CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The Intelligent HVAC System will control Heating, Ventilating, and Air Conditioning (HVAC) of a residence heating. Ventilation and Air Conditioning are ducts used in buildings designed to carry air to and from all parts of the building. This is the building system that regulates the inside temperature of the building and in some systems, the air quality as well. The principles of HVAC design include the basic theory of system operation and the factors that determine the size and capacity of the equipment installed in the system.

In addition to HVAC controls such as thermostats, individual mechanical components, such as actuators for control dampers, can be directly monitored and controlled via IoT**.** This permits digital communication without the need for a separate control panel. IoT can use cloud-based platforms, eliminating the need for an on-site computer and server applications.

1.2 PROJECT OBJECTIVE

- To become familiar with the components of HVAC Systems and know their functions.
- To use Internet Of Things (IoT) in HVAC system.
- To identify and understand the use of various Sensing and control strategies.

1.3 PROBLEM STATEMENT

Heating, Ventilating and Air Conditioning (HVAC) systems are among the main installations in residential, commercial and industrial buildings. The purpose of the HVAC systems is normally to provide a comfortable environment in terms of temperature, humidity and other environmental parameters for the occupants as well as to save energy.

The main purpose of an HVAC system is to provide thermal comfort and acceptable indoor air quality.

CHAPTER 2

CONVENTIONAL METHOD

2.1 HEATING

Heaters are mostly used to generate heat (i.e. warmth) for the building. This can be done through Central Heating. Such a system contains a boiler, furnace, or heat pump to heat water, steam, or air in a central location such as a furnace room in a home, or a mechanical room in a large building. The heat can be transferred by convection, conduction, or radiation.

Fig 2.1 Furnace

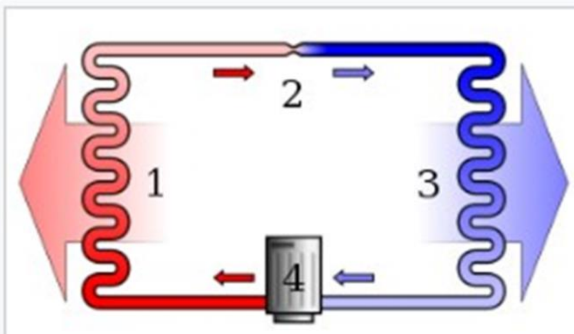
2.2 VENTILATION

Ventilation is the process of changing or replacing air in a room to control temperature or remove any combination of moisture, odors, heat, dust, airborne bacteria or carbon dioxide and to replenish oxygen. Ventilation includes both the exchange of air with the outdoor as well as circulation of air within the building. It is one of the most important factors for maintaining acceptable indoor air quality in buildings.

Fig 2.2 Ventilator

2.3 AIR CONDITIONING

An air conditioning system, or a standalone air conditioner, provides cooling and humidity control for all or part of a building. Outside, fresh air is generally drawn into the system by a vent into the indoor heat exchanger section, creating positive air pressure. The percentage of return air made up of fresh air can usually be manipulated by adjusting the opening of this vent. Air conditioning and refrigeration are provided through the removal of heat. Heat can be removed through radiation, convection, or conduction. Refrigeration conduction media such as water, air, ice, and chemicals are referred to as refrigerants. A refrigerant is employed either in a heat pump system in which a compressor is used to drive thermodynamic refrigeration cycle, or in a free cooling system which uses pumps to circulate a cool refrigerant.



A simple stylized diagram of the refrigeration cycle: 1) condensing coil, 2) expansion valve, 3) evaporator coil, 4) compressor

Fig 2.3 Working of an AC

CHAPTER 3

DESIGN OF THE SYSTEM

3.1 HARDWARES

- Arduino UNO (ATMEGA 328)
- Relay module
- Node MCU
- LM35
- DC motors
- Jumper wires

3.2 SOFTWARE

- Arduino IDE
- Thinker.io (to view the data in online)

3.3 SPECIFICATIONS OF THE COMPONENTS

3.3.1 Arduino UNO

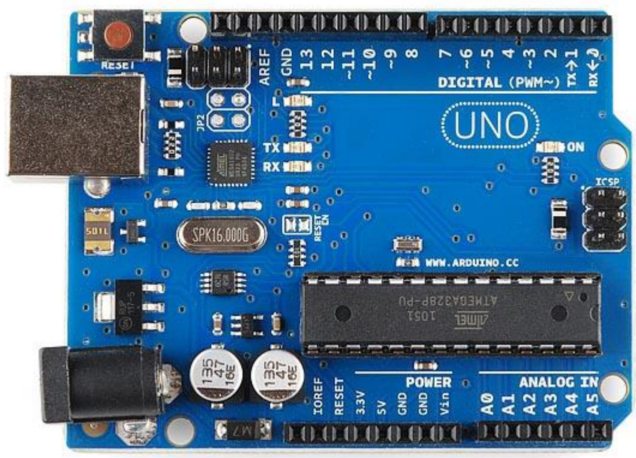


Fig 3.1 Arduino UNO

Microcontroller	AT mega 328
Operating voltage	5V
Analog input pins	6(A0-A5)
Digital I/O pins	14(6 PWM)
Flash memory	32 KB
Frequency Speed	16MH

3.3.2 Relay Module

Fig 3.2 4 Relay Module

- ✓ On-board EL817 photoelectric coupler with photoelectric isolating anti-interference ability strong
- ✓ On-board 5V, 10A / 250VAC, 10A / 30VDC relays
- ✓ Relay long life can absorb 100000 times in a row
- ✓ Module can directly and MCU I/O link, with the output indicator
- ✓ Module with diode current protection, short response time
- ✓ PCB Size: 45.8mm x 32.4mm

3.3.3 NODE MCU

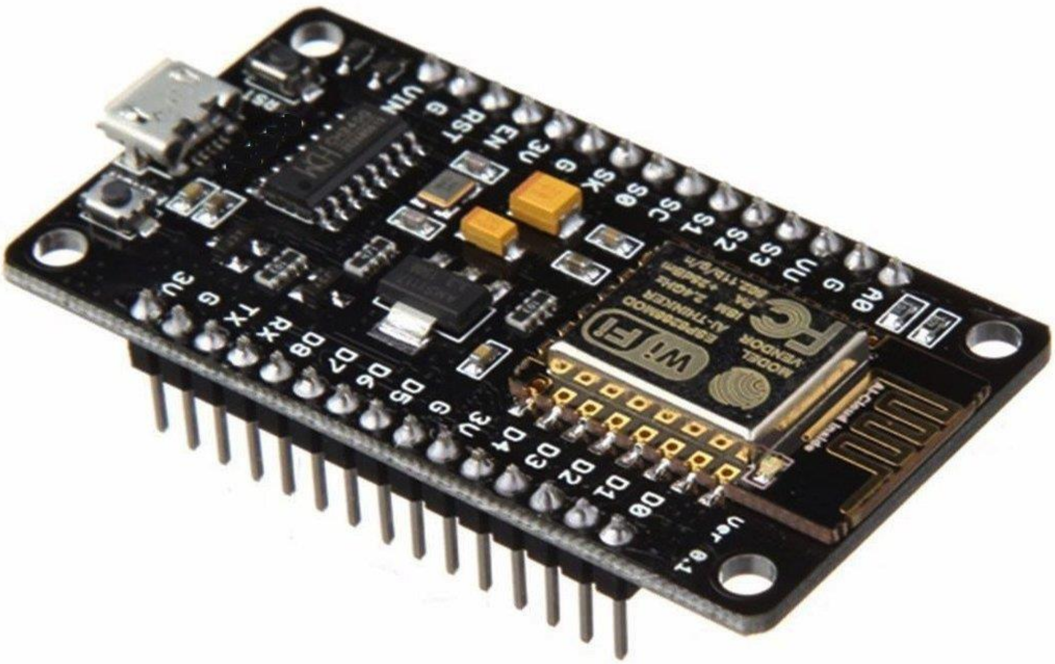


Fig 3.3 NodeMCU

Node MCU is Wi-Fi module chip (ESP8266) which connects the electrical and mechanical components to the internet. It is a highly integrated chip designed to provide full internet connectivity in a small package.

3.3.4 LM 35

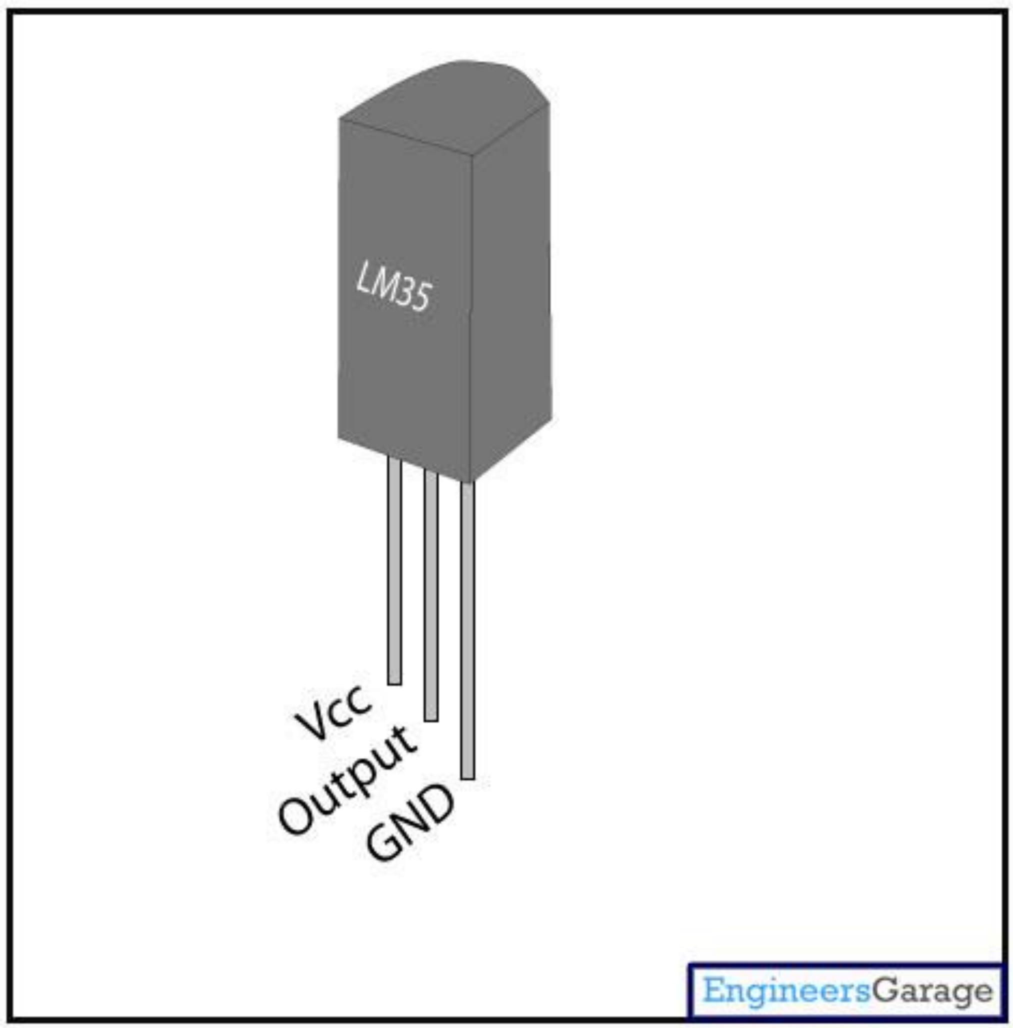


Fig 3.4 LM35 Temperature Sensor

Operating temperature	-55° C to 150° C
Output voltage	10Mv
Scalable factor	0.01V/ °C

3.3.5 DC Motor

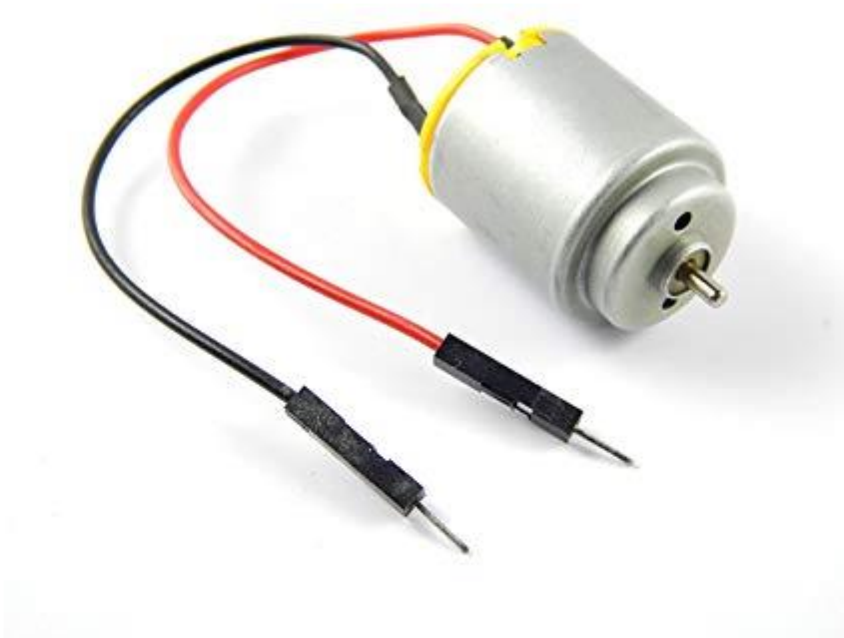


Fig 3.5 DC Motor

Operating voltage	1.5V to 4.5V
No load speed	23000 RPM (@4.5V)

3.3.6 Arduino IDE

The Arduino Integrated Development Environment (IDE) is an open source application used to write, run and upload the programs on the Arduino using computers.

CHAPTER 4

METHODOLGY

4.1 BASIC FUNCTION OF HVAC SYSTEM

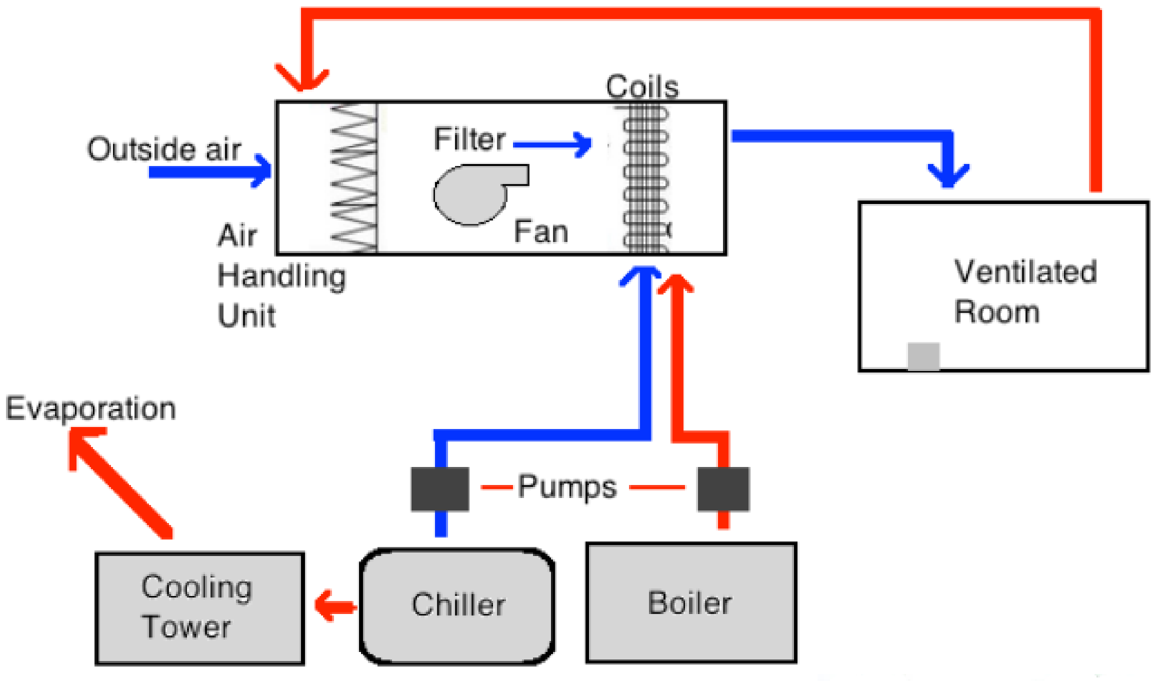


Fig 4.1 System Block diagram

The above block diagram explains the construction and working of an HVAC system.

4.2 COMPONENTS OF HVAC SYSTEM

- Thermostat and Furnace
- Heat exchanger and Evaporator coil
- Refrigerant lines
- Ductwork and Vents

4.3 HOW IoT WORKS IN HVAC SYSTEM

- IoT in HVAC equipment offers many advantages to the building owner, occupants and facility managers. This increases the efficiency of the entire system and users can automatically monitors and control wide range of variables, sensors and actuators.
- This involves the use of different wireless sensors, smart vents with the ability to control each room independently, and other technologies that add intelligence to the HVAC system and its components.
- Different kinds of sensors are integrated into the HVAC system to monitor a wide range of variables and provide real-time status of almost all the components.
- The HVAC IoT sensor data is fed to the control system which then sends commands to automatically turn the system ON or OFF, or perform other functions. The other control functions include changing the temperature, speed of air flow, closing or opening vents, or adjusting other conditions to suit a user's preference.
- Monitoring the HVAC components and the environment provides data which can be used for planning purposes as well as determining how people are using the services in the building.

  This includes variables such as the temperature, water usage, lighting, occupancy levels etc.

- This data can be displayed and accessed using computers, tablets, smartphones or centralized control panels.

  Most importantly, the sensor data enables the relevant HVAC components to automatically adjust themselves based on the time of the day, temperature, occupancy, weather or any other variable as per the program.
- In addition, the sensors provide a means of continuous monitoring of the system status as well as real-time diagnostics for routine maintenance and repairs. Once the sensors detect a potential problem, they can then send an alert to the technicians or maintenance personnel, hence ensuring immediate mitigation and prevention of major breakdowns.

4.4 HVAC SENSING AND CONTROLS

A proper environment is described with four variables:

- Temperature
- Humidity
- Pressure
- Ventilation – Air Flow

Sensors used are:

- Temperature – RTD, Thermostats
- Humidity / DEW Point – Hygrometer – Resistance, capacitance etc.
- Pressure – Diaphragm
- Ventilation – Air Flow – Anemometers, Pitot Tubes etc.

Actuators used are:

- Heater,
- Valves,
- Dampers,
- Diaphragms and
- Fans.

Controllers used are:

- Temperature Controller
- Humidity Controller
- Enthalpy Controller

4.5 INTERNET OF THINGS

The internet of things is a network of sensors, meters, appliances and other devices that are capable of sending and receiving data. The main benefits of setting IoT device are flexibility and observability.

4.5 FACTORS AFFECTING HVAC DESIGN

1. Heat gained by the walls, roof, windows and partitions. Since these parts of a building is highly exposed to the sun in the day-time and the heat is emitted at night-time inside the room. Therefore those parts should be insulated well.

2. Heat generated by the people and the electrical appliances.

3. Heat gained by outside Air Outside air is normally at a greater temperature than the room temperature. When this air comes inside the room, it brings certain amount of heat along with it.

4.7 CHALLENGES OF IOT IN HVAC SYSTEMS

1. Security flaws are still a major concern for most users and professionals.

2. Some consumers fear that hackers can access some IoT sensors through the internet, and comprise the operation of devices as well their privacy and security.

3. Other challenges include the incompatibility between various components and some HVAC professionals who fear that the proactive approach is likely to reduce the need for emergency repairs hence decrease their revenues.

CHAPTER 5

SYSTEM IMPLEMENTATION

5.1 CONNECTIONS:

- Arduino 5V – LM35 Vcc, Relay Vcc
- Arduino GND – LM35 GND, Relay GND
- Arduino A0 – LM35 Output
- Arduino 7,8 – Relay IN1, IN 4
- Relay Normally Open – Power Supply
- Relay Normally Closed – GND
- Relay Common – Motor positive & negative

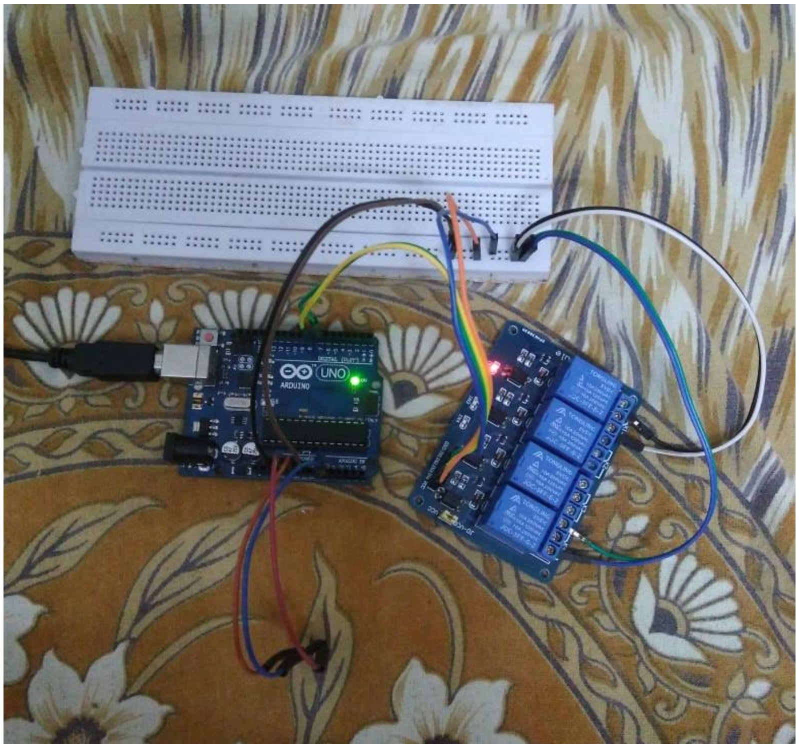


Fig 5.1 Working Model of the HVAC System

5.2 PROGRAMS

hvac

```
#include <Wire.h>
float tempC;
int reading;
int tempPin = 0;
int led =13;
#define CW 7
#define CCW 8
void setup(){
  pinMode(led,OUTPUT);
  pinMode(CW,OUTPUT);
  pinMode(CCW, OUTPUT);
  Wire.begin();
  Serial.begin(9600);
}

void loop()
{
reading = analogRead(tempPin);
tempC = (5.0*reading*100.0)/1024.0;
Serial.print("temp in C =");
Serial.println(tempC);
if (tempC <  32){
  digitalWrite(led,HIGH);
  digitalWrite(CW,HIGH);
  delay(1000);
  digitalWrite(CW,LOW);
}
else if (tempC > 32){
  digitalWrite(led,LOW);
  digitalWrite(CCW,HIGH);
  delay(1000);
  digitalWrite(CCW,LOW);
  }
}
```

Fig 5.2 Arduino program to control HVAC System

DHT11 §

```
#include <ESP8266WiFi.h>
#include <ThingerESP8266.h>

#define USERNAME "DHARUNJ"
#define DEVICE_ID "dht11"
#define DEVICE_CREDENTIAL "[redacted]"

#define SSID "dj"
#define SSID_PASSWORD "0987654321"

ThingerESP8266 thing(USERNAME, DEVICE_ID, DEVICE_CREDENTIAL);
#include "DHT.h"
#define DHTTYPE DHT11

#define dht_dpin 0
DHT dht(dht_dpin, DHTTYPE);
void setup(void)
{
  dht.begin();
  Serial.begin(9600);
  Serial.println("Humidity and temperature\n\n");
  delay(1000);
    float h = dht.readHumidity();
    float t = dht.readTemperature();
    Serial.print("Current humidity = ");
    Serial.print(h);
    Serial.print("%  ");
    Serial.print("temperature = ");
    Serial.print(t);
    Serial.println("C  ");
  delay(1000);
  thing.add_wifi(SSID, SSID_PASSWORD);
  thing["temperature"] >> outputValue(dht.readTemperature());
  thing["humidity"] >> outputValue(dht.readHumidity());
}
void loop() {
  thing.handle();
}
```

Fig 5.3 Arduino program to display the temperature in thinker.io

CHAPTER 6
CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

In this paper, we have created small HVAC system which is controlled by Arduino UNO. This paper explains more about the fundamentals about IoT and HVAC system. The development of the ‘Internet of things’ begins to increase. As the number of devices continues to increase, more automation will be required in order to control, monitor and analyze the hardware and software as well. Our future aim will be to handle the data from IOT hardware sensors and devices by proxy network sensors. This sensor should be safeguarded, because of security issues.

6.2 FUTURE SCOPE

SMART HVAC

Advanced controls for heating, ventilation and air conditioning (HVAC) systems can reduce consumption in unoccupied zones of a building. They can also continuously adapt the operation to fit the demand and detect needs for maintenance.

The Buildings Performance Institute Europe- BPIE (2017) found that building automation reduces energy consumption by around 27% in households, and smart technology can save an average of 23% of energy consumption in offices.

INTERNATIONAL ENERGY AGENCY (IEA):

According to the IEA, the energy savings linked to smart control of HVAC systems are a consequence of the following:

1. Smart HVAC systems allow demand control, by improving the response of systems to the heating, cooling and ventilation needs.

2. Smart systems can also embed, in addition to sensors, learning algorithms in order to better fit with user’s behavior or building's use.

3. Another strength of smart systems is their ability to communicate information about their operation, energy consumption and energy efficiency. This information can be used by consumers, owners, building managers, maintenance staff and energy grid managers. This allows human or automatic actions to adjust the system.

CHAPTER 7

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