



Project

«Optical DC Sensors for Electrolysis industry»



1 PROJECT DESCRIPTION

Registration date:	10 th December 2010
Registration capital	12 131 840 USD
Shareholder: Rusnano	99.99%
Domain	Technologies for precise metering of current and voltage
Stage of the project	■ Scale-up or mass production
Patents	14

Profotech is an original Russian developer of fiber optics technologies and producer on its basis optical Faraday sensors.

Development began from 1975, company established in 2010, and at 2020 became a player in world market among well-known



Benefits are: ultimate precision, absence of saturation effect, immunity to the side EM fields, immunity to the environment temperature difference, compact sizes, ability to deploy to various application which need to be measured (could be industrial busbar, High voltage apparatus and bushings, transient points of cable lines and etc.)

Currently team of Profotech, has strong intention to open the doors to Chinese market and find a partner to deliver its technologies and devices to the region thanks to its size which is more capacious than the rest of world.





2 CORE TEAM

- **Staff:** highly professional engineers and scientists of the Institute of Radio Engineering and Electronics of the Institute of the Russian Academy of Sciences, the Moscow Power Engineering Institute
- **Equipment:** Faraday`optical current transformers,
electronic voltage transformers
combined transformers up to 750 kV
- **Purposes:**
Metering of Direct current up to 600 kA DC
Metering of Alternative current up to 190 kA AC
Optical current transformers for digital substation IEC-61850-9-2 (AC, HVDC)



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Head of the optical
measuring laboratory

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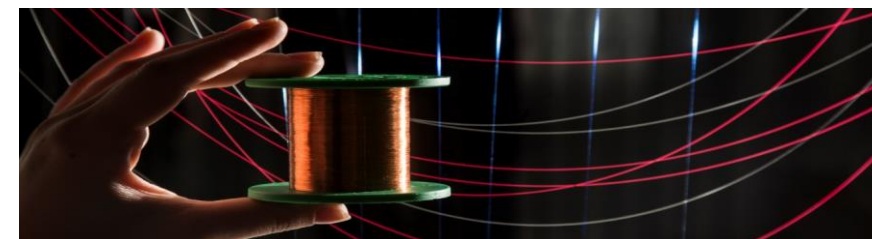
北京航空航天大学



▪ **Production plant and office:** Moscow, Russia



▪ **R&D center:** Skolkovo Innovation Center, Moscow, Russia





3 PRODUCT DESCRIPTION EFOCT-F [Fiber-optical current transformer with flexible sensing element]

EFOCT-F | EFOCT-F-DC | EFOCT-F-REF - Measurement principle based of Faraday effect



Sets of outputs

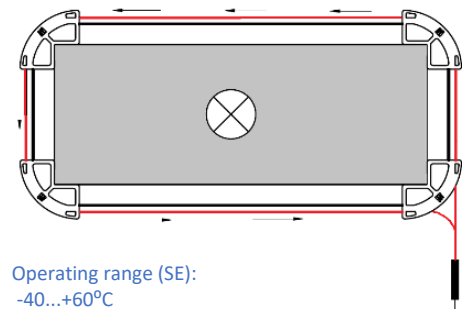
Operating range (EPU)
: +10...+40°C

EPU - Electronic Processing Unit's Front panel outputs designs

FREQ	3 x Frequency outputs (1..10kHz at rated current) 1 x Low-Current (4..20mA - 0.2% precision only) 1 x Modbus (registry map – Profotech) 1 x Impulse Integral (Nimp/kA*s). Update rate approx. 40mS
mA	4 x Low-Current (4..20mA – 0.2% precision only) 1 x Modbus (registry map – Profotech) 3 x Watchdog outputs (Overheating, Overcurrent, Reversed Current) Update rate approx. 40mS
FAST	1 x Frequency output (10kHz at rated current) 2 x Low-Current (0-20..mA - 0.2% precision only) 1 x Modbus (registry map – Profotech) 1 x Low voltage output (0-1V 0.2% precision only) Update rate approx. 0.5mS
IEC-61850-9-2	Standard IEC 61850-9-2LE SV Sample rate IEC 61850-8-1 Sync SV80; SV256; Redundancy 1PPS optical. IEEE 1588-2008 (PTPv2); PRP

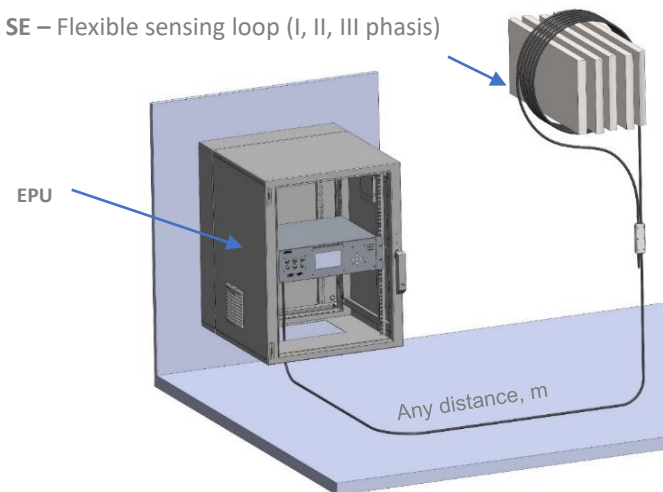
SE - Sensing Element performance

Rated direct current (Ir)	up to 350 kA up to 600 kA <i>by request</i>
Accuracy	0.2, 0.1, 0.05



Operating range (SE):
-40...+60°C
(+70°C according to request)

SE – Flexible sensing loop (I, II, III phasis)



Flexible SE is based on an armored cable with PVC isolation with sensitive optical fiber inside. For installation on the busbar a special protective housing is used.

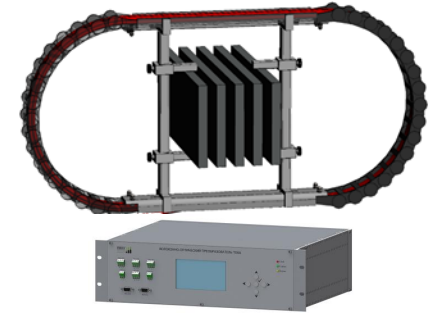
- Installation versatility allows for a wide range of modern protection solutions
- Lack of saturation effect improves the efficiency of protection algorithms
- The consistently high accuracy of optical CTs makes it possible to detect a number of phenomena that are inaccessible to electromagnetic CTs.
- High sample rate capability for transient recording

Protection class	
SE	IP65
EPU	IP20
Power supply	
Design 2PS	110V DC or 220V DC or 110V AC or 230V AC
EPU power consumption	150W max
Physical dimensions	
SE and EPU weight	Single phase weight ≤12 kgs
EPU size	19" rack, 3U height (390×465×220)
Cable	external ø 9.5mm Fiber sheathed cable, Min bending radius 200 mm



4 TECHNOLOGY INNOVATION

Advantages of Faraday`s DC optical sensor



No	Parameter	Shunt	Rogowski Coil	Hall Sensor	Faraday optical sensor
1	Temperature operating range	-40°C... +50°C	-30°C ... 50 °C	-30°C... +50°C	-40°C ... +70°C
2	Current measurement rangeDC	≤ 15 kA	≤ 20 kA	≤ 600 kA	≤ 600 kA
3	Accuracy class	0.5-1.0 %	1-5%	0.2-1%	≤ 0.1 %
4	Length of the cable route	-	≤ 1 m	≤ 70 m	Not limited, m
5	Busbar dimensions	240×310×100 mm	∅ 100..580	any	any
6	Independency of ambient temperature	✗	✗	✗	✓
7	Immunity to induced EM fields	✗	✗	✗	✓
8	No NEED on-site calibration	✗	✗	✗	✓
9	No NEED of accurate sensor positioning	✗	✗	✗	✓
10	Output signal variety	75mV	0-5 V 4-20 mA Modbus	0-5 V 4-20 mA	1..10kHz 0..20mA Modbus IEC-61850-9-2 Impulse 0-1V Watchdog
11	Mobile version of device	✗	✓	✗	✓
12	Calibration cycle, years	2	2	2	8
13	Mean Time Between Failures (MTBF), years	99 000	90 000	100 000	138 000
14	Life cycle, years	12	5	5	25

Economical aspect:

15	Indicative price for general design (I rated =200kA DC)	482 580 ₺	...	553 000 ₺	2 730 000 ₺
16	Specific cost of equipment per year (rubles / year)	40 215 ₺	...	110 600 ₺	109 200 ₺



5 ECONOMICAL EFFECT for AL Smelters. RUSAL` case

RUSAL Krasnoyarsk smelter:

INITIAL DATA

I - Potline value	175 kA
U - Potline value	400 V
QTYc - Electrolyses cell quantity per potline	94 pcs
δ - Existing deviation of DC metering	0,68 %
δ1 - Profotech deviation of DC metering	0,2 %

OBTAINED DATA

Ppotline Consumption of POTLINE	70000 kW
Pcell Consumption of CELL	744,7 kW
ΔI on POTLINE under δ0 & δ1	0,84 kA
ΔReducing consumption on Cell	3,57 kW
New consumption on Cell	741,11 kW

U0 Existing voltage on Cell	4,26 V
U1 New voltage on Cell	4,23 V
ΔU	0,020 V

ECONOMICAL EFFECT

POTLINE QTY	2 pcs
POTLINE Working hours/year	8760 hours
Energy Tariff	0,03 USD/kW*hour
EXISTING Energy BILLS / year	37 230 000 USD
NEW Energy BILLS / year	37 051 296 USD
SAVINGS per year	178 704 USD



Use **EFOCT-F-DC**, makes possible to reach accuracy of current measurement and reduce the voltage level on the potline.
As a result, annual **Energy consumption sized** under the same AL output:

Energy Bills	before	37 230 mln \$
	after	37 051 mln \$

Savings annually **178 704 \$**





6 COMMERCIALIZATION

Target market of EFOCT-F focuses on electrolysis industry which includes:



1. Primary aluminum smelters



2. Primary copper smelters



3. Titan production plants



4. Electrolytic manganese metal (EMM) plants



5. Nickel production plants



6. Zinc production plants



7. Graphite electrode production plants



8. Chlor-Alkali industry (Chlorine, Vinyl, Caustic soda producers)

Factories in industry:

113 smelters

15 smelters and refineries

12 plants

10 producers

3 smelters

6 smelters

11 plants

18 plants

Planned MVP launch date:

2019 JAN mass production began in Russia
2024 SEP begin mass production in China



ECONOMICS effect for customers:

The use of high-precision optical current sensors makes to do optimal load the rectifier units on the electrolyzer line possible, and as result - achievement the maximum outcome of the final product within the determined production period.

The use of optical sensors carries the task of maximizing the performance of equipment and the reliability of operation of the line of electrolyzers, the overload of which can result in forced outage (ERBD) of equipment and its expensive repair.



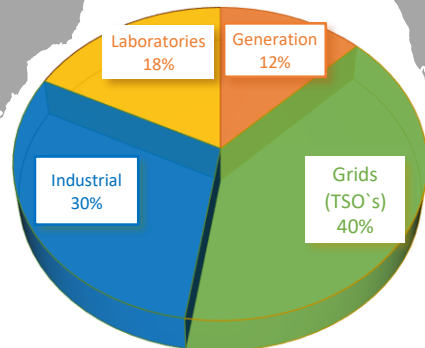


7 REFERENCE LIST

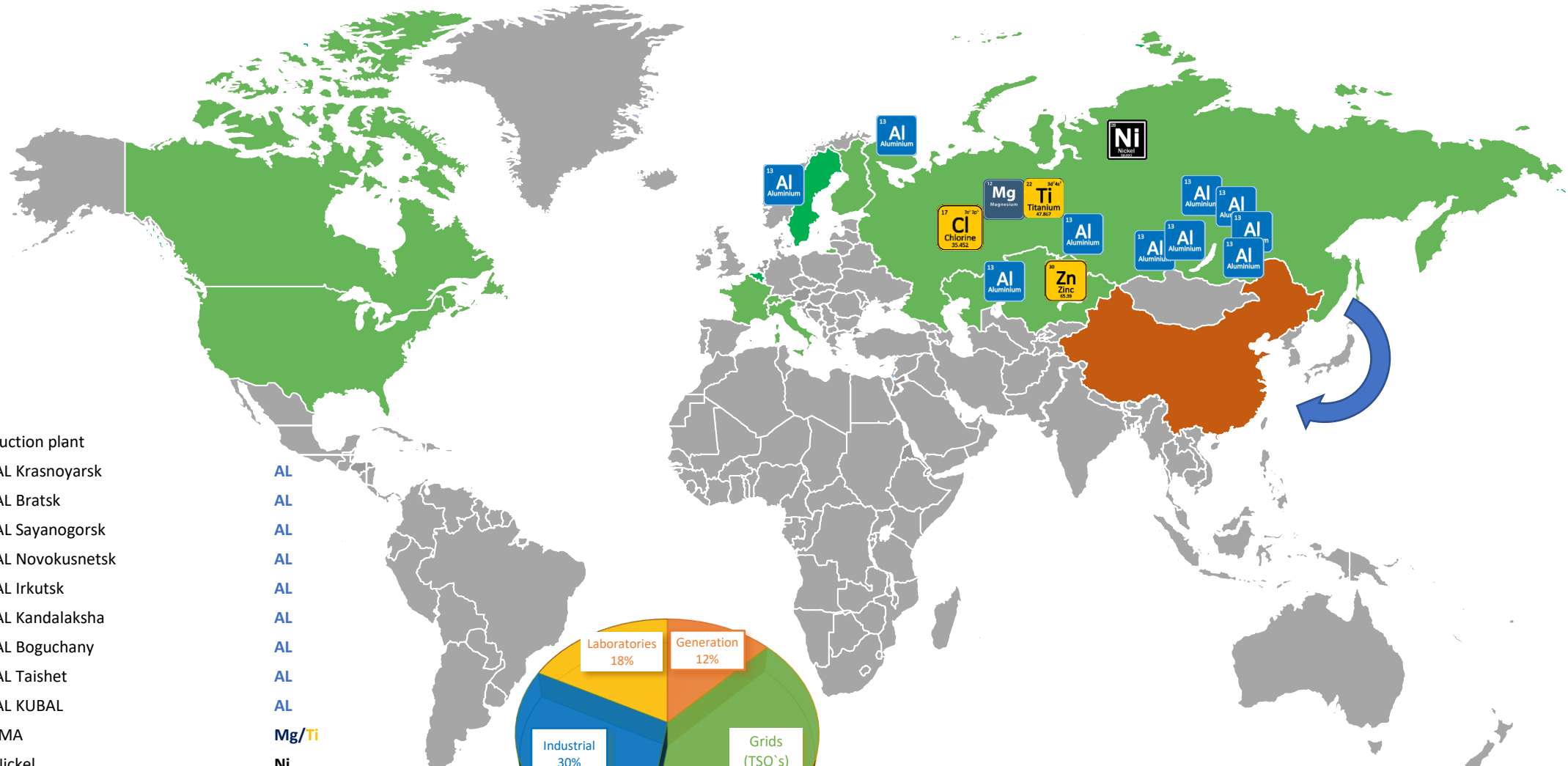
No Production plant

- 1 RUSAL Krasnoyarsk
- 2 RUSAL Bratsk
- 3 RUSAL Sayanogorsk
- 4 RUSAL Novokusnetsk
- 5 RUSAL Irkutsk
- 6 RUSAL Kandalaksha
- 7 RUSAL Boguchany
- 8 RUSAL Taishet
- 9 RUSAL KUBAL
- 10 AVISMA
- 11 NorNickel
- 12 KAZZINC
- 13 ERG
- 14 Rusvynil

AL
AL
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AL
AL
AL
Mg/Ti
Ni
Zn
AL
CL



Profotech's equipment operates in **9 countries** and more than **50 facilities**



2021 DEC Profotech

PROFOTECH` infrastructure includes:

PRODUCTION:

Russia – Production plant
 R&D department
 Own High voltage & climatic certified Laboratory
 Installation and commissioning division
 (19 engineering staff including Ph.D. developers)

Switzerland – localization of «SKD» - large-node assembly

SALES:

Russia – Headquarter office (CIS and Worldwide)
 Switzerland – EU official representative office
 Kazakhstan – Local official representative office
 Portugal – Local official representative office

CERTIFICATION:

CE, EAC, ISO 9001, EAC, KEMA TYPE TEST, IEC-61850

Business model:
 Distribution sales with localizing

2022 SEP Profotech enter to China`s Market

Profotech`s plan of market penetration imply next actions:

I Find a local partner for distribution of equipment

II Localization of production in China

III A Create R&D center,
 B Customer service department,
 C Training center for teaching maintenance staff.

Next laboratories equipped by EFOCT-F,
 which highlight its reliability and unique
 performance properties:





9 COMPETITOR ANALYSIS

Market	Status	Producer	Comments
<p>WORLD WIDE OPERATING</p>			<p>Only Profotech has worldwide market presence in 8 countries & its equipment deployed in more than 50 facilities. That statistic prove equipment reliability and customer loyalty</p>
	<p>Left market </p>		
	<p>Left market </p>	GE DynAmp (Technology of GE)	
<p>ONLY CHINA LOCALY</p>		XunDi 湖北迅迪科技有限公司	
		COMCORE 上海康阔光智能技术有限公司	
		Wuhan XinHua 武汉市新华仪表电器厂	
	<p>Left market </p>	HWELL 西安华伟光电技术有限公司	
	<p>Left market </p>	SWT Optics 北京世维通光智能科技有限公司 Shanghai Runjing 上海润京能源科技有限公司	



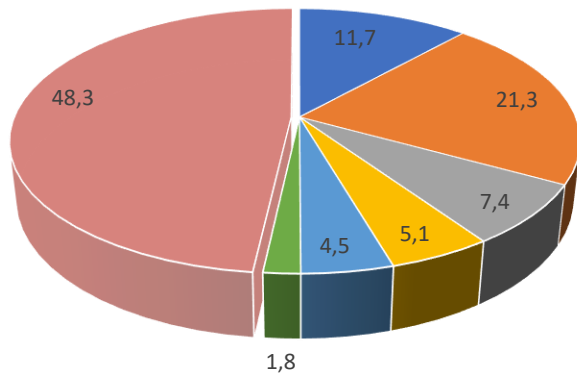
10 MARKET & INVESTMENT PLAN

World, including:	Optical DC sensors market,		Volume:
	pcs	USD	%
CIS	1 120	44 800 000	11,7
Europe	2 044	81 760 000	21,3
North America	708	28 320 000	7,4
South America	484	19 360 000	5,1
Africa	428	17 120 000	4,5
Oceania	172	6 880 000	1,8
China	4 624	184 960 000	48,3
TOTAL:	9 580	383 200 000	100

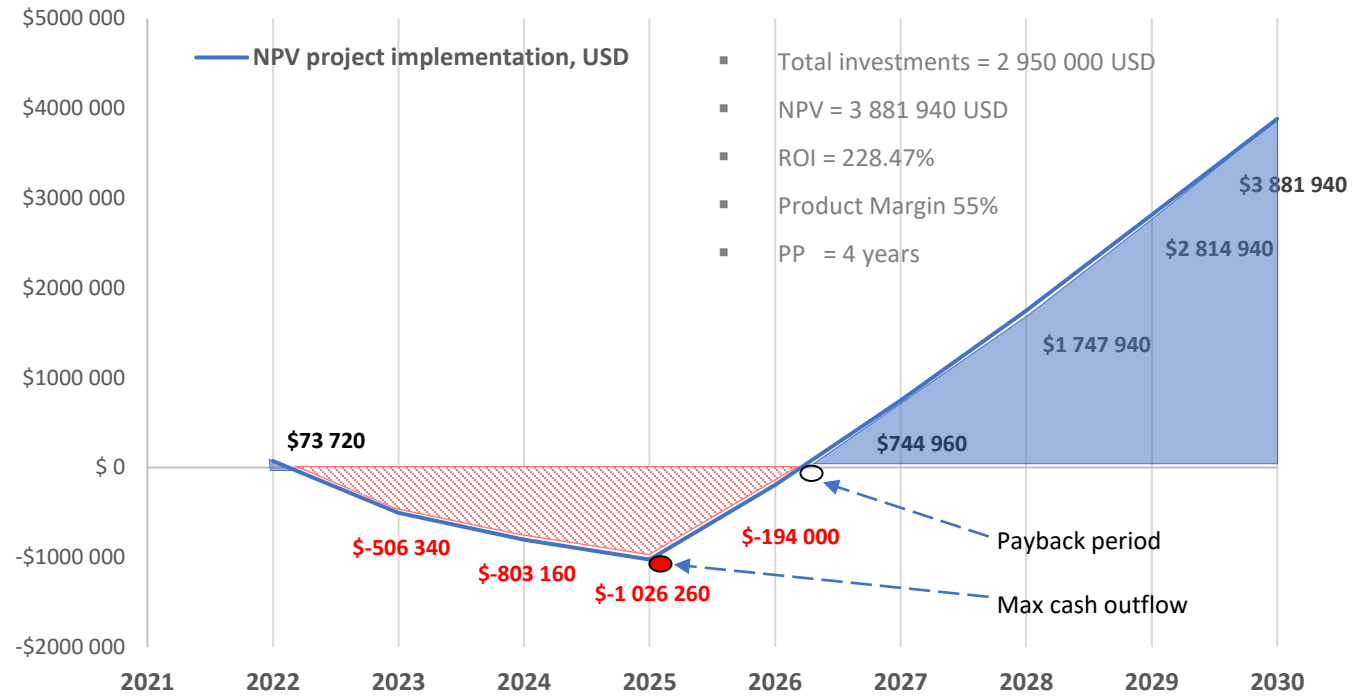
Optical DC sensor market

world scale

- CIS
- Europe
- North America
- South America
- Africa
- Oceania
- China

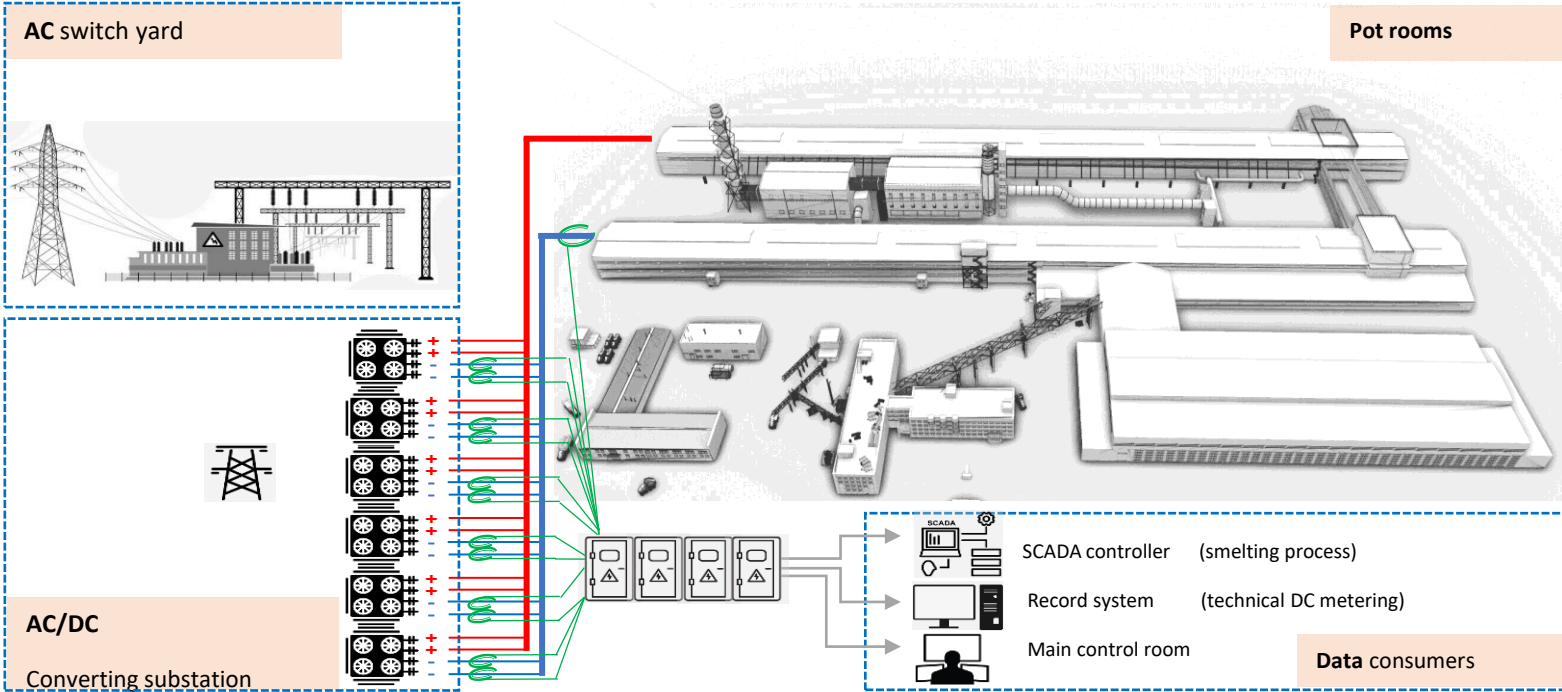


Total market estimated in 383,2 mln \$



Investment Plan (in USD)			
Year	Stage	Investment	Purpose of investment
2022	1	60 000	Establish the office and assembling plant
	2	40 000	Certification
2023	2	150 000	Pilot projects
	3	800 000	Start of mass production of DC sensors for Chine's market
2024	4	350 000	Development of OCT for HVDC
	5	300 000	Pilot project with Grid
2025	5	250 000	Certification of HVDC
	6	1 000 000	Start of Mass production of HVDC product
Total investment		2 950 000	

11 SHOW CASE

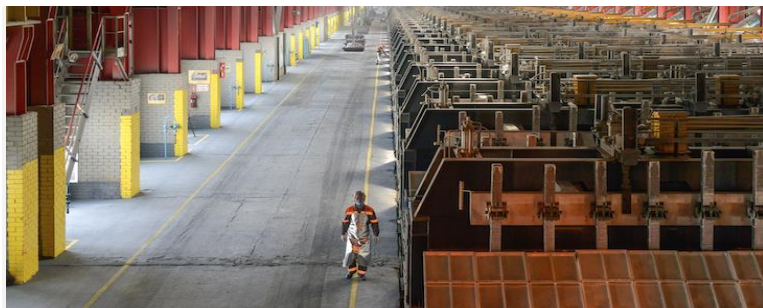


Heavy industry enterprises have to control behavior of technological processes such as smelting electrolysis and others, because its performance directly depends on the consumed electricity and its quality.

There are several methods of electrical currents measurement at busbars, they are Rogowski coil, Hall effect sensors, forks based on Ohm law, shunts, but nowadays most reliable and modern technology is a fiber optic current sensor, based on Faraday effect.


This type of sensors has the following advantages:

- High accuracy, up to 0.05%, with wide operating range;
- Wide measured limits up to 600 kA DC;
- Correct and stable measurements, on despite of angled conductor arrangements in homogeneous magnetic
- Easy mounting. The magnetic centering of the sensor is not
- Absence of necessity of optimal placement of the sensor
- Absence of mandatory onsite calibration;
- Convenient settlement of station record-keeping spot. Distance between sensing element and processing unit is up to 1200m, which allow locate it at any suitable place of factory.



- Instrument transformers included in register of the state agency of measuring instruments in Russia and Kazakhstan.
- Can be used at industrial hazardous facilities, used to build systems for technical and commercial metering of electricity, protection systems and automation of electrical substations and generation facilities.

Key facts:

Fiber optical sensor EFOCT-F-DC 
 Outputs: 4..20 mA, frequency, impulse, Modbus
 Temperature range: - 40...+ 60 C
 Length between Sensor & EPU is not limited





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