Financial and Energetic Investigation of Saudi District cooling system

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Overview

Cost optimal analysis technique was employed to assist the performance of building in order to minimize the energy consumption [1]. District energy (DC) is a pipeline infrastructure covering urban areas that connects thermal sources to thermal sinks. " as shown in figure1 [2]. "The results indicate that DC is responsible for a minor part of the useful energy demand of Europe for cooling with around 3 TWh/y." [3]. Compare to a conventional air-conditioning systems, applying district cooling technology (DC) can significantly reduce the energy consumption for cooling purposes. Basically DC is a combined cold resource system designed for distributing chilled water via a fluid based pipe network to meet buildings cooling demand of the end-users [2].

The plan of Ministry of Housing in the Kingdom of Saudi Arabia included 133 residential projects which will provide 154,676 accommodation units. employing DC systems in this project is expected to provide a significant impact on reducing energy consumption and gas emissions. Based on cooling load profile, the overall capacity was determined. A case study for a new campus in Saudi Arabia is studied to find out the energy consumption based on the local rate for electricity at 2022. Load of air-conditioning for a typical house is considered to investigate energy saving based on the season throughout the year [4]. This study included the cost estimation of the proposed system compared to a unitary system. The impact on the energy saving and the environment was highlighted.

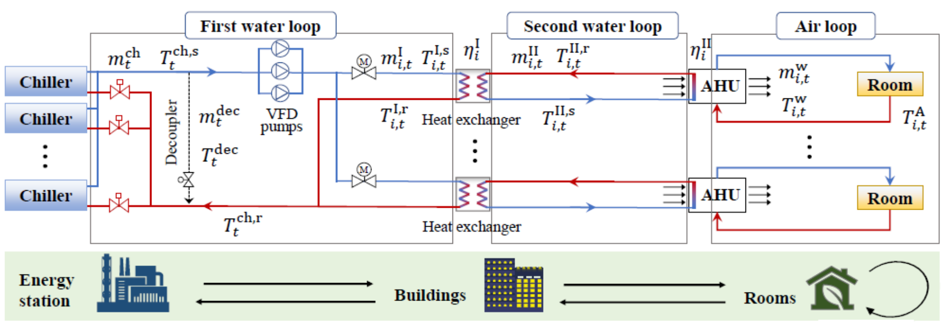

Figure 1 Schematic diagram of a district cooling system [5].

Globally needed for energy are supplied 75% from convention resources such as fossil fuel [6]. 10% of worldwide CO2 emissions are brought on by refrigeration and air conditioning[7]. There are generally two types of air-conditioning systems unitary and centralized systems which usually have better energy performances. Employing District cooling systems (DC) technology is expected to reduce annual energy consumption by15% and also reduce carbon emissions by 15.0% [8]. Some of advantages of DC systems combines the chillers required in each building into a central plant, reduction in the cost of equipment in the building, more space on building roofs and help to reduce energy consumption, gas emission such as carbon dioxide. DC has been a subject of research since the late of the nineteenth century when the refrigerants was the main fluid in the piping system. The second generation of the DC was based on the water as a distribution fluid that supplied child water to the demanding zones. The third generation was based on mix of cooling sources such as adding natural cooling rather than depending on just a compression chiller. The fourth generation of DC employed renewable energy , smart control system and also district heating system [2].

Win-win situation between the end-user and the investor of district cooling systems. 37 commercial and residential building were designed to be supplied by DCS. Several groups of chilled water systems were supplied 3400 refrigeration tons. Ice storage system reduced approximately 4% of the operation cost. It was recommended that to employed a power generating system which saved approximately 30% compared to conventional DCS [9]. DC provide an opportunity to utilize local resources to produce cooling. This included utilizing renewable energy, waste energy or free cooling. The efficiency of DC systems exceeded times higher than a conventional air-conditioning. More space instead of equipment on the buildings roofs as well as less noise. Analyzing the demand for cooling and potential end-user is the first step for the feasibility study of DC [10] [11]. A case study in Riyadh investigated the performance of Solar district cooling system to supply a compound of several villa [12]. Figure 2 represents a cooling load in a typical villa in Riyadh throughout the year which required a cooling power up to 48 KW to meet the cooling demand in the peak time in the summer.

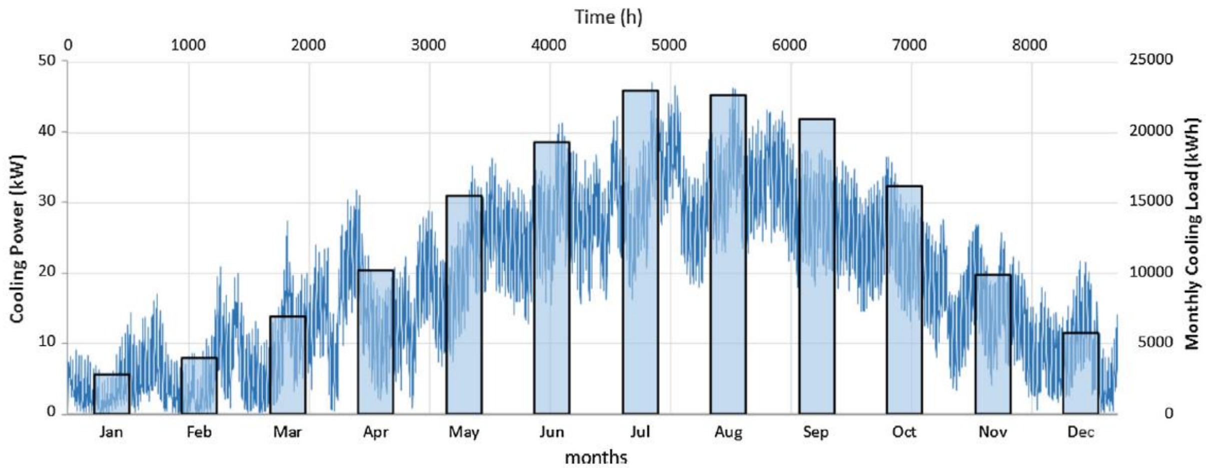

Figure 1 Cooling load in a typical villa in Riyadh throughout the year [12].

New campus on Saudi arabia has been taken as a case study. The focus was on air-conditioning load on building which is affected by the bulding insulation. A modified bin method was employed to optimize the energy efficiency ratio (EER) [13]. Approximately 213 USD billion required to be invested I desalination and electricity sector to meet the Kingdom demand [14]. The DC network infrastructure, which frequently constitutes the largest initial investment in a DC system (i.e., typically 50–75% of the total cost), requires careful design and optimal operation[15].

Methods

The plan of Ministry of Housing in the Kingdom of Saudi Arabia included 133 residential projects which will provide 154,676 accommodation units. A case study in Riyadh from the Ma'ali Annan project is taken to analyze the cooling load and electricity consumption. The project includes 440 housing units available in one type of housing unit (villa). The project is located on an area with approximately 105,000 square meters. Energy consumption was calculated and CO2 emissions was estimated based on [16] for different alternative cooling systems. To meet the cooling load which is approximately 22 RT for a Villa in this project,13 conventional air conditioner units suggested to be installed as a reference system.

Results

For a typical house in the case study, a reduction in energy consumption, when replaced unitary units with EER of 7.5 to units with EER of 12, was 1497.6 KWh/Month. This represents a saving of approximately 270 SR/Month of the electricity bill. A reduction of CO_2 emissions was 711 kg/Month for each house.
The reduction on the energy consumed by the residential project for the cooling system when moved to DC was in the range of 59.304 MWh/month to 0.415 GWh/Month which lead to reduce CO_2 emissions to the range up to 0.2 kt/month

Conclusions

Economical and environmental updated results of residential energy sector were reported in this study. Utilising DC to meet the demand for air-conditioning systems in atypical project in Saudi Arabia was evaluated economically and environmentally. A case study was investigated to analyse energy consumption based on the local rate electricity. Employing DC technology is expected to reduce monthly energy consumption up to 0.975 GWh/Month and also reduce carbon emissions by 0.463 kt/month. Environmental index which included CO_2 emissions, net savings with the proposed system and Levelized COE (nominal) were also investigated.

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