Some Issues of Energy Performance and Management of Residential Buildings in Norway and North-west Russia

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Abstract. This article summarizes parts of the work conducted in the Kolarctic ENPI project "Sustainable Buildings for the High North" (SBHN). SBHN had strong focus towards residential buildings performance in the northern Nordic and north-west parts of Russia (Barents region). Results show that there is large potential for improvement of the building mass both with respect to energy consumption and building management. The study reveals some important reasons for the differences between the countries. Regarding energy efficiency, the motivation for improving existing buildings energy performance always has a strong economic component. The end user/building owner assesses different measures in the light of investment cost and payback over time. If weak economic incentives exist, building owners are not likely to make investments to improve energy performance of their properties. In particular for Russia, such incentives are weak. In most areas, energy is paid by square meter residential area or even volume, not by actual usage, which means that whatever is used of energy, the total paid price will still be the same. Costly energy efficiency measures are thus not encouraged. Another problem in Russia is how to maintain and manage the shared areas of existing apartment buildings, such as exterior building parts (walls, roof etc.), stairways, technical rooms, storage rooms, outdoor areas etc. The main problem is that no one takes responsibility for this, and as a result the buildings are slowly deteriorating. Management, and consequently modernization, of building facilities is hence a major challenge. It is particularly important in the cold climate regions, where buildings often are exposed to harsh climatic conditions.

Introduction

The project "Sustainable Buildings for the High North" (SBHN) has been focusing on buildings performance in the northern Nordic and north-west parts of Russia. The project consisted of 6 work packages dealing with commercial and public markets for building products and services, energy efficiency of buildings, traditional building technologies, building materials, building automation systems and laws and regulations. One of the main outcomes from the project is the Building Evolution Portal, Goahtin [1], which currently is being expanded. The purpose of the portal is to collect information about recent and on-going projects in the areas of building technology, energy efficiency, building operation, maintenance and management, laws and regulations, as well as identifying the possibilities for companies and other stakeholders to establish long term cross border cooperation and develop businesses, and to present all this information under the mentioned portal.

This article focuses on the work related to energy efficiency/performance and building regulations, and the main goal has been to point out the major differences and issues that have impact on further development.

Recent years, cross border activities in the Barents region involving Nordic and Russian partners have increased substantially. While focusing on better accommodated conditions for trade and commercial benefits between the countries within the building sector, it has become clear that differences in or lack of regulations and standards are representing a important obstacle. This paper summarizes results from a study of national legislation, regulations and standards for the residential building sector, related to energy efficiency, for Norway and Russia.

Residential Housing Stock in Norway and Russia

For Norway the residential area used per capita is 53,4 m^2 and for the Arkhangelsk and Murmansk regions in Russia it is 25,9 m^2 and 24,5 m^2 respectively. The average living area per capita in north-west Russia is approximately two times lower than in Norway. The main reason is that most people live in multi storey buildings in NW Russia, and detached houses in Norway. Also the population in some parts of NW Russia is currently decreasing. In Murmansk, the decrease is particularly obvious, and the city has lost almost a third of its population during the recent decades.

In Norway, most residential buildings are privately owned detached houses. The majority of the detached houses are made of wood, and in the cold climate of northern Norway, this building type has shown very well suited. Wooden houses do however need continuous maintenance and are not so structural robust as concrete buildings. In cities, apartment blocks constructed from steel and concrete are naturally more common, and shared areas are often managed by private housing associations. Since majority of residential houses are of detached type, building owners have strong motivation for keeping all parts of the building in good shape.

In north-west Russia, residential buildings are dominated by privately owned multi storey flats. Only about 23% are municipality or state owned. However, in some regions, detached houses are still relatively common, as for instance in the Arkhangelsk region, which has a long tradition building wooden houses, but mainly owned by municipalities. These are unfortunately being fewer and fewer, mainly due to lack of proper maintenance. In Murmansk city older multi storey concrete buildings are most common.

Fig. 1 Multistory Residential Building in Murmansk, Russia

According to Russian Federal State Statistics Service by January 1, 2013 the total number of multi storey buildings in need of major repair was 1,629,361 units where approximately 45 million people live. The total area of dilapidated housing stock and that being in a critical condition with depreciation of more than 66 % among the multi storey buildings is 56.9 million square meter (where the former accounts for 38.4 million square meters and the latter for 18.6 million square meters), [5]. In north-west Russia, the need of upgrading buildings is not less than in the rest of Russia.

Annual Energy Consumption

Average energy consumption for heating in residential buildings in Russia is 350-380 kWh/m$^2 \cdot$ year [2], not including energy consumption of lights and electrical appliances. The total energy consumption of households in Norway is about 45 TWh per year [3]. Average annual specific delivered energy in 2012 was 153 kWh/m^2 for large dwellings (multi storey buildings and detached houses) [4]. This includes energy for lighting and electrical appliances. From these numbers we realize that the largest impact can be achieved by improving the residential buildings on the Russian

side, where the energy usage is more than twice that of Norway. The numbers are comparable since climatic conditions are not very different. There are several reasons for low energy performance of the Russian multi storey buildings. Analyses have shown that poorly insulated building envelopes, poor windows, large leakage areas, cold bridges and the fact that energy is paid by the size of the apartment rather than by actual use constitute the major posts of the energy performance. In addition, exterior parts of buildings (outer walls, roof) are in many cases not considered the responsibility of the flat owner, and are hence not being upgraded or maintained. Being the second largest energy user in Russia, the residential housing sector has a great energy efficiency potential which can be fully addressed through a combination of simultaneous repair and energy efficient modernization of multi storey buildings and also carrying out energy effective projects after repair works have been finished.

Obstacles/barriers for upgrading of residential buildings

Some of the main obstacles for carrying out upgrading of existing residential buildings on the Russian side have been identified as follows [5]:
- Municipalities have not enough institutional, infrastructural and organizational experience in registration of commonly shared property in multi storey buildings, which is a prerequisite for doing repair works of the shared property.
- Low level of income for the majority of households. High risks involved in saving, managing and spending accumulated funds for reconstruction.
- A major part of apartment owners are not organizationally or financially capable conducting major reconstruction of the shared property.
- No legislative and regulatory base and methodology.
- Lack of knowledge and experienced personnel, lack of motivation for the building owners.
- Weak competition between and inadequate professional training of utilities companies and municipal managers.
- Lack of large-scale campaigns organized in the housing sector on the regional level.

In Norway, the following barriers have been identified, including each barrier's relative strength (weight) in percent [6]:
- Too expensive, 19.72%
- Lack of public recommendations and support schemes, 14.05%
- Too difficult, too time consuming, 10.92%
- Limited impact on comfort and indoor climate, 8.02%
- Will it really work? 7.22%
- We will move in near future… 6.95%
- Lack of information about relevant, reliable products and/or services, 6.73%
- Lack of motivation, 6.16%
- Other issues… 20.22%

As can be interpreted from this is that there are still many principal issues to overcome before energy efficiency can be seamlessly integrated as part of renovation projects of residential buildings. In Russia, major obstacles lays in the regulatory instruments, how energy tariffs are implemented and the "what's in it for me"-factor for the flat owners. In Norway, barriers are generally related to high investment costs combined with lack of knowledge about benefits after measures have been implemented, not to the regulatory instruments provided by authorities.

Regulations

European Union (EU) is a driving force for stricter requirements in regulations in Norway, and Norwegian authorities are obliged to implement related directives of EU. This has led to relatively frequently updating of standards and regulations in the building sector during the last decades. Table 1 shows historical development of regulations for U-values and other parameters in Norway. The trend is that the requirements are becoming more demanding in order to meet challenges related to

climatic conditions and limited availability of renewable energy. Next revision is anticipated in 2015, and it is expected that energy performance level of buildings will be as for passive houses.

Tab. 1 Development of Minimum Requirements of the Norwegian Building Regulations from 1949 until 2010 (U-values and other parameters)

Building part:	U-value requirements (W/m^{2}K)						
	1949	**1969**	**1985**	**1987**	**1997**	**2007**	**2010**
Exterior wall	0,93 - 1,16	0,58 - 1,28	0,45 - 0,9	0,30	0,22	0,18	0,18
Roof	0,93	0,46 – 0,58	0,23 - 0,9	0,20	0,15	0,13	0,13
Floor	-	0,46	0,23 – 0,9	0,20 – 0,30	0,30	0,15	0,15
Windows and doors	-	-	2,10 – 2,70	2,0-2,4	1,6	1,2	1,2
Other parameters:							
Cold bridges [W/(m^{2}K)]	-	-	-	-	0,06	0,06	0,06
Leakage at 50 Pa [h^{-1}]	-	-	1,5 - 3	3/1,5 [1]	1,5	1,5	1,5
Heat recovery [%]	-	-	-	-	70	70	80
SFP [kW/(m^3/s)]	-	-	-	-	2/1 [2]	2/1 [2]	2,0

[1] 2 floors and less/3 floors and more
[2] Day/night

In Russia, federal act 261 [8] is possibly the most important document on energy efficiency. The purpose of act 261 is to provide legislative, economic and organizational stimulus for increased energy saving and improved energy efficiency. Requirements for building energy consumption are issued by [9] and general requirements for technical installations are specified in [11].

Tab. 2 Prevailing U-value Requirements for Residential Houses in Norway and Russia W/(m$^{2 \cdot \circ}$ C)

Requirements	Exterior wall	Roof	Floor to the ground and unheated spaces	Windows and doors
Norway				
Energy eff. measures	≤ 0.18	≤ 0.13	≤ 0.15	≤ 1.2
Minimum requirements	≤ 0.22	≤ 0.18	≤ 0.18	≤ 1.6
Russia (according to[9,10])				
Baseline value (4000 degree days)	≤ 0.36	≤ 0.27	≤ 0.24	≤ 2.2
Baseline value (6000 degree days)	≤ 0.29	≤ 0.22	≤ 0.19	≤ 1.7
Baseline value (8000 degree days)	≤ 0.24	≤ 0.18	≤ 0.16	≤ 1.4

Table 2 shows a comparison of prevailing U-values of Norway and Russia. In Norway, minimum requirements are specified by the regulations, while recommended "baseline" values are given for new buildings or buildings being upgraded to better energy standards. In Russia there are only recommended values for the U-values given by [9,10].

According to [10] Russian developers are not obliged to implement energy saving technologies. It is however allowed to re-calculate the estimated energy consumption per unit room volume (refer to Table 3), hence energy efficiency apparently will be increased by more than 30%, while the actual energy consumption for heating is not lower. In fact it can be higher. Thus, in comparison to Russian Construction Regulations [9], the updated set of rules in [10] actually recommends an increase in energy consumption for heating instead of reduction [5]. This example shows that Russia have challenges still related to different regulations giving different rules on how energy efficiency should be defined and calculated. In practice this lead to confusion and also that project are conducted differently, with no guarantee of performance.

Tab. 3 Recommended Specific Value of Heat Loss for Heating and Ventilation of Multi Storey Residential Buildings, $W/(m^3 \, {}^\circ C)$ Dependent on Number of Floors [9,10].

Number of floors	1	2	3	4, 5	6, 7	8, 9	10, 11	>12
Specific heat loss	0.455	0.414	0.372	0.359	0.336	0.319	0.301	0.290

Energy Labelling

Norwegian regulations on energy labelling of buildings is based on EU's energy directive. Energy labels are issued based on the buildings performance evaluated from a set of rules that makes it possible to compare different buildings of the same category but from different locations. Energy labels consist of a energy grade (from A to G) and a heating grade (ranging from 0%-green to 100%-red use of fossil fuels). Oslo-climate is used as a reference for comparing buildings. In addition, standardized values of ventilation flow rates, internal gains, operation hours and so on are used in the calculations. Russia has defined its own system ranging from A++ to C- for new residential and public buildings, and D to E for existing ones. Special scale is used for multi storey buildings, ranging from A to C for new buildings and D to E for existing buildings. A deviation rate index is used for each of the grades to specify to what percentage the energy consumption deviates from the baseline (normal) [8,9,10]. For instance, in order to achieve A-grade for a new multi storey building, energy consumption must be 45% lower than a defined baseline. The value of the baseline depends on climatic conditions decided by degree days of the location in question.

The SBHN project has been focused towards identification of differences on the regulatory level, and pointed out that these need to be addressed in order to establish commercial activities and cooperation across borders.

Building Automation

Another area where obvious improvement potential is found is within building automation. As opposite to Norwegian conditions, where building automation systems are quite well integrated in dwellings, existing Russian dwellings are still lacking considerable practice in this area. The equipment needed to control thermal conditions and air quality is in many cases poor and even not installed at all. Heat supply to multi storey buildings of north-west Russia are mostly in the form of hot water from district heating system. Domestic heating systems are lacking automatic valves and sensors, and in some cases radiators have no means of even manual control. Ventilation systems are in most cases lacking. During excursions to different buildings in the Murmansk region, it was also notified that to save the costs of using heat exchangers, hot consumer water sometimes is used directly from the district heating network. Improving automation systems can lead to significantly reduced energy consumption.

Summary

In Norway, average annual specific delivered energy in 2012 was 153 kWh/m^2 for large dwellings (multi storey buildings and detached houses) [4]. This includes energy for lighting and electrical appliances. In Russia, the average annual energy consumption for heating in homes is 350-380 kWh/m^2 (not including lights and appliances). Analyses have shown that poorly insulated building envelopes, poor windows, large leakage areas, cold bridges, lack of automation systems and the fact that energy is paid by the floor area of the apartment rather than by actual use constitute the major posts of the energy performance. These are main reasons for the high energy consumption in Russian dwellings. There are still many principal issues to overcome before energy efficiency can be seamlessly integrated as part of renovation projects of residential buildings. In Russia, major obstacles lays in the regulatory instruments, how energy tariffs are implemented and the "what's in it for me"-factor for the flat owners. In Norway, barriers are generally related to high investment costs

combined with lack of knowledge about benefits after measures have been implemented, not to the regulatory instruments provided by authorities.

Both for Norway and Russia legislation and regulations concerning energy efficiency are well developed. Both countries have developed a framework to promote more energy efficient buildings, but methods to calculate or determine some values, parameters and units of measurements are quite different. Russian regulations have come quite far in the sense that regulations allow for differing between requirements for new and existing residential buildings. This is not the case in Norway, where all buildings have to fulfill the same requirements. Russian regulations are however defined in a manner that can be misinterpreted, and what is allowed and not allowed is not always clear because different legal documents are conflicting in certain issues and some "requirements" appear as recommendations.

Acknowledgement

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