References:

1. Blekhman, I.I., *Sinkhronizatsiya v prirode i tekhnike* (Synchronization in Nature and Engineering), Moscow: Nauka, 1971.
2. Blekhman, I.I., *Sinkhronizatsiya dinamicheskikh system* (Synchronization in Dynamic Systems), Moscow: Nauka, 1971.
3. Pikovskii, A.S., Rozenblum, M., and Kurts, Yu.,*Sinkhronizatsiya. Fundametal’noe nelineinoe yavlenie* (Synchronization: A Fundamental Nonlinear Phenomenon), Moscow: Tekhnosfera, 2003.
4. Gordeev, B.A., Gordeev, A.B., Kovrigin, D.A., and Leont’eva, A.V., Hydraulic Vibrational Bearings in Synchronizing Mechanical Systems, *Provolzhsk. Nauchn. Zh.*, 2009, no. 3, pp. 49 –53.
5. Electric drive: a tutorial / YN Dement'ev, LK Chernyshev, IL Chernyshev, Tomsk Polytechnic University. Tomsk Univ TPU, 2010.-224 with.
6. http://h4e.ru/elektricheskie-mashini/136-rabota-dvukh-elektrodvigatelej-na-odin-val.
7. http://www.elec.ru/market/offer-14937312501.html.
8. http://stroy-technics.ru/article/sinkhronnoe-vrashchenie-dvukh-asinkhronnykh-elektrodvigatelei-v-sisteme-elektroprivoda.
9. http://en.wikipedia.org/wiki/Conveyor_system.

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Power balance of the Siberian Federal District: dynamics and prospects

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Introduction

Issues of energy management and energy efficiency are of high importance in the world.

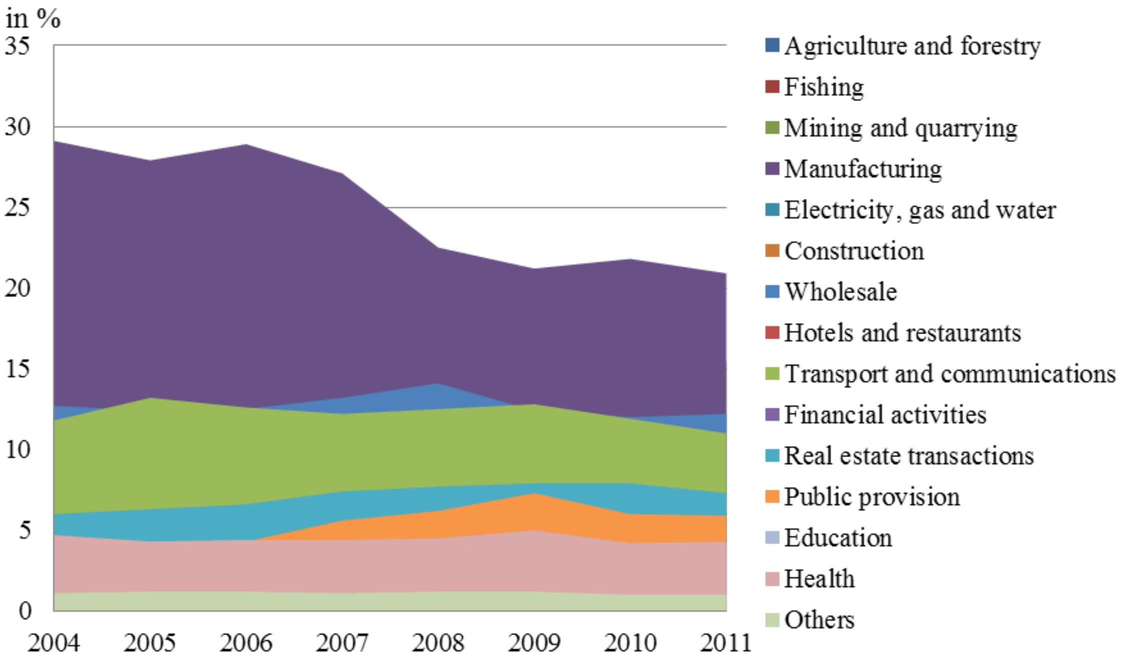
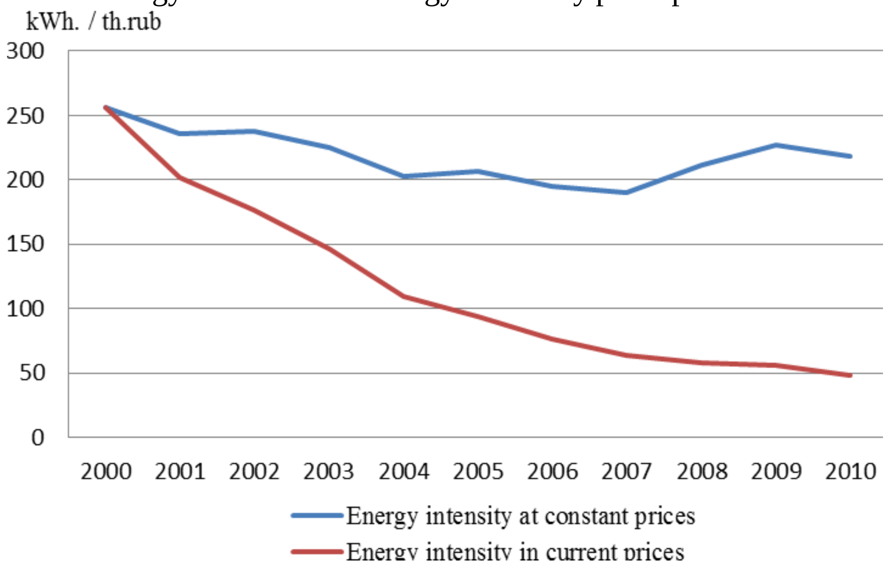


Fig.1 Structural Dynamics of GRP under comparable conditions relative to 2000.

Siberian Federal District (SFD) possesses fuel, energy and raw material recourses, satisfying not only own needs for fuel and energy resources (FER), but also being a major supplier to other regions.

The Balance of electrical energy efficiency (EE) is a partial derivative of the composite energy balance in SFD considered in [1, 2] and of the socio-economic level of development of the territory, as well as an indicator of effectiveness concerning the implementation of the State policy in the field of energy conservation.

Adoption in 2008 of the Presidential Decree number 889, and in 2009 the Federal Law number 261 was the impetus for the development of long-term programs in the area of energy efficiency [1] The main indicators of energy efficiency in accordance with the legislation are: the combined energy balance, private energy balances, indicators of socio-economic development, energy and electricity production unit of gross regional product, the consumption of energy resources and energy efficiency per capita.



Despite the fact that all developed the paralysis of energy efficiency compared to 2009, the authors in this paper use statistical data from 2000, as a large selection enables more correct predictions for the future, improving the accuracy of the models and conclusions.

Fig.2. GRP electricity intensity in current and comparable conditions.

Energy Efficiency Indicators

SFD is one of the few districts of Russia, which is almost self-sufficient in energy efficiency of its own production, 96% of which goes to power plants and hydro. During the time, the production of EE at SFD increased by 6%, and consumption by 13%.

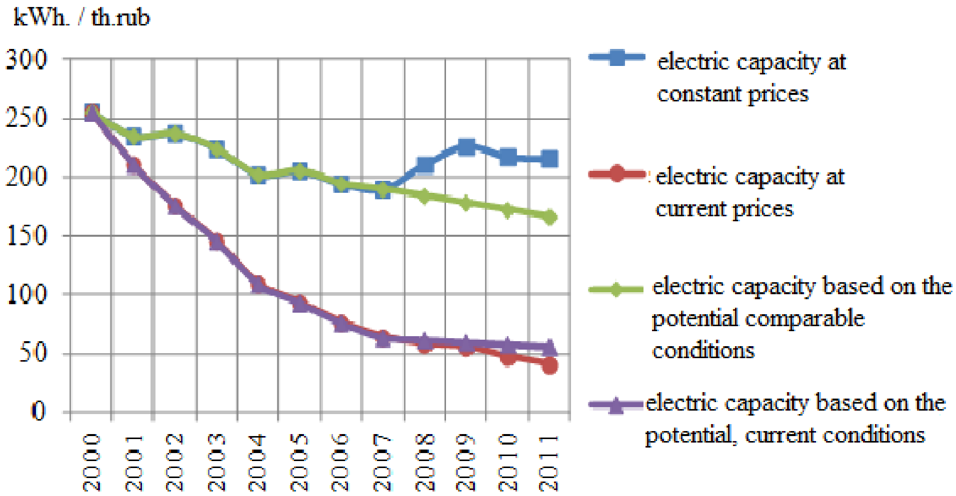


Fig.3. GRP electricity intensity in current and comparable conditions with and without the energy saving potential.

The most significant factor affecting power consumption is the gross regional product (GRP), its structure and the possibility of changes in the future. Thus, in the current circumstances manufacture GRP SFD data regarding 2000 increased by 7.3 times. 66% generated GRP accounts for the Krasnoyarsk Territory, Irkutsk, Kemerovo, Novosibirsk region. In the industrial structure it is dominated by the GRP manufacturing (21%), transport and communications (13%), wholesale and retail trade (13%), organizations that work with real estate and public administration (15%), extractive industries (10%).

Fig. 1 shows that the share of economic activity is really creating products in values of 66-69%. Depending Graphs shown in Fig. 2 show the natural decline of electrical capacity in the current environment.

Fig. 3 shows us that in comparable prices GRP electricity intensity in 2011 were 216 kWh / thousand rubles, which are 40 kWh / thousand rubles less than 2000. Reduction occurs mainly due to changes in the structure of GRP toward non-energy activities. If you save electricity consumption trends observed in the SFD in the near future can be estimated using the equation obtained in the program STATISTICA.

$W'_{\text{ВРП}} = 2230{,}1409 \cdot x - 4{,}2868 \cdot 10^6$, *mln kWh.*

Taking into account the implementation of energy-saving electric capacity assigned by 2020 it should reach 114 kWh / thousand rubles. In accordance with the state program of energy saving potential it is supposed to achieve this by raising extra budgetary sources and further reduce the proportion of non-energy activities in GRP. Equation takes the form:

$W'_{\text{ВРП}} = -2604{,}9007 \cdot x + 5{,}3973 \cdot 10^6$, *mln kWh.*

What changes in the pattern of capacitance by type of economic activity will occur in the future, we cannot say now, because there is no forecast of socio-economic development of the SFO until 2020. In 2011 values of electric capacity FEA have reached the following rates (Table 1).

Table 1. Electric capacity production by economic activity

Economic activities	kWh / thousand rub.
Extractive industries	59,1
Manufacturing industries	79,7
Production, distribution, energy efficiency, gas, water	17,2
Construction	2,2
Agriculture and forestry	3,3
Transport and communications	18,4
Others	17

Mining and manufacturing industries (Table 1) are characterized by the production of electrical capacitance; therefore, search for the major reserves of energy savings should start with them.

Conventionally, all economic activities can be divided into creating the means of production and creating consumer goods [3] That is, the end user of direct and indirect products of economic activities is the population. Purchasing consumer goods, the population pays electrical component in the cost of production at unregulated prices for industrial consumers. Consuming energy in households, the population pays its regulated prices approved by the Departments of tariff regulation or the Regional Energy Commissions.

Table 2. Population

	2000	..….	2010	2011
Per capita income, thousand	1933	…	15007	16568
Per capita consumption of EE kWh	958	…	1174	1282
Abundance, thousand	20333	…	19252	19261

In Siberia there is a stable trend of decrease of population alongside with rising consumption of electric energy (EE) (Table 2). To explain the increase in per capita consumption of energy efficiency on the background of ever-increasing rates is possible only against the background of the welfare of citizens.

In terms of implementation of energy saving policy population – the most severe category of consumers and the state is looking for incentives, for example – the social norm of consumption of electricity for the population. On the other hand, it is a hidden increase in tariffs for the population.

While maintaining the existing trends we obtain the following equation forecast relating to electricity consumption for this group.

$$W_P = 68,3287\cdot x^2 - 2,7362\cdot 10^5\cdot x + 2,7394\cdot 10^8 .$$

On average, the increase in SFD equal to 1500 rubles per capita income will increase consumption of electric energy corresponding to 100 kWh per year.

Consumer power balance part will consist of the sum of two units.

$$W = W_{GRP} + W_P .$$

In the current situation, when frequent accidents occur at electric power facilities, there is a growing need to replace power equipment. The cost of production of fossil energy resources dominates in the share of the energy balance, as a result, the importance of planning and forecasting electric balance on territories is on par with the state policy to improve energy efficiency of the country.

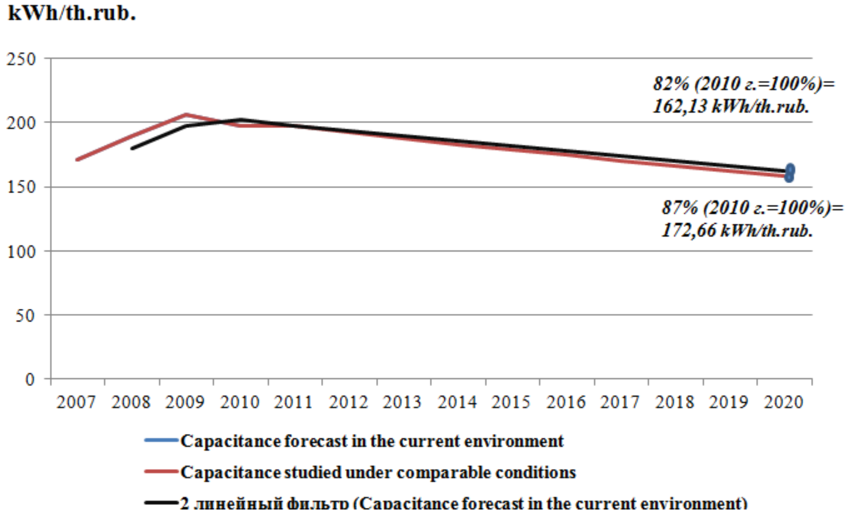


Fig.4. Study dynamics GRP SFD in the future from 2011 to 2020.

So, following the scenario of social and economic development of the 2030 Russia:

1. Production of the GRP should increase to 45% the year; (2007 = 100%).
2. Electric capacity should decrease in 2020 by 18%; (2010 = 100%).
3. The share of consumption EE should decrease by 20% by 2020; (2010 = 100%).

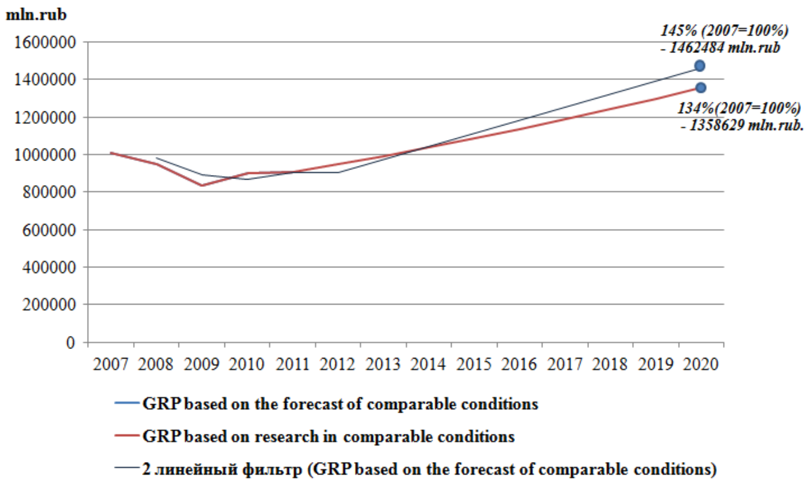


Fig.5. Study the dynamics of electric capacity (EC) GRP SFD in the future from 2011 to 2020.

I did some research changes relating to the dynamics of the GRP, by changing its structure.

While not affecting the trend of GRP. Thus: with the increase of non-energy sectors (Agriculture and forestry, Transport and Communications, Building) from 2011 to 2020 and decreasing share of energy from 2018-2020 (mining, manufacturing, production quantity and distribution of EE), the share of GRP SFD continues to grow and the final year in comparable terms increased by 34%.

Also was approximate forecast electric capacity 2020 in comparable prices. So with due decrease of 18%, capacitance decreased by 13%.

Conclusion

The plan may include energy efficiency of the economy in my opinion:

1. Introduction of energy-saving technologies that will reduce the burden on the economy due to lower energy consumption and reduce the cost of production.
2. Qualitative and accurate planning and forecasting, power balances;.
3. Implementation of innovative programs, as well as the introduction of new energy facilities and replacement of the existing outdated equipment.

References:

1. Klimova G.N., Litvak V.V. Seven and seven key issues of energy conservation. Tomsk: Publishing "Red Flag", 2013. 148c.
2. Klimova G.N. The role of energy balance in the energy efficiency program Tomsk Oblast // Bulletin of the Tomsk Polytechnic University, 2005. T.308. № 7. With. 232-236.
3. Klimov G.N., Litvak V.V., Jaworski M. An estimate of the energy needs of the region's population / / Resources regions of Russia, in 2004. №5. With. 20-24. Federal State Statistics Service. Mode of access: http://gks.ru.

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HVDC transmission systems

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The application of HVDC transmission systems

The issue of application of HVDC transmission is very urgent nowadays since the use of power electronics in this system enables to reduce power losses and as a result increase its efficiency.

A high-voltage, direct current (HVDC) electric power transmission system uses direct current for the bulk transmission of electrical power, in contrast with the more common alternating current systems. For long-distance transmission, HVDC systems may be less expensive and suffer lower electrical losses. For underwater power cables, HVDC avoids the heavy currents required to charge and discharge the cable capacitance each cycle. HVDC allows power transmission between unsynchronized AC transmission systems. Since the power flow through an HVDC link can be controlled independently of the phase angle between source and load, it can stabilize a network against disturbances due to rapid changes in power. HVDC also allows transfer of power between grid systems running at different frequencies, such as 50 Hz and 60 Hz. This improves the stability and economy of each grid, by allowing exchange of power between incompatible networks.

Principle of operation

High voltage is used for electric power transmission to reduce power losses due to wire resistance. Unfortunately at present there is no method to vary DC voltage level without any