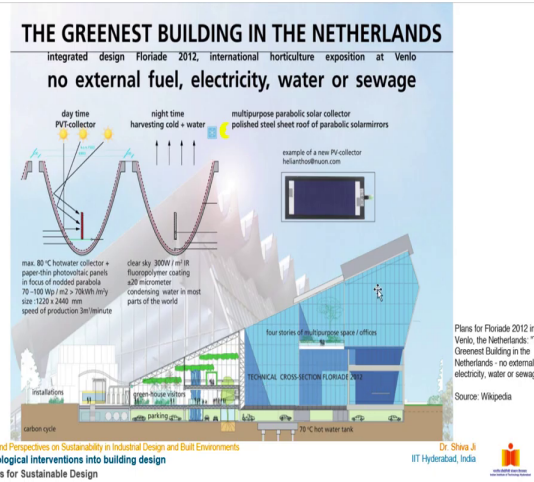


Strategies for Sustainable Design
Professor Dr Shiva Ji
Indian Institute of Technology Hyderabad, India
Lecture 42
Case 4: A Comparative Analysis of International Design Projects

(Refer Slide Time: 0:28)



Hello everyone, in this lecture we will discuss about a comparative analysis of international design projects. So, we will see like how architectural projects from across the world are dealing with this actually overall climates and how they are actually going further like a sustainable designs. So, one of the actually a beautiful examples, I have taken is from like this Netherlands, so this is the greenest building actually called in the like a Netherland.


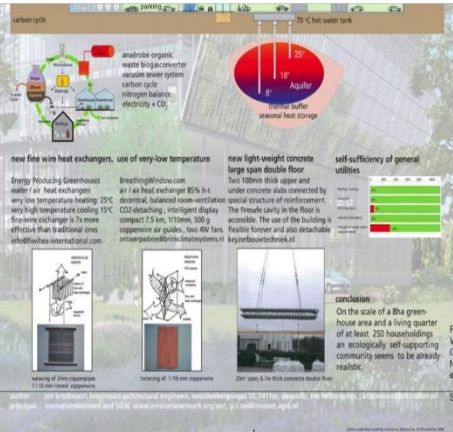
So, it does not uses any external fuel, any external electricity you know water or even like a sewage. It actually caters to all if its needs from the site itself and it actually recycles everything on the site itself. So, this is one of the actually most amazing actually projects from across the world you know, so that is why I have chosen this to give you the first example of this building.

So, you see this it has actually followed a unique design you know for like these solar photovoltaic like a panels, so on this actually there is a parabolic actually the shape in the daytime they use for like collecting the actually for this power generation and in the night time

they use this actually trough for like a you know harvesting water from the like a dew and the atmospheric actually the (()) (1:30).

So and this is actually typical cross section so you can see the parking level in the like a basement service areas, greenhouse like a visiting areas over here technically like this technical cross section of florid like a 2012 and this is further here like a four storeys of like multipurpose spaces and offices.

(Refer Slide Time: 1:51)

The slide, titled "carbon cycle", details several sustainable building technologies:

- Energy Producing Greenhouses:**
 - water/air heat exchangers
 - very low temperature heating 25°C
 - very high temperature cooling 15°C
 - flow rate exchange is 7x more effective than 9 additional ones
- new fine wire heat exchangers, use of very-low temperature:**
 - breathingWindow.com
 - air/air heat exchanger 85% h-r
 - decentral, balanced room-ventilation
 - CO2-detecting, intelligent display
 - compact 2.5 cm, 110mm, 300g
 - copennium air guides, two 6W fans
- new light-weight concrete large span double floor:**
 - Two 100mm thick upper and under concrete slabs connected by special structure of reinforcement
 - The feasible cavity in the floor is accessible. The use of the building is flexible forever and also detachable
- self-sufficiency of general utilities:**
 - On the scale of a Bha greenhouse area and a living quarter of at least 250 households, an ecologically self-supporting community seems to be already realistic.

Conclusion: On the scale of a Bha greenhouse area and a living quarter of at least 250 households, an ecologically self-supporting community seems to be already realistic.

Plans for Floride 2012 in Venlo, the Netherlands: "The General Building in the Netherlands - no external fuel, electricity, water or sewage."

Source: Wikipedia

Week 4: Debates and Perspectives on Sustainability in Industrial Design and Built Environments
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 Course: Strategies for Sustainable Design

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Further in the lower level you can see this building utilizes this thermal actually you know this energy of this the ground beneath this actually project you know and like it uses this fine wire heat exchangers use of a very low temperature actually this thing. So, you see like how this water is being sent actually in the lower floors for like a heat exchange and all that and the secondly like it uses like a lightweight concrete large span double actually flooring system you see one unit is suspended here in the air, so to cover actually the floors you know wider floors with the minimal amount of actually energy and self-sufficiency in general utilities.

So, this building it practically has achieved a self-sufficiency it does not require actually any type of like a fuel or energy or anything that is also from the outside you know so one of the actually most beautiful and amazing actually examples you must actually look for like a detailed you know understanding of this project you know once you are done with this lecture.

(Refer Slide Time: 2:58)



A 35,000 litre rainwater harvesting tank in Kerala
Source: Wikipedia



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So, one by one I will show you some examples from across the world. This is actually a rainwater harvesting tank from Kerala, so well this kind of like efforts are being used you know everywhere is Kerala is known for like this water surplus actually state you know there is a huge amount of water you know available in there like a ground water you know as well as it receives like a huge amount of like this rainfall also every year but still they have actually this kind of like a systems in the place which is worth praising.

(Refer Slide Time: 3:28)



The California Academy of Sciences, San Francisco, California, is a sustainable building designed by Renzo Piano. It opened on September 27, 2008
Source: Wikipedia



Week 4: Definitions and Perspectives on Sustainability in Industrial Design and Built Environments
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The next example of this California Academy of Sciences from San Francisco, California. So this is a sustainable building designed by a famous architect Renzo Piano so you can see like how they have used this an extensive actually this landscaping on this campus and there is urban heat island effect to counter they have used actually this green actually surface on the top of this building.

(Refer Slide Time: 3:55)



Bullitt Center Seattle

Opened in 2013 on Earth Day, this office located in Seattle, Washington, is infamous for being zero-energy building. The entirety of its energy consumption is fully covered by the 575 solar panels that harvest more than it uses in a year. So yes, the claim is definitely bona fide—this Miller Hull-designed six-storey building has even got a Living Building Certificate.



<https://indoesiadesign.com/story/sustainable-architecture>

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Dr. Sheela
IIT Hyderabad, India



The next building is from like a Seattle you know this was opened in 2013 on the earth day. This office located in Seattle Washington is infamous for being a zero energy building. The entirety of its energy consumption is fully covered by the 575 solar panels on the top you can see, that harvest more than it uses in a year. So, yes the claim is definitely bonafide. This Miller Hull design 6 storey building has even got a living building certificate.

So, one of the very unique features like we have been discussing buildings are like a living organism but here they have started already giving this certification system also like and this building has received it's like a living building a certificate.

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The Edge Amsterdam

The Edge is an app-controlled green building situated in Amsterdam. Designed by PLP Architecture firm, this office refrains traditional electric lights and embraces LED technology powered by what they called "digital ceiling". It's basically a sensor system connected by computer cables, pre-empting lighting needs instead of running at a fixed rate. It is estimated to save 80% energy compared to traditional lighting. Window blinds are flexible to adjust with the app.

Outside, the building exterior is clad with solar panels to generate electricity. Temperatures inside are controlled by pumping cooler and warmer water from different altitudes in an aquifer. No wonder this building got 98.3% in British rating system Building Research Establishment Environmental Assessment Methodology (BREEAM)—the highest score to date.



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The next is The Edge from Amsterdam. The Edge is an app control green building you know situated in Amsterdam designed by PLP Architectural firm. This office refrains to actually traditional electric lights and embraces led technology powered by what they call digital ceiling. It is basically a sensor system connected by computer cables, pre-empting lighting needs instead of running at a fixed rate and it is estimated to save 80 percent of the energy compared to traditional lighting.

Window blinds are flexible to adjust with the app. Outside the building exteriors is clad with solar panels to generate electricity. Temperatures inside are controlled by pumping cooler and warmer water from different altitudes in an aquifer. No wonder this building got 98.3 percent in British rating system Building Research in Establishment Environment Assessment Methodology commonly we know it has BREEAM you know.

The highest score you know received by any building till date. So, this is one of the actually beautiful examples of how the buildings can be integrated with the technology you know and can be actually optimized for like energy as well as like resource consumption.

(Refer Slide Time: 5:42)



CopenHill *Copenhagen*

CopenHill is an eco-friendly power plant that incinerates waste to generate electricity. Opened just a few years back in 2017, the multipurpose project was commissioned to Bjarke Ingels Group (BIG), where genius young architect Bjarke Ingels is the founding partner and creative director. The 16,000 sqm structure is designed to convert 400,000 tons of waste per year into scads of clean energy, enough to power over 100,000 homes within the region, emitting zero toxins in the process to the atmosphere's advantage.

As outstanding it is as a waste-to-energy plant, CopenHill is also a superb sports facility. Capped by over 500 metres ski slopes design, visitors could use it for hiking trails, snowboarding, playground, trail running, wall climbing, and skiing. The last one is what locals are most thankful for, because even though Denmark receives heaps of snow in the winter, it is a generally geographically flat, preventing it from being ideal terrain for ski and snowboard enthusiasts.



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Next, we have this Copen Hill. This is from Copenhagen. So, Copen Hill is an eco-friendly power plant that incinerates waste to generate electricity, opened just a few years back in 2017. The multi-purpose project was commissioned to Bjarke Ingels Group BIG, where genius young architect Bjarke Ingels is the founding partner and creative director.

The 16000 square meter structure is designed to convert 400000 tons of waste per year into scads of clean energy enough to power over 100000 homes within the region emitting zero toxin in the process to the atmosphere's advantage. As outstanding it is as a waste to energy plant Copen Hill is also a superb sports facility capped by over 500 meter ski slope design, visitors cozy could use it for like hiking trails, snowboarding you know playground, trail running, etc, wall climbing and skiing, etc.

The last one is what locals are most thankful for because even though Denmark receives heaps of snow in the winter. It is a generally geographically flat preventing it from being ideal to reinforce key and snowboards and enthusiasts. So, you see like how this building is converted into a recreational arena also in the like a winter month is like a ski arena you know so and with no actually toxic like effluents or exhaust you know this building consumes waste to generate energy. So, one of the actually amazing examples of like a sustainability in the like recent times.

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Taipei 101 *Taipei*

Taipei 101 (then Taipei World Financial Center) is a super-tall skyscraper designed by CY Lee. Standing proudly over 509 metres high, the architecture is deemed as the world's tallest green building by Leadership in Energy and Environmental Design (LEED) standards back in summer 2011. Its double-pane windows block external heat by 50%. It uses low-flow water system that effectively lessens its water consumption by 30%, saving roughly 7.4 million gallons of water each year. It is also expected to save over 14 million kWh of electricity, equivalent to approximately \$1.2 million each year.



<https://indoesigdesign.com/story/sustainable-architecture>
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The next example is a Taipei 101. You may have seen this building in pictures or you may have been to this place in Taiwan. This is from Taipei; Taipei 101 is a super tall skyscraper designed by CY Lee. Standing proudly over 509 meters high. The architecture is deemed as the world's tallest green building by leadership in energy and environmental design lead certification system. Back in like a summer of 2011 it is a double pane window block external heat by 50 percent.

It uses low flow water system that effectively lessens its water consumption by 30 percent, saving roughly 7.4 million gallons of water each year. It is also expected to save over 14 million kilowatt hours of electricity equivalent to approximately 1.2 million dollars each year.

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One Angel Square Manchester

Award-winning architecture practice 3DRied had flexibility in mind when they designed One Angel Square. The structure of the office building located in Manchester is convenient and open to reorganization so tenants could easily rearrange the space as they see fit. This ultimately saves the energy and cost needed to refit the whole system. The building's facade is designed to be double-skinned, reducing cooling and heating costs. Underground concrete tubes were installed to bring in cool air via a heat exchanger. Inside, the stylish furniture are made of recycled waste pallets. For the whole system, it got a BREEAM score of 95.16%.



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Further we have this example of One Angel Square from Manchester. Award-winning architecture practice 3DRied had a flexibility in mind when they designed One Angel Square. The structure of the office building located in Manchester is convenient and open to reorganization so tenants, schools could easily rearrange the space as they see fit.

This ultimately saves the energy and cost needed to refit the whole system. The building's facade is designed to be double skinned reducing cooling and heating costs. Underground concrete tubes were installed to bring in cool air via a heat exchanger. Inside the stylish furniture are made to recycle of like a waste pallet for the whole system it got a BREEAM score of 95.16 percent.

(Refer Slide Time: 8:52)



Apple Park California

One must say, Apple's latest HQ is the ultimate architectural achievement for how the campus of a visionary company should be designed. Designed by Foster + Partners firm, the 708,200 sqm complex was Steve Jobs' vision that he got when he walked through London's Hyde Park. The campus includes a central, ring-shaped building that runs completely on sustainable energy harvested by the solar panels that capped the spaceship-like megastructure. Canopies are installed between each floor to protect staffs from the intense California sun. Each canopy is further equipped with a ventilation system that dispenses air in and out of the building. All in all, this is a sustainable architecture that actually breathes.



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Okay, this you must be aware of this is like a Apple Park from California, it is recently actually a completed building. One must say Apple's latest headquarter is the ultimate architectural achievement of how the campus of a visionary company should be designed. Designed by Foster plus Partners Firm. The 708200 square meter complex was Steve Jobs vision, that he got when he walked through the London side park.

The campus includes a central ring-shaped building that runs completely on sustainable energy harvested by the solar panels that cap the spaceship like megastructure. The canopies are installed between each floor to protect staffs from the intense California sun. Each canopy is further equipped with the ventilation system that dispenses air in and out of the building. All in all this is a sustainable architecture that actually breeds.

So, here you can see from the site itself the rest of the actually area you know apart from this building you know looks like a place of like a landscape you know like a densely landscape area. Green space even inside this circle if you see it is a highly vegetated area you know and this building is capped by these solar photovoltaic panels for like harvesting energy. So, this building is also one of the best examples of sustainable projects in the recent times.

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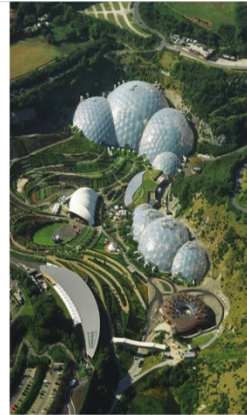


Eden Project Cornwall *Cornwall*

A megaproject envisioned to make a better life for all, Eden Project is a public attraction situated in Cornwall, UK. Nestled in a huge crater, this Nicholas Grimshaw-designed complex consists of two massive enclosures that house thousands of plant species in adjoining domes, simulating rainforest and Mediterranean environment respectively.

All water used to create the humid conditions of the rainforest biome and to provide the toilet facilities are sanitized rainwater, while main water from public infrastructure is used for handwashing and cooking.

For electricity, Eden Project uses renewable energy from adjacent wind turbines. At the end of 2010, the Eden Project was granted permission to build a geothermal electricity plant. It is estimated to generate 4MWe, sufficient to supply Eden and approximately five thousand households.



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The next one Eden Project Cornwall from Cornwall. A megaproject envisions to make better life for all. Eden project is a public attraction situated in Cornwall, UK. Nestled in a huge crater, this Nicholas Grimshaw designed complex consists of two massive enclosures that house thousands of plant species in adjoining domes, simulating a rainforest and Mediterranean environment respectively. All water used to create the humid conditions of the rain forest biome and to provide the toilet facilities are sanitized rain water, while main water from the public infrastructure is used for like a hand washing and cooking.

For electricity when a project uses renewable energy from adjacent and wind turbines, at the end of 2010 the Eden project was granted permission to build a geothermal electricity plant. It is estimated to generate 4 megawatts of sufficient to supply hidden and approximately 5000 like a household also. So, you see the unique actually you know structure and the unique adaption like in this actually a place like how they have built this structure.

(Refer Slide Time: 11:11)



Shanghai Tower *Shanghai*

Most people recognized Burj Khalifa as the tallest building in the world at the moment. Little did they know that the building at the second place is nothing to be overlooked. Standing at 632 metre high, Shanghai Tower is both an architectural wonder as well as a sustainable one. Opened in 2015, the Gensler-designed office, hotel and retail complex is clad with transparent second skin, creating a buffer of captured air for natural ventilation, automatically reducing energy costs. Its exterior lights are powered by 270 wind turbines that incorporated into the façade. Thanks to these measures, the tower receives a platinum LEED certification for using significantly less power than most skyscrapers would.



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Further we have this Shanghai Tower from Shanghai. Most people recognized Burj Khalifa as the tallest building in the world at the moment. But little did they know that the building at the second place is nothing to be overlooked. Well, a new building has also come up in those like actually countries you may be aware of who have actually overtaken all to be the tallest building. Well, this building standing at 632 meter high, Shanghai Tower is both an architectural wonder as well as a sustainable one also.

Opened in year 2015, the Gensler design office, hotel and retail complex is clad with transparent second skin, creating a buffer of captured air for natural ventilation, automatically reducing energy cost. Its exterior lights are powered by 270 wind turbines that incorporated into a façade. Thanks to these measures, the tower receives a platinum LEED certification for using significantly less power than most skyscrapers would.

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Project: The Edith Green – Wendell Wyatt Federal Building, Portland, Oregon

- The Edith Green-Wendell Wyatt (EGWW) Federal Building is an 18-story, 512,474 sf office tower in downtown Portland, Oregon. Originally built in 1974, the building received funding from the American Recovery and Reinvestment Act to undergo a major renovation to replace outdated equipment and systems. This funding stipulated the project must meet the stringent energy and water conservation requirements of the Energy Independence and Security Act (EISA).
- As significant as the 55% energy use reduction and 65% water use reduction are, the most remarkable result of the renovation was the increased occupant satisfaction achieved. One year after moving into EGWW, tenants indicated increased satisfaction compared to their temporary quarters in a survey for the Center for the Built Environment.



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Further I would like to explain one project in detail. This is the project The Edith Green from a Wendell Wyatt Federal Building Portland, Oregon. The Edith Green Wendell Wyatt EGWW Federal Building is an 18 storey, 512474 square foot office tower in Downtown Portland, Oregon. The originally built in 1974 the building received funding from American Recovery and Reinvestment act to undergo a major innovation to replace outdated equipment and systems. This funding actually stipulated the project must meet the stringent energy and water conservation requirements of the energy independence and security act EISA.

As significant as the 55 percent energy use reduction and 65 percent water use reduction are the most remarkable result of the renovation was the increased occupant satisfaction achieved. One year after moving into EGWW tenants indicated increased satisfaction compared to their temporary quarters in a survey for the center for the built environment.

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Project Overview

EGWW is a model project for GSA nationwide, both as a premier federal office space and as an energy efficient renovation project. -
Photo Credit: Nic Lehoux



<http://www.aiaa.org/node/484>



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Design & Innovation

The vertical reeds support climbing vines and give occupants a connection to nature. -
Photo Credit: Nic Lehoux



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Regional/Community Design

The area surrounding EGWW is rich with transportation and services that reduce workers' need to drive. - Photo Credit: SERA



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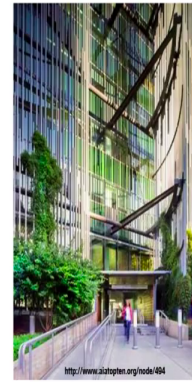
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Land Use & Site Ecology

The building's west-facing reeds filter the sun's rays and host a variety of native deciduous vines. - Photo Credit: Nic Lehoucq



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So, we will see some images and like a details more details of this project. So, this is actually building so it was not actually existing building and a retrofitting exercise was actually carried out here to make it sustainable and also this is actually a model project for GSA nationwide both as a premier federal office space and as an energy efficient renovation project.

Well on the design and innovation front, the vertical reeds support climbing vines and give occupants a connection to the nature.

Now, while regional and community design the area surrounding EGWW is rich with transportation services that reduce workers need to drive, so they actually rely mostly on like a public transport.

Land use and site ecology, the building's west facing reeds filter the sun's rays and host a variety of like native deciduous wines.

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Bioclimatic Design

Because of the importance daylighting plays in human health and comfort, the project optimized daylighting in the perimeter zone utilizing a task/ambient approach to lighting.
- Photo Credit: SERA



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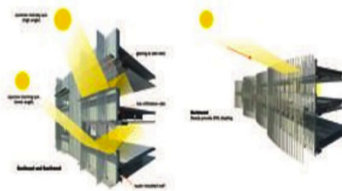
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Light & Air

Key to the building's energy efficient design was transforming the existing, un-insulated facade to a high-performance curtain wall with elevation-specific shading devices. - Photo Credit: SERA



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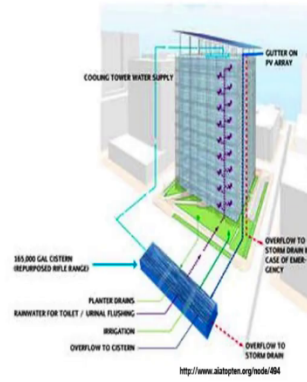
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Water Cycle

65% water savings has been achieved through a dual strategy of incorporating water conserving plumbing fixtures together with a rainwater collection system. - Photo Credit: SERA



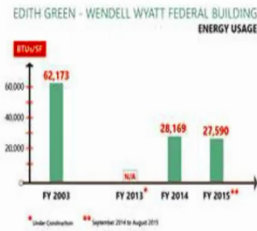
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Energy Flows & Energy Future

Since its completed renovation, EGWW's energy consumption has been cut in half. Post-occupancy studies have allowed for fine-tuning of its systems and thus additional energy savings. - Photo Credit: SERA



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Materials & Construction

Over the course of a year, BGWW transformed from a pre-cast concrete facade to a high performance curtain wall.

- Photo Credit: SERA



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Long Life, Loose Fit

The primary design goal was to transform the existing building from an aging energy hog to one of the premier environmentally-friendly buildings in the nation. - Photo Credit: Nic Lehoux



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Bioclimatic Design, as you can see here on this section because of the importance daylighting plays in human health and comfort the project optimized daylighting in the perimeter zone utilizing a task ambient approach to the lighting.

Light and air, key to the building's energy efficient design was transforming the existing uninsulated facade to a high-performance curtain wall with elevation specific shading devices.

Water cycle, 65 water savings has been achieved through a dual strategy of incorporating water conserving plumbing fixtures together with the rain water collection system.

Energy flows and Energy Future site, since its completed renovation EGWW's energy consumption has been cut in half, post occupancy studies have allowed for fine tuning of its systems and thus additional energy savings. Materials and construction, over the course of a year EGWW transformed from a precast concrete facade to a high-performance curtain wall, you could see in this picture how the transformation has taken place.

Long Life, Loose Fit- the primary design goal was to transform the existing building from an aging energy hog to one of the perimeter, premier environmentally friendly buildings in the nation. So, this is the how this project has actually succeeded in its like intent.

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HBS TATA HALL EXECUTIVE EDUCATION CENTER
HARVARD WAY, BOSTON, MA 02163
PROJECT PROFILE

The Tata Hall Executive Education Center serves as a model for high performance building design on the Harvard Business School (HBS) campus. The project's design is centered on creating a healthy and sustainable learning, living and working environment that is focused on human comfort, energy and water conservation, and environmental stewardship.

The 7-story, 153,700 square foot multi-use building, located to the west of the Charles River, provides living and learning spaces for the HBS Executive Education Program. Tata Hall houses 22 living groups with 180 bedrooms and associated living group lounges, two 99-person case method classrooms, seminar spaces, project rooms, reception lounges, and administrative offices.

The project team applied an integrated approach to sustainable design, which incorporated environmental strategies that influenced all aspects of the building's design. The site and landscape were designed to integrate strategies to reduce stormwater runoff and create a comfortable outdoor environment. The building envelope was designed to meet a high performance target for occupant comfort while reducing total energy use of the building. The daylighting design creates well-lit workspaces for students, faculty and staff offering solar control during critical periods of the day to reduce cooling loads and create a high quality visual environment. The high efficiency HVAC system provides comfort, high indoor air quality, user controls, and energy conservation, while the plumbing design strategy conserves potable water use. The project design achieved LEED Platinum certification.

Photo Copyright Willem Raan Associates, Architects, Inc., 2014

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Finally, we will see one more example of a sustainable building constructed in the recent times. This is Harvard Business Schools, Tata Hall Executive Education center on the Harvard Bay Boston Massachusetts this is in United States foot of America and this was rated under the LEED new construction version 3 and it has received LEED platinum rating in year 2014.

So, I would briefly give you information about this project where why is it called like a Tata Hall. This was actually funded by the honorable Ratan Tata from India, as a like a philanthropic

work he has studied in his like early days from this Harvard Business School. So, like this Tata Hall Executive Education Center serves as a model for a high-performance building design on the Harvard Business School campus.

The project's design is centered on creating a healthy and sustainable learning you know living and working environment that is focused on human comfort energy and water conservation and environmental stewardship. The 7 storey 153700 square foot multi-use building located to the west of the Charles River provides living and learning spaces for the HBS Education Executive Education program.

Tata Hall houses 22 living groups with 180 bedrooms and associated living group lounges, 299 percent case method classrooms, seminar spaces, project rooms, reception lounges and administrative offices. The project team applied an integrated approach to sustainable design which incorporated environmental strategies that influenced all aspects of the building's design. The site and landscape were designed to integrate strategies to reduce storm water runoff and create a comfortable outdoor environment.

The building envelope was designed to meet a high-performance target for occupant comfort while reducing total energy use of the building. The daylighting design creates well-lit workspaces for students, faculty and staff offering solar control during critical periods of the day to reduce cooling loads and create a high-quality visual environment. The high efficiency HVAC system provides comfort high indoor air quality you know user control and energy conservation while the plumbing design strategy conserves portable water use. The project design achieved LEED platinum certification.

(Refer Slide Time: 17:47)

The slide displays LEED Facts and Project Metrics for the Harvard Business School Tata Hall Executive Education Center. The LEED Facts table lists various categories and their scores, while the Project Metrics table highlights key performance indicators.

LEED® Facts	
Harvard Business School Tata Hall Executive Education Center	
Location.....	Boston, MA
Rating System.....	LEED-NC v3
Certification.....	Platinum
Total Points.....	82/110
Sustainable Sites.....	22/26
Water Efficiency.....	6/10
Energy and Atmosphere.....	28/35
Materials and Resources.....	6/14
Indoor Environmental Quality.....	11/15
Innovation and Design.....	6/6
Regional Priority.....	3/4

PROJECT METRICS	
48%	water savings compared to an Energy Policy Act of 1992 baseline
43%	reduction in energy costs compared to the baseline standard (ASHRAE 90.1-2007), estimated via energy modeling
5.2%	of energy use (by cost) is provided by an on-site renewable energy system (PV)
92%	of regularly occupied areas have access to views
90%	of individual spaces, including bedrooms, have individual lighting controls
90%	of individual spaces, including bedrooms, have individual thermal comfort controls

Week 1: Definitions and Perspectives on Sustainability in Industrial Design and Built Environments
Lecture 4: Technological interventions into building design
Course: Strategies for Sustainable Design


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IIT Hyderabad, India

Some major actually project metrics you see 48 percent water savings compared to an energy policy act of 92, 1992 baseline, 43 percent reduction in energy costs compared to the baseline standard. A 5.2 percent of energy used by cost is provided by an on-site renewable energy system photovoltaic solar cell. 92 percent of regularly occupied areas have access to views. 90 percent of individual spaces including bedrooms have individual lighting control. 90 percent of individual spaces including bedrooms have individual thermal comfort controls also.

So, you see some of the facts are given here on the left side, the location in Boston you know rating system was used like a LEED new construction version 3, certification it has received platinum, total points it has received 82 out of 110, 110. On the like sections these are actually sections in the LEED certification system. So, on the sustainable sites it has received 22 out of 26. Water efficiency is 6 points out of 10, energy and atmosphere 28 out of 35, materials and resources 6 points out of 14, indoor environmental quality 11 out of 15, innovation and design 6 out of 6, regional priority 3 out of 4.

So, you can see like innovation and design it has received the maximum actually like a criteria point. So, which shows the kind of emphasis and attention given by the architects and the designer and the other stakeholders involved in this actually project.

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TATA HALL EXECUTIVE EDUCATION CENTER
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PROJECT OVERVIEW


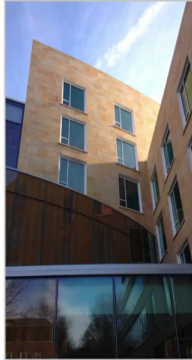
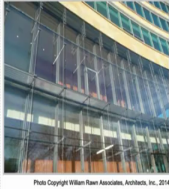



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So, some of the actually pictures you can see from here like a how this building is utilizing these actually a glazed you know these surfaces to create like a huge and wider spaces from even if while you are sitting inside you can have a look till like how far places, maximizing even the like a daylight in intake inside this space, you see like here the sunlight this shade is actually falling from this side so it is entering till like a deeper inside this particular space reducing the actually need of like electricity based luminaires.

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PROJECT TEAM


Owner	Harvard Business School
Project Manager	Harvard Business School
Architect	William Rawn Associates, Architects, Inc.
MIP Engineer	AKF Group LLC
Contractor	BOND
Commissioning Authority	Asmark
Sustainability Consultant	Ashley Tan, Green Building Services

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See, the landscaping is also like designed in such a way that it feels like as if we are sitting integrated with the outside and the outer like a landscape of this particular place.

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ENERGY EFFICIENCY AND INDOOR ENVIRONMENTAL QUALITY

MECHANICAL AND ELECTRICAL SYSTEMS

- ECM 1: Displacement Ventilation (Classrooms)
- ECM 2: High Efficiency Fan Coil Units (Living Groups)
- ECM 3: Enthalpy Recovery System
- ECM 4: High Efficiency Fans and Motors
- ECM 5: Energy Efficient Lighting
- ECM 6: Occupancy Sensors
- ECM 7: High Efficiency Condensing Boilers

The overall strategy of the HVAC system design was to reduce energy use through the installation of high efficiency equipment and controls. The fans are controlled by variable frequency drives and have variable air volume boxes downstream of the supply fans in order to provide ventilation. Occupancy sensors tied to the variable air volume (VAV) boxes were installed in the bedroom and living areas to control the ventilation air and reduce HVAC system energy when these spaces are unoccupied. CO₂ sensors were also installed in densely occupied spaces in order to reduce energy consumption. The HVAC system also includes an enthalpy recovery system that recovers energy from the exhaust air to precondition ventilation air (for dedicated outdoor air units). Additionally, high efficiency condensing boilers were installed for space heating as well as for the domestic hot water. All water-side systems in the building have variable flow pumping.

All lighting in the building is energy efficient fluorescent or LED type. Lighting controls were installed throughout the building including vacancy sensors for living areas and specific controls for classrooms, and the provision to help reduce the lighting energy load. A daylight harvesting system was also used to automatically turn off or dim lighting in areas when the amount of illumination provided by daylight is sufficient. Low electrical metering of distribution panels serving lighting, HVAC, and response loads was also installed.





Typical Energy Exchange Through an Enthalpy Wheel. Copyright DAC Sales. http://www.dac-sales.com/energy-recovery-energy-wheels-what-is-an-enthalpy-wheel/. 2012


Displacement Ventilation Design. Copyright AMT Group LLC, 2011

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On the energy efficiency and indoor environmental quality if you see like how they have actually worked to actually for like a fresh air change you know using actually in these methods in the like a summer condition and in the winter condition.

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INDOOR ENVIRONMENTAL QUALITY

The high indoor environmental quality of the Tata Hall building was a significant focus of the project. The selection of low chemical-emitting building and finish materials, as well as appropriate construction measures to prevent mold and mildew growth within the building ensure a high level of indoor air quality, and thus occupant health, throughout the project. All chemical use spaces have auto-closing doors as well as compliant exhaust systems. To reduce contaminants brought in from the outdoors, all main entryways have grills or floor mats.

Other strategies to increase the indoor environmental quality addressed the lighting and thermal comfort of the space. These included:

- High efficiency lighting with appropriate light levels
- Filtered outdoor air for ventilation
- Occupancy sensors and controls
- Daylight access and views
- High performance double skin facade (control glare and solar heat gain)

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Photo: Copyright Wilson-Rae Architects, Architects, Inc., 2014

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In the like a indoor environmental quality like high efficiency lighting with appropriate light levels, filtered outdoor air for ventilation, occupancy sensors and control, daylight access and views, high performance double skin façade.

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LANDSCAPE AND SITE

The Tata Hall landscape and site are designed to be integrated into the Harvard Business School campus and surrounding community. The design features a large open lawn facing the Charles River to the west and more intimate outdoor gathering spaces on the east. The design is centered on reducing and filtering stormwater runoff, mitigating the urban heat island effect, and creating a comfortable outdoor environment around Tata Hall.

The proximity to the Charles River makes stormwater management a priority for the project. The site was designed to filter sediments and phosphorus. Infiltration basins on the site then slowly release stormwater during off peak hours. This system will help reduce peak stormwater run-off rates to ease the burden on the local infrastructure.

The project's site design strategy to have limited hardscape and a vast vegetated area on the ground contributes to reducing the urban heat island effect. The design also included a high albedo roof membrane, pavers with high SRI values, and increased shading of the hardscape areas.

For most of the landscaped areas, native plant species were used in order to help reduce the need for non-natural fertilizers and pesticides as well as decrease the need for irrigation.

Site Plan: Copyright Reed Hilderbrand Associates, Inc. 2012

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NPTEL

For the landscape and site, you can see in this like a diagram this site plan over here, this is the building you know and how they have actually integrated with the neighboring actually building which are existing from before over here and how they have responded with the actually language of this curvaceous-ness. The neighboring buildings have actually this curvaceous front lines. So, the same language is adopted here in this building as well.

(Refer Slide Time: 21:18)



PLUMBING SYSTEMS AND POTABLE WATER USE REDUCTION



1.28 GPF Toilet Copyright American Standard, 2012

0.125 GPF Urinal Copyright American Standard, 2012

Decreasing the demand for potable water is the first step towards sustainable water management. Sinks, toilets, urinals, showers, and irrigation systems that are designed to use less water than typical fixtures and systems are widely available and when combined with conscientious occupant use patterns and controls, can result in a large reduction in water use.

Some of the water conservation strategies incorporated in the project include:

- Low-flow plumbing fixtures (urinals: 0.125 GPF; toilets: 1.28 GPF and 1.13 GPF; showers: 1.5 GPM; lavatory faucets: 0.5 GPM)
- Water efficient appliances
- Water efficient irrigation system
- Reduced HVAC water use

These strategies led to a 48% reduction in water use, compared to the EPA Act 1992 baseline.

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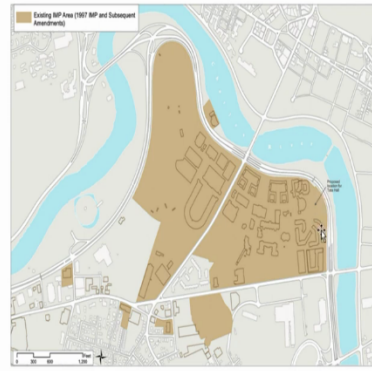
FIG. 3-1: Locus Map

Peter Reed Associates, Architects, Inc.
Boston, MA



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FIG. 1: Existing IMP Area

Urban Form Associates, Architects, Inc.
Boston, MA



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Plumbing systems and portable water use reduction so they have used low flow pumping plumbing fixtures you know water efficient appliances, water efficient irrigation systems, reduced HVAC water uses.

This is the site and this is actually location of a Harvard Business School you can see from the aerial image. In the layout in this like area you can see this is the location of this project okay and how do you see these building facades have this actually curvaceous front faces, so the building is actually following the same actually visual language okay and that is why it has received the maximum actually values in like innovation and design.

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Harvard Business School Tata Hall




Category	Points	Weight	Score
Project Points	100	100	100
Leadership in Innovation	10	10	10
LEED-CS-101	1	1	1
LEED-CS-102	1	1	1
LEED-CS-103	1	1	1
LEED-CS-104	1	1	1
LEED-CS-105	1	1	1
LEED-CS-106	1	1	1
LEED-CS-107	1	1	1
LEED-CS-108	1	1	1
LEED-CS-109	1	1	1
LEED-CS-110	1	1	1
Building Green	20	20	20
LEED-CS-201	1	1	1
LEED-CS-202	1	1	1
LEED-CS-203	1	1	1
LEED-CS-204	1	1	1
LEED-CS-205	1	1	1
LEED-CS-206	1	1	1
LEED-CS-207	1	1	1
LEED-CS-208	1	1	1
LEED-CS-209	1	1	1
LEED-CS-210	1	1	1
Energy & Atmosphere	30	30	30
LEED-CS-301	1	1	1
LEED-CS-302	1	1	1
LEED-CS-303	1	1	1
LEED-CS-304	1	1	1
LEED-CS-305	1	1	1
LEED-CS-306	1	1	1
LEED-CS-307	1	1	1
LEED-CS-308	1	1	1
LEED-CS-309	1	1	1
LEED-CS-310	1	1	1
Water Efficiency	10	10	10
LEED-CS-401	1	1	1
LEED-CS-402	1	1	1
LEED-CS-403	1	1	1
LEED-CS-404	1	1	1
LEED-CS-405	1	1	1
LEED-CS-406	1	1	1
Indoor Environmental Quality	10	10	10
LEED-CS-501	1	1	1
LEED-CS-502	1	1	1
LEED-CS-503	1	1	1
LEED-CS-504	1	1	1
LEED-CS-505	1	1	1
LEED-CS-506	1	1	1
LEED-CS-507	1	1	1
LEED-CS-508	1	1	1
LEED-CS-509	1	1	1
LEED-CS-510	1	1	1
Sustainable in Design	10	10	10
LEED-CS-601	1	1	1
LEED-CS-602	1	1	1
LEED-CS-603	1	1	1
LEED-CS-604	1	1	1
LEED-CS-605	1	1	1
LEED-CS-606	1	1	1
LEED-CS-607	1	1	1
LEED-CS-608	1	1	1
LEED-CS-609	1	1	1
LEED-CS-610	1	1	1
Regional Priority	10	10	10
LEED-CS-701	1	1	1
LEED-CS-702	1	1	1
LEED-CS-703	1	1	1
LEED-CS-704	1	1	1
LEED-CS-705	1	1	1

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This is actually this report card of this LEED certification, with the points given to this building you can see this slide in detail for your deeper understanding like how these actually final criteria are evaluated you know and how much like ratings are given in each of them.

(Refer Slide Time: 22:24)



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So, this is this actually building a give one of the actually best examples like how a building can actually work for like a sustainable like goals how we can minimize the impact. So, we one actually the exam the reason for giving you these actually case examples from around the world

from like a different corner of India and the world is to make you aware of the actually state of the art actually advancements happening in this area, you must actually learn from these projects you should actually apply these strategies in your designs. So, with this we have come to the end of this lecture, thank you everyone.