

# **Increasing Thermal Performance and Energy Efficiency of Buildings in Russia: Problems and Solutions**

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***2007 Building X Conference***  
***December 1-5***

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## **Overview of the presentation**

- **What has Russia achieved in Thermal Performance and Energy Efficiency of Buildings (EEB)?**
- **How is it achieved?**
  - *standardization* ■ *new technology in construction*
- **Implementation of EEB in Russia**
- **Barriers to implementation & opportunities to improve implementation**
- **Conclusion**

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## **Partnership and Sponsorship**

**Russia's Research Institute for Building Physics (NIISF) has led development of Russia's EEB codes & standards**

**with help from the Natural Resources Defense Council (NRDC), the Institute for Market Transformation (IMT), and the Center for Energy Efficiency (CENEf) sponsored by the U.S. Environmental Protection Agency (EPA) and Renewable Energy and Energy Efficiency Partnership (REEEP)**

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## **How We Define Energy Efficiency in Buildings (EEB)**

**The properties of buildings and their technical systems such that they consume a limited level of heat energy while delivering optimal indoor air climate to the occupied premises**

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**Russia adopted its first regional EEB code in 1994 and its national EEB code in 1995 and 2003**



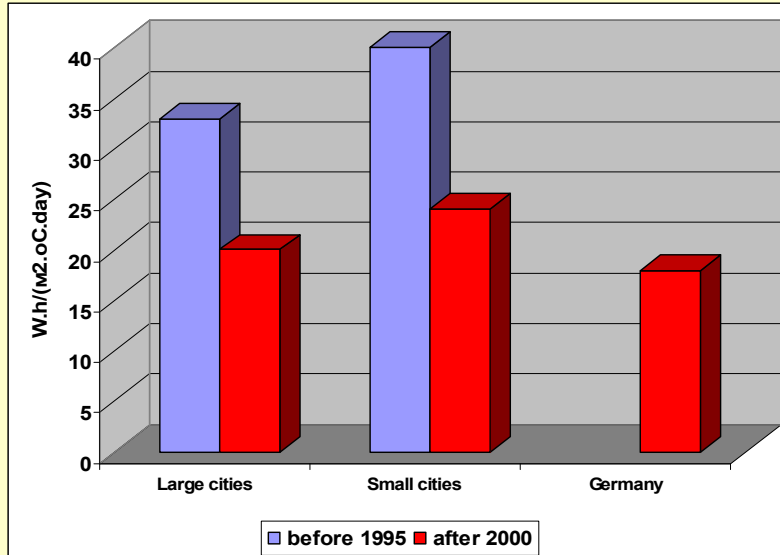
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**How has been achieved in Russia during last 12 years:**

- A new set of building energy codes and standards have been developed and implemented
- New construction technologies have been introduced

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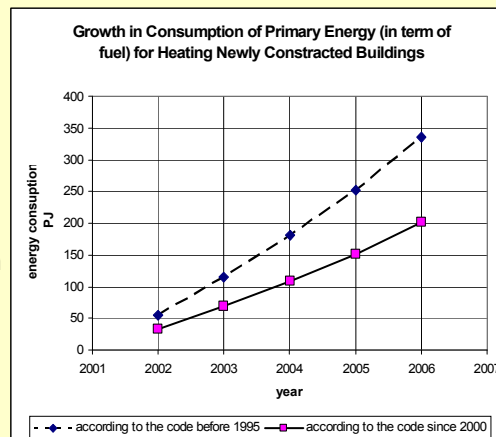
## Reduction of 40 % in Energy Consumption for Heating



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## Estimated Energy Savings in Russia (From 2002 to 2006, new residential construction totaled 205 million square meters)

- Primary energy savings of fuel over the period from 2002 to 2006 estimated at 375 PJ (or 13,4 mln tons of coal eq.)
- **This has led to an almost 25,5 mln tons reduction in CO<sub>2</sub> emissions**
- Annual fuel consumption for the generation of heat grew only by 201 PJ compared with a baseline growth of 336 PJ had buildings been constructed in accordance with prior codes – 135 PJ was saved in 2006 alone.



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## **Fundamentals of Russian Building Energy Codes**

- **EEB rating system – five Classes of EEB, including two classes that exceed code requirements**
- **Maximum permitted specific energy consumption levels for heating the whole building**
- **The “Energy Passport” – a single verification protocol used in building in both building design and operations**
- **New codes account for energy for ventilation, internal heat gain and solar radiation under cloud conditions**
- **New codes account for the efficiency of the heat supply system including renewable sources of energy**
- **Harmonization with international level, in particular, EPBD of EC (2002/91/EC)**

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## **New Code Have Two Compliance Paths:**

- **A prescriptive path, with required thermal resistance values for individual building envelope elements**
- **A performance path, with maximum permitted specific energy consumption levels for heating the whole building and optimal comfort**

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## Performance Path Gives Designers More Flexibility

Maximum Allowed Energy Demand for Heating  
a Building ( $q_h^{req}$ ) over the Heating Season,

$$Q_h^{req} \geq Q_h^{des}$$

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## Energy Rating - Classes of Energy Efficiency for Buildings

Letter grade and graphical representation	Name of the class	Percent deviation of design or normalized measures specific energy consumption from code-stipulated level	Recommended measures
<i>For new and renovated buildings</i>			
<b>A</b> 	<i>Very high</i>	Less than - 51	Economic incentives
<b>B</b> 	High	From - 10 to - 50	As above
<b>C</b> 	Normal	From + 5 to - 9	-
<i>For existing buildings</i>			
<b>D</b> 	Low	From + 6 to + 75	Renovation desirable
<b>E</b> 	<i>Very low</i>	Greater than 76	Upgrades urgently required

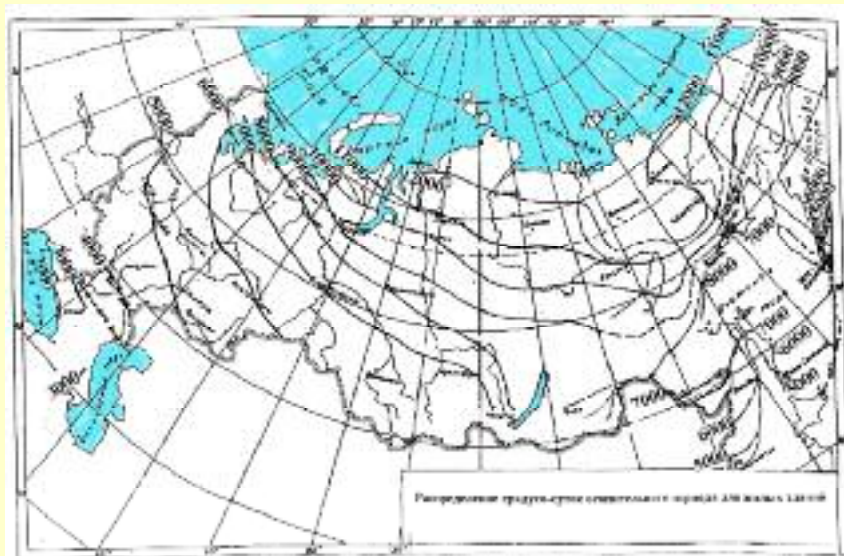
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## Performance Path

Types of Buildings	Number of Stories				
	W·h/(m <sup>2</sup> ·°C·day) [W·h/(m <sup>3</sup> ·°C·day)]				
	1-3	4-5	6-9	10-12	> 12
Residential	36	24	22	21	19
Educations & Offices	[10 (9)]	[8 (7,5)]	[8 (6,5)]	[7,5 (6)]	[7 (5,5)]
Medical	[10-9]	[8,5]	[8]	--	--
Pre-schools	[12]	--	--	--	--

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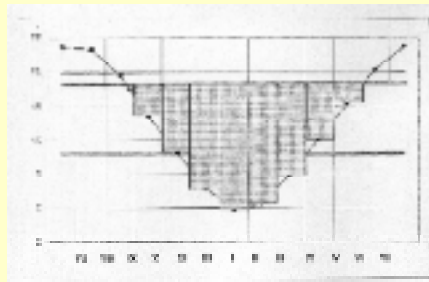
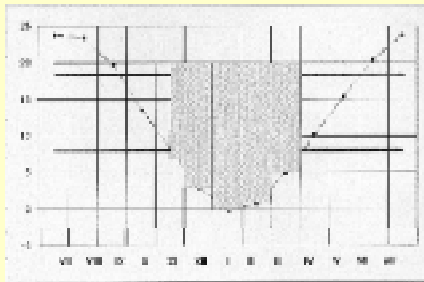
## Distribution of Degree-Days in Russia



## The Difference in Methods for Calculation Degree-Days in the US and in Russia

*Russian Method*

*American Method*



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## The Degree-Days

City	Degree-days	
	American Methods	Russian Methods
New York	2745	2339
Boston	3128	2640
Washington	2353	1822
Minneapolis	4376	4092

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## Four principles are key creation EEB

- Selection of a geometric form for the building that reduces heat losses
- Then reduction of demand for energy by increasing thermal performance level
- Provision of required air exchange
- Finally meeting remaining needs for energy in the most effective manner

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## Code Stipulated Thermal Resistance of Building Envelope Elements Depending of Degree-Days

R-value, °F.h.ft <sup>2</sup> /Btu, (m <sup>2</sup> .°C/W)			U-value, Btu/°F.h.ft <sup>2</sup> , (W/m <sup>2</sup> .°C)
Roofs	Walls	Floors on the ground	Windows
16,5 – 46,6	10,8 – 31,8	14,6 – 41,5	0,68 – 0,22
(2,9 – 8,2)	(1,9 – 5,6)	(2,57 – 7,3)	(3,85 – 1,25)

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## How to Compare of the USA and Russia Codes for walls

### Example

- Thermal resistance of walls in the city Boston is 11 °F.h.ft<sup>2</sup>/Btu or 1,94 m<sup>2</sup>.°C/W
- Correction by revising the degree-days from the American method to the Russian method:  
 $1,94 * 2640 / 3128 = 1,64 \text{ m}^2 \cdot \text{°C/W}$
- Determine the equivalent for the conditions of Moscow, Russia:  
 $1,64 * 4943 / 2640 = 3.07 \text{ m}^2 \cdot \text{°C/W}$
- Requirement of Russian Code for Moscow is 3.13 m<sup>2</sup>.°C/W

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## The “Energy Passport”

- The energy passport is a verification protocol
- It demonstrates energy code compliance – an integral part of the plan review process
- It shows asset-based and performance-based (real world) specific heat consumption
- Can be used to compare a building’s actual and its projected (design) performance
- Passports will help tenants to evaluate energy efficiency and allow investors to capitalize value of energy savings

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## **A Typical Construction in Moscow**



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## **Two towers “Federation” in Moscow, 87 storey, 356 m high**



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## **Design Solutions Used in Complying with New Codes**

- **Widened buildings with a lower surface-area-to-volume ratio**
- **Monolithic-frame construction using lightweight aggregate concrete**
- **External insulation systems**
- **The double-skin-facade wall system**
- **Energy-efficient windows with low-e glass**
- **Regulated air intake systems**
- **Energy-efficient heating and ventilation equipment**
- **Heat delivery systems for individual apartments**

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## **Wall Systems with thickness $\leq 350 - 400$ mm (14 - 16")**

- **Single layer walls  $< 6000 - 7000$  °C.days  
Light weight aggregate concrete is use**
- **Three layers walls  $< 6000 - 7000$  °C.days  
Internal thermal insulation of plastic foam and flexible ties are use**
- **Two layers walls have no restriction  
by °C.days Out insulation is use –  
fiberglass and mineral wool**

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## Light Weight Thermal Insulation

Materials	Market share, %	Density, kg/m <sup>3</sup>	Thermal conductivity, W/(m.°C)
Mineral wool	45	25-250	0.045-0.084
Fiber glass	25	11-150	0.045-0.07
Plastic foam	20	15-150	0.031-0.064
Light weight aggregate concrete	3	150-600	0.06-0.2

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## Overall demand of thermal insulation is increasing by 20% of each year

2004 – 6-17 mln m<sup>3</sup>

2005 – 8-20 mln m<sup>3</sup>

2006 – 22-24 mln m<sup>3</sup>

2007 – 24-26 mln m<sup>3</sup>

**Forecast 2010 – 31-32 mln m<sup>3</sup>**

Production in Russia now is 10 mln m<sup>3</sup>

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## **Two variant of facade systems are used – both two layers**

- 1. System with out insulation and with external plaster layer without an air space**
- 2. System with out insulation and a ventilated air space - double wall**

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## **Problems of variant 1**

- **A substantial influence of metallic affixation elements on thermal homogeneity (thermal bridges);**
- **Disregard of recommendations on density of insulation material (70-80 kg/m<sup>3</sup>); vertical filtration of air where lighter insulation materials are used (30-35 kg/m<sup>3</sup>) in the absence of a vapor-permeable sheet;**
- **Insufficient vapor permeability of the external plaster layer, and the possible accumulation of moisture in insulation;**
- **Formation of cracks in plaster if a netting of glass fabric is absent;**
- **Discontinuity of insulation after incorrect installation.**

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## Problems of variant 2

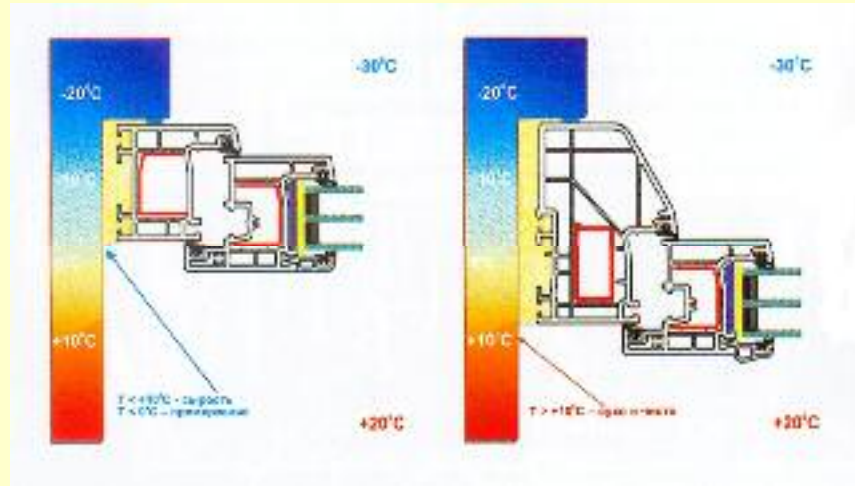
- Even greater influence than with variant 1 of affixation elements on thermal homogeneity;
- Corrosion of the affixation elements of the ventilated façade if there is insufficient anticorrosion coating;
- Discontinuity of insulation after incorrect installation;
- Disregard of recommendations on density of insulation material (70-80 kg/m<sup>3</sup>); vertical filtration of air where lighter insulation materials are used (30-35 kg/m<sup>3</sup>) in the absence of a vapor-permeable sheet;
- Increased speed of air movement in the air layer (more than one m/s) if recommendations on areas of openings are not observed, and gradual breakage of insulation from the side of the surface that faces the air space;
- Trapping of insulation in places with surfacing where there is a minimal thickness of the air layer because of uneven wall layers;
- Absence of fireproof barriers over the entire height of the air layer;
- With a thickness of the air layer greater than 150 mm, emergence of wind noise

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## Fenestration

- Two mistakes are which leads to the formation of condensate or even freezing: the small thickness (50-55 mm) of window frame; place a window frame on the front of the facade
- Another mistakes are linked with wrong consideration of the air infiltration through a very tight window. There is deficient air exchange in occupied areas and increased humidity in the premises

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## Barriers to implementation

### Major Barriers

- Inertia
- Limited local government capacity and uneven motivation
- Energy subsidies; insufficient heat metering and price signals; misaligned incentives

### Lessons learnt

- Identify competent and empowered officials.
- Take the time to listen to them, build relationships and earn their trust.
- Respect local cultural, linguistic, architectural and economic differences

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## **Russia's Construction Sector has been Transformed**

- **The Russian market has undergone fundamental transformation toward production, sale, and use of energy-efficient building materials and products, and the use of new energy-efficient designs**
- **Examples include several new insulation factories and hundreds of factories producing efficient low-e windows (Most are joint ventures with Western firms)**

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## **Publications**

[www.cenef.ru/home-pg/hp-6r.htm](http://www.cenef.ru/home-pg/hp-6r.htm)

[www.imt.org/papers.htm#Russia-NIS](http://www.imt.org/papers.htm#Russia-NIS)

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**Thanks for your attentions**

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