The «New Angrarstroy» as a project of non-primary-based integration of Russian and Chinese economies: opportunities and challenges

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Abstract. In the context of non-primary-based cooperation of Russia and China the innovation Project «New Angrarstroy»: Baikal-Amur metallurgical super-combine, is being considered. It was developed as a key part of the new stage of industrialization in Russia, including of large scale Trans-Siberian and Baikal-Amur railway reconstruction. The project serves as an alternative to further increasing the exploitation of forest resources in the Baikal region, creating here new environmentally harmful cellulose and chemical plants and tourist hotels on Baikal. The project assumes the development of the largest metallurgy production of national and international scale, which will includes high-quality ferrous metallurgy of the full cycle and titanium-magnesium industry. The development of the Baikal ecological territory is assumed within the framework of the Lake-Temple subproject.
1 Introduction

The economic growth model which took China to the heights of the world economy in the 1990-2000s cannot combine high economic development rates with building of Chinese socialism, solving of social and ecological problems, eliminate inequality and the construction of a «medium-wealthy society» [1].

According to "The Chinese dream and the world", “the Chinese economy, being the second world economy, can influence the whole global economy. Will the economic growth rates in China slow down…? What measures will China take to prevent economic degradation? Will the country be able to realize the goal of doubling the gross domestic product and income of urban and rural residents compared to 2012, set by the 18th Communist Party Congress? These questions are asked by the Chinese and other nations” [1, c. 153].

In [13, p. 276-277], we argued that “the goal of the external policy of Russia is to develop an alternative economic and political world center by integrating economies and policies of Russia, CIS, China, India and developing countries of Latin America, Africa and Asia. … Integration and strategic partnership of Russia and China are crucial. The following forms of integration can be suggested: Russia and China co-develop technologies, and then China, using quality and cheap materials, alloys, articles and parts produced in Russia, manufactures products for the whole world”. A new strategy for Russia, as we imagine it, is, therefore, its non-primary economic integration with China. For China, then, a new strategy or development model is non-raw integration with Russia.

The primary-based integration model involving exportation of gas, oil, ores, wood is not promising. For Russia, this policy is inefficient since the utility (the full value) of exported natural resources tens of times exceeds their export prices. Instead of providing jobs, cheap production tools and generating revenues, this full value contributes to development of foreign economies [13].

The former model of accelerated economic growth of China was based on constant inflows of foreign capital, cheap labor resources (due to a large number of rural dwellers) and world demand for cheap Chinese goods. The world crisis of 2008 decreased the world demand which was substituted for the internal one – government investment in the economy and social areas.

However, the development rates dropped twice due to a decrease in foreign capital inflows and cheap labor resources. The foreign capital inflows were affected by the world crisis. Besides, foreign investors are
more interested in goods exportation rather than in selling goods for the
country currency. The decrease in cheap labor resources is due to the
efficient industrialization which decreased the number of rural dwellers and
government measures aimed at increasing per capita income and eliminating
inequality. Technologies and natural resources are new – fourth and fifth –
resources of development which will help combine the economic growth and
social goals. The "Chinese dream and the world" also refers improvement of
technologies to key sources of development [1, p. 167].

However, massive implementation of technological innovation products
requires natural resources. To become sources of improvement of living
standards, new technologies and equipment have to be massive, cheap and
long-lasting. They also have to be used for implementing unique industrial
projects development of territorial production complexes. It requires the
fifth source of economic growth – large, cheap, high-quality natural
resources. China lacks these resources. Only the Soviet Union could provide
these resources to China, but their relations suddenly damaged. Socialism
won in Russia because Russia possessed and possesses unique natural
resources and does not depend on the global capital [3]. It is not about the
supply of raw materials to the China, but about the organization of powerful
Russian-Chinese territorial production complexes on the basis of natural
resources of Russia. Initial and middle links, as an end links too, of these
complexes have to be created in Russia. But a massive part of the assembly
production for the whole world could be located in China. The New
Angarstroy could be initiating this mutually beneficial integration for the
benefit of the whole world [11].

2 Methods

The research is based on the methods of territorial production complexes
(TPC) and social energy production cycles (SEPC) which have been
developed in Russia since 1918. It is a government electrification plan
initiated by V.I. Lenin and also the works of N.N. Baranskiy, N.N.
Kolosovskiy and their followers [8, T. 36, c. 228–231; 2, 5, 6, 4]. In 1918, at
the beginning of the period of foreign intervention and civil war, thinking,
nevertheless, about the future, V.I. Lenin wrote in the Outline of a Plan for
Scientific and Technical Works: “This plan should include: rational
placement of industry in Russia in terms of the proximity of raw materials
and the possibility of minimal labor loss during the transition from
processing raw materials – to all successive stages of processing semi-
finished products up to the finished product. ... Paying special attention to the electrification of industry and transport and the application of electricity to agriculture. The use of non-first-class fuel grades (peat, coal of the worst grades) to generate electrical energy with the lowest costs for the extraction and transportation of fuel. Water forces and wind turbines in general and applied to agriculture” [8, Vol. 36, p. 228–231].

TPCs of different hierarchical levels (district, national, international) were formed only in the USSR. However, they did not manage to achieve their full potential. TPCs are special social energy production economic systems aimed at transferring the effect of natural resource and technology utilization to the society and nature. They are different from energy absorbing economic systems or objects – transnational and national corporations, financial groups, clusters, etc, as far as TPCs aim to produce the maximum volume of products at minimum costs and at decreasing prices rather than to get profit. TPCs have to develop at national (a consolidated national economic complex), regional and international (mutually beneficial cooperation of countries) levels. The latter will be fully possible when Marx's principle of "the free development of everyone as a necessary condition for the free development of all" is established in all countries, replacing the ideology of profit, domination and subordination [10, Vol. 4, p. 447].

The production chains that make up the TPC – from raw materials to all stages of its final processing, which are formed on the basis of the use of natural resources and energy, N.N. Ko-losovskiy called social energy production cycles (SEPC) [5; 6]. Social energy is an end product derived from natural resources. The delivery of social energy at moderate prices within TPCs and SEPC ensures minimum expenses on production (“labor losses”) [8, Vol. 36, p. 228; 6, p. 270] and the growth of free time of society, used for the spiritual and physical development of an individuality, as its main wealth [10, Vol. 23, p. 188–189].

3 Results

New Angarstroy is a project of creation of the third (eastern) industrial base of Russia (after the Central and Ural-Kuznetsk bases created in the last century). As the area of "New Angarstroy" will be the Baikal-Amur region: Irkutsk oblast, the Republic of Buryatia, Zabaikalye krai, west of the Amur oblast, partially, Krasnoyarsk kray, Republics Tyva and Yakutia, southeast of Kemerovo oblast. And its main territory should be the Irkutsk oblast. The
oblast was a pivot of the Soviet Angarstroy (1950-1980s) starting with the construction of Irkutsk, Bratsk and Ust-Ilimsk power stations and energy-intensive enterprises. However, ferrous metal and titanium magnesium industries which could use cheap Angara hydro-energy were not developed [5].

The third (Eastern) Russian base of ferrous metal and titanium magnesium industries in Baikal-Amur region will develop using unique vanadium containing titanomagnetite ores of deposits Chiney and Malotagul (Zabaikalye krai, Irkutsk oblast) [7; 16], Savinsky magnesite deposit (Irkutsk oblast), Kovykta gas (Irkutsk oblast), coal of Irkutsk basin and hydropower of the Angara, Vitim and other rivers (Figure 1).

The justification of potential demand for products of the Eastern Siberian metallurgy industry is based on the assumption about inevitable and rapid economic growth of Russia. In 1988, steel production output was 94 million tons a year; in 1990, it was 90 million tons; in 2008, it was 69 million tons, in 2015 – 69 million tons; i.e. it decreased by 25 million tons since 1988 and by 21 million tons since 1990. On 15% - in accordance with the magnitude of the final decline in the entire industrial production of the country relative to the 1990 level, which confirms the relationship between the scale of the economy and its need for steel and other metals [13]. To recover production volumes, needs and economic growth rates to the level of the middle of 1980s, steel production volumes have to be increased by 25 million tons. Until the crisis of 2007-2008, the volume of imported metal products was 7 million tons, which must replacing by domestic production. The volume of Chinese imported metal products is 22 million tons a year, including 14 million tons of rolled steel (mainly sheet), 2 million tons of ferrous alloys, 5 million tons of scrap iron [15]. Thus, the demand of China for quality metal products is minimum 10 million tons a year and further can be increased. So the possible volume of production of ferrous metallurgy is estimated according to the project in the amount of minimum 42 million tons. Although the New Angarstroy aims at satisfying the internal demand of the Russian economy, the large-scale demand of China for high-quality ferrous metals and titanium magnesium products can be satisfied as well. Speech, thus, is about creating an international Russian-Chinese TPC.

Combines of full cycle ferrous metallurgy (Ust-Kut, Ilim, and Tayshet) of Irkutsk oblast (see Figure 1 and the map in [11]) have to apply a direct ore reduction technology using coal and natural gas and further smelting direct reduction iron in electric furnaces to obtain quality steel, rolled steel and raw materials, in the form of slag, for titanium and vanadium production. To put the combines into operation is supposed in the order of approaching the pipeline to them from the Kovykta gas field, where Ust-Kut is the nearest
point, including in accordance with the existing project of the Power of Siberia gas pipeline. From the Ust-Kut to Ilim and Tayshet combines, the gas-pipe line can run along the line “Eastern Siberia – Pacific Ocean” oil pipeline [11].

Figure 1. Metallurgy social energy production cycle of the New Angarstroy. A – the flow of products, containing raw materials; B – high processed and end products, including machine building ones. Combines of ferrous metallurgy of full cycle: 1 – Ust-Kut plant, 2 – Ilim plant (Zheleznogorsk-Ilimsky), 3 – Taishet plant. I – internal cycle; II – flows in national and international complexes (cycles).

Ust-Kut is a point where the section of planned “The Power of Siberia” gas pipeline will run from Kovykta deposit (Irkutsk oblast) to China through Yakutia [11]. But, in our opinion, connecting the Kovykta field to this gas pipeline is only advisable for supplying the New Angarstroy regions through it, and not for the purpose of exporting gas to China. According to calculations, the complex of all productions of New Angarstroy (Baikal-Amur Metallurgical Super-combine), not only ferrous metallurgy, may require in total up to 55,8 billion m$^3$ of gas per year, which is 3 times higher than the planned supply of gas to China from the Kovykta field – 19 billion m$^3$ per year during forty yeas. Supplies to China will be able to provide Chayandinsky and other deposits of Yakutia, as well as the Krasnoyarsky kray.
The capacity of each of the combines of ferrous metallurgy is proposed for steel – 13 million tons per year, the total – 39 million tons per year. At the same time, the production of titanium and vanadium will be provided on an unprecedented scale, as well as magnesium (90% of the domestic aluminum capacities are already in the region). The source of magnesium will be the largest in the CIS Savinskoye field of magnesites (Irkutsk oblast) [11]. The Golden Age predicted on earth may thus also be the age of titanium, vanadium, and magnesium.

Three combines of ferrous metallurgy have to function simultaneously on the basis of deposits Chinney and Malota gul. This will create a pendulum “New Chara – Taishet and Taishet – New Chara” which is similar to the pendulum of the Ural-Kuznetsk territorial-production complex of the 1930s-1940s. The aim is to reduce transport costs and empty miles [5, 6, 11]. The new pendulum also will reduces loading on the natural and social environment (decreases open ore mining pits sizes) and transport loading on the BAM. However, the pendulum needs to be extended to Irkutsk, Ulan-Ude, Chita, Svobodny for transportation of metallurgy products, raw materials for the titanium-magnesium industry of Irkutsk oblast and rolling and alloys plants of the whole Baikal-Amur region (outside the region, the products will go their own trains) [11]. In the reverse direction on New Chara will be delivered means of production: coal of the Irkutsk basin, mining and steel making equipment, refractory products, fluxes, manganese, silicon, rare and non-ferrous metals.

The project can be implemented by a large Government Russian company, which, for example, is the Russian Railways company with its branch East-Siberian Railway. Such a company will be able to attract private companies to the project, all the more so if their shares are owned by the state, and after putting the objects of New Angarstroy into operation it will ensure the supply of products for national purposes at low prices.

3 Discussion

Due to rich reserves of titanomagnetite ores, hydropower, gas and coal, application of coal- and gas-based direct iron reduction method ITmk3 is most reasonable for Irkutsk oblast. However, the method might need modification or improvement depending on conditions and scales of the project. According to [14], ITmk3 technology has been developing by Hares Engineering with Nishin, Kobe Steel Ltd, since 1996 when ITmk3 effect was discovered. Coal is used for recovery, while gas is applied for warming up.
ITmk3 technology was introduced in 2010 in a Minnesota plant producing 500 thousand tons of iron a year. The project of the second plant was implemented by Hares Engineering at SBS Steel (Kazakhstan, Aktobe). The technology involves the heating of ore-flux-coal pellets using the gas air mixture coming through a gas burner, smelting of pellets in industrial rotary hearth furnaces at 1450°C and division of pellets into cast iron and slag. The slag is finally separated from the cast iron after the final cooling. The process lasts for about 8-12 minutes. Tests in the laboratory Nishin showed that when processing titanomagnetite ores, almost all titanium falls into the slag. Direct reduced granulated iron (high quality cast iron) and slag TiO₂ are produced. As a result of vanadium containing titanomagnetite ores processing using ITmk3 method, one can obtain high quality vanadium cast iron which, after being smelted in electric furnaces, turns into high-quality steel with separated vanadium slag useful for production of V₂O₅ and ferrovanadium.

The application of ITmk3 non-blast furnaces to the unique titanomagnetite vanadium-containing ores of the Baikal region enable to obtain the above products in two steps (direct reduction of iron + electrometallurgy of steel). At the same time, at the blast furnaces and steel plants of the Ural (on the basis of the ore of the Kachkanar deposit) similar products are planned to obtain in four stages [9]: division of titanomagnetite concentrate into magnetite and ilmenite ones + blast-furnace smelting (production of cast iron and vanadium slag) + smelting of ilmenite concentrate (production of cast iron and titanium slag) + steel making. Besides in the Ural, electricity and fuel are much more expensive as compared with Irkutsk oblast. Therefore, fixation of the Russian ferrous metallurgy and titanium magnesium industries on Ural and Kuznetsk plants puts brakes on the development of the country. Development of metallurgy only in the Urals and Kuzbas now is a dead lock. This is the same as if the development of the country in the 1930s relied only on the resources of the European part of Russia – a dead end version of development, as wrote N.N. Kolosovsky [5].

Regional government authorities have sufficient actuators to force all participants of investment processes to act in the national interest [17]. Elements of stabilization and economy sustainability assessment have to be identified when developing large regional investment projects. The following elements have to be taken into account: reservation, insurance, adjustment, diversification of purchases and sales, variation in project participants. Simulation of these elements ensures stability (Table 1).

Table 1. The algorithm of calculation and warranty policy justification.
| Calculation formula | Description of elements and components by calculation stages 7 |
|---------------------|-------------------------------------------------------------|
| 1. $p_i$            | Costs of the projects, its technological component.        |
| 2. $C_i = k \cdot p_i$, $k = 0.5-0.85$ | A share of costs covered by the agency’s warranty. The amount of money requested. |
| 3. $C_{i_{\text{warranty}}} = (1-k)P_i$ | A shared funded by the entrepreneur. |
| 4. $R_i = \rho \cdot P_i$, $\rho < 1$ | A share of sold equipment of the bankrupt. |
| 5. $\rho$           | Equipment cost reduction factor.                           |
| 6. $f = \sum_{i=1}^{m} C_i^0 / \sum_{i=1}^{n} C_i$ | Mean loan impairment ratio from practical experience of the agency. |
| 7. $C_i^\beta = (1+f) \cdot C_i$ | Bank loan amount directly guaranteed by the agency. |
| 8. $\beta_i$, $R_i$, $K$ | Owned funds (insurance fees, equipment sales revenues, owned capital). |
| 9. $f \cdot C_i = \beta + \rho \cdot P_i \cdot f_i + K$ | Loan default balance of the warranty agency. |
| 10. $(\beta_i + \rho \cdot P_i f_i) > C_i^g$, $K = 0$ | Condition of the ordinary operation of the agency. |
| 11. $f_i C_i g_i$ | Where $g_i$ is the net risk of the warranty agency. It is calculated and taken as a standard for managers. If the probability is equal to 0.5, $g_i = 0.5$. It will be adjusted. |
| 12. $\beta_i > C_i f_i g_i$ | It can be taken unified for all insurance premium calculation conditions. |
| 13. Calculation of the insurance premium (%) at $g_i = 0.5$, $f_i = 0.1$, $(0.5-100\%) \cdot 0.1 = 5\%$ | Total insurance premium for the $i$-th project. |
| 14. $f_i C_i g_i \leq C_i f_i g_i + \rho f_i (1/k) C_i + K$ | The entrepreneur has to pledge 5% of $C_i$. |
| 15. If the value of $C_i f_i g_i$ equals to zero, for a careful banker, the border value of the credit line size can be | at $\beta_i = C_i f_i g_i$, where $f_o$ is the critical loan impairment ratio. |
presented as
\[ C_t \leq K / g \cdot (f_o - f_i) \text{ at } f_o = 1 \]
\[ C_t \leq k / g(1 - f_i) \]

In the investment optimization model under multi-period capital rationing, the situation is determined by the limited total amount of financing in each period \( t \). Unused capital is not carried forward. It is necessary to select projects to ensure a maximum target function: \( \sum c_i x_i \rightarrow \max \) at

\[ \sum_t \sum_i I_i x_i \leq K_i, \quad x_i = 0, 1 \text{ or } \sum_i x_i = 1 \text{ for all } i, \quad \text{where } c_i \text{ is the target function ratio taking values of the optimality criterion, } I_i \text{ are capital costs of the } i \text{ project in } t, \text{ } x_i \text{ is the investment project or its share included in the financing procedure.} \]

One more approach involves the selection of the largest total net present value of the investment program so that the total capital outflow is not exceeded. \( \sum_i NPV_i x_i \rightarrow \max \) given that \( \sum_t \sum_i PV_i x_i \leq O_t, \quad 0 \leq x_i \leq 1 \),

where \( NPV_i \) is the net present value of project \( i \), which is larger than zero; \( x_i \) is the unknown value, share or project included in the program; \( PV_i \) is the capital inflow in project \( i \) for \( t \); \( O_t \) is the total money outflow for \( t \).

The task can be solved for each planning interval. Let us assume that \( x_i \) is a share of project \( i \) \((0 < x_i < 1)\). Each project will generate net present value \( NPV_i \). It is necessary to maximize the total amount of the net present value:

\[ \sum_i NPV_i x_i \rightarrow \max \text{ given that limitations on investment for year } t \]

\[ \sum_i I_i x_i \leq K_i, \quad I_i \text{ are capital costs for a unit of project } i \text{ in } t, \text{ and } K_i \text{ is the total volume of financing in } t. \]

One of these limitations have to be set within each period when there are limited financial resources. At \( x_i = 1 \) or \( 0 \), the project can be implemented in whole \((x_i = 1)\) or rejected in whole \((x_i = 0)\).

Changing the meaning of \( I_i \), one can argue that money flows generated by the project in \( t \) have been described. Then the issue of a type of borrowing for each year can be dealt with. It will be necessary to maximize the total amount of the net present value \( \sum_t \sum_i NPV_i x_i \rightarrow \max \).

Optimal values of borrowing limits can be analyzed through dual estimates for each period. Let \( B_i \) be the amount of money which can be borrowed in \( t \), and \( A_i \) is the amount of real borrowed resources. \( A_i \leq B_i \), where \( A_i \) is the amount of borrowed resources used in each period \( t \) \((a_i)\). Let
us assume that project costs are covered by internal and external resources in equal portions. Limitations of financial resources in \( t \) is
\[
\sum_{i} I_{ti} x_i + \sum_{i} a_{ti} x_i \leq K_t + B_t .
\]
The first component in the left part is the total amount of owned investment resources used in each project. The second component is the amount of borrowed resources required for each project in \( t \). Limitations are applied only to \( t \). Similar limitations can be applied to any period when borrowing limits are set.

If it is necessary to take into account proportions of internal and external financial resources, the correlation can be expressed as 
\[ \frac{a_{ti}}{l_{ti}} = k, \]
where \( l_{ti} \geq 0 \) and \( l_{ti} \leq 0 \), \( k \) - guaranteed correlation of internal funds used in any project \( (l_{ti}) \) and external resources \( (a_{ti}) \).

The consideration of the effects of projects and partial transfer of money flows on future periods ensuring maximization of the net present value
\[
\sum_{i} NPV_i x_i \rightarrow \max
\]
allows you to assess the possibility of redistribution of unused funding in the previous period. Let \( s_t \) be financial resources passing from \( t \) to \( t+1 \). Let us assume that they will generate revenue \( r \). Then the restriction for \( t = 0 \) can be written as
\[
(\sum_{i} PV_{0i} x_i) + s_0 = O_0 .
\]
By analogy, for \( t = 1 \), the restriction can be written as
\[
(\sum_{i} PV_{1i} x_i) \leq (O_1 + (1+r) s_0) .
\]
The restriction on other resources is 
\[
\sum_{i} r_{pi} x_i \leq R_{pi}, \quad \text{where} \quad r_{pi} \quad \text{is the use of resources} \ p \quad \text{in project} \ i \quad \text{in interval} \ t , \quad R_{pi} \quad \text{is resource} \ p \quad \text{in period} \ t .
\]

One of the risk reduction mechanisms is hedging. When forward market hedging is unavailable or expensive or futures market hedging is fraught with payment cessation risks, hedging operations can be carried out in the short-term capital market. The hedging strategy which does not influence the values of expected revenues but decreases their variation, decreases the probability of using revenues for solving financial problems. The hedging strategy decreasing the probability of lacking revenues for investment can increase the value of investment programs by decreasing the probability of new emission and extra loans.

4 Conclusion
Neither of New Angarstroy facilities will be located in the area of Baikal lake [10]. The lake cannot also be an object of traditional mass tourism. Baikal lake contains 40% of world reserves (ocean) of clean fresh water, has a unique ecosystem. It is known for its natural beauty. For this reason, it is called the Sacred Lake. It has to develop as a Lake-Temple rather than as an object of economic profit. A large share of hydro-energetic rent produced by The Angara river and Baikal lake has to become a source of its development [11]. Facilities located near Baikal Lake have to meet strict ecological and architectural requirements and blend into the natural, cultural and religious landscape of the lake and its future temple system of traditional in region religions. This will turn the New Angarstroy into a source of not only industrial but also spiritual development of Russia.

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