ANALYSIS OF CARBON DIOXIDE EMISSIONS FROM NON-RENEWABLE SOURCES AND SUSTAINABLE APPROACH TO A GREENER FUTURE.

Practicum Project

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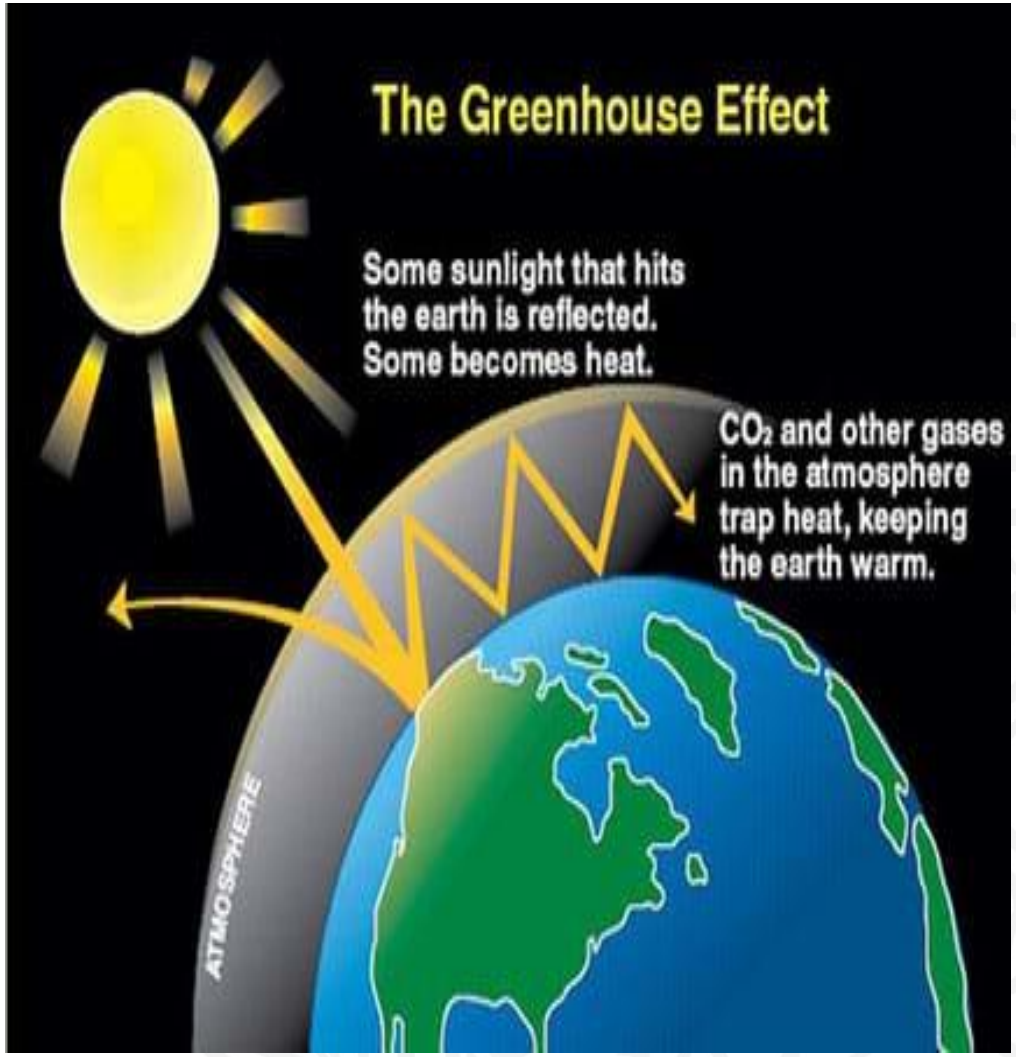
Introduction

Greenhouse gases primarily Carbon Dioxide emissions, a major contributor towards Global Warming. Excessive concentrations of greenhouse gases increase the earth's atmospheric temperature by reflecting the radiations back to the earth's surface.

Man made sources include the burning of fossil fuels, production of metals from mineral ores. We will discuss about the major sources of fossil fuels like Coal, Natural Gas Dry and Plant Liquid, and Crude Oil or Petroleum that causes Carbon Dioxide emissions.

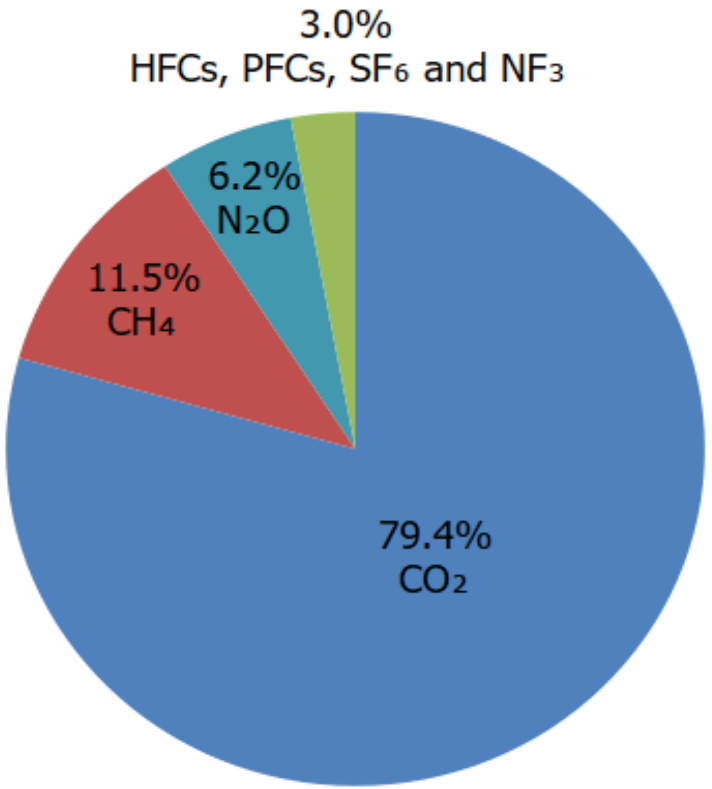
The growth of energy production from renewable sources is mitigating the ill effects of carbon emissions.



Types of Greenhouse Gases

There are four major types of Greenhouse gases in the atmospheric air are Carbon dioxide, methane, nitrous oxide, and fluorinated gases like HFCs, CFCs, etc.

Out of these constituents, Carbon dioxide is the most abundant greenhouse available. It is almost 79 percent of the greenhouse gases emitted in total in United States.

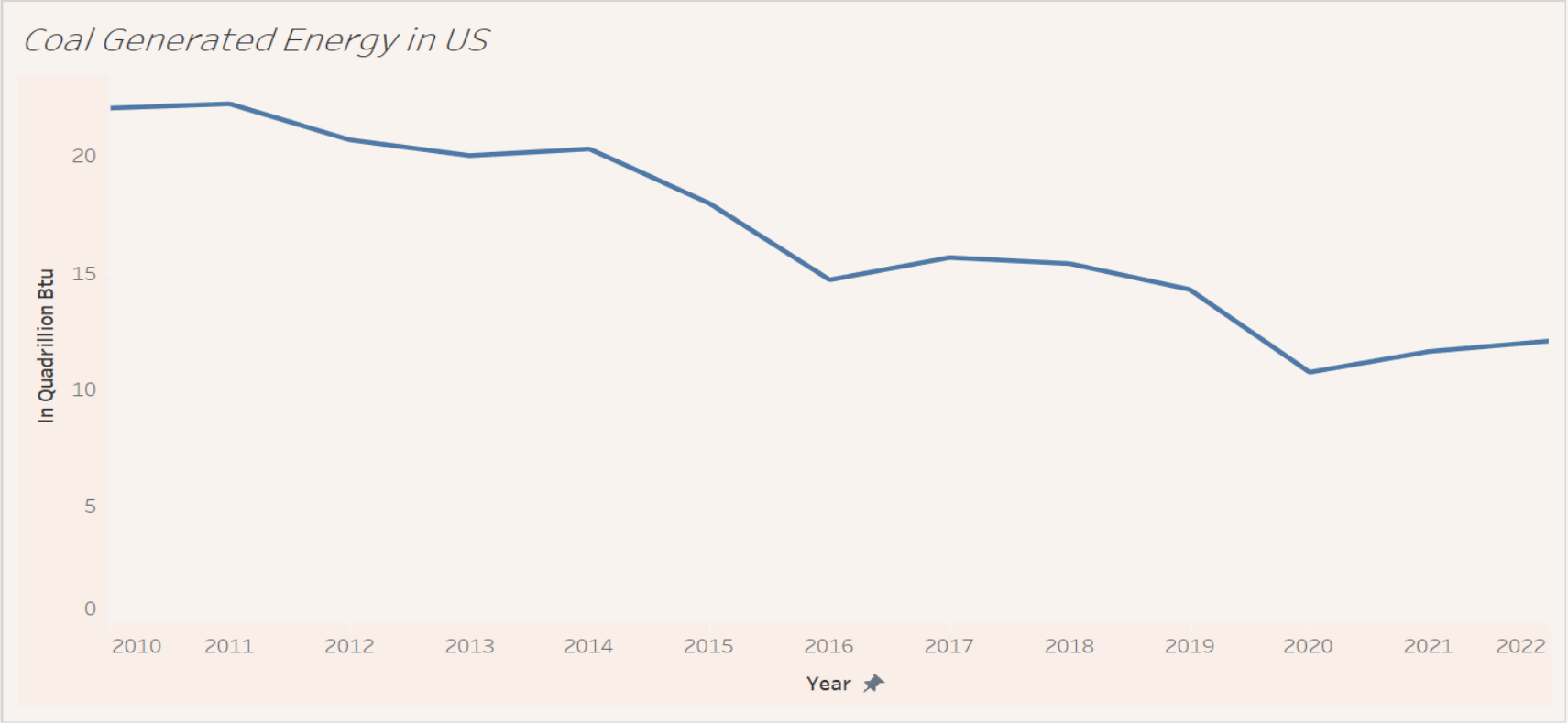


Major Sources of Carbon Dioxide Emissions in US - Coal

Coal contributes maximum volumes of Carbon dioxide emissions in the earth's atmosphere among all other non-renewable fossil fuels.

Sixty percent of electricity is generated from coal combustion in United States.

In 2020 the energy production is lowest due to restrictions in mobility during pandemic.

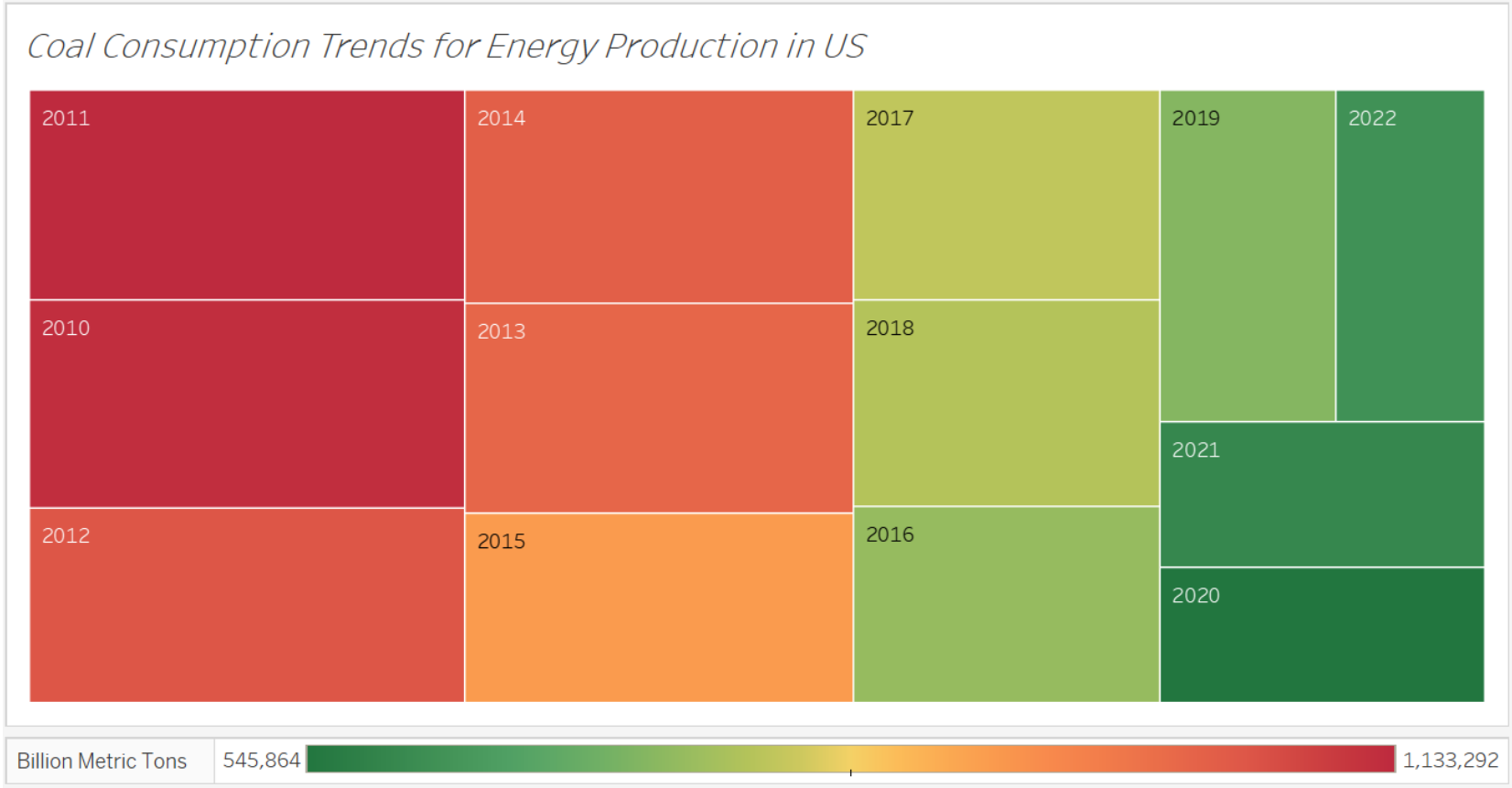


Consumption of Coal for Power in United States

Coal mining is equally an environmental threat causing ecological balance like landslides, earthquakes, land and marine pollution.

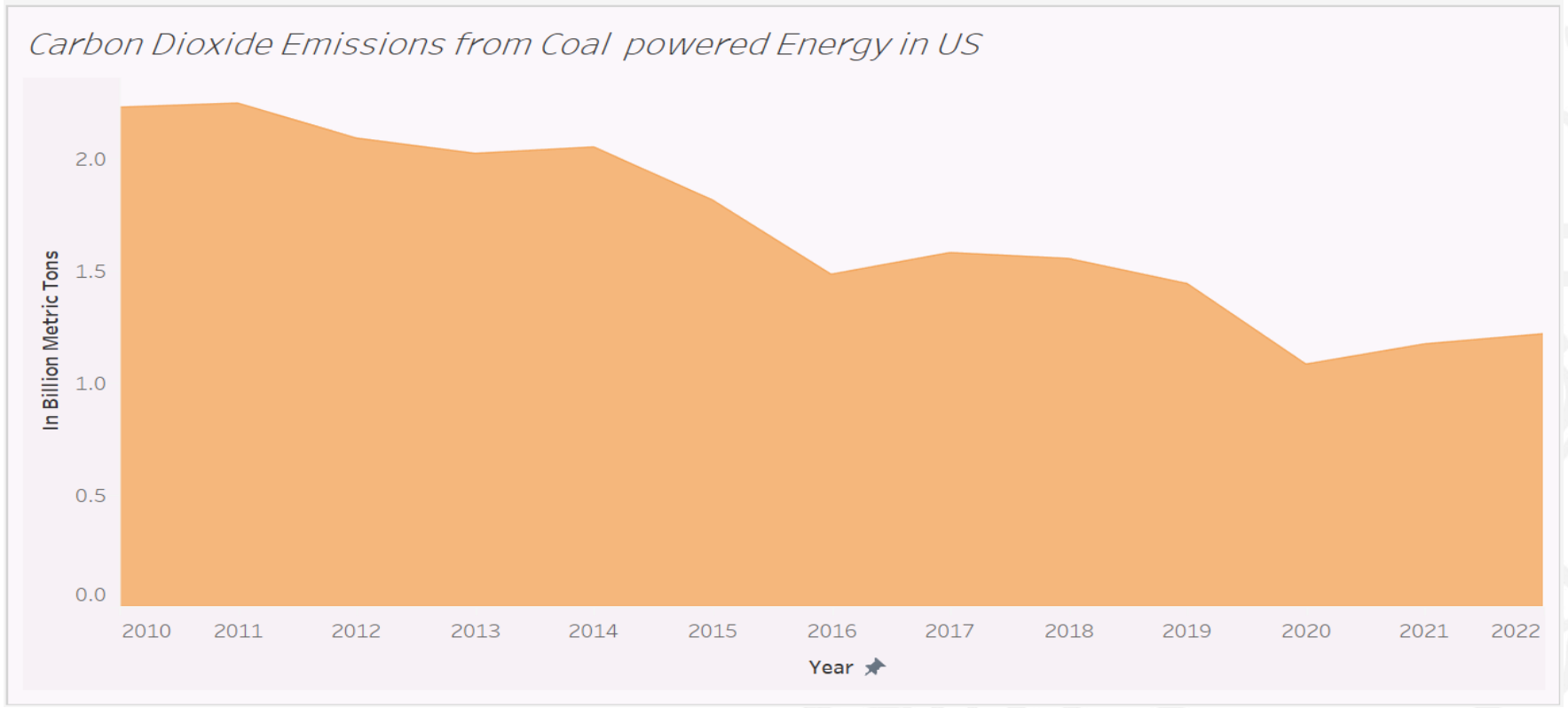
In recent times sixty two percent of coal consumed in United States is mined domestically.

Strict government regulations on coal mining for environmental safety is prime reasons for declining consumption.



Carbon Dioxide Emissions in US from Coal Power

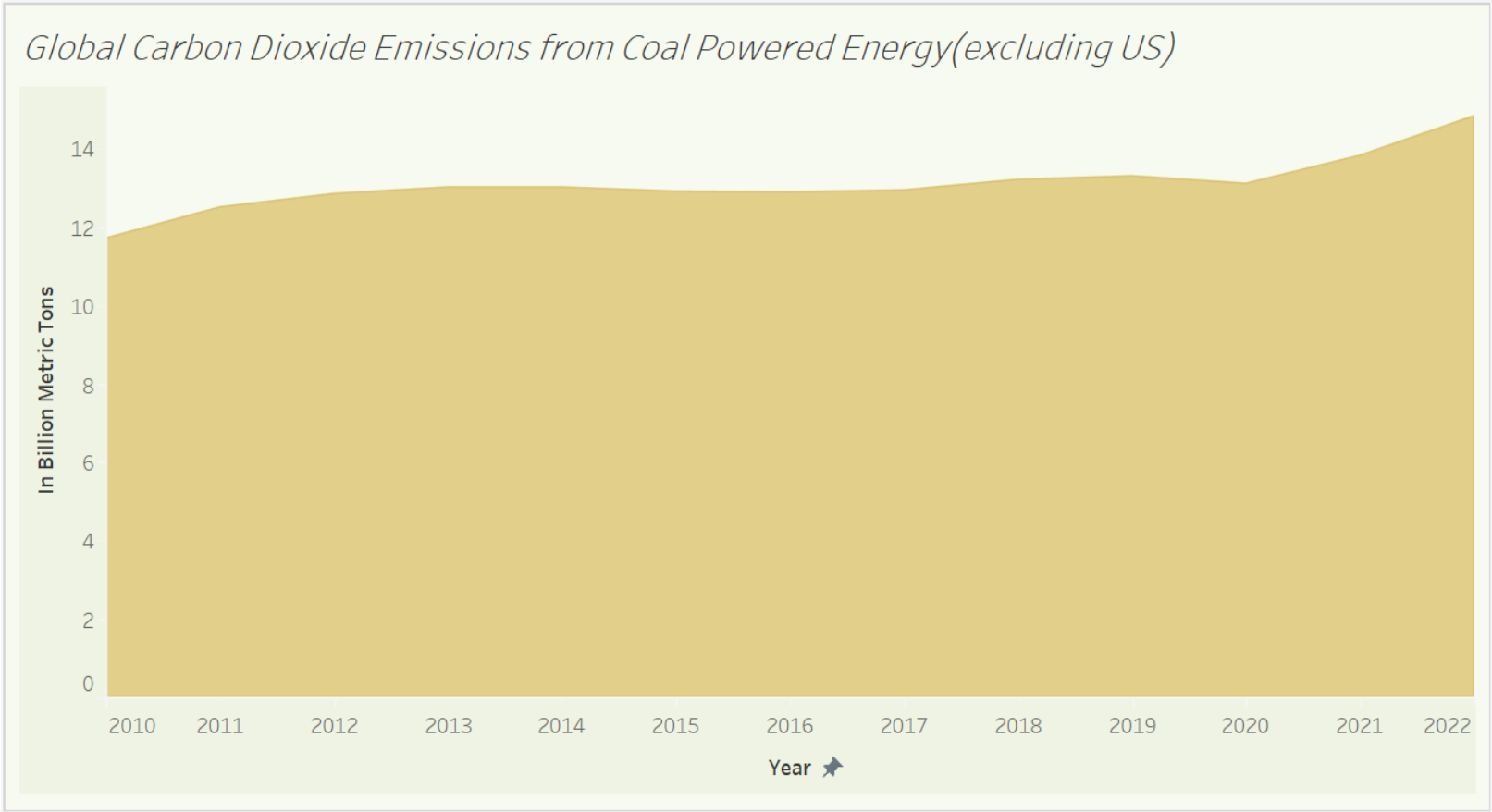
Declining trend in Carbon Dioxide emissions in Coal Power Plants is due to increase awareness for greener sustainability.



Global Carbon Dioxide Emissions from Coal Power w/o US

China's power generation is heavily dependent on coal. This shoots the graph upwards in comparison to declining trend of carbon emissions from coal in US.

It is estimated that half of the global carbon emissions by coal is due to China in 2021.



Carbon Dioxide Emissions Calculations Table from Coal

Values considered for Calculations:

1 trillion Btu energy requires 51,000 Metric Tons of Coal.

1 quadrillion Btu requires 51,000,000 Metric Tons of Coal.

From Carbon coefficients table, 1 million Btu emits 0.101 Metric Tons of CO2 from coal combustion

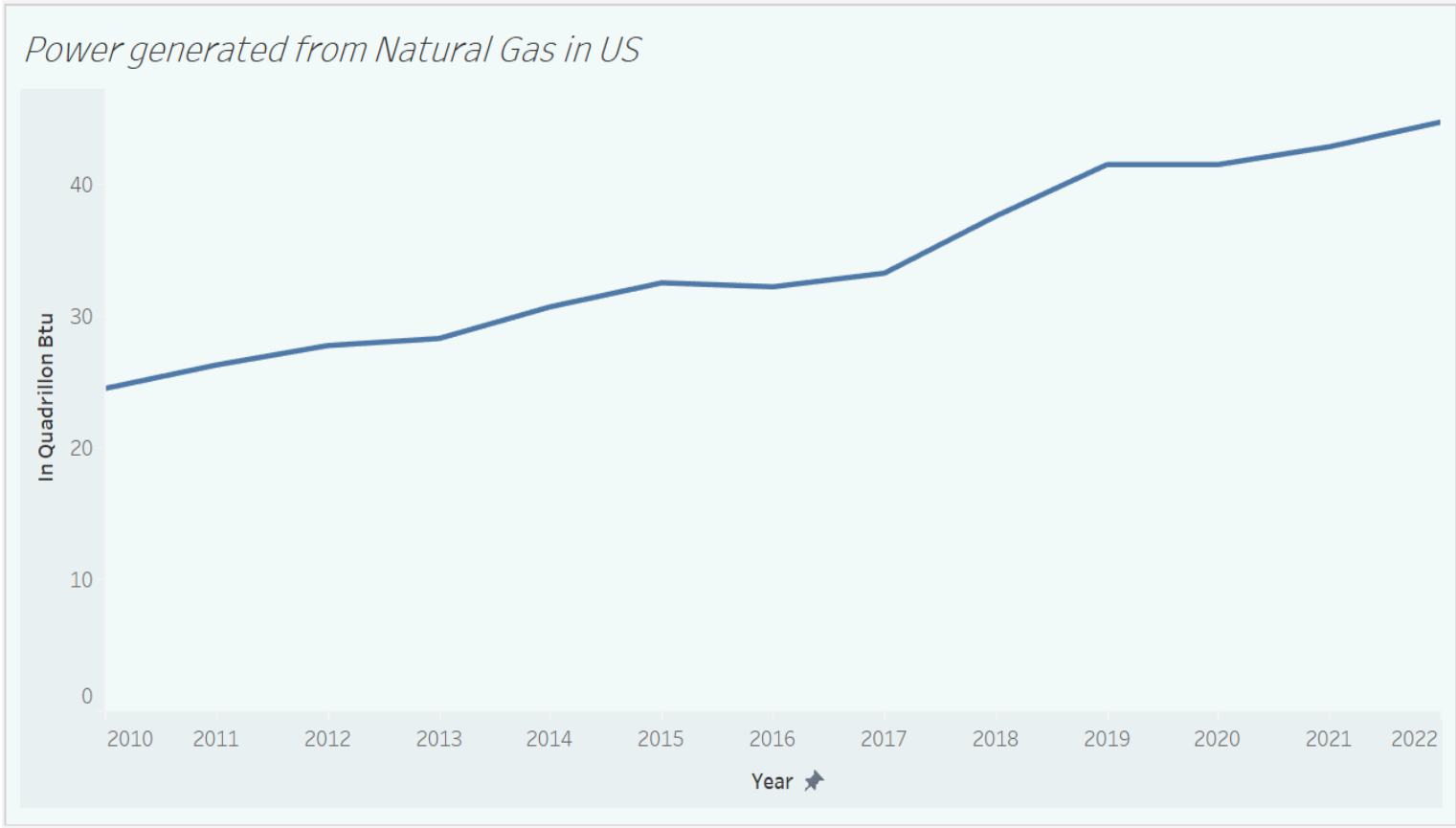
1 quadrillion Btu emits 101,000,000 Metric Tons of CO2.

Year	(Quadrillion Btu)	Amount of Coal in MT per Quadrillion Btu	Coal consumed in Billion Metric Tons	Amount of CO2 in MT produced per Quadrillion Btu	CO2 Produced in Billions MT	Global CO2 in Billion Metric Tons	Global CO2 in Billion Metric Tons except US
2010	22.04	51,000,000	1,123,950	101,000,000	2.23	13.927	11.70
2011	22.22		1,133,292		2.24	14.737	12.49
2012	20.68		1,054,522		2.09	14.923	12.83
2013	20.00		1,020,067		2.02	15.024	13.00
2014	20.29		1,034,571		2.05	15.052	13.00
2015	17.95		915,251		1.81	14.71	12.90
2016	14.67		748,022		1.48	14.361	12.88
2017	15.63		796,894		1.58	14.507	12.93
2018	15.36		783,536		1.55	14.747	13.20
2019	14.26		727,044		1.44	14.726	13.29
2020	10.70		545,864		1.08	14.175	13.09
2021	11.60		591,410		1.17	14.98	13.81
2022	12.04		614,204		1.22	16.03	14.81

Major Sources of Carbon Dioxide Emissions in US – Natural Gas

Natural gas for energy generation lesser carbon dioxide emissions than coal or crude oil. Methane emissions are hazardous in natural gas plants and refineries. Flaring is done to prevent it.

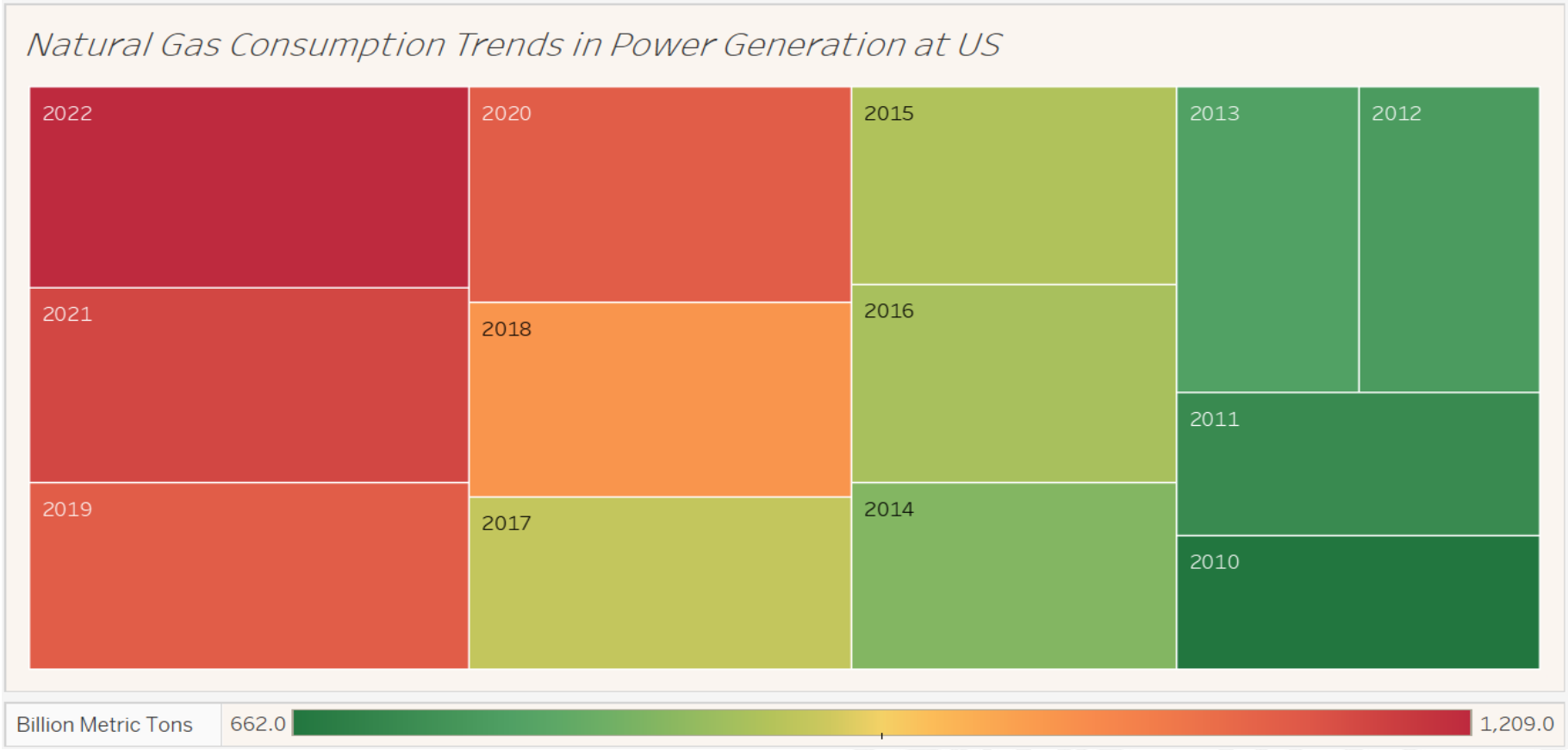
Well drilling activities for exploration and laying pipelines to transport natural gas from refineries to consumers involves land clearing for burying pipes causes biological environmental imbalance.



Consumption of Natural Gas for Power in United States

The demand for natural gas a power generation fuel has increased over year so the consumption increasing every year.

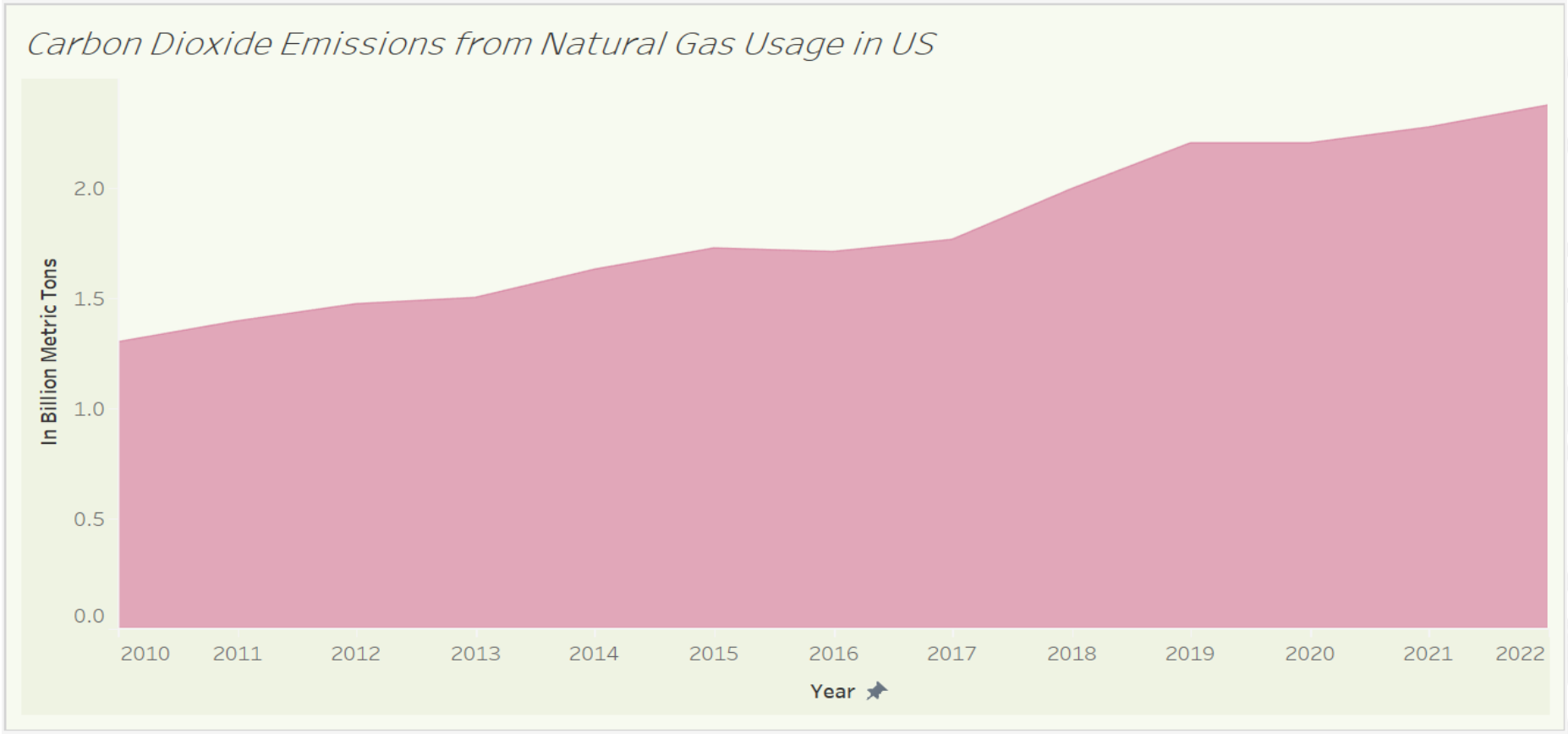
4.4 percent increase from 2021-2022 and 2.6 percent from 2020-2021.



Carbon Dioxide Emissions in United States from Natural Gas

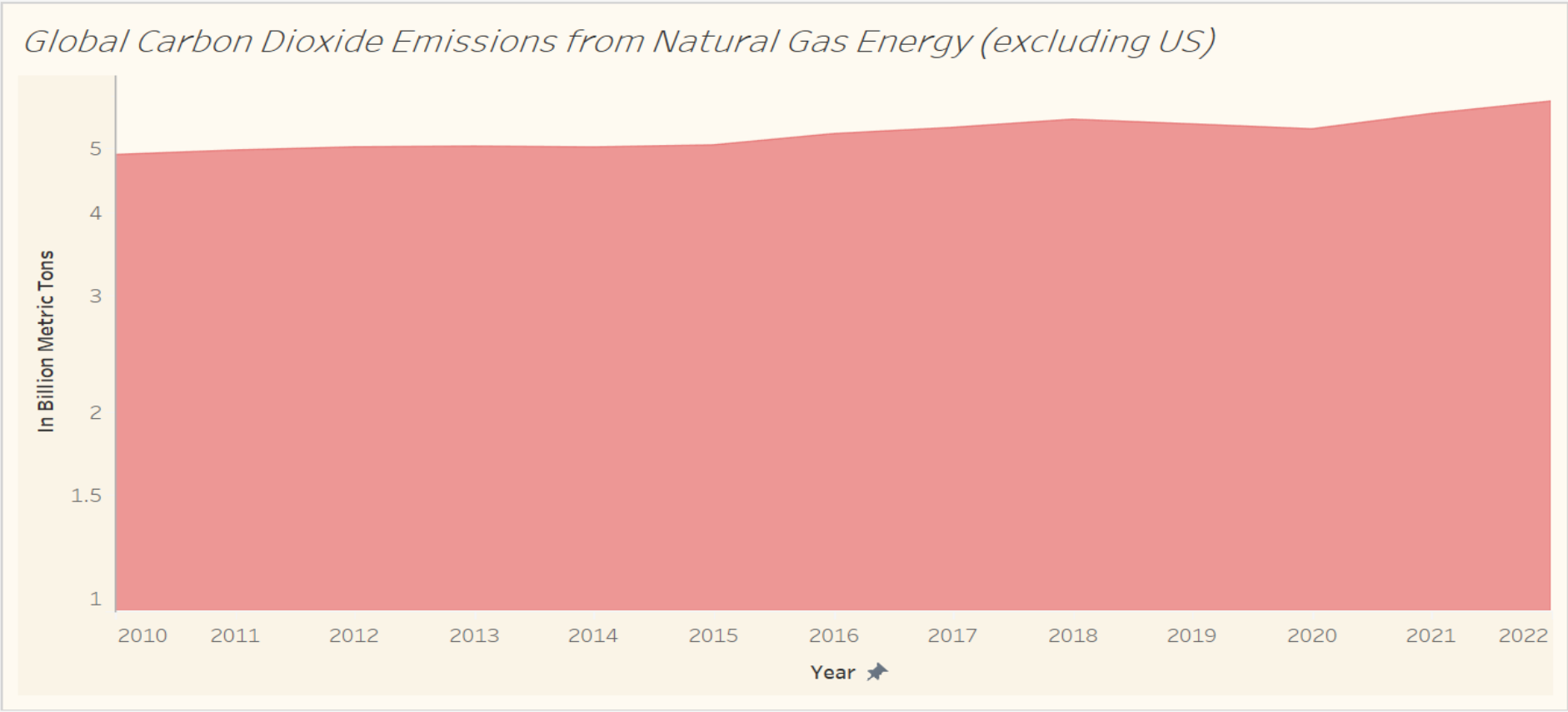
It is estimated in 2022 United States contributes 40 percent of share in total carbon dioxide emissions across the globe from natural gas usage.

The trend shows an alarming growth which is detrimental to green sustainability approach



Global Carbon Dioxide Emissions from Natural Gas w/o US

The global trends shows consistency, yet the volumes of carbon dioxide emitted is alarming and needs remedial strategies.



Carbon Dioxide Emissions from Natural Gas Calculation Table

Values considered for Calculations:

1 Million Btu energy produced from 946.32 cubic Feet of Natural Gas

1 Cubit Feet = 0.029 Metric Tons.

946.32 Cubic Feet = 27 Metric Tons approx.

1 Quadrillion Btu produced from 27,000,000,000 Metric Tons of Natural Gas.

1 Million Btu energy emits 0.053 Metric Tons of CO2 from natural gas combustion. (Ref. Carbon Coefficients Table).

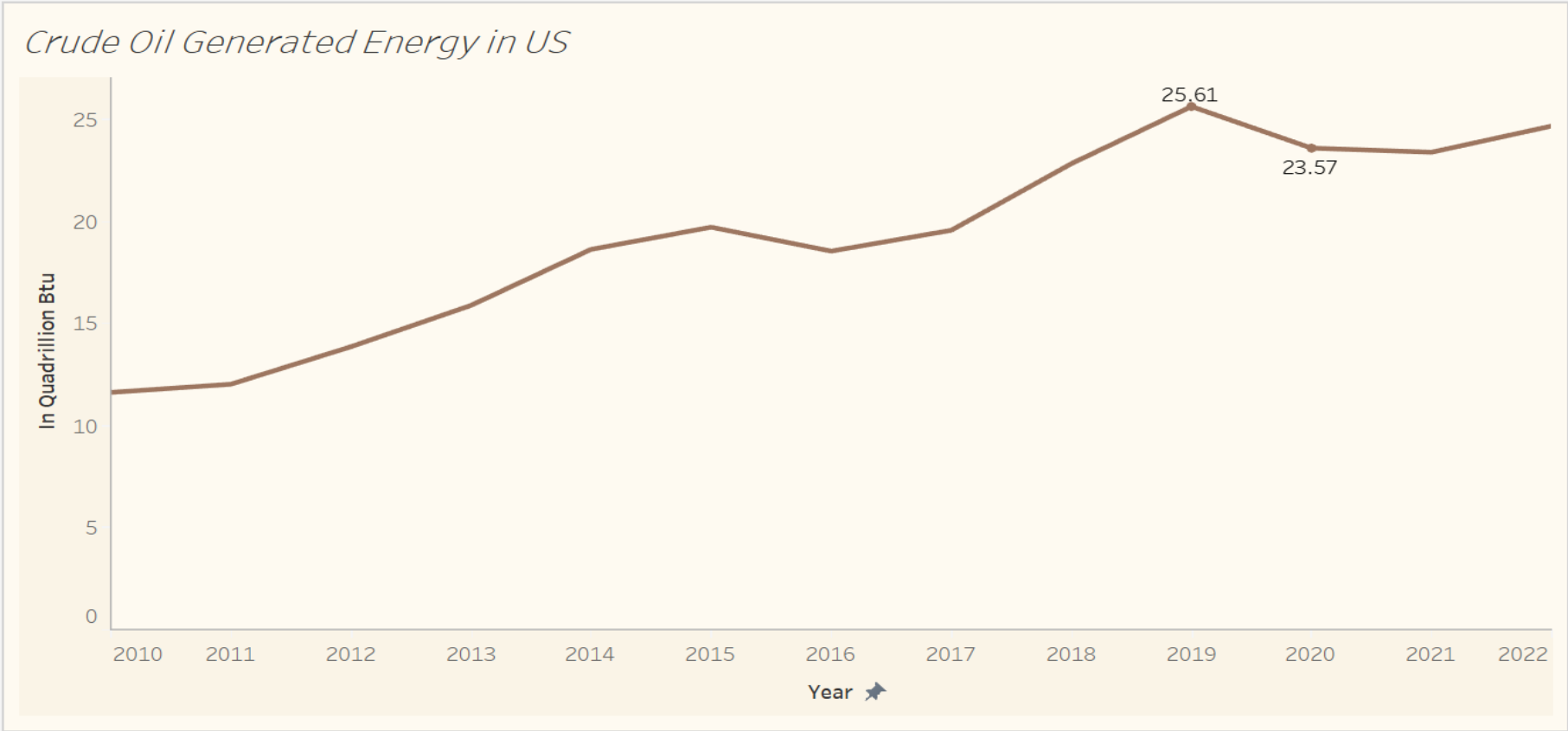
1 Quadrillion Btu emits 53,000,000 Metric Tons of CO2.

Year	Natural Gas (Dry) Production (Quadrillion Btu)	Natural Gas Plant Liquids Production (Quadrillion Btu)	Total Natural Gas (Quadrillon Btu)	Amount of Natural Gas in Metric Tons per Quardillon Btu	Natural Gas Consumed in Billions Metric Tons	Amount of CO2 in MT produced per Quadrillion Btu	Total CO2 Produced in Billion Tons	Global CO2 in Billion MT	Global CO2 in Billion Metric Tons Except US
2010	21.81	2.70	24.51	27,000,000,000	662	53,000,000	1.30	6.20	4.90
2011	23.41	2.89	26.30		710		1.39	6.37	4.97
2012	24.61	3.16	27.77		750		1.47	6.50	5.03
2013	24.86	3.45	28.31		764		1.50	6.54	5.04
2014	26.72	4.01	30.72		830		1.63	6.66	5.03
2015	28.07	4.48	32.54		879		1.72	6.79	5.06
2016	27.58	4.66	32.24		871		1.71	6.97	5.27
2017	28.29	4.99	33.28		898		1.76	7.15	5.38
2018	31.88	5.73	37.61		1,015		1.99	7.53	5.54
2019	35.19	6.35	41.54		1,122		2.20	7.65	5.45
2020	34.73	6.80	41.54		1,121		2.20	7.56	5.35
2021	35.79	7.10	42.89		1,158		2.27	7.92	5.65
2022	37.10	7.67	44.77		1,209		2.37	8.27	5.90

Major Sources of Carbon Dioxide Emissions in US – Crude Oil

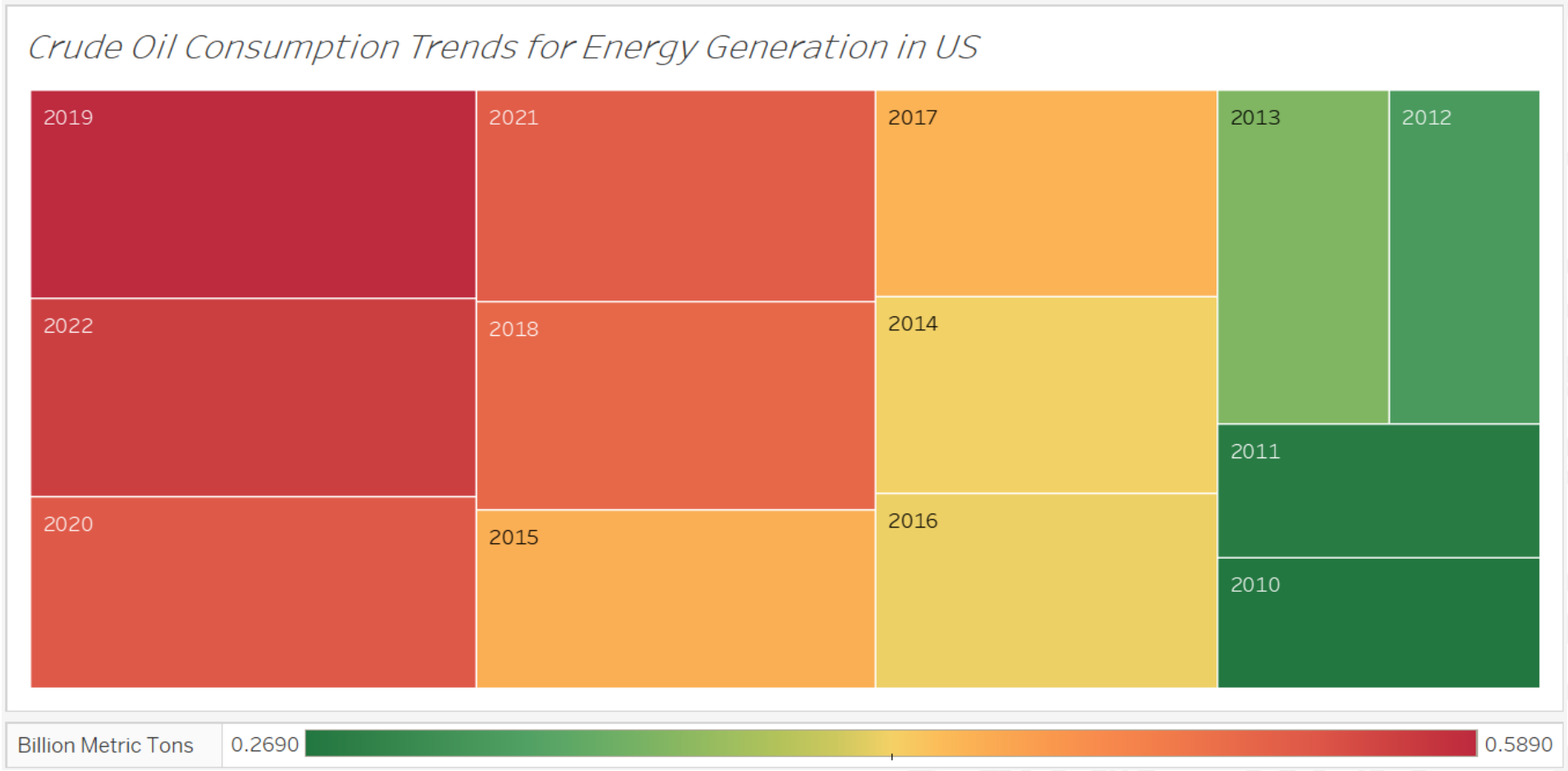
Hydraulic fracturing is used to convert crude oil into fuel for power generation and running vehicles.

Leakage of crude during exploration causes water contamination harmful for marine ecosystem.



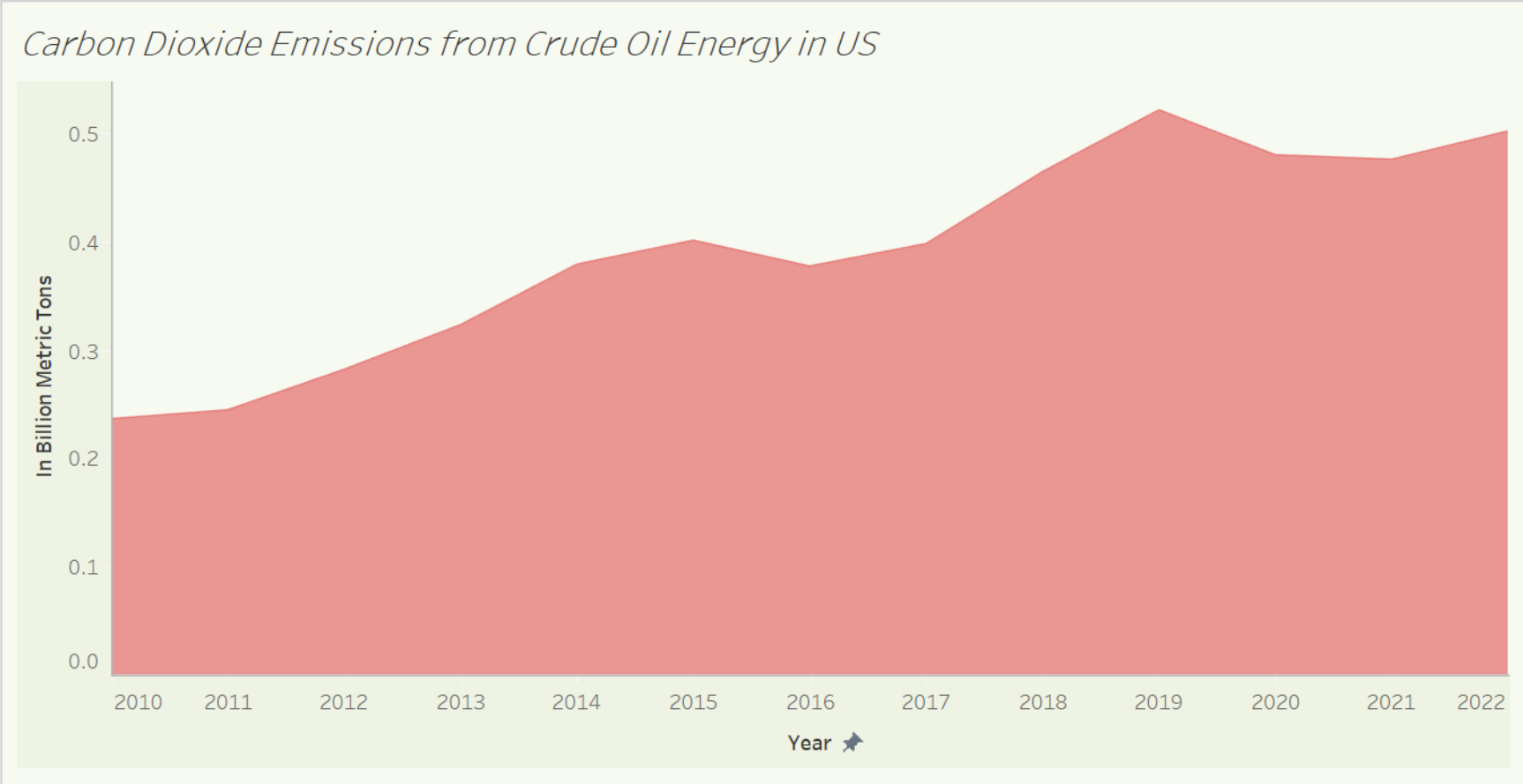
Consumption of Crude Oil for Energy in United States

The rising trend of consumption shows that there is demand for its usability in United States which always comes at a cost of endangering natural ecosystems.



Carbon Dioxide Emissions from Crude Oil Power in US

The demand for this fossil source in generating power electricity causes carbon emissions to rise continuously in United States.



Carbon Dioxide Emissions from Crude Oil Calculation Table

Values for consideration:

1 Million Btu energy produced from 7.24 Gallons of crude oil

7.24 Gallons = 0.023 Metric Tons

1 Quadrillion Btu energy produced from 23,000,000 Metric Tons of Crude Oil.

1 Million Btu emits 0.02033 Metric Tons of CO2 (Ref. Carbon Coefficients Table)

1 Quadrillion Btu emits 20,330,000 Metric Tons of CO2.

Year	(Quadrillion Btu)	Amount of Crude Oil in Metric Tons per Quardillon BTU	Crude Oil Consumed in Billions Metric Tons	Amount of CO2 in MT produced per Quadrillion Btu	Total CO2 Produced in Billion Metric Tons
2010	11.61	23,000,000	0.27	20,330,000	0.24
2011	12.01		0.28		0.24
2012	13.85		0.32		0.28
2013	15.87		0.37		0.32
2014	18.62		0.43		0.38
2015	19.70		0.45		0.40
2016	18.53		0.43		0.38
2017	19.55		0.45		0.40
2018	22.81		0.52		0.46
2019	25.61		0.59		0.52
2020	23.57		0.54		0.48
2021	23.37		0.54		0.48
2022	24.66		0.57		0.50

Carbon Coefficients Table

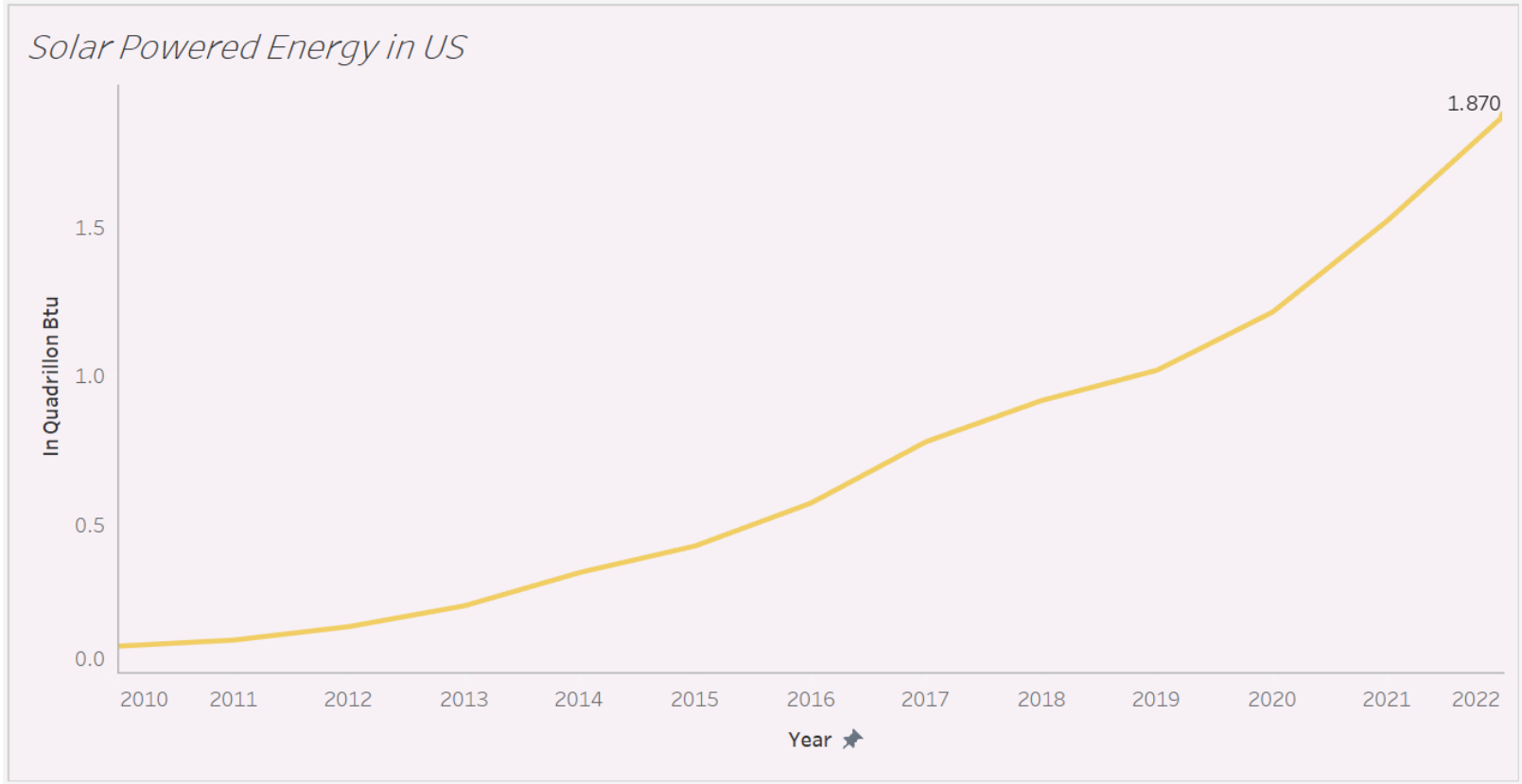
Carbon Dioxide Emissions Coefficients by Fuel						
	Pounds CO_2		Kilograms CO_2		Pounds CO_2	Kilograms CO_2
Carbon Dioxide (CO_2) Factors:	Per Unit of Volume or Mass		Per Unit of Volume or Mass		Per Million Btu	Per Million Btu
For homes and businesses						
Propane	12.68	gallon	5.75	gallon	138.63	62.88
Crude Oil						20.33
Diesel and Home Heating Fuel (Distillate Fuel Oil)	22.45	gallon	10.19	gallon	163.45	74.14
Kerosene	21.78	gallon	9.88	gallon	161.35	73.19
Coal (All types)	3,876.61	short ton	1,758.40	short ton	211.87	96.10
Natural Gas	120.96	thousand cubic feet	54.87	thousand cubic feet	116.65	52.91
Finished Motor Gasoline[a]	17.86	gallon	8.10	gallon	148.47	67.34
Motor Gasoline	19.37	gallon	8.78	gallon	155.77	70.66
Residual Heating Fuel (Businesses only)	24.78	gallon	11.24	gallon	165.55	75.09
Other transportation fuels						
Jet Fuel	21.50	gallon	9.75	gallon	159.25	72.23
Aviation Gasoline	18.33	gallon	8.32	gallon	152.54	69.19
Industrial fuels and others not listed above						
Petroleum coke	32.86	gallon	14.90	gallon	225.13	102.12
Nonfuel uses						
Asphalt and Road Oil	26.25	gallon	11.91	gallon	166.12	75.35
Lubricants	23.58	gallon	10.70	gallon	163.29	74.07
Naphthas for Petrochemical Feedstock Use	18.74	gallon	8.50	gallon	149.95	68.02
Other Oils for Petrochemical Feedstock Use	22.61	gallon	10.26	gallon	163.05	73.96
Special Naphthas (solvents)	19.94	gallon	9.04	gallon	159.57	72.38
Waxes	21.10	gallon	9.57	gallon	160.06	72.60
Coals by type						
Anthracite	5,715.11	short ton	2,592.33	short ton	228.60	103.69
Bituminous	4,933.59	short ton	2,237.84	short ton	205.57	93.24
Subbituminous	3,747.36	short ton	1,699.78	short ton	214.13	97.13
Lignite	2,813.18	short ton	1,276.04	short ton	216.40	98.16
Coke	7,196.24	short ton	3,264.17	short ton	250.59	113.67

Renewable Energy Sources – Solar Energy in US

An hour and a half of sunlight is sufficient to cater the entire world's energy consumption for a year. It is in abundance and zero carbon emissions

The skyrocketing demand for this energy in US shows the need towards greener future.

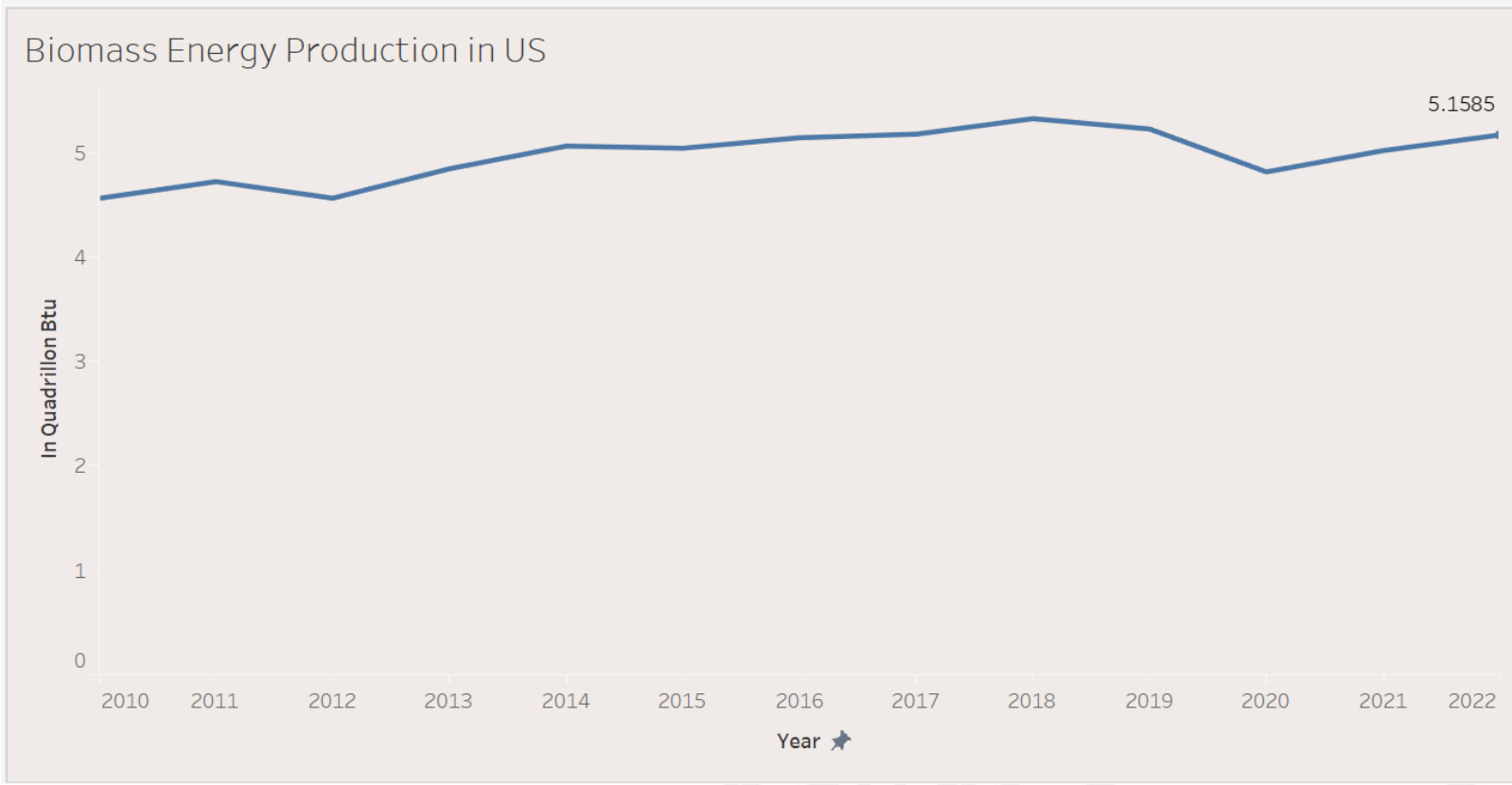
In our campus more than 2200 panels are fitted aim to produce 12.7 million kWh of electricity.



Renewable Energy Sources – Biomass Energy in US

Biomass is renewable organic decompose of plants and animals. It was in demand in United states at mid-1800's but in 2021 it contributes 5 percent of total energy generation.

The most ecological way to extract biomass energy is thermochemical conversion of biomass includes pyrolysis and gasification.

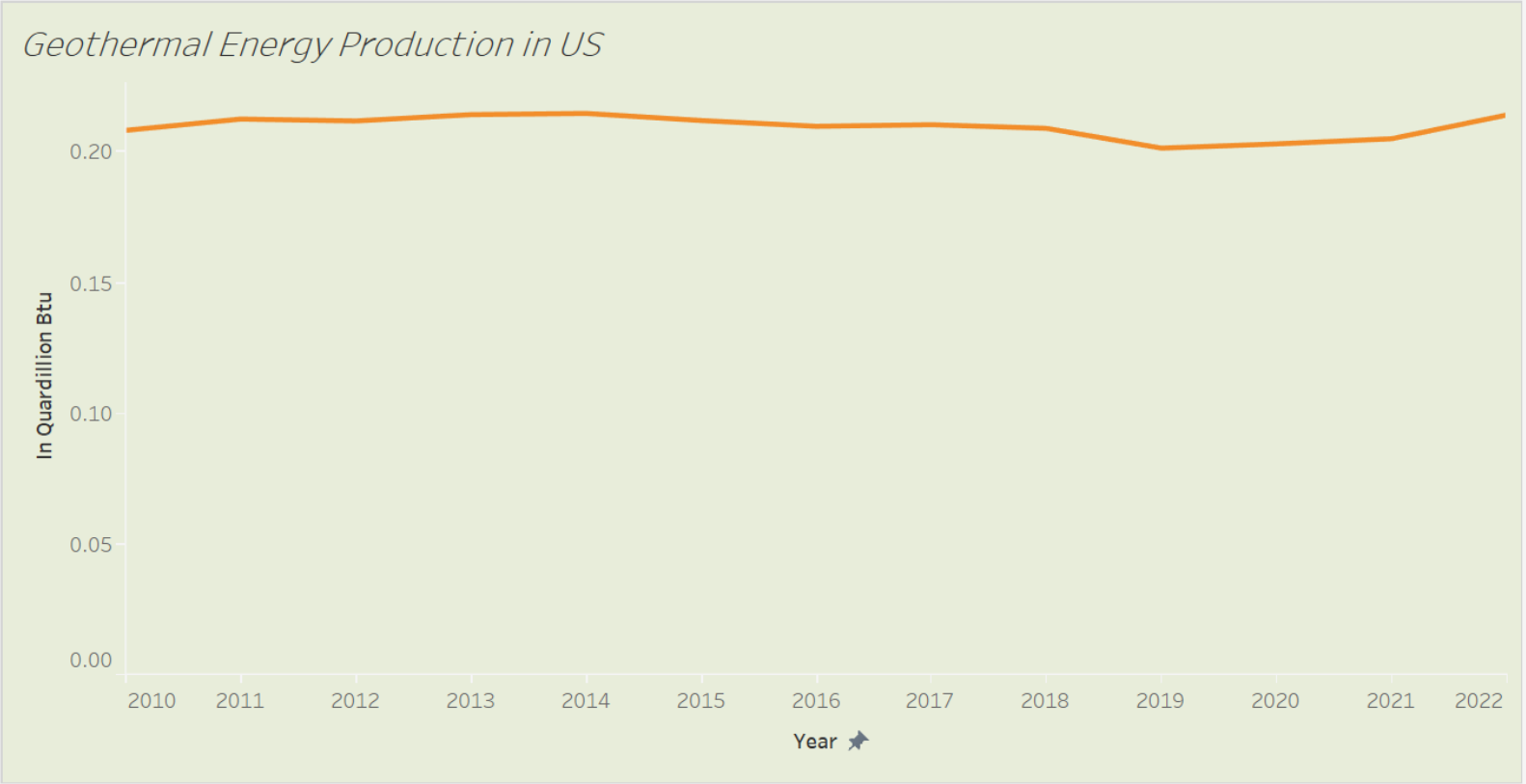


Renewable Energy Sources – Geothermal Energy in US

It is one of the purest and reliable renewable sources from inside earth's crust.

In United States, this energy most geothermal reservoirs are in West Coast.

This energy is plentiful, available for almost all the time regardless of weather conditions. With zero carbon emissions this is a potential future resources of green energy.



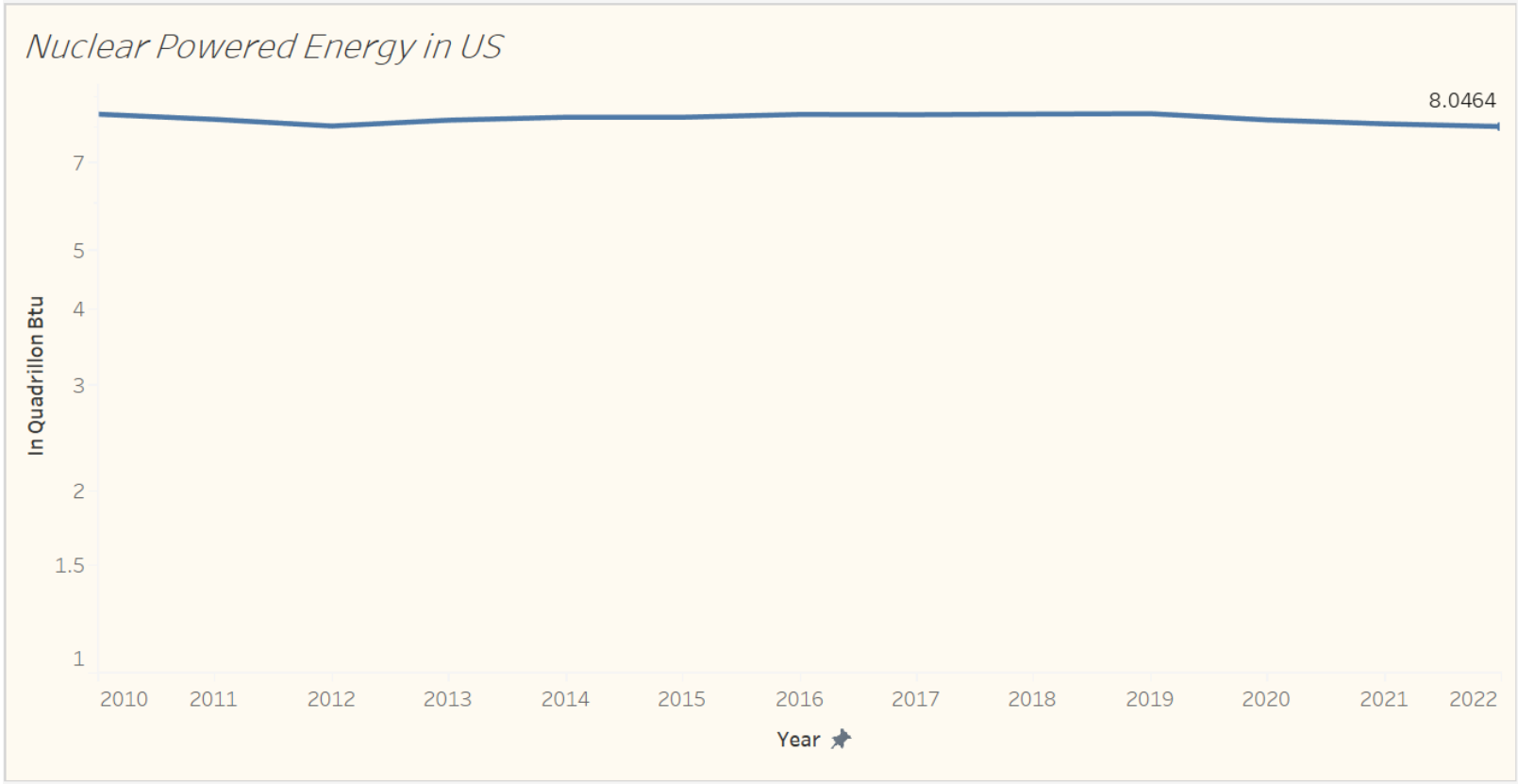
Renewable Energy Sources – Nuclear Energy in US

Lowest carbon footprints hence considered as a renewable energy source.

55 nuclear power plants with 93 operable reactors produces electricity as of 2021 in US.

In 2022 Nuclear energy contributes 8 percent share out of total energy production in US.

Uranium spills and radioactive emissions if not controlled is a possible environmental threat.

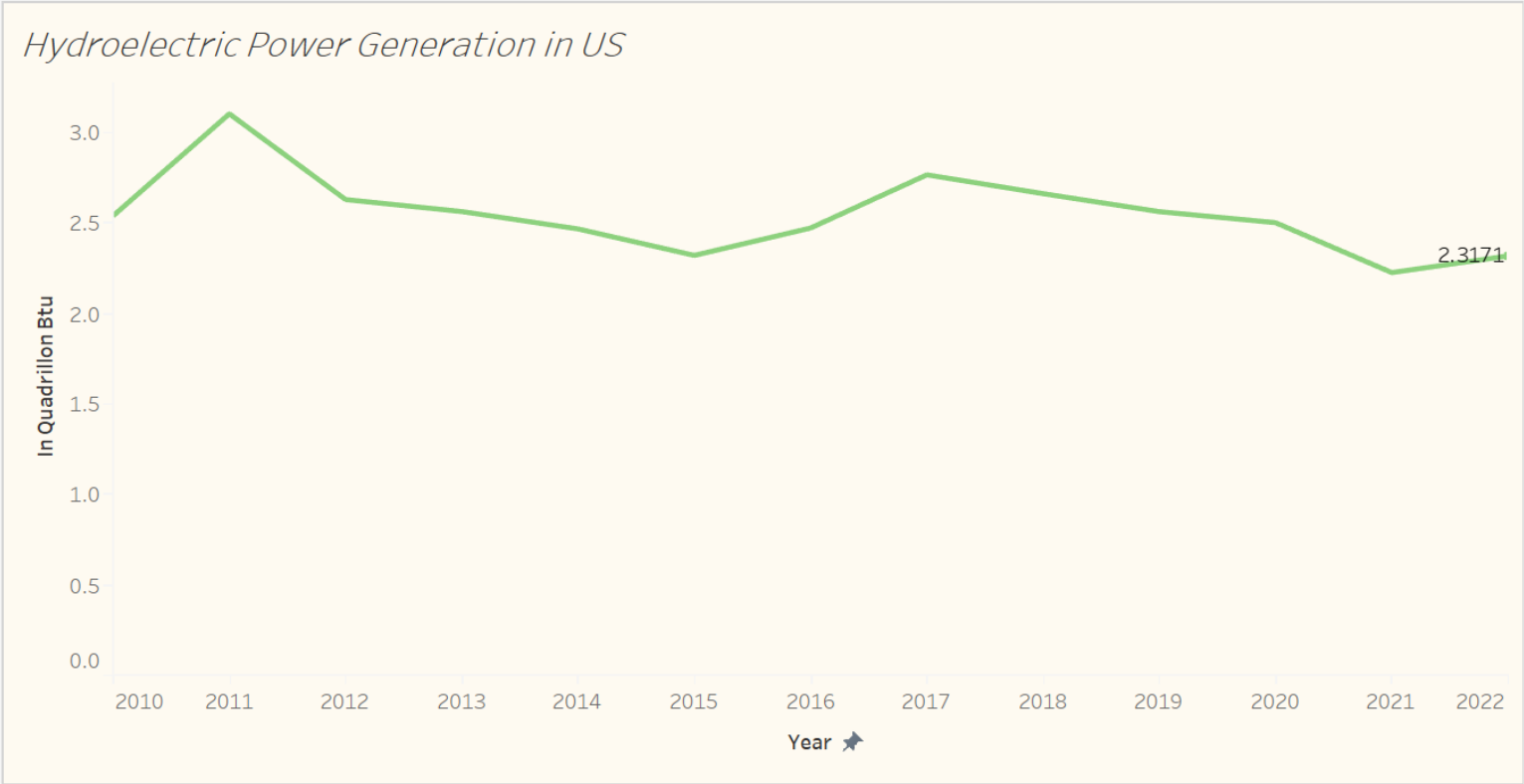


Renewable Energy Sources – Hydroelectric Energy in US

Hydroelectric energy or hydropower contributes 6.3 percent of total US energy generation.

Recent decline of hydroelectric generation in US due to drying up streams and rivers, uneven rainfall and rising droughts due to climate change by Global Warming.

Estimated by 2050, 61 percent of global hydroelectric sources will face acute imbalance of continuous water supply unless we limit the greenhouse emissions.

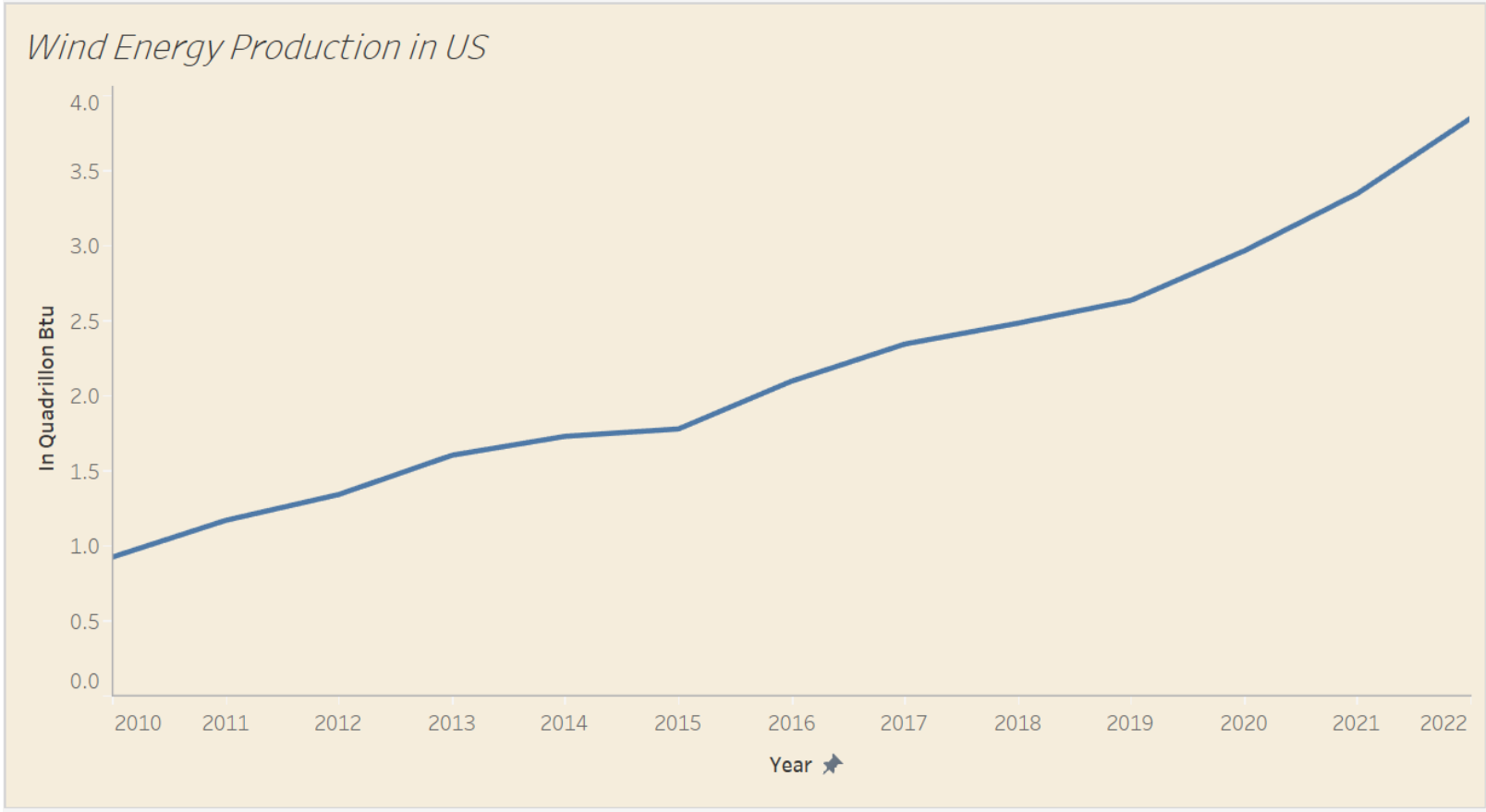


Renewable Energy Sources – Wind Energy in US

United States scales up wind power production by 30 percent year over year.

Wind energy reduces 329 million metric tons of carbon dioxide emissions annually approximately equivalent to 71 million cars worth of emissions in United States.

Currently it holds around 10 percent of share in total energy produced in United States as form of electricity.



Conclusion

Analytically breaking the components of major non-renewable energy sources Coal, Natural Gas and Crude Oil, it is observed they produce billion metric tons of Carbon Dioxide causes Global Warming.

The excavation of these fossil fuels is critical to human life and modern environment causing natural calamities and extremely hazardous after effects of combustion. Globally coal to be extinct in around 114 years more, Oil for 50 years more and Natural gas for 53 years more.

Hence, the world needs a energy spectrum shift to the a more sustainable greener approach. Initial investing in renewable energy sources is exorbitant and requires a lot of strategic decisions in terms of deployment, operations, and maintenance costs.

Renewable energy sources are still in budding stage and requires a lot more initiative from every nation to develop and scale up so as to generate equivalent energy to that of fossils currently produce. To make earth a better place to survive it is now a collaborative responsibility to curb down the greenhouse emissions almost to zero.

References

Datasets and Relevant Knowledge Base from following sites

https://www.eia.gov/

https://www.statista.com/

https://www.energy.gov/