

**Glass in buildings: Design and Application**  
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**Lecture - 46**  
**Glazing Choices for Project Segments**

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**6<sup>th</sup> Generation**

**Need:** Higher selectivity  
Best-in-class solar control and thermal insulation glass  
Triple silvered low-e glass  
Very high spectral selectivity  
Excellent light transmission





Well, now that we have read about all of the 6 generations of products, and how and what they were designed based on, let us look at where they are applied. Let us look at the various segments they could fall under.

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The slide features a white background with a blue silhouette of a city skyline at the bottom. In the top right corner, there are two logos: NPTEL (National Programme on Technology Enhanced Learning) and GLASS ACADEMY. A woman with long dark hair and glasses, wearing a patterned dress, stands on the right side of the slide, appearing to be speaking. The main text on the slide is:

▣ The product range availability needs to be supplemented with suggestions to the relevant segments

Of course, the product range availability needs to be supplemented with our suggestions is to which segment it applies to.

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Today we are going to cover a series of segments; the first segment being if you were to design green hospitals.

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NPTEL GLASS ACADEMY

VISUAL CONNECT TO THE EXTERNAL ENVIRONMENT  
Light transmission 20% - 30% 4<sup>th</sup> Generation

Well, green hospitals let us look at what are the prime needs of a hospital.

Well, in the hospital it is always mention in several research papers that the recuperation time of a patient in hospital improves significantly if he or she has connection to the outdoor world. And how do you give connection to the outdoor world? But for access to the outside space in a safe environment, or a view to the outside world with just a beautiful glazing. For this kind of application, the kind of products that we suggest is a product of in the range of a light transmission of 20 to 30 percent with the 4th generation kind of glasses.

And the reason we say 20 to 30 percent is if you were to put up glazing of a light transmission to significantly high, he would suffer with the problem called glare. And the patient whose probably just recuperating and wants to look into the outside world does not want to be squinting his eyes and looking outside with great difficulty. Let us look at further applications of glare as we talked about in different segments and how this can be addressed with much more superior glazing solutions.

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NPTEL  
GLASS ACADEMY

**ACOUSTIC COMFORT**

Sound level reduction 35 dB – 40 dB



Monolithic glass 12 mm

Laminated glasses 65.4 – 12 – 6



Well, in hospitals of course, as we talking about patient care and recuperation which is the key of every hospital, we need to really address the topic of acoustic comfort. How do we get acoustic comfort? The more optimum sound level inside in hospital or a hospital bed to enjoy a comfortable resting sort of an environment is up to 30 to 40 decibels. And for this it is important to use the right thickness of glass or glasses with the right kind of value additions.

What we suggest here is either a thick monolithic glass of 12 mm or a laminated DGU glass; when I say a laminated DGU glass. It means, a double glazing unit with one of the glasses laminated with an acoustic PVB or even a standard PVB.

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**HYGIENE**  
Elimination of dust by replacement of the function of blinds | Usage of non-toxic materials  
Dynamic Glazed Facade, Wall cladding of Lacquered glass, Non-toxic and safe Glass fixing accessories



The next issue in the hospital primarily is because of the fact that there is sufficient research talking about hospital acquired information, hospital acquired infection among patients. Hospital acquired infection happens, because of the lack of hygiene. And to ensure extremely high hygiene standards every hospital needs to have interior materials designed to be able to maintain them in a hygienic environment. The way we would like to suggest that hospitals design their interior spaces is by using a range of glazing products which not just act as your facade materials, but also act as interior cladding.

Today there is glazing products available for interior cladding in a wide range of colors among in the market. When you use this kind of materials it is simple easy to clean does not have a bacteria. And therefore, makes it the best choice for a hospital interior space. You could also use what I call the dynamic glazing facade. Well, I will come back to dynamic glazing facade and this is on the subject of glare, but other than that we should also be using accessories like which are appropriate for the glass fixing, for your carpet fixing and all other materials so that they produce very low VOCs.

VOCs are volatile organic compounds which when inhaled create significant disturbances to your health and coming back to the subject of dynamic glazing. Well, dynamic glazing is actually to address this problem of glare. There are certain points of time in the day when you would get a very low angle sun; which means you would have this flood of light hitting your eye and then you would not be able to look at it. What you

do in such a case? In typical situations people pull down the blinds and then leave it to be.

But what is the purpose of blinds? If the whole purpose of having a glazed facade was to look outside, and if you were putting down the blinds, you would barely be looking outside. Further, it spoils the view of the building from outside, because the vision of the architect was to build the beautiful facade, but if he or she were to see indifferent blinds at different levels in buildings, it would totally destruct the view of the building.

Well, dynamic glazing facade is today at the state of the art solution that is available in terms of glazing solutions that can serve this specific need. Dynamic glazing at the press of a button can change the tint of the glass therefore, cutting out glare solving your glare problem and maximizing occupant comfort.

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### Ideal specification for a Green Hospital



Performance parameter		Ideal specification
Light transmission		20% - 30%
Solar factor/SHGC		0.2 - 0.25
U-value		< 2 W/m <sup>2</sup> K
Acoustic comfort	Traffic	40 dB - 45 dB reduction
	Non-traffic	35 dB - 40 dB reduction

 Suggested product  
Single silver, low-e glass



Going on to summarizing therefore, what is the ideal specification for a green hospital. Well as you can see it is a light transmission between 20 to 30 percent a solar factor between 0.2 to 0.25 and a sufficient acoustic comfort.

Well, I have given 2 acoustic comfort bandwidth saying: if it were a traffic ridden area in which a building was; well, you need to at least reduce about 40 decibels of sound and if it were a non-traffic area above 35 decibels of sound at the least. And these sort of facades need to have U-value of less than 2 watts per meter square Kelvin. For this

particular segment, we suggest the product range of single silver low e glass that falls under the 4th generation of products.

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Going on to the next segment which is Green Educational Institutes.

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**ENERGY EFFICIENCY**  
Solar Factor: Classroom < 0.35 | Library 0.20 – 0.25 | Auditorium < 0.25 | Hostel < 0.3  
4<sup>th</sup> and 5<sup>th</sup> Generation Products

A woman with long dark hair, wearing glasses and a blue patterned top, is standing and speaking. She is positioned to the right of the hallway image. The hallway image shows a long, bright corridor with large glass windows on both sides, and a person in a red hat and blue pants walking away in the distance. The NPTEL and GLASS ACADEMY logos are in the top right corner. At the bottom of the slide, there is a blue silhouette of a city skyline with various icons representing different buildings and infrastructure.

Schools and colleges today have to be designed well and effectively to maximize their use occupants comfort to improve their productivity and their learning capacity. More importantly schools also occupy a lot of people at one place. Therefore, the energy

consumption sort of increases and it is way more important to improve the energy efficiency of these buildings in their design stage itself.

For a classroom for example, it is important to have a solar factor of about 0.35. For a library between 0.2 to 0.25; for an auditorium less than 0.25 because, otherwise you would be spending excessively on your AC requirements in an auditorium to be able to achieve significant comfort. Similarly, in the hostel area about 0.3 if you see the way, it is clustered in the solar factors are clustered is depending on the amount of people who would be concentrated in an area at a point and time.

In classrooms, you are going to have a fairly dispersed audience in libraries. Again a dispersed audience, in auditoriums you are going to have a lot of people at one time accumulating there could be lights there could be music there could be a lot of electronic appliances that could generate heat. Hostels again you are talking about a very diverse split out sort of a setting. Therefore, for this sort of solutions we suggest the 4th and the fifth generation products.

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**DAYLIGHTING**  
Light transmission: Classroom 30%-40% | Library 30%-40% | Hostel 20%-30%  
3<sup>rd</sup> Generation and dynamic facades



Moving onto the subject of day lighting in schools: in schools and colleges or educational institutions across the world, the primary concern is day lighting, people students perform better with natural day light coming in students can read better can write better and overall improves the enthusiasm and the positivity in the environment. To get a very good day lighting, again we suggest for classroom spaces. A light

transmission between 30 to 40 percent, you will notice that this is different from the hospitals where I said 20 to 30 percent.

Because in hospitals the shortest situation that people are in is resting setting. As compared to classrooms with someone is supposed to be in an awake setting. Therefore, we suggest that they have a light transmission of between 30 to 40 percent. In libraries again we suggest 30 to 40 percent, because people need to be reading on their desks and reading in an alert situation and not sort of dozing off.

But in the hostels we suggest another 20 to 30 percent, because again that is a resting environment. And we all know how important it is to rest if you want to perform better at school. Well, for this kind of facade offerings we suggest the third generation of products, and dynamic facades for example. If you had classrooms with too much clear and people were not able to look at the board or people were not able to write, if that problem could be solved dynamic facades, you would have far more better performing students in your educational institutions.

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The slide features a photograph of a student reading a book on the left and a presenter on the right. Logos for NPTEL and Glass Academy are in the top right. A 'NOISE-FREE LEARNING SPACES' section includes a 'no noise' icon and technical specifications for sound level reduction and DGU types.

**NOISE-FREE LEARNING SPACES**  
Sound level reduction: Library 35-40 dB | Auditorium 45-50 dB  
Laminated DGU (65.4 – 12 – 6) | Double laminated DGU (65.4 – 12 – 86.2)

Apart from the day lighting factor, we also need to look at the fact that these learning spaces need to be noise free. For this we again suggest certain specific decibel level reductions for different spaces.

Libraries for example, decibel level of 35 to 40 percent, and auditorium for example, 45 to 50 decibel; because there is going to be so much acoustic padding there is going to be a show happening, it cannot possibly have acoustic disturbances from outside the building. For this particular suggestion we suggest double laminated glasses which is a DGU with lamination on both sides or a single DGU with laminated glass on one side. More than monolithic façade monolithic glasses, it would be important to have acoustic related solutions or acoustic PVBs for this lamination to be able to achieve the kind of performance is that we suggest.

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**Ideal specification for a Green Educational Institute**




Performance parameter	Classroom	Library	Auditorium	Hostel
Light transmission	30% - 40%	30% - 40%	NA	20% - 30%
Solar factor/SHGC	< 0.35	0.2 - 0.25	< 0.25	< 0.3
U-value	NA	< 2 W/m <sup>2</sup> K	< 2 W/m <sup>2</sup> K	NA
Acoustic comfort	NA	35 dB - 40 dB sound reduction	45 dB - 50 dB sound reduction	NA

 **Suggested product**

*High performance glass with solar control and Thermal Insulation performance in single glazing*



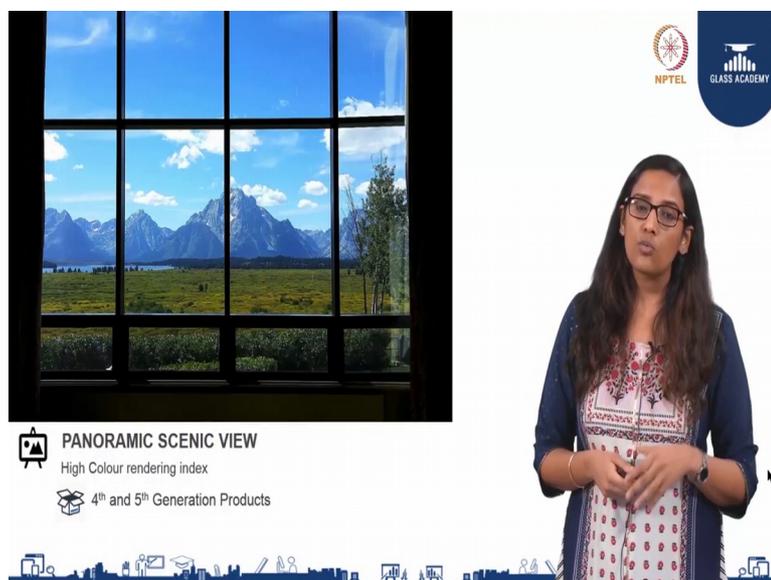
And therefore, to summarise for an educational institution what is the ideal spec? Like I have been talking to you the specs out of differs for every space that you are designing in there in the space in the educational institution. It is different for a class room different for a library for an auditorium and a hostel. Overall, if you see the entire range of high performance classes that offer both solar control and thermal insulation need to be applied for this range of an segment. You could also look at applying dynamic glazing solutions for the segment as well.

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Moving onto the next segment of the green hotels: well, green hotels are places where people rest, people go to rejuvenate themselves, there also places of luxury where people expect impeccable service.

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Therefore, what is expected in a hotel? One, sometimes you have beautiful hotels settled in mountains and they offer the best views to the outside world. And to make the best of these best views, you need to have the best of the glazing solutions. For this we suggest

having a beautiful panoramic scenic view that has with the glazing product that has a very, very high colour rendering index.

What is the colour rendering index you may ask? Well, colour rendering index means, about it talks about the ability of the glazing medium which is in front of you to be able to replicate the colour of the object that you see through the medium, in the same colour that that object is visible and natural light. For example, if I were to look at the clear glass and an object behind my clear glass was appearing yellow in colour. But if I were to put another class in front of it, I could assume if the glass was too dark in front of me that the product outside my glass would look slightly different. Therefore, it is important to have a product which has a very very high colour rendering index and load distortion of colours.

For this we suggest our 4th and fifth generation of products which come with the silver coating therefore, giving high performance high range of colours you choose your external colour, but your substrate colour remains solid and therefore, guaranting you the best colour rendering index.

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 **NOISE-FREE ROOMS**  
Sound level reduction: Guestrooms 40-45 dB (High traffic areas) 50-55 dB (Proximity to transportation terminals)  
 Laminated DGU (65.4 – 12 – 6) | Double laminated DGU (86.4 – 24 – 68.4)



The next setting in of course, in hotel is the is the fact that you need noise free rooms. Several hotels today require a sleep guarantee that they need to offer to their customers; which means glazing solutions need to be prepared to offer a very significant decibel reduction from the outside world. For this solution again we suggest a laminated DGU or

a double laminated DGU to be able to achieve upto 50 to 55 decibel reduction, especially if the hotels are in proximately to transportation hubs, like the airports for example.

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**Ideal specification for a Green Hotel**

Performance parameter	Common Areas	Guest rooms
Light transmission	40% - 50%	~20%
Solar factor/SHGC	0.2 - 0.25	0.2 - 0.25
U-value	< 2 W/m <sup>2</sup> K	< 2 W/m <sup>2</sup> K
Internal reflection	Less than 20%	Less than 20%

**Suggested product**

5<sup>th</sup> Generation products  
*Double silvered low-e glass from the house of Saint-Gobain Infinity*

The slide also features the NPTEL and Glass Academy logos in the top right corner and a presenter on the right side.

Therefore, in summary if you were to design a green hotel, the kind of specification that we would suggest a sort of split across 2 areas. One in the guest rooms and one in the common areas; the light transmission in the common areas we suggest you go for really clear and bright glasses which allow a lot of light to come in; simply because the entry becomes welcoming and it does not feel dark and dingy. However, in the guest rooms we suggest a more settled and a lower light transmission glass, because in the hotel rooms if their supposed to be resting spaces.

If you are guest was not comfortable in the space and was flooded with light and had to permanently pull out the shades, what would be the point of the view, right? And in terms of solar control though we recommend the same level of solar performance in the guest rooms and the common areas, because these areas are going to have high footfalls or will be areas in which you are going to have a highly efficient hvac system working to bring down the temperatures. In terms of intern sound reduction, you need to have a significant sound reduction, and in terms of internal reflection, again you need to have a very low internal reflection, because people would not want to see a mirror image of themselves on the internal face of the glass during night times.

For this our suggested range of products is the fifth generation of products. We also suggest the dynamic glazing solution especially in sort of projects, where you have this fantastic view and do not want it to be cut down by blinds or window shades or curtains, simply because that view is the USB to the customer. And with dynamic glazing solutions you will be able to guarantee that view to them, and still guarantee comfort, because you would be cutting of the glare.

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The next segment is green offices.

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When office spaces like in the picture that you see, you have a lot of light required to be able to keep people enthused and active. However, you also have a lot of computers these days. So, if the light was falling on the computer, you would barely be able to see and you would be squinting to look into your computer and be able to do your work, making you much less productive. You know, it is like an anti-thesis you try to increase a light to make employees active, but then you increase the glare on their computer screens to become less active, it is lot of a loop that you are in.

It is for this kind of solution that we suggest the dynamic glazing solution because it is completely solves this problem. You could also look for products from the 4th to the 6th generation; which is the much better spectral selectivity this silver based products. That can give you very good thermal comfort and at low light transmissions can be giving you optimum light in the building for your use.

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The slide features a woman on the right side, wearing glasses and a patterned top, presenting. On the left, there is a photograph of a modern office interior with large windows and red seating. Below the photograph, there is a green leaf icon and the text: "ENERGY EFFICIENCY", "Solar Factor 0.2 - 0.25", and "Dynamic Glazing; 4<sup>th</sup> - 6<sup>th</sup> Generation Products". In the top right corner, there are logos for NPTEL and GLASS ACADEMY. At the bottom, there is a blue silhouette of a city skyline.

In this slide what we have going to talk about is the energy efficiency in terms of thermal comfort inside the building in an office space. In office spaces you would notice that it is there perenary air conditioned. And for them to be perenary air conditioned it requires it is sucks out a lot of electricity to be able to run an air conditioning equipment.

To be able to do this in a much more energy efficient way, we need to design the entire building envelope that is going to let in the heat in a more efficient way so as to reduce the heating (Refer Time: 17:38) for this we suggest glass of solar factor between 0.2 to

0.25; which is way more effective. Again, we suggest the dynamic glazing solutions that are available and products from the 4th to the 6th generation.

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### Ideal specification for a Green Office



Performance parameter	Ideal specification
Light transmission	20% - 30%
Solar factor/SHGC	0.2 - 0.25
U-value	< 2 W/m <sup>2</sup> K
Daylight factor	2% - 3%

 Suggested product

*Single silver up to triple silvered low-e glass that maximizes human comfort with improved energy efficiency*



To summarize an ideal specification for a green office is a light transmission between 20 to 30 percent, because you do not want the glare problem; a solar factor between 0.2 to 0.25 and a daylight factor of 2 to 3 percent. Like I told you, we suggest the glazing dynamic glazing solutions and products from the 4th to the 6th generation which will be able to solve a lot of thermal efficiency issues and be able to a give you best light transmissions.

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In the last segment that we would covered today is the segment of green residences.

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Well homes are places where we live in. Do we care as much about the way we design glazing in our homes as much as we design in our offices? Well, increasingly today there has been an awareness about designing better for homes, designing greener homes and more importantly designing comfortable homes for occupants like you and me to be able to live well.

In this particular picture that you see you see is really settle light that is coming into the house, really comfortable environment that is feels like, you really feel cozy in that situation. It is for this kind of a home that we recommend a solar factor of less than about 0.3 percent. Therefore, sort of minimizing all the direct solar radiation that is going to come into this building, and bringing in just the right amount of light; here we suggest the third generation of products which can actually give you both solar control and thermal insulation in a single glazing solution.

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**PRIVACY**  
Optimum value of external reflection  
3<sup>rd</sup> generation products coupled with higher external reflection

In terms of homes well we know privacy is an issue and if you had more and more glass you would really be opening up your home to the outside world. And where you often we do not want that and we start putting in the blinds, we put in a curtains and shades and that was the point of the glass. Therefore, we suggest that you choose a glass with a significantly higher external reflection. What it does is the glass gets reflective on the outside, and therefore becoming a sort of privacy medium for the people living inside your home.

Again the third generation of products with optimum light transmission also can offer you suggestions for a highly externally reflective range of glasses.

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## Ideal specification for a Green Residence



Performance parameter	Ideal specification
Light transmission	20% - 30%
Solar factor/SHGC	< 0.3
U-value	NA

 **Suggested product**

3<sup>rd</sup> Generation products

*High performance glass in single glazing with a combination of thermal insulation and solar control*



Therefore, the ideal specifications for a green residence in our opinion is that the light transmission range between 20 to 30 percent, because that is sufficient otherwise you would have a glare problem. In terms of solar factor less than 0.3, because again you need to be thinking about how you are going to cool your home space. And U-value is not a significant issue, because in homes the window to wall ratio is much smaller therefore, letting in so much lesser space for glazing. For the green residences, we suggest that you use a third generation product, which has both high performance through thermal insulation and solar control for efficient performance.

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## Summary

By the end of this video, you have learnt about:

- The ideal specifications of,
  - Green hospitals
  - Green educational institutes
  - Green hotels
  - Green offices, and
  - Green residences

