TEXAS UTILITY ELECTRICITY AND THE ELECTRIC BUTTERFLY™

AN EXPLORATORY STUDY FOR THE JLN SOLAR ELECTRIC BUTTERFLY™

28 SEPTEMBER 2020

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1- SUMMARY OF TEXAS ENERGY PRODUCTION FACTS

QUICK FACTS (From the USA Energy Information Administration.
(Data Last Updated: March 19, 2020**)**

- Texas is the top U.S. producer of both crude oil and natural gas. In 2019, the state accounted for 41% of the nation's crude oil production and 25% of its marketed natural gas production.

- As of January 2019, the 30 petroleum refineries in Texas were able to process about 5.8 million barrels of crude oil per day and accounted for 31% of the nation's refining capacity.

- **Texas leads the nation in wind-powered generation and produced about 28% of all the U.S. wind-powered electricity in 2019**. Texas wind turbines have produced more electricity than both of the state's nuclear power plants since 2014.

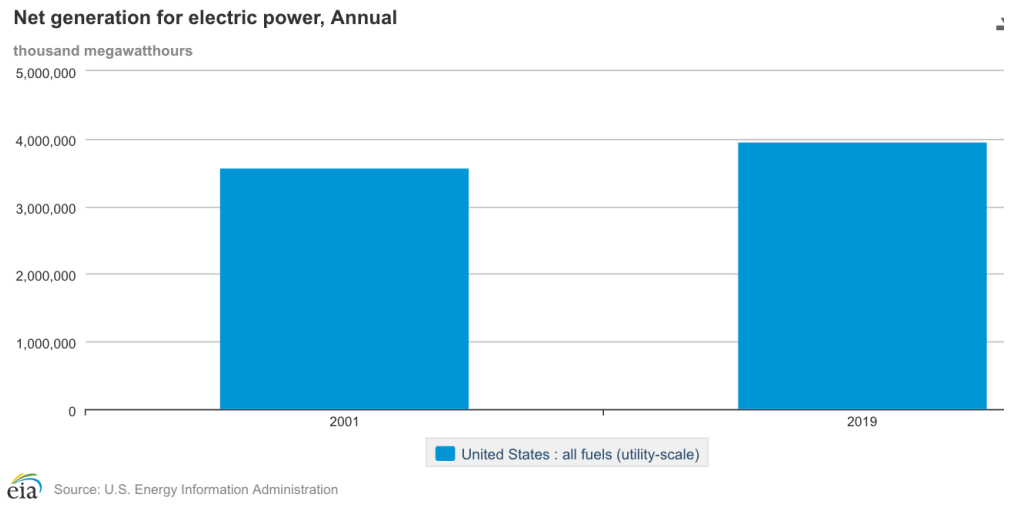
- **Texas produces more electricity than any other state**, generating almost twice as much as Florida, the second-highest electricity-producing state.

- **Texas is the largest energy-producing and energy-consuming state in the nation**. The industrial sector, including its refineries and petrochemical plants, accounts for half of the energy consumed in the state.

2- TX ELECTRICITY GENERATION PROFILE

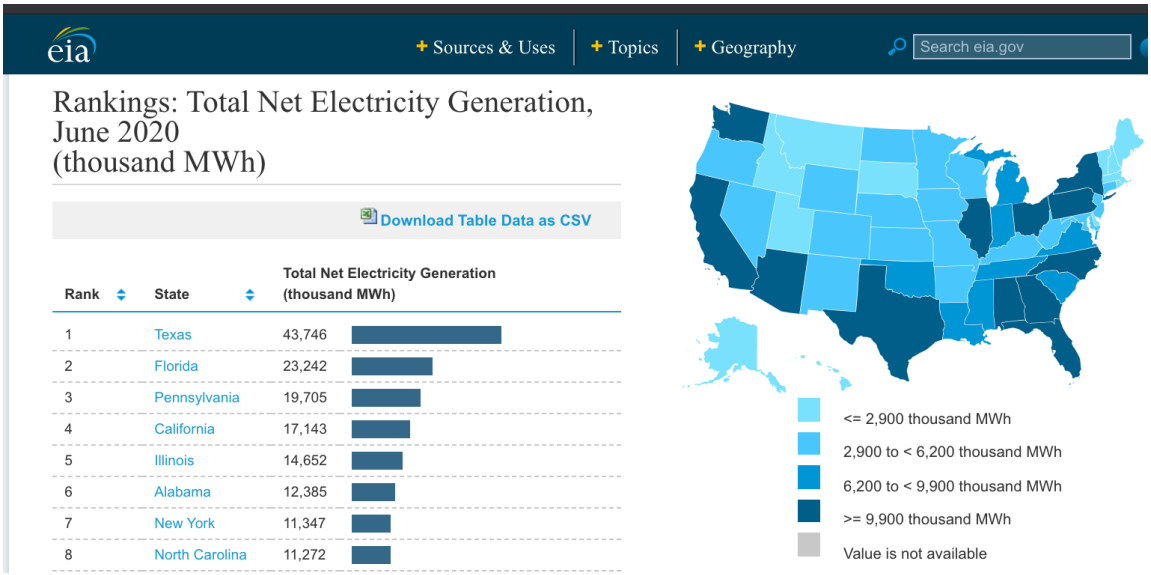
	2016	2017	2018	2019
Texas				
All fuels	410,076	410,083	432,030	436,809
Coal	121,231	134,648	111,723	91,822
Petroleum liquids	79	72	57	44
Petroleum coke	0	0	0	0
Natural gas	185,014	164,379	197,031	211,727
Other gases	1,318	1,482	1,413	1,699
Nuclear	42,079	38,581	41,186	41,298
Conventional hydroelectric	1,342	1,060	1,125	997
Other renewables (total)	58,915	69,801	79,427	89,135
Wind	57,483	67,008	75,637	84,363
All utility-scale solar	729	2,187	3,204	4,316
Geothermal	--	--	--	--
Biomass (total)	704	606	586	456
Wood and wood-derived fuels	117	83	158	72
Other biomass	586	523	429	384
Hydro-electric pumped storage	--	--	--	--
Other	97	59	68	86
All solar	--	--	--	--
Small-scale solar photovoltaic	--	--	--	--
All utilitv-scale solar	729	2.187	3.204	4.316

As a reference point to TX generation of electricity excellence and to put in perspective, we can consider the total US electric generation capacity as shown in the graph bellow:



Thus, using official government yearly figures from 2019; when the USA had an electricity generation of nearly 4,000,000 MWh and TX 436,809 MWh, we can estimate TX generated around 11% of all electricity generation of the USA.

In other words, and using more recent monthly figures for the month of June 2020, the state of Texas has the number 1 ranking in electricity generation in the Union :



3- TX ELECTRICITY DOMESTIC CONSUMPTION: UTILITIES

Texas Electricity Profile 2018

Table 1. 2018 Summary statistics (Texas)

Item	Value	Rank
Primary energy source		**Natural gas**
Net summer capacity (megawatts)	**122,159**	**1**
Electric utilities	29,542	2
IPP & CHP	92,617	1
Net generation (megawatthours)	**477,352,425**	**1**
Electric utilities	92,964,516	8
IPP & CHP	384,387,908	1
Emissions		
Sulfur Dioxide (short tons)	224,145	1
Nitrogen Oxide short tons)	188,316	1
Carbon Dioxide (thousand metric tons)	230,076	1
Sulfur Dioxide (lbs/MWh)	0.9	15
Nitrogen Oxide (lbs/MWh)	0.8	23
Carbon Dioxide (lbs/MWh)	1,060	23
Total retail sales (megawatthours)	**424,418,628**	**1**
Full service provider sales	424,418,628	1
Energy-only provider sales	.	.
Direct use (megawatthours)	**38,490,458**	**1**
Average retail price (cents/kWh)	**8.48**	**44**

Sources: U.S. Energy Information Administration, Form EIA-860, *Annual Electric Generator Report*, U.S. Energy Information Administration, Form EIA-861, *Annual Electric Power Industry Report,* U.S. Energy Information Administration, Form EIA-923, *Power Plant Operations Report* and predecessor forms.

Definitions/Acronyms:
IPP = Independent Power Producer
CHP= Combined Heat and Power plant(s)

Texas private industrial sector of independent power producers (IPP), combined heat and power plants (CHP) account for the majority of the electricity generated by the state, specifically and using the most recent data for 2018 indicate IPP and CHP electric generation accounted for 384,387, 908 MWh, whereas the electric utility sector, that provides all electricity for domestic consumption by residential and commercial end users in TX is just a fraction of the electricity generated by IPPs and CHPs. As it can be

seen in the table above, in 2018 the Energy Information Administration estimated utilities in TX generated a total of **92,964,516 MWh**.

4- THE POWER AND ENERGY OF THE ELECTRIC BUTTERFLY™

The PV Module to be used in the Electric Butterfly, is based on the American invented and developed CIGS ($CuInGaSe_2$) thin film PV technology. CIGS PV Modules are the most advanced and the most efficient among the thin film technologies. Today, the efficiency of a laboratory solar cell is 23.3%, the champion module efficiency is slightly in excess of 18.5%, and the shipped commercial module is between 14% and 16% efficient. JLN SOLAR,INC. projects its module efficiency resulting from the first pilot 125 MW plant to be between 15% - 16%, with potential continuous improvements towards >18% efficiency. The module is 1240mm x 630mm with a rating of about 120-130 W.

5- THE ELECTRIC BUTTERFLY™ ENERGY YIELD IN THREE DIFFERENT GEOGRAPHICAL LOCATIONS OF TEXAS

To model the energy output of the Electric Butterfly, the following assumption are used as input in the NREL PV Watts simulation software:

1) Modules are rated at 125W each, thus, 125x72 =9kW for the system capacity
2) dual-axis tracking
3) Standard module efficiency of 15%
4) Thermal coefficient of power loss -0.47 %/˚C
5) 10% system losses
6) Inverter efficiency of 96%
7) DC to AC size ratio 1.2
8) Three locations in TX are modelled:
    Austin, TX
    Fort Stockton, TX
    Kingsville, TX

5.1- Austin, TX results

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The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

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The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

18,782 kWh/Year*

System output may range from 18,147 to 19,304 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	5.87	1,324	138
February	6.67	1,343	140
March	6.60	1,454	152
April	7.67	1,626	170
May	7.94	1,705	178
June	8.87	1,810	189
July	9.04	1,889	197
August	9.06	1,866	195
September	8.02	1,633	170
October	7.15	1,544	161
November	6.45	1,369	143
December	5.40	1,219	127
Annual	7.40	18,782	$ 1,960

Location and Station Identification	
Requested Location	Ausitin ,tx
Weather Data Source	Lat, Lon: 30.25, -97.74 1.1 mi
Latitude	30.25° N
Longitude	97.74° W

PV System Specifications *(Residential)*	
DC System Size	9 kW
Module Type	Standard
Array Type	2-Axis Tracking
Array Tilt	0°
Array Azimuth	180°
System Losses	10%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics	
Average Retail Electricity Rate	0.104 $/kWh

5.2- Fort Stockton, TX

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The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

23,048 kWh/Year*

System output may range from 22,534 to 24,385 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	8.07	1,782	196
February	8.20	1,636	180
March	9.48	2,066	227
April	10.17	2,106	231
May	10.47	2,192	241
June	10.66	2,169	238
July	10.42	2,157	237
August	9.56	1,998	219
September	9.20	1,853	203
October	8.35	1,792	197
November	7.71	1,646	181
December	7.43	1,652	181
Annual	9.14	23,049	$ 2,531

Location and Station Identification

Requested Location	fort stokton, tx
Weather Data Source	Lat, Lon: 30.89, -102.9 1.0 mi
Latitude	30.89° N
Longitude	102.9° W

PV System Specifications *(Residential)*

DC System Size	9 kW
Module Type	Standard
Array Type	2-Axis Tracking
Array Tilt	0°
Array Azimuth	180°
System Losses	10%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.110 $/kWh

Performance Metrics

Capacity Factor	29.2%

5.3- Kingsville, TX

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The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

19,201 kWh/Year*

System output may range from 18,706 to 19,773 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	5.47	1,232	135
February	6.72	1,333	146
March	7.20	1,569	172
April	7.81	1,631	179
May	8.27	1,756	193
June	9.46	1,962	215
July	9.23	1,955	215
August	9.22	1,947	214
September	7.55	1,557	171
October	7.92	1,702	187
November	6.45	1,368	150
December	5.35	1,190	131
Annual	7.55	19,202	$ 2,108

Location and Station Identification

Requested Location	Kingsville, TX
Weather Data Source	Lat, Lon: 27.49, -97.86 1.2 mi
Latitude	27.49° N
Longitude	97.86° W

PV System Specifications *(Residential)*

DC System Size	9 kW
Module Type	Standard
Array Type	2-Axis Tracking
Array Tilt	0°
Array Azimuth	180°
System Losses	10%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.110 $/kWh

Performance Metrics

Capacity Factor	24.4%

6- THE ELECTRIC BUTTERFLY SOLUTION FOR UTILITY ELECTRICITY AND TX DOMESTIC ELECTRICITY CONSUMPTION

Considering the most recent data on the annual **utility electricity** generated in TX (92,964,516 MWh), we can estimate the following number of Electric Butterfly units needed to supply TX with all utility generated electricity that is consumed domestically by the residential and commercial end users in the state:

6.1- AUSTIN, TX LOCATION

92,964,516,000 kWh / 18,782 kWh. = **4,949,660** Electric Butterflies would be needed in the Austin, TX area to supply the entire state of TX with its yearly demand for utility electricity

6.2- FORT STOCKTON, TX LOCATION

92,964,516,000 kWh / 23,048 kWh. = **4,033,518** Electric Butterflies would be needed in the Fort Stockton, TX area to supply the entire state of TX with its yearly demand for utility electricity

6.3- KINGSVILLE, TX LOCATION

92,964,516,000 kWh / 19,201 kWh. = **4,841,650** Electric Butterflies would be needed in the Kingsville, TX area to supply the entire state of TX with its yearly demand for utility electricity

All of the above figures consider a standard module efficiency of 15%. Higher efficiencies will reduce the number of electric Butterflies accordingly. For instance, and to a first approximation, the number of Electric Butterflies needed to supply a given demand, would be reduced by 25% [1-(15/20)] if PV modules with an efficiency of 20% are employed. Similarly, a projected module efficiency of 18% is used, the number of Electric Butterfly units can be reduced by [1-(15/18)] approximately 17%.

REFERENCES

1) Energy Information Agency (www.eia.gov)

2) NREL PV Watts (https://pvwatts.nrel.gov/)