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Hot Spring Bathing: Low-carbon & High-efficiency Health Industry Worldwide

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ABSTRACT

Even long time ago ancient people knew hot spring bathing could treat disease. Ancient scientist Heng Zhang (AD 78-139) wrote "Ode of Hot Spring" and described that hot spring had function of healing disease. The keynote lectures of WGC2020+1 showed that hot spring bathing and swimming were important component of geothermal direct use worldwide. It occupies 44.1% of worldwide 2020 direct use without heat pump. Hot spring water come from subsurface geothermal reservoir. It does not burn fossil energies coal and oil etc. and avoids air pollution. It belongs to clean energy industry. Hot spring water contains special geothermal components such as silica, boron, fluorine, lithium and hydrogen sulfide etc. to form thermal mineral water. It has precious medical value to be available for physical therapy and medical treatment. There are many small towns owned hot spring worldwide. They developed hot spring as special relaxation, sightseeing and tourist industry, and had grown local economy. Looking around the world there is extensive public acceptance for hot spring bathing. And operators could gain consistent return. All of these have testified it is the everlasting health industry for thousands of years human society. At recent years some environmental protection and water conservation experts assert that hot spring made pollution and surface subsidence. In fact, hot spring bathing and relaxation as low-carbon and high-efficiency health industry it should be supported and encouraged. China advocates energy saving and emission reduction, hot spring as geothermal energy is able to play a positive role. It will help us to reach our ambitious target for peak carbon dioxide emissions in 2030 and carbon neutrality in 2060.

1. HOT SPRING SERVICE INDUSTRY IS EVERLASTING HUMAN'S HEALTH INDUSTRY OVER THOUSANDS YEARS

Immemorial hot spring bath had started 5,000 years ago. There was no written record at that time. What is the method for dating? The carbon-14 dating was used. Hot springs have medical value especially for arthritis and diseases of orthopedics and traumatology. Ancient patients went to take a bath in hot spring with tree fork for walking stick. After bathing they walked back and gave up the stick. Modern scientist collected the stick to do ^{14}C dating. The radioactive half-life of ^{14}C is 5,700 years. Comparison to modern trees we get the age of ancient stick. There is no need special technique and facilities for hot spring bath. Just a hot spring pit OK. As we see that still some such simple and crude hot springs in Tibet (Figure 1).



Figure 1: Simple and crude hot spring bath in Tibet

Chinese geothermal record at ancient is hot spring bath basically. The *Hot Spring Ode* written by Zhang Heng, a scientist of the Eastern Han Dynasty in the second century AD, is the earliest description of the medical utilization of hot springs in China. It says that "When the six climate (namely wind, cold, hot, wet, dry and heat) changes are mixed up, people will get sick. The hot spring flows out, which can remove diseases". The Emperor Taizong of Tang dynasty (AD 627-649) wrote *Inscription of Hot Spring* to say hot spring as "Gold pulp and jade liquid can make you happy". The Emperor Xuanzong of Tang dynasty (AD 713-756) played hot spring bath with imperial concubine Yang in Huaqing pool of Lintong, Xi'an. Famous poet Juyi Bai (AD 772-846) wrote *A Song of Everlasting Sorrow* to say "Cold spring season awards bath in Huaqing pool. Smooth hot spring water washed out congealed fat". The Emperor Wuzong of Ming dynasty (AD 1506-1521) wrote a hot spring poem "An unusual even in winter. Why a small pool warmer than soup? It flows away since ancient time to nowadays. For human no longer wash in cold bath".

There is still the industry that hot spring bath had lasted nowadays. Bath is for sanitation. Hot mineral water is beneficial for living in healthy lifestyle. It is recognized that the hot mineral water isn't medication but better than medication. There are so many famous SPA scenic spots in the world. Regardless the times and development it is still social demand.

2. HOT SPRING BATH AND SWIMMING IS IMPORTANT COMPONENT OF GEOTHERMAL DIRECT USE WORLDWIDE

Somebody discredits that why hot spring bath belonged to geothermal use. However, it is recognized worldwide that more than trillion African burn grass and trees belonged to biomass energy utilization. Keynote speech of geothermal use in WGC2020+1 showed that worldwide direct use 2020 without heat pumps (TJ/yr) achievement: hot spring bath and swimming of 44.1% was more than geothermal district heating of 38.1% (Figure 2).

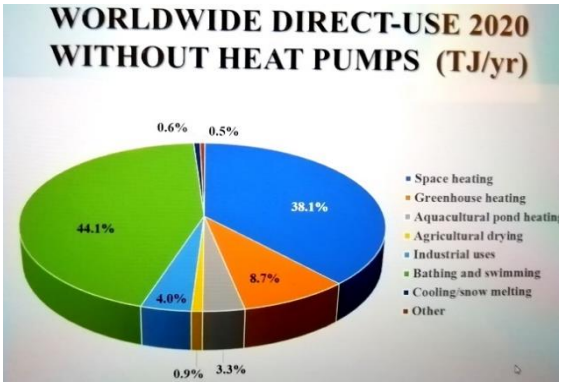


Figure 2: Geothermal direct use without heat pump in 2020 worldwide (TJ/yr)

Hot spring bath is geothermal use worldwide and it is dominant section. It is the right time, right place and right requirement. Regardless of frigid zone, temperate zone and tropic zone it is universal demand for human life. The Polynesia SPA in Rotorua New Zealand is one of Top Ten SPAs in the World. The cheapest ticket is $15 (NZ), while the slap-up is $50-100 (NZ). However, the local Maori have their free hot spring bath in a simple cemented pool. Each takes what he needs (Figure 3).



Figure 3: World's top SPA (left) and Maori's simple hot spring pool (right) in New Zealan

3. HOT SPRING LEISURE TOURISM INDUSTRY IS EFFICIENT UTILIZATION OF CLEAN ENERGY

Hot spring water come from subsurface geothermal reservoir. It is not necessary to burn fossil energy of coal and petroleum etc. so there is no air pollution. It is clean energy industry. Geothermal hot spring use is none-carbon. But it needs pumping to use electricity. If the electricity come from fossil power plant it includes carbon emission transferred by coal burning. Therefore, geothermal use belongs to low carbon use.

We advocate to use clean energy. The worldwide comparison of carbon emission for various energies shows that the emission of natural gas is a half of coal and petroleum. While in nuclear power and renewables biomass and solar energies have relatively higher emission, but geothermal, winds, hydraulic and nuclear power are the lowest emission (Figure 4).

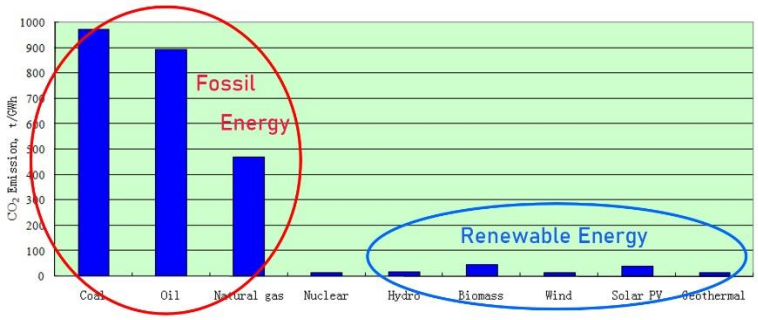


Figure 4: Comparison of CO_2 emission for various energies

Except warm and no-carbon the hot spring water contents special mineral substances such as silica, boron, fluorine, lithium and hydrogen sulfide etc. to form geothermal mineral water. It has medical value to be used for physical therapy and medical treatment. Taking full advantage of low temperature mineral water sources will give play to maximum economic benefit. It is most profitable business in whole geothermal direct use.

4. HOT SPRING LEISURE TOURISM INDUSTRY IS A WAY OF EARNING MONEY FOR LOCAL ECONOMY

World famous featured hot springs do not located in metropolis while in small place. Based on hot spring business to develop local economy to be very significant for locality.

Japan located in Pacific Rim geothermal zone. There are hot springs throughout. Japanese territorial area is 37.7×10^4 km^2. There is total 2,283 hot springs. The most famous hot spring is Kusatsu hot spring in Gunma-ken. It is northwest more than 200 km away from Tokyo. It receives 3 million guests per year. Japanese receive VIP in Tokyo. But they use full day to bring you to Kusatsu for leisure tourism. There is no highway on the journey. Tour bus takes you for 4-5 hours. Several dozen hot springs passed on the way. But the target is Kusatsu. There are most classical and traditional Japanese style in Kusatsu hot spring. Due to higher water temperature, Japanese ladies dressed in kimono and hold a long wood oar to stir water for heat dissipation. There are many kinds of hot spring use and scene in this area. The town center is the main hot spring upflow within a hot lake. Top grade hotels and small hot spring inns surrounded the lake area. A flow of hot spring was led into a small street kiosk for foot bath of visitors (Fig 5). There are many small hot spring flows distributed from town center to suburb. They were used by small firms for boiling eggs, steaming foods, steam fuming face and skin, drinking and other hot spring products etc. There is a natural park of hot spring valley with natural landscape and stone caved statue of God, and the open-air hot spring bath pool. The one-day tour in Kusatsu gave visitors to share hot spring enjoyment for eating, drinking, bathing and touring.



Figure 5: Hot spring small kiosks for visitor's foot bath in Kusatsu, Japan

Taupo volcanic zone in New Zealand is a part of Pacific Rim geothermal zone. It stretches more than 200 km and includes dozen geothermal fields. High temperature geothermal manifestation includes geysers, boiling spring and mud pool etc. They are world grade tourist attraction. Wairakei geothermal power station is the world's second station and the first wet steam flashing technology application there. Natural geothermal manifestations are for visit only, but not for touching. It is not permitted to pick up a piece of color sinter. Hot spring SPA opens in Rotorua only. It was a fishing village lakeside. However, it was developed as hot spring feature with dozens SPA and bath houses, including the famous Polynesia SPA which as one of the top ten SPAs in the world (figure 6). The SPA has dozens of public and privacy bath pools with different prices and hot spring products as crystalized powder and mineral mud soap etc. for selling.



Figure 6: Polynesia hot spring SPA in Taupo, New Zealand

Afyon is world famous hot spring land. The small town is away from the capital Ankara and the Eurasian city Istanbul or Mediterranean seaside tourism city Antalya all bout 200 km. WGC2005 field trip visited there. The Pamukkale scenery of sinter terrace is near there (Figure 7). Hot spring leisure center and hotels can be found everywhere. Their business is booming. Traditional

Turkey bath retained the Ottoman Empire style. Marble floor and wall in a bath hall with a huge marble stone bed for a rubdown with a damp towel. There are also hot spring shower and sauna cabin. Various mineral therapies include herbal hydrotherapy, hydro-electric therapy, vortex hydrotherapy, ultrasonic hydrotherapy, mineral mud therapy, aromatherapy etc. attracted different guests. There is also pure natural hot spring pool, ditch or pit and crowd various visitors in bathing, too.



Figure 7: Foreign visitors in Pamukkale sinter terrace hot spring in Turkey

Iceland lies on the mid-Atlantic ridge where the earth's crust splits. Hot springs distributed everywhere. There is colder weather in Iceland. House needs space heating 365 days per year. Geothermal space heating reaches 100% in capital Reykjavik and 87% in whole country. But Icelanders want 365 days of outdoor hot spring swimming. The capital has 6 hot spring bath and swimming pools for more than 100,000 of people. They often packed with crowds (Figure 8). Even more intriguing is the drainage pit of geothermal power station. It was a black volcanic basalt pit. Due to white silica scaling deposit from geothermal brine the pit become a blue lagoon. Water depth about 1 m is just suitable for bathing and swimming. Even snow covered land, the blue lagoon is still a place people yearn for in winter.

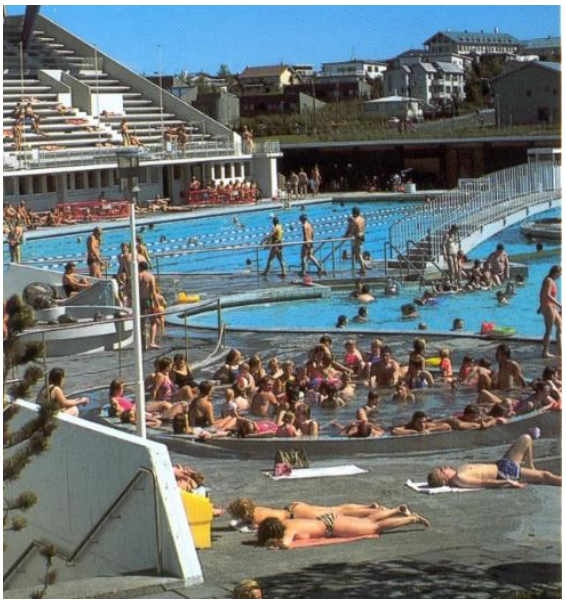


Figure 8: Hot spring swimming pool in Reykjavik, Iceland

The world's hot spring leisure tourism industry has always been thriving. Even in Australia where rare hot spring, somebody has found the way to develop leisure hot spring. An Australian young man Charles Davidson married with Japanese wife. They created a Peninsula hot spring in Mornington, south of Melbourne as the first one in the country. There is no experience for them. The man requested IGA president to recommend them to learn concern in China. I brought him to visit in Beijing, and then he went to Kunming, Xiamen and Haikou. When he went back home, he made Peninsula hot spring to include hot spring bath, SPA massage, rehabilitation discharge poison, leisure entertainment, and catering service to become a booming industry (Figure 9).

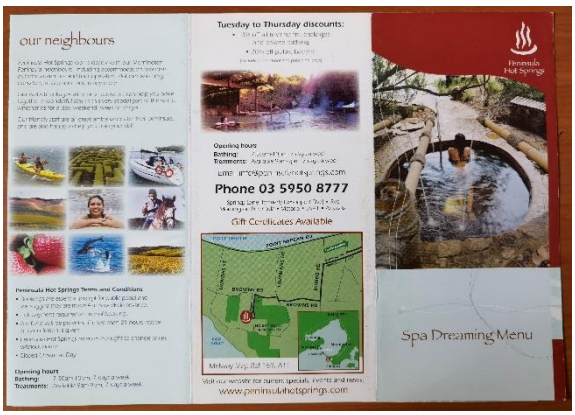


Figure 9: Peninsula hot spring Spa in a small town in Australia

5. CHINA HOT SPRING INDUSTRY SHOULD GET MORE ATTENTION FROM GEOTHERMAL DEVELOPMENT POLICY

Look around the world the hot spring leisure industry is a booming industry. It receives user's acceptability and operators get steady return. All prove that she is the eternal health industry of mankind for thousands of years. Under present new situation of energy saving, emission reductio and energy transition, it is low carbon and high efficiency green industry.

5.1 Inappropriate Scenarios Should be Turned off

In recent years, geothermal development in some parts of the country has been disturbed. Some lobbyists in the guise of experts despite the fact and make public opinion. It disturbed the order of geothermal development. Inappropriate scenarios as below should be turned off.

5.1.1 Scenario 1: Not Permit to Geothermal Exploitation

Some environmental and water conservation "experts" said that geothermal development made pollution emission and surface subsidence. Thus some local governments accept as true. Then issued some government documents to suppress geothermal exploitation. No longer to approve new well drilling. We can see the example in Beijing. Tap water supply uses groundwater within depth 30-300 m in urban downtown. Total exploitation is 3,000 billion m^3 per year. However geothermal exploitation is 10 billion m^3 per year. Geothermal water is buried under 300 m groundwater aquifer, and need penetrate more 700-1,500 m consolidated sandstone (no water) to reach geothermal reservoir of karst limestone of basement rock. Who is the reason that subsidence was caused by 3,000 billion m^3 of shallow groundwater, or by 10 billion m^3 of geothermal water.

5.1.2 Scenario 2: Not Allow to Consume Geothermal Water

Some environmental and water conservation "experts" emphasized that need 100% reinjection of tail water after geothermal district heating in order to avoid pollution. It has been written into government documents for implementation. In fact, Beijing geothermal water contains the total dissolved solids (TDS) 400-600 mg/L. While the groundwater contains the TDS 300-500 mg/L. It is just little difference. There is 1~6 mg/L of fluorine in geothermal water. It is the only component which exceeded the standard of drinking water of 1 mg/L. My proposition is not necessary for 100% reinjection. We can retain 5% of tail water after geothermal district heating. It will be used for hot spring bath leisure industry in order to give full play to its medical benefits as hot mineral water. Geothermal water is rich in silica, fluorine, boron and lithium etc. components to own precious medical value. Why it has to be return into reservoir by reinjection? Why do not allow to use its precious medical value? And that will create higher economic value, too.

5.1.3 Scenario3: Ban Hot Spring Bathing Leisure Industry

There are 6 countries that their capital has hot spring worldwide. They are Iceland, France, Hungary, Bulgaria and Rumania originally. Then we drilled successful geothermal wells in Beijing urban in 1971. So, Beijing became the 6th country which has capital hot spring. World Geothermal Congress (WGC) 2023 will be held in Beijing. How wonderful that we could serve global geothermal honored guests to take Beijing SPA. Unfortunately, government has ordered that some geothermal mining permit for hot spring SPA leisure industry would be cancered when expired. Such case has arisen. Well JR-45 was drilled in China Rehabilitation Research Center in 1987. The well depth is 2,150 m. Its yield was 1,020 m^3/d in 57°C. It has been using for geothermal physical therapy and is popular with favor from Beijing and outside patients. Its geothermal mining permit has expired. Government does not give recertification. Patients is waiting for daily physical therapy. The center can't stop the geothermal well. Government section does not dare to go to shut in the well. Why the government likes such scenario to looking embarrass itself.

5.2 Create a New Order Conducive to Geothermal Development

Beijing is a international metropolis. There are geothermal wells but do not permit to operate hot spring SPA service. What kind of image will receive internationally? Existing public document is not irrational. Geothermal water with rich mineral components is permitted for district heating only using its heat. It has to be reinjected back to reservoir 100% after heating use. It is not permitted to retain a few percent using as hot spring healthy leisure industry. *China Mineral Resource Law* explained that geothermal belongs to liquid energy mineral resources but does not restrict its hot spring health leisure industry use. *China Renewable Energy Law* included geothermal energy but also does not restrict its hot spring health leisure industry use. But some local government's documents stipulated to implement such restricts. And it ordered that geothermal administration do no further comments are allowed. This is crazy.

Consumers are willing to pay a premium for hot spring. And it makes the country also more tax revenue. Why the hot spring bath was forbidden while need return to simple burning tap water for bathing. Hot spring SPA is as healthy industry of low carbon and high efficiency to be progress in the world. China also deserves policy support to develop the healthy industry. It is not capitalism. It is not necessary to be opposed.

Former US president Trump had retreated *Paris Climate Agreement*. But global warming is a fact of life. A look back at the world of the climate in 2021. The frequency of extreme change is unprecedented. The melting of icebergs at the North and South poles is accelerating. It's not supposed to be melted. A cold spell assault in Texas in March of 2021. It's not supposed to be frozen. It broke a 30-year low temperature record (Figure 10). It made that outage for 170,000 households and water break for 14.4 million people. A household's monthly electricity bill rose to $10,000.



Figure 10: A cold spell assault in Texas in March of 2021

The climate is warming because the world is emitting too much carbon dioxide. Therefore, we need to get to the target of carbon peak and carbon neutral. We should support renewable geothermal energy development and utilization which including hot spring healthy industry. It is avail to reduce emission of carbon dioxide.

Geothermal hot spring industry as low carbon and high efficiency healthy industry should be supported and encouraged. We need create a new order conducive to geothermal development. So that we can grow healthily on the way to carbon peak and carbon neutral.

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