Sustainable Architecture
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Lecture – 55
Whole Building Performance-V

Good morning, welcome back to this last lecture of this week where we are learning the Whole Building Simulation Software as part of this ongoing online course on Sustainable Architecture and I am your instructor Dr. Avlokita Agrawal from Department of Architecture and Planning, IIT Roorkee.

So, in the past four lectures we have developed the model of a building which is going to be simulated and its performance analyzed. So, we are developing our base case in the yesterday's lecture we have completed putting in all the input parameters which are required to completely create this building and we have also set the model for simulation running the annual simulation.

So, today I have already completed the simulation and I have the results with me. I hope that you have also completed the simulation for the building and you are ready with the results.

So, today we are going to look at the results and we are going to understand how to analyze these results, because there are a lot of values which get generated. So, what are these different parameters, if you remember yesterday when we were setting up the simulation; we had already selected the different output parameters that we require. Ideally, we are looking at only the energy performance the only output parameter that we require here is energy consumption the total energy consumption and that is going to be our basis for comparing.

However, if we want to improve upon the performance of the building; we would need to know what are the different heads where energy is being consumed. And says if we understand that energy is going to be consumed for artificial lighting for cooling for heating for different things, we need to know what is causing that cooling load to increase. So, if I want to reduce my energy consumption of the proposed case, then in

that case I need to probably cut down the heat gain of the building not I cannot directly reduce the energy consumption of the building.

Therefore, even though the final compliance criteria may come in the form of energy consumption. We would still need to understand all other parameters of heat gain of building materials, the envelope, the design and all of those and let us see how do we read all these input and output parameters. So, we will switch back to the screen of the software and understand how to read the analysis and the summary that gets generated.

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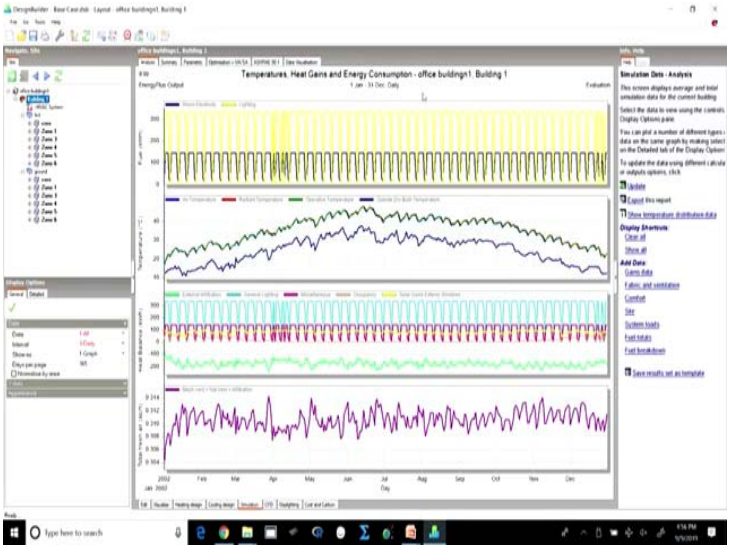

So, we have seen in the last four lectures, how to create a base case building and what are the different inputs that we require and then we also showed how to start with the simulation of this building. So, for the previous lecture I had shown you how to simulate it for a week. Here I already have simulated the same building for an entire year. So, I have run an annual simulation for the same building same inputs and we have got these results.

So, I have simulated on an hourly basis. So, the values for each hour are available. For any green building rating system compliance, whenever we want to show the energy performance of a building using simulation software we have to simulate the building for an entire year on an hourly basis hourly simulations are required. So, all the 8 7 6 0 hours will be simulated here and on the basis of the simulation, the comparison between the proposed case and the base case will be shown and the compliance will thus be achieved

So, here if we look at the results, if we look at the data which we get we can see different types of data here. First of all we have the environmental parameters. In this we have the air temperature we also have the radiant temperature and operative temperature and we have the outside dry bulb temperature which is this. So, this is the outside dry bulb temperature which is received here and the air temperature indoors and the radiant temperature is shown here.

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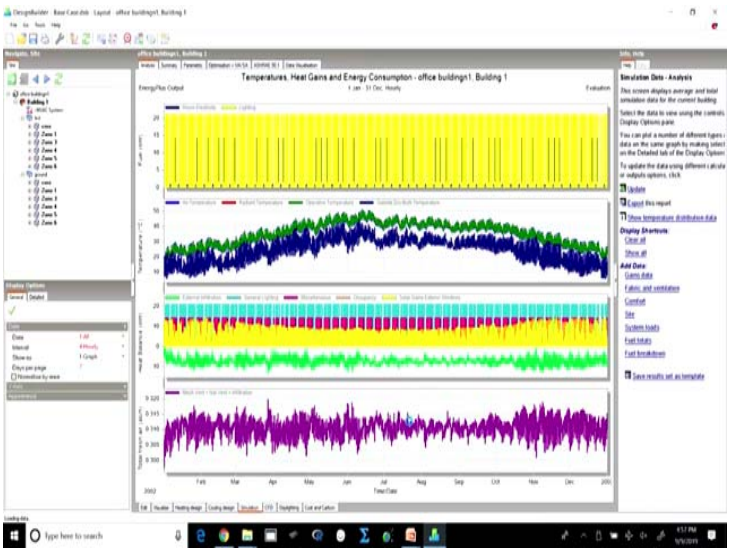

So, instead of a daily graph, if we look at the hourly graph and instead of 365 let us just look at say 7 days.

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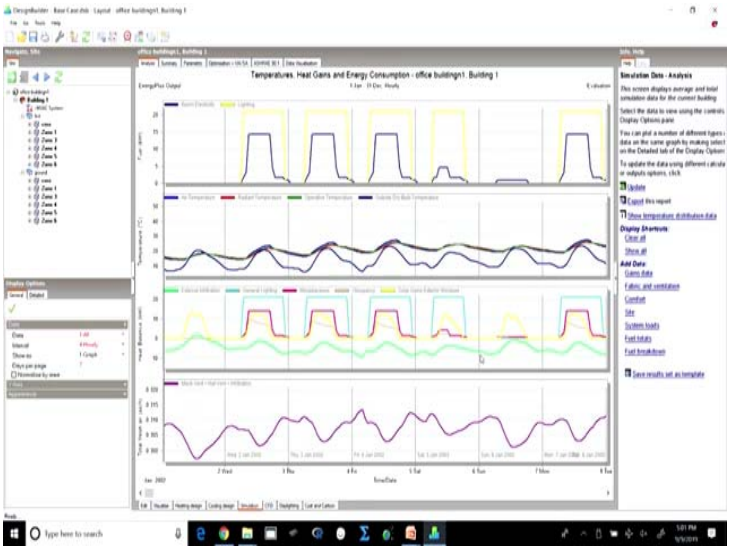

So, we can see the graphs, the same graphs in details. So, for 7 days; so, this is for each day. So, it starts from January first and that is how it progressively shows. We can see that the outdoor temperature is varying as it should vary and correspondingly, we can see the air temperature, the radiant temperature and operative temperature varying.

So, we can see that the building is able to bring the temperatures, it is able to raise the temperatures to some constant temperatures indoors. If we move on, we can see the 7 days at a time and if we move on and we see how the situation is when we come to summer. So, here we are in May, June in New Delhi and we can see that the outside air temperature is lower than the indoor air temperature and radiant temperatures and to manage that these temperatures and to bring them back to a comfort zone, the amount of electricity which will be consumed for cooling for room electricity and lighting is shown here

So, so we can see that this is the environment these are the environmental parameters here, we can also see the corresponding use of electricity for different purposes for different processes. At the same time, we can also see the heat balance here from where the heat is coming from where the in case of May, the graphs for May, we can see the heat gains. So, we can see that in May, heat is largely coming because of now the maximum is because of general lighting we also have miscellaneous constantly we have

the solar heat gains because of the exterior windows and we can see that during the non sunshine hours that is during the night.

The solar gain from the exterior windows is 0, while there is a lot of heat gain because of general lighting. So, if you remember the radiant fraction of the luminary was quite high it was around 70 percent. So, during the office hours, huge amount of load cooling load is added because of general lighting which can be definitely taken care of, then we also have some little load because of infiltration rather there is no load. In fact, infiltration is helping the building to lose the heat.

We also have miscellaneous loads. So, this miscellaneous is coming because of the computers that we had added, the office equipment that we had added. So, this is the summary of different heat loads. We can see the same for extreme winter. So, suppose we looking at January, we see that infiltration is losing a lot of heat, the general lighting is again adding a lot of heat and there is heat gain due to solar and miscellaneous also the occupancy is adding heat to the interiors.

So, we can actually see from where the heat is coming from, where the heat is going. We can also look at the air ventilation rates because of the natural ventilation plus infiltration and this is what the summary of this entire thing is.

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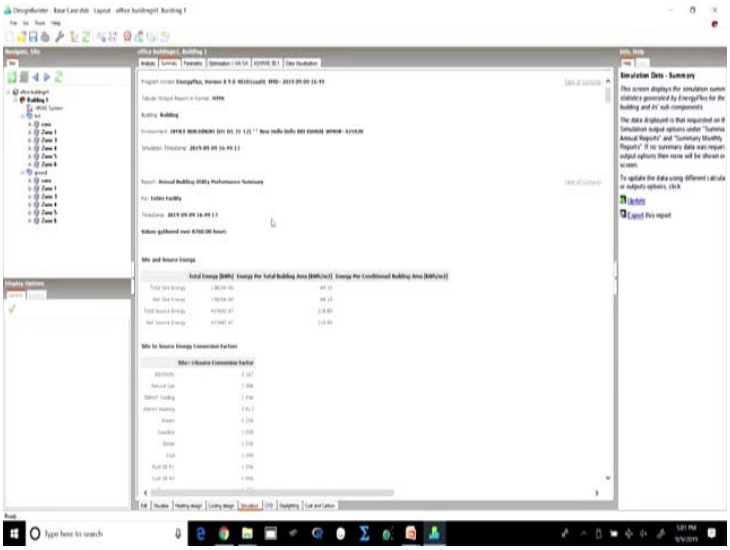

So, if we go to this tab which is called summary. We can actually have this is the kind of report which is generated.

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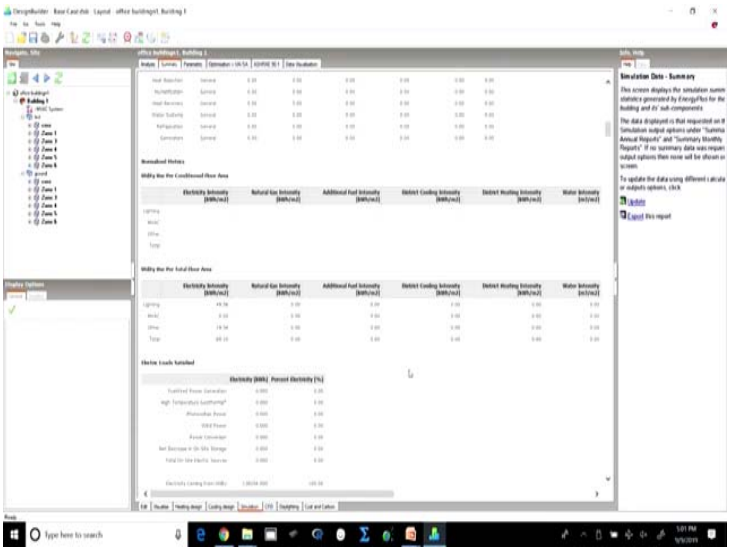

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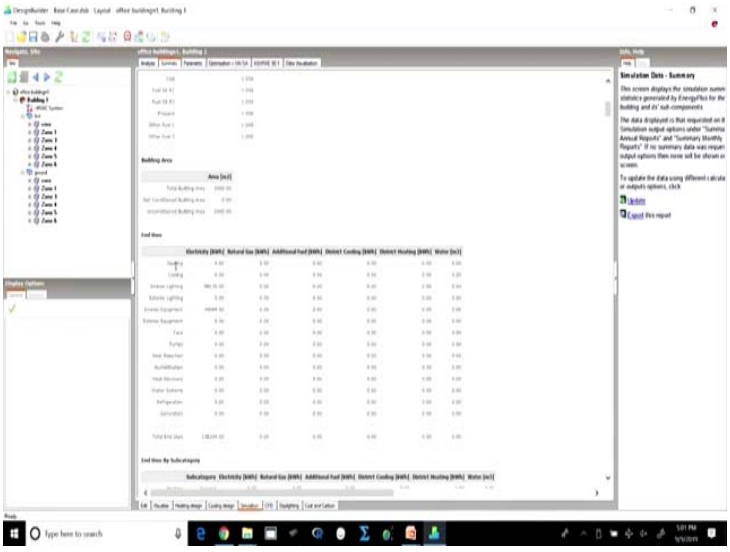

Here we can see, what are the different loads which are taken. So, it will give you the summary that what is this total site energy which is consumed which is the what is the total source energy which is coming in what is the total building area the unconditioned building area.

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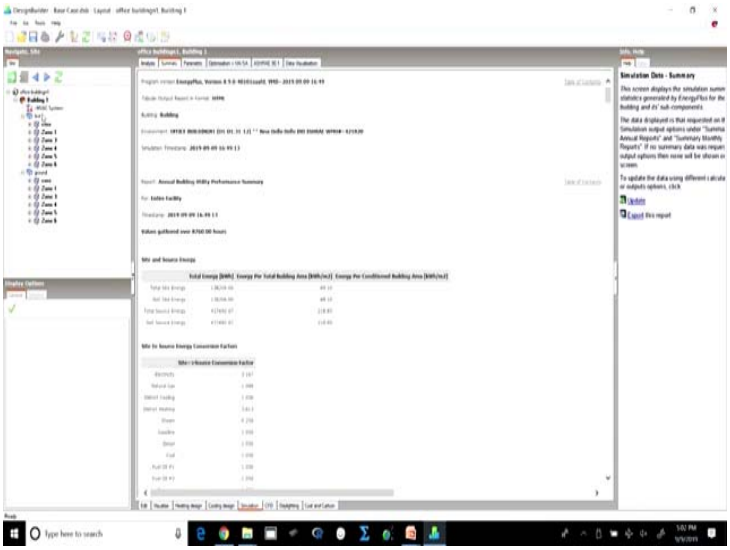

So, here we see that the total building area is 2000 square meters which is what we had taken right from the beginning. And it shows as unconditional building area is 2000 while what we had intended was that we were creating the building to be fully air conditioned.

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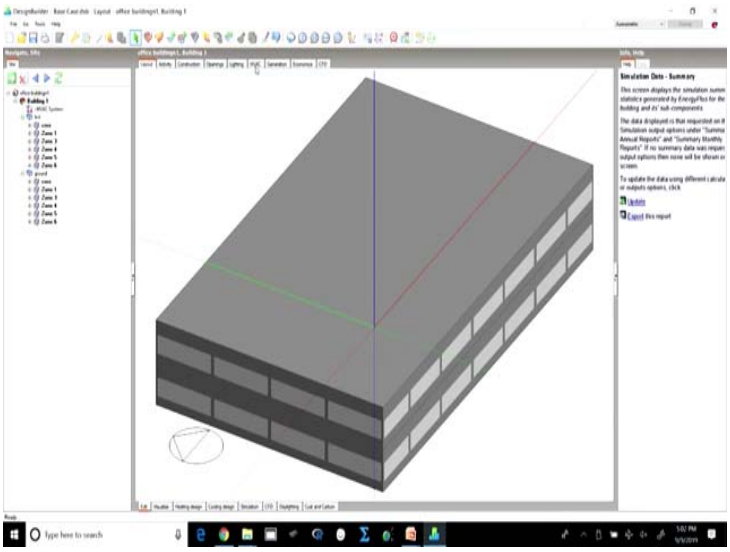

So, we know very clearly that there are some problem, we can go back to editing the model and we can check the HVAC, because we must be getting the air conditioning load.

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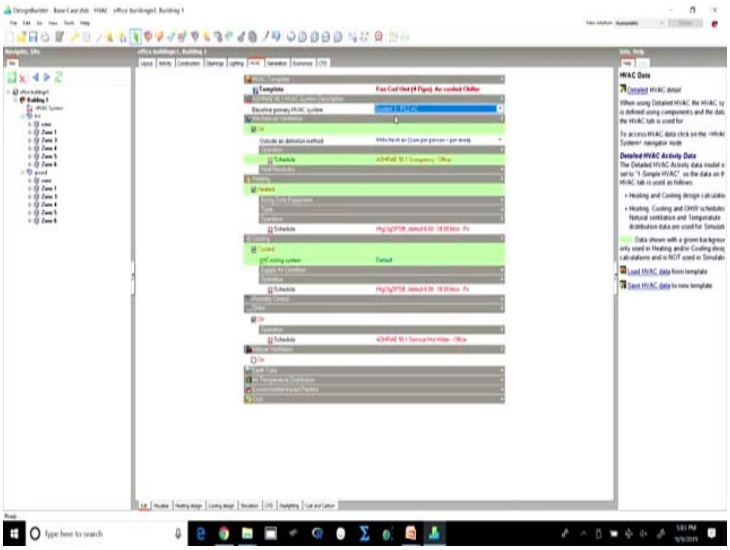

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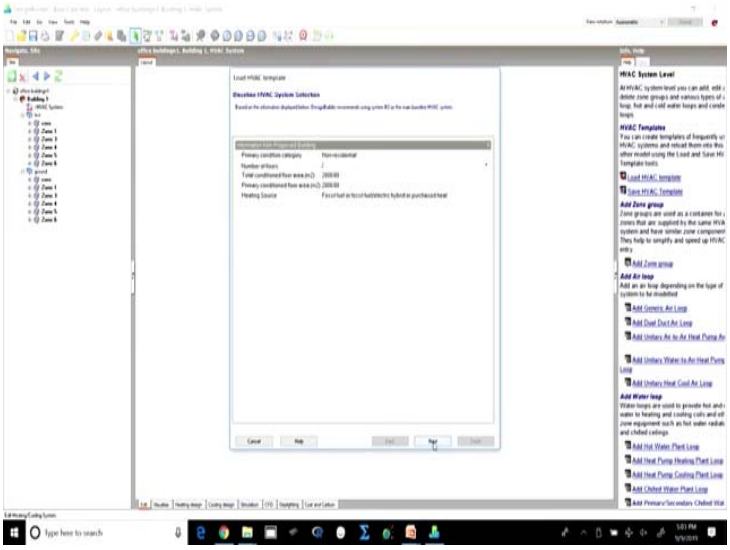

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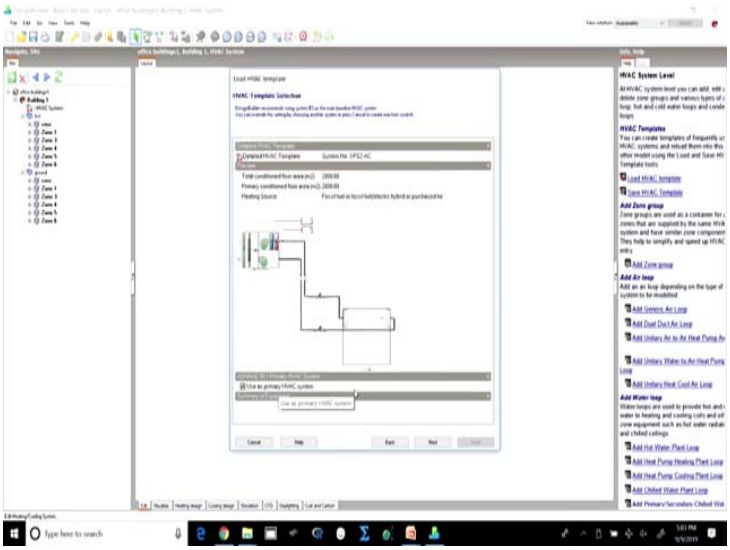

So, here at the baseline primary system I select again as system 3 and we have the default cooling system which is 3 and we are using it as primary system as well.

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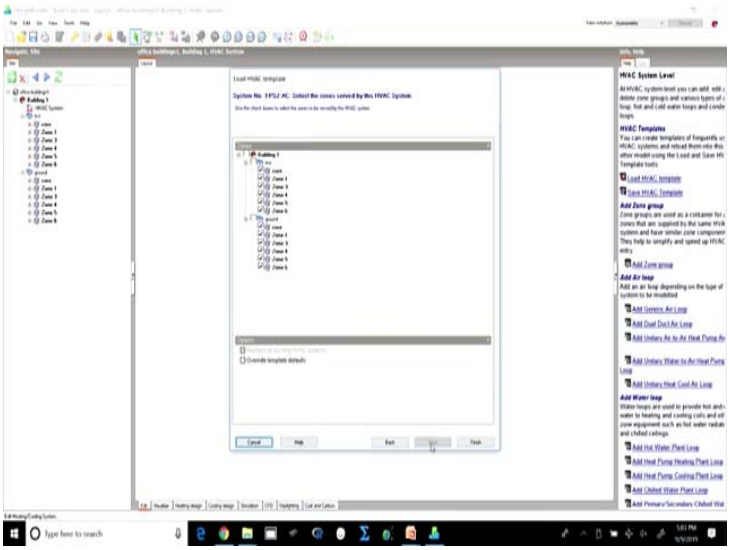

So, if we quickly simulate only for a day.

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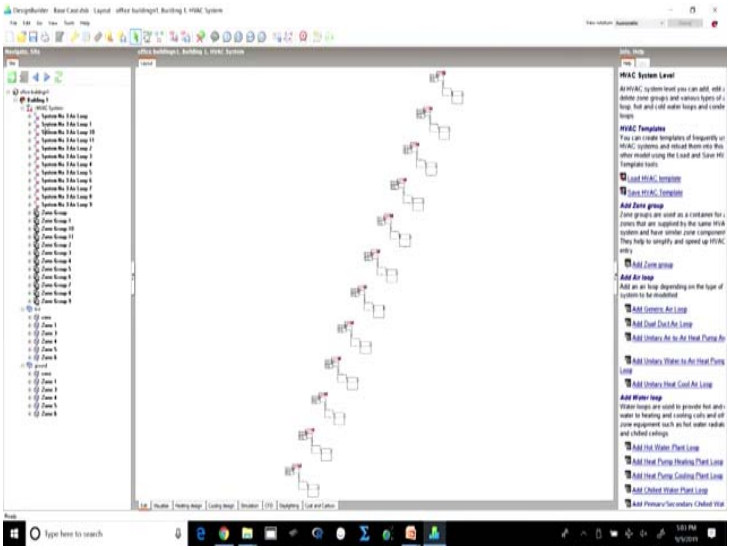

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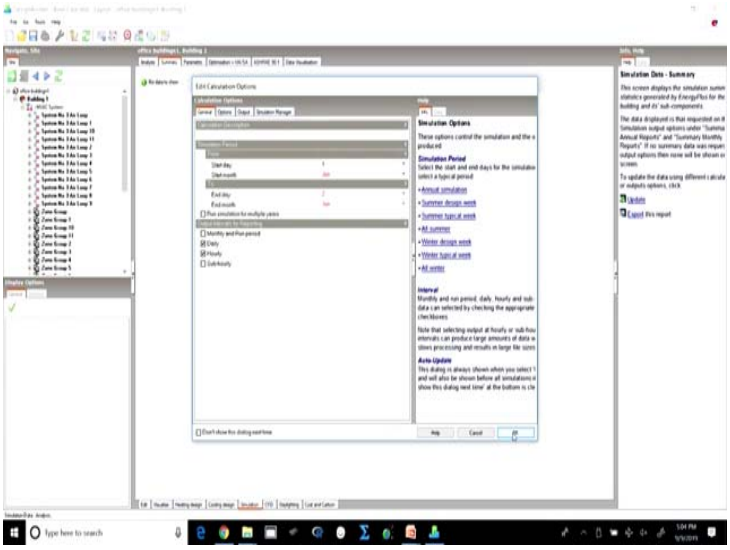

So, if I simulate only for one day in June, we should be able to see whether it is taking into account the cooling or not and then, we can go ahead with the entire annual simulation and achieve receive the summary for it as well.

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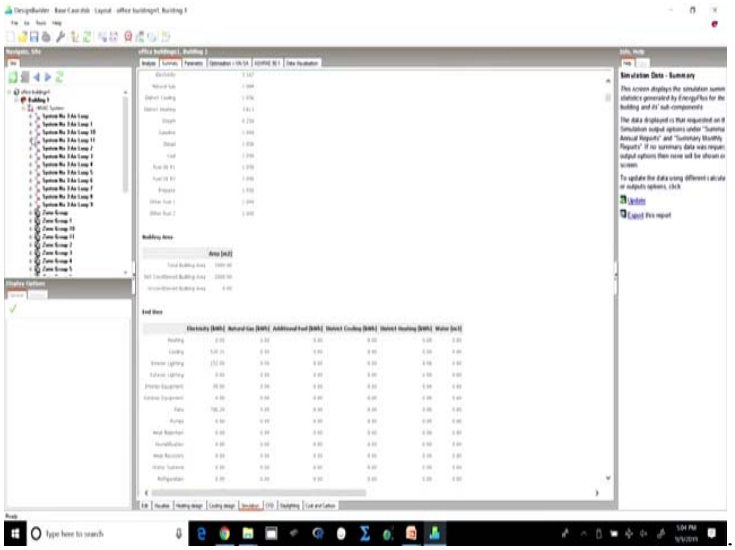

So, now if we see, so there must be something wrong that must have gone in here when I selected.

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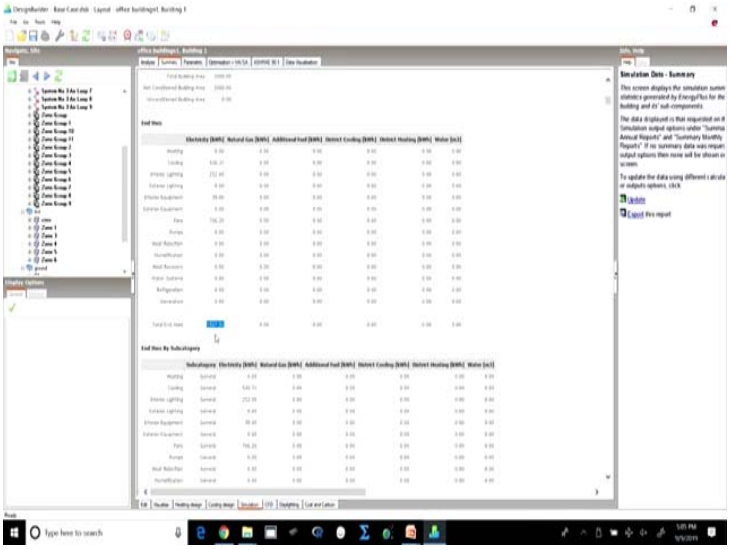

Now, we can see that the total building area is 2000 and the condition building area is again taken as 2000 and because while I was selecting the H V A C system I did not change the core and I continued to take the core as conditioned area.

Now, if we see it for a day, this is the summary if we see it for the day we can see that the cooling the electricity required for cooling is this much and for interior lighting is this much, this is in the absence of lighting controls for interior equipment which we had taken in and fans which are part of the mechanical ventilation. So, overall the end use of electricity is this much we have not taken into account other fuels.

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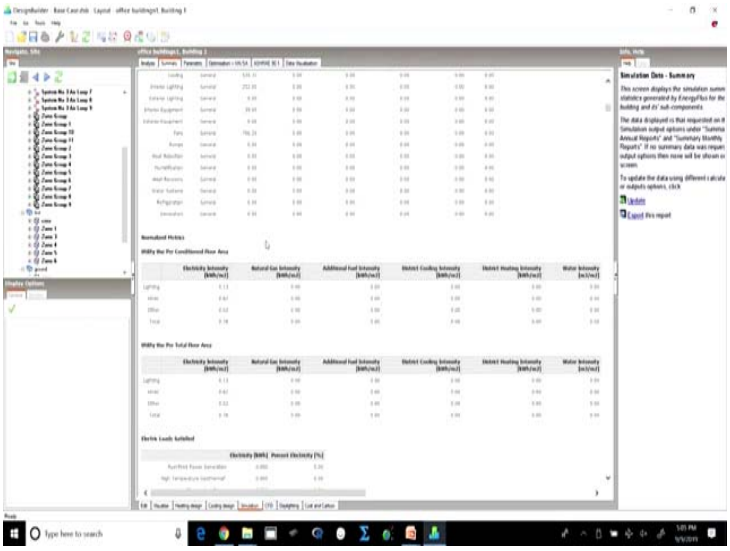

So, the total electricity consumed is this. So, this is the summary that we will get out of this software, we can download the summary we can export. We can export the report file, we can export the summary and we can use it to calculate and to compare the base case with the proposed case later on.

So, the summary will also normalize it will give us the utility use per floor area.

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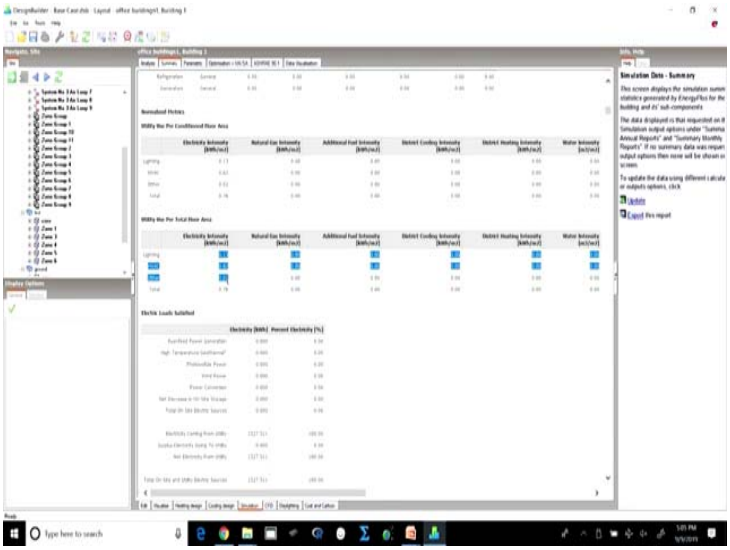

So, it will give us the HVAC lighting and other users per meter square area. So, that is what it amounts to the total. It will also give us the summary for onsite thermal sources and water sources, it will also give us the set point not met criteria where the default values have been given as per ASHRAE the default values.

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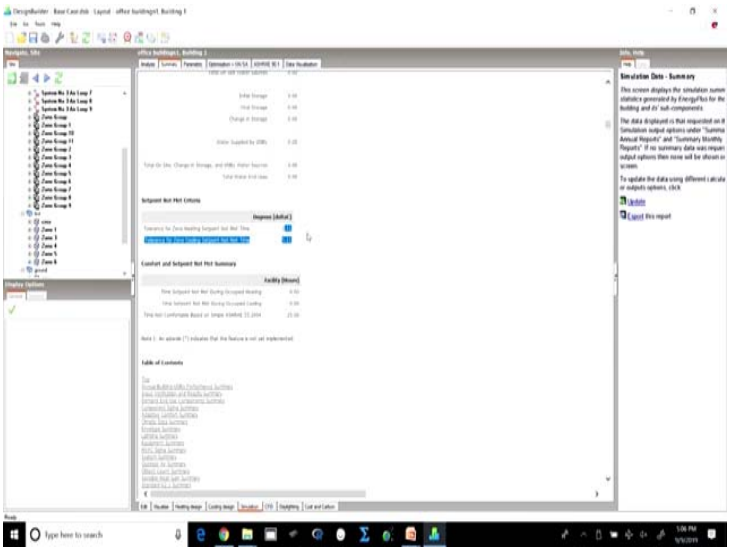

We can also look at the comfort and set point not met summary that what how many times the set point was not met during the occupied cooling. So, this is what is the summary in addition to that if we look at this, it will give us the climatic data summary.

The adaptive comfort somebody we can go to each one of these. So, suppose we look at the climatic data summary it will give us the kind of climate it has taken.

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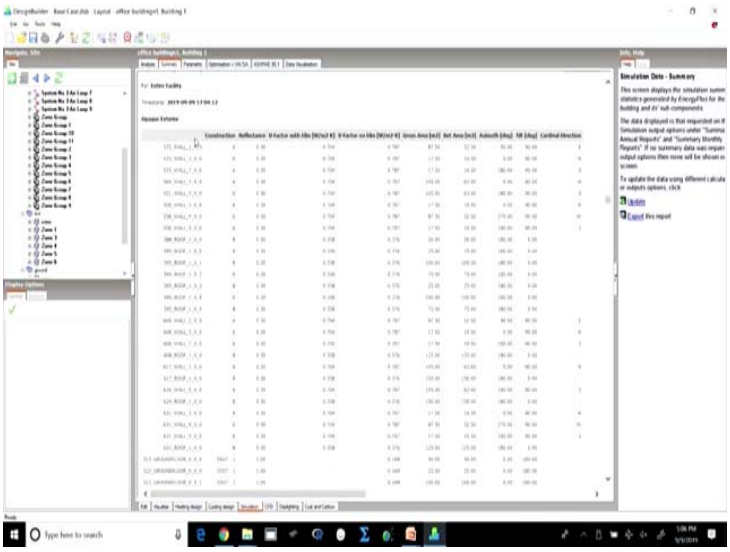

So, the weather data statistics will be given in addition to that we also have the envelope summary where the u values of different walls and floors and the exterior fenestration. So, all of these will be taken.

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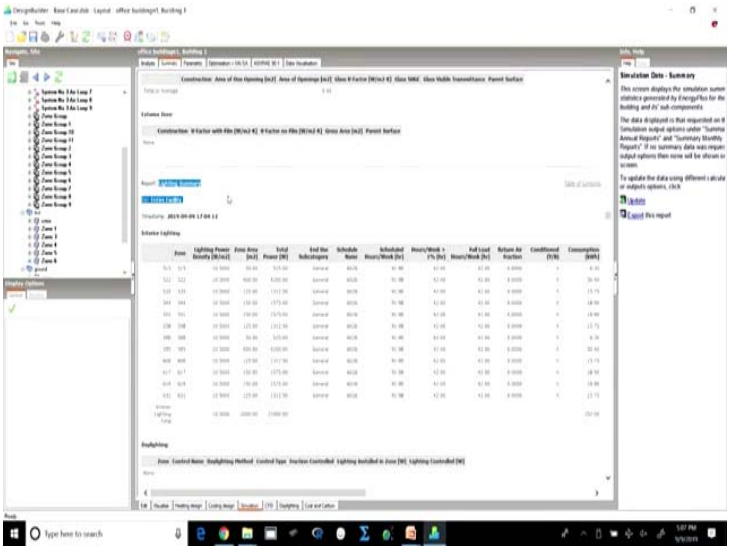

We have the summary for lighting. So, what are the different zones and what are the different lighting power densities that have been taken. So, here since we did not change,

it gives us 10.5. So, basically we can look at all the inputs that have gone in and then we can also look at the outputs which we have been received. So, in the beginning we will have the outputs and towards the end we will have the inputs. This is the summary of the simulation on the basis of the input parameters we have given and also the output parameters that we have defined.

So, if you look at this, you can go to each one of these head the LEED summary will give us the kind of performance that the building is giving. So, on the basis of the [electric/electricity] electricity use it will give us, what is the performance of the building. And the same numbers can be directly used for compliance with the LEED green building rating system.

Here, one thing that we have not done is compare the performance of this base case with the proposed case, also one thing which is there is we have not completed the base case simulation as I had told you in the beginning.

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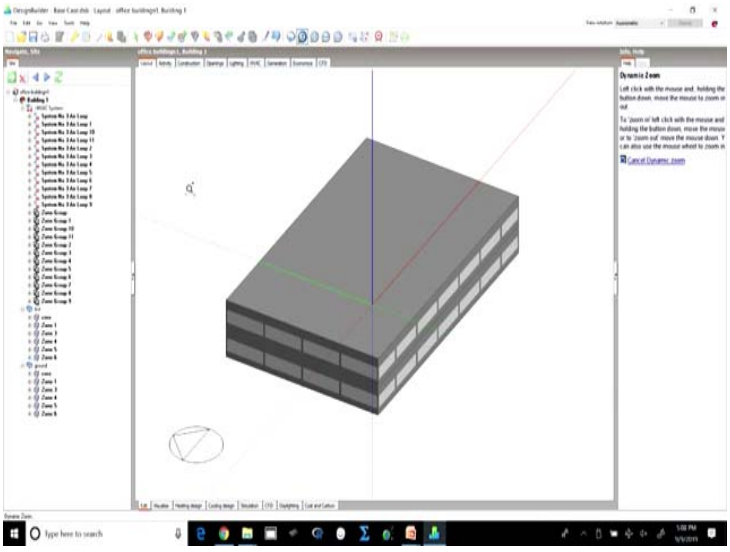

For calculating the average performance of the building for the base case calculations, we have to rotate the building for in all the four directions. So, what we will do next is; we can save this building as base case one, which is oriented to the north. We create, we copy and we create three more cases where we orient the building to all the four directions.

So, north and then north on the shorter side north on the longer side, but the other one here in this case is the building is rectilinear, it will not make much of a difference and we can average out of two as well because it is uniform. However if we are doing an irregular building then, we simulated for all four major orientations and then calculate the average over all electricity consumption energy consumption for the building by taking an average of the four base case buildings. Once we have done this we would have arrived at the base case performance.

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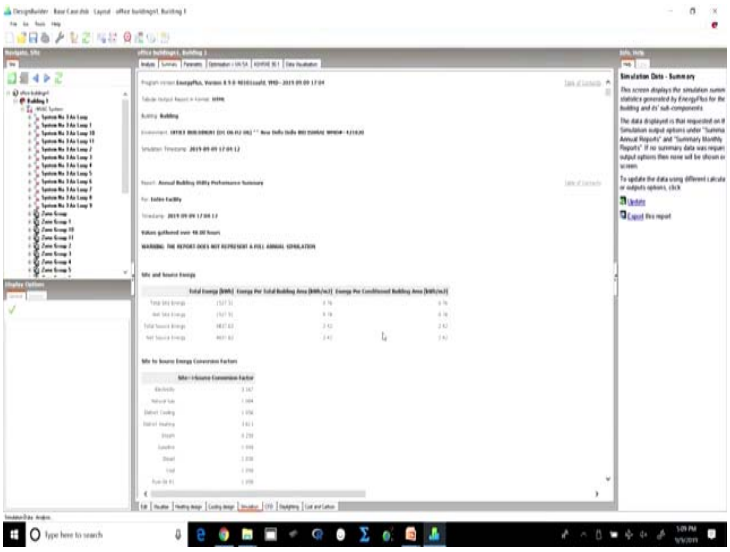

Another thing if we look at the simulation data, we can see is the parametric figure.

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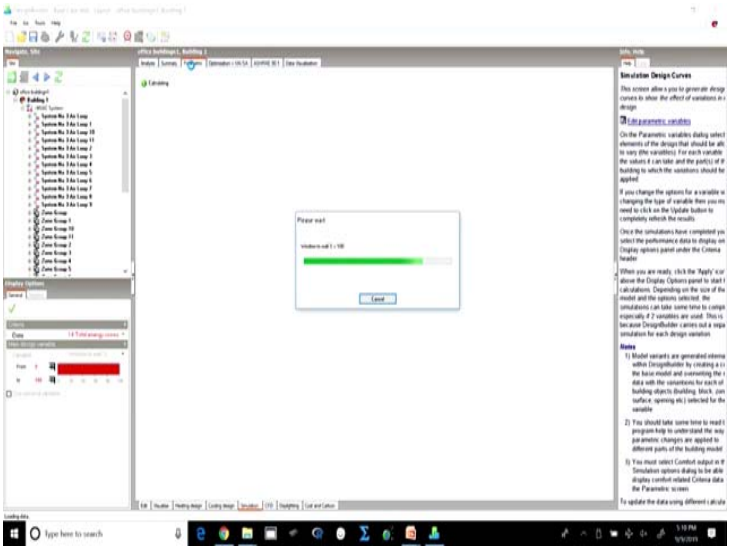

Here what this parametric tab which is a new tab does is; we can vary the design variable for now, the design variable is window to wall ratio which is the percentage. So, it will show from 0 to 100 percent, how the energy total energy consumption in this building would vary if the window wall ratio was to be varied. So, this it there will be it will generate a graph where it will vary the window to wall ratio from 0 to 100, this is what we are defining here 0 to 100 and it will show what the total energy consumption is going to be.

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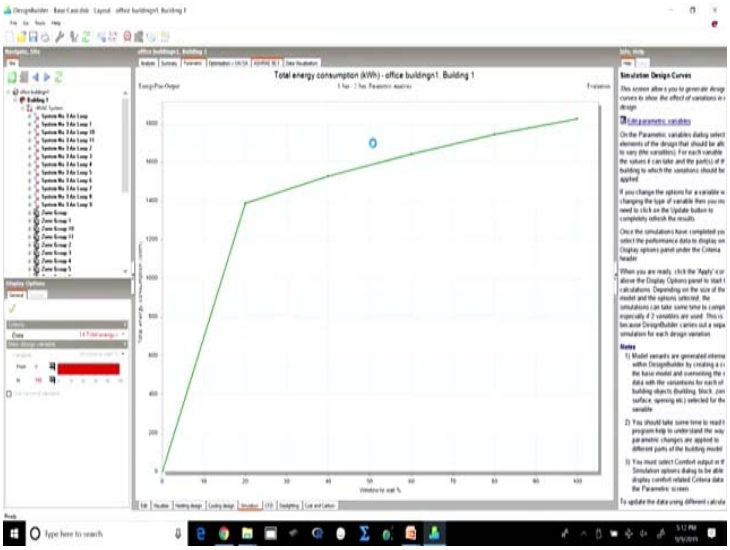

So, let us quickly check the parametric graph on the basis of this single parameter which is window to wall ratio there are not many parametric variables. So, here we see currently we had our window to wall ratio set at 40 percent which is here, but it shows if we have a 100 percent fenestration if the entire envelope is made of glass and it is the fenestration, then the light the energy consumption would be this much.

However, if we take it to 60 percent, it would still be here. If we reduce it to 20 percent, the energy consumption itself would be reduced and between 20 to 0, it will steeply reduce the total energy consumption. So, accordingly for the proposed case, this is the base case and hence we have to take it at 40 percent. But, for the proposed case we can make the changes as far as this variable is concerned which is WWR.

So, this is another interesting feature which is here and we can make good use of it when we are in early stages of design. So, we can vary this parameter and find out what would be the best suited option for us.

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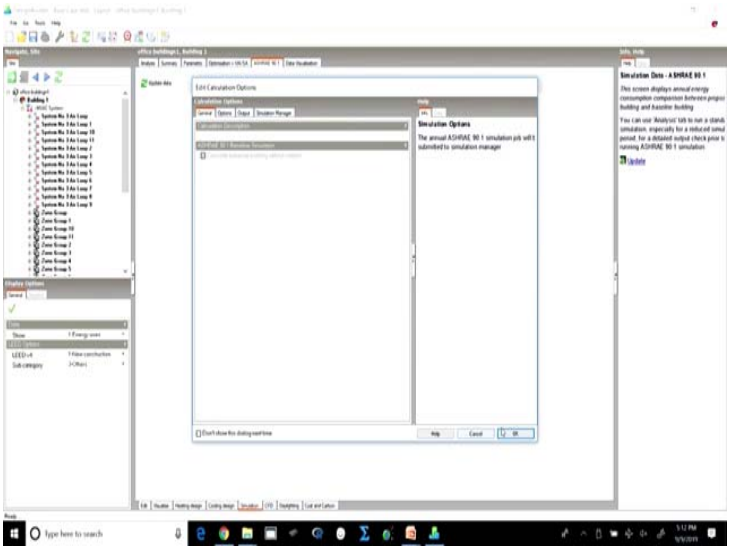

If we look at this ASHRAE 90.1 option and we simulate it will give us a summary of what the baseline building is.

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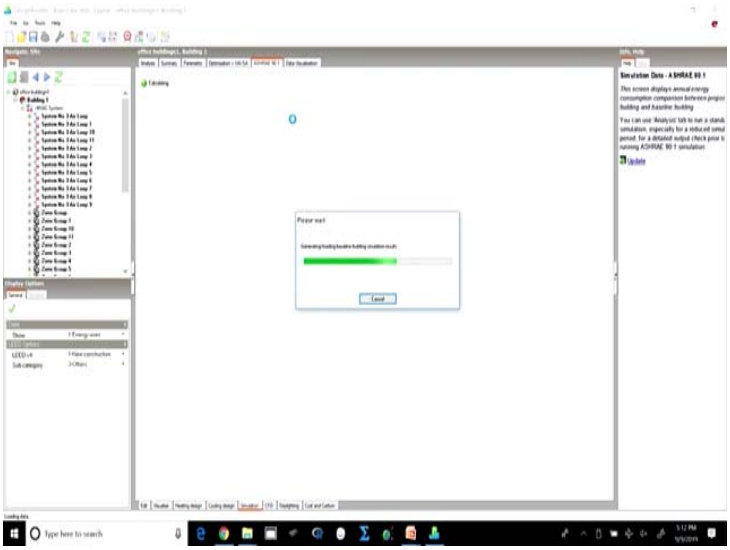

So, it will give us the performance on the basis of the same simulation results which we have done here, it will give us a summary of the results on the basis of this a ASHRAE 90.1 baseline building method. And once we have simulated the base case along with the proposed case, it will also give us a comparison of the base case and proposed case here.

So, we will quickly have a look at this and then we will be done with our base case simulations, I hope that before you come for the next weeks classes you would have averaged out the base cases and you would be ready to simulate the proposed case with the changed parameters with the change criteria.

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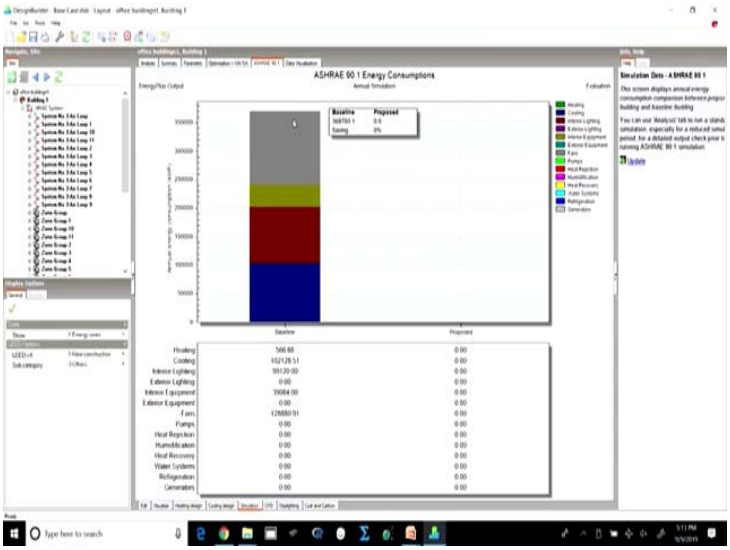

So, here it very clearly shows that what is the baseline performance, what is the total energy consumption for the baseline building and where all for the annual is this energy going in. So, a lot of energy is going into fans for mechanical ventilation for bring for bringing in the outdoor air substantial amount of energy is going into cooling and interior lighting as well. There is some amount of electricity going into interior equipment, but very little amount of energy which is going towards heating.

So, we can very clearly see that for a place like New Delhi and an office building which is a daytime office building, we do not really need a lot of heating. So, we may omit installing the heating equipment altogether.

However, another interesting thing that you can do is you can change the place and the same building can be simulated for a cold climate. For example, you can pick up Shimla, it could be set in a hot dry climate for example, Ahmadabad or Jaipur, you could take it to Bangalore for a moderate climate and then you can compare the results from all these five different climates and then you can see how the energy consumption under different heads varies for the same building, but in different climates and for the same systems.

So, we will close here and in the next week we will start by simulating the proposed case and then we will compare how the performance of the base case and proposed case vary. Thank you very much for being with us this week see you again next week.

Thank you and bye.