

Faults of modern buildings HWAC system and problem solutions

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SUMMARY

The main objective of study was to formulate solutions to provide functioning of heating system in case of force majeure. The problem is particularly urgent in Latvia, and other former Soviet Union country, as in the entire in district heating and housing fund situation is similar. Many of these countries have a long heating season with cold snowy winters. Frequent things are storms in the autumn and spring, causing outage of electric power supply and heating for many thousands of households yearly.

The main threats that may cause the above situations are such as natural gas and electricity supply risks and the natural disasters affect (Latvia is unable to generate enough, to ensure electric power supply and heating all year round). All threats can be minimized by providing solutions for diversification of heating systems - it is possible to use both solar, wind energy and renewable energy resources.

INTRODUCTION

Climatic change and global warming is no longer a myth, but a scientifically proven fact. In recent years, in various countries had been seen drastic changes in nature - destructive storms, disappearance of different species, temperature changes and other variable events that led to open serious discussions on this topic.

Local energy resources in Baltic States are poorly - the most important is oil shale (in Estonia), timber (in Estonia and Latvia) and hydropower (in Latvia). Consumption of wind energy, peat resource (in Estonia, Latvia) and domestic crude oil (in Lithuania) is low, but locally significant. Significant Lithuanian primary energy source is nuclear energy. This short list shows the necessity to import other types of energy resources: natural gas, crude oil and petroleum products, Latvia also has to import electricity. According to import rates, Latvia can be compared with Finland, Hungary, Germany and Slovakia.

Automation of the HWAC of the modern fashionable buildings systems becomes still more difficult and does not imaginable without a computerized power supply, which controlling processes of air replacements, heat and humidity amount and water prepare processes in the building, and regulating this processes according to the planted modes and climatic features.

Computerized power supply regulates main energy resources systems for buildings - such energy resources as gas, heat, water and electricity mostly are delivered centralized on the main networks and are provided with the electricity powered automatic guidance systems. The unsolved problem is to provide alternative energy source in case of *force majeure* when

for example because of nature cataclysms is interrupted power supply, what causes in interrupting delivery of other resources.

There are not sufficiently much alternative electric power production sources in the state, for example, there aren't created enough independent parks of wind generators and their mutual networks.

METHODS

There were made researches on solar energy options, using computer program models of solar collectors combined with other energy sources. The program did modelling and analyzing in a variety of solar system (sun + electricity, sun + gas, sun + biomass, etc.), to obtain data on the production of heat, a part of all the heat, cover the solar collectors, temperature of the manifold, heat and hot water temperature, etc. data. Solar collectors produce 3093.2 kWh in warm water and solid-fuel boiler 1316.8 kWh in warm water and follow the sun gives 70.1% in hot water preparation.

The sun collector with an area of 7.4 m², with a slope angle of 45°, can produce 3233 kWh per year. Having regard to the pipeline and caused the loss of the pump, solar collector heat output capacity will be 3093 kWh per year.

Initially was found out how this produces a 1 m² of solar collectors, it is impossible to determine what the savings compared to electricity. So from 1m² of solar collector in such a situation can get 418 kWh/m² in the year.

RESULTS

Latvian background

In different territories of Latvia there are very different the housing and heating solutions. 70% of the total housing stock is privately owned, while 30% owned by state and local governments. Most of the Latvian city and town dwellers are living in houses built after the Second World War, the majority - from the 1961st to 1990, when in residential construction widely was used projects of prefabricated concrete panels. 66.4% of the population lives in houses built in this period. Significantly lower proportion of the population lives in a houses built before Soviet Union, most of which are private homes, raised in the end of 19th century and beginning of the 20th century.

In the rural areas, people mainly lives in individual farmsteads, whose heating is provided with different types of wood stove, pellet boiler or other localized heating system. In the cities has both private houses, where are used stove heating and apartment houses (as well as various social facilities, such as hospitals, educational institutions, etc.), which provides centralized computerized heating systems or using local heating systems.

In the district heating sector, the heat is produced in cogeneration stations and in the boiler houses. Unfortunately, existing technologies are now outdated, since most of them are constructed in times of the Soviet Union - before 20 to 40 years. In addition must be mentioned a recent building boom, where as a result are new living territories out of the cities with apartment houses, family houses and semi-detached houses, where mostly heating is provided with a gas boiler, or other systems that are powered by electric current.

Weather conditions of Latvia are turning up intensity of the problem, as there are long heating periods and a „dark“ periods yearly, what cause the great necessity for heating and artificial lighting actions, unlike that is in the southern countries (some EU countries such as Cyprus, Malta has no heating season at all).

Historically in Latvia electricity sales are handled by only one public company. Latvia does not have sufficient electricity generating capacity and the domestic supply is dominated by hydropower. The amount of produced electricity influences by the weather, that's way Latvia has to import electricity from Estonia, Lithuania and Russia. In cases where the water level in the Daugava River is high and the electricity output exceeds domestic consumption, Latvia exports electricity to Estonia and Lithuania.

The main difference of energy markets of Baltic States from other EU countries' markets is that the Baltic power system is not connected with the EU, but with the CIS countries (mainly Russia) power systems. Baltic countries receiving natural gas only from Russia, and thus is totally independent from monopoly “Gazprom”.

For now there in Latvia are installed wind generators with total capacity of 26.9 MW. The wind energy division of Latvian is highly irregular. The average year has a theoretical potential of 250-1250 million. KWh. Wind energy is mainly affected by the fact that the wind speed is not constant. This factor creates additional demands and costs of integrating wind power plant's electricity supply system.

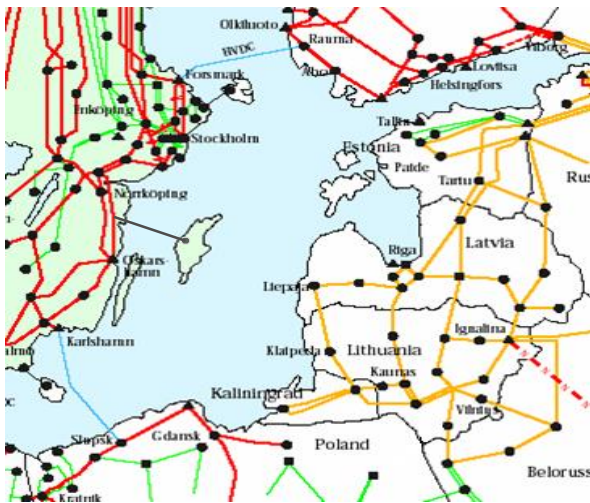
In Latvia is relatively low intensity of solar radiation. The total amount of solar energy is 1109 kWh/m² year. Solar thermal energy utilization period is from April last decade, when the radiation intensity of 120 kWh/m² until the first decade of September. During this period (about 1800 hours) can be used solar energy for preparing hot water. That is found out, that solar energy Latvian currently can not compete with other forms of energy because of its cost, however, solar energy resources in Latvian is sufficient for the practical use of them.

The potential problem which would require solutions

High dependence from “Gazprom”, as energy supply monopolist. Latvia is importing 67% of the necessary energy, where 60% of received natural gas is used in heating and electricity production. In the case of supply interruption there is little possibility of replacing natural gas with other energy sources. There is a risk that a supplier could realize racket, manipulating with the power supply, for achieving his favourable political and/or economic conditions.

In the short-term supply problems may occur if in the Russia would be a very cold winter (in that case Russian government can set up an export restrictions), problems arising from the pipeline or supply interruptions due to other causes. The long-term problems can arise due to the supplier's capacity - according to various sources of information in Russia currently used natural gas fields could be exhausted already after 5 - 10 years before the new natural gas fields yet fail to provide a full supply volume.

Baltic gas and electricity markets isolation, which demonstrative can be seen in the 1st Fig. Baltic grids are interconnected with each other and also with Russia, but Russian significantly lower network technical quality creates additional risk for the Baltic electricity. For example, if at the same time in all three Baltic countries would be local electricity shortage, complications could arise to import electricity from Russia.



1. Fig. Electricity transmission system in the Baltic

Specific threats are the weather conditions, which are common both in the Latvia and in other European countries. Every year from disorders of electricity supply what are caused by both spring and autumn storms and the same during the winter high snow quantitative influence.

Such natural disasters often results in cut of power supply for thousands of households and farms, who must live without electricity (and so – in many cases without heating and other social necessities) for some days, but sometimes even several weeks. As we all know – in nowadays a lot of functions in residential buildings and livestock complexes are operated directly by electricity. If the interruption of production function can only cause financial losses, then the serious problem arises when power supply and heating are interrupted for long time in residential complexes, especially in the winter months, when temperature can reach – 30°C.

For example, in the winter 2009 due to high snowstorm there was electricity supply interruption for more than 30 000 households - after a snow storm road were full of snow and services responsible for power lines, can't get to the damaged lines fix them without road cleaning equipment. Mostly disorders were caused because of wet snow and ice. A similar situation was also seen in previous years.

Every year in autumns there are powerful storms what causes interruption of electricity supply for many households, for example, in autumn of 2009 there was 12 000 households without electricity.

The weather conditions and disasters of recent years indicate that necessity to provide alternative energy collateral is not an issue only for Latvia. For example, in autumn of 2008 in the U.S. because of snowstorm more than 100 thousand buildings remained without electricity. Similar in Poland, because of snowstorm in spring of 2008 without electricity, water and communications remained approximately 400 000 people.

Force majeure conditions in power supply may also cause a variety of failures – for example, like in the winter of 2009 fire accident in the electricity substation, what causes that the half the city of Rezekne, including the hospital, remained without electricity (approximately 17 763 people). However, the medical institution has generators to provide electricity in such

situations. In the 2004 there were silly situation in Estonia, when cat, which entered (and died) in Tartu electrical substation, left without electricity Estonia's second largest city - Tartu.

We can find unpleasant precedents in the world, when there were power cuts because of cybercrime. In the 2009 because of the hacker 3 million Brazilian were left without electricity - cyber-criminals intervened energy transport systems in operation (previously same power gap was in September of 2007, and lasted for two days, leaving more than 3 million inhabitants in many towns without lighting). Admittedly, this is a very serious warning to all other countries – because of this kind of crime without electricity supply can remain even countries (especially in smaller countries, where electricity is provided by one or a few large companies).

In result of researches is established, that it's necessary to find solutions for diversifying of energy resources, to provide a successful action of the HWAC systems also in the case of *force majeure* circumstances, taking into account, that with influence of global warming the various nature cataclysms happening more often.

The independence of building in extreme circumstances can provide only classic, natural system what is provided with reserves of resources, and what provides comfort minimum in emergency conditions - that system can be either stove or fire-place, fuel reserve accumulations, heat accumulate in accumulators etc.

DISCUSSION

Discussing the solutions for the state level, must be noted that Latvian security of energy supply will increase logging in the transport networks, as well as ensuring that Latvia is able to produce 100% of electricity consumed.

Different types of households have access to different solutions to temporarily provide electricity and heating in cases of cut of power supply, such as installing in family houses various types of power generators, or the autonomous electricity providers, which is useful in isolated farmsteads, businesses and households. Generators can be conditionally divided into professional and amateur, as well as taking into account considerations that it will serve only in emergency situations or in everyday life, for water pumping, for operating heating system or ensure other devices work.

One of the newest small-scale heating installations is micro-cogeneration boiler equipped with Stirling engines. This type of boilers requires small electrical power (from 0.2 to 4 kW) engines. Internal combustion engines and gas turbines for this purpose can not be observed because their power is bigger. Low-power engines are already possible to buy and they are practically the most useful for households' cogeneration. This engine technology perfectly meets the requirements of households, because their electric power is low and the external combustion allows regulate heat without changing the required parameters. The main advantages of technology are: engine does not depend on the type of fuel and combustion equipment, low operating costs because of the external combustion, engine has far fewer moving parts than internal combustion engine, not the valve and ignition system, so it is much quieter than internal combustion engine, in electricity production is not dependent on thermal generation, low GHG emission levels, high engine resource.

Still such solution is not suitable for multi-apartment buildings, since such objects are unable to use portable power generators, and generators do not provide enough power for operating heating systems.

As experimental studies have showed, sun collectors' use in Latvia is possible with good results. Solar radiation energy in Latvian can be used for 1700-1900 hours per year. Sunlight duration and intensity depends on the season, weather and national geography. The annual global solar radiation on a horizontal surface of the sun band regions can reach 2200 kWst/m². In Northern Europe the maximum of solar radiation is 1100 kWh/m². There are sight conditions in Latvia, which makes solar collectors use more attractive and relevant in recent years: the tendency to build new buildings, where solar collectors may be incorporated during construction and renovation of many buildings were are now repairing or restoring heating systems.

For alternative heating can be used "heat pumps" - special equipment what helps to use solar energy what have been accumulated in the ground and water tanks. The heat energy produces by the tubes with non-freezing liquid, which are inserted in soil or water tank, and that's the way how so-called "heat pumps" shall transform energy for using that in heating, or preparing hot water. These pumps are using in the sun "free" energy, although electricity is required for the conversion of energy (heat pump can be compared with fridge freezer which fulfils the functions of such a tube dug into the ground). Installation of the system itself is very expensive, but the fuel, as you understand, then does not pay anything. There are presumptions that the system is ecological, without a doubt there is no bottom, but remains an open question how will flora and fauna react to the cold which is excreted into the ground, well or water.

As additional heat source may also be used solar batteries. On the roof can be an installed special battery, which uses solar heat, for example for preparing hot water during summer. This system can be described as ecologically cleanest (even in wind energy leads to a noise generator, and often killed the birds wings), but unfortunately, the Latvian conditions not very much can be used in autumn and winter.

In purposes of fuel diversification it is to recommended in cogeneration in small quantities to use also coal and peat, however, these fuels is characterized by high technology costs (especially in the typical for Latvia small-scale range), which are generally associated with the installation of flue gas cleaning equipment required to meet environmental protection requirements.

In Latvia in the next 10-15 years in urban areas with sufficiently high heating load is appropriate to put into practice widely applied technology - steam turbine, gas turbine, combined cycle and internal combustion engines.

From the economical viewpoint in Latvia for covering base load would be advisable to build power stations, which operate with coal or mixture from coal, peat and biomass. Since the clean biomass option is more expensive than other solid fuel use options that would be advisable to use a mixture from biomass and solid fuels such as coal and peat.

It's advisable for local governments in perspective is to introduce cogeneration CSAS, ensuring hospitals, dispensaries, schools, kindergartens and housing fund with electricity and heat in the case of heating and electricity cut because of natural disasters or accidents.

That is necessary already at the designing of buildings to provide independent engineering solutions for power supply: sun collectors in combination with heat storage equipment for hot water preparation; If the energy source is natural gas, must be created a propane-butane gas reserves, as well as quickly and easily replaceable boiler burner assembly of liquefied gas combustion; If energy source is a solid fuel, appropriate must be reserved fire and water safe area for savings of dry solid fuel; In the engineering project of buildings heating systems should be at least two types of energy sources, for example, gas and solid fuels or solid fuels and heat pump in combination with adequate power generators (3:1 ratio) and fuel reserves.

Each automatic system must be secured with emergency electrical generators and conformable fuel accumulation (reserves approximately for 7 days). It's necessary to develop solutions, in planning process of new catchments areas, to provide modern heat supply systems and accumulations of reserves of resources

It's necessary to create heat accumulation tanks collateral to heat resources. That heating energy can be used to both to prepare hot water and for building heat supply.

It's necessary to provide with an independent heat source each building or group of buildings, for example, with stoves, which burns with the classic fuel (for example, wooden logs or briquette).

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