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THE DEVELOPMENT OF NEW AND RENEWABLE SOURCES OF ENERGY IN THE PEOPLE'S REPUBLIC OF CHINA

(Report to the United Nations Conference on New and Renewable Sources of Energy)

China, situated in East Asia, having a vast territory and a large population, is an agricultural country long since. For generations the labouring people depended on cattle for cultivation, firewood for cooking, horses for travel, junks for sailing, water power for milling, wind power for pumping, solar radiation focusing for fire and hot spring baths for treatment. This indicates that massive utilization of new and renewable energy sources such as biomass, solar energy, wind power, hydro-power and geothermal energy has a long history in this country.

The founding of the People's Republic of China in 1949 put an end to the long standing reactionary rule in old China. The Chinese people have resumed a new lease of life and have developed industrial and agricultural production. Independent branches of industry of coal, petroleum and electricity were gradually established, thus providing various sources of energy for socialist economic constructions. However, energy consumption in China increases rapidly along with the constant growth of national economy. Currently the insufficiency of energy has become a prominent problem in the development of Chinese national economy.

Since the Chinese rural population covers more than 80% of the total, the solution of long existing problem in rural energy means a solution of significance as it supplies energy for production and livelihood to most of Chinese people. New and renewable sources of energy not only have a history of traditional use, but also serve as a major means for meeting rural energy requirement and may bring about benefits to industrial and agricultural production as well as livelihood of urban and rural inhabitants. Consequently, in addition to the efforts devoted to developing conventional energy sources and in reducing energy consumption, the Chinese government also puts emphasis on the development of new and renewable sources of energy, in the hope to make full use of various resources for China's modernization.

(I)

Biomass is a major component of current Chinese energy.

It constitutes more than one quarter of the total energy consumption of the country, i.e. equivalent to 220 million tons of standard coal. Biomass plays a significant role in meeting daily life energy needs of broad masses of Chinese people as the fuel in the vast countryside of China comes basically from biomass in the form of firewood and straw. The biomass is commonly utilized by direct burning, the heat efficiency of which is as low as around 10%, caus-ing a loss of organic fertilizers, reduction in soil fertility, destruction of ecosystem and pollution of environment. Therefore, to strengthen scientific research so as to improve the utilization of biomass is an important task facing us. The study and application of biogas serves the purpose.

During the late 50s, mass experiments on biogas emerged in Chinese rural areas, but most of them had been given up because of insignificant success owing to lack of technical guidance. Then in the early 70s, experiments on small scale biogas digesters for domestic use resumed in organized way in some areas of Sichuan province. The peasants improved the technique in building water presured digesters enabling them to satisfy their practical needs. The government timely summarized the experience and convened an experience exchanging conference, policy of developing rural biogas being formulated. Families were encouraged to build biogas digester by various forms of appropriations bank loans and subsidies from production teams and communes, and a

series of problems related with production and supply of con-struction materials and necessary apparatus are being delt with. Training courses on biogas technology had been sponsored in quite a few places to train technicians for the pro-duction teams. Biogas production was thus spread rapidly all over the country.

460 thousand small digesters for domestic use were built in various places by 1975 when the first nationwide experience interchanging conference on biogas was held; and by 1978 when the second conference was convened, the number was increased to 6.39 million. And some digesters of large size for electricity and power generation were available then. In view of this swift development of the situation, the national Leading Group for Biogas Development and National office for Biogas were set up in 1979, when biogas research institutions were organized as well in provinces like Sichuan, Gyangdong, Jiangsu and Zhejiang. Now more than forty institutions have undertaken research on biogas, and a "Biogas Science & Technology" magazine began its publication in 1980. The development of biogas had been incorperated in China's national economy programme as an important part in the modernization of her agriculture.

Benefits from biogas utilization are obvious. Firewood and straw are conserved, organic fertilizers increased and agricultural production developed, housework for women are reduced, the environmental conditions improved and general satisfaction achieved in the communes and production brigades where biogas is properly utilized. The successful experiences

reinforced highly the peasants' confidence in finding solution to rural energy problem. Being economical, reliable, effective and endurable are necessary qualifications for successful development of biogas. Over the last two decades, considerable efforts have been made in studying digester models. The design of water pressure digester has been improved by adopting coating and cement pasting layers to prevent leakage caused by excessive inner pressure. Now the investment cost for a 10-m^3 digester is around 70-100 yuan RMB. Such digester produces 1.2-1.5m^3 biogas per day, enough to satisfy the energy need of cooking and lighting for a family of five.

However, disequilibrium exist in the development of biogas utilization from place to place. In some areas, owing to overspeed expansion without proper technical guidance and scientific management, or to the limitations of local materials and conditions, the digester construction fails to reach technical requirements as a result. The digesters were rather low in gas production rate and unable to play their proper role. That is why a policy of readjustment has been adopted in the last two years , which involves slowing down the construction speed of new digesters and with emphasis on restructuring the 7 million digesters that have already been built. The restructuring is to reconstruct or to abandon those digesters which failed to perform their proper function, as well as to develop some new ones of higher quality. Furthermore, digesters of other types have also been constructed, and larger mesophilic digesters and digesters using industrial organic wastes and/

or urban sewage as raw materials have also been constructed. Research have been organized on adjusting the digester structure, on expanding sources of fermentation materials, on mechanical discharging, on improving fermentation technology as well as heat efficiency of stoves in biogas utilization, so as to achieve a sound technological basis for the further development of biogas utilization.

The major policies and measures taken in chinese rural areas are:

(1) Progressive expanding guided by typical examples. Peasants believe in reality. A new technology could be expand-ed only when, through the establishment of convencing examples, it is accepted by the peasants. At the early stage of expansion in Sichuan province, efforts have been focused first on establishing a number of demostrative digesters in a district of Mianyang city, which solved the problem for the peasants in fueling, contributed to a good harvest by supplying humic acid manure out of the digester sludge, thus demonstrating the benefits of biogas to agricultural production as well as to livelihood of the masses. Hence there was a rapid expansion throughout the city. By 1975 the utilization of biogas was spread over the whole city of Mianyang and its agricultural production has increased successively. With development of biogas night soil was properly managed and has resulted in a con-siderable decrease of parasitosis such as schistosomiasis.

(2) Focus the development of biogas in areas short of fire-wood and where schistosomiasis prevails. This order of priority meets the urgent requirements of the masses and also

makes the expansion easier.

(3) Develop biogas utilization district by district in a planned way to facilitate provision of technical guidance and scientific management. Low quality and waste digesters had been turned out in areas where people were in a haste to quick results at the early stage of biogas development, wast -ing both manpower and materials to amend and dampening the enthusiasm of the masses. And now an increasing probability of success is achieved by stressing individual responsibility, e.g. who builds the digester who is responsible for it, developing by district and strengthening technical training.

(4) Bring supply of fund and materials for construction of biogas digesters into line with the state and local government plans. Peasant households should raise funds for the construction mainly on their own, with subsidies from the communes and the state as supplementary means. Higher subsidies are supplied to newly developed areas by the goverment and the collectives. Low interest or interest-free loans are provided to the peasants through the national banks, while the materials for digester construction are supplied by the production teams and the government. The related government departments appropriate part of funds for the development and maintenance of biogas digesters. Research fund of a fixed amount is allocated every year for the improvement of biogas technology in gas production, rate of combustion as well as extermination of germs and bacteria.

(5) Establish biogas management system, taking into consideration both the interests of peasants and the collectives. The ownership of means of production in Chinese rural areas is chiefly the collective ownership. The manure and crop stalks

are mostly owned by the production teams and used mainly as fertilizer. How to distribute these residues as raw material feed for digesters and collect the discharge as fertilizer of production team is a very important question. Certain plans and measures regarding raw material feed for digesters and use of manure from digester have been laid down in line with the practical condition there. The collectives pay the peasants for the manure and the manure need of both the production teams and the commune members' private plots were taken into account.

Biomass energy is an important branch of new and renewable sources of energy, while biogas is merely one aspect. In recent years, China has been cultivating energy plants and firewood forests in addition to the vigorous development of rural biogas. Attentions have also been paid to the modification and spreading of advanced firewood stoves, to reduce firewood consumption and environmental pollution. Furthermore in some institutions, studies which may have significant effect upon future development of biomass energy, have begun, namely, they are gasification of solid biomass, hydrogen generation through photo-synthesis as well as enzymatic hydrolysis of cellulose and lignose. The advance of such study indicates a tremendous potential and a promising prospect for biomass energy.

(II)

China has abundant Solar Energy resource, with an annual insolation of over 2,000 hours. Two-thirds of China has total solar radiation over I40 kcal/cm^2 per annum.

As a modern energy technology, the solar energy R&D started in the middle of 70's. In recent years, the Chinese government pays much attention to solar energy R&D and encourages people to utilize solar energy. Two national solar energy application conferences were held in I975 and I979; the solar energy R&D Programme was worked out then; the China Solar Energy Society was organized in I979 and two magazines, the "Acta Energiae Sola ris Sinica" and the publication of a popular science magazine "Solar Energy", started publication in I980. In most of the provinces, solar energy research work has been undertaken. A solar energy technical contigent is gradually built up. A couple of solar energy demonstration spots have been estsblished. Some solar energy application devices which can be easily popularized and gain benefits are developing rapidly throughout the country. A number of solar energy device manufacturies which produce solar collectors, solar cookers and photovoltaic devices, etc. have been set up to meet the increasing needs. In view of this situation, we consider that the solar energy device production in China has begun its industrialization.

Solar cookers have been widely used in areas rich in sunshine but lack of fuels. The cookers are highly appreciated by the peasants. These solar cookers are locally manufactured with local materials, so the cost is as cheap as some 40-50 yuan RMB each, which could be afforded by most of the peasants. The trial production and disseminate fees are partly funded by the state. There are over 2,000 solar cookers in daily service. They will be further expanded and are planned to be comprehensively used with biogas and firewood-saving stoves to ensure cooking energy supply to peasant families.

Solar heater is one of the major items being popularized. In large cities like Beijing, Shanghai, Tianjin, Guangzhou, Wuhan and elsewhere, solar collectors are now being used for hot water supply to public bathrooms, hotels, hospitals and offices. There are about I00,000m^2 flat plate solar collectors

in service in China, most of which being tube and sheet type and some of flat integrated channeled or other types. In order to get high operating temperature for high thermal performance, the glass vacuum tubular collectors and parabolic trough concentrating collectors are also being developed. Ceramic enamel or plastic collectors are also under pilot study. Various kinds of solar driers have been put on probation to dry tobacco, jujubes, medicine herbs, rubber, mushrooms, as well as grain and timber. Plastic solar greenhouses are being used in vegetable plantation over a vast area of 6,000 hectares in total. These facilities are both technologically and economically practical and expanded step by step.

In China, silicon solar cell production has a history of over twenty years. Owing to the high costs, they have been limited to applications in space and as a kind of photovoltaic device in a long time. Since the 70's, a comprehensive utilization of single crystal silicon has begun. The manufacturing technology of solar cells has been improved and their costs reduced rapidly. Silicon solar cells have been extensively used in beaconing light, railway signal, electric fence, TV repeater and communication, etc. At present, in order to reduce the cost and improve the photo-electric conversion efficiency, and extend their fields of application, polycrystal silicon, amorphous silicon, cadmium sulphide and gallium arsenide solar cells are being developed.

The passive solar houses being tested will play an effective role in energy conservation and in space heating. Recently, several passive solar houses built in nothern and northwestern China have achieved iniatial success. Since their cost is low, they will influence the old houses retrofit style in rural areas of northern China. extensively

The scientific research in solar energy is being carried out. In addition to the specialized research institutions, some basic and applied research is also done in universities, factories and other institutes. Our government gives necessary support in fund, materials and trained personnel, and the policy is to encourage the activities of the scientists and technicians, bring their initiative into full play and help the application departments to speed up trial and expansion of new technology. However, our level of solar energy technology is not so advanced, generally speaking, it is still in an experimental stage. For those technologically

feasible and economically reasonable solar devices, we will perfect them step by step and put them into extensive use.

China has a long history of wind energy utilization. Until now, in middle and southern China, some civil water transportations in the river network still rely on sailing boats. There were about 600,000 tons of cargo transported by junks in I979. But over the past two decades we have not paid enough attention to the development of wind energy even replaced some traditional use of wind energy with electricity. Consequently it had sharpened the shortage of electric power supply in rural areas. Over the past two years, every part of the country has realized the importance of making full use of energy resources available, and the utilization of wind energy has again drawn the attention of people. Now some small wind turbines has been developed in Inner Mogolia Autonomous Region, Gansu and Zhejiang Province, and their power varies from I00W to I0 KW. Some I8KW and 40KW wind turbines were equipped with old helicopter propeller blades. In view of the real technical and economic situation in China, we plan to develop the small size wind turbines at first, and then put our emphasis of wind energy development on those remote regions with rich wind energy resources but are lack of conventional energy resources.

(III)

The Hydropower potential in China is abundant, with a total theoretical capacity of 680,000 MW, of which 370,000 MW could be economically exploited. However, 70% of the hydropower resources spreads over the southeast part that is sparsely populated. The hydropower potential which has already been exploited and utilized is only 3% of the total. Therefore, the potentiality of the hydropower resources in China is very great. The development of small hydropower will be one of the focal points in the future energy development of China.

The guiding principle of development of hydropower in China is the combination of large, medium and small scale stations. 18 large hydropower stations over 250,000 KW totaling a capacity of 8.15 million KW, i.e. over 40% of total electricity capacity from hydropower, together with nearly 90,000 small hydropower stations of less than 12,000 KW with a total capacity of 6.8 million KW, i.e. over 30% of total electricity from hydropower, have been constructed; and the rest are of medium scale.

The largest hydropower station in China at present is Liujiaxia Hydropower Station on the upper reaches of the Yellow River,which has a concrete gravity dam 157 meters high, a 5.7 billion cubic meter reservoir and a 1.225 million KW installed capacity as well as an annual electricity generation capacity of 5.7 billion KWH. The Gezhouba Hydropower Station being built on the Yangtze River,the longest river of China,has an estimated capacity of 2.7 million KW.

The large hydropower stations are invested and managed by the state,the medium ones are built by the provincial,regional or the central governments,while the small scale ststions are constructed and managed by the counties,communes or production teams. As mini-hydro requires less technology and investment. The state supplies an appropriate subsidy or loan to bring the masses' enthusiasm into play and practises a policy of "owned,managed and profited by those who built them". More than 1,500 out of 2,000 counties in China have built up mini-hydro stations,covering some 40% agricultural electricity consumption. The mini-hydro has played a proper role and well accepted,especially in remote mountainous areas and the areas inaccessable to large grids.

China has a coastline longer than 18,000 KM. and a tremendous reserve of Tidal Power. The estimated exploratory tidal power capacity is around 28 million kW,with an annual electricity generation capacity of 70 billion KWH. However,only several small tidal pilot power stations have been built along the coast of Guangdong, Zhejiang,Jiangsu and Shandong provinces,with a total capacity of 6,300 kW. The Jiangxia Tidal Power Station recently built in Zhejiang Province has a designed capacity of 3,000 KW, and a 500-KW generator set already in operation.

(IV)

China is relatively rich in Geothermal resources. There are around 2,500 naturally outcropping hot springs and partially exposed underground hot water deposits in this country. The hot springs mainly exist in provinces along the southeastern coast and in Tibet, west Yunnan and west Sichuan in the southwest. In the two zones mentioned, hot springs are not only large in number but also high in temperature, forming two medium and high temperature geothermal zones, designated as Pacific Oceanside Geothermal Zone and Tibet-Yunnan Geothermal Zone respectively. The Pacific Oceanside Zone involves Chinese Taiwan, Fujian Guangdong provinces as well as

east Liaoning and the Shandong peninsulas, possessing nearly 600 hot springs which are equivalent to some quarter of total outcropping hot springs in this country. High temperature hot springs in this zone mostly exist in Taiwan Province. The temperature in Macao area reaches 293°C. Those in the provinces on the continent are mostly medium temperature hot water deposits of about 100°C. The Tibet-Yunnan Zone is the most violent area of hydrothermal activity in China, possessing a large number of fountains and vapour springs. There are some 500 hot springs discovered in this zone, together with some 100 hydrothermal activity areas of intrinsic temperature higher than the local boiling points. At Yangbajing geothermal field now under exploration, steam of 171°C is obtained from drilled holes over 200 m. in depth. And the temperature measured in 12-m. shallow holes in Tengchong geothermal field in Yunnan is 145°C. Numerous hot springs are also distributed over other areas in China, but mostly are with low temperature water below 90°C.

Geothermal energy is pressently utilized in the livelihood of the Chinese people as well as in industrial and agricultural production. Underground hot water was used in medical treatment and domestic usages before the fifties, then in industry and agriculture in the sixties. In the seventies, the resources were considered as a new source of energy and larger scale investigation, research and utilization of it followed . Geothermal energy is used at present in electricity generation, industrial processing, domestic space heating, agricultural greenhouses, aquaculture as well medical treatment. The utilization of geothermal energy has yielded fine results in coal saving, transportation reduction and pollution alleviation.

However, the exploration and utilization of geothermal resources in China are yet in general at a preliminary stage, hence in a small scale of productive utilization. In the light of the features of Chinese geothermal resources and the potentials of current economy and technology, the major policy in a period to come is to carry out survey, exploration and comprehensive utilization of geothermal energy in a planned way, and with certain priority.

(V)

Besides the above mentioned new and renewable sources of energy, Animal Power, Oil shale and Peat, etc. are also utilized and developed to varied degrees as energy resources in China. Animal power is extensively used in our country. The use of cattle, horses, mules, donkeys and oxen to pull carts and till farms has played an important role in a considerably long period in the history of our country. Up to now, using oxen to cultivate farms is still quite common in Chinese villages, especially in hilly areas and irrigated farms with varied topography. Most farm products are still transported by horse-drawn carts in the northern rural areas. According to China's geographical feature and technical and economical conditions, animal power will play an important part for a rather long period in the future. Particularly, since the state could not provide enough petroleum products to meet the rural needs due to the energy shortage, further development of animal power has its real significance. Presently we have altogether 50 million head of draught animal like horses and oxen. It is predicted that animal power will still increase considerably in the near future along with the increase of agricultural production.

The oil shale deposit in China is quite rich and it dispersed over Liaoning, Guangdong, Jilin and other provinces. In some areas the oilshale deposit is not deeply buried and the layer is quite thick, suitable for opencast mining. The oil shale industry in China has a history of several decades and produces mainly the shale oil and its by-products by ways of dry distillation. Since the founding of the People's

Republic, shale industry has expanded rapidly. The type of furnance and the processing technology have both been greatly improved and developed. Shale oil refineries were established in Liaoning and Guangdon provinces. Some R & D works on oil shale are carried out in these refineries. The development of shale oil processing levels off since the extensive exploitation of raw petroleum. The present annual production of shale oil in China amounts to 300,000 tons, but there are still many areas in production equipments and technology to be improved.

Peat is also one of the valuable natural resources. It has a wide use in industry, agriculture and medicine. China also has a rich peat deposit, approximately 8,5% of the world's reserve. But before 1960, no systematic investigation nor exploration was carried out. Thereafter, a nationwide survey of peat resource was organized and study was carried out on its utilization in many fields, for instance, as domestic fuel or fuel for baking meat to brew high quality liquor, as an ingredient of fertilizer, fibreboard and light weight insulation brick, and as raw material from which acid is extracted. Full utilization of peat represents an important course to take.

Energy is closely related to the development of national economy and the improvement of living standard of people. Presently the main energy resources are still the conventional ones as coal, petroleum and natural gas. From the point of a global view, the tremendous consumption of conventional energy and its ever increasing growth have already constituted an obvious threat to the limited resources. Despite the fact

that energy resource condition vary from country to country, shortage of conventional energy is, to certain extent, common to all countries. And China is no exception. Undoubtedly conventional energy still holds positive dominance within this century, but the strain will increase day after day. In the 21st century, the decreasing resources and rising prices of conventional energy will reach such a point that the present development of conventional energy will lose its momentum and will leave gradually its place to other new energy. According to the historical experience, two to three or even more decades of transition period is needed to complete every significant revolution of energy. If we do not place right now the new and renewable energy onto agenda, a serious situation of temporary shortage of energy will certainly arise in the 21st century, not to mention that some new energy already have brought practical results. Based on this understanding, the Chinese government is undertaking research and development on new and renewable sources of energy. Since China is a populous and a large country and a developing country as well, we have to develop our new and renewable energy with our efforts according to our specific situation, and at the same time, we also wish to learn the advanced technologies and experiences from other countries, so as to establish extensive international scientific and technological cooperations. We believe that the prospects for these cooperations are very broad. We hope to promote further development on new and renewable sources of energy throughthe common efforts of all countries.

We suggest that a feasible programme of action be formulated through this UN Conference on New and Renewable Sources of Energy, in order to mobilize the governments of all countries in adopting active measures in developing international technological cooperation. And in partcular, the countries technically advanced and experienced should contibute more to the progress of mankind and give necessary assistance to the developing countries. We also suggest that some experts be dispatched by the United Nations to investigate and evaluate new and renewable resources in the world, and to put forward reasonable schemes of utilization for reference of the countries concerned. To break through the technical and economic barries in applying new and renewable sources of energy, we hope that the United Nations would choose and subsidize some countries and in establish disciplinary and regional centres of research and demonstration so as to create favourable conditions for training specialists and developing international cooperations.