ENERGY SAVINGS

TECHNICAL NOTES

A technical note for Understanding Potential HVAC Energy Savings in Indian Commercial Buildings Using IoT–BMS versus traditional BMS.

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INTRODUCTION

This technical note investigates the energy-saving potential of using an Internet of Things (IoT)-based Building Management System (BMS) for heating, ventilation, and air conditioning (HVAC) systems in commercial buildings in different climatic zones in India.

The main objective of the study was to compare the energy-saving potential of HVAC systems between conventional Building Management Systems (BMS) and IoT-based BMS. The study utilized a simulation exercise to assess the energy savings achieved through various factors enabled by IoT-based BMS, such as sensor networks for addressing thermal imbalances, indoor air quality requirements, total fresh air needs, chilled water optimization, CO_2 sensors, and strategies to capitalize on temperature reversals in the building.

- **Energy savings in HVAC for different climates are as follows:** Composite - up to 13.40%, Warm and Humid - up to 13.40%, Temperate - 15.40%, and Hot & Dry - 13.70%.
- **The percentage savings on EPI in buildings are as follows:** Composite climate - 7%, Warm and Humid climate - up to 8.30%, Temperate climate - 7.80%, and Hot & Dry climate - 5.90%.

METHODOLOGY

The energy models of all the buildings were developed using BEE-approved eQUEST simulation tools while following the guidelines of the Energy Conservation Building Code (ECBC) of 2017. The input parameters, such as thermal transmittance of external wall, roof and glazing system, Lighting Power Density (LPD), Equipment Power Density (EPD), and occupancy schedules, were based on the standards specified in the ECBC Code. The design parameters of the building's HVAC system were used as per Indian HVAC industry norms.

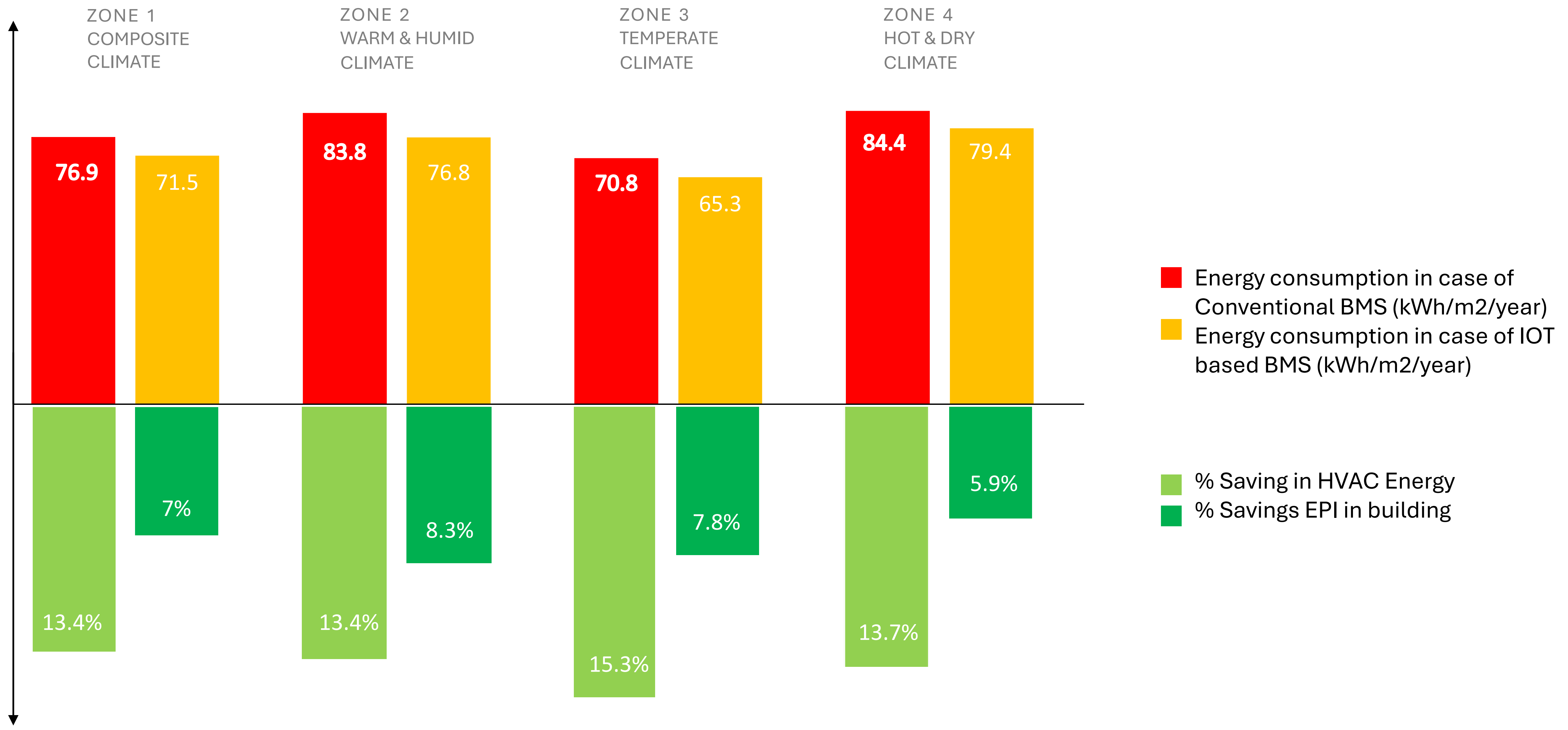
The energy models were simulated using eQUEST version 3.65 and DOE-2, which can dynamically simulate building energy demand for each hour throughout the year. Each energy model included a baseline model (Conventional BMS) and a design model (IoT-BMS), with the latter incorporating the advanced control strategies developed by 75F. Various centralized HVAC systems, primary-secondary pumps, VAV systems, and cooling towers, condenser pumps were considered for the analysis of larger buildings > 50,000 sq. ft. As Variable Refrigerant Flow (VRF) systems are a great option for compact spaces because of their adaptability and efficacy, refrigerant-based systems were considered for smaller buildings between 5,000 sq. ft. and 50,000 sq. ft.

To identify the potential for energy efficiency in commercial buildings in India, sixteen (16) commercial buildings of four different typologies, i.e., offices, health care, hospitality and retail, are studied using a simulation approach. While evaluating IoT-based BMS, the study tested these seven advanced control strategies of 75F: Outdoor Air Optimization (OAO), OAO Interval Modulation, Smart Variable Air Volume, Dynamic Chilled Water Balancing, Dynamic Air Balancing, and Epidemic Mode.

Input parameters for energy simulations for commercial buildings

Climatic Zone	Built Up-Area, sq. ft.	External wall thermal transmittance, W/m2K	External Roof thermal transmittance W/m2K	WWR	Glazing thermal transmittance W/m2K	Cooling Set-point, ◦C	LPD, W/m2	EPD, W/m2
Composite	2,51,358	0.4	0.33	65%	1.8	24	5	3
Warm & Humid	2,51,358	0.4	0.33	65%	1.8	24	5	3
Temperate	2,51,358	0.4	0.33	65%	1.8	24	5	3
Hot & Dry	2,51,358	0.4	0.33	65%	1.8	24	5	3

RESULTS | Commercial Buildings



75F® Dynamic Airflow Balancing™

75F's wireless sensors, placed in each zone, capture thousands of data points a minute and millions of data points daily. Data flows across a secure 900 MHz wireless mesh network, to the 75F cloud, where third party weather forecasting and historical data merges in a dynamic thermal model of each building to predict optimal control strategies. After just a few days, the 75F cloud can accurately anticipate heat loads and can use that information to predictively and proactively control the temperature and air volume in zones or offices.

After a just a few weeks the weighted average and zone priorities of each building begin to allow zones to arrive at their setpoints at the same time, increasing building comfort, time the system spends in ventilation modes, the life of HVAC equipment, and energy savings even further.

The decisions flow from the 75F cloud back and down to the CCU to engage the RTU or AHU at the optimal time, with adjustments made to dampers in zones throughout the building simultaneously to maximize the performance of the system. This application effectively keeps the HVAC system optimized, or in balance, while simultaneously ensuring air is always being directed where it is needed most.

75F® Dynamic Chill Water Balancing™

75F Dynamic Chilled Water Balancing is an end-to-end solution for chilled water systems. 75F sensors in each zone gather millions of data points daily and communicate these points via a 900 MHz wireless mesh network to the 75F® Central Control Unit™ — giving users the ability to monitor the inlet and outlet temperatures, chilled water flow rates, and BTU energy consumption across the line. 75F's system understands, analyzes, and optimizes the overall performance of the HVAC system under various conditions, thereby driving significant energy savings at an AHU level and at the chiller plant.

75F designs and manufactures the world's leading IoT-based Building Management System, an out-of-the-box, vertically integrated solution that is more affordable and easier to deploy than anything on the market today. The company leverages IoT, Cloud Computing and Machine Learning for data-driven, proactive building intelligence and controls for HVAC and lighting optimization. Investors include some of the biggest names in energy and technology. 75F's mission is to improve occupant productivity through enhanced comfort and indoor air quality — all while saving energy.

75F® Outside Air Optimization™

75F® Outside Air Optimization™ (OAO) is an application that combines hardware, software, and real-time weather data providing advanced sequences of operation from rooftop economizers to built-up air handlers in a wide range of commercial buildings. While OAO's three primary benefits are improved efficiency, comfort and indoor air quality, this report will focus on OAO's efficiency potential. This study includes three OAO control strategies: OAO, OAO Interval Modulation (IM), and OAO Smart Demand Control Ventilation (DCV). This report focuses exclusively on OAO data, though specific control strategy descriptions are available for all three.

- **OAO** reduces the required ventilation of outdoor air leveraging additional sensors and optimized setpoints.
- **OAO IM** cycles the fan to maintain minimum outdoor air ventilation. Applied in any building with constant-speed fans in the HVAC equipment that provides ventilation to occupants.
- **OAO Smart DCV** uses CO2 sensors to detect occupancy and adjusts ventilation by room in VAV systems. Applied in buildings with central HVAC systems serving multiple zones leveraging traditional VAV terminal units.

CONCLUSION

IoT-BMS, in comparison to conventional BMS, leads to a decrease in air flow requirements (CMF/sq. ft.) and an improvement in HVAC system performance (sq. ft./ton).

This analysis shows significant savings from IoT based BMS that uses applications such as Dynamic Chill Water Balancing, Outside Air Optimization sequences and Smart VAV in large offices, particularly in the Temperate zone.

The study suggests that implementing the IoT-BMS solution in place of traditional BMS systems can significantly reduce electricity usage of HVAC systems, **ranging from 13.4 – 15.4%.**

After analyzing various building typologies and climatic zones in India, the study revealed that over 50% of energy savings for centralized chillers stem from the chiller side. This includes fan energy savings, accounting for 6 to 19% of total HVAC energy savings, heat rejection energy savings ranging from 8 to 14%, and pump energy savings contributing 21% to 25% of overall HVAC savings.