Understanding Domain and Issues

Insight Inspectors

October 2022

Contents

1 Domain

1.1 Introduction

Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed. Sunlight and wind, for example, are such sources that are constantly being replenished [3].

Solar and wind powered renewable energy systems must be designed to cater the climatic conditions of a specific region. The Prediction Of Worldwide Energy Resources (POWER) project was initiated to improve upon the current renewable energy data set and to create new data sets from new satellite systems.

Generating renewable energy creates far lower emissions than burning fossil fuels. Transitioning from fossil fuels, which currently account for the lion's share of emissions, to renewable energy is key to addressing the climate crisis. Renewable energy is now cheaper in most countries, and generate three times more jobs than fossil fuels.

The analysis of the data thus obtained will help to improve the solar and wind energy-providing systems as renewable energy is cost efficient and sustainable

Common resources of renewable energy:

Solar Energy

Wind Energy

Wind Energy

Geothermal Energy

Hydro-power

Ocean Energy

Bio Energy

1.2 Glossary

Following terminologies are being used in the data:

- LAT: Latitude- The angular distance of a place north or south of the earth's equator, or of the equator of a celestial object, usually expressed in degrees and minutes.
- LON: Longitude- The angular distance of a place east or west of the Greenwich meridian, or west of the standard meridian of a celestial object, usually expressed in degrees and minutes
- PS: Surface Pressure measured in kPa
- TS: Earth Skin Temperature measured in °celcius (Refers to the effective radiating temperature of the soil plus canopy surface).

  T2M: MERRA-2 Temperature at 2 Meters (C)

  TS_MAX: MERRA-2 Earth Skin Temperature Maximum (C)

  TS_MIN: MERRA-2 Earth Skin Temperature Minimum (C)

  T2M_MAX: MERRA-2 Temperature at 2 Meters Maximum (C)

  T2M_MIN: MERRA-2 Temperature at 2 Meters Minimum (C)

  T2M_RANGE: MERRA-2 Temperature at 2 Meters Range (C)
- WD: Wind direction is the direction from which the wind is blowing; the direction from which the air is moving.

  WD10M: MERRA-2 Wind Direction at 10 Meters (Degrees)

  WD50M: MERRA-2 Wind Direction at 50 Meters (Degrees)

  WS10M: MERRA-2 Wind Speed at 10 Meters (m/s)

  WS50M: MERRA-2 Wind Speed at 50 Meters (m/s)
- T2MDEW: Dew/Frost point at 2 metres measured in °celcius
- T2MWET: MERRA-2 Wet Bulb Temperature at 2 Meters (C)

1.3 Customers and users

Atmospheric scientists, meteorologists, design engineers, solar power companies will benefit from the analyzed renewable energy data and provide access to parameters specifically tailored to assist in the design of solar and wind powered renewable energy systems [1].

1.4 Tasks and procedures currently performed

These procedures of analyzing the data and designing systems to cater to the citizens of the country are being currently used by India's leading renewable energy providing systems like Tata Power, Suzlon, Renew Power etc through systems like solar panels, wind farms, solar roofs etc.

2 Issues

Renewable energy still faces major hurdles to wider adoption. Some are associated with various renewable energy technologies, and others are due to the modern realities of the marketplace, regulations and infrastructure [4].

The fact that we need to design products with parameters with respect to the atmospheric and climatic conditions at a particular region can be a tedious task.

3 Conclusion

Hence weather and climatic data needs to be analyzed in order to design systems that generate renewable energy according to the resources available.

References

[1] https://power.larc.nasa.gov/

[2] https://www.site.uottawa.ca/ laganier/seg2500/domain

[3] https://www.un.org/en/climatechange/what-is-renewable-energy

[4] https://www.azom.com/article.aspx?ArticleID=18220

Data Description Documentation

Insight Inspectors

November 2022

Contents

1 Data Description:-

It is a Climatology Data which is collected using API from NASA POWER i.e **NASA Prediction Of Worldwide Energy Resources** website.

Model Used is :- Modern-Era Retrospective analysis for Research and Applications, Version 2 **(MERRA-2)**. It provides data beginning in the year 1980 close up to a few months within near-real time.

2 What is Climatology?

Climatology is the branch of meteorology dealing with climate formation, the distribution of climates over the globe, the analysis of the causes of differences in climate (physical climatology), and the application of climatic data to the solution of specific design or operational problems (applied climatology).

Climatology is the study of the atmosphere and weather patterns over time. This field of science focuses on recording and analyzing weather patterns throughout the world and understanding the atmospheric conditions that cause them. It is sometimes confused with meteorology, which is the study of weather and weather forecasting.

Climate models are used for a variety of purposes from the study of the dynamics of the weather and climate system to projections of future climate. Weather is known as the condition of the atmosphere over a period of time, while climate has to do with the atmospheric condition over an extended to an indefinite period of time

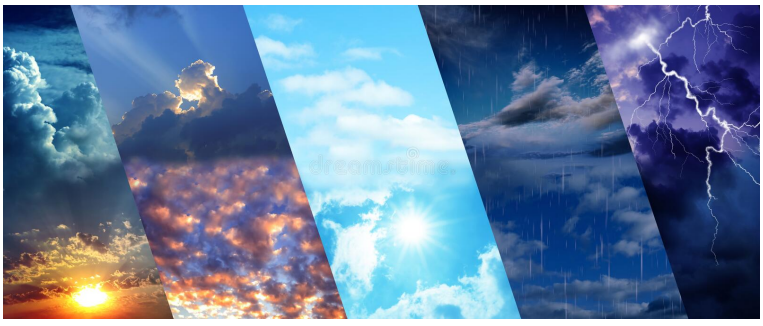


Figure 1: Climatology

3 Parameters Used in Data:-

Parameters	Full Form
PS	Surface Pressure (kPa)
TS	Earth Skin Temperature (C)
T2M	Temperature at 2 Meters (C)
WD10M	Wind Direction at 10 Meters (Degrees)
WD50M	Wind Direction at 50 Meters (Degrees)
WS10M	Wind Speed at 10 Meters (m/s)
WS50M	Wind Speed at 50 Meters (m/s)
T2MDEW	Dew/Frost Point at 2 Meters (C)
T2MWET	Wet Bulb Temperature at 2 Meters (C)
TS-MAX	Earth Skin Temperature Maximum (C)
TS-MIN	Earth Skin Temperature Minimum (C)
T2M-MAX	Temperature at 2 Meters Maximum (C)
T2M-MIN	Temperature at 2 Meters Minimum (C)
T2M-RANGE	Temperature at 2 Meters Range (C)
WS10M-MAX	Wind Speed at 10 Meters Maximum (m/s)
WS10M-MIN	Wind Speed at 10 Meters Minimum (m/s)
WS50M-MAX	Wind Speed at 50 Meters Maximum (m/s)
WS50M-MIN	Wind Speed at 50 Meters Minimum (m/s)
WS10M-RANGE	Wind Speed at 10 Meters Range (m/s)
WS50M-RANGE	Wind Speed at 50 Meters Range (m/s)

4 Detailed information about the parameters:-

- **Surface Pressure (kPa):-**

  Surface pressure is the atmospheric pressure at a location on Earth's surface (terrain and oceans). It is directly proportional to the mass of air over that location. It is an indicator of the weather. So when there is low pressure it usually leads to cloudiness, wind, and precipitation and when the surface pressure is high it leads to fair, calm weather.

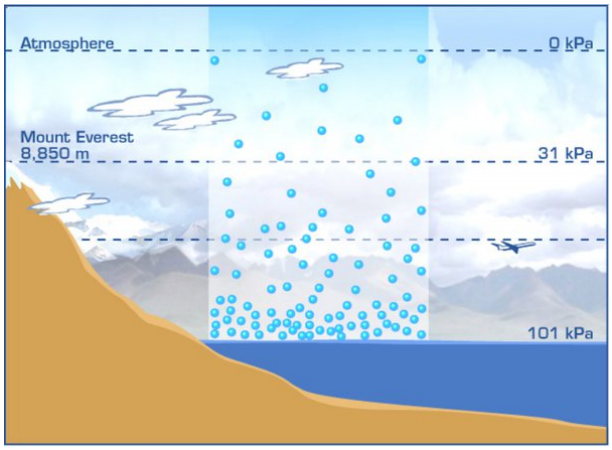


Figure 2: Surface Pressure

- **Earth Skin Temperature (C):-**

  Refers to the effective radiating temperature of the soil plus canopy surface. It is inferred from satellites in the 8-12 um window region. In climate models, it is the temperature used to determine upward thermal emission. The skin temperature usually shows a larger diurnal variation than the

surface air temperature a factor that needs to be considered when evaluating data/model comparisons.

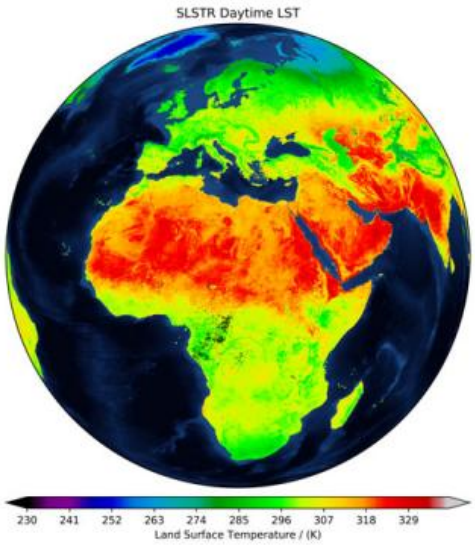


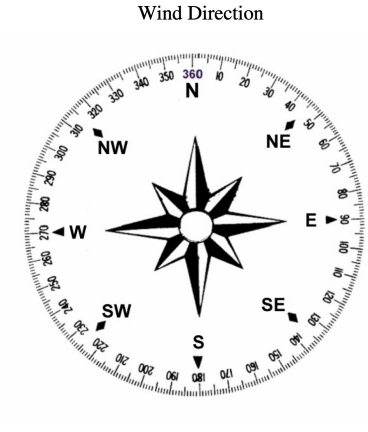
Figure 3: Earth Skin Temperature

- **Temperature at 2 Meters (C):-**

  This second air temperature device, similar to the one at 15 meters, hangs lower on the tower. The temperature of the air at 2 meters is of special interest because people live and breathe in the air present at this height, and the temperature at 2 meters can be quite different from the one at the top of the tower. The temperature difference helps estimate the stability of the atmosphere.

- **Wind Direction at 10 Meters (Degrees):-**

  The wind direction at a height of 10 meters above the ground according to the degrees in the compass. This variable is a measure of the steadiness of wind direction. A small standard deviation indicates the wind is blowing from the same direction.



Common	Degree
N	350, 360, 010
N/NE	20, 30
NE	40, 50
E/NE	60, 70
E	80, 90, 100
E/SE	110, 120
SE	130, 140
S/SE	150, 160
S	170, 180, 190
S/SW	200, 210
SW	220, 230
W/SW	240, 250
W	260, 270, 280
W/NW	290, 300
NW	310, 320
N/NW	330, 340

Figure 4: Wind Direction in Degrees

- **Wind Direction at 50 Meters (Degrees):-**

  The wind direction at a height of 50 meters above the ground according to the degrees in the compass.

- **Wind Speed at 10 Meters (m/s):-**

  The Average wind speed at 10 meters above the ground level at a particular location is called Wind speed at 10 meters (m/s).

- **Wind Speed at 50 Meters (m/s):-**

  The Average wind speed at 50 meters above the ground level at a particular location is called Wind speed at 50 meters (m/s).

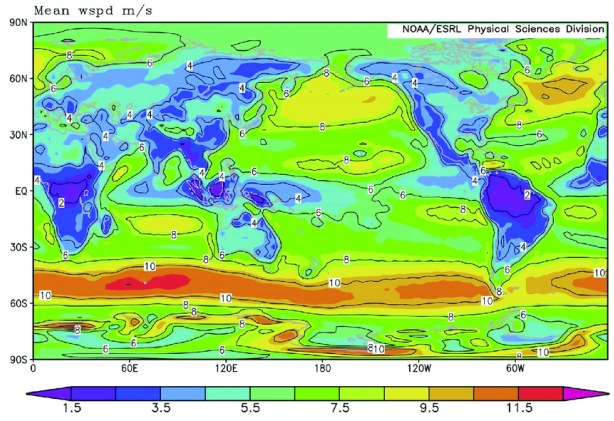


Figure 5: Wind Speed in m/s

- **Dew/Frost Point at 2 Meters (C):-**

  The **dew point** is the temperature to which air must be cooled to become saturated with water vapor, assuming constant air pressure and water content. When cooled below the dew point, moisture capacity is reduced and airborne water vapor will condense to form liquid water known as dew. When this occurs via contact with a colder surface, dew will form on that surface.

  The dew point is affected by humidity. When there is more moisture in the air, the dew point is higher. When the temperature is below the freezing point of water, the dew point is called the frost point, as **frost** is formed via deposition rather than condensation. In liquids, the analog to the dew point is the cloud point.

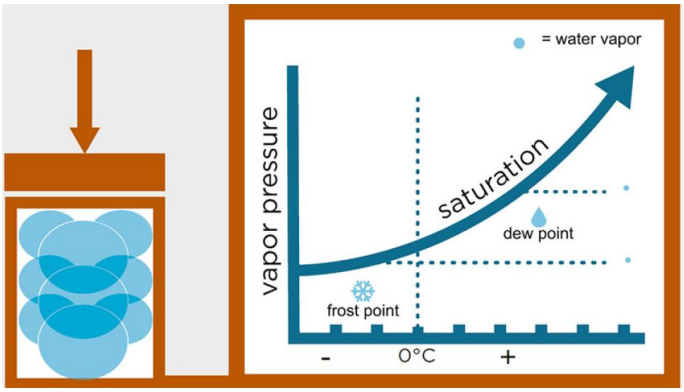


Figure 6: Dew Point and Frost Point

- **Wet Bulb Temperature at 2 Meters (C):-**

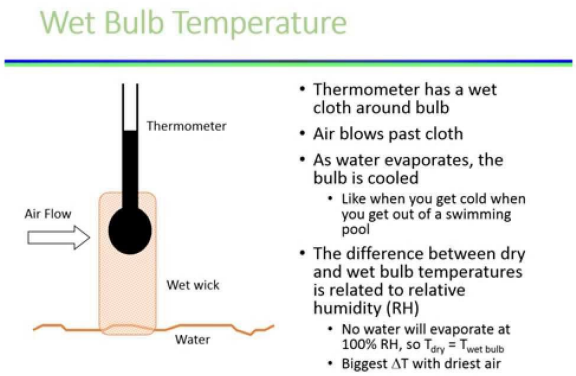


Figure 7: Wet Bulb Temperature

The wet-bulb temperature (WBT) is the temperature read by a thermometer covered in water-soaked (water at ambient temperature) cloth (a wet-bulb thermometer) over which air is passed. At 100 percent relative humidity, the wet-bulb temperature is equal to the air temperature (dry-bulb temperature); at lower humidity, the wet-bulb temperature is lower than the dry-bulb temperature because of

evaporative cooling.

- **Earth Skin Temperature Maximum (C):-**

  The maximum Earth Skin Temperature at a particular location on the earth's surface is defined by this parameter. The unit is Celsius.

- **Earth Skin Temperature Minimum (C):-**

  The minimum Earth Skin Temperature at a particular location on the earth's surface is defined by this parameter. The unit is Celsius.

- **Temperature at 2 Meters Maximum (C):-**

  The parameter that gives Maximum Temperature on earth's surface at 2 meters above the ground level is called the Temperature at 2 Meters Maximum(C).

- **Temperature at 2 Meters Minimum (C):-**

  The parameter that gives Minimum Temperature on the earth's surface at 2 meters above the ground level is called Temperature at 2 Meters Minimum (C).

- **Temperature at 2 Meters Range (C):-**

  The difference between the maximum and minimum temperatures at 2 meters or between the highest and lowest mean temperatures during a specified time interval, for example, daily, monthly, or seasonal is called the range.

- **Wind Speed at 10 Meters Maximum (m/s):-**

  Maximum Wind Speed at 10 meters above the ground level is called Wind Speed at 10 meters Maximum(m/s).

- **Wind Speed at 10 Meters Minimum (m/s):-**

  Minimum Wind Speed at 10 meters above the ground level is called Wind Speed at 10 meters Minimum(m/s).

- **Wind Speed at 50 Meters Maximum (m/s):-**

  Maximum Wind Speed at 50 meters above the ground level is called Wind Speed at 50 meters Maximum(m/s).

- **Wind Speed at 50 Meters Minimum (m/s):-**

  Minimum Wind Speed at 50 meters above the ground level is called Wind Speed at 50 meters Minimum(m/s).

- **Wind Speed at 10 Meters Range (m/s):-**

  The difference between the maximum and minimum Wind Speed at 10 meters or between the highest and lowest mean Wind speed at 10 meters during a specified time interval, for example, daily, monthly, or seasonal is called the range.

- **Wind Speed at 50 Meters Range (m/s):-**

  The difference between the maximum and minimum Wind Speed at 50 meters or between the highest and lowest mean Wind speed at 50 meters during a specified time interval, for example, daily, monthly, or seasonal is called the range.

5 Additional Information:-

- Our data has been divided and collected from the main 4 regions of India.**i.e NORTH, SOUTH, EAST, WEST**.
- All the parameters are manually selected regarding the scope of project.

6 References And Links:-

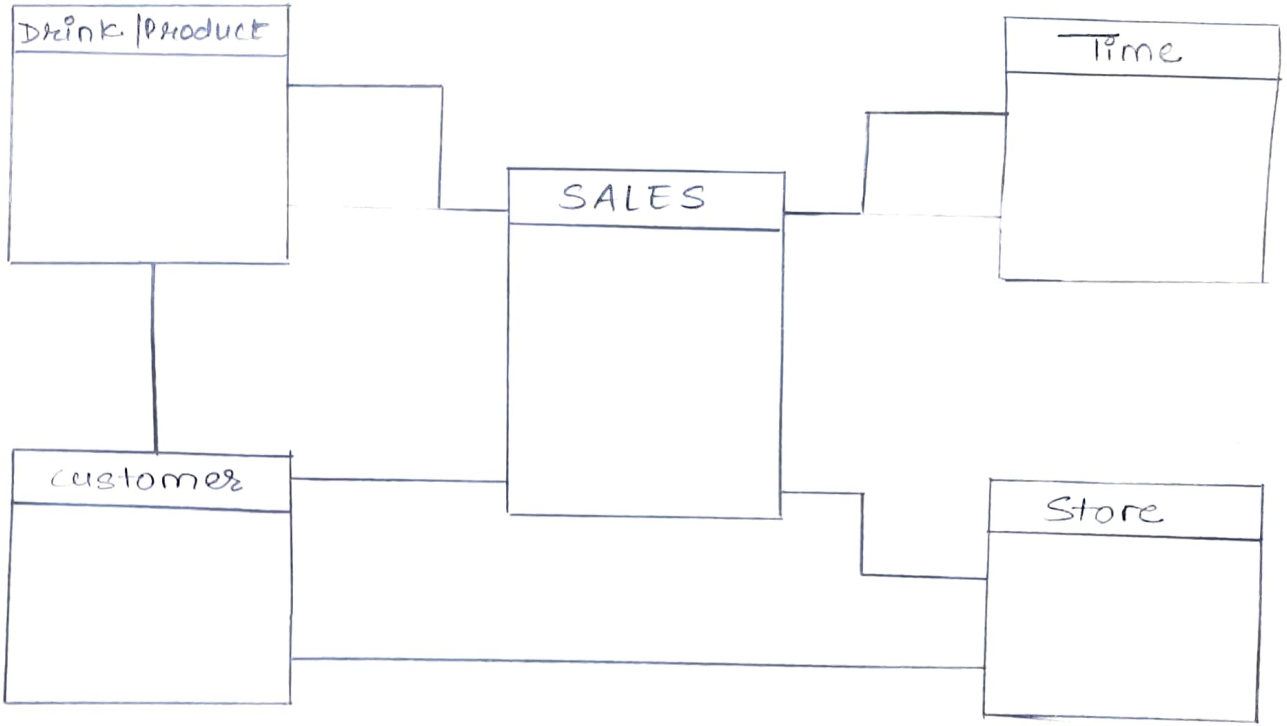
- For using the API use Access API Link
- For Meteorological Data Overview Reference Link
- For NASA POWER Data Methodology Reference Link
- For NASA POWER Story Maps Reference Link
- Youtube Link For Resilience Hub to know about NASA POWER project Youtube Link

DATA MODEL

Insight Inspectors.

Nishant Pangare, Aditi Kathalay
Janhavi Deshpande, Angela Abraham
Shriniwas Bewoor

1) Conceptual Model for STARBUCKS SALES



DATA MODEL

2] Logical Model

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for STARBUCKS SALES

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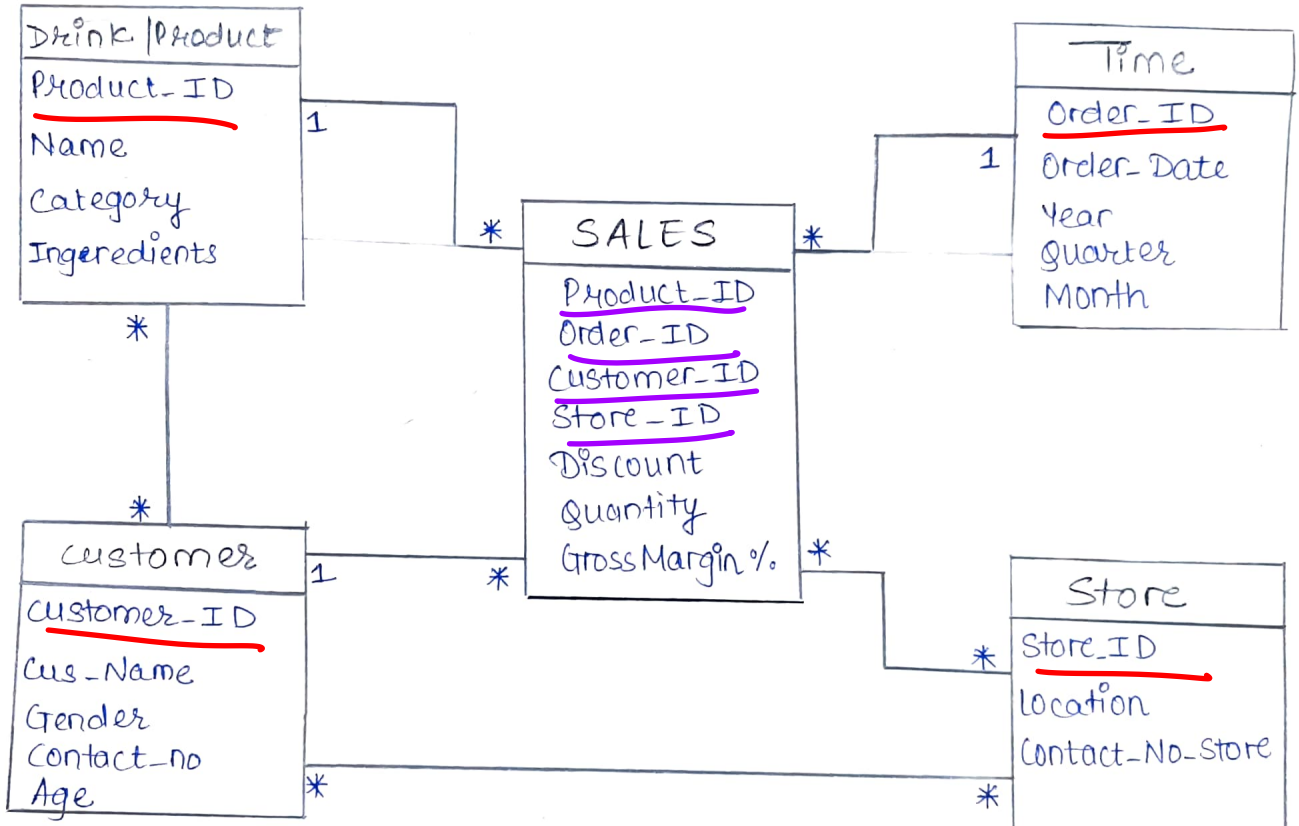
Janhavi Deshpande, Angela Abraham
Shriniwas Bewoor



* → Many 1 → One

DATA MODEL

3]Physical Model

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for STARBUCKS SALES

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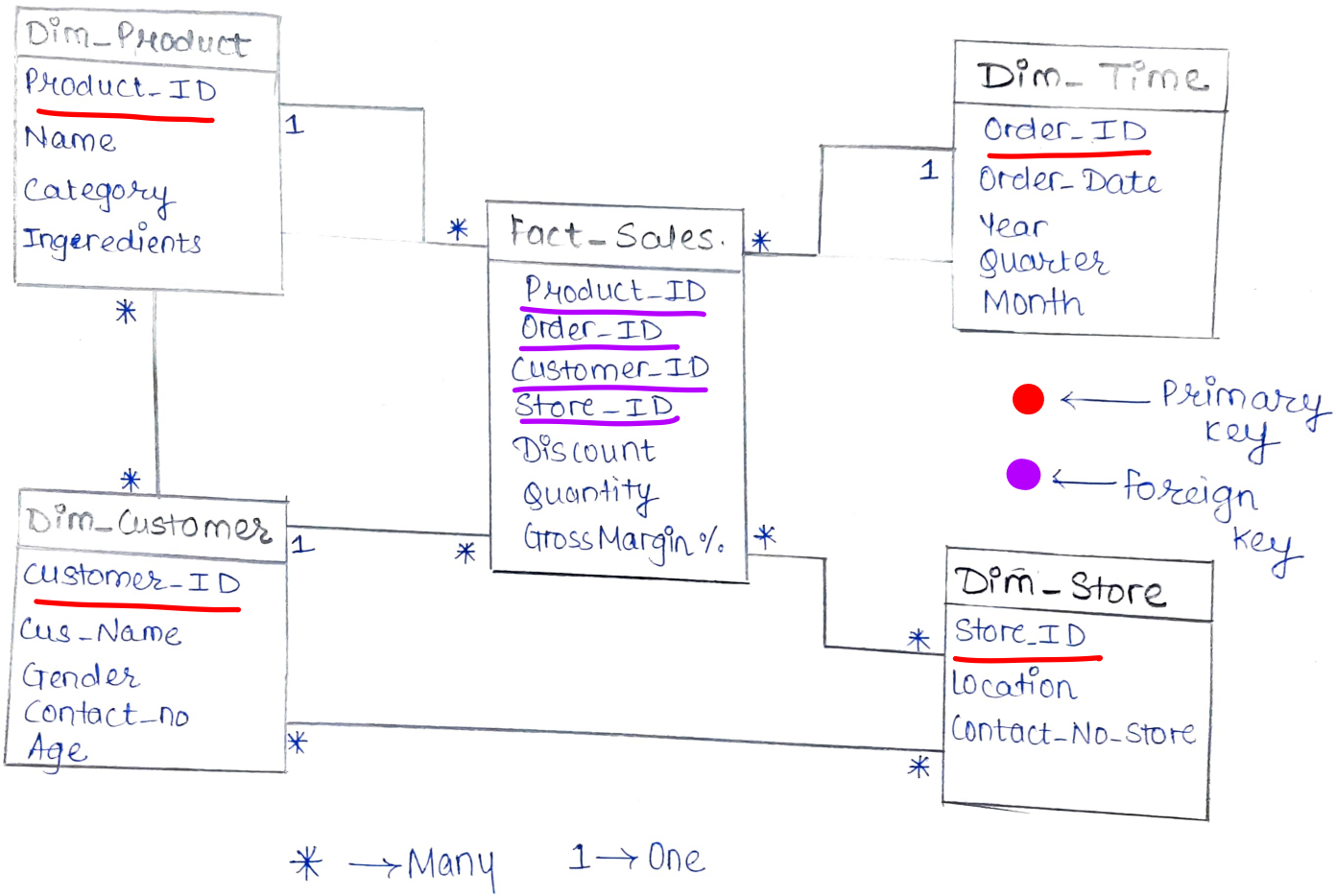
Janhavi Deshpande, Angela Abraham
Shriniwas Bewoor



Data Source Documentation

Insight Inspectors

November 2022

Contents

1 Name/title of data source

- NASA Prediction of Worldwide Energy Resources (NASA Power)

2 Originator/Owner of the data source

- NASA Prediction of Worldwide Energy Resources

- Obtained from the NASA Langley Research Center (LaRC) POWER Project funded through the NASA Earth Science/Applied Science Program.

3 Data Procurement

Data was acquired from power.larc.nasa.gov website where input parameters were given. Climatology data was procured in order to perform analysis on renewable energy requirements for a particular region.

4 Time period of data collection and frequency of updates

- January 1st 1984-2019

- Updated every several months

5 Flow Diagram

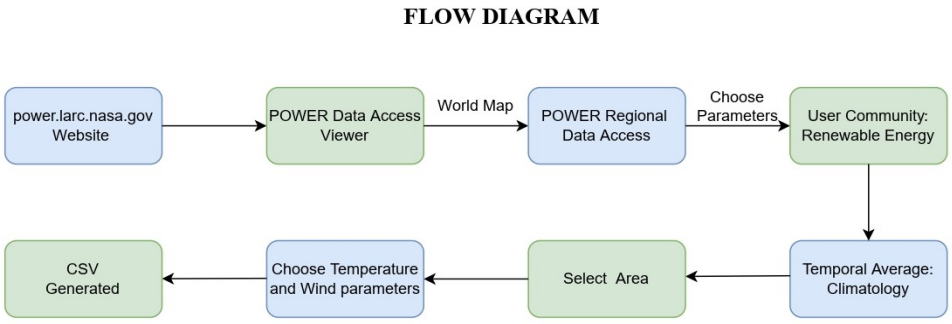


Figure 1: NASA Power Data Flow Diagram

6 Languages covered in data source

- English

7 Geographical area(s) covered in the data source.

India:

- North(New Delhi, Jammu and Kashmir, Rajasthan, Uttar Pradesh)

- South(Maharashtra(below Kolhapur), Andhra Pradesh, Karnataka, Tamil Nadu, Kerala,Telangana)

- East(Maharashtra(after Nagpur), Madhya Pradesh, Andhra Pradesh(Hyderabad),Odissa, Bihar, West Bengal)

- West(Maharashtra, Gujrat, Madhya Pradesh, Rajasthan(certain parts))

8 Size of type of data

Four different CSVs were generated for each region(north, south, east, west). A final merged CSV will be taken for analysis.

- 2.9 MB approx with 15 columns and approximately 32,000 rows

9 5 Vs of data

- Volume: 2.9 MB approx

- Velocity:Temperature and wind direction/speed can change every day. Records in the data are taken on monthly basis and system is updated after every several months

- Variety: Majority of the records consist of float values for all parameters as well as latitude and longitude.

- Veracity: According to Goddard Space Flight Center established by NASA, the MERRA-Land data is more accurate than any other data, with a few exceptions.

- Value: Organizations can use this data to analyze and predict weather and climatic conditions for a particular region. Organizations can analyze data and give farmers an insight on suitable months for loosening the soil, seeding, special watering, moving plants when they grow bigger, and harvesting etc. Here we are going to analyze data to understand what form of renewable energy could be used for a particular regions along with specifications of the device required

10 Publication form and reference

- Zhang, T., P. W. Stackhouse, B. Macpherson, and J. C. Mikovitz, 2021: A solar azimuth formula that renders circumstantial treatment unnecessary without compromising mathematical rigor: Mathematical setup, application and extension of a formula based on the subsolar point and atan2 function. Renewable Energy, 172, 1333–1340, https://doi.org/10.1016/j.renene.2021.03.047.

- Zhang, T., P. W. Stackhouse, B. Macpherson, and J. C. Mikovitz, 2021: A solar azimuth formula that renders circumstantial treatment unnecessary without compromising mathematical rigor: Mathematical setup, application and extension of a formula based on the subsolar point and atan2 function. Renewable Energy, 172, 1333–1340, https://doi.org/10.1016/j.renene.2021.03.047.

- White, Jeffery W., G. Hoogenboom, P.W. Wilkens, P.W. Stackhouse, J.M. Hoell, 2011: Evaluation of Satellite-Based, Modeled-Derived Daily Solar Radiation Data for the Continental United States. Agronomy Journal, Vol. 103(4), pp. 1242-1251.

- Tollenaar, T., J. Fridgen, P. Tyagi, P. W. Stackhouse Jr., and S. Kumudini, 2017: The Contribution of Solar Brightening to the US Maize Yield Trend. Nature Climate Change, 7, 275-278 (2017), https://doi.org/10.1038/nclimate3234.

11 Legal background and/or reason for data collection

- Educational use to gain insights on weather data and analyze outcomes based on climatic conditions(wind and temperature)

12 Content of the data source

The data accessed for the project is taken from Climatology domain and will be used to perform analysis.

- Wind(Speed,Direction), temperature, dew/frost points for the entire India measured using latitude and longitude values annually since the year 1981

13 Constraints of data source

- Data is only available for three domains: Climatology, Sustainable buildings and Renewable energy and certain values of wind and temperature for some particular regions are unavailable. Obtained data is from 4 different regions and thus merging is required

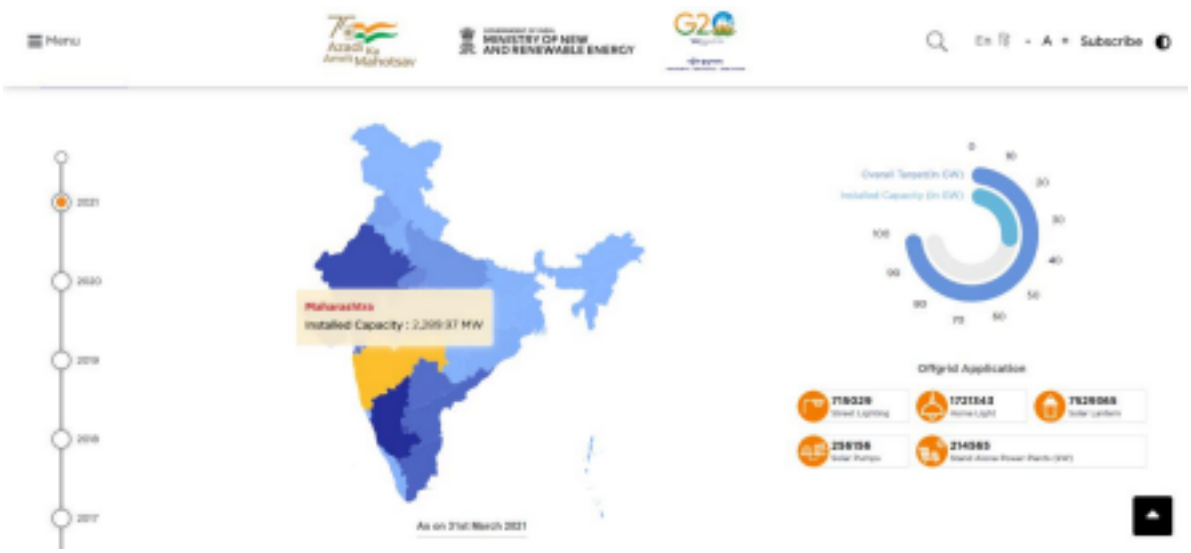
PREVIOUS DASHBOARD RESEARCH DOCUMENTATION
PROJECT TEAM - INSIGHT INSPECTORS

Central Electricity Authority
(https://www.renewablesindia.in/)

Monitor trends in renewable energy generation in India and conduct bespoke analysis with easy to access state/project level data. Renewable energy is energy that is collected from renewable resources that are naturally replenished on a human timescale. It includes sources such as sunlight, wind, and geothermal heat. Although most renewable energy sources are sustainable, some are not.

Ministry of New and Renewable Energy
(https://mnre.gov.in/)

The Ministry of New and Renewable Energy (MNRE) is the nodal Ministry of the Government of India for all matters relating to new and renewable energy. Solar and wind energy are the only two renewable energies that depend on atmospheric parameters.



Solar Energy

Wind Energy

Weathercloud
(https://weathercloud.net/en)

Their mission is to extend our knowledge of how weather affects people and our planet by developing and applying innovative technologies to the data provided by our users, and give them in exchange tools to manage and explore that data in the most beautiful and efficient way possible.

Dribble
(https://dribbble.com/tags/home_temperature_dashboard)

Common man can check weather updates through their mobiles or through some website. Atmospheric parameters of all years collectively also contribute in weather predictions.

Project Scope Documentation
Insight Inspectors
Nov 2022

Table of Contents

Project Summary

- Domain: Weather/Climatology
- Data obtained from NASA (power.larc.nasa)
- Main Columns:
    1. Parameters
    2. Latitude and Longitude
    3. Location
    4. Month (Jan-Dec)
- Data available from the year 1984-2019
- Aims to describe/predict and compare weather data with respect to geographical region and months.

Project Scope

- To create dashboard with respect to each longitude and latitude values that is by each location
  Location Dashboard:
    1. Values of different parameters based on one separate location
    2. Month wise weather data for each location
    3. Comparing monthly data for particular location
    4. Calculating Average for a particular month for one location
- Month Dashboard:
    1. Different parameter values for every month
    2. Comparing monthly average
    3. Maximum values of parameters for a particular month