

21

Setting-up silicon production for solar power systems

project "Solar Silicon"

Aims:

To become one of the leading Russian companies in producing:

- refined metallurgical silicon of "chemical" qualities
- multicrystalline silicon for solar energy
- ground-based solar systems

To enter the world market of silicon for solar energy in an amount not less than 10%

To raise working conditions and salary up to average European level

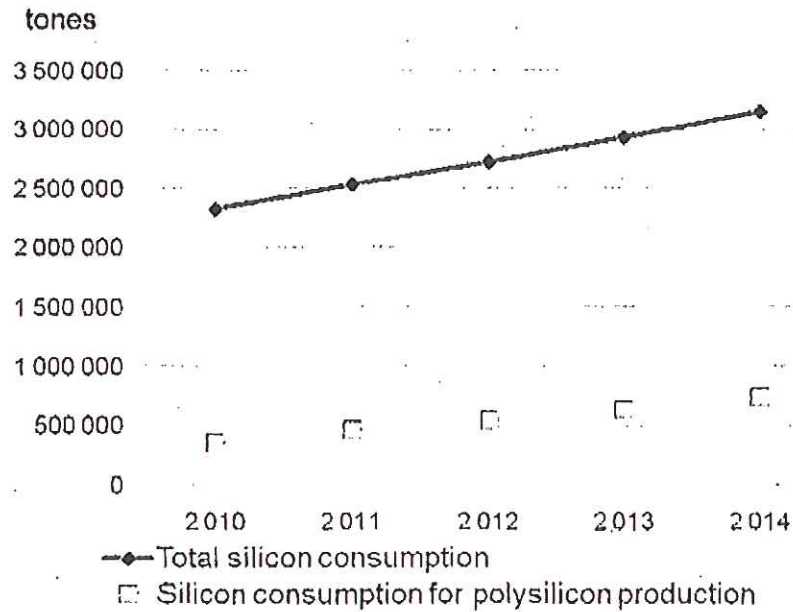
Provide cost reduction:

- photovoltaic converters to a value of 0,7-1,4 \$/W;
- solar modules to the value of 1,0-2,0 \$/W;
- electricity power to 0,10-0,12 \$/kWh

Market

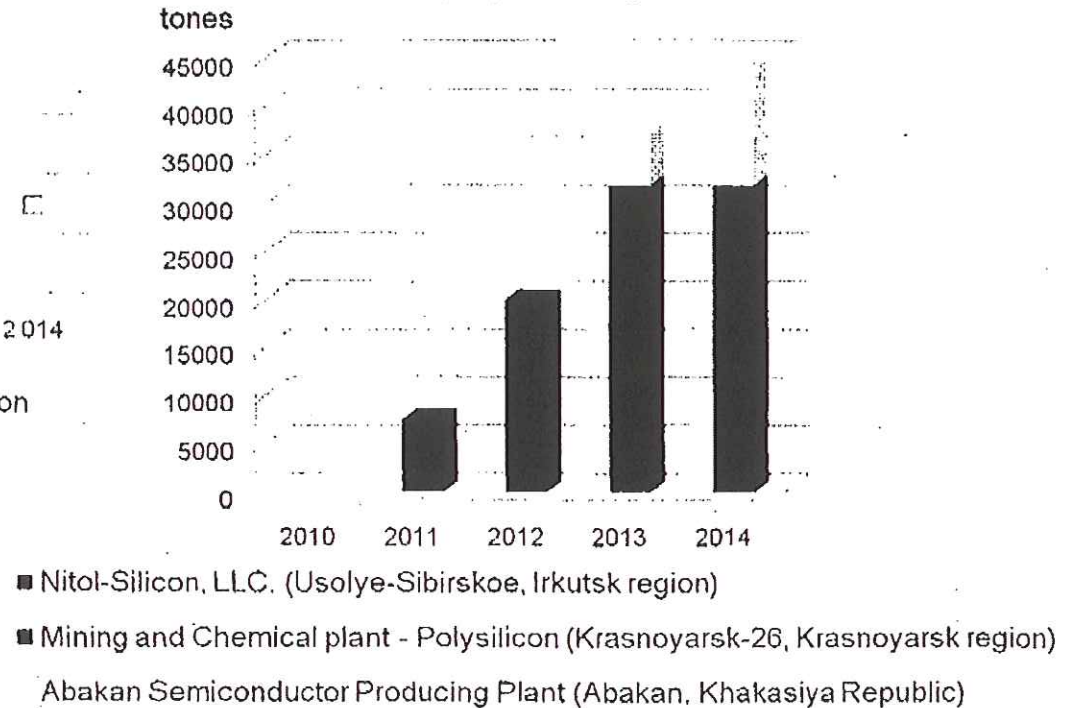
Metallurgical silicon market

Global market of metallurgical silicon (without Russia)



Establishing of regional market of refined metallurgical silicon of "chemical" quality

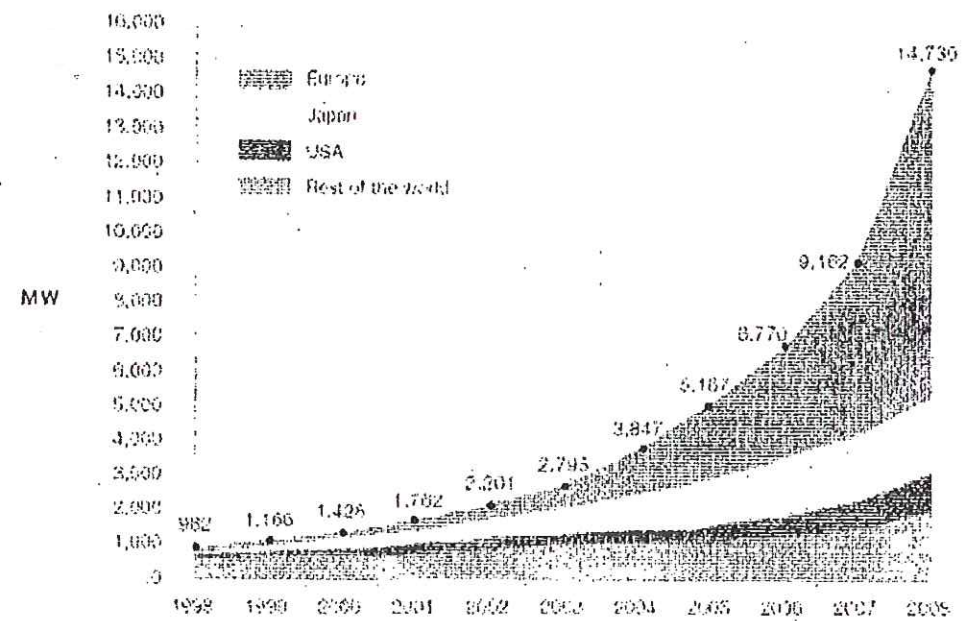
Raw material in Siemens-process for polysilicon production



Market

Solar Energy Market

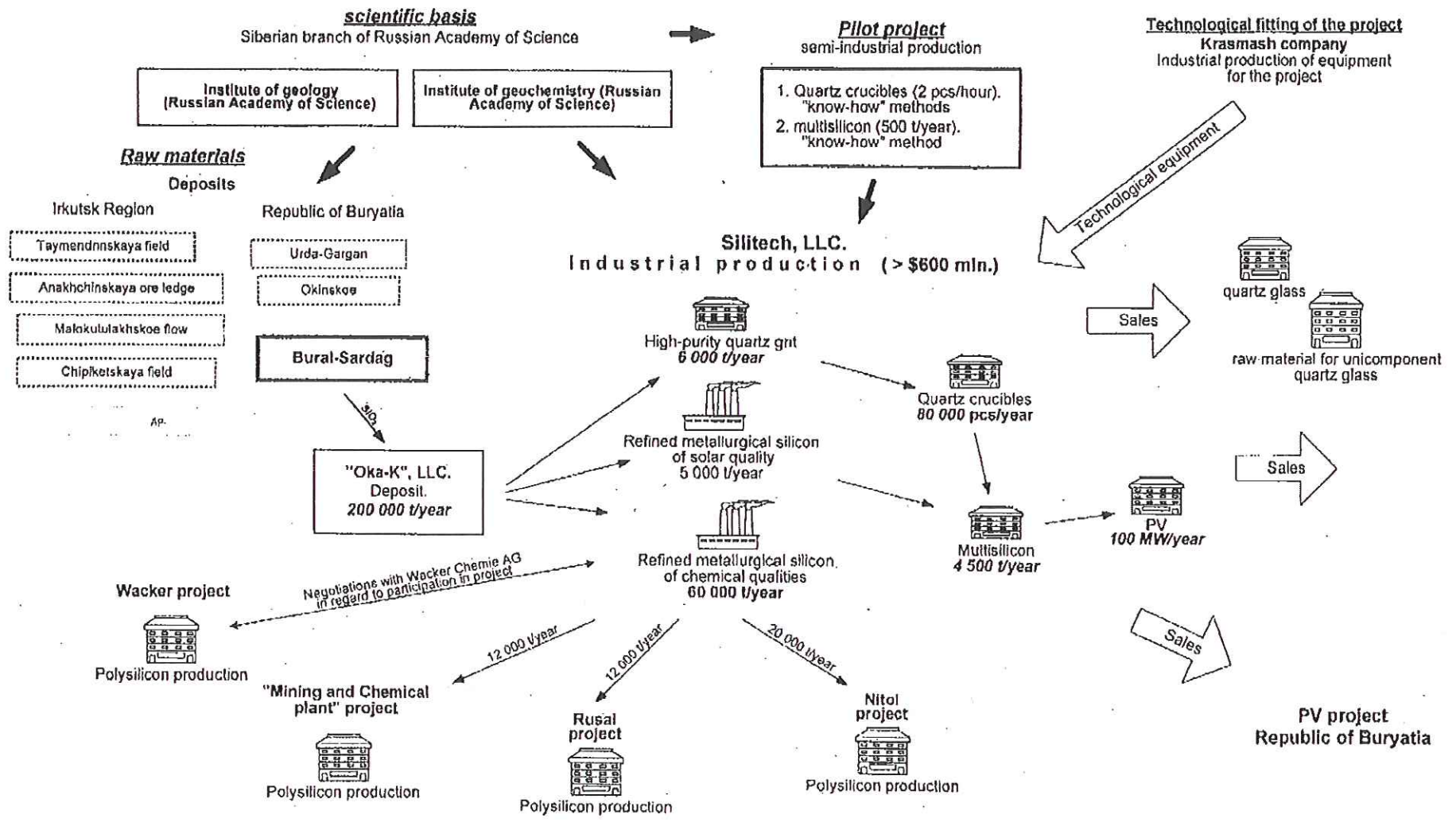
Figure 1: Historical development of Global cumulative PV power installed per Region



- **Global energy consumption: 16.500 TWh/year**
- **Assessment of the proportion of PV energy production: 70 TWh/year**
- **Installed capacity of solar power - 4.7 GWh (in 2008 – more than 5 GWh)**
- **PV energy share: 0.42%.**
- **PV energy share by 2030: up to 10%**

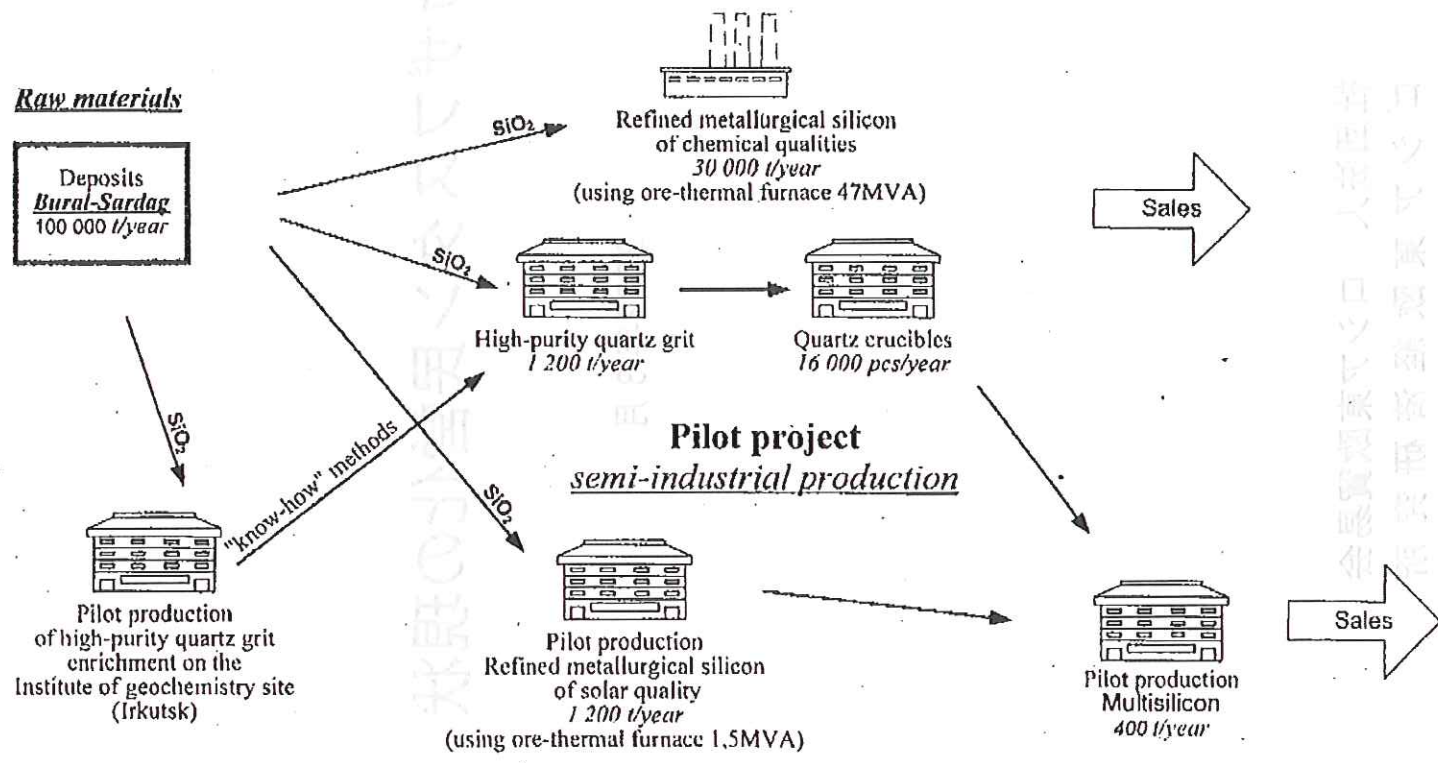
The Project details

The concept of deep processing of high-purity quartz raw material of Eastern Siberia Project "Solar Silicon"



The Project details

I-st stage of the project



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Technology

Operating technology

Carbothermal process ($\text{SiO}_2 + 2\text{C} = \text{Si} + 2\text{CO}$)

Obtaining trichlorsilan ($\text{Si} + 3\text{HCl} + \text{H}_2$)

Rectification of trichlorsilan .

Trichlorsilan Reduction by hydrogen and precipitation of polysilicon on hot rod.

Growing of silicon monocrystals for microelectronics.

Trimming of monocrystals (obtaining scrap)

Growing of mono /multisilicon ingots from scrap

Project technology

Carbothermal process ($\text{SiO}_2 + 2\text{C} = \text{Si} + 2\text{CO}$)

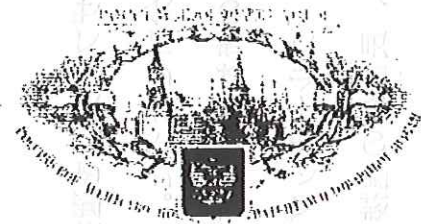
Refinement of silicon in melt [Know-how]

Growing of multisilicon ingots [Know-how]

(Ecologically pure process)

Проект The project technology:

- ✓ excludes application of chloral and products of its synthesis;
- ✓ provides dramatic reduction of production expenditure;
- ✓ is aimed at establishing a large-scale production



ВЕДЬМОТВОРЬ

№ 2131843

Исходный текст документа...

СООБЩЕНИЕ ПОЛУЧЕНИЯ КРЕМНИЯ ВЫСОКОЙ ЧИСТОТЫ

Исходный текст документа...

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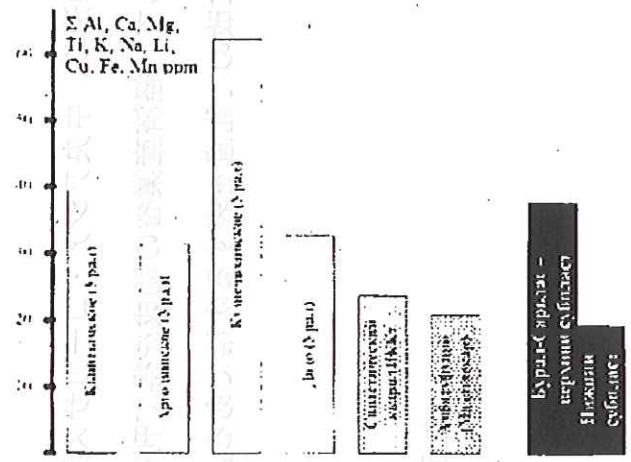
Исходный текст документа...



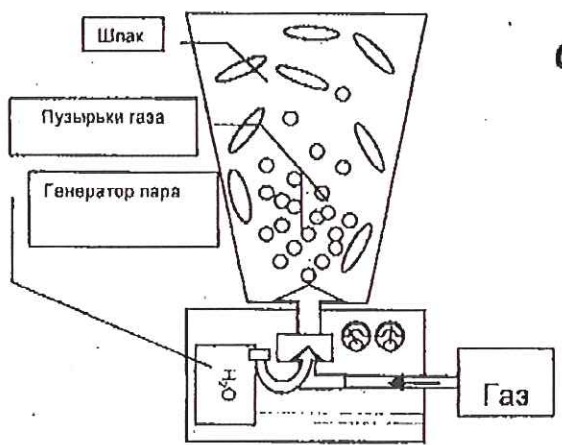
Competitive Advantages

Raw materials source

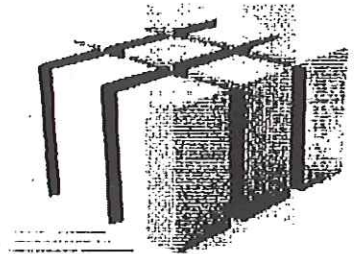
Comparative evaluation of the quality of the known sources of raw materials for unicomponent glass



"Know-how" Refining of melted silicon in the ladle



"Know-how" Growth of multisilicon ingots from high-purity refined metallurgical silicon



Comparative geochemical characteristic of quartzite main types

Quartzite type	Amount of samples	Average containing (ppm)							
		Al	Fe	Ca	Ti	Na	B	Cr	Ni
Bural-Sardag deposit									
Silicon-type microquartzite	8	80.0	43.0	2.0	5.0	13.0	1.0	1.0	0.2
Control		170.0	99.7	1.9	3.1	2.05	0.45	0.4	0.3
Albitized quartzite	23	64.0	50.0	10.0	3.5	8.0	0.5	<0.5	<0.5
Control		68.2	9.7	-	1.2	2.6	0.28	0.4	0.3
Superquartzite (general sample)	20	30.0	19.0	5.0	2.0	8.0	<0.5	0.5	<1
Superquartzite (bedding rock)	11	50.0	47.0	-	12.0	7.5	-	-	-
Control		4.20	5.50	2.5	0.8	3.5	0.25	-	0.07
Cheremshanka deposit									
Quartzite	Average value	370	350	32	46	851	6	37	39

Parameters

P - type
$\rho - 0,5 - 3 \text{ Ohm} \cdot \text{cm}$
$\tau > 10 \mu\text{sec}$
$\lambda > 100 \mu$
$C < 10^{17} \text{ cm}^{-3}$
$O < 10^{18} \text{ cm}^{-3}$

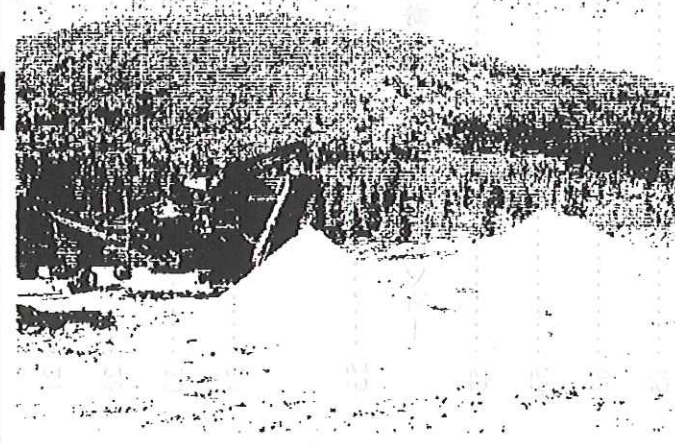
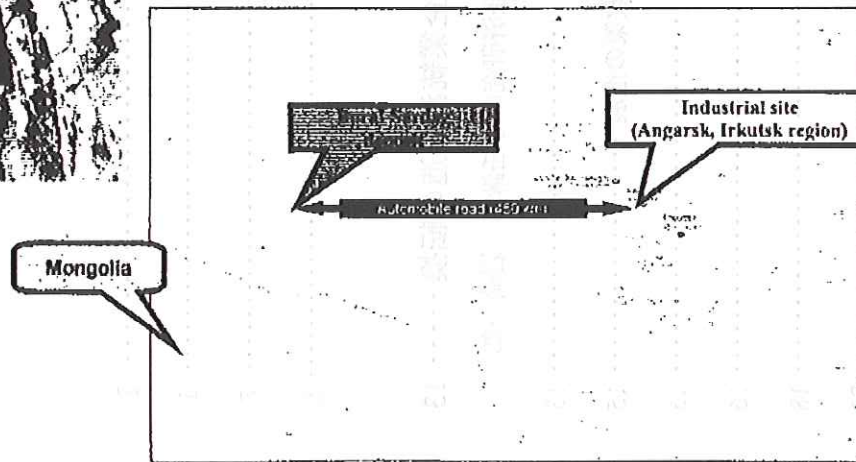
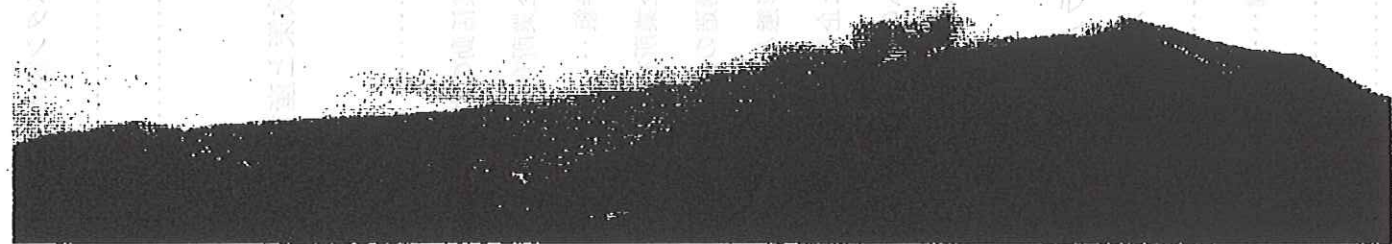
Placing Production Plants

Deposit

Deposit - Okinskiy district – Republic of Buryatia

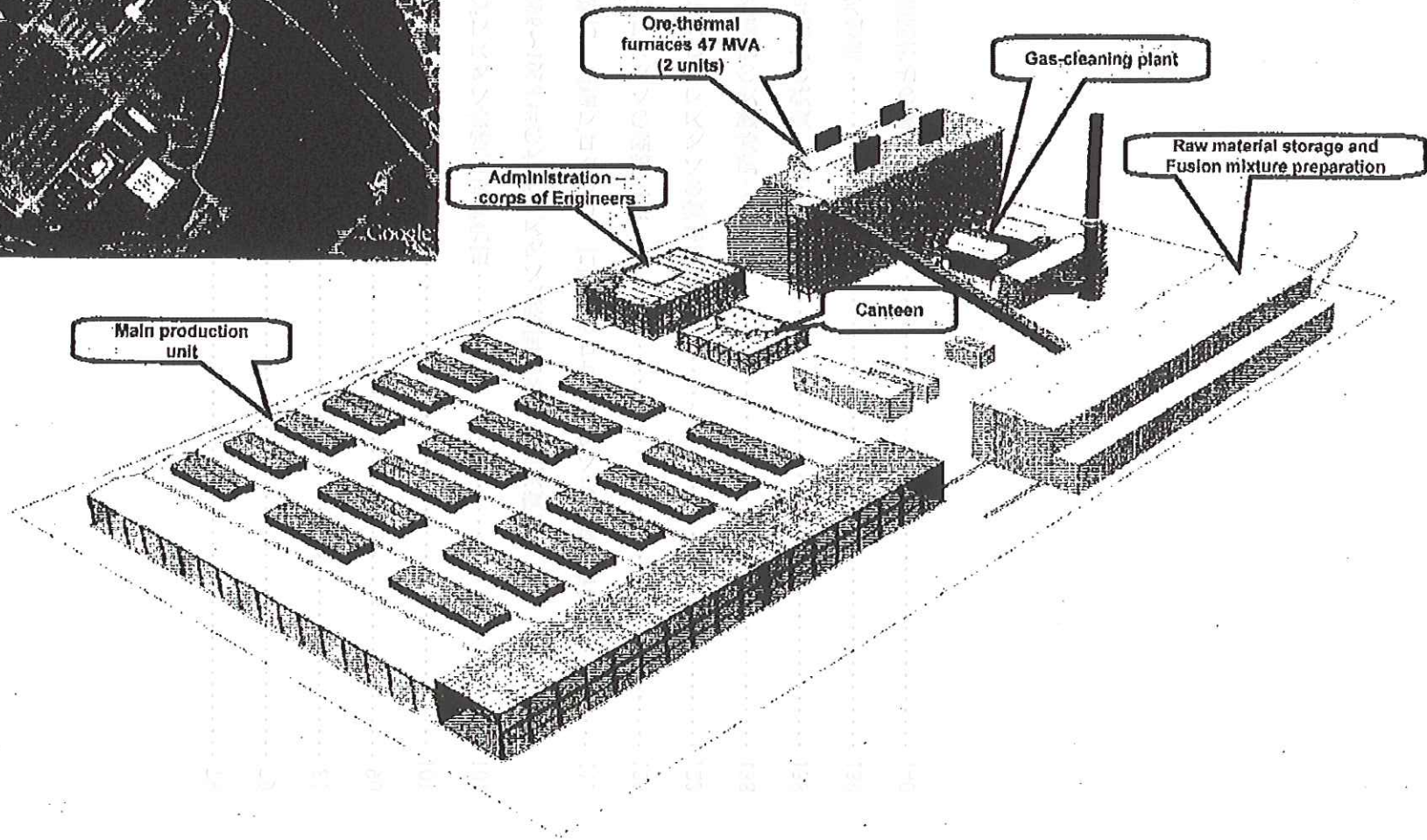
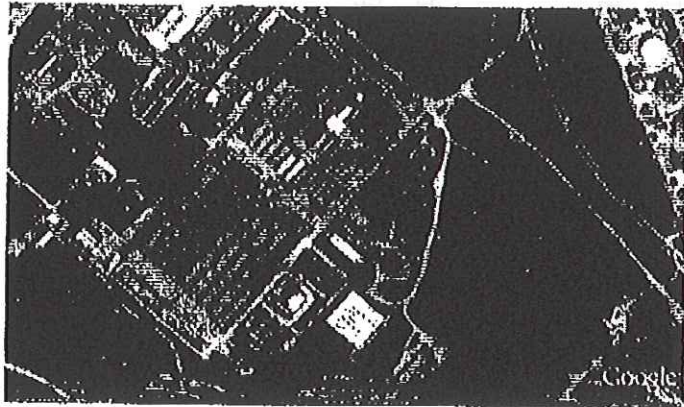
Eastern Sayani mountains, Bural-Sardag deposit

Balanced reserves of categories $C_1 + C_2$ are estimated as 980 000 tones



Placing Production Plants

Basic industrial site: the territory of Angarsk Electro - Mechanical Plant (Irlutsk Region)



Placing Production Plants

**Industrial site on the territory of
Angarsk Elctro - Mechanical Plant (Angarsk, Irkutsk region)**

Products

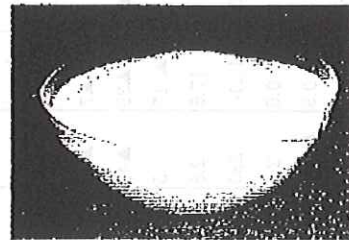
High-purity quartz grit

Production capacities:

Pilot project – 400 t/year

I -st stage of the project – 1 200 t/year

Industrial project – 6 000 t/year



Аналог	Элементы примеси (ppm)																
	Al	Ca	Fe	Li	Na	K	B	Co	Ge	Mg	Mn	P	Ti	Zr	As	Sb	OH
IOTA-St	15,2-22	0,4-1,5	0,3-1,5	0,7-1,5	0,9-1,5	0,7-1,5	0,08-1	0,005									
IOTA-4	7,9-10	0,6-1,0	0,3-1,0	0,2-1,0	1,0-1,3	0,4-1,0	0,04-0,05	0,08									
IOTA-6	7,9-9,5	0,5-0,7	0,2-0,3	0,2-0,3	0,1-0,2	0,1-0,2	0,03-0,04	0,4									
GE	8-14	0,4-0,6	0,2-0,5	0,01	0,02	0,03	0,1-0,2		0,05	0,1	0,05	0,2	1,1-1,4	0,2-0,8	0,01	0,003	70

Кварцевые тигли

(В России не производится)

Production capacities

**Industrial site on the territory of
Angarsk Elctro - Mechanical Plant (Angarsk, Irkutsk region)**

Products

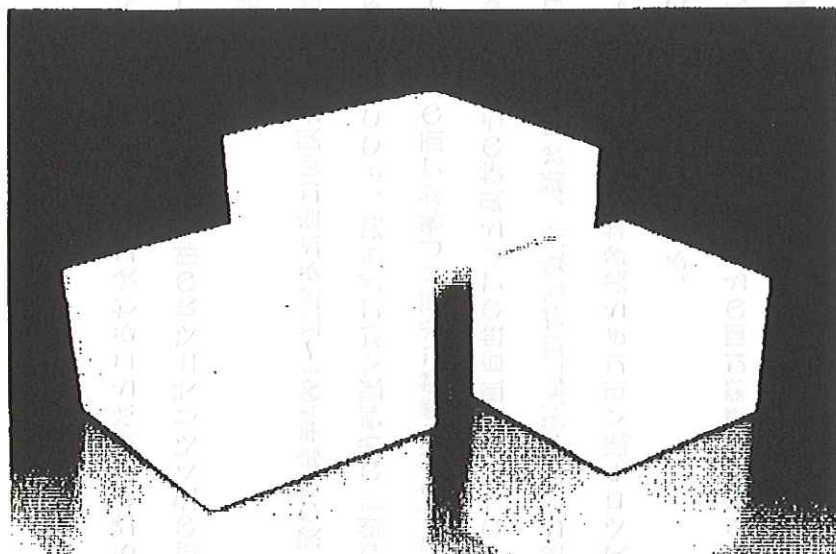
Quartz crucibles

(currently no productions in Russia)

Production capacities:

Pilot project – 16 500 pcs/year

Industrial project (year 2015) – 60 000 pcs/year

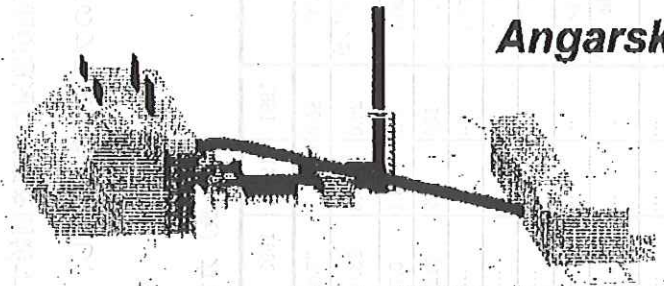


Technical characteristics

Linear sizes (mm)			Multicrystalline silicon ingot mass (kg)	Type of raw material used
X	Y	h		
660	660	320	280	KTO 6 (similar to Iota-4)

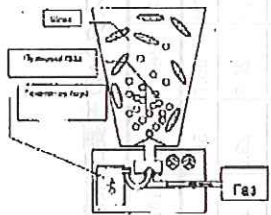
Production capacities

**Industrial site on the territory of
Angarsk Electro - Mechanical Plant (Angarsk, Irkutsk region)**



Products

**High-purity refined
metallurgical silicon
of «chemical» qualities**

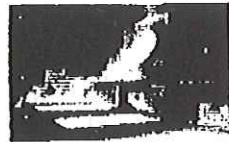
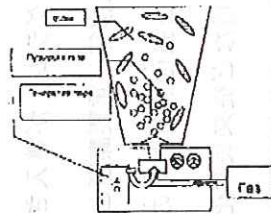


**Production capacities:
I - st stage of the project – 30 000 t/year
Industrial project – 60 000 t/year**

Type	%				ppm				
	Si	Fe	Al	Ca	P	Ti	Ni	Mn	B
Refined metallurgical silicon of chemical qualities	99,9	0,02	0,01	0,02	10	100	5	300	15

Production capacities

**Industrial site on the territory of
Angarsk Elctro - Mechanical Plant (Angarsk, Irkutsk region)**



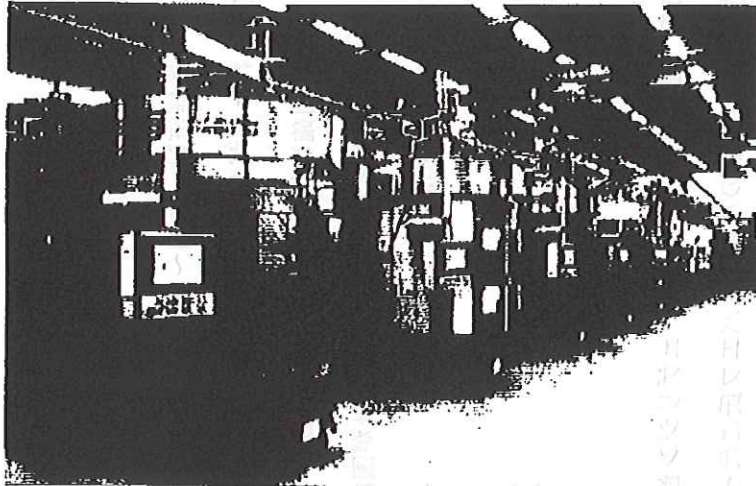
Products

**Refined metallurgical silicon
of solar quality**

**Production capacities:
Pilot project – 500 t/year
Industrial project – 5 000 t/year**

Production capacities

**Industrial site on the territory of
Angarsk Elctro - Mechanical Plant (Angarsk, Irkutsk region)**



Products

Multisilicon

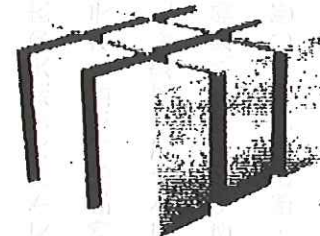
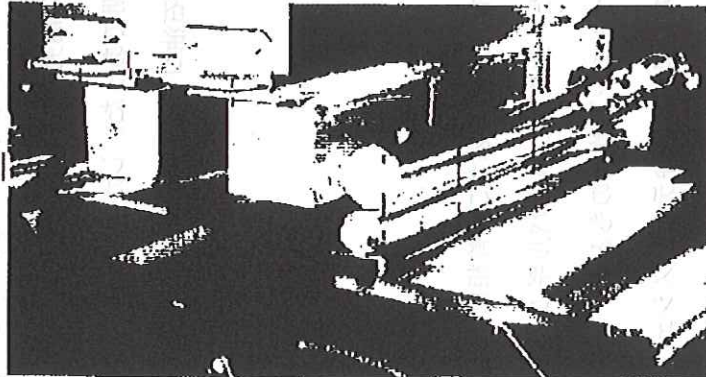
(multisilicon wafers)

(currently no productions in Russia)

Production capacities:

Pilot project – 425 t/year

Industrial project – 4 500 t/year



Р - тип
$\rho - 0,5 - 3 \text{ Ом} \cdot \text{см}$
$\tau > 10 \text{ мсек}$
$\lambda > 100 \text{ м}$
$C < 10^{17} \text{ см}^{-3}$
$O < 10^{18} \text{ см}^{-3}$

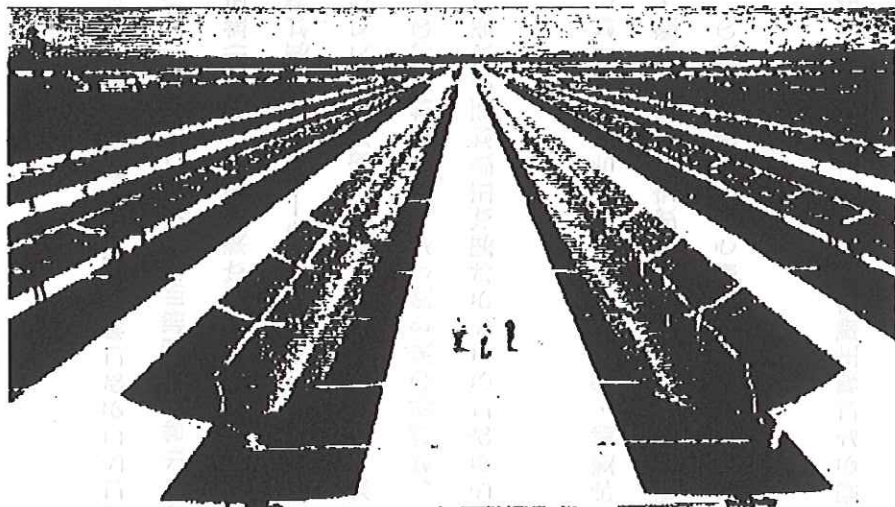
Production capacities

*Industrial site on the territory of
Angarsk Elctro - Mechanical Plant (Angarsk, Irkutsk region)*



Products

Photovoltaic converters (PV)



Production capacities:

Pilot project – 30 MW/year

Industrial project – 100 MW/year

Parameter	Value
Shape	square
Area, dm^2	1,0; 1,5; 2,25; 4,41
Efficiency, %	>14

Technical and Economical Parameters

1 - st stage of the project

The cost of the first phase of the project - 150 mln. USD

Payback period – not more than 6 years

The cost of the entire project - 600 mln. USD.

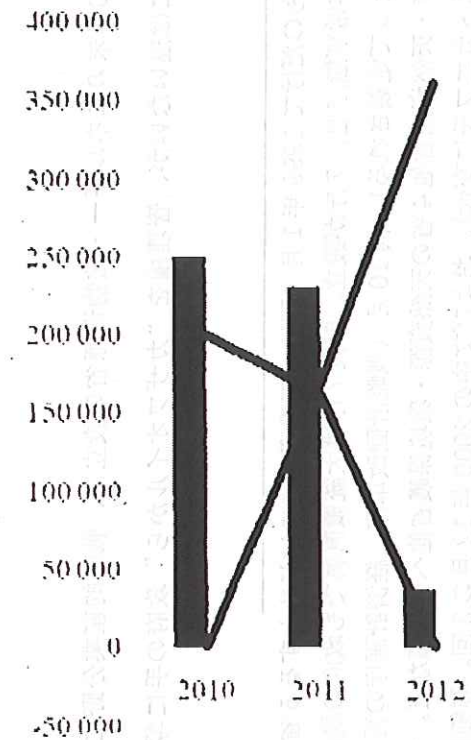
Payback period – not more than 3 years

Pilot project

Effectiveness of investments

Total project cost, mln. \$	43.2
Implementation period, year	3
Discount rate, %	20.2
Payback period, months	31
Discounted payback period, months	37
Average rate of return, %	59.15
Net present value (NPV), mln. \$	33.7
Profitability index	1.77
Internal rate of return, %	49.52
Modified rate of return, %	34.29
Annual turnover for 5 years, mln. \$	55.3
Number of employees, persons	171
Payments to the budget, mln. \$	19.8

thousand rubles



- The cost of the Pilot project
- Our own financial means
- Loans for implementation
- - Profit

Offer for an investor

Loans for implementation:

- pilot project;
- I st stage of the project;
- the project as it is.

Share in capital.

Establishing joint production.

Contacts:

Scientific advisor – Nepomnyaschih Aleksandr Iosifovich.

E-mail: ainep@igc.irk.ru, тел.tel. (+7 3952) 51 14 66; +7 902 5 135 572.

Project Manager – Romanov Victor Stefanovich.

E-mail: romanov@solar-si.ru, тел. (+7 3952) 45 87 90; +7 902 5 669 282.

Business-partner – Antonova Tatyana Aleksandrovna.

E-mail: westanglia@mail.ru, тел. (+7 495) 699.32 09; +7 985 741 12 49