Bringing Natural Light Indoors

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December 23, 2020

Estimated time : 3o hours

Overview:

The lifestyle these days has made us dependent upon the artificial light even during the day time when we have the leisure of sunlight. This has led to an increased power consumption for lighting, increasing the carbon emissions. With the use of fibre optical cables, sunlight can be harnessed for the lighting system during the day.

Vocabulary:

1. Artificial and natural light
2. Non-renewable and renewable source of energy
3. Carbon footprint and carbon emissions
4. Total Internal Reflection
5. Sustainable architecture

Objectives:

1. Generate awareness about Carbon footprint.
2. Increasing sensitivity to green building norms
3. Discuss the need and usage of renewable source of energy for sustainable architectural norms.
4. induce the concept of energy saving via usage of fibre optical cables.

Next Generation Science Standards:

1. ESS2.D Weather and climate
2. ESS3.A Natural resources
3. ESS3.C Human impacts on Earth systems
4. ESS3.D Global climate change

5. PS3.A Definitions of energy
6. PS4.B Electromagnetic radiation
7. PS4.C Information technologies and instrumentation

Required Project Material:

For prototype

- plastic fibre cables
- white LED
- funnel
- aluminium paint
- battery, wires, switch
- flower vase

For actual project

- coated glass fibre cables
- concave reflectors
- cardboard boxes

For alternative ideas

- OHP sheets
- Solar panels

Multimedia resources:

- https://youtu.be/0MwMkBET_5I
- What Is Optical Fiber? -Definition And Types Of Optical Fiber byjus.com > Physics > Optics (google.com)
- 9 Uses of Fiber Optic Cables (rs-online.com)
- https://youtu.be/-VYhfR8Fv2I

Engage:

Background:

Natural resources are of two types:

- renewable resource : replenishes to replace the portion used up within a given time period in a human life-time, like sunlight.
- non-renewable resource : cannot be readily replaced by natural means at a quick pace to keep up with consumption, like carbon-based fossil fuel.

Green building norms in India:

1. Sustainable Architecture and Design
2. Site Selection and Planning
3. Water Conservation
4. Energy Efficiency
5. Building Materials and Resources
6. Indoor Environmental Quality
7. Innovation and Development

Introduction:

With rising pollution and threat from global climate change, it is necessary to reduce Carbon footprint to decrease carbon emissions. Only then it is possible to achieve the Paris Climate Change Agreement goal to keep limit the global temperature rise this century below 2 degree Celsius.

The changing work lifestyle, pushed further by the pandemic-enforced country-wide lock-down, has increased our dependency on artificial lights even during day time. This has led to an increased electrical light consumption at house-hold and individual level.

Indoor community places such as swimming pools, lounge areas, hotel receptions, etc also use a lot of electrical lighting system throughout the day. This has led to an increased cumulative and collective carbon footprint.

Advantages of using fibre cables:

1. support sustainable architecture
2. low usage of copper
3. compliance to environment-friendly policies
4. less repair rate
5. capable of lighting up till 330 feet
6. occupies minimum space
7. no risk of electrical hazards
8. easy installation
9. tropical and equatorial regions receive sunlight almost throughout the year. This can harness the sunlight in the best way.
10. flexible enough to tie knots

Other uses of fibre optical cables:

1. underwater communication cables
2. resource monitoring sensors
3. Passive Optical LAN
4. medical uses : Remote spectrophotometry, Endoscopic imaging, Pressure and position sensing, Scintillation counting, Intravascular pressure transducers

Explain:

Concepts:

- **Reflection** : Light falling on any surface is thrown back with almost no absorption.
- **Refraction** : Incident light wave, upon changing the medium of travel, experiences a change in speed and direction.
- **Critical angle** : the angle of incidence beyond which rays of light passing through a denser medium to the surface of a less dense medium are no longer refracted but completely reflected, causing **Total Internal Reflection (TIR)**
- **Fibre optic cable** : a cable consisting of one or more thin flexible fibres with a glass core, through which light signals can be sent with very little loss of strength.
- **Carbon footprint** : total greenhouse gas (GHG) emissions caused by an individual, event, organization, service, or product, expressed as carbon dioxide equivalent
- **Tubular skylight** : device that captures light from the roof of a building, and then channels that light through specially designed tubes to into a room.

Explore:

Building the prototype: (Fibre Optic Lamp)

1. Make a basic circuit using the LED, wires, switch and battery.
2. Place it inside the flower vase.
3. Paint the funnel with the aluminium paint. It will work as a reflector.
4. Bundle up all the plastic fibre optic cables and insert it in the funnel.
5. Place the funnel facing downwards, while the cables should be coming out from the bottom of it.
6. Place the funnel with the cable bundle on flower vase
7. Switch on the LED.

Figure 1: A Fibre Optic Lamp

Visit a nearby construction site: (observe and discuss)

- What changes need to be made in the architectural design to adopt fibre optic lighting system
- Understand viability and application of using fibre optic cables
- Compare with the usage of tubular skylights (in a multi-storey structure)

Elaborate:

Enhancements to the prototype:

- instead of funnel: use concave metal reflector
- material of cables for better efficiency: coated glass fibre optic cables
- surface where the apparatus is built: reflecting and bright coloured surface
- modifications to the reflector: sun tracking system

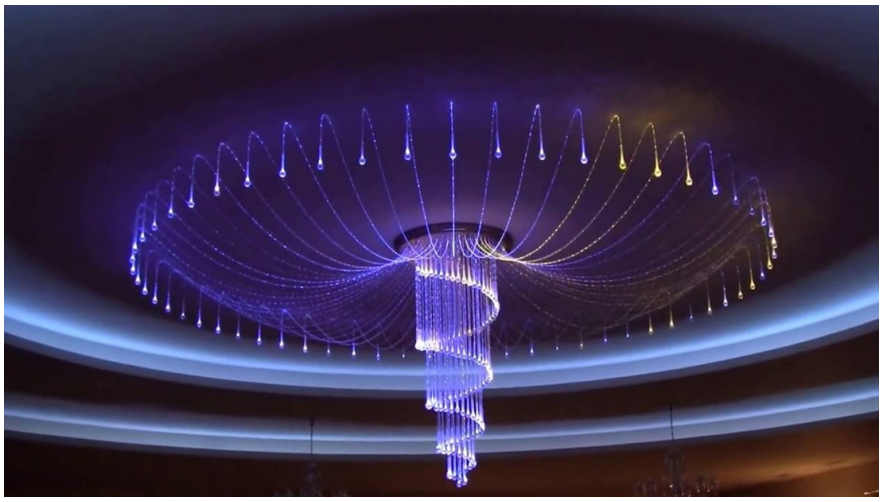

Figure 2: Lighting up Buildings with FIbre Optic Cables

Alternatives to use sunlight/solar energy:

- glass panels for walls facing sun
- solar panel rooftop
- solar panels in the glass windows

Building models:

Divide the participants into groups

1. use coated glass cables and metal reflector in cardboard building
2. use solar panel in cardboard building
3. use of transparent walls: OHP sheets/glass
4. usage of more than one methodology to harness sunlight/solar energy

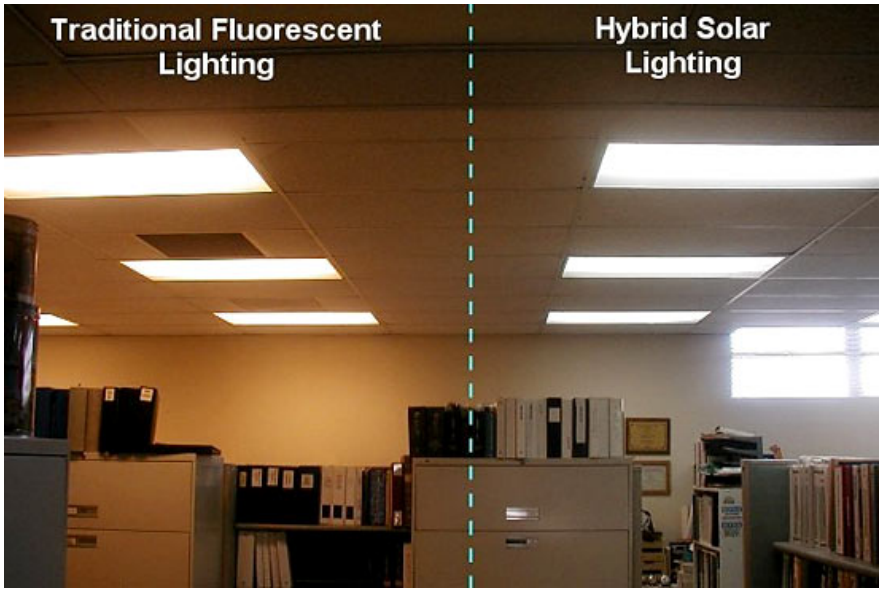

Figure 3: Hybrid Solar Lighting : S olar with Atificial Lght

Evaluate:

Formative:

1. Research aptitude
2. class participation

Summative:

1. Group discussion : which alternative is the best, can combining 2 or more models be the best way?
2. Assessment sheet: knowledge based written question and answer session

References:

1. Fiber Optics: Road to an Eco-Friendly Network - Nexus-net (nexus-net.info)
2. Creating Sustainable Spaces with Fiber Optic Full Spectrum Daylighting | U.S. Green Building Council (usgbc.org)
3. Advances in Medical Fiber Optic Technology for Improving Patient Care (nai-group.com)
4. IGBC - Smart Cities & Green Building Concept in India
5. Development of Optical Fiber-Based Daylighting System and Its Comparison. Irfan Ullah et al. Energies 2015, 8, 7185-7201
6. Energy Conservation Building Code 2017, Ministry of Power, Government of India