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Climate Consultant: A Software for Designing Energy Efficient Building

Mr. Ashwani Kumar[1] , Dr. Arabinda Sharma[2]
[1,2]*Department of Civil Engineering, BRCM CET,Bahal,Haryana*

***Abstract:** In this study, the concept of Climate Consultant Software for making a building energy efficient is represented. This is a modern software which is very helpful now-a-days in designing the buildings. Climate Consultant helps us in designing climatic data like temperature, humidity, dew point, sky cover range, wind velocity, psychrometric chart etc.*
***Keywords:** Climate Consultant, Energy Efficient Building, Carbon Footprints, Green building, Psychrometric Chart*

I. INTRODUCTION

Hui Yan et al (2010) studied that four different sources of GHG emissions in building construction, which are: manufacture and transportation of building materials; energy consumption of construction equipment; energy consumption for processing resources; and disposal of construction waste. He also developed calculation method of GHG emissions from different source.

Hoseini et al (2013) elucidated the essence of sustainability in green building design implementations. The study drew attention to the sustainable energy performances of green buildings to identify the influential parameters. The study elaborated the contemporary trends and applications of green building design and the respective impacts on sustainable developments.

Vinyangkoon (2012) studied that green building has become globally vital for commercial building development, especially in the United States where the United States Green Building Council (USGBC), a national non-profit membership organization has developed the Leadership in Energy and Environmental Design (LEED) System to provide a guideline and rating system for green buildings. According to Gradnja (2012), Global sustainability goals have led to the development of the green building movement. His paper provides an overview of how green building relates to sustainable development practices. Sustainability also governs decisions concerning building materials. A comprehensive explanation of what constitutes a green building material is discussed and how renewable material like wood fare in the deciding criteria.

A. Analysis Of Climatic Parameters

In Climate Consultant Software, various parameters are analysed which are responsible for climate change. These are discussed below:-

1) *Temperature:* Hissar has a continental climate, with very hot summers and relatively cool winters. Predominantly, there is aridity, extremes of temperature, and scanty rainfall. Temperature range of the location in Climate Consultant software is shown in Fig 5.1-

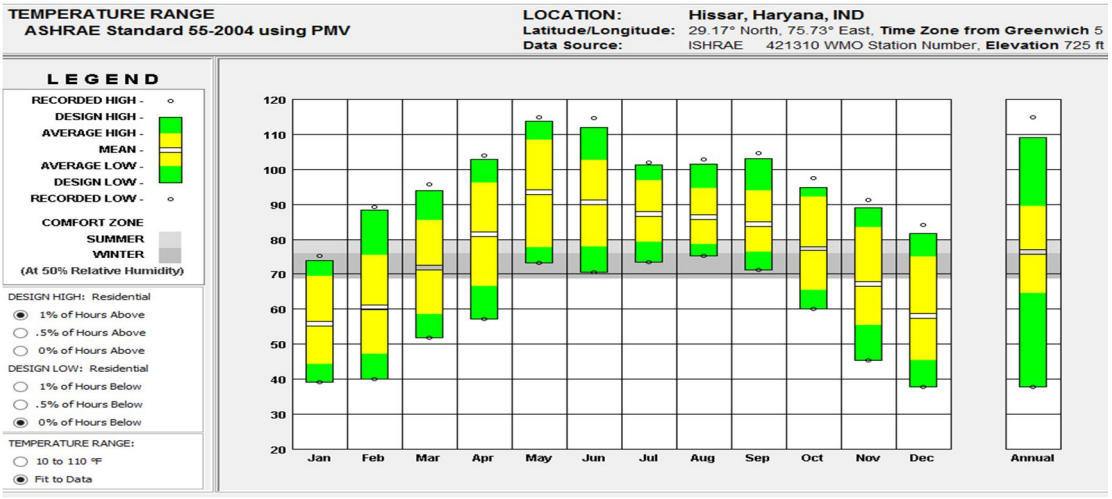

Fig 1: Monthly Temperature Range

In the above Fig 1, monthly variation is shown at abscissa and temperature at ordinate side. In top right corner of the Figure, the location ,longitude/latitude ,elevation etc. are shown. Non colour portion in bar chart shows the mean temperature which isannually approx. 77 °F (25°C).

Above and below the mean temperature, average high and average low temperature are depicted in yellow portion which lies in the range 77-90 °F and 65-75 °F respectively. Design high temperature and design low temperature lies in the range of 90-110 °F and 37-65 °F respectively as shown in the Fig 1. Light grey colour depicts about summer temperature while dark grey colour shows winter temperature range.

2) Radiation Range: Radiation range of the location region is shown in Fig 2

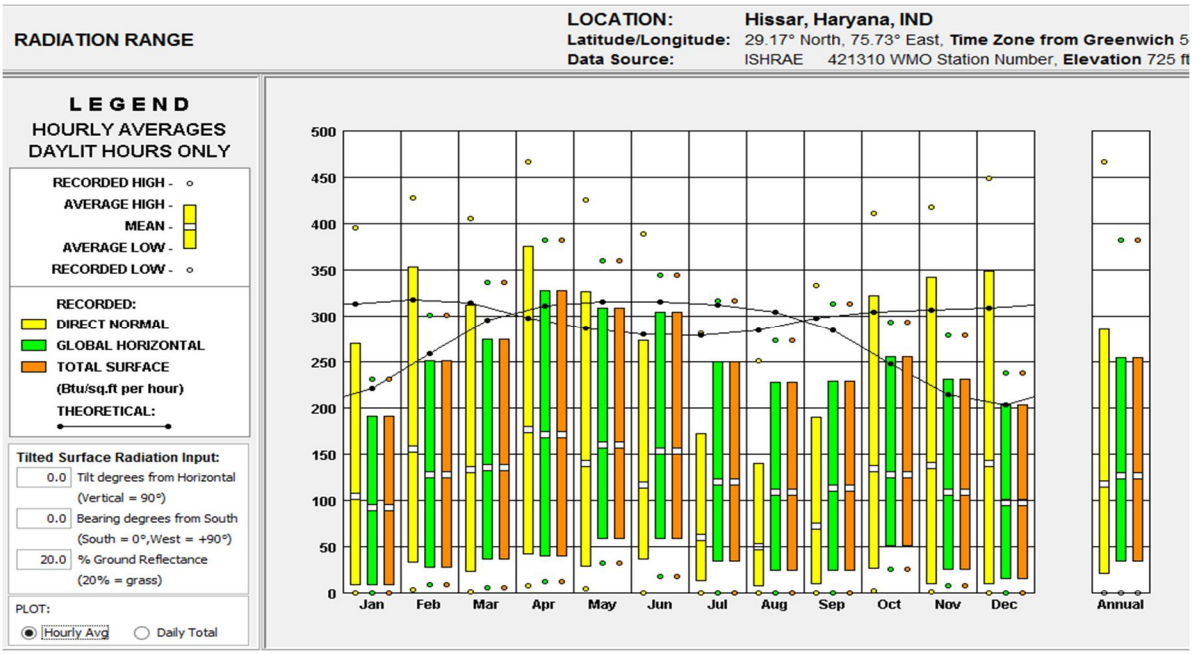

Fig 2: Monthly Radiation Range(Hourly Average)

High intensity radiations are responsible to rise in temperature and many other problems of skin etc. Here in the above Figure radiation of hourly average are shown. These are represented in yellow, green and red colour which indicates direct normal, global horizontal and total surface (Btu/sq. ft. per hour).So, Direct Normal Radiations has large range than Global Horizontal and Total Surface radiation. For the daily variation in radiation the following bar chart can be analysed as in Fig 3. This depicts that high radiations are only during the month of April, May&June.

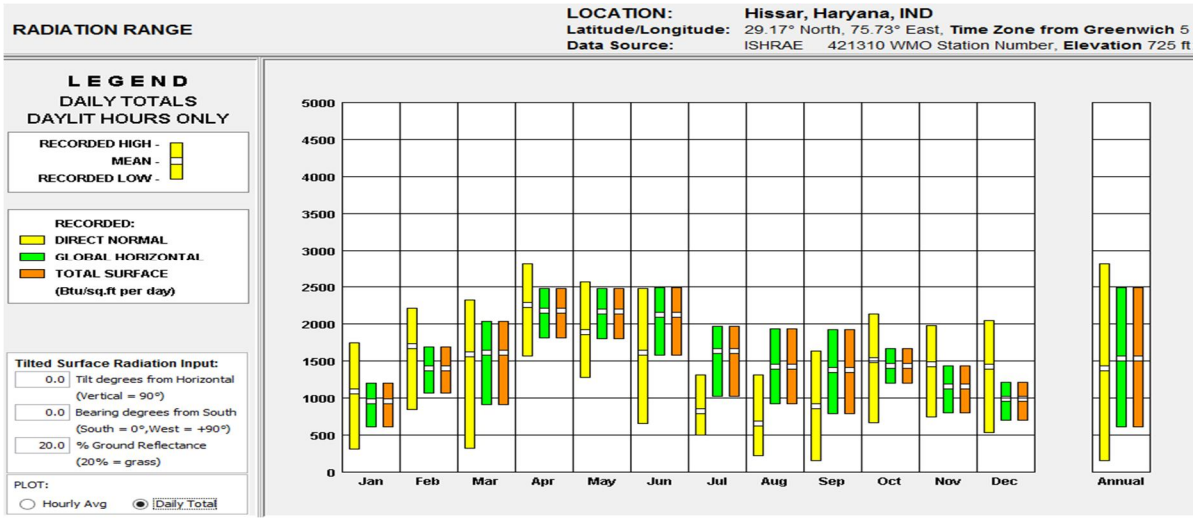

Fig 3: Radiation Range(Monthly Average)

3) *Sky Cover Range:* Sky Cover means the fraction of the sky obscured by clouds when observed from a particular location. It was found that 20 % of the sky is covered with clouds on an average .Sometimes , there may have clear sky i.e. 0% sky cover while sometimes it may be 100%. The Bar Chart of the Sky Cover Range is shown in Fig.4:-

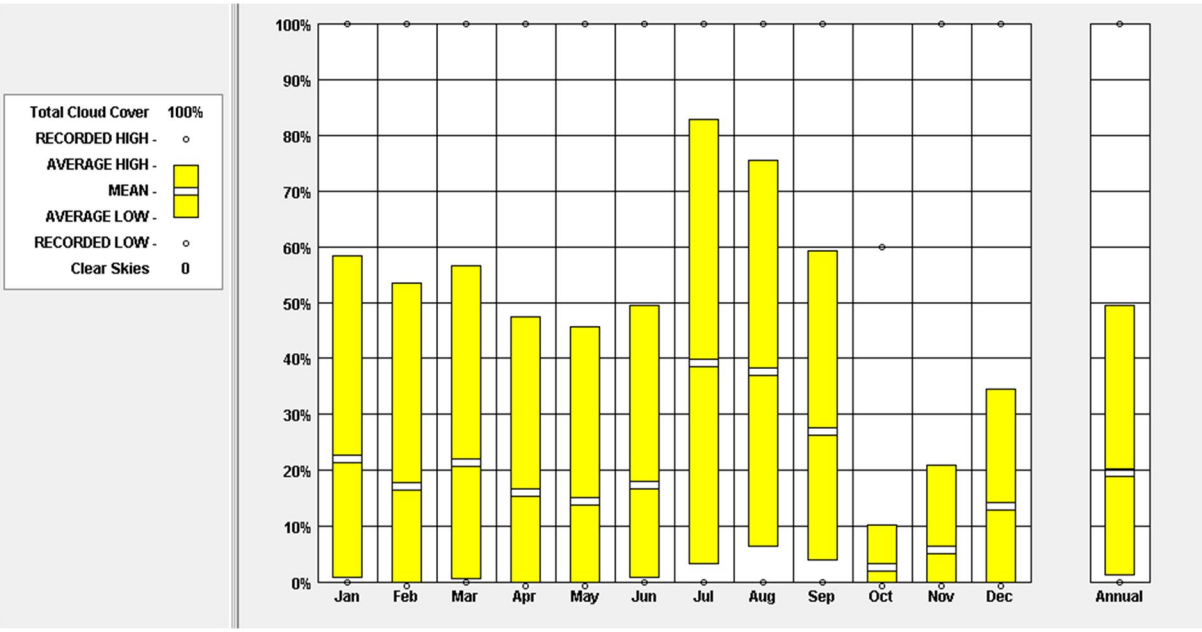

Fig 4: Monthly Sky Cover Range

4) *Wind Velocity Range:* Wind speed is caused by air moving from high pressure to low pressure, usually due to changes in temperature. Wind Direction, from which the wind blows, is defined as the number of degrees from North, measured clockwise. For calm winds, wind direction equals zero. The Monthly Mode displayed in the Weather Data Summary is the wind direction that occurs most often. It is measured in 10 degree increments. Wind velocity recorded is as 0-6 mph on an average while it is recorded 29 mph high. It can be illustrated in Fig 5 :-

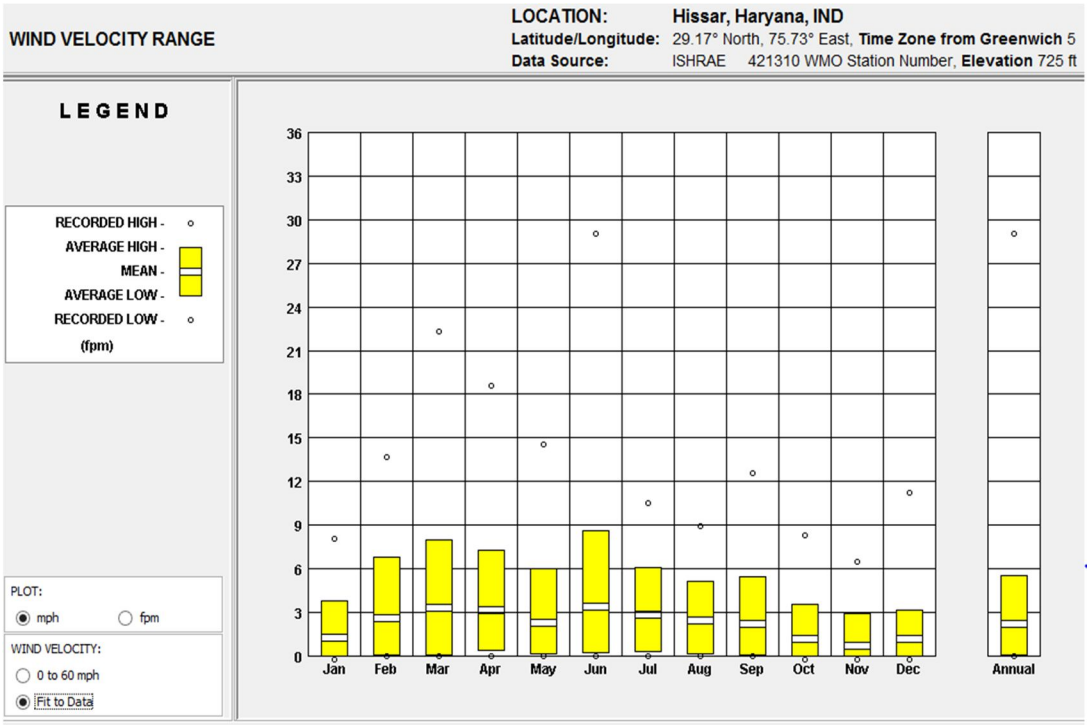

Fig 5: Monthly Wind Velocity Range

The wind rose describing the predominant direction and frequency and velocity wind in the region is shown as in Fig 6:-

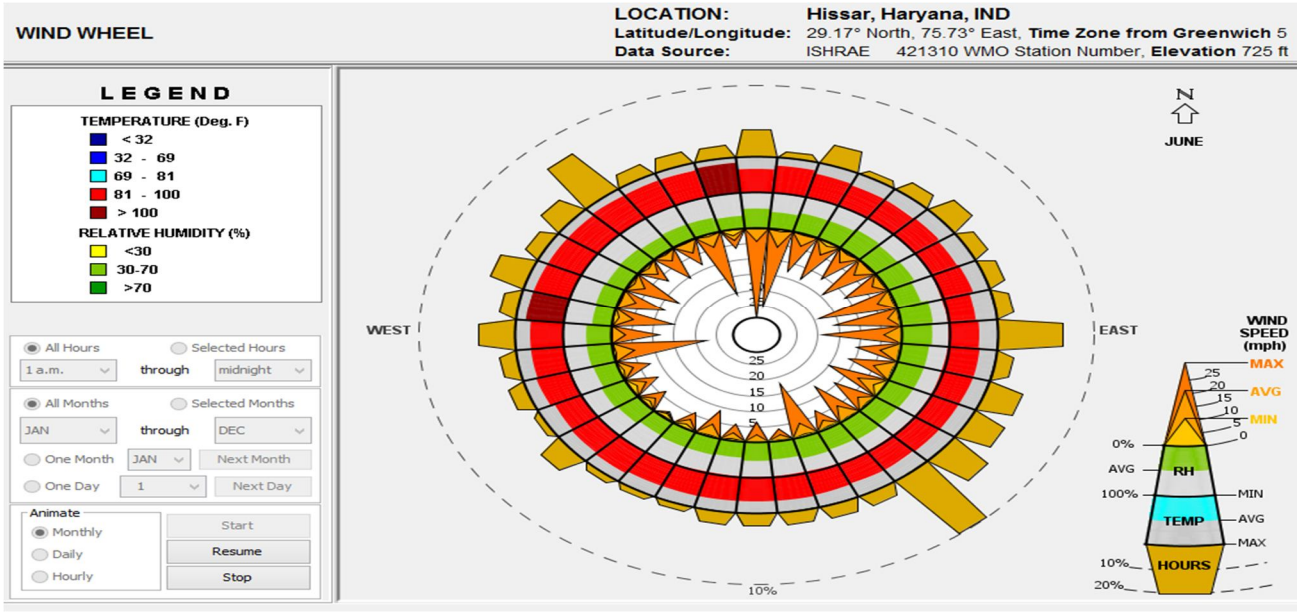

Fig 6: Wind Rose of Hissar(for June)

Here, the Wind Rose for the month of June is conspired .Likewise, we get for the other months also . Red shade displays the temperature range between 81-100 °F and dark red shade displays temperature above 100 °F. Light green shade displays relative humidity between 30-70 %. Pencil nib type triangles in light orange shade depicts low wind speed while in dark orange shade depicts high speed.

5) *Dry Bulb and Dew Point:* Dry Bulb and Dew Point is shown in 12 Charts in fig 7. These 12 charts are the average for each hour of each month of the Dry Bulb Temperature (yellow dot) and the concurrent Dew Point (green dot). Also shown on each monthly chart is a grey bar for the Comfort Zone . Dry Bulb temperature increases sharply at sunrise and peaks around 2 or 3 in the afternoon, but that Dew Point temperature is relatively stable throughout the day. As shown in Fig 7

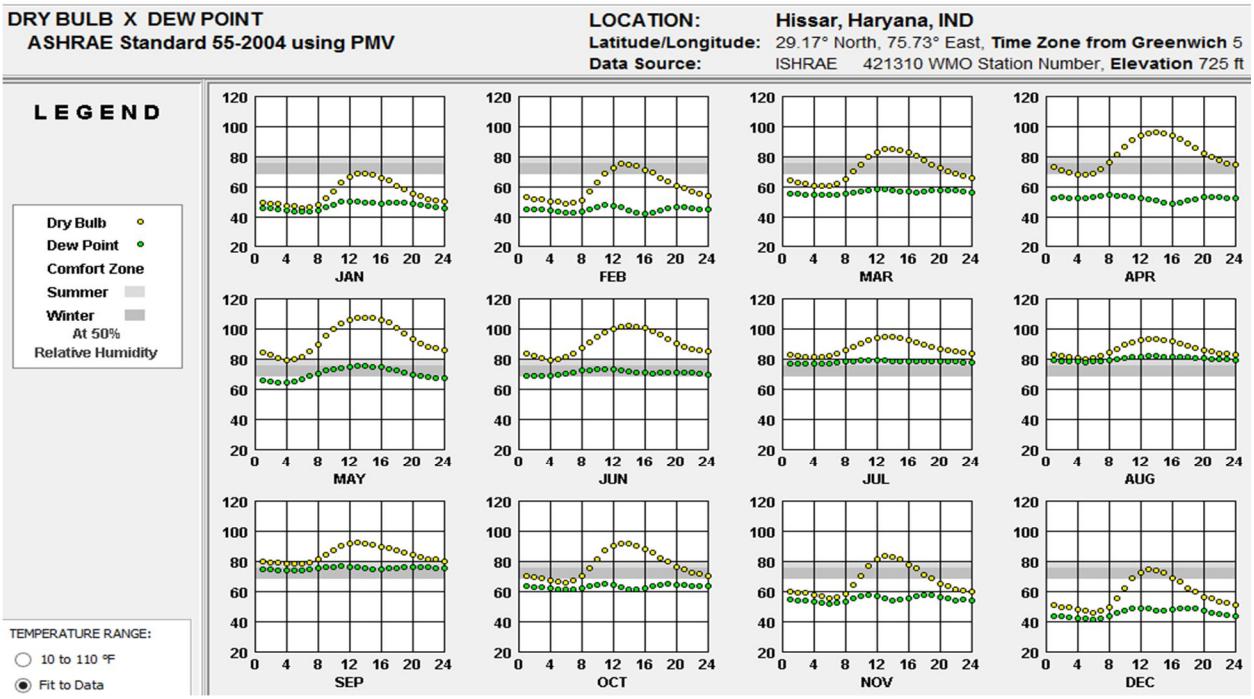

Fig 7: Monthly Dry Bulb and Dew Point

6) *Ground Temperature:* The Average Monthly Temperature of the soil at various depths 1.64, 6.56, 13.12 feet in yellow, parrot and green colours respectively is shown on the Ground Temperature chart(Fig 8). The top and the bottom of the bar charts on the right express the highest monthly temperature and lowest monthly temperature, while the average monthly temperature is shown in the centre of each bar. Depth is given in feet (or meters) and the temperatures are in degrees F (or degrees C). As the depth increases the thermal mass of

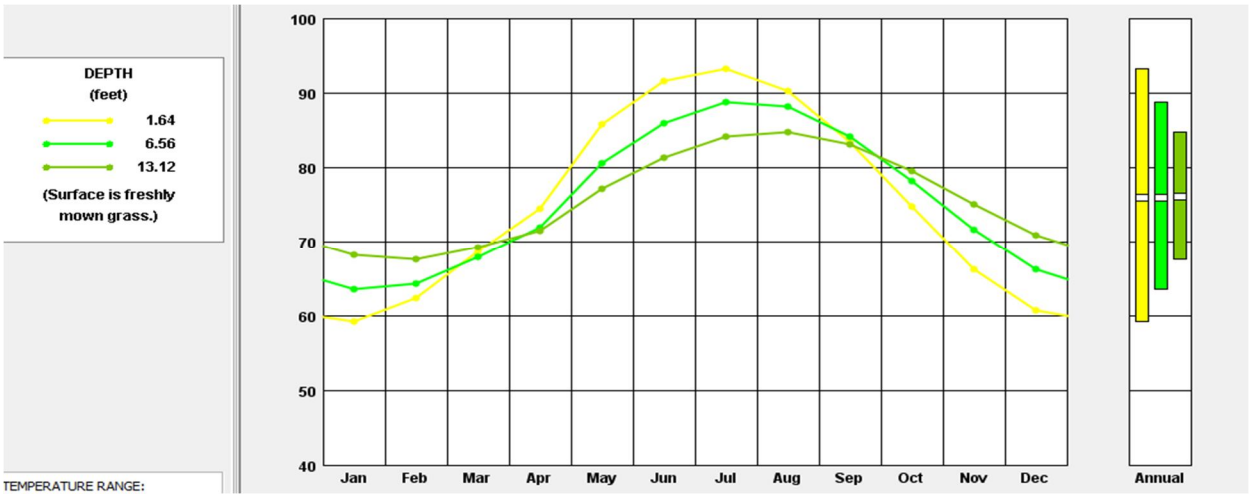

Fig 8: Ground temperature(Monthly Average)

7) *Dry Bulb and Relative Humidity:* Dry Bulb Temperature is the sensible temperature typically measured by a thermometer with a dry bulb while Relative Humidity is the ratio of the amount of moisture in the air compared to the total amount it could hold at the same dry bulb temperature. Relative Humidity is measured as a percentwhile Dry Bulb are either in degrees C or F. These 12 charts (Fig 9) are the average for each hour of each month of the Dry Bulb Temperature (yellow dot) and the concurrent Relative Humidity (green dot). Also shown on each monthly chart is a grey bar for the Comfort Zone as defined on the Criteria screen. Dry bulb temperature is almost exactly the inverse of relative humidity.

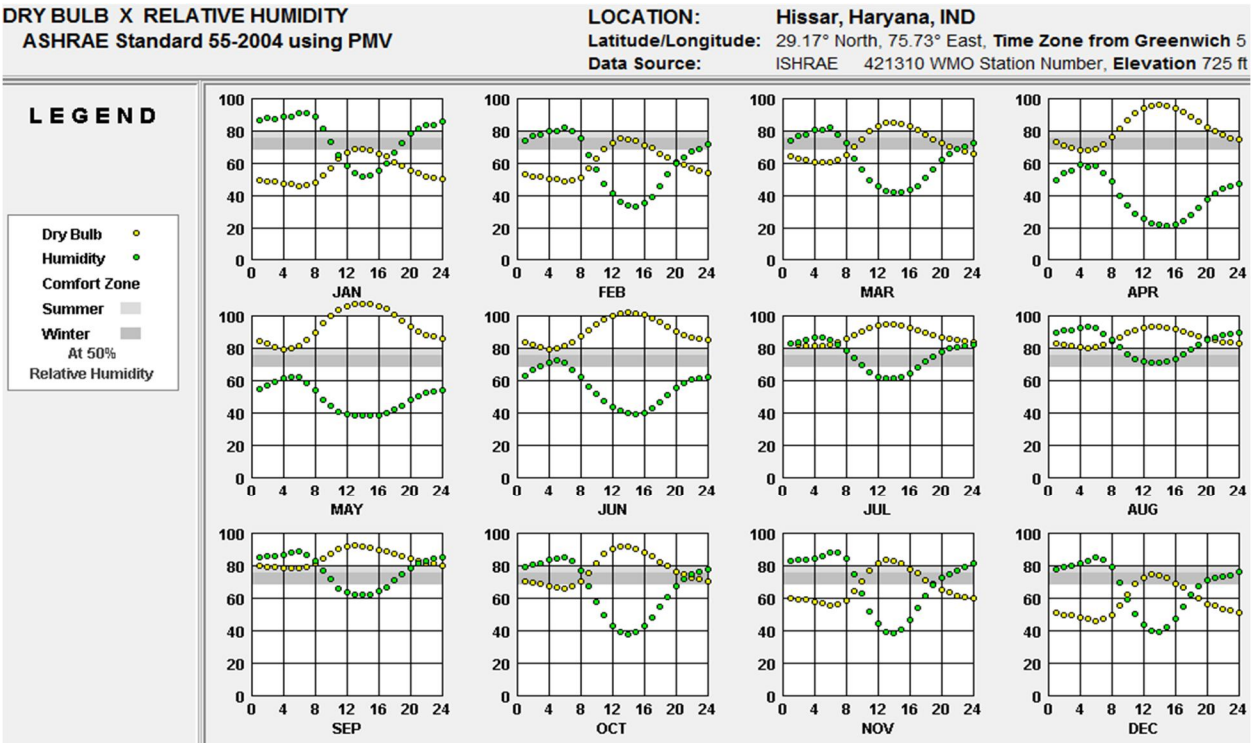

Fig 9: Monthly Dry Bulb and Relative Humidity

8) Psychrometric Chart: Psychrometric chart(Fig 10) is one of the most powerful design tools in Climate Consultant. It shows dry bulb temperature across the bottom and moisture content of the air up the side. This vertical scale is also called absolute humidity and can be shown as the humidity ratio in pounds of water per pound of dry air (or grams of water per kilogram of dry air), or as the vapour pressure. The curved line on the far left is the saturation line (100% Relative Humidity line) which represents the fact that at lower temperatures air can hold less moisture than at higher temperatures. Every hour in the EPW climate data file is shown as a dot on this chart. Some dots may represent more than one hour, for example when a given temperature and humidity occurs more than once in any month. A given hour's dot might meet the criteria for more than one strategy zone, in which case it is counted in the Percentage of Hours for both zones, which is why the percentages add up to more than 100%.

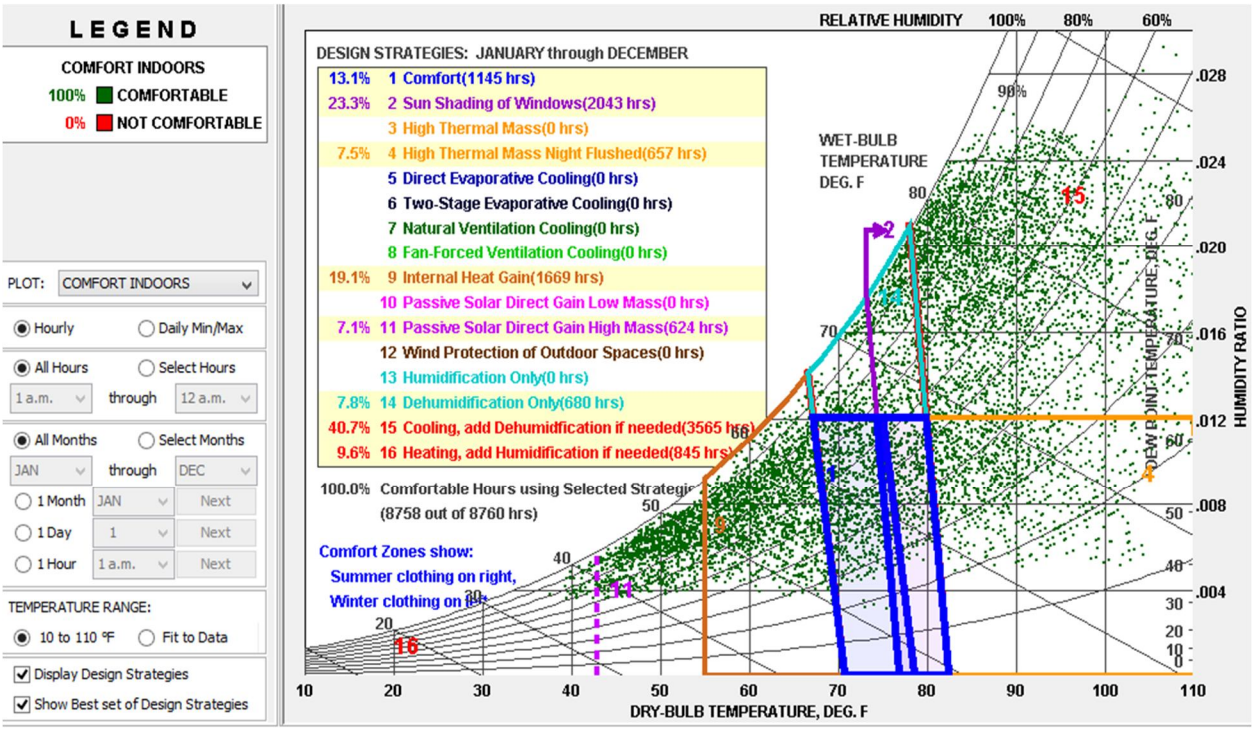

Fig 10:Psychrometric Chart

Best eight Design Strategies are shown in above Psychrometric chart .This depicts that 40.7% cooling and 9.6% heating is required in that particular area.

II. SUMMARY

Various studies that drew attention towards energy efficient residential building have been taken into consideration. It was observed that the energy conservation through energy efficiency in the building has acquired prime importance all over the world.Due to excessive energy consumption worldwide, the demand for saving strategies increases. Noteworthy policy actions towards the promotion of energy-efficiency in the building sector have been developed with different intensity and structure.However, in order to lower expenses even further, in the present study, building design is analysed with the benefit of Climate Consultant software for Hissar region in Haryana, India. This modern software set a foundation stone for achieving energy efficiency in various type of buildings. Climate Consultant reads the local climate data in EPW (Energy Plus Weather) format and displays dozens of different graphic charts of various weather characteristics. For analysing other climatic data like Temperature Range and Radiation Range bar charts(Fig 1 &Fig. 2) were plotted for each day of the month showing the highest day of the month, the lowest day, and the mean or average day of the month. It was found that the mean temperature was approx. 77 °F (25°C)annually.The Sky Cover Chart (fig 4)showing Sky Cover for each month and for the full year was prepared . It was detected that on an average in Hisar region 20 % sky is covered with clouds. Further in the study, other climatic data were observed .Wind velocity recorded as 0-6 mph on an average and as high as 29 mph. Ground temperature of the region decreases as depth of earth increases. Surface temperature goes upto 95 °F and it was as low as 60 °F . Most important Psychrometric Charts which shows dry bulb temperature across the bottom and moisture content of the air up the side were plotted.

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III. CONCLUSION

The study was conducted with the aim to optimize the energy efficiency and so as to reduce the carbon foot print of a residential building. The important results obtained from the study are summarized below:

A. Climatic parameters of Hissar, important for the designing energy efficient building were considered and analyzed thoroughly.
B. Carbon foot print of the buildings were found to be 927402.5 kg in the order for the entire life period of 50 years .
C. The optimized designed building has 11% of improvement it terms of energy requirement and carbon footprint over the standard design of the building as per California energy code.
D. Pollution Emissions were found in order of CO_2 content> Hg content>SO_x content > NO_x content.

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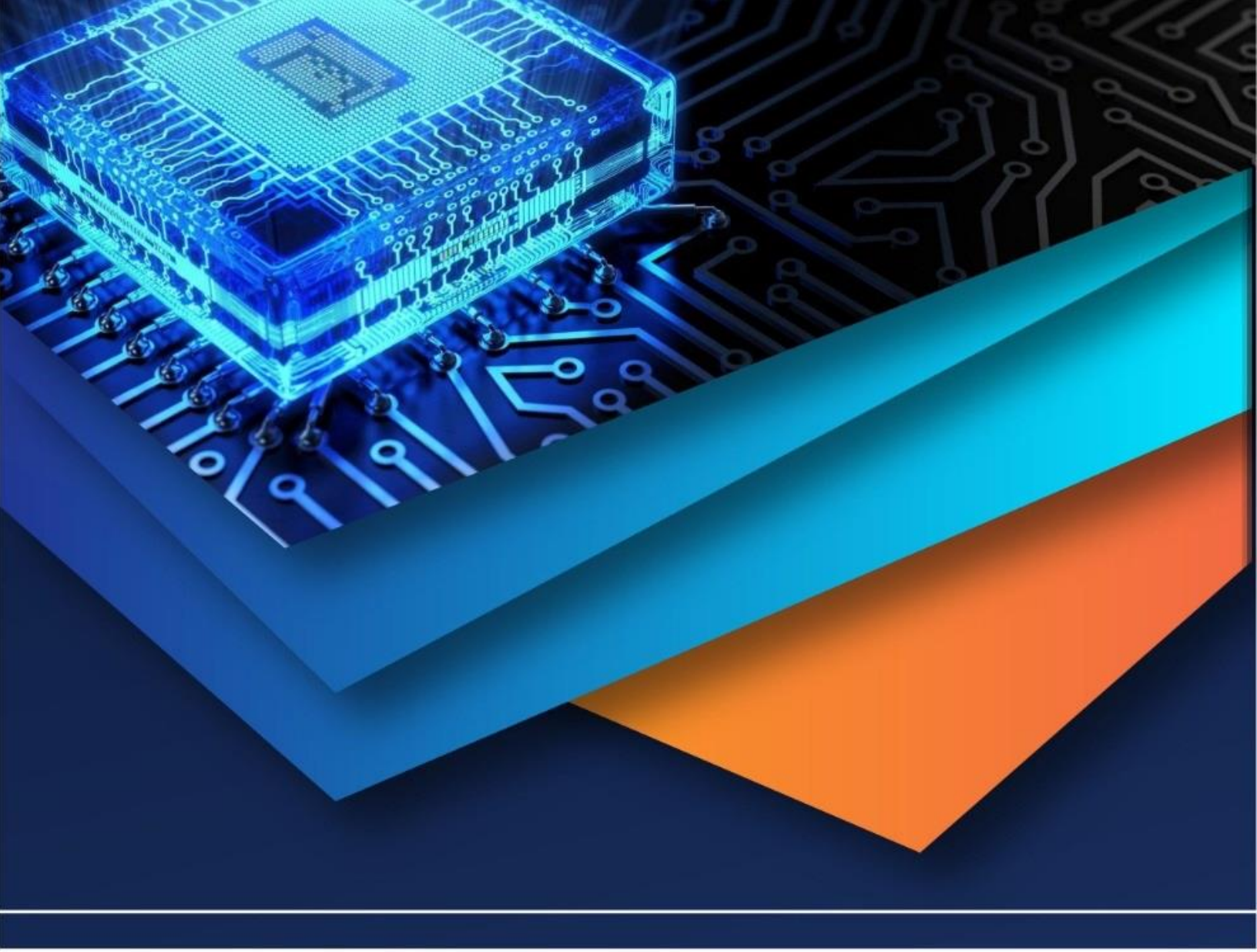

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