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Economic Feasibility Study of Ground Source Heat Pump in Al-Musayyib Hospital

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Abstract : In this research the calculations of consumption electric energycost in summerseason (May to September, 150 day) and winter season (December to February, 90 day) were performed by using the coefficient of performance percent for each air and ground source heat pump. The place of study case take relative to solar path in to account and the study case was three halls (men, women, and surgery halls) in Al-Musayyib hospital in Babylon.
Keywords : Cost of consumption electric energy cost, Ground source heat pump, Hospital halls, Coefficient of performance percent.

Introduction

Ground source heat pumps are characterized by high capital costs and low operational costs compared to other HVAC systems. Their overall economic benefit depends primarily on the relative costs of electricity and fuels, which are highly variable over time and across the world. Based on recent prices, ground-source heat pumps currently have lower operational costs than any other conventional heating source almost everywhere in the world. Natural gas is the only fuel with competitive operational costs, and only in a handful of countries where it is exceptionally cheap, or where electricity is exceptionally expensive. In general, a homeowner may save anywhere from 20% to 60% annually on utilities by switching from an ordinary system to a ground-source system[1].

Ground source heat pumps are recognized as one of the most efficient heating and cooling systems on the market. They are often the second-most cost effective solution in extreme climates (after co-generation), despite reductions in thermal efficiency due to ground temperature. (The ground source is warmer in climates that need strong air conditioning, and cooler in climates that need strong heating.), Commercial systems maintenance costs in the US have historically been between \$0.11 to \$0.22 per m^2 per year in 1996 dollars, much less than the average \$0.54 per m^2 per year for conventional HVAC systems[2].

Governments that promote renewable energy will likely offer incentives for the consumer (residential), or industrial markets. For example, in the United States, incentives are offered both on the state and federal levels of government. In the United Kingdom the Renewable Heat Incentive provides a financial incentive for generation of renewable heat based on metered readings on an annual basis for 20 years for commercial buildings. The domestic Renewable Heat Incentive is due to be introduced in Spring 2014 for seven years and be based on deemed heat[3].

The Study situation

Ground source heat pumps (GSHPs) are well-established systems that can economically heat and cool buildings. Hospitals are promising settings for GSHPs because of their year-round and often round the clock heating and cooling requirements.

GSHPs utilize a ground or groundwater heat exchanger, taking advantage of the relatively constant temperature of the earth just a few meters below the surface. This approach makes GSHPs far more energy efficient than conventional heat pumps (ASHP), which use the outside air as the heat exchange medium and must compensate for wide seasonal variations in air temperature.

In the present work an open loop ground source heat pump system was used to cast the water from depth 20m and applied on Al-Musayyibhospital. The three main halls, which are men, women, and surgery halls, were the cases of the present study (see Figure 1). The characteristics of these halls are listed in Table 1.

Table 1: Characteristics of halls (case study) in Al-Musayyibhospital.

Hall name	Design Temperature (^oC)	Space Volume (m^3)
Men Hall	22	258.4
Women Hall	22	224.5
Surgery Hall	22	225.6

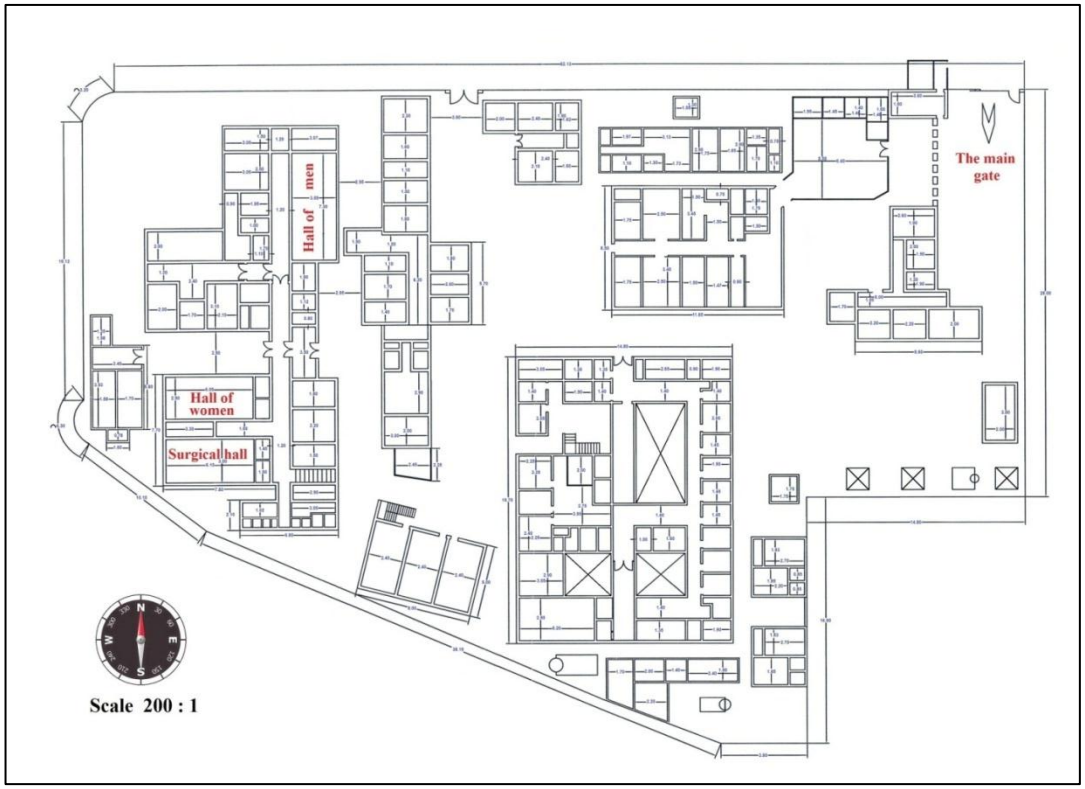

Figure 1: The configuration of al-Musayyibhospital.

Results and discussion

The cost has a relation with the consumption electrical energy, where the one kilo watt accepter one cent or 118 Iraqi dinar (ID) therefore,

$Cost = 118\ P_{con.}(\text{ID})(1)$

or in thousand Iraqi dinar (TID),

$Cost = 0.118\ P_{con.}(\text{TID})(2)$

The GSHP was used in cooling and heating systems. It was operating 24 hour per day. The cost details are listed in Tables 2 and 3.

Table 2: Energy consumption and cost in summer.

Time	Elctrovalency ($/KWh)	Operation time	Energy consumption (KWh)	Operation cost ($)
8AM-8AM	0.11	24 hours	50.09	5.5093
operation season		150 day	7513	826.43

Table 3: Energy consumption and cost in winter.

Time	Elctrovalency ($/KWh)	Operation time	Energy consumption (KWh)	Operation cost ($)
8AM-8AM	0.11	24 hours	22.733	2.5007
operation season		90 day	2046	225.06

Operation cost of one year = cooling cost + heating cost = 1051.49 $

Figure 2 and 3 show the cooling and heating cost, respectively in thousands Iraqi dinars (TID, 1$=1.18 TID), of the case study space in summer season for the conventional cooling system (ASHP) and ground source heat pump cooling system. It is appearing that the GSHP cooling system save about 40% of the total cost of ASHP.

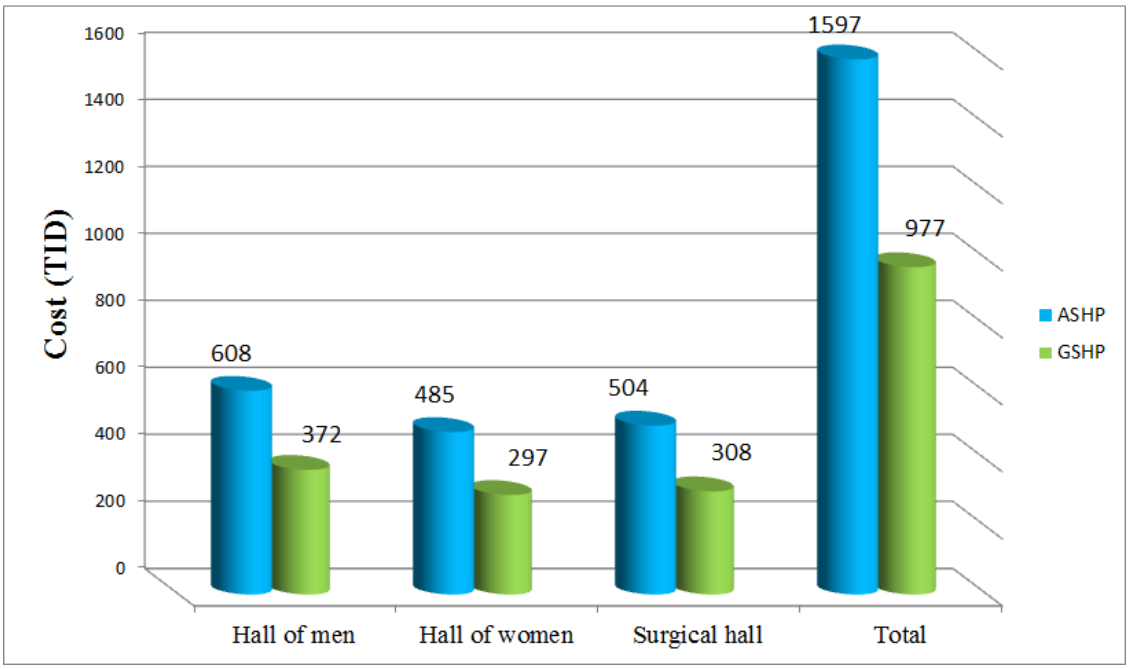

Figure 2: Total cost of consumption electric energy by using ASHP and GSHP for all halls in summer.

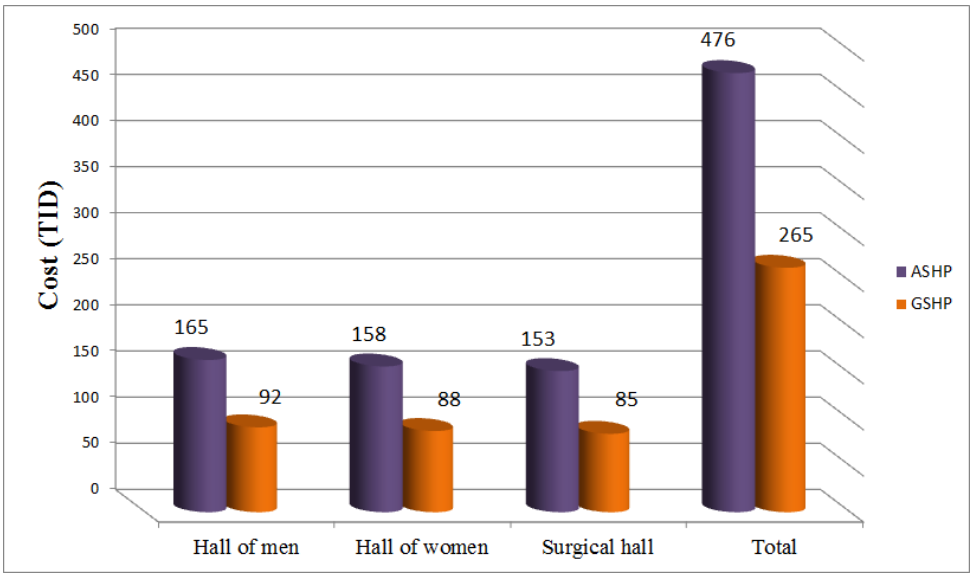

Figure 3: Total cost of consumption electric energy by using ASHP and GSHP for all halls in winter.

For ASHP cooling and heating system the total cost per year is:

Operation cost of one year = cooling cost + heating cost

= 1351.79 $ + 402.05 $ = 1753.84 $

Thus the total cost saving that is achieved by the GSHP for heating and cooling processes was about 40%. and the initial cost of the GSHP equipment is shown in Table 4,

Table 4: Initial cost of the GSHP equipment.

Equipment	**$**
Heat pump	750
Ground tubes	170
Borehole digging	900
Installation	100
Others	100
Total cost	2020
Bay back	2.88 year

Conclusion

It can be concluded that the GSHP can offer the benefits of reduced energy bills, and reduced maintenance costs.

Refrences

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