Course Name: Architectural Approaches to Decarbonization of Buildings

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Lecture 02

Strategies to reduce Operational Energy and Case study

Last time we saw the impact of operational carbon, what are the ways to reduce operational carbon, what are the reasons for increase in operational carbon and so on. Now, in this segment, we will see in this and the forthcoming segment which will also be a continuation, we will look at what are the impacts of this operational carbon, what are the ways we can reduce it and not in the architectural sense, but what is the way forward that is what we would see in the forthcoming lectures. So, now we will discuss about the global scenario and some case studies and what is carbon offsetting in building operations, the impacts, challenges and future trends. We will also be learning a little bit about the factors that influence the energy use. So let's now look at India and the energy benchmarking and standards. Now building energy benchmarking is a process of comparing a building's energy performance to that of a similar building.

Typically using key performance indicators to assess and identify areas of improvement. So you take one to one, have a benchmark of what is happening today and see how the new building is performing with reference to the benchmark. The Bureau of Energy Efficiency, BEE in India plays a significant role in promoting energy efficiency in India. And it plays an important role in also trying to create awareness amongst people to follow energy efficiency.

BEE has introduced several initiatives and programs to improve energy performance in buildings. The Energy Conservation Building Code is a key regulatory framework that has been given by Bureau of Energy Efficiency and that sets minimum energy performance standards for commercial buildings and large residential buildings. We have seen more on this in our previous classes. The BEE also has improvement and it has also done some kind of a implementation of star rating program for office buildings which provides a benchmark for energy performance. The star rating is normally given with respect to the actual energy performance per square meter of the buildings.

Buildings are rated from 1 star to 5 star with 5 stars indicating the highest level of energy

performance. In the US, benchmarking is done by taking a building's total energy use and dividing by the building's total area. This number is frequently referred to as the energy usage intensity or EUI. This is then compared to the buildings of the same use type for example office space with office space to determine how efficiently the building is utilizing energy. Through energy benchmarking building auditing, this can be pursued more effectively when determining which buildings are inefficiently using energy.

So, in order to have energy certification, we need to have a benchmarking. We must have benchmarking of buildings for energy certification Energy certification is given either in the form of rating or it is given in the form of labeling. In India, the Bureau of Energy Efficiency, BEE, gives in the form of rating 1 to 5 stars. And what is energy performance index for commercial buildings? Energy performance index for a commercial building is annual grid electricity with the annual DG electricity divided by the total built up area. So, it does not consider the renewable electricity that you use, but it considers what you take from the main meter.

from the grid and from the DG and what is the total electricity that it uses divided by the built up area. Let us now look at energy audits and performance assessment. So, BEE is energy conservation building code is a key regulatory framework that sets minimum energy performance standards for commercial buildings and large residential buildings. The performance assessment process typically includes these steps. First one is the energy audit.

So conducting an energy audit is the first step in assessing a building's energy performance. This involves a comprehensive examination of the building's energy use. It includes lighting, HVAC systems, appliances and any other equipment. The audit may be conducted by certified energy auditors and it involves collecting data on energy consumption, analyzing utility bill and inspecting the buildings system. Next second stage is data collection and analysis.

this step the information is gathered on energy consumption so all the energy consumption occupancy pattern operational schedules. All the data pertaining to this is collected and this includes electricity, data consumption data pertaining to electricity gas water and any other utility These are collected. Then software tools may be used and energy modeling is used to analyze the data and identify energy consumption patterns. This helps in understanding which systems or components are major consumers of energy. The third one, third step is benchmarking.

comparing this building's energy performance with industry benchmarks or standards. So, here comparison takes place. In India, benchmarks may be set by Bureau of Energy

Efficiency or any other relevant authority. Bureau of Energy Efficiency's Energy Conservation Building Code, which is called as ECBC, provides benchmarks for different building types. So, these are already available.

The fourth step is identification of energy efficiency measures. Based on the audit and benchmarking results based on step 1, 2 and 3 but primarily 1 and 3 identifying specific measures to improve energy efficiency happens in this step. This may include upgrading of upgrading of lighting systems upgrading of HVAC systems or optimizing I can say upgrading of lighting systems and no optimizing of these systems enhancing insulation or adopting renewable energy systems. All this takes place in this stage. Prioritize measures based on their potential impact and cost effectiveness.

The next step is energy performance certificates or EPC. In some cases, buildings in India may be required to obtain a energy performance certificate to demonstrate compliance with energy efficiency standard. EPCs provide information about a building's energy performance and recommendations for improvement. Then the next step is implementation of energy efficiency measures. Implement the identified energy efficiency measures may involve retrofitting existing systems.

So, retrofit of existing systems -this may also involve incorporating new technologies and it may involve incorporating new technologies to enhance energy efficiency. EPCs based on this they can consider energy management systems and building automation systems for real-time monitoring and control so BMS and EMS, energy monitoring system may be implemented based on need. The seventh step is monitoring and verification. After implementing the energy efficiency measures, the building must continue to monitor energy performance to ensure that the expected improvement or achievements are met because what is the point in making all the changes without even monitoring whether it is benefiting or not. So, monitor the benefit.

Monitor the benefits and report it or document it and then next is training and awareness now under training and awareness we have to provide training to building operators facility managers and occupants on energy efficient practices And in this manner we have to increase awareness which can contribute to sustained energy saving. We must also encourage energy conservation habits among the occupants such as turning off lights or equipments or air conditioners when not in use. Also small things like -how the lift is operated, also contributes to energy efficiency. If somebody has to go to the next floor they must only operate the button which indicates next floor upper floor but normally people tend to press both the switches because they are in a hurry. So, you have a button like this and a button like this on the indicator.

So, when someone has to go up floor, they should know that they must press only this button and not this button. This must not be pressed if one has to go up. So, these kinds of awareness programs must be brought in once you want to make your buildings very efficient. It can save a lot of energy also. Compliance with regulation- Ensure compliance with relevant energy efficiency regulations such as ECBC, Energy Conservation Building Code or any state specific guidelines.

Then documentation and reporting- You have to maintain a detailed documentation of the energy performance assessment including audit reports, benchmarking results and records of implemented measures. You need to prepare regular reports on energy performance for building owners, occupants and relevant authorities. Next, we will see the policies and regulations in India. India has implemented robust policies and regulations to curtail operational energy consumption.

The Energy Conservation Act 2001 mandates energy audits and promotes efficiency across sectors. The Perform, Achieve and Trade PAT scheme incentivizes energy saving initiatives in industries. The Bureau of Energy Efficiency BEE spearheads standards, labeling and awareness programs. Rooftop solar policies often offer incentives while the energy conservation building code sets efficiency standards for buildings regulations like renewable purchase obligation drive renewable energy usage while initiatives like the smart cities mission integrate energy efficient technologies into urban development. These measures effectively and collectively foster energy efficiency and encourage the adoption of renewable energy sources in India. India's National Energy Policy and Climate Action Plan have outlined ambitious targets for sustainable energy development.

This includes achieving a 175 gigawatts renewable energy capacity by this year along with a commitment to reduce emissions by at least 33 to 35 percent by 2030 compared to the 2005 levels. Additionally, the plan aims for a non-fossil fuel based capacity of over 40% in the power mix by 2030. To support these goals, the government has allocated about 11,500 crores in fiscal year 2022 for 28 central government measures subsidizing renewable energy. A significant portion that is 2500 crores was designated as a one-time cash infusion to bolster the Indian Renewable Energy Development Agency and the Solar Energy Corporation of India, empowering them to expand operations within the renewable sector. These measures reflect India's commitment to scaling up renewable energy infrastructure and fostering a cleaner, more sustainable energy landscape.

So, India's policy aim towards the Climate Action Plan which it has already committed and that comes in the form of the Energy Conservation Act the Energy Conservation Act which is a legal framework for energy conservation in buildings and other sectors. ECBC is a very very important organization that is working hard to set minimum energy

performance standards for new commercial buildings and large residential buildings. However, it is not a mandatory program, but it is a voluntary regulation. The EcoNiwas Samhita which we have seen is a code for energy efficiency and thermal comfort in residential building. Whereas, GRIHA is another which is green rating for integrated habitat assessment is a holistic environmental performance evaluation over a building's life cycle.

We also have energy efficiency label for residential buildings which is a rating system measuring energy performance of home. So, India is doing all it can all it can in all the domains to ensure that we go net zero and net carbon. What I have mentioned here is only pertaining to the building industry and that is also not exhaustive. Let us just have a glimpse of what is being happening in a particular case study. Now, the retrofitting technique deployed in this case study is aimed to significantly curtail the automotive center which is our case study and it is know the retrofitting technique was deployed to curtail the operational energy consumption of this building.

Let us explore the impact of each technique. In this building, Application of cellulose insulation was one technique. Now this method involves enhancing the building's thermal performance by applying cellulose insulation which helps in reducing heat transfer. The insulation can effectively minimize heat loss during colder seasons and restrict heat gain in warmer weather. Ultimately contributing to decreased energy consumption for heating and cooling purpose.

Replacement of windows with double glazed windows- Here this shift from standard windows to double glazed windows is pivotal in improving the building's energy efficiency. Double glazing provides better insulation by creating a barrier between the interior and exterior environments thereby reducing heat transfer and air conditioning needs. Substitution of lighting with 23 watts LED bulbs has also made a significant change in the energy efficiency compared to traditional lighting sources. The lower wattage while maintaining or even enhancing illumination levels can lead to substantial energy savings in lighting related electricity consumption.

The fourth one, third we have already seen. Fourth is use of passive cooling techniques to improve thermal performance and reduce energy utilization in the building. So, this causes improvements. as it involves architectural design strategies or natural elements to regulate indoor temperatures without relying heavily on mechanical systems. Implementing these techniques can contribute to a reduced need for active cooling system thereby lowering overall energy use.

In this figure, it depicts the effect of these retrofitting techniques on the building's annual

energy consumption likely showcases a noteworthy reduction trend. Each technique by targeting different aspects of energy consumption, which is heating, cooling, lighting, could have contributed to a cumulative decrease in overall energy demands. Through this multifaceted approach, the study likely demonstrate how a combination of all these retrofitting techniques can synergetically contribute to a substantial reduction in the building's annual energy consumption, emphasizing the importance and efficacy of comprehensive energy efficient measures. I have just taken an example of a building. I am not going into the details of this building because the idea is only to tell you by applying these strategies, how much does the total road requirement after retrofitting it has reduced for various months compared to the original building before retrofitting.

Now with this I will stop this class. I will stop this class and we will continue in our next class which will be more on carbon offsetting and what is the world trying to look at in the future, what are the future trends in operational energy. That is what we will see in the forthcoming class. Thank you.