IGU and solar panel application optimization with numerical model for the various Russian regions

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Introduction

Specific consumption of energy in Russia exceeds numbers of advances countries tenfold. So special efforts must be initiated for increasing of energy consumption effectiveness.

Introduction: New Projects

Sochi Airport

Ecological park, Moscow

Energy carriers costs forecast

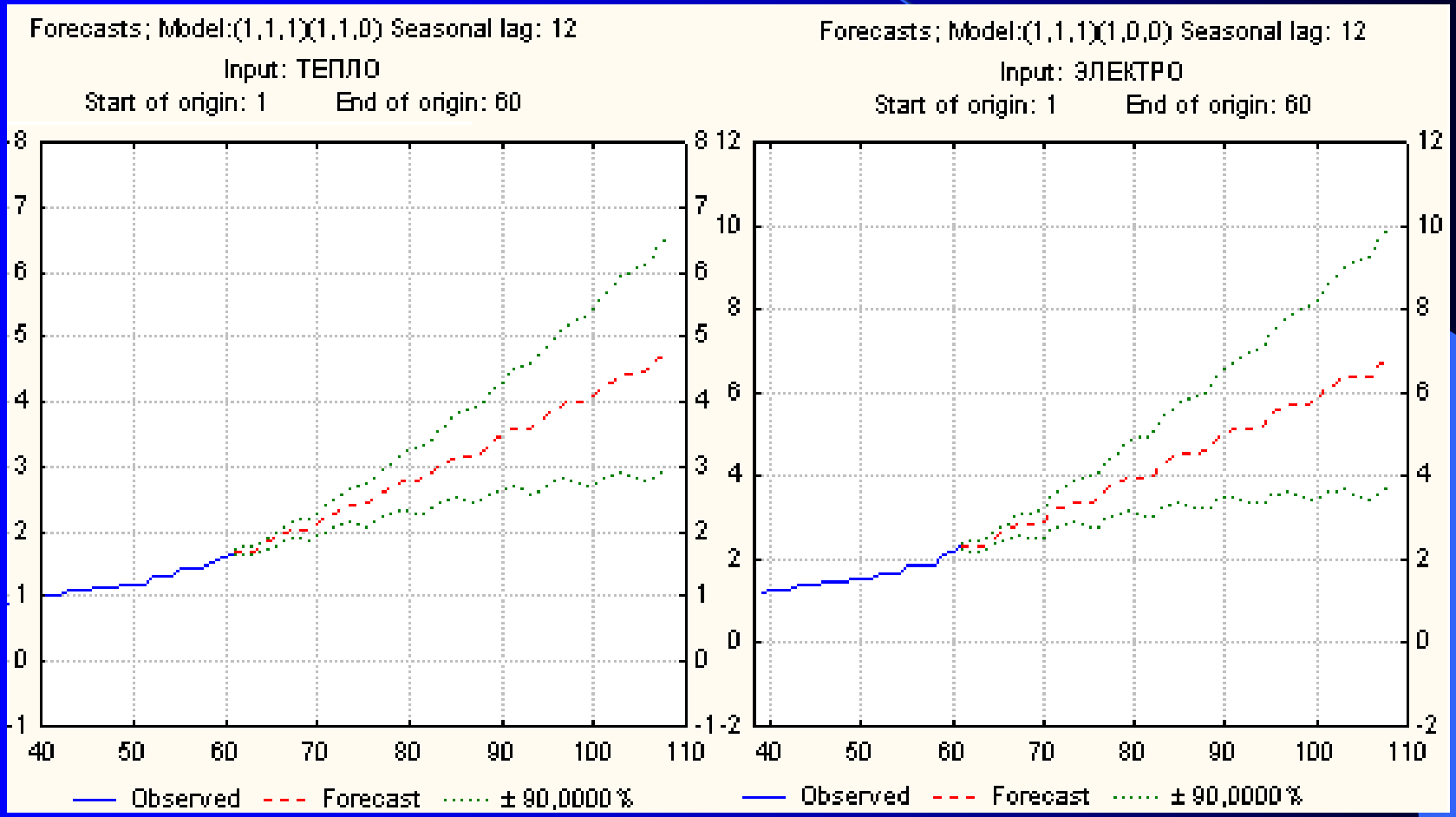


Figure 1. Forecast for the heat (left) and electric power (right) prices

Optimization of the heat cost for the building: Optimization model

$Q > Q_{norm}$, Q_{norm} is heat power consumption for comfort temperature support.

$A_{gl}(i) * C(i) \rightarrow$ min, where C is cost per 1 m^2 of i-th glazing.

$Q_{hp} * C_{hp} \rightarrow$ min, where C_{hp} is heating cost.

And additional conditions and limitations

$$Q = Q_{tot} \cdot T_{heat},$$

where Q_{tot} is total heat loss, [W]; T_{heat} is duration of heating period of the given region; $A_{gl}(i)$ is area of i-th type of glazing, [m^2]

Parameters of the optimization model

- S_i – area of every types of envelop construction;
- H – building height;
- k_i – heat transfer coefficient of every surface;
- U – U-value of glazing;
- f – shading coefficient;
- A_{gl} – glazing area;
- C_i – price per 1 m^2 of i-th type of the glazing with coefficient k_i;
- C_{hp} – heating price per KW*h;
- C_{el} – electric power price per KW*h;
- C_{panel} – price per 1 m^2 of the solar panel;
- P_p – nominal output of the solar panel in [KW];
- Region (climate conditions).

Solar panels in the optimization model

$$P\ (KW \bullet h/day) = P_p\ (KW) \cdot I\ (KW \bullet h/m^2\ per\ day) \cdot PR,$$

where P_p is nominal output in [KW] of full solar panel; I is exposition of solar radiation on the surface in [KW•h/m^2 per day]; PR is productivity factor of the system.

Comparison of the regions: Optimal U-value

Sochi, both orientations:

orientation	*N/W*	*N/E*	*S/E*	*S/W*
U-value	5,80	5,80	5,80	5,80

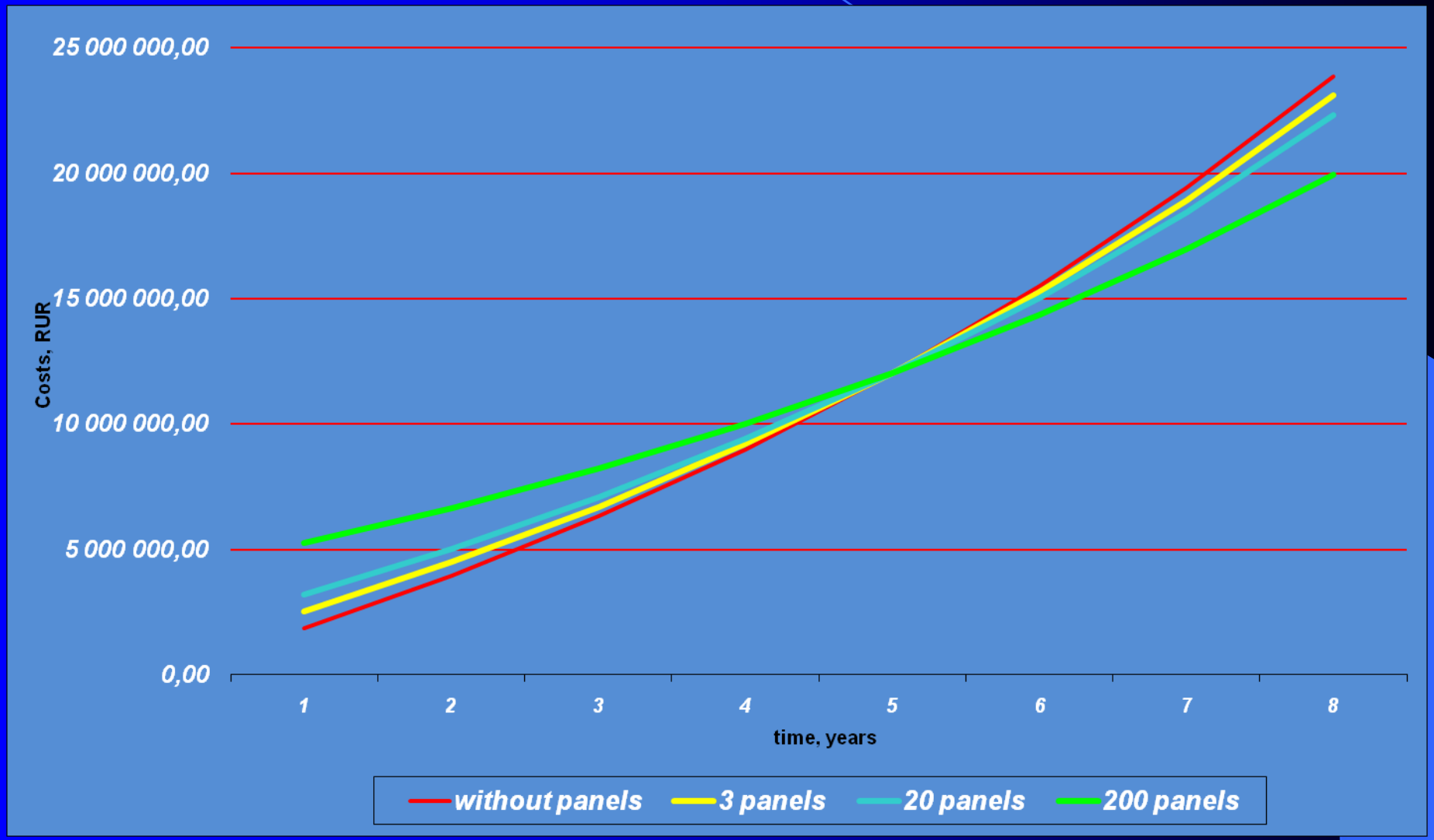
Arkhangelsk:

orientation	*N/W*	*N/E*	*S/E*	*S/W*
U-value	2,70	2,70	2,70	2,70
orientation	*N*	*E*	*S*	*W*
U-value	2,62	2,51	5,58	2,50

Comparison of the regions: Heat costs

	City			
	Arkhangelsk		***Sochi***	
	orientation		***orientation***	
	N/E-S/W	N-S	N/E-S/W	N-S
Total heat loss	26 275,05	26 275,05	26 275,05	20 024,56
Total heat gain	173 561,73	163 260,14	295 150,56	291 248,24
Annual heating consumption	1 201,82	1 212,13	225,50	223,92
Heating cost, p	29 544 284,05	29 797 526,53	5 083 819,56	4 987 889,34
Glazing cost, p	3 149 358,66	3 149 358,66	3 149 358,66	3 149 358,66
Total cost, p	32 693 642,71	32 946 885,19	8 233 178,22	8 137 248,00

Cost recovery for the solar panels in Sochi



Conclusions

Optimization problem for the glazing in building project between its price and energy-efficiency is stated. Corresponding program was developed.

Some calculations for the set of IGU and symbolic project in various climatic regions were made.

We calculated that it is possible to save up to 30% of heating costs by the optimization of the glazing and orientation of the building.

Effectiveness of solar panel application was estimated. Optimistic prognosis of price decreasing makes them very interesting in the nearest future.

Thank you for attention!

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