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RE-EVALUATION OF THE DEVELOPMENT STRATEGY OF THE INTEGRATED GEOTHERMAL PROJECT "KOTCHANY" - MACEDONIA

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ABSTRACT

After about 17 years of exploitation, the integrated geother-mal project "Kotchany" showed all the positive and negative aspects of its initial development strategy, either from the technical/technological or the economical point of view. In combination with the requests of new state economy sur-rounding which dictates organizational reorganization, that conditions re-evaluation of the project development strategy.

Problems to be resolved can be summarized in:

- *Need for a new approach to the reservoir engineering*. Im-proving the elasticity of the system by the introduction of new exploitation well(s), reinjection of the effluent water and its treatment before reinjection;
- *Need for gradual change of the composition of heat consu-mers* in order to improve the total annual heat loading factor and, in that way, the economy of the system exploitation; and
- *Need fo rintroducing of a new pricing system* with more significant stimulation of the better use of the temperature difference on disposal.

Results of recent analysis are presented in the paper and re-commendations for the elements of a new strategy for deve-lopment of the Kotchany integrated geothermal system du-ring the period of next ten years.

1. DEVELOPMENT OF THE KOTCHANY INTEGRATED GEOTHERMAL PROJECT

Kotchany integrated project is the second biggest one (after the project in Gevgelia) in Macedonia. Its development began in 1980, after the exploitation borehole EBMP-1 has been completed. Its maximal capacity of 150 l/s (100 l/s for conti-nual use) offered possibilities to resolve the bad energy situ-ation of the neighbouring greenhouse complex "Kotchansko pole" of 12 ha (36 MW design heat power), under the influ-ence of the "world energy crisis" during that period. With very minor modifications of the heating systems (originally designed for temperature regime of 110/70 °C) and construc-tion of a 3 km long connection pipe-line (all done in one year time), problems were practically resolved. Existing boilers have been used for covering the peak heat demands during the first season, but immediately has been found that "it was not necessary". By the use of a stronger thermal water flow through the heating systems, it was possible to use only the upper part of the temperature difference on disposal and to keep the internal air temperatures rather satisfactory.

However, such a "good situation" lasted very short time. Neighbouring agricultural combine "Mosha Pijade" decided to built a new greenhouse complex of 6 ha (15 MW design heat power), expecting also that all the heat demand shall be covered only with geothermal energy. As result of such an approach, the initial artesian pressure of 6.5 bars dropped to 0 during the first year of joint exploitation due to the high demand of thermal water by the growers. The well in Banja, feed by the same geothermal field, ran dry and the existing balneological use has to be stopped. That provided the first practical lesson for the joint use of geothermal energy. The following season a contract between the users has been signed in order to regulate the division of available water flow. "Mosha Pijade" adapted its greenhouse production program in such a way that the heat demand could be covered by 40% of the available thermal water flow, and "Kotchansko pole" adopted technical solution of the heating systems in order to enable covering of the peak heat demands by the existing boiler plant. 60% of the available thermal flow covers about 90% of the total heat consumption for an average climatic year. In 1983 also a rice drying plant of 1,36 MW has been connected to the geothermal system, enabling improvement of its annual heat loading characteristic.

The last successful borehole of 450-600 l/s, opened the way for geothermal energy introduction also in the other life sec-tors of the Kotchany valley (industry, public buildings, dwel-lings, etc.). However, the project development has been going slowly due to

the continious difficult economy situation in the country and it was practically stopped during the last six-seven years.

2. PROBLEMS

Development process of the Kotchany integrated geothermal system has been escorted with problems of different nature, such as are:

2.1. Reservoir behavior

Maximal possible flow rate of 600 l/s is far of the real renewal capacity of the reservoir. Interdependence between the flow and period of discharge has been found very early (Popovski, 1982), however intensive emptying of it follows until now. It is possible to follow a constant decrease of the water level of the reservoir (Naunov, 1997).

2.2. Submerged pumps

Temperature of the thermal water of 78 °C is to high for the known types of submerged pumps. Technical team for maintenance of the system has continual troubles with the changes and repair of the pumps in exploitation.

One of the very important experiences of the exploitation during the period of more than 10 years is that not only the reserve pumps are necessary for secure exploitation, but also reserve wells.

2.3. Heating systems

The main problem with the heating systems connected to the geothermal one is that all of them have been previously designed for the use of heat produced by light or heavy oil boilers. Design temperature regime for the greenhouses has been 110/70 °C, and for the others 90/70 °C. Introduction of larger heat exchange surfaces resolved the problem only partially. It enabled to keep requested temperatures of most of the heated rooms but temperature of the effluent water is normally over 35-40 °C (in some cases even over 45 °C), and results with over pumping of the geothermal resource during the colder months of the year.

2.4. Energy price

It is one of the most difficult problems during all the years of the system exploitation. Users are under the pressure of the opinion that geothermal energy is a "free of charge" public energy source and that they should not pay for its use (except probably some small amount for the distribution and maintenance costs).

The problem has also another negative side; the intention to use only the upper part of the temperature difference on disposal in order to save investment costs for the heating installation completion.

2.5. Legislative aspects

Properly not defined "ownership" of the geothermal water resource continuously creates problems in the work of the system. Even nearly 90% of the exploration and development costs have been covered by the state, initial users (Combines "Kotchansko pole" and "Mosha Pijade") intend to have some particular rights (read: to have the energy free of charge) because they have been organizers of the initial development. Town gave the rights for exploitation to the publically owned communal organization "Vodovod" (water management in the town of Kotchany) which has no particular interest for "additional" problems in work.

2.6. Environmental impact

Thermal water is potable, i.e. without high mineralization and content of harmful minerals. However, high temperature of the effluent water from the greenhouses disturbs the balance of the fauna and flora life conditions in the river. Up to now, this problem is completely neglected by the geothermal energy users.

2.7. Development strategy

Initially, development of the geothermal system began with-out a defined development strategy. The main problem has been to complete the thermal water pumping stations and dis-tribution systems to the main heat users (geothermal green-houses) and to the town. Practically, no real attention has been paid to the development of the energy market and com-position of convenient heat users in order to improve the very low annual efficiency of the geothermal energy source use.

Later on, some kind of rough strategy has been introduced, consisting the following main elements:

- Concentration towards proper completion of the source in a as shorter as possible period (drilling and completion of several new exploitation boreholes at different locations of the geothermal field and their connection to the central pumping station);
- Collection of the effluent water and its pumping back to the geothermal reservoir (reinjection);
- Connection of new energy users in the town.

Unfortunately, the strategy has not been supported with the necessary technical/technological and economy feasibility studies, concrete plans for actions with defined sources of

investment funds, planned terms of performance, etc. In that way, it has always been more a list of "wishes" than a real strategy.

3. SOLUTIONS

3.1. Reservoir engineering

Initial negative experiences led to a quick reaction of the geo-thermal energy users. Taking into account the character of the annual heat loading of the connected greenhouses, it was easy to conclude that the maximal loadings during the winter months should be limited to certain defined loadings, in cor-relation to the necessary time for the reservoir recovering. However, reached results have been of a questionable value. First of all, the initial artesian pressure is definitively lost and, secondly, the reservoir behavior is changed. That is the reason why the first reinjection borehole has been realized, but it is far from enough to reach a real "management" of the reservoir. It is necessary to try to collect all the effluent water of the system and to reinject it back to the reservoir.

This is the most important question to be resolved during the coming years of the system development.

3.2. Submerged pumps

Reserve pumps have been purchased and the existing repai-red. However, it is not enough. More "reserve" wells should be completed in order to ensure proper continual and elastic supply of the system.

3.3. Heating systems

Design of heating systems for the new geothermal energy users is put under control and defined temperature parameters of the effluent water can be reached in that way. However, the problem of the biggest users (greenhouses) is still not resol-ved. A complete reconstruction of their heating systems is necessary (Popovski, 1989) and addition of new very low temperature users (aquaculture, soil heatings, etc.) in order to reach designed temperatures of the effluent water and to enable connection of new users.

3.4. Energy price

A new state regulation was reached in 1999: The energy of geothermal origin has certain value and price which should be covered by the users. It is composed of the costs of exploration and investigation, project development and sys-tem exploitation and maintenance. It is conditioned that the price should be not lower than 40% or higher than 60% of the heat unit of a heavy oil origin. In order to ensure a proper use of the temperature difference on disposal, used energy should not be calculated in energy units but in cubic meters of the
used thermal water.

3.5. Legislative aspects

The right for work with geothermal energy of the whole geothermal field "Kotchany" (concession) was given to a public firm under state control. That enabled definition of the technical and economic regulations for using the heat of the integrated system "Geoterma" and opened possibilities to ensure proper technical solutions of connected heating installations and regulation of the heat supply.

However, the choice of such a firm became questionable under the influence of new economy conditions in the country. That is a communal organization principally orientated towards covering the town water, canalization, streets etc. manage-ment. That is a very complex problematics and, therefore, there was no particular interest for development of a new complica-ted "side" activity, which needs people of other qualificati-ons and manages with much higher finances than the "basic" ones. That resulted with some kind of unproper management of the funds for system development, granted by the state or earned with its exploitation. Concentration of the efforts in the firm has been regularly orientated towards the communal problems, which is very normal if taking into account their nature and importance for the quality of the life in the town.

Political balance in the town still doesn't offer possibilities for reorganization of the property status of the integrated geothermal system. However, the process is already started in similar organizations in the country (it is obvious that it is the oiliest feasible and justified solution in the new economy surrounding) and shall come to this system, too.

3.6. Environmental impact

As already said, no attention has been paid to this problem up to now. However, a pressure of the "greens" can be expected very soon and some serious measures have been taken.

Necessary technical measures for new users are already incor-porated through the introduction of the technical regulations for connecting to the system. However, it is not enough and doesn't comprise the old users. Onliest real solution is development of the planned reinjection system, comprising collection of all the effluent waters and their return into the geothermal reservoir. Unfortunately, necessary investment costs are very high and a longer period of realization can be expected.

4. DISCUSSION

Even the problems of exploitation and further development are located and possible solutions defined, it is necessary to underline that the most important question for the system survival and development lies somewhere out of them. That is the problem how to reach a technically feasible and economically justified annual heat loading factor of the integrated system. The use of the installed heat power of the present users is with a very unregular distribution over the year. High investment costs in long pipe-lines and voluminous heating systems should be repayed with a full use only during the three winter months and a partial one during the other three-four.

The solution is located long years ago (Popovski, 1985). It is a combination of known possibilities, such as are the intro-duction of cascades everywhere where possible, covering the peak loadings with heavy oil boilers and maximal introduc-tion of heat users with different annual heat loading charac-teristics. Particularly important is the last one. Example of the rice drying unit excellently showed the most economical way for enlarging the system and improving the heat loading factor. Heat for drying is necessary only in October and par-tially in November, when greenhouses practically doesn't need it. In that way, it is possible to use their connection pipe-lines for the new users without additional investments.

Task for the near future is to improve the present annual heat loading factor of about 0.35 to 0.60 (based on the maximal allowed continual geothermal water flow of 170 l/s) with a better heat consumption distribution over the year (Fig.2). That should decrease the price of the used heat unit for about 60% and should prevent the geothermal reservoir of winter consumption "strikes", i.e. short time lasting overpump-ings, resulting with sudden water level decrease.

5. REDEFINITION OF THE DEVELOPMENT STRATEGY

Listed foundlings of the investigations and definition of possible solutions optimally accommodated to the character-istics of the geothermal reservoir, possible composition of the heat users and limitation of possible negative impact to the environment enables definition of the contures of the fi-nal project composition and resulting development directi-ons. That is practically the base for definition of the frame of a new development strategy.

Without neglecting the interdependence of influencing fac-tors, following levels of importance of consisting activities characterizes the composition of the redefinded development strategy of the system:

First priority: Concentration to quick and basic change of the heat users composition. From the technical point of view, main dificulty of the system exploitation is its 90% depen-dence on the agricultural users with unproperly designed heating systems, connections to the water distribution system and very bad annual heat loading factor characteristics. From the economical point of view, such composition of heat users do not allow to introduce heat prices, consisting collection of funds for development strategy performance.

Second priority: Definition and implementation of the mini-mal technical conditions for connection and use of geother-mal energy from the system. A full control of the water supply should be reached and protection from the short lasting peak loadings. Heat users characterized with very low inertia (greenhouses) should introduce additional devices for covering peak loading demands (boilers, heat accummula-tors, etc.). Each heat user should be equipped with a thermal water flow measuring unit and protection device from overflows. New pricing system consisting stimulation of lower temperature levels use should be implemented and, in that way, reaching improvement of the annual heat loading factor and lowering the maximal thermal water flows.

Third priority: Finalization of the completion of the technical system for proper reservoir engineering and environmental protection. By introducing of a complete collection of the ef-fluent geothermal water and necessary number of reinjection wells , the reservoir shall be protected of overexploitation and environment of the negative impacts of geothermal energy use.

Technical frame for the new development strategy composition can be embraced with the final scheme of the integrated geothermal system (Fig.3). However, due to the economy situation in the country, introduction of the time dimension in the development strategy is not possible in the moment. It shall depend on the definition of the state strategy for recovering and new development of the agricultural sector, definition and financing of measures for "clean" energy resources develop-ment and improvement of the environmental protection.

When taking into account that also the neighbouring countries (Albania, Bulgaria, Serbia, Bosnia and Herzegovina and Romania) are in a very similar and some of them in a more difficult economy situation and that they are the traditi-onal market for the Macedonian agricultural production, it is clear that any positive impact can come only from the EC. And, it should be clear, when agricultural production is in question, it is not a free market and any positive or negative impact depends only on its political and strategical interest for Macedonia and the region.

The pesimistic variant of the strategy previews prolongation of the present political situation during the next 5 years pe-riod (1999-2004) and begining of the positive changes du-ring the second 5 years period (2005-2009). No significant improvement can be reached with that variant during the pe-riod of next ten

years except definition and performance of the reorganizational process, introduction and partial imple-mentation of the minimal technical conditions for the heat users, minimal improvement of the heat users composition by introduction of new heat users from the town district heating system and technical/technological interventions financed by foreign grants.

The "moderate" one previews 3 years prolongation of the present situation (1999-2002), 3-4 years for begining of positive changes (2003-2006) and full stabilization and extensive development after that. This variant previews significant improvements during the period after 2005-2006, when the sys-tem should become able to produce profit for self investing development. A complete change of the technical composition of the existing and 50% new agricultural users should be rea-ched, plus about 50% of the industrial and public uses in the town.

The optimistic variant preview introduction of positive changes from 2000-2003 and full stabilization and extensive development after that. Practically, it contains the full reor-ganization of the existing system and reaching all the goals by its spreading to all the planned new consumers. After the 2003, system should be able for self reproduction and development, plus possibility to produce profit for further in-vestigations and development.

6. CONCLUSION

Development of a big geothermal system is neither easy nor simple problem. It depends on many influencing factors, which are not always of simple technical/technological or economical nature, like it was the case with the Kotchany integrated system. It was a real school, where the Macedo-nian geothermists learned most of the necessary lessons.

The most important result, reached after the 17 years of development, is that the system passed all the Scilae and Haribdae and it is now working more or less profitably. It still keeps "hot" the process of geothermal energy development in the country, i.e. it was and it is the project where the destiniy of the geothermal energy use in the country has been and is determined.

Unfortunately, further destiny of the project is still not certain and depends on non-technical/technological and non-economical factors. It confirmed both, the technical and economical feasibility of low-temperature geothermal energy application and its competitiveness to the other energy sources on disposal in the country. However, if that fact shall give a chance for its full incorporation in the energy balance of the country, it shall depend on the political and economy situation development in the country and surrounding "seismic" region.

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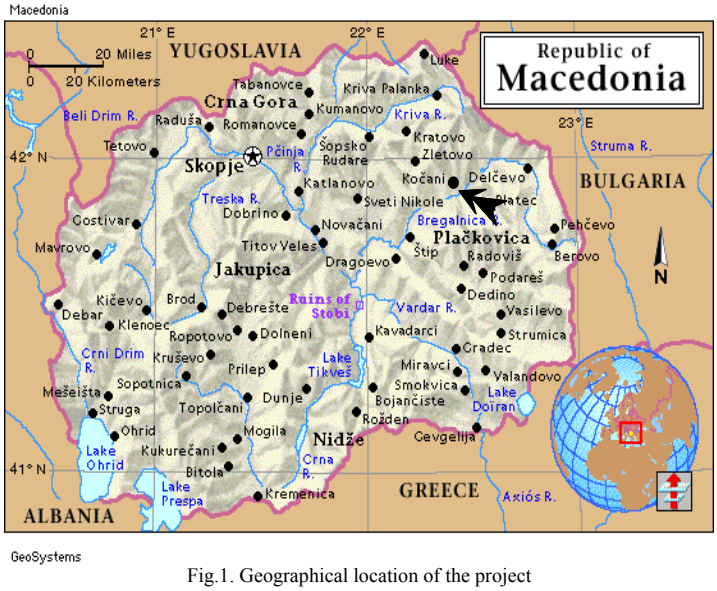


Fig.1. Geographical location of the project

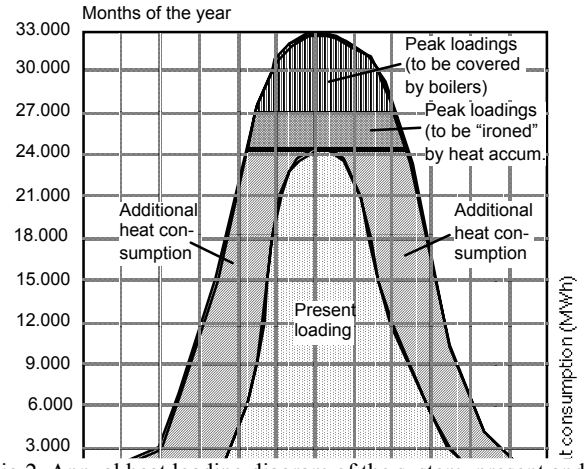
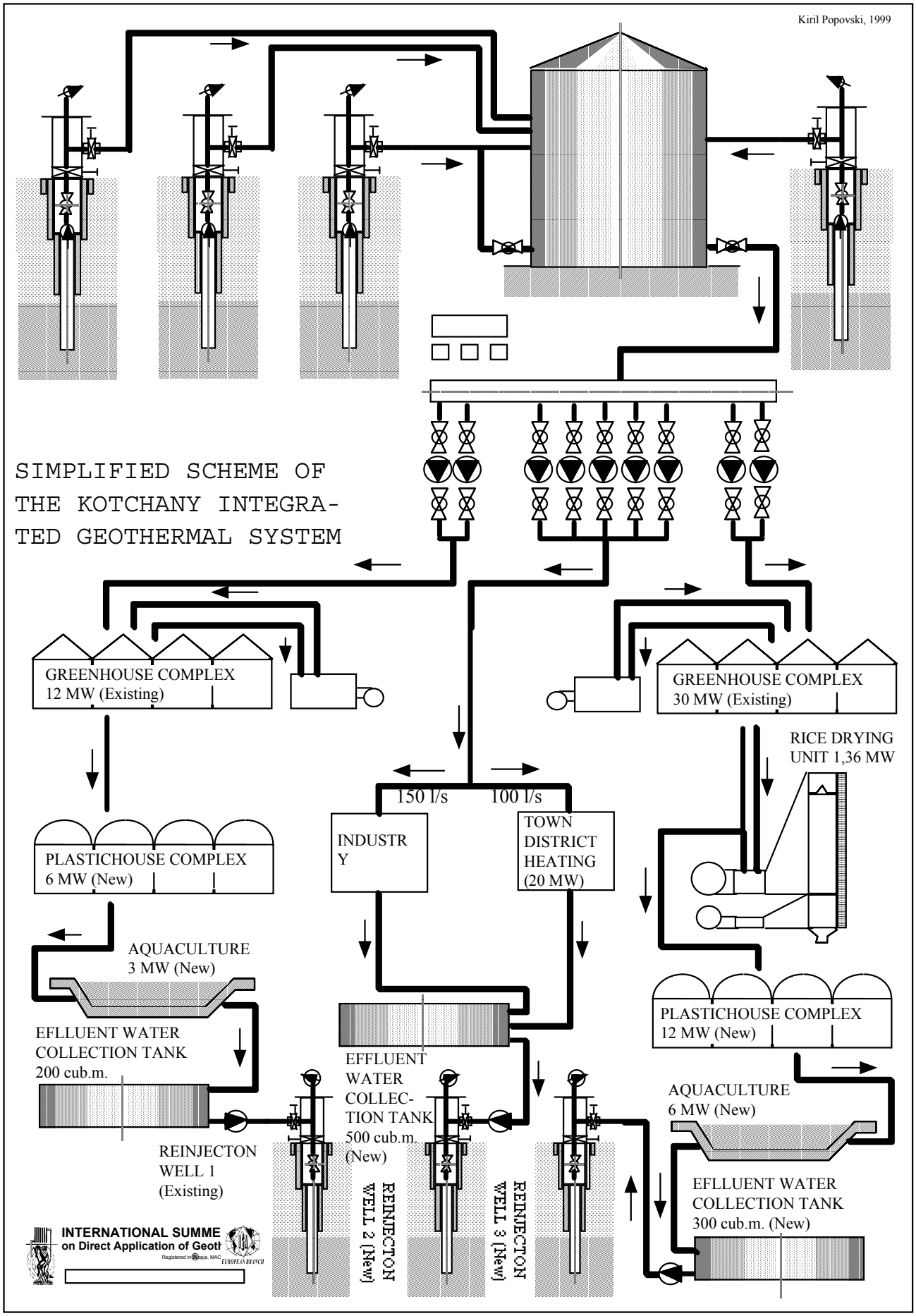


Fig.2. Annual heat loading diagram of the system, present and optimized with incorporation of new consu-mers and measures for covering the peak loadings


Kiril Popovski, 1999
SIMPLIFIED SCHEME OF THE KOTCHANY INTEGRA-TED GEOTHERMAL SYSTEM
GREENHOUSE COMPLEX 12 MW (Existing)
GREENHOUSE COMPLEX 30 MW (Existing)
RICE DRYING UNIT 1,36 MW
150 l/s
100 l/s
INDUSTR Y
TOWN DISTRICT HEATING (20 MW)
PLASTICHOUSE COMPLEX 6 MW (New)
AQUACULTURE 3 MW (New)
EFLLUENT WATER COLLECTION TANK 200 cub.m.
EFFLUENT WATER COLLEC-TION TANK 500 cub.m. (New)
PLASTICHOUSE COMPLEX 12 MW (New)
AQUACULTURE 6 MW (New)
REINJECTON WELL 1 (Existing)
REINJECTON WELL 2 (New)
REINJECTON WELL 3 (New)
EFLLUENT WATER COLLECTION TANK 300 cub.m. (New)
INTERNATIONAL SUMME
on Direct Application of Geoth
EUROPEAN BRANCH