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Smart Concept expansion from local to city scale

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Abstract. Rapid urbanization leads to the cities expansion in both dimensions: horizontal and vertical. Thus causing significant increase of energy consumption and reduction of environment quality. Nowadays European Initiative on Smart Cities development becomes a very popular across the globe. The aim of this initiative is to insure sustainable city development taking into consideration quality of life and reduction of carbon emissions. Residential sector is one of biggest energy consumers and carbon emission production in Latvia. Also, city transport is a crucial carbon emission producers. In scope of this study the city development potential is analyzed. The increase of energy efficient scale is taking into consideration.

1 Introduction

During the last decades cities population is growing overall the world. The main reason is migration with in the countries. However, in some capital cities of former soviet countries population decrease was observed in 2009-2014 (Figure 1). Is can be explained by real estate market development in suburban areas which were used as farmer lands before 1990ies. Figure 1 present analyses of four cities located in Baltic region.

Takin into account rapid growth of cities, smart cities concept has been actively developed across the globe [1]. While energy-saving technologies, options for using renewable energy and engineering systems for passive and autonomous houses have been developed for many years, the problem of introduction of smart concept is more relevant than ever [2, 3]. In addition, along with studying the possibilities of consuming less energy, methods for reducing energy losses are investigated, for example, by working with thermal bridges [4] or by improving methods for calculating the effect of thermal stresses in elements on the strength characteristics of the system [5], as well as methods for the optimal selection of planning and design solutions [6]. Other problems that faces big cities are air pollution and soil position [7].

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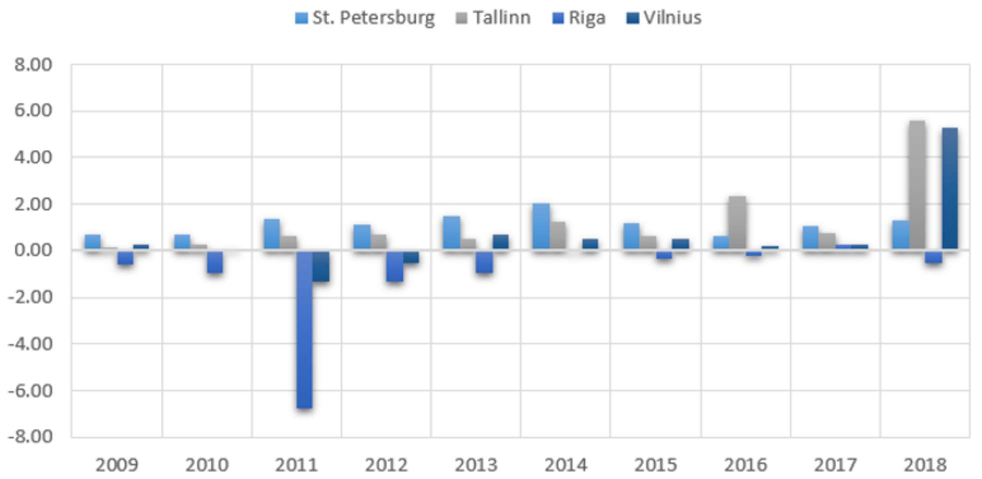

Fig. 1. City population total growth

2 Increasing the scale of smartness

Nowadays new common challenge has arises - self-sufficiency and carbon neutral districts and cities. Chine has started development of large-scale living district using passive house concept [8]. In order to get better efficiency and to insure optimal use of human resources all existing single energy efficient activities should be rescaled and implemented at the large scale. [9, 10].

Modern cities can achieve 20-20-20 and 30-30-30 goals only by significant improvements such major areas as buildings, energy and transport. Covenant of Mayor has introduced Sustainable Energy Action Plan SEAP to be developed by cities in order to insure better planning and monitoring of energy efficient measure. According to Covenant of Mayor data there are 53 countries across the globe and eastern partners which already have SEAP (https://www.covenantofmayors.eu). For example, in Portugal SEAP covers 60% of the total population [11], which allow to plan city energy flows more actuality and insure better living conditions do more than half of populations.

Initially SEAP was focused on standalone actions such as buildings' retrofitting, efficient lighting and introduction of local renewable energy sources. Smart City concept take into consideration synergy between all cities element, where energy consumers becomes energy producers. There is no global definition of Smart City [12]. In general, the Smart Cities general concept characterized as improvement of performance by implementation of ICT and stakeholders engagement. Currently work on standardization activities in field of sustainable development and smart cities takes place [13].

Example of "energy and technology" indicator of building renovation process at differen scale (Figure 2).

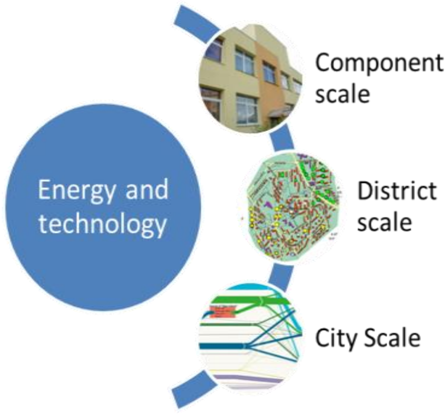

Fig. 2. Example energy and technology dimension

In case of building renovation the component scale includes single building renovation. The district scale may include grouped building renovation. According to Borodinecs study [14, 15] the estimated savings can be about 10% due to grouping development, compared to the component scale renovation. The city scale renovation can include analysis of different building renovation scenarios and future city energy flow planning.

2.1 Local scale

Main city components are inhabitant, transportation infrastructure, buildings, energy and water supply. Currently all major activities are focused on local scale [16, 17]. The main energy priorities for big city are electric car and public transport promotion, retrofitting of buildings. In Riga such activities nowadays are implemented at the local scale, building retrofitting is carried out by house owner without clear vision on whole district development. In case of municipality support district can be retrofitted taking into account all modern needs such as installation of electric vehicle charging station, centralized installation of renewable energy sources and group building retrofitting. Electric vehicle charging station are installed by local transport authorities and doesn't take into consideration wide network installation in existing living districts, which significantly limits inhabitant interest for electric cars. Single building retrofitting also have several shortcomings [18-22]. One of them is payback time. Under low energy prices payback time for building retrofitting exceed 25 years in Latvia.

The public transport actions also seek to reduce CO_2 emissions and improve air quality, and the renovation of buildings connected to a district heating system seeks to reduce energy consumption. For example centralized installation of PV panel on flat roof of existing buildings can provide extra energy for electric vehicle chagrins station in living districts.

2.2 City scale

Usually big cities have some waste heat sources (heavy industry plants, underground tubes, landfills with possible waste incineration etc.) that can be used as a heat source, furthermore as a free source. But all these ideas are in mind for the future plans and hopefully will be implemented in the nearest future. At the moment city of Riga can provide one good example of using a waste heat at the existing eco-landfill Getlini. Getlini ecological landfill is responsible for the collection and ecological management of waste within the Riga waste management area. Non-recyclable waste is deposited in environmentally safe biodegradable cells, which cannot be penetrated by either air or rainwater. The landfill gas that forms in the cells is channelled to the Getlini power unit, incinerated and transformed into energy, while wastewater is collected and purified. Thus, the impact of waste on the environment is reduced to a minimum. Since 2002 the landfill produces biogas which is used in a cogeneration station with a power capacity of 5.3 Mwel. and a heat capacity of 6.8 MWth. The heat energy is mostly used for a modern greenhouse complex which has been built next to the co-generation station growing vegetables, berries and flowers. Apart from that heat is also used for the technological process of the infiltrate reactor, for heating the office and auxiliary premises and for hot water preparation. Getlini ecological landfill is one of the largest and most modern producers of green energy in Latvia. Gas production and management of both the power unit and power supply at Getliņi are supervised by professionally trained technical personnel.

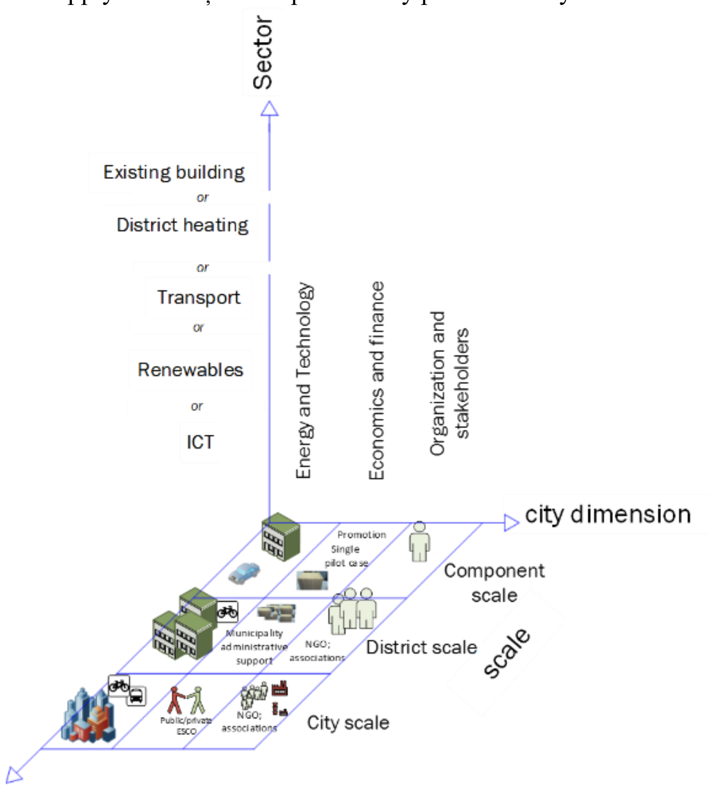

Fig. 3. Scale of energy actions

Before gas is supplied to the power unit, it is purified of H2S, Cl, F, siloxanes and volatile organic compounds (VOC). Calculated in terms of pure methane (CH4): 7 844 760 m3, corresponding to 78 011 MWh of energy, have been produced in recent years.

The gas produced is incinerated by internal combustion engines within the Getlini power unit. Six JGS 320 gas engines made by GE Jenbacher have been installed. The gas conducted energy is transformed into electricity and heat in the following proportions: 40% electricity and 46% heat. Heat is used as a component within the economic operations at Getlini providing heating, hot water production, heating the water purification equipment reactor, and heating the infiltrate collection and recirculation basin. After analysis of heat consumption in recent years and taking potential surplus heat into account, a project has been developed entailing the construction of a complex of greenhouses that are already being built [16].

2.3 District heating

District heating is the most feasible and ecologic way how to provide heating to inhabitants within the city with dense building. It is comfortable, energy efficient and sustainable solution for the modern cities, which are ready to take a step forward and become smart. District heating in Riga is provided by the JSC "RIGAS SILTUMS", and company constantly introducing new technologies in the heat production and transfer of heat through the heating network. The city has a well-developed district heating system which provides for about 76% of the total heat energy consumption therefore improving of heat production and transfer gives such an appreciable effect on the city scale.

During the last 8 years company has implemented number of modernization measures on the biggest owned heat production sources. Flue gas heat recover implemented since 2008 by installing after the boiler a condensation type economizer which utilizes not only the physical heat of the flue gas, but also the flue gas water vapour condensation (latent) heat by cooling the flue gas below dew point temperature. This allows increasing the capacity of the boiler installation by 7-30 % without additional combustion. In 2012 the measure resulted in 41 297 additional MWh produced with no extra fuel consumption.

JSC "Rīgas siltums" started to use wood chips in 1996 when the steam boiler of HP "Daugavgrīva" was equipped with a front furnace for wood-chip combustion and additionally a cogeneration unit with steam turbines was installed. Since then, the company has been focusing on increasing the use of wood chips and has reached significant results.

Based on JSC "RIGAS SILTUMS" annual reports information, until year 2015 the company constantly has been reducing share of fossil fuel – natural gas in overall fuel balance and increased the share of renewable energy source (wood chips) up to 32% using it for electricity production in cogeneration heating plants as well.

The total capacity of the wood-chip fueled boiler is 59.5 MW, which together with the condensation economizers (7.3MW) ensures a 66.8 MW capacity of the state of art wood chip fuelled heat plants. In the abovementioned heat plants the efficiency rate of heat production exceeds 100 % calculated at lowest calorific value of the fuel.

3 Conclusions

There are approximately 39000 multi apartment buildings in Latvia. Until February of year 2017 there are only few percent of already renovated multi storey buildings in Latvia. There are several co-financial mechanisms in Latvia which can be used for building retrofitting.
Modern cities can achieve EU energy goals only by consequent improvements in such important sectors as transport and buildings. The main document which proved overall plan in sustainable city development is SEAP.
City of Riga has achieved significant improvement of operation of district heating systems. Implemented measure allows increasing the capacity of the boiler installation by 7-30 % without additional combustion and reduction of CO_2 emission.

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