0	WEST	W	334,927	976	306,812	745
GOPHER_UNIT2	Gopher Creek Wind	BORDEN	76.0	WEST	W	318,875	959	291,335	740
GPASTURE_WIND_I	Green Pastures W	BAYLOR	150.0	WEST	W	477,399	1,557	399,920	1,150
GRANDVW1_COLA	Colbeck's Corner	CARSON	100.2	PANHANDLE	W	606,972	1,859	412,685	1,061
GRANDVW1_COLB	Colbeck's Corner	CARSON	100.2	PANHANDLE	W	603,916	1,839	410,129	1,046
GRANDVW1_GV1A	Grandview Phase 1 (Conway Windfarm)	CARSON	107.4	PANHANDLE	W	630,206	1,861	432,194	1,071
GRANDVW1_GV1B	Grandview Phase 1 (Conway Windfarm)	CARSON	103.8	PANHANDLE	W	595,915	1,762	413,210	1,031
GUNMTN_G1	Gunsight Mountain	HOWARD	119.9	WEST	W	505,832	1,421	467,303	1,100
GWEC_GWEC_G1	Goldthwaite Wind Energy	MILLS	148.6	NORTH	N	551,504	1,560	490,675	1,054
HARALD_UNIT1	Harald (BearKat Wind B)	GLASSCOCK	162.1	WEST	W	576,787	1,725	528,271	1,311
H_HOLLOW_WND1	Horse Hollow Phase 1	TAYLOR	230.0	WEST	W	765,175	2,105	704,045	1,563
HHOLLOW2_WND1	Horse Hollow Phase 2	TAYLOR	184.0	WEST	W	603,128	1,748	549,407	1,256
HHOLLOW3_WND_1	Horse Hollow Phase 3	TAYLOR	241.0	WEST	W	734,568	2,090	673,653	1,531
HHOLLOW4_WND1	Horse Hollow Phase 4	TAYLOR	115.0	WEST	W	418,746	1,154	385,346	857
HI_LONE_WGR1A	High Lonesome W	CROCKETT	46.0	WEST	W	175,954	561	152,852	454
HI_LONE_WGR1B	High Lonesome W	CROCKETT	52.0	WEST	W	162,756	563	140,897	452
HI_LONE_WGR1C	High Lonesome W	CROCKETT	25.3	WEST	W	105,426	333	91,278	268
HI_LONE_WGR3	High Lonesome W	CROCKETT	127.6	WEST	W	408,287	1,315	369,020	1,021
HI_LONE_WGR4	High Lonesome W	CROCKETT	101.6	WEST	W	330,624	1,087	300,221	864
HI_LONE_WGR2	High Lonesome Wind Phase II	CROCKETT	122.5	WEST	W	397,480	1,380	345,436	1,108
HI_LONE_WGR2A	High Lonesome Wind Phase II	CROCKETT	25.3	WEST	W	108,389	332	99,260	268
HICKMAN_G1_J01	HICKMAN (SANTA RITA WIND) 1	REAGAN	76.3	WEST	W	333,052	957	309,968	760
HICKMAN_G1_J02	HICKMAN (SANTA RITA WIND) 1	REAGAN	76.3	WEST	W	328,904	957	304,592	760
HICKMAN_G2_J01	HICKMAN (SANTA RITA WIND) 2	REAGAN	73.8	WEST	W	322,154	963	297,347	755
HICKMAN_G2_J02	HICKMAN (SANTA RITA WIND) 2	REAGAN	73.8	WEST	W	318,378	963	292,439	755
HORSECRK_UNIT1	Horse Creek Wind	HASKELL	131.1	WEST	W	530,343	1,502	463,403	1,105
HORSECRK_UNIT2	Horse Creek Wind	HASKELL	98.9	WEST	W	401,942	1,158	355,699	867
HRFDWIND_JRDWIND1	Jumbo Road Wind (Hereford 2)	DEAF SMITH	146.2	PANHANDLE	W	704,573	1,991	483,470	1,132
HRFDWIND_JRDWIND2	Jumbo Road Wind (Hereford 2)	DEAF SMITH	153.6	PANHANDLE	W	735,924	2,080	502,125	1,174
HRFDWIND_WIND_G	Hereford Wind Project (Hereford 1)	DEAF SMITH	99.9	PANHANDLE	W	404,519	1,260	274,956	733
HRFDWIND_WIND_V	Hereford Wind Project (Hereford 1)	DEAF SMITH	100.0	PANHANDLE	W	517,934	1,697	353,088	982
HWF_HWFG1	Hackberry Wind Farm	SHACKELFORD	163.5	WEST	W	418,089	1,209	384,360	945
INDL_INADALE1	Inadale	NOLAN	95.0	WEST	W	248,944	704	225,384	504
INDL_INADALE2	Inadale	NOLAN	102.0	WEST	W	261,375	723	237,566	510
INDNENR_INDENR	Desert Sky Wind Power Project	PECOS	85.1	WEST	W	242,386	816	221,132	640
INDNENR_INDENR_2	Desert Sky Wind Power Project	PECOS	85.1	WEST	W	242,629	796	221,647	621
INDNENR_UNIT_1B	Desert Sky Wind Power Project	PECOS	24.0	WEST	W	81,427	260	75,013	206
INDNENR_UNIT_2B	Desert Sky Wind Power Project	PECOS	15.0	WEST	W	49,804	165	45,474	130
INDNWP_INDNNWP2	Indian Mesa	PECOS	91.8	WEST	W	239,522	798	218,167	614
KARAKAW1_UNIT1	Karakawa Wind	SAN PATRICIO	103.3	COASTAL	S	350,306	874	310,723	694
KARAKAW1_UNIT2	Karakawa Wind	SAN PATRICIO	103.3	COASTAL	S	352,928	873	312,213	686
KARAKAW2_UNIT3	Karakawa 2 Wind	SAN PATRICIO	100.4	COASTAL	S	340,755	838	302,446	661
KEECHI_U1	Keechi Wind	JACK	110.0	NORTH	N	455,474	1,285	405,997	875
KEO_SHRBINO2	Sherbino Mesa Wind Farm 2	PECOS	132.0	WEST	W	581,302	1,960	535,630	1,687
KING_NE_KINGNE	King Mountain Wind Ranch	UPTON	79.7	WEST	W	148,262	450	137,250	345
KING_NW_KINGNW	King Mountain Wind Ranch	UPTON	79.7	WEST	W	173,460	545	161,550	438
KING_SE_KINGSE	King Mountain Wind Ranch	UPTON	40.5	WEST	W	61,588	186	56,253	139
KING_SW_KINGSW	King Mountain Wind Ranch	UPTON	79.7	WEST	W	170,860	546	158,458	440
LGD_LANGFORD	Langford Wind Power	TOM GREEN	160.0	WEST	W	629,812	1,770	585,434	1,378
LGW_UNIT1	Logan's Gap Wind I	COMANCHE	106.3	NORTH	N	379,850	1,060	337,516	700
LGW_UNIT2	Logan's Gap Wind I	COMANCHE	103.8	NORTH	N	355,441	1,016	312,323	660
LHORN_N_UNIT1	Longhorn Energy Center North	FLOYD	100.0	PANHANDLE	W	533,303	1,442	371,161	819
LHORN_N_UNIT2	Longhorn Energy Center North	FLOYD	100.0	PANHANDLE	W	552,521	1,525	383,277	865
LMAJADAS_UNIT1	Las Majadas	WILLACY	110.0	COASTAL	S	368,703	1,045	322,830	825
LMAJADAS_UNIT2	Las Majadas	WILLACY	24.0	COASTAL	S	73,549	209	63,404	164
LMAJADAS_UNIT3	Las Majadas	WILLACY	138.6	COASTAL	S	440,848	1,236	385,540	976
LNCRK_G83	Lone Star - Mesquite Wind	SHACKELFORD	194.0	WEST	W	512,154	1,366	476,687	1,030
LOCKETT_UNIT1	Lockett Wind Farm	WILBARGER	183.7	WEST	W	823,400	2,415	741,188	1,879
LNCRK2_G871	Lone Star - Post Oak Wind	SHACKELFORD	98.0	WEST	W	252,828	694	235,363	534
LNCRK2_G872	Lone Star - Post Oak Wind	SHACKELFORD	100.0	WEST	W	260,390	699	242,789	541
LONEWOLF_G1	Lorraine Windpark	MITCHELL	48.0	WEST	W	119,645	367	108,265	281
LONEWOLF_G2	Lorraine Windpark	MITCHELL	51.0	WEST	W	114,362	345	103,420	262
LONEWOLF_G3	Lorraine Windpark	MITCHELL	25.5	WEST	W	66,464	204	60,103	156
LONEWOLF_G4	Lorraine Windpark	MITCHELL	24.0	WEST	W	57,287	176	51,609	134
LV1_LV1A	Los Vientos I	WILLACY	200.1	COASTAL	S	478,626	1,171	364,980	925
LV2_LV2	Los Vientos II	WILLACY	201.6	COASTAL	S	519,961	1,324	444,222	1,013
LV3_UNIT_1	Los Vientos III	STARR	200.0	SOUTH	S	916,327	2,770	639,769	1,668
LV4_UNIT_1	Los Vientos IV	STARR	200.0	SOUTH	S	946,168	2,936	659,972	1,782
LV5_UNIT_1	Los Vientos V	STARR	110.0	SOUTH	S	459,966	1,452	322,662	890
MARIAH_NORTE1	Mariah Del Norte	PARMER	115.2	PANHANDLE	W	595,977	1,725	423,027	1,034
MARIAH_NORTE2	Mariah Del Norte	PARMER	115.2	PANHANDLE	W	604,250	1,806	424,953	1,064
MAVCRK_E_UNITS	Maverick Creek I W	CONCHO	71.4	WEST	W	247,058	804	224,833	634
MAVCRK_E_UNIT6	Maverick Creek I W	CONCHO	33.3	WEST	W	129,519	367	116,097	287
MAVCRK_E_UNIT7	Maverick Creek I W	CONCHO	22.0	WEST	W	81,936	236	73,174	185
MAVCRK_E_UNIT8	Maverick Creek I W	CONCHO	20.0	WEST	W	69,417	195	61,391	150
MAVCRK_E_UNIT9	Maverick Creek I W	CONCHO	76.8	WEST	W	216,680	628	164,426	494

Table 3-1: Summary of Annual Power Production for All Wind Farms Operated for more than 6 months in (Continued)

Wind Unit Name	Facility Name	County	Capacity (MW)	ERCOT Wind Zone	CL Zone	Wind Power for 2018 Predicted		Wind Power for 2021 Measured	
						Annual (MWh/yr)	OSP (MWh/day)	Annual (MWh/yr)	OSP (MWh/day)
MAVCRK_W_UNIT1	Maverick Creek II W	CONCHO	201.6	WEST	W	691,174	2,155	615,232	1,705
MAVCRK_W_UNIT2	Maverick Creek II W	CONCHO	11.1	WEST	W	39,109	110	34,566	84
MAVCRK_W_UNIT3	Maverick Creek II W	CONCHO	33.6	WEST	W	118,797	359	105,232	279
MAVCRK_W_UNIT4	Maverick Creek II W	CONCHO	22.2	WEST	W	81,342	227	72,514	174
MARYNEAL_UNIT1	Maryneal Wind	NOLAN	182.4	WEST	W	349,453	453	184,823	353
MCDLD_FCW1	Forest Creek Wind Farm	GLASSCOCK	124.2	WEST	W	300,020	936	271,736	702
MCDLD_SBW1	Sand Bluff Wind Farm	GLASSCOCK	90.0	WEST	W	67,564	228	60,274	181
MESQCRK_WND1	Mesquite Creek W	DAWSON	105.6	WEST	W	336,636	895	315,716	707
MESQCRK_WND2	Mesquite Creek W	DAWSON	105.6	WEST	W	342,044	934	311,373	698
MESTENO_UNIT_1	Mesteno Wind	STARR	201.6	SOUTH	S	487,107	1,556	400,504	1,182
MIAM1_G1	Miami Wind 1 Project	GRAY	144.3	PANHANDLE	W	751,335	2,169	506,821	1,249
MIAM1_G2	Miami Wind 1 Project	GRAY	144.3	PANHANDLE	W	744,976	2,228	512,406	1,266
MIDWIND_UNIT1	Midway Wind	SAN PATRICIO	162.8	COASTAL	S	511,342	1,366	445,058	1,056
MIRASOLE_MIR11	Hidalgo & Starr Wind	HIDALGO	52.0	SOUTH	S	192,367	651	140,919	407
MIRASOLE_MIR12	Hidalgo & Starr Wind	HIDALGO	98.0	SOUTH	S	371,471	1,246	273,204	777
MIRASOLE_MIR13	HIDALGO II WIND	HIDALGO	50.4	SOUTH	S	165,973	550	121,391	336
MIRASOLE_MIR21	Hidalgo & Starr Wind	HIDALGO	100.0	SOUTH	S	352,013	1,169	258,953	722
MOZART_WIND_1	Mozart	KENT	30.0	WEST	W	63,309	173	58,527	134
MWEC_G1	McAdoo Wind Energy	DICKENS	150.0	PANHANDLE	W	526,441	1,652	399,032	1,044
NBOHR_UNIT1	Niels Bohr (BearKat Wind A)	GLASSCOCK	196.6	WEST	W	675,361	2,055	616,676	1,549
NWF_NWF1	Notrees 1A (Vestas)	WINKLER	92.6	WEST	W	209,495	679	196,046	593
NWF_NWF2	Notrees 1B (GE Energy)	WINKLER	60.0	WEST	W	135,679	434	126,237	376
OVEJA_G1	Oveja Wind	IRION	151.2	WEST	W	662,861	1,988	603,821	1,560
OVEJA_G2	Oveja Wind	IRION	151.2	WEST	W	654,626	1,972	594,156	1,541
OWF_OWF	Ocotillo Windpower 1	HOWARD	58.8	WEST	W	41,235	107	37,921	83
PALMWIND_UNIT1	Palmas Altas Wind	CAMERON	144.9	COASTAL	S	301,554	827	271,773	685
PAP1_PAP1_J01	Papalote Creek Wind Farm	SAN PATRICIO	50.9	COASTAL	S	124,176	341	108,465	265
PAP1_PAP1_J02	Papalote Creek Wind Farm	SAN PATRICIO	129.0	COASTAL	S	387,205	1,026	335,040	784
PC_NORTH_PANTHER1	Panther Creek	HOWARD	142.5	WEST	W	567,208	1,610	527,129	1,238
PC_SOUTH_PANTHER2	Panther Creek 2	HOWARD	115.5	WEST	W	441,603	1,244	408,853	939
PC_SOUTH_PANTHER3	Panther Creek 3	Sterling	215.4	WEST	W	561,863	1,346	530,531	1,019
PENA_UNIT1	Penascal Wind Farm	KENEDY	160.8	COASTAL	S	225,623	697	206,784	605
PENA_UNIT2_J01	Penascal Wind Farm	KENEDY	70.8	COASTAL	S	105,817	339	91,771	264
PENA_UNIT2_J02	Penascal Wind Farm	KENEDY	70.8	COASTAL	S	116,985	372	102,674	296
PENA3_UNIT3	Penascal Wind Farm 2	KENEDY	100.8	COASTAL	S	143,015	443	129,433	381
PEY_UNIT1	Peyton Creek Wind	MATAGORDA	151.2	COASTAL	S	412,864	901	368,675	700
PH1_UNIT1	Panhandle Wind 1	CARSON	109.2	PANHANDLE	W	468,593	1,669	317,584	933
PH1_UNIT2	Panhandle Wind 1	CARSON	109.2	PANHANDLE	W	443,758	1,557	303,733	887
PH2_UNIT1	Panhandle Wind 2	CARSON	94.2	PANHANDLE	W	461,762	1,726	320,885	1,017
PH2_UNIT2	Panhandle Wind 2	CARSON	96.6	PANHANDLE	W	468,385	1,768	324,208	1,039
PHILLWIND_UNIT1	Prairie Hill Wind	LIMESTONE	153.0	NORTH	N	427,047	1,222	374,808	792
PHILLWIND_UNIT2	Prairie Hill Wind	LIMESTONE	147.0	NORTH	N	437,091	1,279	381,559	825
PYR_PYRON1	Pyron	NOLAN	121.5	WEST	W	349,403	967	319,595	703
PYR_PYRON2	Pyron	NOLAN	127.5	WEST	W	365,502	1,010	334,165	736
RANCHERO_UNIT1	Ranchero	CROCKETT	150.0	WEST	W	641,026	2,036	588,204	1,601
RANCHERO_UNIT2	Ranchero Wind	CROCKETT	150.0	WEST	W	642,806	2,005	592,519	1,598
RDCANYON_RDCNY1	Red Canyon 1	BORDEN	89.6	WEST	W	347,068	1,008	318,243	762
REDFISH_MV1A	Magic Valley Wind	WILLACY	99.8	COASTAL	S	280,710	730	249,506	586
REDFISH_MV1B	Magic Valley Wind	WILLACY	103.5	COASTAL	S	290,580	755	256,661	600
RELOJ_UNIT1	Reloj del Sol	ZAPATA	55.4	SOUTH	S	163,235	618	122,063	429
RELOJ_UNIT2	Reloj del Sol	ZAPATA	48.0	SOUTH	S	166,719	624	128,805	426
RELOJ_UNIT3	Reloj del Sol	ZAPATA	83.1	SOUTH	S	224,040	862	155,229	603
RELOJ_UNIT4	Reloj del Sol	ZAPATA	22.8	SOUTH	S	71,666	242	44,760	168
ROUTE_66_WIND1	Route66 Wind	CARSON	150.0	PANHANDLE	W	650,748	2,619	461,846	1,615
RSNAKE_G1	RattleSnake Wind Ph 1	GLASSCOCK	104.3	WEST	W	296,717	826	274,068	647
RSNAKE_G2	RattleSnake Wind Ph 1	GLASSCOCK	103.0	WEST	W	318,611	899	293,992	710
RTS_U1	RTS WIND	MCCULLOCH	160.0	SOUTH	S	743,821	2,015	548,537	1,292
RTS2_U1	RTS 2 Wind	MCCULLOCH	89.9	SOUTH	S	410,065	1,114	307,985	708
RTS2_U2	RTS 2 Wind	MCCULLOCH	89.9	SOUTH	S	445,295	1,226	337,212	787
SAGEDRAW_UNIT1	Sage Draw Wind	LYNN	169.2	WEST	W	678,005	1,872	607,910	1,435
SAGEDRAW_UNIT2	Sage Draw Wind	LYNN	169.2	WEST	W	649,633	1,748	581,854	1,325
SALTFORK_UNIT1	Salt Fork Wind	Gray	64.0	PANHANDLE	W	367,890	1,037	255,185	585
SALTFORK_UNIT2	Salt Fork Wind	Gray	110.0	PANHANDLE	W	636,530	1,803	435,809	1,005
SALVTION_UNIT1	Willow Springs Wind	HASKELL	125.0	WEST	W	503,574	1,401	461,667	1,062
SALVTION_UNIT2	Willow Springs Wind	HASKELL	125.0	WEST	W	500,132	1,392	460,325	1,054
SANROMAN_WIND_1	San Roman Wind 1	CAMERON	95.2	COASTAL	S	221,380	524	200,286	436
SANTACRU_UNIT1	Chapman Ranch Wind 1	NUECES	150.6	COASTAL	S	418,022	1,032	365,859	795
SANTACRU_UNIT2	Chapman Ranch Wind 1	NUECES	98.4	COASTAL	S	292,185	752	254,581	579
SENATEWD_UNIT1	Senate Wind Project	JACK	150.0	NORTH	N	541,332	1,531	480,065	1,003
SGMTN_SIGNALM2	Big Spring Wind Power	HOWARD	6.6	WEST	W	11,961	34	10,729	24
SGMTN_SIGNALMT	Big Spring Wind Power	HOWARD	27.7	WEST	W	54,231	141	49,753	101
SHAFFER_UNIT1	Shaffer Wind	NUECES	226.1	COASTAL	S	648,147	1,617	564,351	1,248
SHANNONW_UNIT_1	Shannon Wind	CLAY	204.1	WEST	W	579,598	1,573	534,670	1,226
SPLAIN1_WIND1	South Plains Wind I	FLOYD	102.0	PANHANDLE	W	437,720	1,277	304,732	789
SPLAIN1_WIND2	South Plains Wind I	FLOYD	98.0	PANHANDLE	W	445,919	1,322	311,437	819
SPLAIN2_WIND21	South Plains Wind II Phase a	FLOYD	148.5	PANHANDLE	W	706,861	2,066	480,236	1,151
SPLAIN2_WIND22	South Plains Wind II Phase b	FLOYD	151.8	PANHANDLE	W	718,383	2,061	484,525	1,116
SRWE1_SRWE2	Stephens Ranch Wind Phase b	BORDEN	164.7	WEST	W	572,962	1,532	527,063	1,136
SRWE1_UNIT1	Stephens Ranch Wind Phase 1	BORDEN	211.2	WEST	W	781,983	2,131	721,551	1,614

Table 3-1: Summary of Annual Power Production for All Wind Farms Operated for more than 6 months in (Continued)

Wind Unit Name	Facility Name	County	Capacity (MW)	ERCOT Wind Zone	CL Zone	Wind Power for 2018 Predicted		Wind Power for 2021 Measured	
						Annual (MWh/yr)	OSP (MWh/day)	Annual (MWh/yr)	OSP (MWh/day)
SSPURTWO_SS3WIND1	Spinning Spur Wind III	OLDHAM	96.0	PANHANDLE	W	557,296	1,684	389,102	1,010
SSPURTWO_SS3WIND2	Spinning Spur Wind III	OLDHAM	98.0	PANHANDLE	W	578,979	1,782	411,380	1,103
SSPURTWO_WIND_1	Spinning Spur Wind II	OLDHAM	161.0	PANHANDLE	W	844,697	2,601	583,250	1,554
STELLA_UNIT1	Stella 2 Wind	KENEDY	201.0	COASTAL	S	642,268	1,735	544,798	1,365
STWF_T1	South Trent Wind Farm	NOLAN	98.2	WEST	W	292,593	871	263,582	647
S_HILLS_UNIT1	Seymour Hills Wind	BAYLOR	30.2	WEST	W	151,189	429	139,767	342
SWEC_G1	Stanton Wind Energy	MARTIN	120.0	WEST	W	247,430	766	225,801	614
SWEETWN2_WND2	Sweetwater Wind 2	NOLAN	110.8	WEST	W	411,639	1,208	377,906	896
SWEETWN2_WND24	Sweetwater Wind 2	NOLAN	16.8	WEST	W	49,966	140	45,819	99
SWEETWN3_WND3A	Sweetwater Wind 3 (Cottonwood Creek)	NOLAN	33.6	WEST	W	118,737	337	109,826	253
SWEETWN3_WND3B	Sweetwater Wind 3 (Cottonwood Creek)	NOLAN	118.6	WEST	W	400,929	1,154	370,135	864
SWEETWN4_WND4A	Sweetwater 4a	NOLAN	125.0	WEST	W	330,990	920	305,755	665
SWEETWN4_WND4B	Sweetwater 4b	NOLAN	112.0	WEST	W	300,631	832	279,451	611
SWEETWN5_WND5	Sweetwater 5	NOLAN	85.0	WEST	W	192,305	590	172,525	441
SWEETWIND_WND1	Sweetwater Wind 1	NOLAN	42.5	WEST	W	150,977	446	138,970	333
TAHOKA_UNIT_1	Tahoka Wind	LYNN	150.0	WEST	W	623,592	1,709	557,427	1,308
TAHOKA_UNIT_2	Tahoka Wind	LYNN	150.0	WEST	W	639,975	1,770	571,845	1,351
TGW_T1	Gulf Wind 1	KENEDY	141.6	COASTAL	S	291,400	1,058	247,468	856
TGW_T2	Gulf Wind 1	KENEDY	141.6	COASTAL	S	368,375	1,246	318,063	1,006
TKWSW1_ROSCOE	Roscoe Wind Farm 1	NOLAN	114.0	WEST	W	291,699	834	266,033	600
TKWSW1_ROSCOE2A	Roscoe Wind Farm 1	NOLAN	95.0	WEST	W	231,414	649	211,474	465
TORR_UNIT1_25	Torreillas Wind	WEBB	150.0	SOUTH	S	743,650	2,272	549,394	1,495
TORR_UNIT2_23	Torreillas Wind	WEBB	23.0	SOUTH	S	106,304	315	77,169	199
TORR_UNIT2_25	Torreillas Wind	WEBB	127.5	SOUTH	S	629,240	1,892	469,680	1,253
TRENT_TRENT	Trent Mesa Wind	NOLAN	38.3	WEST	W	145,452	428	131,060	318
TRENT_UNIT_1B	Trent Mesa Wind	NOLAN	15.6	WEST	W	67,296	210	60,456	164
TRENT_UNIT_2	Trent Mesa Wind	NOLAN	50.5	WEST	W	176,510	523	161,670	386
TRENT_UNIT_3A	Trent Mesa Wind	NOLAN	38.3	WEST	W	141,668	420	130,216	313
TRENT_UNIT_3B	Trent Mesa Wind	NOLAN	13.8	WEST	W	54,755	170	49,666	135
TRINITY_TH1_BUS1	Trinity Hills Wind Farm	ARCHER	103.4	WEST	W	451,759	1,263	417,564	972
TRINITY_TH1_BUS2	Trinity Hills Wind Farm	ARCHER	94.6	WEST	W	418,984	1,170	385,769	892
TRUENO_UNIT1	West Raymond	WILLACY	116.6	COASTAL	S	289,185	829	195,790	678
TRUENO_UNIT2	West Raymond	WILLACY	123.2	COASTAL	S	246,305	769	199,298	645
TTWEC_G1	Turkey Track Energy Center	NOLAN	169.5	WEST	W	388,044	1,163	351,375	886
TYLRWIND_UNIT1	Tyler Bluff Wind (Muenster Wind)	COOKE	125.6	NORTH	N	414,943	1,189	354,196	731
VENADO_UNIT1	Venado Wind	ZAPATA	105.0	SOUTH	S	400,258	1,371	284,737	876
VENADO_UNIT2	Venado Wind	ZAPATA	96.6	SOUTH	S	369,432	1,279	263,483	819
VERAWIND_UNIT1	Vera Wind	KNOX	12.0	WEST	W	46,542	133	42,325	99
VERAWIND_UNIT2	Vera Wind	KNOX	7.2	WEST	W	22,477	57	18,936	43
VERAWIND_UNIT3	Vera Wind	KNOX	100.8	WEST	W	408,785	1,157	374,898	885
VERAWIND_UNIT4	Vera Wind	KNOX	22.0	WEST	W	91,605	264	83,319	198
VERAWIND_UNIT5	Vera Wind	KNOX	100.8	WEST	W	384,298	1,049	355,007	807
VERTIGO_WIND_I	Green Pastures W	BAYLOR	150.0	WEST	W	474,340	1,395	429,918	1,044
WAKEWE_G1_J01	Wake Wind	DICKENS	59.0	PANHANDLE	W	340,874	978	248,753	590
WAKEWE_G1_J02	Wake Wind	DICKENS	55.9	PANHANDLE	W	322,308	925	235,209	558
WAKEWE_G2_J01	Wake Wind	DICKENS	73.0	PANHANDLE	W	400,666	1,134	292,106	681
WAKEWE_G2_J02	Wake Wind	DICKENS	68.3	PANHANDLE	W	378,843	1,072	276,200	644
WEC_WECG1	Whirlwind	FLOYD	57.0	PANHANDLE	W	232,299	701	155,831	405
WHIMESA_UNIT1	White Mesa wind	CROCKETT	152.3	WEST	W	0	0	216,100	863
WH_WIND_UNIT1	Whitehorse Wind	FISHER	209.4	WEST	W	644,411	1,706	569,129	1,246
WH_WIND_UNIT2	Whitehorse Wind	FISHER	209.5	WEST	W	682,231	1,869	633,682	1,394
WHTTAIL_WR1	Wolf Ridge Windfarm	COOKE	112.5	NORTH	N	434,001	1,276	371,846	777
WILDWIND_UNIT1	Wildcat Creek	COOKE	18.4	NORTH	N	53,508	183	36,915	115
WILDWIND_UNIT2	Wildcat Creek	COOKE	48.0	NORTH	N	109,633	259	56,152	174
WILDWIND_UNIT4	Wildcat Creek	COOKE	54.6	NORTH	N	149,949	483	110,433	317
WILDWIND_UNIT5	Wildcat Creek	COOKE	52.8	NORTH	N	113,910	208	61,412	137
WL_RANCH_UNIT1	Wilson Ranch Win	SCHLEICHER	199.5	WEST	W	842,419	2,341	779,318	1,805
WINDTHST2_UNIT1	Windthorst 2	ARCHER	67.6	WEST	W	229,507	601	213,494	462
WOODWRD1_WOODWRD1	Woodward Mountain Ranch	PECOS	91.7	WEST	W	186,015	615	166,216	466
WOODWRD2_WOODWRD2	Woodward Mountain Ranch	PECOS	86.0	WEST	W	152,753	486	138,471	376

Table 3-2: Summary of 2018 and 2021 Monthly Average Wind Speed for Five ERCOT Weather Zones

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	OSP Average
		2018	2021	2018	2021	2018	2021	2018	2021	2018	2021	2018	2021		
Wind Speed COASTAL (mph)	2018	11.8	12.3	11.8	12.5	12.5	13.0	10.8	11.8	9.0	11.7	10.9	11.7	11.7	11.4
	2021	10.4	11.9	13.4	13.0	12.3	9.9	8.9	9.9	9.6	10.1	10.4	11.4	10.9	10.1
Wind Speed NORTH (mph)	2018	13.2	12.0	11.3	14.0	16.5	17.6	12.6	11.0	8.5	11.1	12.9	12.9	12.8	13.2
	2021	11.0	11.4	14.5	12.8	11.3	11.0	9.8	10.1	10.7	10.3	14.2	18.6	12.1	10.6
Wind Speed PANHANDLE (mph)	2018	17.4	17.4	18.2	19.7	18.3	19.1	13.7	15.3	14.8	14.5	16.1	15.4	16.7	10.2
	2021	12.7	11.2	14.8	14.2	13.0	10.8	9.4	11.1	13.3	14.6	14.0	17.9	13.1	11.5
Wind Speed SOUTH (mph)	2018	11.6	11.9	13.6	13.8	14.8	13.5	11.8	13.7	10.4	12.4	10.9	11.6	12.5	10.2
	2021	11.6	11.4	12.7	11.2	11.5	10.5	9.4	9.5	8.7	9.5	9.3	9.8	10.4	9.9
Wind Speed WEST (mph)	2018	11.6	11.9	13.6	13.8	14.8	13.5	11.8	13.7	10.4	12.4	10.9	11.6	12.5	12.8
	2021	12.4	10.2	14.8	13.0	12.4	11.3	9.6	11.2	11.7	12.9	12.2	12.9	12.0	11.2

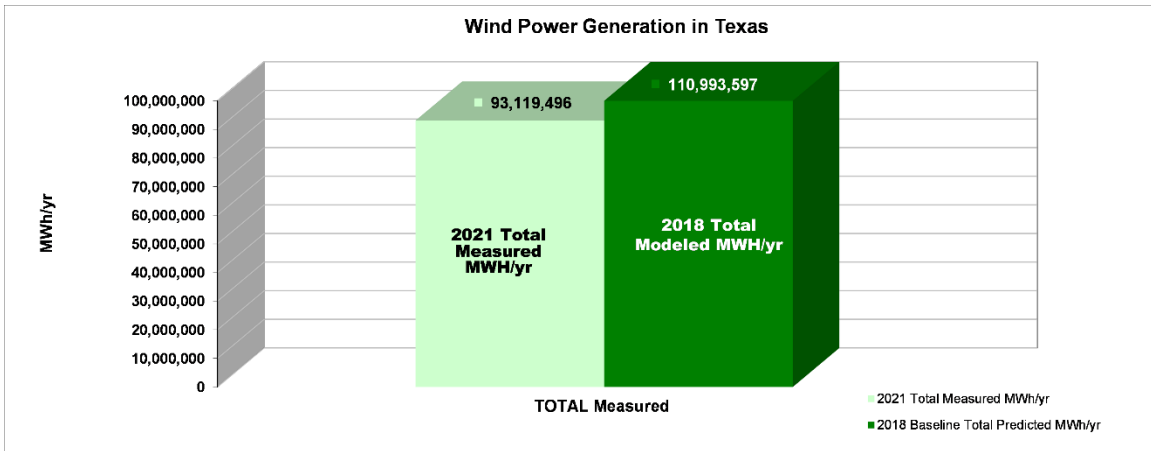


Figure 3-6: Comparison of Total 2021 Measured and 2018 Modeled Power Production

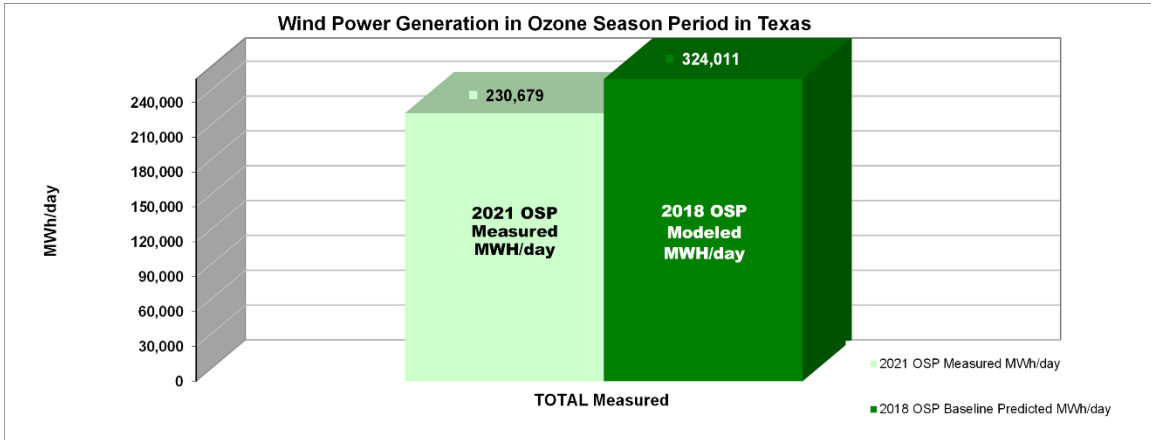


Figure 3-7: Comparison of Total 2021 OSP Measured and 2018 OSP Modeled Power Production

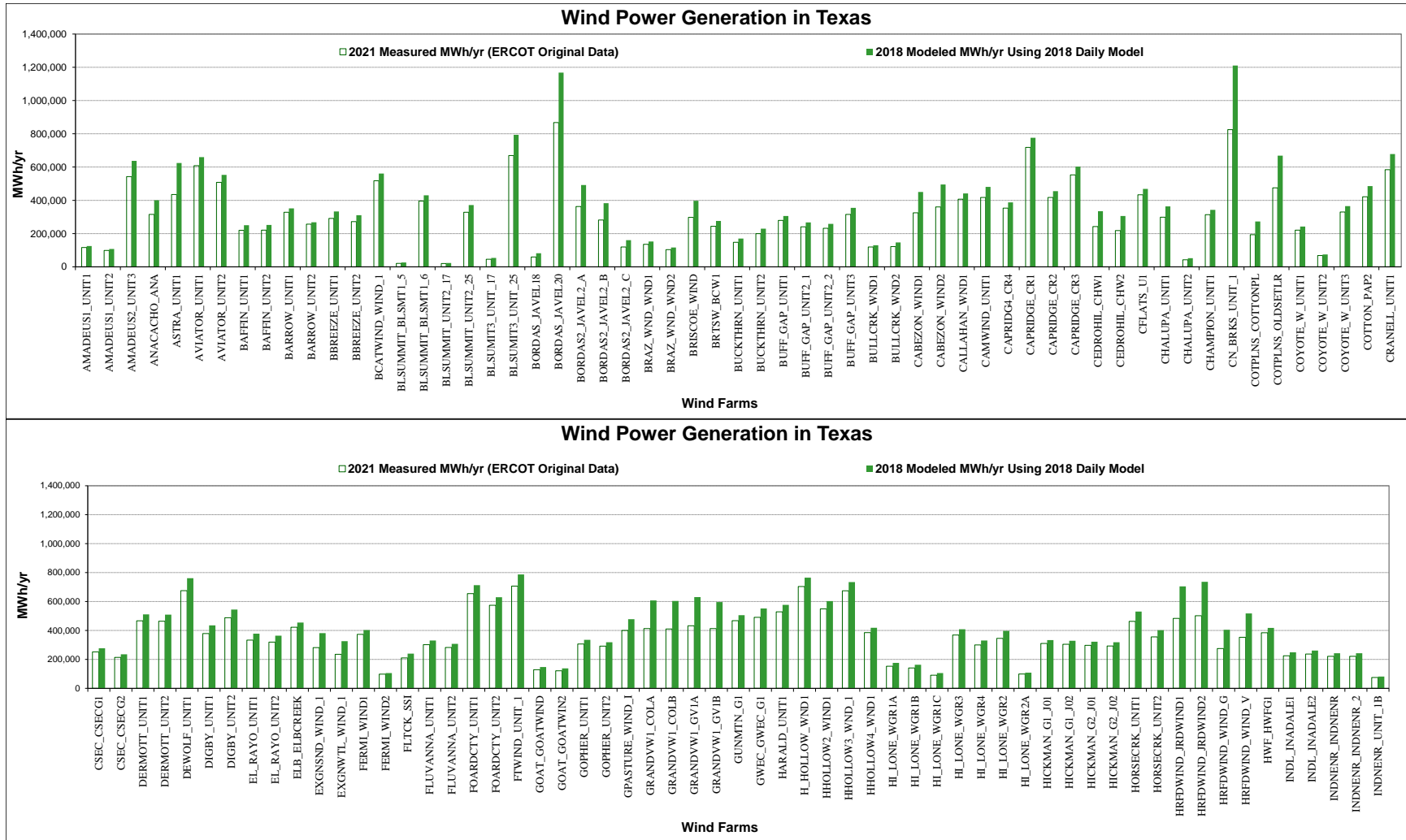


Figure 3-8: Comparison of 2021 Measured and 2018 Modeled Wind Power Production for Each Wind Farm

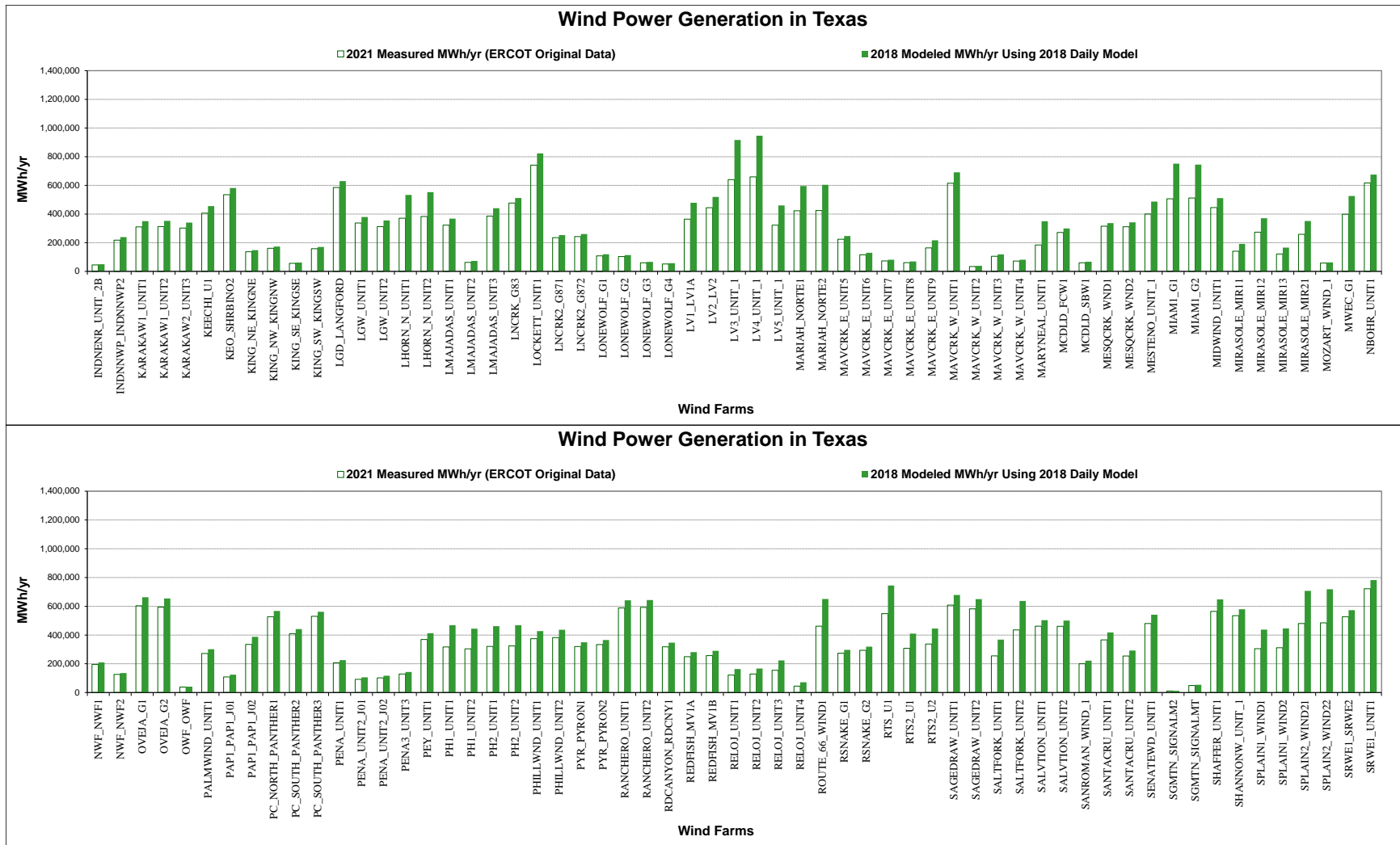


Figure 3-8: Comparison of 2021 Measured and 2018 Modeled Wind Power Production for Each Wind Farm (Continued)

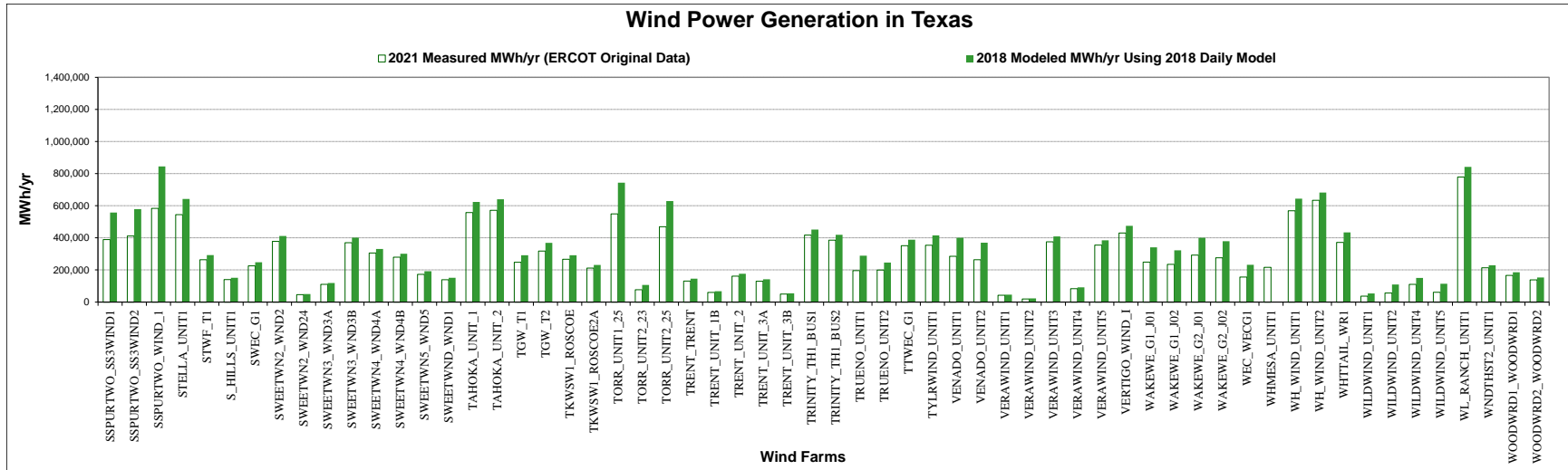


Figure 3-8: Comparison of 2021 Measured and 2018 Modeled Wind Power Production for Each Wind Farm (Continued)

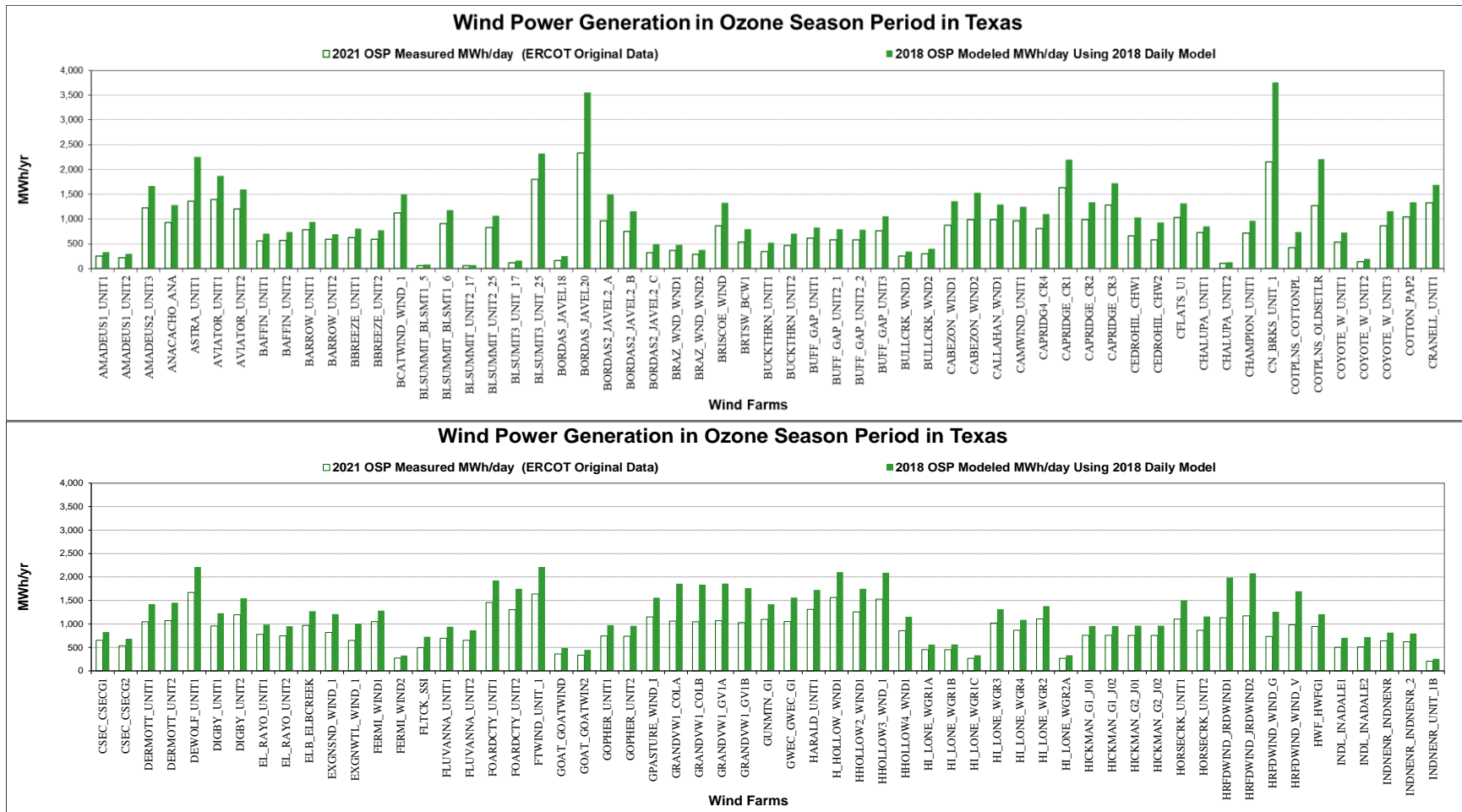


Figure 3-9: Comparison of 2021 OSP Measured and 2018 OSP Modeled Wind Power Production for Each Wind Farm

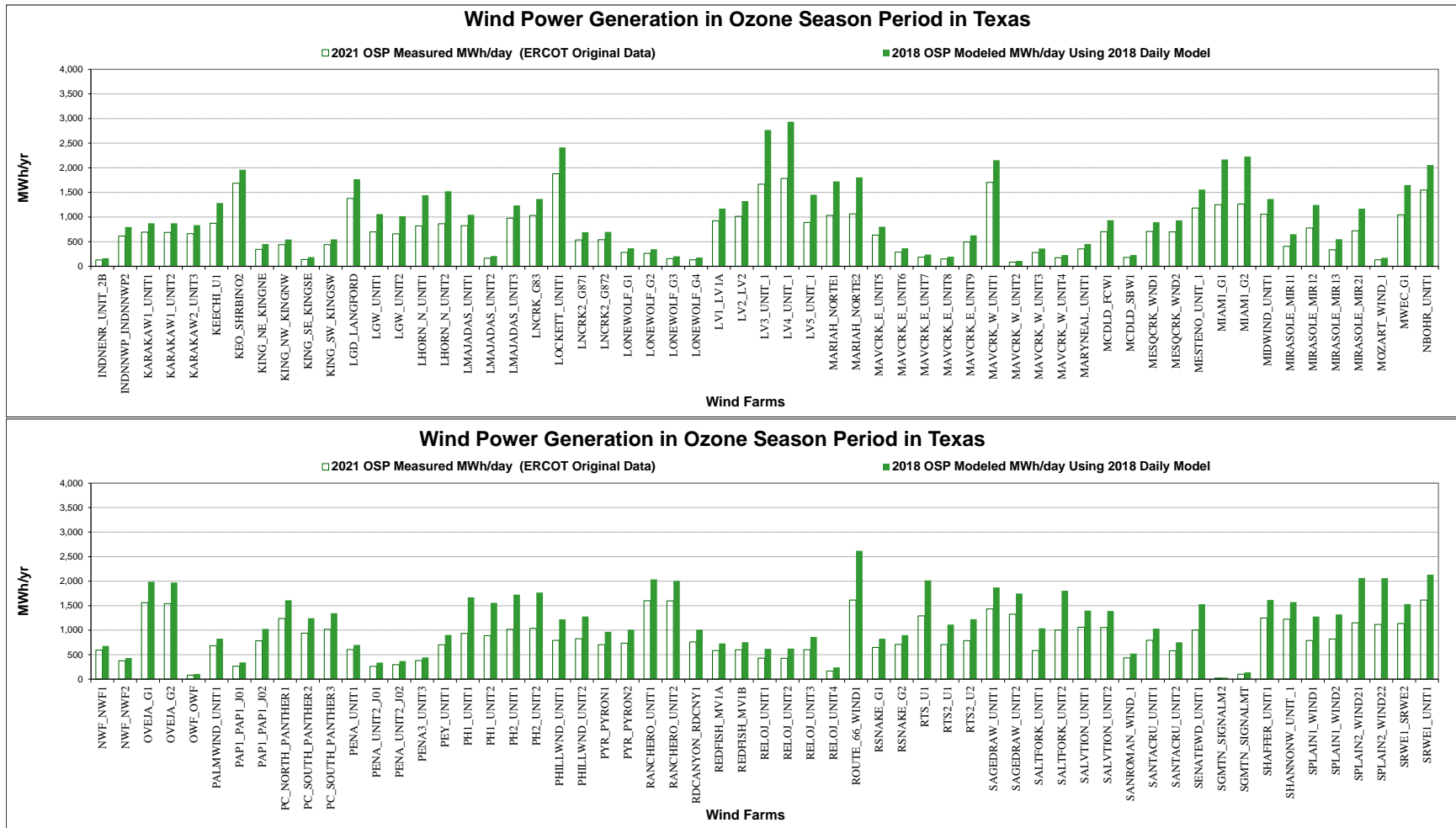


Figure 3-9: Comparison of 2021 OSP Measured and 2018 OSP Modeled Wind Power Production for Each Wind Farm (Continued)

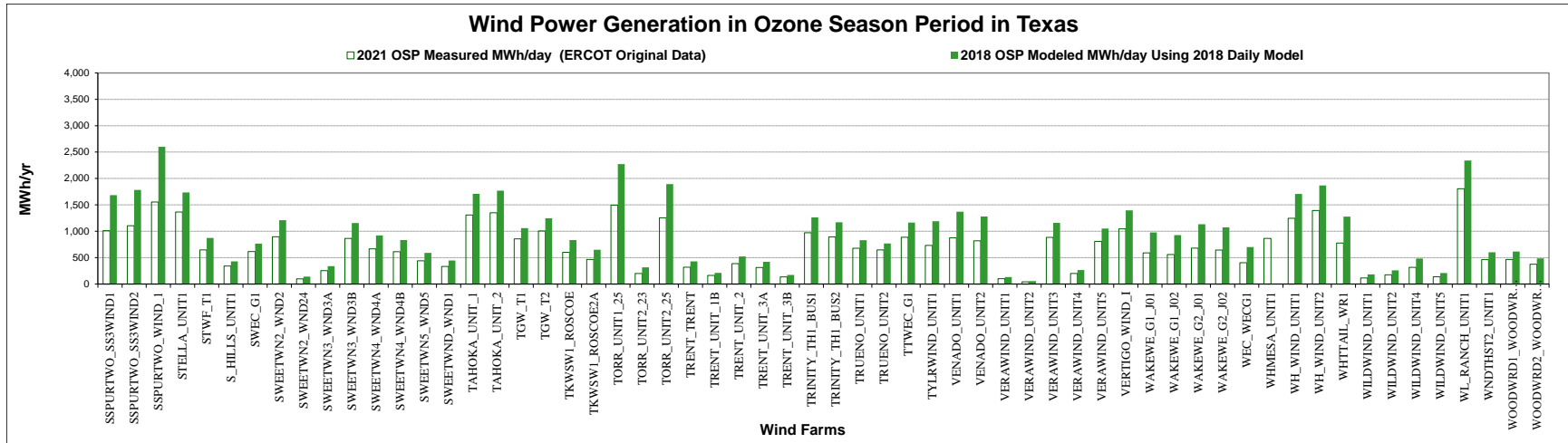


Figure 3-9: Comparison of 2021 OSP Measured and 2018 OSP Modeled Wind Power Production for Each Wind Farm (Continued)

3.3 Comparison of Measured Wind Power in Previous Reports and Present Report

The daily model is used for predicting the annual and OSP wind power productions. Due to the different base year analysis, this section only compares the ERCOT measured annual and OSP wind power productions. Compared to what was reported in the previous year's annual report, an increase of 9% on measured annual wind production was observed, from 87,079,414 MWh/yr in 2020 to 94,952,574 MWh/yr in 2021¹⁴.

The average daily wind power production during the OSP showed an increase of 3.8%, from 225,118 MWh/day to 233,740 MWh/day.

Eleven new wind farms including twenty-eight new meters with over 3,138 MW capacity have started operating since the beginning of 2021. Western Trail Wind (AJAX Wind), Aquilla Lake Wind, Baird North Wind, Coyote Wind Unit3, Griffin Trail, Priddy Wind Project, Panther Creek Wind3 (A&B), West Raymond (EL Trueno) Wind, Tg East Wind, White Mesa wind, and Wildcat Creek Wind Farm are the new wind farms in 2021. Figure 3-10 shows the measured annual wind power comparison of 2008 through 2021 for all the wind farms. Figure 3-11 shows the wind power comparison of 2008 through 2021 during the ozone season. The annual wind power difference percentages are compared for 2008 through 2021, shown in Figure 3-12. It has been observed that most of the analyzed wind farms show differences in percentage between 2018 and 2021. According to 2021 ERCOT data, Aviator Wind, Cranel Wind, Harald (BearKat Wind B), and High Lonesome Wind (phase I and phase II) had over 50% power generation increase compared to last year. This is due to the differences in wind speed values resulted in different power generation values. In addition, Figure 3-13 shows the difference comparison of 2018 through 2021 measured data during the ozone season. Wind farms with no comparison in 2020 are excluded in these comparisons.

¹⁴ This value reflects the total power generation for all windfarms operated ERCOT region in 2021.

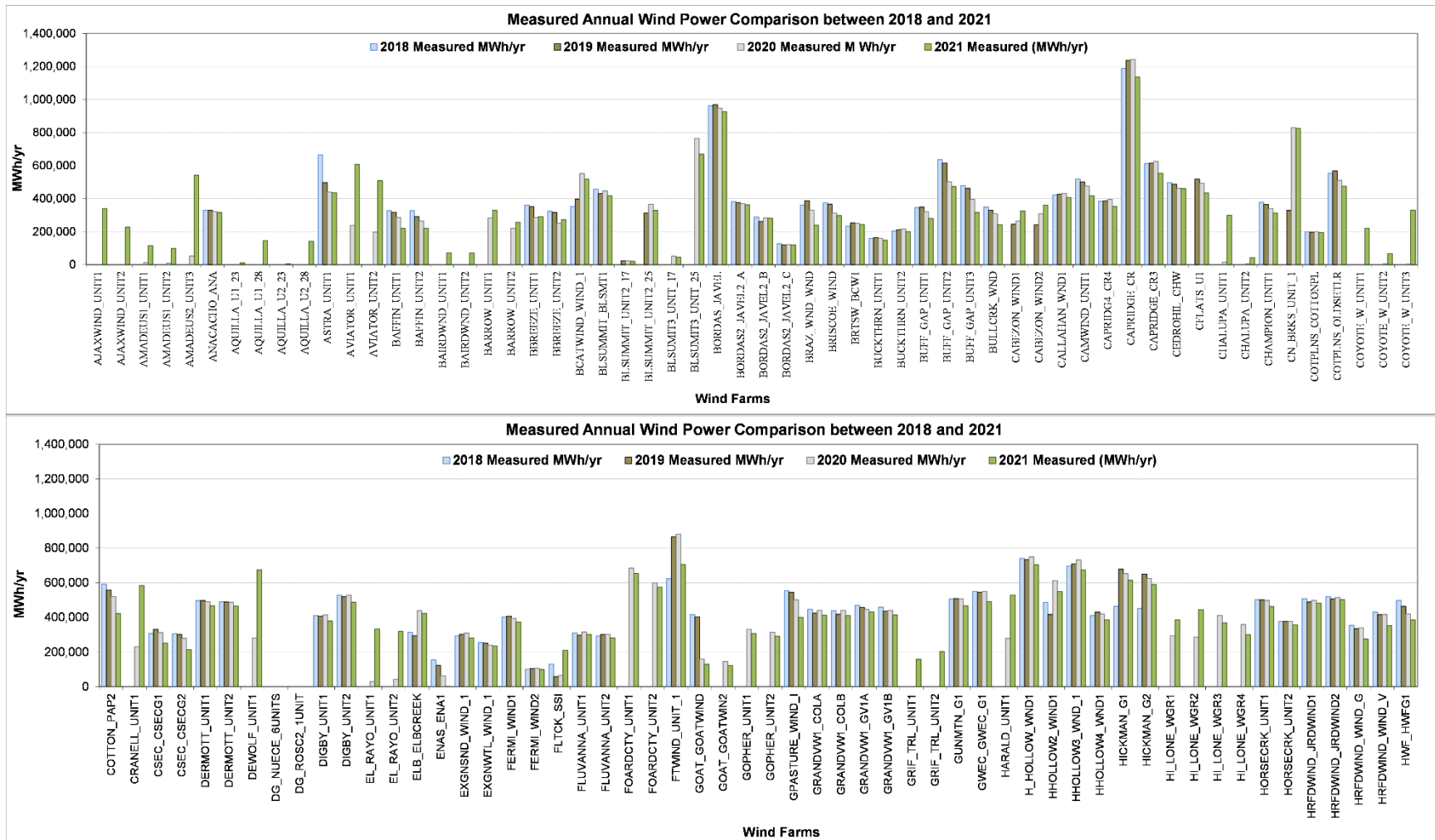


Figure 3-10: Measured Annual Wind Power Comparison between 2018 and 2021

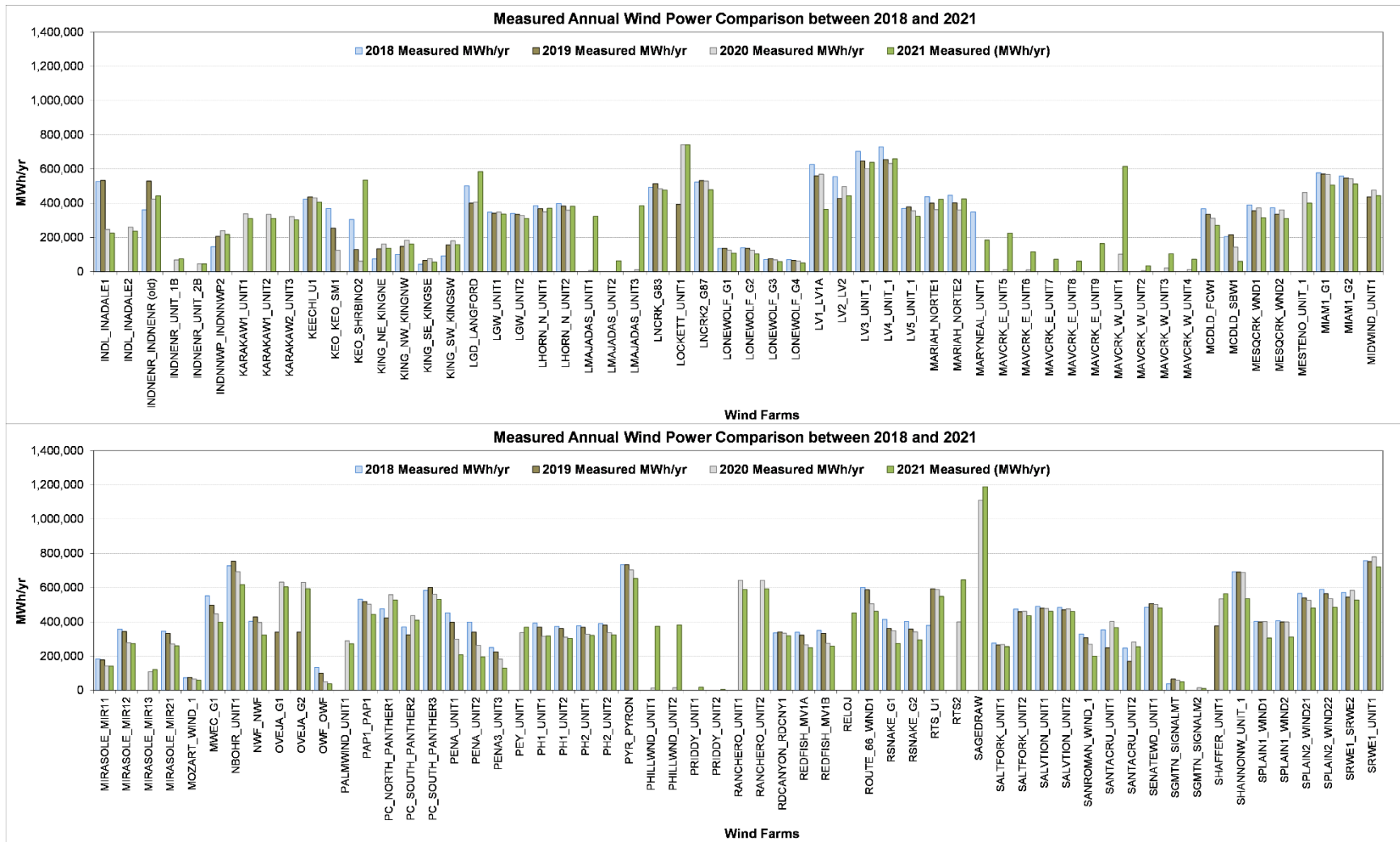


Figure 3-10: Measured Annual Wind Power Comparison between 2018 and 2021 (Continued)

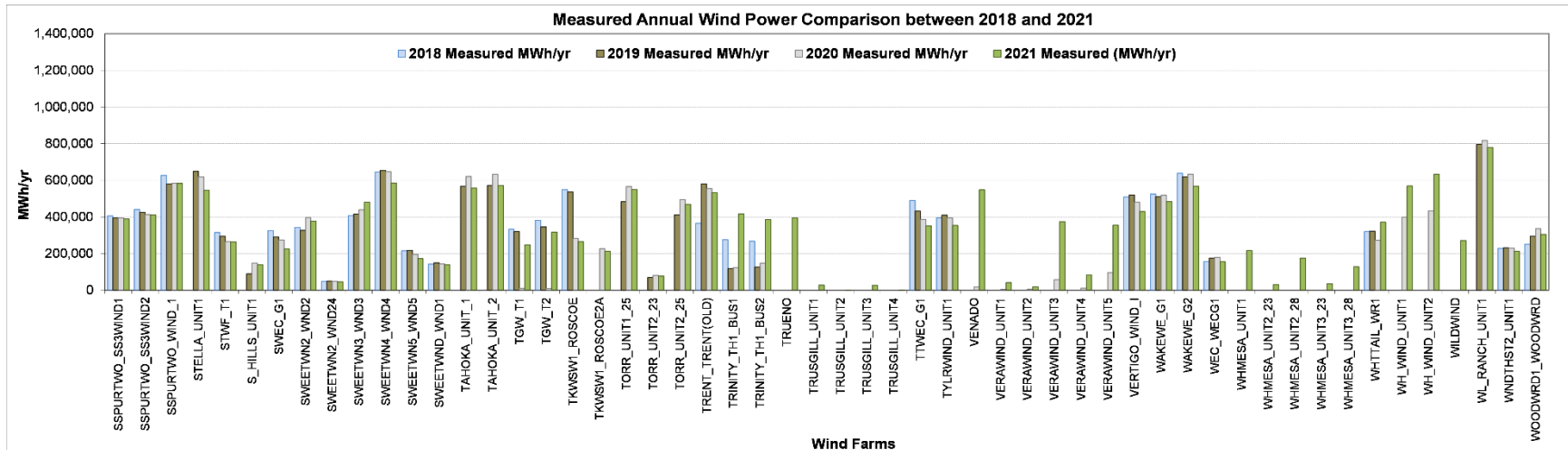


Figure 3-10: Measured Annual Wind Power Comparison between 2018 and 2021 (Continued)

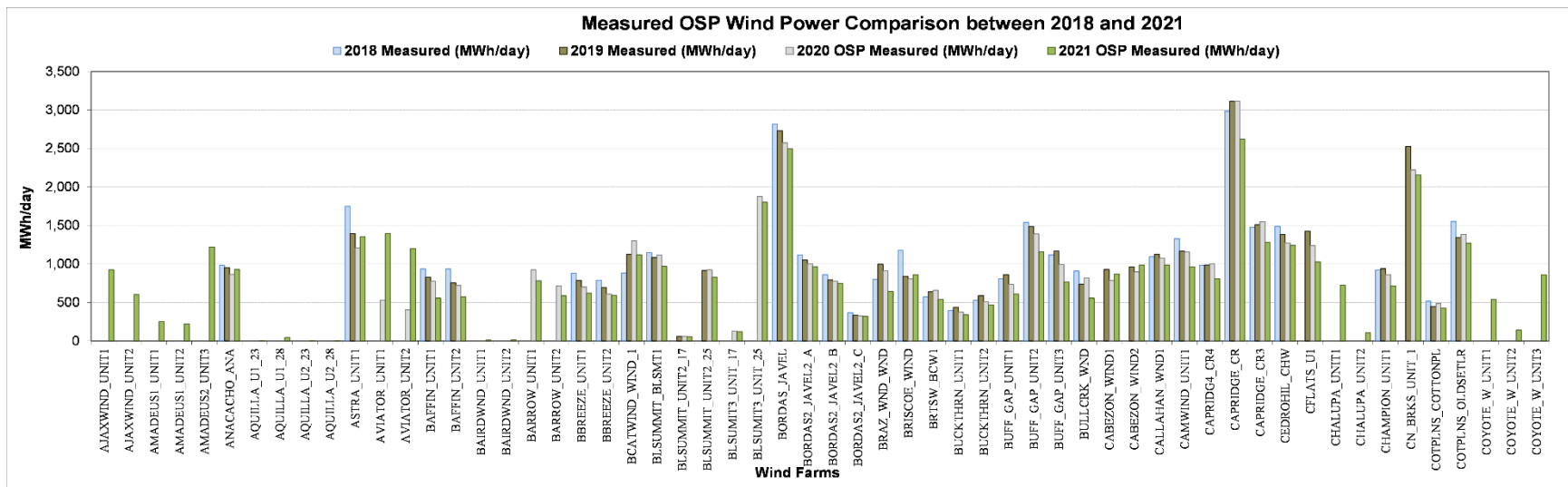


Figure 3-11: Measured OSP Wind Power Comparison between 2018 and 2021

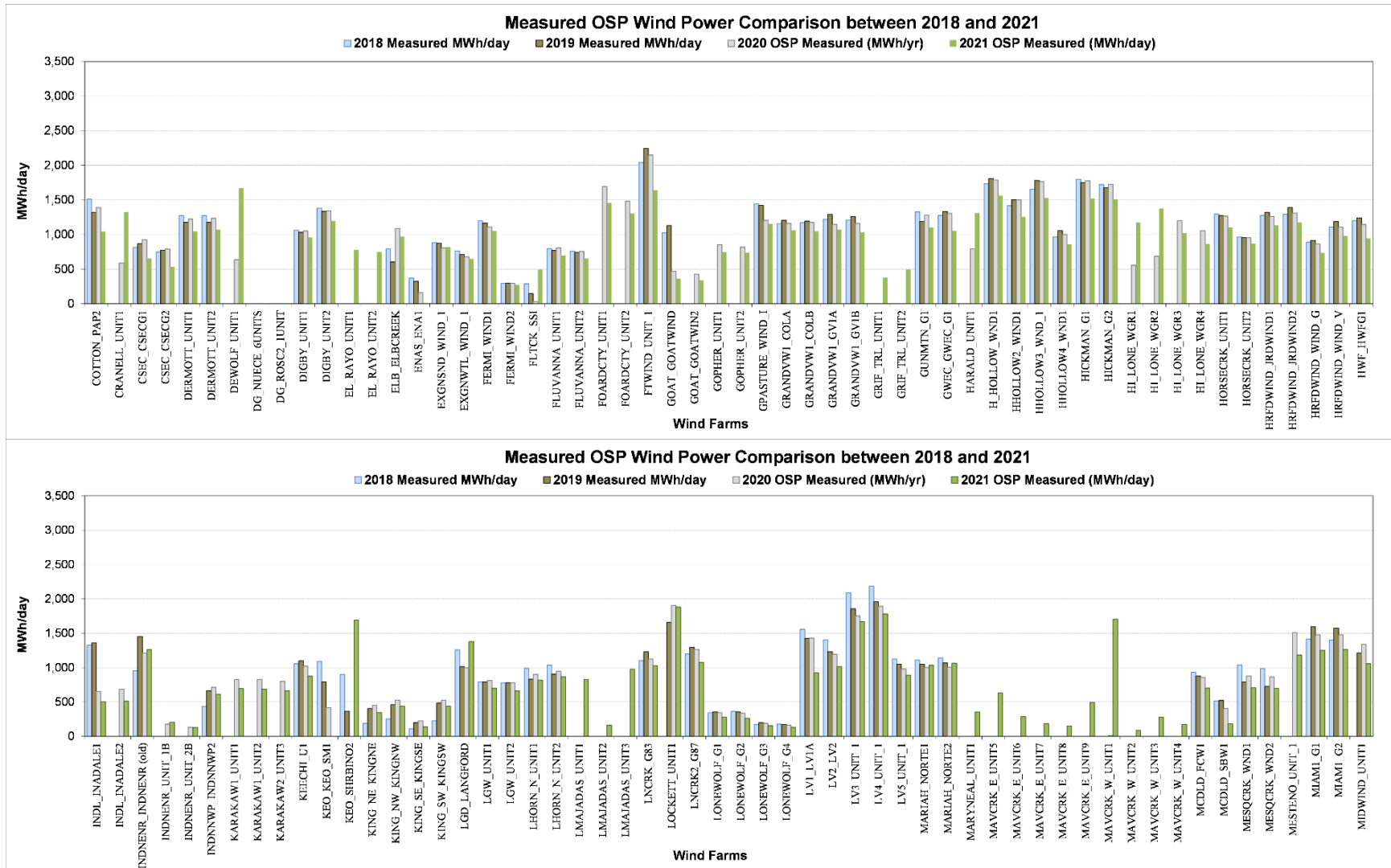


Figure 3-11: Measured OSP Wind Power Comparison between 2018 and 2021 (Continued)

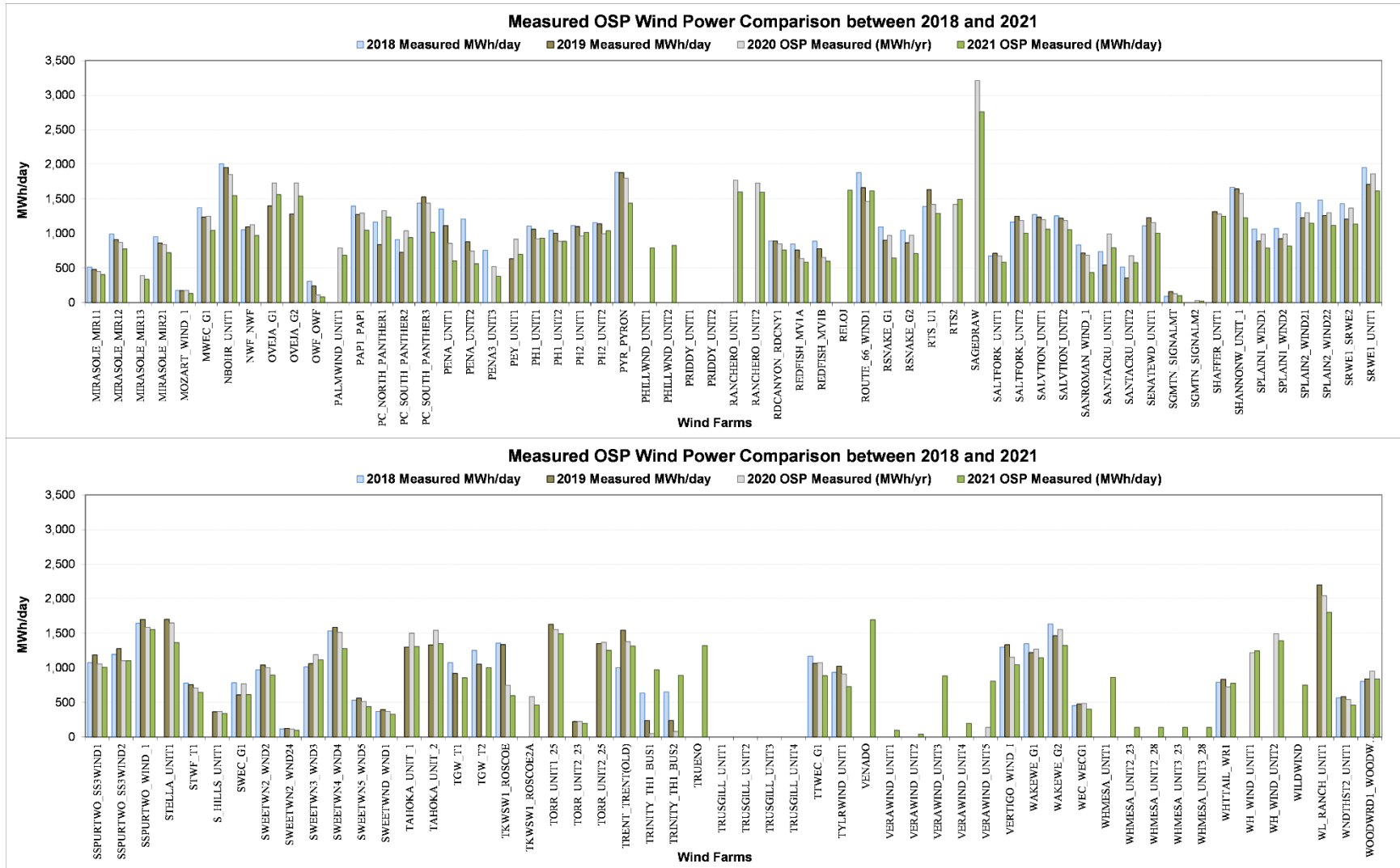


Figure 3-11: Measured OSP Wind Power Comparison between 2018 and 2021 (Continued)



Figure 3-12: Difference Comparison between 2018 and 2021 - Measured Annual Wind Power

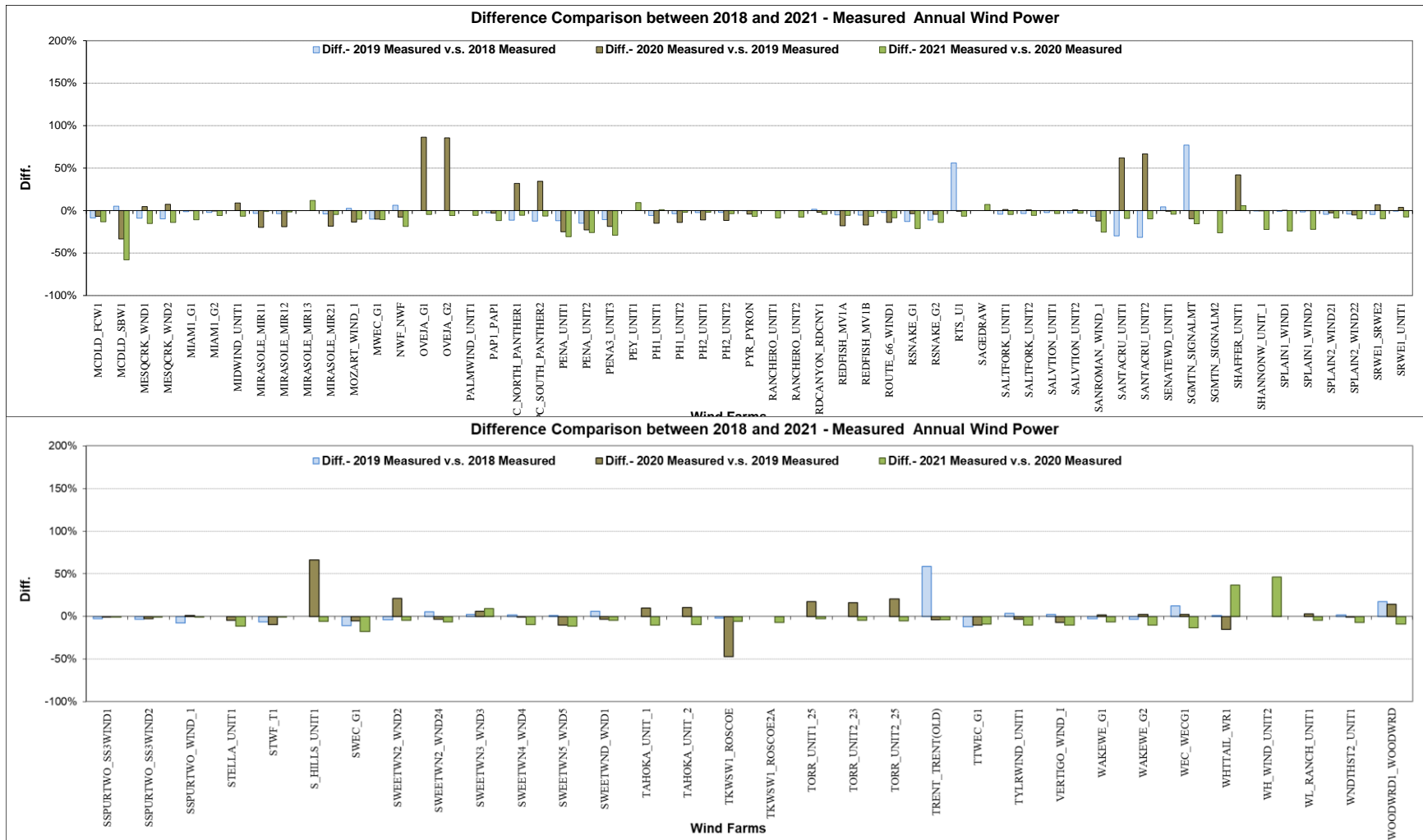


Figure 3-12: Difference Comparison between 2018 and 2021 - Measured Annual Wind Power (Continued)

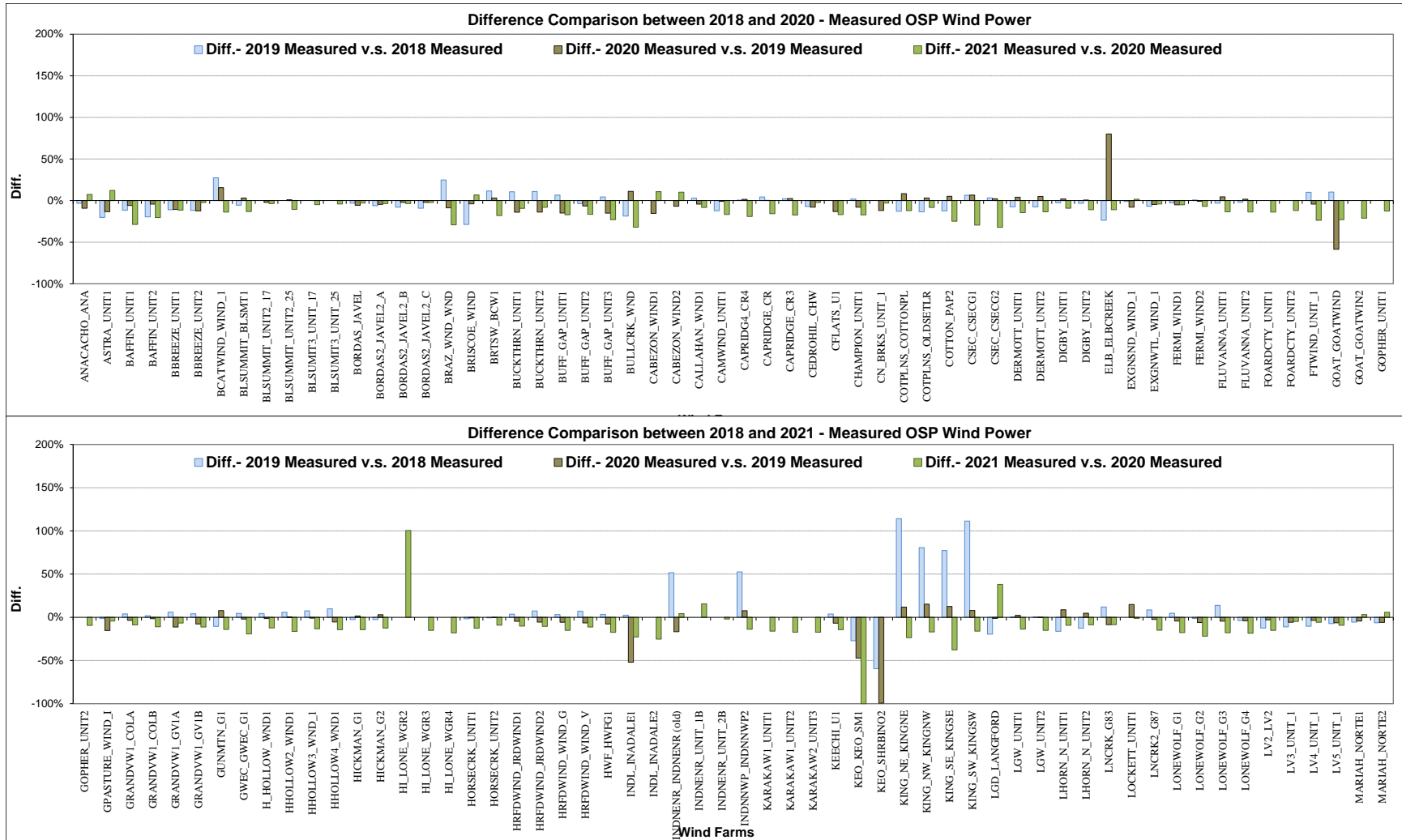


Figure 3-13: Difference Comparison between 2018 and 2021 - Measured OSP Wind Power

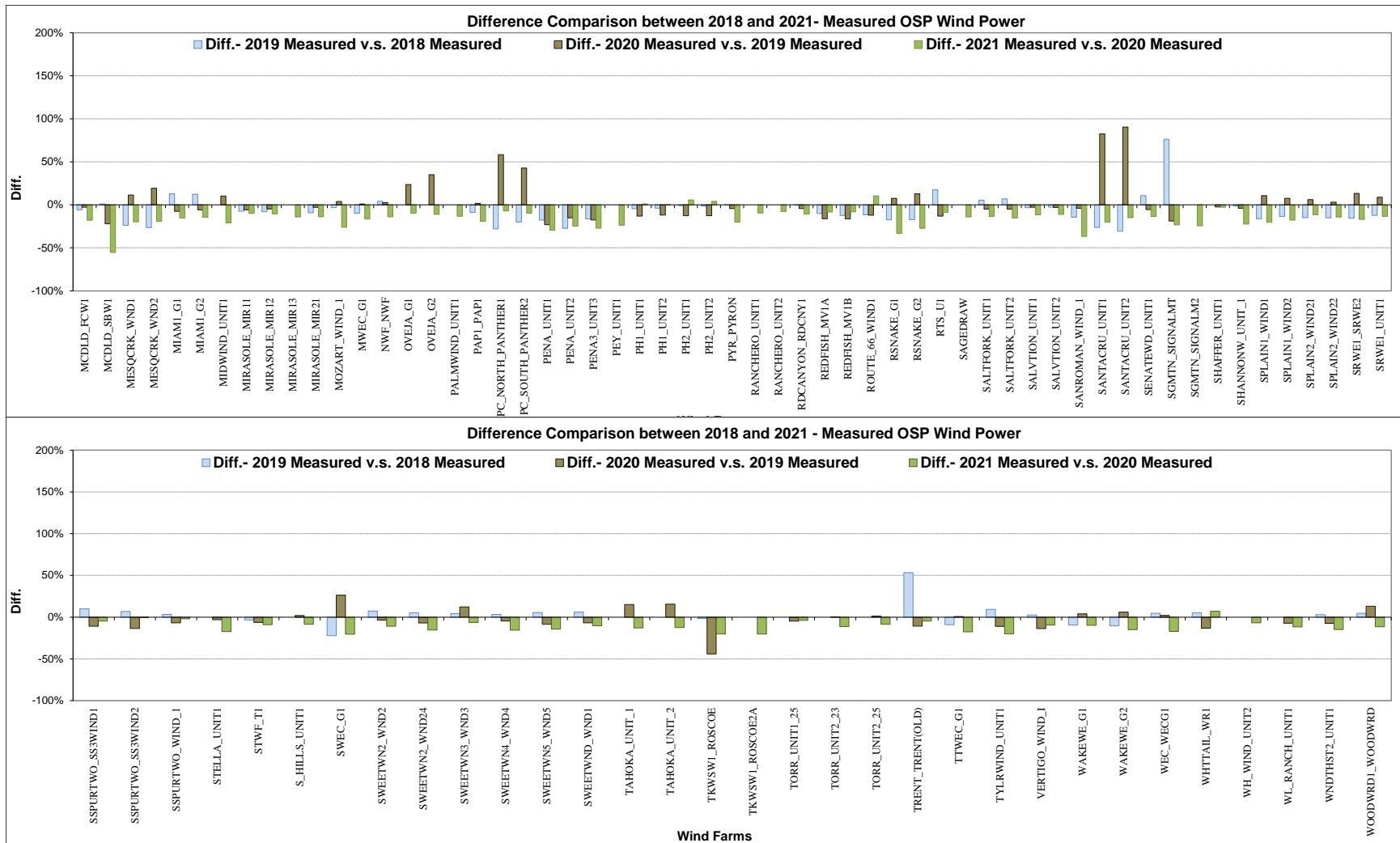


Figure 3-13: Difference Comparison between 2018 and 2021 - Measured OSP Wind Power (Continued)

3.4 Uncertainty Analysis on the 2021 Daily Regression Models

One of the advantages of using regression models is that it allows for an uncertainty analysis to be calculated, which can be used to assess the accuracy of the model. This section of the report presents an updated uncertainty analysis for the daily regressions that were applied to the 2020 data.

Assuming that the daily energy production of wind farm data can be related linearly with the daily average wind speed (see Figure 3-14) and expressed as

$$\hat{E}_i = c_o + c_1 V_i \quad \text{Equation 1}$$

where V is the daily average wind speed, \hat{E} is the daily total energy production, and c_o and c_1 are the resultant coefficients of linear regression. The subscript i represents any day over the modeling period.

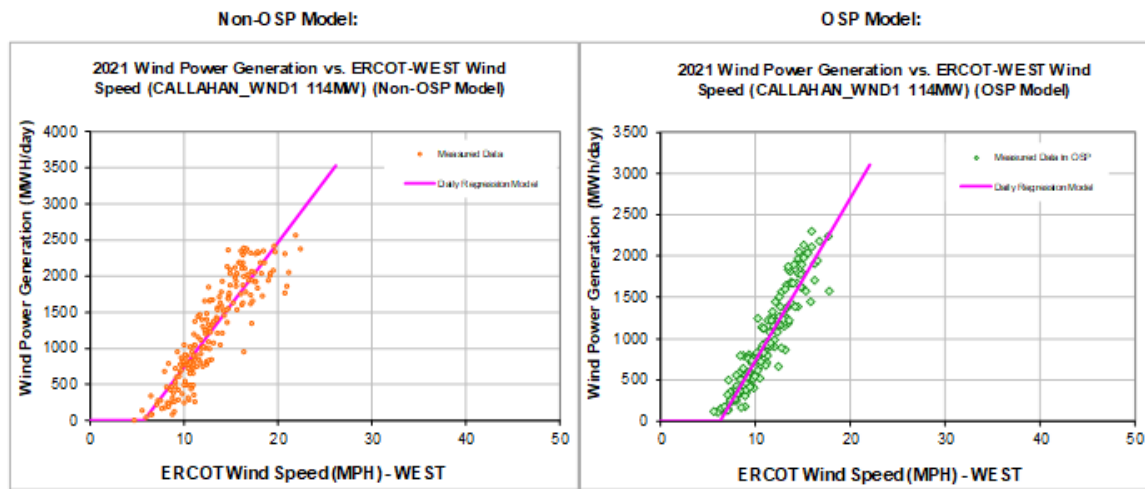


Figure 3-14: Linear Model Presentation of the Daily Wind Power Generation on the Year 2021 for Callahan_Wind_1 Farm

The primary purpose of modeling in this analysis is to back-cast the wind power production or predict the power production in another year that would have occurred if the turbines had been installed and operating. This allows for the evaluation of the NOx reductions during the base-year weather conditions. Unfortunately, any prediction intrinsically contains uncertainty, which is related to the prediction variance. Thus, the prediction uncertainty, $\sigma^2(\hat{E}_{pred,j})$, assuming no autocorrelation effects in the data used to generate the linear model, can be presented for a particular observation, j , during any time a particular condition is presented as follows:

$$\sigma^2(\hat{E}_{pred,j}) = MSE(\hat{E}_i) \cdot \left[1 + \frac{1}{n} + \frac{(V_j - \bar{V}_n)^2}{\sum_{i=1}^n (V_i - \bar{V}_n)^2} \right]$$

Equation 2

The mean square error, $MSE(\hat{E}_i)$, during the period of the development of the linear model can be computed by:

$$MSE(\hat{E}_i) = \left[\frac{1}{n - (k + 1)} \right] \sum_{i=1}^n (E_i - \hat{E}_i)^2$$

Equation 3

Where n is the number of days in the period used for the developed model, k is the number of regressor variables in the linear model and \bar{V}_n is the mean value of the velocity on the modeling period.

The last term in the brackets of equation 2 accounts for the increase in the variance of the energy prediction for any particular observation, j , which is different from the centroid of the modeling data. On the other hand, the second term accounts for the variance in predicting the mean energy predicted for the observation, j .

The total uncertainty for a period of interest, of m days, is then the sum of all the wind energy predicted $\hat{E}_{pred,j}$ in each individual observation.

Assuming that

$$\sum_{j=1}^m \sigma^2(\hat{E}_{pred,j}) = \sigma^2\left(\sum_{j=1}^m (\hat{E}_{pred,j})\right) = \sigma^2(\hat{E}_{pred,total})$$

Equation 4

And the total prediction variance or uncertainty is obtained through

$$\sigma^2(\hat{E}_{pred,total}) = MSE(\hat{E}_i) \cdot m \cdot \left[1 + \frac{1}{n} + \frac{\sum_{j=1}^m (V_j - \bar{V}_n)^2}{m \sum_{i=1}^n (V_i - \bar{V}_n)^2} \right]$$

Equation 5

Thus, it is observable that the last equation is affected by the number of days that the wind energy will be predicted, the number of days used for the modeling development and the uncertainty due to the distances between the data predicted and the centroid of the modeling data. Therefore, increasing n and m yields an effective relative decrease in the uncertainty, which is expected.

Table 3-3 presents all the statistical parameters for the daily linear models of all the wind farms in the ERCOT region.

Table 3-4 and Figure 3-15 show the uncertainty of applying the linear models to predict the energy generation that they would have had in the 2018 non-OSP using the non-OSP model, which considers the period of Jan 1 through April 30 and October 1 through December 31. The uncertainty of using non-OSP models for predicting wind power in the 2018 non-OSP varies from 2.5% to 15.7%. The maximum uncertainty comes from a wind farm named West Raymond (El Trueno) Wind_Unit2. One reason for this may be the meter problems suspected when measuring the data since include "0" generation values regardless of the wind speed. In the current modeling, the average wind speed provided by ERCOT is used for all the wind farms. Therefore, the average wind speed may not represent the real wind speed where the wind farms are located. The model uncertainty can come from incorrect wind speed information.

In addition, the same table and figure include the uncertainty related to the predicted wind generated for the same wind farms in the 2018 OSP using the OSP model, which considers the period of May 1 through September 31 – about 153 days. The uncertainty of using OSP models for predicting wind power in the 2018 OSP varies from 1.48% to 11.71% for all the wind farms. The maximum uncertainty of OSP models comes from a wind farm named Wildcat Creek Wind Farm_Unit2.

Table 3-3: Statistical Parameters for the 2021 Daily Wind Power Production Linear Models

Wind Farm	Statistical Parameters of Non-OSP Daily Models						Statistical Parameters of OSP Daily Models					
	C ₀	C ₁	AdjR ²	RMSE	CV-RMSE	# Days	C ₀	C ₁	AdjR ²	RMSE	CV-RMSE	# Days
AMADEUS1_UNIT1	-264.71	49.90	0.79	97.60	28.4%	210	-325.73	51.36	0.87	55.19	21.9%	152
AMADEUS1_UNIT2	-268.31	45.65	0.79	87.88	27.5%	202	-303.58	46.81	0.85	53.58	24.1%	152
AMADEUS2_UNIT3	-1096.63	235.26	0.77	488.98	25.9%	211	-1585.26	253.84	0.88	260.67	21.3%	118
ANACACHO_ANA	-175.89	92.49	0.43	324.27	39.5%	211	-300.10	123.54	0.69	204.15	22.0%	153
ASTRA_UNIT1	289.99	60.18	0.13	718.59	62.8%	204	-809.36	189.35	0.71	416.79	30.8%	149
AVIATOR_UNIT1	-1681.23	279.53	0.87	408.80	21.4%	207	-1975.94	300.17	0.88	310.30	22.2%	153
AVIATOR_UNIT2	-1285.71	222.34	0.87	315.70	20.1%	207	-1624.66	251.58	0.87	263.98	22.0%	153
BAFFIN_UNIT1	-280.88	80.01	0.50	281.32	43.9%	210	-699.43	123.68	0.82	159.88	28.8%	153
BAFFIN_UNIT2	-300.77	80.74	0.47	300.90	47.9%	211	-751.10	130.59	0.82	165.83	28.9%	153
BARROW_UNIT1	-327.37	105.88	0.65	295.12	28.9%	208	-327.87	99.33	0.55	243.82	31.2%	148
BARROW_UNIT2	-260.66	83.13	0.62	244.26	30.5%	209	-162.38	66.67	0.39	230.40	39.2%	152
BBREEZE_UNIT1	-963.41	164.51	0.86	238.59	25.7%	211	-897.04	149.57	0.88	149.93	24.2%	153
BBREEZE_UNIT2	-861.14	149.41	0.87	207.80	24.2%	211	-840.23	141.34	0.88	139.71	23.5%	153
BCATWIND_WIND_1	-970.97	205.75	0.66	559.38	34.1%	211	-1587.00	241.04	0.81	321.68	28.7%	153
BLSUMMIT_BLSMT1_5	-13.96	6.22	0.27	39.61	62.7%	171	-63.98	11.48	0.66	22.74	35.0%	153
BLSUMMIT_BLSMT1_6	-499.96	136.24	0.56	457.80	37.3%	210	-1044.42	173.45	0.78	254.83	28.2%	153
BLSUMMIT_UNIT2_17	10.40	3.60	0.12	37.16	66.8%	205	-65.67	10.98	0.73	18.30	31.8%	153
BLSUMMIT_UNIT2_25	-303.35	103.96	0.57	346.33	34.6%	202	-879.60	152.44	0.78	218.71	26.5%	152
BLSUMMIT3_UNIT_17	-27.39	13.52	0.45	54.16	39.0%	196	-142.24	23.41	0.77	34.88	29.2%	151
BLSUMMIT3_UNIT_25	-437.28	202.99	0.50	751.51	36.4%	192	-1843.73	325.54	0.79	457.78	25.4%	152
BORDAS_JAVEL18	-107.45	25.05	0.73	46.55	28.6%	211	-152.17	31.62	0.85	32.05	19.8%	153
BORDAS_JAVEL20	-1201.21	335.73	0.75	586.44	24.3%	211	-1926.93	428.61	0.89	373.94	16.0%	153
BORDAS2_JAVEL2_A	-540.10	144.70	0.76	246.53	24.1%	210	-871.81	184.73	0.90	152.38	15.8%	153
BORDAS2_JAVEL2_B	-439.78	114.34	0.76	193.12	24.3%	210	-691.19	144.62	0.92	107.88	14.4%	153
BORDAS2_JAVEL2_C	-156.26	45.55	0.74	81.19	24.2%	210	-255.67	57.84	0.90	48.49	15.2%	153
BRAZ_WND_WND1	-151.00	42.29	0.32	218.00	54.5%	202	-513.31	77.77	0.71	136.86	38.0%	153
BRAZ_WND_WND2	-107.13	31.06	0.31	164.46	55.2%	201	-383.77	59.54	0.72	103.10	36.2%	153
BRISCOE_WIND	326.01	34.45	0.06	646.03	78.7%	203	-279.21	99.43	0.45	376.75	43.8%	152
BRTSW_BCW1	102.10	49.77	0.27	377.71	49.4%	211	-502.85	98.60	0.80	140.87	26.1%	153
BUCKTHRN_UNIT1	-86.36	40.50	0.49	193.00	42.5%	210	-409.12	70.91	0.81	97.18	28.6%	153
BUCKTHRN_UNIT2	-83.80	52.42	0.47	256.76	41.7%	209	-479.79	89.52	0.78	135.65	29.1%	153
BUFF_GAP_UNIT1	-1032.02	151.63	0.79	274.14	29.1%	202	-979.55	141.44	0.76	218.35	35.8%	146
BUFF_GAP_UNIT2_1	-572.20	102.28	0.55	325.76	42.7%	200	-934.22	134.82	0.77	203.30	34.9%	152
BUFF_GAP_UNIT2_2	-552.32	97.50	0.55	311.38	43.3%	200	-928.32	133.83	0.75	210.82	36.6%	152
BUFF_GAP_UNIT3	-738.43	133.60	0.51	461.49	45.9%	201	-1294.97	183.54	0.76	288.65	37.7%	148
BULLCRK_WND1	-193.03	45.24	0.41	197.71	50.7%	206	-352.18	54.23	0.66	107.20	41.7%	153
BULLCRK_WND2	-196.52	48.67	0.38	231.52	53.8%	177	-424.26	64.51	0.68	120.85	40.3%	153
CABEZON_WND1	-693.51	148.71	0.76	254.04	27.9%	211	-839.93	171.95	0.83	191.59	22.0%	153
CABEZON_WND2	-668.81	154.01	0.73	284.05	28.7%	211	-907.18	190.47	0.84	200.36	20.3%	153
CALLAHAN_WND1	-985.67	172.81	0.81	298.38	23.7%	203	-1221.70	196.66	0.87	205.11	20.8%	153
CAMWIND_UNIT1	-1217.98	218.13	0.78	405.35	31.2%	210	-1381.46	230.76	0.85	263.05	27.3%	150
CAPRIDG4_CR4	-1068.24	170.30	0.87	236.65	20.7%	201	-1286.84	186.39	0.86	207.00	25.5%	152
CAPRIDG_CR1	-2277.28	352.97	0.89	445.12	19.3%	203	-2395.85	358.62	0.90	336.69	20.6%	153
CAPRIDG_CR2	-1227.23	195.26	0.81	329.97	25.1%	202	-1495.77	221.37	0.79	316.72	32.0%	153
CAPRIDG_CR3	-1728.65	270.24	0.88	352.03	19.7%	200	-1842.52	278.00	0.83	352.94	27.6%	153
CEDROHIL_CHW1	-458.76	104.71	0.74	188.29	27.9%	209	-634.58	130.20	0.88	116.29	17.6%	153
CEDROHIL_CHW2	-477.05	100.95	0.75	173.38	28.2%	209	-641.91	123.30	0.88	110.35	18.9%	153
CFLATS_U1	-626.62	152.83	0.60	444.70	32.8%	204	-1060.88	185.99	0.75	296.57	28.8%	153
CHALUPA_UNIT1	-875.56	166.62	0.53	537.95	53.9%	188	-304.17	101.31	0.44	307.96	42.5%	153
CHALUPA_UNIT2	-123.62	23.55	0.52	76.81	54.3%	188	-47.16	15.05	0.44	45.75	43.3%	153
CHAMPION_UNIT1	-751.20	135.45	0.71	319.14	32.3%	207	-1068.63	158.75	0.85	185.41	26.0%	153
CN_BRKS_UNIT_1	-956.16	232.13	0.70	722.44	30.6%	211	-1700.72	337.34	0.85	481.73	22.3%	152
COTPLNS_COTTONPL	-160.25	53.77	0.75	147.26	24.2%	211	-330.27	66.06	0.75	129.41	30.3%	153
COTPLNS_OLDSETLR	287.59	74.30	0.19	719.66	53.6%	209	-1014.69	199.39	0.75	389.69	30.7%	153
COYOTE_W_UNIT1	-573.55	96.63	0.51	352.06	53.1%	208	-796.91	119.08	0.84	145.84	27.0%	153
COYOTE_W_UNIT2	-236.94	36.23	0.79	70.76	31.5%	206	-247.50	34.70	0.84	42.17	29.7%	153
COYOTE_W_UNIT3	-802.92	137.17	0.45	548.84	56.3%	204	-1244.61	187.21	0.85	215.13	25.1%	153
COTTON_PAP2	-773.34	176.54	0.47	665.10	52.1%	205	-1403.41	241.34	0.69	438.00	41.9%	153
CRANELL_UNIT1	-1319.87	277.84	0.76	552.93	29.6%	204	-1658.44	294.35	0.76	452.29	34.0%	153
CSEC_CSECG1	-34.68	60.28	0.24	394.10	53.5%	208	-655.47	116.04	0.66	226.03	34.7%	152
CSEC_CSECG2	61.10	44.87	0.20	328.77	51.7%	208	-542.47	95.92	0.65	191.96	35.9%	153
DERMOTT_UNIT1	-1026.87	195.54	0.87	285.90	19.6%	210	-1631.62	238.49	0.90	214.11	20.5%	153
DERMOTT_UNIT2	-1033.06	193.78	0.87	284.27	19.8%	210	-1655.09	242.49	0.91	209.03	19.6%	153
DEWOLF_UNIT1	-1902.78	315.83	0.79	592.05	26.7%	189	-2206.40	345.22	0.86	389.48	23.3%	153
DIGBY_UNIT1	-311.22	119.63	0.53	432.82	36.2%	195	-896.24	173.84	0.78	252.63	26.4%	153
DIGBY_UNIT2	-448.30	153.84	0.52	560.05	37.6%	205	-1310.71	223.28	0.77	337.74	28.2%	153
EL_RAYO_UNIT1	-784.24	156.31	0.85	230.12	22.7%	211	-916.40	167.24	0.89	162.26	20.8%	153
EL_RAYO_UNIT2	-851.84	158.66	0.86	227.30	23.3%	211	-933.73	165.69	0.89	161.63	21.6%	153
ELB_ELBECREEK	-1085.17	187.39	0.86	265.48	19.7%	203	-1190.49	192.34	0.88	193.22	19.9%	153
EXGNSND_WIND_1	-406.43	107.92	0.72	204.53	27.0%	208	-546.22	137.31	0.78	178.43	21.8%	151

Table 3-3: Statistical Parameters for the 2021 Daily Wind Power Production Linear Models (Continued)

Wind Farm	Statistical Parameters of Non-OSP Daily Models						Statistical Parameters of OSP Daily Models					
	C ₀	C ₁	AdjR ²	RMSE	CV-RMSE	# Days	C ₀	C ₁	AdjR ²	RMSE	CV-RMSE	# Days
EXGNWTL_WIND_1	-477.13	104.62	0.68	215.97	33.1%	209	-599.45	125.53	0.87	120.70	18.6%	153
FERMI_WIND1	-200.33	95.07	0.46	392.33	39.0%	211	-612.43	148.06	0.58	349.78	33.3%	153
FERMI_WIND2	-11.36	22.04	0.40	102.16	38.1%	211	-117.41	34.86	0.54	87.97	32.1%	153
FLTCK_SSI	-8.73	49.04	0.49	229.32	35.3%	208	-454.45	89.69	0.84	110.58	22.4%	153
FLUVANNA_UNIT1	-680.71	126.69	0.85	199.57	21.1%	207	-1011.87	152.47	0.90	138.48	19.9%	152
FLUVANNA_UNIT2	-595.91	115.27	0.85	180.18	20.4%	207	-848.50	133.84	0.90	125.81	19.3%	152
FOARDCTY_UNIT1	-693.76	215.97	0.55	740.18	36.2%	211	-1901.89	299.14	0.79	422.75	29.0%	153
FOARDCTY_UNIT2	-676.82	193.17	0.59	614.48	34.6%	211	-1862.98	282.04	0.81	371.87	28.5%	153
FTWIND_UNIT_1	897.28	96.41	0.17	968.64	44.2%	208	-707.89	222.00	0.56	559.66	34.2%	153
GOAT_GOATWIND	-153.51	39.96	0.29	215.23	58.9%	201	-559.13	81.98	0.69	151.53	41.9%	153
GOAT_GOATWIND2	-76.76	32.88	0.26	190.91	54.5%	201	-462.46	71.15	0.68	134.14	39.8%	153
GOPHER_UNIT1	-557.36	116.22	0.80	214.29	22.9%	207	-899.66	146.53	0.86	161.90	21.7%	152
GOPHER_UNIT2	-452.20	102.49	0.79	195.31	22.7%	208	-823.42	139.29	0.88	144.81	19.6%	152
GOPASTURE_WIND_I	-777.04	154.46	0.69	387.81	32.5%	209	-1530.03	241.16	0.83	301.92	26.2%	151
GRANDVW1_COLA	-230.35	102.80	0.71	313.95	25.5%	203	-874.52	168.90	0.92	172.26	16.2%	153
GRANDVW1_COLB	-237.11	103.19	0.69	329.94	26.8%	203	-878.48	167.92	0.92	172.93	16.5%	153
GRANDVW1_GV1A	-238.72	109.62	0.72	325.35	24.6%	203	-847.61	167.40	0.90	186.93	17.5%	153
GRANDVW1_GV1B	-166.36	100.08	0.69	324.23	25.8%	203	-742.78	154.78	0.87	201.08	19.5%	153
GUNMTN_G1	-793.44	174.70	0.82	310.22	21.6%	209	-1191.41	204.12	0.84	248.08	22.6%	152
GWEC_GWEC_G1	-37.51	120.25	0.50	563.15	36.1%	211	-1004.98	194.79	0.80	272.99	25.9%	153
HARALD_UNIT1	-1474.81	239.21	0.73	505.58	31.0%	201	-1649.99	263.68	0.81	348.35	26.6%	153
H_HOLLOW_WND1	-1643.21	302.83	0.78	576.32	25.2%	203	-2297.77	343.79	0.85	397.89	25.5%	153
HHOLLOW2_WIND1	-1764.11	271.32	0.84	422.57	24.0%	203	-2224.39	309.89	0.86	350.39	27.9%	153
HHOLLOW3_WND_1	-2055.30	325.27	0.84	508.41	23.4%	202	-2447.83	354.23	0.86	397.61	26.0%	153
HHOLLOW4_WND1	-906.52	166.22	0.77	326.20	26.0%	203	-1256.86	188.22	0.85	214.24	25.0%	153
HI_LONE_WGR1A	-259.07	55.46	0.49	205.64	44.4%	181	-309.53	68.05	0.70	122.88	27.1%	152
HI_LONE_WGR1B	-262.76	50.58	0.44	206.16	52.1%	181	-343.26	70.84	0.59	163.10	36.1%	153
HI_LONE_WGR1C	-141.75	32.34	0.49	119.44	42.8%	180	-195.00	41.24	0.71	73.34	27.3%	153
HI_LONE_WGR3	-746.67	139.76	0.58	441.53	42.5%	205	-1089.10	187.84	0.75	301.16	29.5%	153
HI_LONE_WGR4	-464.32	100.50	0.50	376.16	45.9%	205	-729.19	141.89	0.72	240.90	27.9%	153
HI_LONE_WGR2	-800.92	136.13	0.46	535.56	55.1%	181	-848.88	174.21	0.70	314.79	28.4%	153
HI_LONE_WGR2A	-127.79	32.38	0.54	112.00	39.2%	204	-190.07	40.81	0.73	68.71	25.6%	153
HICKMAN_G1_J01	-472.90	109.72	0.74	232.24	24.5%	204	-651.90	125.76	0.72	214.50	28.2%	153
HICKMAN_G1_J02	-366.41	99.47	0.66	257.55	27.9%	204	-651.85	125.75	0.72	214.64	28.2%	153
HICKMAN_G2_J01	-476.30	105.50	0.76	211.82	23.8%	204	-732.84	132.52	0.82	170.64	22.6%	153
HICKMAN_G2_J02	-378.54	96.10	0.68	234.65	27.1%	204	-732.91	132.52	0.82	170.65	22.6%	153
HORSECRK_UNIT1	-772.28	177.59	0.70	435.74	29.7%	207	-1488.77	233.62	0.85	265.66	24.0%	145
HORSECRK_UNIT2	-523.05	128.37	0.64	359.40	32.8%	206	-1150.69	180.35	0.88	183.47	21.2%	150
HRFDWIND_JRDWIND1	-695.70	151.66	0.80	355.91	24.2%	211	-952.33	181.88	0.87	244.38	21.6%	153
HRFDWIND_JRDWIND2	-771.49	161.00	0.80	378.53	24.8%	211	-1024.70	191.90	0.86	266.67	22.7%	153
HRFDWIND_WIND_G	-290.25	75.65	0.43	407.02	52.0%	208	-545.06	111.56	0.77	205.97	28.1%	153
HRFDWIND_WIND_V	-267.12	87.13	0.41	486.97	50.2%	209	-752.82	151.42	0.80	255.62	26.0%	153
HWF_HWFG1	-354.20	117.85	0.39	547.13	47.5%	208	-949.05	168.61	0.76	261.84	27.7%	153
INDL_INADALE1	-691.08	110.06	0.76	232.44	32.5%	207	-907.54	125.68	0.84	149.70	29.7%	153
INDL_INADALE2	-753.77	118.78	0.76	249.10	32.5%	208	-984.63	133.12	0.83	167.25	32.8%	153
INDNENR_INDENNR	-437.80	80.47	0.56	263.17	44.2%	207	-617.67	112.00	0.73	186.08	29.1%	153
INDNENR_INDENNR_2	-462.37	83.69	0.55	278.69	45.5%	207	-636.83	111.98	0.71	197.41	31.8%	153
INDNENR_UNIT_1B	-136.84	26.94	0.56	87.64	41.7%	207	-180.23	34.40	0.73	58.36	28.3%	153
INDNENR_UNIT_2B	-68.51	14.97	0.53	52.01	42.1%	207	-118.54	22.13	0.69	40.81	31.4%	153
INDNWP_INDNNWP2	-565.04	90.68	0.49	334.23	55.2%	205	-706.74	117.59	0.71	208.81	34.0%	153
KARAKAW1_UNIT1	-669.05	142.43	0.77	276.36	28.5%	211	-795.07	146.73	0.80	197.19	28.4%	153
KARAKAW1_UNIT2	-677.96	144.30	0.76	286.96	29.2%	211	-855.59	151.94	0.79	211.89	30.9%	153
KARAKAW2_UNIT3	-594.08	134.55	0.70	313.72	32.9%	211	-791.03	143.14	0.78	207.46	31.4%	153
KEECHI_U1	-217.86	114.47	0.54	484.22	36.7%	207	-793.53	157.81	0.66	323.73	37.0%	152
KEO_SHRIBINO2	-322.33	133.62	0.40	592.96	42.3%	198	-273.06	174.48	0.49	486.73	28.9%	153
KING_NE_KINGNE	-422.12	64.59	0.65	173.57	42.1%	205	-404.17	66.71	0.71	117.90	34.2%	153
KING_NW_KINGNW	-343.07	62.29	0.44	256.87	56.0%	206	-326.17	68.05	0.60	154.49	35.3%	153
KING_SE_KINGSE	-183.25	27.52	0.57	86.74	50.5%	204	-197.24	29.91	0.70	53.61	38.6%	153
KING_SW_KINGSW	-292.00	57.06	0.43	238.68	53.9%	206	-324.06	68.02	0.56	166.94	38.0%	153
LGD_LANGFORD	-1094.85	226.17	0.70	527.15	28.6%	203	-1431.11	250.14	0.77	381.12	27.7%	153
LGW_UNIT1	-182.94	96.22	0.53	415.30	37.5%	208	-759.97	138.10	0.78	207.32	29.6%	153
LGW_UNIT2	-144.00	86.46	0.49	401.94	39.6%	208	-778.98	136.16	0.79	201.29	30.5%	153
LHORN_N_UNIT1	-449.77	113.04	0.74	320.61	27.5%	211	-690.44	131.76	0.72	282.40	34.5%	153
LHORN_N_UNIT2	-459.55	115.41	0.75	320.40	26.9%	211	-734.56	139.61	0.74	282.71	32.7%	153
LMAJADAS_UNIT1	-745.64	145.78	0.70	333.79	35.8%	211	-989.20	178.83	0.88	178.22	21.6%	153
LMAJADAS_UNIT2	-163.62	30.31	0.69	71.67	38.7%	207	-208.21	36.67	0.82	46.83	28.5%	153
LMAJADAS_UNIT3	-1032.14	187.00	0.72	414.98	37.1%	211	-1164.20	210.96	0.85	240.69	24.7%	153
LNCRK_G83	-1551.50	241.71	0.86	367.51	24.2%	210	-1372.66	213.93	0.82	276.96	26.9%	153
LOCKETT_UNIT1	-443.32	209.40	0.50	805.62	36.5%	207	-2037.40	347.87	0.82	456.20	24.3%	151
LNCRK2_G871	-585.40	103.59	0.73	237.16	32.4%	210	-611.42	101.99	0.75	162.84	30.5%	153

Table 3-3: Statistical Parameters for the 2021 Daily Wind Power Production Linear Models (Continued)

Wind Farm	Statistical Parameters of Non-OSP Daily Models						Statistical Parameters of OSP Daily Models					
	C ₀	C ₁	AdjR ²	RMSE	CV-RMSE	# Days	C ₀	C ₁	AdjR ²	RMSE	CV-RMSE	# Days
LNCRK2_G872	-569.88	104.91	0.73	243.19	31.8%	209	-597.67	101.35	0.74	166.14	30.7%	153
LONEWOLF_G1	-146.61	36.19	0.43	146.93	45.3%	201	-331.16	54.52	0.78	78.98	28.1%	153
LONEWOLF_G2	-149.51	35.66	0.44	144.10	45.8%	201	-330.81	52.81	0.77	79.63	30.4%	153
LONEWOLF_G3	-86.72	20.53	0.44	81.82	45.3%	201	-189.26	30.70	0.78	45.24	29.1%	153
LONEWOLF_G4	-76.10	17.75	0.42	74.74	48.2%	201	-173.16	27.31	0.75	42.92	32.1%	153
LV1 LV1A	-1247.78	224.17	0.76	434.18	33.2%	190	-1262.79	213.90	0.75	332.70	36.0%	126
LV2 LV2	-1793.46	276.77	0.87	381.10	27.4%	208	-1543.96	252.02	0.90	228.38	22.5%	153
LV3_UNIT_1	-1584.29	316.89	0.73	583.55	31.9%	210	-2173.04	386.28	0.86	381.97	22.9%	153
LV4_UNIT_1	-1548.43	315.69	0.74	562.40	30.3%	209	-2240.21	404.46	0.86	401.62	22.5%	153
LV5_UNIT_1	-612.00	140.53	0.61	329.50	36.9%	209	-1072.64	197.32	0.87	190.23	21.4%	153
MARIAH_NORTE1	-279.20	108.31	0.55	469.80	37.1%	210	-644.07	146.41	0.74	299.39	29.0%	152
MARIAH_NORTE2	-288.71	107.72	0.56	456.79	36.6%	210	-736.14	157.10	0.78	285.25	26.8%	153
MAVCRK_E_UNIT5	-312.58	72.79	0.43	298.61	47.2%	202	-581.19	108.22	0.81	146.16	23.0%	153
MAVCRK_E_UNIT6	-270.98	50.05	0.81	86.17	23.3%	195	-286.46	51.06	0.81	67.83	23.6%	153
MAVCRK_E_UNIT7	-136.68	28.64	0.73	61.51	26.4%	193	-179.88	32.48	0.83	40.81	22.1%	153
MAVCRK_E_UNIT8	-139.18	26.43	0.78	50.34	25.3%	193	-171.86	28.67	0.79	41.18	27.4%	153
MAVCRK_E_UNIT9	-258.11	67.04	0.37	309.31	50.1%	144	-468.20	85.67	0.76	133.72	27.1%	153
MAVCRK_W_UNIT1	-1193.18	235.03	0.63	645.55	35.5%	195	-1524.72	287.55	0.80	397.03	23.3%	153
MAVCRK_W_UNIT2	-89.79	15.79	0.79	28.73	25.2%	190	-100.94	16.49	0.82	21.27	25.2%	153
MAVCRK_W_UNIT3	-206.26	41.14	0.69	98.05	30.6%	195	-297.07	51.29	0.82	66.05	23.7%	153
MAVCRK_W_UNIT4	-183.45	32.70	0.81	56.40	24.0%	195	-207.75	33.98	0.83	42.97	24.7%	153
MARYNEAL_UNIT1	-545.47	151.51	0.33	771.28	55.4%	95	-326.53	60.92	0.21	320.37	90.7%	149
MCDLD_FCW1	-542.57	103.99	0.56	329.72	40.7%	203	-964.68	148.44	0.78	216.57	30.8%	153
MCDLD_SBW1	-3.75	12.79	0.14	110.39	68.2%	201	-153.27	29.78	0.55	73.81	40.7%	153
MESQCRK_WND1	-522.24	118.74	0.65	322.48	32.2%	207	-643.62	120.26	0.55	298.02	42.2%	153
MESQCRK_WND2	-530.81	119.27	0.67	308.00	30.8%	205	-957.19	147.67	0.78	218.50	31.3%	152
MESTENO_UNIT_1	134.49	84.09	0.25	435.91	41.9%	211	-123.01	131.23	0.31	479.17	40.5%	153
MIAMI_G1	-399.69	139.60	0.68	445.01	27.6%	208	-1060.48	199.57	0.80	333.40	26.7%	137
MIAMI_G2	-529.22	142.96	0.70	429.97	28.1%	208	-1069.55	203.79	0.84	299.59	23.7%	153
MIDWIND_UNIT1	-1249.15	225.39	0.69	529.91	39.4%	211	-1503.71	252.22	0.79	352.25	33.4%	153
MIRASOLE_MIR11	-51.40	39.60	0.29	184.65	49.3%	210	-443.53	85.50	0.73	128.43	31.6%	153
MIRASOLE_MIR12	-63.39	74.15	0.27	363.08	49.4%	210	-856.45	164.30	0.72	254.22	32.7%	153
MIRASOLE_MIR13	-24.00	33.18	0.28	159.70	48.0%	210	-408.57	74.90	0.77	100.42	29.9%	153
MIRASOLE_MIR21	-36.01	69.03	0.26	349.81	49.5%	210	-833.23	156.43	0.72	238.12	33.0%	153
MOZART_WIND_1	-56.04	18.64	0.39	89.26	49.4%	211	-147.00	24.98	0.71	43.59	32.6%	153
MWEC_G1	469.93	48.01	0.13	588.06	50.9%	207	-429.21	128.59	0.52	417.46	40.0%	153
NBOHR_UNIT1	-1700.17	275.85	0.75	568.36	30.1%	201	-2070.67	322.27	0.84	391.30	25.3%	153
NWF_NWF1	239.19	20.83	0.06	305.26	60.6%	209	-26.51	55.16	0.32	220.33	37.2%	153
NWF_NWF2	183.40	11.54	0.04	208.26	63.0%	208	-40.25	37.03	0.35	139.49	37.1%	153
OVEJA_G1	-1164.87	231.72	0.79	432.22	23.6%	199	-1503.61	272.82	0.85	319.49	20.5%	153
OVEJA_G2	-1078.84	222.50	0.76	457.46	25.4%	199	-1554.07	275.54	0.85	323.28	21.0%	153
OWF_OWF	-38.56	12.62	0.21	85.23	67.6%	201	-91.26	15.51	0.43	48.81	59.0%	152
PALMWIND_UNIT1	-249.38	90.50	0.41	379.51	47.7%	210	-483.91	115.20	0.63	240.22	35.1%	153
PAP1_PAP1_J01	-220.73	47.18	0.58	141.90	44.1%	211	-366.78	62.24	0.76	96.14	36.3%	153
PAP1_PAP1_J02	-1072.13	181.78	0.85	274.49	26.9%	211	-1202.83	195.83	0.82	251.38	32.1%	153
PC_NORTH_PANTHER1	-1245.26	223.75	0.84	348.33	20.9%	203	-1423.62	237.02	0.88	244.24	19.7%	153
PC_SOUTH_PANTHER2	-1059.71	182.04	0.84	282.84	21.6%	203	-1246.54	194.56	0.89	186.64	19.9%	153
PC_SOUTH_PANTHER3	-1359.84	246.55	0.63	668.88	36.3%	203	-1313.46	207.71	0.81	281.78	27.6%	153
PENA_UNIT1	115.99	37.34	0.15	302.34	55.6%	210	-160.01	75.37	0.38	261.35	43.2%	153
PENA_UNIT2_J01	-71.53	27.40	0.31	143.29	58.6%	210	-358.09	61.31	0.73	100.42	38.0%	153
PENA_UNIT2_J02	-47.09	27.81	0.28	154.59	0.56	209.00	-326.22	61.33	0.67	115.91	0.39	153.00
PENA3_UNIT3	49.33	25.69	0.17	195.18	0.57	207.00	-127.84	50.13	0.38	172.89	0.45	153.00
PEY_UNIT1	-560.73	156.50	0.49	561.96	0.45	211.00	-958.96	163.48	0.61	354.54	0.51	153.00
PH1_UNIT1	-47.42	61.73	0.27	480.32	0.58	210.00	-850.62	155.69	0.86	217.01	0.23	153.00
PH1_UNIT2	-18.37	57.88	0.28	432.04	0.54	209.00	-737.27	141.79	0.85	198.70	0.22	153.00
PH2_UNIT1	22.17	53.28	0.24	448.68	0.57	211.00	-703.72	150.18	0.80	255.60	0.25	153.00
PH2_UNIT2	16.68	53.67	0.24	451.24	0.58	211.00	-730.56	154.42	0.79	266.99	0.26	153.00
PHILLWIND_UNIT1	-365.24	119.14	0.45	617.32	0.51	209.00	-945.97	164.46	0.61	377.22	0.48	153.00
PHILLWIND_UNIT2	-297.15	114.20	0.40	657.52	0.54	210.00	-963.71	170.16	0.60	381.29	0.46	152.00
PYR_PYRON1	-852.30	146.20	0.76	306.65	0.30	208.00	-1166.38	166.48	0.85	191.45	0.27	153.00
PYR_PYRON2	-846.29	149.35	0.75	324.79	0.30	208.00	-1212.87	173.49	0.85	199.56	0.27	153.00
RANCHERO_UNIT1	-962.06	204.04	0.64	551.20	0.33	205.00	-1517.12	277.66	0.74	451.16	0.28	153.00
RANCHERO_UNIT2	-793.34	192.82	0.64	525.60	0.31	205.00	-1323.86	260.12	0.76	401.80	0.25	153.00
RDCANYON_RDCNY1	-665.70	127.76	0.87	188.38	0.19	208.00	-1000.13	156.87	0.89	155.14	0.20	153.00
REDFISH_MV1A	-507.13	109.92	0.87	147.15	0.19	211.00	-596.15	116.52	0.89	110.25	0.19	153.00
REDFISH_MV1B	-604.68	120.51	0.86	169.21	0.22	211.00	-686.28	126.72	0.88	130.17	0.22	153.00
RELOJ_UNIT1	-0.83	26.24	0.18	164.01	0.58	200.00	-231.01	66.36	0.60	132.78	0.31	153.00
RELOJ_UNIT2	71.43	21.36	0.10	187.41	0.62	211.00	-264.78	69.45	0.64	128.30	0.30	153.00
RELOJ_UNIT3	205.28	18.42	0.02	313.60	0.79	158.00	-300.90	90.88	0.49	224.92	0.37	153.00
RELOJ_UNIT4	-20.13	14.87	0.14	93.71	0.72	147.00	-88.35	25.79	0.57	55.23	0.33	152.00

Table 3-3: Statistical Parameters for the 2021 Daily Wind Power Production Linear Models (Continued)

Wind Farm	Statistical Parameters of Non-OSP Daily Models						Statistical Parameters of OSP Daily Models					
	C ₀	C ₁	AdjR ²	RMSE	CV-RMSE	# Days	C ₀	C ₁	AdjR ²	RMSE	CV-RMSE	# Days
ROUTE_66_WIND1	643.31	31.11	0.04	686.72	0.63	200.00	-793.34	210.87	0.77	389.19	0.24	152.00
RSNAKE_G1	-325.45	91.53	0.44	365.50	0.42	202.00	-635.58	114.21	0.66	225.87	0.35	153.00
RSNAKE_G2	-279.33	91.89	0.40	395.07	0.43	202.00	-640.73	120.30	0.68	226.68	0.32	153.00
RTS_U1	-254.79	187.07	0.34	792.90	0.45	197.00	-1230.43	253.62	0.61	496.27	0.38	153.00
RTS2_U1	-177.74	105.96	0.35	431.20	0.44	206.00	-710.27	142.59	0.63	270.16	0.38	153.00
RTS2_U2	-111.36	107.51	0.33	463.74	0.44	206.00	-743.50	153.87	0.62	292.14	0.37	153.00
SAGEDRAW_UNIT1	-949.61	226.80	0.73	518.68	0.27	202.00	-1696.49	278.80	0.80	380.92	0.27	153.00
SAGEDRAW_UNIT2	-928.75	221.53	0.69	547.10	0.29	202.00	-1699.78	269.33	0.77	404.31	0.31	153.00
SALTFORK_UNIT1	-164.51	67.60	0.71	207.05	0.26	207.00	-509.24	95.53	0.87	126.65	0.22	153.00
SALTFORK_UNIT2	-383.16	122.35	0.74	346.38	0.25	207.00	-932.74	169.08	0.91	184.87	0.18	153.00
SALVTION_UNIT1	-775.17	173.51	0.71	422.48	0.30	210.00	-1366.20	216.17	0.88	219.58	0.21	153.00
SALVTION_UNIT2	-802.51	174.98	0.74	400.71	0.28	211.00	-1361.85	215.08	0.90	202.06	0.19	153.00
SANROMAN_WIND_1	-405.57	90.30	0.57	275.35	0.43	211.00	-291.68	71.68	0.47	206.69	0.47	153.00
SANTACRU_UNIT1	-1060.56	192.79	0.85	287.03	0.25	211.00	-1152.81	191.97	0.81	251.38	0.32	153.00
SANTACRU_UNIT2	-750.16	133.58	0.85	195.23	0.25	211.00	-847.49	140.59	0.80	191.44	0.33	153.00
SENATEWD_UNIT1	-366.65	144.41	0.56	591.78	0.38	209.00	-1132.81	202.10	0.85	243.75	0.24	153.00
SGMTN_SIGNALM2	-41.26	5.95	0.57	18.31	0.50	200.00	-41.08	5.82	0.80	8.02	0.34	145.00
SGMTN_SIGNALMT	-227.15	30.83	0.85	45.23	0.26	200.00	-170.88	24.32	0.80	33.17	0.33	146.00
SHAFFER_UNIT1	-1208.33	261.09	0.65	679.25	0.38	208.00	-1791.89	299.55	0.86	323.68	0.26	153.00
SHANNONW_UNIT_1	-84.93	136.37	0.27	844.70	0.51	211.00	-1264.63	221.72	0.66	441.70	0.36	153.00
SPLAIN1_WIND1	-167.47	76.89	0.36	473.45	0.52	204.00	-383.57	102.64	0.53	328.25	0.42	150.00
SPLAIN1_WIND2	-137.26	75.49	0.36	469.42	0.51	204.00	-387.06	105.61	0.55	325.07	0.40	150.00
SPLAIN2_WIND21	-557.10	140.93	0.62	529.13	0.36	209.00	-1067.88	193.66	0.76	374.06	0.32	153.00
SPLAIN2_WIND22	-502.48	141.09	0.60	550.53	0.36	209.00	-1154.96	198.77	0.76	376.84	0.34	151.00
SRWE1_SRWE2	-1050.96	214.82	0.74	480.17	0.28	209.00	-1688.53	251.45	0.79	360.71	0.32	153.00
SRWE1_UNIT1	-1289.64	279.03	0.76	588.90	0.26	208.00	-2089.00	329.67	0.78	486.36	0.30	153.00
SSPURW2_SS3WIND1	-455.58	109.73	0.76	290.80	0.26	211.00	-625.58	142.72	0.73	292.00	0.29	153.00
SSPURW2_SS3WIND2	-384.93	107.42	0.73	309.47	0.27	211.00	-541.78	143.59	0.70	317.30	0.29	153.00
SSPURW2_WIND_1	-805.31	171.00	0.71	520.51	0.32	211.00	-986.57	221.72	0.74	447.46	0.29	153.00
STELLA_UNIT1	-1496.47	275.86	0.89	344.51	0.20	197.00	-1682.23	300.33	0.88	296.31	0.22	153.00
STWF_T1	-585.01	108.38	0.62	300.31	0.36	201.00	-973.17	144.02	0.80	201.74	0.31	151.00
S_HILLS_UNIT1	-101.29	40.88	0.67	110.89	0.27	210.00	-288.46	56.10	0.83	69.78	0.20	153.00
SWEC_G1	83.44	42.92	0.17	346.79	0.55	208.00	-475.62	97.03	0.61	211.56	0.34	153.00
SWEETW2_WND2	-1107.17	176.49	0.88	228.89	0.19	202.00	-1331.23	198.29	0.90	183.80	0.21	153.00
SWEETW2_WND24	-190.57	26.27	0.87	35.72	0.24	202.00	-191.26	25.86	0.88	25.95	0.26	153.00
SWEETW3_WND3A	-310.69	50.89	0.88	65.07	0.18	202.00	-349.38	53.61	0.89	51.93	0.21	153.00
SWEETW3_WND3B	-1063.39	172.02	0.88	219.87	0.19	202.00	-1207.09	184.41	0.88	187.36	0.22	153.00
SWEETW4_WND4A	-1187.53	168.73	0.86	243.14	0.24	201.00	-1140.93	160.80	0.85	182.91	0.28	153.00
SWEETW4_WND4B	-1078.97	153.52	0.85	230.81	0.25	201.00	-956.42	139.59	0.83	176.39	0.29	153.00
SWEETW5_WND5	-277.13	61.50	0.42	256.08	0.49	200.00	-622.94	94.71	0.76	147.42	0.33	153.00
SWEETWND_WND1	-428.33	66.37	0.88	86.84	0.20	204.00	-475.40	71.94	0.90	67.22	0.20	153.00
TAHOKA_UNIT_1	-755.33	199.74	0.73	451.65	0.25	201.00	-1561.12	255.50	0.79	361.19	0.28	153.00
TAHOKA_UNIT_2	-720.59	199.64	0.73	455.31	0.25	202.00	-1645.65	266.81	0.80	364.68	0.27	153.00
TGW_T1	-529.06	95.99	0.39	426.80	0.72	198.00	-812.03	164.34	0.68	303.54	0.35	153.00
TGW_T2	-798.93	137.83	0.53	460.78	0.58	207.00	-975.98	195.32	0.68	363.87	0.36	153.00
TKWSW1_ROSCOE	-831.26	130.15	0.74	279.19	0.33	206.00	-1055.75	147.41	0.82	193.37	0.32	153.00
TKWSW1_ROSCOE2A	-675.31	105.26	0.73	235.65	0.35	206.00	-835.24	115.79	0.79	165.18	0.36	153.00
TORR_UNIT1_25	-878.95	222.68	0.76	379.15	0.25	210.00	-1214.98	272.51	0.86	272.72	0.18	153.00
TORR_UNIT2_23	-141.90	33.70	0.71	65.01	0.29	210.00	-205.56	40.71	0.84	42.91	0.22	153.00
TORR_UNIT2_25	-646.42	182.30	0.73	334.98	0.25	210.00	-974.44	224.01	0.85	232.83	0.19	153.00
TRENT_TRENT	-394.66	62.61	0.81	109.46	0.26	195.00	-463.71	69.59	0.89	68.35	0.22	153.00
TRENT_UNIT_1B	-98.31	21.44	0.67	53.29	0.29	195.00	-166.14	29.37	0.86	32.38	0.20	153.00
TRENT_UNIT_2	-494.61	77.02	0.69	183.68	0.36	201.00	-588.89	86.77	0.85	98.61	0.26	153.00
TRENT_UNIT_3A	-398.14	61.87	0.83	99.26	0.24	201.00	-449.14	67.88	0.91	60.59	0.19	153.00
TRENT_UNIT_3B	-18.06	12.44	0.45	48.60	0.34	201.00	-116.19	22.37	0.86	25.37	0.19	153.00
TRINITY_TH1_BUS1	-667.77	153.07	0.74	345.33	0.27	211.00	-1112.29	185.56	0.80	253.82	0.26	153.00
TRINITY_TH1_BUS2	-583.45	139.10	0.71	339.52	0.29	211.00	-1098.06	177.21	0.82	231.67	0.26	153.00
TRUENO_UNIT1	-357.17	94.54	0.21	642.02	0.90	129.00	-572.40	123.20	0.56	298.47	0.44	153.00
TRUENO_UNIT2	-106.45	60.02	0.08	704.42	1.18	170.00	-382.10	101.13	0.37	354.29	0.55	152.00
TTWEC_G1	-205.04	96.88	0.34	514.50	0.50	210.00	-1100.00	176.81	0.71	314.84	0.36	153.00
TYLRWIND_UNIT1	-86.60	94.25	0.37	565.22	0.49	208.00	-1103.24	173.56	0.84	214.63	0.29	153.00
VENADO_UNIT1	-304.06	97.40	0.47	316.70	0.42	201.00	-851.46	173.69	0.82	201.58	0.23	153.00
VENADO_UNIT2	-220.89	84.23	0.41	305.82	0.44	200.00	-784.86	161.32	0.82	184.78	0.23	153.00
VERAWIND_UNIT1	-54.06	14.39	0.62	43.17	0.34	211.00	-141.53	21.45	0.81	28.72	0.29	153.00
VERAWIND_UNIT2	-25.38	7.35	0.45	31.22	0.46	188.00	-58.91	9.02	0.57	21.53	0.50	147.00
VERAWIND_UNIT3	-382.93	119.66	0.62	357.77	0.32	211.00	-1064.73	173.57	0.86	189.96	0.21	153.00
VERAWIND_UNIT4	-93.79	27.18	0.60	84.60	0.34	211.00	-271.29	41.82	0.84	49.96	0.25	153.00
VERAWIND_UNIT5	-401.38	118.11	0.64	341.73	0.31	211.00	-926.97	154.41	0.85	180.09	0.22	153.00
VERTIGO_WIND_I	-974.58	178.88	0.71	435.72	0.34	211.00	-1475.57	224.14	0.82	287.56	0.28	150.00

Table 3-3: Statistical Parameters for the 2021 Daily Wind Power Production Linear Models (Continued)

Wind Farm	Statistical Parameters of Non-OSP Daily Models						Statistical Parameters of OSP Daily Models					
	C ₀	C ₁	AdjR ²	RMSE	CV-RMSE	# Days	C ₀	C ₁	AdjR ²	RMSE	CV-RMSE	# Days
WAKEWE_G1_J01	-28.59	54.58	0.65	189.52	0.25	211.00	-351.66	82.18	0.73	171.47	0.29	153.00
WAKEWE_G1_J02	-26.95	51.60	0.65	179.16	0.25	211.00	-332.47	77.70	0.73	162.12	0.29	153.00
WAKEWE_G2_J01	-45.42	65.53	0.65	229.30	0.26	211.00	-417.88	95.90	0.71	209.06	0.31	153.00
WAKEWE_G2_J02	-42.87	61.95	0.65	216.77	0.26	211.00	-395.09	90.67	0.71	197.67	0.31	153.00
WEC_WECG1	34.87	32.53	0.30	232.03	0.47	198.00	-277.33	60.47	0.62	159.43	0.39	145.00
WH_WIND_UNIT1	-1955.41	305.18	0.86	444.33	0.23	192.00	-2020.57	290.87	0.90	268.10	0.22	153.00
WH_WIND_UNIT2	-1965.63	310.96	0.90	378.65	0.19	206.00	-1992.07	301.49	0.91	254.77	0.18	153.00
WHTTAIL_WR1	-175.11	103.48	0.45	530.61	0.44	210.00	-1215.81	188.57	0.82	252.60	0.33	153.00
WILDWIND_UNIT1	-63.77	14.66	0.31	102.22	0.71	137.00	-149.85	25.20	0.65	52.53	0.45	150.00
WILDWIND_UNIT2	-104.23	34.57	0.46	194.73	0.49	94.00	-157.85	31.68	0.29	135.00	0.78	109.00
WILDWIND_UNIT4	-160.79	41.32	0.25	325.09	0.77	146.00	-356.75	63.71	0.54	167.44	0.53	153.00
WILDWIND_UNITS	-91.57	38.11	0.43	227.15	0.49	94.00	-141.48	26.54	0.24	128.77	0.94	133.00
WL_RANCH_UNIT1	-1372.31	296.57	0.72	654.35	0.26	203.00	-2035.29	341.95	0.74	559.10	0.31	153.00
WLDTHST2_UNIT1	-316.55	78.31	0.60	243.40	0.36	211.00	-534.04	88.66	0.76	139.20	0.30	153.00
WOODWRD1_WOODWRD1	-458.46	72.28	0.51	262.02	0.56	206.00	-534.40	89.84	0.62	194.03	0.42	148.00
WOODWRD2_WOODWRD2	-379.29	60.71	0.48	231.56	0.58	206.00	-365.75	66.58	0.55	166.59	0.44	148.00

Table 3-4: Uncertainty of the 2021 daily wind power prediction using linear models (2018 base year)

Wind Farm	2018 Non Ozone Season Period				2018 Ozone Season Period (OSP)			
	Predicted days	Total Variance	Total Estimated	Relative Uncertainty	Predicted Days	Total Variance	Total Estimated	Relative uncertainty
AMADEUS1_UNIT1	212	2,791.46	73,954	3.77%	153	1,342.82	50,427.1	2.66%
AMADEUS1_UNIT2	212	2,514.02	62,149	4.05%	153	1,303.64	44,963.1	2.90%
AMADEUS2_UNIT3	212	13,985.45	380,586	3.67%	153	6,349.22	196,369.4	3.23%
ANACACHO_ANA	212	9,286.48	203,737	4.56%	153	4,972.36	195,961.8	2.54%
ASTRA_UNIT1	212	20,576.41	277,946	7.40%	153	10,157.68	335,927.7	3.02%
AVIATOR_UNIT1	212	11,694.18	372,539	3.14%	153	7,550.50	285,769.7	2.64%
AVIATOR_UNIT2	212	9,031.07	307,165	2.94%	153	6,423.22	244,261.1	2.63%
BAFFIN_UNIT1	212	8,044.90	141,222	5.70%	153	3,889.67	108,286.3	3.59%
BAFFIN_UNIT2	212	8,604.78	138,844	6.20%	153	4,034.46	112,404.4	3.59%
BARROW_UNIT1	212	8,441.18	206,509	4.09%	153	5,934.23	139,599.1	4.25%
BARROW_UNIT2	212	6,986.81	161,373	4.33%	153	5,606.20	105,003.6	5.34%
BBREEZE_UNIT1	212	6,822.90	208,857	3.27%	153	3,647.78	123,152.1	2.96%
BBREEZE_UNIT2	212	5,942.55	192,569	3.09%	153	3,399.00	117,517.8	2.89%
BCATWIND_WIND_1	212	15,998.74	330,330	4.84%	153	7,827.21	229,427.2	3.41%
BLSUMMIT_BLSMT1_5	212	1,133.18	13,251	8.55%	153	553.25	12,691.8	4.36%
BLSUMMIT_BLSMT1_6	212	13,093.71	249,036	5.26%	153	6,200.59	179,867.3	3.45%
BLSUMMIT_UNIT2_17	212	1,062.90	11,591	9.17%	153	445.32	11,447.9	3.89%
BLSUMMIT_UNIT2_25	212	9,906.53	206,613	4.79%	153	5,322.65	162,834.4	3.27%
BLSUMIT3_UNIT_17	212	1,549.74	29,432	5.27%	153	848.86	23,763.2	3.57%
BLSUMIT3_UNIT_25	212	21,501.25	436,269	4.93%	153	11,140.08	352,986.9	3.16%
BORDAS_JAVEL18	212	1,333.07	42,506	3.14%	153	780.54	38,625.8	2.02%
BORDAS_JAVEL20	212	16,794.63	620,240	2.71%	153	9,107.61	544,375.6	1.67%
BORDAS2_JAVEL2_A	212	7,060.54	262,589	2.69%	153	3,711.44	228,301.0	1.63%
BORDAS2_JAVEL2_B	212	5,530.96	204,741	2.70%	153	2,627.59	177,412.5	1.48%
BORDAS2_JAVEL2_C	212	2,325.38	85,577	2.72%	153	1,181.03	74,124.0	1.59%
BRAZ_WND_WND1	212	6,237.93	78,191	7.98%	153	3,330.18	73,825.2	4.51%
BRAZ_WND_WND2	212	4,705.98	58,232	8.08%	153	2,508.74	57,919.4	4.33%
BRISCOE_WIND	212	18,498.91	193,058	9.58%	153	9,181.49	202,112.6	4.54%
BRTSW_BCW1	212	10,797.71	153,754	7.02%	153	3,440.97	121,731.1	2.83%
BUCKTHRN_UNIT1	212	5,517.50	89,209	6.18%	153	2,373.88	80,455.5	2.95%
BUCKTHRN_UNIT2	212	7,340.38	121,389	6.05%	153	3,313.54	107,038.7	3.10%
BUFF_GAP_UNIT1	212	7,844.62	177,245	4.43%	153	5,313.63	121,537.6	4.37%
BUFF_GAP_UNIT2_1	212	9,321.99	145,348	6.41%	153	4,946.92	120,529.1	4.10%
BUFF_GAP_UNIT2_2	212	8,910.48	137,116	6.50%	153	5,129.98	119,514.5	4.29%
BUFF_GAP_UNIT3	212	13,205.72	191,739	6.89%	153	7,023.90	156,456.4	4.49%
BULLCRK_WND1	212	5,656.32	76,959	7.35%	153	2,608.56	52,353.0	4.98%
BULLCRK_WND2	212	6,625.34	85,177	7.78%	153	2,940.55	61,467.3	4.78%
CABEZON_WND1	212	7,275.25	240,509	3.02%	153	4,666.38	208,157.8	2.24%
CABEZON_WND2	212	8,134.76	259,544	3.13%	153	4,879.87	234,137.1	2.08%
CALLAHAN_WND1	212	8,537.42	241,587	3.53%	153	4,990.79	198,234.5	2.52%
CAMWIND_UNIT1	212	11,592.32	289,290	4.01%	153	6,399.81	186,662.3	3.43%
CAPRIDG4_CR4	212	6,771.03	217,742	3.11%	153	5,037.04	167,342.8	3.01%
CAPRIDGE_CR1	212	12,736.68	438,178	2.91%	153	8,192.52	336,111.5	2.44%
CAPRIDGE_CR2	212	9,442.10	249,155	3.79%	153	7,706.55	204,934.2	3.76%
CAPRIDGE_CR3	212	10,073.16	338,554	2.98%	153	8,587.83	262,774.8	3.27%
CEDROHIL_CHW1	212	5,392.70	175,610	3.07%	153	2,832.42	157,830.9	1.79%

Table 3-4: Uncertainty of the 2021 daily wind power prediction using linear models (2018 base year)
(Continued)

Wind Farm	2018 Non Ozone Season Period				2018 Ozone Season Period (OSP)			
	Predicted days	Total Variance	Total Estimated	Relative Uncertainty	Predicted Days	Total Variance	Total Estimated	Relative uncertainty
CEDROHIL_CHW2	212	4,965.72	161,944	3.07%	153	2,687.64	143,200.0	1.88%
CFLATS_U1	212	12,723.61	265,423	4.79%	153	7,216.22	201,851.1	3.58%
CHALUPA_UNIT1	212	15,390.38	232,492	6.62%	153	7,492.51	129,819.7	5.77%
CHALUPA_UNIT2	212	2,197.55	32,891	6.68%	153	1,113.04	18,980.4	5.86%
CHAMPION_UNIT1	212	9,129.65	193,860	4.71%	153	4,511.52	147,580.4	3.06%
CN_BRKS_UNIT_1	212	20,684.47	632,348	3.27%	153	11,740.44	571,193.0	2.06%
COTPLNS_COTTONPL	212	4,216.21	159,443	2.64%	153	3,153.68	113,006.2	2.79%
COTPLNS_OLDSETLR	212	20,606.76	328,262	6.28%	153	9,496.73	338,382.6	2.81%
COYOTE_W_UNIT1	212	10,070.86	130,379	7.72%	153	3,548.66	111,407.9	3.19%
COYOTE_W_UNIT2	212	2,024.16	44,330	4.57%	153	1,026.13	30,183.0	3.40%
COYOTE_W_UNIT3	212	15,703.36	187,442	8.38%	153	5,234.56	176,386.9	2.97%
COTTON_PAP2	212	19,021.08	279,049	6.82%	153	10,656.03	205,413.3	5.19%
CRANELL_UNIT1	212	15,813.14	417,390	3.79%	153	11,003.90	258,665.6	4.25%
CSEC_CSECG1	212	11,273.34	149,742	7.53%	153	5,500.41	126,084.0	4.36%
CSEC_CSECG2	212	9,404.59	129,887	7.24%	153	4,670.86	104,817.2	4.46%
DERMOTT_UNIT1	212	8,177.41	291,966	2.80%	153	5,209.86	217,746.9	2.39%
DERMOTT_UNIT2	212	8,130.72	286,079	2.84%	153	5,086.27	221,990.4	2.29%
DEWOLF_UNIT1	212	16,941.58	420,245	4.03%	153	9,477.15	338,647.2	2.80%
DIGBY_UNIT1	212	12,381.03	245,778	5.04%	153	6,147.22	187,962.0	3.27%
DIGBY_UNIT2	212	16,019.27	305,861	5.24%	153	8,218.08	236,675.1	3.47%
EL_RAYO_UNIT1	212	6,580.71	225,986	2.91%	153	3,947.56	150,924.3	2.62%
EL_RAYO_UNIT2	212	6,500.06	217,591	2.99%	153	3,932.22	145,569.9	2.70%
ELB_ELBRCREEK	212	7,596.48	258,556	2.94%	153	4,701.65	194,544.3	2.42%
EXGNSND_WIND_1	212	5,857.72	195,706	2.99%	153	4,345.72	182,843.1	2.38%
EXGNWTL_WIND_1	212	6,185.21	171,485	3.61%	153	2,939.67	154,059.4	1.91%
FERMI_WIND1	212	11,220.93	205,269	5.47%	153	8,511.11	196,198.0	4.34%
FERMI_WIND2	212	2,921.89	55,034	5.31%	153	2,140.52	50,291.4	4.26%
FLTCK_SSI	212	6,556.30	128,334	5.11%	153	2,701.20	111,175.0	2.43%
FLUVANNA_UNIT1	212	5,709.14	185,919	3.07%	153	3,369.79	142,984.0	2.36%
FLUVANNA_UNIT2	212	5,154.34	174,104	2.96%	153	3,061.40	131,474.6	2.33%
FOARDCTY_UNIT1	212	21,169.81	415,726	5.09%	153	10,286.55	294,960.1	3.49%
FOARDCTY_UNIT2	212	17,574.83	359,911	4.88%	153	9,048.50	267,546.2	3.38%
FTWIND_UNIT_1	212	27,693.36	446,142	6.21%	153	13,670.91	338,957.9	4.03%
GOAT_GOATWIND	212	6,159.39	71,591	8.60%	153	3,687.19	75,101.1	4.91%
GOAT_GOATWIN2	212	5,463.29	69,421	7.87%	153	3,263.94	68,630.0	4.76%
GOPHER_UNIT1	212	6,130.15	184,695	3.32%	153	3,939.57	148,341.4	2.66%
GOPHER_UNIT2	212	5,586.73	171,227	3.26%	153	3,523.53	145,816.8	2.42%
GPASTURE_WIND_I	212	11,092.58	237,826	4.66%	153	7,349.92	204,007.7	3.60%
GRANDVW1_COLA	212	8,989.29	320,953	2.80%	153	4,198.07	284,359.8	1.48%
GRANDVW1_COLB	212	9,446.99	320,937	2.94%	153	4,214.36	281,329.3	1.50%
GRANDVW1_GV1A	212	9,315.64	343,716	2.71%	153	4,555.60	284,768.0	1.60%
GRANDVW1_GV1B	212	9,283.42	324,732	2.86%	153	4,900.46	269,554.1	1.82%
GUNMTN_G1	212	8,873.52	287,045	3.09%	153	6,036.46	215,984.1	2.79%
GWEC_GWEC_G1	212	16,099.22	311,251	5.17%	153	6,668.36	238,746.2	2.79%
HARALD_UNIT1	212	14,468.11	311,231	4.65%	153	8,476.15	263,980.1	3.21%
H_HOLLOW_WND1	212	16,490.14	441,017	3.74%	153	9,681.68	322,067.7	3.01%
HHOLLOW2_WIND1	212	12,090.86	334,016	3.62%	153	8,525.88	267,463.4	3.19%
HHOLLOW3_WND_1	212	14,547.21	412,772	3.52%	153	9,675.00	319,788.7	3.03%
HHOLLOW4_WND1	212	9,333.54	241,100	3.87%	153	5,213.02	176,502.3	2.95%
HI_LONE_WGR1A	212	5,885.45	89,598	6.57%	153	2,990.09	85,313.9	3.50%
HI_LONE_WGR1B	212	5,900.30	76,121	7.75%	153	3,968.53	86,189.8	4.60%
HI_LONE_WGR1C	212	3,418.38	54,219	6.30%	153	1,784.61	50,919.1	3.50%
HI_LONE_WGR3	212	12,630.30	206,002	6.13%	153	7,327.99	201,169.8	3.64%
HI_LONE_WGR4	212	10,760.54	163,467	6.58%	153	5,861.62	166,254.0	3.53%
HI_LONE_WGR2	212	15,327.71	185,180	8.28%	153	7,659.63	211,214.1	3.63%
HI_LONE_WGR2A	212	3,204.02	57,280	5.59%	153	1,671.77	50,812.9	3.29%
HICKMAN_G1_J01	212	6,644.88	185,663	3.58%	153	5,219.43	146,478.8	3.56%
HICKMAN_G1_J02	212	7,369.06	181,531	4.06%	153	5,222.73	146,474.1	3.57%
HICKMAN_G2_J01	212	6,060.72	173,940	3.48%	153	4,152.12	147,334.2	2.82%
HICKMAN_G2_J02	212	6,713.69	170,170	3.95%	153	4,152.42	147,337.9	2.82%
HORSECRK_UNIT1	212	12,463.74	299,057	4.17%	153	6,465.59	217,819.0	2.97%
HORSECRK_UNIT2	212	10,280.45	223,637	4.60%	153	4,464.65	173,732.2	2.57%
HRFDWIND_JRDWIND1	212	10,190.10	398,064	2.56%	153	5,955.58	304,583.7	1.96%
HRFDWIND_JRDWIND2	212	10,837.85	415,606	2.61%	153	6,498.79	318,307.6	2.04%
HRFDWIND_WIND_G	212	11,655.07	210,621	5.53%	153	5,019.58	192,792.7	2.60%
HRFDWIND_WIND_V	212	13,944.00	256,816	5.43%	153	6,229.59	259,702.7	2.40%
HWF_HWFG1	212	15,650.35	232,014	6.75%	153	6,371.18	184,932.5	3.45%
INDL_INADALE1	212	6,649.12	140,586	4.73%	153	3,642.61	107,678.1	3.38%
INDL_INADALE2	212	7,125.39	150,063	4.75%	153	4,069.64	110,597.9	3.68%

Table 3-4: Uncertainty of the 2021 daily wind power prediction using linear models (2018 base year)
(Continued)

Wind Farm	2018 Non Ozone Season Period				2018 Ozone Season Period (OSP)			
	Predicted days	Total Variance	Total Estimated	Relative Uncertainty	Predicted Days	Total Variance	Total Estimated	Relative uncertainty
INDNENR_INDENR	212	7,528.23	116,936	6.44%	153	4,527.71	124,787.5	3.63%
INDNENR_INDENR_2	212	7,972.38	120,145	6.64%	153	4,803.39	121,821.8	3.94%
INDNENR_UNIT_1B	212	2,506.96	41,418	6.05%	153	1,420.00	39,786.6	3.57%
INDNENR_UNIT_2B	212	1,487.86	24,476	6.08%	153	993.11	25,191.5	3.94%
INDNNWP_INDNNWP2	212	9,562.33	116,722	8.19%	153	5,080.98	122,146.0	4.16%
KARAKAW1_UNIT1	212	7,902.94	215,565	3.67%	153	4,797.51	133,784.1	3.59%
KARAKAW1_UNIT2	212	8,206.03	218,379	3.76%	153	5,155.00	133,584.1	3.86%
KARAKAW2_UNIT3	212	8,971.40	211,684	4.24%	153	5,047.38	128,139.9	3.94%
KEECHI_U1	212	13,843.78	257,682	5.37%	153	7,907.82	195,262.8	4.05%
KEO_SHRBINO2	212	16,966.44	279,874	6.06%	153	11,843.44	299,840.0	3.95%
KING_NE_KINGNE	212	4,965.77	79,059	6.28%	153	2,868.90	68,798.1	4.17%
KING_NW_KINGNW	212	7,348.50	89,644	8.20%	153	3,759.06	83,341.7	4.51%
KING_SE_KINGSE	212	2,481.65	32,989	7.52%	153	1,304.56	28,430.6	4.59%
KING_SW_KINGSW	212	6,828.10	86,799	7.87%	153	4,062.02	83,594.6	4.86%
LGD_LANGFORD	212	15,083.74	357,275	4.22%	153	9,273.67	270,816.5	3.42%
LGW_UNIT1	212	11,873.54	216,651	5.48%	153	5,064.24	162,161.3	3.12%
LGW_UNIT2	212	11,491.47	198,989	5.77%	153	4,916.86	155,481.4	3.16%
LHORN_N_UNIT1	212	9,179.38	311,273	2.95%	153	6,882.13	220,572.4	3.12%
LHORN_N_UNIT2	212	9,173.48	317,757	2.89%	153	6,889.76	233,254.6	2.95%
LMAJADAS_UNIT1	212	9,545.41	207,742	4.59%	153	4,335.98	159,954.2	2.71%
LMAJADAS_UNIT2	212	2,049.45	41,376	4.95%	153	1,134.58	31,971.8	3.55%
LMAJADAS_UNIT3	212	11,867.23	250,534	4.74%	153	5,855.88	189,109.4	3.10%
LNCRK_G83	212	10,511.35	301,708	3.48%	153	6,739.08	209,046.3	3.22%
LOCKETT_UNIT1	212	23,041.82	451,689	5.10%	153	11,100.74	364,631.6	3.04%
LNCRK2_G871	212	6,783.16	145,964	4.65%	153	3,962.35	106,173.2	3.73%
LNCRK2_G872	212	6,955.66	152,659	4.56%	153	4,042.51	107,019.3	3.78%
LONEWOLF_G1	212	4,204.34	63,221	6.65%	153	1,921.85	56,097.3	3.43%
LONEWOLF_G2	212	4,123.34	61,226	6.73%	153	1,937.61	52,823.7	3.67%
LONEWOLF_G3	212	2,341.22	35,116	6.67%	153	1,100.71	31,166.2	3.53%
LONEWOLF_G4	212	2,138.59	30,131	7.10%	153	1,044.36	26,999.7	3.87%
LV1_LV1A	212	12,419.98	298,130	4.17%	153	8,101.23	147,566.9	5.49%
LV2_LV2	212	10,899.27	315,954	3.45%	153	5,556.36	202,586.6	2.74%
LV3_UNIT_1	212	16,711.93	489,987	3.41%	153	9,303.22	423,836.6	2.20%
LV4_UNIT_1	212	16,106.35	494,421	3.26%	153	9,781.91	449,161.4	2.18%
LV5_UNIT_1	212	9,438.47	236,478	3.99%	153	4,633.22	222,231.5	2.08%
MARIAH_NORTE1	212	13,450.95	330,425	4.07%	153	7,296.11	262,198.5	2.78%
MARIAH_NORTE2	212	13,078.60	326,292	4.01%	153	6,951.66	276,307.3	2.52%
MAVCRK_E_UNITS	212	8,543.77	123,416	6.92%	153	3,556.39	122,966.7	2.89%
MAVCRK_E_UNIT6	212	2,465.87	73,021	3.38%	153	1,650.48	56,144.8	2.94%
MAVCRK_E_UNIT7	212	1,760.45	45,646	3.86%	153	993.05	36,066.1	2.75%
MAVCRK_E_UNIT8	212	1,440.39	39,378	3.66%	153	1,001.90	29,848.8	3.36%
MAVCRK_E_UNIT9	212	8,860.04	119,991	7.38%	153	3,253.83	96,097.5	3.39%
MAVCRK_W_UNIT1	212	18,472.51	359,574	5.14%	153	9,660.82	329,712.4	2.93%
MAVCRK_W_UNIT2	212	822.24	22,143	3.71%	153	517.52	16,858.8	3.07%
MAVCRK_W_UNIT3	212	2,805.72	63,499	4.42%	153	1,607.06	54,974.1	2.92%
MAVCRK_W_UNIT4	212	1,613.88	46,368	3.48%	153	1,045.60	34,751.2	3.01%
MARYNEAL_UNIT1	212	22,133.29	279,182	7.93%	153	7,796.58	67,503.9	11.55%
MCDLD_FCW1	212	9,434.54	155,996	6.05%	153	5,269.61	143,204.3	3.68%
MCDLD_SBW1	212	3,158.91	32,528	9.71%	153	1,795.98	34,851.7	5.15%
MESQCRK_WND1	212	9,225.16	198,727	4.64%	153	7,251.65	136,989.2	5.29%
MESQCRK_WND2	212	8,810.96	198,275	4.44%	153	5,316.78	141,900.6	3.75%
MESTENO_UNIT_1	212	12,483.70	247,656	5.04%	153	11,670.53	238,119.8	4.90%
MIAM1_G1	212	12,743.76	417,440	3.05%	153	8,130.59	297,139.6	2.74%
MIAM1_G2	212	12,313.18	402,059	3.06%	153	7,301.00	340,880.6	2.14%
MIDWIND_UNIT1	212	15,153.81	300,894	5.04%	153	8,569.99	209,050.8	4.10%
MIRASOLE_MIR11	212	5,288.28	92,293	5.73%	153	3,128.01	99,548.4	3.14%
MIRASOLE_MIR12	212	10,398.28	179,797	5.78%	153	6,191.66	190,659.5	3.25%
MIRASOLE_MIR13	212	4,573.69	81,377	5.62%	153	2,445.90	84,142.3	2.91%
MIRASOLE_MIR21	212	10,018.37	172,249	5.82%	153	5,799.65	178,801.8	3.24%
MOZART_WIND_1	212	2,552.83	36,705	6.96%	153	1,060.61	26,431.1	4.01%
MWEC_G1	212	16,838.45	272,316	6.18%	153	10,173.65	252,686.5	4.03%
NBOHR_UNIT1	212	16,263.41	359,033	4.53%	153	9,521.27	314,483.0	3.03%
NWF_NWF1	212	8,730.76	104,983	8.32%	153	5,361.09	103,939.2	5.16%
NWF_NWF2	212	5,956.77	68,955	8.64%	153	3,394.27	66,352.9	5.12%
OVEJA_G1	212	12,366.76	356,935	3.46%	153	7,773.96	304,114.7	2.56%
OVEJA_G2	212	13,089.10	351,115	3.73%	153	7,866.31	301,722.2	2.61%
OWF_OWFF	212	2,439.03	24,710	9.87%	153	1,187.77	16,305.7	7.28%
PALMWIND_UNIT1	212	10,853.25	174,223	6.23%	153	5,844.24	126,506.6	4.62%

Table 3-4: Uncertainty of the 2021 daily wind power prediction using linear models (2018 base year)
(Continued)

Wind Farm	2018 Non Ozone Season Period				2018 Ozone Season Period (OSP)			
	Predicted days	Total Variance	Total Estimated	Relative Uncertainty	Predicted Days	Total Variance	Total Estimated	Relative uncertainty
PAP1_PAP1_J01	212	4,057.90	71,603	5.67%	153	2,339.05	52,233.0	4.48%
PAP1_PAP1_J02	212	7,849.51	229,205	3.42%	153	6,115.87	156,942.8	3.90%
PC_NORTH_PANTHER1	212	9,967.18	319,319	3.12%	153	5,943.04	246,339.8	2.41%
PC_SOUTH_PANTHER2	212	8,093.14	250,009	3.24%	153	4,541.43	190,386.7	2.39%
PC_SOUTH_PANTHER3	212	19,139.29	354,445	5.40%	153	6,856.44	205,883.2	3.33%
PENA_UNIT1	212	8,646.57	118,291	7.31%	153	6,358.39	106,715.4	5.96%
PENA_UNIT2_J01	212	4,097.72	53,586	7.65%	153	2,443.16	51,941.9	4.70%
PENA_UNIT2_J02	212	4,421.16	59,807	7.39%	153	2,819.99	56,858.6	4.96%
PENA3_UNIT3	212	5,582.11	74,918	7.45%	153	4,206.24	67,705.6	6.21%
PEY_UNIT1	212	16,070.29	273,852	5.87%	153	8,625.52	137,883.8	6.26%
PH1_UNIT1	212	13,752.72	212,005	6.49%	153	5,288.54	255,307.8	2.07%
PH1_UNIT2	212	12,371.36	204,320	6.05%	153	4,842.33	238,225.5	2.03%
PH2_UNIT1	212	12,846.27	196,372	6.54%	153	6,229.01	264,127.9	2.36%
PH2_UNIT2	212	12,919.72	196,585	6.57%	153	6,506.65	270,519.9	2.41%
PHILLWIND_UNIT1	212	17,648.03	238,845	7.39%	153	9,214.49	187,035.3	4.93%
PHILLWIND_UNIT2	212	18,796.98	240,150	7.83%	153	9,317.89	194,467.1	4.79%
PYR_PYRON1	212	8,771.80	200,523	4.37%	153	4,658.48	147,925.0	3.15%
PYR_PYRON2	212	9,290.50	209,966	4.42%	153	4,855.79	154,537.7	3.14%
RANCHERO_UNIT1	212	15,769.80	327,761	4.81%	153	10,977.81	311,513.5	3.52%
RANCHERO_UNIT2	212	15,037.49	334,295	4.50%	153	9,776.81	306,754.3	3.19%
RDCANYON_RDCNY1	212	5,388.64	191,855	2.81%	153	3,774.99	154,265.2	2.45%
REDFISH_MV1A	212	4,207.96	168,311	2.50%	153	2,682.27	111,631.6	2.40%
REDFISH_MV1B	212	4,838.99	174,203	2.78%	153	3,166.87	115,583.3	2.74%
RELOJ_UNIT1	212	4,698.42	68,206	6.89%	153	3,234.05	94,582.8	3.42%
RELOJ_UNIT2	212	5,367.16	70,801	7.58%	153	3,124.98	95,462.0	3.27%
RELOJ_UNIT3	212	8,993.65	91,523	9.83%	153	5,478.01	131,905.0	4.15%
RELOJ_UNIT4	212	2,692.67	34,490	7.81%	153	1,345.19	36,738.6	3.66%
ROUTE_66_WIND1	212	19,666.93	248,279	7.92%	153	9,485.49	398,072.0	2.38%
RSNAKE_G1	212	10,458.48	169,527	6.17%	153	5,495.97	126,379.9	4.35%
RSNAKE_G2	212	11,304.87	180,234	6.27%	153	5,515.82	137,506.6	4.01%
RTS_U1	212	22,712.24	433,481	5.24%	153	12,087.16	308,307.4	3.92%
RTS2_U1	212	12,349.93	238,437	5.18%	153	6,579.91	170,507.8	3.86%
RTS2_U2	212	13,281.92	256,566	5.18%	153	7,115.27	187,512.6	3.79%
SAGEDRAW_UNIT1	212	14,838.26	389,720	3.81%	153	9,268.83	286,433.0	3.24%
SAGEDRAW_UNIT2	212	15,651.24	380,406	4.11%	153	9,837.89	267,452.6	3.68%
SALTFORK_UNIT1	212	5,928.10	208,291	2.85%	153	3,086.43	158,594.2	1.95%
SALTFORK_UNIT2	212	9,917.41	358,910	2.76%	153	4,507.69	275,881.6	1.63%
SALVTION_UNIT1	212	12,083.42	287,811	4.20%	153	5,342.89	214,386.5	2.49%
SALVTION_UNIT2	212	11,460.83	285,849	4.01%	153	4,916.57	212,916.5	2.31%
SANROMAN_WIND_1	212	7,874.12	140,616	5.60%	153	5,028.64	80,159.4	6.27%
SANTACRU_UNIT1	212	8,208.04	259,033	3.17%	153	6,115.86	157,846.6	3.87%
SANTACRU_UNIT2	212	5,582.89	176,276	3.17%	153	4,657.62	115,111.0	4.05%
SENATEWD_UNIT1	212	16,918.20	305,623	5.54%	153	5,954.05	234,229.5	2.54%
SGMTN_SIGNALM2	212	523.90	6,796	7.71%	153	195.27	4,864.4	4.01%
SGMTN_SIGNALMT	212	1,294.26	32,547	3.98%	153	807.32	20,550.9	3.93%
SHAFFER_UNIT1	212	19,425.00	399,014	4.87%	153	7,874.84	247,361.9	3.18%
SHANNONW_UNIT_1	212	24,159.22	337,368	7.16%	153	10,747.75	240,646.4	4.47%
SPLAIN_WIND1	212	13,558.87	241,096	5.62%	153	8,000.36	191,595.6	4.18%
SPLAIN_WIND2	212	13,443.33	242,464	5.54%	153	7,922.82	198,271.2	4.00%
SPLAIN2_WIND21	212	15,149.92	388,870	3.90%	153	9,115.80	316,059.5	2.88%
SPLAIN2_WIND22	212	15,762.53	401,019	3.93%	153	9,183.98	311,278.0	2.95%
SRWE1_SRWE2	212	13,734.48	337,024	4.08%	153	8,776.93	234,372.5	3.74%
SRWE1_UNIT1	212	16,845.40	453,732	3.71%	153	11,834.33	326,115.0	3.63%
SSPURW2_SS3WIND1	212	8,325.94	298,135	2.79%	153	7,116.05	257,637.6	2.76%
SSPURW2_SS3WIND2	212	8,860.48	304,804	2.91%	153	7,732.58	272,592.4	2.84%
SSPURW2_WIND_1	212	14,902.75	444,403	3.35%	153	10,904.71	397,985.9	2.74%
STELLA_UNIT1	212	9,853.60	375,082	2.63%	153	7,209.01	265,431.4	2.72%
STWF_T1	212	8,593.33	158,471	5.42%	153	4,908.84	131,580.4	3.73%
S_HILLS_UNIT1	212	3,171.67	85,066	3.73%	153	1,697.90	65,710.1	2.58%
SWEC_G1	212	9,919.87	129,543	7.66%	153	5,147.90	117,210.3	4.39%
SWEETWN2_WND2	212	6,549.69	225,647	2.90%	153	4,472.33	184,867.2	2.42%
SWEETWN2_WND24	212	1,022.08	28,341	3.61%	153	631.51	21,488.3	2.94%
SWEETWN3_WND3A	212	1,861.90	66,844	2.79%	153	1,263.66	51,568.0	2.45%
SWEETWN3_WND3B	212	6,291.62	223,232	2.82%	153	4,558.88	176,602.3	2.58%
SWEETWN4_WND4A	212	6,957.58	189,338	3.67%	153	4,450.64	140,747.4	3.16%
SWEETWN4_WND4B	212	6,604.78	172,567	3.83%	153	4,292.07	127,243.1	3.37%
SWEETWN5_WND5	212	7,328.00	101,526	7.22%	153	3,587.10	90,253.7	3.97%
SWEETWIND_WND1	212	2,484.73	82,358	3.02%	153	1,635.74	68,207.0	2.40%

Table 3-4: Uncertainty of the 2021 daily wind power prediction using linear models (2018 base year)
(Continued)

Wind Farm	2018 Non Ozone Season Period				2018 Ozone Season Period (OSP)			
	Predicted days	Total Variance	Total Estimated	Relative Uncertainty	Predicted Days	Total Variance	Total Estimated	Relative uncertainty
TAHOKA_UNIT_1	212	12,920.84	360,378	3.59%	153	8,788.66	261,510.1	3.36%
TAHOKA_UNIT_2	212	13,025.28	367,472	3.54%	153	8,873.50	270,754.4	3.28%
TGW_T1	212	12,206.67	128,760	9.48%	153	7,384.82	161,843.8	4.56%
TGW_T2	212	13,177.17	176,681	7.46%	153	8,852.56	190,687.0	4.64%
TKWSW1_ROSCOE	212	7,987.32	163,318	4.89%	153	4,705.21	127,584.4	3.69%
TKWSW1_ROSCOE2A	212	6,741.68	131,448	5.13%	153	4,019.35	99,333.0	4.05%
TORR_UNIT1_25	212	10,858.68	393,961	2.76%	153	6,642.27	347,656.7	1.91%
TORR_UNIT2_23	212	1,861.95	57,749	3.22%	153	1,045.08	48,264.8	2.17%
TORR_UNIT2_25	212	9,593.66	338,010	2.84%	153	5,670.82	289,511.3	1.96%
TRENT_TRENT	212	3,132.31	79,643	3.93%	153	1,663.19	65,410.9	2.54%
TRENT_UNIT_1B	212	1,524.98	35,028	4.35%	153	787.92	32,083.4	2.46%
TRENT_UNIT_2	212	5,256.23	96,084	5.47%	153	2,399.41	79,944.3	3.00%
TRENT_UNIT_3A	212	2,840.27	77,010	3.69%	153	1,474.22	64,271.2	2.29%
TRENT_UNIT_3B	212	1,390.82	28,584	4.87%	153	617.31	26,020.8	2.37%
TRINITY_TH1_BUS1	212	9,876.70	257,326	3.84%	153	6,176.19	193,198.4	3.20%
TRINITY_TH1_BUS2	212	9,710.72	238,789	4.07%	153	5,637.09	179,050.4	3.15%
TRUENO_UNIT1	212	18,384.92	161,504	11.38%	153	7,261.42	126,891.4	5.72%
TRUENO_UNIT2	212	20,152.28	128,040	15.74%	153	8,619.62	116,823.6	7.38%
TTWEC_G1	212	14,715.83	209,009	7.04%	153	7,660.96	177,975.5	4.30%
TYLRWIND_UNIT1	212	16,158.92	231,848	6.97%	153	5,242.80	181,961.1	2.88%
VENADO_UNIT1	212	9,070.71	189,366	4.79%	153	4,909.65	209,798.6	2.34%
VENADO_UNIT2	212	8,759.04	172,663	5.07%	153	4,500.36	195,760.5	2.30%
VERAWIND_UNIT1	212	1,234.76	26,038	4.74%	153	698.89	20,376.2	3.43%
VERAWIND_UNIT2	212	893.04	13,766	6.49%	153	524.00	8,309.8	6.31%
VERAWIND_UNIT3	212	10,232.71	230,648	4.44%	153	4,622.24	177,019.9	2.61%
VERAWIND_UNIT4	212	2,419.50	50,941	4.75%	153	1,215.73	40,414.5	3.01%
VERAWIND_UNITS	212	9,773.84	222,703	4.39%	153	4,382.12	160,545.6	2.73%
VERTIGO_WIND_I	212	12,462.09	259,680	4.80%	153	6,997.26	209,180.4	3.35%
WAKEWE_G1_J01	212	5,426.28	190,282	2.85%	153	4,178.69	149,660.2	2.79%
WAKEWE_G1_J02	212	5,129.47	179,920	2.85%	153	3,950.93	141,507.0	2.79%
WAKEWE_G2_J01	212	6,565.19	226,093	2.90%	153	5,094.91	173,479.0	2.94%
WAKEWE_G2_J02	212	6,206.31	213,780	2.90%	153	4,817.29	164,028.3	2.94%
WEC_WECG1	212	6,645.22	124,396	5.34%	153	3,887.08	101,659.4	3.82%
WH_WIND_UNIT1	212	12,715.26	381,638	3.33%	153	6,523.52	261,012.6	2.50%
WH_WIND_UNIT2	212	10,832.73	394,449	2.75%	153	6,199.16	285,917.5	2.17%
WHITTAIL_WR1	212	15,169.18	237,586	6.38%	153	6,170.38	195,229.9	3.16%
WILDWIND_UNIT1	212	2,924.85	25,422	11.51%	153	1,283.38	27,391.9	4.69%
WILDWIND_UNIT2	212	5,574.55	69,664	8.00%	153	3,310.12	28,260.6	11.71%
WILDWIND_UNIT4	212	9,301.48	75,637	12.30%	153	4,090.19	73,902.4	5.53%
WILDWIND_UNITS	212	6,502.73	81,743	7.96%	153	3,151.13	27,691.8	11.38%
WL_RANCH_UNIT1	212	18,722.88	481,906	3.89%	153	13,604.28	358,211.2	3.80%
WNDTHST2_UNIT1	212	6,961.42	136,958	5.08%	153	3,387.19	91,921.7	3.68%
WOODWRD1_WOODWRD1	212	7,495.92	91,351	8.21%	153	4,721.82	91,079.1	5.18%
WOODWRD2_WOODWRD2	212	6,624.48	77,938	8.50%	153	4,054.15	71,966.7	5.63%

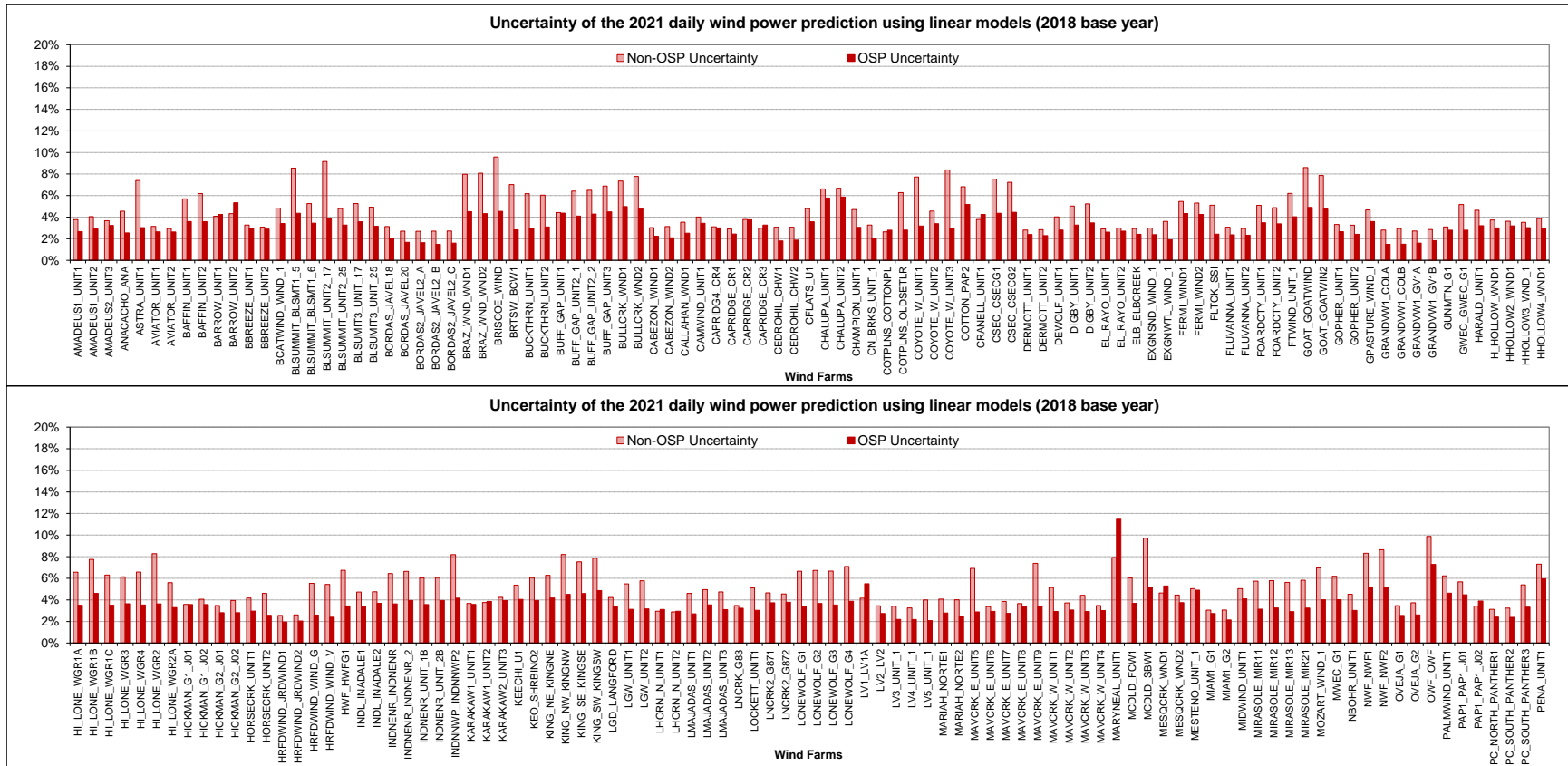


Figure 3-15: Uncertainty of the 2021 daily wind power prediction using linear models (2018 base year)

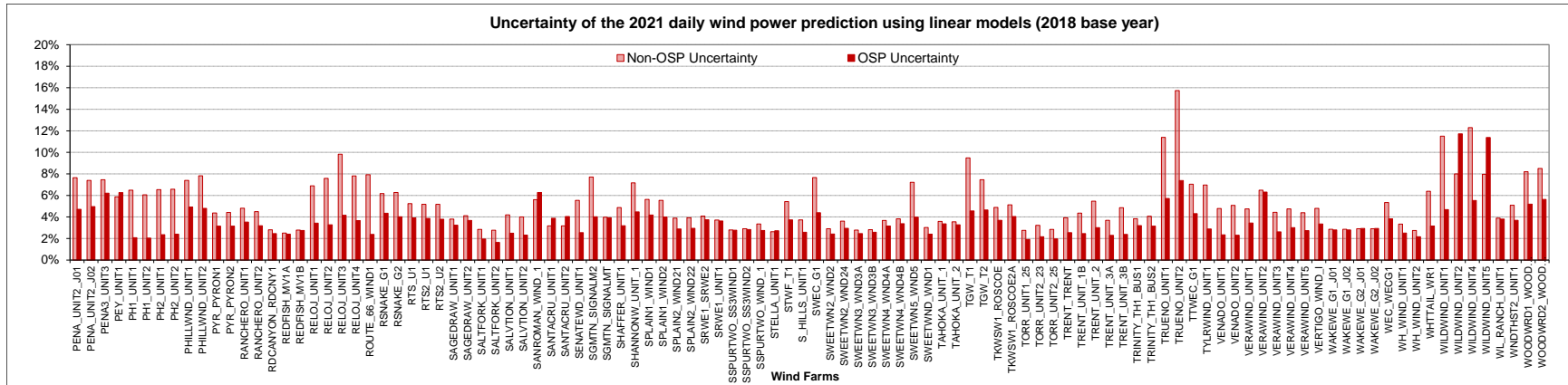


Figure 3-15: Uncertainty of the 2021 daily wind power prediction using linear models (2018 base year) (Continued)

4 DEGRADATION ANALYSIS FOR WIND FARMS

This report contains an updated analysis to determine any degradation that could be observed in the measured power generation from Texas wind farms. By request of the TCEQ, the ESL has been evaluating any observed degradation from the measured data for Texas wind farms. To accomplish this, in this report one hundred and fifty-seven sites¹⁵ built from 2002 to 2018, which have been in operation for more than three years, were evaluated with a total capacity of 19,722.8 MW (see Table 4-1).

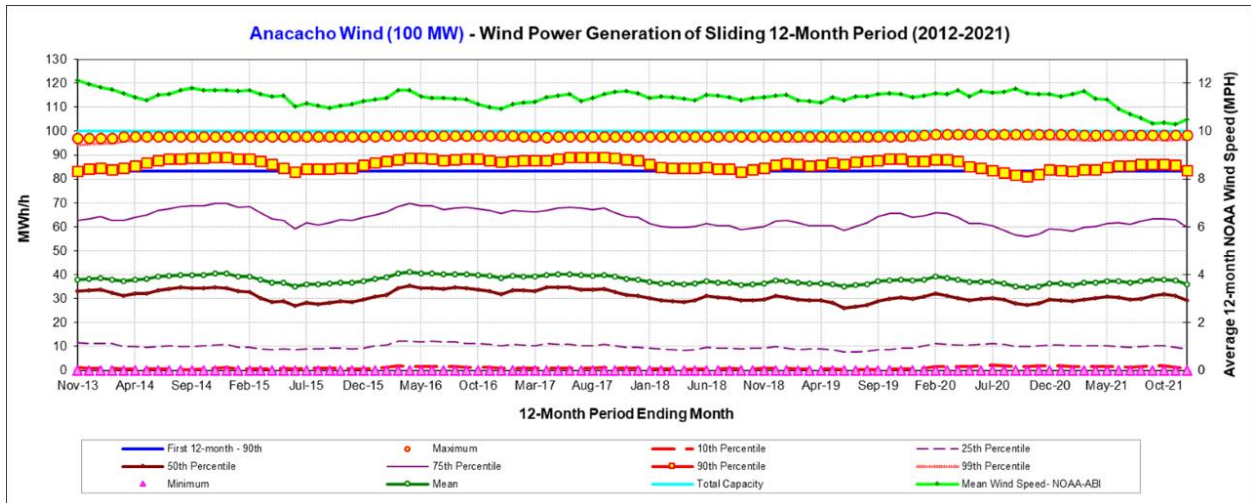
In this analysis, a sliding statistical index was established for each site that used the 10th, 25th, 50th, 75th, 90th, and 99th percentiles of the hourly power generation over a 12-month sliding period, as well as mean, minimum and maximum hourly power generation of the same 12-month period. These indices were then displayed using one data symbol for each 12-month slide, beginning from the first 12-month period until the last 12-month period for each of the wind farms.

Table 4-1 presents a summary of the degradation analysis for the one hundred and fifty-seven sites. For each of the wind farms that are included in the degradation analysis, Table 4-1 includes the first year, average, maximum, and minimum 12-month sliding 90th percentile as well as the number of months of data and the capacity. The first year 12-month sliding 90th percentile reports the 90th percentile for the generation in MW for the first 12-months that the wind farm has been in operation. Similarly, the 90th percentile for the generation in each 12-month is calculated by sliding one month at-a-time toward the current date. Then the maximum and minimum of the calculated 12-month 90th percentiles are reported for each wind farm. Furthermore, the difference between the first 12-month 90th percentile and each of the average, maximum, and minimum 12-month 90th percentiles are reported.

Of the one hundred and fifty-seven sites analyzed, eighty-seven sites showed an increase when one compares the 90th percentile of the whole period to the 90th percentile of the first 12-month period, ranging from 0.1% to 58.1%, the remaining seventy sites showed a decrease from -0.1% to -39.1%. The weighted average of this increase across all wind farms studied is 2.4% (positive), which indicates that no degradation was observed from the aggregated energy production from these wind farms over the studied operation period. Based on the observations, special attention needs to be paid to sites Capricorn Ridge Wind 3 (-10.1%), Gulf Wind 2 (-10.1%), Roscoe Wind Farm (-10.3%), Papalote Creek Wind Farm (-11.4%), Penascal Wind 1 (-12.0%), Briscoe Wind 19 (-12.1%), Gulf Wind 1 (-12.5%), Sand Bluff Wind (-13.3%), Snyder Wind Project (-14.2%), Penascal Wind 3 (-18.1%), Big Spring Wind Farm (-21.7%), Sherbino 2 Wind (-32.1%), and Harbor Wind (-39.1%). Those wind farms have comparison percentages larger than 10%, which may be caused by wind farm operation issues, meter problems or other similar issues.

Table 4-2 and Figure 4-2 show the design capacity, the maximum and minimum of the observed maximum hourly wind power over the sliding 12-month period, and the observed maximum hourly wind power for the last 12-month period for the studied wind farms. It is interesting to note that in most cases the observed maximum hourly wind power generation is equal to, or slightly lower than the design/announced capacity for all the sites. Figure B-1 to Figure B-157 (in Volume II, Appendix B) also present sliding 12-months wind power generations for degradation analysis. An example of the degradation analysis figures shown in Appendix B is illustrated in Figure 4-1.

¹⁵ The one hundred and fifty-seven sites presented in the degradation analysis section include one hundred and eighty-six individual wind farms.



Note: The wind speed dropping from approximate 11.5 MPH to 10.5 MPH from June through December is unusual for 2021 since the wind power production remained relatively constant during these months. It is possible that the NOAA wind speed sensor is out of calibration.

Figure 4-1: Example Sliding 12-month Hourly Wind Power Generation for Anacacho Wind

Table 4-1: Summary of 90th Percentile Hourly Wind Power Degradation Analysis for 157 Wind Farms in Texas

Wind Farm	12-Month Sliding 90th Percentile Hourly Wind Report								No. of Months of Data	Capacity (MW)
	First Year		Average		Minimum		Maximum			
	First 12-mo Ending Mo.	MW	MW	% Diff. vs. First 12-mo	MW	% Diff. vs. First 12-mo	MW	% Diff. vs. First 12-mo		
Anacacho Wind	Nov-13	83.4	86.2	3.4%	81.2	-2.7%	89.2	6.9%	98	100
Baffin Wind 1	Dec-16	80.5	80.3	-0.3%	61.2	-24.0%	86.3	7.2%	61	100
Baffin Wind 2	Dec-16	73.3	77.3	5.5%	64.2	-12.4%	83.3	13.6%	61	102
Barton Chapel Wind 1	Dec-09	74.9	73.9	-1.3%	61.2	-18.2%	89.1	19.0%	145	120
Big Spring Wind Farm	Dec-02	27.2	21.3	-21.7%	11.1	-59.2%	27.2	0.0%	229	41
Blue Summit Wind	Oct-13	121.9	117.8	-3.4%	107.6	-11.7%	128.5	5.4%	99	135
Bobcat Bluff Wind	Nov-13	115.0	112.4	-2.2%	92.8	-19.4%	129.8	12.9%	98	150
Brazos Wind Ranch	Dec-04	127.5	120.0	-5.9%	75.2	-41.0%	139.4	9.3%	205	160
Briscoe Wind_19	Jun-16	123.4	108.4	-12.1%	79.1	-35.9%	128.3	4.0%	67	149.8
Buckthorn Wind 1 A	May-18	36.9	39.5	6.9%	36.9	0.0%	41.1	11.2%	44	44.9
Buckthorn Wind 1 B	May-18	47.7	50.1	5.2%	47.6	-0.1%	52.5	10.1%	44	55.7
Buffalo Gap 1	Nov-06	100.9	96.4	-4.5%	75.4	-25.2%	105.7	4.8%	182	120
Buffalo Gap 2	Apr-08	183.4	175.8	-4.2%	104.9	-42.8%	207.6	13.2%	165	233
Buffalo Gap 3	Apr-10	122.4	135.4	10.6%	97.7	-20.2%	152.1	24.2%	141	170
Bull Creek Wind Plant	Dec-09	93.9	94.4	0.6%	41.5	-55.8%	130.4	38.9%	145	180
Callahan Divide Wind	Feb-06	93.3	94.8	1.6%	83.9	-10.0%	101.5	8.8%	191	114
Cameron County Wind (Camwind_Unit 1)	Dec-16	128.0	128.8	0.6%	119.3	-6.8%	142.5	11.4%	61	165
Camp Springs Wind 2	Jan-09	94.0	94.1	0.1%	64.8	-31.0%	107.9	14.8%	156	120
Camp Springs Wind Energy Center	Apr-08	111.3	103.4	-7.1%	76.2	-31.6%	120.9	8.6%	165	130
Capricorn Ridge Wind 1&2	Aug-08	258.0	263.3	2.0%	174.5	-32.4%	309.3	19.9%	161	364
Capricorn Ridge Wind 3	Dec-11	136.3	122.5	-10.1%	101.9	-25.2%	136.9	0.4%	121	150
Capricorn Ridge Wind 4	May-09	83.5	88.4	5.9%	67.6	-19.0%	100.2	20.0%	152	112.5
Cedro Hill Wind	Jan-09	89.4	100.8	12.7%	87.2	-2.5%	113.2	26.6%	156	126.5
Champion Wind Farm	Jan-09	89.4	100.8	12.7%	87.2	-2.5%	113.2	26.6%	156	126.5
Chapman Ranch Wind IA (Santa Cruz)	Mar-18	104.4	95.8	-8.3%	54.6	-47.7%	122.0	16.8%	46	150.6
Chapman Ranch Wind IB (Santa Cruz)	Mar-18	71.1	64.8	-8.9%	41.5	-41.7%	78.9	11.0%	46	98.4
Desert Sky Wind Farm	Dec-02	89.0	115.7	29.9%	83.1	-6.7%	134.4	50.9%	229	160.5
Doug Colbeck's Corner (Conway) B	Jan-17	90.1	92.5	2.7%	85.7	-4.8%	94.7	5.2%	60	100.2
Doug Colbeck's Corner (Conway) A	Jan-17	92.6	92.9	0.4%	91.2	-1.5%	95.2	2.8%	60	100.2
Elbow Creek Wind	Dec-09	94.5	94.8	0.4%	70.2	-25.7%	108.5	14.8%	145	121.9
Falvez Astra Wind	Jan-18	149.3	135.8	-9.1%	112.8	-24.5%	155.6	4.2%	48	163.2
Forest Creek Wind	Dec-07	105.2	101.4	-3.6%	77.7	-26.1%	111.2	5.7%	169	124.2
Goat Wind	Apr-09	67.0	102.3	52.7%	61.8	-7.8%	122.6	83.0%	153	150
Goldthwaite Wind 1	Dec-14	122.8	126.6	3.1%	115.8	-5.7%	134.4	9.4%	85	149
Grandview Wind 1 (Conway) GV1A	Nov-15	99.3	97.8	-1.5%	91.0	-8.3%	101.4	2.2%	74	107
Grandview Wind 1 (Conway) GV1B	Nov-15	94.0	93.5	-0.5%	89.5	-4.8%	98.0	4.2%	74	104
Green Mountain Wind 1 (Brazos)	Aug-18	92.7	93.8	1.2%	82.7	-10.8%	103.3	11.4%	41	120
Green Mountain Wind 2 (Brazos)	Aug-18	82.8	84.0	1.4%	75.9	-8.3%	90.0	8.8%	41	108
Green Pastures Wind I_19	Feb-16	125.2	130.8	4.5%	103.5	-17.3%	139.2	11.2%	71	150
Gulf Wind 1	Jun-10	108.6	95.0	-12.5%	0.7	-99.4%	119.4	9.9%	139	141.6
Gulf Wind 2	Jun-10	116.5	104.7	-10.1%	3.1	-97.3%	126.3	8.4%	139	141.6
Gunsight Mountain Wind	Jan-17	109.5	112.7	2.9%	109.3	-0.1%	115.2	5.2%	60	119.9
Hackberry Wind	Dec-09	138.0	125.7	-8.9%	105.8	-23.3%	140.6	1.9%	145	165.5
Harbor Wind	Jan-13	6.1	3.7	-39.1%	0.0	-100.0%	7.1	15.9%	108	9
Hereford Wind G_19	Dec-15	80.9	82.7	2.3%	75.3	-6.9%	86.9	7.5%	73	99.9
Hereford Wind V_19	Dec-15	90.4	93.7	3.7%	90.4	0.0%	95.7	5.8%	73	100
Hidalgo & Starr Wind 11	Jul-17	45.1	44.2	-1.9%	37.1	-17.8%	47.3	5.1%	54	52
Hidalgo & Starr Wind 12	Jul-17	85.8	84.8	-1.2%	71.5	-16.7%	91.2	6.3%	54	98
Hidalgo & Starr Wind 21	Jul-17	85.0	83.1	-2.3%	68.1	-19.9%	89.2	4.9%	54	100
Horse Creek Wind 1	Dec-17	121.6	122.2	0.5%	119.7	-1.6%	123.6	1.7%	49	131.1
Horse Creek Wind 2	Dec-17	92.3	92.2	-0.1%	90.5	-1.9%	93.8	1.6%	49	98.9
Horse Hollow Phase 1	Jun-06	157.0	168.4	7.3%	141.3	-10.0%	185.1	17.9%	187	213
Horse Hollow Phase 2	Aug-07	145.7	142.1	-2.5%	99.0	-32.1%	164.9	13.2%	173	184
Horse Hollow Phase 3	May-07	169.2	169.8	0.4%	123.9	-26.8%	187.7	11.0%	176	223.5
Horse Hollow Phase 4	Jun-07	88.6	91.3	3.0%	80.9	-8.7%	103.1	16.3%	175	115
Inadale Wind	Sep-10	117.9	140.2	18.9%	99.0	-16.0%	166.3	41.1%	136	197
Indian Mesa Wind Farm	Dec-02	48.0	55.3	15.3%	36.0	-24.9%	72.2	50.5%	229	82.5
Javelina II Wind 1	Dec-17	86.2	86.6	0.5%	83.2	-3.5%	89.1	3.3%	49	96
Javelina II Wind 2	Dec-17	64.9	66.1	1.9%	63.4	-2.3%	68.0	4.7%	49	74
Javelina II Wind 3	Dec-17	27.5	27.5	0.2%	26.4	-3.9%	28.5	3.8%	49	30
Javelina Wind 18&20_19	Sep-16	211.0	220.2	4.4%	211.0	0.0%	229.3	8.7%	64	249.7
Jumbo Road Wind 1_19	Mar-16	117.3	124.2	5.9%	117.3	0.0%	129.1	10.1%	70	146.2
Jumbo Road Wind 2_19	Mar-16	119.7	128.4	7.2%	119.7	0.0%	134.7	12.5%	70	153.6

Table 4-1: Summary of 90th Percentile Hourly Wind Power Degradation Analysis for 157 Wind Farms in Texas (Continued)

Wind Farm	12-Month Sliding 90th Percentile Hourly Wind Report								No. of Months of Data	Capacity (MW)
	First Year		Average		Minimum		Maximum			
	First 12-mo Ending Mo.	MW	MW	% Diff. vs. First 12-mo	MW	% Diff. vs. First 12-mo	MW	% Diff. vs. First 12-mo		
Keechi Wind 138 Kv Joplin_19	Dec-15	99.7	102.4	2.7%	99.5	-0.2%	103.8	4.1%	73	110
King Mountain-NE Wind Farm	Dec-02	41.8	43.3	3.6%	20.8	-50.3%	56.4	34.8%	229	79.3
King Mountain-NW Wind Farm	Dec-02	44.7	51.4	15.0%	27.7	-37.9%	65.3	46.1%	229	79.3
King Mountain-SE Wind Farm	Dec-02	21.6	21.8	0.6%	11.8	-45.7%	28.1	29.8%	229	40.3
King Mountain-SW Wind Farm	Dec-02	41.6	44.4	6.7%	22.9	-44.9%	53.7	29.1%	229	79.3
Langford Wind	Dec-10	115.7	125.2	8.2%	107.8	-6.9%	141.3	22.1%	133	150
Logans Gap Wind I U1_19	Apr-16	88.5	86.0	-2.8%	80.6	-9.0%	90.6	2.3%	69	103.8
Logans Gap Wind I U2_19	Apr-16	83.8	83.1	-0.8%	77.5	-7.6%	86.6	3.3%	69	106.3
Lone Star-Mesquite Wind	Sep-08	140.4	144.5	2.9%	121.0	-13.9%	168.1	19.7%	160	200
Lone Star-Post Oak Wind	Mar-09	149.1	149.7	0.4%	128.1	-14.1%	170.5	14.4%	154	200
Longhorn Wind North U1_19	Mar-16	91.0	92.4	1.6%	90.8	-0.3%	94.0	3.3%	70	100
Longhorn Wind North U2_19	Dec-15	88.9	93.0	4.7%	88.9	0.0%	95.0	6.9%	73	100
Lorraine Windpark I	Dec-10	30.4	35.6	17.1%	25.9	-14.8%	42.3	39.2%	133	126
Lorraine Windpark II	Dec-10	27.8	36.1	29.9%	25.7	-7.6%	43.3	55.7%	133	124.5
Lorraine Windpark III	Jan-12	16.2	20.2	24.7%	16.2	0.0%	22.6	39.4%	120	26
Lorraine Windpark IV	Dec-12	17.4	17.2	-1.2%	5.0	-71.5%	20.8	19.1%	109	24
Los Vientos I Wind	Oct-13	148.5	161.6	8.8%	120.0	-19.2%	175.1	17.9%	99	200.1
Los Vientos II Wind	Nov-13	153.3	147.2	-4.0%	124.6	-18.7%	164.3	7.2%	98	201.6
Los Vientos III Wind_19	Feb-16	154.0	167.1	8.6%	154.0	0.0%	175.9	14.3%	71	200
Los Vientos IV Wind	Apr-17	167.7	172.6	2.9%	160.1	-4.5%	180.0	7.3%	57	200
Los Vientos V Wind	Dec-16	92.1	91.7	-0.4%	80.7	-12.4%	96.9	5.2%	61	110
Magic Valley Wind (Redfish) 1A	Apr-13	88.6	82.6	-6.8%	61.9	-30.1%	90.7	2.4%	105	99.8
Magic Valley Wind (Redfish) 1B	Jul-13	94.2	86.4	-8.3%	65.0	-31.1%	94.6	0.4%	102	103.5
Mariah Del Norte 1	Dec-17	103.7	102.8	-0.9%	97.2	-6.3%	106.7	2.8%	49	115.2
Mariah Del Norte 2	Dec-17	105.6	103.1	-2.3%	95.5	-9.6%	107.9	2.2%	49	115.2
McAdoo Wind	Dec-09	111.7	134.2	20.1%	111.7	0.0%	143.6	28.5%	145	150
Mesquite Creek Wind 1_19	Dec-15	93.3	91.0	-2.4%	83.1	-10.9%	97.7	4.7%	73	105.6
Mesquite Creek Wind 2_19	Dec-15	90.5	89.9	-0.7%	83.6	-7.6%	96.2	6.2%	73	105.6
Miami Wind G1	Aug-15	125.8	128.7	2.3%	123.5	-1.8%	132.6	5.4%	77	144
Miami Wind G2	Aug-15	126.0	128.9	2.3%	121.3	-3.8%	133.4	5.9%	77	144
Notrees Windpower	Feb-10	103.7	111.6	7.6%	97.2	-6.2%	122.9	18.6%	143	153
Ocotillo Windpower	Dec-09	39.1	36.3	-7.3%	12.5	-68.2%	47.2	20.7%	145	58.8
Panhandle Wind 1 U1	May-15	94.5	93.7	-0.8%	81.6	-13.6%	101.3	7.2%	80	109
Panhandle Wind 1 U2	May-15	90.6	89.8	-0.8%	76.6	-15.4%	98.0	8.2%	80	109
Panhandle Wind 2 U1	Oct-15	88.2	86.2	-2.3%	79.7	-9.6%	90.0	2.0%	75	94
Panhandle Wind 2 U2	Sep-15	90.2	89.1	-1.2%	83.2	-7.7%	93.4	3.6%	76	97
Panther Creek	Dec-09	114.4	122.7	7.2%	107.8	-5.8%	134.3	17.4%	145	142.5
Panther Creek 2	Dec-09	91.8	97.6	6.3%	83.5	-9.0%	108.2	17.8%	145	115.5
Panther Creek 3	Aug-10	128.5	152.9	19.0%	78.4	-39.0%	177.1	37.8%	137	199.5
Papalote Creek Phase II	Dec-11	174.2	160.3	-8.0%	120.7	-30.7%	176.3	1.2%	121	200.1
Papalote Creek Wind Farm	Dec-10	150.1	133.0	-11.4%	39.6	-73.6%	157.9	5.2%	133	180
Penascal Wind 1	Feb-11	133.2	117.3	-12.0%	62.1	-53.4%	141.5	6.2%	131	161
Penascal Wind 2	Dec-09	83.3	102.8	23.4%	57.7	-30.8%	125.4	50.5%	145	142
Penascal Wind 3	May-11	87.1	71.3	-18.1%	39.3	-54.9%	88.8	2.0%	128	101
Pyron	Dec-09	157.2	192.4	22.4%	151.4	-3.7%	220.1	40.0%	145	249
Rattlesnake Den Wind Phase 1 G1_19	Mar-16	97.0	89.4	-7.9%	70.3	-27.5%	99.7	2.8%	70	104.3
Rattlesnake Den Wind Phase 1 G2_19	Mar-16	93.5	87.8	-6.1%	76.2	-18.5%	97.3	4.0%	70	103
Red Canyon I	Aug-07	76.4	76.0	-0.5%	71.0	-7.0%	79.6	4.2%	173	84
Roscoe Wind Farm	Dec-08	169.4	151.8	-10.3%	108.1	-36.2%	179.8	6.2%	157	209
Route 66 Wind_19	Mar-16	139.0	138.0	-0.7%	129.3	-7.0%	142.6	2.5%	70	150
Saltfork_Unit1	Aug-17	58.1	60.7	4.6%	58.1	0.0%	61.7	6.2%	53	64
Saltfork_Unit2	Aug-17	100.9	104.2	3.2%	100.9	0.0%	105.4	4.4%	53	110
San Roman Wind	Dec-17	82.1	75.9	-7.6%	56.9	-30.7%	82.9	1.0%	49	95.2
Sand Bluff Wind	Nov-08	69.4	60.2	-13.3%	18.9	-72.7%	75.4	8.6%	158	90
Senate Wind	Sep-13	127.1	125.5	-1.3%	119.0	-6.4%	132.2	4.0%	100	150
Sendero Wind Energy_19	Aug-16	67.2	70.5	4.9%	67.2	0.0%	72.6	8.1%	65	76
Shannon Wind_19	Oct-16	175.3	176.7	0.8%	154.7	-11.7%	183.9	4.9%	63	204.1
Sherbino 1 Wind	Dec-09	104.7	95.7	-8.5%	0.0	-100.0%	128.1	22.4%	145	150
Sherbino 2 Wind	Dec-12	125.7	85.4	-32.1%	13.3	-89.5%	125.7	0.0%	109	150
Silver Star Wind	Apr-09	40.6	40.5	-0.2%	6.1	-85.0%	50.5	24.4%	153	60
Snyder Wind Project	Dec-08	46.5	39.8	-14.2%	0.5	-99.0%	50.9	9.6%	157	63
South Plains Wind 2_19	Jul-16	89.2	89.8	0.7%	86.0	-3.6%	92.5	3.7%	66	98

Table 4-1: Summary of 90th Percentile Hourly Wind Power Degradation Analysis for 157 Wind Farms in Texas (Continued)

Wind Farm	12-Month Sliding 90th Percentile Hourly Wind Report								No. of Months of Data	Capacity (MW)
	First Year		Average		Minimum		Maximum			
	First 12-mo Ending Mo.	MW	MW	% Diff. vs. First 12-mo	MW	% Diff. vs. First 12-mo	MW	% Diff. vs. First 12-mo		
South Plains Wind I_19	Jul-16	94.8	92.9	-2.1%	86.9	-8.4%	95.5	0.8%	66	102
South Plains Wind II A	Dec-16	120.2	135.2	12.5%	120.2	0.0%	141.3	17.5%	61	148.5
South Plains Wind II B	Dec-16	128.1	139.8	9.1%	128.1	0.0%	145.1	13.2%	61	151.8
South Trent Wind Farm	Dec-08	79.4	93.4	17.6%	72.7	-8.5%	107.1	34.8%	157	120
Spinning Spur 3 (Wind 1)_19	Apr-16	87.5	90.6	3.5%	87.5	0.0%	91.6	4.7%	69	96
Spinning Spur 3 (Wind 2)_19	Apr-16	88.4	92.6	4.7%	88.4	0.0%	93.9	6.2%	69	98
Spinning Spur Wind Two	May-15	140.9	145.1	3.0%	139.0	-1.3%	149.4	6.1%	80	161
Stanton Wind Energy	Jan-06	71.4	83.0	16.3%	71.4	0.0%	89.6	25.6%	192	97.5
Stephens Ranch Wind 2_19	Mar-16	144.3	148.4	2.9%	144.3	0.0%	151.9	5.3%	70	164.7
Stephens Ranch Wind Phase 1	Nov-15	182.9	189.0	3.3%	182.9	0.0%	193.1	5.6%	74	211
Sweetwater Wind 1	Dec-04	34.1	33.2	-2.4%	28.8	-15.4%	36.2	6.2%	205	37.5
Sweetwater Wind 2	Jan-06	71.4	83.0	16.3%	71.4	0.0%	89.6	25.6%	192	97.5
Sweetwater Wind 3	Dec-06	99.6	102.3	2.6%	67.1	-32.7%	123.1	23.6%	181	135
Sweetwater Wind 4	Mar-08	161.0	171.4	6.4%	153.2	-4.9%	182.2	13.2%	166	240.8
Sweetwater Wind 5	Dec-08	66.5	60.5	-9.0%	43.9	-33.9%	69.3	4.3%	157	80.5
Sweetwater Wind24	Mar-08	13.1	13.6	4.0%	12.0	-8.7%	14.8	13.3%	166	16
Trent Mesa Wind Farm	Dec-02	108.8	104.9	-3.6%	33.3	-69.4%	132.8	22.0%	229	150
Trinity Hills Wind Farm 1	Dec-12	78.8	73.6	-6.6%	12.5	-84.2%	98.5	25.0%	109	118
Trinity Hills Wind Farm 2	Dec-12	74.8	72.3	-3.4%	23.9	-68.0%	89.9	20.3%	109	108
Turkey Track Wind Energy Center	Dec-09	77.4	122.3	58.1%	76.5	-1.1%	143.1	85.0%	145	169.5
Tyler Bluff Wind	Aug-17	104.0	107.3	3.2%	102.6	-1.4%	110.7	6.5%	53	125.6
Vertigo Wind (Formerly Green Pastures V	Nov-16	123.5	127.1	2.9%	115.3	-6.6%	133.4	8.0%	62	150
Wake Wind 1	Apr-17	109.3	108.2	-1.1%	104.0	-4.9%	110.2	0.8%	57	114.9
Wake Wind 2	Apr-17	136.0	133.8	-1.6%	123.1	-9.5%	137.0	0.7%	57	142.3
Whirlwind	Dec-08	54.0	52.1	-3.6%	39.8	-26.3%	56.9	5.4%	157	60
Whitetail Wind	Oct-13	72.9	67.1	-7.9%	60.2	-17.4%	73.1	0.3%	99	92
Willow Springs Wind A	Jul-18	118.1	118.4	0.2%	116.8	-1.2%	119.6	1.2%	42	125
Willow Springs Wind B	Jul-18	117.7	118.2	0.5%	117.4	-0.2%	119.3	1.4%	42	125
Windthorst 2	Oct-15	50.3	56.4	12.0%	50.3	0.0%	59.4	18.1%	75	68
WKN Mozart Wind	Oct-13	22.4	21.5	-4.0%	17.1	-23.6%	25.8	15.0%	99	30
Wolf Ridge Wind	Dec-09	105.9	99.4	-6.1%	81.2	-23.4%	108.8	2.7%	145	112.5
Woodward Wind Farm	Dec-02	85.3	94.1	10.3%	65.2	-23.5%	112.4	31.8%	229	159.7
Weighted Average:				2.4%		-20.0%		14.2%	Total:	19722.8

Table 4-2: Summary of Maximum Hourly Wind Power Analysis for 157 Wind Farm in Texas

Wind Farm	Design Capacity (A)	12-Month Sliding Maximum MW - Measured		Maximum MW in Last 12-mo - Measured (D)	Difference (A-B)	Difference (B-D)
		Maximum (B)	Minimum (C)			
Anacacho Wind	100	98.7	97.0	98.5	1.3	0.1
Baffin Wind 1	100	98.6	92.3	92.3	1.4	6.3
Baffin Wind 2	102	99.9	96.4	96.4	2.1	3.5
Barton Chapel Wind 1	120	114.1	99.4	105.8	5.9	8.3
Big Spring Wind Farm	41	37.0	17.1	26.2	4.0	10.8
Blue Summit Wind	135	135.0	132.7	134.6	0.0	0.4
Bobcat Bluff Wind	150	150.0	145.2	150.0	0.0	0.0
Brazos Wind Ranch	160	160.0	117.1	117.1	0.0	42.9
Briscoe Wind_19	150	147.9	141.1	145.5	1.9	2.3
Buckthorn Wind 1 A	45	44.2	43.9	44.2	0.7	0.0
Buckthorn Wind 1 B	56	54.6	54.3	54.6	1.1	0.0
Buffalo Gap 1	120	120.0	102.5	102.5	0.0	17.5
Buffalo Gap 2	233	232.7	214.8	214.8	0.3	17.8
Buffalo Gap 3	170	167.9	146.7	147.1	2.1	20.8
Bull Creek Wind Plant	180	177.6	73.6	167.0	2.4	10.5
Callahan Divide Wind	114	114.0	103.7	112.1	0.0	1.8
Cameron County Wind (Camwind_Unit1)	165	163.9	156.4	163.9	1.1	0.0
Camp Springs Wind 2	120	120.0	108.7	108.7	0.0	11.3
Camp Springs Wind Energy Center	130	130.0	125.7	130.0	0.0	0.0
Capricorn Ridge Wind 1&2	364	358.3	335.8	352.7	5.7	5.6
Capricorn Ridge Wind 3	150	150.0	144.5	150.0	0.0	0.0
Capricorn Ridge Wind 4	113	112.5	110.1	112.5	0.0	0.0
Cedro Hill Wind	127	124.5	122.1	122.1	2.0	2.4
Champion Wind Farm	127	124.5	122.1	122.1	2.0	2.4
Chapman Ranch Wind 1A (Santa Cruz)	151	148.3	76.1	138.7	2.3	9.6
Chapman Ranch Wind 1B (Santa Cruz)	98	97.3	51.3	97.3	1.1	0.0
Desert Sky Wind Farm	161	160.3	105.8	133.6	0.3	26.6
Doug Colbeck's Corner (Conway) A	100	99.5	97.6	98.5	0.7	1.0
Doug Colbeck's Corner (Conway) B	100	100.1	97.9	97.9	0.1	2.3
Elbow Creek Wind	122	118.7	88.9	118.3	3.2	0.3
Falvez Astra Wind	163	162.8	162.0	162.5	0.4	0.4
Forest Creek Wind	124	123.9	109.2	113.1	0.3	10.8
Goat Wind	150	149.9	80.9	137.1	0.1	12.8
Goldthwaite Wind 1	149	148.7	141.7	141.9	0.3	6.8
Grandview Wind 1 (Conway) GV1A	107	106.9	103.5	105.3	0.1	1.7
Grandview Wind 1 (Conway) GV1B	104	103.8	99.3	100.2	0.2	3.6
Green Mountain Wind 1 (Brazos)	120	120.0	113.3	120.0	0.0	0.0
Green Mountain Wind 2 (Brazos)	108	108.0	107.2	108.0	0.0	0.0
Green Pastures Wind 1_19	150	149.9	143.7	143.7	0.1	6.2
Gulf Wind 1	142	140.7	20.2	132.3	0.9	8.3
Gulf Wind 2	142	140.9	30.0	140.5	0.7	0.4
Gunsight Mountain Wind	120	118.6	118.3	118.3	1.3	0.3
Hackberry Wind	166	162.8	162.0	162.1	2.7	0.7
Harbor Wind	9	9.0	0.0	0.0	0.0	9.0
Hereford Wind G_19	100	99.0	96.6	99.0	0.9	0.0
Hereford Wind V_19	100	99.2	98.0	98.5	0.8	0.7
Hidalgo & Starr Wind 11	52	51.7	51.1	51.6	0.3	0.0
Hidalgo & Starr Wind 12	98	97.8	96.1	96.4	0.2	1.3
Hidalgo & Starr Wind 21	100	98.3	97.2	97.2	1.7	1.1
Horse Creek Wind 1	131	130.9	130.3	130.3	0.2	0.6
Horse Creek Wind 2	99	98.6	98.1	98.6	0.3	0.0
Horse Hollow Phase 1	213	212.2	196.7	210.7	0.8	1.6
Horse Hollow Phase 2	184	183.4	156.7	173.9	0.6	9.5
Horse Hollow Phase 3	224	223.0	178.7	218.9	0.5	4.0
Horse Hollow Phase 4	115	114.0	105.3	112.2	1.0	1.8
Inadale Wind	197	197.0	188.5	196.9	0.0	0.1
Indian Mesa Wind Farm	83	82.5	49.4	81.4	0.0	1.0
Javelina II Wind 1	96	95.8	95.1	95.5	0.2	0.4
Javelina II Wind 2	74	73.7	73.4	73.4	0.3	0.3
Javelina II Wind 3	30	30.0	29.9	30.0	0.0	0.0
Javelina Wind 18&20_19	250	247.9	241.8	241.8	1.8	6.1
Jumbo Road Wind 1_19	146	144.9	143.3	143.7	1.3	1.3
Jumbo Road Wind 2_19	154	153.2	151.0	151.4	0.4	1.8

Table 4-2: Summary of Maximum Hourly Wind Power Analysis for 157 Wind Farm in Texas (Continued)

Wind Farm	Design Capacity (A)	12-Month Sliding Maximum MW - Measured		Maximum MW in Last 12-mo - Measured (D)	Difference (A-B)	Difference (B-D)
		Maximum (B)	Minimum (C)			
Keechi Wind 138 Kv Joplin_19	110	107.5	106.7	107.4	2.5	0.1
King Mountain-NE Wind Farm	79	77.0	47.2	76.0	2.3	1.0
King Mountain-NW Wind Farm	79	77.6	52.1	61.9	1.7	15.7
King Mountain-SE Wind Farm	40	40.0	27.8	37.0	0.3	3.0
King Mountain-SW Wind Farm	79	75.9	45.6	66.7	3.4	9.2
Langford Wind	150	150.0	147.2	150.0	0.0	0.0
Logans Gap Wind I U1_19	104	103.3	95.6	102.5	0.5	0.8
Logans Gap Wind I U2_19	106	102.1	99.4	101.3	4.2	0.9
Lone Star-Mesquite Wind	200	195.0	171.0	178.1	5.0	16.8
Lone Star-Post Oak Wind	200	192.1	175.1	175.1	7.9	17.0
Longhorn Wind North U1_19	100	99.3	97.6	98.0	0.7	1.4
Longhorn Wind North U2_19	100	99.0	97.7	98.1	1.0	0.9
Loraine Windpark I	126	95.2	48.0	48.2	30.8	47.0
Loraine Windpark II	125	85.0	48.7	48.7	39.5	36.3
Loraine Windpark III	26	26.0	23.6	25.4	0.0	0.6
Loraine Windpark IV	24	24.0	17.5	23.7	0.0	0.3
Los Vientos I Wind	200	199.2	195.7	197.7	0.9	1.6
Los Vientos II Wind	202	201.4	192.1	193.3	0.2	8.0
Los Vientos Iii Wind_19	200	195.5	188.0	193.8	4.5	1.8
Los Vientos IV Wind	200	195.6	192.0	194.2	4.4	1.4
Los Vientos V Wind	110	107.8	104.5	104.5	2.2	3.3
Magic Valley Wind (Redfish) 1A	100	98.7	73.7	73.7	1.1	24.9
Magic Valley Wind (Redfish) 1B	104	103.4	78.7	78.7	0.1	24.7
Mariah Del Norte 1	115	113.7	112.9	113.2	1.5	0.5
Mariah Del Norte 2	115	114.3	113.7	114.2	0.9	0.1
McAdoo Wind	150	150.0	149.6	149.9	0.0	0.1
Mesquite Creek Wind 1_19	106	104.1	99.2	102.9	1.5	1.2
Mesquite Creek Wind 2_19	106	104.3	99.7	104.3	1.3	0.0
Miami Wind G1	144	141.3	139.1	140.1	2.7	1.1
Miami Wind G2	144	141.5	138.9	140.0	2.5	1.4
Notrees Windpower	153	151.7	137.3	141.2	1.3	10.5
Ocotillo Windpower	59	57.5	32.5	32.5	1.3	25.0
Panhandle Wind 1 U1	109	109.0	106.1	109.0	0.0	0.0
Panhandle Wind 1 U2	109	108.3	103.7	105.6	0.7	2.8
Panhandle Wind 2 U1	94	93.8	91.3	92.2	0.2	1.6
Panhandle Wind 2 U2	97	96.9	94.7	94.8	0.1	2.1
Panther Creek 2	143	142.5	139.0	142.5	0.0	0.0
Panther Creek 3	116	115.5	112.2	115.5	0.0	0.0
Panther Creek	200	199.5	193.6	199.4	0.0	0.1
Papalote Creek Phase II	200	195.6	191.6	192.9	4.5	2.7
Papalote Creek Wind Farm	180	180.0	49.2	175.6	0.0	4.4
Penascal Wind 1	161	161.0	123.0	123.0	0.0	38.0
Penascal Wind 2	142	142.0	103.6	105.4	0.0	36.6
Penascal Wind 3	101	100.9	82.5	84.0	0.1	16.9
Pyron	249	249.0	244.3	246.9	0.0	2.1
Rattlesnake Den Wind Phase 1 G1_19	104	103.6	89.2	96.2	0.7	7.4
Rattlesnake Den Wind Phase 1 G2_19	103	101.7	95.9	99.6	1.3	2.0
Red Canyon1	84	84.0	82.1	83.5	0.0	0.5
Roscoe Wind Farm	209	209.0	199.5	208.1	0.0	0.9
Route 66 Wind_19	150	147.1	146.3	146.6	2.9	0.5
Saltfork_Unit1	64	64.0	62.8	63.3	0.0	0.7
Saltfork_Unit2	110	108.7	108.3	108.4	1.3	0.3
San Roman Wind	95	94.4	92.2	92.2	0.8	2.2
Sand Bluff Wind	90	89.3	41.9	41.9	0.7	47.4
Senate Wind	150	146.1	141.8	144.2	3.9	1.9
Sendero Wind Energy_19	76	76.0	75.9	76.0	0.0	0.0
Shannon Wind_19	204	203.5	198.8	203.5	0.6	0.0
Sherbino 1 Wind	150	149.9	0.2	0.2	0.1	149.7
Sherbino 2 Wind	150	146.8	44.4	127.2	3.2	19.5
Silver Star Wind	60	60.0	14.1	51.6	0.0	8.4
Snyder Wind Project	63	63.0	2.9	2.9	0.0	60.1
South Plains Wind 2_19	98	97.3	95.5	95.7	0.7	1.6

Table 4-2: Summary of Maximum Hourly Wind Power Analysis for 157 Wind Farm in Texas (Continued)

Wind Farm	Design Capacity (A)	12-Month Sliding Maximum MW - Measured		Maximum MW in Last 12-mo - Measured (D)	Difference (A-B)	Difference (B-D)
		Maximum (B)	Minimum (C)			
South Plains Wind I_19	102	100.7	99.1	99.2	1.3	1.5
South Plains Wind II A	149	146.4	145.5	146.3	2.1	0.1
South Plains Wind II B	152	150.2	148.3	150.2	1.6	0.0
South Trent Wind Farm	120	120.0	96.9	96.9	0.0	23.1
Spinning Spur 3 (Wind 1)_19	96	95.4	93.6	94.2	0.6	1.2
Spinning Spur 3 (Wind 2)_19	98	98.0	95.2	95.2	0.0	2.7
Spinning Spur Wind Two	161	157.9	156.3	156.9	3.1	0.9
Stanton Wind Energy	98	97.5	91.8	97.5	0.0	0.0
Stephens Ranch Wind 2_19	165	164.1	160.5	161.8	0.6	2.3
Stephens Ranch Wind Phase 1	211	207.6	204.8	206.0	3.4	1.6
Sweetwater Wind 1	38	37.5	36.0	36.8	0.0	0.7
Sweetwater Wind 2	98	97.5	91.8	97.5	0.0	0.0
Sweetwater Wind 3	135	134.5	121.5	134.5	0.5	0.0
Sweetwater Wind 4	241	240.6	216.7	228.9	0.2	11.7
Sweetwater Wind 5	81	80.5	76.9	78.7	0.0	1.8
Sweetwater Wind24	16	16.0	15.9	16.0	0.0	0.0
Trent Mesa Wind Farm	150	147.6	37.2	38.3	2.4	109.3
Trinity Hills Wind Farm 1	118	117.7	29.4	101.9	0.3	15.9
Trinity Hills Wind Farm 2	108	107.6	45.5	92.9	0.4	14.7
Turkey Track Wind Energy Center	170	169.5	164.8	169.3	0.0	0.2
Tyler Bluff Wind	126	123.2	117.5	123.0	2.4	0.2
Vertigo Wind (Formerly Green Pastures Wind 2)	150	148.6	139.8	139.8	1.4	8.8
Wake Wind 1	115	114.5	109.7	109.7	0.4	4.8
Wake Wind 2	142	140.4	133.0	133.0	1.9	7.4
Whirlwind	60	59.3	57.0	58.2	0.7	1.1
Whitetail Wind	92	90.7	88.5	88.7	1.3	2.0
Willow Springs Wind A	125	125.0	124.5	124.5	0.0	0.5
Willow Springs Wind B	125	124.5	124.0	124.5	0.5	0.0
Windthorst 2	68	66.7	64.5	64.9	1.3	1.8
WKN Mozart Wind	30	30.0	29.8	29.8	0.0	0.1
Wolf Ridge Wind	113	112.5	109.2	112.2	0.0	0.3
Woodward Wind Farm	160	148.7	104.1	137.0	11.0	11.7
Total:	19722.8	19477.0	16894.0	18286.4	245.8	1190.6

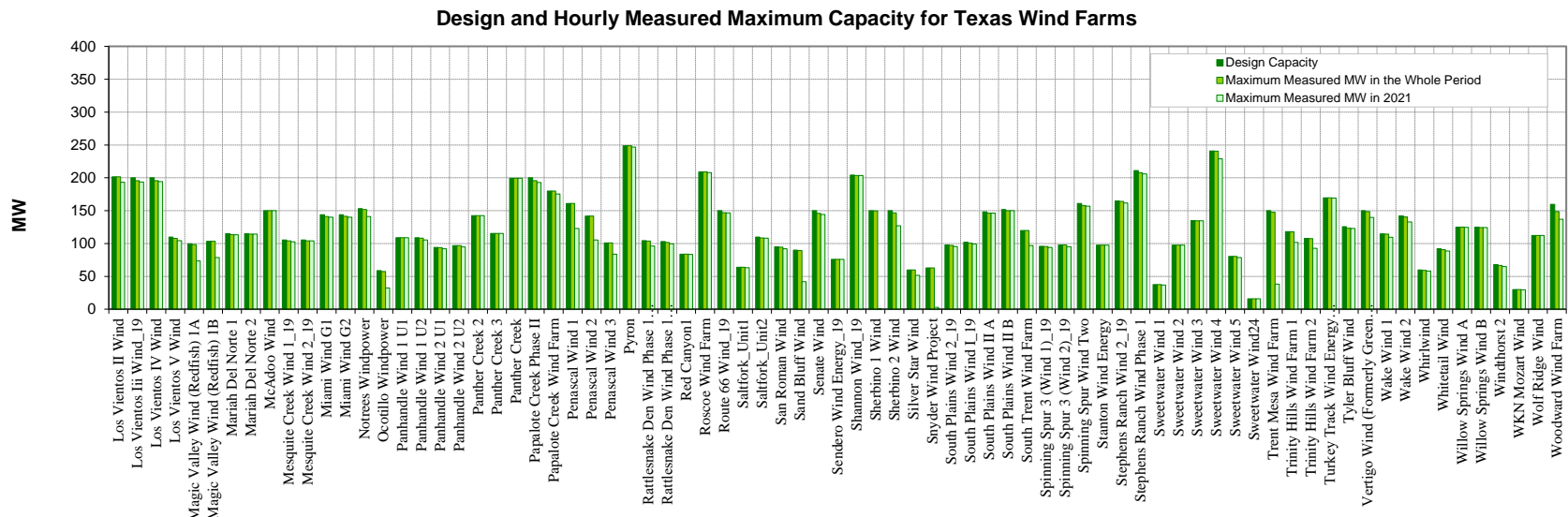
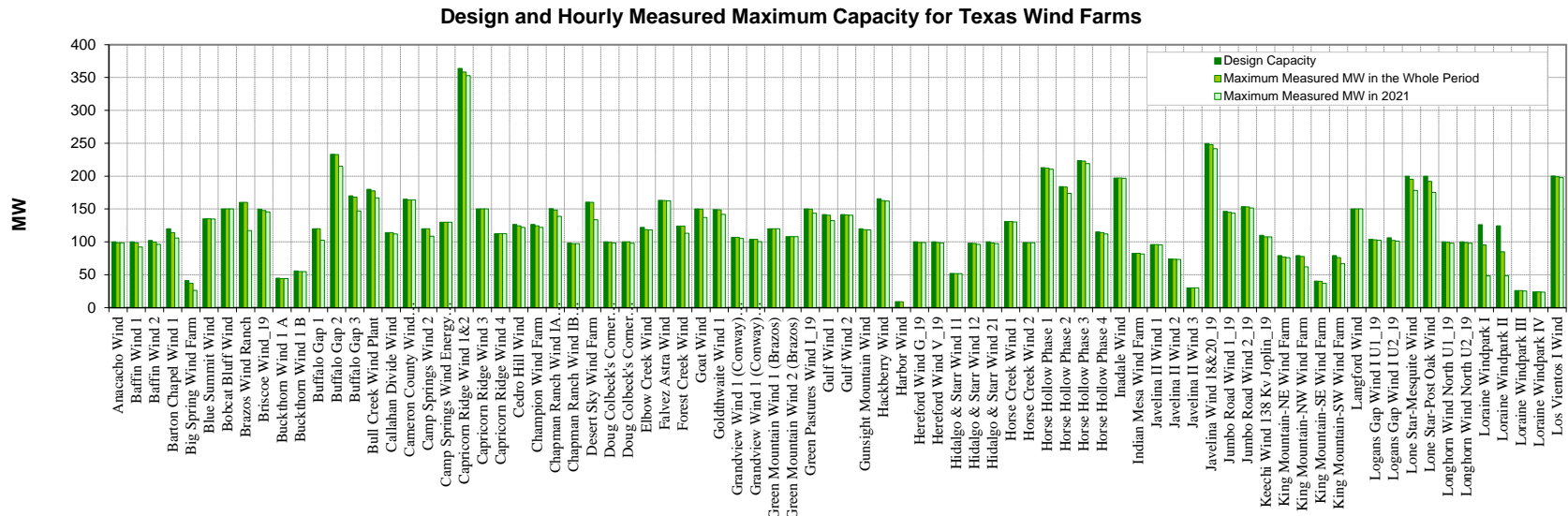


Figure 4-2: Design and Hourly Measured Maximum Capacity for 157 Wind Farms

5 CALCULATING NO_x EMISSIONS REDUCTION FROM WIND POWER

5.1 Calculation of NO_x Emissions from Wind Power Using 2018 eGRID

The Energy Systems Laboratory has worked closely with the TCEQ and EPA to develop credible procedures for calculating NO_x reductions from electricity savings using the 2018 EPA's Emissions and Generation Resource Integrated Database (eGRID¹⁶). The calculation uses a simplified dispatch approach of the ERCOT grid to estimate NO_x emission reductions across the ERCOT region in Texas. ERCOT is currently divided into four CL zones: Houston (H), North (N), South (S), and West (W). The 2018 eGrid table, which describes the distribution of the NO_x emission reductions per Competitive Load (CL) zone for each county in Texas, has four developed steps (EPA and ESL: 2008):

1. assign energy savings to CL Zones
2. assign generation reductions within each CL Zone to individual plants
3. determine plant-specific NO_x emission rates
4. assemble all CL Zones for total savings

The procedure presented in this section calculates annual and peak-day, county-wide NO_x reductions from electricity generations from wind projects implemented in the ERCOT CL Zones listed in the EPA's eGRID. For this purpose, a special version of eGRID¹⁷ was developed that reflects the 2018 electricity and pollution from electric utilities in ERCOT. The NO_x production for each power plant is provided from the 2018 eGRID database for four CL zones: Houston, North, West, and South. This eGRID matrix was utilized to assign the power plant used by CL zones, once a CL zone had been chosen for a given county. Figure 5-1 shows a snapshot of the NO_x emission distribution among Texas counties from generating one mega-watt-hour of electricity in the CL zones, which was derived from the 2018 Annual eGRID table. For example, the counties marked in red show higher NO_x emissions of above 0.1 lbs/MWh. The counties marked in dark green were least impacted by the NO_x emissions (less than 0.0005 lbs/MWh), Figure 5-1 and Figure 5-2 shows county-wide NO_x emissions distribution for all the CL zones: Houston, North, West, and South.

Table 5-1 shows the latest wind farm information from PUCT, updated in Jan 2022. To calculate the NO_x emissions reduction from the wind projects within the ERCOT region, the total MWh wind power for each CL zone is summarized in Table 5-2 for modeled 2018 baseline and 2021 measured data. Both annual wind power and OSP wind power are presented. Only the completed projects are shown in the ERCOT, WSCC and SPP regions, with a total generation capacity of 36,694 MW by wind resource. The total MWh production in each CL zone was input in the corresponding cells in the eGRID table to calculate the total annual and OSP emissions reductions for the entire ERCOT region in 2018 model (using 2018 wind speed data) and 2021 (using measured data), as shown from Table 5-3 to Table 5-6.

According to the developed models, the total MWh savings in the base year 2018 for the wind farms within the ERCOT region are 110,993,597 MWh/yr and 324,011 MWh/day in the OSP, compared with total 93,119,496 MWh/yr savings and 230,679 MWh/day in the OSP in 2021 within ERCOT. The total NO_x emissions reductions for modeled 2018 across all the counties amount to 67,456.7 tons/yr and 186.0 tons/day for the OSP. Compared to the modeled 2018, the total NO_x emissions reductions in 2021 is lower by 15.9 %, from 67,456.7 tons/yr to 56,732.0 tons/yr. For the OSP, the total NO_x emissions reductions in 2021 is lower by 28.7 %, from 186.0 tons/day to 132.6 tons/day. The distribution of the NO_x emissions reduction in the counties within the ERCOT region is shown in Figure 5-3 through Figure 5-6. The EPA finalized, on July 25th, 2018, that the nonattainment county designations are: Brazoria, Chambers, Fort Bend, Galveston, Harris, Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Tarrant, Wise, Bexar, Freestone, Howard, Rusk, Anderson, El Paso, Hutchinson, Liberty, Montgomery, Navarro, Panola, Rockwall, Titus, and Waller¹⁸. The non-attainment county Montgomery, Anderson, Liberty, Navarro, Rockwall, Titus, and Waller did not reduce NO_x emissions this year. Hutchinson and Panola are within SPP, El

¹⁶ This report used the non-attainment areas established by TCEQ information at https://www.tceq.texas.gov/assets/public/comm_exec/pubs/rg/rg388/rg-388.pdf

¹⁷ 2018 eGRID table for Texas was retrieved by the US EPA at <https://www.epa.gov/egrid>

¹⁸ The EPA finalized nonattainment county designations were retrieved at <https://www.tceq.texas.gov/airquality/sip/texas-sip>

Paso is within WECC. The 2018 eGRID shows that the counties Scurry, Ector and Wilbarger got the most emissions benefit from the wind farms.

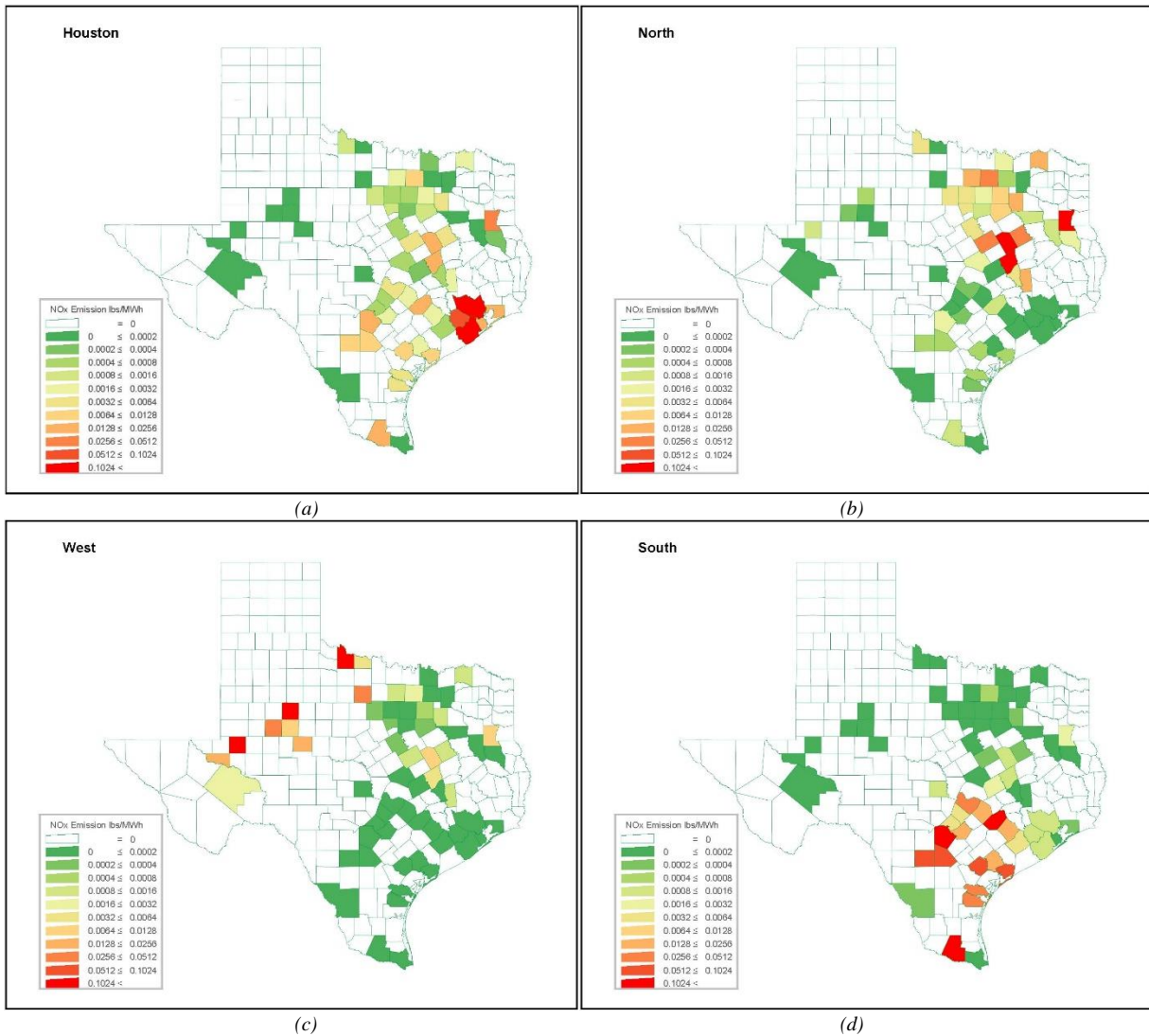


Figure 5-1: 2018 Annual eGRID NOx Emissions for the CL zones: (a) Houston, (b) North, (c) West and (d) South.

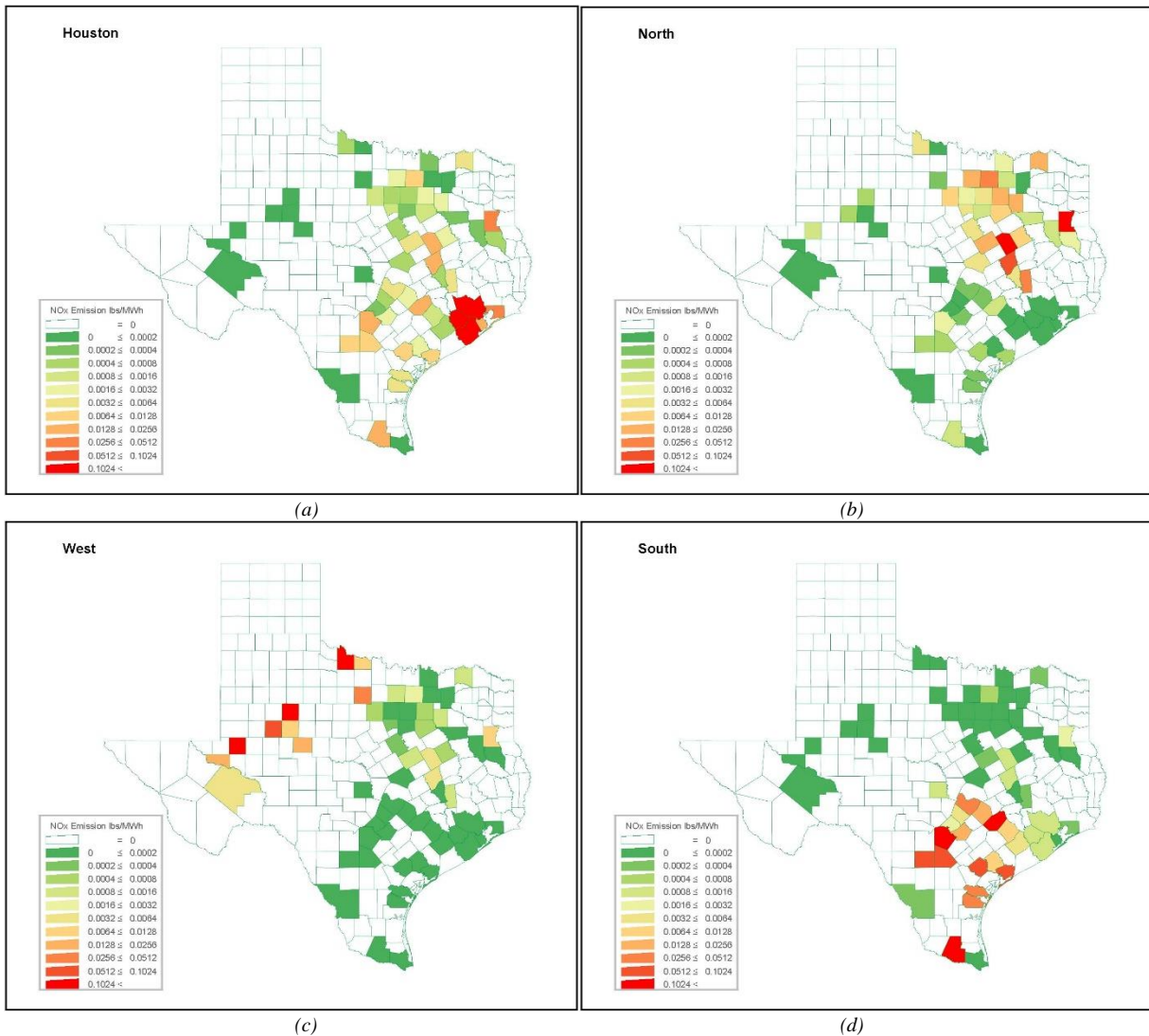


Figure 5-2: 2018 OSP eGRID NOx Emissions for the CL zones: (a) Houston, (b) North, (c) West and (d) South.

Table 5-1: Texas Wind Farm Information — Updated Jan 15th, 2022

Facility	County	Resource	Capacity (MW)	In Service	Region*	Notes
Big SpriGas Wind Power	Howard	Wind	27.7	Feb-99	ERCOT	
Big SpriGas Wind Power	Howard	Wind	6.6	Jun-99	ERCOT	
Hueco Mountain Wind Ranch	El Paso	Wind	1.3	Apr-01	WSCC	
Indian Mesa	Pecos	Wind	91.8	Jun-01	ERCOT	
Woodward Mountain Ranch	Pecos	Wind	177.7	Jul-01	ERCOT	
Trent Mesa	Nolan	Wind	156.5	Nov-01	ERCOT	
Desert Sky (Indian Mesa II)	Pecos	Wind	209.2	Dec-01	ERCOT	
KiGas Mountain Wind Ranch	Upton	Wind	279.6	Dec-01	ERCOT	
Llano Estacado Wind Ranch	Carson	Wind	79.0	Jan-02	SPP	
Brazos Wind Ranch	Scurry	Wind	160.0	Dec-03	ERCOT	
Sweetwater Wind 1	Nolan	Wind	42.5	Dec-03	ERCOT	
	Hansford	Wind	3.0	Dec-03	SPP	
Callahan Divide Wind Energy Center	Taylor	Wind	123.1	Feb-05	ERCOT	
Sweetwater Wind 2	Nolan	Wind	127.6	Feb-05	ERCOT	
Buffalo Gap 1	Taylor	Wind	120.6	Sep-05	ERCOT	
Horse Hollow Phase 1	Taylor	Wind	230.0	Oct-05	ERCOT	
Sweetwater Wind 3 (Cottonwood Creek)	Nolan	Wind	152.2	Dec-05	ERCOT	
Horse Hollow Phase 2	Taylor	Wind	184.0	May-06	ERCOT	
Red Canyon 1	Borden	Wind	89.6	May-06	ERCOT	
Horse Hollow Phase 3	Taylor	Wind	241.4	Sep-06	ERCOT	
Forest Creek Wind Farm	Glasscock	Wind	124.2	Dec-06	ERCOT	
Sand Bluff Wind Farm	Glasscock	Wind	90.0	Dec-06	ERCOT	
Wildorado Wind Ranch	Oldham	Wind	161.0	Apr-07	SPP	
Sweetwater Wind 4 (Cottonwood Creek)	Nolan	Wind	237.0	May-07	ERCOT	
Camp SpriGass I	Scurry	Wind	130.5	Jul-07	ERCOT	
Buffalo Gap 2 (Cirello 1)	Taylor	Wind	232.5	Aug-07	ERCOT	
Capricorn Ridge Wind	Sterling	Wind	381.2	Sep-07	ERCOT	703.6
Capricorn Ridge Wind (exp)	Sterling	Wind	322.4	May-08	ERCOT	
Barton Chapel Wind 1	Jack	Wind	120.0	Dec-07	ERCOT	
Lone Star - Mesquite Wind	Shackelford	Wind	194.0	Dec-07	ERCOT	
Sweetwater Wind 5	Nolan	Wind	85.0	Dec-07	ERCOT	
Whirlwind	Floyd	Wind	57.0	Dec-07	ERCOT	
Champion Wind Farm	Scurry	Wind	126.5	Jan-08	ERCOT	
Roscoe Wind Farm 1	Scurry	Wind	209.0	Jan-08	ERCOT	previously Goat Mtn.
Stanton Wind Energy	Martin	Wind	120.0	Jan-08	ERCOT	
Buffalo Gap 3	Taylor	Wind	170.2	Apr-08	ERCOT	
Goat Wind	Sterling	Wind	80.0	Apr-08	ERCOT	
Lone Star - Post Oak Wind	Shackelford	Wind	198.0	May-08	ERCOT	
McAdoo Wind Energy	Dickens	Wind	150.0	May-08	ERCOT	
Camp SpriGass II	Scurry	Wind	120.0	Jun-08	ERCOT	
Panther Creek	Howard	Wind	142.5	Jul-08	ERCOT	
Ocotillo Windpower 1	Howard	Wind	58.8	Aug-08	ERCOT	
South Trent Wind Farm	Taylor	Wind	98.2	Oct-08	ERCOT	previously Goat Mtn.
Wolf Ridge Windfarm	Cooke	Wind	112.5	Oct-08	ERCOT	
Bull Creek Wind Plant	Borden	Wind	178.0	Nov-08	ERCOT	
Elbow Creek wind repower	Howard	Wind	121.9	Nov-08	ERCOT	
Gulf Wind 1	Kenedy	Wind	283.2	Nov-08	ERCOT	
Hackberry Wind Farm	Shackelford	Wind	163.5	Nov-08	ERCOT	
Inadale	Nolan	Wind	197.0	Nov-08	ERCOT	
Panther Creek 2	Howard	Wind	115.5	Nov-08	ERCOT	
Penascal Wind Farm	Kenedy	Wind	160.8	Nov-08	ERCOT	
Pyron	Scurry	Wind	249.0	Nov-08	ERCOT	
Turkey Track Energy Center	Nolan	Wind	169.5	Nov-08	ERCOT	
Notrees Windpower	Ector	Wind	152.6	Jan-09	ERCOT	
Noble Great Plains Windpark	Hansford	Wind	114.0	Feb-09	SPP	
Goat Wind Phase 2	Sterling	Wind	69.6	Apr-09	ERCOT	
Panther Creek 3	Concho	Wind	199.5	Aug-09	ERCOT	
Sunray Wind I, II, III	Moore	Wind	49.5	Aug-09	SPP	
Papalote Creek Wind Farm	San Patricio	Wind	179.9	Sep-09	ERCOT	
LaGasford Wind Power	Tom Green	Wind	160.0	Oct-09	ERCOT	
Loraine Windpark	Mitchell	Wind	148.5	Oct-09	ERCOT	
JD Wind 1-7, 9-11, Wege	Hansford	Wind	189.8	Dec-09	SPP	
Majestic Wind	Carson	Wind	79.5	Dec-09	SPP	
Penascal Wind Farm 2	Kenedy	Wind	141.6	Mar-10	ERCOT	
Papalote Creek Phase II	San Patricio	Wind	200.1	Jun-10	ERCOT	
Little PriGasle 1,2	Hutchinson	Wind	20.0	Sep-10	SPP	
Cedro Hill Wind	Webb	Wind	150.0	Oct-10	ERCOT	
Ralls Wind Farm	Crosby	Wind	10.0	Jul-11	SPP	completed 2006-2009
GS Panhandle Wind Ranch	Oldham	Wind	78.0	Sep-11	SPP	

Note: * Texas Wind Farm Information from ERCOT and PUCT

Table 5-1: Texas Wind Farm Information — Updated Jan 15th, 2022 (Continued)

Facility	County	Resource	Capacity (MW)	In Service	Region	Notes
Sherbino Mesa Wind Farm 2	Pecos	Wind	132.0	Nov-11	ERCOT	
Trinity Hills Wind Farm	YouGas	Wind	198.0	Jan-12	ERCOT	
Frisco Wind Farm	Hansford	Wind	20.0	Feb-12	SPP	
Magic Valley Wind	Willacy	Wind	203.3	Apr-12	ERCOT	
Anacacho Windfarm	Kinney	Wind	99.8	Dec-12	ERCOT	
Blue Summit Wind	Wilbarger	Wind	133.1	Dec-12	ERCOT	
Cirrus Wind Energy	Lynn	Wind	61.2	Dec-12	SPP	
Majestic Wind II	Carson	Wind	79.6	Dec-12	SPP	
Mozart	Kent	Wind	30.0	Dec-12	ERCOT	
Senate Wind Project	Jack	Wind	150.0	Dec-12	ERCOT	also called Redfish
SpinniGas Spur Wind Ranch	Oldham	Wind	161.0	Dec-12	SPP	
Whitetail Wind Project	Webb	Wind	92.3	Dec-12	ERCOT	
Los Vientos I	Willacy	Wind	200.1	Jan-13	ERCOT	
Los Vientos II	Willacy	Wind	201.6	Jan-13	ERCOT	
Bobcat Bluff	Clay	Wind	162.0	Mar-13	ERCOT	15-yr PPA JP Morgan EV
Goldthwaite Wind Energy	Mills	Wind	148.6	Jun-14	ERCOT	
Pantex Wind Farm	Carson	Wind	11.5	Jun-14	SPP	15-yr PPA SPS
SpinniGas Spur Wind II	Oldham	Wind	161.0	Jun-14	ERCOT	25-yr PPA Austin Energy
Panhandle Wind 1	Carson	Wind	218.4	Jul-14	ERCOT	25-yr PPA CPS Energy
Panhandle Wind 2	Carson	Wind	190.8	Nov-14	ERCOT	PPA Austin Energy
Grandview Phase 1 (Conway Windfarm)	Carson	Wind	211.2	Dec-14	ERCOT	
Miami Wind 1 Project	Gray	Wind	288.6	Dec-14	ERCOT	
Palo Duro Wind	Ochltree	Wind	250.0	Dec-14	SPP	
Stephens Ranch Wind Phase 1	Borden	Wind	211.2	Dec-14	ERCOT	
Windthorst 2	Archer	Wind	67.6	Dec-14	ERCOT	
Keechi Wind	Jack	Wind	110.0	Jan-15	ERCOT	
Jumbo Road Wind (Hereford 2)	Castro	Wind	299.8	Apr-15	ERCOT	
Mesquite Creek W	Borden	Wind	211.2	Apr-15	ERCOT	
Hereford Wind Project (Hereford 1)	Deaf Smith	Wind	199.9	May-15	ERCOT	
Stephens Ranch Wind Phase b	Borden	Wind	164.7	May-15	ERCOT	
Route66 Wind	ArmstroGas	Wind	150.0	Aug-15	ERCOT	
Logan's Gap Wind I	Comanche	Wind	210.1	Sep-15	ERCOT	
LoGashorn Energy Center North	Briscoe	Wind	200.0	Sep-15	ERCOT	PPA AE
RattleSnake Wind Ph 1	Glasscock	Wind	207.3	Sep-15	ERCOT	
Pleasant Hill Wind Energy	Crosby	Wind	20.0	Oct-15	SPP	
SpinniGas Spur Wind III	Oldham	Wind	194.0	Oct-15	ERCOT	
Briscoe Wind	Briscoe	Wind	149.8	Nov-15	ERCOT	
Green Pastures W	Knox	Wind	300.0	Nov-15	ERCOT	
South Plains Wind I	Floyd	Wind	200.0	Nov-15	ERCOT	
Shannon Wind	Clay	Wind	204.1	Dec-15	ERCOT	prev. Rattlesnake Den
Los Vientos III	Starr	Wind	200.0	Dec-15	ERCOT	
Sendero Wind Energy Project	Jim Hogg	Wind	78.0	Dec-15	ERCOT	PPAs GUS, GPL
Javelina Wind	Zapata	Wind	249.7	Dec-15	ERCOT	
Cameron County Wind	Cameron	Wind	165.0	Jan-16	ERCOT	
Colbeck's Corner	Carson	Wind	200.4	May-16	ERCOT	
South Plains Wind II Phase a	Floyd	Wind	148.5	Jun-16	ERCOT	prev. South Clay Wind
South Plains Wind II Phase b	Floyd	Wind	151.8	Jun-16	ERCOT	25-yr PPA Austin Energy
Baffin Wind Farm (Penascal 3)	Kenedy	Wind	202.0	Jun-16	ERCOT	
Los Vientos IV	Starr	Wind	200.0	Jun-16	ERCOT	
Gunsight Mountain	Howard	Wind	119.9	Sep-16	ERCOT	
Los Vientos V	Starr	Wind	110.0	Sep-16	ERCOT	
Wake Wind	Dickens	Wind	257.2	Oct-16	ERCOT	
Salt Fork Wind	Donley and Gray	Wind	174.0	Dec-16	ERCOT	
Tyler Bluff Wind (Muenster Wind)	Cooke	Wind	125.6	Dec-16	ERCOT	
Hidalgo & Starr Wind	Hidalgo	Wind	250.0	Dec-16	ERCOT	25-yr PPA Austin Energy
Electra Wind	Wilbarger	Wind	230.0	Jan-17	ERCOT	
Horse Creek Wind	Haskell	Wind	230.0	Jan-17	ERCOT	
Bethel Wind Energy Facility	Castro	Wind	276.0	Jan-17	SPP	
Javelina 2 Wind	Zapata	Wind	200.0	Feb-17	ERCOT	
San Roman Wind 1	Cameron	Wind	95.2	Feb-17	ERCOT	
Mariah Del Notre	Parmer	Wind	230.4	Mar-17	ERCOT	
Old Settler Wind	Floyd	Wind	151.2	Apr-17	ERCOT	
Cotton Plains Wind	Floyd	Wind	50.4	Mar-17	ERCOT	
Falvez Astra Wind	Deaf Smith	Wind	163.2	May-17	ERCOT	
Dermott Wind 1	Scurry	Wind	253.0	Aug-17	ERCOT	
Chapman Ranch Wind 1	Nueces	Wind	249.0	Oct-17	ERCOT	Mariah Wind B
Val Verde Wind	Val Verde	Wind	149.3	Oct-17	ERCOT	Blanco Canyon Wind 1
Fluvanna Renewable 1	Scurry	Wind	155.4	Nov-17	ERCOT	Blanco Canyon Wind 2
Willow Sprig Wind (SALVTION)	Haskell	Wind	250.0	Dec-17	ERCOT	Blanco Canyon Wind 1
BUCKTHORN WIND	Erath	Wind	100.6	Dec-17	ERCOT	Amazon Wind Farm

Table 5-1: Texas Wind Farm Information — Updated Jan 15th, 2022 (Continued)

Facility	County	Resource	Capacity (MW)	In Service	Region	Notes
BBREEZE (BruenniGas's Breeze)	Willacy	Wind	228.0	Dec-17	ERCOT	
Niels Bohr (BearKat Wind A)	Glasscock	Wind	196.6	Feb-18	ERCOT	Rock SpriGass
HICKMAN	Reagan	Wind	300.0	May-18	ERCOT	
Flat Top Wind I	Comanche	Wind	200.0	Sep-18	ERCOT	
RTS Wind Project	McCulloch	Wind	160.0	Sep-18	ERCOT	
Stella 1 Wind	Kenedy	Wind	201.0	Dec-18	ERCOT	
Wildcat Ranch Wind Project	Cochran	Wind	150.5	Dec-18	SPP	Magic Valley II and Redfish
Fiber Winds Energy Project	Crosby	Wind	78.8	Dec-18	SPP	
Blue Cloud Renewable Energy	Bailey and Lamb	Wind	148.4	Dec-18	SPP	Santa Rita Wind Energy Center
Tahoka Wind	Lynn	Wind	300.0	Mar-19	ERCOT	Logan's Gap Wind II
Hale Community Energy	Hale	Wind	478.0	Jun-19	SPP	Rattlesnake Wind Project
Midway Wind	San Patricio	Wind	162.8	Jun-19	ERCOT	
S_Hills Wind	Baylor	Wind	30.2	Aug-19	ERCOT	
Lockett Wind	Wilbarger	Wind	183.7	Sep-19	ERCOT	
Torreillas Wind	Webb	Wind	300.5	Nov-19	ERCOT	
Foard City Wind	Foard	Wind	350.3	Nov-19	ERCOT	
Cabezon Wind	Starr	Wind	237.6	Dec-19	ERCOT	
Canadian Breaks Wind	Oldham	Wind	210.1	Dec-19	ERCOT	
Karankawa Wind	San Patricio	Wind	206.6	Dec-19	ERCOT	
Karankawa 2 Wind	San Patricio	Wind	100.4	Dec-19	ERCOT	
Gopher Creek Wind	Borden	Wind	158.0	Mar-20	ERCOT	Javelina III
Wilson Ranch	Schleicher	Wind	199.5	Apr-20	ERCOT	
Blue Summit II	Wilbarger	Wind	96.4	Apr-20	ERCOT	Rio Bravo
Blue Summit III	Wilbarger	Wind	195.8	May-20	ERCOT	
Ranchero Wind	Crockett	Wind	300.0	May-20	ERCOT	
Peyton Creek Wind	Matagorda	Wind	151.2	Jun-20	ERCOT	
Palmas Altas Wind	Cameron	Wind	144.9	Nov-20	ERCOT	
WKN Amadeus Wind	Fisher	Wind	250.2	Apr-21	ERCOT	
Vera Wind V110	Knox	Wind	34.0	May-21	ERCOT	
RTS 2 Wind	McCulloch	Wind	179.8	May-21	ERCOT	
Vera Wind	Knox	Wind	208.8	May-21	ERCOT	
Aviator Wind	Coke	Wind	525.0	Jun-21	ERCOT	
Espiritu Wind	Cameron	Wind	25.2	Jun-21	ERCOT	
Chalupa Wind	Cameron	Wind	173.3	Jun-21	ERCOT	
Shaffer Wind	Nueces	Wind	226.1	Jun-21	ERCOT	
East Raymond Wind (El Rayo)	Willacy	Wind	194.0	Jun-21	ERCOT	
High Lonesome Wind	Crockett	Wind	449.7	Jul-21	ERCOT	
High Lonesome Wind Phase II	Crockett	Wind	50.6	Jul-21	ERCOT	
Hidalgo II Wind	Hidalgo	Wind	50.4	Jul-21	ERCOT	
Barrow Ranch Wind	Andrews	Wind	160.7	Sep-21	ERCOT	
West Raymond (Trueno) Wind	Willacy	Wind	239.8	Oct-21	ERCOT	
Oveja Wind	Irion	Wind	302.4	Oct-21	ERCOT	
Griffin Trail Wind	Knox	Wind	225.6	Oct-21	ERCOT	47% generation
Venado Wind	Starr	Wind	201.6	Dec-21	ERCOT	
Whitehorse Wind	Fisher	Wind	418.9	Sep-20	ERCOT	
Mesteno Wind	Starr	Wind	201.6	Mar-22	ERCOT	
Harald (BearKat Wind B)	Glasscock	Wind	162.1	Jan-22	ERCOT	
Cranel Wind	Refugio	Wind	220.0	Mar-22	ERCOT	
Sage Draw Wind	Lynn	Wind	338.4	Dec-20	ERCOT	
Silver Star Phase I	Erath	Wind	52.8	Mar-08	ERCOT	
Las Majadas Wind	Willacy	Wind	272.6	Nov-21	ERCOT	
WILDWIND	Cooke	Wind	180.1	Dec-21	ERCOT	
Prairie Hill Wind	McLennan	Wind	300.0	Dec-21	ERCOT	
Priddy Wind	Mills	Wind	302.4	Dec-21	ERCOT	9% GENERATION
Coyote Wind	Scurry	Wind	242.6	Dec-21	ERCOT	
Maryneal Wind	Nolan	Wind	182.4	Dec-21	ERCOT	59% Generation
Ajax Wind	Wilbarger	Wind	366.6	Dec-21	ERCOT	~47% generation
Maverick Creek I Wind	Concho	Wind	373.2	Jan-22	ERCOT	
Maverick Creek II Wind	Concho	Wind	118.8	Jan-22	ERCOT	
White Mesa Wind	Crockett	Wind	152.3	Jan-22	ERCOT	47% generation
Aquilla Lake Wind	Hill	Wind	149.3	Jan-22	ERCOT	
Aquilla Lake 2 Wind	Hill	Wind	150.8	Jan-22	ERCOT	
White Mesa 2 Wind	Coke	Wind	348.3	Jan-22	ERCOT	
Reloj Del Sol Wind	Zapata	Wind	209.3	Jan-22	ERCOT	
Baird North Wind	Callahan	Wind	345.0	Feb-22	ERCOT	~28% generation
TG East Wind	Knox	Wind	336.0	Mar-22	ERCOT	23% generation
Cactus Flats Wind	Concho	Wind	148.4	Jun-22	ERCOT	
Panther Creek	HOWARD	Wind	106.9		ERCOT	
Panther Creek	HOWARD	Wind	108.5		ERCOT	
Penascal Wind Farm 2	KENEDY	Wind	100.8	Oct-10	ERCOT	not listed in gentable
HORSE HOLLOW WIND 4	TAYLOR	Wind	115.0	May-06		not listed in gentable
Total			36694.1			

Table 5-2: Modeled 2018 and Measured 2021 Wind Power Production and Emission Assigned to Each CL Zone in the ERCOT Region

CL Zones	Modeled 2018				Measured 2021			
	Annual Wind Power		OSP Wind Power		Annual Wind Power		OSP Wind Power	
	Generation (MWh/yr)	NOx Emission Reduction (Tons/yr)	Generation (MWh/yr)	NOx Emission Reduction (Tons/yr)	Generation (MWh/yr)	NOx Emission Reduction (Tons/yr)	Generation (MWh/yr)	NOx Emission Reduction (Tons/yr)
Houston	0	0	0	0	0	0	0	0
North	6,126,521	2132.2	17,515	5.6	5,281,720	1,838.2	11,637	3.7
West	77,823,624	51,955.4	228,286	143.9	66,209,296	44,201.6	163,059	102.8
South	27,043,453	13,369.2	78,210	36.4	21,628,480	10,692.2	55,983	26.1
Total	110,993,597	67,456.7	324,011	186.0	93,119,496	56,732.0	30,679	132.6

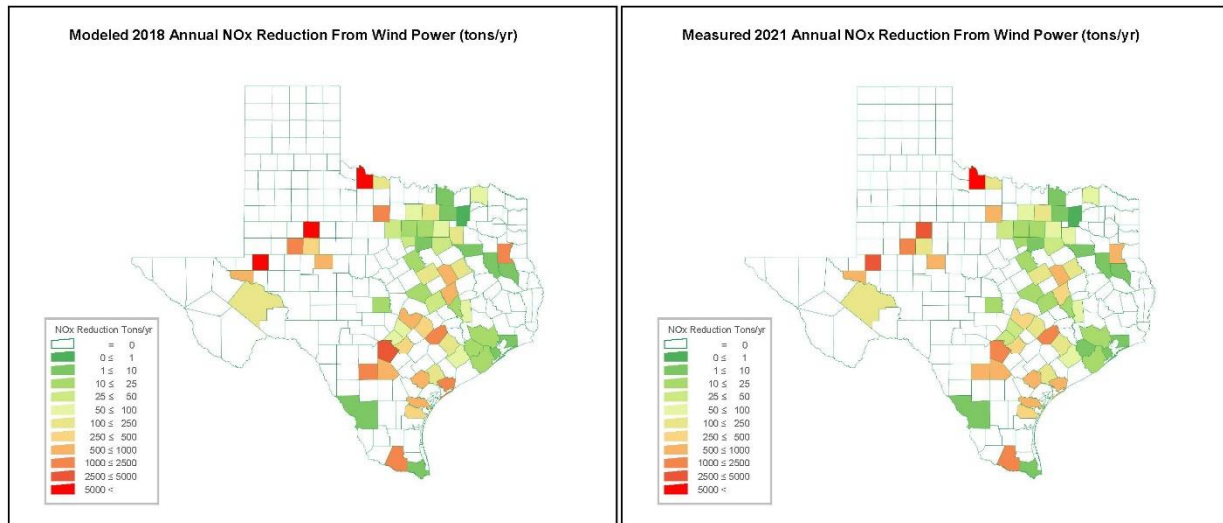


Figure 5-3: Modeled 2018 and Measured 2021 Annual NOx Reductions from Wind Power in Texas Map

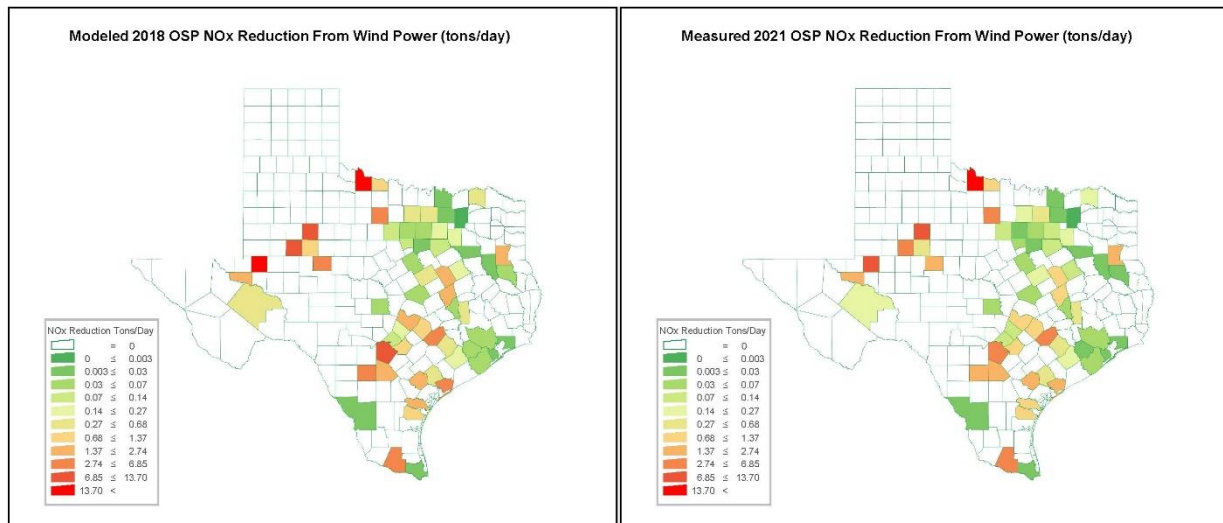


Figure 5-4: Modeled 2018 OSP and Measured 2021 OSP NOx Reductions from Wind Power in Texas Map

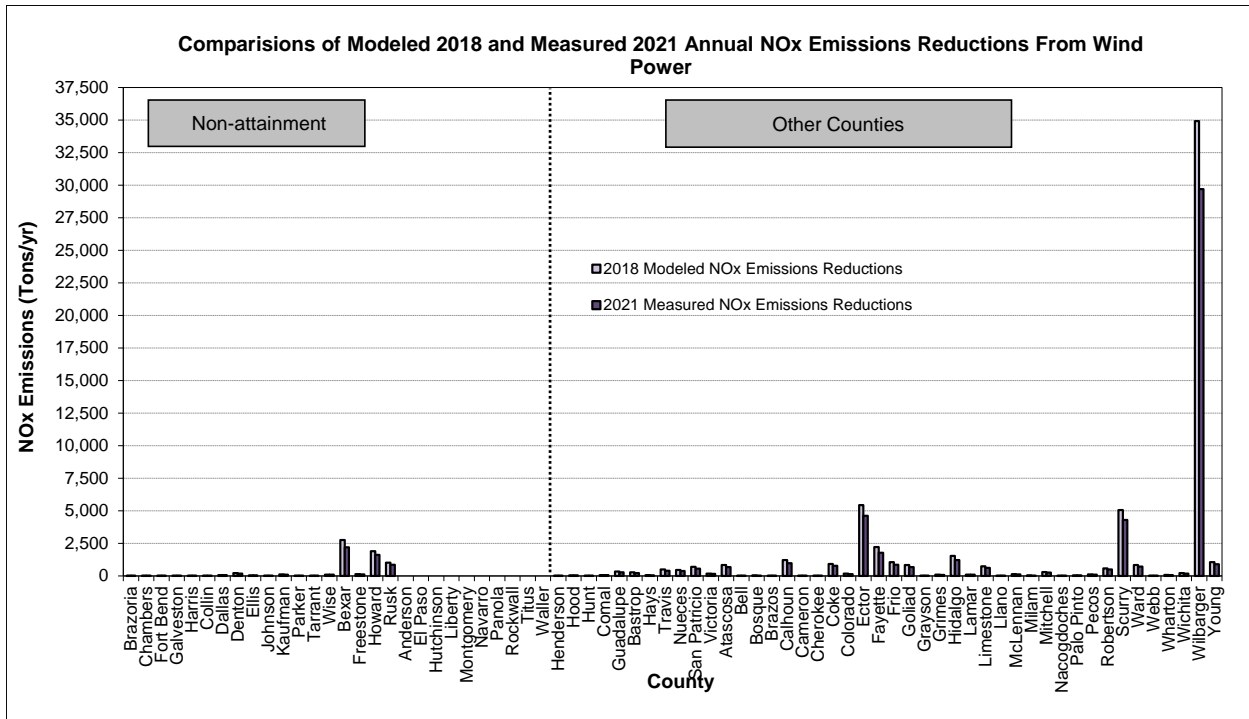


Figure 5-5: Comparisons of Modeled 2018 and Measured 2021 Annual NOx Emissions Reductions from Wind Power

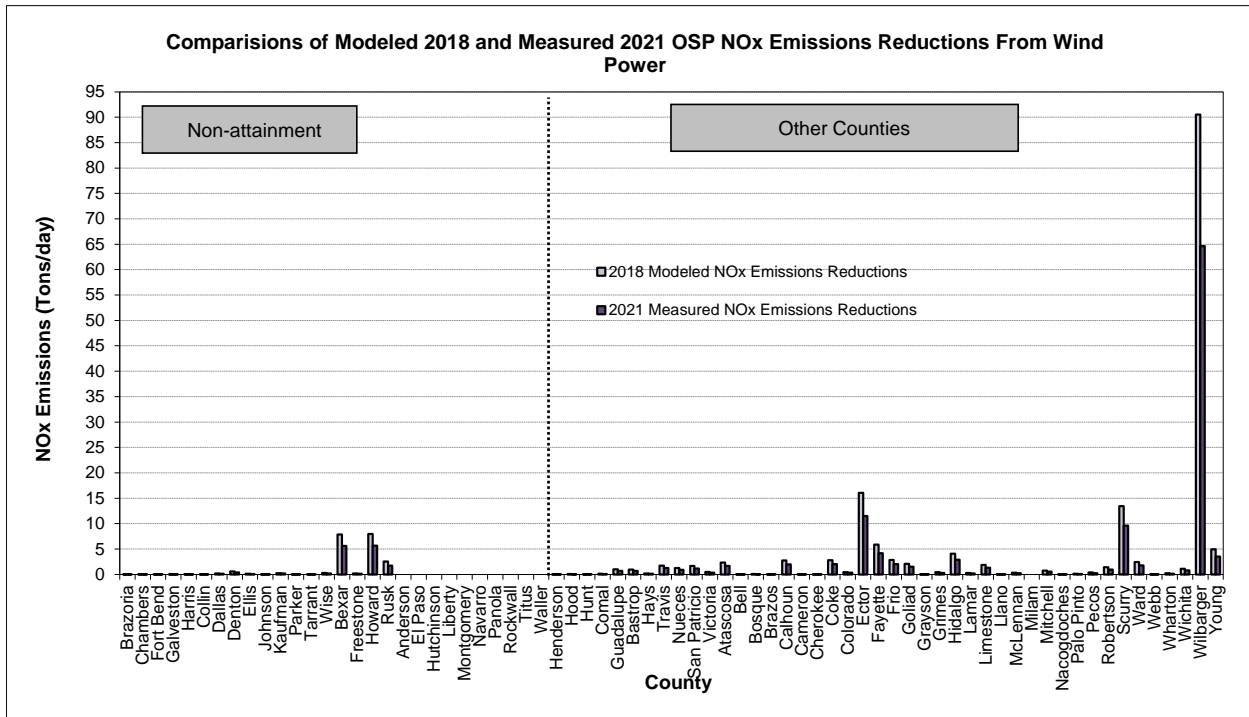


Figure 5-6: Comparisons of Modeled 2018 and Measured 2021 OSP NOx Emissions Reductions from Wind Power

6 OTHER RENEWABLE SOURCES

Five specific renewable sources were determined: solar, biomass, hydroelectric, geothermal, and landfill gas-fired, to generate energy throughout the State of Texas, six types of renewable energy projects were identified: solar photovoltaic (PV), including solar power, solar thermal, biomass power, hydroelectric power, geothermal HVAC, and landfill gas-fired power projects. The generated, avoided, and used energy from renewable energy projects impacts emissions reductions throughout the State of Texas. To determine the amount of NO_x emission reductions using 2018 eGRID, this report collected installation and/or generation data of renewable energy projects. The majority of the collected data were after the year 2000. However, projects before the year 2000 were also included in order to provide a complete record.

6.1 Implementation

This report included newly located renewable energy projects in the six renewable energy projects categories, as already discussed. The information was collected using the following modes:

- information from the internet websites of manufacturers, distributors, and consultants related to renewable energy products;
- some information was collected by personally emailing individuals, who were either manufacturers, distributors or consultants; and
- information published from environmental agencies like the Electric Reliability Council of Texas (ERCOT), the Environmental Protection Agency (EPA), U.S. Energy Information Administration (EIA), and Lawrence Berkeley National Laboratory (LBNL) which are available to the general public.

It was mainly the same methodology/protocol followed for data collection used in the previous report. Most of the information collected from websites was very limited since the information did not include detailed project information such as system specifications data. To obtain more information, we emailed manufacturers, consultants, distributors, or officers in environmental agencies. Unfortunately, we were not able to take many responses back from the people whom we contacted. Therefore, most of the updated information in the present report was obtained from environmental agencies like ERCOT, EPA, EIA, and LBNL.

In this report, the data for non-utility scale solar PV projects throughout the State of Texas were identified from the *Tracking the Sun* database of the Lawrence Berkeley National Laboratory (LBNL). The three other utility-scale renewable resources (i.e., solar power, biomass, and hydroelectricity) were obtained from the Electric Reliability Council of Texas (ERCOT) and the U.S. Energy Information Administration (EIA). The solar thermal projects and geothermal projects throughout the State of Texas were identified from various web sources. The information for the landfill gas-fired power plant section was provided by the Environmental Protection Agency's (EPA's) project database for Landfill Methane Outreach Program (LMOP).

To determine energy savings from solar photovoltaic, solar thermal, and hydroelectric, the generated energy was calculated in electricity and electricity equivalent. Then, NO_x emission reductions throughout the State of Texas were evaluated based on the generated energy. To determine NO_x emission reductions, the 2018 eGRID version was used. Figure 6-1 presents the work process to implement the analysis of other renewable resources, including steps: project classification, data collection, data preparation, NO_x emission reductions calculation, and result production.

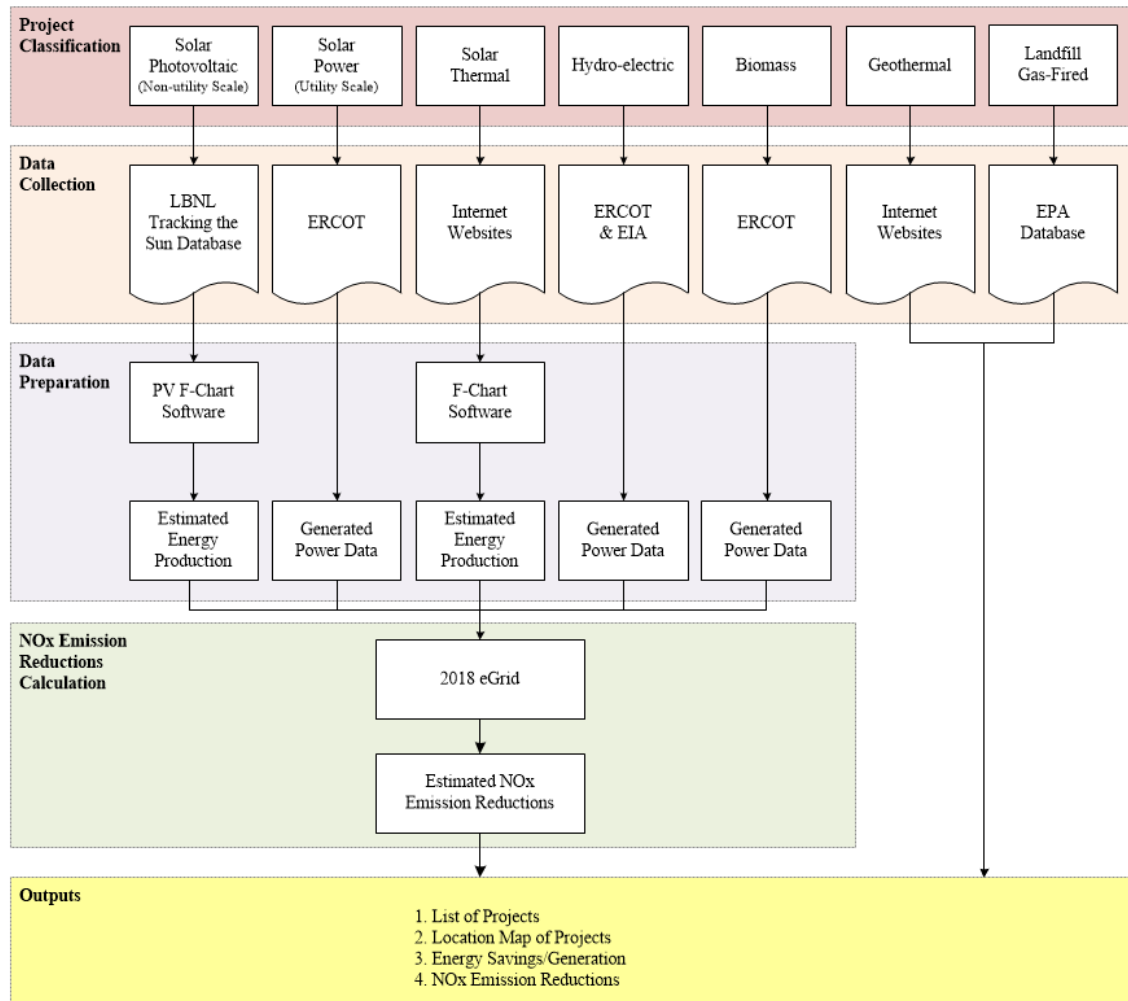


Figure 6-1: Chart of Workflow for Other Renewable Energy Projects

6.2 Renewable Energy Projects

6.2.1 Solar Photovoltaic

As of the end of 2021, a total of 40,700 projects (non-utility scale) were found. These data were collected from the *Tracking the Sun* public database of the Lawrence Berkeley National Laboratory (LBNL). The new database from Tracking the Sun provides information about solar PV projects that have been implemented since 2004. The database includes individual solar PV projects (non-utility scale) of residential and non-residential in Texas. Also, it provides detailed information, such as zip code, system size (kW DC), system efficiency, total installed cost, installed date and location. All of the solar PV projects identified in this report can be found in Table G-1 (Vol II, Appendix G).

The generated energy from all the solar PV projects is presented in Table 6-1. Figure 6-2 shows the map of the solar PV projects installed in each county of Texas. In addition, Table 6-2 provides detailed information about Figure 6-2, including: county name, FIPS code, number of solar PV projects and total installed capacity for each county. The annual electric generations per county and the OSP electric generations per county, which were estimated from these projects, are presented in Figure 6-3 and in Figure 6-4. Please note that Figure 6-3 is presented using a logarithmic scale for the electricity generation because of the large

variation in the amounts shown. Lastly, the corresponding annual NOx emission reductions are shown in Figure 6-5.

To improve the accuracy of the current calculation methods, this report recalculated the weighted solar PV efficiencies based on *2021 Tracking the Sun* data. Using the PV F-Chart software, the annual solar generation coefficients and OSP solar generation coefficients were recomputed using forty TMY3 weather stations to estimate annual and OSP solar PV generations by county. Also, the target counties were expanded from the previous 41 counties to 254 counties to treat entire regions across Texas.

Table 6-1: Solar Photovoltaic Projects: Annual Energy and OSP Energy through 2021

County	Annual Elec. Generation (MWh/year)	OSP Elec. Generation (MWh/Day)	County	Annual Elec. Generation (MWh/year)	OSP Elec. Generation (MWh/Day)
Anderson	31.8	0.10	Crockett	-	-
Andrews	-	-	Crosby	-	-
Angelina	92.1	0.28	Culberson	-	-
Aransas	93.6	0.33	Dallam	-	-
Archer	243.9	0.72	Dallas	5,265.9	15.76
Armstrong	-	-	Dawson	-	-
Atascosa	1,663.9	5.07	Deaf Smith	-	-
Austin	-	-	Delta	-	-
Bailey	-	-	Denton	740.9	2.22
Bandera	-	-	De Witt	-	-
Bastrop	-	-	Dickens	-	-
Baylor	-	-	Dimmit	-	-
Bee	4.5	0.01	Donley	-	-
Bell	452.9	1.41	Duval	25.7	0.09
Bexar	401,221.4	1,221.94	Eastland	33.6	0.10
Blanco	303.4	1.00	Ector	70.5	0.20
Borden	-	-	Edwards	-	-
Bosque	41.3	0.13	Ellis	459.5	1.38
Bowie	195.3	0.63	El Paso	5,997.9	16.85
Brazoria	17.0	0.06	Erath	17.0	0.05
Brazos	-	-	Falls	10.2	0.03
Brewster	432.7	1.24	Fannin	15.7	0.05
Briscoe	-	-	Fayette	-	-
Brooks	-	-	Fisher	-	-
Brown	100.5	0.29	Floyd	-	-
Burleson	-	-	Foard	-	-
Burnet	17.2	0.06	Fort Bend	-	-
Caldwell	13.6	0.04	Franklin	6.2	0.02
Calhoun	-	-	Freestone	-	-
Callahan	237.0	0.69	Frio	7.5	0.02
Cameron	1,695.4	5.36	Gaines	-	-
Camp	-	-	Galveston	108.0	0.35
Carson	-	-	Garza	-	-
Cass	48.4	0.16	Gillespie	-	-
Castro	-	-	Glasscock	-	-
Chambers	-	-	Goliad	42.4	0.13
Cherokee	104.3	0.31	Gonzales	-	-
Childress	-	-	Gray	-	-
Clay	53.3	0.16	Grayson	130.4	0.42
Cochran	-	-	Gregg	329.9	1.06
Coke	-	-	Grimes	19.9	0.06
Coleman	18.7	0.05	Guadalupe	9,978.9	30.39
Collin	1,053.1	3.38	Hale	23.8	0.07
Collingsworth	-	-	Hall	-	-
Colorado	37.9	0.12	Hamilton	20.1	0.06
Comal	5,735.2	17.47	Hansford	-	-
Comanche	-	-	Hardeman	-	-
Concho	-	-	Hardin	30.1	0.09
Cooke	136.6	0.41	Harris	34.7	0.10
Coryell	15.6	0.05	Harrison	23.4	0.08
Cottle	-	-	Hartley	-	-
Crane	-	-	Haskell	18.6	0.05

Table 6-1: Solar Photovoltaic Projects: Annual Energy and OSP Energy through 2021 (Continued)

County	Annual Elec. Generation (MWh/year)	OSP Elec. Generation (MWh/Day)	County	Annual Elec. Generation (MWh/year)	OSP Elec. Generation (MWh/Day)
Hays	-	-	Oldham	-	-
Hemphill	-	-	Orange	124.9	0.38
Henderson	67.6	0.20	Palo Pinto	8.6	0.02
Hidalgo	3,875.1	12.42	Panola	32.0	0.11
Hill	4.0	0.01	Parker	80.7	0.23
Hockley	-	-	Parmer	-	-
Hood	20.5	0.06	Pecos	43.5	0.12
Hopkins	407.2	1.31	Polk	-	-
Houston	-	-	Potter	-	-
Howard	363.6	1.03	Presidio	563.2	1.62
Hudspeth	-	-	Rains	-	-
Hunt	64.6	0.21	Randall	-	-
Hutchinson	-	-	Reagan	-	-
Irion	-	-	Real	34.4	0.12
Jack	-	-	Red River	61.3	0.18
Jackson	14.8	0.05	Reeves	101.4	0.29
Jasper	-	-	Refugio	-	-
Jeff Davis	132.0	0.38	Roberts	-	-
Jefferson	42.7	0.13	Robertson	6.8	0.02
Jim Hogg	5.9	0.02	Rockwall	91.7	0.29
Jim Wells	588.4	1.99	Runnels	16.9	0.05
Johnson	143.9	0.43	Rusk	40.7	0.13
Jones	74.4	0.22	Sabine	-	-
Karnes	13.6	0.04	San Augustine	-	-
Kaufman	41.8	0.13	San Jacinto	-	-
Kendall	7,036.4	21.43	San Patricio	36.6	0.12
Kenedy	-	-	San Saba	-	-
Kent	-	-	Schleicher	34.9	0.10
Kerr	-	-	Scurry	-	-
Kimble	83.8	0.24	Shackelford	63.1	0.18
King	-	-	Shelby	-	-
Kinney	-	-	Sherman	-	-
Kleberg	44.3	0.15	Smith	266.2	0.80
Knox	78.0	0.24	Somervell	-	-
Lamar	208.3	0.70	Starr	115.1	0.37
Lamb	-	-	Stephens	-	-
Lampasas	-	-	Sterling	-	-
La Salle	10.2	0.03	Stonewall	-	-
Lavaca	-	-	Sutton	-	-
Lee	-	-	Swisher	-	-
Leon	27.5	0.08	Tarrant	3,536.6	10.59
Liberty	-	-	Taylor	432.4	1.26
Limestone	16.4	0.05	Terrell	-	-
Lipscomb	-	-	Terry	-	-
Live Oak	-	-	Throckmorton	-	-
Llano	-	-	Titus	-	-
Loving	-	-	Tom Green	950.1	2.75
Lubbock	-	-	Travis	141,332.7	465.62
Lynn	-	-	Trinity	15.1	0.05
McCulloch	-	-	Tyler	24.6	0.08
McLennan	1,009.6	3.08	Upshur	9.0	0.03
McMullen	-	-	Upton	-	-
Madison	-	-	Uvalde	11.7	0.04
Marion	-	-	Val Verde	22.0	0.07
Martin	-	-	Van Zandt	39.6	0.13
Mason	-	-	Victoria	8.8	0.03
Matagorda	62.2	0.18	Walker	32.0	0.10
Maverick	109.1	0.33	Waller	13.8	0.04
Medina	2,093.4	6.99	Ward	-	-
Menard	-	-	Washington	-	-
Midland	174.9	0.50	Webb	2,106.4	6.47
Milam	-	-	Wharton	10.5	0.03
Mills	-	-	Wheeler	-	-
Mitchell	-	-	Wichita	410.7	1.22
Montague	6.6	0.02	Wilbarger	134.3	0.40
Montgomery	261.8	0.78	Willacy	38.6	0.12
Moore	-	-	Williamson	876.4	2.90
Morris	23.4	0.08	Wilson	51.7	0.16
Motley	-	-	Winkler	2.3	0.01
Nacogdoches	-	-	Wise	-	-
Navarro	31.0	0.09	Wood	15.4	0.05
Newton	-	-	Yoakum	-	-
Nolan	18.1	0.05	Young	16.0	0.05
Nueces	948.9	3.00	Zapata	-	-
Ochiltree	-	-	Zavala	-	-

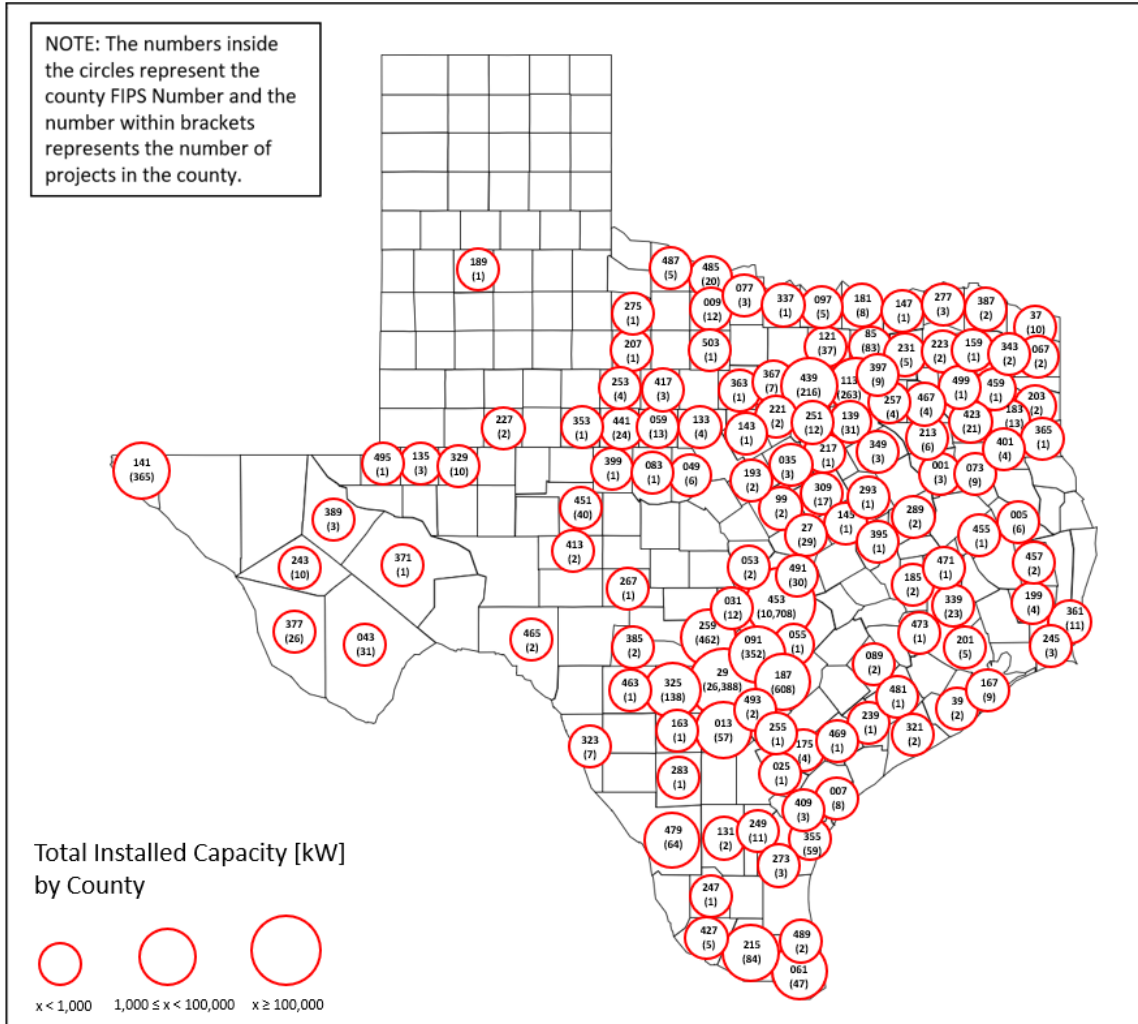


Figure 6-2: Map of Non-Utility Solar PV Projects Installed in Each County of Texas through 2021

Table 6-2: Texas Non-Utility Solar Photovoltaic Projects up to 2021

County	FIPS Code	No. of Projects	Total Installed Capacity (kW)	County	FIPS Code	No. of Projects	Total Installed Capacity (kW)
Anderson	001	3	21	Cottle	101	0	0
Andrews	003	0	0	Crane	103	0	0
Angelina	005	6	62	Crockett	105	0	0
Aransas	007	8	64	Crosby	107	0	0
Archer	009	12	142	Culberson	109	0	0
Armstrong	011	0	0	Dallam	111	0	0
Atascosa	013	57	1,025	Dallas	113	263	3,161
Austin	015	0	0	Dawson	115	0	0
Bailey	017	0	0	Deaf Smith	117	0	0
Bandera	019	0	0	Delta	119	0	0
Bastrop	021	0	0	Denton	121	37	445
Baylor	023	0	0	De Witt	123	0	0
Bee	025	1	3	Dickens	125	0	0
Bell	027	29	282	Dimmit	127	0	0
Bexar	029	26,388	247,086	Donley	129	0	0
Blanco	031	12	211	Duval	131	2	18
Borden	033	0	0	Eastland	133	4	21
Bosque	035	3	25	Ector	135	3	38
Bowie	037	10	130	Edwards	137	0	0
Brazoria	039	2	12	Ellis	139	31	2,909
Brazos	041	0	0	El Paso	141	365	2,909
Brewster	043	31	207	Erath	143	1	11
Briscoe	045	0	0	Falls	145	1	6
Brooks	047	0	0	Fannin	147	1	10
Brown	049	6	56	Fayette	149	0	0
Burleson	051	0	0	Fisher	151	0	0
Burnet	053	2	11	Floyd	153	0	0
Caldwell	055	1	9	Foard	155	0	0
Calhoun	057	0	0	Fort Bend	157	0	0
Callahan	059	13	133	Franklin	159	1	4
Cameron	061	47	1,181	Freestone	161	0	0
Camp	063	0	0	Frio	163	1	5
Carson	065	0	0	Gaines	165	0	0
Cass	067	2	32	Galveston	167	9	77
Castro	069	0	0	Garza	169	0	0
Chambers	071	0	0	Gillespie	171	0	0
Cherokee	073	9	69	Glasscock	173	0	0
Childress	075	0	0	Goliad	175	4	29
Clay	077	3	31	Gonzales	177	0	0
Cochran	079	0	0	Gray	179	0	0
Coke	081	0	0	Grayson	181	8	88
Coleman	083	1	11	Gregg	183	13	219
Collin	085	83	714	Grimes	185	2	14
Collingsworth	087	0	0	Guadalupe	187	608	6,145
Colorado	089	2	26	Hale	189	1	13
Comal	091	352	3,532	Hall	191	0	0
Comanche	093	0	0	Hamilton	193	2	13
Concho	095	0	0	Hansford	195	0	0
Cooke	097	5	82	Hardeman	197	0	0
Coryell	099	2	10	Hardin	199	4	21

Table 6-2: Texas Non-Utility Solar Photovoltaic Projects up to 2021 (Continued)

County	FIPS Code	No. of Projects	Total Installed Capacity (kW)	County	FIPS Code	No. of Projects	Total Installed Capacity (kW)
Harris	201	5	24	Loving	301	0	0
Harrison	203	2	16	Lubbock	303	0	0
Hartley	205	0	0	Lynn	305	0	0
Haskell	207	1	10	McCulloch	307	0	70
Hays	209	0	0	McLennan	309	17	70
Hemphill	211	0	0	McMullen	311	0	70
Henderson	213	6	45	Madison	313	0	0
Hidalgo	215	84	2,648	Marion	315	0	0
Hill	217	1	2	Martin	317	0	0
Hockley	219	0	0	Mason	319	0	0
Hood	221	2	13	Matagorda	321	2	45
Hopkins	223	2	276	Maverick	323	7	70
Houston	225	0	0	Medina	325	138	1,458
Howard	227	2	194	Menard	327	0	0
Hudspeth	229	0	0	Midland	329	10	93
Hunt	231	5	44	Milam	331	0	0
Hutchinson	233	0	0	Mills	333	0	0
Irion	235	0	0	Mitchell	335	0	0
Jack	237	0	0	Montague	337	1	4
Jackson	239	1	10	Montgomery	339	23	184
Jasper	241	0	0	Moore	341	0	0
Jeff Davis	243	10	63	Morris	343	2	16
Jefferson	245	3	30	Motley	345	0	0
Jim Hogg	247	1	4	Nacogdoches	347	0	0
Jim Wells	249	11	412	Navarro	349	3	19
Johnson	251	12	86	Newton	351	0	0
Jones	253	4	42	Nolan	353	1	10
Karnes	255	1	8	Nueces	355	59	672
Kaufman	257	4	28	Ochiltree	357	0	0
Kendall	259	462	4,333	Oldham	359	0	0
Kenedy	261	0	0	Orange	361	11	86
Kent	263	0	0	Palo Pinto	363	1	5
Kerr	265	0	0	Panola	365	1	22
Kimble	267	1	47	Parker	367	7	51
King	269	0	0	Parker	367	7	51
Kinney	271	0	0	Parker	367	7	51
Kleberg	273	3	31	Parker	367	7	51
Knox	275	1	46	Parker	367	7	51
Lamar	277	3	135	Parker	367	7	51
Lamb	279	0	0	Parmer	369	0	0
Lampasas	281	0	0	Pecos	371	1	23
La Salle	283	1	46	Polk	373	0	0
Lavaca	285	0	0	Potter	375	0	0
Lee	287	0	0	Presidio	377	26	269
Leon	289	2	20	Rains	379	0	0
Liberty	291	0	0	Randall	381	0	0
Limestone	293	1	10	Reagan	383	0	0
Lipscomb	295	0	0	Real	385	2	24
Live Oak	297	0	0	Red River	387	2	45
Llano	299	0	0	Reeves	389	3	55
				Refugio	391	0	0
				Roberts	393	0	0
				Robertson	395	1	5
				Rockwall	397	9	62
				Runnels	399	1	9

Table 6-2: Texas Non-Utility Solar Photovoltaic Projects up to 2021 (Continued)

County	FIPS Code	No. of Projects	Total Installed Capacity (kW)	County	FIPS Code	No. of Projects	Total Installed Capacity (kW)
Rusk	401	4	27	Trinity	455	1	10
Sabine	403	0	0	Tyler	457	2	16
San Augustine	405	0	0	Upshur	459	1	6
San Jacinto	407	0	0	Upton	461	0	0
San Patricio	409	3	26	Uvalde	463	1	8
San Saba	411	0	0	Val Verde	465	2	15
Schleicher	413	2	20	Van Zandt	467	4	27
Scurry	415	0	0	Victoria	469	1	6
Shackelford	417	3	35	Walker	471	1	23
Shelby	419	0	0	Waller	473	1	10
Sherman	421	0	0	Ward	475	0	0
Smith	423	21	175	Washington	477	0	0
Somervell	425	0	0	Webb	479	64	1,345
Starr	427	5	79	Wharton	481	1	8
Stephens	429	0	0	Wheeler	483	0	0
Sterling	431	0	0	Wichita	485	20	239
Stonewall	433	0	0	Wilbarger	487	5	78
Sutton	435	0	0	Willacy	489	2	27
Swisher	437	0	0	Williamson	491	30	547
Tarrant	439	216	2,123	Wilson	493	2	32
Taylor	441	24	242	Winkler	495	1	1
Terrell	443	0	0	Wise	497	0	0
Terry	445	0	0	Wood	499	1	10
Throckmorton	447	0	0	Yoakum	501	0	0
Titus	449	0	0	Young	503	1	10
Tom Green	451	40	531	Zapata	505	0	0
Travis	453	10,708	100,097	Zavala	507	0	0

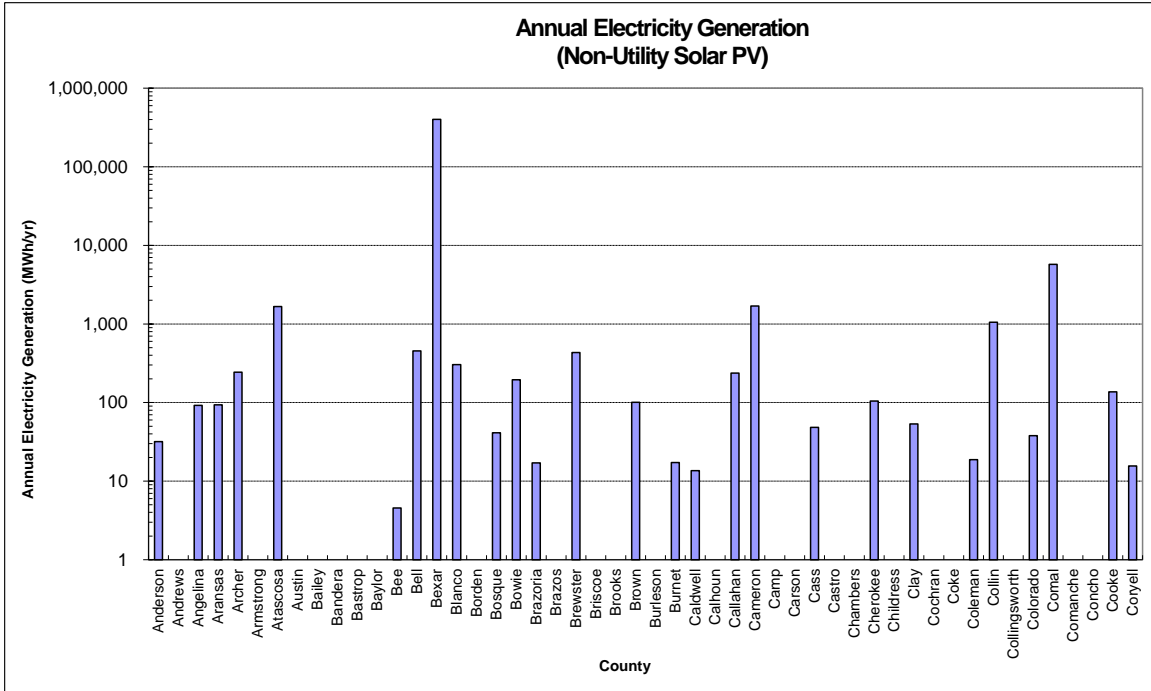


Figure 6-3: Annual Electricity Generation per County from Solar Photovoltaic Projects through 2021

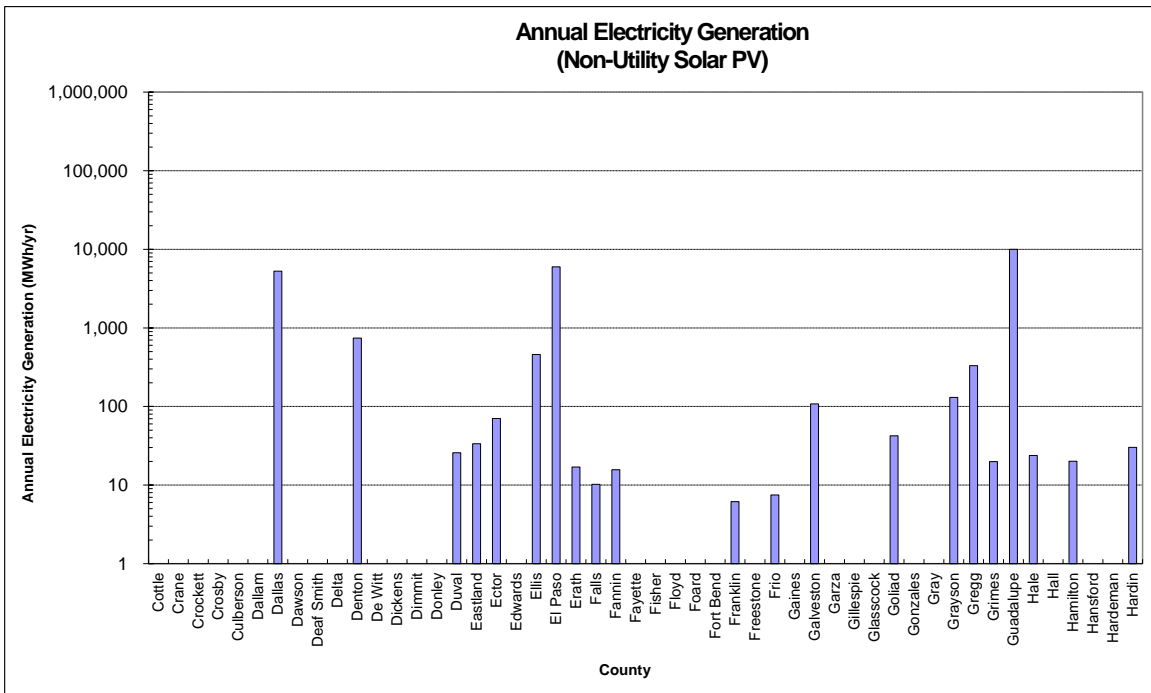


Figure 6-3: Annual Electricity Generation per County from Solar Photovoltaic Projects through 2021 (Continued)

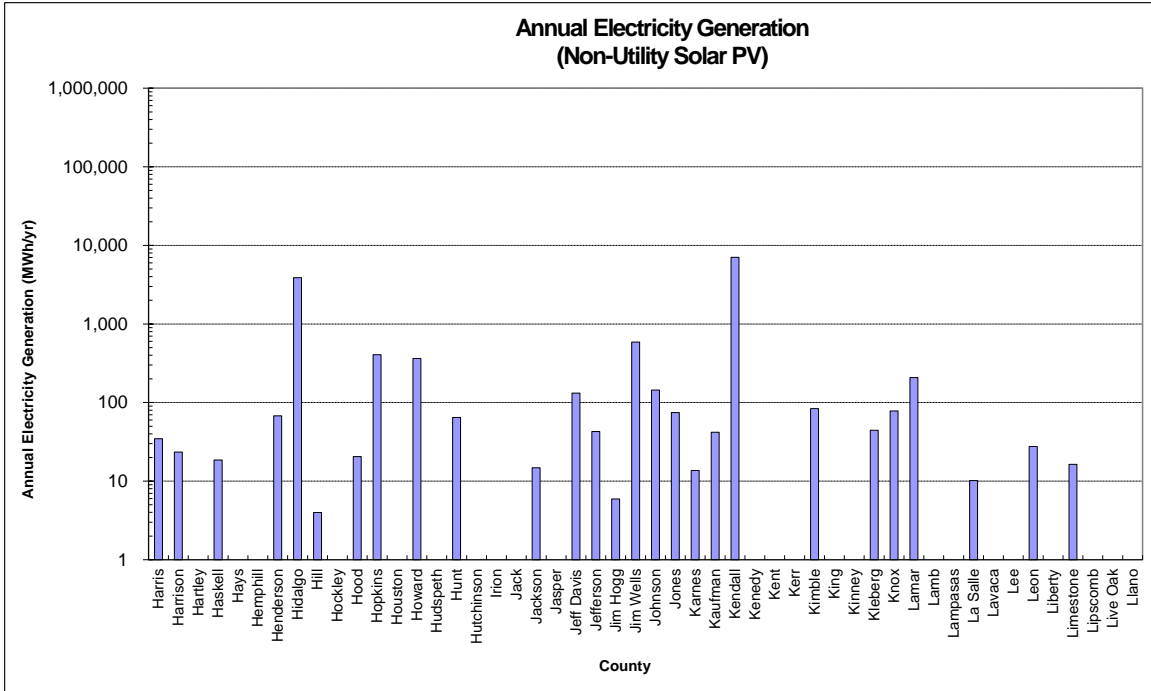


Figure 6-3: Annual Electricity Generation per County from Solar Photovoltaic Projects through 2021 (Continued)

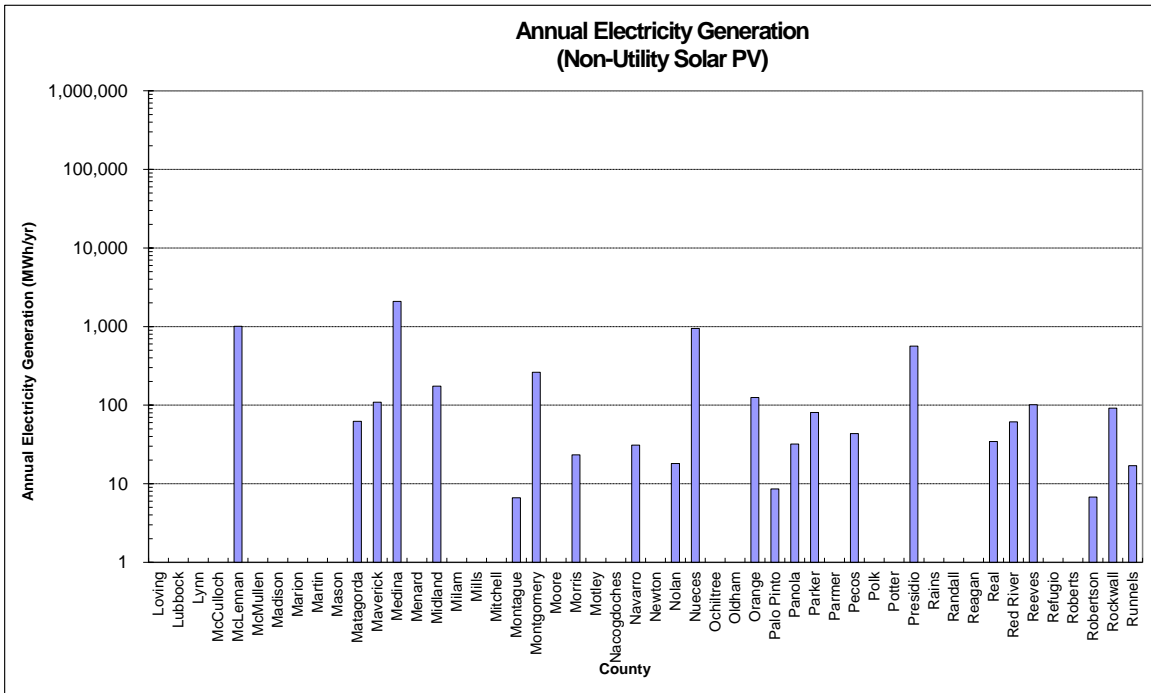


Figure 6-3: Annual Electricity Generation per County from Solar Photovoltaic Projects through 2021 (Continued)

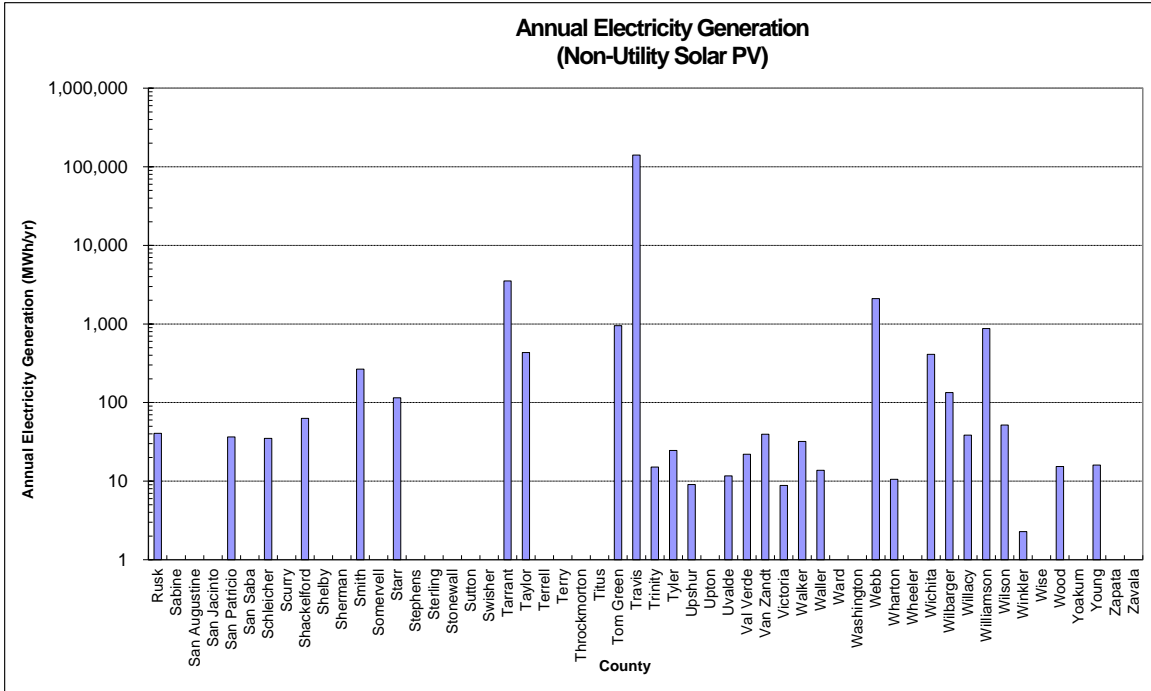
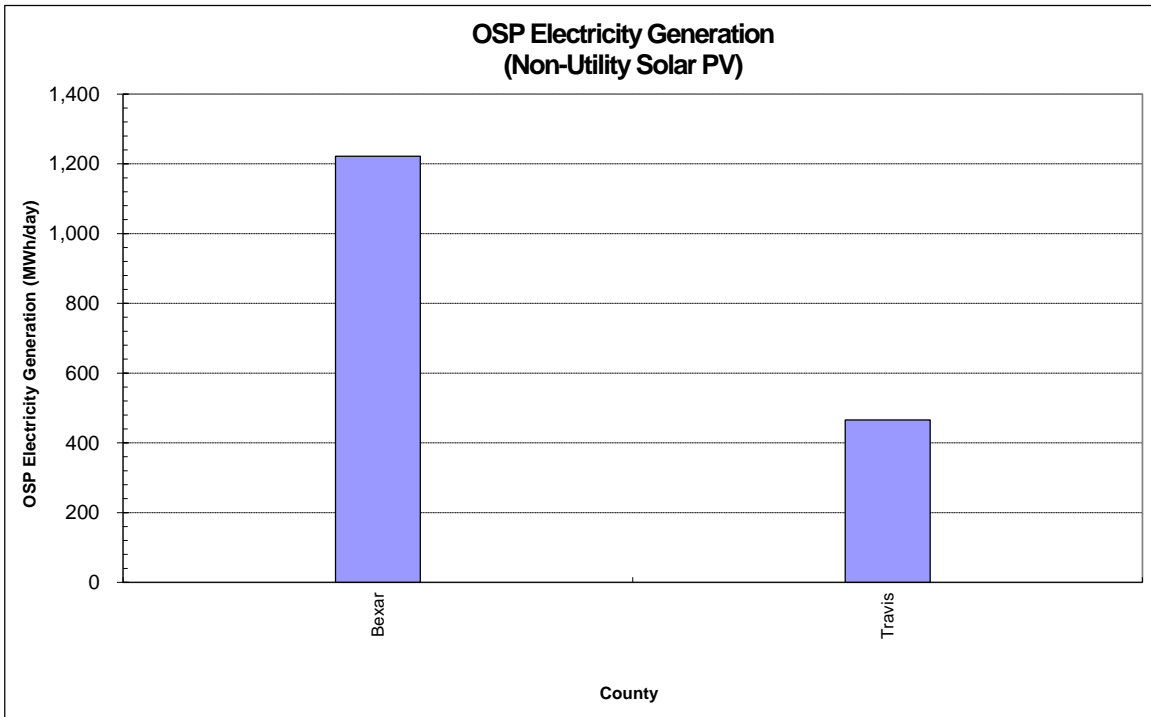


Figure 6-3: Annual Electricity Generation per County from Solar Photovoltaic Projects through 2021 (Continued)



Note: OSP electricity generation for Bexar and Travis counties are shown separately in Figure 6-4 due to the generation scale.

Figure 6-4: OSP Electricity Generation per County from Solar Photovoltaic Projects through 2021

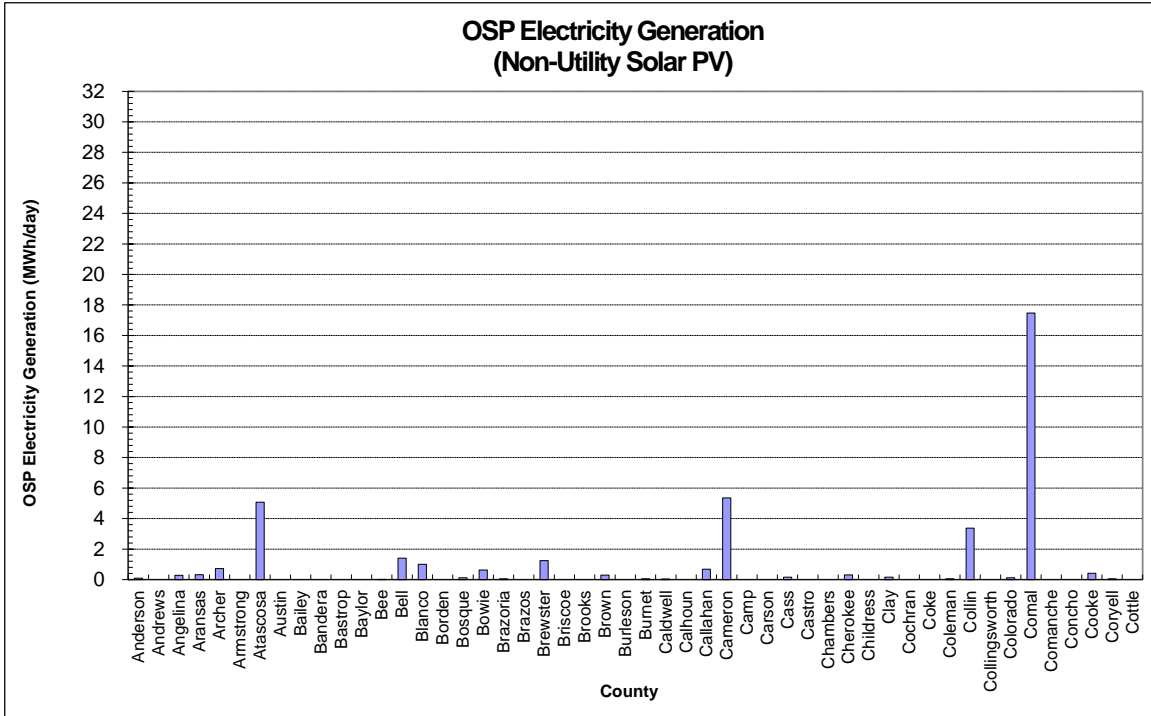


Figure 6-4: OSP Electricity Generation per County from Solar Photovoltaic Projects through 2021 (Continued)

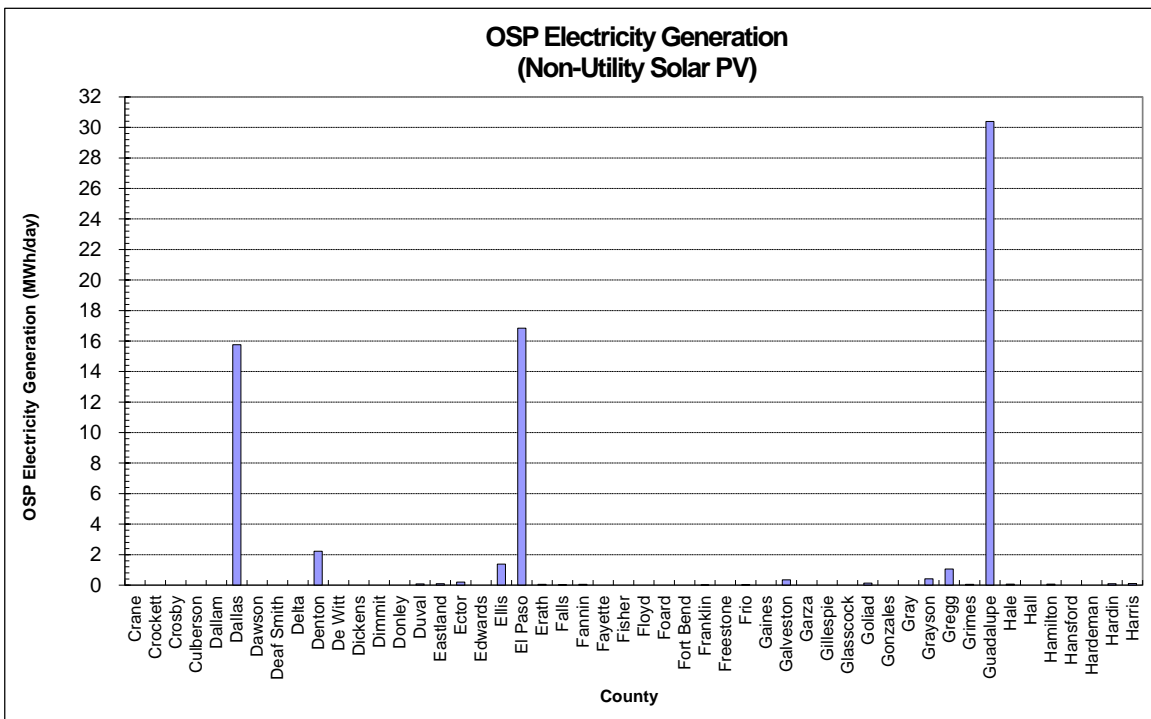


Figure 6-4: OSP Electricity Generation per County from Solar Photovoltaic Projects through 2021 (Continued)

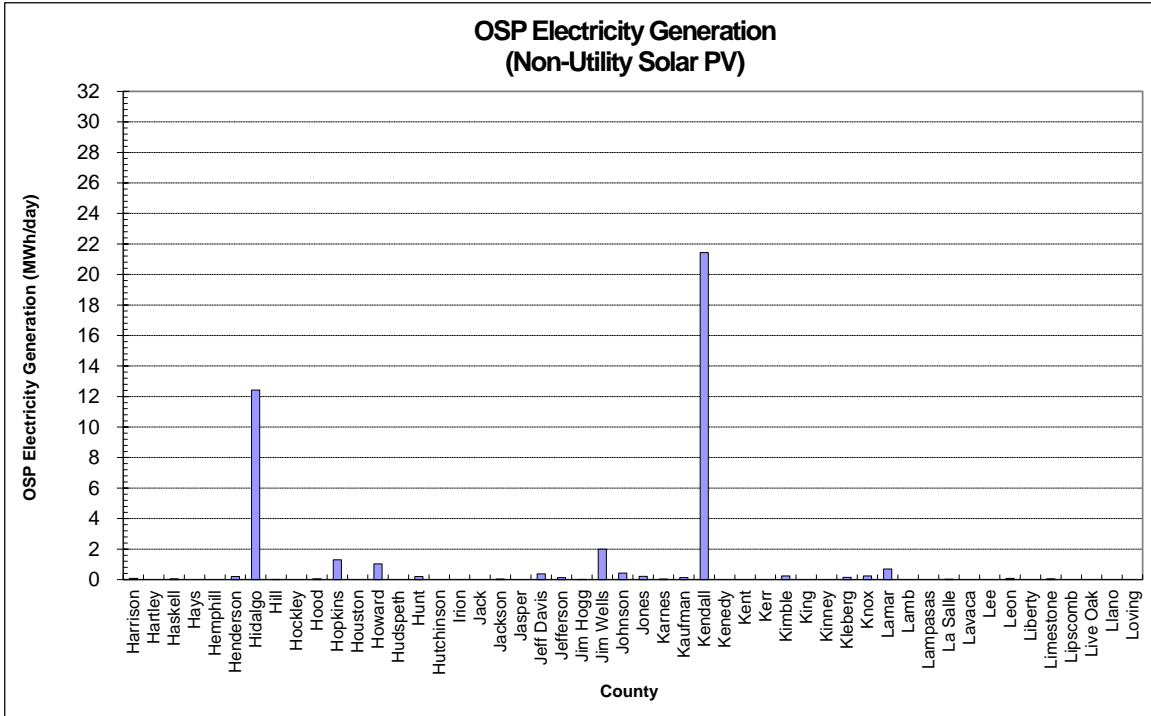


Figure 6-4: OSP Electricity Generation per County from Solar Photovoltaic Projects through 2021 (Continued)

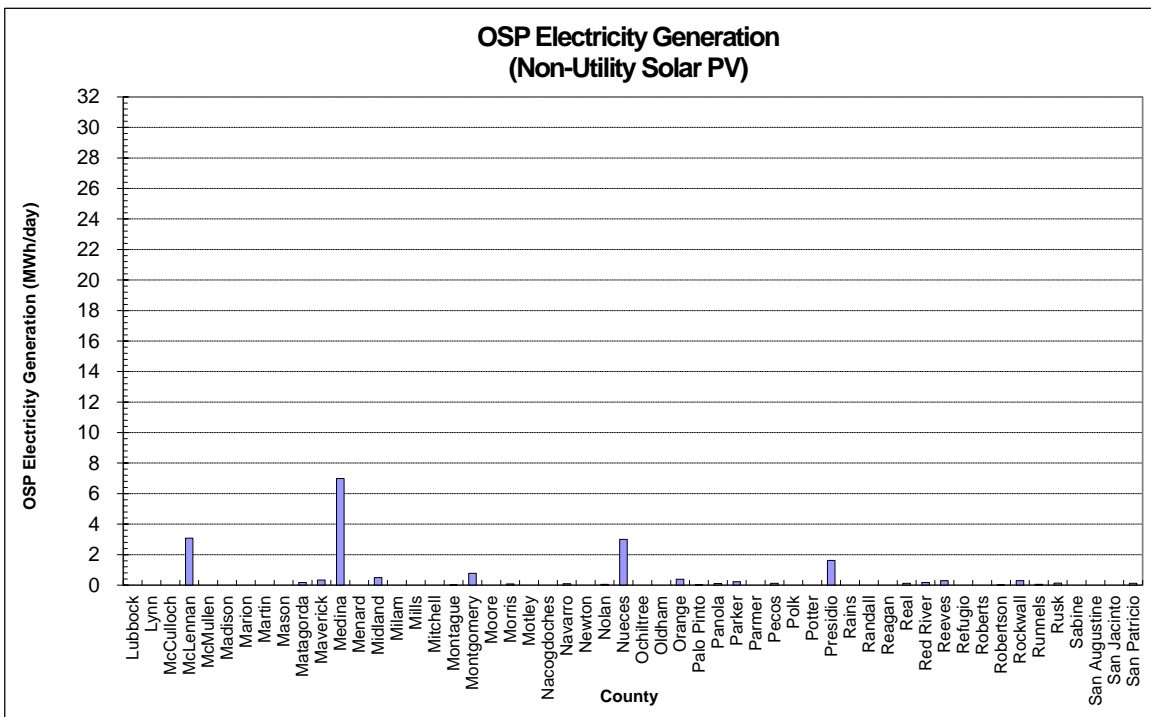


Figure 6-4: OSP Electricity Generation per County from Solar Photovoltaic Projects through 2021 (Continued)

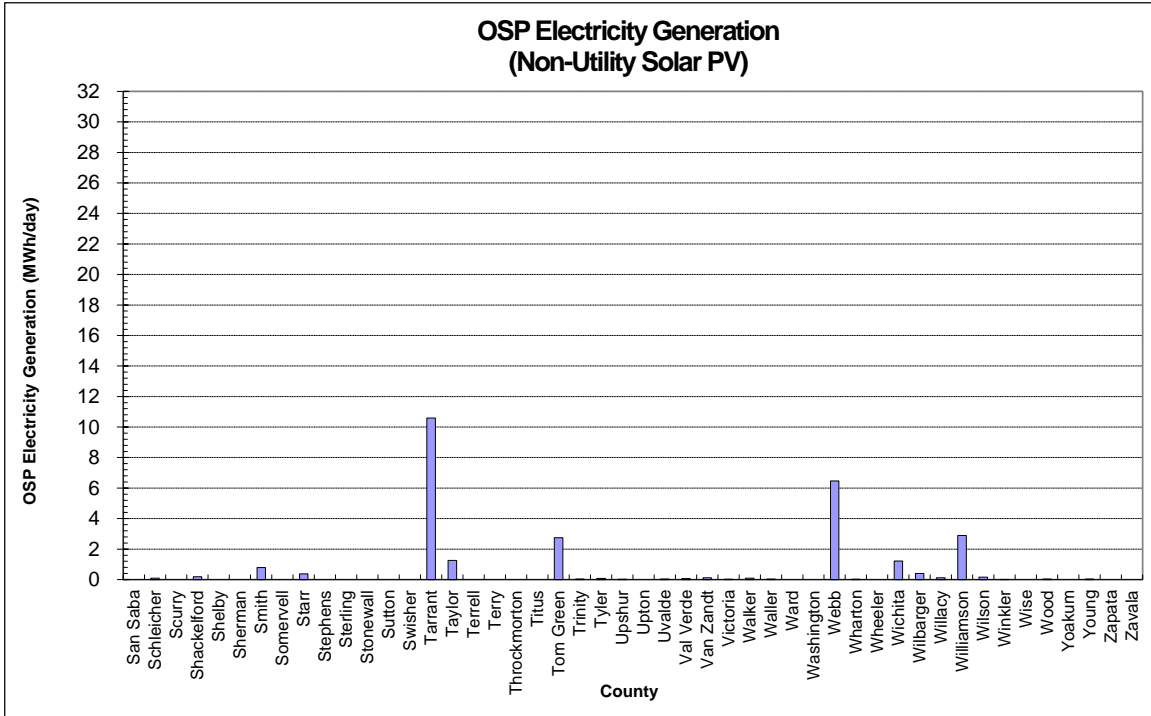


Figure 6-4: OSP Electricity Generation per County from Solar Photovoltaic Projects through 2021 (Continued)

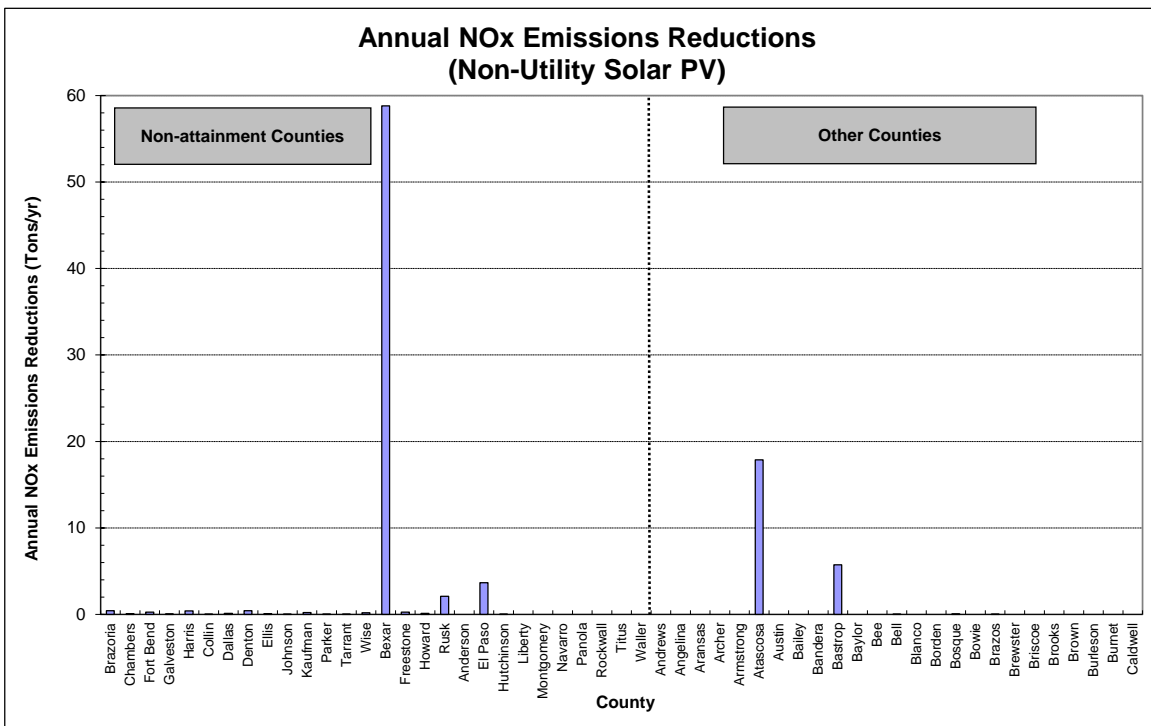


Figure 6-5: NOx Emissions Reductions per County from Solar Photovoltaic Projects through 2021

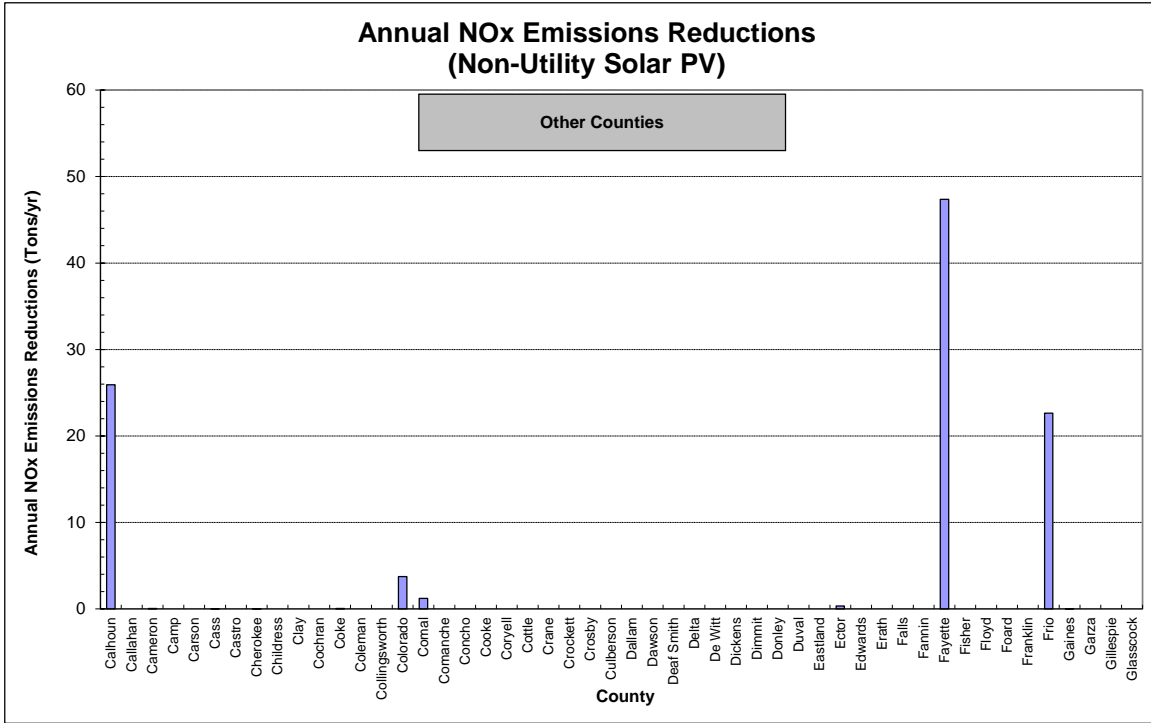


Figure 6-5: NOx Emissions Reductions per County from Solar Photovoltaic Projects through 2021 (Continued)

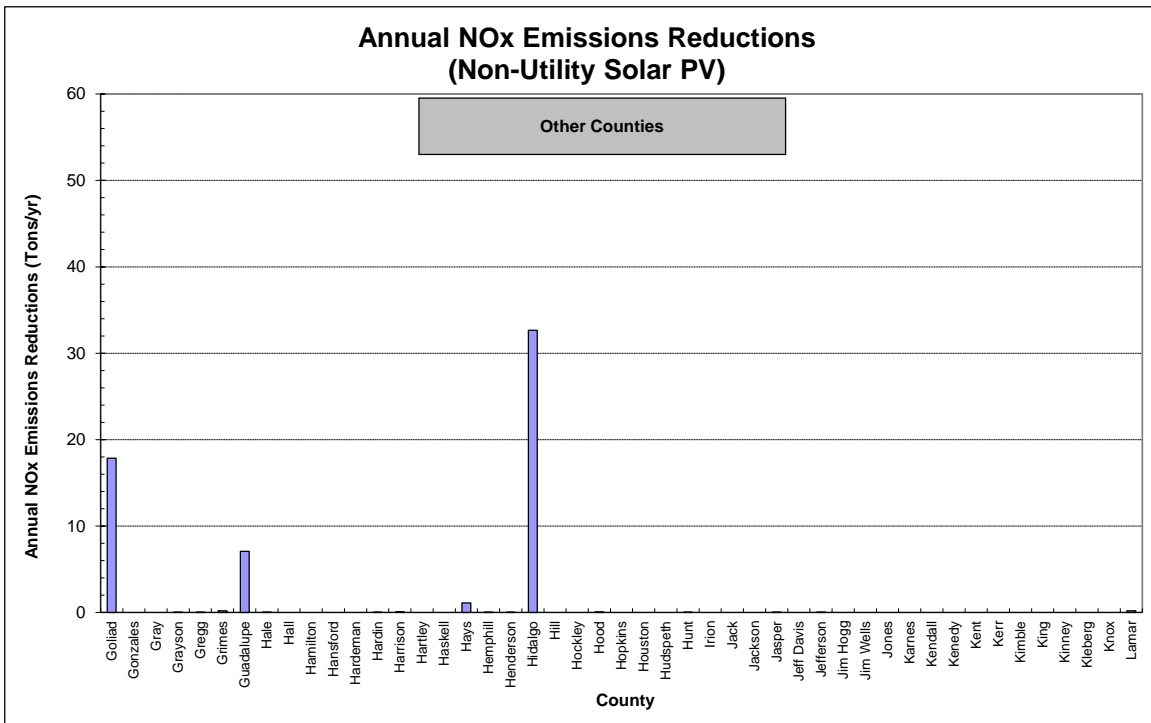


Figure 6-5: NOx Emissions Reductions per County from Solar Photovoltaic Projects through 2021 (Continued)

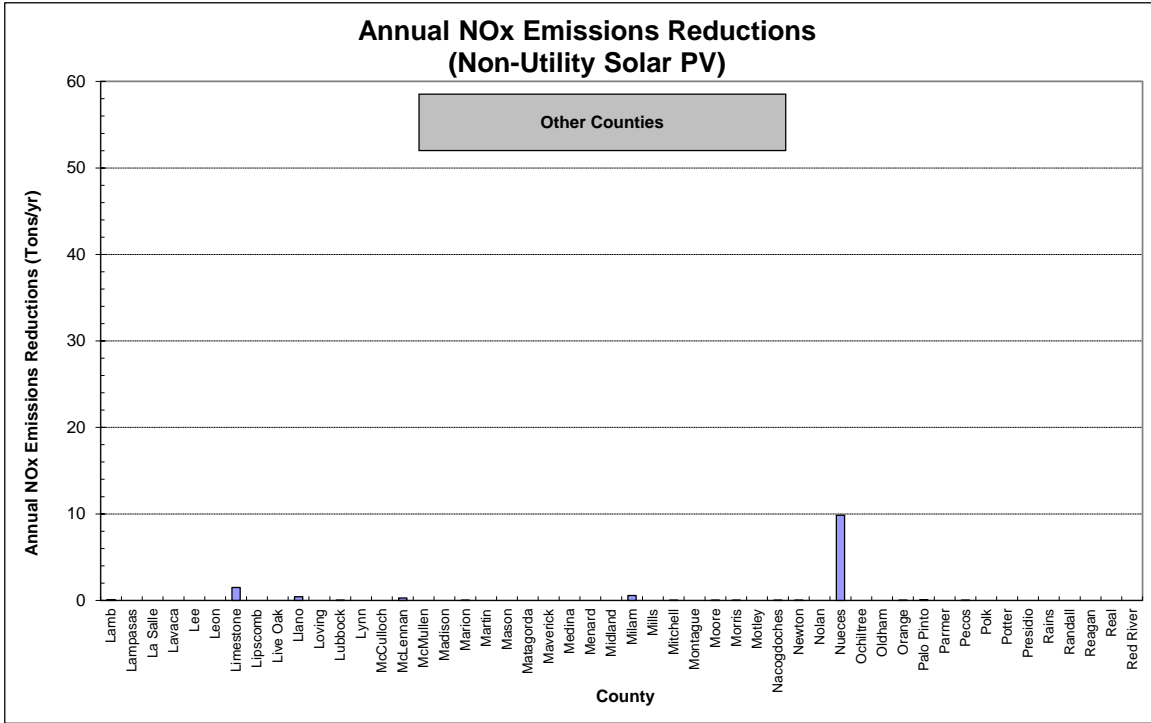


Figure 6-5: NOx Emissions Reductions per County from Solar Photovoltaic Projects through 2021 (Continued)

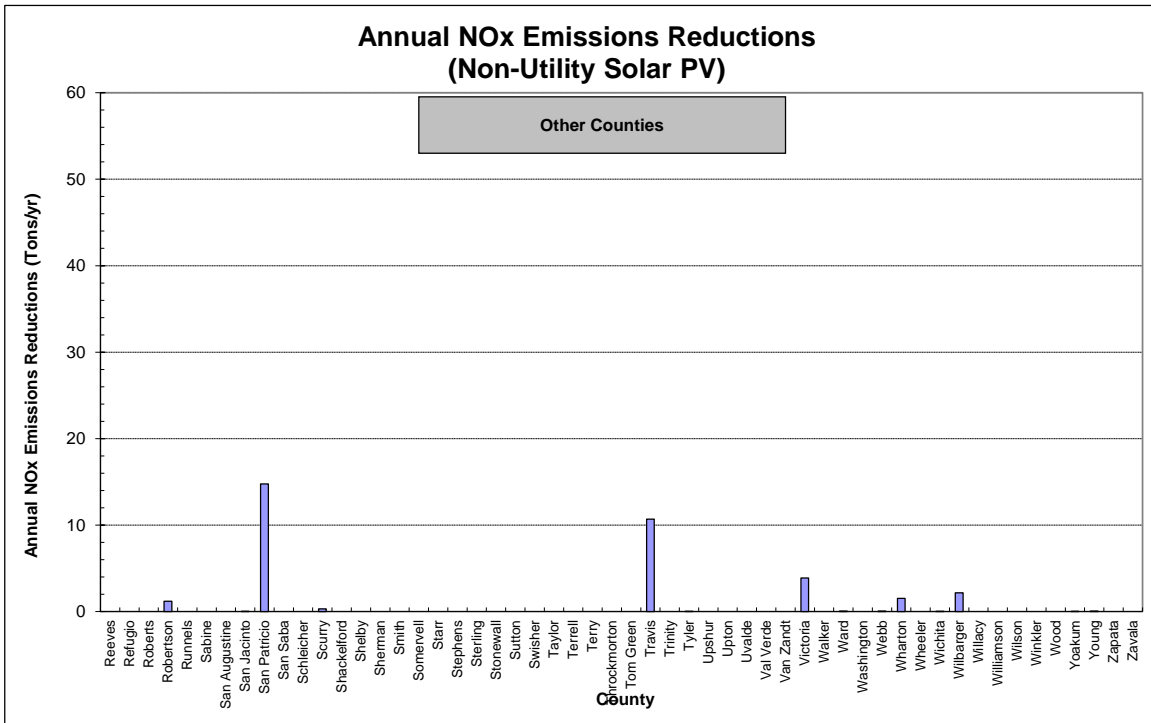


Figure 6-5: NOx Emissions Reductions per County from Solar Photovoltaic Projects through 2021 (Continued)

6.2.1.1 Solar Power

This section includes only solar power plant projects (i.e., utility-scale) in Texas. The data from one-hundred seventeen solar power plants identified in the State of Texas were obtained. Table 6-3 shows the list of solar power plant projects with their names, respective county, year commissioned, the forecast zone they serve, installed capacity and total electricity produced for the year 2021. Figure 6-6 shows the annual electricity generation of solar power plant projects. Figure 6-7 shows the map of the number of solar power plants for each county. In addition, Table 6-4 provides detailed information about Figure 6-7, including: county name, FIPS code, number of solar power plants and total installed capacity for each county. The total electricity generated for the year 2021 from all of the projects was 15,562,995 MWh/year.

The annual electric savings per county, which were estimated from these projects, are presented in Figure 6-8. In addition, the OSP electric savings per county, which were estimated from these projects, are presented in Figure 6-9. The corresponding annual NOx emission reductions are shown in Figure 6-10.

The hourly and daily total electricity generation profiles of different solar power projects are shown in Volume II, Appendix C. Figure 6-11 shows an example of the hourly electricity generation profile. Figure 6-12 shows an example of the daily total generation profile.

Table 6-3: Solar Power Plant Projects in the State of Texas through 2021

No	Name of the Project	County	Year Commissioned	ERCOT Zone	Installed Capacity* (MW _{AC})	Annual Power Generated in 2021** (MWh/year)	Daily Average Power Generated in 2021 OSP (MWh/day)
1	ACACIA_UNIT_1	Presidio	2012	West	10.0	24,568	74
2	ALEXIS_ALEXIS	Brooks	2019	South	10.0	8,495	27
3	ANSON1_UNIT1	Jones	2021	West	100.0	232,644	792
4	ANSON1_UNIT2	Jones	2021	West	100.0	219,778	752
5	ARAGORN_UNIT1	Culberson	2021	West	185.0	29,982	0
6	AZURE_SOLAR1	Haskell	2021	West	74.9	74,082	282
7	AZURE_SOLAR2	Haskell	2021	West	153.5	163,972	603
8	BOOTLEG_UNIT1	Pecos	2017	West	121.1	285,319	929
9	BOVINE_BOVINE	Austin	2018	South	5.0	8,186	25
10	BOVINE2_BOVINE2	Austin	2018	South	5.0	7,437	21
11	BRIGHTSD_UNIT1	Bee	2021	South	50.0	3,490	0
12	BRNSN_BRNSN	Fort Bend	2018	Houston	5.0	8,004	25
13	BRNSN2_BRNSN2	Fort Bend	2018	Houston	5.0	8,255	27
14	CAPRIDG4_BB_PV	Sterling	2019	West	30.0	69,208	252
15	CAPRIDG4_BB2_PV1	Sterling	2021	West	100.0	244,354	863
16	CAPRIDG4_BB2_PV2	Sterling	2021	West	15.0	36,071	127
17	CASCADE_CASCADE	Wharton	2018	South	5.0	9,086	31
18	CASCADE2_CASCADE2	Wharton	2018	South	5.0	9,177	30
19	CASL_GAP_UNIT1	Upton	2018	West	180.0	445,196	1,479
20	CECSOLAR_DG_BECK1	Bexar	2016	South	1.0	1,797	6
21	CHISUM_CHISUM	Lamar	2018	North	10.0	16,262	55
22	CONIGLIO_UNIT1	Fannin	2021	North	125.7	141,834	609
23	CORAZON_UNIT1	Webb	2021	South	202.6	171,312	578
24	COSEVRSS_CSS1	Denton	2015	North	2.0	2,948	8
25	CS10_CATAN	Karnes	2020	South	10.0	23,339	77
26	DG_BROOK_1UNIT	Bexar	2010	South	7.6	9,830	31
27	DG_ELMEN_1UNIT	Bexar	2010	South	7.3	11,060	35
28	DG_SOME1_1UNIT	Bexar	2012	South	5.6	6,753	20
29	DG_SOME2_1UNIT	Bexar	2012	South	5.0	6,145	20
30	DG_STHWG_UNIT1	Bexar	2014	South	4.4	8,019	26
31	DG_VALL1_1UNIT	Bexar	2012	South	9.9	11,839	37
32	DG_VALL2_1UNIT	Bexar	2012	South	9.9	12,407	39
33	DG_WALZM_UNIT1	Bexar	2014	South	5.5	10,703	34
34	DG_WHITNEY_SOLAR1	Bosque	2017	North	10.0	19,397	73
35	E_BLACK_UNIT_1	Travis	2021	South	144.0	193,287	869
36	ECLIPSE_UNIT1	Kinney	2014	South	37.6	62,339	226
37	EDDYII_EDDYII	McLennan	2018	North	10.0	16,186	55
38	ELARA_SL_UNIT1	Frio	2021	South	132.4	38,913	0
39	EUNICE_PV1	Andrews	2021	West	189.6	324,695	1,255
40	EUNICE_PV2	Andrews	2021	West	237.1	392,833	1,552
41	FIFTHGS1_FGSOLAR1	Travis	2016	South	1.6	4,399	11
42	FWLR_SLR_UNIT1	Crane	2020	West	150.0	382,650	1,343
43	GALLOWAY_SOLAR1	Concho	2021	West	257.0	247,769	868
44	GREASWOD_UNIT1	Pecos	2021	West	124.6	284,768	958
45	GREASWOD_UNIT2	Pecos	2021	West	130.4	302,059	999
46	GRIFFIN_GRIFFIN	McLennan	2019	North	5.0	8,947	28
47	HELIOS_UNIT1	Uvalde	2015	South	100.0	198,330	651
48	HOLSTEIN_SOLAR1	Nolan	2020	West	102.2	211,333	749
49	HOLSTEIN_SOLAR2	Nolan	2020	West	102.3	213,542	767
50	HOVEY_UNIT1	Pecos	2015	West	22.0	42,307	137

* Capacity, Demand and Reserves Report May 2022.xls from the webpage of the ERCOT (<http://www.ercot.com/gridinfo/resource/index.html>)

** 2021 ERCOT solar power 15-min generation data

Table 6-3: Solar Power Plant Projects in the State of Texas through 2021 (Continued)

No	Name of the Project	County	Year Commissioned	ERCOT Zone	Installed Capacity* (MW _{AC})	Annual Power Generated in 2021** (MWh/year)	Daily Average Power Generated in 2021 OSP (MWh/day)
51	HOVEY_UNIT2	Pecos	2020	West	7.4	15,792	44
52	HWY56_HWY56	Grayson	2017	North	5.3	7,178	24
53	IMPACT_UNIT1	Lamar	2021	North	198.5	270,708	975
54	JUNO_UNIT1	Borden	2021	West	162.1	333,681	1,307
55	JUNO_UNIT2	Borden	2021	West	143.5	204,112	853
56	KELAM_SL_UNIT1	Van Zandt	2020	North	59.8	126,925	436
57	LAMPWICK_LAMPWICK	Menard	2019	West	7.5	17,742	57
58	LAPETUS_UNIT_1	Andrews	2020	West	100.7	219,952	776
59	LASSO_UNIT1	Brewster	2018	West	50.0	118,163	358
60	LEON_LEON	Hunt	2017	North	10.0	15,793	50
61	LGDRAW_S_UNIT1_1	Borden	2021	West	98.5	227,830	764
62	LGDRAW_S_UNIT1_2	Borden	2021	West	128.3	300,774	991
63	LILY_SOLAR1	Kaufman	2021	North	147.6	213,883	959
64	LMESASLR_IVORY	Dawson	2018	West	50.0	110,237	356
65	LMESASLR_UNIT1	Dawson	2018	West	101.6	210,569	751
66	MARLIN_MARLIN	Falls	2017	North	5.3	9,863	33
67	MARS_MARS	Webb	2019	South	10.0	24,753	84
68	MISAE_UNIT1	Childress	2021	North	121.4	240,963	925
69	MISAE_UNIT2	Childress	2021	North	118.6	233,250	903
70	NGNSVL_NGAINESV	Cooke	2017	North	5.2	6,835	22
71	OBERON_UNIT_1_J01	Ector	2020	West	180.0	338,165	1,216
72	OBERON_UNIT_1_J02	Ector	N/A	West	N/A	63,129	229
73	OCL_ALM1_UNIT1	Bexar	2013	South	39.2	84,459	281
74	OXYSOLAR_SOLAR_1	Ector	N/A	West	16.8	7,177	25
75	PCOMM_1UNIT	N/A	N/A	N/A	N/A	2,114	8
76	PFK_PFKPV	Travis	2017	South	2.6	3,922	12
77	PHOEBE_UNIT1	Winkler	2019	West	125.1	270,228	1,010
78	PHOEBE_UNIT2	Winkler	2019	West	128.1	288,299	1,035
79	PHOENIX_UNIT1	Fannin	2021	North	83.9	117,428	525
80	PROSPERO_UNIT1	Andrews	2020	West	153.6	330,235	1,148
81	PROSPERO_UNIT2	Andrews	2020	West	150.0	327,963	1,141
82	PRSPERO2_UNIT1	Andrews	2021	West	126.5	173,544	1,148
83	PRSPERO2_UNIT2	Andrews	2021	West	126.4	205,275	1,141
84	QUEEN_SL_SOLAR1	Upton	2020	West	102.5	233,984	769
85	QUEEN_SL_SOLAR2	Upton	2020	West	102.5	243,761	801
86	QUEEN_SL_SOLAR3	Upton	2020	West	97.5	242,744	825
87	QUEEN_SL_SOLAR4	Upton	2020	West	107.5	264,195	896
88	RAMBLER_UNIT1	Tom Green	2020	West	200.0	426,501	1,557
89	REDBARN_UNIT_1	Pecos	2021	West	222.0	233,988	889
90	REDBARN_UNIT_2	Pecos	2021	West	28.0	45,598	198
91	REROCK_UNIT1	Pecos	2016	West	78.8	177,782	584
92	REROCK_UNIT2	Pecos	2016	West	78.8	170,684	558
93	RIGGINS_UNIT1	Pecos	2018	West	150.0	327,719	1,181
94	RIPPEY_UNIT1	Cooke	2020	North	59.8	130,351	448
95	SEALY_1UNIT	Austin	2015	South	1.6	1,385	6
96	SIRIUS_UNIT1	Pecos	2017	West	110.2	214,725	719
97	SIRIUS_UNIT2	Pecos	2017	West	49.1	94,383	333
98	SOLARA_UNIT1	Haskell	2016	West	112.0	242,778	773
99	SPTX12B_UNIT1	Upton	2017	West	157.5	355,949	1,282
100	STRATEGC_UNIT1	Ellis	2021	North	136.8	37,812	0

* Capacity, Demand and Reserves Report May 2022.xls from the webpage of the ERCOT (<http://www.ercot.com/gridinfo/resource/index.html>)

** 2021 ERCOT solar power 15-min generation data

Table 6-3: Solar Power Plant Projects in the State of Texas through 2021 (Continued)

No	Name of the Project	County	Year Commissioned	ERCOT Zone	Installed Capacity* (MW _{AC})	Annual Power Generated in 2021** (MWh/year)	Daily Average Power Generated in 2021 OSP (MWh/day)
101	STRLING_STRLING	Hunt	2018	North	10.0	14,290	53
102	TAYGETE_UNIT1	Pecos	2021	West	125.9	271,700	918
103	TAYGETE_UNIT2	Pecos	2021	West	128.9	304,781	1,058
104	TI_SOLAR_UNIT1	Culberson	2021	West	136.8	52,046	78
105	TI_SOLAR_UNIT2	Culberson	2021	West	131.1	96,638	248
106	VISION_UNIT1	Navarro	2021	North	129.2	30,424	0
107	W_PECOS_UNIT1	Reeves	2019	West	100.0	251,609	838
108	WAYMARK_UNIT1	Upton	2018	West	182.0	354,555	1,231
109	WBORO_WHTSBORO	Grayson	2017	North	5.0	8,919	29
110	WBOROII_WHBOROII	Grayson	2017	North	5.0	8,199	29
111	WEBBER_S_WSP1	Travis	2011	South	26.7	55,044	177
112	WGU_UNIT1	Brazoria	2021	Houston	120.0	233,415	766
113	WHTRT_WHTRGHT	Fannin	2017	North	10.0	16,888	56
114	WLNTSPRG_1UNIT	Bosque	2016	North	10.0	10,960	36
115	WMOOREII_WMOOREII	Grayson	2018	North	5.0	7,418	25
116	X443PV1_SWRI_PV1	Bexar	2019	South	5.0	5,483	18
117	YLWJACKET_YLWJACKET	Bosque	2018	North	5.0	10,041	33
Total					8,916	15,562,995	55,457

* Capacity, Demand and Reserves Report May 2022.xls from the webpage of the ERCOT (<http://www.ercot.com/gridinfo/resource/index.html>)

** 2021 ERCOT solar power 15-min generation data

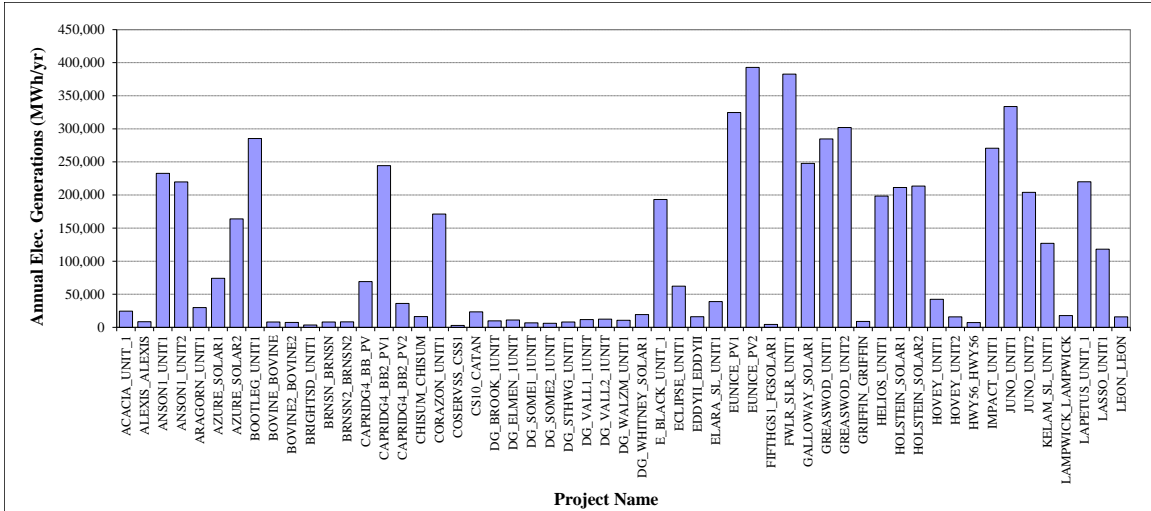


Figure 6-6: Annual Electricity Generation by Solar Power Plants in the State of Texas through 2021

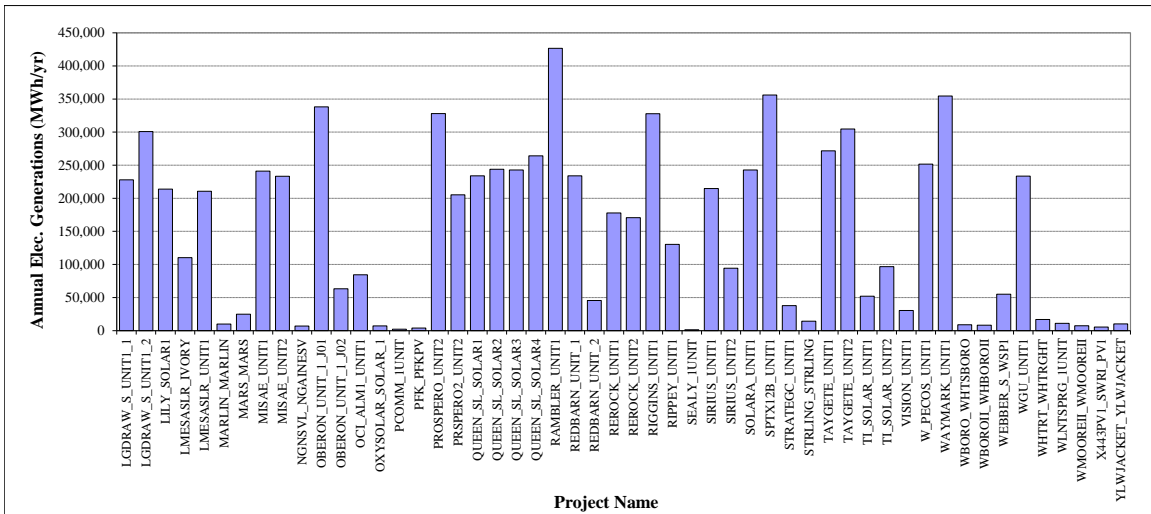


Figure 6-6: Annual Electricity Generation by Solar Power Plants in the State of Texas through 2021 (Continued)

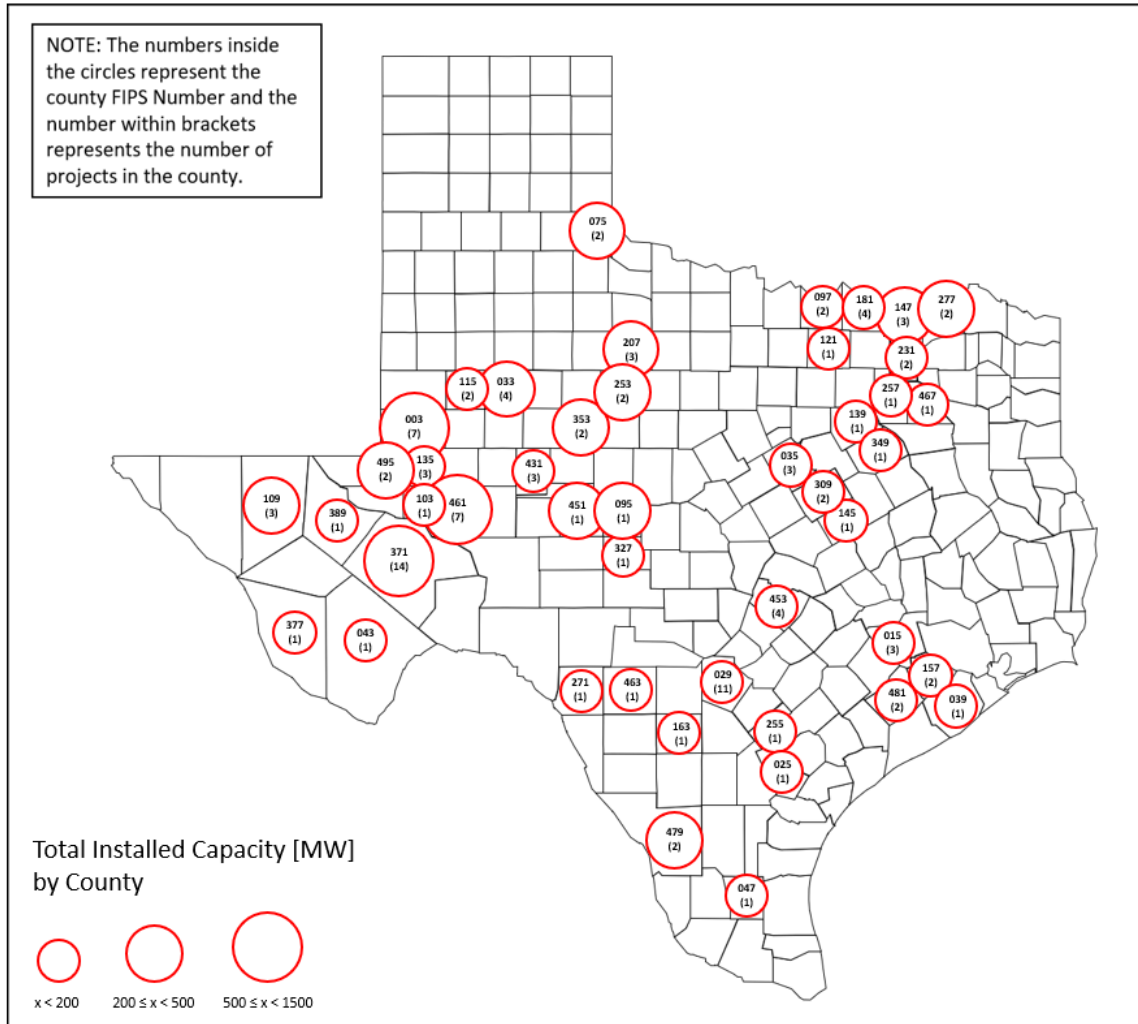


Figure 6-7: Map of Solar Power Plants Projects Installed in Each County of Texas

Table 6-4: Solar Power Plant Projects throughout Texas through 2021

County	FIPS Code	No. of Projects	Total Installed Capacity (MW _{AC})	County	FIPS Code	No. of Projects	Total Installed Capacity (MW _{AC})
Andrews	003	7	1,084	Haskell	207	3	340
Austin	015	3	12	Hunt	231	2	20
Bee	025	1	50	Jones	253	2	200
Bexar	029	11	100	Karnes	255	1	10
Borden	033	4	532	Kaufman	257	1	148
Bosque	035	3	25	Kinney	271	1	38
Brazoria	039	1	120	Lamar	277	2	209
Brewster	043	1	50	McLennan	309	2	15
Brooks	047	1	10	Navarro	349	1	129
Childress	075	2	240	Menard	327	1	8
Concho	095	1	257	Nolan	353	2	205
Cooke	097	2	65	Pecos	371	14	1,377
Crane	103	1	150	Presidio	377	1	10
Culberson	109	3	453	Reeves	389	1	100
Dawson	115	2	152	Sterling	431	3	145
Denton	121	1	2	Tom Green	451	1	200
Ector	135	3	197	Travis	453	4	175
Ellis	139	1	137	Upton	461	7	930
Falls	145	1	5	Uvalde	463	1	100
Fannin	147	3	220	Van Zandt	467	1	60
Fort Bend	157	2	10	Webb	479	2	213
Frio	163	1	132	Wharton	481	2	10
Grayson	181	4	20	Winkler	495	2	253

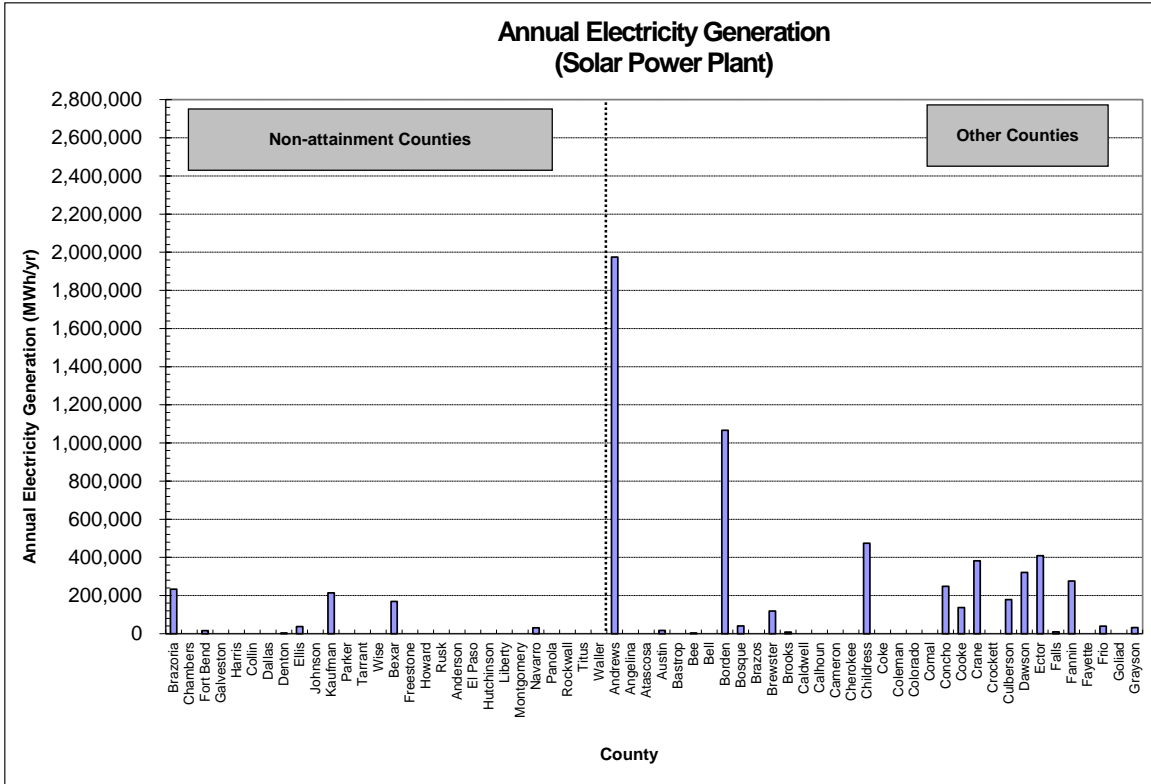


Figure 6-8: Annual Electricity Generation per County from Solar Power Plant Projects through 2021

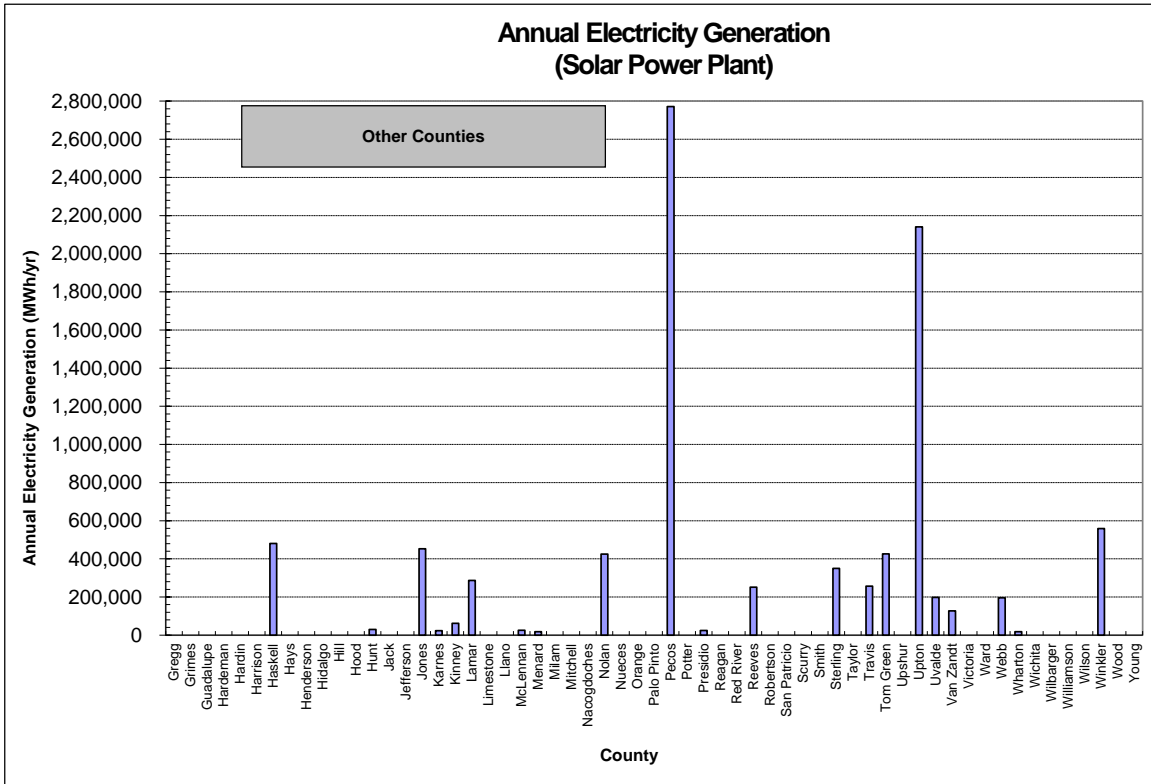


Figure 6-8: Annual Electricity Generation per County from Solar Power Plant Projects through 2021 (Continued)

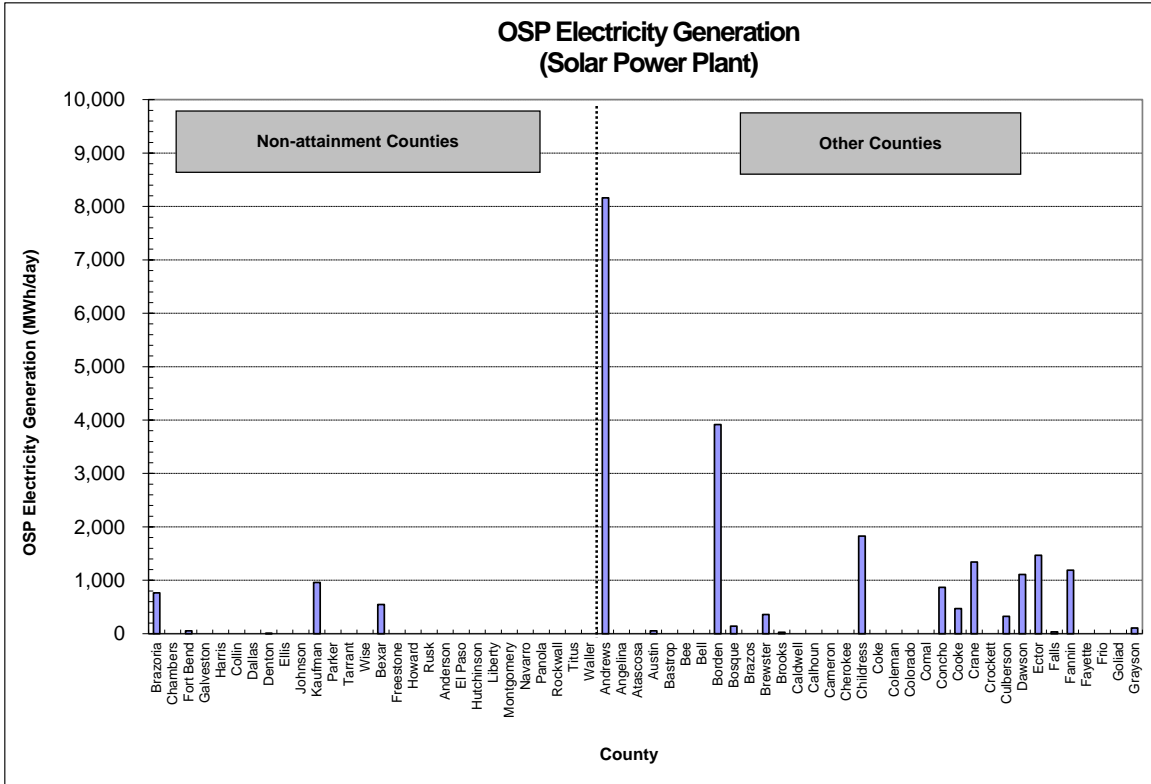


Figure 6-9: Ozone Season Period Electricity Generation per County from Solar Power Plant Projects through 2021

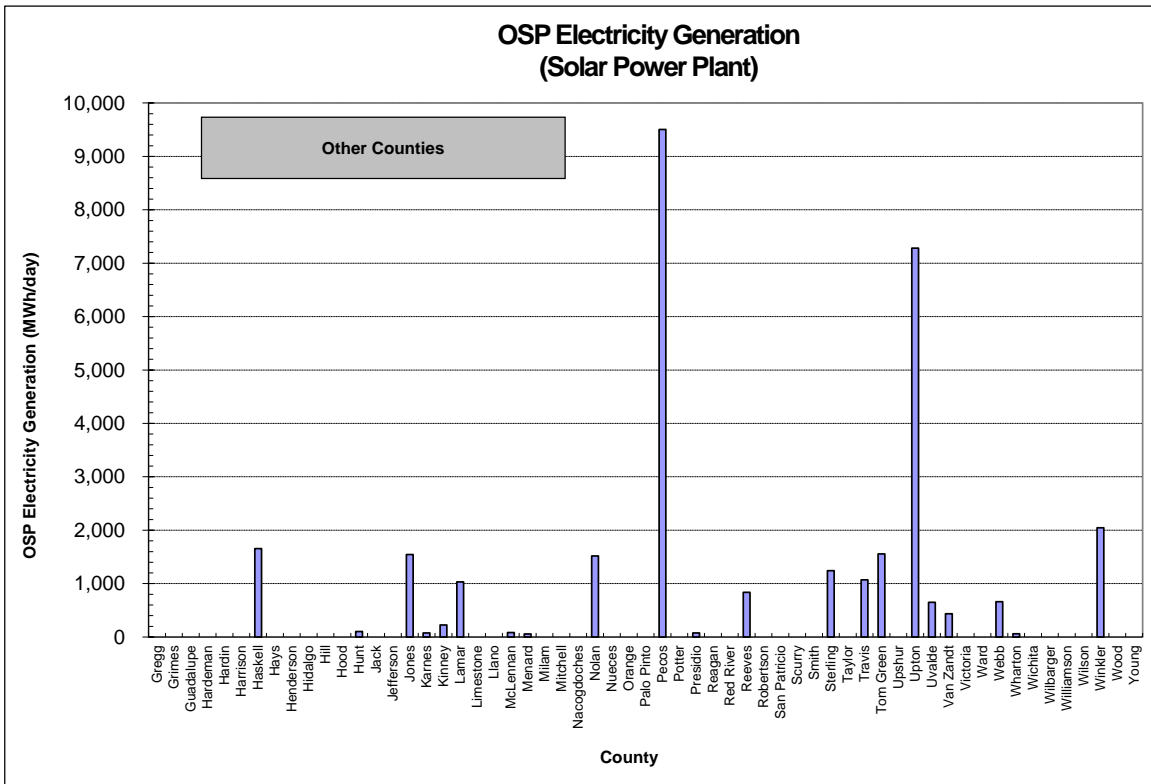


Figure 6-9: Ozone Season Period Electricity Generation per County from Solar Power Plant Projects through 2021 (Continued)

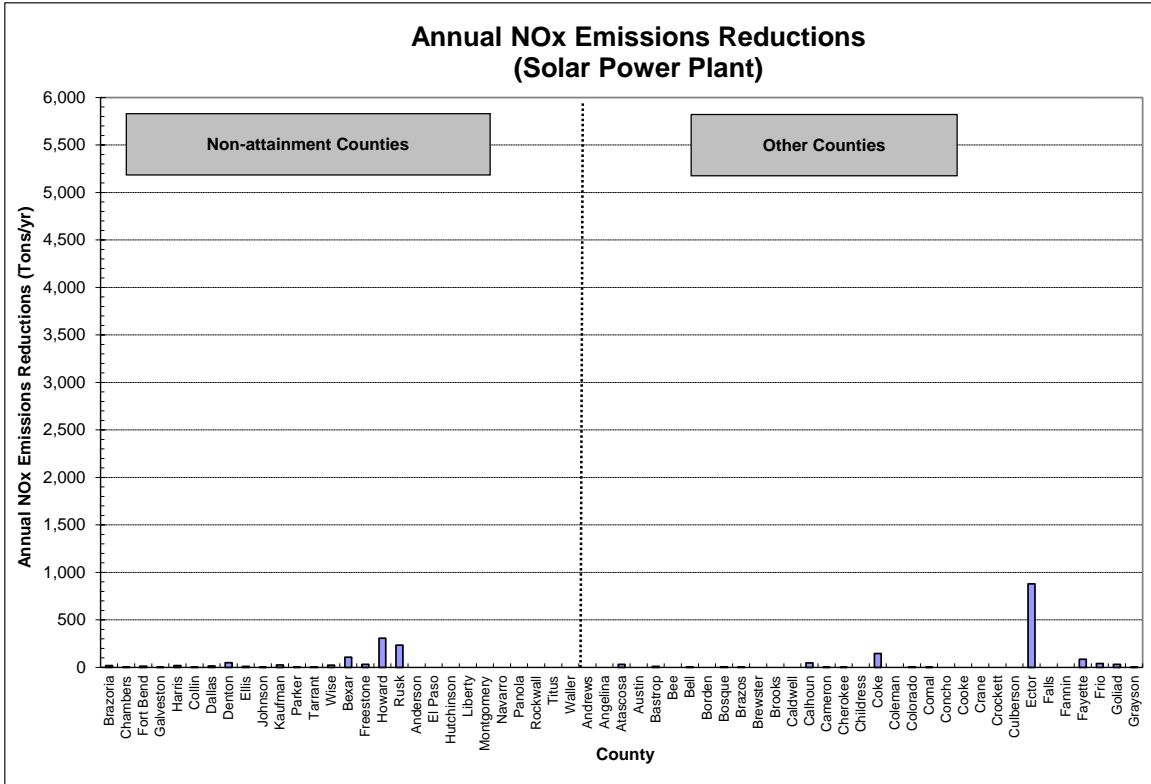


Figure 6-10: NOx Emissions Reductions per County from Solar Power Plant Projects through 2021

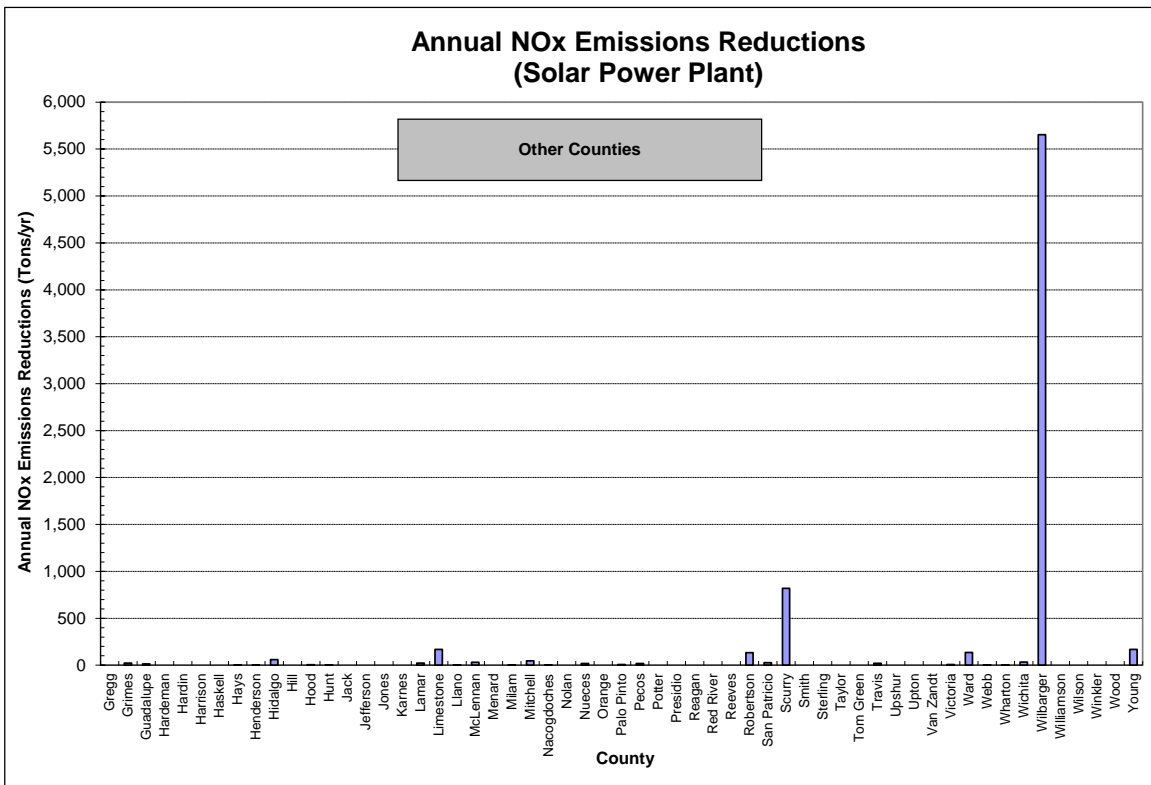


Figure 6-10: NOx Emissions Reductions per County from Solar Power Plant Projects through 2021 (Continued)

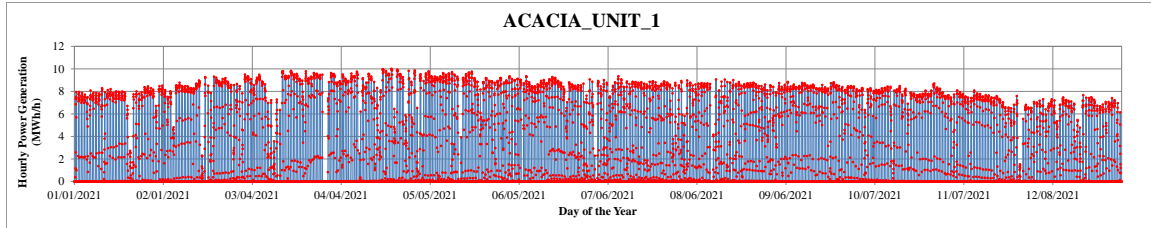


Figure 6-11: Hourly Electricity Generation Profile for Solar Photovoltaic Project ACACIA_UNIT_1

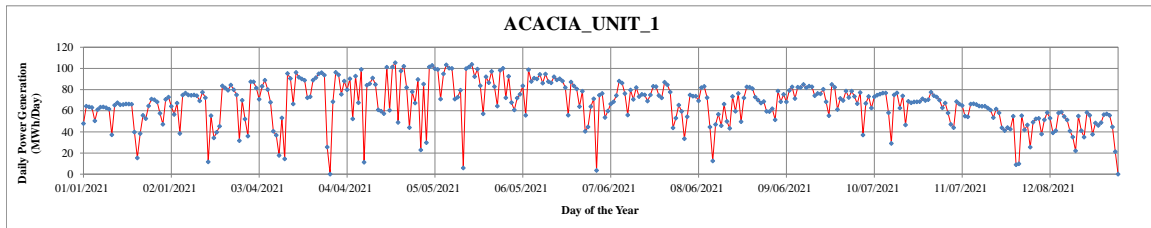


Figure 6-12: Daily Total Electricity Generation Profile for Solar Photovoltaic Project ACACIA_UNIT_1

6.2.2 Solar Thermal

Solar thermal projects are to generate thermal energy so that buildings utilize the thermal energy to heat water or air for their use. Many of the solar thermal projects throughout the State of Texas were identified from various web sources. In the present report for the year 2021, unfortunately, no new solar thermal projects were found. As a result, the total number of solar thermal projects for the present report was 41. In 2021, it was estimated that solar thermal in Texas produced 254,511 kWh/yr through 2021 and 689 kWh/day in the OSP from nine counties.

The equivalent energy in electricity from all the solar thermal projects are presented in Table 6-5. The equivalent energy in electricity was estimated how much electricity can be saved by the amount of hot water produced by solar thermal water heater systems. eCalc (f-Chart method) was used in designing liquid solar heating system to calculate the hot water produced. Due to the limited availability of solar thermal project information, the estimation was based on the collector areas and project locations. The list of all the projects is shown in Table G-2 (Vol. II, APPENDIX G).

Figure 6-13 shows the map of the solar thermal projects identified in each county of Texas. In addition, Table 6-6 provides detailed information about Figure 6-13, including: county name, FIPS code and number of solar thermal projects for each county. The annual electric savings per county and the OSP electric savings per county, which were estimated from these projects, are presented in Figure 6-14 and in Figure 6-15, respectively. Lastly, the corresponding annual NO_x emission reductions are shown in Figure 6-16.

Table 6-5: Solar Thermal Projects: Energy Reductions up to 2021

County	Annual Energy Savings (for Base Year Conditions)	OSP Energy Savings (for Base Year Conditions)
	Annual Elec. Equivalent (kWh/year)	OSP Elec. Equivalent (kWh/day)
Bexar	60,388	161
El Paso	141,850	390
Fort Bend	16,318	44
Hays	276	1
Nueces	12,250	34
Parker	9,806	27
Travis	1,768	1
Victoria	336	1
Williamson	11,519	31
Total	254,511	689

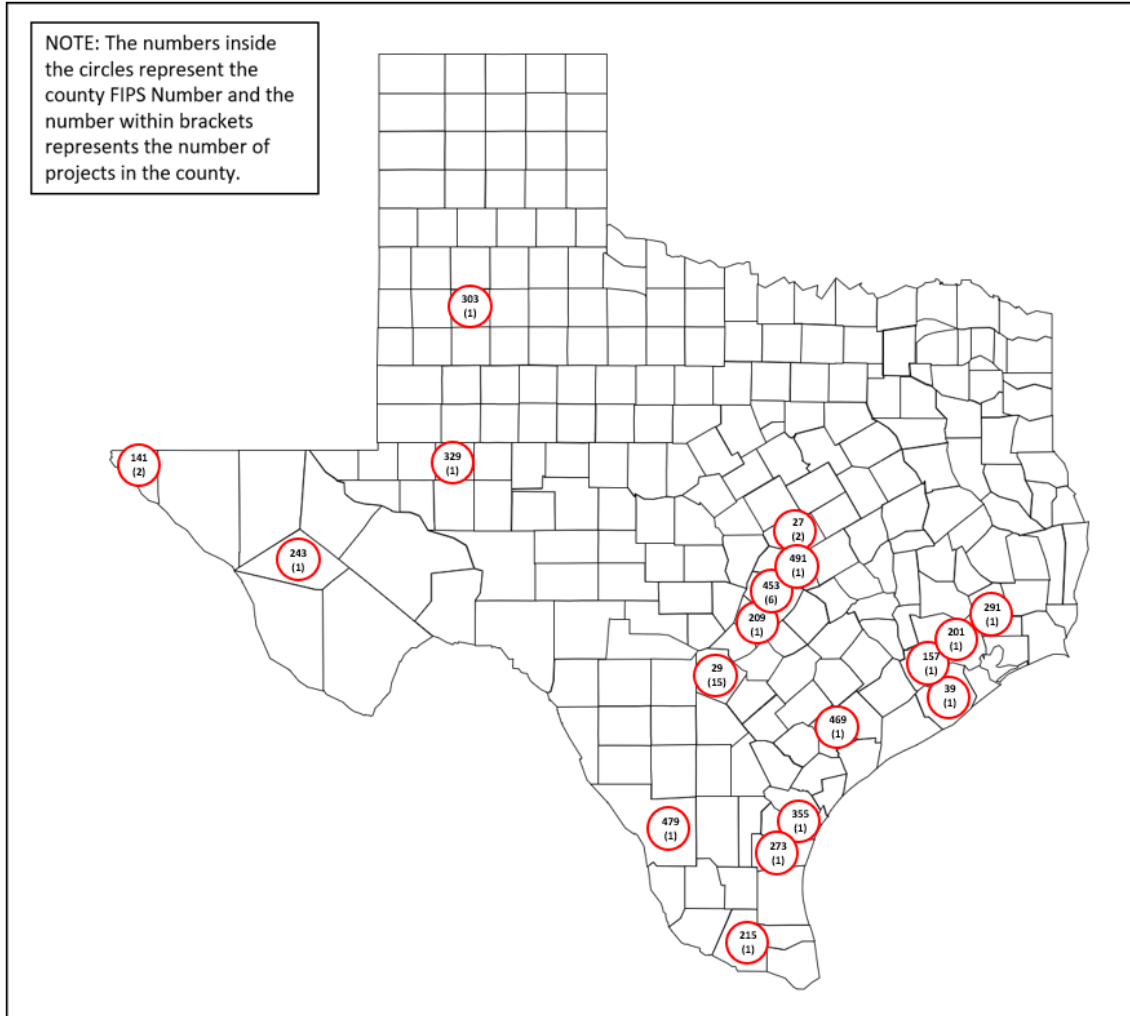


Figure 6-13: Map of Solar Thermal Projects Installed in Each County of Texas

Table 6-6: Solar Thermal Projects throughout Texas through 2021

County	FIPS Code	No. of Projects
Bell	27	2
Bexar	29	15
Brazoria	39	1
El Paso	141	2
Fort Bend	157	1
Harris	201	1
Hays	209	1
Hidalgo	215	1
Jeff Davis	243	1
Kleberg	273	1
Liberty	291	1
Lubbock	303	1
Midland	329	1
Nueces	355	1
Travis	453	6
Victoria	469	1
Webb	479	1
Williamson	491	1
N/A	-	2

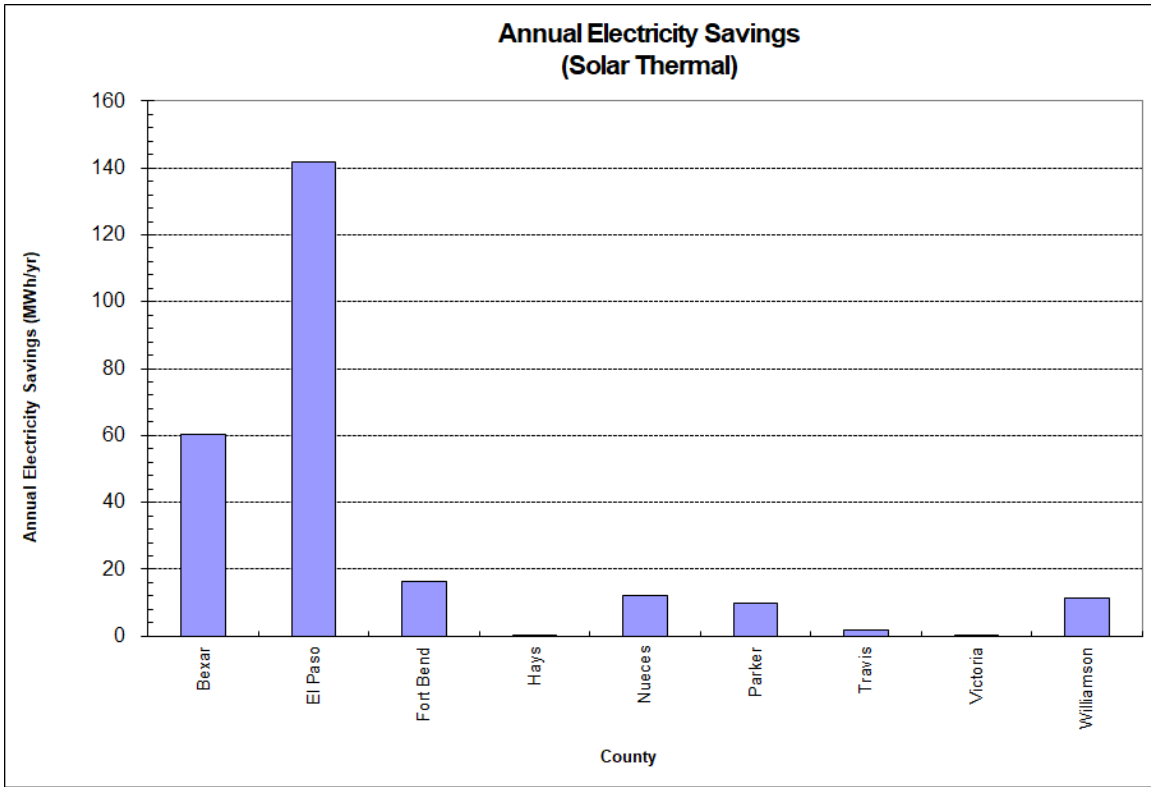


Figure 6-14: Annual Electricity Savings per County from Solar Thermal Projects through 2021

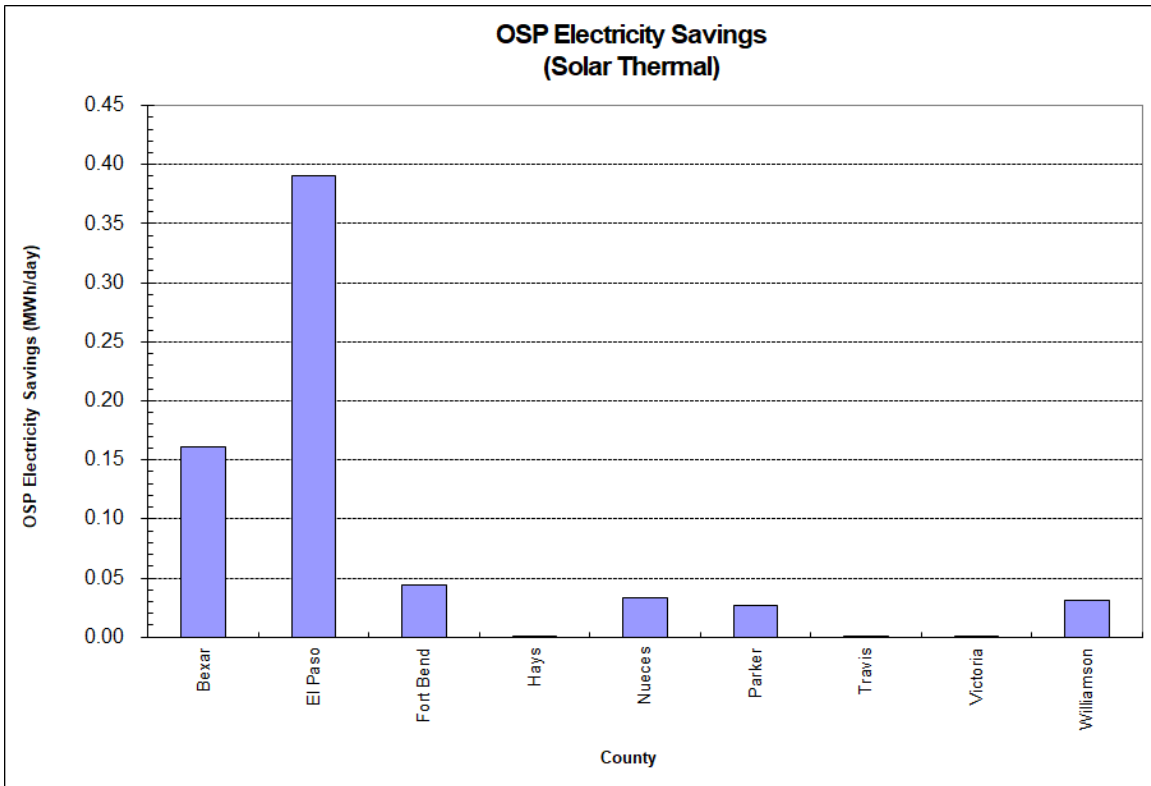


Figure 6-15: Ozone Season Period Electricity Savings per County from Solar Thermal Projects through 2021

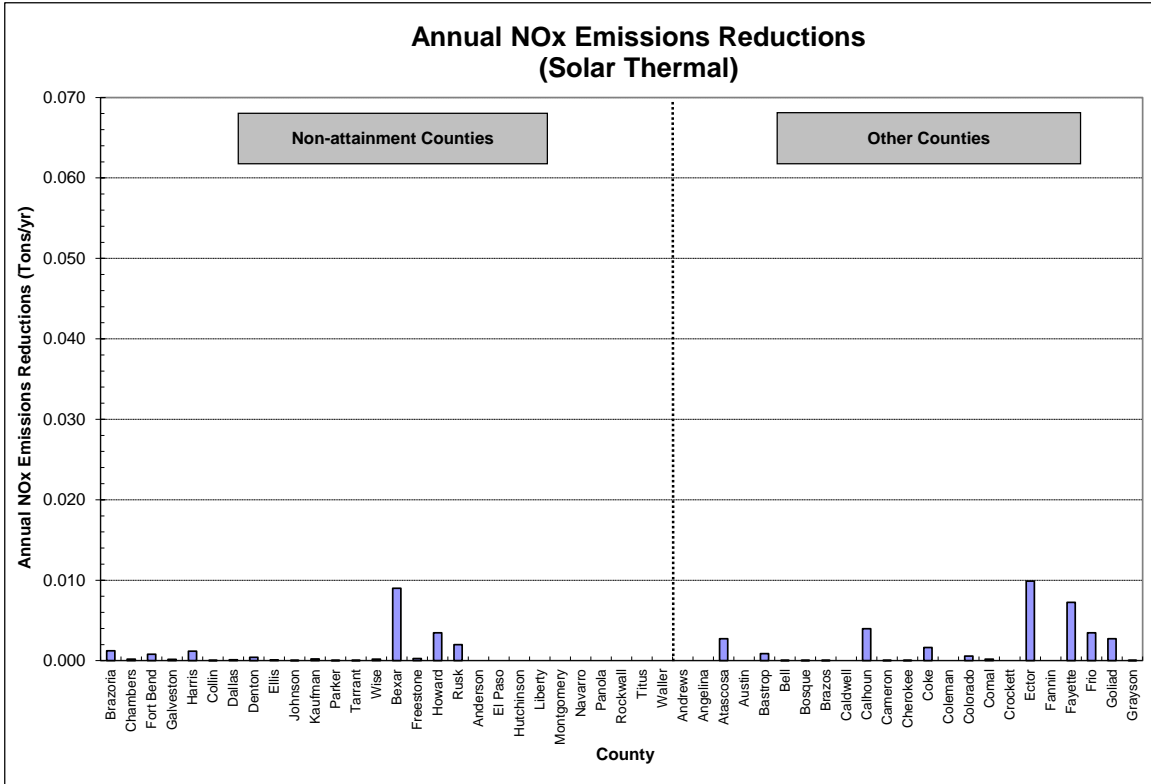


Figure 6-16: NOx Emissions Reductions per County from Solar Thermal Projects through 2021

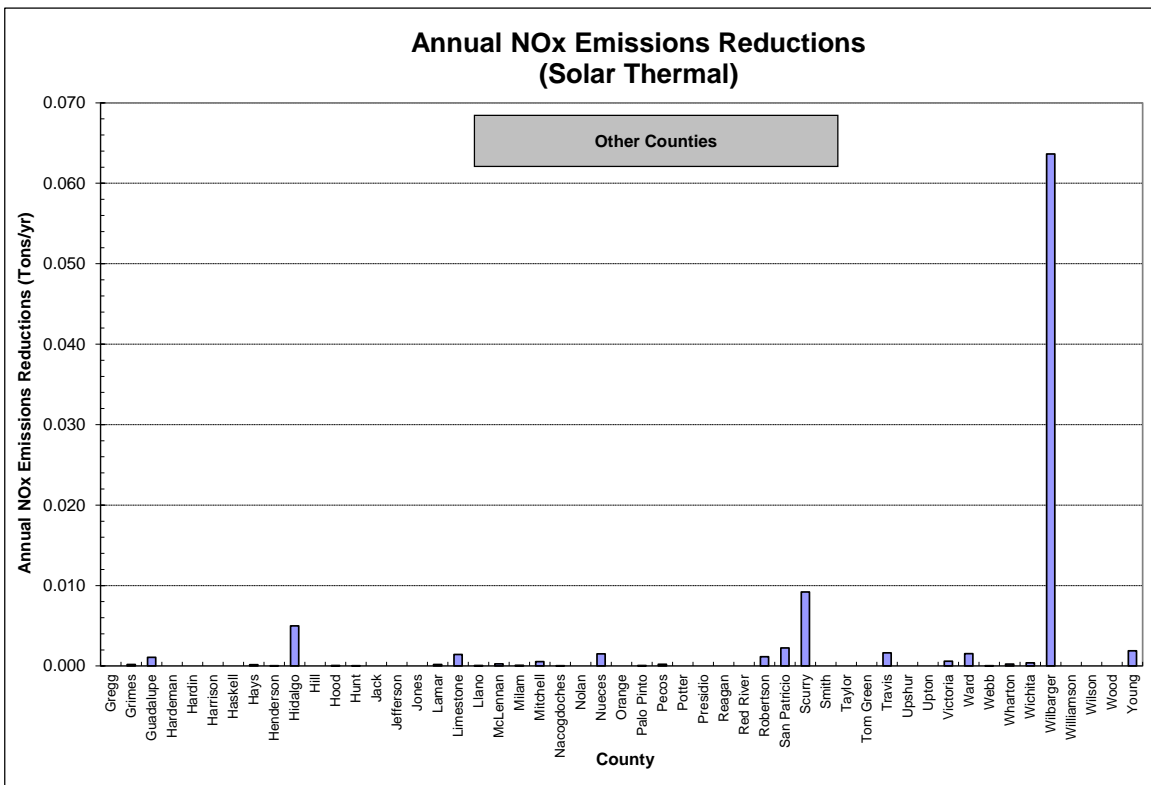


Figure 6-16: NOx Emissions Reductions per County from Solar Thermal Projects through 2021 (Continued)

6.2.3 Biomass

The data from 12 biomass power plants in the State of Texas were obtained from ERCOT. Table 6-7 shows the list of the biomass projects with their names, respective county, year commissioned, the forecast zone they serve, installed capacity and total electricity produced for the year 2021. Figure 6-17 shows the annual electricity generation of the identified biomass projects in the State of Texas. In addition, Figure 6-18 shows the map of the number of biomass projects for each county. The total power generation capacity from all biomass projects in 2021 is 167 MW. The capacity in 2021 is equal to 2020 capacity. However, compared to what was reported in the previous year's annual report, an increase of 23% on measured annual biomass production was observed, from 352,924 MWh/yr in 2020 to 434,278 MWh/yr in 2021.

The annual electric savings per county and the OSP electric savings per county, which were estimated from these projects, are presented in Figure 6-19 and in Figure 6-20, respectively. In addition, the corresponding annual NO_x emission reductions are shown in Figure 6-21 and OSP NO_x emission reductions are shown in Figure 6-22.

The hourly and total daily electricity generation profile of different Biomass projects is shown in Volume II, Appendix D. Figure 6-23 shows an example of the hourly electricity generation profile and Figure 6-24 shows an example of the daily total generation profile.

Table 6-7: Biomass Projects in the State of Texas through 2021

SNo	Name of the Project	County	Year Commissioned	ERCOT Zone	Installed Capacity (MW _{AC})	Annual Power Generated in 2021 (MWh/year) **	Daily Average Power Generated in 2021OSP (MWh/day) **
1	DG_78252_4UNITS	Bexar	2013	South	4.2	12,938	34
2	DG_BIO2_4UNITS	Denton	2009	North	6.4	40,892	115
3	DG_BIOE_2UNITS	Denton	1988	North	6.2	38,301	102
4	DG_FREIH_2UNITS	Comal	2011	South	3.2	23,639	68
5	DG_HBR_2UNITS	Denton	2011	North	3.2	24,328	64
6	DG_MEDIN_1UNIT	Bexar	2005	South	9.6	40,884	109
7	DG_S_SNR_UNIT1	Cameron	1973	South	4.5	300	0
8	DG_SPRIN_4UNITS	Travis	2007	South	6.4	29,086	83
9	DG_WALZE_4UNITS	Bexar	2002	South	9.8	3,673	0
10	DG_WSTHL_3UNITS	Parker	2010	North	4.8	11,861	27
11	NACPW_UNIT1	Nacogdoches	2012	North	105	208,313	1,059
12	TRIRA_1UNIT	Dallas	2015	North	4	64	0
Total					167	434,278	1,663

* 2021 ERCOT Renewable Generator Details.xlsx from ERCOT and PUCT

** 2021 ERCOT Renewable Generation (15min).xlsx from ERCOT

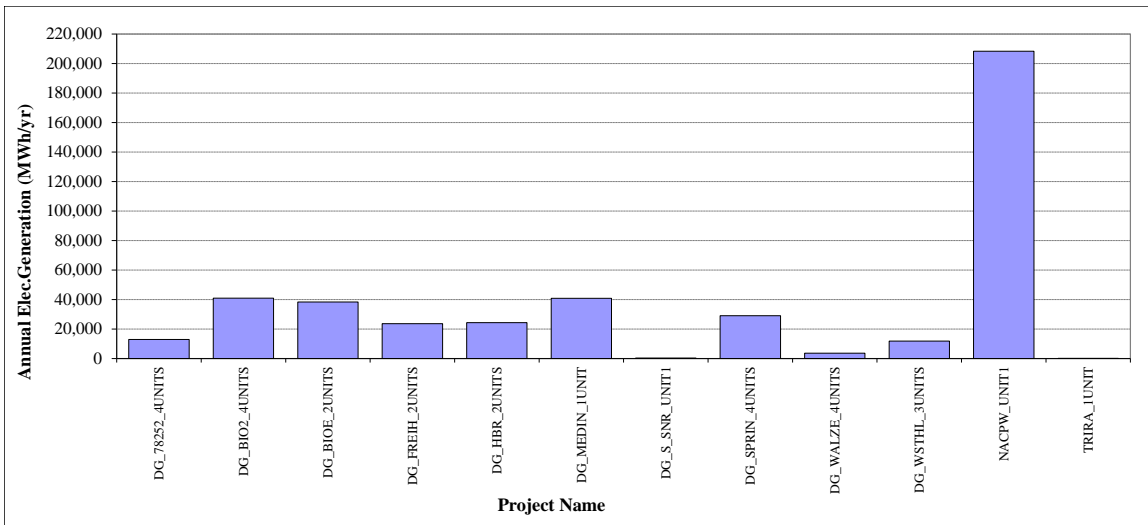


Figure 6-17: Annual Electricity Generation by Biomass Projects in the State of Texas through 2021

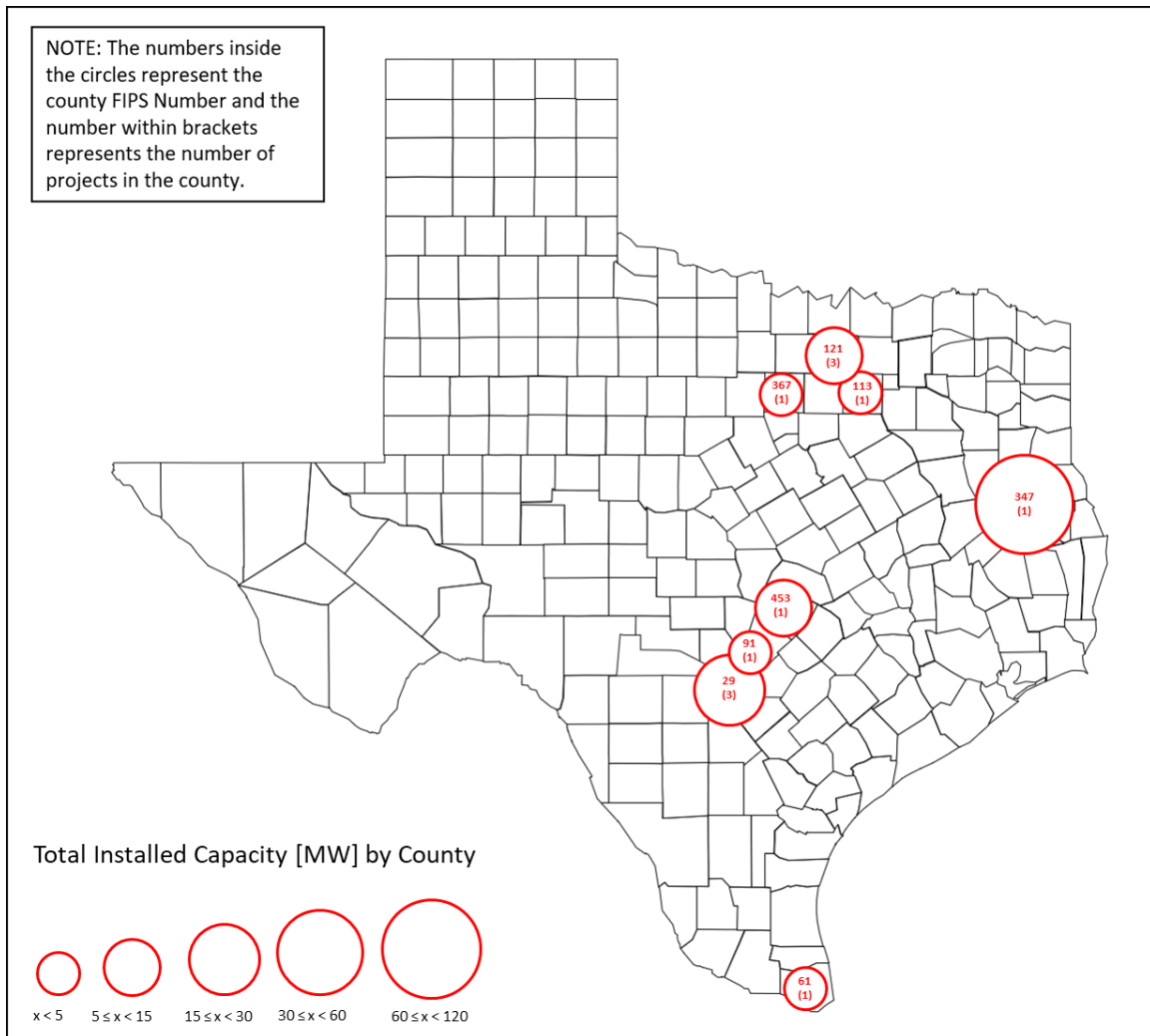


Figure 6-18: Map of Biomass Projects Installed in Each County of Texas

Table 6-8: Biomass Projects throughout Texas through 2021

County	FIPS Code	No. of Projects
Bexar	29	3
Cameron	61	1
Comal	91	1
Dallas	113	1
Denton	121	3
Nacogdoches	347	1
Parker	367	1
Travis	453	1

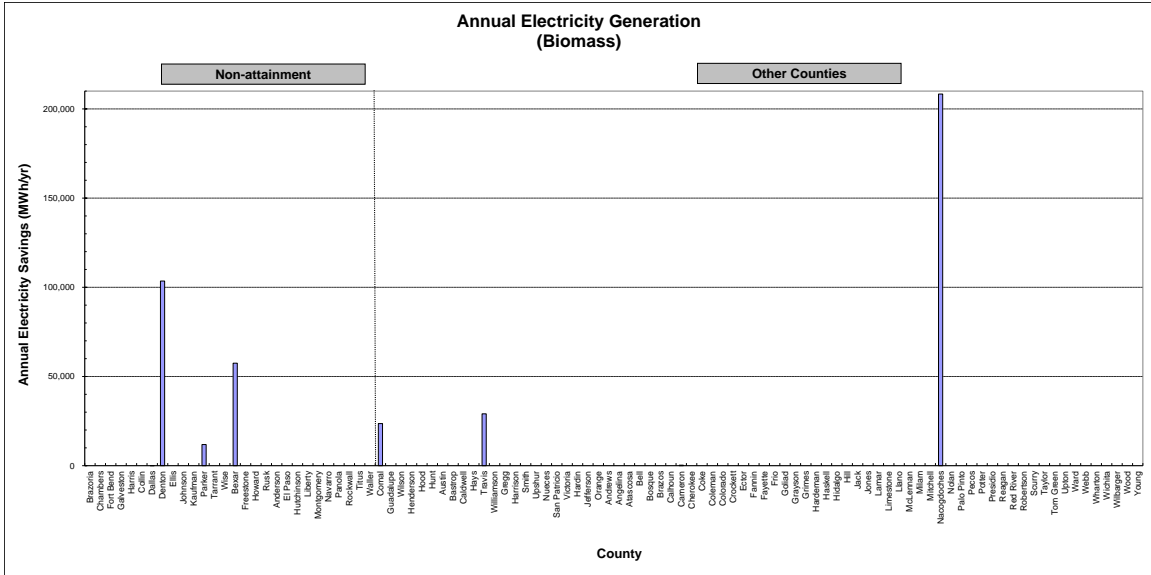


Figure 6-19: Annual Electricity Savings per County from Biomass Projects through 2021

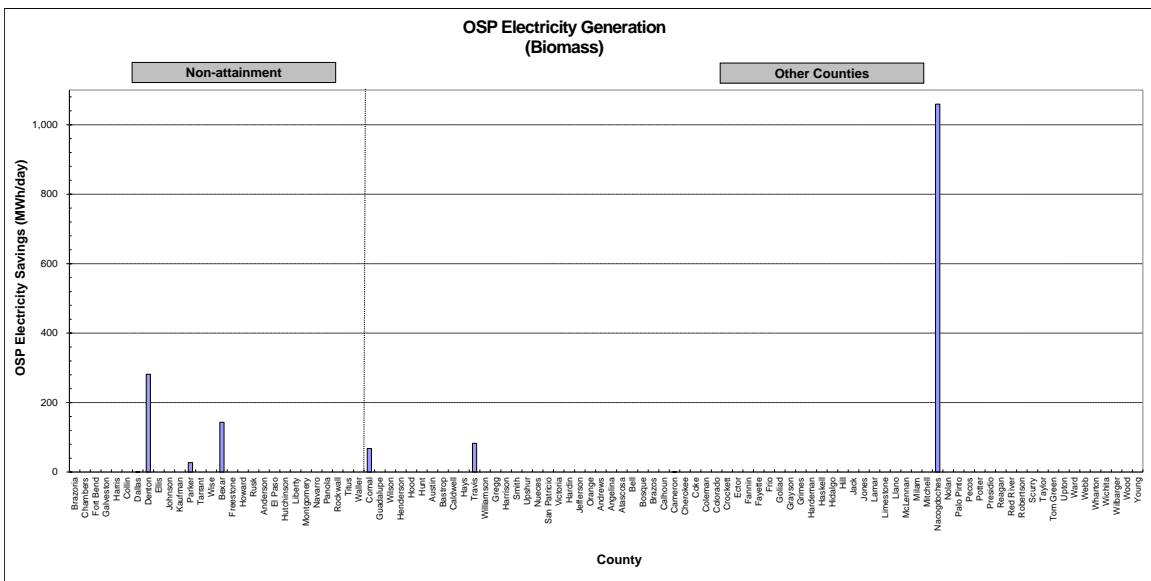


Figure 6-20: Ozone Season Period Electricity Savings per County from Biomass Projects through 2021

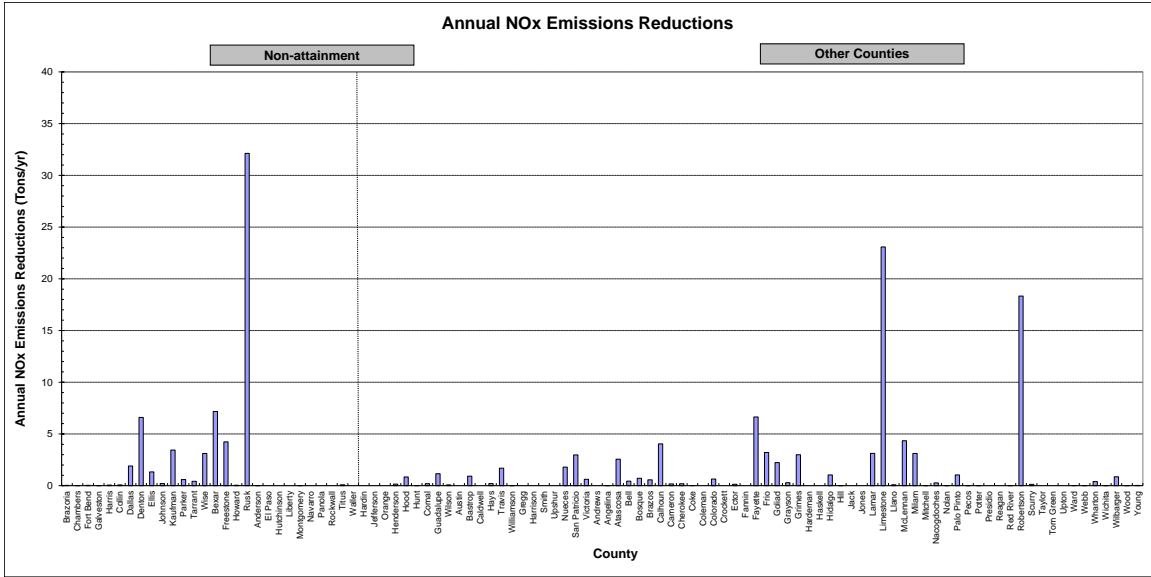


Figure 6-21: NOx Emissions Reductions per County from Biomass Projects through 2021

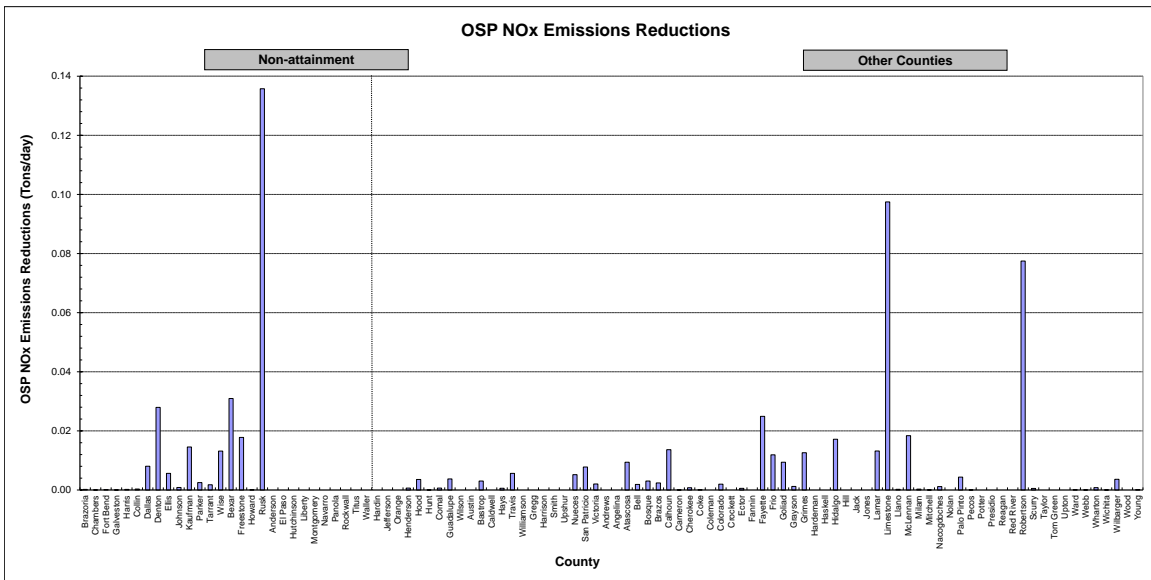


Figure 6-22: NOx Emissions Reductions per County from Biomass Projects through 2021 OSP

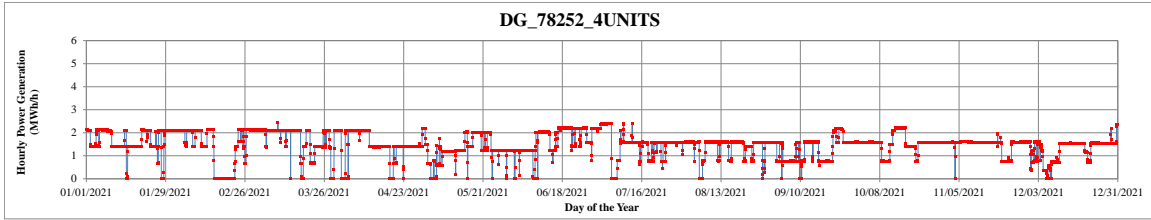


Figure 6-23: Hourly Electricity Generation Profile for Biomass DG-78252-4UNITS

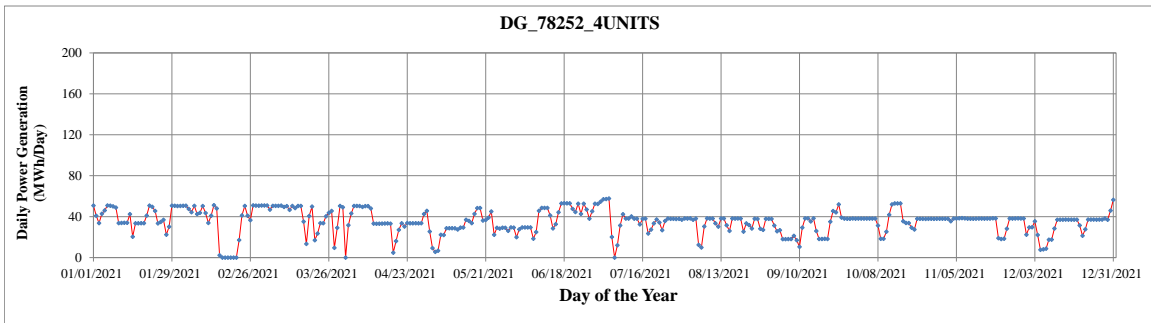


Figure 6-24: Daily Total Electricity Generation Profile for Biomass Project DG-78252-4UNITS

6.2.4 Hydroelectric

The data from thirty-three hydroelectric power plants in the State of Texas were obtained. Table 6-9 shows the list of hydroelectric projects with their names, respective county, year commissioned, the ERCOT zone they serve, installed capacity and total electricity produced for the whole-year 2021 as well as Ozone Season Period (OSP). Four hydroelectric power plants (i.e., RC Thomas, Robert D Willis, Sam Rayburn and Toledo Bend), which are installed outside ERCOT region, were identified from U.S. DOE Energy Information Administration (EIA) data.

Figure 6-25 shows the annual electricity generation of the identified hydroelectric projects in the State of Texas. Figure 6-26 shows the map of the number of hydroelectric projects for each county. In addition, Table 6-10 provides detailed information about Figure 6-26, including: county name, FIPS code, number of hydroelectric power plants and total installed capacity for each county. The total power generation capacity from all hydroelectric projects in 2021 is 744.8 MW. The total annual electricity generation from all the hydroelectric plants for the year 2021 was 597,687 MWh/year.

The annual electricity savings per county, which were estimated from these projects, are presented in Figure 6-27. The OSP electricity savings per county, which were estimated from these projects, are presented in Figure 6-28. In addition, the corresponding annual NO_x emission reductions are shown in Figure 6-29.

The hourly and daily total electricity generation profiles of different hydroelectric projects are shown in Volume II, Appendix E. Figure 6-30 shows an example of the hourly electricity generation profile and Figure 6-31 shows an example of the daily total generation profile. Based on the power generation data from the hydroelectric power plants, one significant pattern was observed. Most of the hydroelectric plants were intermittently operated for a few hours of the day.

Table 6-9: Hydroelectricity Power Projects in the State of Texas through 2021

No	Name of the Project	County	Year Commissioned	ERCOT Zone	Installed Capacity* (MW _{AC})	Annual Power Generated in 2021** (MWh/year)	Daily Average Power Generated in 2021 OSP (MWh/day)
1	AMISTAD_AMISTAG1	Val Verde	1983	West	37.9	30,192	65
2	AMISTAD_AMISTAG2	Val Verde	1983	West	37.9	29,476	61
3	AUSTPL_AUSTING1	Travis	1940	South	8.0	3,774	14
4	AUSTPL_AUSTING2	Travis	1940	South	9.0	3,783	14
5	BUCHAN_BUCHANG1	Llano	1938	South	16.0	4,316	10
6	BUCHAN_BUCHANG2	Llano	1938	South	16.0	1,845	9
7	BUCHAN_BUCHANG3	Llano	1950	South	17.0	4,459	11
8	CANYHY_CANYHYG1	Comal	1989	South	6.0	236	0
9	DG_LKWDT_2UNITS	Gonzales	1931	South	4.8	3,364	14
10	DG_LWSVL_1UNIT***	Denton	1991	North	2.2	0	0
11	DG_MCQUE_5UNITS	Guadalupe	1928	South	7.7	15,956	55
12	DG_OAKHL_1UNIT	Tarrant	2014	North	1.4	749	0
13	DG_SCHUM_2UNITS	Guadalupe	1928	South	3.6	41	0
14	DNDAM_DENISOG1	Grayson	1944	North	49.5	201,050	861
15	DNDAM_DENISOG2	Grayson	1948	North	49.5	178	0
16	EAGLE_HY_EAGLE_HY1	Maverick	2005	South	9.6	38,424	100
17	FALCON_FALCONG1	Starr	1954	South	12.0	3,405	9
18	FALCON_FALCONG2	Starr	1954	South	12.0	6,695	18
19	FALCON_FALCONG3	Starr	1954	South	12.0	12,476	21
20	INKSDA_INKS_G1	Llano	1938	South	14.0	5,520	16
21	MARBFA_MARBFAG1	Burnet	1951	South	21.0	5,104	19
22	MARBFA_MARBFAG2	Burnet	1951	South	20.0	6,234	21
23	MARSFO_MARSFOG1	Travis	1941	South	36.0	6,229	32
24	MARSFO_MARSFOG2	Travis	1941	South	36.0	12,769	36
25	MARSFO_MARSFOG3	Travis	1941	South	36.0	13,187	37
26	RC THOMAS	Polk	2020	N/A	26.7	93,953	351
27	ROBERT D WILLIS****	Jasper	1989	N/A	8.0	N/A	N/A
28	SAM RAYBURN****	Jasper	1965	N/A	52.0	N/A	N/A
29	TOLEDO BEND****	Newton	1969	N/A	81.0	N/A	N/A
30	WIRTZ_WIRTZ_G1	Burnet	1951	South	29.0	6,810	26
31	WIRTZ_WIRTZ_G2	Burnet	1951	South	29.0	9,389	30
32	WND_WHITNEY1	Bosque	1953	North	22.0	39,021	243
33	WND_WHITNEY2	Bosque	1953	North	22.0	39,053	243
Total					744.80	597,687	2,316

* 2021 ERCOT Renewable Generator Details.xlsx from ERCOT and PUCT

** 2021 ERCOT hydroelectric 15-min generation data and EIA annual power generation data

*** In the ERCOT data, DG_LWSVL_1UNIT had no generation

**** The EIA data did not include annual power generation information for the year 2021

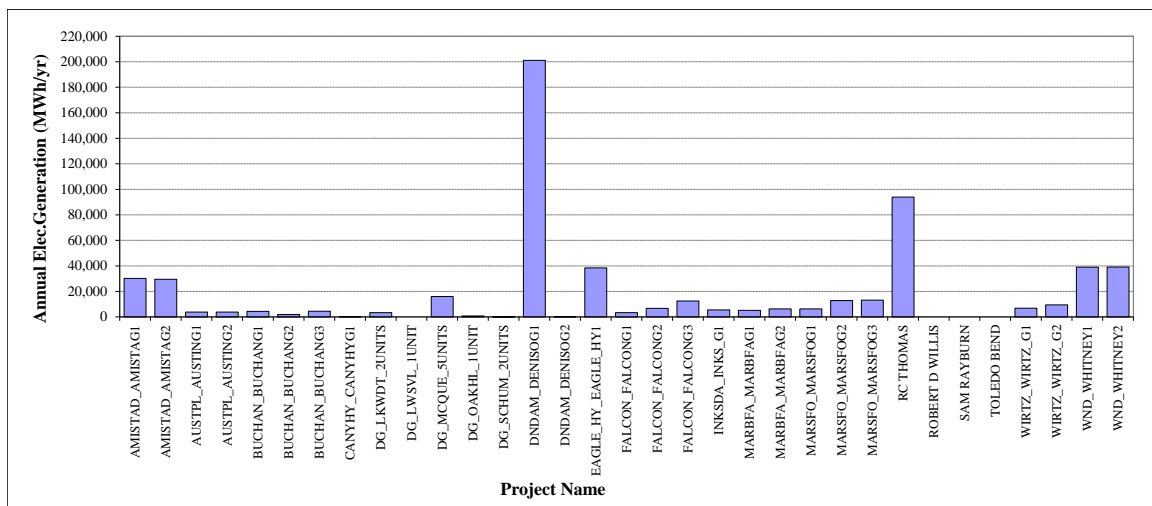


Figure 6-25: Annual Electricity Generation by Hydroelectric Projects in the State of Texas through 2021

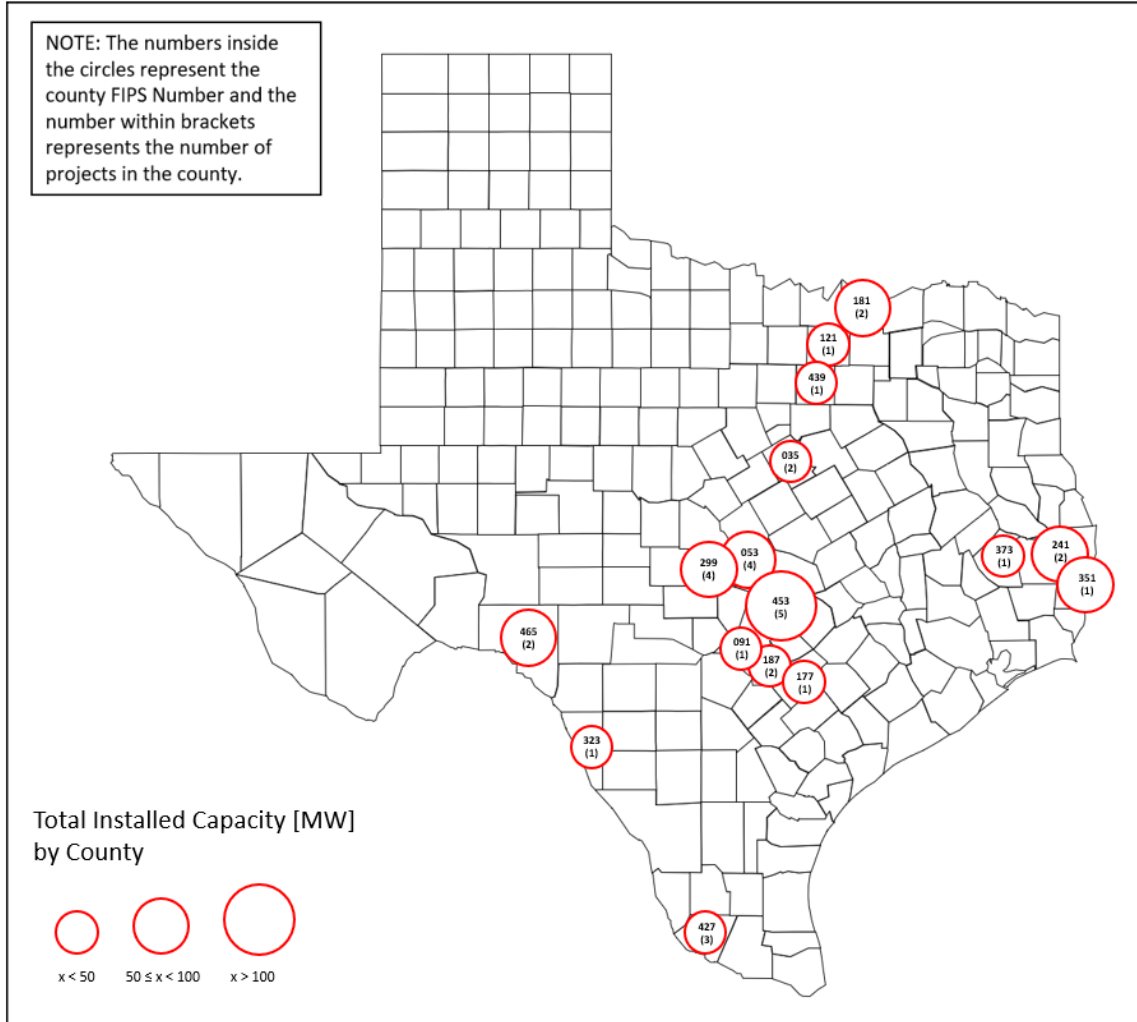


Figure 6-26: Map of Hydroelectric Projects Installed in Each County of Texas

Table 6-10: Hydroelectric Projects throughout Texas through 2021

County	FIPS Code	No. of Projects	Total Installed Capacity (MW)
Bosque	35	2	44
Burnet	53	4	99
Comal	91	1	6
Denton	121	1	2
Gonzales	177	1	5
Grayson	181	2	99
Guadalupe	187	2	11
Jasper	241	2	60
Llano	299	4	63
Maverick	323	1	10
Newton	351	1	81
Polk	373	1	27
Starr	427	3	36
Tarrant	439	1	1
Travis	453	5	125
Val Verde	465	2	76

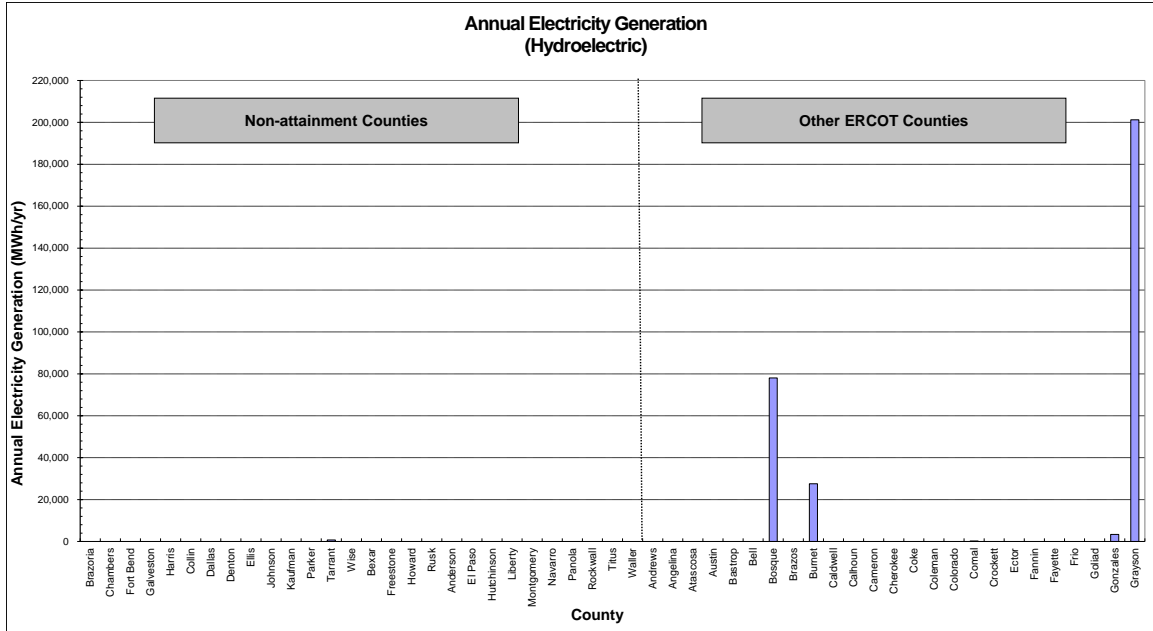


Figure 6-27: Annual Electricity Savings per County from Hydroelectric Projects through 2021

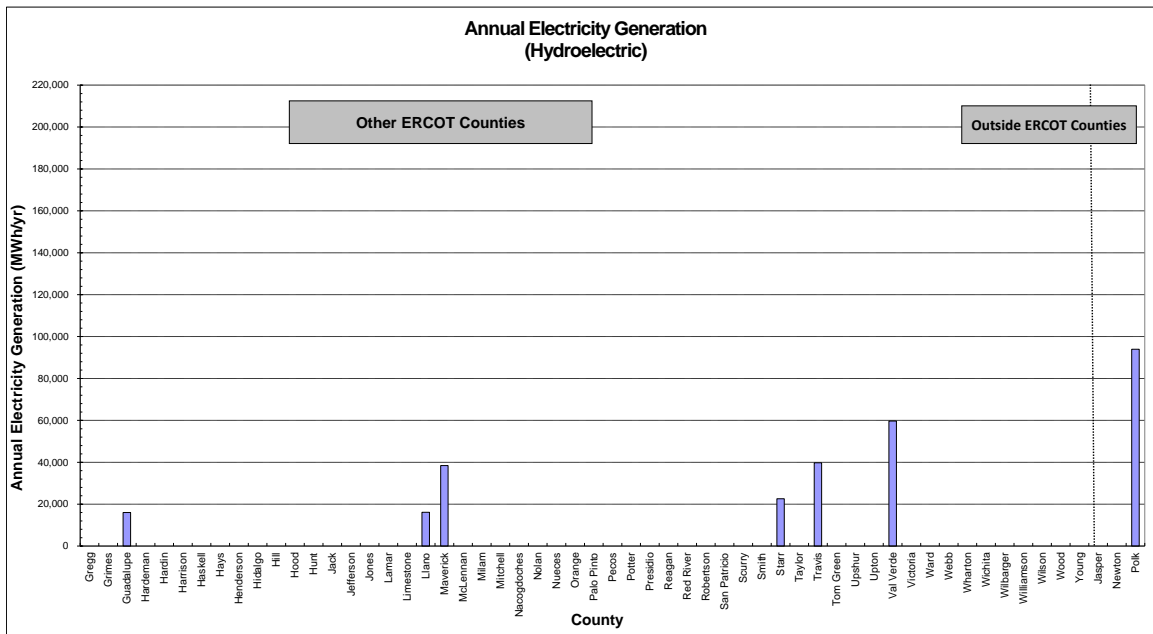


Figure 6-27: Annual Electricity Savings per County from Hydroelectric Projects through 2021 (Continued)

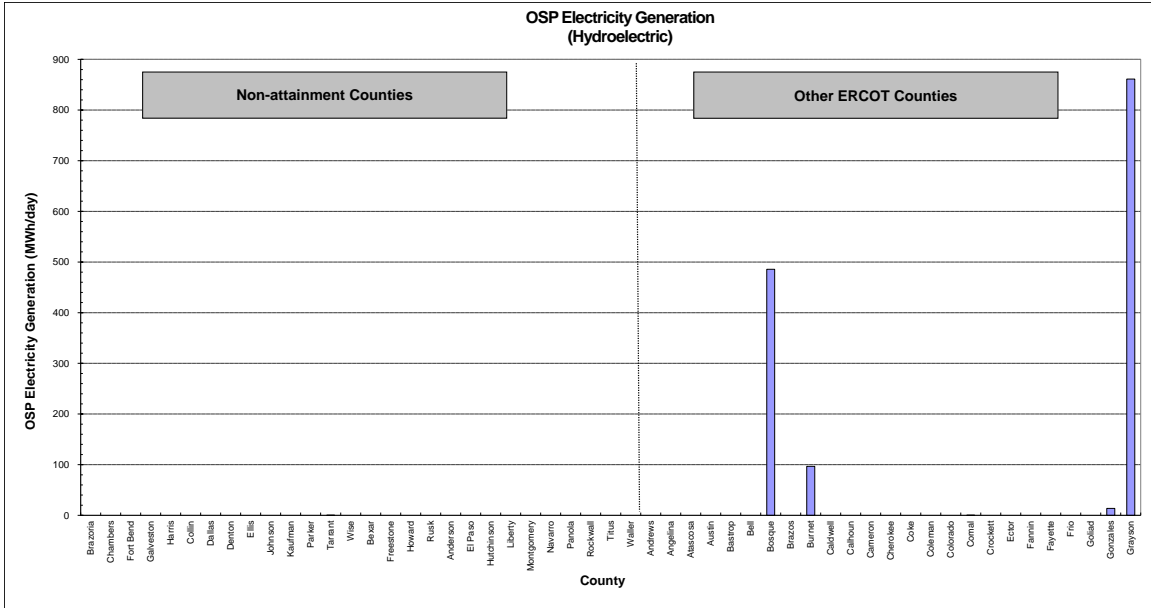


Figure 6-28: Ozone Season Period Electricity Savings per County from Hydroelectric Projects through 2021

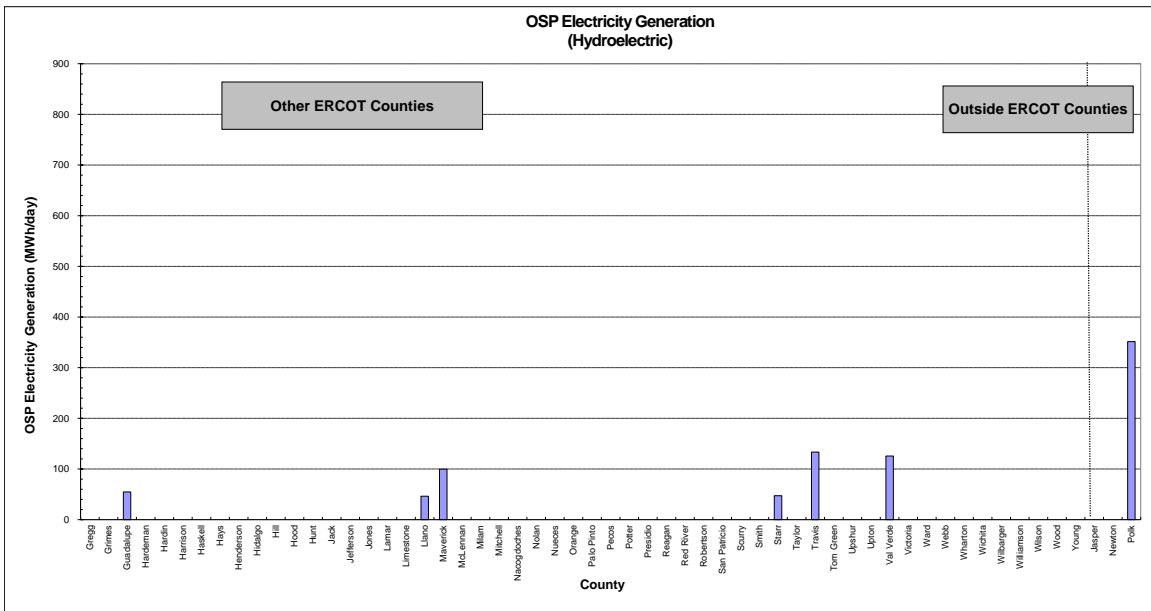


Figure 6-28: Ozone Season Period Electricity Savings per County from Hydroelectric Projects through 2021 (Continued)

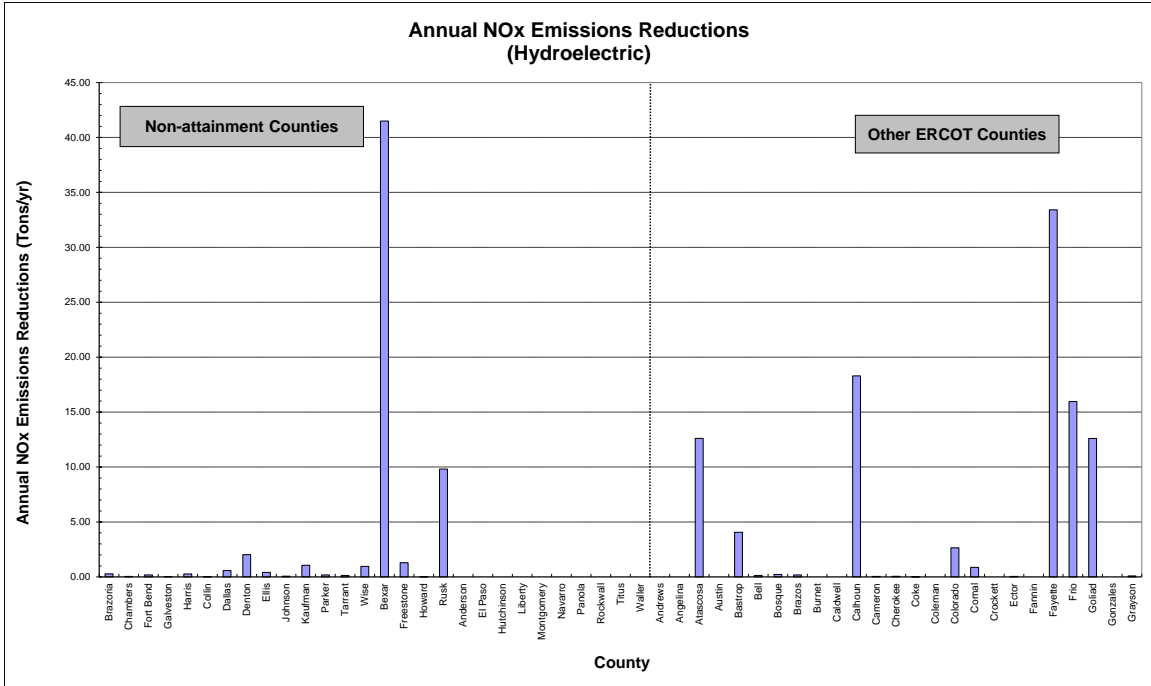


Figure 6-29: NOx Emissions Reductions per County from Hydroelectric Projects through 2021

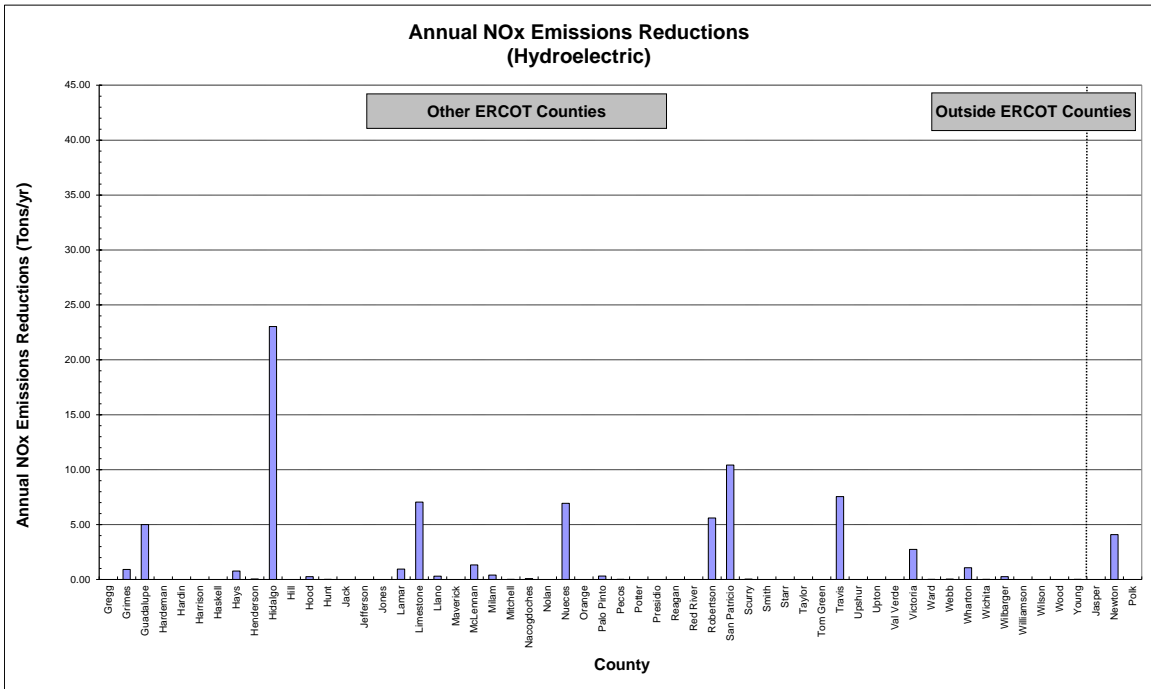


Figure 6-29: NOx Emissions Reductions per County from Hydroelectric Projects through 2021 (Continued)

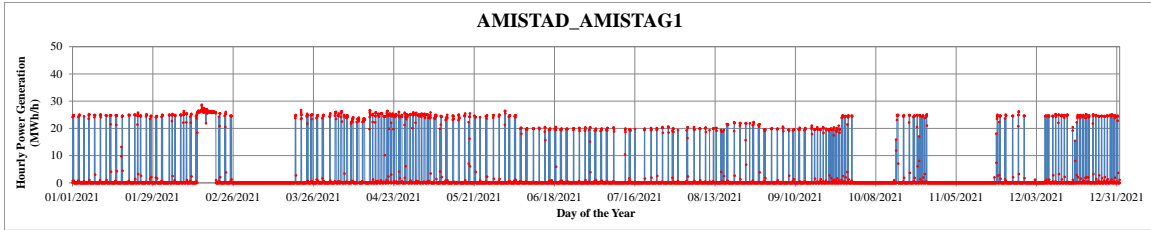


Figure 6-30: Hourly Electricity Generation Profile for Hydroelectric Project AMISTAD_AMISTAG1

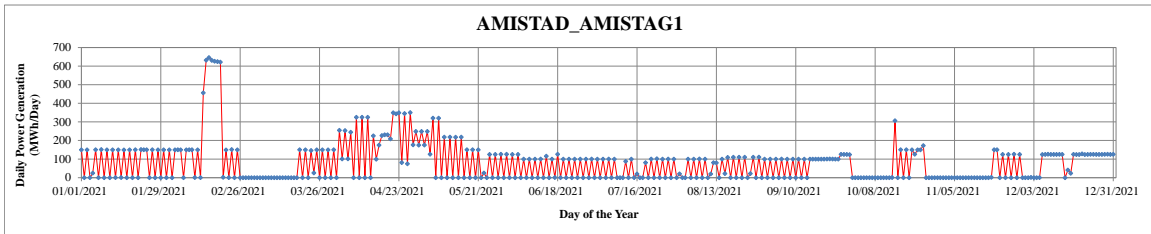


Figure 6-31: Daily Total Electricity Generation Profile for Hydroelectric Project AMISTAD_AMISTAG1

6.2.5 Geothermal

The total number of the identified geothermal projects for the present report was 306. Most of the geothermal projects throughout the State of Texas were identified from various web sources. In the present report for the year 2021, unfortunately, no new geothermal projects were found.

Figure 6-32 shows the map of the number of geothermal projects for each county. In addition, Table 6-11 provides detailed information about Figure 6-32, including: county name, FIPS code, number of geothermal projects and total installed capacity for each county. We could not find either annual or OSP electricity savings and the NO_x emission reductions per county from the geothermal projects, which were not possible to be estimated. Table G-4 (in Volume II, Appendix G) shows the list of the geothermal projects with their names, respective county, implementation year, installed capacity, and service area.

6.2.6 Landfill Gas-Fired

The information for the landfill gas-fired power plant section was found in the Environmental Protection Agency's (EPA's) project database for Landfill Methane Outreach Program (LMOP). The information includes all the landfill gas-fired power plants in operational, candidate, potential, construction, shutdown, and planned status. The EPA updated the project's information, and this report located the updated project information until March 2021.

Based on the EPA project database, 35 operational, 49 candidates, 37 potential, 2 construction, 31 shutdowns, 4 planned, and 3 other landfill gas-fired projects were identified. EPA reported three (3) new operational landfill gas-fired while EPA removed two (2) operational projects in 2021 database compared to last year (2020) operational projects list. Table G-5 (Volume II, Appendix G) represents the operational landfill gas-fired power plants up to 2021. Figure 6-33 shows in the Texas map the location and the number of landfilling projects in each county which are operational. This report did not include either annual or OSP electricity savings and NO_x emission reductions per county from the landfill gas-fired projects, which could not be estimated.

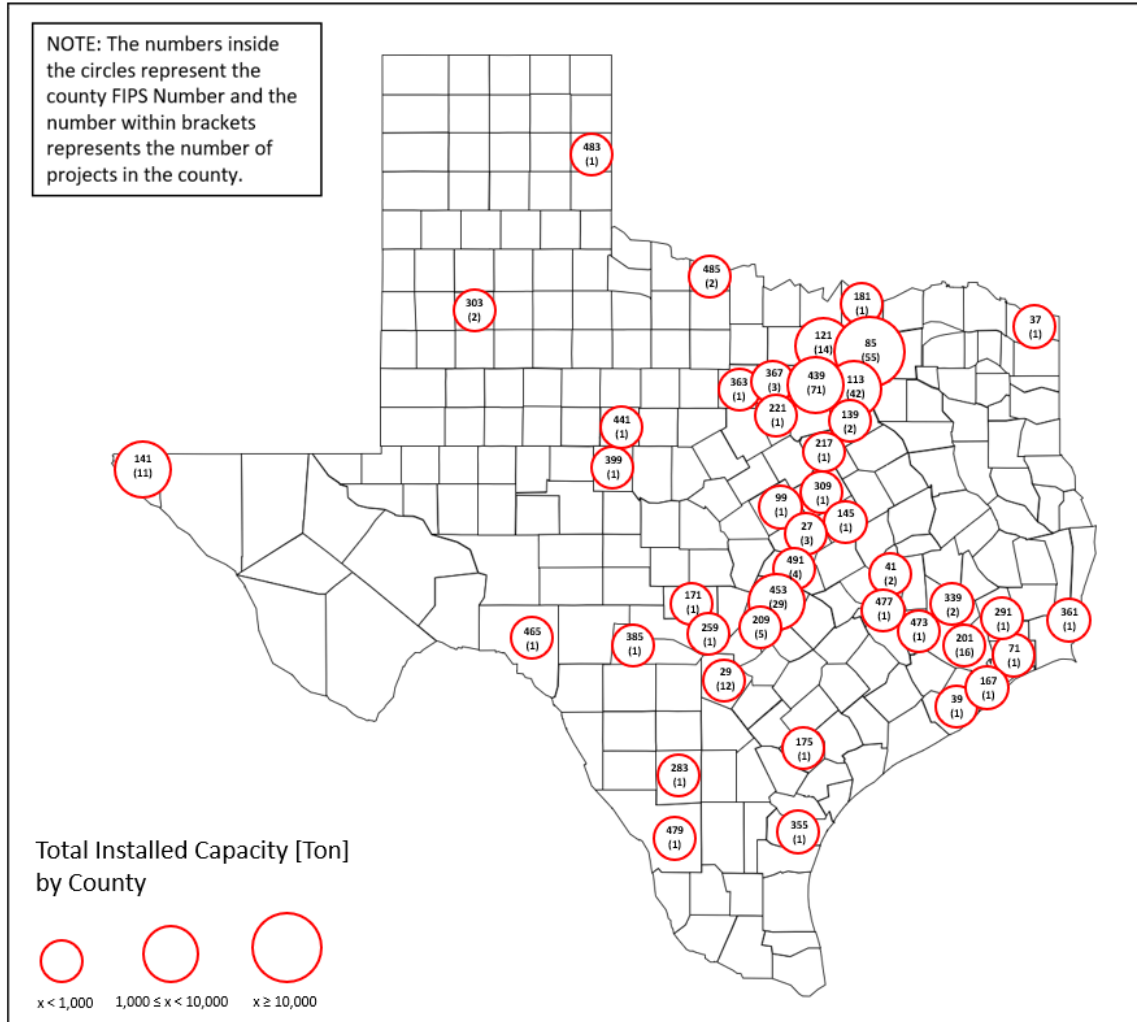


Figure 6-32: Map of Geothermal Projects Installed in Each County of Texas

Table 6-11: Geothermal Projects throughout Texas by 2021

County	FIPS Code	No. of Projects	Total Installed Capacity (Ton)	County	FIPS Code	No. of Projects	Total Installed Capacity (Ton)
Bell	27	3	208	La Salle	283	1	N/A
Bexar	29	12	80	Liberty	291	1	N/A
Bowie	37	1	N/A	Lubbock	303	2	800
Brazoria	39	1	N/A	McLennan	309	1	14
Brazos	41	2	90	Montgomery	339	2	70
Chambers	71	1	N/A	Nueces	355	1	N/A
Collin	85	55	13,144	Orange	361	1	50
Coryell	99	1	4	Palo pinto	363	1	N/A
Dallas	113	42	4,292	Parker	367	3	367
Denton	121	14	2,609	Real	385	1	120
Ellis	139	2	N/A	Runnels	399	1	N/A
El Paso	141	11	2,600	Tarrant	439	71	5,025
Falls	145	1	N/A	Taylor	441	1	N/A
Galveston	167	1	100	Travis	453	29	3,224
Gillespie	171	1	120	Val Verde	465	1	150
Goliad	175	1	N/A	Waller	473	1	70
Grayson	181	1	N/A	Washington	477	1	3
Harris	201	16	786	Webb	479	1	N/A
Hays	209	5	430	Wheeler	483	1	N/A
Hill	217	1	N/A	Wichita	485	2	1
Hood	221	1	N/A	Williamson	491	4	N/A
Kendall	259	1	N/A	N/A	-	5	1,437

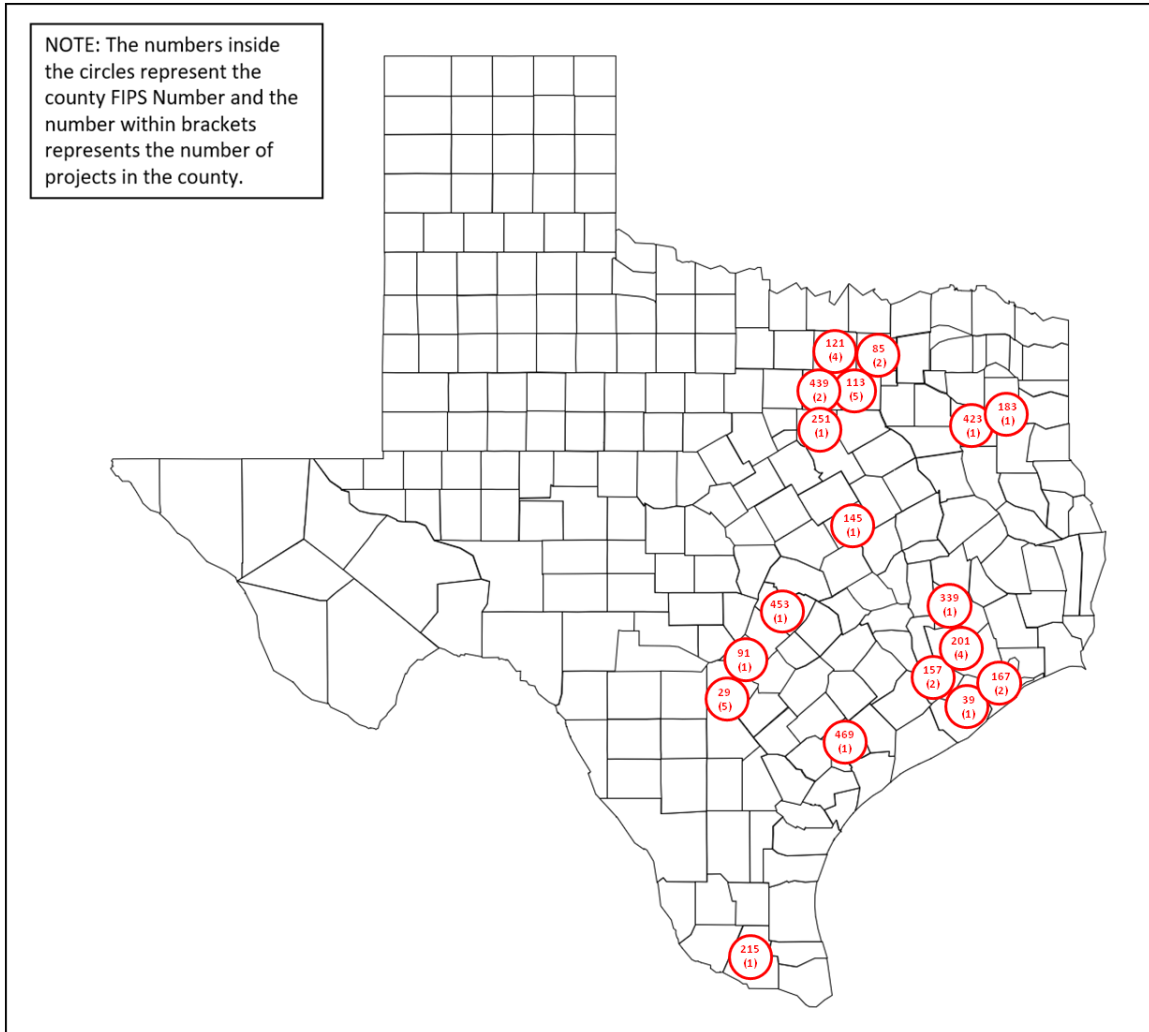


Figure 6-33: Map of Landfill Gas-Fired Projects Installed in Each County of Texas

Table 6-12: Landfill Gas-Fired Projects Installed throughout Texas by 2021

County	FIPS Code	No. of Projects
Bexar	29	5
Brazoria	39	1
Collin	85	2
Comal	91	1
Dallas	113	5
Denton	121	4
Ellis	139	0
Fort Bend	157	2
Galveston	167	2
Gregg	183	1
Harris	201	4
Hidalgo	215	1
Johnson	251	1
Montgomery	339	1
Smith	423	1
Tarrant	439	2
Travis	453	1
Victoria	469	1

6.3 Summary

The State of Texas leads the renewable energy development in the U.S. In June 2022, around 5,960 new renewable energy projects in Texas, which were not part of the previous report published, were identified, located and included in the present report. The details of the new project can be found in Table 6-13.

Table 6-13: Comparison of the Projects Identified from Previous and Present Reports

Renewable Energy Source	Number of Projects in 2020	Number of New Projects in 2021	Total Number of Projects in 2021
Solar Photovoltaic ^a	34,781	5,919	40,700
Solar Power	82	35	117
Solar Thermal	41	0	41
Biomass	12	0	12
Hydroelectric	30	3	33
Geothermal	306	0	306
Landfill Gas-Fired ^b	34	3	35 ^c

Note:

^a This TERP report used the *Tracking the Sun* public data.

^b Landfill gas-fired project information from EPA have seven sub-categories for their status: operational, candidates, potential, construction, shutdown, planned, and others. Only operational projects were considered.

^c Three (3) new landfill projects were added to the operational list while two projects from last year's operational list (2020) were removed.

This report also presents county-wide annual/OSP energy savings for solar photovoltaic including solar power, solar thermal, biomass, and hydroelectric projects. The annual/OSP energy savings calculation for non-utility scale solar photovoltaic was conducted based on the LBNL public dataset. The power generation data for the other utility scale renewable energy projects (solar power, biomass, and hydroelectric), which were obtained from the ERCOT and EIA, were used to evaluate the annual/OSP energy generation. The annual/OSP energy savings calculation for solar thermal was conducted based on the project data from various web sources. Then, the annual NO_x emission reductions calculation was conducted with the special version of Texas 2018 eGRID, based on their energy savings/generation.

In 2021, the total annual energy savings and the OSP daily average energy savings from each renewable projects across all the counties were:

- solar photovoltaic projects (non-utility scale): 607,389 MWh/yr and 1,885 MWh/day; in addition, solar power projects (utility-scale): 15,562,995 MWh/yr and 55,457 MWh/day,
- solar thermal projects: 255 MWh/yr and 0.7 MWh/day,
- biomass projects: 434,278 MWh/yr and 1,663 MWh/day, and
- hydroelectric projects: 597,687 MWh/yr and 2,316 MWh/day.

In 2021, the annual NO_x emission reductions from renewable projects across all the counties were:

- solar photovoltaic projects (non-utility scale): 299.6 tons/yr; in addition, solar power projects (utility-scale): 9,584.4 tons/yr,
- solar thermal projects: 0.1 tons/yr,
- biomass projects: 167.3 tons/yr, and
- hydroelectric projects: 239.2 tons/yr.

These savings and reductions do not represent all of the solar thermal projects in the State of Texas. They only reflect the projects based on the investigated resources.

7 REVIEW OF ERCOT'S RENEWABLE ENERGY CREDIT PROGRAM INFORMATION

7.1 Introduction

In this section, the information posted on ERCOT's Renewable Energy Credit (REC) Program site (www.texasrenewables.com) was reviewed for use in the Laboratory's report to the TCEQ. In particular, information posted under the "Public Reports" tab was downloaded and assembled into an appropriate format for review. This includes ERCOT's 2001 through 2021 reports to the Legislature, which were converted into a tabular format for analysis and insertion into this report (in Volume II, Appendix H). Similarly, information from ERCOT's listing of REC generators was inspected to determine how it compared with other sources of information the Laboratory has assembled.

7.2 Summary of Renewable Projects in Texas

Each year ERCOT is required to compile a list of grid-connected sources that generate electricity from renewable energy and report it to the Legislature. Table 7-1 shows quarterly electricity generation by renewable sources from 2001 to 2021. In Table 7-1, 2019 solar and 2020 wind, solar and hydro REC data is updated due to ERCOT's data modification this year. Table 7-2 contains the data reported by ERCOT from 2001 through 2021.

Figure 7-1, Figure 7-2, Figure 7-3 and Figure 7-4 have been included to better illustrate the annual data collected by ERCOT. In Figure 7-1, the annual total electricity generation of all the renewable sources is shown. In Figure 7-2, the annual electricity generation of renewable sources excluding wind is shown. In Figure 7-3, the annual electricity generation of renewable sources excluding wind and hydro is shown. Similarly, in Figure 7-4, the annual electricity generation of renewable sources excluding wind, hydro and landfill gas is shown. This was done to understand the contribution of individual energy sources to the total electricity generated.

In the figures and tables, it is clear to see that the electricity generated by wind each year is the largest single source of renewable energy in Texas. The renewable energy in Texas has grown from 596,236 MWh in 2001 to 117,751,978 MWh in 2021. This is followed by:

- Wind energy has grown from 565,597 MWh in 2001 to 101,310,613 MWh in 2021;
- Biomass energy has grown from 39,496 MWh in 2003 to 248,245 MWh in 2021;
- Hydroelectric energy has grown from 30,639 MWh in 2001 to 222,136 MWh in 2021;
- Landfill gas energy has grown from 29,412 MWh in 2002 to 209,019 MWh in 2021; and
- Solar energy has grown from 87 MWh in 2002 to 15,761,965 MWh in 2021.

Other sources of information present some differences in the values of the renewable electricity generated in Texas. It has been found some discrepancies between U.S. DOE Energy Information Administration (EIA) and ERCOT sources on electricity generation from wind, but it has been a small difference. In 2021, the wind electricity generation data from the ERCOT website is similar to the generation data from the EIA website. The EIA wind electricity generation for 2021 was 100,049 thousand MWh in a net generation, and EIA are 1.25% lower than ERCOT.

Table 7-1: Quarterly Electricity Generation by Renewable Sources, in MWh, for 2001–2021

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2001	0	0	0	0	0
Hydro	2001	0	0	11,293	19,346	30,639
Landfill gas	2001	0	0	0	0	0
Solar	2001	0	0	0	0	0
Wind	2001	0	0	201,118	364,479	565,597
Totals		0	0	212,411	383,825	596,236

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2002	0	0	0	0	0
Hydro	2002	105,817	69,165	80,154	56,956	312,093
Landfill gas	2002	8,216	7,073	6,986	7,137	29,412
Solar	2002	0	29	37	21	87
Wind	2002	611,708	716,896	622,262	500,618	2,451,484
Totals		725,741	793,163	709,440	564,732	2,793,076

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2003	8,876	11,253	10,999	8,368	39,496
Hydro	2003	92,680	52,592	71,699	22,713	239,684
Landfill gas	2003	29,995	44,629	39,920	39,662	154,206
Solar	2003	32	70	69	49	220
Wind	2003	561,994	670,248	617,794	665,446	2,515,482
Totals		693,577	778,792	740,481	736,238	2,949,087

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2004	6,274	11,459	11,482	7,725	36,940
Hydro	2004	55,638	52,735	52,350	74,067	234,791
Landfill gas	2004	52,801	47,964	53,659	49,018	203,443
Solar	2004	31	67	70	44	211
Wind	2004	815,010	1,014,396	610,157	770,066	3,209,630
Totals		929,755	1,126,621	727,718	900,920	3,685,014

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2005	13,921	15,069	14,764	14,883	58,637
Hydro	2005	108,974	106,893	61,189	33,246	310,302
Landfill gas	2005	52,118	51,193	56,166	54,301	213,777
Solar	2005	46	69	67	46	227
Wind	2005	801,232	1,246,182	869,508	1,304,646	4,221,568
Totals		976,291	1,419,406	1,001,693	1,407,122	4,804,512

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2006	16,327	10,479	17,152	16,610	60,569
Hydro	2006	55,000	83,064	44,870	27,143	210,077
Landfill gas	2006	69,191	78,650	75,665	82,580	306,087
Solar	2006	26	43	41	360	470
Wind	2006	1,478,927	1,584,166	1,376,540	2,091,295	6,530,928
Totals		1,619,471	1,756,403	1,514,268	2,217,988	7,108,131

Table 7-1: Quarterly Electricity Generation by Renewable Sources, in MWh, for 2001–2021 (Continued)

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2007	13,052	15,870	13,073	12,105	54,101
Hydro	2007	66,084	120,486	139,965	56,346	382,882
Landfill gas	2007	84,367	86,372	85,612	99,987	356,339
Solar	2007	339	503	541	461	1,844
Wind	2007	1,961,153	2,029,807	2,020,870	3,339,338	9,351,168
Totals		2,124,995	2,253,039	2,260,062	3,508,238	10,146,333

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2008	21,154	14,019	12,564	23,095	70,833
Hydro	2008	98,510	177,051	78,751	91,116	445,428
Landfill gas	2008	105,217	97,361	88,470	96,062	387,110
Solar	2008	446	862	992	1,038	3,338
Wind	2008	4,030,973	4,737,188	2,639,509	4,878,770	16,286,440
Totals		4,256,300	5,026,481	2,820,287	5,090,081	17,193,150

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2009	25,083	18,938	17,187	12,156	73,364
Hydro	2009	76,480	179,512	88,491	163,024	507,507
Landfill gas	2009	94,377	101,709	104,854	111,983	412,923
Solar	2009	101	1,409	1,761	1,222	4,492
Wind	2009	5,413,648	5,385,203	4,248,223	5,549,030	20,596,105
Totals		5,609,689	5,686,771	4,460,516	5,837,415	21,594,390

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2010	20,974	27,769	17,407	31,385	97,535
Hydro	2010	196,238	133,408	192,252	87,358	609,257
Landfill gas	2010	110,511	114,893	116,789	122,711	464,904
Solar	2010	1,385	2,042	3,483	7,539	14,449
Wind	2010	6,459,442	7,806,011	5,307,840	7,255,367	26,828,660
Totals		6,788,550	8,084,123	5,637,771	7,504,361	28,014,805

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2011	26,692	20,039	24,890	65,383	137,004
Hydro	2011	60,614	102,583	55,029	48,887	267,113
Landfill gas	2011	121,232	135,365	122,790	118,258	497,645
Solar	2011	7,390	10,160	11,202	7,827	36,580
Wind	2011	7,447,218	9,540,116	5,849,557	7,932,783	30,769,674
Totals		7,663,146	9,808,263	6,063,468	8,173,139	31,708,016

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2012	41,567	95,834	100,633	50,954	288,988
Hydro	2012	122,942	125,992	68,908	71,355	389,197
Landfill gas	2012	129,505	132,653	144,644	142,235	549,037
Solar	2012	17,299	41,246	44,007	36,887	139,439
Wind	2012	8,938,807	8,399,672	6,376,312	9,031,743	32,746,534
Totals		9,250,120	8,795,396	6,734,504	9,333,174	34,113,195

Table 7-1: Quarterly Electricity Generation by Renewable Sources, in MWh, for 2001–2021 (Continued)

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2013	36,648	36,622	78,316	48,976	200,564
Hydro	2013	118,008	58,910	37,467	79,853	294,238
Landfill gas	2013	132,757	138,876	136,378	142,834	550,845
Solar	2013	36,112	44,268	57,165	40,781	178,326
Wind	2013	9,702,680	11,386,839	6,708,823	9,111,043	36,909,385
Totals		10,026,205	11,665,516	7,018,149	9,423,488	38,133,358

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2014	67,700	88,454	111,573	75,743	343,469
Hydro	2014	39,915	106,890	47,850	46,138	240,792
Landfill gas	2014	130,630	130,738	126,337	130,876	518,580
Solar	2014	54,330	80,675	100,351	77,402	312,757
Wind	2014	10,474,109	11,930,083	7,735,157	10,505,013	40,644,362
Totals		10,766,684	12,336,839	8,121,267	10,835,171	42,059,961

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2015	101,209	60,737	111,231	76,422	349,600
Hydro	2015	88,592	153,061	76,269	96,366	414,289
Landfill gas	2015	136,295	132,252	145,414	147,953	561,915
Solar	2015	79,124	109,563	137,757	83,875	410,318
Wind	2015	8,957,407	11,909,543	10,763,871	13,534,520	45,165,341
Totals		9,362,627	12,365,157	11,234,542	13,939,137	46,901,462

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2016	57,139	50,673	87,606	52,224	247,643
Hydro	2016	117,562	137,075	86,712	52,392	393,740
Landfill gas	2016	145,658	132,271	121,302	119,174	518,403
Solar	2016	142,149	181,690	291,644	232,927	848,410
Wind	2016	15,226,603	13,799,634	13,335,532	15,434,392	57,796,161
Totals		15,689,111	14,301,343	13,922,795	15,891,109	59,804,357

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2017	69,465	54,806	37,671	54,489	216,431
Hydro	2017	117,264	150,743	129,146	47,300	444,453
Landfill gas	2017	116,195	116,211	109,684	104,029	446,119
Solar	2017	388,388	640,167	713,644	547,195	2,289,394
Wind	2017	18,415,248	18,112,145	12,667,406	17,054,441	66,249,240
Totals		19,106,560	19,074,073	13,657,550	17,807,453	69,645,636

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2018	69,323	95,818	83,508	38,364	287,014
Hydro	2018	103,841	125,344	58,133	47,142	334,460
Landfill gas	2018	101,233	96,217	97,221	100,756	395,428
Solar	2018	603,579	924,274	985,609	669,777	3,183,238
Wind	2018	19,518,189	22,106,314	14,445,761	17,890,313	73,960,577
Totals		20,396,165	23,347,967	15,670,232	18,746,352	78,160,716

Table 7-1: Quarterly Electricity Generation by Renewable Sources, in MWh, for 2001–2021 (Continued)

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2019	39,315	18,885	76,082	19,250	153,531
Hydro	2019	63,622	110,156	57,341	35,599	266,718
Landfill gas	2019	101,180	83,434	78,870	71,878	335,361
Solar	2019	771,136	1,275,379	1,444,295	1,002,035	4,492,846
Wind	2019	19,767,639	21,050,791	19,512,263	21,439,607	81,770,300
Totals		20,742,892	22,538,645	21,168,850	22,568,370	87,018,756

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2020	38,198	14,600	63,198	24,881	140,878
Hydro	2020	82,394	58,587	37,743	43,528	222,252
Landfill gas	2020	70,709	70,958	66,135	62,575	270,377
Solar	2020	1,219,107	2,535,593	3,015,940	1,999,198	8,769,838
Wind	2020	23,626,732	25,304,220	19,768,237	24,807,869	93,507,058
Totals		25,037,139	27,983,958	22,951,253	26,938,051	102,910,401

Technology Type	Year	Quarter1	Quarter2	Quarter3	Quarter4	Total MWh
Biomass	2021	16,557	19,870	158,958	52,860	248,245
Hydro	2021	58,030	76,336	56,975	30,795	222,136
Landfill gas	2021	54,668	52,031	51,826	50,493	209,019
Solar	2021	2,524,351	4,112,873	5,391,584	3,733,157	15,761,965
Wind	2021	25,688,698	26,580,729	20,791,664	28,249,522	101,310,613
Totals		28,342,304	30,841,840	26,451,007	32,116,828	117,751,978

Table 7-2: Annual Electricity Generation by Renewable Sources (MWh, ERCOT: 2001–2021)

Year	Biomass (MWh)	Hydro (MWh)	Landfill gas (MWh)	Solar (MWh)	Wind (MWh)	Total (MWh)
2001	0	30,639	0	0	565,597	596,236
2002	0	312,093	29,412	87	2,451,484	2,793,076
2003	39,496	239,684	154,206	220	2,515,482	2,949,087
2004	36,940	234,791	203,443	211	3,209,630	3,685,014
2005	58,637	310,302	213,777	227	4,221,568	4,804,512
2006	60,569	210,077	306,087	470	6,530,928	7,108,131
2007	54,101	382,882	356,339	1,844	9,351,168	10,146,333
2008	70,833	445,428	387,110	3,338	16,286,440	17,193,150
2009	73,364	507,507	412,923	4,492	20,596,105	21,594,390
2010	97,535	609,257	464,904	14,449	26,828,660	28,014,805
2011	137,004	267,113	497,645	36,580	30,769,674	31,708,016
2012	288,988	389,197	549,037	139,439	32,746,534	34,113,195
2013	200,564	294,238	550,845	178,326	36,909,385	38,133,358
2014	343,469	240,792	518,580	312,757	40,644,362	42,059,961
2015	349,600	414,289	561,915	410,318	45,165,341	46,901,462
2016	247,643	393,740	518,403	848,410	57,796,161	59,804,357
2017	216,431	444,453	446,119	2,289,394	66,076,742	69,473,139
2018	287,014	334,460	395,428	3,183,238	73,960,577	78,160,716
2019	153,531	266,718	335,361	4,492,846	81,770,300	87,018,756
2020	140,878	222,252	270,377	8,769,838	93,507,058	102,910,401
2021	248,245	222,136	209,019	15,761,965	101,310,613	117,751,978

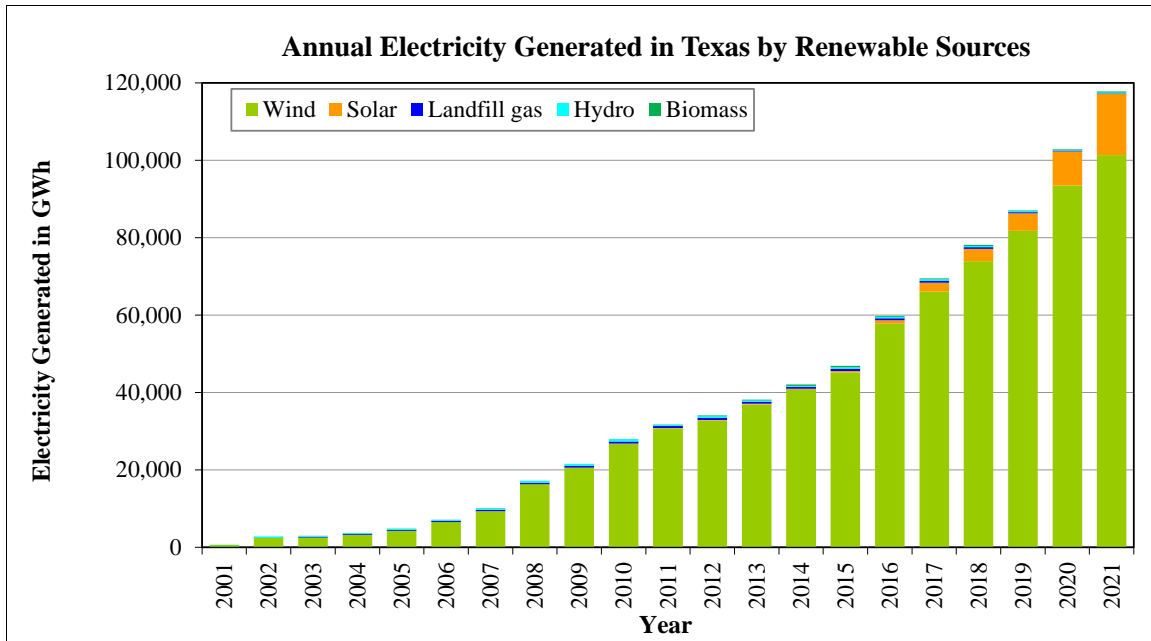


Figure 7-1: Electricity Generation by Renewable Sources (ERCOT: 2001–2021 Annually)

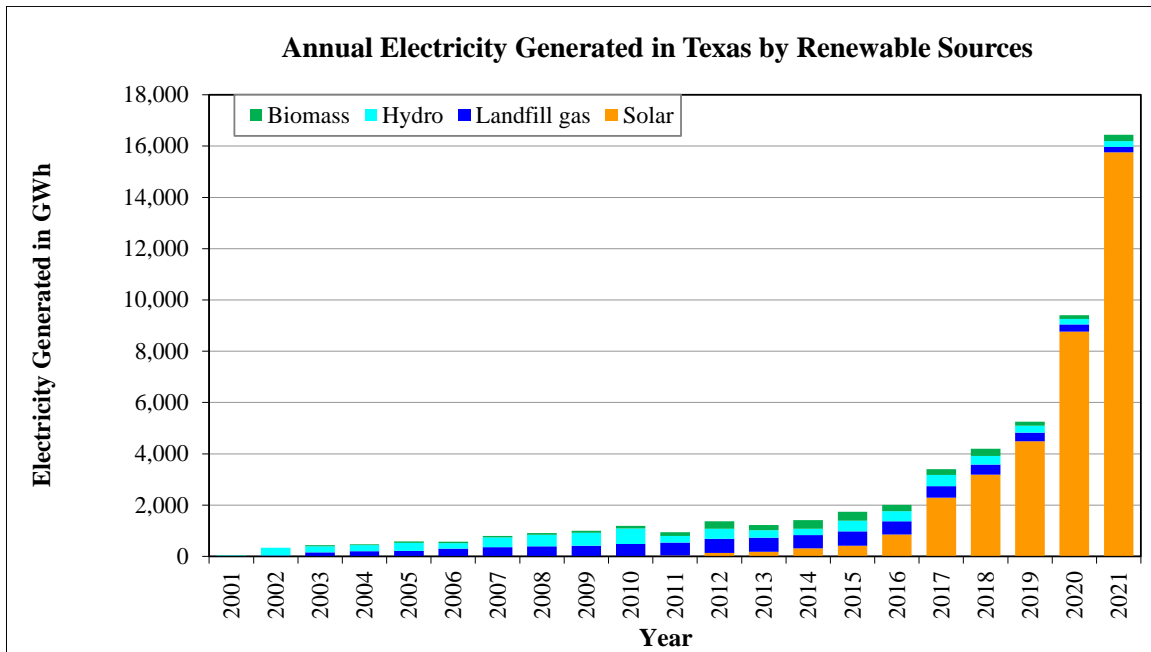


Figure 7-2: Electricity Generation by Renewable Sources Other than Wind (ERCOT: 2001–2021 Annually)

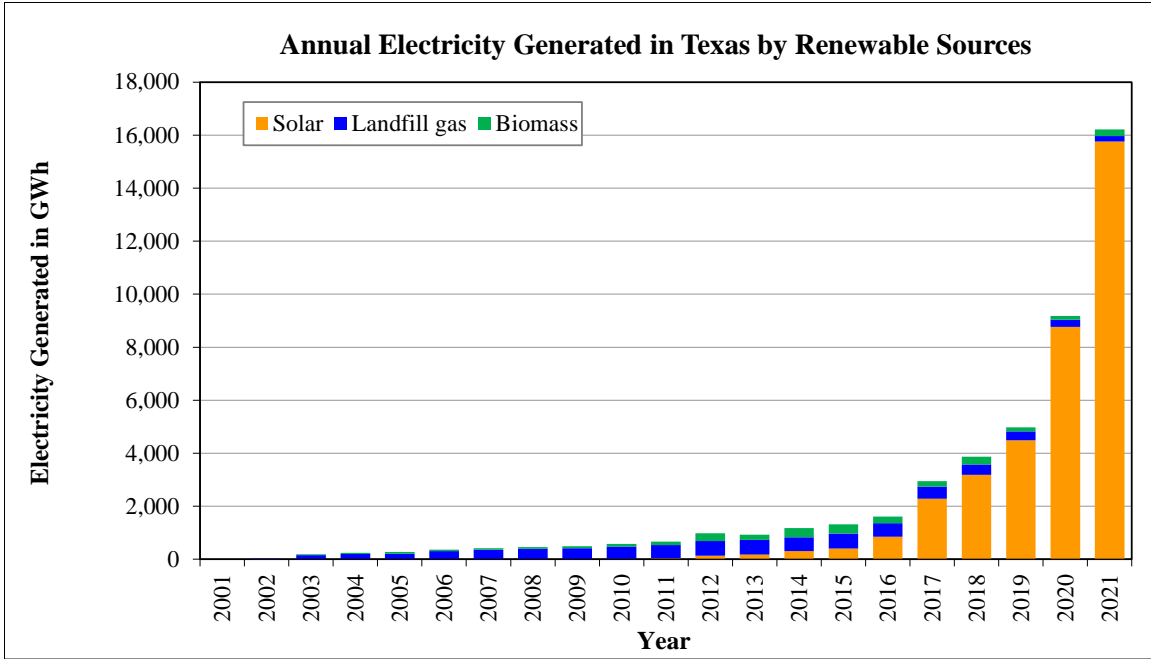


Figure 7-3: Electricity Generation by Renewable Sources from Solar, Landfill Gas, and Biomass (ERCOT: 2001–2021 Annually)

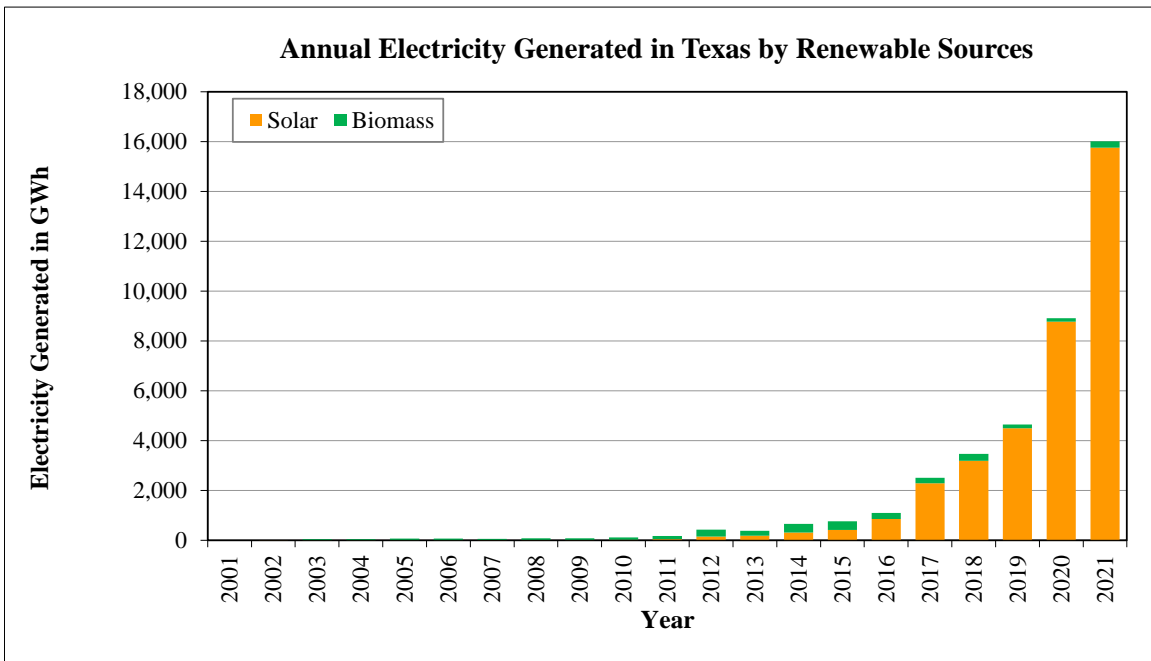


Figure 7-4: Electricity Generation by Renewable Sources from Solar and Biomass (ERCOT: 2001–2021 Annually)

8 REFERENCES

USEPA. (2008) "Estimation of Annual Reductions of NOx Emissions in ERCOT for the HB3693 Electricity Savings Goals", December 2008, Energy Systems Laboratory Report No. ESL-TR-08-12-04

Baltazar, Juan-Carlos; Haberl, Jeff; Yazdani, Bahman; Li, Qinbo; Claridge, David; Azimi, Mitra; Ahn, Jounghwan; Sun, Yu. "Statewide Air Emissions Calculations from Wind and other Renewables VOL I", July 2021, Energy Systems Laboratory Report No. ESL-TR-21-07-01.

Baltazar, Juan-Carlos; Haberl, Jeff; Yazdani, Bahman; Li, Qinbo; Claridge, David; Azimi, Mitra; Ahn, Jounghwan; Sun, Yu. "Statewide Air Emissions Calculations from Wind and other Renewables VOL II", July 2021, Energy Systems Laboratory Report No. ESL-TR-21-07-02.

ERCOT. (2022). 2021 ERCOT Annual REC Report. Retrieved June 01, 2022, from: <https://sa.ercot.com/rec/public-reports>

ERCOT. (2022). REC Generator List. Retrieved June 01, 2022, from: <https://sa.ercot.com/rec/rec-generator>

ERCOT. (2022). Quarter / Annual Renewable Energy Generation in Texas by Technology Type. Retrieved June 01, 2022, from: <https://sa.ercot.com/rec/account-tech>

LBL. (2022). Tracking the Sun. Retrieved June 01, 2022, from: <https://emp.lbl.gov/tracking-the-sun>

NOAA. (2022). Local Climatological Data (LCD). Retrieved from: <https://www.ncei.noaa.gov/products/land-based-station/local-climatological-data>

PUCT. (2022). New Electric Generating Plants in Texas since 1995. Retrieved June 09, 2022, from: <http://www.puc.texas.gov/industry/Electric/reports/Default.aspx>

Simplemaps. (2022). Retrieved June 01, 2022, from: <https://simplemaps.com>

USEPA. (2022). Emissions & Generation Resource Integrated Database (eGRID). Retrieved June 09, 2022, from: <https://www.epa.gov/egrid>

USEPA. (2022). Landfill Technical Data. Retrieved June 09, 2022, from: <https://www.epa.gov/lmop/landfill-technical-data>

Useful information was obtained from the following websites:

- <http://205.254.135.7/cneaf/electricity/page/eia860.html>
- <http://www.fhp-mfg.com/>
- http://geo-energy.org/plants_dev.aspx#Texas
- <http://www.energyhomes.org/projects.html>
- <https://www.eia.gov/electricity/data.php#generation>
- <http://www.eia.gov/state/?sid=TX>
- <http://www.eia.gov/renewable/data.cfm>
- <https://www.thewindpower.net/>
- <http://www.ercot.com/gridinfo/resource>
- https://www.gem.wiki/Cone_Renewable_Energy_Project_wind_farm
- <http://txsolarpower.org/resources/>
- <https://emp.lbl.gov/tracking-the-sun/>
- https://www.ercot.com/files/docs/2022/05/16/CapacityDemandandReservesReport_May2022.pdf
- <https://www.windpowerengineering.com/rwe-completes-220-mw-cranell-wind-farm-in-texas/>
- https://www.tceq.texas.gov/assets/public/comm_exec/pubs/rg/rg388/rg-388.pdf
- <https://www.eia.gov/electricity/data/browser>
- <https://www.tceq.texas.gov/airquality/sip/texas-sip>