Intergeotherm SC

Dr., Prof. **Oleg A. Povarov**

Director General

Dr. **Alexander I. Nikolskiy**

Technical Director

EXPERIENCE OF RUNNING GEOTHERMAL POWER PLANTS UNDER SEVERE CLIMATE CONDITIONS IN RUSSIA

Content

- Fossil fuel resources in Russia and in the World
- Geothermal resources of Russia
- Modern district heating systems in Russia
- Geothermal resources of Russia 10-12 times exceed total reserves of oil, gas and coal
- Geothermal heat and power – less expensive, more reliable and environmentally friendly
- Local geothermal heat and power supply systems
- GSI, BPP and utilization of heat of the Earth – main trends of energy sector development in Russia
- New promising geothermal projects in Russia

Energy Geopolitics: East-West

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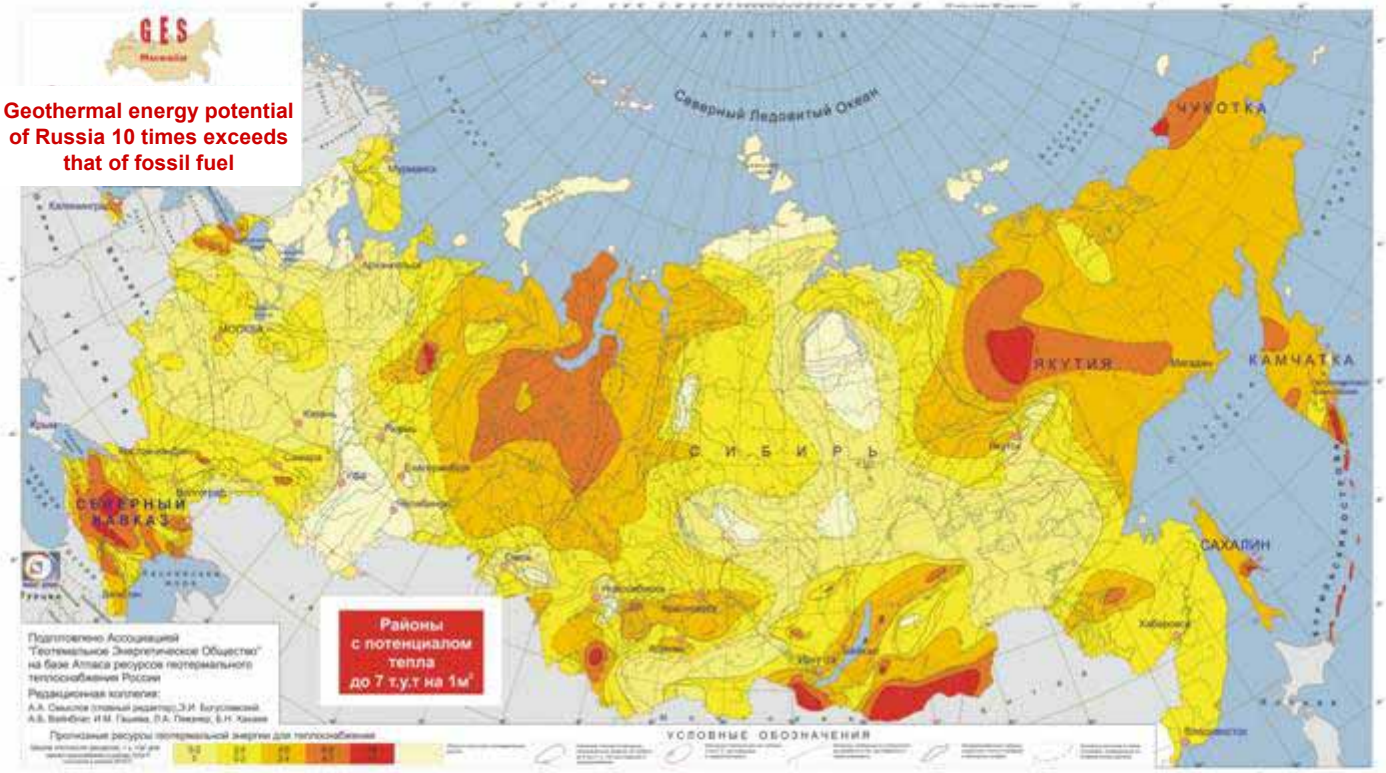
WP5, Engine Project
Strasbourg, France, 13-16 September, 2006

Geothermal Resources of Russia



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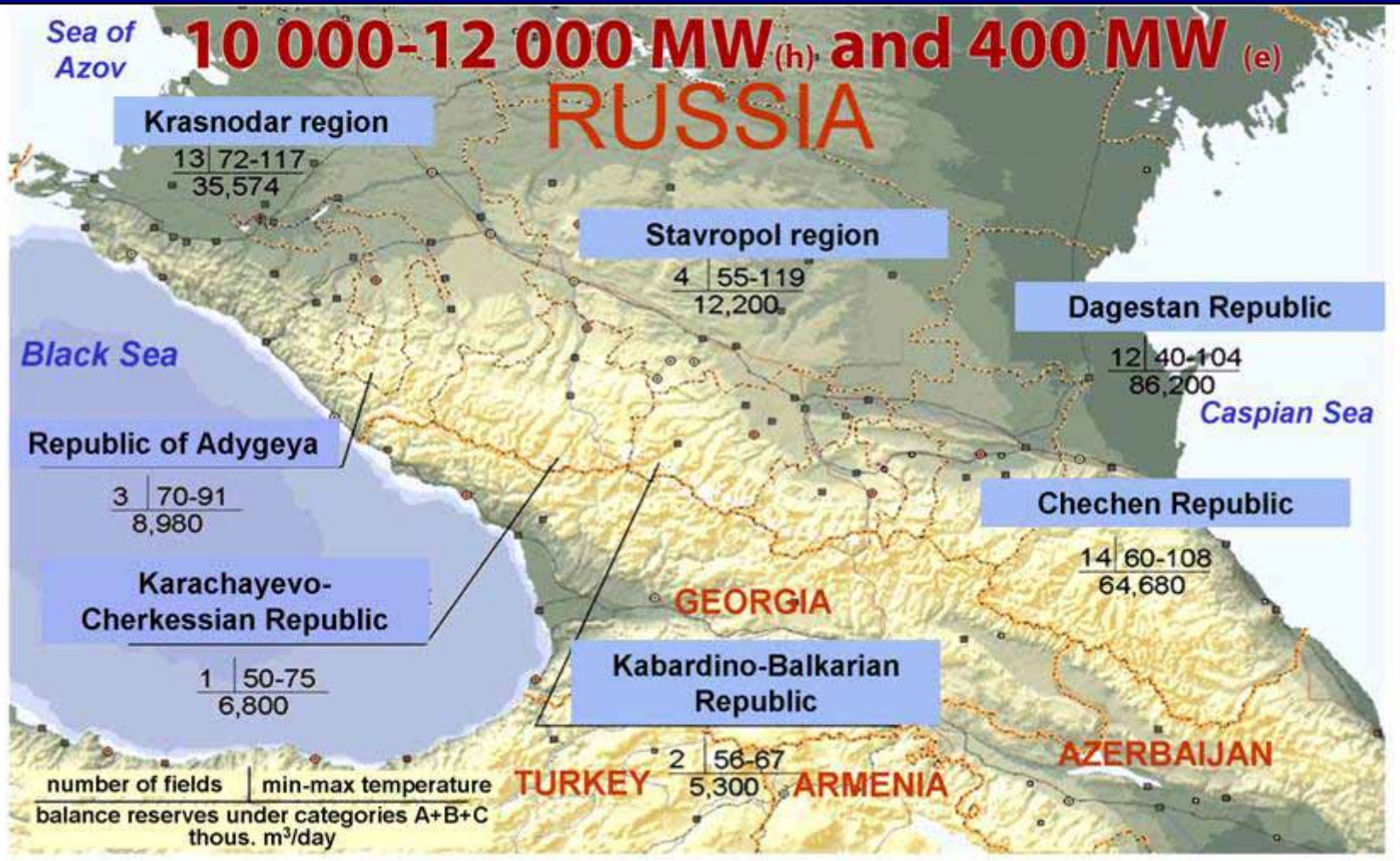
Geothermal Resources of North Caucasia



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Kamchatka and Kuril Islands

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Kuril Islands

Verkhne-Mutnovsky GeoPP

Pauzhetsky GeoPP

Mutnovsky GeoPP

Mendeleevsky geothermal energy complex

Russia

Sea of Okhotsk

Kamchatka

Paramushir Island

Sakhalin Island

Heat of the Earth – a bridge to successful development of Kamchatka and Kuril Islands

Urup Island

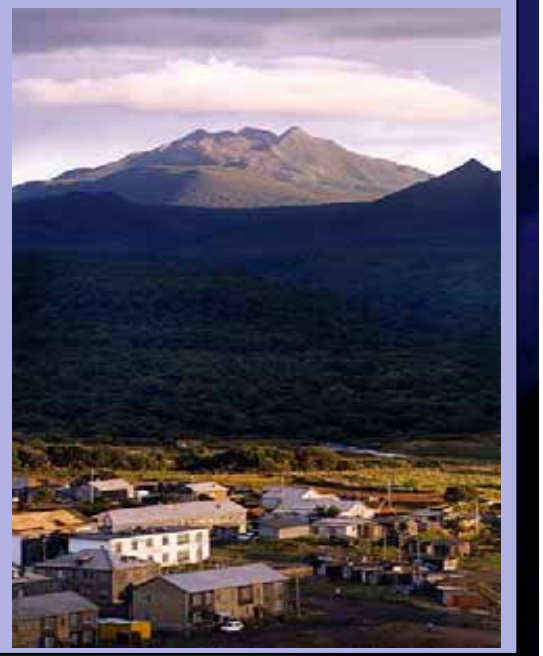
Iturup Island

Kunashir Island

Japan

Pacific Ocean

Iturup Island



Reidovo

Kitovy

Iturup Island

Volcano of Baransky

Okeanskaya GeoPP

Burevestnik

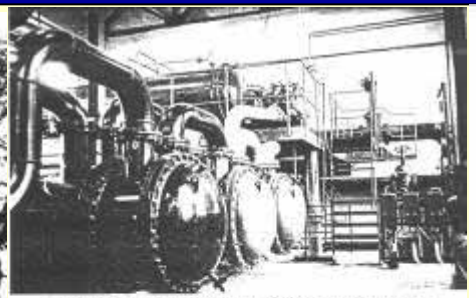
N

W

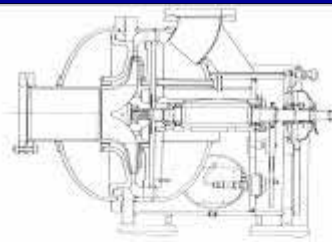
E

S

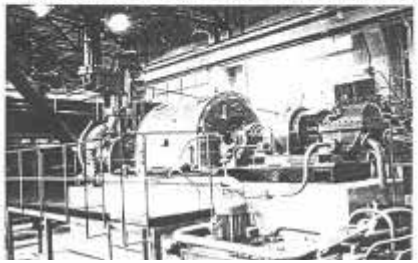
The First World Geothermal Binary Cycle Power Plant was installed in 1967 (Kamchatka).

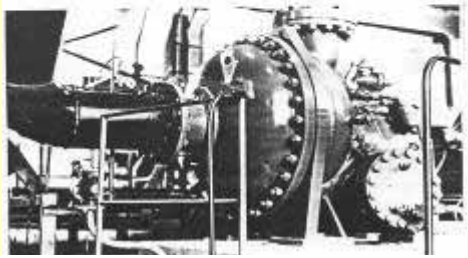


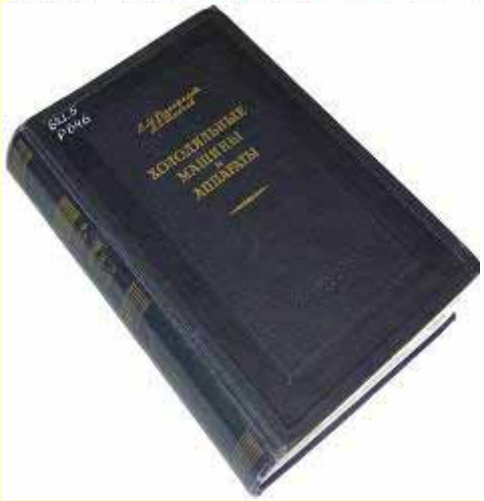
Подогреватели ПНГ-150 котла и конденсаторная площадка



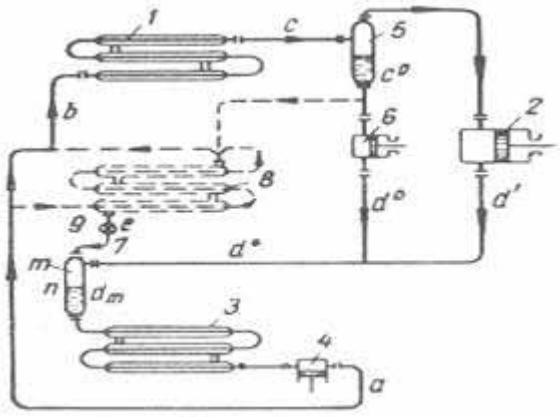
Хлопковая одноступенчатая
центростремительная турбина ТФ-60/0,75

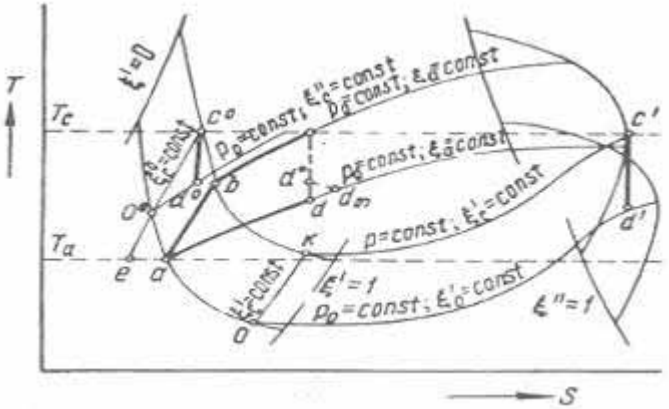






Detailed description of power generating cycles where NH_3 and $NH_3 + H_2O$ are used as a working fluid were published by Soviet scientists as long ago as 1955.



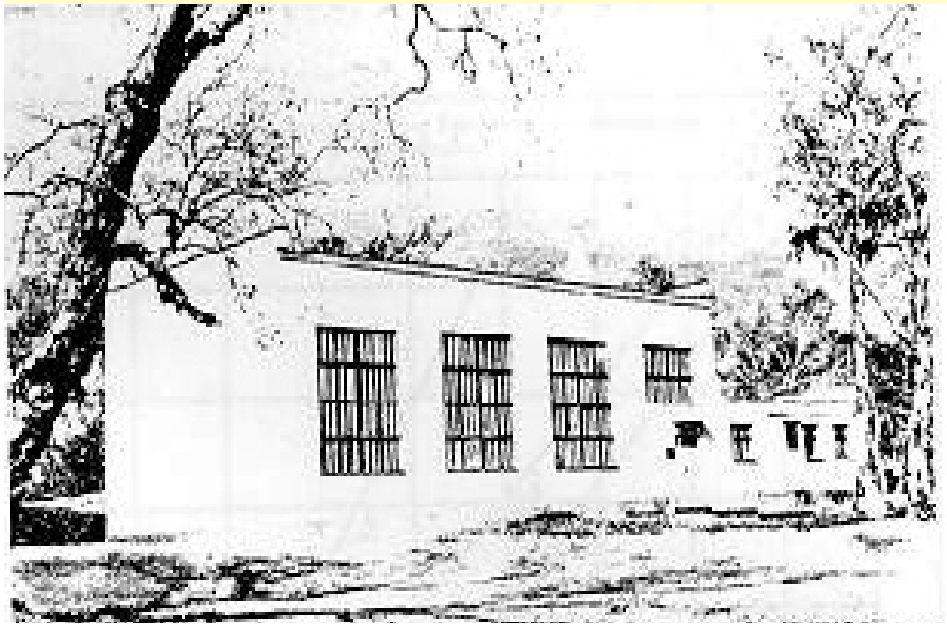


Paratunskaya Binary Cycle Geothermal Power Plant

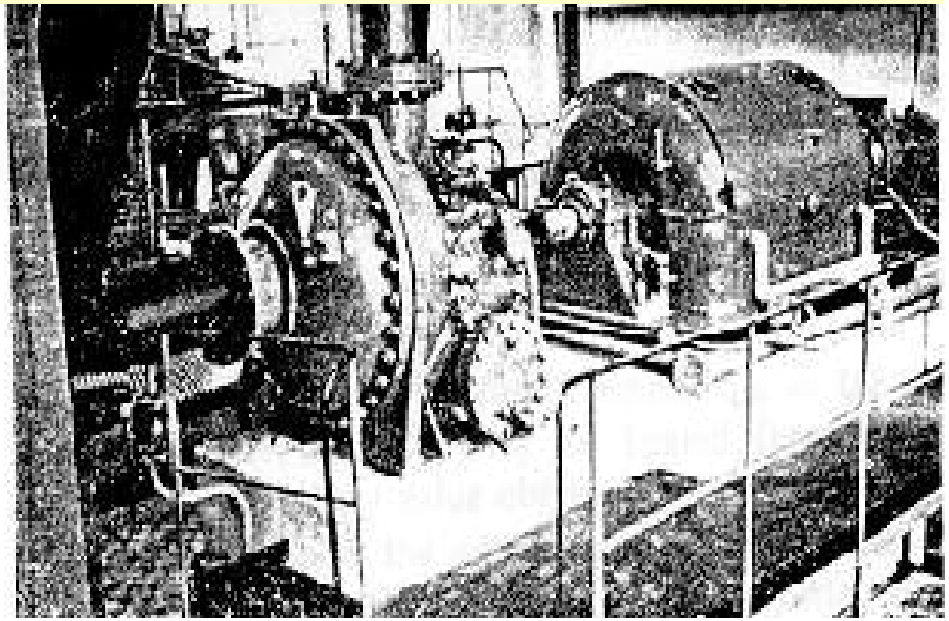
The First World Binary Cycle Geothermal Power Plant was put into operation in Kamchatka, Russia (USSR) in 1967. It was a large-scale research achievement in generating electricity from hot water with the temperature over 85 ^{0}C.

(ref. Kutateladze S.S., Rosenfeld L.M. License № 94151724-6 February 3.)

For many years systematic research works of thermodynamic properties of organic low-boiling working fluids have been carrying out in Russia.

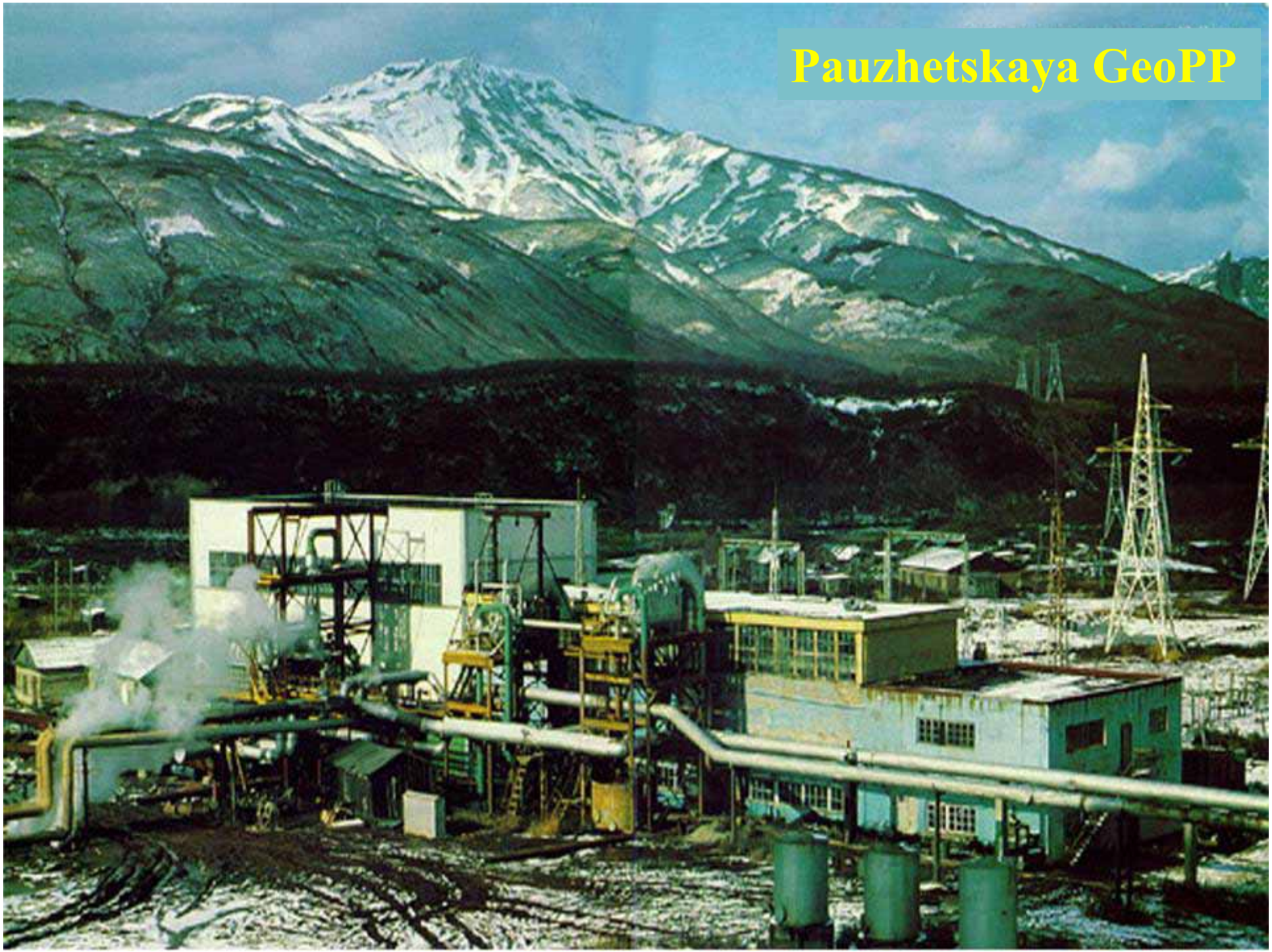


General view of Paratunkskaya Binary Cycle GeoPP



Turbo-generator (turbine building)

Nowadays it is planned to construct about 200 Binary Cycle Geothermal Power Plants with different capacities in Russia.


Pauzhetskaya GeoPP

2.0 MW GeoPP (Kunashir Island)

Environmentally friendly Verkhne-Mutnovsky GeoPP (commissioned in 1999)

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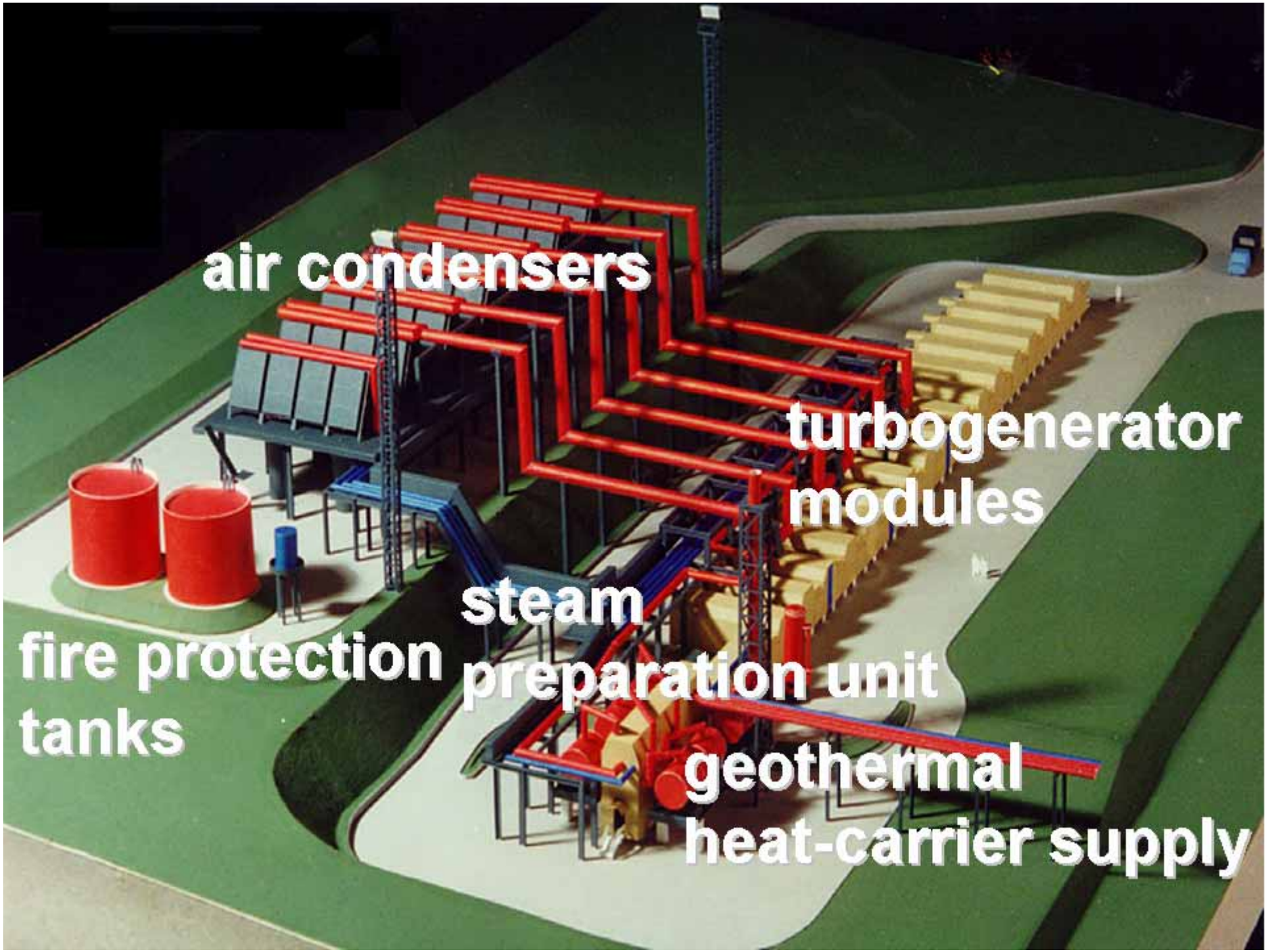
WP5, Engine Project
Strasbourg, France, 13-16 September, 2006


Verkhne-Mutnovskaya GeoPP 12 MWe
the first
environmentally friendly
power plant
in the World


air condensers
turbogenerator modules
steam preparation unit
fire protection tanks
geothermal heat-carrier supply





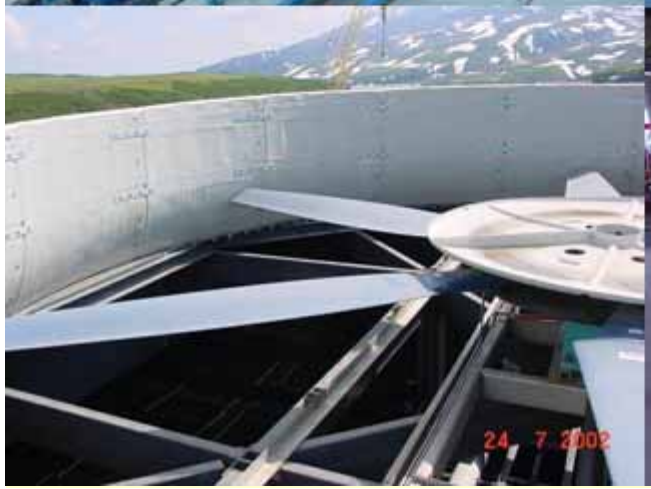




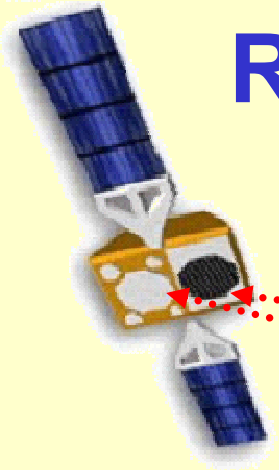
Mutnovsky GeoPP 50 MWe
Remote management system
High heat-economy figures
High automation level
Severe environmental conditions
Unique equipment


12 10 2002


15 10 2002


24 7 2002

Remote Monitoring System



Nauka SC
Control Center

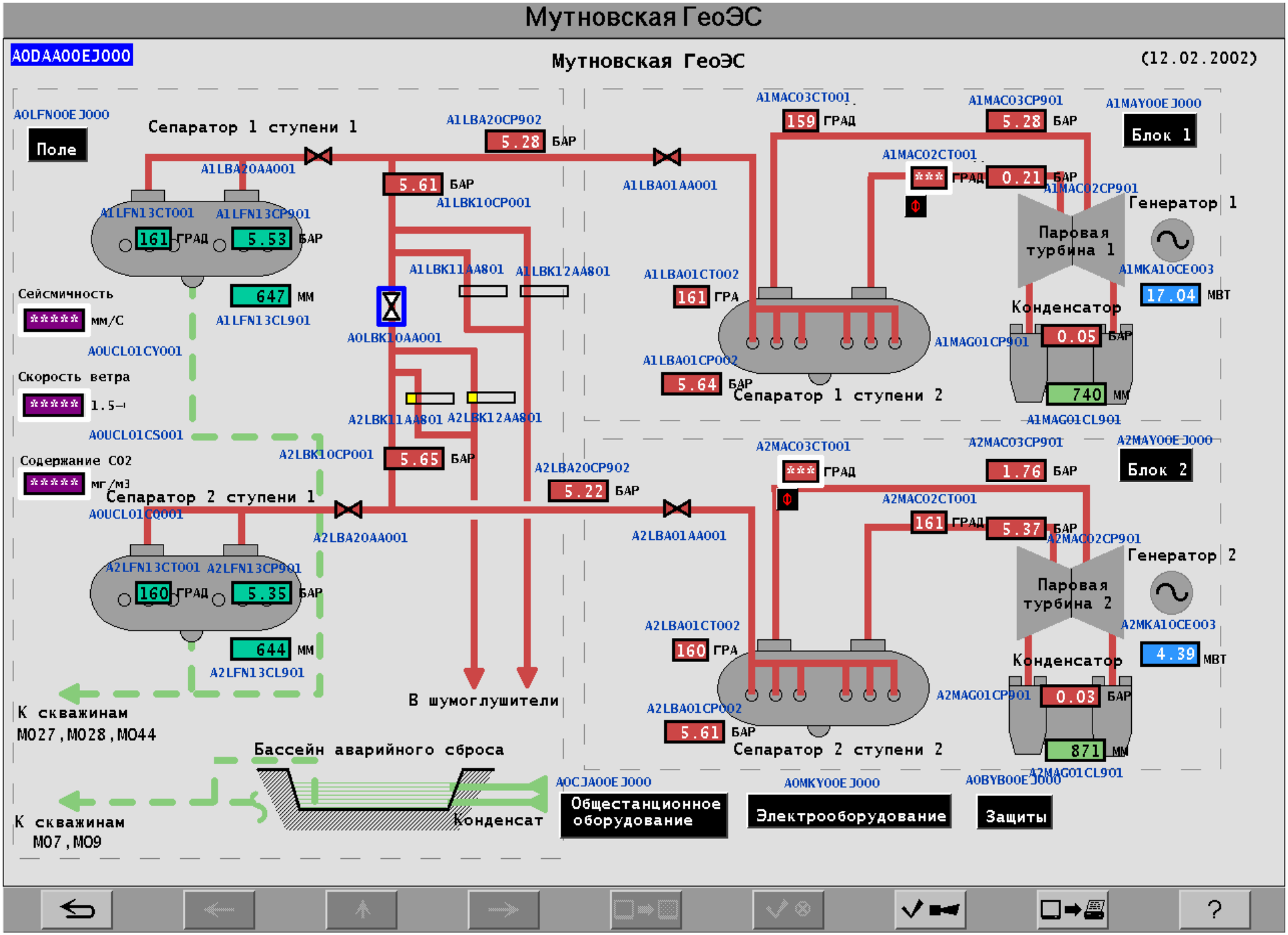
НАУКА
NAUKA

Mutnovsky Geo PP
Distributed Control System
manufactured by **Siemens**
(TPE)

Control Center of RAO UES of Russia

MPEI CTP Siemens

FS UE MPEI's Design Office


Мутновская ГеоЭС
A0DAA00EJ000
Мутновская ГеоЭС
(12.02.2002)
A0LFN00EJ000
Поле
Сепаратор 1 ступени 1
A1LBA20CP902
5.28 БАР
A1LBA20AA001
5.61 БАР
A1LBK10CP001
A1LBA01AA001
A1LFN13CT001
A1LFN13CP901
161 ГРАД
5.53 БАР
647 мм
A1LFN13CL901
A1LBK11AA801
A1LBK12AA801
A0LBK10AA001
Сейсмичность
***** мм/с
A0UCL01CY001
Скорость ветра
***** 1.5
A0UCL01CS001
Содержание CO2
***** мг/м3
A2LBK11AA801
A2LBK12AA801
A2LBK10CP001
5.65 БАР
A2LBA20CP902
5.22 БАР
Сепаратор 2 ступени 1
A0UCL01CQ001
A2LBA20AA001
A2LBA01AA001
A2LFN13CT001
A2LFN13CP901
160 ГРАД
5.35 БАР
644 мм
A2LFN13CL901
К скважинам
M027,M028,M044
В шумоглушители
Бассейн аварийного сброса
Конденсат
К скважинам
M07,M09
A1MAC03CT001
159 ГРАД
A1MAC03CP901
5.28 БАР
A1MAY00EJ000
Блок 1
A1MAC02CT001
*** ГРАД
0.21 БАР
A1MAC02CP901
Генератор 1
Паровая турбина 1
A1MKA10CE003
17.04 МВТ
Конденсатор
A1MAG01CP901
0.05 БАР
740 мм
A1MAG01CL901
A1LBA01CT002
161 ГРА
A1LBA01CP002
5.64 БАР
Сепаратор 1 ступени 2
A2MAC03CT001
*** ГРАД
A2MAC03CP901
1.76 БАР
A2MAY00EJ000
Блок 2
A2MAC02CT001
161 ГРАД
5.37 БАР
A2MAC02CP901
Генератор 2
Паровая турбина 2
A2MKA10CE003
4.39 МВТ
Конденсатор
A2MAG01CP901
0.03 БАР
871 мм
A2MAG01CL901
A2LBA01CT002
160 ГРА
A2LBA01CP002
5.61 БАР
Сепаратор 2 ступени 2
A0CJA00EJ000
Общестанционное оборудование
A0MKY00EJ000
Электрооборудование
A0BYB00EJ000
Защиты

BINARY POWER PLANT

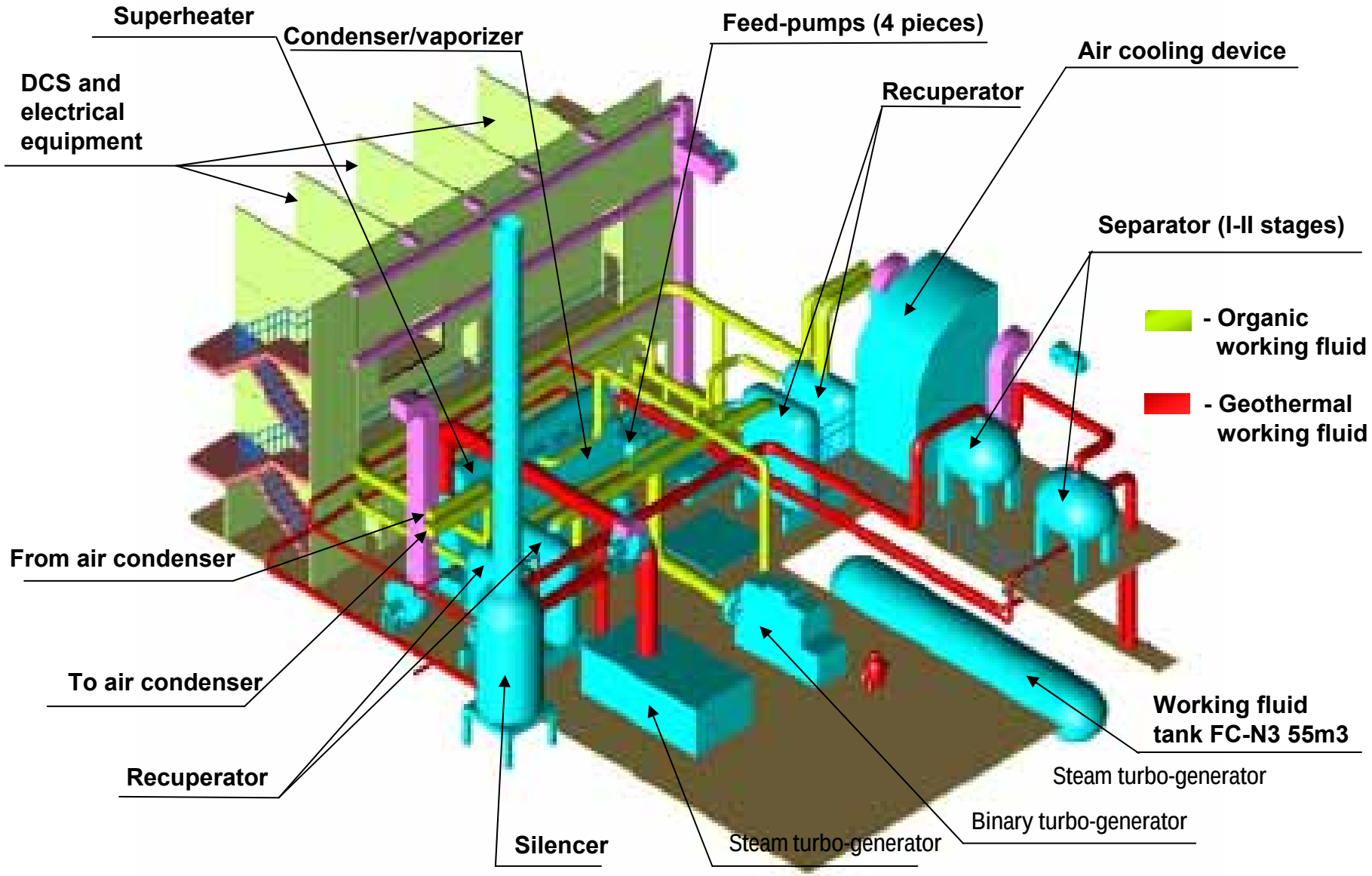
NAUKA SC

Unmanned operation

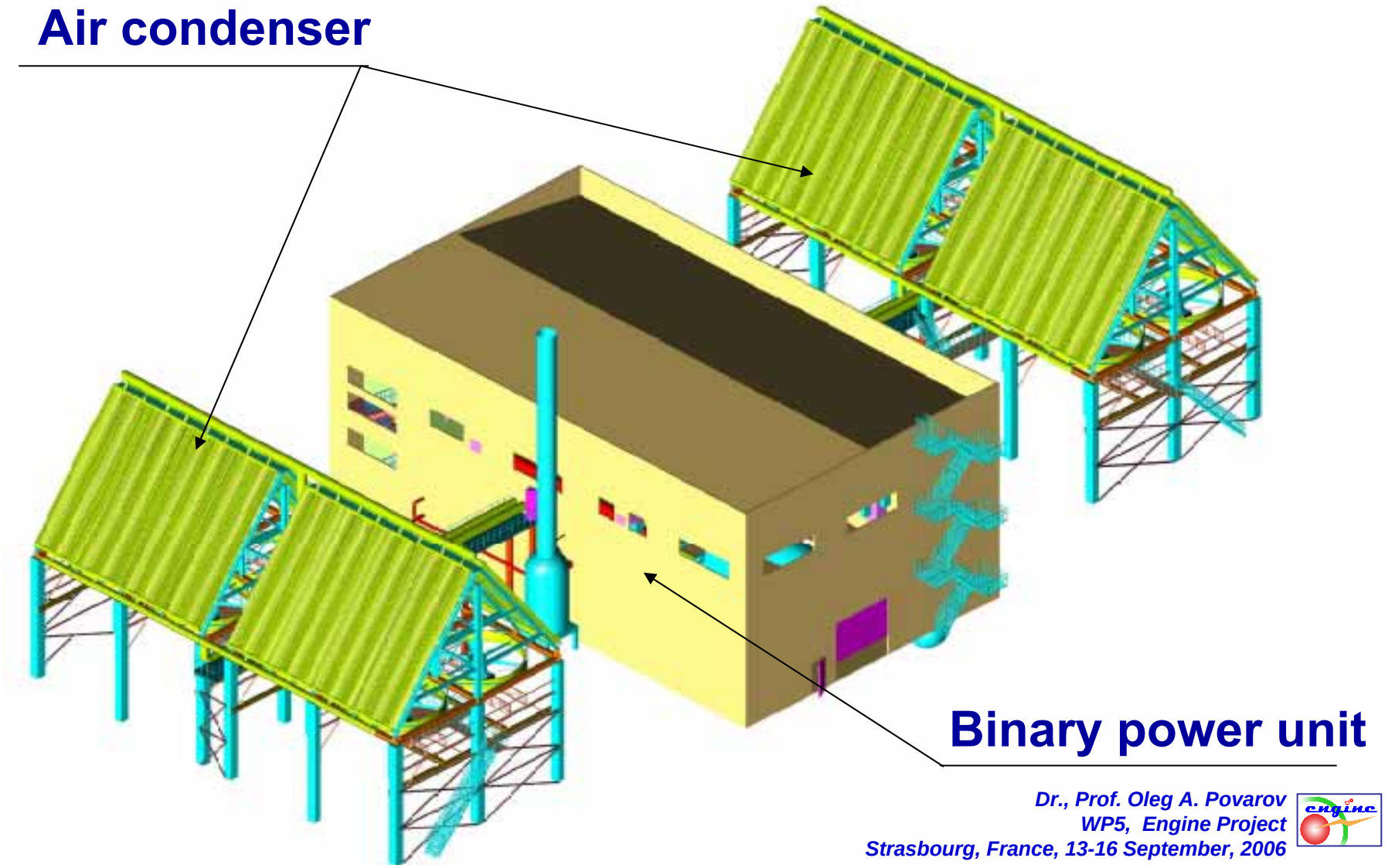
High efficiency

Environmentally friendly

Binary power unit of Vekhne-Mytnovskaya GeoPP



Binary Power Unit of Vekhne-Mytnovskaya GeoPP



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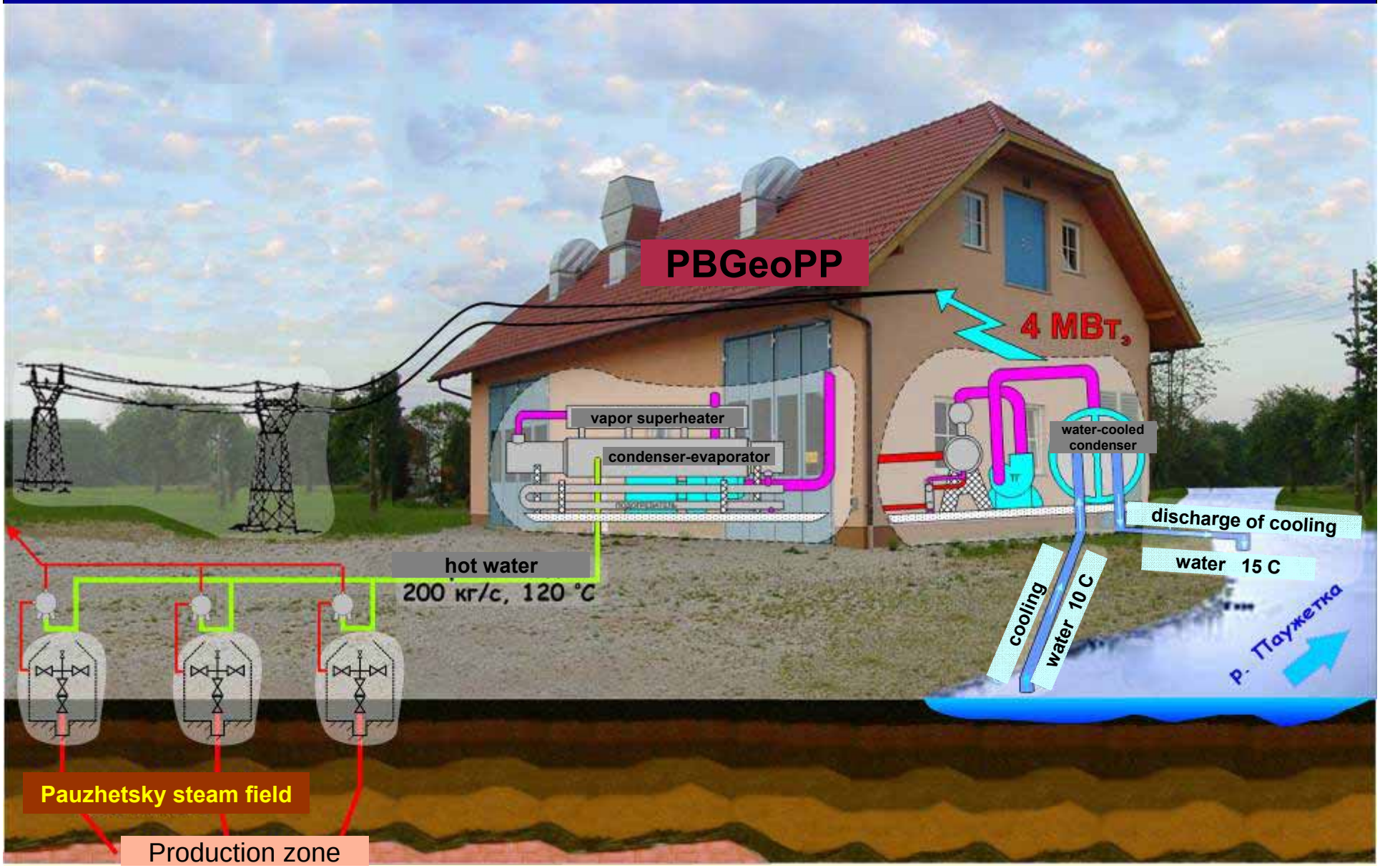
Strasbourg, France, 13-16 September, 2006

Pauzhetsky Binary Cycle GeoPP (PBGeoPP)

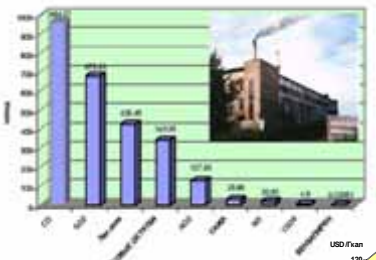


KAMCHATKA. FULL HEAT AND POWER SUPPLY OF ELIZOVO REGION FROM GEOTHERMAL RESOURCES

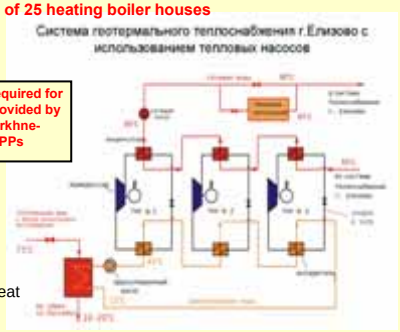
PTOJECT GOALS:

1. CONSTRUCT ADVANCED DISTRICT HEATING AND POWER SUPPLY SYSTEM FOR ELIZOVO REGION THROUGH UTILIZATION OF LOCAL GEOTHERMAL RESOURCES
2. IMPROVE THE ECOLOGICAL SITUATION BY REDUCING USE OF FOSSIL FUEL BY 132,2 THOUS. T/YEAR
3. DEVELOP THE REGION INFRASTRUCTURE BY CONSTRUCTING:
   - GREENHOUSES OPERATING ON THERMAL WATER TO GROW VEGETABLES, FRUITS AND FLOWERS
   - HOTEL NEAR THE AIRPORT "ELIZOVO" WITH SAUNAS, THERMAL SWIMMING POOLS AND AQUAPARK
   - SEVERAL SWIMMING POOLS WITH THERMAL WATER

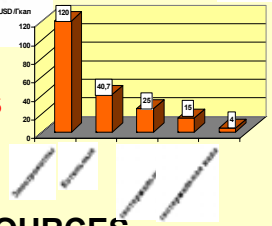
Annually Elizovo purchases coal for the amount of USD 15 mln to support operation of 25 heating boiler houses



40 MW of electricity required for heat pumps will be provided by Mutnovsky and Verkhne-Mutnovsky GeoPPs



Cost of 1 Gkal of heat In Kamchatka



Annually 25 heating boiler houses emit into the atmosphere of Elizovo over 2.5 thous. t of noxious gases and 300 thous. t of CO_2

STRATEGY FOR THE PROJECT IMPLEMENTATION:

Preparation of the business plan.

Preparation of the Feasibility Study.

Receiving investments, loans and other financial support of the Project.

Holding tenders and signing contracts.

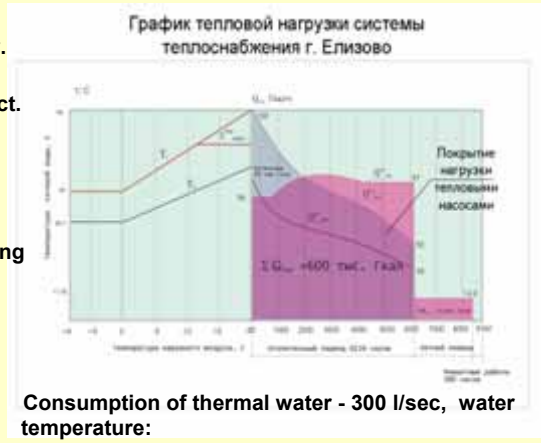
Executing drilling and construction works.

Commissioning of the district heating.

PROJECT INCLUDES:

1. Pilot Project for the Elizovo State Hospital reconstruction
2. Pilot Project for reconstruction of the district heating system of Ketkino settlement
3. Construction of the heating delivery pipe from Verkhne-Paratunsky field to Elizovo city
4. Reconstruction of main heat networks in Elizovo
5. Construction of heat pump plants (HPP) and advanced automated heat points
6. Construction of balneological swimming pools, advanced green houses, industrial facilities and building industry facilities, utilizing geothermal resources
7. Drilling works and geothermal wells set up

Geothermal resources will cover 92% of heat demand of Elizovo



Consumption of thermal water - 300 l/sec, water temperature:

- at HPI inlet - 75° C
- at HPI outlet - 10 – 20° C
- at heat network inlet - 80° C.

GEOTHERMAL RESOURCES OF ELIZOVO REGION:

Geothermal fields:

MUTNOVSKY – almost 300 MW(e)

PARATUNSKY AND VERKHNE-PARATUNSKY– water (t = 70-90^{0}C, Q=46600 m3/day)

KETKINSKY – water (t = 45-69^0 C, Q = 3509 m3/day)

OTHERS….

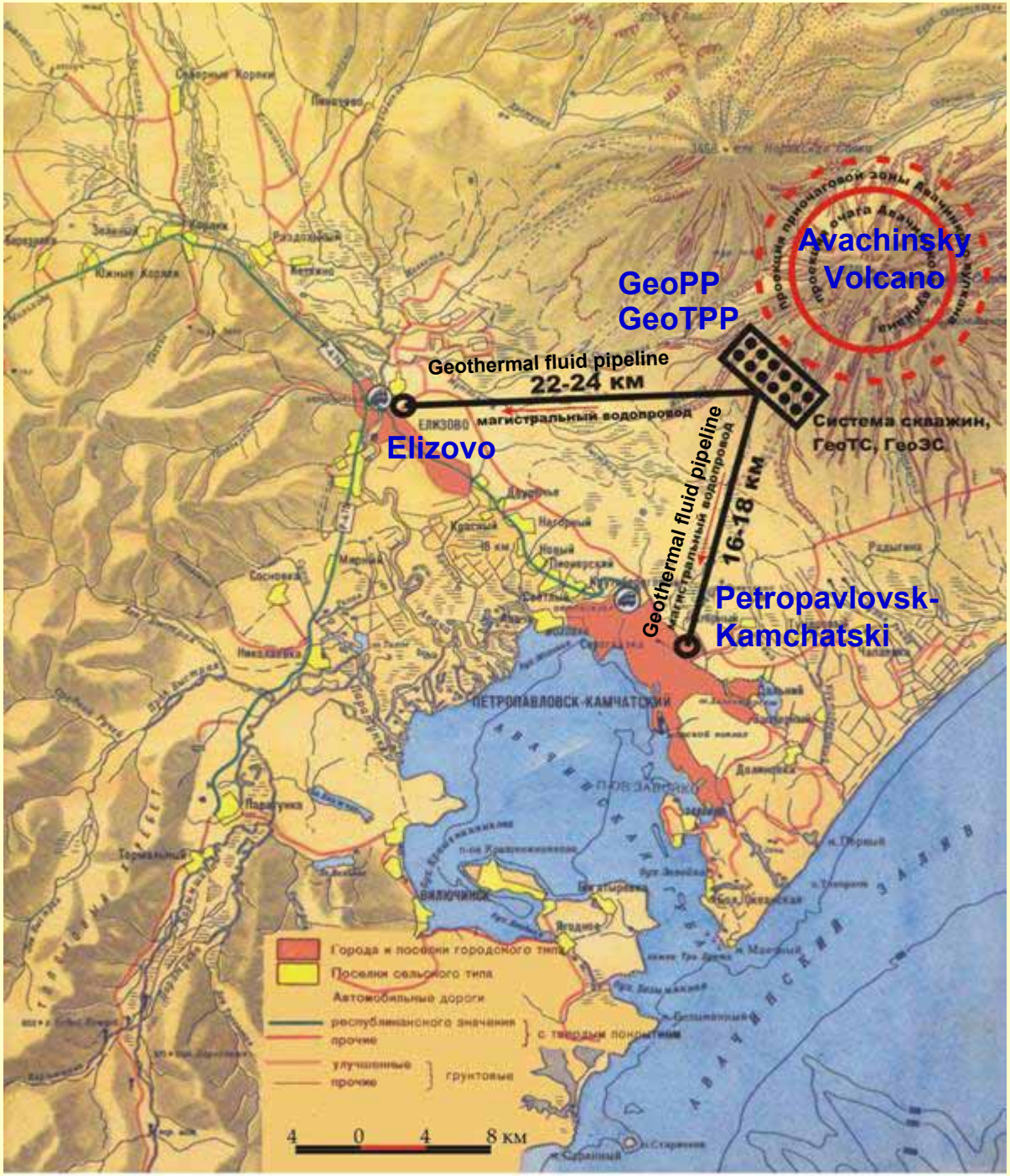
THERE ARE ALSO FIELDS OF THERMAL WATER, WHICH ARE LOCATED ON THE TERRITORY ADJACENT TO THE CITY AS WELL AS ON THE TERRITORY OF THE CITY, AND WHICH RESOURCES CAN BE USED LOCALLY

PROJECT KEY FIGURES:

Project Cost	-	USD 50 mln
Pilot Projects Cost	-	USD 5 mln
Cost of the Feasibility Study	-	USD 0,8 mln
Period of implementation	-	33 months
Payback Period	-	5 years

Reduction of 1 Gkal heat cost in 2-3 times

This Project is included into the FEDERAL TARGET PROGRAMME «Energy Efficient Economy» for 2002-2005 and further until 2010



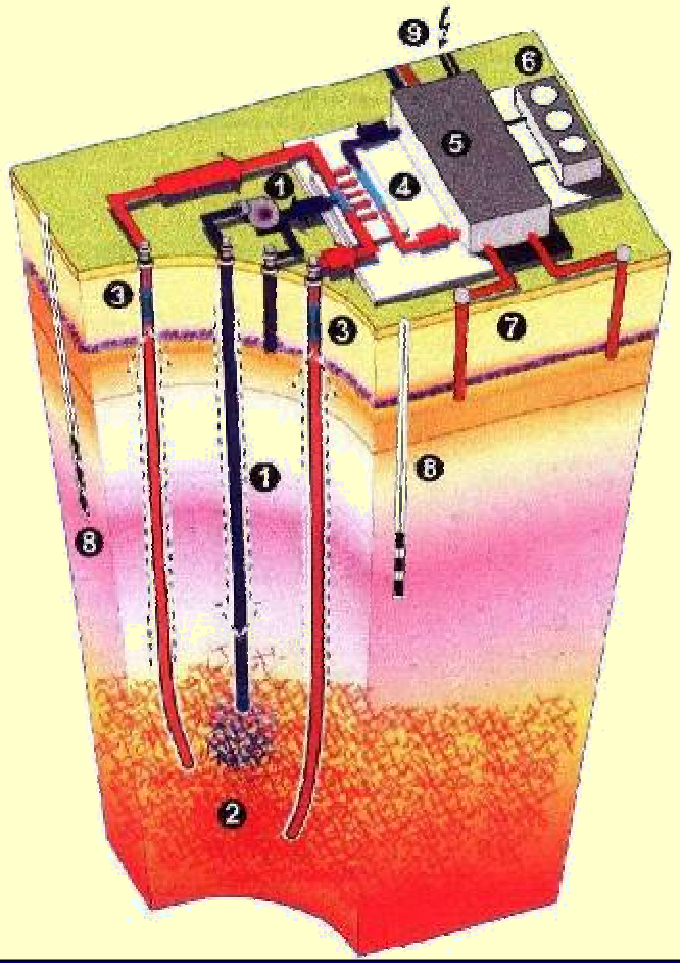
District Heating System of Petropavlovsk-Kamchatski City operating on HDR Technology

Dr., Prof. Oleg A. Povarov
WP5, Engine Project
Strasbourg, France, 13-16 September, 2006

Avachinsky Volcano in Kamchatka

Avachinsky volcano eruptions are hazardous for 250,000 population of Petropavlovsk-Kamchatski City (Russia) located 25 km away from it. The Cone of the volcano was formed 3500 years ago and has erupted 15 times since 1737 with an average mass rate estimated at 150 kg/s. Last events include lava plug overlay of 300 m in diameter and 200 m deep crater of the Avachinsky volcano Cone (1991), fracturing and steam explosion in the lava plug associated with earthquakes swarm (2001).

Hot Dry Rock Technology



1. Injection Drill Hole and Injection Pumps
2. Stimulated Joint System
3. Production Drill Holes
4. Heat Exchanger
5. Turbines and Generators
6. Cooling Cycle
7. High Temperature Underground Storage
8. Seismic Monitoring Drill Holes
9. Consumers of Electricity and Heat

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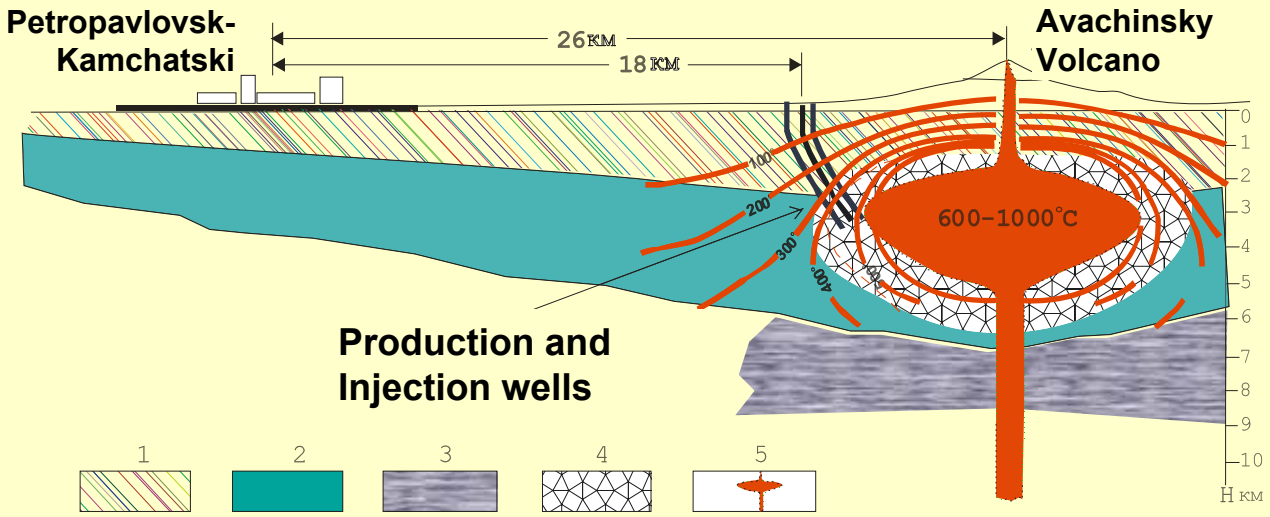
WP5, Engine Project
Strasbourg, France, 13-16 September, 2006

Construction of the Geothermal Heat and Electricity Supply System of Petropavlovsk-Kamchatski City – Major International Project



- The population of Petropavlovsk-Kamchatski City is 250,000 people, the city is located 20 km away from GeoPP proposed site (near Avachinsky volcano)
- Avachinsky magma chamber (MC) is 1500 m above the sea level, ~ 1000 m in diameter, with temperature in the chamber reaching 1000 ^{0}C
- 400-600 MW(e) GeoPP and 500 MW(th) GeoPP could be constructed in the vicinity of MC using HDR technology
- Avachinsky MC will allow covering all heat and electricity demands of Petropavlovsk-Kamchatski City
- This Project could be a promising and viable international project

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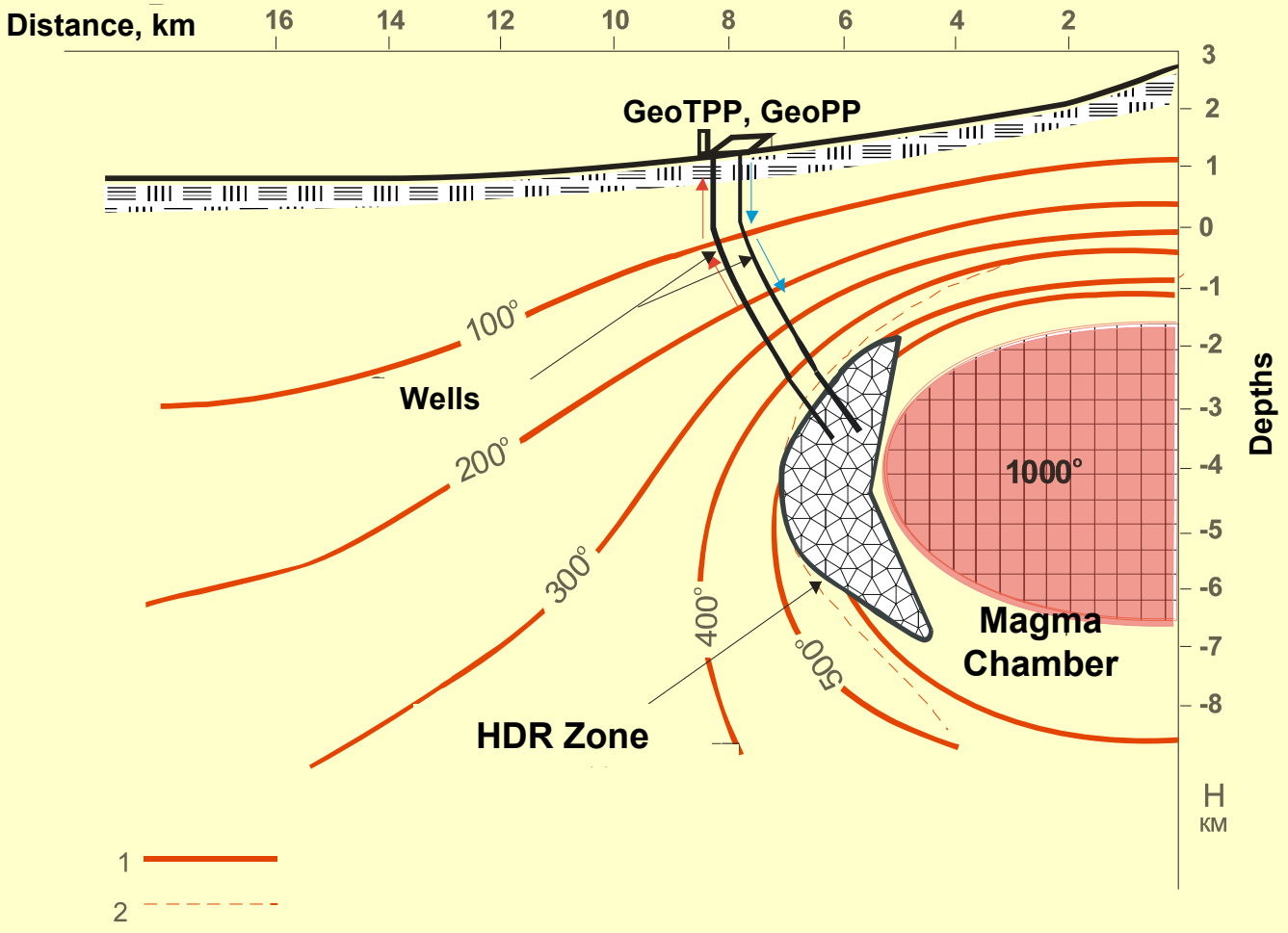
WP5, Engine Project
Strasbourg, France, 13-16 September, 2006

Temperature Distribution at Various Depths around the Avachinsky Magma Chamber



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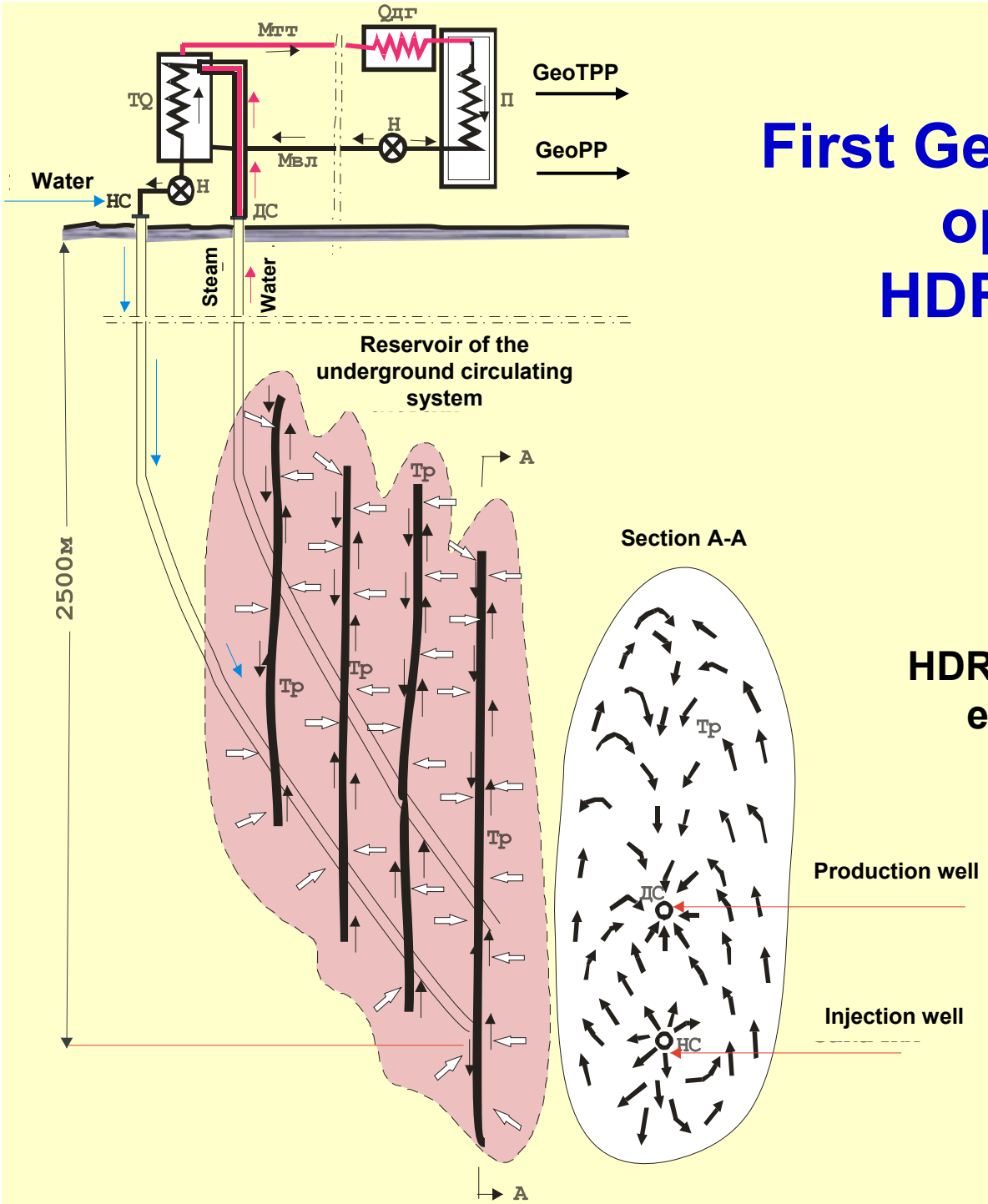

First Geothermal System operating on HDR Technology

USSR, 1973-1985

HDR utilization for heat and electricity production

Dr., Prof. Oleg A. Povarov
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Strasbourg, France, 13-16 September, 2006

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E-mail: povarov@geotherm.ru