Optimization Supplying of Electricity and Heat Energy – An Aspect of Sustainability in the Hospital Maribor

GREGOR PIVEC[1], LILIJANA EISNER[2], DAVORIN KRALJ[3]

Splošna bolnišnica Maribor,Ljubljanska 5, 2000 Maribor, SLOVENIA[1],
ART-K, BusinessConsulting, Na gricu 47, 2000 Maribor, SLOVENIA [2],[3]
Faculty of Management Koper, University of Primorska, Cankarjeva 5, 6000 Koper, SLOVENIA [3]

Abstract:

Organizations assume responsibility for their economic success as well as for the environment and society. For only organizations that take account of the interests of people and the needs of the environment can achieve long-term success, including the Health Service. This paper presents a model that is developed to optimize the operation of electricity and heat energy in a Hospital Maribor. The model can be used for decision support regarding in both design and operation of hospital energy systems. The approach is composed of an aspect of Sustainability, Sustainable Management and optimization model to optimize the selection and operation of electricity and heat energy. For the Hospital Maribor, sustainability management means using resources efficiently and sparingly, acting in a socially responsible way and thus enhancing the Hospital's reputation.

Key words: cogeneration, electricity and heat energy, optimization, sustainability, sustainable management,

1 Introduction

Europe's energy system demonstrates unsustainable patterns of development characterised by growing dependence on important fossil fuels, rising energy demand and growing CO_2 emissions [10]. Energy is a critical element essential to the delivery of quality healthcare services. According to the EPA, healthcare organizations spend over $6 billion on energy each year to meet patient needs. The upsurge in the use of technology in healthcare has increased energy demand within hospitals. At the same time, energy costs have been on the rise, due to increased demand, aging energy infrastructure, and deregulation of energy markets [1]. The economical and political system changed and led to modifications in the business activity of Slovenian Health Services and pharmacies as well as to new market proportions. The modifications took place even though health care and pharmacies are believed to be a stable system with permanent upgrading of expert knowledge and development in the field of providing health services and medicinal products. For an organization to function effectively and efficiently, it has to identify and manage numerous linked activities. An activity using resources, and managed in order to enable the transformation of inputs into outputs, is considered as a process [2.] Electricity can be described as an intermediate form of energy between it source and final application. There are few processes that use electricity to directly produce a result, but it is often transformed via other energy types (such as heat) that will produce a desired result. Therefore, it is important to pay close attention on energy losses by transformation within systems at the hospital [4]. Hospital Maribor, based in Maribor town, is an integrated health care facility with significant energy demand. Hospital's complex spreads on area of approximately 10 hectares and includes over fourteen buildings. In order to reduce energy costs, the Hospital first identified and implemented several low-cost and no-cost energy saving measures including: optimizing the peak power demand by operating high-load heat consumers during of-peak hours, optimizing the

reactive power compensation system, improving the insulation in the existing steam and heating pipes, installing a recovery unit in the air-conditioning system and installing a central electricity and heat monitoring and control system. Despite these improvements, the Hospital still needed to increase the efficiency of their energy supply by reducing their dependence on municipal energy services, because of new applicable legal requirements and environmental protection. Figure 1 presents map of Hospital Maribor.

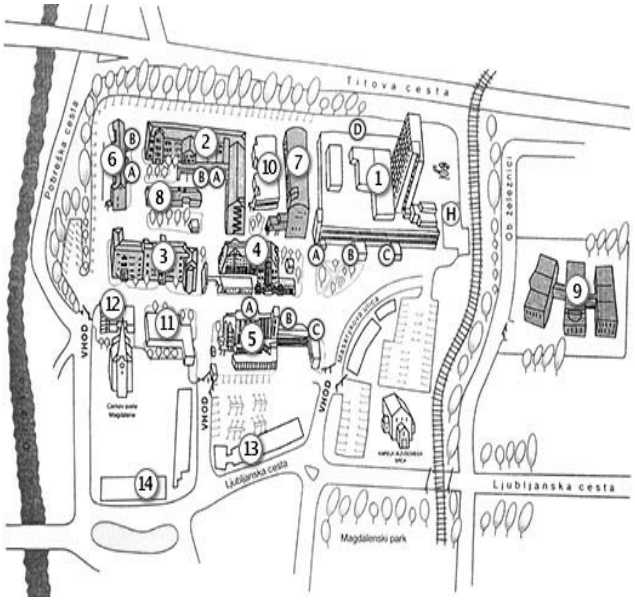

Figure: Hospital Maribor

2 From the Manager to Environmental Management and Sustainability

The environment management is so the consequence of EU Environmental Policy and Slovene Environmental Policy [3]. Hospital Maribor has engaged actively in environmental protection as a part of sustainability. Environmental management systems guarantee Hospital Maribor environmental protection at all locations. This include putting into practice best environmental practice. One of the most important thing in environmental management is leadership. The whole treat of environment in the administration and leading of professional processes is inevitable condition for the preservation of natural balance in the environment [5]. Leaders establish utility of purpose and direction of the organisation. They should create and maintain the internal environment in which people can become fully involved in achieving the organization's objectives [8]. And environmental objectives are organization's objectives. Specific management representative who, irrespective of other responsibilities, has defined roles, responsibilities and authority for:

- ensuring that environmental management system is established, implemented and maintained,
- reporting to top management on the performance of the environmental management system for review, including recommendations for improvement [9].

Management representative collects data on the environment related aspects of various activities, such as energy consumption. Therefore the greatest opportunities of saving costs should be based on electrical energy management. An energy management plan should include a characterization of the energy type and its applications, characterization of typical consumption, evaluation of facilities and systems, evaluation of supply contract and other possibilities of acquiring energy, identification and evaluation of energy-saving opportunities and, finally, development of an action plan to implement and review the plan. This process should be continuous, being constantly revised in an effort to discover new opportunities [4]. In a typical hospital, water heating, space heating, and lighting account for 61-79 percent of total energy use, depending on climate relative to the number of cooling- and heating-degree days. Energy is a significant factor in the growing percentage of healthcare operating costs, which are increasing at the rate that cannot be offset by increases in reimbursement rates. In order to survive, healthcare facilities must aggressively control costs. Strategies for energy cost controls have led to a trend of dealing with energy supply costs, reliability, and quality as managed risk [1].

3 Final Energy Consumption in Slovenia

The Resolution on the National Energy Programme adopted by the Government of the Republic of Slovenia in 2003 provides for a steady growth of final energy consumption in the period from 2000 to 2010 with an average annual growth rate of 1.9 % (2.2 % in industry, 1.3 % in transport and 2.1 % in other consumption). In 2010, the final energy consumption is expected to amount to 217.4 PJ (65,1 PJ in industry, 64,4 in transport and 88,0 PJ in other consumption)[7].

The object of consideration is the presentation of the quantity and shares of final energy consumption at the locations of end use by industry, transport and other consumption sectors of use within Slovenia, as well as the comparison with the European Union (EU-15).
In the area of industry, we show the consumption of final energy in mining and processing industry; in the area of transport, we show the consumption of final energy in total transport (land transport, pipeline transport, water navigation, air transport, rail transport and shipping); and in the area of other consumption, we show the consumption of final energy in households, service and public sectors, agriculture and other activities. Consumption of final energy in the industry sector fell in the Republic of Slovenia in the period from 1992 to 2002 by 2.4 PJ or by 4.3 % (in the EU-15 it grew by 690,8 PJ or 6.5 %) with an annual rate of reduction of -0.4 % (in the EU-15 by +0.8 %). The share held by the industry in the entire final energy consumption, which in 1992 amounted to 36.8 % (EU-15 only 28.6 %), fell in 2002 to 28.7 %, which is already comparable with the EU-15 (28.5 %) where the industry share remains at the practically same level as in 1992. Figure 2 presents final energy consumption by sector use in Slovenia [7].

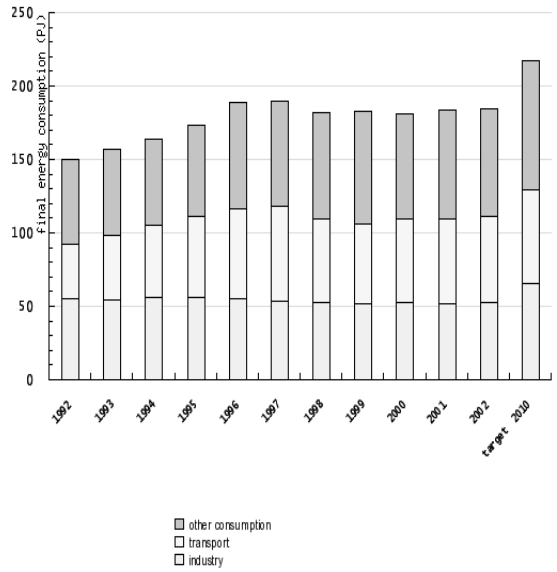

Figure 2: Final energy consumption by sector use in Slovenia. [7]

Consumption of final energy in the transport sector grew in Slovenia between 1992 and 2002 by 21.6 PJ or by 58.8 % (in the EU-15 by 1997.1 PJ or 18.0 %) with an average annual growth rate of 4.7 % (in the EU-15 by 2.1 %). The share of transport in the entire consumption of final energy in the Republic of Slovenia, which in 1992 amounted to 24.4 % (30.1 % in the EU), grew in 2002 to 31.6 % (in the EU-15 to 32.7 %), which is just under the European Union average. Consumption of final energy in the other consumption sector grew in Slovenia between 1992 and 2002 by 14.8 PJ or by 25.4 % (in the EU-15 by 443,8 PJ or 2.9 %) with an average annual growth rate of 2.3 % (in the EU-15 by 0.4 %). The share of other consumption in the entire consumption of final energy in Slovenia, which in 1992 amounted to over 38.8 %, grew in 2002 to 39.7 % which is already on the level of the European Union average in both years (39,2%) [7].

4 Optimization a Supplying of Electricity and Heat Energy in Hospital Maribor

Opportunities of energy conservation may vary form one institution to another because they are directly related to the unit's characteristics. The project was initiated with a conceptual plan for managing energy. A feasibility study (No.B-05 03.04/02) on using a combined heat and energy facility at the Hospital Maribor was then conducted. The final stage of the project involved selecting the most appropriate alternative, prepared a feasibility study for that and tender documents for procurement and installation of cogeneration plant. A feasibility study was conducted. Analyses of the Hospital's present energy (heat and electricity) demand, future energy growth, and options for covering the extended demand were conducted. Alternatives were developed, including financial considerations for introducing cogeneration were generated. Economic and financial analyses and the selection of an optimal solution were generated, including the investment outlays. The most appropriate alternative, own producing steam, hot water and electricity with a natural gas turbine cogeneration plant in existing location of boiler house, was selected and consisted of the following:

- giving the lowest nonprofit price for heat,
- giving the highest internal level profitability in 20 years live cycle by the lowest nonprofit price for heat,
- reducing greenhouse gases emissions:
  - 12.589.225 kg CO_2 / year
  - 1200 kg N_2O / year
  - 784 kg NMVOC /year

- 95.449 kg SO_2 /year [11].

The project generated several benefits:

- capacity building,
- environmental benefits,
- economic benefits,
- sustainability benefits.

Clean energy refers to electricity that is generated by a process that does not burn oil as a primary fuel, and that it does not burn coal or any municipal solid waste. By using fossil fuels more efficiency and also through using natural gas as the primary source of energy CHP reduces the environmental impact associated with heat and power production considerably[6]. Figure 3 presents emissions balance comparison between natural gas (blue) and fuel oil (orange).

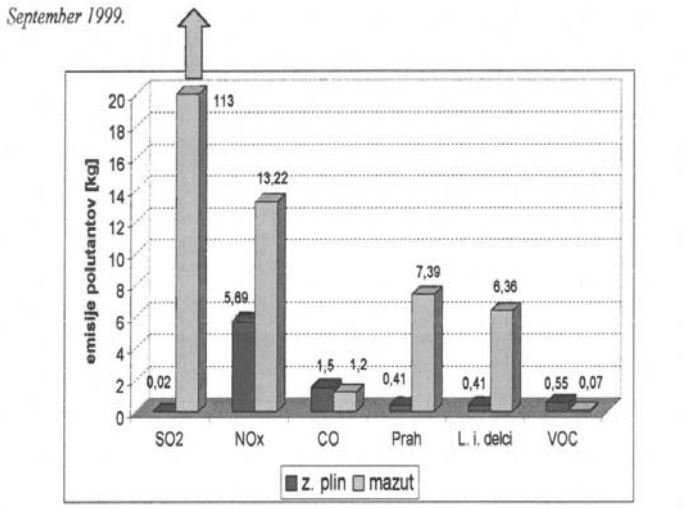

Figure 3: Emissions balance comparison between natural gas (blue) and fuel oil (orange) [13]

4.1 Technology

Natural gas is widely used for electricity generation worldwide. Benefits of natural gas electricity generation include the ability to quickly construct facilities in strategic locations to relieve transmission bottlenecks as well as the ability of generators to provide load following and peaking service during periods of high demand. Furthermore, compared to the average air emissions from coal-fired generation, natural gas produces half the CO2 (carbon dioxide), less than a third of the nitrogen oxides (NOx), and only one 1% of the sulphur oxides at the power plant.

4.2 Simple Cycle

Gas turbines operate by burning the natural gas. Hot gasses produced during the combustion process turn the turbine and generate electricity. This type of electricity generation is typically favored for meeting peak loads, as the turbines can quickly achieve full generation capability. Plants of this type typically exhibit efficiencies as high as 35%.

4.3 Combined Cycle

The most efficient method of generating electricity from natural gas is a combined cycle unit. This configuration consists of one or more gas and steam turbines. The gas turbines operate as described above, except that the excess heat during the combustion of natural gas is directed to generate steam and turn a steam turbine. Therefore, both the gas and steam turbines generate electricity, achieving efficiencies of up to 55%.

This configuration takes advantage of the peaking capabilities of the gas turbine, in addition to the steady amount of power obtained from the steam turbine. This allows a typical natural gas plant to meet peak and intermediate demand. Further, any excess steam that is generated may be sold to neighboring buildings for district heating to achieve even greater efficiencies [12].

With implementation of the energy scheme to install a natural gas turbine cogeneration plant at the Hospital Maribor, greenhouse gas emissions and energy costs were reduced.

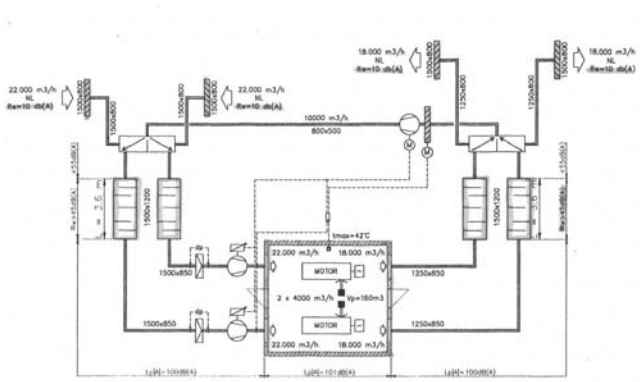

Figure 4: Schematic of Gas Motor

Cogeneration technical data:

Type: 2 x TBG 620 V 12 K Deutz

Motor:	
Mechanical Power:	1040 kW
Cylinder:	V -12
Consumption of Natural Gas:	255 m^3/h
Quantity of Combustion Air:	4400 m^3/h
Generator:	
Voltage:	1000 V
Electrical Power:	1010kW

5 Conclusion

Energy management is a part of organization's environmental management and an aspect of sustainability. An optimization supplying electricity and heat energy may result in great energy savings and reducing costs. An energy management plan could range from simple actions, such as awareness campaigns, to complex solutions engaging more investments and long-term revenues, such as co-generation plants. Nevertheless, the commitment of all hospital communities is extremely important, especially that of higher administration, for the implementation of successful plan [4].

References:

[1] http://www.ashe.org/ashe/23.02.2007
[2] Kralj D.,Stamenković, M: *Optimizing Health Service and Environment Management System.* WSEAS transactions on environment and development, Nov. 2005, vol. 1, iss. 2 .
[3] Kralj, D., Goricanec, D., Eisner, L.: Entrepreneur process need environmental management system. *WSEAS transactions on environment and development*, Nov. 2005, vol. 1, iss. 2.
[4] Rose, J.E.Z, Santos, M.S: *Electrical Energy Management in the Hospital Environment,* http://www.touchbriefings.com/pdf/23.02.2007
[5] Kralj, D., Ogrin, U., Krope, J.: *Environment protection culture as a part of innovating of management in construction industry.* WSEAS transactions on environment and development, Nov. 2005, vol. 1, iss. 2 .
[6] http://www.sei.ie/uploadedfiles/23.02.2007
[7] http://eionet-si.arso.gov.si/kazalci/23.02.2007
[8] ISO 10014:2006(E) *Quality management – Guidelines for realizing financial and economic benefits*
[9] ISO 14001:2004(E) *Environmental management system – Requirements guidance for use*
[10] ttp://www.fpp.uni-lj.si/23.03.2007
[11] EGS: *Dolgoročni program oskrbe bolnišnice Maribor s toplotno in električno energijo,* Aktualizacija študije izvedljivosti št. B-05 03.04/02, Maribor, 2000
[12] http://www.powerauthority.on.ca/23.02.2007
[13] Oikos: *Poročilo o vplivih na okolje – Rekonstrukcija energetskega vira SBM* , Domzale, 2002