A detailed look on cranfield's university desired plan to increase energy efficie...

Environment, Ecology

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Abstract

This study is going to outline a plan to implement energy efficiency in building 40 and the Cranfield Campus. The goal is not easy, but with the determination of the Cranfield University to meet the ambitious CO2 reduction commitment and policies friendly to the environment can fulfill the three goals we scored in the medium term. These challenges, which are: the reduction of energy intensity, climate change and security of supply, I will keep them in mind during the development of the report since the technologies to be implemented; will be the means to reach that ultimate aim.

Focusing on our topic, we know statistically that energy use in buildings is at least annually between 40% and 50% of the total power consumed in the UK,

and 36% of CO_2 emissions in the EU. This is about three times the transport sector consumption. [1]

Given that, the UK has committed to halving carbon emissions by 2025 from 1990 levels changing to a greener energy production, it is necessary to reduce the high energy consumption of buildings, therefore, in this essay, we will focus our efforts for that purpose.

Introduction

“ Be the change you want to see in the world.” Mahatma Gandhi (1869 – 1948)

We are in an era of changes; we begin to be conscious that what we do now or not, will have an impact on future generations. Gradually, we become aware that the future will not be governed by the same energy sources that the present and we begin to see that they are finite. Fossil fuels will not be there forever. When become depleted greater would be the supply problems for the entire world population.

Part of our task in addition to ensuring energy supply will be increasing energy efficiency. The cost of natural resource depletion would be exponential and unlimited, so we must be aware that it is necessary coexistence of using fossil and renewable fuels. Thereby ensuring that peak energy demand will be covered due which the intermittency of renewables cannot guarantee a continuous supply.

Insofar we develop topics, we must become aware that our report should not only focus on actions that we implement in Cranfield campus buildings; we have also to debate how we want to supply energy for future. Likewise when discussing energy consumption, we should note the difference between the building consumption itself and the consumption of primary fuel, since the difference of technologies to be applied in both cases will be radically different.

The ability to save energy is close related to adopt technologies as the district heating such as the Cranfield University is developing and we shall see below how to implement their efficiency, either by combining it with actions such as solar, geothermal and wind power, we will see which of they are or not possible for our particular case.

The rest of the paper will be structured according to ISO 50001 [ ]. If we want to see change in the world, we must begin by us, as Gandhi said. Therefore, in this report implement the most current energy policy, we will develop, gradually step by step. Will, as a rule, the following structure: Section 2, Check. This section will develop a summary of energy technologies and infrastructures and buildings on campus. Section 3: Act. After we know what exists, we must find the resources to better manage, being the dynamic changes and advocating continuous changes. Section 4: Plan. Explain and discuss the possibilities of technologies and improvements which could be implemented in our case. Section 5: Do. After investigation and feasibility, it comes time to draw up a plan for monitoring and tracking our energy targets. Section 6: Conclusions. Be developed report results.

Check

We start this application of ISO 50001 by knowing the existing infrastructure facilities on campus. We begin with a description of the Cranfield University, its buildings and consumption, using as an example building 40 consumption. The campus is between Bedford and Milton Keynes, while at 2. 5 km from Cranfield village approximately.

At the Cranfield Campus there are 323 buildings which represent a total area of 180, 053. 18 ft². The figure [] is a map of the entire campus.

Focusing on the case of a building that will serve as a reference to calculate the consumption of the entire campus, we analyze the building 40, its size and consumption of electricity and heating provided by the energy manager of the university.[ ]

Heating is provided by two district heating schemes: Steam supplying the hangars, and LTHW serving educational buildings. The electricity is supplied by a high voltage ring.

Similarly, as demand peaks that occur mainly in January and February, other energy sources used in the university are: gas heating, the heating oil and a new CHP unit. []

The campus electricity system works with a HV ring which is around the campus. Using two transformers of 415 and 320V, imported electricity is about 20MWh.

Turning now to our particular building, we know that the building 40 has 705 square feet of floor area spread over two floors. In the two following designs appreciate having to teach classes four rooms, restrooms, a kitchen and various office spaces throughout the property. [ ]

Tables [] shows us the consumption of electricity and heating in 2009 which will take as references. Regarding the heating should mention the implementation of a new system of which supplies the CHP district heating today. The temperatures oscillate between 19 and 25 ° Celsius during the day, from 6 am to 8 pm. After that, centrally off at night to save fuel.

We know Likewise although we were not provided the data that there is a mechanical ventilation in the building. In summer supplies air conditioning to some of education classes and faculty offices.

Once known all the practices and resources on campus and in our building, we will study what we can do to increase energy efficiency and help to achieve the aim of reducing by 50% the carbon footprint in 2020.

Act

This section will develop specific measures to increase energy efficiency of what already exists on campus.

To improve the energy efficiency we have to consider three factors: The first one measure the reduction of energy demand in heating and cooling depends on the losses of heating loss and air permeability. Another factor is how efficiently the building meets that energy demand which depends on the efficiency of its heating, cooling, ventilation and hot water systems. Finally, one of the most important issues currently is the buildings CO2 emissions. That depends on the carbon intensity of the fuel and electricity used by the building. [2]

First and focusing on the consumption of heating, district heating is a good solution for the campus supply. Since it caters to low temperature (below 60 º C) losses are minimal, but the cost of investment is high. [] in Table 3 is shown the difference in heat loss, and differences between investments MTDH and LTDH system.

After examining existing technologies on campus exposed by the Energy & Environment Manager of Cranfield University [ ], plans go through further developing the district heating, to the school and residential halls buildings. Currently they are supplied with gas heating or electric heating, depending on the area.

There are technologies available to design a solar heating district as shown in Figure [] but having started college investment in a CHP system, it would not be economically profitable. So in terms of heat generation, we should focus our efforts on avoiding losses and improve the efficiency of CHP which is currently 37%.

Electricity, will develop in the part of planning, it will be a good natural resource installing photovoltaic cells on buildings. An example of this is already implemented on campus in the hall Stringfellow, 8 solar collectors facing south, and supplying electricity to the area.

We see that in terms of generating the university is making progress to meet the 2020 target, as with everything, you can do more. For example, in Figure [] we see a cogeneration system that uses waste heat to generate electricity as a heating source. It is compared energy consumption of a conventional system in which electricity is imported from the grid, and the necessary thermal energy is generated in a boiler. Against this, a schema of a cogeneration system. It is assumed that the performance in the generation and transportation of electricity are 35% and the boiler efficiency of 85%. In cogeneration have been a power generation efficiency of 35% and an overall yield of 85%. The cogeneration system 100 units of fuel consumed to produce 50 units and 35 units thermal power, while the conventional system that has the same production would consume 180 units.

We see then that the system established by the university is really useful; however, we should investigate new fuels for CHP, as although third reduced reliance on external electricity grid has raised gas dependence. In part of planning, will be considered which renewable fuels can help mitigating gas consumption for a more sustainable source.

In Table [] are shows CO2 emissions per kilogram of fuel in the generation of a KWh, hence, that our challenge must be, in addition to installing renewable technologies, we should research how to implement biogas, biomass or waste heat, as fuel of our heating and electrical supply.

Plan

In these paragraphs it will be develop specific ideas to increase energy efficiency with technologies that are not yet on campus and will be proposed as a sustainable energy resource.

Conceptualizing renewable technologies that could be implemented on campus, discard some being very interesting to study for installation in the UK, in the location of our study could not be conducted. In Table 1 we see renewable resources for electricity generation in the UK. Besides the geographical limitations which exclude (tidal, wave and offshore), neither will develop the study of deep geothermal because as shown in Figure [ ] Cranfield Campus is not in a rich zone in geothermal resources.

For onshore wind, although there are currently windmills in the surroundings of Milton Keynes, install a wind farm on campus is not covered in this report owing to the proximity of the airfield from college.

Given the enormous financial efforts being made by the university at the facility to extend the district heating, not recommending the implementation on the campus of solar energy as it is understood that the solar radiation not as great as in Greece or Spain, the unit of money invested in the implementation of this technology on campus make it more expensive than investing that money in developing other technologies. This does not mean they do not succeed in countries with less sun as Denmark, Germany, and the United Kingdom. Having the district heating technology, not have sense investing in the installation of this technology on campus. As an operation example, in the exhibit [] have the graphic reproduction of how solar thermal has worked in Denmark. []

The recommended option for installation on the campus of a renewable technology is solar photovoltaic, as most of our buildings are in use during daylight hours (buildings for teaching), these hours coincide with the peak in the system UK pricing, so a self-supply of electricity for each building, would be a considerable saving in the electricity bill of the university.

En la imagen [ ] vemos como en la zona donde se encuentra el campus la radiación solar está entre 1000 y 1100 kWh/m2.

Using Sunrise PV application, we can calculate the ratio produced KWh per square meter of PV installed. As shown in the graphs and tables, installing 220 m2 of PV electricity demand would cover the entire campus, as we saw earlier was approximately 28, 300 kWh and the power installed would cover up to 30, 000 KWh of demand.

Then, once the technological resources had been developed, we must focus on building design. It is very important to the design of the facade, because that directly affects the thermal and lighting needs. The relevant decisions are taken during the design phase of the building but in our case, we will propose some improvements. In the election of one kind or another facade will affect the type of ventilation (natural or mechanical), the glazing ratio and the influence of the type of shading in building orientation. [3] In the election of one kind or another facade will affect the type of ventilation (natural or mechanical), the glazing ratio and the influence of the type of shading in building orientation.

A measure difficult to quantify but important result is isolation savings. According to an environmental study on materials in residential, increasing from 10% to 20% glazing ratio, could save between 3-4% of the total heat loss of the building. [] This, coupled with an insulation of 20 cm with foam blocks on the roof, would the measures we have to implement in the building. [ ]

Other passive measures that need to be aware for installation and energy compliance targets can be: the lighting, motion sensors, and light control to not turn on the lights during the day. Implement measures to promote natural ventilation instead of mechanics installed would be optimal, as the 25 ° C maximum in summer that usually does, not enough for ignition. By implementing these passive measures would save to use it.

Do

In this last phase that presents the ISO 50001, we will focus on operational monitoring technologies that we have implemented on campus and in Building 40.

Now that we have researched and decided to do, it’s time to install the PV roofs around campus, always facing south. Look for the best fuel proposed for the CHP, and implement cost-saving measures in the building: insulation, windows with greater glazing ratio … But, how do we know if we have improved energy efficiency?

In our project, the potential savings generated needs to be verified and the actual energy use must be measured for comparison with the initial model to calculate savings. We will implement with the Metasys application which is a program for Microsoft Windows developed by “ Johnson Controls”.

Allows users control the functions of the buildings to be installed. Examples of these functions include: management systems air conditioning, lighting, security and other control options, using the infrastructure and building internal communications.

Using monitoring, control of HVAC, lighting, electrical and building strength with some simple calculations we get loads of ventilation, infiltration, heat transfer in walls and solar radiation in the building. These loads will be useful to calculate the final demand which requires the building in terms of energy.

Following this monitoring plan, confirm that we have installed a proper system and has the potential to generate the expected savings. Determine the value of the energy savings measures using data provided by the Cranfield Energy department. Will use this option as there is a high level of interaction between the systems installed energy conservation and savings measurement of individual components is difficult. All critical variables that affect energy consumption, as well as deadlines, need to be specified, to be considered in the model or not. The critical variables may be weather, occupancy patterns, breakpoints and operating programs.

It is necessary to know the outdoor climate, specifically the dry outside air temperature, relative humidity and global radiation on inclined surface oriented north, south, east and west, corresponding to the orientations of every building facade. The particulars relating to primary cooling system are collected by the Metasys program with a tendency to 5 minutes.

These measures are modeled as follows, is developing in Table X the meaning of each variable and its units:

$$LBul = LBasic - LVent – Linf – LHT – LSR$$

$$LVent = \dot{m}vent \cdot C \cdot \rho air (Texp – Text)$$

$$Linf = \dot{m}inf \cdot C \cdot \rho air (Tint – Text)$$

$$LHT = U \cdot A \cdot (Tint – Text)$$

$$LSR = ASE \cdot IG$$

It also collects data from direct radiation, diffuse and global horizontal surface every 5 seconds using a pyrheliometer, a band of shade and a pyrometer respectively. Accurate calculation of demand for heating and cooling and evaluation of energy saving.

Such improvement is based on the creation of software that monitors all variables for model creation characterization of cooling and heating demand continuously for 365 days a year. Thus, the model created daily, the software would be able to reproduce the expected demand and propose improvement measures appropriate for each situation.

Conclusions

This commitment translates into a change in EU legislation on efficiency; in order at substantially improve the efficiency energy of key sectors of energy consumers. However, legislation force in this regard will not cause alone saving enough energy to reach this target of 20% reduction by 2020. The main barriers to improving energy efficiency can be cited: Poor implementation of existing legislation, the absence of awareness among consumers, and the absence of habits conducive to investment as fundamental as building maintenance products and energy-efficient services.

With this report we have seen that ISO 50001: 2011 is not just a certification, it is also a way of stating a project. A project like the one shown here is constantly changing project. Once we had the one year data of Methasys we might suggest new and more accurate energy saving policies for our building.

In the next quarter century, middle-class consumers will increase by three billion in the world and will test the inexhaustible natural resources.

An international consulting firm had in its monthly magazine not long ago the following chart that I found interesting to share here:

As can be seen, energy efficiency in buildings is a valuable market for the future, not only for the ongoing maintenance and therefore investment, but because it must be remembered that reaches constitutes 50% of energy consumption of a country.

Therefore it is so important the investment in technology that the Cranfield University is going to perform, not only for the modernization and renovation of its campus, but also for the benefits that sustainable model we have proposed here will mean for future generations.