Title	**Biogas and ecological sanitation - combining German and Chinese know-how**
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Short CV for Introduction Purposes (100 words max)	Ms. Zhang is leading the Biogas and Waste Treatment Group of the Institute of Energy and Environmental Protection (IEEP) in the Chinese Academy of Agricultural Engineering (CAAE) for the past three years. Ms. Zhang is an experienced biogas and fertilizer expert. Mr. Mang works for over 25 years on projects involving renewable energy, biogas, waste and wastewater treatment and reuse, and ecological sanitation. He designed decentralized community waste treatment and recovery systems and introduced urine separation toilets in Bolivia in 1994. He trained Bolivian, Burundian, Burkina, Cuban, Chinese and Jamaican institutions on decentralized wastewater treatment. He is engaged as biogas expert of the CAAE.
Photograph attached (jpg)	

1. Introduction

China's problems in human waste disposal are massive, and the country is seen by the United Nations as crucial to helping it meet the Millennium Development Goal of halving the proportion of the world's population without access to basic sanitation. **But - if China could not fulfil the target, how other countries could ever reach the goal?**

Although China is one of the countries with the richest fluvial and lake system, it belongs to the countries with the lowest per capita water resources. China faces water shortages in half of the country's 600 cities. The water resources available per person are one fourth of the world average (2500 m3). The level of ground water is decreasing. An important share of the population has no access to drinking water, and 170 million people use polluted water and contaminated drinking water. Till 2030, when the Chinese population will count 1.6 billion people, the total water consumption is estimated at 700-800 billion m3, whereas estimated resources available will be about 800-900 billion m3. The water quality of the Chinese rivers is low to the point that only 25% of the water after treatment achieve drinking water standards. The main reason is the discharge of untreated agriculture, industry and household wastewater in the watercourses. Only 20% of the wastewater is treated before discharge. (4)

Rural areas do not have sewage systems, and almost all of the domestic wastewater and runoff are discharged directly to the surface water. This situation has led to serious non-point pollution in many areas. The absence of infrastructure creates a demand for small-scale wastewater treatment and improved sanitation facilities. (5) Household stock farms could combine wastewater treatment and biogas collection and usage systems, as showed in millions of cases already existing in China.

However, in recent years China has created an advanced legislative framework for environmental protection, and in order to apply these laws more effectively, central and local authorities are seeking support from national and international experts familiar with advanced sanitation and environmental technology and experienced in other dense populated developing countries. There is a felt need for specialists with experience in the implementation of laws and guidelines and also in policies, incentives and even in technologies to support public services, households and private enterprise to adopt "green technologies" and "cycle management" that are in demand.

Such integrated international experts working in China have an additional task: to help master the complicated transition from a planned economy to a market economy. After all, the Federal Republic of Germany has had to cope with the same problems in the east of the country in the wake of reunification. Here, too, the priority tasks were to privatise state owned companies, encourage the founding of small and medium-sized enterprises, introduce environmental sanitation, and to provide an attractive climate for investment. This – together with an European and world wide experience with ecological sanitation gathered by German Enterprises, German Research and Educational Institutions and German Development Cooperation - is a good starting point for the transfer and local development of appropriate know-how in sustainable sanitation. On the other hand, Germany supplied 17.5 % (1996) of the world market for environmental technology. However, common barriers for foreign environmental technology promotion in China are for instance the price, which does not match the demand, the fact that the technology is not adequate for the status of development of the market, and the different cultural perceptions of the natural environment.

Therefore joint expert team cooperation is needed. By following this approach, it is possible to combine in an optimal way the specialist know-how in the areas of sanitation, agriculture, horticulture, landscape gardening and sector business organization. The integration in local, regional and international networks as well as facilitating the access to potential partners, clients and key decision-makers in China and Germany makes such cooperation useful.

With a GDP rate of growth of 8%, the industrial and economic development impacts the

environment. However, China, at this economic development stage, is more advanced in addressing environmental issues and integrating environment into its overall policy than any other country has been in the past, as the World Bank admits.

Experts consider China still 15 years behind Europe in the field of environmental protection. A report from the China Council for International Cooperation on Environment and Protection mentioned the lack of environmental knowledge and technology transfer as reasons for the slow development of environmental protection. To satisfy the needs of pollution prevention and the protection of the ecologic environment, efforts in developing new technologies and the promotion of environmental sound technologies have been intensified. (4) As for wastewater treatment and biogas generation, China develops its own local design and manufacturing capacity. Technologies for sustainable sanitation, decentralised wastewater treatment, as well as basic monitoring equipment have developed significantly during the last two decades.

2. What is sustainable sanitation?

Epidemiologists studying historical records can point to the impact of sanitation on people's health. Life expectancy increased as access to clean water and sanitation increased. Sewers played their part, moving pathogens from more to less populated areas. Diseases like typhoid and cholera saw dramatic reductions in urban populations with access to sewerage. Only recently we started to understand the long-term health and environmental costs of sewers, and now the world is a much more crowded place than it was, when the first sewers were built.

“Sustainable Sanitation” is a key to Sustainable Development! Conventional sanitation can only operate with high water consumption. Conventional sanitation has been developed without consideration of water and fertiliser reuse thus depriving the served region of valuable resources. Mixing the small amount of dangerous faecal matter with large amounts of water spreads pathogens to receiving waters - often without treatment as it can be seen all around the world. Conventional sewerage systems do flood the streets with raw wastewater in countries with heavy rainy seasons in too many cases (just to name a few of the many problems). Sustainable sanitation is designed for low water consumption (demand side management) and aims for full reuse of water and fertiliser. Sustainable sanitation is often based on source control of faecal matter to secure highest hygienic standards and keep it apart from freshwater. Sustainable sanitation is adaptable to the socio-economic conditions trough the use of high-to-low-tech technologies. Sustainable sanitation allows economic water reuse by separate collection and treatment of greywater, the fraction of wastewater not polluted with faecal matter. Sustainable sanitation is often decentralized and is capable to provide high performance at low costs – user involvement and proper maintenance is a key to success. (1)

Scientifically spoken: Sanitation that is sustainable spends the minimal amount of energy and resources with the least loss of useable matter to contain and convert it to its usable form in agriculture, gardening and landscaping. Evaluating any given sanitation system calls for a survey of energy and material inputs to useable and un-useable outputs.

How can we decide which is the optimal sanitation system for a given place? By using the concept of entropy - a concept derived from the second law of thermodynamics - to measure the relationship between waste (human and industrial), the processes and methods used to treat it, and its final disposition. Entropy is a tool that can measure natural resources, energy, capital, and labour inputs and evaluate outputs. Sustainable sanitation utilizes low entropy systems, which minimize inputs and maximize useful outputs. (2)

3. Identifying markets for sanitation sub products

China is currently the fastest growing economy in the world. There are very good medium to long-term development and business prospects for the reuse of organic fertilizer also based on sanitation recyclates for agriculture, horticulture and landscape gardening: A powerful industrialization and urbanization as well as a heavily polluted environment make the extension of existing and the construction of new open and green spaces absolutely necessary. A growing national average income, an extended national food security policy combined with the need for lowering the expansive artificial fertilizer use, and leisure awareness is increasing the demand for open green spaces, sports facilities and children's playgrounds.

Central and local Chinese government bodies have already formulated future-oriented guidelines for regional, state and urban green spaces as well as the associated specific implementation measures for horticulture and landscape gardening. Under the motto "New Beijing – Green Olympics", the city of Beijing has for example set itself the target of turning half the entire city area into green spaces by 2010. (3)

This and many other planned green space projects provide promising cycle management opportunities. Recycling economy is becoming a topic of high interest to the authorities and the wealthiest cities are developing concepts in this direction. Germany's waste technology know-how and products can benefit from this potential development of the Chinese market. Low cost resource recovery systems and ideas are most interesting in this frame, as for example the German concept of waste as "secondary raw material", which was very developed in East Germany. Together with an improved sanitation strategy for urban and rural areas an 'Environment-Friendly Agriculture' should be promoted, with a focus on a '3 Don'ts' movement which aims to eliminate chemical weed killers, agricultural chemicals and chemical fertilizers.

Wastewater reclamation facilities in buildings and residential areas are usually greywater treatment and reuse, and storm-water collection and reuse. Reused water can be used for toilets, lawn and crop irrigation, dust control, and car washing. Wastewater reclamation systems may play an important role in water saving, given China's serious water shortages; however, only limited operations have been implemented to date. Citizens are potentially the largest group of end users. However, the basic requirements from all of these end users are low price, proper quality, and hygiene.

Biological treatment equipment in China includes devices in aerobic treatment, anaerobic treatment, sludge digesting, comprehensive biogas utilization, and anaerobic-aerobic treatment. The basic technical principle of these devices is the same as it is in developed countries.

Especially in rural areas biogas sanitary installations also provide safe fertilizers for cultivation, eliminate environment for reproduction and growth of insects which helps to reduce the amount of harmful insects by 70% to 80%, protect farmers' health and increase the productivity and quality of crops. It provides gas to serve the needs of families in rural areas, and will gradually enhance the awareness of the people and improve their living standard, while protecting the environment. The problem of water pollution and increase of flies and mosquitoes due to waste water could be overcome.

However, the greatest difficulty to overcome is the limited awareness of the Chinese urban and rural population concerning environmental issues.

4. Combining know-how

Work areas of the cooperation between Chinese and German experts to promote clean and environmentally sound sanitation and reuse technologies are: regulations, environmental management systems, subsidy programs, research programmes, labelling, economic instruments like taxes, promotion of self commitments of the industry, environmental education, specific training programmes, and institutional advice.

One possibility to combine such know-how is the cooperation of Chinese institutions and enterprises with CIM – the “Centrum für internationale Migration und Entwicklung”, the human resources recruitment and placement organisation for German development cooperation. CIM is a small and flexible organisation operating within the overall system of German development cooperation. Two strong partners, the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH (German technical cooperation) and the German Federal Employment Agency (BA), form a joint operation that supports CIM as a supplement to their own range of services. A local employment contract and commonly agreed work goals ensure that the experts and managers placed are fully integrated into local structures. As part of networks and partnerships that span the world, these specialists pursue in their work the development policy goal of the Federal Republic of Germany: results-oriented, sustainable development through international cooperation.

Nowadays 43 CIM experts are working in China as one of the focal countries in Asia, the majority of them engaged by central or local institutions and companies working in sustainable environmental sanitation, environmental protection and awareness building, and renewable energy issues. Chinese employers often approach CIM for the referral of German experts in environmental monitoring systems and impact assessment, research and instruction, technology transfer and adaptation, urban planning, waste management and water supply. (6)

There is an increased demand for CIM supported staff in certain fields as:

- introduction of environmentally-friendly technologies that lower the costs of energy, raw materials and waste disposal, and thus make it possible both to reduce resource consumption and to increase efficiency and competitiveness
- development of international and regional institutions and networks for the transfer of knowledge and technology that stress environmental protection and promotion of small and medium-sized enterprises
- utilisation of synergy with the German private sector.

Since the mid-90s CIM is also cooperating with European industry, trade and NGOs within the scope of Public Private Partnerships. Three parties join forces – German / European businesses, local employers and CIM. Not only do they share the costs; each party can tap into the experience and status of the others so that they can better achieve their common goals. The partner country too benefits from the lasting improvement in framework conditions, and from the new ideas introduced.

The Institute for Energy and Environment Protection (IEEP) of the Chinese Academy of Agricultural Engineering (CAAE) under the Chinese Ministry of Agriculture (MoA) engaged since December 2004 two integrated CIM supported experts to work in a Chinese-German team on the following aspects:

- Research, development and extension of technology and equipment for agricultural and agroindustrial waste treatment, resource comprehensive utilization and eco-agricultural construction engineering, including the creation of rural and urban ecological sanitation closed loops;
- Topic related technical cooperation, exchange and training in China and in partner countries.

Based on our expert teamwork since December 2004, we could already identify that the implementation of the concept of environmental sanitation requires support in awareness

raising, capacity building and technological development for the Chinese market.

Identified technologies that could be suitable to the Chinese conditions and needs are:

• Biological denitrification and phosphorus removal technologies

• Membrane separation and manufacturing technologies and equipment

• Manufacturing technology of anaerobic biological reactors

• High-concentration organic wastewater treatment technology and equipment

• Wastewater treatment equipment with water and nutrient recycling possibility

• Water-saving and water free sanitation technologies and equipment

• Natural water-body rehabilitation technology.

In order to broaden the know-how of Chinese and German environmental sanitation experts and decision makers, study tours from China to Germany and from Germany to China have already been carried out and will promote also in future the understanding of differences in sanitation concepts, public awareness and cultural perceptions, service for low-income population, and common environmental needs between the two countries. (7)

5. Bibliography

(1) Prof. Dr.-Ing. Ralf Otterpohl, Prof. Dr.-Ing. Peter Wilderer and Prof. Dr.-Ing. Peter Krebs (all Germany), Prof. Dr. Willi Gujer (Switzerland), Prof. Dr. Mogens Henze (Denmark), Prof. Dr. Heinz A. Preisig (The Netherlands), Prof. Dr.-Ing. Raimund Haberl (Austria), Prof. Dr. Goen Ho (Australia): Open letter to Johannesburg Summit, Division for Sustainable Development, United Nations, presented for the PREPCOM 2, 28 January - 8 February 2002, New York, USA, distributed by Fax to: 1-917-367 2341 and to all delegates, observers, NGOs and journalists.

(2) Laura Orlando: Sustainable Sanitation; The ReSource Institute for Low Entropy Systems; 179 Boylston Street; Boston, MA 02130 USA; info@riles.org; Tel 617 524-7258; Fax 617 522-0690; June 5, 2000

(3) Axel Bartkus: The horticulture and landscape gardening market in China is booming; Fair “GaLaBau China” in May 2005; published by Nürnberg Global Fairs Messezentrum; D-90471 Nuremberg, Germany; Tel.: +49 (0) 9 11. 86 06-86 88, -86 87; Fax: +49 (0) 9 11. 86 06-86 94; axel.bartkus@nuernbergglobalfairs.com; September 2004

(4) Arbeitsgemeinschaft industrieller Forschungsvereinigungen „Otto von Guericke“ e.V. (AiF): Environmental Industry in China - Netzwerk Internationale Technologiekooperation, Länderinformation China; Tschaikowskistraße 49, D-13156 Berlin, Telefon: 030 48163-470, Fax: 030 48163-404; berlin@intec-online.net; www.aif.de ; www.intec-online.net; August 2004

(5) U.S. Department of Commerce, International Trade Administration Washington, D.C.: Water Supply and Wastewater Treatment Market in China, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; www.ntis.gov; January 2005

(6) CIM: CIM - A Joint Operation - Who we are, what we do, www.cimffm.de

Petter Jenssen, Johannes Heeb, Elisabeth-Maria Huba-Mang, Ken Gnanakan, William Warner, Karen Refsgaard, Thor-Axel Stenstroem, Bjoern Guterstam, Knut Werner Alfsen: Ecological Sanitation and Reuse of Greywater – A Thinkpiece, Norway 2004