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New Education Policy and Energy Efficiency: Understanding through the Lens of a Solar Decathlon India Team

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Highlights

- Academic Institutions are encouraged to leverage energy efficiency and water conservation goals in future planning to cut on operation costs.
- 81.27% reduction may be achieved by a combination of rainwater harvesting and use of fixtures.
- 220 MWh renewable energy generation potential exists with the envisaged building.
- Government of India's New Education Policy 2020 is not only curricula change but also invites new building concepts.
- Solar Decathlon India's Educational Building Contest is an important avenue for idea generation.

Abstract

Academic institutions are excited about the opportunities that are showcased by the Government of India's New Education Policy 2020 regarding the potential impact that it can have on learners. Inspired by this important development, a team of engineering and architecture students took the initiative to consider exploring energy-efficient building designs through the Solar Decathlon India contest in support of the new policy. The team contributed to developing a concept for a "Student Life Centre" - a building that particularly deals with student activities to enable them to pursue their passions along with their studies. This idea was a unique concept for an educational building as participating students got an opportunity to visualize and appreciate the economic aspects. From the author's analysis, before introducing coursework based on the New Education Policy in curricula, academic institutions may benefit if they visualize the options that the built environment may offer in accelerating learning.

Keywords: Education, Solar Decathlon India, Energy-Efficient Buildings, Governance, Building Science

Introduction

The New Education Policy (NEP) envisaged by the Government of India offers opportunities to inculcate skills like: "scientific temper and evidence-based thinking; creativity and innovativeness; aesthetics and art; communication; health and nutrition; physical education and sports; collaboration and teamwork gender sensitivity; environmental awareness including water and resource conservation, sanitation and hygiene" amongst the student community. In the pursuit of developing the eight new IITs envisioned by the Ministry of Education (MoE), Government of India in 2008 to expand the reach and enhance the quality of technical education in the country, the Indian Institute of Technology Ropar has emerged to be one of the flagship institutions [1]. It was envisaged in 2020 that the Solar Decathlon India contest might be leveraged to initiate and accelerate the dialogue of linking energy efficiency with student wellness, engagement, and learning.

The Solar Decathlon India is an annual competition that intends to inculcate skills in emerging students and architects to build net-zero buildings with the eventual aim of addressing climate change through the building sector. The contest is organized by the Indian Institute for Human Settlements (IIHS) and Alliance for an Energy Efficient Economy (AEEE) under the aegis of the Indo-US Science and Technology Forum (IUSSTF). It is supported by the Department of Science and Technology, Government of India.

Under the 2020 Solar Decathlon India Competition Team, the Indian Institute of Technology Ropar contributed to developing a concept for a "Student Life Centre" - a building that particularly deals with student activities so that they can pursue their passions along with their studies [2]. The building will help in integrating life skills as desired by the curriculum revisions of the New Education Policy. From an educational building category contest entry viewpoint for Solar Decathlon India, this proposal was a unique concept as participating students got an opportunity to visualize and work out the economics of developing the educational building. The entry was one of the finalist entries in the Solar Decathlon India 2020 contest.

Methods

The conceptualization of the Student Life Centre brings an innovative concept of an educational building that envisages being "Of the students, for the students, and by the students". The Student Life Centre is proposed to be an educational building in the campus of an academic institution with the Government of India, which operates primarily on a non-profit basis. The possibility of inviting Corporate Social Responsibility funds to help student activities may be explored, provided a "backbone" infrastructure is present on campus to encourage investments. An important consideration is that operational expenses are expected to be minimized, and capital -intensity is a concern as the possibility of revenue generation is less as compared to a commercial building. Table 1 provides the salient site characteristics associated with the Student Life Centre. As can be seen, the hours of operation and the site location (e.g., Seismic Zone IV) influenced some of the design decisions, like having a Ground Floor Level and three additional floors. For furthering the analyses, the team used tools like Design Builder (Provided by Solar Decathlon India), Climate Studio (Provided by Solar Decathlon India), AutoCAD, Photoshop, Sketchup, and MS Excel-based programs (e.g. CBE Comfort Tool).

Table 1: Salient design features of the student life centre (proposed)

Climate zone:	Ropar has a tropical, semi-arid, hot, and subtropical monsoon type of climate with cold winter and hot summer
Occupant Profile:	Students involved in various activities like technical, cultural, sports etc.
Site Specifications:	Site has loose alluvial soil. It comes under seismic zone IV.
Hours of Operation:	24*7, Peak Hours: 4 PM - 10 PM daily
Occupancy expected	840
Building purpose:	Build-own-operate building dedicated to student activities

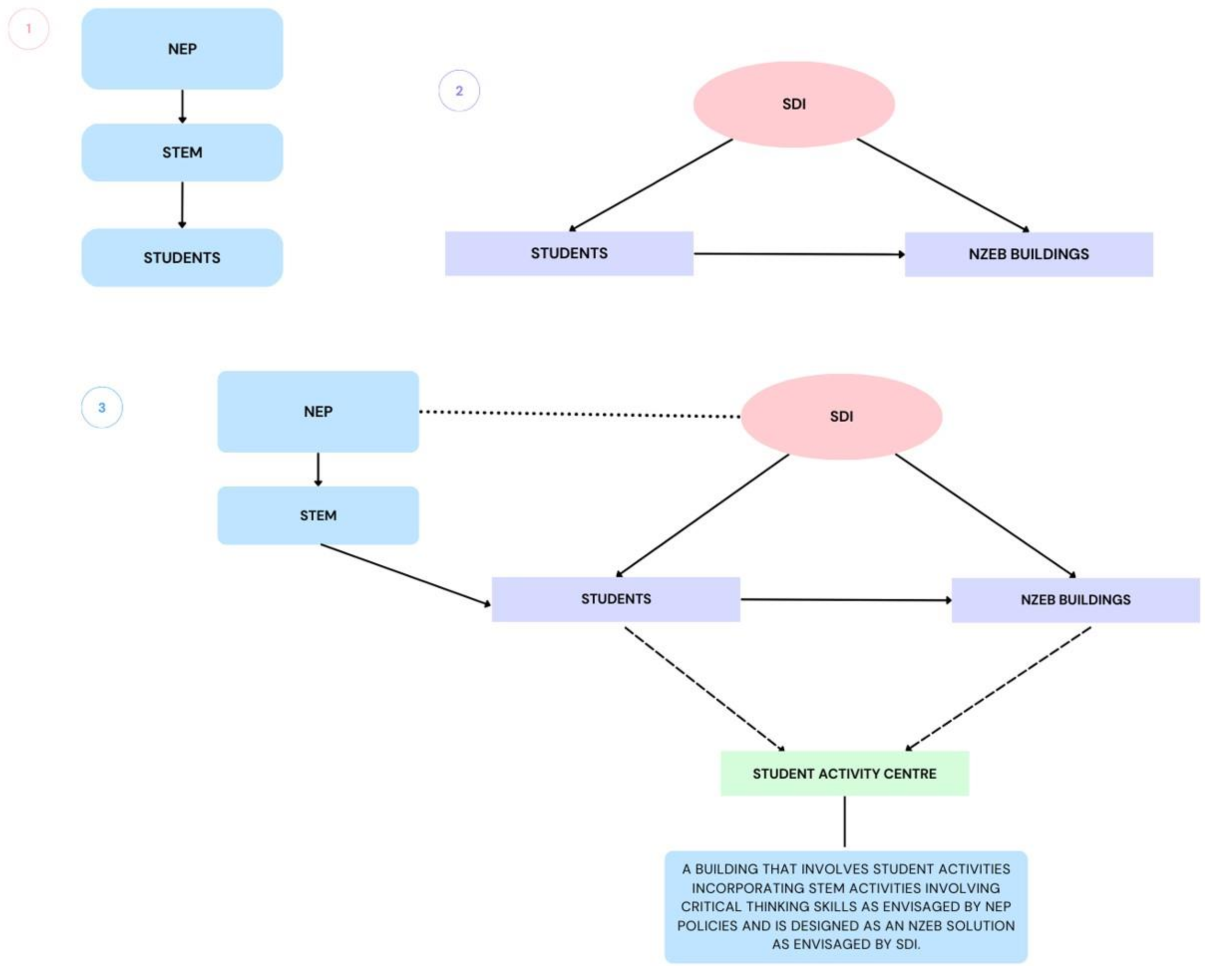

Figure 1: The triumvirate between New Education Policy, Teaching and Learning, and Energy Efficient Buildings

Understanding the triumvirate between New Education Policy, Teaching and Learning, and Energy Efficient Buildings

The triumvirate between New Education Policy, Teaching and Learning, and Energy Efficient Buildings (or NetZero Energy Buildings) may be best understood with the help of Figure 1. The New Education Policy envisaged by the government of India has promoted multidisciplinary education and acknowledgment of Science, Technology, Engineering, and Mathematics (STEM) as one of the core principles. At the other end of the spectrum, the Solar Decathlon India contest has emerged as a connector between enunciating building science principles based on net zero, addressing sustainability, climate change, and energy efficiency, and the student community.

The Student Life (or Activity) Center is one of the important buildings in any institution where students would like to spend most of their time after their classes. The implementation of the New Education Policy shall require the planning of new learning spaces. In the author's opinion, Solar Decathlon India may serve as a remarkable opportunity to inculcate the need for net zero and sustainable buildings by involving students in providing design input to their academic institutions.

Recent literature in andragogy related to sustainability and energy efficiency has acknowledged the role of "learning by doing" in sustainability education [3], the role of developing clean energy communities to promote education [4], and recognizing the need to impart education beyond the formal learning environment [5]. The educational impact of Solar Decathlon competitions in the European editions [6-7], Middle East [8,9], and Latin America [10] has been very well acknowledged in the research literature. The literature also acknowledges the role of participatory design student competitions as a vehicle to foster advances in building science education [11-13]. To the best of the author's knowledge, this conference paper is one of the first to document the potential impact of Solar Decathlon India in providing important input to the New Education Policy envisaged by the Government of India.

Results

The architectural thought process was initiated by a stakeholder survey with students, which revealed that "privacy and individuality" were some of the key considerations that the students may like to experience in a building that aims to bridge the community. On further exploration, it was identified that students appreciate spaces for science and technology that are helped by a less noisy environment and, hence, were provided at the top of the building so that focus and attention may be maximized. The sports area and auditorium were planned on the ground floor so that they are easily accessible without much disturbance. Figure 2 represents the elevation and side views of the Student Life Centre.

The plan of the Student Life Centre in Figure 3 shows the cultural activity areas that were provided in the centre of the building, which acts as the inner atrium and helps in acoustics. The cultural areas are expected to provide a lot of interaction space and are not at the entrance, which is likely to create an atmosphere of anticipation before getting immersed in the event atmosphere. Since the Student Life Centre is expected to be a building that may serve as the heartbeat of the institution by hosting various events and participation from other academic institutions is also expected hence, luggage rooms, an auditorium, and an associated audio-visual room were also provided.

The Student Life Centre on its first floor encompasses a defense art room, badminton court, and common playroom. The second floor has a dedicated space for music and dance, drama and fine arts, and a digital lab. The emphasis on Science, Technology, Engineering, and Mathematics (STEM) activities like aero modelling, robotics, astronomy, and the automotive club were provided on the third floor. The idea was how the experiential learning envisaged by the New Education Policy may be integrated into one dedicated building.

Figure 2: Elevations and side views of student life centre

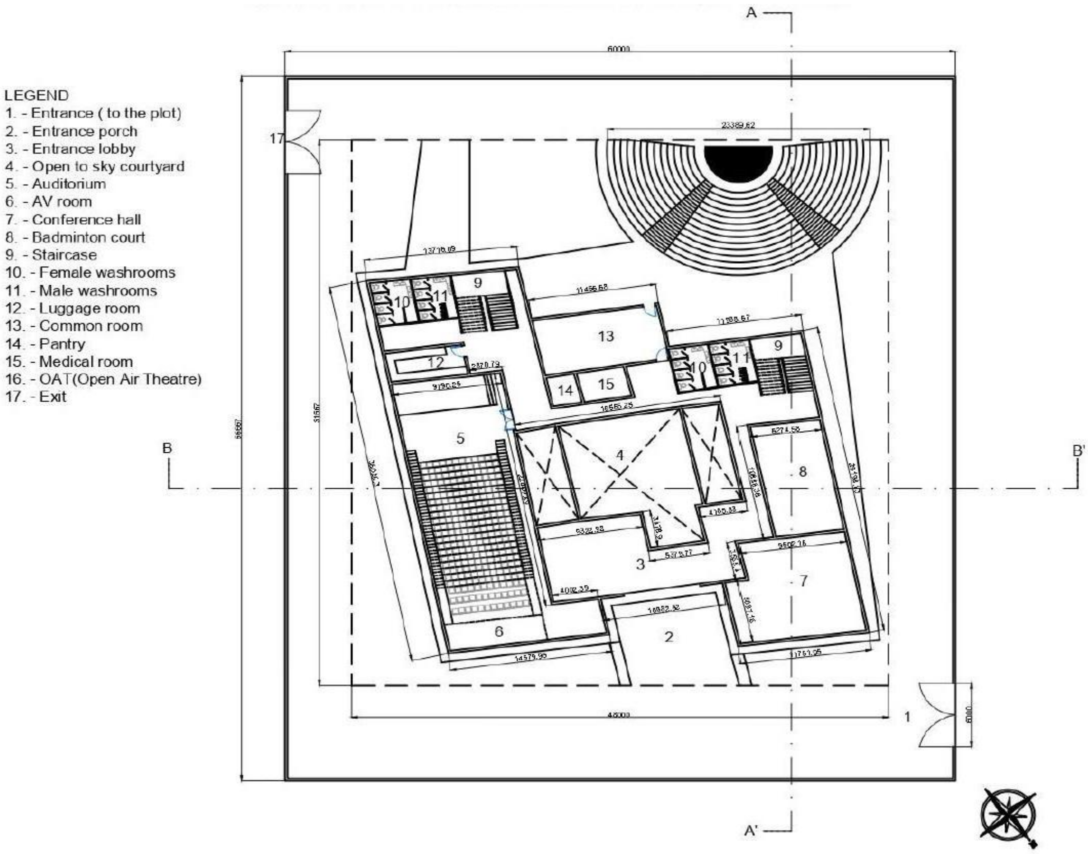

Figure 3: Ground floor of the student life centre

Table 2 provides the salient design features of the Student Life Centre. The opportunity to use energy efficient lightning. Rainwater harvesting based systems promoting renewable solar energy are very strong. If a nation has to showcase novel technologies and promote their use, then in the opinion of authors, all future educational buildings should lead the way in showcasing these concepts. It was calculated that 220 MWh of renewable energy generation potential exists with the envisaged building.

Table 2: Salient design features of the student life centre (proposed)

Built-Up Area	2600 m^2
Lighting (LPD)	2.7 watts per square foot(building)
Electrical (EPD)	1.38 watts per square foot
Water systems	Annual Consumption- 17,28,536.2 L Annual Greywater Treatment- 6,09,938.9 L Annual Blackwater Treatment- 3,25,300.8 L Annual Rooftop Rainwater Harvesting- 5,75,503.0 L Annual Hardscape Rainwater harvesting- 15,01,567.2 L Underground Tank Capacity (with partitions)- 9,589 L (rooftop rainwater) + 25,019.1 L (hardscape rainwater) + 4275 L (municipal water) Overhead Tank Capacity (with partitions)- 9,589 L (rooftop rainwater) + 27,523.9 L (recycled greywater + hardscape rainwater) + 4275 L (municipal water) Surface Area of Root Zone Bed- 79.5 m^2
HVAC	System type - air cooled VRF CoP - 3.5 EER - 12 Star-rating - 5
Renewable energy (system type, generation capacity)	Solar panel system of capacity 165 kW is installed, with 450 pvs and each p.v of 350 W, mix of roof and ground mounted. Annual Generation: 220 MWh

Discussion

The analysis of energy consumption of the Student Life Center is shown in Figure 4 which reveals important engineering possibilities. As identified in the detailed analysis in the report, the overall energy consumption could be significantly reduced by changing from Single glazed, 30% WWR, wooden frame with no local shading to Double glazing, 15% WWR with UPVC frame along with overhang changed from 693 MWh to 541.96 MWh, i.e, a drop of 22%. Other considerations include looking into roof-top insulation with a U-value of 0.175 and external wall insulation with a U-value of 0.27, which further leads to a reduction in the consumption to 324 MWh, i.e., a further drop of 30%. Adoption of mixed mode ventilation and further attached radiator surface in the ceiling along with VAV water-cooled chiller may facilitate reduction of energy consumption by 13 MWh. However, adopting air-cooled VRF systems led to a potential reduction from 324 MWh to 193 MWh, i.e., a drop of 40.4%. The adoption of an air-cooled VRF system as an HVAC Solution for the three buildings with cooling capacities 85 kW, 31 kW, and 154 kW, with maximum terminal side airflow rates of 1.34m^3/s, 0.62 m^3/s and 1.34 m^3/s respectively may be considered in the design.

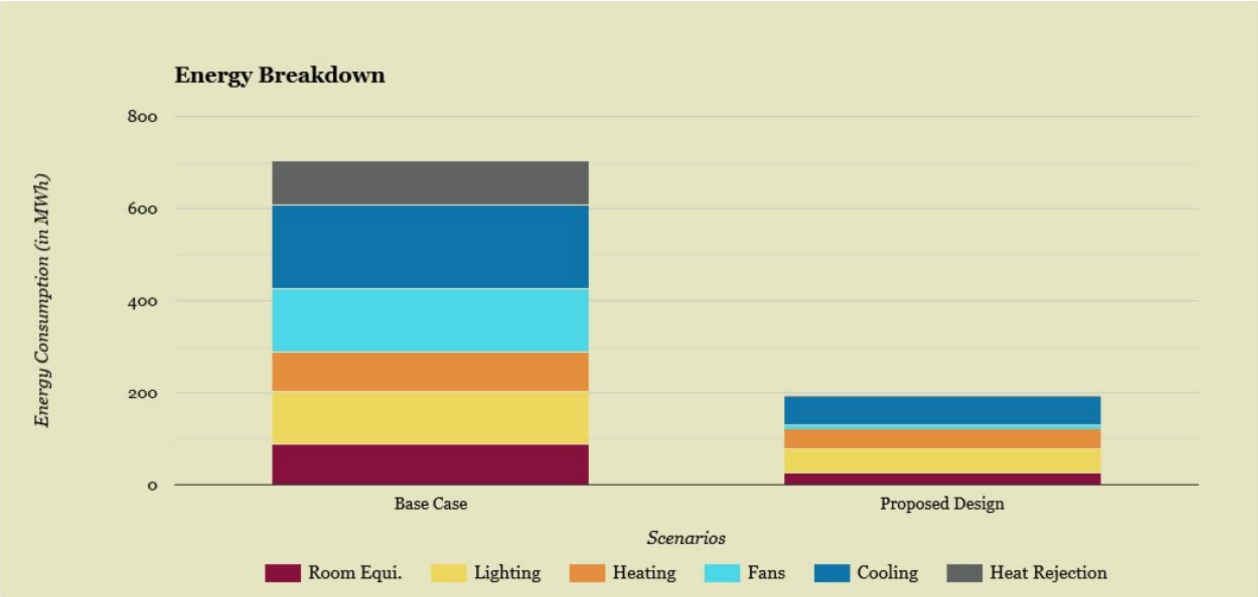

Figure 4: Estimation of energy consumption in the student life centre

Table 3 highlights the role in the reduction of energy in cooling, use of fans, lighting, and the significant savings that can be achieved through building energy efficiency measures in the Student Life Centre. The Lighting simulations on Design-Builder software revealed that for the base case scenario, lighting consumption was on the very high side (112.83 MWh). With the reduction of power required for lighting, the obvious choice was to go with LED lighting fixtures, as LEDs are far more efficient and have a higher luminescence-to-power ratio than traditional lighting fixtures (A luminous efficacy of 150 lm/W for LED vs. 35 lm/W) and may have a significant impact.

Table 3: Energy end use breakdown for base case and proposed case

Demand	Base Case Scenario (Energy in MWh)	Proposed Energy Efficient Case (Energy in MWh)
Room Equipment	89	27
Lighting	113	51
Heating	86	43
Fans	139	10
Cooling	181	62
Heat Rejection	95	0

Figure 5 gives the analysis of water consumption in the Student Life Centre. The calculations were performed by assuming the same amount of rainfall and taking into account. Annually, 575503 L of rainwater can be harvested from the building roof and used for potable needs. A decision was made to reduce the irrigation area, which resulted in more space for walkways and other hardscape areas. The water falling on these surfaces will be carried to treatment systems installed to make them fit for non-potable uses instead of being disposed of. This results in the collection of an additional 1501567 L annually. Although the total harvested rainwater (2077070.3 L) is greater than our total consumption of 1728536L, thereby resulting in a net positive water performance, there is a deficit of potable water. Hence, 465459L of municipal water (an offsite resource) is needed. Thus, it is evident that the use of efficient systems and rainwater harvesting has heavily reduced our dependence on offsite resources (a reduction of 81.27%). Furthermore, the utility of having greywater and blackwater treatment systems may easily be witnessed in Figure 6, which shows the flow of water to and from tanks and different use locations. The junction number and annual use/capacity have been mentioned for each location and system as an illustration.

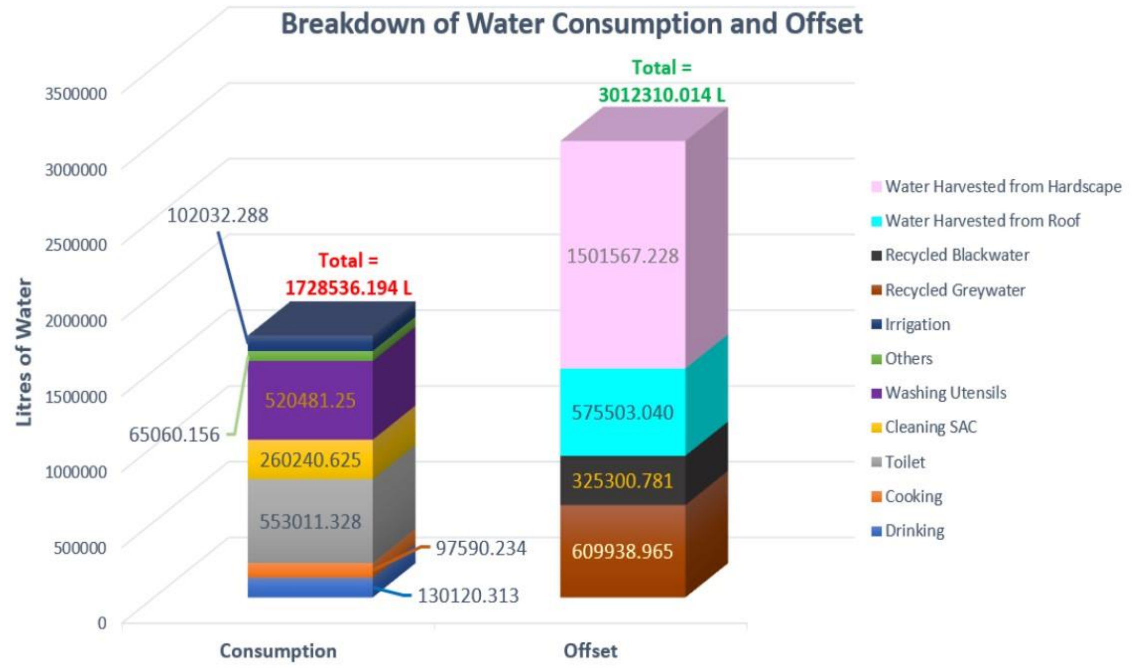

Figure 5: Estimation of water consumption in student life centre

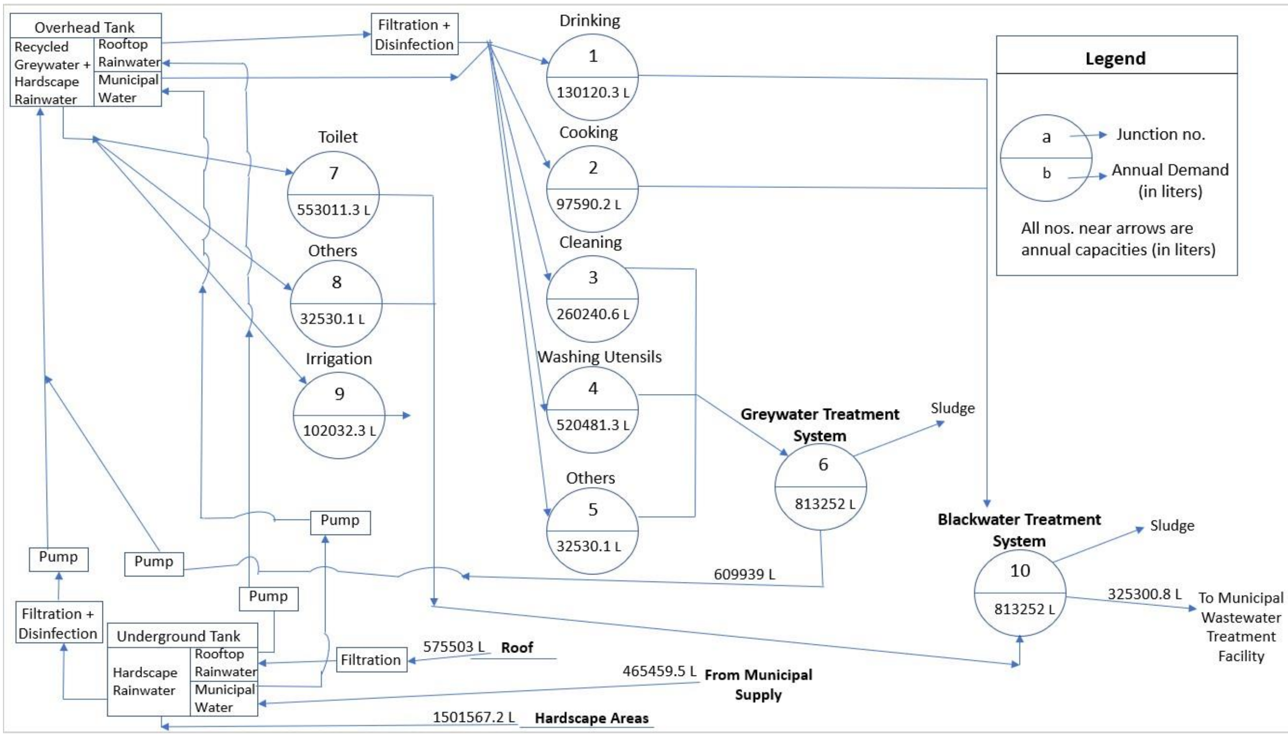

Figure 6: Water flow diagram in student life centre

Other innovations that can be considered in campuses include grid-based PV installations, the use of aerators, piezoelectric flooring, and the conversion of plastic waste into bituminous material for the construction of roads. If students are able to explore the various facets of life at a campus like the Indian Institute of Technology Ropar, which is in a semi-urban area, then this concept can be adopted nationwide and help in generating revenue. One of the ideas that we would like to work on in further development is that sections of the building be sponsored through Corporate Social Responsibility (CSR) funds. A notable effort is MPower to promote mental health and well-being in the most holistic manner conceivable, which was founded by Ms. Neerja Birla [14]. As funding for higher education is getting reduced globally, and economic hardships have been severe on millennial and Generation Z students (e.g., the 2008 Crisis, Corona Economic Slowdown), concepts of integrating energy and water efficiency, low operation cost, modern architecture, and student life are essential. An important aspect is that if education becomes a symbol of energy efficiency, then it can impact the economic outcomes of an educational institution significantly as money can be diverted into research and development and improving academic infrastructure.

Conclusions

Through a Solar Decathlon India design competition entry, it has been demonstrated how academic institutions may be able to leverage new building concepts involving energy efficiency, incorporation of renewable energy, and water conservation measures into future planning. As educational institutions work eagerly to explore their transition to multidisciplinary institutions, leveraging “Promotion of Indian Languages, Arts, and Culture”, and identifying avenues for mechanisms and opportunities for enabling clubs and activities organized by students as some of the goals, the need for a building like the “Student Life Centre” exists.

From an academic point of view, the analysis in this paper clearly presents the case of the need for careful planning of an academic community of students. Prestigious Universities like Harvard [15] have leveraged the services of reputed firms like Hopkins Architects, Bruner/Cott Architects (Cambridge, MA) Arup, Faithful+Gould, Simpson Gumpertz & Heger, and Michael Van Valkenburgh Associates on their Smith Campus Center project. Stanford University is currently undergoing a consultative process involving the design of its Town Center, whose elements shall discover the depth and range of endeavor across the university through direct, spontaneous exposure of the institution’s intellectual diversity, and is engaging LMN Architects as a partner [16]. Another fascinating academic building concept is EPFL’s Rolex Learning Center, which has novel architectural elements with gentle slopes and terraces undulating around a series of internal ‘patios’, with almost invisible supports for its complex curving roof, which has required innovative methods of construction. The building is known as Forum Rolex, wherein the conference and event venue has a seating capacity of 600, arranged around a collapsible circular stage of 70 m^2 [17].

In light of important developments across prestigious academic institutions, it is high time that new policies in education should be synergized with leveraging equivalent advancements in energy efficiency, water conservation, and renewable energy. The Solar Decathlon India contest is a great avenue to ideate the buildings of the future through students under the guidance of experienced mentors and drive a conversation that has the potential to significantly transform Indian Academia by reducing operation costs and promoting a living and demonstrable example of sustainability and energy efficiency.

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