American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)
ISSN (Print) 2313-4410, ISSN (Online) 2313-4402

http://asrjetsjournal.org/

Simav Sample in Automated Control of Geothermal Heating System

Nurullah Kıratlı[a*], Şükrü Kitiş[b], Kudret Armağan[c]

[a]*Simav Faculty of Technology, Dumlupınar University, Simav, Kütahya, TURKEY*
[b,c]*Simav Vocational School, Dumlupınar University, Simav, Kütahya, TURKEY*
[a]*Email: nurullah.kiratli@dpu.edu.tr*
[b]*Email: sukru.kitis@dpu.edu.tr*
[c]*Email: kudret.armagan@dpu.edu.tr*

Abstract

A major part of energy requirement is provided by fossil-based energy product today. New and renewable energy resources are came up because of decrease in current consumable fossil energy resources and environmental problems resulted from some resources. Among these resources, geothermal energy is the only energy resource that is environment friendly and is used without foreign-dependent. In this study supported by Zafer Development Agency, the control of geothermal energy system by automation was provided in Kutahya, Simav town, which has 25.500 population, and around 90 percent of population utilizes geothermal energy for heating and hot water requirement. A pilot area involving 30 geothermal subscribers, district heating center and main heating control center in 101 Evler District was determined and automation system was installed. Energy, pressure, temperature, and flow values needed by selected geothermal energy subscribers were identified. Electricity expenditure leading of the biggest expenditures in geothermal utilization of Simav Municipality was saved up at the rate of 68 percent by means of automated controlled energy given to system. Meanwhile, efficient utilization of geothermal energy resources was ensured according to Energy Efficiency Law with act numbered 5627, as well. At the end of the result, electricity expenditures for January 2013, February 2013, January 2014, and February 2014 were compared in 101 Evler district chosen as pilot area, and it was detected that the difference between January 2013 and January 2014 is 8.124 TL and the difference between February 2013 and February 2014 is 8.657 TL. Electricity saving of 16.691 TL for only two months shows that automation system was reached to desired goal.

Keywords: Geothermal Energy; Automation; Energy Efficiency; SCADA.

---

* Corresponding author.

1. Introduction

Geothermal energy is an independent energy resource from outer environment by its nature. Therefore, its usability is pretty much and it's the most stable one among other energy resources. Besides, geothermal energy doesn't require any storage or transportation process. It reduces the necessity of imported fossil fuel due to it is clean and local energy resource [1,2,3]. The most important renewable resources for the Turkish energy sector are geothermal, wind and solar. The utilization of geothermal energy and its contribution to the economy of Turkey has been increased from day to day [4-5-6]. Turkey is among lucky countries with regards to geothermal energy and it takes third places in the ranking of renewable energy sources and their usage [7]. Turkey takes first rank in Europe with detected 170 geothermal areas and around totally 1000 hot and mineral water that lower temperature limit is accepted as 20^0C [8]. Business goal in geothermal area heating system is to minimize electricity expenditure of system, while supplying heat energy to consumers who needs it. In order to reach the business goal, it's required that all pumps need to be operated according to changing system heat load and in the way of the most productive, from production to distribution [9]. Renewable energy systems have mostly been developed to serve the electricity needs via a network utilizing locally available energy resources [10]. Renewable energy is accepted as a key source for the future, not only for Turkey but also for the world. Modern building automation systems do not only provide improved comfort but also offer significant energy cost savings [11-12].

As geothermal energy plays an important role in health tourism, it has usage area in many subjects such as city heating, electricity production, dry ice and CO_2 production, green housing, and growing fish. Geothermal energy is used in Simav as pretty extensive. It has usage area in heating of city and public buildings, hot water utilization in houses, heating systems in some green houses. While it has pretty advantageous structure for consumers, there is also a matter of some problems. One of these problems is that geothermal energy is not unlimited as specified "providing energy necessity of the country adequately, reliable and economically in the way of supporting and leading objective economic growth and social progress, and also considering environmental impact" [13] in Energy Efficiency Law with act numbered 5627 went into effect in official gazette with act numbered 26510 in May 2, 2007. Another problem is that electricity bill expenditures are too much with regard to local government because of wrong operation.

In this study, it was switched to automation system by choosing a pilot area in terms of efficient utilization of geothermal resources, as well. A district automation center to control automation system in pilot area and a main automation center with the objective to provide controlling whole city by Simav Municipality in future years were installed and were brought into service. This project was performed as 50 percent supported by Zafer Development Agency [14-15].

2. Material and Method

2.1. Material

In the current system, electricity expenditure takes the biggest percentage of business expenditures. This expenditure corresponds to 60 percent of business expenditure approximately. This study was done on the

purpose of providing both more profitable and stable heating of business.

The steam getting out from geothermal wells comes to cooling center via pipes and is lowered to 96 ^{0}C after being treated distillation and cooling process via engines in various sizes. Later, it is pumped with 94 ^{0}C in wellhead heat exchanger building to inner city heat center locating 4 km away. Hot water is transmitted from a second heat center in city center to ultimate users. Meantime, there is unbalanced energy distribution between subscribers given heat in districts and streets because of heat and flow differences. In this situation, extra energy because of overheating is released via opening window by subscriber in a district, while subscriber in another district complains about not heating enough. In the study, the project consists of 3 main parts as main control center, 101 Evler automation center, and 30 building entrance; Main Control Center: Automation center control scheme working with SCADA (Supervisory Control and data Acquisition) software is as shown figure 1. It was designed as collecting data sent from center districts through R/F receiver-transmitter, evaluating these data, and sending supervisory information to district according to these evaluations (Figure 2). It only takes data coming from 101 Evler District, analyzes, and also dominates to 101 Evler District currently.

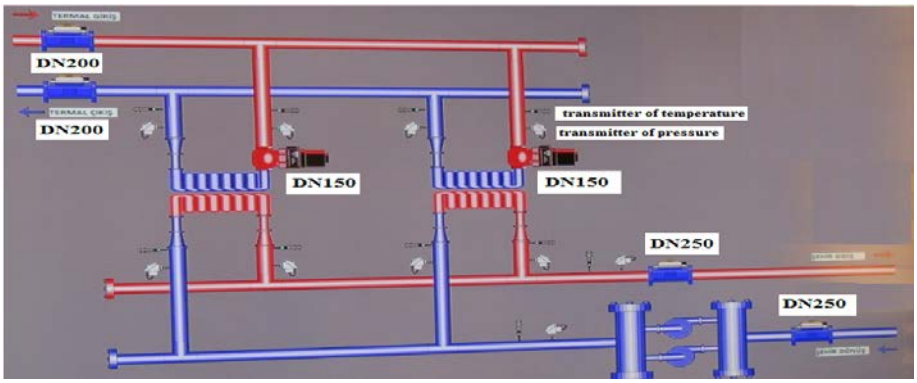

Figure 1: Automation Center Control Scheme

Figure 2: Automation Center Collecting Data

There are 2 DN150 proportional flow control valves, 2 DN200 electromagnetic flow meters (Figure 3), 10 PT100 temperature transmitters, 10 pressure transmitters, 2 55 KW Frequency convertors, 1 set of 2.4 MHz R/F modem, 1 set of 433 MHz R/F modem, 1 set of PLC and dashboard in 101 Evler heating center. In building

entrances, there are DN32 calorimeter Modbus, DN proportional valve, PLC, R/F modem (Figure 4). In main control center, there are SCADA system, telemetry, and R/F receiver-transmitter.

Figure 3: 101 Evler heat center

Figure 4: Under building control point

Automation center in 101 Evler district was designed as taking, processing and checking information from 30 building entrances that is done as example by R/F receiver-transmitters. It transmits these collected data to main control center and it has processing properties of supervisory information coming from main center. District center is considered as suitable to develop again yet. It is calculated how much temperature and pressure this district needs by data coming from 30 houses, it is economized from electricity and geothermal resource by

running valves due to frequency convertors as suitable to this calculation.

2.2. Method

Measurements of designed and produced system for same months were performed on the purpose of investigating the effect of pressure, temperature and flow controls in automation. First measurement was conducted as January 2013-February 2013, and second measurement was conducted as January 2014-February 2014.

Electricity expenditures in heating center for heating period and heating of subscribers connected to 101 Evler District heating center chosen as pilot area for specified period were measured.

2.2.1. Measurement of Electricity Expenditure

After the automation was done, electricity consumption was continuously measured. However, Electricity consumption for the months of January and February that belong to 2013 and 2014 was considered in the study since the coldest months of the region are January and February.

3. Results and Discussion

Economic development and social welfare create an increasing demand in energy consumption. It's encountered with difficulties such as environmental problems and security problems in energy supply to compensate this demand.

The only way for both living same welfare and compensating the increase in energy consumption is that increasing energy efficiency and saving up in used electricity energy. Energy efficiency is the conversion of every unit of energy spent to more service and product. Increasing energy efficiency leads the most talked and worked subjects of the world, especially after initiatives about climate change.

With this study, it was provided to be used geothermal energy having an important heating potential as comfortable heating tool by considering "energy management" fundamentals with an ecological approach, and to be brought "energy tracking and control system" by installing the example in Kütahya province, Simav town to an applicable state for other regional heating system.

As a result of both measurements, electricity consumptions and billing costs for months were given in Table 3.1, and electricity consumption measurement differences before automation and after automation were given in Table 3.2.

Electricity energy consumption (KWh) before and after automation was shown in Figure 3.1, and electricity energy consumption costs (TL) before and after automation were shown in Figure 3.2.

Table 3.1: Electricity consumptions and billing cost for months

Billing Period	**2013/01**			**Ave. Monthly[16] Temperature 3,4 ^{0}C**	
	Daytime(KWh)	**Puant(KWh)**	**Night(KWh)**	**Total(KWh)**	**Billing (TL)**
Last Index	2139	988	1603		
First Index	1943	899	1462		
Difference	196	89	141	426	11.614
Billing Period	**2013/02**			**Ave. Monthly Temperature 5,7 ^{0}C**	
	Daytime(KWh)	**Puant(KWh)**	**Night(KWh)**	**Total(KWh)**	**Billing (TL)**
Last Index	2313	1067	1731		
First Index	2139	988	988		
Difference	174	79	743	996	10.478
Billing Period	**2014/01**			**Ave. Monthly Temperature 6,2 ^{0}C**	
	Daytime(KWh)	**Puant(KWh)**	**Night(KWh)**	**Total(KWh)**	**Billing (TL)**
Last Index	3005	1398	2296		
First Index	2948	1373	2256		
Difference	57	25	40	122	3.490
Billing Period	**2014/02**			**Ave. Monthly Temperature 6,7 ^{0}C**	
	Daytime(KWh)	**Puant(KWh)**	**Night(KWh)**	**Total(KWh)**	**Billing (TL)**
Last Index	3034	1412	2318		
First Index	3005	1398	2296		
Difference	29	14	22	65	1.911

Table 3.2: Electricity Consumption Differences before and after automation

January Months Differences (KWh)	**January Months Differences (TL)**	**February Months Differences (KWh)**	**February Months Differences (TL)**	**Total Difference (KWh)**	**Total Difference (TL)**
304	8.124	931	8.567	1235	16.691

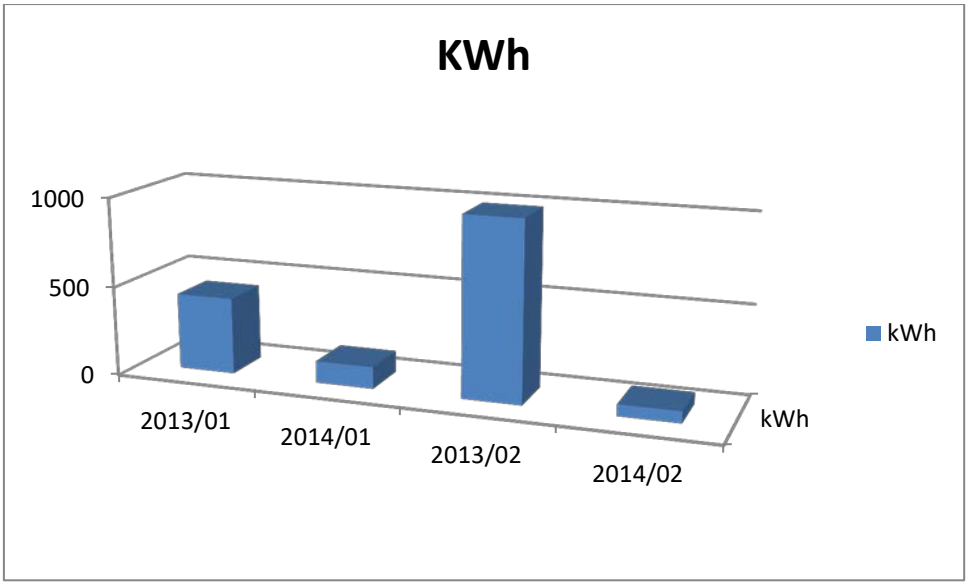

Figure 3.1: Electricity energy consumptıon before and after automatıon (KWh)

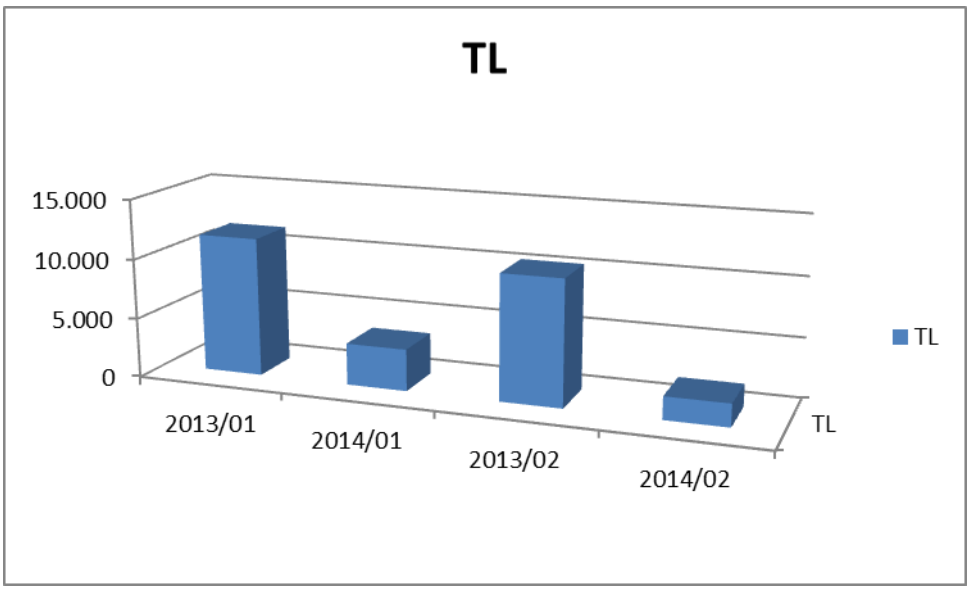

Figure3.2: Electricity energy consumption cost before and after automation (TL)

Investigating tables and figures; in pilot area; totally 426 KWh of electricity energy in January 2013 and 996 kwh of electricity energy in February 2013 were consumed before automation, while 122 KWh of electricity energy in January 2014 and 65 KWh of electricity energy in February 2014 were consumed. It was observed that the automation significantly affected electricity consumption. There are significant differences when compared before automation and after automation. In other words, it was seen that there is 68 percent difference between electricity consumption before and after automation.

When it is approached this situation as numeral, business cost will be saved up at the rate of 47 percent approximately if it is considered that electricity expenditures originate the biggest part of business expenditures.

It is reality that business expenditures will decrease more, when the current system is entirely done with wellhead heat center, and heat center automation system connected subscriber.

Making optimum level of heating system in housing caused a decrease in unit price of heating energy paid by subscribers and making no progress in the long run, and it was seen 20 percent decrease of leakages in indoor and the line after modernization was done because there is no automation and calorimeter application in current system. Unbalanced energy distribution, which occurs from heat and flow differences, between subscribers given heat in districts and streets was removed. This situation eliminated releasing extra energy via opening window because of overheating and complaining subscriber in another district about not heating enough.

Following automation means electricity saving for both local government and subscribers. At the same time, it results in efficient usage of geothermal energy resources with regards to local government. Thus, supplying geothermal energy for heating and hot water necessity of entire town, which are wanted by Simav Municipality and community, can be reached in a short time.

4. Conclusion

As a result of performed study, it was provided the savings that is thought at he beginning, and working system as stable. It was fulfilled a balanced heat distribution in regional heating with performed system. By this study, it was saved up 68 percent of electricity consumption seeming to be the most expenditure of Simav Municipality in the meaning of the utilization and the processing og geothermal energy since 2013. At the same time, it became an important study about non-usage of geothermal energy resources inefficiently according to Energy Efficiency Law with act numbered 5627 went into effect in 2007. The basic principle of this study was to send geothermal energy having temperature, pressure, and flow as much as they need in specified areas. Thereby, both unnecessary working of engines were prevented, and geothermal energy wasn't wasted. Thus, housing number that is heated in pilot area with same energy was increased in the percentage of 20 on condition that used energy didn't change. It was also resulted in an increase in subscriber number all across town, and hot water and heating necessity of areas that cannot receive geothermal energy because of well scantiness will be supplied.

5. Suggestions

As a result of this study, the automation technology used in Simav can be a good example to areas heated with geothermal energy that is processed manually. As a result of its side reaction, environmental pollution will be significantly prevented since solid fuel (coal, fuel oil, diesel fuel etc) consumption will be decrease because of increasing amount of subscribers with system modernization.

References

[1] Environmental advantages to the utilization of geothermal energy, Brophy, P., Renewable Energy, 10, 367-77, 1997

[2] Geothermal energy for the benefit of the people, Fridleifsson, I.B., 2001, Renewable&Sustainable Energy Reviews, 5, 299-312.

[3] Examining Of Power Generation Potential In Simav Geothermal Field, Oğuz ARSLAN, Ramazan KÖSE, Bayram ALAKUŞ, M. Arif ÖZGÜR, Dumlupınar Üniversitesi Fen Bilimleri Enstitüsü Dergisi, Sayı 12, Aralık 2006

[4] Performance investigation of two geothermal district heating systems for building applications: energy analysis. Ozgener L, Hepbasli A, Dincer I. Energy Build 2006;38:286–92.

[5] An economical analysis on a solar greenhouse integrated solar assisted ground coupled heat pump system. Ozgener O, Hepbasli A. ASME – J Energy Resour Technol 2006;128(1):28–34.

[6] Monitoring of energy exergy efficiencies and exergoeconomic parameters of geothermal district heating systems (GDHSs), Leyla Ozgener, Onder Ozgener, Applied Energy 86 (2009) 1704–1711

[7] Türkiye'nin Enerji Potansiyeline Bakış, İbrahim Atılgan, Gazi Ünv. Müh. Mim. Fak. Der. Cilt 15, No 1, 31-47, 2000

[8] MTA, (Maden Tetkik Arama Genel Müdürlüğü), 2005, Türkiye Jeotermal Kaynakları Envanteri.

[9] Jeotermal Bölge Isıtma Sistemlerinde Optimum Kontrol, Şener,A., C., M., Gökçen, G., Tesisat Mühendisliği / Mart-Nisan 2004

[10] Renewable energy sources for desalination, Eftihia Tzena, Richard Morris, Solar Energy 75 (2003) 375–379

[11] Vertical integration in building automation systems, S. Soucek and D. Loy, Proc. 4th IEEE Int. Conf. Ind. Inform. (INDIN'07), Vienna, 2007, pp. 81–86.

[12] Software Support for Building Automation Requirements Engineering-An Application of Semantic Web Technologies in Automation, Stefan Runde, Alexander Fay, IEEE Transactions on Industrial Informatics, Vol. 7, No. 4, November 2011

[13] Website: www.mevzuat.gov.tr/MevzuatMetin/1.5.5627.doc, last date accessed: 1\1\2017.

[14]Website: http://www.zafer.org.tr/ajans-haberleri/3013-simav-jeotermal-enerjisini-kontrol-altna-ald.html, last date accessed: 1\1\2017.

[15] Website: http://zafer.org.tr/jdownloads/Kurumsal%20Dokmanlar/E-Dergi/zeka_dergi_02.pdf, last date accessed: 1\1\2017.

[16] Hasan Baskıcı, Kütahya Meteroloji Genel Müdürlüğü