WALK-THROUGH ENERGY AUDIT OF HOT WATER SYSTEM – A CASE STUDY OF THE UNIVERSITY OF BOTSWANA INDOOR SPORTS CENTRE

3RD INTERNATIONAL SUSTAINABLE ENERGY CONFERENCE 2024 HELD IN GRAZ, AUSTRIA

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Presentation Layout

- Introduction
- Study Methodology
- Results and Discussion
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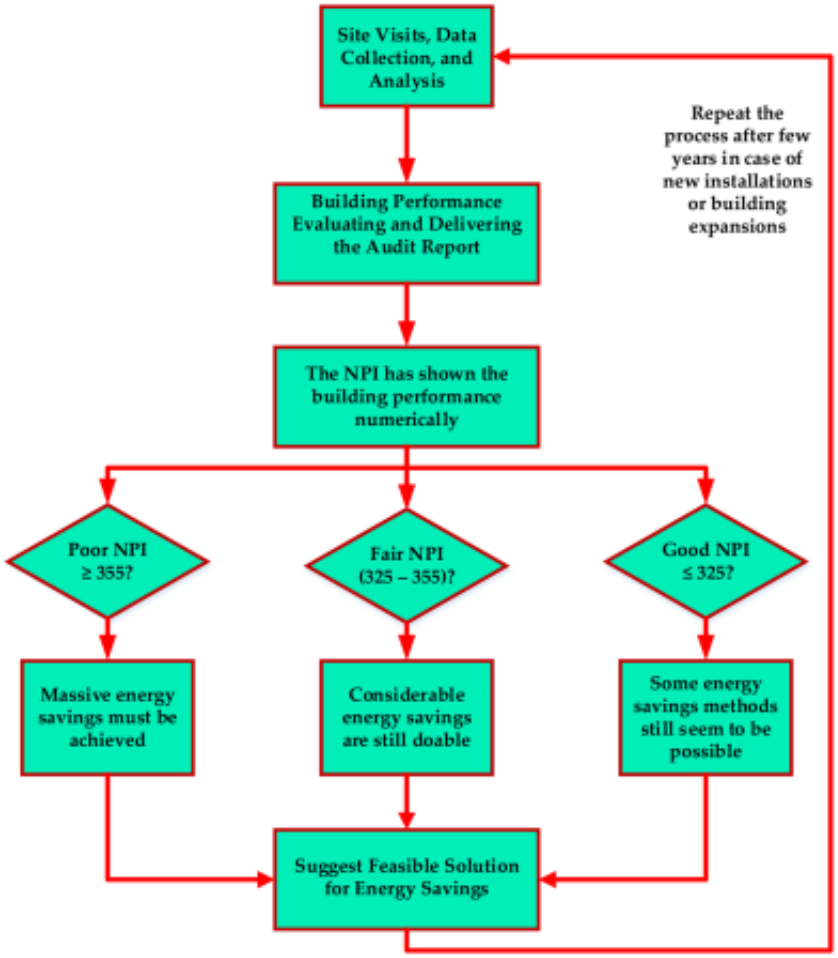
Introduction

- Energy auditing is a process of assessing and analyzing the energy usage and efficiency of a building, facility, or industrial process.
- Through it, it is possible to analyze the energy balance of a system in order to define possible improvements in its energy efficiency, achieve the mitigation of its environmental impact, and reduce energy costs (Darshan, et al., 2022).
- An energy audit examines how much energy a household or building consumes and then develops a method to optimize energy consumption by increasing efficiency.
- Energy auditing can be comprehensive, targeted, or preliminary (walk-through) (Mohamed, Fakhoury, Aldalou, & Almasri, 2022).
- Preliminary energy audits are crucial in order to identify the essential problems regarding energy consumption in the building and suggest practical solutions and this can be usually done without the need to undergo detailed energy audits.

Preliminary Audit Process - Normalized Performance Indicator (NPI)



- Ídentify the essential problems regarding energy consumption in the building
- Suggest practical solutions
- It avoids using the direct numeric value of energy consumption
- Usually done without the need to undergo detailed energy audits
  - Complete an energy analysis of the system
  - Identify energy waste
  - Defining the retrofitting plan for reduction of energy consumptions
  - Implement systematic plan for the development of energy saving projects and monitoring of the results

Introduction

- A hot water system in a building is designed to supply heated water for activities such as showering, laundry, and space heating.
- The components of a hot water system can vary but they generally include, a water heater, a distribution system (piping), temperature regulation devices or thermostats and insulation (Kubba, 2012).
- There are several losses that can be experienced on water heating systems – system losses.
- Longer showers, frequent hot water use, and high-temperature settings on appliances can increase energy consumption.
- Efforts to reduce the energy consumption of a hot water system include using efficient water heaters, improving insulation, implementing temperature controls, and adopting water-saving practices.

Introduction

- Multipurpose buildings such as an Indoor Sports Centre generally have larger thermal loads
- Increased energy consumption leads to increased operating budget.
- This study undertook a walk-through audit of the hot water system in the University of Botswana (UB) Indoor Sports Centre.
- The rapid walk-through survey focuses on energy input, areas of energy waste, and Energy Conversion Opportunities (ECOs).
- Audit Questions?
  - Design Issues
  - Collector Installation
  - Storage Tank
  - Plumbing Components

Introduction

Fig 1: A storage tank boiler at the Indoor Sports Centre

Methodology

- Four boilers of a total capacity of 12.7 kW heat up water which is delivered to the showers on both the first floor and the second.

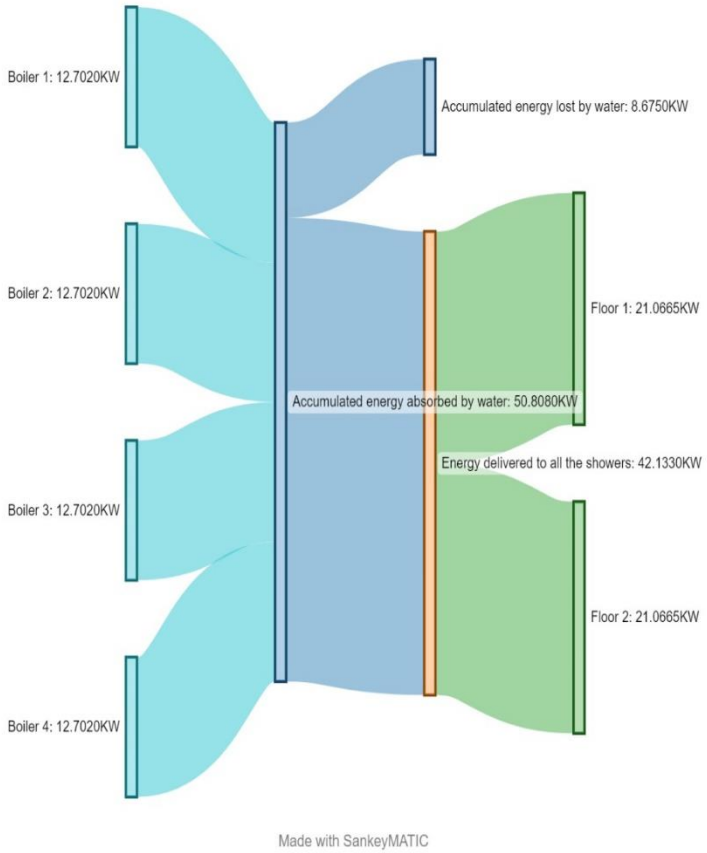
- The following procedure was followed in data acquisition for the walk-through audit of the UB Indoor Sports Centre hot water system.
  - The room temperature and initial test water temperature were all measured.
  - A 20-litre bucket was filled with hot water from the shower and the temperature of the water was recorded.
  - The time taken to fill the 20-litre bucket was recorded.
  - The same procedure was repeated 8 times, hence a total water capacity of 160 litres.
  - A 5-minute break was taken to allow for the pipes to cool.
  - When the break ended the initial temperature after cooling was recorded.
  - The testing procedure resumed, and another bucket was filled and continued with the same procedure of filling the bucket, recording the temperature, and dumping the water.
  - This was repeated four times until the temperatures stabilized.

Results and Discussion

Capacity	Obtained Testing Temperature (°C)
20	41.0
40	35.0
60	47.4
80	48.2
100	46.0
120	47.9
140	47.6
160	47.2
COOLING BREAK	COOLING BREAK
20	46.2
40	47.6
60	47.3
80	47.7

Parameters	Value
Density of Water	1000 kg/m^3
C_p of water	4181 J/kg.k
Temperature of water at the boiler	50°C
Number of boilers	4
Room temperature of water	25.4 °C
Volume of bucket	20 l = 0.02 m^3
Time taken to fill the bucket	162 s
Volumetric flowrate	1.235×10^{-3} m^3/s
Mass flowrate	0.1235 kg/s
Power used by one boiler	12.702 kW
Accumulated Power lost by Water (recorded average temp of water = 45.8 °C)	8.675 kW
Accumulated power delivered to the showers	42.133 kW

Results and Discussion



- 42.1330 kW of the energy in the water is delivered to the showers, and 8.6750 kW is lost to the surroundings which is about 17 % of the energy is lost to the surrounding.
- Recommended energy efficiency measures:
  - Properly insulate hot water pipes that supply the showers and use of high-quality insulation materials.
  - Review the reticulation of hot water pipes to minimize the length of the pipe.
  - Install heat traps or check valves on the hot water lines to prevent the natural convection of hot water within the pipes.
  - The installation of timer-based or on-demand hot water recirculation systems to ensure hot water is available at the fixtures when needed, thereby reducing the need to run water and wait for it to heat up.
  - Implementation of advanced control systems that allow for better monitoring and control of hot water distribution, helping to optimize energy use and reduce waste is very helpful.

Conclusion

- SOLTRAIN+ Project is promoting the implementation of energy efficiency measures in Industry.
- The following audit questions need answers:
  - Design Issues
  - Collector Installation
  - Storage Tank
  - Plumbing Components

- This work is a contribution in advancing the goals of SOLTRAIN+

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THANK YOU!

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