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Non-Technical Barriers to Energy Efficient Renovation of Residential Buildings and Potential Policy Instruments to overcome Them—Evidence from Young Russian Adults

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Abstract: Several scientific articles discuss non-technical barriers and policy instruments related to energy efficient building renovation. However, they are seldom systematically categorized and hardly ever related to Russian context even if Russian housing provides remarkable potential for energy-efficiency improvements. This paper identifies non-technical barriers to building energy renovations and potential policy instruments to overcome these barriers. The study was carried out by using the following methods: first, we mapped the barriers and policy instruments addressed in renovation-related studies. Following this step, we studied the importance of barriers and the feasibility of various policy instruments in and with a few selected Russian experts. The outcome of the interviews indicates that standards, information dissemination and awareness raising are the most efficient instruments to promote energy renovations of buildings in Russia. Both students and the interviewed Russian experts shared the view that the role of the Government is highly important regarding introduction of these instruments.

Keywords: energy efficient renovation; barriers; policy instruments; Russia

1. Introduction

Russia is one of the most energy consuming countries in the world, which can partly but not completely be explained by its cold climate and heavy industry. The high energy intensity encompasses all sectors of the Russian economy and is higher than in other economies with similar levels of gross domestic product (GDP) per capita. Even though the country's energy intensity has decreased during the last decades, the drop is not as significant as in most former Soviet Republics [1].

In Russia, the residential sector is the second largest energy consuming sector after manufacturing [1], and studies on the energy consumption and energy-efficiency of Russian buildings from the 1990s indicate a strong need for energy-efficiency improvements of Russian housing [2–5]. As the average heating energy consumption (including both space heating and heating of domestic hot water) for old multi-family buildings is about 229 kWh/m^2/year but only 77 kWh/m^2/year for new ones, it is evident that rehabilitating projects could offer extensive energy savings [6]. There are quite a few recent studies [7–12], which also discuss the considerable potential to improve energy-efficiency in Russian residential buildings and the related infrastructure in districts. A study by IFC and World Bank [1] presents that residential, commercial and public buildings hold the greatest potential to decrease final energy consumption in Russia, as energy efficiency investments could enable savings up to 68.6 Mtoe per year, and the technical potential to reduce energy consumption of residential buildings would be 53.4 Mtoe [1].

Prior to 2005, a systematic Russian energy policy did not exist [13]. The energy strategy of Russia for the period up to 2030 states that Russia must improve its energy-efficiency and reduce the energy intensity of its economy to the level of countries with similar climatic conditions, such as Canada and the Scandinavian countries [14]. In addition, the strategy requires that Russia's living standards must correspond to those of the developed countries. However, the Russian energy strategy is characterized by its non-binding nature because it functions only as a program document for the national energy policy describing the long-term goals in the field of energy policy as well as the mechanisms to achieve these goals [15]. The Energy Efficiency Act from 2009 constitutes legally binding implementation of the strategy although it covers less than half of the energy efficiency measures mentioned in the strategy [15]. Even if energy efficiency policies offer many potential benefits for reducing greenhouse gas emissions, climate concerns do not appear to be the government's primary motivation [16].

In the Western context, several barriers to energy-efficient building renovations are addresses, such as social barriers (e.g., [17–19]), economic barriers (e.g., [20–22], technical barriers (e.g., [18,23,24]), and political barriers (e.g., [11,23,25,26]). Some non-technical barriers to energy-efficient renovation of Russian apartment buildings and residential districts have been identified but a more focused analysis is however missing. Boute [27] highlights that it is essential to identify the specific obstacles that prevent the transition of the Russian economy towards more energy efficient patterns.

Ürge-Vorsatz et al. [28] identified 20 policy instruments and mechanisms that have been used to decrease CO_2 emissions from buildings by improving energy efficiency. This extensive study suggests that the most cost-effective instruments are application of standards, demand-side management programs and mandatory labelling. However, the wide study does not deal with neither building renovation nor Russia which are the focus of this paper.

Perhaps the two dominant challenges in renovating Russian residential districts to more energy efficient ones are financing the renovations and the joint decision-making among apartment owners [26]. In addition, outdated norms have been identified as important obstacles in building renovation [11]. This paper aims to identify non-technical barriers to energy efficient renovation of residential districts and highlight the ones which are relevant in Russia. In addition, the paper examines policy instruments discussed in the renovation-related scientific literature and evaluates their usability in overcoming barriers. The focus is on Russia but a more general view will also be provided.

1.1. Russian Housing

According to latest statistical data, the total population of Russia is 146.5 million of which 74% live in urban areas [29]. The average living area per inhabitant is 23.9 m^2 [29]. In Russia, there are nearly 20 million residential buildings with a total floor area of over 3300 million m^2 [30]. 42% of these buildings were built during 1946–1970 and 30% during 1971–1995 (Figure 1). During the Soviet era, starting in the late 1950s, the housing problems of the Soviet Union were solved by building big blocks of flats which were poorly insulated and heated with district heating solutions which were implemented inefficiently. These energy-wasting buildings and facilities still comprise a majority of the buildings in Russian cities (Figure 2), although it was assumed that in 25 years they would be replaced by better dwellings and systems [31]. Estimates differ about the percentage of flats which should be repaired, ranging from 40 to 60% [32,33].

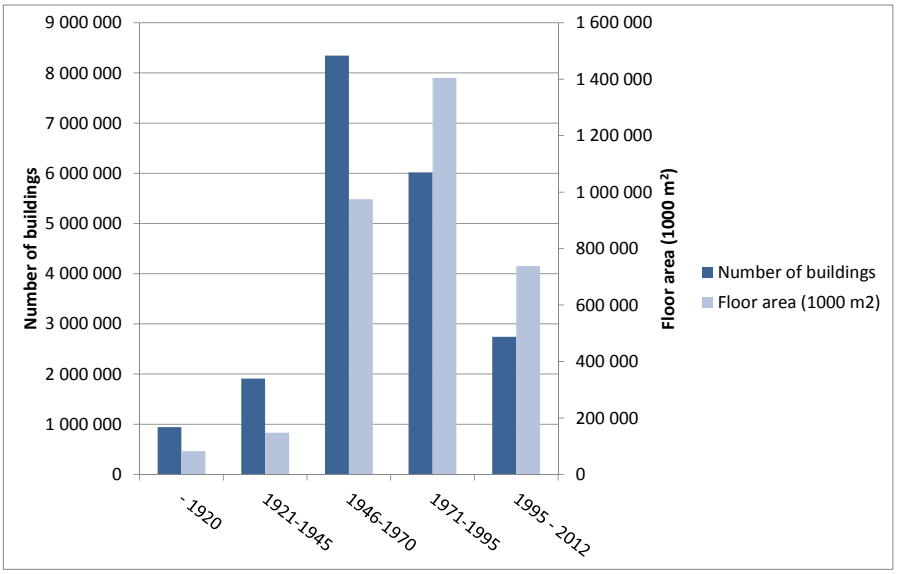

Figure 1. Russian residential buildings by the year of construction (Source: [30]).

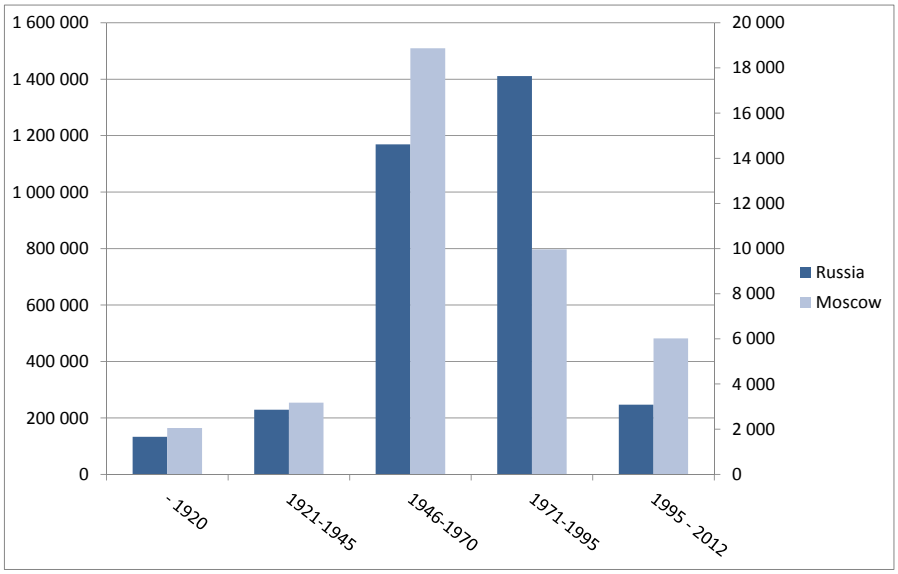

Figure 2. Number of apartment buildings by the year of construction in Russia and in Moscow (Source: [30]).

The housing stock in Russia has a rather high level of amenities. An average of 61.4% of housing is provided with all basic amenities. In 2009, 89% of urban housing stock had access to water supply, 87% to sewerage, 92% to heat supply, and 80% to hot water [34]. In 2014, 73.3% of households had access to Internet [29].

Majority of Russian housing is privately owned (in 2014, 88.6% of the housing stock [35]) due to the free privatization of housing after the Soviet collapse [34]. Because of this no-cost transfer of ownership, Russia has become a country of poor owners who cannot afford property maintenance and taxation leading to discussion on whether ownerships should be returned to municipalities [36].

District heating accounts for 70% of the total heat supply in Russia, especially in urban areas [37,38]. Due to the technical structure of district heating used in Russia, heating typically cannot be controlled in Russian apartment buildings [38,39], which means that energy renovations of single buildings seldom lead to reduced energy production. Because heat exchangers are lacking between the district

heating networks and buildings in Russia, reduced energy demands of a building does not lead to savings in the beginning of the energy chain but may instead lead to overheating of the building [11]. Energy production demand will reduce only if the residential districts and their various utilities and networks undergo a holistic renovation process. [26].

Paiho et al. [40] analyzed investment costs (The exchange rate between rubles and euros have varied a lot during the years, in 2013 a typical exchange rate was €1 = 40 RUR as in September 2016 it was €1 = 73 RUR. When comparisons are made with different currencies, typical exchange rates at a corresponding time were used.) of different holistic energy-efficient renovation concepts of a residential district in Moscow. At the building level, the investment costs of different renovation packages varied between €125/m^2 and €200/m^2 depending on the extent of the selected renovation package. The building level cost estimates by Paiho et al. [40] is in line with average cost of capital repair, referring to a major repair taken place for the first time, in 2012 across Russia which was 4500 RUR/m^2 (€110/m^2) according to Russian Statistics [41]. In case the whole district would be renovated (both buildings and related energy and water infrastructure) the cost per inhabitant varied between €3360 and €5200. The cost of building renovations stood for about 90% of the total cost. In 2015, monthly average per capita income was 30,225 RUR (approximately €415) indicating that financial issues are crucial in energy renovations in Russia [29].

Residential consumers are charged for communal services such as heating, water, sewage, and waste disposal with one bill [42], in which heating is the dominant item, with regional variations of 47–65% of the total. A mandatory fixed fee for capital repairs is itemized separately as part of accommodation payment for owners of premises in apartment blocks [43]. However, this fee is hardly enough to cover the repair costs.

In 2015, average Russian residential tariffs were €19.4/MWh (1649 RUR/Gcal) for heating, €0.05/kWh (3.3 RUR/kWh) for electricity, €0.08/m^3 (5.51 RUR/m^3) for gas, €0.32/m^3 (23.64 RUR/m^3) for water, and €0.26/m^3 (18.90 RUR/m^3) for wastewater [29], by using a typical exchange rate of 73 (€1 = 73 RUR). Majority of the housing and communal services (HCS) in Russia are based on monopolies which in turn, lead to a constant increase in tariffs [33]. Regulated tariffs for residential customers are subsidized and do not reflect the costs of producing electricity [44] or heating [42]. Even if the tariffs are below the real costs, there is a large number of non-payers due to low income and inflated prices [33].

1.2. Non-Technical Barriers for Energy Efficient Renovations

A large body of international scientific literature has examined barriers which hinder adoption of energy efficient technologies within the construction sector. In this section a summary of these non-technical barriers (categorized as *social*, *economic* and *regulatory* barriers) is presented. A large number of barriers were identified in all the three categories and hence a broad range of issues regarding energy efficiency improvements were covered. The studied papers also cover a large geographical area: Even if most papers focus on Western countries, a few papers also deal with barriers in Asian countries (China, South Korea and Russia). Figure 3 summarizes the main barrier types found in our literature review.

Some of the *social barriers* are related to information and knowledge, suggesting that lack of information and motivation are hindering the dwellers from implementing energy saving measures [45]. These information related barriers are mainly related to uncertainty about advantages of energy efficiency improving measures and technologies [17,20,46], such as micro-generation technologies [22], or even fear of unknown technologies [19] as well as uncertainty of economic consequences of implementing these measures [17,20,47,48]. As solutions to overcome these information related barriers, literature suggests increased government support for communication and information dissemination for consumers, investors and financial institutions (for example [17]). Also, Du et al. [49] present that adoption of an effective communication approach among local

governments, architects, contractors, researchers and manufacturer would help to increase application of energy-saving technologies.

Some studies focus on barriers from the point of view of certain stakeholders. For example Hoppe [25] presents several barriers related to fear and mistrust of tenants or housing associations as well as tensions between local authorities and housing companies in the Netherlands. Distrust is presented as a crucial social barrier also in the UK [18] and in Russia [11]. Williams et al. [18] suggest that public mistrust of the government's energy efficiency programs is a significant barrier in the UK. According to the same study, there might also be lack of clarity over who is responsible for change (homeowners or governance). As a solution to tackle the issues related to mistrust between different stakeholders, Hoppe [25] suggests recruitment of a motivated project leader or an inter-organizational project group.

According to Paiho et al. [50], one significant social barrier in Russia arises in extensive renovation projects when each apartment owner needs to sign a temporary resettlement agreement. In Russia also different income levels among residents may complicate joint decision making on building renovation.

Other mentioned knowledge related barriers include lack of research about low-energy buildings, inadequate know-how [23] and lack of appropriate skills for low energy construction or refurbishment [21,22]. Some literature also highlights lack of appropriate technologies as well as lack of access to cost effective components [21,23].

As solutions to barriers related to lack of skills and technologies, the literature suggests improved education [23,51], more research and better precondition for research [22,23], increased low carbon housing refurbishment knowledge for industry actors [22], informing dwellers about energy consumption problems [45] as well as increasing the number or volume of demonstration projects [23,25].

Economic barriers presented in the literature are very often related to too high initial investment costs and long payback time [20–22,46,48,49], problems with finding financial resources [24,25] sometimes because of unwillingness to borrow money [47] and sometimes because of banks' low willingness to provide loans [19]. Baek and Park [46] present that the investment costs of housing renovation are too big especially to low-income families who often have great potential for CO_2 reductions. Similarly, concern for lack of resources to refurbish homes and public spaces in suburbs has been expressed by Williams et al. [18]. Also, in Sweden, the low tariffs of district heating might cause a barrier as the reduction in cost for reducing energy consumption might remain rather low providing no incentive for energy saving [52].

As solutions lack of funding opportunities, the literature suggests government grants or subsidies for energy-efficiency measures [17,22,25,49,53], financial incentives to encourage change of behavior [24] and to increase the profitability of the energy saving technologies [49]. Incentives could be tax rebate for sustainable refurbishment projects [22] or a sliding scale of subsidy for improvements depending on the carbon emission reduction [54]. Other suggested solutions are energy contracting [24], increased government support for specific technologies and products [22] and new finance models for large-scale whole-house retrofits [53].

Regulative barriers for energy efficiency suggested by the literature vary largely depending on the geographic location. For example in South Korea there is a lack of an extensive regulatory system covering the existing residential building sector [46]. In China an important regulative barrier is the lack of effective supervision [49]. According to Paiho et al. [11] in Russia, municipal administrations might conceal information on the actual technical state of residential buildings in case they are declared as "dilapidated" or "dangerous", as the residents must be resettled and provided with substitute housing.

In European countries the regulative barriers are often related to insufficient or lax regulation, malfunctioning incentives, unclear regulation about labelling and frequent changes in regulation [55]. Hoppe [25] presents that in the Netherlands there are problems related to the roles of stakeholders: Local authorities have an initiating role but they tend to lose influence. Also, local authorities set high targets but they turn out to be not feasible, causing tension and distrust among local

stakeholders. Problems observed in the UK are lack of clear building regulations for low carbon housing refurbishment [22] and the unclear definition of the "zero-carbon" goal as well as absence of a clear medium-to-long term energy supply policy for the domestic sector [23].

Solutions suggested in the literature consist of, among others, establishing a well-resourced cross-government team to help define policy and coordinate implementation [46], increased government supplied low carbon programs and schemes [22], enforcement of building regulations on existing homes which would encourage investment in energy efficiency [54] and progressive regulation for higher renovation standard [53].

Some barriers can be categorized as *other* barriers. As an example of a barrier in this category, the historic preservation of old buildings might pose limitations for energy efficient refurbishment as deployment of thermal insulation measures might be difficult in these cases [24]. Another barrier, recognized particularly in the UK is the poor quality of buildings which according to Downson et al. [21] will not be refurbished without stronger incentive schemes, active promotion and technological innovations.

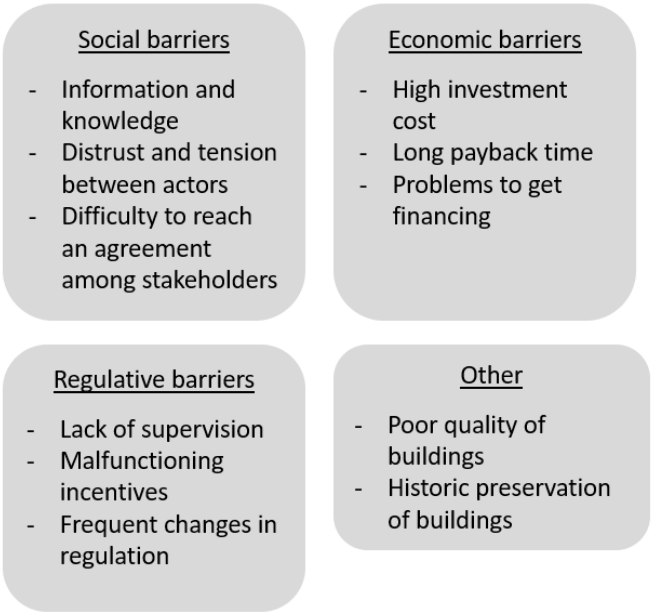

Figure 3. Four categories of barriers presented in this study and the main barrier types found.

2. Materials and Methods

This research is based on a review of scientific literature on renovation related policy instruments, focused questionnaires and semi-structured interviews. A group of Russian Bachelor students studying building energy technology and the Finnish building codes in the Mikkeli University of Applied Science in Finland answered a questionnaire and were interviewed in the semi-structured interviews. First, they were asked to answer a preliminary set of questions in an Internet survey. Then, based on an analysis of the results the semi-structured interviews were formulated and conducted face-to-face with the students. Based on literature review and interviews, a suggestion on effective and feasible policy instruments in Russia was made. This suggestion was further validated by conducting an interview with four Russian experts in Finland who have a deep understanding of the political and/or economic situation of Russia. The experts were selected based on personal contacts and their expertise regarding Russian policy, Russian trade, and Russian energy transition. With help of interviews, opinions of the Russian experts were obtained and included in the suggestion on policy instruments.

The interviewed students were young adults coming from Russia. It is important to notice that they do not represent "average" Russian young adults since those ones studying abroad have usually

attended private schools. The interviewed students have better education and better knowledge of other countries and they might have more flexible and open attitudes towards other countries. In addition, a significant proportion of Russian citizens, and especially those who identify themselves as young economic and intellectual 'elites', appear more concerned about modernization [16]. This may have affected the responses of our interviewees and therefore these responses may not represent attitudes of an average Russian. In addition, due to their age their opinions do not necessarily follow opinions of older Russian adults. However, this target group was chosen because the students have profound knowledge of the Russian society but through their studies they have also attained relevant technical understanding of the issues regarding building energy efficiency improvements in their country. In addition, they studied Bachelor degree which is more practice oriented than Master studies. The students participated in a course with the focus on energy efficient renovation in general and particularly in Russia. These interviews were part of this course.

The overall analysis was carried out in the following steps:

A. Categorizing and analyzing renovation related policy instruments discussed in the scientific literature
B. Formulating and performing the preliminary questionnaire
C. Analyzing the results of the questionnaire
D. Defining the main target questions for the semi-structured interviews and formulating the general structure of those interviews
E. Performing the semi-structured interviews
F. Analyzing the results of the semi-structured interviews
G. Giving a suggestion on effective policy instruments in Russia and validating the suggestion by interviewing selected Finnish Russian experts in Finland.

The questionnaire was divided into two parts. In the first part the respondents were requested to assess a set of barriers and solutions to energy efficient refurbishment in Russia on an estimation scale. The second part consisted of open-ended questions inquiring about the situation of energy efficient refurbishment in Russia and about the issue of demolition versus refurbishment of old buildings. The idea behind our approach was to enable comparability of the results, by using the estimation scale, but also to allow the respondents to more freely express their own thoughts on the issues.

The aim of the semi-structured interviews was to further study the issues which were identified in the survey. After a short introduction to the topic, the session proceeded with the following steps:

1. The participants were asked to present their opinion on the benefits and drawbacks of refurbishment but also on demolition and rebuilding in case of an old, deteriorated building.
2. The participants were asked to distribute 10 points between a set of policy instruments (presented in Table 1) according to how (a) effective, and (b) feasible they could be in speeding up energy efficient renovation in Russia.
3. The participants were encouraged to have free discussion about the role of the public sector in promoting energy efficient refurbishment activities in Russia.

3. Results

This section is organized as follows: Section 3.1 categorizes renovation related policy instrument identified in the scientific literature, Section 3.2 presents the results of the focused questionnaire to the students of the Russian class in Mikkeli University of Applied Science, and Section 3.3 presents the results of the semi-structured interviews of the same group of students. And finally, Section 3.4 presents the results of the interviews with the Russian experts.

3.1. Renovation Related Policy Instruments

Table 1 addresses the policy instruments discussed in the renovation-related scientific literature. The issues presented in the articles were categorized based on the primary topic they were related to. The topics were categorized as *Codes & regulations*, *Certifications & labels*, *Standards*, *Economic instruments*, *Information dissemination & awareness raising*, *Voluntary agreements*, *Programs & campaigns* and *others*. Many articles deal with more than one primary topic. Figure 4 shows the number of papers dealing with these topics. The figure illustrates that *Economic instruments* were by far most often discussed in the papers. The frequency of a policy instrument is not interpreted as an indicator of its usefulness but only as an indicator of which policy instruments have been suggested the most. In Table 1, the *economic instruments* include different types of measures, including different types of monetary support (grant, subsidy, loan, tax reduction, etc.). In addition, studies may include aspects not relevant to renovation, since it is not necessarily distinguished which instruments are targeted at renovation only. The most typical instruments are *Economic instruments*, *Codes & regulations*, *Information dissemination*, and *Certifications & labels*. Typically, no observed impacts are analyzed; the papers may state that the proposed instrument is effective but there is rarely any actual proof of the effect after its realization. In addition, there usually is no (or only limited) analysis of side-effects or negative impacts, such as the free-ridership or unjustified public support to some market player. It should also be noted that only one paper deals with the Russian context.

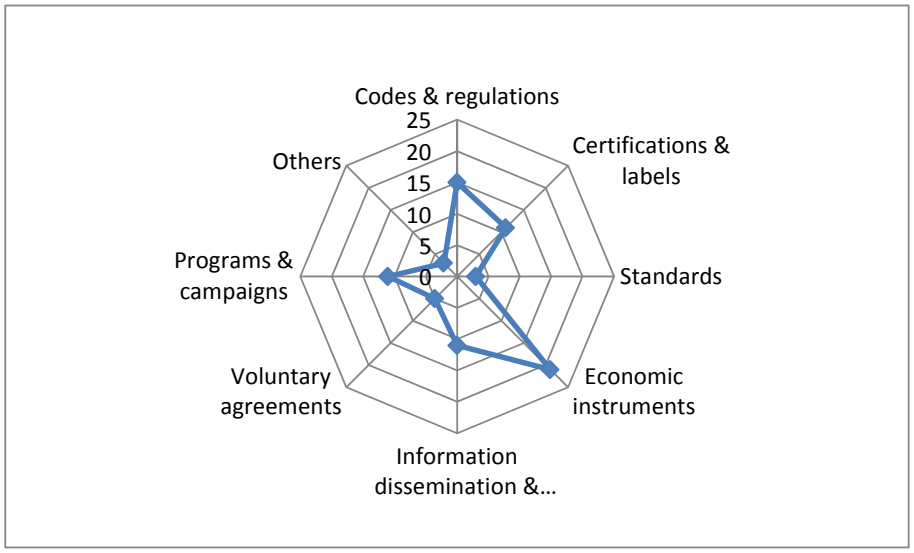

Figure 4. Number of papers dealing with the primary topics.

Table 1. Policy instruments addressed in renovation-related studies (may include other issues as well).

Reference	Target Sectors	Countries	Codes & Regulations	Certifications & Labels	Standards	Economic Instruments	Information Dissemination & Awareness Raising	Voluntary Agreements	Programs & Campaigns	Others	Comments
Ástmarsson et al. [56]	rented residential buildings	Denmark		x		x	x	x	x	x	list of instruments, not information given on the effectiveness
Baek and Park [57]	residential buildings	Denmark, France, Germany, Sweden	x	x		x				x	review how renovation policies are changing, and what political strategies promote housing renovation, no effects reported
Baek and Park [46]	residential buildings, mainly single-family houses	Denmark, France, Germany, Korea, Netherlands	x	x		x	x				barriers and instruments introduced, no effects reported
Charlier and Risch [58]	households	France				x					evaluation of 4 financial support policies available only if renovations are done by building professionals. In the absence of environmental policies, very few energy-saving renovations are profitable or can be financed by households. Share of "free-riders" about 40%.
Dowling et al. [59]	buildings, energy supply	Australia	x		x	x	x		x		some effects reported, not actual standards for building renovation presented (rather referred to regulations and performance standards)
Galvin [60]	existing homes	Germany	x			x					cost-effectiveness of building codes, not reported how they would function in practice
Gram-Hanssen [61]	single-family houses	Denmark	x	x			x				no effects reported
Gupta et al. [62]	owner-occupied dwellings	UK							x		results of energy retrofits of 27 owner-occupied homes showing energy use reductions
van der Heijden [63]	retrofits of existing buildings	Australia, Netherlands, USA				x		x			voluntary programs may be successful in particular niche markets

Table 1. *Cont.*

Reference	Target Sectors	Countries	Codes & Regulations	Certifications & Labels	Standards	Economic Instruments	Information Dissemination & Awareness Raising	Voluntary Agreements	Programs & Campaigns	Others	Comments
Jones et al. [48]	housing stock	UK	x			x			x		programs analyzed for energy savings, CO_2 reduction, and costs
Karvonen [64]	housing stock	UK	x			x	x		x		introduced community-based partnership includes several stakeholders. Could in some form be applied to Russia. Some examples of the effects given.
Korppoo and Korobova [42]	residential heating	Russia	x		x	x			x	x	existing policies analyzed, no known effects at the time of writing, obstacles discussed, possible changes of heat consumption standards (not mentioned which ones)
Lewis [65]	neighborhoods	Baltimore City, USA				x			x		focus on spatial analyses, probability of residential renovation is examined (i.e., compared to, for example, how close to public transportation)
Lloyd et al. [66]	houses	New Zealand				x			x		physical effects of a government sponsored residential energy efficiency upgrade program, thermal indoor conditions improved since the houses had no insulation before the program
Meijer et al. [67]	residential building stocks	Austria, Finland, France, Germany, Netherlands, Sweden, Switzerland, UK	x	x		x	x		x		some data on the contents and effects of the policies and incentives
Murphy et al. [68]	residential dwellings	Netherlands	x	x		x	x	x			results demonstrate weak impact of some key instruments

Table 1. *Cont.*

Reference	Target Sectors	Countries	Codes & Regulations	Certifications & Labels	Standards	Economic Instruments	Information Dissemination & Awareness Raising	Voluntary Agreements	Programs & Campaigns	Others	Comments
Murphy [69]	existing dwellings	Denmark, Germany, Sweden, UK	x	x		x	x				instruments between countries differ considerably, little is known about the effects
Nauleau [70]	existing homes	France				x					positive effects of tax credits for home insulation reported, share of "free-riders" who would have invested anyway ranged from 40 to 70%
Rosenow et al. [71]	residential buildings	UK				x			x		analysis of budgetary (fiscal) effects of energy efficient programs focusing on solid wall insulation, significant uncertainties in the model
Sunikka [72]	housing stock	European countries, mainly Finland, France, Germany, Netherlands, UK	x	x		x	x	x			analyzing and suggesting policies, no effects reported
Sunikka-Blank et al. [73]	social housing	UK		x		x	x				results on effects in a case house
Tuominen et al. [55]	housing stock	Bulgaria, Czech Republic, Denmark, Germany, Finland, Latvia, Netherlands, Portugal, UK	x	x		x	x	x	x		no realized effects reported, the interest rate of 10% used in cost-effectiveness calculations is too high for most Western European countries, in Russia it is a typical one
Uihlein and Eder [74]	residential building stock	EU-27	x		x						potential environmental and economic impacts of two policies analyzed offering energy savings
Weiss et al. [24]	single-family houses	Germany	x	x		x			x		state that the instruments are effective but does not give any evidence on that
Number of papers dealing with the issue:			15	11	3	21	11	5	11	3	

3.2. Results on Questionnaires

Altogether 17 students responded to the questionnaire. 9 of the respondents were male and 8 were female students, and the average age of the respondents was 21.5 years. All the 17 students responded to each question and therefore it was assumed that they have been thorough in answering the questions and that the responses are valid.

First, the respondents were asked to identify main barriers for energy efficient building refurbishment in Russia by assessing a set of barriers on the scale from 1 to 5. The results indicate that poor condition of buildings which supports demolition instead of refurbishment, unclear political targets regarding energy efficiency improvements and lack of financing opportunities are perceived as the most significant barriers (Figure 5). Barriers such as outdated norms and building codes and lack of information regarding energy efficient refurbishment measures and their effects/benefits were seen as less important barriers. However, the differences in the scores given to the barriers are rather small.

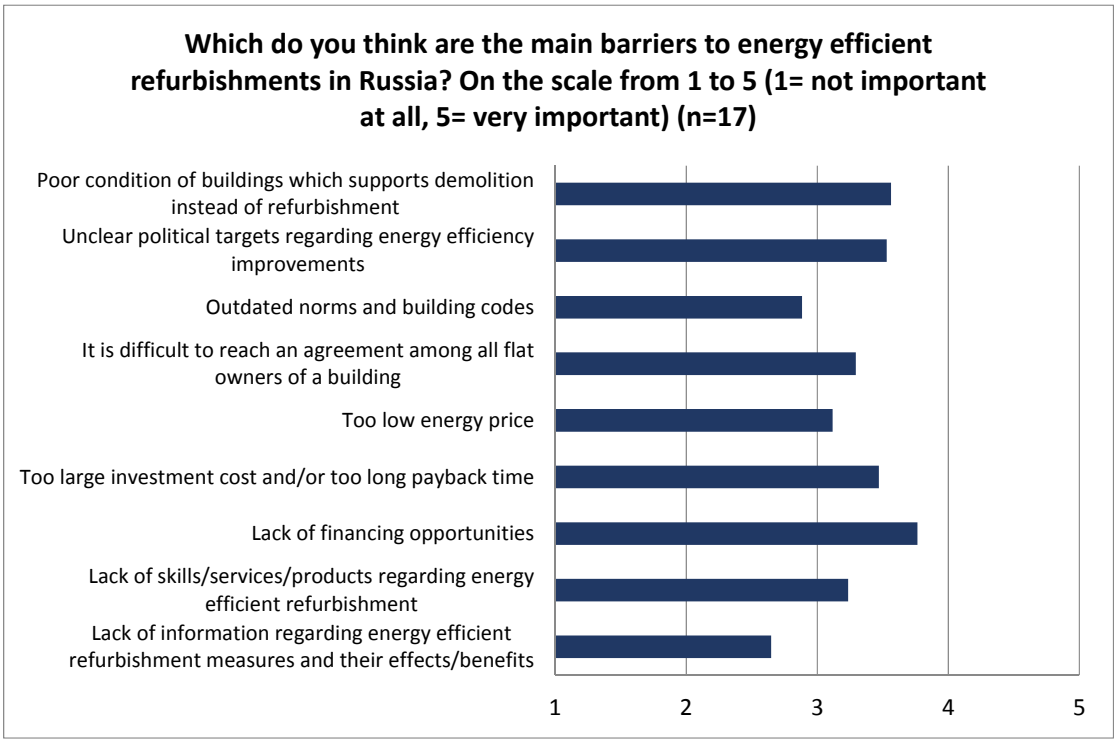

Figure 5. Main barriers identified by the respondents of the survey.

Next, the respondents were asked to assess potential solutions, also on the scale from 1 to 5. The differences in scores between the suggested solutions are not significant. "Loans/grants/tax reliefs provided by the government for energy efficient refurbishments", "the support of the public sector and change of attitudes" and "increasing interest in environmental issues" scored highest (4,2) (Figure 6).

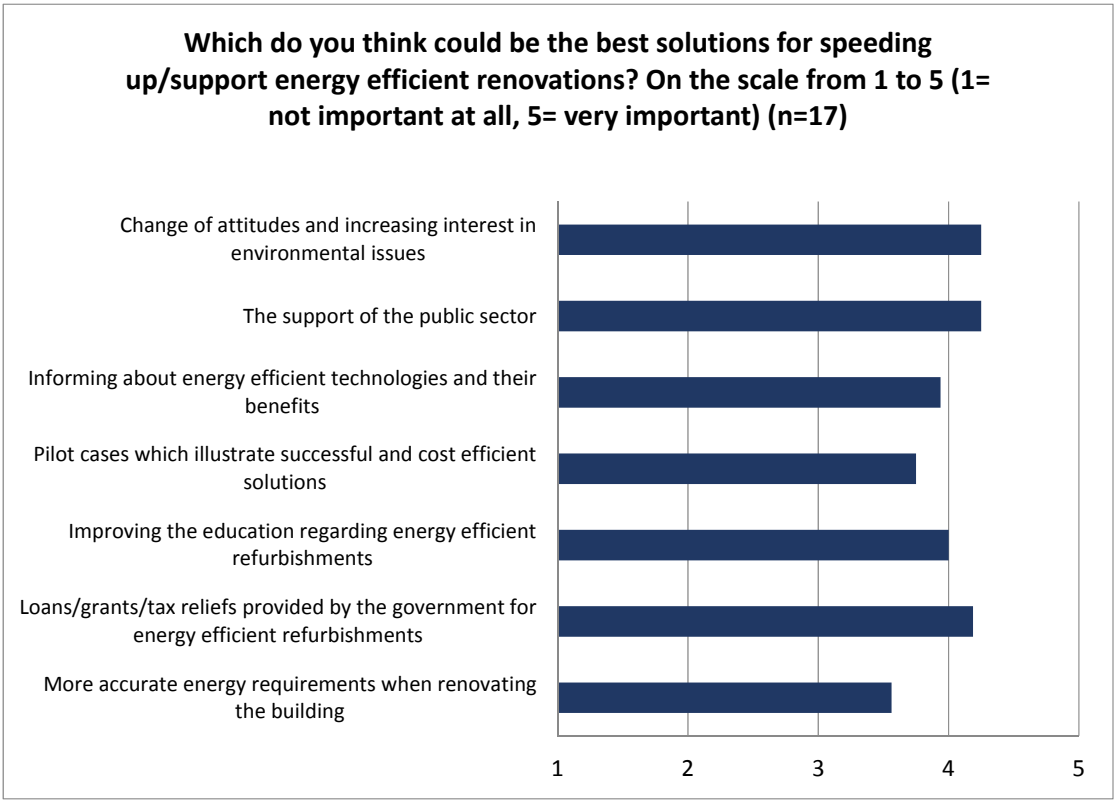

Figure 6. Most potential solutions for speeding up energy efficient renovations in Russia.

The respondents were also asked to answer a few open-ended questions about the level of interest regarding energy efficient refurbishment in their home country and the issue of demolition versus refurbishment. The respondents felt that the level of interest is rather low although a few respondents pointed out that a positive change is taking place. Examples of the responds are presented below:

> *"Nowadays Russian government is capable to improve and refurbish energy efficient technology but I guess it's quite new for us and we don't know what to do in order to reach great quality."*
>
> *"[Energy efficient refurbishment] becomes more popular. The companies which provide such options are learning from the foreign experience."*
>
> *"Unfortunately, nowadays we haven't enough support from Government for reconstruction and energy efficient refurbishment of residential houses. In the view of customers the level is high (of course to save money), but in my opinion there are no instructions from builders for new technologies and for the building development industry."*
>
> *"Almost nobody is interested in energy saving. People just got used to high running costs."*

The thoughts on whether an old building should be demolished or refurbished were contradictive: about half of the respondents thought it is better to demolish than to renovate whereas the other half either thought renovation is a better option, or pointed out that each case is different, depending on the building type and condition, and therefore a simple answer cannot be given. Examples of these responds are presented below:

> *"I think if it [the building] is in very bad condition it is much better to demolish it. Old buildings are not energy efficient and very massive."*
>
> *"It depends on the condition of the building (and which part is damaged more dangerously: wall constructions, basement, engineering systems etc.). Sometimes renovation of an old building costs*

more than to demolish. This is the reason to demolish building and build new ones instead of renovation."

3.3. Results on Semi-Structured Interviews

Altogether 17 students participated in the semi-structured interview. After a short presentation of the topic and the aim of the interview, the participants were asked to assess the usability of a number of policy instruments (the same ones as presented in Table 1) by distributing 10 points among the seven instruments according to their expected effectiveness and feasibility. The level of *effectiveness* indicates how effective an instrument would be if it was implemented whereas the level of *feasibility* indicates how probable it is that the instrument would be implemented. The results are presented in Figure 7.

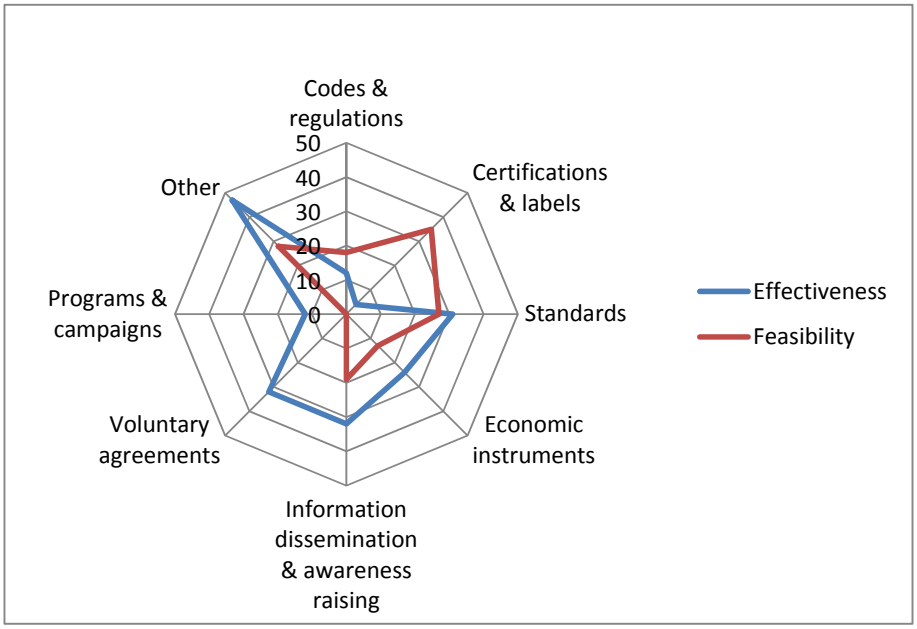

Figure 7. Evaluations of the effectiveness and feasibility of the instruments.

Standards, information dissemination & awareness raising and voluntary agreements were seen as by far the most effective policy instruments whereas codes & regulations, certifications & labels and programs & campaigns were not viewed as very useful. However, the same instruments were not seen as the most feasible ones. Only standards were identified as both effective and highly feasible. Surprisingly, the belief in taking up voluntary agreements, which was seen as one of the most effective instruments, was minimal. According to the interviews, the instruments referred to as "other" were mainly related to government initiatives and elimination of corruption.

The participants were also asked to explain the reasons behind distributing the given points. A few issues arose from this discussion: the role of the government, regulation and standards, information dissemination and financial issues. In this context 'the government' is understood not only as the political administration of the state but instead, the concept represents the public sector in a broad way including e.g., education, training and information dissemination through campaigns and programs.

Most of the interviewees shared the opinion that it is the government's responsibility to provide information to people, take charge in promoting renovation and to also provide funding for the renovations. As an example of this thought is the quote: *"Everything depends on the government. It regulates everything"*. Evidence exists that the government has taken some initiative in supporting building renovation: In the years 2008–2011 budget-funded programs of capital repairs were implemented in almost every region of Russia [43] however, only a limited number of buildings have

been repaired so far. Most capital repairs on apartment buildings in Russia are currently co-funded by "Housing and Utilities Reform Fund", a state-owned corporation mandated, for the period up till end of 2017, to support capital repairs of apartment buildings, while encouraging market transformation in the housing sector. The corporation distributes funding to regions to co-fund implementation of their regional "address-list" programs. The average co-funding rate is 70 percent [75], but the rate may vary substantially by region as it depends on self-sufficiency of regional budgets. However, regional energy efficiency measures can be opposed for fiscal reasons because by reducing the share of energy expenditure in the regional budget, energy savings can also affect the redistribution of fiscal resources between the regions [27].

One issue mentioned several times in the discussion was the lack of information, and it was suggested that people do not make initiatives themselves and therefore improvements in information dissemination are needed. This is in line with the observation by Bashmakov [10] who states that even if price information is provided by the market, this is not enough to speed up the change and therefore market signals should travel through clear channels.

Also, the role of public sector regarding energy issues was highlighted and many of the interviewees thought that energy is too cheap in Russia. The problem of cheap energy has been recognized as one important barrier and for example Lychuk et al. [76] suggest that several energy efficient technologies do exist in Russia, provided either by domestic or foreign manufacturers. According to the authors however, the history of cheap oil and natural gas does not encourage builders to use better insulation to decrease heating costs and similarly, artificially low tariffs for district heating make it unaffordable for district heating suppliers to make investments to improve the district heating infrastructure, which needs to be replaced.

Some hope was also put on *standards, codes & regulations*, which can be seen in quotes such as "The standards are the most important ones. Every company needs to follow them." and "Maybe we would build more energy efficient buildings if there were regulations." It is no surprise that the need for better standards was expressed when considering the state of the infrastructure systems: As an example, regarding district heating, a number of technical standards and norms are outdated in regard of new, modern technologies [38]. Also Sinyak et al. [77] state that elimination of heat losses in heating by replacing of pipelines by new ones made from modern materials and applying efficient methods must become a priority for district heating systems. Similarly, the need for better standards regarding technologies and equipment is recognized by Bashmakov [10] who suggest that adoption of energy-efficiency standards would prevent low-efficient technologies from entering the market, which is effective especially in sectors with high information barriers.

Even if *codes & regulations* were mentioned by a few interviewees during free discussion, they however did not rank very high when evaluating the effectiveness and feasibility of the proposed instruments. This is no wonder considering that also IEA [78] has noted that dealing with regulations, policy co-ordination among the numerous ministries involved, as well as implementation of policies, legislation and regulation, is often challenging. For example, by law no electric bulbs may be sold after 2011 if their rated power is 100 watt or above [15]. This law was realized by starting to sell 99 watt bulbs. In addition, a regulatory framework for implementing energy efficiency projects is missing [27].

As financial issues have been observed as major barriers in the international scientific literature, the situation in Russia seems to be no exception. According to IEA [78], federal budget funding for energy efficiency or district heating modernization remains insufficient. Also the IFC [6] presents that receiving funding for renovation projects is indeed an obstacle in Russia as well, because organizations providing loans are more interested in large contractors than individual owners.

The participants also pointed out frequently that a major problem regarding energy efficient renovations in Russia is the high level of corruption. This is also supported by the claim that in Russia, any attempted systemic reforms are hampered by grinding bureaucracy and corruption [16]. All the participants agreed on that the mentality of both people and government needs to change. Need for change in mentality is evident also regarding the observation by Lychuk et al. [76]: as average incomes

have been growing in Russia people demand better comfort in living, leading into increasing demand for air conditioning and ventilation. There are also problems regarding the apartment ownership: as most Russian apartments are privately owned and homeowner associations are not always common, it is challenging to introduce extensive retrofit projects without any organizing force [76]. Also, low willingness of people to invest in energy efficiency is evident in the comment of one interviewee: "*When you renovate, you never think about the environment, you only think about the money.*"

3.4. Selected Policy Instruments to Overcome Barriers

Figure 8 summarizes the key findings of the paper showing the main barriers identified in the literature and policy instruments to overcome the barriers, suggested by the authors. Based on the analysis of the Russian context and the semi-structured interviews, also suggestions on the most effective instruments in Russia are given. The figure was validated by interviewing selected Russian experts with Finnish nationality. Three questions were asked from the experts:

4. How relevant are the suggested barriers in the Russian context?
5. How efficient could the presented policy instruments be if they were implemented?
6. How likely is it that the policy instruments will be implemented in Russia?

The significant barriers identified from the literature, and which are also relevant in Russia, are divided into three groups: Information and knowledge related barriers, economic barriers, regulative barriers and other barriers. As is illustrated in the figure, all the proposed policy instruments are needed also in the Russian context, especially the ones requiring a stronger involvement of the public sector such as *information dissemination & awareness raising* and *programs & campaigns*. A summary of the comments given by the interviewed experts is presented in the text below. The only barrier which was not considered as highly important by all experts is *lack of information*. Three of the interviewed experts shared the view that information does exist (and can be found) but a bigger problem is the lack of interest in the environmental sustainability and energy efficiency. Also, the mentality to view issues with only short term perspective was mentioned as one obstacle. Currently, energy savings are not seen as important because the country is rich with energy, and therefore focus is rather put on other issues such as wellbeing.

One additional barrier which was mentioned by one of the interviewed experts is the symbiotic system of small and large energy consumers and producers which derives from the Soviet tradition. Because of this it is essential to question whether efficiency improvements can be made without changing the structure of the whole system. Another issue mentioned is that especially in St. Petersburg there have been a number of cases in which ownership of cellar and attic spaces is unclear due to corruption, which complicates understanding on who is responsible for paying for the building refurbishment measures. It was also mentioned that earlier there has been lack of comprehensive land use planning instead of focusing on individual buildings, but at least St. Petersburg now has a housing plan and several development plans, and therefore this seems to be improving. Another significant barrier in Russia was also pointed out by the experts: regulated energy prices were mentioned as one barrier and liberating the pricing of natural gas was suggested as a solution as this would give motivation for energy savings.

The experts held slightly differing views on the efficiency and feasibility of the policy instruments presented in Figure 8. One expert stated that *codes & regulations*, *certifications & labels* and *standards* are the hardest ones to change as they are the ones which prevent any reforms of the overall system. Another had doubts about the impact of *programs & campaigns*. Also, *information dissemination & awareness raising* were not seen as efficient instruments among those who did not see lack of information as a major barrier. One expert pointed out the problems of laws and regulations which impedes taking up renovation measures (for example a maintenance agreement has to be signed separately by each inhabitant) but this expert did not expect this law to change.

Several comments were received regarding the future of Russia and energy-efficiency improvements in the country. One presented view was that problems with the economy of the country might speed up implementation of some small-scale projects but this requires that economic benefits of the renovation project can be proven for the whole duration of the project and to all stakeholders. As this is not self-evident it remains debatable whether these benefits can motivate decision-makers. It was also mentioned that some improvements (such as exhaust air heat recovery) could be advertised better by focusing on their health benefits instead of benefits for the environment.

It was also suggested that Russia is not willing to adopt European standards—on the contrary, there seems to be a tendency to maintain old Soviet era standards. Also, economic modernization (including energy efficiency improvements) seems unlikely in the current political situation.

One expert pointed out that it is hard to say anything about the efficiency of the policy instruments and the likelihood of their implementation as regulation in Russia is mainly regional and therefore the choice of measures depend largely on the region, city, neighborhood and its civil servants.

It was also presented that if the economic situation will not worsen radically and resources can be combined with an active information campaign, energy efficiency could become a politically important matter (if it can be presented as a Russian invention). However, political capital is essential—if this exists, other resources can be found.

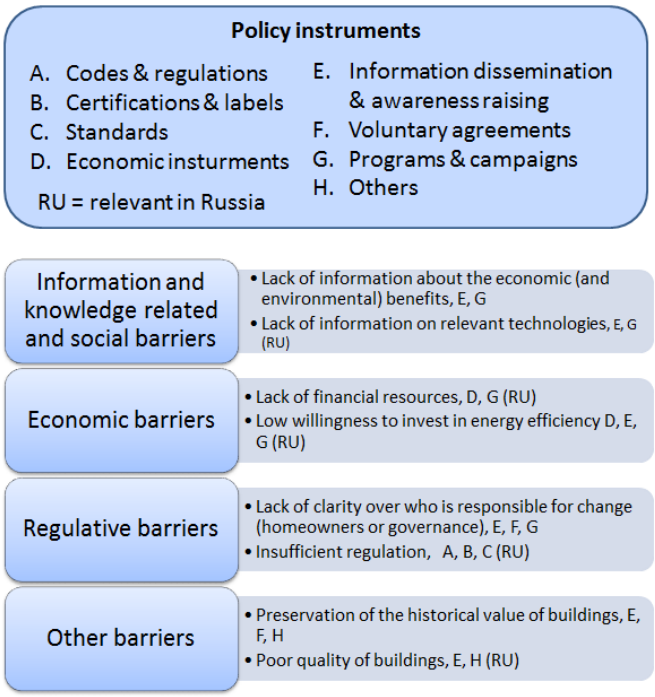

Figure 8. Barriers for energy efficiency and applicable policy instruments in the Russian context.

4. Discussion

We carried out an in-depth review of international scientific literature related to obstacles and policy instruments in building energy renovations. Surprisingly, only few scientific papers deal with Russia. This indicates how little international research about energy-efficiency of Russian buildings has been done, highlighting the pioneering work done in this paper.

There are some examples of building renovations done in Russia [50,79] but they are still rare. Due to the similarities in buildings and energy systems, many technologies applied and tested in Finland could also be applied to Russian apartment buildings [80]. District heating is widely used in both countries [81,82] but the system structures differ significantly. A major difference is that apartment buildings in Russia (or in any other Central and Eastern European country which

were under centralized planned economy during the Former Soviet Union) typically do not include building-specific heat exchangers or any other means to control heating [39]. This means that in addition to buildings, also the related district infrastructure must be renovated in order to improve living conditions and achieve wider benefits in the district scale. The later applies also to any Western country having district-level energy or water systems.

There was not much variation on the results of the questionnaires. Almost all the barriers and solutions to speed up energy renovations in Russia were assessed as equally important and scored in the middle of the given scale. One possible explanation for this result is that this might have been the first time that the students were contemplating this issue and therefore all the barriers might have appeared equally important to them. Also, a questionnaire not allowing assessing different options as equally important might have given more significant results. This could have been done for example by asking to organize the different option in an order according to their importance. However, even if the results of the questionnaire might not provide useful and explicit information, it can be viewed as a needed "warm up" and preparation for the semi-structured interviews, in which the issues were discussed in more details.

The interviewees did not consider *programs & campaigns* as neither very effective nor feasible policy instruments. However, the importance of the public sector in boosting energy renovations was repeatedly mentioned in the interviews and this suggests that programs could serve as effective instruments in Russia if they would be supported by the public sector. There are examples from Great Britain how community-based retrofit programs including regional partnership of different stakeholders have been successfully implemented to boost energy efficient renovations [64]. However, both the housing stock and the policy context in Britain differ considerably from the ones in Russia.

The activities of the public sector are also essential in *information dissemination & awareness raising*, which ranked high in the semi-structured interviews. Since there are many stakeholders involved in building renovations in Russia [26] some mechanism for community involvement could be suggested. For example in Lithuania, an Energy Lab approach to exploit stakeholder involvement on energy and environmental decisions at community level and to increase community acceptance was proven to be quite popular [83]. However, the Russian policy-making process generally does not include consultation with organized groups in society or take public opinion into account [16].

Financing—which was one of the main barriers identified in the literature study—is one of the crucial issues for (energy) renovations of Russian apartment buildings. Different financing models and solutions have been developed and suggested (for example [32,43]). There have also been federal and municipal financing programs. However, due to the crisis in Ukraine, the latest news from Russia report ceasing the national funding to the energy efficiency projects since budget money is allocated to other sources [84]. In addition, the international financing organizations, such as the European Bank for Reconstruction and Development [85], have cut their activities in Russia. Before this situation changes, high volumes of building renovations will hardly occur.

As was already mentioned, *programs & campaigns* did not score very high in the semi-structured interviews. However, we suggest that they could work also in Russia, together with a strong involvement of the public sector, and energy-efficiency improvements would be presented as "Russian innovations". For example Nuorkivi and Kalkum [38] present that rehabilitation and modernization programs are badly needed in Russia in secondary networks and building sector where the highest potential for energy-efficiency exists. This could also aid in convincing both the inhabitants and the financiers. In Russia, the creation of trust plays an important role in business relationships [26] and therefore strong commitment of the public sector, for example through *programs & campaigns*, could also support trust creation among the various stakeholders.

Since lack of financing was identified as one of the key barriers to energy-efficient renovations [40], policy measures tackling this issue are highly needed. In order to identify the most effective economic instruments (such as fiscal instruments or direct subsidies), more research within the Russian context is needed. Successful examples can be found from abroad, such as the Canadian ENERGY

Retrofit—Homes programe grants, which were provided to over 640,000 homeowners of low-rise residential properties who improved the energy performance of their home. According to an estimate, the grants enabled an average energy performance improvement of 24% per home, leading to more than 2.1 Mt reductions of greenhouse gas emissions per year (63 Mt reduction between 2011 and 2041). Benefits of grants and loans provided for building refurbishment have also been observed in Germany [86].

According to Ahonen et al. [87] economic instruments might sometimes be effective. Taxation can serve as an effective tool to decrease energy consumption as it leads to higher energy costs. In Nordic countries, energy taxes, together with support for energy efficient solutions have proven to be efficient. Also, France provides a successful example of implementing tax incentives for homeowners: due to a tax credit scheme providing tax credits for homeowners adopting measures which improve the energy performance of their dwellings, a 26% reduction in energy consumption of residential buildings by 2020 is expected [86].

Due to the outdated norms, the authorities are cautious when accepting new design solutions [11]. This may hinder implementation of technologies, which are considered typical outside of Russia, but which are not widely applied in Russia. Updating regulations could both improve Russian living standards and facilitate product entries to the Russian market. Even if *codes & regulations* did not rank high in the semi-structured interviews, they are essentially related to the role of public sector, which was repeatedly mentioned by both interviewed students and experts, hence emphasizing the necessity of change.

Codes & regulations receive support from Ahonen et al. [87] who studied different policy instruments implemented in Nordic countries, and their applicability in Russia. According to the study *codes & regulations* could be one effective way to improve energy efficiency but only if their enforcement can be ensured. Evidence supporting the important role that building codes can have in reducing energy consumption of new buildings can be found from Denmark.

According to a poll made for Russian residents, 80% of the respondents had not heard of mechanical ventilation [88], which indicates a need for enhanced information dissemination and education about technical solutions. This is in line with the results of our study: the participants of the semi-structured interviews ranked *information dissemination & awareness raising* as the most effective policy instrument for boosting energy renovations in Russia. Awareness raising is seen as important also in Nordic countries; a research center focusing on building and energy efficiency has been established in Norway (Research Centre on Zero-Emission Buildings), "which aims at creating a critical mass of expertise that can carry out regular, in-depth and scientific research and evaluations" [87]. Information dissemination in Russia seems important also considering the study by Lychuk et al. [76] which suggests that lack of knowledge and capacity on energy efficiency affect the market but the growing need for living comfort and energy efficient solutions makes Russia a promising market for foreign businesses providing energy efficient technologies, knowledge and services.

Only few studies report the effects of certain policy instruments suggesting that analyzing the impacts is highly challenging. This should also be better taken into consideration when developing new policy instruments for energy-efficiency in general. Since all policy instruments have limitations and they help overcoming only some of the barriers, they are most effective if combined into policy packages designed for the respective location, economy and culture [28]. Also in the Russian context, it should be analyzed whether a combination of policy instruments could be most effective. In addition, developing policy instruments for renovations and energy-efficiency could be one form of cooperation between the EU and Russia [89].

5. Conclusions and Policy Implications

This paper studied non-technical barriers to energy renovations of buildings and policy instruments which could be used to overcome these barriers. Based on an in-depth review of background information on Russian residential buildings and a questionnaire and semi-structured

interviews conducted with a group of Russian students, barriers and potential policy instruments in the Russian context were analyzed. The effectiveness of potential policy instruments was further discussed with selected Russian experts in Finland.

Standards, *information dissemination & awareness raising* and *voluntary agreements* were seen as by far the most effective policy instruments by the interviewed students. However, not all of them were viewed also as feasible, and only *standards* were identified as both effective and highly feasible. The role of the government was strongly highlighted regarding information dissemination, promoting renovation as well as providing funding for renovations.

The interviewed Russian experts held slightly varying views about the barriers and effective policy measures but on average they did agree on the main barriers and effective policy measures (summarized in Figure 8). Some experts thought that lack of information is not a significant barrier but instead, lack of willingness to invest in energy-efficiency was seen as the main challenge. Most interviewed experts shared the view with the interviewed students that the government has a major role in speeding up renovations in the country and that progress is not likely to take place without government's will and initiative.

In this paper we examined barriers to energy efficiency improvements in Russian housing which is a topic that has so far remained rather unstudied in spite of its high importance. Hence, we shed a light on issues which are highly relevant considering the world-wide need for reduction of energy consumption. Although our paper provides new and valuable information, this topic should however be further studied. We studied the topic from the viewpoint of a group of Russian students and a few Russian experts living in Finland. In future it is important to gain deeper understanding of residents of Russian buildings with poor energy performance. Therefore, a wide survey study would provide useful insight to the problems and motivation regarding energy improvements. Also, to better understand regulative and legislative barriers it would be fruitful to conduct in-depth interviews with representatives of administration and governmental authorities in Russia. Filling the knowledge gap with these angles would enable a more comprehensive understanding of the barriers.

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