Factors influencing the energy use in building, Concepts of energy efficient building, Energy efficient buildings in Kenya

Factors influencing the energy use in building

Choosing energy-efficient building materials

Building materials both in the production phase should have energy-efficient features in the use phase. Energy-efficient building material properties are described below.

Local material: In the total energy consumption of constructions, the amount of energy spent for transportation of the construction materials to construction sites is considerable and also affects the constructions' energy efficiency and economical cost. For this reason, if the construction materials are local material and are manufactured in nearby places to the construction site as much as possible, energy consumption in transportation will decrease and that saving in transportation will give the construction an important ecological quality.

Recycled resources: A large amount of energy is used in manufacturing many building materials. In the manufacture of building material, using recycled sources instead of the sources which are not newly processed material provides a considerable preservation of raw material and also a considerable amount of energy saving. Recycling building materials are essential to reduce the embodied energy in the building; for instance, the use of recycled metal makes considerable energy savings between the rates of 40 and 90% comparing the material produced from natural resources.

Materials manufactured through low density industrial processes: Building materials play a significant role in the energy efficiency of buildings. A large proportion of the total energy used during the building life cycle is consumed during the production of building materials (especially embodied energy). The proportion of the energy amount consumed in the manufacture of construction materials to the total energy amount of a construction with a 50-year process of use consumes in its life cycle processes varies between 6 and 20% depending on the construction methods, climate, and similar conditions. The intensity of energy consumption in the first of these phases for the production of buildings and their components has increased with industrialization. Nonexistence of heavy procedures in the manufacturing process will cause less energy consumption, which provides energy efficiency to materials. Using the developed technologies in industrial processes such as a heat recovery method reduces energy consumption. For instance, in cement manufacturing technology, using the shaft furnaces instead of the conventional rotary furnaces makes energy saving between 10 and 40%. Similarly, the use of an arc furnace instead of a rotary furnace in the steel industry makes about 50% energy saving.

Natural materials that are quickly obtained from renewable resources: Generally, the energy content of natural materials is lower than that of artificial materials since these materials are manufactured with less energy and labour cost. Such kinds of materials which are easy to be locally provided are generally among the renewable resources. Such vegetal materials used in constructions for instance, wood, bamboo, reed, straw, rye stalk, sunflower stalk, mushroom are the natural materials which are quickly gained from renewable sources.

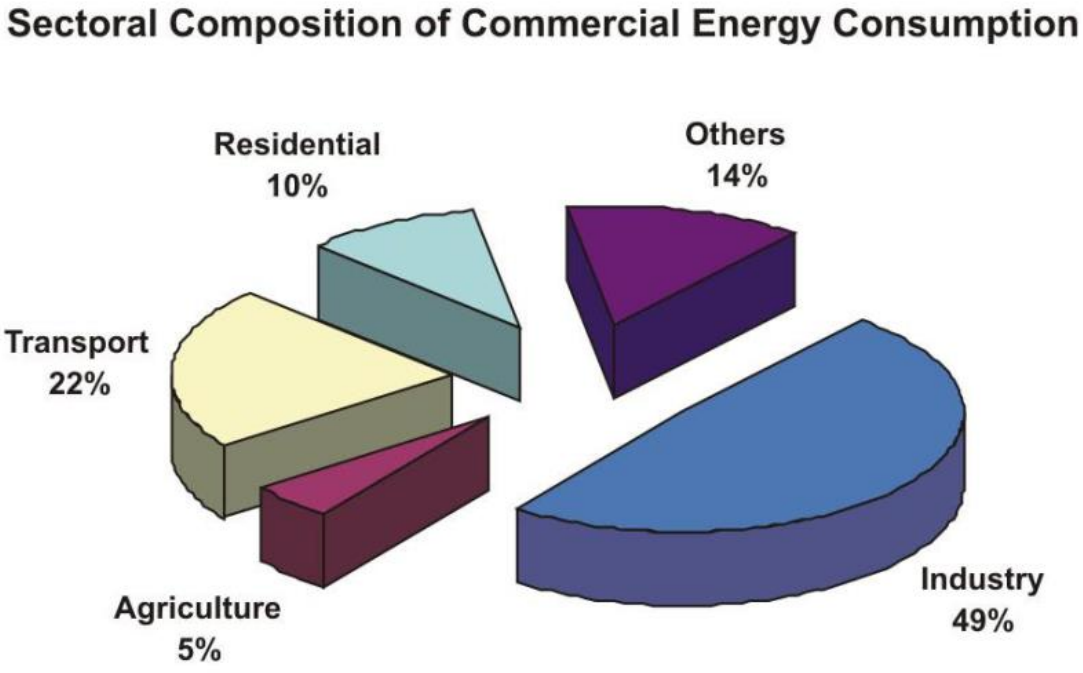
Labour intensive materials: Using highly qualified man power in manufacturing materials will reduce the processes based upon industry, and accordingly decrease the energy consumption. Materials manufactured by using renewable energy resources: especially renewable energy resources (solar energy, wind energy, etc.) instead of fossil fuels should be preferred as a primary energy supplier in the manufacturing process.

Materials consuming less energy during the worksite process: The management of worksite, the need for electricity energy, and machines in operation, heating, and lightening affect the energy consumption of the worksite. As a result of the increase in mechanization in worksites, the electricity consumption has increased considerably as well.

Use of durable building materials: Use of durable materials in the buildings makes them more resistant and long-lasting against various factors. This delays or eliminates the need of renewing material or maintenance due to impairment and aging. In this way, it is saved from the energy spent for the material to be used in maintenance or renewing.

Building materials with high thermal insulation capacity: With the choice of building materials whose thermal insulation capacity is high, the energy amount that the construction consumes in its usage stage will be decreased. As mentioned as examples are opaque and translucent insulating materials.

Commercial energy consumption pie



Concepts of energy efficient building

Kenya has come a long way from using the traditional forms of energy entities for day to day uses such as firewood for preparing meals to solar panels with car batteries for households to power their homes.

Renewable Energy

The record of the national utility Kenya Power and Light Company (KPLC) in rural electrification has improved over the years from 2002 after the rural electrification program was launched by former president Mwai Kibaki. But still the rate of grid-based rural electrification is far below the rate of increase in potential customers, despite a levy on electricity bills to fund it. Innovative approaches to off-grid electrification are helping to make up for the lack of grid-based rural electrification. One of the attempts to address this is the establishment of the Rural Electrification Authority (REA) in 2006 which now manages the rural electrification programme.

Biomass

Due to increased poverty, there is a significant shift to non-traded traditional biomass fuels. The proportion of households consuming biomass has risen because it is cheaper and very affordable as compared to electricity. The Biomass Energy Resources in Kenya like firewood, charcoal and agricultural wastes contributed approx. up to 70% of Kenya’s final energy demand and provided for almost 90% of rural household energy needs, about one third in the form of charcoal and the rest from firewood. According to the 2019 Kenya Population and Housing Census, 55.1% of Kenyan Households use firewood for cooking followed by 23.9% using LPG.

Charcoal, firewood, paraffin, and LPG continue to be the main sources of cooking fuel and heating up homes during cold seasons. Almost 90% of the rural population is dependent on firewood for cooking and heating, whilst in urban areas approximately 10% of the population use firewood. Firewood is increasingly supplied from private smallholder lands and farm woodlots. Charcoal, on the other hand, is mainly an urban fuel, 82% of urban households depend on it as part of their energy mix, compared to 34% of households using charcoal in rural areas. One set of biomass users includes educational institutions (primary and secondary schools, as well as colleges). Of Kenya’s 20,000 educational institutions, about 90% use wood fuel to prepare meals. Due to rising petroleum prices, recently also the industry gained more interest in wood-based fuels. Charcoal is produced inefficiently using tradition earth kilns whose efficiency range between 10–13% yet higher recoveries of between 30-40% have been achieved using brick kilns. Biomass comes from various forest formations such as closed forest, woodlands, bushlands, wooded grasslands, farms with natural vegetation and mixtures of native and exotic trees, industrial and fuel wood plantations, and residues from agricultural crops and wood-based industries. However, although there are apparently large wood volumes available from the various vegetation types, not all of it is accessible for energy. Accessible depends on a number of factors such as legal issues, environmental issues, ownership, objectives of management, distance, and infrastructure. Additionally, most of the population are engaged in production, transformation, transportation and sale of wood and charcoal, making it one of the most important sources of paid livelihood. As a result, woody biomass is diminishing due to poor management and utilization in unsustainable ways. Government ministries are supporting in one way or the other the sustainable production of energy crops, trade of charcoal and the dissemination of improved cooking stoves.

Kenya has the potential for generation of electricity from biomass sources generated from agricultural wastes from the sugar cane (biogas), sisal, timber (sawdust) and meat industries. The development of a bioenergy industry can improve energy security, reduce energy imports, and promote the agricultural and forestry sector by adding value to traditional crops. It further plays an important role in off-grid electrification of rural regions, can bring health benefits and reduce pressure on the environment. However, biomass feedstock can also endanger ecosystems and biodiversity, especially when being cultivated in monocultures. In plantations, large amounts of water are needed for irrigation and agrochemicals must often be added which can lead to water pollution. Therefore, it is essential to find a balance between opportunity maximization and risk minimization for which a well-defined regulatory framework is essential.

Biogas

Although there are several thousand biodigesters installed in Kenya, most of them operate below capacity or are currently in disuse due to management, technical, socio-cultural or economic problems. Biogas is widely used in institutions due to their high potential of waste utilization for biogas generation. Several pilot programs have been established. Biogas can be used not only for cooking purposes but also for heating up buildings with the right set up in place.

Hydropower

Hydropower is the single largest generation source for grid electricity in Kenya providing some 677 MW of the total installed grid capacity. As of 2007, a 60 MW hydro generation plant was being developed on the Sondu Miriu with a further 20 MW planned for 2008. With the exception of Turkwell Gorge (Rift Valley) and Sondu Miriu (Lake Victoria) some 470 MW or 70% of the total developed hydro capacity lies on the Tana River alone. Properly managed, this form of energy generating source could ease up the high energy bills required to power homes and provide energy needs.

Solar Energy

Kenya has high insolation rates with an average of 5-7 peak sunshine hours (The equivalent number of hours per day when solar irradiance averages 1,000 W/m^2), and receives an average daily insolation of 4-6kWh/m^2. Only 10-14% of this energy can be converted into electricity due to the conversion efficiency of PV modules. Kenya introduced a VAT on solar products totalling 16% in Q3 2013, but the government has now decided that it will dismiss this tax in a move to cut cost of renewable energy products. Member of National Assembly (MP) Mr. John Mbadi introduced the motion to nix the VAT in April, with it taking effect on May 30. Solar products in Kenya were already on the rise, and now expect to see even more products – particularly in the off-grid arena – grow even more.

Since 2006-2007, the Ministry of Energy has been actively promoting use of solar energy for off grid electrification. In particular, it has funded the solar for schools' programme and is targeting to extend this to off grid clinics and dispensaries.

Energy efficient buildings in Kenya

Examples include: Two rivers mall which is entirely run on green energy (solar), Total petrol stations which have managed to move up to 80% of their stations country wide to using green energy and they plan on reaching 100% amongst others. Let us now list a few energy sources for building in Kenya:

Solar Home Systems (SHS)

An estimated 200,000 rural households in Kenya have solar home systems. This success has been largely due to private sector activity. The high level of uptake has been through the sale of products that best fit the purchasing power of rural households, and by making these products available within the mobility range of potential customers, typically less than 40km from the customers' home.

In mature market areas, such as central and western Kenya, between 20 and 40% of households have systems. Most units are in the power range of 10 to 20 Wp. With prices being as low as US$50, the products have been affordable by medium class families without a need for subsidies and credit. However, financial assistance will be necessary for poorer families to be able to afford an SHS. Most of the SHS traders started selling these products in the 1990s.

As the Kenyan business culture is mainly based upon imitation, once a few shops had been convinced by the Nairobi based distributors, businessmen all over the country replicated their success by selling systems. The level of competition is high with over 800 rural outlets, and by shopping around even the least informed end-user will buy at a reasonable price. Information from friends and relatives is currently the main source that new customers turn to for advice on the best system to use, as the shopkeepers are rarely trusted.

Solar Hybrid mini-grids

Currently (as of 2019 according to the 2019 Kenya Population and Housing Census), only about 65 percent of the Kenyan people have access to electricity. In remote areas electrification rates can be as low as 15 percent. Improving the access to modern energy services in rural areas remains a major development priority. In order to achieve this goal complementary solutions to grid extension, such as solar-hybrid mini-grids are necessary.

Wind Energy

The Equatorial areas are assumed to have poor to medium wind resource. This could be a general pattern for Kenya. However, some topography specifics (channelling and hill effects due to the presence of the Rift Valley and various mountain and highland areas) have endowed Kenya with some excellent wind regime areas. It is expected that about 25% of the country is compatible with current wind technology. The main issue is the limited knowledge of the Kenyan wind resource. The meteorological station's data are quite unreliable while modern measurement campaigns have started recently for investigating wind park locations. Kenya has 35 metrological stations that are spread all over the country. Information gathered is not adequate to give detailed resolutions due to sparse station network.

Geothermal Energy

Kenya is endowed with geothermal resources mainly located in the Rift Valley. It is estimated conservatively that the Kenya Rift has a potential of greater than 2000 MW of geothermal Power. Geothermal utilization first started by drilling two wells in 1956 in Olkaria and was followed by increased interest in the 1970s. Initial production started in 1981 when the first plant of 15MW was commissioned in Olkaria. Currently 45MW is generated by Olkaria geothermal power station, 70 MW by Olkaria II (both operated by KenGen) and an IPP is producing 12Mwe at Olkaria III. KenGen and the IPP produce a total of 129 MW of geothermal energy and this is expected to increase to 576MWe within the next 20 years. The national geothermal potential is estimated at between 7,000 and 10,000 MW.

In Kenya's Least Cost Power Development Plan, geothermal power has been identified as a cost-effective power option and the Geothermal Development Company (GDC) was set up to fast track harnessing Kenya's vast resources. Explorations for geothermal energy in the high potential areas of the Kenyan Rift are now ongoing. KenGen, together with the Ministry of Energy conducted surface scientific studies in Suswa, Longonot, Eburru, Menengai, Arus and Bogoria, Lake Baringo area, Korosi and Chepchuk, and Paka. Preliminary results indicate significant potential of geothermal power in these prospects. Six exploratory wells were drilled at Eburru. Recent studies show that the Eburru area can sustain 25 MW of electric power.

Fossil Fuels

Petroleum is Kenya’s major source of commercial energy and has, over the years, accounted for about 80% of the country’s commercial energy requirements. Kenya had one refinery, the Mombasa refinery, with a nameplate capacity of 90,000 barrels per day. Since its commission the refinery has not operated at full capacity.

As of 2007 there were 4 prospective petroleum basins in Kenya, about 30 exploration wells had been drilled and although none has encountered a commercial discovery, a number of drill stem tests have recovered or tested gas. In 2012 significant oil reserves were discovered in North Western Kenya. Studies are still being carried out to establish the economic feasibility.

LPG

Consumption of LPG has increased by about 59% between 2003-2008 from 40,000 to 80,000 metric tons/year. The Kenya Petroleum Refinery makes about 30, 000 metric tons of LPG and to balance growing demand reliance on imported LPG has increased. However, there are plans underway to upgrade the refinery to make 115,000 metric tons of LPG.

Coal

The Ministry of Energy has identified two areas with possible commercially exploitable quantities of coal. These are the Mui basin of Kitui and Mwingi Districts and Taru basin of Kwale and Kilifi Districts. As of 2007, 10 wells have been drilled in Mui basin with encouraging results indicating possible existence of commercial quantities of coal.

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