1 Energy supply and efficiency

Energy supply and efficiency are strongly related. At times when energy seems to be endless, the efficiency tends to be low. At times when the energy supply is becoming short, energy efficiency improves and new energy efficiency innovations are starting to be developed. Over the last two centuries, different events had an impact on the energy supply and effectiveness.

1.1 History of energy supply

At the beginning of human civilization, people started to harvest energy by collecting wood. In these days, it was mainly used for cooking and heating. Over time, humans began to find other energy resources, like coal and whale oil. In the mid-18th century the industrial revolution started and the demand for energy rose exponentially. In the 18th century mechanical energy was becoming popular for getting work done, such as the use of the steam engine. In the year 1839, Alexandre Edmond Becquerel discovered the photovoltaic effect 18 years before James Young distilled kerosene from petroleum the first time.

The discovery of kerosene, in the year 1857, could be seen as the start of the oil age and the energy supply from oil was considered to be an endless source. In the year 1973 the first oil crisis took place. The price of oil quadrupled in just a half a year because of an oil embargo by the members of the Organization of Arab Petroleum Exporting Countries. This shortage was the first time that the Western world realized how dependent they have become on fossil fuel and the region of its deposits.

In an effort to become less dependent on oil, the Western world pushed for additional research and development into nuclear energy sources. More reactors were planned and installed until the Chernobyl disaster in the year 1986. This “ultimate maximum credible accident” triggered the green movement in general.

The movement against nuclear power plants started to grow rapidly, especially in Germany. At the same time the idea of peak oil, which was developed in the 1950s, became more popular and concepts without fossil fuel and nuclear power were developed.

Peak oil, an event based on M. King Hubbert's theory, is the point in time when the maximum rate of extraction of petroleum is reached, after which the rate of production is expected to enter terminal decline [1]. The highest rate of extraction will be achieved in the next 15 years and most likely even in the next five years [1] [2]. When this point is reached, fossil energy will be more expensive, and renewable energy will be more price effective.

Renewable energy sources like photovoltaic cells, the photovoltaic effect of which was discovered even before kerosene, will become or already are cheaper than fossil fuel and atomic energy. Renewable energy sources are the energy sources of the future, even though their percentage in the energy mix is still small, as shown Figure 1-1. However, energy will not be as cheap as it used to be, and fuel needs to be used more efficiently.

1.2 History of houses regarding energy efficiency

In the past, people were accustomed to life in cold and drafty houses that did not present health hazards. These homes consumed an enormous amount of energy to provide limited comfort. After the oil crisis in 1973, people started to insulate their homes thermally. This thermal insulation improved the comfort of homes and reduced the energy consumption, but increased the risk of mold and fungi. For this reason, people lived in warm and drafty homes that turned out to be harmful to the occupants' health. Over the last 30 years, it became apparent that the mold and fungi problems are a condensation issue mostly related to the lack of airtightness and thermal bridging. A positive development has recently been seen; the industry is taking more care about the airtightness level and thermal bridging. New buildings are warm and draft-free whilst being healthy, but the high degree of airtightness brings new issues.

Because of the excellent airtightness levels, there is a lack of air exchanges. This lack is causing a rise in CO_2 and other air pollution levels and can cause moisture and health problems like the sick building syndrome. Sick building syndrome is used to describe situations in which building occupants experience acute health issues that appear to be linked to time spent in a building.

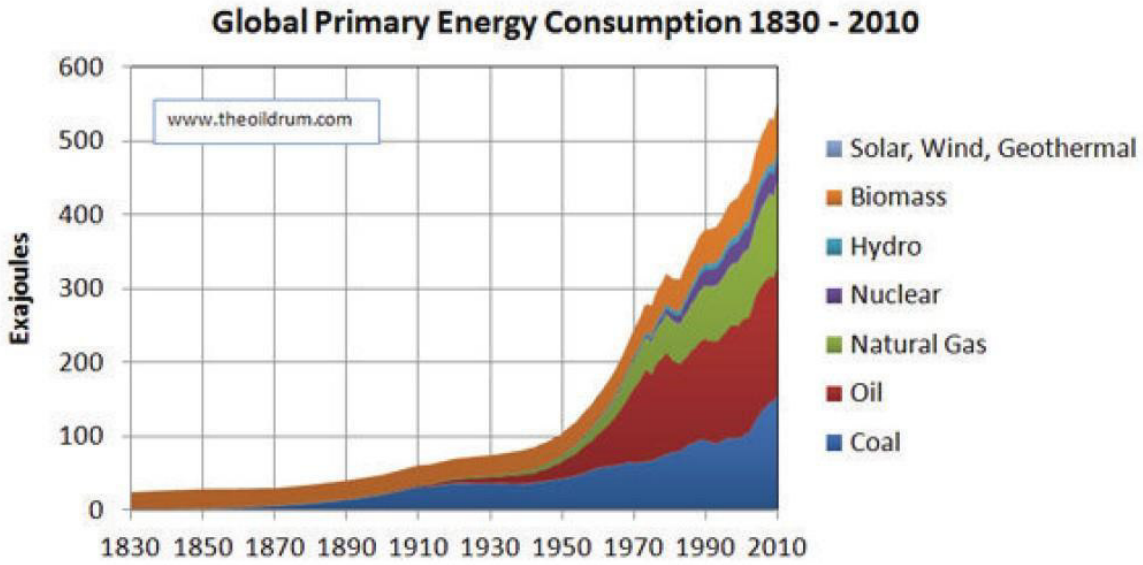

Figure 1-1 Global Primary Energy Consumption from 1830 to 2010 in Exajoules. [2]

1.3 Impact of energy efficiency on the design of houses in Australia

The price rise in electricity over the last five years in Australia was about 50 percent. The public wants a higher indoor comfort level in any climate. This comfort demand is pushing the energy demand and is putting stress on the Australian electricity networks. In Australia, the electricity bill is already seen as a second rent, and can lead to fuel poverty. Fuel poverty means that the occupants of a building cannot afford their energy bill any longer. This situation increased pressure on the government and the industry to develop new systems that are cheaper, faster and better than the existing ones. This circumstance explains the need for energy efficient homes.

A study in Queensland, Australia, shows the residential demand for electricity in the winter and summer is 43 percent of the peak demand. About 13 percent of the electricity network is only required on extreme temperature days and so is used for less than 1 percent of annual hours. This poor usage of the electricity grid is caused by the 74 percent of houses in Queensland that have an air-conditioning ventilation system in conjunction with a poor building envelope. The number of air-conditioners is rising in Queensland; about 3000 units were installed every week in 2010. Queensland invested $ AUS 15.6 billion in their electricity network from 2010 to 2015, which explains why 49 percent of residential electricity charges are network costs. The residents of Queensland experienced a price rise of 53 percent in the last five years. [3]

A lot of different concepts for energy efficient houses exist. The most common types are the low energy house, passive house, nearly zero energy house, net zero energy house, zero energy house, plus energy house and the active house. The passive house seems to be the most economic and well developed standard used worldwide and will be explained in the next section.

Sources

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[3] Australian Bureau of Statistics (ABS), "dme.qld.gov.au," 23 03 2011. [Online]. Available: http://www.dme.qld.gov.au/media. [Accessed 12 02 2015].