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THE STATE-OF-THE-ART AND FUTURE DEVELOPMENT OF GEOTHERMAL ENERGY IN CHINA COUNTRY UPDATE REPORT FOR THE PERIOD 1996-2000

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ABSTRACT

In this paper, the State-of-the-Art and future development of geothermal energy in China for the past 5 years have been reported. As a Country Update Report, some statistics are given and some figures are outlined.

With economic development and demand for high environment quality, geothermal energy develops rapidly with annual increase of 12% in the past 10 years. By the end of 1998, geothermal space heating reaches an area of about 8,000,000 m^2; geothermal green house, 700,000 m^2; geothermal aqua-culture, 3,000,000 m^2; spa & sanatorium utilization of thermal water, >1600 sites. In total, the capacity of non-electrical utilization of geothermal energy in China equals 4,310,000 t standard coal. The installed capacity of geothermal power plant in China as of 1999 exhibits 29MW, among which Yanggbajing geothermal power plant of 25MW produces 100 million kWh annually.

During the past two yeas, intensive geothermal exploration has been carried out in Daiqing oil field of Songliao basin in Northeast China with high latitude & sever winter, and in Yingchuan area of Ordos basin, Northwest China where water-shortage causes big problem. Results indicate that geothermal resources in these two areas and basins are quite large. In Tengchong Cenozoic volcanic area of Yunnan Province, remote area of SW China, exploration for high temperature geothermal resources is under the way, which will provide the necessary parameters for construction of geothermal power plant with single unit of 10MW. In downtown area of Beijing, thermal water with temperature up to 88ºC has been discovered recently which will contribute a lot to reduce the environmental problem in the capital of China provided that these resources been utilized intensively.

Currently, State-Projects on the science & technology development and industrialization of new & renewable energy for the period 2001-2010 are under consideration and it is obvious that rapid development of geothermal energy in China can be anticipated for the next century.

1. GEOTHERMAL RESOURCES

Based on geological survey, more than 3200 thermal anomalies have been found in China, among which exploration and resources assessment have been conducted for more than 50 geothermal fields. High-temperature geothermal resources are mainly concentrated in southern Tibet and western parts of Yunnan & Sichun Provinces. In Yangbajing geothermal field, the highest temperature (329.8ºC) was observed in well ZK4002 at a depth of 2006m. In total, 255 high-temperature geothermal systems have been discovered nationwide and the potential for power generation is estimated as 5800 MW.30a. Low-medium temperature geothermal resources are widespread over the vast area of SE coast, North China basin, Songliao basin, Jianghan basin, Weihe basin etc. In these basins, thermal water with temperature of 80-100ºC can usually be reached at a depth of 1000-3000m. The natural heat discharge of more than 2900 hot spring area turns out to be 1.04x1014 kJ/a, which is equivalent to 3,600,000 t standard coal.

2. R&D IN GEOTHERMICS

At the request of geothermal industrialization, correspondent R&D in Geothermics are as follows:

·Systematical technology and methodology on geothermal resources survey, exploration & evaluation as well as geothermal exploitation & utilization techniques have been established, which include geothermal geology, geochemistry, geophysics, air-remote sensing, drilling, modeling, space heating, geothermal drying, agriculture, aqua-culture, monitoring, environment protection etc. It is of significant importance for normalization & standadization of geothermal development in China.

· Direction drilling technique has been developed for geothermal wells in Tianjin city. Well-control technique, drilling mud composition, testing & management for high-temperature (>250ºC) geothermal drilling are developed as well.

·Re-injection technique has been used in Tianjin geothermal field. Based on long-term observation & monitoring in this field, mathematical model for temperature & pressure changes in the reservoir was set up. In addition, the feasibility study for doublets reinjection has been carried out based on hydrogeochemical modeling during re-injection.

· Heat exchange technique in wells, sub-water pumps under high temperature (80-120ºC) were investigated and sub-water pumps with different types are produced.

·In Tibet, mathematical model for mass & energy conservation in high temperature geothermal fields such as Yangbajing & Yangyi has been developed. In Zhangzhou & Fuzhou geothermal fields in Fujian Province of SE China, the management model for exploitation of geothermal resources was set up.

·Preliminary studies on geopressured geothermal resources in Yinggehai basin, South China Sea were conducted and have been reported at 1996 GRC Annual Meeting in Portland, Oregon, USA.

· Geothermal map-set with 1:6,000,000 scale including heat flow, hot springs and natural heat discharge has been compiled and displayed at 1996 WGC in Beijing. Geothermal resources assessment was made nationwide.

3. GEOTHERMAL DEVELOPMENT AND UTILIZATION

In the past 5 years, non-electrical geothermal direct use develops rapidly especially in the area of space heating, sanatorium and tourism. For instance, in Xiaotangshan, Beijing and Xiong County of Hebei Province, a base for sanatorium and tourism has been set up. In Rucheng County of Hunan Province, a base for agriculture, aqua-culture has also been estabished.

The development of geothermal power generation seems to be relatively slow. The main reason is: in Tibet and West Yunnan, where high-temperature geothermal resources are concentrated, the hydro-power is also quite rich and the local people would

like to construct hydro-power station with capacity of 10-20 MW rather than geothermal. However, production of hydro-power station exhibits seasonable, at the maximum, the station can only produces electricity for 3000-4000 hours during the raining season. The best way to get the maximum power generation, according to the view from geothermal community is: combination of geothermal power with hydro-power generation. If this view can be accepted in the future, geothermal power generation will develop rapidly and steadily. The state-of-the-Art of geothermal development & utilization in China is illustrated in Tables 1, 2 and 3.

4. FUTURE DEVELOPMENT

·Strengthen basic research and technology investigation in Geothermics. Promote geothermal industrialization on the basis of market-oriented development. Faster the development of low-medium temperature geothermal resources in sedimentary basins in the East & North-West China with the aim to form a big market.

·According to energy resources feature, combine geothermal with hydro-power generation to protect ecology-environment with the aim to get a sustainable development in China.

·Strengthen the observation & monitoring of geothermal fields. Optimum exploitation pattern and put forward the research on reservoir engineering & environment protection.

·Set up standards for geothermal products, devices and apparatus. New material (high-temperature, anti-corrosion & non-pollution) must be investigated. Heat pump technology should be nationalized and popularized in geothermal community and set up service system for geothermal industry.

· Encourage international cooperation on geothermal research & development and push forward geothermal science & technology.

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Table 1. The Geothermal Utilizations in China (as of 1998)

Item	Amount	Scope	Heat consumption ($\times 10^{11}$kJ)	Standard coal equivalent ($\times 10^4$t)	%
Electric generation	5	32.08 MW	192.97	68.84	13.77
Drying	7		7.53	2.57	0.50
Space heating		790× 10^4m^2	116.23	39.66	7.93
Fish farming	199	300× 10^4m^2	149.97	51.17	10.23
Cultivation	126		63.01	21.50	4.31
Recupe-ration	420		192.55	65.70	13.15
Domestic use	1245		475.62	162.29	32.46
Tourist trade	65		111.08	37.89	7.58
Industrial use	51		48.98	16.71	3.34
Irrigation	112		63.3	21.60	4.30
Earthquake monitoring	35		18.71	6.38	1.28
Others			16.68	5.69	1.15
Total	1675		1456.60	500.00	100

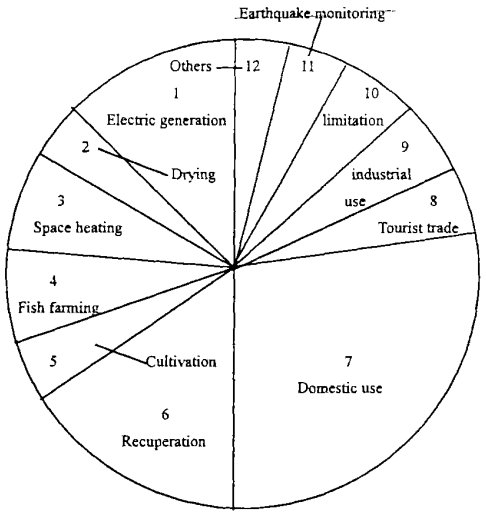

Fig. 1 The heat distribution among different geothermal uses in China (as of 1998)

Table 2. Present and Planned Ppoduction of Electricity in China

	Geothermal		Fossil Fuels		Hydro		Nuclear		Other Rewables (specifiy)		Total	
	Capaci-ty MWe	Gross Prod. GWh/yr	Capaci-ty MWe	Gross Prod. GWh/yr	Capaci-ty MWe	Gross Prod. GWh/yr	Capaci-ty MWe	Gross Prod. GWh/yr	Capaci-ty MWe	Gross Prod. GWh/yr	Capaci-ty MWe	Gross Prod. GWh/yr
In operation in January 20000	32.08	0.11	231550	10300	74250	2350	2100	150	223.6	8.1	308152.4	12808.2
Under construction in January 2000												
Funds commited, but not yet under Construction in January 2000	6 - 10	3.0-5.0	40650	200000	21450	145000	6600	35000	800			
Total projected use by 2005	34 - 38	15.0-16.0	272200	1210000	95700	380000	8700	50000	1020			

Table 3. Utilization of Geothermal Energy for Electric Power Generation in China as of 31 December 1999

Locality	Power Plant Name	Year Com-missioned	No.of Units	Status[1]	Type of Unit[2]	Unit Rating MWe	Total Installed Capacity MWe	Annual Energy Produced 1999[3] GWth/yr	Total under Constr.or Planned MWe
Tibet China	Yangbajing	1−9 Units (1978-1992)	1 −9		D3-1.7/0.5	18-21	25.18	0.1	
	Naqu	1	1		B	1	1		
	Langju		2			1-2	2		
Guangdang	Fengshun		1	N		0.3	0.3		
Hunan	Huitang		1			0.3	0.3		
Tibei	Gingshui	1 (1989)	1	N		3	3		
China	Tuchang	1	1	N	B	0.3	0.3		
Total			16			23.9	32.08		

[1] N = Not operating (temporary), R= Retired. Otherwise leave blank if presently operating.

[2] 1F = Single Flash B = Binary (Rankine Cycle)
2F = Double Flash H = Hybrid
3F =Triple Flash O = Other (please specify)
D = Dry Steam

[3] D =Data for 1999 if available, otherwise for 1998. Please specify which.