PREM JAIN MEMORIAL TRUST

ENERGY EFFICIENCY IN EDUCATIONAL INSTITUTIONS TOOLKIT

2023

JANUARY

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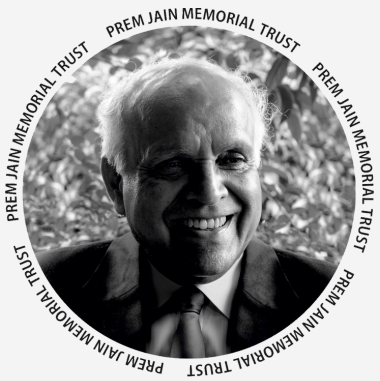

PREM JAIN MEMORIAL TRUST

About
Prem Jain Memorial Trust

Prem Jain Memorial Trust was formed in the year 2018 to continue with the legacy of Dr. Prem C. Jain to promote innovation and sustainability. The mission of **Prem Jain Memorial Trust** is to create, establish and maintain a sustainability paradigm through education, recognition, and nurturing of our present and future generations. The Trust aims at identifying future leaders who can be a catalyst for the global development of sustainability and can create awareness and advocacy about the environment. It also wishes to nurture India's young talent by educating and informing them about sustainable development ecosystems.

Dr. Prem Jain, architect of the modern green building movement **has ushered in a paradigm shift in the way buildings are conceived and designed worldwide**. He has facilitated India's stands tall in the global green building movement and aspired for **"Bharat to emerge as Jagat Guru in Sustainable Built Environment"**.

Dr. Prem Jain began to think about Sustainability as a lifestyle way back in the 1970s. Over a half-century of dedicated work, he thought and spoke a language that was somehow larger than life, and his passion for his 'Janani Janmabhoomi' burnt bright through his life's work and accomplishments. He is also referred to as the 'Father of Green Buildings' in India. The 'green revolution' he started is the foundation for the legacy of PJMT, in the hope that we can balance the need for growth and safety with presentation of our beautiful planet earth.

Foreword

I am pleased to write the 'Foreword' for the handbook on **'Energy Efficiency'**, which is one of the most important aspect in our fight for sustainable living and towards global warming.

The reason is that, most of the energy produced today is produced from Fossil Fuels, and hence not only aids global warming but also is a contributor towards carbon emissions. Achieving energy efficiency, will achieve direct reduction in carbon emissions. More so, water, energy, waste and carbon, are all intertwined and interrelated. Pumping of water for example from areas even beyond 200 KMs for many of our cities and also internally within the built environment, contributes to over 40% of the energy consumption in a city. Incidentally, our country has grown to 17.65% of the world's population but the available fresh water for use of our citizens, is only 4%.

Adding to this problem, is the rate of urbanization which increases the water footprint. 40% plus untreated waste water from buildings are unscrupulously already dumped into our fresh water resources. Our country can only emerge as the "Jagat Guru in Sustainable Built Environment" in the words of Dr. Prem C. Jain, if we concentrate on all four aspects of Energy, Water, Waste & Carbon. It is therefore important to achieve energy efficiency by Renewable Energy means including Solar, Wind & Hydro, achieving energy efficiency in built environment over ECBC baselines, ensuring that the buildings are certified as green and are 3 to 4 degree cooler than the ambient temperature, and hence are energy efficient. Also adding to the health and well being of it's occupants, this will help in reducing our reliance on Fossil Fuels. Today, technologies are available where buildings can be 'Net Zero Energy' and even energy positive, ensuring less or zero burden on our mother earth.

Therefore, releasing and publishing a toolkit on energy efficiency is one of the important steps in the right direction, to achieve a healthy and sustainable living environment.

Gurmit Singh
National Chairman, Cii – Indian Green Building Council
National President, Indian Plumbing Association

Special Message

My beloved Father Dr. Jain said in his book, Path of Green:

"Bharat is amongst the very few civilisations that revere their land-of-birth as Bharat Ma, meaning Mother. Since time immemorial, worship of the sun is a tradition in our country. **Agni** has been given the highest importance amongst the **Panchabhootas** and the sun is considered to be the **Shakti-Punj** or storehouse of all energy. The landmass of Bharat has five climatic zones that range from hot and dry, to cold and moist. But it is incredible that every corner of Bharat gets, on an average, more than 300 days of sunshine throughout the year, thereby lighting our hearts, our minds, our workplaces and our homes. In recent times this abundance is being harnessed to produce solar energy – an environment-friendly source of power that can solve many of Bharat's problems. It has been proven that with modern developments in the growing construction industry and the availability of renewable solar energy, all our current and future needs of energy can be produced through solar farms across the Thar Desert alone. Once the techniques for collection/harvesting, transmission and distribution of this abundant green power is developed, Bharat will become self-sufficient with green power.

Till recently, villages and remote areas of Bharat had no access to power supply; our per capita energy consumption used to be about 5% of the energy consumption of USA. The government has wisely chosen to create self-contained solar parks for each cluster of villages. The stored solar power available after sunset has done wonders for our less privileged brothers and sisters. With the Government of India's ambitious program of meeting 20% of Bharat's energy needs, including future development, through solar power generation by 2030, it has given great impetus to the cause."

We at PJMT believe that 'Youth' brings 'Change', and that our Indian youth will spread the message of sustainability across the globe. Our Mission is to nurture our young talent, by disseminating knowledge about a sustainable ecosystem. PJMT works each day towards a Greener Earth, through education, inclusion, recognition and advocacy.

At the **5th Harit Prem Bharat Mahotsav**, let us together take a pledge to mindfully use all Energy sources, each day here on. Let us begin this year with conviction, intention and awareness to nurture and preserve our Mother Earth.

Payal Jain
Founder Trustee
Prem Jain Memorial Trust

Introduction

The toolkit on Energy Efficiency in Educational Institutions is written in order to enlighten our upcoming generation toward a sustainable future by taking energy-efficient steps in our day-to-day life.

This toolkit focused on intimating the potential that educational institutions hold toward energy saving and the scope of using renewable energy. Improving energy efficiency can lead to improved indoor comfort for students and staff. For example, by upgrading to energy-efficient lighting and HVAC systems, an institution can improve the quality of the light in classrooms and common areas, as well as providing better temperature control.

In addition to the above benefits, energy efficiency in educational institutions can also be used as a learning opportunity for students and staff. Many institutions incorporate energy efficiency education into their curriculum and engage students in energy conservation programs, which can help to develop their understanding of energy use and conservation.

This toolkit provides information on energy management in different ways such as energy-saving tips, policy interventions, alternative energy solutions, etc. This also shares the action plan for energy optimization and the case studies of the practical implementation. The GT Academy along with PJMT focuses on Sustainability, Energy Efficiency, Planning, Engineering, Research, Technology Innovation, Design, and more while writing this toolkit. Overall, it is an attempt to encourage students to learn about energy efficiency and make it relevant, engaging, and accessible to them.

Dhruv Jain,
Executive Council Member, GT Academy

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About the Toolkit:

This is a free and accessible guidebook designed by the Prem Jain Memorial Trust for easy understanding and use by administrators, faculty, staff, and students who may seek to identify ways for their institutions to reduce bills, energy use, and GHG emissions.

This toolkit for Energy Efficiency in Higher Educational Institutions is therefore designed to provide practical strategies for increasing energy efficiency, improving energy management for sufficient utilization, minimizing wastage of electricity and cutting down on carbon footprint, thereby promoting mindful usage of energy. This includes active participation and engagement of staff and students.

PJMT hopes that this toolkit for Colleges and Universities will be a useful resource to the administrators and students seeking to save energy, reduce greenhouse gas emissions, and make savings on annual bills.

1. Why Higher Educational Institutions ?

The potential of transforming campuses of educational institutions to deliver on sustainability is enormous. As of 2013, India has 45 central universities, 318 state universities, 185 state private universities, 129 deemed to be universities, 55 autonomous institutes of national importance and 37,204 registered colleges. To illustrate, this translates to, in terms of energy footprint, emission of approx. 231 million tonnes equivalent of carbon dioxide (eCO2) annually.

Figure 1: Maharaja's College, Kerala

Figure 2: Landscaping at Maharaja's College

As complex organizations, higher education institutions have a significant carbon footprint split among their direct and indirect emissions. On account of that, several studies focus on investigating energy efficiency and behavior at universities.

Education plays a central role in building professionals and knowledge to take the sustainability agenda forward. Transforming places of formal learning - colleges, universities, and other large educational institutions—as resource-efficient and low-carbon campuses shall inevitably demonstrate practice in sustainability.

Institutions of higher education are poised to play a leading role in developing and implementing carbon-neutral policies and involving students in every aspect of this multi-faceted opportunity is an obligation that can no longer be ignored.

Although there are many studies about the influence of students' behaviour in sustainability, specifically in energy consumption and energy efficiency, there is still a comprehensive lack of studies analyzing a potential connection between the initiatives already developed by universities and the knowledge or change of behaviour of academic community towards them, particularly in the context of energy.

In 2016, the University Grants Commission (UGC) recommended all educational institutions to develop green campuses. The suggestion involves the preparation and submission of a proposal by institutions to reduce demand for conventional energy by 10 percent and demand for fossil fuels by 25 percent at the end of five years. Suggested measures include **the preparation of a master plan, energy and water audits for setting a baseline scenario and reducing targets, enhancing supply from renewable energy sources,** and energy efficiency measures such as **energy-efficient street lighting systems, low-energy fixtures, energy-efficient pumping systems, energy-efficient motors and use of star-rated equipment.**

Figure 3: Energy-efficient Street lighting systems

Figure 4: BEE Star rated equipment

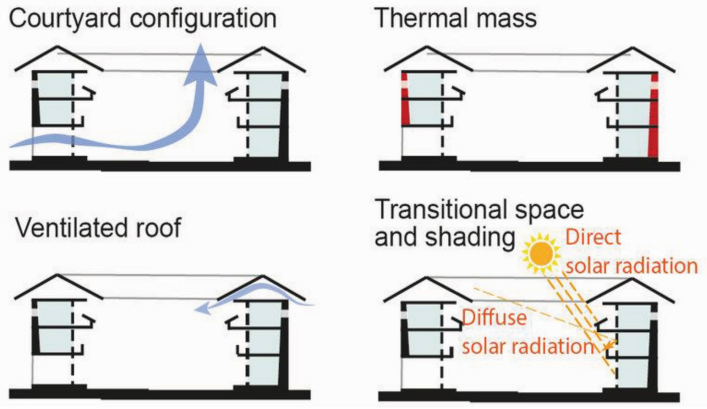
Implementing measures to save energy on campus leads to the development of a green campus which not only optimizes energy efficiency but also saves electricity, prioritizes renewable energy over fossil fuels, and promotes environmentally responsible living.

An energy efficiency program can open pathways to developing a more environmentally aware and responsible generation of citizens. This can equip resourceful faculty members to foster awareness about energy efficiency and enable every member of the education community to understand the scope and significance of the individual role in the efficient and sustainable use of energy resources within the campus. This shall encourage them to demonstrate and scale up the practice. Not to mention, the lessons imparted and the mindset cultivated shall be taken forward across the world by the students.

2. Energy Management

Energy consumption can be reduced by two techniques—conservation and efficiency measures. Energy conservation refers to the reduction of energy consumption by using fewer energy services. Efficient energy use refers to using less energy for a constant service. It involves a smart & practical approach in building design to exploit opportunities across areas such as daylighting strategies, ventilation, maintenance of visual and thermal comfort, etc.

Conducting an energy audit is the first step toward identifying opportunities to reduce energy and related costs. Energy audit is an inspection and analysis of energy use and flow in a building, process or a system, with an aim to reduce the energy input into the system without negatively affecting the output.



Why Energy Management?

- Due to fossil fuel supply chain disruptions.
- Due to upcoming shortage, hence higher prices of fossil fuels.
- To control energy prices, as high energy prices equate to higher prices for all consumables.
- To ensure a better return on investment, i.e., maximum output per unit of input energy.
- To reduce energy bills.
- To attain Sustainable Development Goals (SDGs).
- To help in reducing Forex expenditure/National trade imbalance, resulting in a stronger currency.
- Overall improvement in living standards.

Zero Investment	Moderate Investment	High Investment
• Switching off equipment while leaving classrooms and other spaces. • Keep doors & windows properly shut while HVAC equipment are on. • Remove curtains during the day. • Warm clothing during winters, instead of room-heating.	• Replacement of halogen lamps with LED ones. • Light-color paint for exteriors & interiors. • Pre-setting of HVAC equipment. • Insulated false ceilings for top floors. • Task lighting. • Soft-soaping.	• Installing Occupancy sensors. • Installing Co-generation & Tri-generation plant(s). • Installing Automatic curtains & light sensors. • Installing PLC-based Building Management System (BMS).

Energy management can be split into three discrete categories, which provide the framework for the energy-related elements of the climate action plan:

A) Energy conservation – policy interventions and behavior change programs

- Regular Energy Audit.
- Energy efficiency standards for new construction and refurbishments.
- Energy efficiency purchasing standards.
- Energy conservation training for staff.
- Improved space utilization to avoid new construction or heating/cooling of underutilized space.
- Thermal comfort policy (e.g., widening heating/cooling temperature settings).
- Financial strategies to assign energy costs incurred – and savings achieved – to the responsible cost centres.
- Energy/ climate change awareness programs – posters, stickers, events and competitions, websites, awards, and incentives for switching off unused appliances, reporting waste etc.
- Establishment of an "energy champions" network across campus buildings.

B) Energy efficiency opportunities – maintenance and capital works

- Detailed energy audits every 3 years to identify priority areas.
- Periodic re-commissioning and building-tuning to optimize energy efficiency.
- Building retrofitting – installation of external shading devices, sealing, insulation, double glazing, low emissivity window film, light colored paint.
- Lighting: de-lamping, installation of high-efficiency lighting fixtures, use of task-lighting, lighting controls (timers/sensors).
- Use of LED lighting instead of other artificial lights.
- Maximum daylight utilization using reflective, low U-value glasses, clerestories, skylights, light channels, etc.
- Heating, Ventilation and Air-Conditioning (HVAC) – high-efficiency chillers, boilers, motors, pumps and air handling units, variable air volume fan systems, re-commissioning, tuning, regular maintenance, heat recovery systems.
- Laboratory ventilation and fume hoods – ventilated storage cabinets for storage, variable air volume and low-flow hoods.
- Use of low-cost waste-heat recovery devices such as heat wheels for classrooms, offices, etc.

- Extensive use of nettings (jaalis) in case of low humidity, high temperature and wind-blown geographies.
- Ensuring maximum availability of soft-soaped.

C) Energy-Saving Tips for Heating, Ventilation, and Air Conditioning (HVAC) Systems:

- Incorporating passive cooling strategies such as, Cross ventilation, Green roofing, Double-glazing glass, etc.
- Use of occupancy sensor(s) to regulate HVAC operation as per space-occupancy and switch off appliances in case of no occupancy.
- Replacement of Vapour and Incandescent lamps with LEDs.
- Regular maintenance of HVAC equipment.
- Use of reflective glass in case of external wall facing Southward.
- Use of light-color paints for external and internal walls.
- Use of insulated false ceiling/attic for top floors.
- Use of low thermal mass insulation, especially in the south-facing external walls.
- Minimize the presence of air leaks and gaps through door and window clearances.
- Use of master/main switch to switch off total power in buildings after scheduled working hours.
- Pre-setting of HVAC devices to ensure temperature and humidity conditions corresponding to human thermal comfort.

The major source of carbon emissions from campuses in most cases will be purchased energy, hence the primary focus of a Campus' climate action plan shall generally pivot around energy management. University energy management probably offers the best opportunities for achieving the “little victories” necessary to enable “systemic transformation”.

D) Renewable and alternative energy solutions

- Harnessing of human power. E.g., from treadmills and cycles in gyms, etc.
- Installation of photovoltaic arrays on rooftops.
- Use of solar kitchens and solar water heaters.
- Use of directional windmills in case of wind-blown geographies, to be set up, preferably on terraces.
- Use of miniature biogas plants for kitchen and gardening wastes.
- Installation of cogeneration and tri-generation equipment.
- Fuel switching–conversion of electric space or water heating to natural gas, biomass pellets firing, etc.

3. Action Plan

a) Record

Start by making a note of current consumption. The starting point can be utilized as an initial benchmark. Also, the consecutive electricity bills can be retained for comparative improvement.

Figure 5: Building-Integrated Photovoltaics: Acting as both cladding & Solar generator

Figure 6: Task lighting: Light falls just where it is needed

b) Identify Factors

Make a note of consumption variations throughout the year and identify the causes. For example, if campus buildings are affected by the weather, energy could be conserved by applying better insulation, and savings in the bill can be ensured in the long term.

c) Benchmark current energy use

How does it compare to last year or last season? Make sure you analyze similar time periods (for example, December 2021 with December 2022) to make sure the improvement in efficiency isn't influenced by other factors.

d) Reduction goals

Realistic goals and a target date must be set for measuring consumption again to track how you're doing. The lower the targets for each year and longer the implementation timeline, the more inexpensive the measures.

e) Roadmap

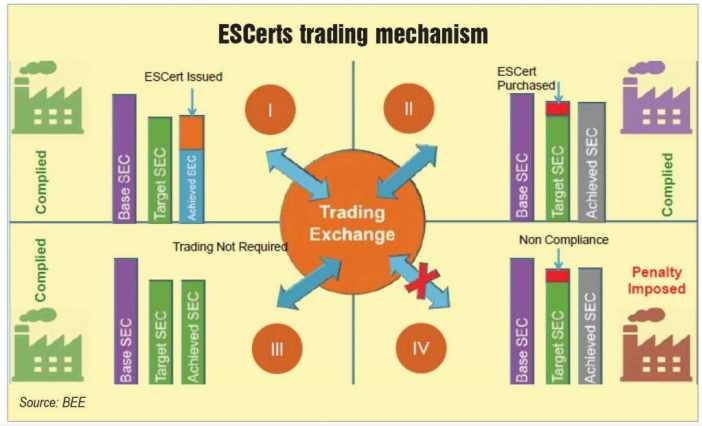
Use the above-mentioned categories to put the advice into practice. Maximum involvement of staff, faculty, and students must be ensured. To motivate staff and students, competitive implementation is a good approach. For example, a free meal out to the team that comes up with the maximum ideas of energy saving or commit to donate the savings to a local charity as they choose; Similar approaches can be taken in the form of inter-institute competitions.

f) Measure achievements

Communicate all improvements to faculty, staff and students to encourage an energy-efficient state of mind. Once it is feasible to adapt to more changes to become energy-efficient, this action plan shall be modified and implemented again.

g) Avail relevant incentives

Upon significant energy savings (in the order of >=1mtoe) and/or significant surplus Renewable generation (>=1MW) within the campus, the institute can obtain remunerative certificates such as ES-Cert(s) & REC(s) respectively, which can be traded in the open market under the PAT Scheme.



This would be a remunerative benefit in addition to the savings from electricity bills. A similar approach can be made towards earning carbon credits by larger campuses with abundant vacant land.

4. Case Study

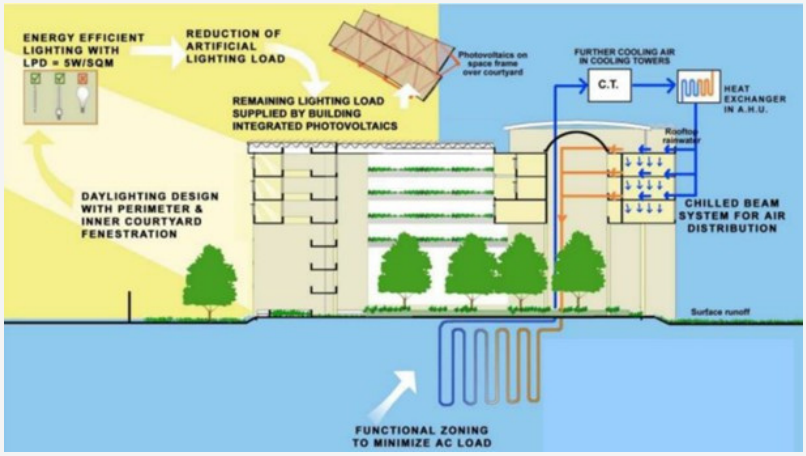
Institute

Net Zero Energy Building (NZEB), Indira Paryavaran Bhawan, Delhi, India.

Achievements

- The Indira Paryavaran Bhawan met the energy demand with the green and clean energy solution, Efficient Solar PV systems.
- The building has a solar PV system installed in a 6000 m2 area of 930 kW capacity.
- The energy consumption is 67.3% less in comparison to the GRIHA benchmark.
- The overall HVAC load of the building is 40 m2/TR, which is 50%.
- Circulation roads and pathways are softly paved to enable groundwater recharge.
- Water consumption has been reduced by 64% by providing water-efficient fixtures.

Figure 7: Installation of Solar PV Panel at Indira Paryavaran Bhawan



- 75% of building floor space is provided with adequate daylight, consequently reducing dependence on artificial sources for lighting.
- 2,844 solar panels (covering area 4650 m2) generate 14.3 lakh unit annually.

5. Way Forward for Institutes: Outreach and Capacity Building

By teaching students to be mindful of how they use energy early on, we can ensure a better future for the energy industry and for the planet. Following are some steps that can be suggested:

Curriculum

- Courses that address topics related to energy efficiency, conservation, circular economy, and such.
- Integration of energy efficiency into traditional disciplines.

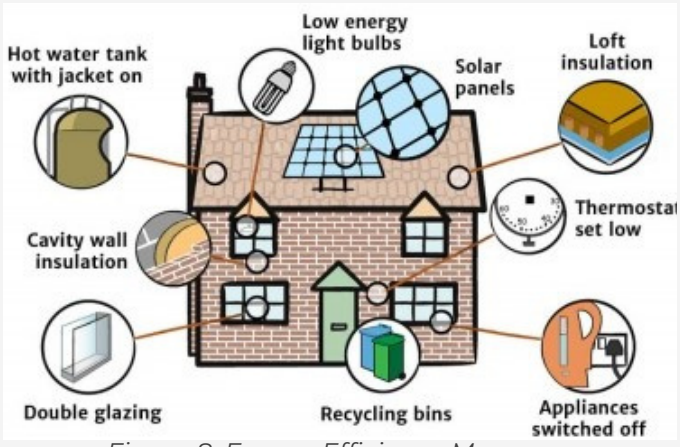


Figure 8: Energy Efficiency Measures

Research and scholarship

- Faculty, research students, and scholarship pertaining to energy efficiency.
- Interdisciplinary structures for research on energy efficiency, education, and policy development.

Rewarding Better Habits

- Exploring little ways to acknowledge and reward users who make the right choice.
- For example, leaving a special sign of gratification on classroom door(s) where the lights are regularly off during lunch, recess, or after college.
- Giving each class an energy efficiency checklist with key improvements listed (e.g., activate computer power settings, remove debris from vents, etc.) and create a "Hall of Fame" type display in a common area, exemplifying which classrooms have completed the checklist.
- There are many ways to reward good behavior, and doing so will help reinforce better habits and make them a permanent part of campus culture.

Outreach and Service

- Partnerships with schools, local government, and local businesses.
- Energy-efficiency community development at the regional level, eventually onto higher levels.
- Staff development opportunities.

Display Reminders

- One simple way to encourage better habits is to post prominent reminders in common areas like hallways, lobbies, libraries, cafeterias, etc.

- If an Institute has a daily or weekly newsletter, a daily announcement, a regularly updated tip or trick towards improving energy efficiency can be added, like opening the blinds on cool sunny days to maximize daylight or shutting them on warmer days to prevent excess heat and reduce the need for air-conditioning.

Student Opportunities

- Orientation on energy efficiency.
- Student energy efficiency centre.
- Student groups focusing on energy efficiency.
- Career counselling keeping energy efficiency in focus.
- Student involvement in campus energy conservation initiatives.

Administration, Mission, and Planning

- Positions and committees dedicated to energy efficiency issues.
- Staff orientation programs.
- Socially responsible investment practices.
- Periodic events on energy efficiency.

6. Way Forward

It has been inferred that an institute may engage in exceptional energy-saving measures on campus, but efforts go unnoticed by students, or “mixed messages” may undermine efficacy. In this way, some other studies suggest that effective approaches to promote energy efficiency are peer education and group-level feedback provided promptly and regularly.

These theories reinforce that institutes need to think of education models or solutions that not only provide feedback for the academic community about its initiatives toward energy efficiency but also educate and raise their awareness on the topic and how they can contribute more to achieve sustainability targets.

On the road to energy efficiency, the first stop is often behavioral change. Encouraging building occupants — like students, teachers, and staff members — to adopt energy-efficient habits can amount to significant savings. Turning off lights in unoccupied rooms, clearing vents of papers and debris, and swapping space heaters for warm clothing are examples of **“low-hanging fruits” or ”Zero Investment category”** that take little or no effort in monetary investment, but consolidate into big savings later on.

By teaching students to be mindful of how they use energy early on, we can ensure a better future for the energy industry and for the planet!

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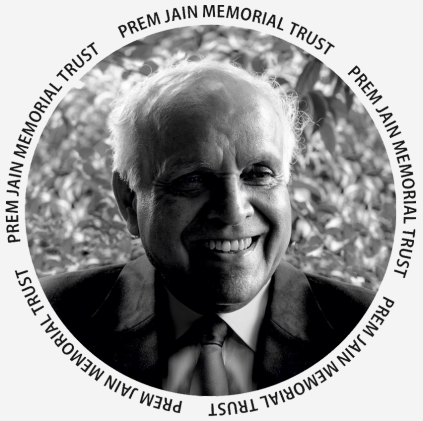

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