SusHumBuild

Sustainable Human to Building Behavioural Interaction: Awareness Development Roadmap and Training Programme

Dr. Hesham Safwat

ASHRAE

The BRITISH UNIVERSITY IN EGYPT

OUTLINE

- Welcome
- Building anatomy
- Literature and background
- Project importance
- Results
- Recommendations

PROBLEM DEFINITION & STATE OF ART

IN LINE WITH THE URGENT DEMAND FOR ENSURING SUSTAINABLE DEVELOPMENT AND ABIDING SUSTAINABILITY REQUIREMENTS, ENERGY ANALYSIS OF BUILDINGS HAS BECOME A GLOBAL INTERESTING AND ATTRACTIVE APPLICATION FOR GOVERNMENTS, ENERGYRELATED BUSINESSES AND EVEN CONSUMERS, SINCE THE BUILDING INDUSTRY IS RESPONSIBLE FOR 20–40% OF WORLDWIDE ENERGY USE.

LITERATURE AND BACKGROUND

Contents list available at IJRED website

Int. Journal of Renewable Energy Development (IJRED)

Journal homepage: https://ijred.undip.ac.id

Research Article

Investigating the Environmental and the Energy Saving Behavior among School Principals through Classification Algorithms

Stamatios Ntanos[a], Grigorios L. Kyriakopoulos[b,*], Theodoros Anagnostopoulos[c], Theodoros Xanthopoulos[c], Christos Kytagias[c], Dimitrios Drosos[a]

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Education is the second-largest consumer of energy in the service sector. School buildings are significant points of energy consumption. In the European Union (EU) context, buildings alone are responsible for 40% of total energy consumption, 60% of electricity consumption and 36% of greenhouse gas emissions. While new buildings generally require less than 3-5 lt/m^2/year of heating oil, older buildings require an average of 25 lt/year. Some energy-intensive buildings require even 60 litres/m^2/year. 35% of EU buildings are over 50 years old (Doukas *et al.*, 2017). Similarly, in the United States, the ASHRAE's Building Energy Quotient (bEQ) program is an eco-

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This paper focuses on the role of the school unit principal as a decision-maker concerning energy-saving action by exploring the environmental perceptions and energy-saving behaviour and unveiling what motivates the application of energy upgrading and the positive environmental perceptions.

More specifically, the objective of this research is to locate the most important predictive variables that are associated with each of the five following statements:

- The importance of providing RES oriented education in schools.
- The teachers' role towards energy saving at the school environment.
- The students' role towards energy saving at the school environment.
- The teachers' role in raising awareness on RES.
- The use of energy upgrading and energy-saving actions at school.

LITERATURE AND BACKGROUND

Improving energy efficiency in buildings is one of the top priorities worldwide. However, little research has focused on linking education policies and energy demand. Therefore, in exploring the role of energy policies in education, researchers need to determine those factors that drive energy policies. To this end, various measures are available, and the decision-maker faces a multi-objective decision problem that must be offset by deciding about energy, finance, and other factors to make a good choice. (Diakaki *et al.*, 2013).

School buildings are significant to society since these represent a significant part of the building stock, and the number of children attending schools is immense. There are more than 100 million in Europe. However, in the design of school buildings, obtaining the proper environment is often not considered a priority. Existing school buildings are often lacking systems that optimize energy consumption. In recent decades, several educational buildings have been built with respect for environmental protection and rational energy use (Zeiler and Boxem, 2013).

LITERATURE AND BACKGROUND

Renewable and Sustainable Energy Reviews 40 (2014) 911–922

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

ELSEVIER

Energy consumption in schools – A review paper

CrossMark

Luísa Dias Pereira [a,*], Daniela Raimondo [b], Stefano Paolo Corgnati [b], Manuel Gameiro da Silva [a]

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Most of the times, the available data on buildings' energy consumption corresponds to the type of (primary) energy delivered to the building. Ideally, the total amount of energy consumption in buildings should be disaggregated by the final energy end-use (consumptions). Disaggregating energy data helps knowing where most energy is used. In the USA, "for schools in general, lighting, ventilation, heating, and cooling account for 80% of energy consumption"; Fig. 1, based on data available at [51], illustrates this scenario. The importance of this theme is later developed in Section 5.

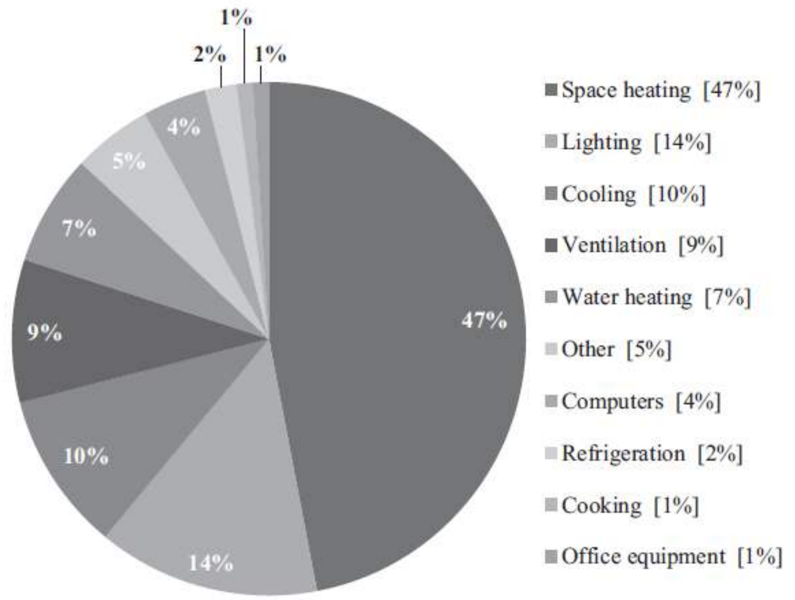

Fig. 1. Average energy use profile of schools in the USA.

LITERATURE AND BACKGROUND

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Energy consumption in schools – A review paper

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Among all public buildings, on account of their educational purpose, school buildings have a major social responsibility. Therefore energy performance in this type of building is of great importance, together with suitable levels of Indoor Environmental Quality (IEQ). Following the Energy Performance of Buildings Directive, at a European level, the MS propose different Energy Performance Certificates (EPC) exhibiting different information at distinct scales, namely continuous and stepped. A similar process has been taking place in the US and in Canada.

According to [15], circa 30% of the European MS "have experience with measured energy used for national/regional energy performance evaluation". On the other hand, most of EPC procedures are based on simulation/calculation methods and not necessarily on operational rating (OR). This means that no direct relation can be established between buildings' energy labeling and benchmarking. This idea was first defended by the authors in [16].

EPCs in public buildings, particularly in schools, could drive into energy benchmark hypothesis (for heating and electricity needs), based upon reference building types, driven, on their turn, from average/typical consumption values or good practice [17].

Through benchmarking, school facility managers can compare their school to how much energy a typical elementary, middle and high school in a specific geographic region should consume, assuming the same target Indoor Climate Conditions (ICC). Throughout benchmarking, substantial energy cost savings could be generated while improving the ICC of school facilities. In resume, it is a fundamental method to be implemented.

The information about the different sources that were considered for the literature review is summarized in Table 1.

LITERATURE AND BACKGROUND

SCHOOL *of* GRADUATE STUDIES
EAST TENNESSEE STATE UNIVERSITY

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Electronic Theses and Dissertations — Student Works

5-2016

Use of Drone and Infrared Camera for a Campus Building Envelope Study

Raheem Taiwo Ariwoola
East Tennessee State Universtiy

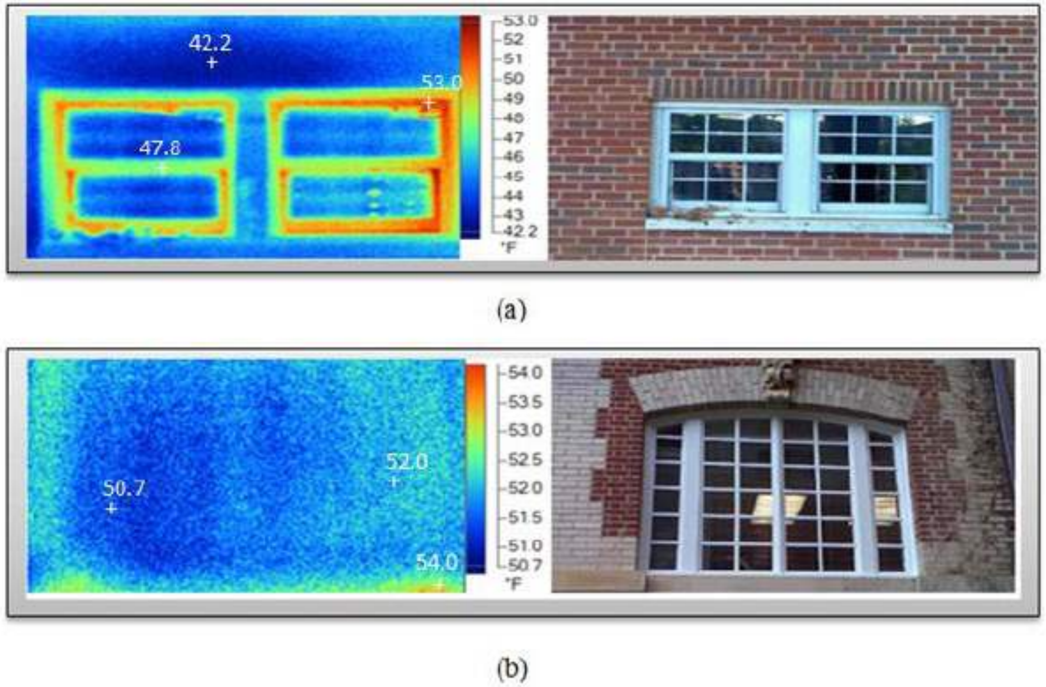

Figure 11 (a & b). Samples of Thermal and Visible Light Images of a Window in Building 1 and 3

The window shown in Figure 11a, displays insulation defects around the frames, however, Figure 11b shows a sample of a window that has a very good resistance to heat transfer. Major defects common to doors are exfiltration through openings, edges or perforated holes on door surfaces as can be seen in Figure 12a, 12b, and 12c. More thermal and visible light images showing window defects are given in appendix B while other samples of door defects and exfiltration are illustrated in appendix C.

LITERATURE AND BACKGROUND

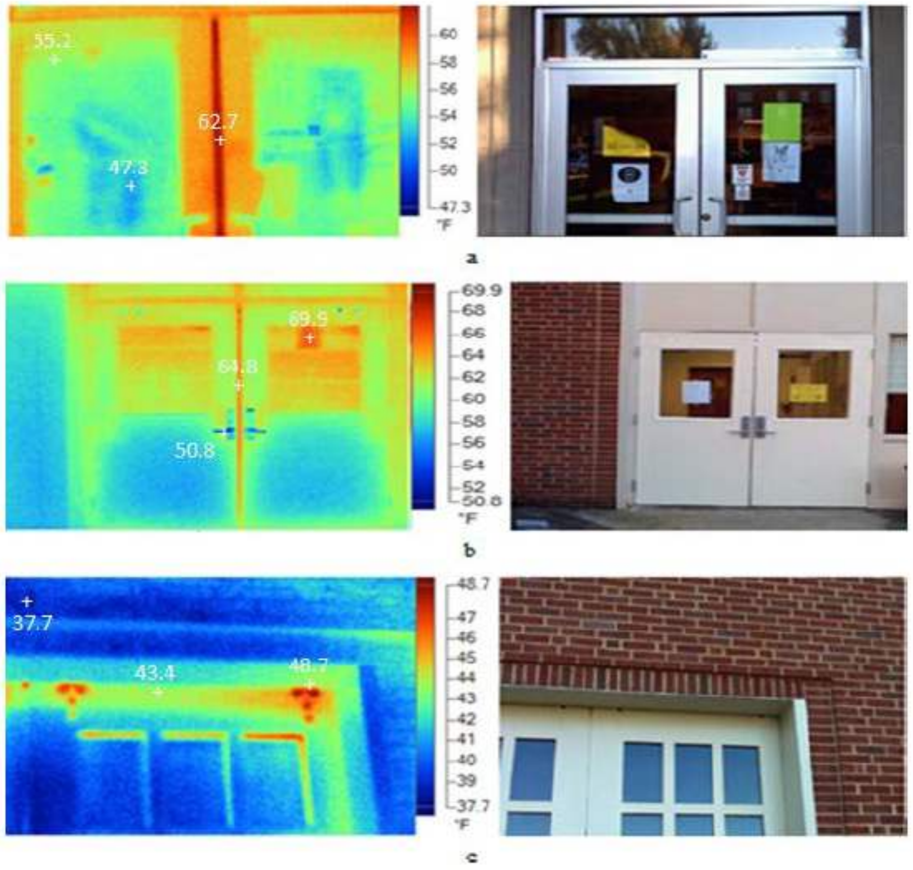

Figure 12 (a, b, and c). Thermal and Visible Light Images showing Exfiltration the Doors

Other defects noticed in the building elements are air leaks due to cracks in walls, moisture detection, thermal bridges and improper insulations. Figure 13a shows gradual amount of heat loss through the wall of building 1 due to cracks in the wall.

5-2016

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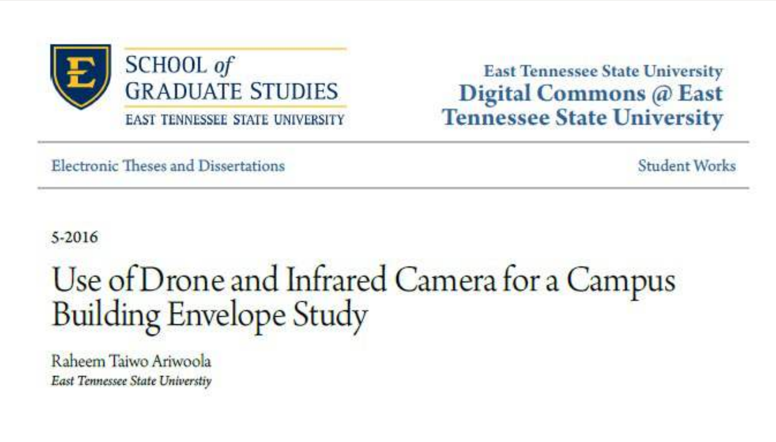
East Tennessee State Universtiy

LITERATURE AND BACKGROUND



SCHOOL *of* GRADUATE STUDIES
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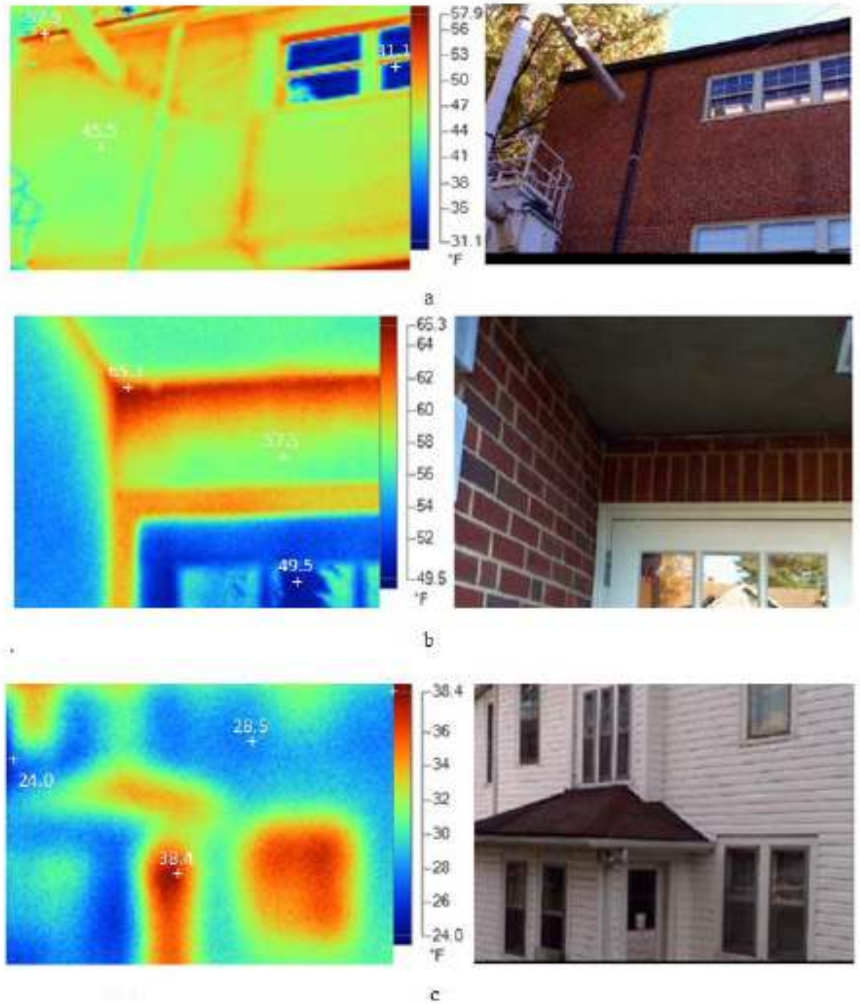
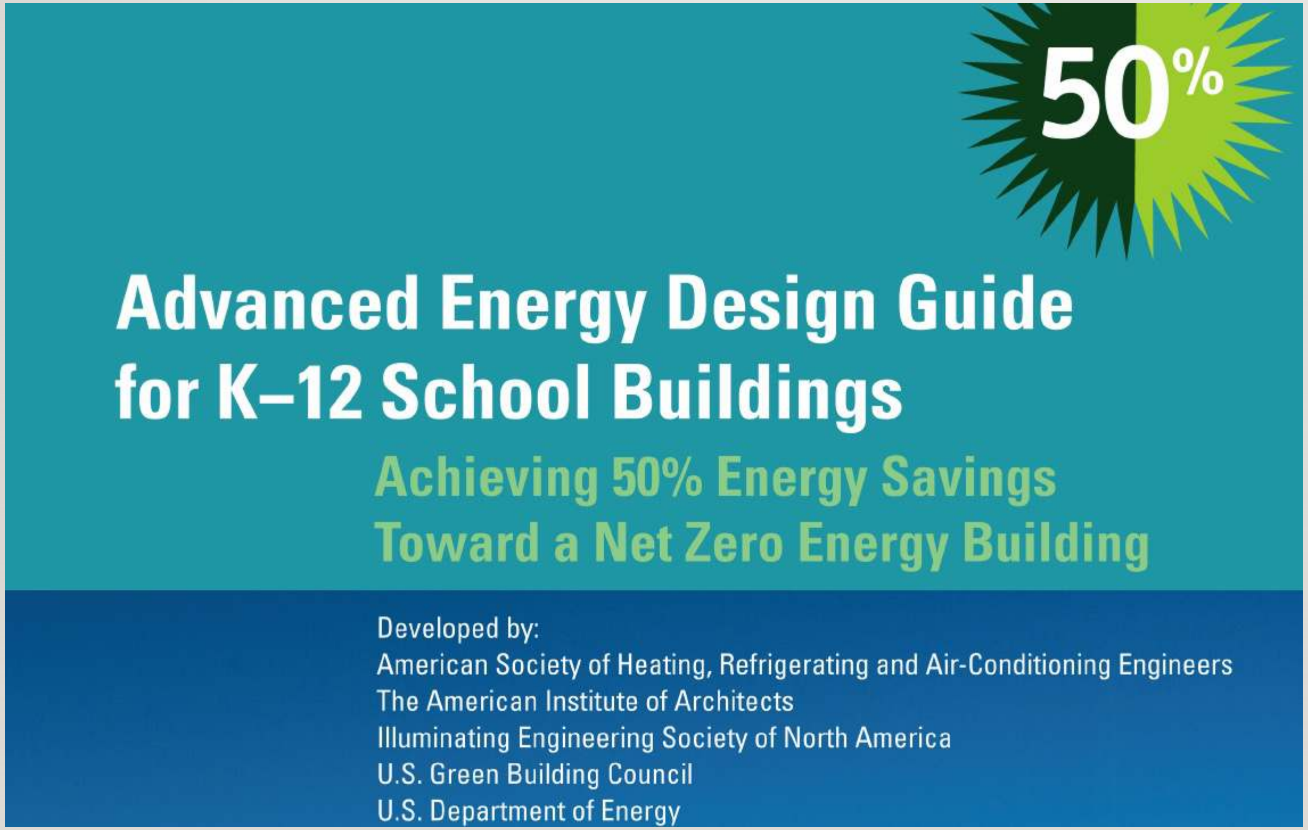


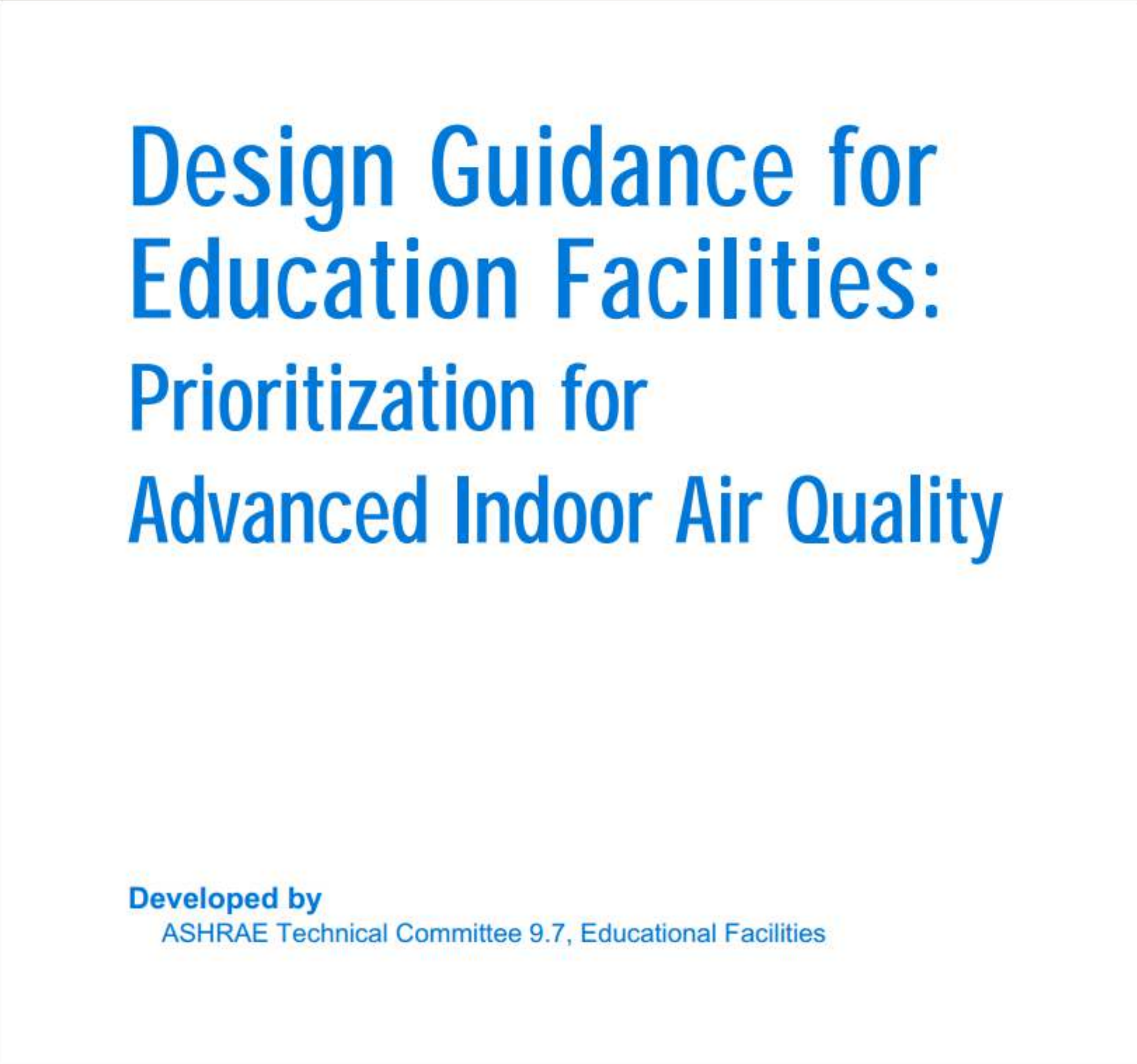
Figure13 (a, b, and c). Thermal and Visible Light Images Showing Heat Loss Due to Wall Cracks and Thermal Bridges

Other samples of wall defects, thermal bridges and moisture defects are given in appendix D.

LITERATURE AND BACKGROUND



LITERATURE AND BACKGROUND

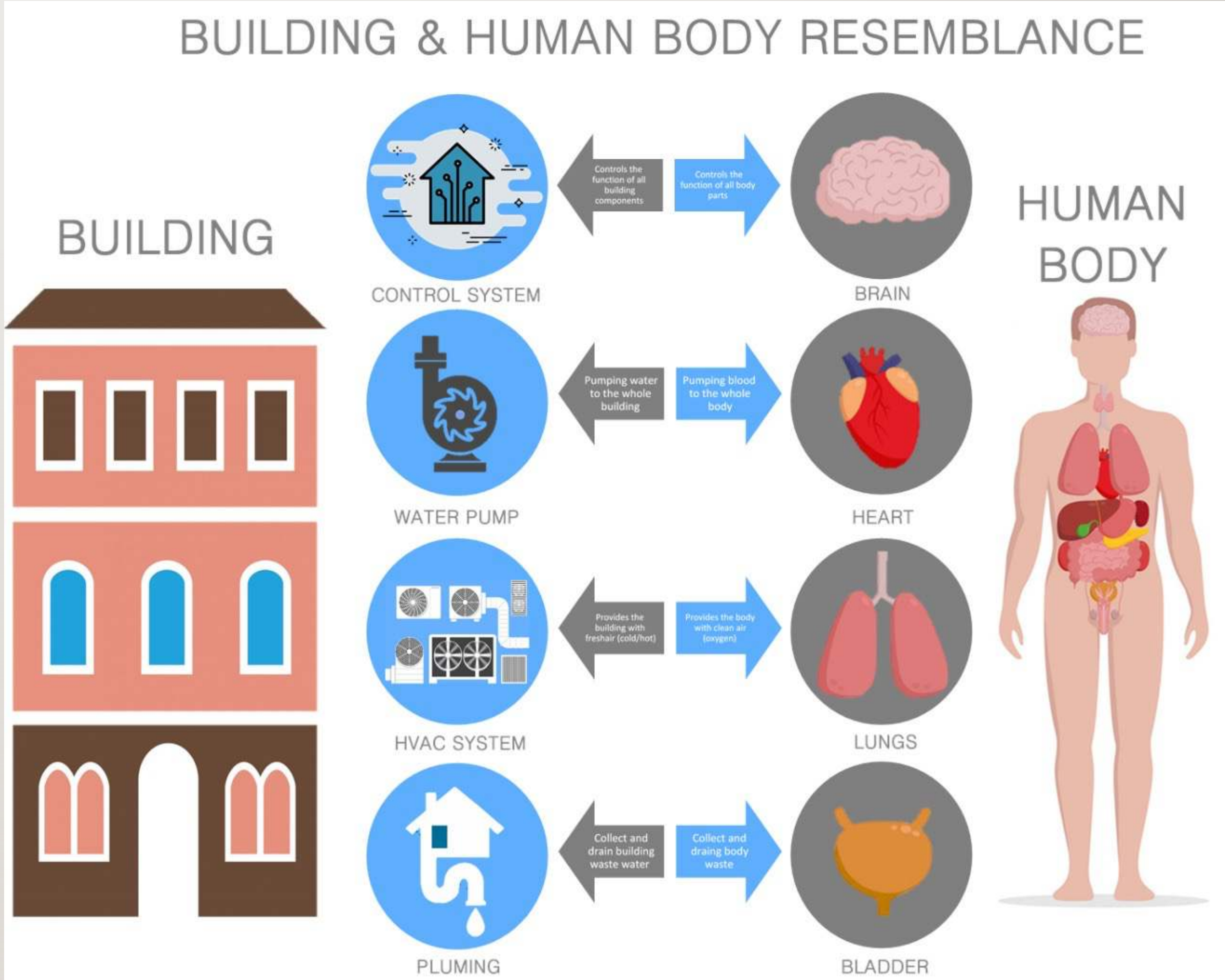


Design Guidance for Education Facilities:
Prioritization for Advanced Indoor Air Quality

Developed by
ASHRAE Technical Committee 9.7, Educational Facilities

LITERATURE AND BACKGROUND

BUILDING ANATOMY



PROJECT IMPORTANCE

Human-Building Relation

Energy & Buildings

Environment & Energy prices

Sharing Expertise

PROJECT IMPORTANCE

I NEED

I WANT

Human-Building Relation

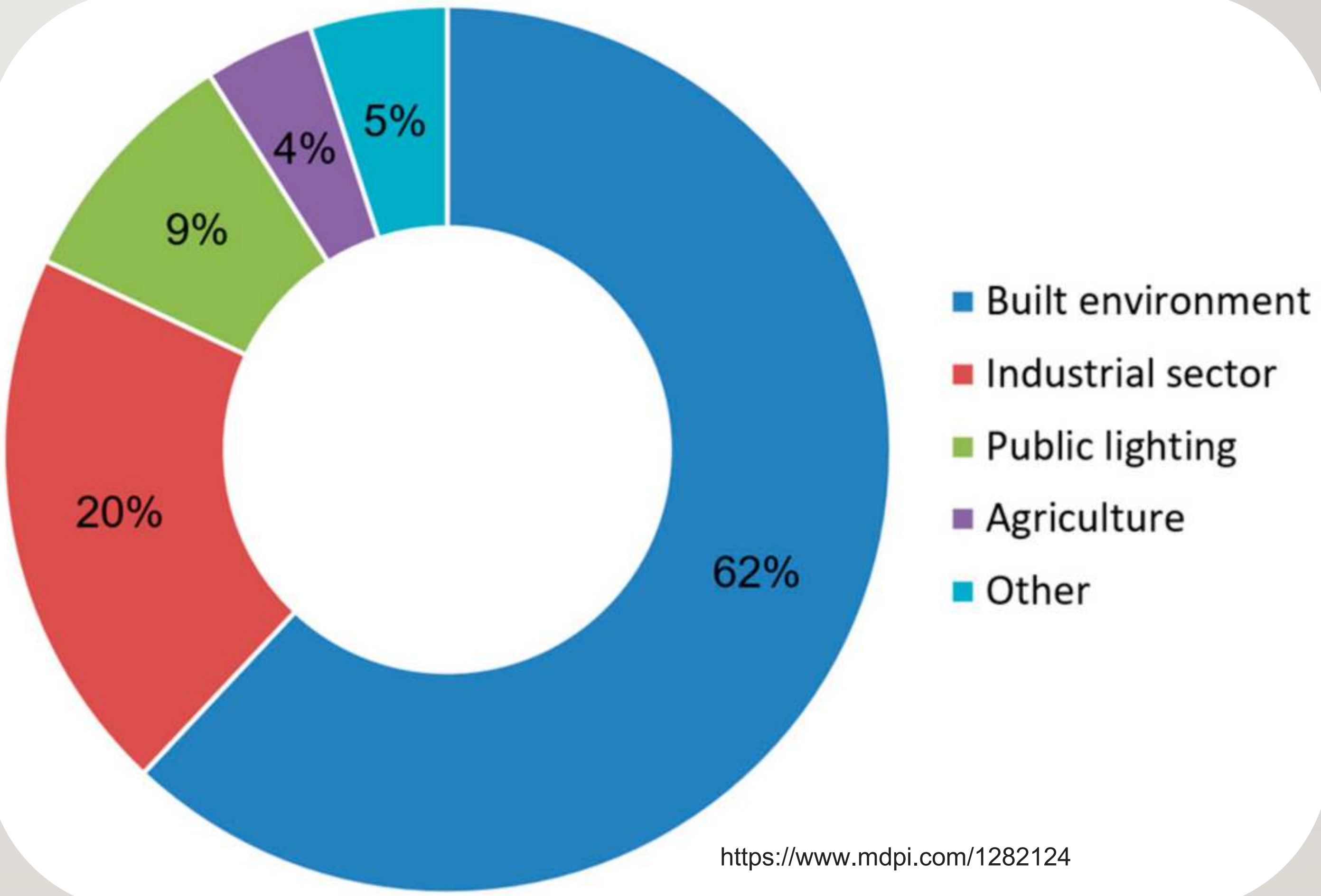
Environment & Energy prices

Sharing Expertise

Energy & Buildings

PROJECT IMPORTANCE

Energy & Buildings



https://www.mdpi.com/1282124

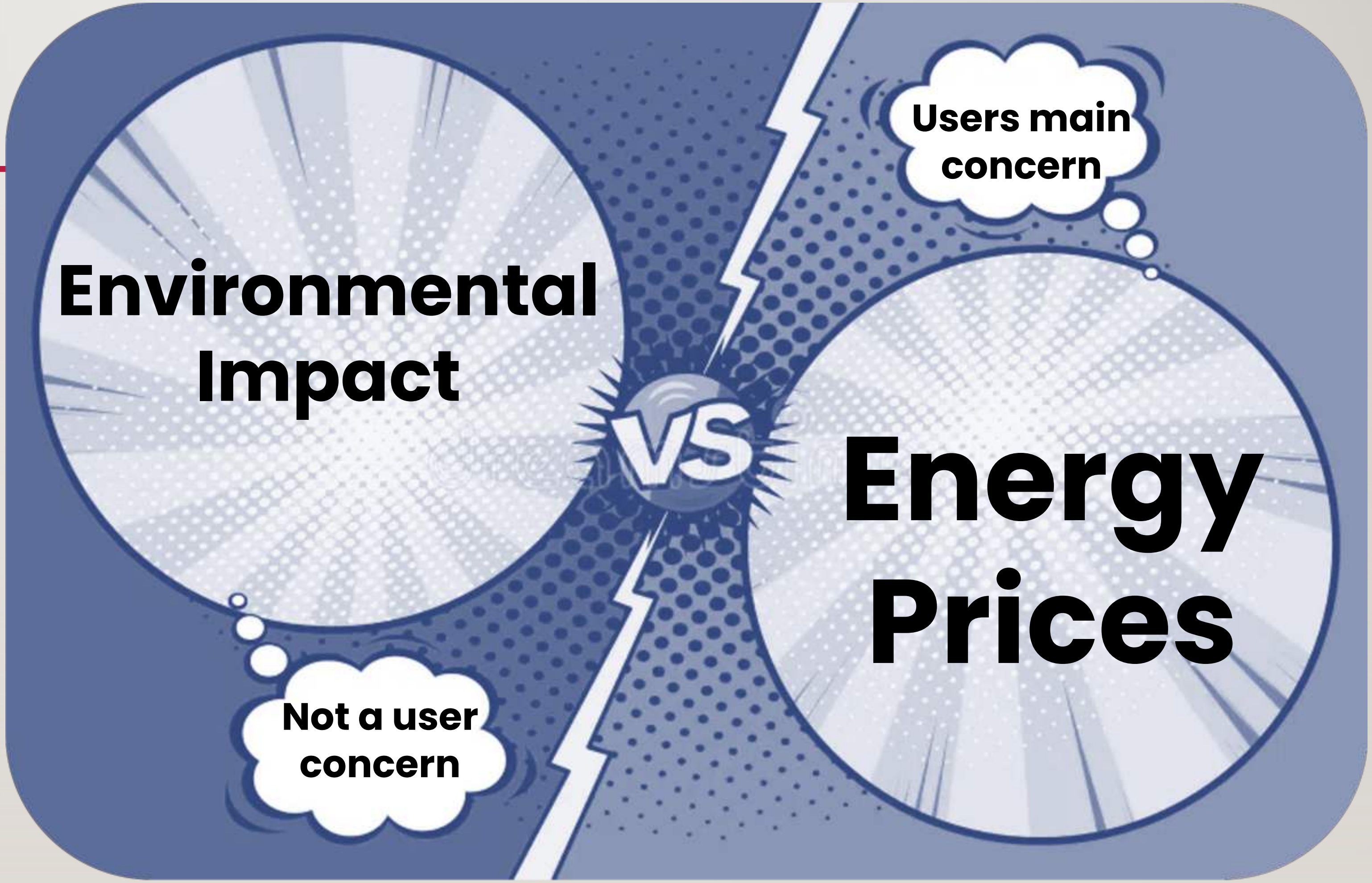
Environment & Energy prices

Sharing Expertise

Human-Building Relation

PROJECT IMPORTANCE

Environment & Energy prices



Energy & Buildings

Sharing Expertise

Human-Building Relation

PROJECT IMPORTANCE

Sharing Expertise

Energy & Buildings

Environment & Energy prices

Human-Building Relation

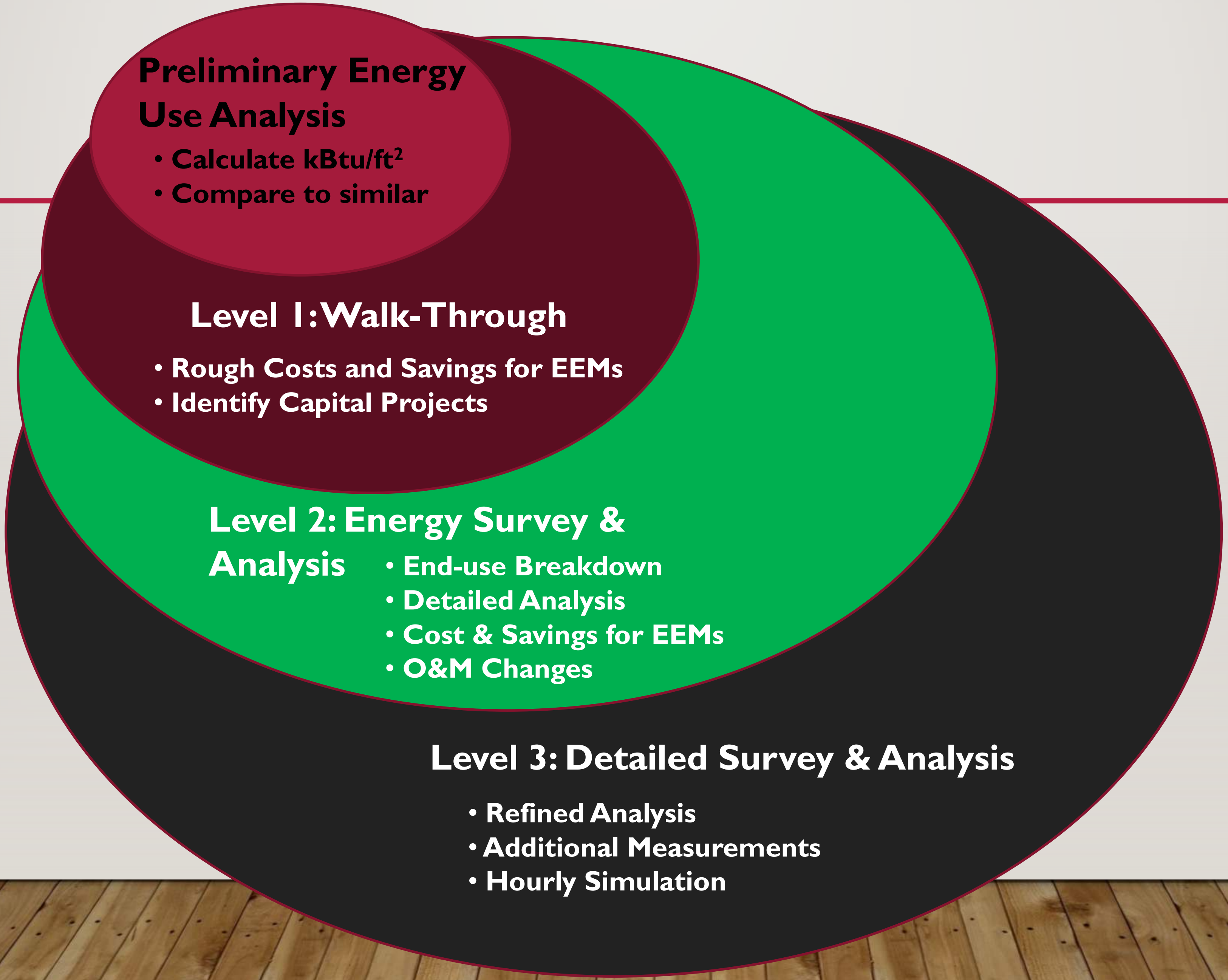
OBJECTIVES

1. To identify the challenges for implementing a sustainable energy-efficient culture in educational buildings in Egypt.
2. Increase the awareness to invest in energy-saving measures and their knowledge about the return on investment (ROI) and overshadow the long-term benefits of reduced energy consumption.
3. Introduce the integration of smart technologies for energy management to be widespread across all educational buildings.
4. Investigate the current UK's significant strides in sustainable energy practices in energy-saving awareness within its building sector for achieving greater efficiency and reducing environmental impact.
5. Disseminate the findings through a workshop in Cairo, Egypt.

METHODOLOGY

RELIABLE ENERGY ANALYSIS OF BUILDINGS RELIES HEAVILY ON **HIGH-QUALITY DATA** LEADING TO PROPER INDICATORS. PREVIOUS STUDIES HAVE HIGHLIGHTED THE IMPORTANCE OF DATA QUALITY IN ANALYZING ENERGY USAGE IN RESIDENTIAL AND NON-RESIDENTIAL BUILDINGS IN ORDER TO TRANSFORM DECLARATIONS TO ACTIONS, OPTIMISE ENERGY EFFICIENCY POLICIES AND MONITOR PROGRESS AND FAILURES IN COUNTRIES.

HOW?


Preliminary Energy Use Analysis
• Calculate kBtu/ft²
• Compare to similar
Level 1: Walk-Through
• Rough Costs and Savings for EEMs
• Identify Capital Projects
Level 2: Energy Survey & Analysis
• End-use Breakdown
• Detailed Analysis
• Cost & Savings for EEMs
• O&M Changes
Level 3: Detailed Survey & Analysis
• Refined Analysis
• Additional Measurements
• Hourly Simulation

THE STEP-BY-STEP PROCEDURE FOR ENERGY ANALYSIS OF THE STUDIED EDUCATIONAL BUILDINGS IS AS FOLLOWS:

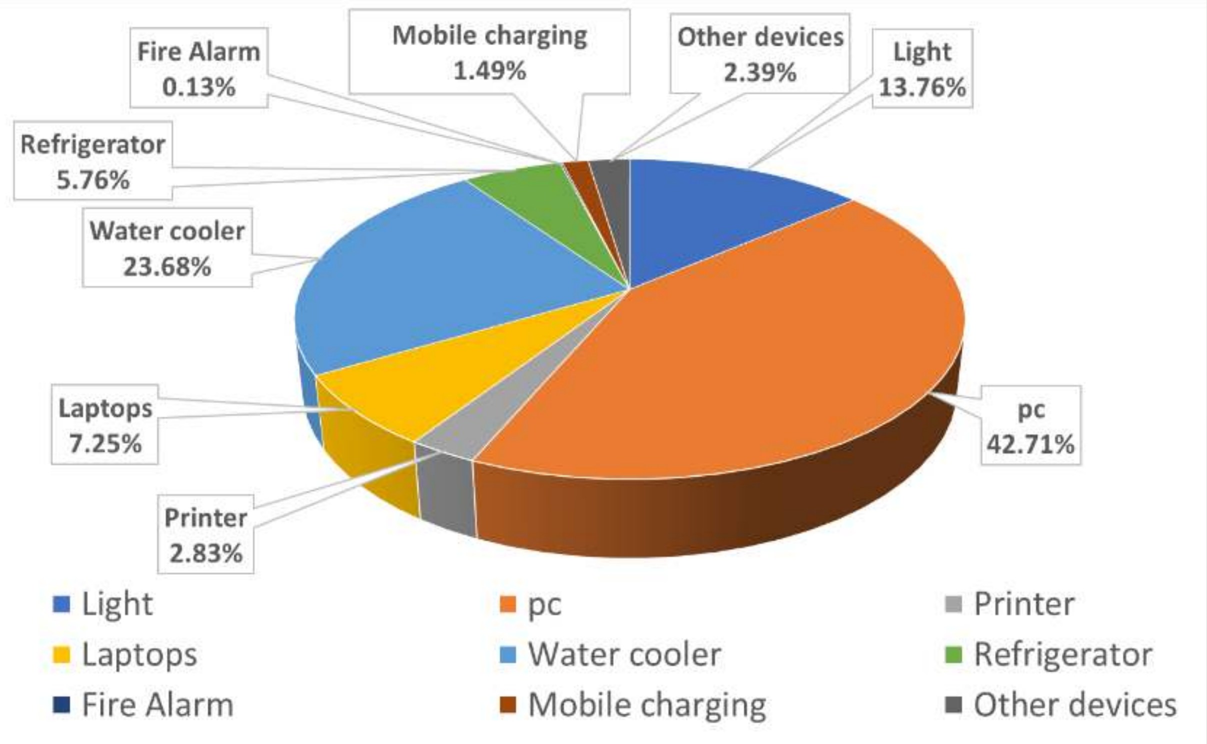
- (1) Choosing the targeted building in each university.
- (2) Recording all energy consuming resources in the building/per floor and per room. Followed by a full assembly of information on energy use in the building.
- (3) Performing a thorough analysis based on the amount of energy used per person and per square meter.
- (4) Comparison based on each space energy use intensity indication.
- (5) Introducing a simulation/modeling analysis to enrich the results from the data collection.
- (6) Comparing energy consumption of the chosen buildings with buildings from other countries as published in the literature.
- (7) Validating the analysis by physical measurements using suitable tools.
- (8) Comparing energy consumption of the chosen buildings with ASHRAE energy model calibration guideline or ISO 13,790 (currently being updated to ISO 50,016).
- (9) Proposing suitable solutions to reduce energy consumption in spaces with high energy indices.

FUTURE IMPACT & MEASURES OF SUCCESS:

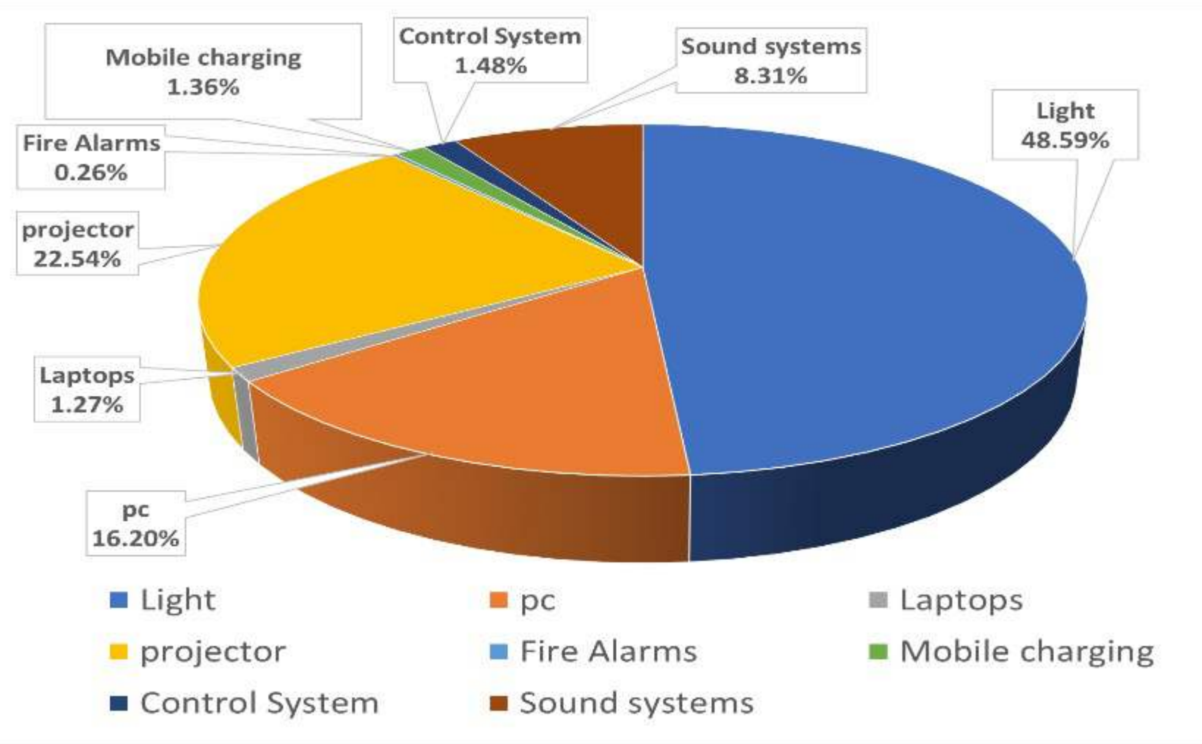
- Establish a knowledge nexus that delivers benefits and guidelines to end users and operators of energy systems.
- Training, workshops and joint collaborations between the LSBU and BUE.
  - Aiming to train approximately 20 participants for each workshop which will be held both in the UK and Egypt. Target groups are undergraduate students, postgraduate taught students, early career researchers, academics, architects, engineers and other industry partners.
  - These workshop series will be laid to develop short courses within these themes as follows: (i) energy performance, (ii) sustainability indicators, and (iii) net-zero energy design principles.
  - Evidence-based guides to support the operation of Egyptian higher education buildings.
- New research collaborations among EGYPT ASHRAE & MEDITERRANEAN CHAPTERS based on the expertise of researchers within the two institutes around Net Zero and energy efficiency, respectively.

RESULTS

ELECTRICAL CONSUMPTION DATA ANALYSIS



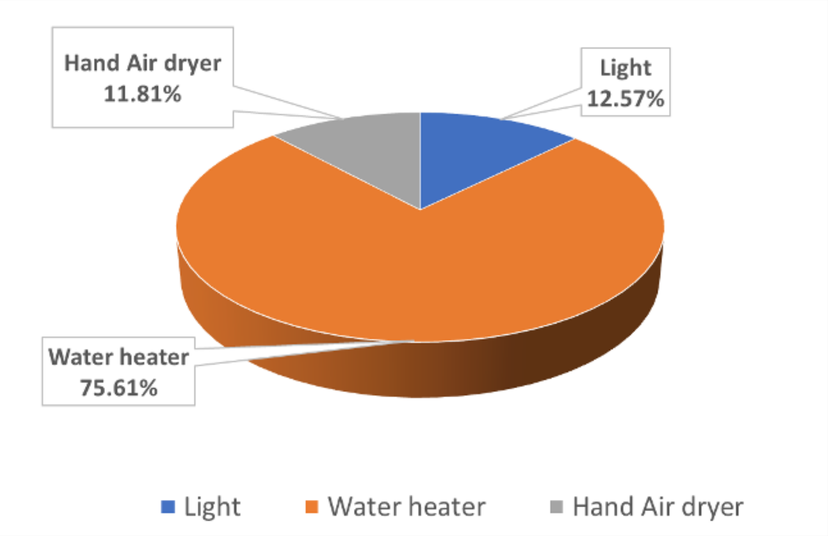
STAFF OFFICES

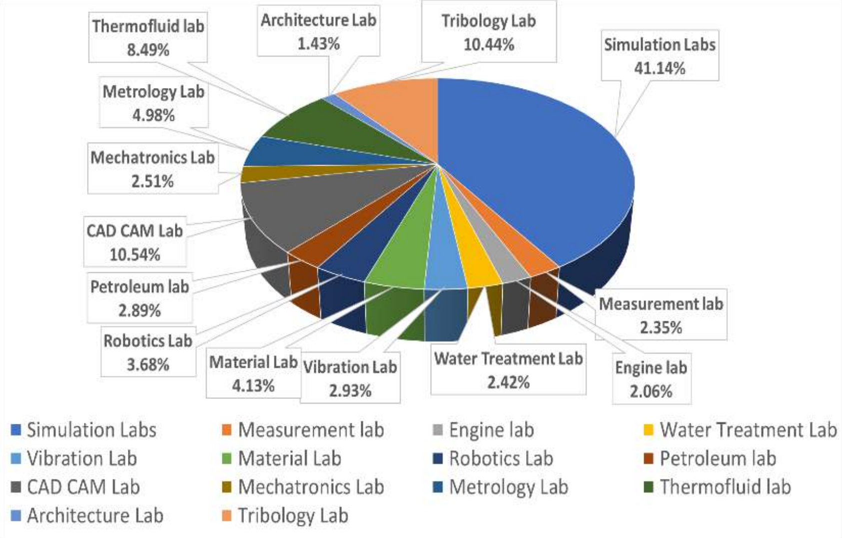


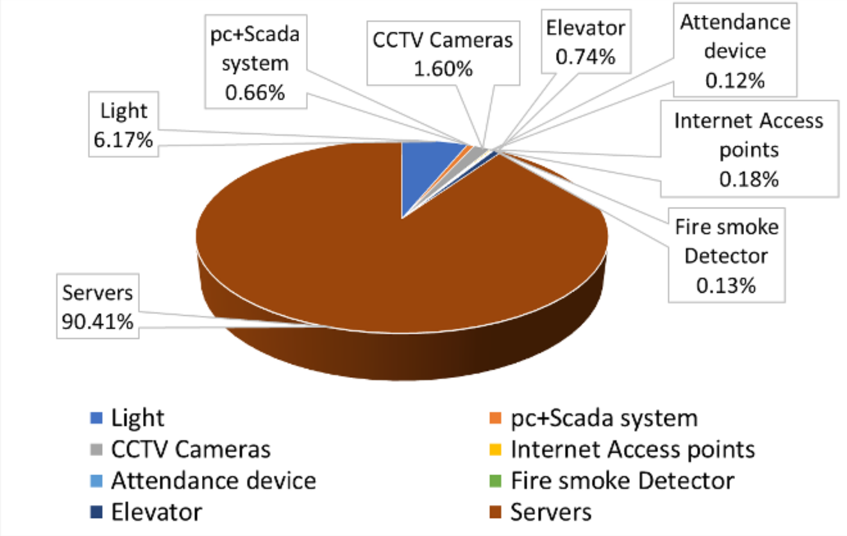
LECTURE HALLS & CLASSROOMS

RESULTS

ELECTRICAL CONSUMPTION DATA ANALYSIS







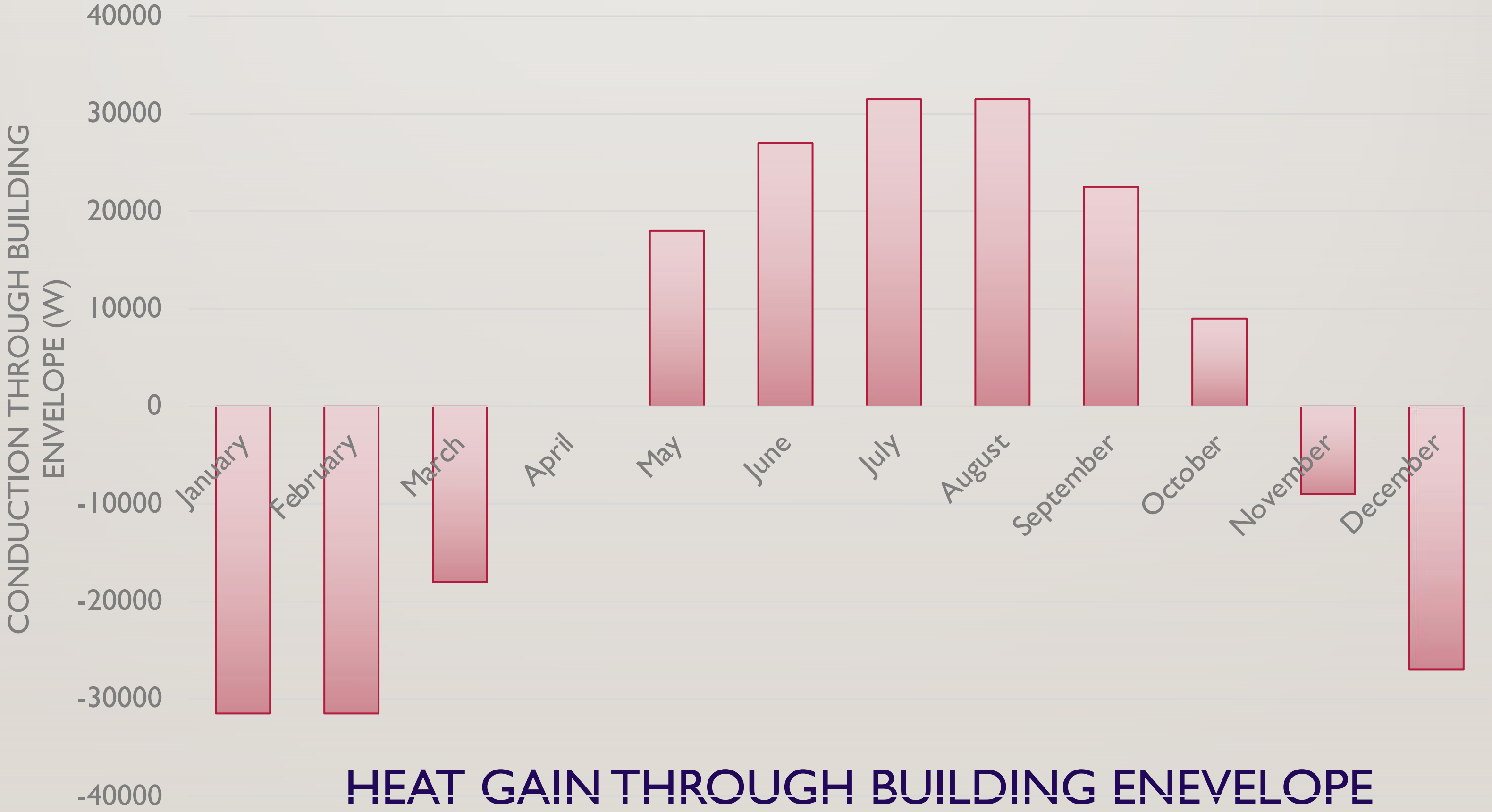
WASHING ROOMS

LABS

BUILDING UTILITIES

RESULTS

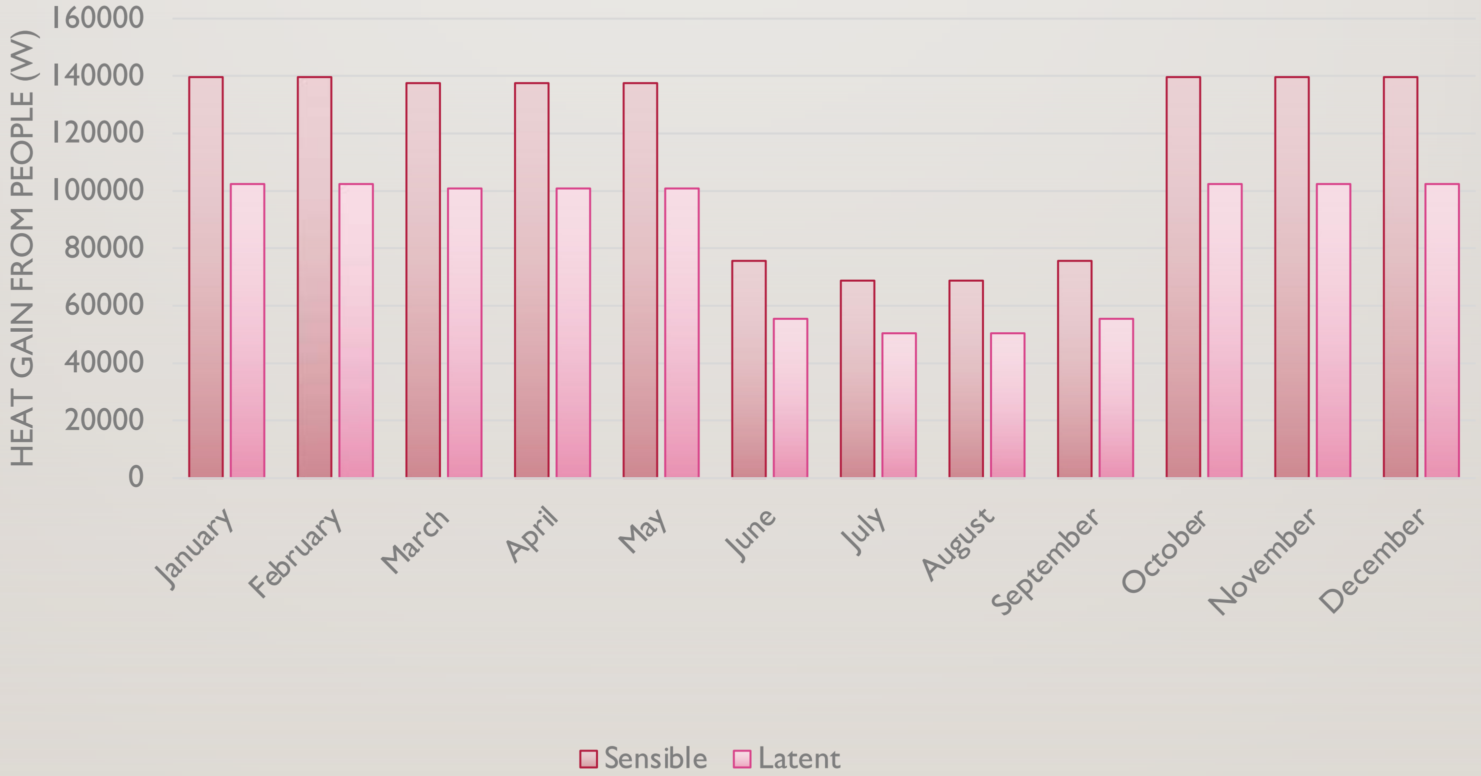
HEAT GAIN ANALYSIS



HEAT GAIN THROUGH BUILDING ENEVELOPE

RESULTS

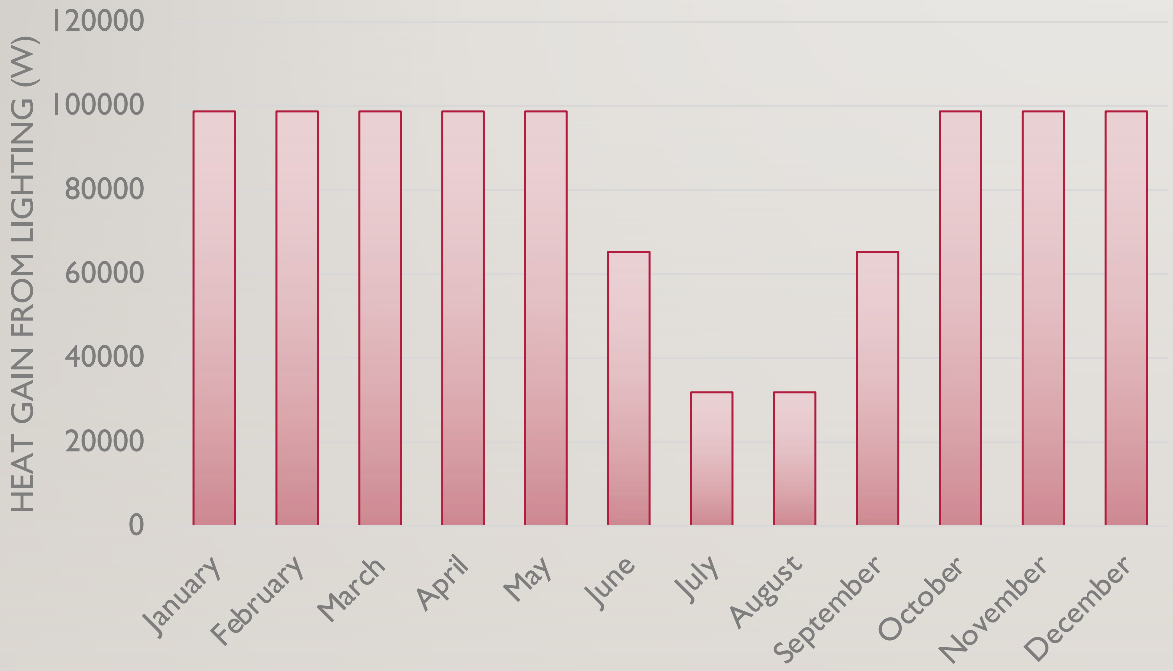
HEAT GAIN ANALYSIS



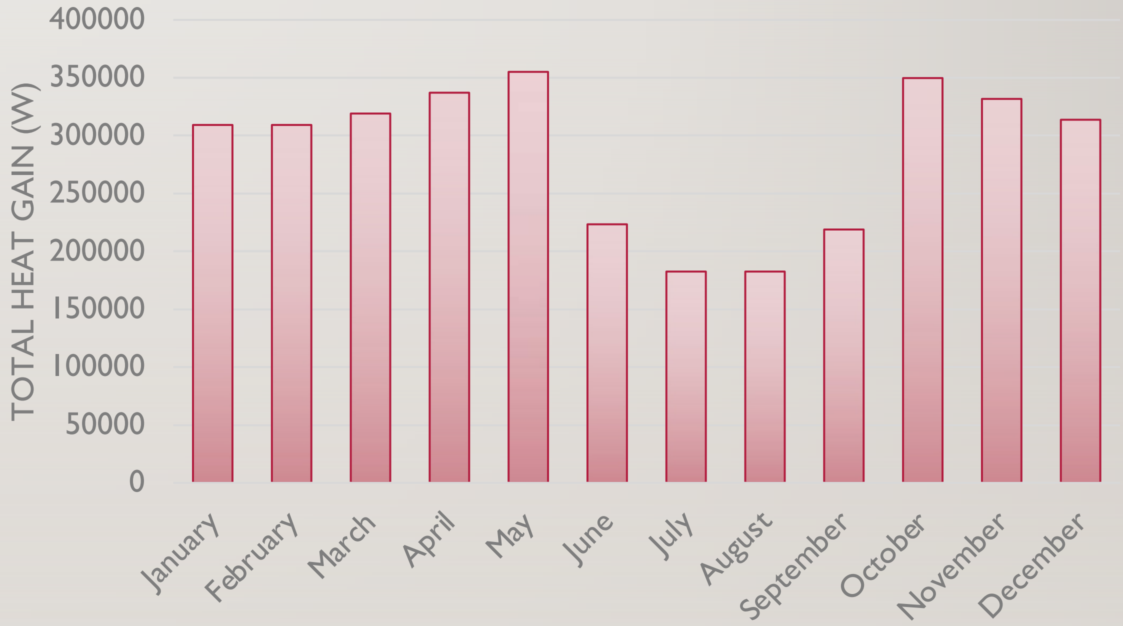
HEAT GAIN FROM PEOPLE

RESULTS

HEAT GAIN ANALYSIS



HEAT GAIN FROM LIGHTING



TOTAL HEAT GAIN

CONCLUSION

- The offered database will be the first seed of online database for Energy in Egyptian Building benchmarking.
- The simulation labs consume more energy (36.79%) than other labs; this is because most PCs are left working for a long time.
- The highest power consumption is in October of 544.38 MWh, other peaks are in June, July, August, and September due to the usage of AC and the variation between these months due to the vacations.
- July and August are the peak heat gain periods, due to the extreme hot temperatures in Egypt, while January and February are the peak periods in Winter, and the power consumption of the air conditioning system or heat pump is noticeably increasing in these periods to achieve the desired comfort zone in the building.
- The Energy Use Index (EUI) parameter is the key indicator for energy building consumption which should be compared with the international energy levels. Compared to international reported values in case studies, the EUI of Building A in the British university in Egypt is about 330 kWh /m^2, lying between the minimum 28.99 kWh /m^2 and maximum 800 kWh /m^2 reported in literature for similar university campus buildings.
- Educational building staff and students should practice energy saving operation.

THANK YOU
FROM OUR TEAM

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