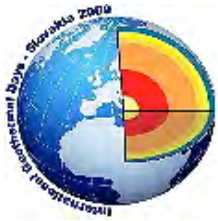

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V.2

GEOTHERMAL FIELD IN DOJRAN, MACEDONIA
Perspective Energy Source for Local Economy Development

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Abstract

New possibilities offered by the recent technological development in RES use and measures, accepted by most European governments, for support of their development, open challenging possibilities for sustainable development of smaller poor rural communities in the Mediterranean region. As illustration, the case of a small region at the South East part of Macedonia is presented, where such an approach allows composition of a specific development strategy based on introduction of geothermal and solar energy, which enables significant independency in energy supply, development of several traditional production sectors (agriculture and food processing plants), introduction of new ones (tourism) and, in that way, full employment and prospective future for inhabitants in an economically feasible way.

INTODUCTION

Probably, the main constraint for quicker development of renewable energies in different life sectors is the approach of possible users to them as to the classical fossil fuels. We are looking for "substitution" of fossil fuels and not for a sustainable incorporation in the local or regional energy balance. If studying carefully the characteristics of all RES, we shall quickly realize that no one of them is "universal" and cannot work on switch on/off system, i.e. to be used in the moment you need it, independently of different influencing factors. Some one are of seasonal character (solar, hydro, wind, etc.); some even daily changeable (solar, wind); if not dependent on the whether season, they are not economical for transportation on longer distances (geothermal energy), etc. Some of them are economically liable for electricity production, some of them partially and some not.

On the other hand, nearly all RES offer a grat advantage in comparison to fossil fuels, they are mostly benign to the human environment and some of them very convenient for use under particular cultural, economic and social conditions.

Recent investigations prove more and more that significant improvement of the development rate can be reached by chanding the approach to incorporation of RES in everyday life and economy in a sustainable way, i.e.

except to look how to substitute fossil fuels use, to create a particular scheme for energy supply by combination of locally on disposal RES with the existing classical energy supply. In other words, to compose strategies of development accommodated to the possibilities of local energy supply but also with the requests of for development the local economy.

First successful results have been reached with development of large geothermal district heating systems (Iceland, France, Italy, etc.), with combinations of solar energy and biomass (Austria, Germany), etc. However, that is always in more developed countries and region, where already developed economic background exists. Intention of this paper is to illustrate that smaller and isolated communities are sometimes more challenging for introduction of such an approach.

1. REGION. ECONOMICAL AND SOCIAL BACKGROUND

Dojran municipality covers an area of 132 km^2 at an altitude of 148 m. Located next to the Dojran Lake, at the Southern tip of Macedonia, near the border with Greece. The lake has area of 43,1 km^2 of which 27,3 km^2 belongs to Macedonia and 25,8 km^2 to Greece. It is the smallest valley type lake in Macedonia with a maximal depth of 10 m. Climate of the Dojran Lake is under strong Mediterranean influence, which makes its water very warm (up to 27ºC during the summer months). Winters are short, however can be quite cold and lake is oftenly frozen. It is an area with vegetation species adapted to reach watering, as are the submerse plants of Myriophillum spicatum and Potamogeton perfoliatus. There are also rich formations of cane in the water near the beaches and some algaes more deep in the lake. Their decay results with high concentration of iodine and some other minerals, giving healing characteristics to the lake's water. Rich Mediterranean vegetation around the lake composes very pleasant landscape, convenient for restful vacations during 8-9 months of the year.

Main economic activities of the population are tourism, agriculture and fishing.

Traditional fishing is very attractive because fishermen are using a very old and specific methodology with help of the local birds. However, the fish fund of the lake became very poor during the recent 20 years due to lowering of the water level and fishing is not any more important activity as used to be before. It is now more a tourist attraction than a serious economy sector. Unfortunately, also tourism is in stagnation during the last 20 years, as consequence of the political and economy transition of the country.

Level of living standard is quite low because traditional agriculture and poor forestry cannot cover the normal living costs of the population. That resulted with intensive emigration during the recent years.

2. POSSIBILITIES FOR DEVELOPMENT

Taking into account the natural resources on disposal, economy and social background, possibilities for development should be looked in:

- Revival of the tourism. Particularly finding possibility to enlarge the tourist season from 1-2 to 5-6 months (or longer) per year;
- Revival of fishing by introduction of intensive breading technologies;
- Introduction of more intensive agricultural production, particularly of out-of-season vegetable and flowers product;
- Introduction of more intensive use of forest residues and agricultural waste for energy production purposes.
- Development of small business sector, base on the needs of listed development directions and small seasonal trade for the need of population and tourists.

3. POSITIVE AND NEGATIVE BACKGROUND FOR DEVELOPMENT

All listed possible directions for development are well accommodated to the local conditions, tradition and character of population. Region is located near the Greek border , whose side of the lake is completely undeveloped and isolated, already has a long experience with (low level) tourism with existing base of 1.500 beds and developed local production of fresh

food during the tourist season. Good transit location.

Fig. 1. Map of the west coast of the Dojran Lake

Negative influencing factors can be summarized in:

- Absence of local capacity for organization of development activities;
- Region is rather isolated of the streams of economic activities of surrounding richer municipalities;
- Weak power supply;
- Weak sewerage system;
- Weak irrigation of fields, except near the lake;
- Continual problems with the water level in the lake (empting from Greek side), which influence the quality of the water and possibilities for bathing.

4. RENEWABLE ENERGY SOURCES ON DISPOSAL

Proposal for composition of a specific development strategy of the target region, based on sustainable incorporation of locally available renewable sources, is justified mainly with the availability of a rich geothermal field but also with rather high solar energy radiation, forest waste and agricultural residues.

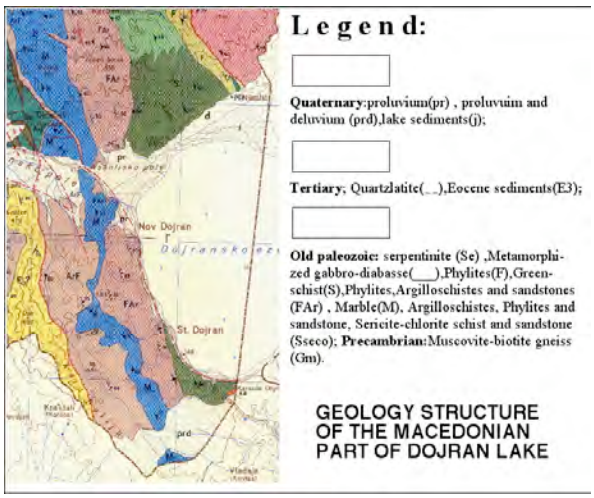

Fig.2. Geological map of Dojran Lake East coast

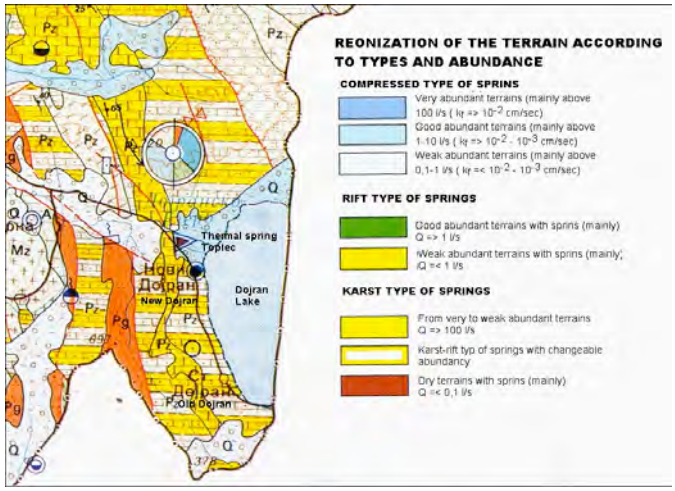

Fig.3. Hydrogeology map of Dojran Lake East coast

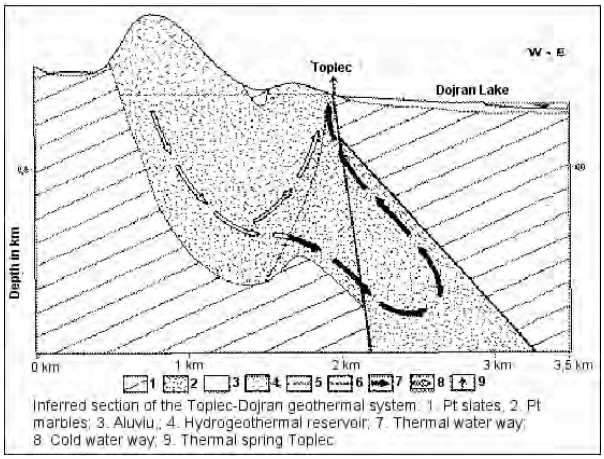

Fig.4. Hydrogeothermal profile of the geothermal field Toplec

3.1. Geothermal Energy

The geothermal system in Dojran is located near Dojran Lake. The system is drained through natural spring Toplec and through several exploitation drillings, made in the period 1986-1997, as well as through exploitation well Deribash, near Star Dojran. The reservoir consists of Paleozoic marbles, which form narrow zone between the zones of Paleozoic schist. The marbles strech in direction Northwest – Southeast with 70° slope towards Dojran Lake. This position enables the existance of hydrogeological isolation made of Paleozoic schist – argilloschist and phyllite. The estimated area covered by this system is 15 km^2, with average thickness of 300 m. The estimated capacity of this system is 200 km^3 and the estimated temperature is about 50-80°C.

Based on the geological structure of the terrain, the Dojran Lake is situated on the boundary parts of two blocks, the geologically older block being situated on its east side. This block is composed of metamorphic rocks and granites (Serbo-Macedonian massif., Belasica and Krusa mountains). The west side block is that of the Vardar zone.

Geothermal field is still not well investiga-

Fig.5. Exploration borehole HID-1 in Toplec

ture and flow cannot be given without realization of at least two-three deeper exploration boreholes. Based on the characteristics of plored geothermal fields of the same chain, flows of 40-60 l/s per borehole and temperatures of 50-80ºC can be estimated as realistic. Maximal total continual flows are going up to 100-130 l/s. That is heat power on disposal between 4,0-15,0 MW/well or totally up to 20 MW.

3.2. Solar Energy

Region is located at the South part of Balkan peninsula and is under strong influence of Mediterranean climate. Precise measurements of the solar radiation do not exists, but according to the estimations, based on measurements from the Greek and Macedonian side (Fig.6), global solar radiation is in the measures between 1.500-1.540 kWh/m^2, which makes it interesting for development of different energy uses.

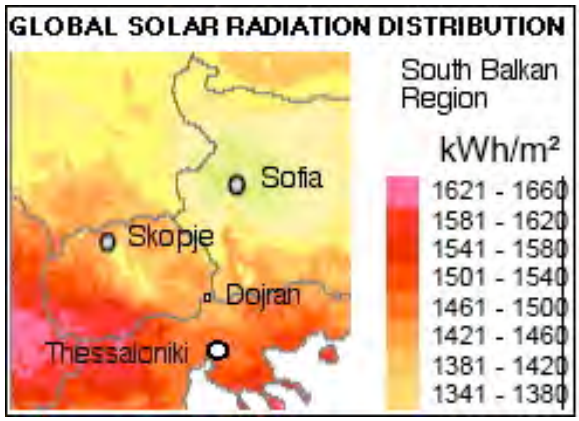

Fig.6. Global solar radiation distribution over the South Balkan region

ted and precise prognosis about the tempera-

3.3. Biomass Energy

Biomass energy source is based on the existing wood production from forests and agricultural land in the community. Forest wood is mainly used for firewood (about 4.000 m^3/yr). There is no organized collection of the wood waste.

Agricultural waste has mainly origin from wineyards, vegetable production and some orchards. Production of grains is small. There is no organized collection of agricultural waste.

3.4. Wind Energy

Wind energy potential of the region is quite poor. Precise long years measurements do not exist but traditionally is known that only temporal appearances of strong winds come several times per year. Normally, it is a characteristically quite area.

3.5. Hydro Energy

Several small flows exist in the region and they are normally dry during the summer months. No possibility for micro or small hydro power plants can be forseen as economically liable.

As conclusion, it can be accepted that obviously geothermal and solar energy resources can be estimated as serious and prospective. In addition, also biomass can be used to cover some of the energy demand of the municipality.

4. COMPOSITION OF RENEWABLE ENERGY PRODUCTION CENTER

Renewable energies on disposal allow specific completion of an integrated energy system, enabling composition of a strategy for economic development of the target region, accommodated to the local conditions, i.e. natural, economic, social, market and environmental influencing factors.

Depending on the results of more detailed geothermal explorations, two variants of the system (Fig.7) can be completed, i.e.:

- System with combined production of heat and power; and
- System with production only of heat.

5.1. Combined production of heat and power

Confirmed temperatures of geothermal water above 65ºC enable composition of co-generation power production plant in combination with solar energy use. During 7-9 months/yr it is possible to increase the water temperature above 100ºC, which is economically feasible technical solution for annual working hours above 2.500 – 3.000 h/yr, and feeding tariff above 10 €c/kWh.

During the winter months, full temperature difference can be used for different heating purposes, and during the others waste water of the power production with temperature of 45ºC fully satisfies their smaller requests.

5.2. Production of heat

Completion of a district heating system based on geothermal heat supply, through a central distribution station with plate heat exchangers dividing two heating loops, i.e. the geothermal water and heating water flows.

Central distribution line is planned to go along the lake coast, from the location of the central distribution station at Toplec, through the village Nov Dojran, Star Dojran and ending in the hotel and campus center Mrdaja, at the Greek/Macedonian border. Along that line (Fig.1) are located all the tourist capacities, trade, residencies, and above the ending part is the high productive agricultural field Vladajsko pole. Therefore, convenient composition of cascade uses of heat is enabled and, in that way, increasing the economy of exploitation of the system.

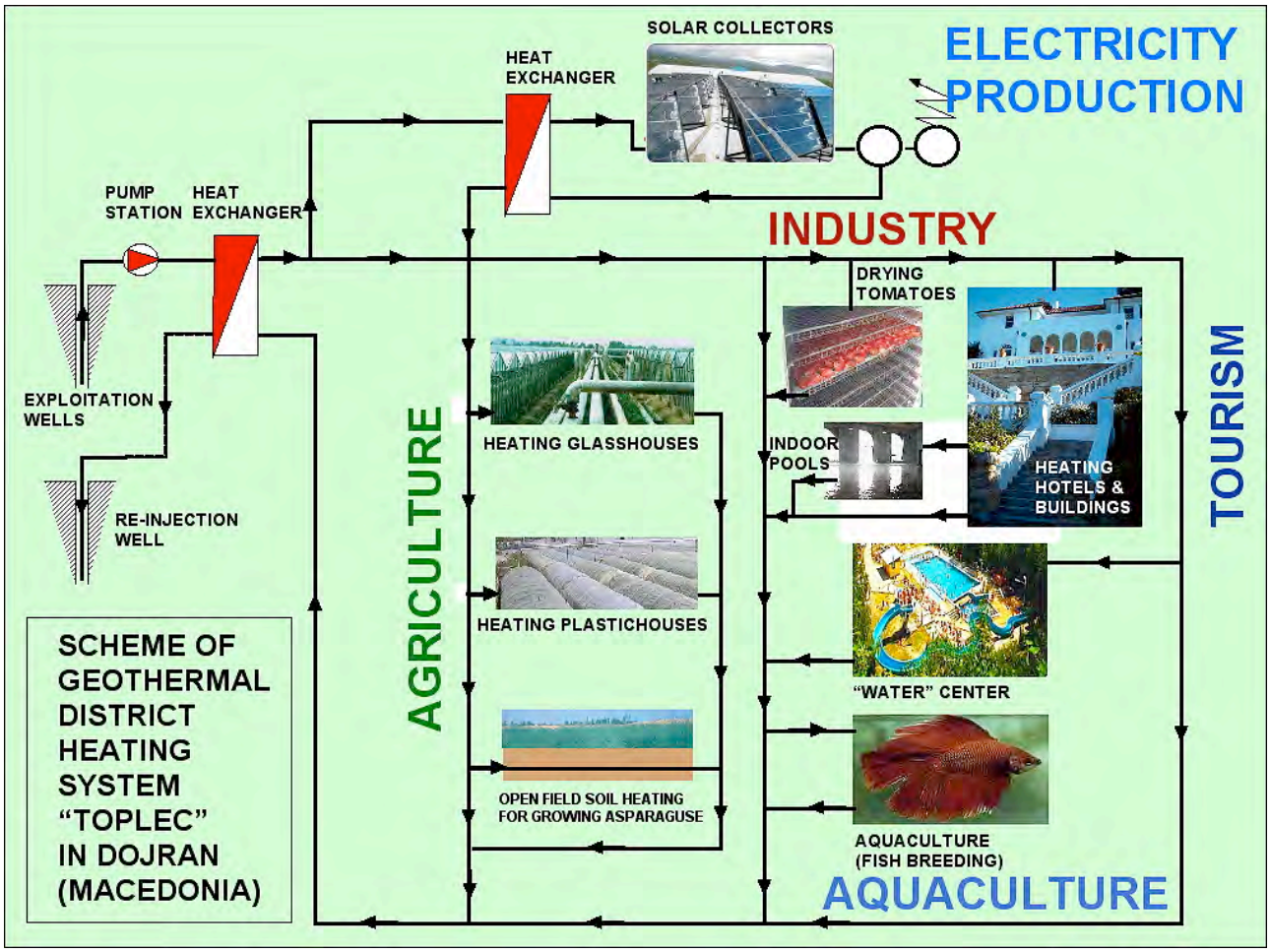

Fig.7. Composition of the geothermal district heating system "Toplec" in Dojran

5. NEW DEVELOPMENT STRATEGY OF THE REGION

Introduction of the integrated RES energy project in target region enables composition of a new development strategy, resulting with complete change of its economy level but, in

the same time, keeping the traditional activities and way of life, and preserving the human environment of negative impacts of modern energy dependent technologies introduction.

Proposed development strategy consists of (Fig.7):

- *Development of the tourist sector*: by enabling introduction of cheap central heating and secure power supply for air conditioning in the existing (mostly substandard) hotel capacities and opening possibilities for development of new ones. Opening possibility for introduction of indoor and outdoor swimming and recreational pools in hotel capacities. Complete supply of tourist sector with warm tap water.
- *Development of agricultural sector*: by opening possibilities for development of out-of-season protected crop cultivation. Climate enables high production results even in winter months, when the market conditions are the best. Introduction of early open field production of special products (asparagus) by roots heating with waste heating water.
- *Development of aquaculture*: Introduction of breeding of local fishes in cages, heated by waste geothermal heat.
- *Development of food processing manufacture*: Opening possibilities for building drying units for locally produced vegetables and fruits for local tourist market, and wider; and
- *Development of quality of life*: By enabling connection of public buildings, shops, residenciel along the lake coast to the district heating system.

Renewable energy mixture on disposal is more than enough to cover the needs of such a development strategy. Normally, its precise composition shall be determined after realizing necessary techno/economical investigations (already initiated).

6. RESULTING BENEFITS

New development strategy offers significant advantages in comparison with any other, investigated up to now, i.e.:

- It opens possibility to recover previous level of development of tourist sector and to improve it with higher quality offer by enabling introduction of cheap central heating, warm tap water and air conditioning during the summer months with stabilized power supply. By introduction of a system of indoor and outdoor pools with warm water, it enables extension of the tourist season and, what is particularly important, good conditions for swimming and recreation in water without algaes. According to the initial investigations, it can be expected that number of tourist beds shall be at least doubled after the first five years of completion of the system, and 5-6 times during the next 5 ones.
- Completion of a 12-18 ha glasshouse complex for protected crop cultivation and about 20 ha soft plastic covered greenhouses, enabling continual supply of the population, tourist sector and market with cheap fresh products all over the year, in combination with the existing open field production.
- Completion of 20-30 ha open field production of asparagus with low temperature soil heating with already used heating fluid. Existing experience in neighboring Greece and Gevgelia confirms existence of excellent market for such early production in Germany and other northern European countries.
- Returning fishery in the lake. Intensive empting and fishing of the lake from the Greek side during the period up to 2006, destroyed traditional fishery in the region. It was always famous because practiced with the help of cormorants. Other limitation for its development is appearances of quite low temperatures during the period of January and February, when from year to year, lakes becomes frozen. As consequence of that fishery is forbidden for a period of several months. By introduction of breeding the fishes in heated cages, both problems can be resolved, i.e. getting all year around supply with the renown Dojran fishes, without loses of uncontrolled fishery from the Greek side.
- Local public buildings, shops and higher quality residencies are disturbed along the coast street of the beach. They shall get possibility to increase the standard and, by development of the tourist sector, change for wider development and shape, like is the one in neighboring Greek places along the seaside.
- Existing agricultural production offers possibility for completion of a larger or a sys-

tem of smaller drying units for vegetables (tomato) and fruits, based on the offer of cheap heat. That shall increase the income of producers.

According to the results of the first investigations, completion of the proposed strategy shall enable opening of about 1.000 jobs and shall increase the total income of the municipality for at least ten times. That should completely change the life conditions in it in a positive way and shall open perspective for the young generation to stop emigration.

7. CONCLUSIONS

A number of incomplete development strategies have been prepared for the Dojran region during the recent 20 years but no one have been completed due to the several important constraints:

- Absence of an organized approach in all the economic sectors;
- Absence of a common line of interest of possible investors for needed initial investments in infrastructure;
- Absence of any challenging possibility for investors in comparison with neighboring and other municipalities in Macedonia;
- Weak attractivity of location in comparison to other lakes for tourist development;
- Weak energy supply during the summer months;
- Primitive agricultural and aquacultural production.

All the listed strategies were looking for development of different economic sectors mainly in an independent way.

In difference to such strategies, the proposed one consists of organization of a specific offer of energy supply, accommodated to the present priorities for development of this sector in the world. Except to look for resolving partial problems with the needed increase energy supply for development of any economic sector, it offers stabile and cheap energy supply and, with that, an attractive base for their competitive development. In other words, except requests for additional investments for development of any new project, a new interesting business is created, i.e. production and sale of energy for secure market. In such a way, all the other projects are becoming attractive for foreign and home investors.

Except to look how to substitute fossil fuels (tourism, agriculture, central heating, aquaculture) and find cheap electricity during the summer months, a complete and convenient energy mixture is offered, completely sustainable and benign in the human environment in question. In that way, RES introduction becomes a “normal” business solution, competitive to any other solution, based on fossil fuels use, and optimally incorporated in the energy system of the country.

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