# Introduction

## Background

Buildings are the largest energy consumer in the United Kingdom, accounting for 40% of total energy consumption [1]. The consumption of electricity in Higher Education (HE) facilities accounts for most of the sector's carbon pollution [2]. Once the Higher Education Funding Council of England (HEFCE) mandated a 43 percent reduction in carbon emissions by 2020 for all participating institutions compared to the baseline year 2005, energy management solutions have quickly acquired traction in the UK HE sectors [3]. Most of England's member institutions now have a dedicated energy management team dedicated to achieving this goal. Figure 1 depicts the change in Dioxide (CO2) emissions in the sector from 2008/09 through 2014/2015. It shows that electricity usage is the largest contributor, accounting for 63%, followed by natural gas, which accounts for 33.3% [1,4,5].

Building type, building age, occupancy, working hours, kind of equipment fitted, and weather patterns are all variables that impact energy usage in university buildings. Academic buildings (42%) and administrative buildings (26%) take up about 68 percent of the space on a typical university campus in England [6]. In 2014/15, non-residential facilities at English universities utilised around 80% of overall energy consumption, while residential buildings consumed 20% of total energy consumption [4].

With shares of 63 percent and 33 percent, respective, the previously stated data shows clearly how gas and electricity use are the two biggest carbon-emitting sources in England's HE sectors [4]. The modest decline in carbon emissions in the industry implies that universities ought to investigate more energy-saving alternatives as well as improve their energy management systems.

One of the essential parts of a successful energy management system is monitoring and analysing building energy consumption trends, which aids in analysing the facility's operational behaviour under various conditions. It also aids in the detection of unintended energy waste under specified conditions. If energy consumption data is properly extracted and stored, the relationship between the data and various variables such as temperature, humidity, number of occupants, and so on may be explored, and future energy projections can be formed using all these variables. Another significant advantage is that forecasted energy consumption data might be utilised to forecast realistic future energy budgets. Universities' energy management teams oversee monitoring, evaluating, and keeping data on energy consumption in their buildings. They oversee setting up realistic energy consumption predictions and identifying options for energy conservation to build their energy budget predictions for the years ahead.

The ability to accurately estimate energy use is important to the effective application of energy management systems. Due to a major lack of forecasting and the adoption of less efficient forecasting methodologies for planning, many businesses have struggled to control energy use and budgets [7,8]. Forecasting aids in assessing present and future economic conditions to guide the organization's policies and decisions. It's a technique that uses past and current data to forecast future information. A credible prediction system can assist financial and energy management teams at universities in establishing objectives and strategic goals and can even be used as part of its annual budgetary process [9].

Researchers have extensively employed diverse predictive techniques including MR, ANN, and GA for energy consumption prediction for various building types in various areas [10]. MR is an easy, reliable, and rapid technique among such [11,12]. Several researchers have employed the MR approach in their studies [11,12,15], but all such MR models anticipate the energy consumption of a single building or an area and require a large amount of input data. Energy managers and their staff are often busy, thus a single, trustworthy, and rapid model for diverse building categories would be preferable to multiple forecasting methods.

This study intends to assist the university's energy management teams by creating a fast and easy predictive model that employs a variety of methodologies. Every manager should be able to anticipate the hourly, daily, and monthly energy usage of the facilities using these methodologies. Three buildings on DE Montfort University's main campus were chosen for this purpose, and their past energy usage data was used to generate the forecasting models.

## Organisation of thesis

There are six chapters in this thesis, as well as an opening abstract. The abstract will give the reader a quick overview of the work that went into creating this dissertation. The foundation of the dissertation is discussed in depth in the first chapter. The chapter also discusses the energy industry's present issues, the purpose for energy prediction, and a brief explanation of the IAC programme. The second chapter looks at various methods for predicting energy usage in buildings. After a brief overview, the chapter discusses how each approach (regression, support vector machines, random forests, and artificial neural network (ann) performed in estimating energy. The methodologies employed in this thesis' case study from the IAC database are detailed in the third chapter. The workings of regression, support vector regression and random forests in parameter prediction are all detailed in this chapter. The fourth chapter explains each variable in the dataset utilised for prediction. The chapter also includes the many equations used in the case study and explains how to apply the methodology from chapter 3 to the dataset utilised in this thesis. The fifth chapter examines the model's performance and describes the results obtained from the model constructed in chapter 4. The chapter also examines a few conclusions drawn from the data. The dissertation is concluded in the last chapter, which also specifies prospective future research.