CDM PERSPECTIVES IN CHINA

OPPORTUNITIES FOR GERMAN KNOW-HOW AND CDM APPLICATION

THE CHINESE WASTE WATER TREATMENT SECTOR

May 2009

gtz

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Imprint:
Published by:

Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ) GmbH
Beijing Office
Sunflower Tower 1100
37 Maizidian Street, Chaoyang District
100125 Beijing, PR China
www.gtz.de

Contact Person:
Dr. Markus Schwegler – Country Manager CDM Service Unit China
E-mail: markus.schwegler@gtz.de

The sector study was supported by the CDM Initiative of the:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Compiled by:

UPM Environmental Engineering Project Management Consulting (Beijing) Company Ltd.

Beijing, May 2009

PREFACE

The global carbon market, with an estimated value of US$ 84 billion in 2009, is highly lucrative, not only for carbon buyers and financial institutions, but also for service providers and for technology transfer.

So far the participation of German companies in the flexible mechanisms established under the Kyoto Protocol remains low. Out of almost 1,600 globally registered CDM Projects only 87 have German involvement.

In 2008 the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) launched the CDM initiative in order to encourage the participation of German companies in the CDM market and to enable market players to make full use of opportunities presented by the CDM in respective host countries.

The CDM Service Unit China operates under the German GTZ and is part of a Global Network with CDM country units in India, Brazil and MENA.

In order to establish clear fundamentals for promoting CER trading among German companies and partners in China, the CDM Service Unit China launched a series of studies to contribute to a better understanding of the market and framework conditions.

In December 2008 the CDM Service Unit China published "Country Study China – A CDM Market Overview".

Now the CDM Service Unit China will publish a series of studies under the title "CDM Perspectives in China for German Know-How".

The following study is entitled "The Chinese waste water treatment sector – opportunities for German know-how and CDM application". It elaborates on the potential to develop CDM projects in the sector of waste water treatment.

Due to its great population and increasing prosperity, China has a huge demand for waste water treatment. Currently the Chinese waste water treatment industry presents a good opportunity for CDM development, since CDM could bring advanced know-how and additional capital to make Chinese waste water treatment plants profitable. Presently there is no registered CDM waste water project in China that can serve as general reference and guidance for Chinese projects. But considering the huge market for waste water treatment applications and the urgent need of sophisticated technology, German contribution is underdeveloped, especially in comparison to other sectors such as the transportation or wind power sectors.

Through this study CDM Service Unit China would like to enhance understanding and magnify the opportunities and challenges of the market. And furthermore, it hopes to make a significant contribution to the implementation of new types of projects within the CDM framework.

Dr. Markus Schwegler
Country Manager CDM Service Unit China
Beijing, May 2009

ABSTRACT

The target of the following study is to evaluate the market potential of waste water handling and disposal projects in China with regard to the Clean Development Mechanism (CDM) for German entities.

The study paper extends to three chapters: CDM feasibility of waste water treatment concepts, technology evaluation of Chinese waste water plants, and market potential of CDM waste water handling.

The first chapter outlines all available CDM methodologies and gives a comprehensive overview of application opportunities for different technologies of waste water treatment. So far, five methodologies related to the waste water sector are accepted by CMD EB. Among them, four methodologies are related to GHG emission reductions and one is applicable to solid reduction in waste water streams. The chapter also outlines the legal and business situation of waste water treatment and lists the applicable Chinese laws and most common business models (BOT and TOT) for construction and operation of waste water treatment plants.

The chapter evaluates CDM validation reports from existing CDM project activities and describes waste water sources and baseline scenario challenges for project developers. Finally, small scale opportunities are described and a table for Certified Emission Reduction (CER) calculation from waste water is provided for a quick overall CER estimation, depending on the amount of treated waste water. Chapter 1 provides a comprehensive overview for German companies with an interest in investing in, or providing technologies to the Chinese CDM waste water treatment sector.

Chapter 2 analyzes the situation of China's sludge and sewage treatment facilities from a technological viewpoint. It summarizes the number, load rate and capacity of waste water treatment plants in operation and currently being constructed. It displays applied; chemical, biological and physical waste water treatment processes. It will also provide an overview of possible sludge treatment (thickening, dewatering, stabilizing) and disposal measures (agricultural use, sanitary landfill, desiccation and incineration) in China.

The third chapter highlights Chinese water demand and waste water treatment capacity. It displays key findings of the study, such as; most suitable provinces for construction or upgrade of waste water treatment facilities with regard to different technologies, available support from governmental site, legal pitfalls, and missing rules for waste water treatment.

Key findings of the desk study are:

China, with well over 1,000 WWTP has huge potential for GHG reduction measures in treatment plants (upgrading of WWTP).

The required CDM methodologies are up to date and ready for application.

The Chinese government is aware of the huge implementation potential and facilitates foreign engagement.

The study acts as a guidebook for German entities that are looking for investment opportunities in the Chinese waste water treatment sector.

TABLE OF CONTENTS

FIGURES

TABLES

ABBREVIATIONS

A-B	Absorption-Bio oxidation	**GB**	National Standard (Chinese: Guo Biao)
ACM	Approved Consolidated Methodology	**GHG**	Greenhouse Gas
AM	Approved Methodology	**IRR**	Internal Rate of Return
AMS	Approved Methodology Small Scale	**KFW**	Kreditanstalt fuer Wiederaufbau
A/O	Anaerobic-Oxic	**m^3**	Cubic meter
A2/O	Anaerobic-Anoxic-Oxic	**MCF**	Methane Conversion Factor
BOD	Biochemical Oxygen Demand	**MOC**	China Ministry of Construction
BOT	Build – Operate – Transfer	**NPV**	Net Present Value
BT	Build-Transfer	**PDD**	Project Design Document
CDM	Clean Development Mechanism	**PRC**	People's Republic of China
CDM EB	CDM Executive Board	**RDF**	Refuse-derived Fuel
CER	Certified Emission Reduction	**SARS**	Severe Acute Respiratory Syndrome
CH	Methane	**SB**	Stabilized Biomass
CHP	Combined Heat and Power	**SBR**	Sequencing Batch Reactor
CO_2	Carbon dioxide	**SSC**	Small scale (project activities)
COD	Chemical Oxygen Demand	**tCO_2e**	Tonne of CO_2 equivalent
CNY	Chinese Yuan	**TOT**	Transfer – Operate – Transfer
DOE	Designated Operational Entity	**UNFCCC**	United Nations Framework Convention on Climate Change
DM	Deutsche Mark	**USD**	United States Dollar
ETS	European Trading Scheme	**WWTP**	Waste water treatment plant
EUA	European Union Allowance	**WW**	Waste water

1. CDM feasibility of waste water treatment concepts in China

China with its huge population and tremendous industrial facilities has a large demand for structures to clean and re-utilize its water resources. Therefore, China disposes of more than 1,000 waste water treatment facilities in order to meet its huge demand for water cleaning. Despite major treatment threats to the environment, the waste water facilities possess an immense energy recovery potential. But among the plants, only a small amount have the financial capacity to invest in the technology required to tap into potential for energy production. The following chapter evaluates the opportunities and challenges the CDM provides to the waste water treatment sector in China.

1.1. The Chinese waste water treatment sector

According to the figures of the Ministry of Construction of China (MOC)[1], by the end of 2008 there were 1321 waste water treatment plants (WWTP) installed in 661 Chinese cities. Their average operation load rate per plant amounts to 63.75%. Overall, 80 million m^3 of waste water is treated per day. Please refer to chapter 2 of this study for a more detailed evaluation of Chinese waste water treatment capacity.[2]

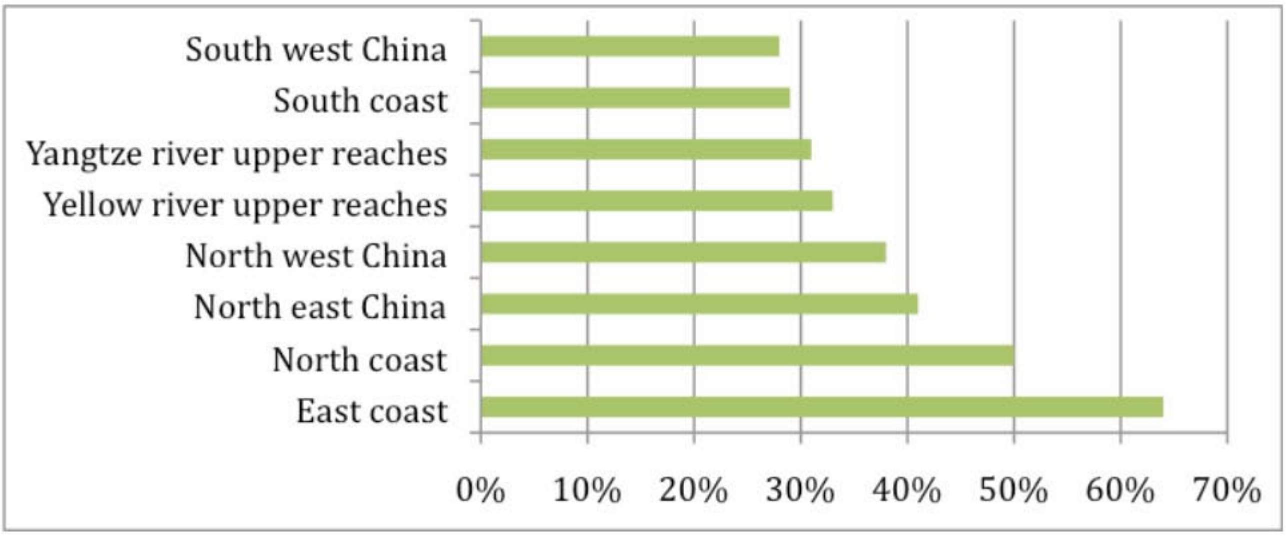


Figure 1: China waste water treatment capacity 2005[3]

The geographic distribution of WWTP in China is not homogenous. Eastern China has the highest waste water treatment capacity, and WWTPs outnumber northeastern and western areas of the country (please see Figure 1). This is due to disparities of economical and social development throughout recent years. The Eastern provinces have good access to harbors and international trading routes, Middle and Western region's economic structures depend largely on agricultural incomes, which is why these provinces, in terms of urban development, cannot keep pace with the advanced Eastern parts of China.[4]

[1] The latest statistical analysis of China's sewage treatment industry, April 18th 2008, http://www.h2o-china.com/download/datum/wushuichulichang.pdf
[2] More details see chapter 2
[3] Analysis on Chinese wastewater treatment industry development
[4] Lu Baokang, Journal of northern Sichuan education college 2001, Edition 4 "Causal Analysis on the Difference Between China's Eastern and Western Economic Development"

In its 11th five year plan (2006 - 2010) related to saving energy and reducing emissions in waste water treatment the government of China aims to increase the national urban wastewater treatment rate to 70% by 2010. By 2010, the Chinese government plans to install at least 1,000 new WWTPs to fulfill the domestic wastewater treatment demand, including industrial waste water. According to the 11th five year plan, the Chinese government will invest approximately 300 billion CNY in the waste water treatment sector.[5]

The Ministry of Construction (MoC) of People's Republic of China (China) is responsible for developing strategies and objectives for the construction sector. Waste water treatment plant organization and sewage sludge handling is also under the authority's jurisdiction. Framework conditions and technical requirements are defined in technical guidelines and building codes, which are prepared under the direction of the MoC. The main emphasis in recent years has been placed on the fast construction and implementation of wastewater treatment plants in order to improve water quality for relevant water usage bodies. The 11th five year plan for the period 2006-2010 aims to treat 70% of China's urban wastewater until 2010.

1.2 CDM opportunities in the Chinese waste water treatment sector

Average waste water contains 99% water with a small amount of dissolved solid matter. Before reuse or discharge the waste water can be treated in a multi-stage cleaning process. This process will be shortly described, followed by implementation fields for the CDM.

The first stage of the treatment process removes larger solid organic and inorganic material. Afterwards the settled waste water passes into sedimentation tanks where biomass from waste water settles and is concentrated as activated sludge. Sludge collected during the treatment process contains a large amount of biodegradable material.

The target of CDM is it to reduce or avoid Greenhouse Gas (GHG) emissions. Therefore, in Figure 2 we can see the potential sources of GHG emissions from a regular waste water treatment process that can be avoided (e.g. number 1 and 2, namely CH_4 emission) if suitable measures or technologies are adopted to improve the situation. Number 3 shows the potential of replacing fossil fuels by using biogas. From a CDM point of view, avoiding CH_4 emissions is very attractive since the Global Warming Potential (GWP) of Methane is 21 times higher than that of CO_2. During CDM project development, project developers have to proof very carefully the sources of CH_4 emission following the strict requirements of the approved methodologies.

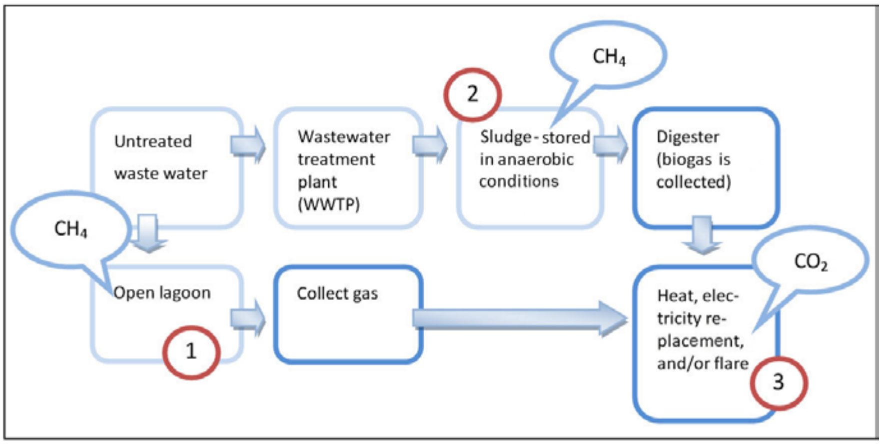


Figure 2: Waste water treatment process model

[5] The difficulties the Chinese wastewater treatment are facing during development http://info.water.hc360.com/2008/11/110933119856.shtml

The purpose of CDM

The CDM was established as one of two mechanisms to address the urgent needs of climate change. It provides a framework for project developers to engage in activities that reduce Greenhouse gas emission and receive for a Certified Emission Reduction (CER) unit for every achieved tonne of GHG - equivalent to CO_2 (CO_2e). The produced CERs may then be sold to an international Carbon trade market. Thus, the CDM becomes an attractive financing instrument to project activities which would otherwise not be financially feasible.
During recent years, CER prices ranged between 7 and 24 EUR per certificate. CERs are traded on different exchange platforms and under different conditions, which is why there is no global CER price. But common factors that influence the price may be identified. Every single CER may be sold at different stages of project implementation; at early stages the contracted CER bears additional delivery risks (defined by the legal and business situation of project's host country, experience of project developers, currency exchange risks, etc.). At later development stages, CERs may be sold for higher prices. Another important factor for CER price definition is the supply and demand situation of entities that have binding GHG emission reduction commitments under the Kyoto Protocol or other trade mechanisms that approve CER import. The largest system in terms of trade volume and amount of reduced CO_2e units is the European Emission Trading Scheme (ETS). That is why during recent years, CER prices have been traded at a discount to European Union Allowances (EUA).
The CDM defines methodologies which are the basis for the implementation of all GHG emission reduction project activities. They provide guidelines on how to prove that emission reductions are additional to any measures that would occur without CDM. Furthermore, they stipulate how to calculate emission reductions.

Waste water CDM methodology assessment

All methodologies considered are from 27th March 2009 and are subject to change. One new methodology is also included, although still in the registration process. Project developers should carefully monitor the process due to uncertainties of final implementation and availability for CDM project development. All methodologies are listed below, followed by a table with all related and most important applicability criteria. For more details and recent information, please use the links specified in the footnotes.
The CDM categorizes three different methodology types. Approved Methodologies (AM) are regular methodologies without any limitations and Approved Small-scale Methodologies (AMS) are those with certain limitations in order to facilitate CDM development in less attractive sectors and regions. Approved Consolidated Methodologies are a combination of other methodologies which have been merged.
In total, 6 methodologies are provided by the CDM with relevance to waste water treatment and 2 with respect to landfill activities. These have been included in this study because, in China the sludge from waste water treatment plants (WWTP) is commonly disposed in landfills often without further treatment and stabilization. Sludge treatment is a major challenge to municipalities in China. Nevertheless, it has major potential to be exploited as a CDM project.

AM0039: Methane emissions reduction from organic waste water and bioorganic solid waste using co-composting, version 02[6]
This methodology is applicable to project activities that avoid GHG emissions resulting from anaerobic degradation of organic waste water in open lagoons or storage tanks in combination with bioorganic solid waste in landfills. Waste from manure management systems is excluded.

ACM0014: Mitigation of greenhouse gas emissions from treatment of industrial waste water, version 03[7]
This methodology is applicable to activities that aim to reduce Methane emissions from industrial waste water. It embraces the treatment of waste water and sludge.

AM-III.H: Methane recovery in waste water treatment, version 10[8]
The methodology embraces measures to recover biogas from organic matter in waste water by introduction or upgrade of an anaerobic system. The recovered biogas may be combusted.[9]

AMS-III.I: Avoidance of Methane production in waste water treatment through replacement of anaerobic systems by aerobic systems, version 07[10]
This methodology comprises measures that avoid the production of Methane by waste water that is being treated in anaerobic systems. The project activity substitutes these anaerobic systems with aerobic ones. No opportunity of collecting Methane for combusting or flaring purposes is provided.

AMS-III.Y: Methane avoidance through separation of solids from waste water or manure treatment systems, version 01[11]
This methodology deals with the removal of volatile solids in anaerobic waste water treatment systems. The separated solids may be further used, e.g. heat generation, RDF/SB[12] production, or animal feeds. The project activity does not apply biogas recovery and combustion methods.

NM0250: GHG mitigation through implementation of aerobic waste water treatment system, version 02[13]
This methodology implements an aerobic treatment system that substitutes an existing or a proposed open anaerobic lagoon. The aerobic treatment system may be equipped with a sludge collection system.

Landfill methodologies

ACM0001: Consolidated baseline and monitoring methodology for landfill gas project activities, version 10[14]
This methodology is applicable to activities that capture biogas from land filling.

AMS-III.G: Landfill Methane recovery, version 06[15]
This methodology embraces all measures to capture methane from landfills including, human, municipal, industrial and other solid wastes containing biodegradable organic matter.

---

[6] AM0039 version 02: http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_PMB1BBMS56VWLFM0GE6S01W8TS5TTP
[7] ACM0014 version 03:http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_4E2WZ1WV1FOT4CUBAB53MI0B0FRNFK
[8] AMS-III.H version 10: http://cdm.unfccc.int/UserManagement/FileStorage/2AGFEDO7ZC6J9UP1MSY5BKHL8IWV4Q
[9] Chinese laws stipulate that 80 per cent of the biogas have to be applied to energy production and only the remaining 20 per cent may be flared.
[10] AMS-III.I version 07:http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_2F55F8VHY9ELZ1DKK2MXZG4MU70NV9
[11] AMS-III.Y version 01: http://cdm.unfccc.int/UserManagement/FileStorage/CDM_AMSPF0L5B0DFF718Z1218V5QQWFFBU5IR
[12] Refuse-derived fuel, Stabilized biomass
[13] NM0250 version 02: http://cdm.unfccc.int/UserManagement/FileStorage/U9CP8I7FE77EM3OIC1XWF6LGIE6ZHB
[14] ACM0010 version 10: http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_C3F7XHP7QE019P091PQEIZ862CDERC
[15] AMS-III.G version 06: http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_341FT628YO0PX9D2BW9IDMHSTPY139

Table 1 gives an overview of all waste water methodologies and their special approach to GHG emission reduction according to the waste water treatment process displayed in Figure 2.

Table 1: Applied CDM Methodologies - brief overview[16]

Methodology	Baseline activity	Project activity	Option for power production	Newly built or upgrade only	What kind of waste water may be used?	Project size (CERs)	Applicable scenario acc to figure 1
AM0039	Anaerobic degradation of waste water in open lagoons	Co-composting processes for waste water treatment	Yes	Both	No waste streams from manure management	Large scale	1, 2
ACM0014	Open anaerobic treatment of waste water and sludge	WW or sludge: anaerobic; sludge: aerobic	Yes	Both	Industrial waste water	Large scale	1, 2, 3 (from industrialized waste water)
AMS-III.H	Existing anaerobic/ aerobic system	Anaerobic newly installed or upgrade of waste water and sludge treatment	Thermal or electrical energy generation	Both	All types of waste water	SSC	1, 2, 3
AMS-III.I	Anaerobic systems without Methane recovery	Aerobic biological systems	No	Upgrade	Waste water from anaerobic treatment of organic matter	SSC	1, 2
AMS-III.Y	Existing anaerobic waste water treatment or manure management system	Solids removal	No (other AMs applicable)	Both	Anaerobic waste water and manure waste	SSC	1 – with focus on the solids removal screen
ACM0001 (Landfill)	Partial or total release of biogas to atmosphere	Biogas is captured and flared/used for energy production	Yes	Both	- (applicable if sludge is disposed)	Large scale	2, 3
AMS-III.G (Landfill)	Landfills used for disposal of organic matter	Methane recovery from landfills	Thermal or electrical application (bottling)	Both	- (applicable if sludge is disposed)	SSC	2, 3

[16] UNFCCC CDM Baseline and monitoring methodologies http://cdm.unfccc.int/methodologies/index.html (accessed 27 March 2009)

Current application of existing methodologies

Table 2 displays the status of all CDM projects that apply waste water methodologies according to their registration process with the CDM EB.

Table 2: Global (China) CDM project activity overview according to development status with the CDM EB[17]

Methodology	Registered World	Requesting registration	At DOE validation	Withdrawn from registration	Total
AM0039	1	-	19	1	20
ACM0014	-	-	11 (1)	-	11 (1)
AMS-III.H	7	-	51 (5)	-	58 (5)
AMS-III.I	3	-	5	-	8
AMS-III.Y	-	-	-	-	0
ACM0001 (Landfill)	79 (15)	10 (1)	78 (18)	-	167 (34)
AMS-III.G (Landfill)	4	1	16 (2)	-	21 (2)
Total	**94 (15)**	**11 (1)**	**180 (26)**	**1**	**286 (42)**

A great number of projects are still in the developmental pipeline (more than 60% of all project activities) due to the fact that the CDM EB recently slowed down the approval process. This is also a sign that waste water treatment potential has been tapped into by project developers only recently. AMS-III.H (small scale projects) has a very high share among all waste water treatment methodologies; landfill project activities usually apply ACM0001 (large scale projects).[18]

1.3 Challenges for CDM implementation in the Chinese waste water treatment sector

The UNFCCC requires that project activities, who want to be registered to the CDM, result in additional Greenhouse gas emission reductions that would not occur in the absence of the proposed project activity (Principle of 'Additionality'[19]). The extent of this additionality check includes an analysis of the legal and financial/business situation in the market of the proposed area of implementation.

Legal situation of Chinese waste water facilities

1. *Water Law of the People's Republic of China (PRC)*[20]
   Article 6, all units shall strengthen the prevention and control of water pollution so as to protect and improve water quality. The Chinese people's government at various levels shall, in accordance with the provisions of the Law on the Prevention and Control of Water pollution, strengthen supervision over, and management of, the prevention and control of water pollution.
2. *The Prevention and Cure Law on Water Pollution of the PRC*[21]
   Article 3, all relevant departments under the State Council and local people's government at various levels must incorporate protection of the water environment in their plans and adopt ways and measures to prevent and control water pollution.

[17] Joergen Fenhann, UNEP Risoe CDM pipeline as of 1 March 2009; summary by UPM-Oasis
[18] Based on methodology evaluation database of UPM-Oasis
[19] Tool for the demonstration and assessment of additionality http://cdm.unfccc.int/methodologies/PAmethodologies/AdditionalityTools/Additionality_tool.pdf
[20] Water law of People's Republic of China
[21] The Prevention and Cure Law on Water Pollution of the PRC

3. Municipal Waste Water Treatment and Pollution Prevention Technique

Term 2.2, all cities and towns with an organization system should build centralized municipal waste water treatment facilities.

4. Management Measures for Municipal Waste Water Drainage Certificate[22]

Article 3, any drainage entity who will discharge waste water into urban drainage pipelines and affiliated facilities shall abide by the measures to apply a waste water drainage certificate.

Article 4, the drainage entities refer to individuals, companies and other entities who will discharge waste water into urban drainage pipelines because of the following activities: manufacture, construction, electricity and gas production, scientific research, health-care, hotel and restaurants operation, household services, other kinds of services, etc.

5. Discharge standard of pollutants for municipal wastewater treatment plant[23]

The standard sets up the pollutants discharging limitation for output effluent, emissions and sludge disposal of the plants.

6. Design Standard of Ancillary Buildings and Affiliated Facilities of Municipal Waste Water Treatment Plant

The focus of development will be placed on the industrialization of the municipal waste water treatment sector and great importance is attached to introducing foreign investment into the sector.

In 2002, the Chinese State Council issued "Ideas to promote industrialization of municipal wastewater treatment and waste disposal sectors".[24] The ideas emphasize that cities with existing waste treatment facilities should impose a waste treatment fee, so that operation costs are covered and a small profit margin can be realized. The plan also proposes franchising business models in the WWTP-sector.
Another issue addressed by the Chinese government is the lack of foreign (advanced) technology. The Ministry of Finance therefore suggested a preferential tax treatment policy for foreign investors in rural and urban drainage systems.
All in all, the legal situation shows the clear target of the Chinese government to develop step by step a real market for WWTP. The legal situation gives a well-developed framework for. From a CDM point of view additionality could be proven in the meaning of legal requirements if existing regulations are considered and the project activity is not in conflict with them.

Business and financial challenges of Chinese waste water facilities

Based on the current situation of existing treatment plants, the cost of investment for wastewater treatment amounts to 1,500 – 2,000 CNY per ton of waste water and the operation cost to 0.8 - 1.4 CNY per tonne.[25] Currently, common practice is that WWTPs are invested in and operated by the Chinese government on provincial and state levels. But state-based solutions for new plants and the upgrade of existing plants will not be sufficient to meet the future demand for waste water treatment. In order to source related investment financing opportunities, several successfully implemented business models from industrialized nations have been introduced into China since early 2000.

---

[22] Management Measures for Municipal Waste Water Drainage Certificate
[23] Discharge standard of pollutants for municipal wastewater treatment plant, National Standardization Management Committee& National Quality Supervision and Inspection and Quarantine proclaiming in 2002
[24] Whole content of the Ideas: http://www.china.com.cn/chinese/PI-c/211533.htm
[25] Wen Bing, Liu Mingyuan "Briefing On Construction And Financing Of Municipal Wastewater Treatment Plant", building in guangxi, 2001, 12 Vol. 26, No. 4

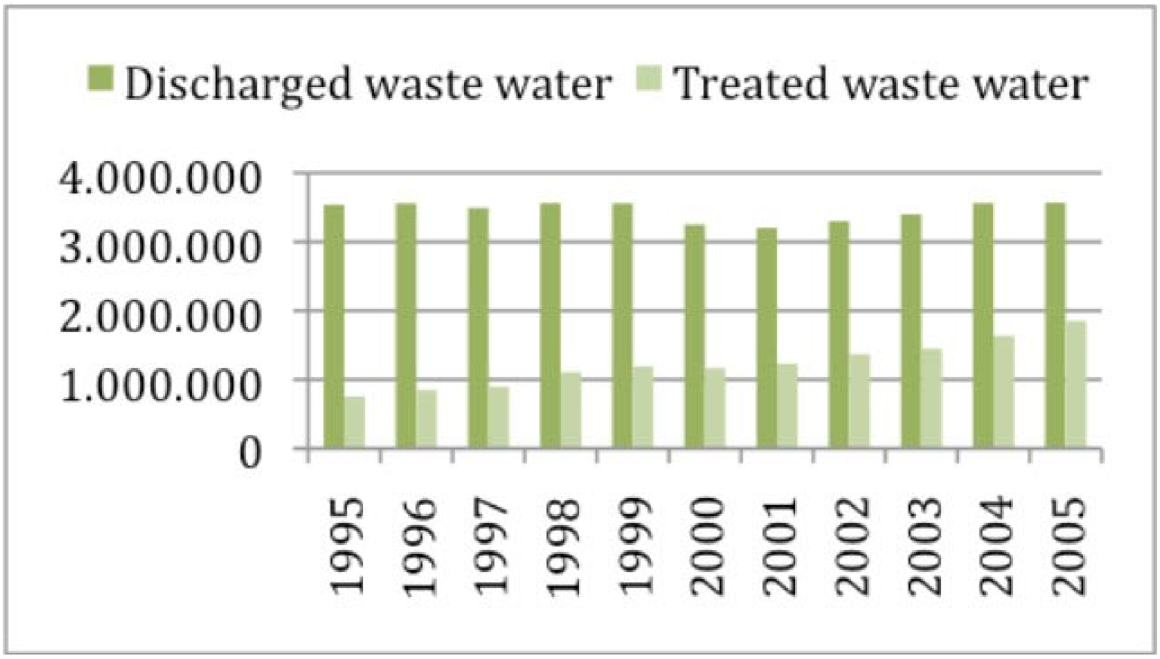


Figure 3: Growing demand for waste water treatment in China

Build – Operate – Transfer (BOT) is the most common franchised operation model for municipal infrastructures. The enterprise is assigned by government authorities with the investment, construction, operation and maintenance of the WWTP. At the end of the franchising period, the ownership right will be transferred to the government. Occasionally, the enterprise remains responsible for the operation of the plant.

Another model is the Transfer – Operate – Transfer (TOT) model. Planning, design and construction of the WWTP is accomplished beforehand by the government. It will then transfer the operation rights to the enterprise, which will operate the WWTP for a specific period. After franchise period termination, the operation rights will be transferred back to the government. In comparison with BOT, the enterprise will have a significantly lower risk at construction stage. In total 72 WWTPs apply the TOT model.

Among all 1,321 sewage treatment projects in operation, there are 342 BOT projects (26%), 98 trusteeship[26] projects (7%), 72 TOT projects (5%) and 35 BT (Build – Transfer) projects (3%). 774 projects apply other operation modes.[27]

An example of BOT mode can be found at Beijing Xiaojiahe WWTP, with a total investment of 110 million CNY. Among the 771 sewage treatment projects under construction, there are 299 BOT projects (39%). In comparison with currently operating projects, the proportion of BOT projects has increased by 13%. The proportion of TOT projects under construction has decreased to only 1%. For detailed figures, please refer to Annex 8.[28] Foreign investors are encouraged to invest in WWTPs in urban areas, either via wholly owned companies or by entering into a joint venture with the municipal utility company or another party. The joint venture then enters into a BOT or TOT concession contract with the municipal utility company.

[26] Trusteeship project: maintenance and operation is entrusted to one specific company
[27] The latest statistical analysis of China's sewage treatment industry, April 18th 2008, http://www.h2o-china.com/download/datum/wushuichulichang.pdf
[28] The latest statistical analysis of China's sewage treatment industry, April 18th, 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

The Chinese government is investing large sums into the waste water treatment sector, although the waste water sector shows poor efficiency and capital-return performances. 4 billion CNY was invested into the top national 51 WWTPs by the Chinese government, nevertheless their net profits are only 390 million CNY per period, with 16 plants being financially unfeasible. The major problems are twofold: the shortage of advanced technology and the lack of operation and maintenance experience. This leads to an increased operational expenditure, unprofitable cash-flows and less attractive investment opportunities for financial sources from abroad. Chinese laws stipulate that project capital for wastewater treatment infrastructure investment cannot be lower than 20% of the total investment and registered project capital must be higher than 50% of the projects annual operation costs. This presents another barrier for investors. A solution might be a reasonable waste water treatment fee to be paid by all users of the treated water. But rural households and families in remote areas are especially incapable of shouldering this additional payload. This is why Chinese WWTPs do not implement a treatment fee. Among other reasons, without a waste water treatment fee, Chinese WWTPs are still barely profitable, and without governmental subsides or other financial aid would not be operating at all. The common situation in the Chinese waste water treatment industry represents a good opportunity for CDM development, since CDM could bring advanced know-how and additional capital to make Chinese WWTPs profitable. The Chinese waste water treatment sector is a feasible target for CDM implementation since the mechanism creates a second income stream which helps to overcome the existing bottleneck and establish a marketable sector.

1.4. Experience from existing waste water CDM project activities

Currently there is no registered CDM waste water project in China that could serve as general reference and guidance for Chinese projects. Nevertheless, worldwide ten waste water treatment projects are registered. Below, the validation reports from the DOE will be evaluated and key findings presented. A CER estimation schedule derived from existing project activities will also be provided.

Experience from CDM validation reports

Seven projects registered solely apply methodology AMS-III.H, three apply AMS-III.I and one AM0039. The sources of waste water treated in these projects are mainly from the food-processing industry, namely palm oil mills, sugar plants, paper plants, maize processing plants, distillery plants, beer mills, soda plants and slaughterhouses etc. The waste water is not treated in public WWTPs but at the industrial sites. The registered projects are located in Thailand, Brazil, Indonesia, India, and Malaysia. Before CDM introduction, waste water is commonly treated in the above mentioned industries in open lagoons. The legal situation in most of these countries does not facilitate the application of advanced waste water treatment technologies, thus without any other incentives there is no need for the plant owners to change the existing way of treating waste water. One particular issue at baseline justification lies in how to rule out other baseline scenarios, such as implementing aerobic treatment measures. This technology is comparatively mature and has been successfully implemented in numerous other countries and constitutes no technological barrier for waste water treatment. Most of the registered projects have chosen to analyze existing financial barriers to their project activity. In terms of this issue, the situation of the projects under methodology AMS-III.I varies from others, because AMS-III.I "comprises technologies and measures that avoid the production of Methane from biogenic organic matter in waste water being treated in anaerobic systems. Due to the project activity, the anaerobic system (without Methane recovery) is substituted by an aerobic biological system." The financial analysis is carried out in such projects by directly comparing the NPV and assessing the lowest one for the baseline scenario.

During the CDM registration process of waste water treatment activities, one of the core issues that valuators care most about is the additionality of projects. In order to speed up the registration process, detailed knowledge on local rules, regulations and laws concerning waste water treatment, and a well prepared financial analysis are vital. The feasibility of waste water CDM projects is mainly proven by the implementation of projects from the food-processing industry. Municipal waste water has to overcome different obstacles, mainly because of the unclear role of local governments. Project owners should focus their barrier analysis on the small income opportunities of waste water treatment plants. Waste water treatment fees are too low in order to make WWTPs run effectively and profitably.

CER estimation schedule

The final CER estimation according to each separate methodology is very complex and has to be done from case to case, considering numerous project-related conditions. So far, ten waste water project activities are registered at UNFCCC. An overview of the amount of waste water treated compared with the annual CER production is given in Figure 4. Each point symbolizes one project, blue points apply AMS-III.H, red points AMS-III.I, and the green point represents the only large scale project.[29] Adjacent to the points are figures related to CER-production efficiency derived from the amount of CERs generated per waste water treatment capacity in one year. For detailed information about the evaluated activities, please refer to Annexes 1 and 2.

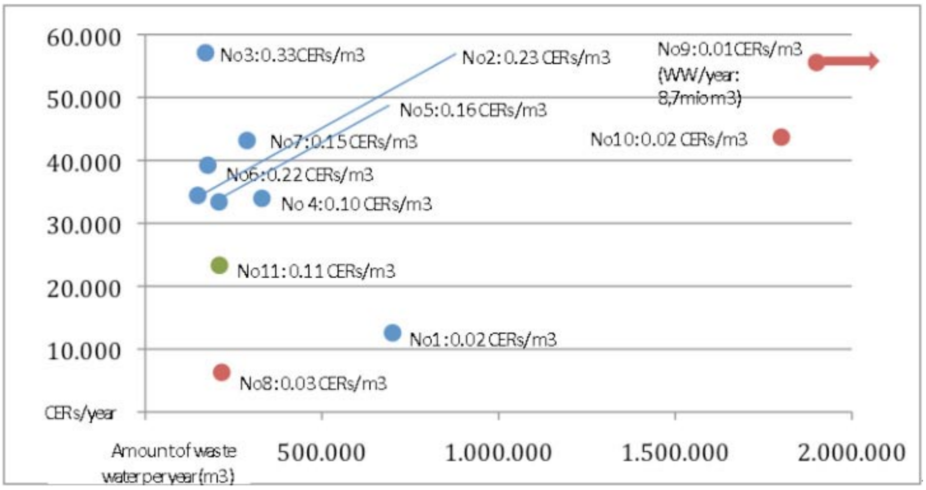


Figure 4: CER production efficiency of registered waste water project activities

The majority spread of CER efficiency within the 6 AMS-III.H project activities is very high due to different baseline conditions, amongst others, because of the wide range of possible BOD and COD. AMS-III.I has a lower CER efficiency since there is no opportunity to generate CERs from fossil fuel displacement. The only large scale activity so far yields the majority of its CERs from solid waste treatment (AM0039), only the waste water CERs are adopted into this graph.

Figure 4 serves as a comparison table to evaluate the CER potential of other project opportunities. Due to the very low implementation grade of waste water CDM activities, the derived results should be evaluated with caution. Other calculation tools can be found at the Institute of Global Environmental Strategies.[30] In addition to numerous helpful guidelines like the "CDM in Charts" for ACM0014 and AMS-III.H a comprehensive calculation tool is provided.[31]

[29] CDM project no. 1359: Palm oil mill waste recycle scheme, Malaysia, targeted CERs: 1,036,926 per 10years
[30] Institute of Global Environmental Strategies: www.iges.org.jp
[31] IGES CER estimation tools for ACM0014 and AMS-III.H: http://www.iges.or.jp/en/cdm/report.html

1.5. Small scale projects opportunity evaluation

The CDM defines small scale (SSC) project activities in order to lower transaction costs and time for activities with considerably small CER potential. Therefore, the CDM approval and registration process requirements for SSC project activities are not as strict as the ones for large scale activities. The most important simplified modalities and procedures comprise of facilitated constraints for the Project Design Document (PDD)[32], simplified methodologies and monitoring requirements, and a lower project registration fee.[33]

What are the limits of SSC waste water treatment plants?

Aforementioned SSC methodology criteria, the UNFCCC defined three criteria to distinguish SSC activities from regular projects. The applicable criterion in the field of waste water treatment is the total amount of CERs produced every year. The produced CERs must not exceed the limit of 60,000CERs/year. For detailed information please review Annex 1 (CDM project activity evaluation for projects applying AMS-III. H) and Annex 2 (CDM project activity evaluation against AMS-III.I).

Due to the fact that all SSC waste water activities apply methodologies AMS-III.H and AMS-III.I, the CER estimation was based on this project's activities (only projects applying one single methodology were considered).

The evaluation shows that on average 13 m^3 of waste water per CER are required annually. Due to UNFCCC restrictions, a SSC project activity may only generate 60,000 CERs per year, a total of 770,000 m^3 annual waste water capacity can be seen as a benchmark for waste water treatment plants applying AMS-III.H. The same evaluation for AMS-III.I results in 68 m^3 of waste water per CER, or 4 million m^3 of waste water annually in total.

[32] Guidelines for completing the simplified project design document; Version 5: http://cdm.unfccc.int/Reference/Guidclarif/pdd/PDD_guid02_v05.pdf
[33] Simplified modalities and procedures for small-scale CDM project activities: http://cdm.unfccc.int/Reference/COPMOP/08a01.pdf#page=43

2. Suitable and currently applied technologies in China

According to the latest analysis of China's sewage treatment industry[34], currently 1408 sewage treatment plants are in operation, treating more than 83 million m^3 of waste water per day. Another 1004 sewage plants are under construction, scheduled implementation is 2010. These plants will treat at least 37 million m^3 of waste water per day. There with, China's daily sewage treatment capacity will reach 120 million m^3 within the next two years, with an average treatment capacity of 50,000 m^3 per day per plant. This equals the waste water treatment demand of 200,000 people[35] per plant.
Eastern provinces have a higher urban sewage treatment rate than the Western regions of China. This reflects the unbalanced situation of economic development and waste water treatment technology investment and the situation of the sewage treatment industry in particular. According to China's urban water resources sustainable development and utilization report[36] it is expected that the investment in the sewage treatment sector will amount to 200 billion CNY during the period 2008 to 2010. For detail information, please refer to Annex 15.

2.1. Analysis of main sewage treatment processes in China

A more detailed view on the WWTPs currently under construction shows the preferred technologies applied. Biological treatment can clearly be identified as the most commonly applied technology with a share of 674 projects (89%) out of total 760.

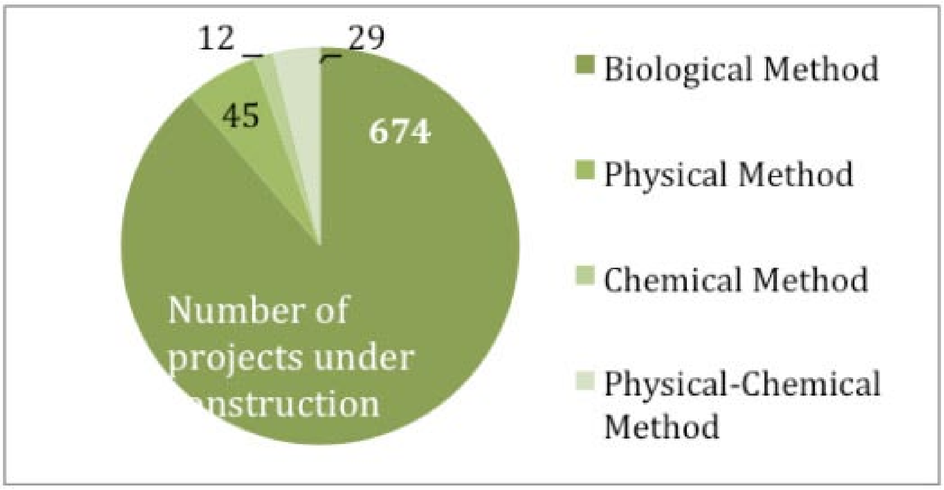


Figure 5: Sewage treatment processes in WWTPs under construction

All applied technologies in Europe as well as in China are suitable for the Chinese waste water sector in terms of different climate conditions, different kinds and sources of waste water, amount of waste water and suitable business models.

[34] The latest analysis of China's sewage treatment industry, April 18th, 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf
[35] KfW 2007 - Case Studies Sewage Sludge Disposal in the People's Republic of China and Germany Conclusive Report
[36] Qian Yi, China's urban water resources sustainable development and utilization reports, December 1st, 2002, Chinese water conservancy and hydropower Press publishing

2.2. Sludge treatment and disposal

Technical policies of urban waste water pollution control and the "Discharge standard of pollutants for municipal wastewater treatment plant" describe specific requirements for sludge stability and agricultural use in municipal waste water treatment plants. But in reality, sewage treatment plants often apply only discharge standards.
In recent years, due to the requirements for de-nitrification and de-phosphorization, many biological waste water treatment processes have evolved. In contrast, for sludge treatment and disposal no clear concepts have been developed and implemented. Sludge treatment in China usually only embraces sludge dewatering. Sludge transportation, use or disposal, is not considered and causes severe secondary pollution effects. The danger of secondary pollution due to inadequate sludge disposal rises with the number of sludge treatment plants becoming operational.
The China Ministry of Construction (MoC) estimates that a total of 10 million tonnes of sewage sludge with a dry solid content of 20% is currently generated every year. Advanced standards of waste water treatment increase sludge quantities further. Every improvement to waste water treatment processes is accompanied by higher amounts of sewage sludge. The rapidly increasing problem of sewage sludge disposal is subject to discussion and waste water related activity of the MoC. Therefore emphasis is given to update technical standards and regulations in order to support implementing agencies and design institutes during project preparation. Since 2007, a new provisional standard[37] embraces technical regulations for all possible methods of sewage sludge disposal.
Regarding CDM, the high content of biodegradable matter in sludge is the most interesting aspect as it is a severe source of GHG emissions (see chapter 1). Therefore special attention will be drawn to sludge treatment technologies and current implementation status in China.

Sludge treatment

The characteristics of sewage sludge (presence or absence of organic matter, nutrients, pathogens, metals and toxic organics) are important to decide both the type of treatment to be applied and the method of disposal after processing. Sludge treatment and disposal generally including several processes and operation steps (treatment chain) incl. thickening, stabilization, disinfection, conditioning, dewatering, drying, thermal reduction and ultimate disposal or reuse. The main process chain can be divided into three steps:

1. Thickening: Thickening is a volume-reducing process in which the sludge solids are concentrated to increase the efficiency of further treatment.

2. Sludge Stabilization: Sludge is stabilized to eliminate offensive odors and reduce toxicity. In sludge high concentrations of metals and toxic organics, as well as high oxygen demand, abnormally high or low pH levels, and unsafe levels of pathogenic microorganisms characterize the toxicity. There are a variety of technologies available for stabilizing toxic sludge; the most common treatment options include anaerobic digestion and aerobic digestion.

[37] Urban sewage treatment plant sludge treatment and disposal and pollution prevention technology policy (Trial)

a. Anaerobic digestion: Anaerobic digestion is a bacterial process that is carried out in the absence of oxygen. Anaerobic digestion generates biogas that can be used for energy purposes. In large treatment plants sufficient energy can be generated in this way to produce more electricity than the machines require. The methane generation is a key advantage of the anaerobic process. Its key disadvantage is the time required for the process (up to 30 days) and the high capital cost

b. Aerobic digestion: Aerobic digestion is a bacterial process occurring in the presence of oxygen. Because the aerobic digestion occurs much faster than anaerobic digestion, the capital costs of aerobic digestion are lower. However, the operating costs are characteristically higher for aerobic digestion because of energy costs for aeration needed to add oxygen to the process.

3. Dewatering / Desiccation: Desiccation equipments are divided into direct and indirect forms, its energy consumption is related to sludge and water composition. When combining desiccation and incineration, the extent of desiccation depends on the calorific value of sludge and the heat recycled in the incinerator; therefore the energy balance could be kept as high as possible without added fuel.

The Tianjin Eastern Treatment Plant has a designed capacity of urban sewage of 40 million m^3 per year, and produces sludge of 2460m^3 per day. Thereof 13,300m^3 of biogas are produced per day which powers four sets of 248kW generators with a maximum electricity production of 23MWh per day.

Figure 6: Tianjin Eastern waste water treatment plant

The sludge drying and incineration system installed in the Shanghai Shidongkou WWTP produces a high sludge calorific value and surplus energy. Fluidized bed sludge incinerator with temperatures at 800°C or above, sand recycling system used in the furnace and adequately exhaust gases treatment.

Figure 7: Shanghai Shidongkou waste water treatment plant

For further options of different sludge treatment combinations and final disposal please refer to Annex 14. According to sludge composition, local requirements and framework conditions, different combinations can be found in China.
Most common sludge treatment chains in currently operating WWTPs are given in Table 3.

Table 3: Sludge treatment processes in currently operating WWTPs (1)[38]

	Sludge treatment technologies	Application
1	Thickener → Digestion tank (aerobic or anaerobic) → Other (Dewatering or Desiccation) →Final disposal	40.53%
2	Thickener → Other (Dewatering or Desiccation) → Final disposal	55.42%
3	Imhoff tank → Other (Desiccation) → Final disposal	4.05%

Treatment processes applied in Chinese WWTPs are shown in Table 4:

Table 4: Sludge treatment processes in currently operating WWTPs (2)[39]

Treatment process	Dewatering	Thickening	Thickening and Dewatering	Stabilizing
Numbers of WWTPs	84	7	25	23
Proportion (%)	60.4	5.0	18.0	16.6

[38] Zhang Shuiying, Zhang Hui, Zhou Jun, Wang Jiawei, Gan Yiping (Beijing City Drainage Group Co., Ltd.), Liu Kun (Zhongyi Inter-national Bidding Company): Current Situation and Development of China's Sludge treatment and disposal

[39] Zhang Shuiying, Zhang Hui, Zhou Jun, Wang Jiawei, Gan Yiping (Beijing City Drainage Group Co., Ltd.), Liu Kun (Zhongyi Inter-national Bidding Company): Current Situation and Development of China's Sludge treatment and disposal

Only 16.6% of the evaluated WWTP are using a stabilization process for the sewage sludge, and more than 60% implement dewatering methods without stabilization. Stabilizing technology might play a major role in the Chinese waste water treatment sector due to the high potential of CDM application. (Please see chapter 1 for details).
The main sludge disposal options are agricultural use, landfill, and incineration.

Sludge disposal

Among all 1,292 project activities, 864 projects apply the sanitary landfill method (67%). This kind of disposal is the main post-treatment for sewage sludge in China. 13% of the sewage treatment plants choose sludge composting. Sludge disposal methods in projects also include belt filter press, centrifuge dewatering and instruments of recycling, but the implementation rate is still not wide-spread.
Among all 771 projects under construction, 483 projects dispose the sewage sludge at sanitary landfill sites, reaching 63% of the total number of projects, and 17% of the WWTPs choose sludge composting. Other methods of sludge post-treatment and disposal, like belt filter press, centrifugal dewatering and natural drying, are rarely applied.

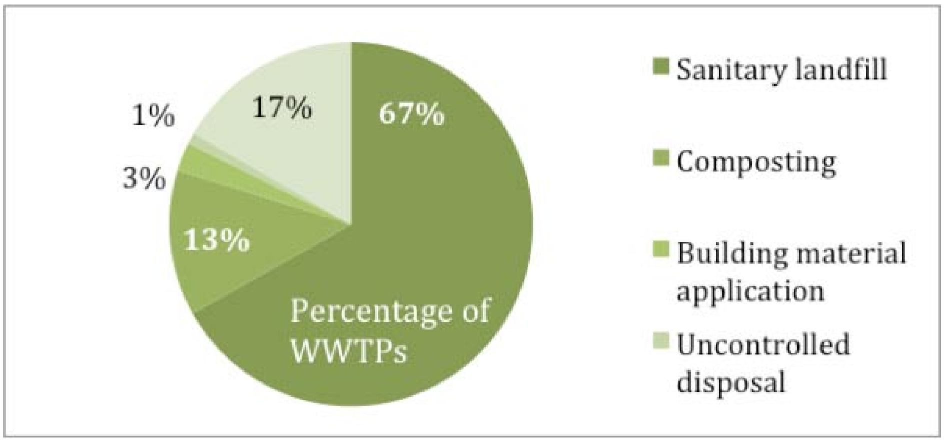


Figure 8: Sludge disposal methods in operating WWTPs in China[40]

2.3. Existing German contribution to waste water treatment in China

Germany has, in general, a very good reputation, not only for advanced technologies but especially for environmental technologies. Nevertheless, the financial structure of WWTP can be very fragile as the operator has very little influence in waste water fee developments. Therefore, most of the WWTPs depend on subsidies from the government.
But considering the huge market of waste water treatment applications and the urgent need of sophisticated technology, the German contribution is underdeveloped in comparison to other sectors (e.g. transportation or wind power sectors).
In the past the German Government supported more than 14 WWTP with grants and low-interest loans through KfW Bank. Please refer to Annex 18 for an overview of existing German-Chinese cooperation and a detailed example of Haikou Baishamen sewage treatment plant in Annex 19.

[40] The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

2.4. Potential of German contribution to the waste water sector in China – upgrading of existing waste water treatment plants for sludge utilization

Germany has rich experience with all kinds of waste water worldwide. Therefore German companies could cover all waste water related areas with suitable technologies and related experience.

Commonly applied sludge treatment processes of German sewage treatment plants

Sludge treatment process technologies applied in Germany can be divided into two kinds according to the stabilization mode: (1) anaerobic digestion and (2) aerobic stabilization. These two models apply to different sizes of plants. To evaluate in accordance with the present existing equipments, civil works and operating price in Germany, for a plant with a population equivalent more than 30,000 (equivalent to 6,000 m^3 per day), the use of anaerobic digestion is more economical. If the size of a sewage treatment plant is less than 30,000 population equivalent, the more economical choice would be the aerobic stabilization process. A process flow diagram of an aerobic and anaerobic stabilization of sewage treatment and sludge treatment process, applicable to large-scale sewage treatment plants, is displayed in Annexes 14 and 15. Standard sludge treatment technologies comprise of pre-thickening, stabilization, post-thickening, conditioning and dewatering.
Since the 1990s, China has been investing enormous amounts of financial and material resources to build a large number of sewage treatment plants in order to improve water quality. At that time, because the main purpose of sewage treatment plants was to reduce the water pollution, limited funds were used for water treatment, and sludge treatment was not taken seriously. Consequently most of the sewage treatment plants have no sludge treatment stability system, and the remaining sludge is only dewatered and then disposed of. Only a small number of sewage treatment plants (many of them are supported by the German government or World Bank projects) have built anaerobic digestion systems.

Utilization of biogas from sewage sludge

The by-product biogas of anaerobic sludge treatment can be used in different ways and could generate additional income to the WWTP, or reduce operation costs. There are different application scenarios for biogas from sewage sludge (also refer to Figure 9).

1) Direct use of biogas at WWTP.
2) Utilization of biogas after having removed CO_2 - refined into "Natural gas".
3) Utilization of biogas after reforming and removal of CO_2 - refined into "Hydrogen".

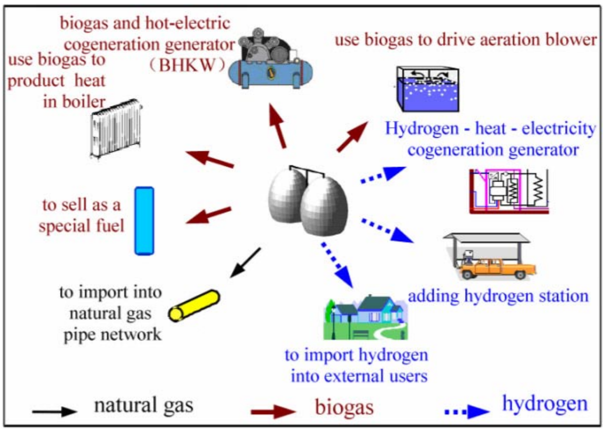


Figure 9: Utilization of biogas from sewage sludge treatment[41]

[41] Dr.-Ing. M. Schröder, Dr.-Ing. Yao Gang: Basis of the separate anaerobic sludge stabilisation process ("Digestion") in Germany

Direct use of sludge

Various sewage treatment plants in Beijing, Tianjin, Shijiazhuang, etc. have built anaerobic digestion systems, which adopted German sophisticated technology. But because of the differences in sludge characteristics, gas production is generally lower in Chinese WWTPs compared to Germany. The economic benefits are also less significant compared to anaerobic digestion systems for sludge treatment in Germany - there is still much room for optimization.
Before final disposal, sludge must be pre-treated to avoid too high a moisture content, and toxic and harmful substances resulting in secondary pollution. Sludge drying is recommended as an effective pre-treatment. The main purpose of preconditioning is to reduce, or if possible to remove, water from sludge, followed by disinfection and drying of sewage sludge to a ratio of 50% dry substance. The procedure is comparatively simple and the respective machine, the disc-drier works absolutely reliably. The investment and operating costs for a part drying machine are by far smaller than those of a full-drying machine. In China, the application range for partly dried sludge is very large. It is used as organically rich soil for greenification, or as top or middle layer soil in waste disposal sites. It is also widely used as fuel in energetically self-sustaining fluidized bed incinerators. This could be an investment opportunity for German investors with a large demand for partly dried sludge.

Opportunities for sludge disposal

Under normal conditions, the treated and dewatered sewage sludge is not to be disposed of on the site of the waste water treatment plant itself. For this reason, the sludge has to be transported to its final disposal place. Due to the absence of proper disposal methods, waste water treatment plant operators are presently in a very difficult situation. Frequently used but still unsustainable methods are; 1) interim storage on the site of the treatment plant 2) no abstraction of sludge from the treatment process 3) discharge of sludge into the receiving water body 4) ocean dumping 5) dumping in gravel pits and quarries 6) handing over to private businesses without control.

3 Market potential of CDM waste handling and disposal projects in China

3.1. Technology areas for implementation

Although a large number of waste water treatment plants are installed in China, in former times the focus lay on reducing water pollution. Only a small number of waste water treatment facilities installed CH_4 emission reduction measures (mainly sludge treatment) or biogas-to-energy procedures. These waste water plants are feasible for implementation of CH_4 destruction or application measures. The CDM provides the required methodologies AMS-III.H. and AMS-III.I. for either anaerobic or aerobic treatment of waste water. AMS-III.H. additionally it provides the opportunity of electricity production. In combination with the guaranteed feed-in tariff of the Chinese government, this generates a very important income for investment realization, as without the benefits from the CDM, a very small number of CH_4 emission reduction projects have been implemented.

There is already some experience in the Chinese market since some project activities already apply anaerobic treatment measures in combination with CDM benefits. Project developers and owners of new activities may learn from these and can get support from the Chinese government, since China clearly lacks the utilization of energy from waste water.

Also, sludge treatment is not a sophisticated technology in Chinese WWTPs. Many treatment plants apply German technology but because of the differences in sludge characteristics, the biogas production from sludge is usually lower than in German WWTPs. This leads to lesser economic benefit from anaerobic sludge treatment and a decreased level of attractiveness for other project owners. German companies already have access to the Chinese waste water treatment market. This advantage over other companies should be used in order to increase existing anaerobic sludge treatment efficiencies.

3.2. Suitable Chinese provinces for waste water treatment

China has a very significant number of waste water treatment plants in operation and also in the installation stage to come online within the next few years. Also, already lined out in chapter 2, most WWTPs are located in Jiangsu province (195), Shandong province (140), Henan province (126) and Guangdong province (125). Most of the waste water is treated in Jiangsu province (14,420,000 m^3 per day) since the waste water sector is strongly developed.

In chapter 1 we concluded that existing CDM project activities have an average waste water to CER ratio of 0.17 CERs per m^3 waste water. Applying this figure, Jiangsu province has a total CER potential of 2.4 mio CERs. Jiangsu province is followed by Shandong province (1.3 mio CERs) and Guangdong province (1.2 mio CERs). These figures were based on the accumulated treatment capacity at the end of 2008. Readers should bear in mind that various CDM projects have already been implemented, thus a share of the CER potential shown has already been tapped into by existing CDM project activities.

Figure 10: Waste water treatment capacity (m^3 per day) at the end of 2008 and calculated CER potential according to selected provinces

For an efficient operation of the anaerobic digestion process an average temperature of 10° C for the project implementation site is required. Relevant CDM methodologies also stipulate this temperature. Although projects may be realized in areas with average temperatures below 10° C, for these periods no Greenhouse gas emission reductions may be claimed.

For a final province recommendation we therefore evaluated the average temperatures of each Chinese province based on Figure 11.

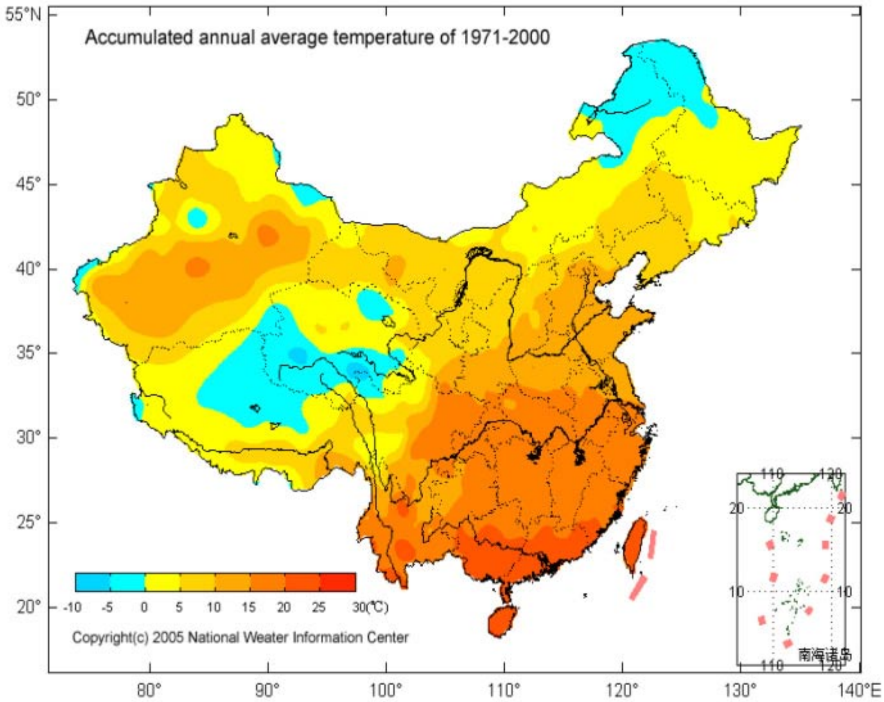


Figure 11: Accumulated and annual average temperature in China[42]

Nevertheless, the figures give an overview and indication of the CER production potential of the various provinces. Based on these figures, we recommend Jiangsu province, Shandong province and Guangdong province as the most favorable implementation areas for waste water treatment facilities and upgrade measures according to the CDM.

[42]China National Weather Information Center, 2005

4. Summary

The desk study "Chinese waste water treatment potential in the field of the CDM" was finalized in March 2009. All findings are based on the most recent evaluations and figures.

Due to its great population and its increasing prosperity, China has a huge demand for waste water treatment. This will be largely met by the existing 1,321 WWTPs in operation and the targeted ones currently under construction. Chinese WWTPs are setup to solve water pollution needs and only a small number of plants are reducing GHG emissions mainly caused by unstabilized sludge. A large proportion of Chinese WWTPs still emit CH_4 into the atmosphere. The Global Warming Potential (GWP) of CH_4 is 21 times higher than that of CO_2. That makes CH_4 projects very attractive from a CDM and CER-production point of view.

National and regional governments in China established a clear legal framework in the waste water sector. Legal guidelines like 'Municipal Waste Water Treatment and Pollution Prevention Technique' are ratified and motivate Chinese city and province governments to implement waste water treatment facilities. Nonetheless, waste water facilities are not required to implement treatment process for CH_4 emission reduction. So, emission reductions are additional to any that would occur without the participation of CDM.

A great share of existing WWTPs are located in the Eastern, developed provinces (please refer to Qingdao Tuandao WWTP). Fast access to project site and project owners, well-developed information infrastructure, a legal framework, as well as financing and subsidy opportunities are available for investors.

The CDM provides the required methodologies for CH_4, respectively CO_2 reduction in waste water facilities. Project developers possess some international experience according to the implementation of these methodologies. 11 project activities are already registered with CDM EB and 86 are currently under DOE validation, thereof the first six activities in China. Most important methodologies are AMS-III.H. and AMS-III.I. for small scale application and AM0039 for large scale. Also waste water from industrial application is becoming a target for foreign CDM investment under ACM0014.

Another application field is the treatment and disposal of waste water sludge. Sludge treatment as a single measure is currently not covered in the CDM methodologies. Still, there is huge potential in Chinese WWTPs since project owners do not take the processing of sludge and resulting products such as possible fertilizer into consideration. This is also due a to lack of investment and technology means. German technology can play a major role, even if these fields are so far untapped by CDM.

We highly recommended finding a Chinese partner for project applications as the Chinese market is very complex and difficult to understand for foreign entities. Often, business relations fail due to a lack of understanding by the opposite business partner.

5. Annex

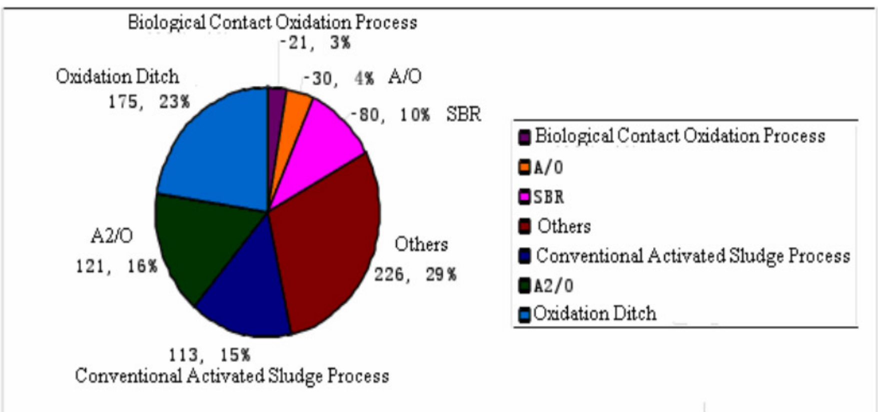
Annex 1: CDM project activity evaluation for projects applying AMS-III. H: Methane recovery in waste water treatment

Prj. no	Project name (CDM project number)	Expected amount of WW treated per year	Estimated emission reduction (CERs)	CER per treated WW m^3	Treated WW per tones of CO_2e emission reduction
		[m^3_{WW}/year]	[tCO_2e /year]	[tCO_2e /m^3 $_{WW}$]	[m^3 $_{WW}$/tCO_2e]
1	Methane recovery from waste water, India (935)	700,000	12,578	0.02	55.65
2	Forced Methane extraction from organic waste water, India (1088)	148,500	34,424	0.23	4.31
3	Methane recovery in waste water treatment, Malaysia (1616)	170,529	57,094	0.33	2.99
4	KKSL Lekir Biogas Project, Malaysia (1888)	330,000	33,955	0.10	9.72
5	Methane recovery in waste water treatment, Indonesia (1899)	208,713	33,390	0.16	6.25
6	Methane recovery in waste water treatment, Indonesia (2130)	176,947	39,218	0.22	4.51
7	Methane recovery and utilization through organic waste water treatment, Malaysia (2313)	288,000	43,152	0.15	6.67
	Average	**288,956**	**36,259**	**0.17**	**12.87**

Annex 2: CDM project activity evaluation against AMS-III.I: Avoidance of Methane production in waste water treatment through replacement of anaerobic systems by aerobic systems, version 07[43]

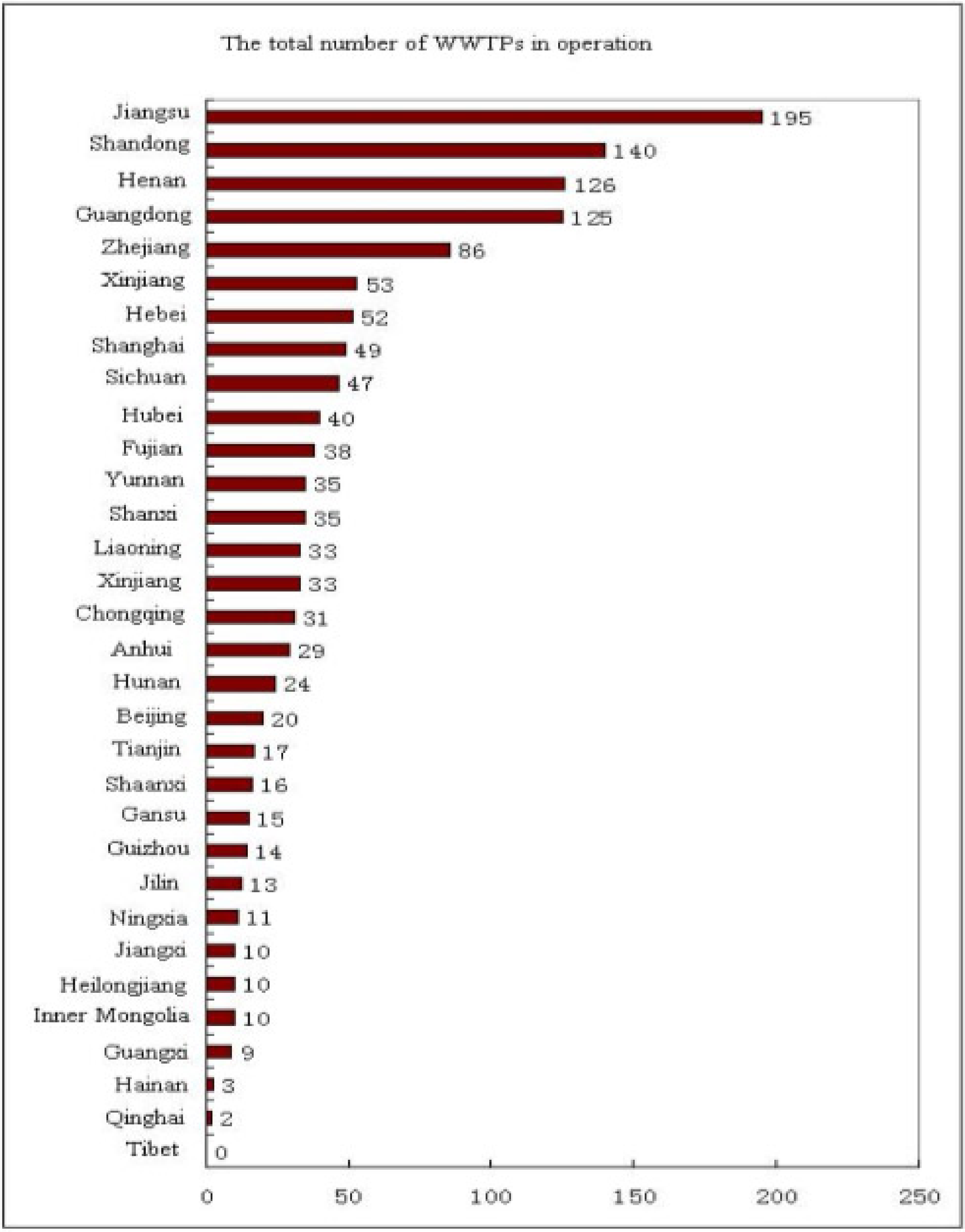
Prj. no	Project name (CDM project number)	Expected amount of WW treated per year	Estimated emission reduction (CERs)	CER per treated WW m^3	Treated WW per tones of CO_2e emission reduction
		[m^3_{WW}/year]	[tCO_2e /year]	[tCO_2e /m^3 $_{WW}$]	[m^3 $_{WW}$/tCO_2e]
8	De Martino WWTP upgrade, Chile (1290)	216,350	6,300	0.03	34.34
9	Irani waste water avoidance, Brazil (1410)	8,760,000	55,553	0.01	127.69
10	Methane avoidance in slaughterhouse, Argentina (1570)	1,800,360	43,680	0.02	41.22
	Average	**3,592,237**	**33,288**	**0.02**	**67.75**

Annex 3: Sewage treatment processes en detail[44]



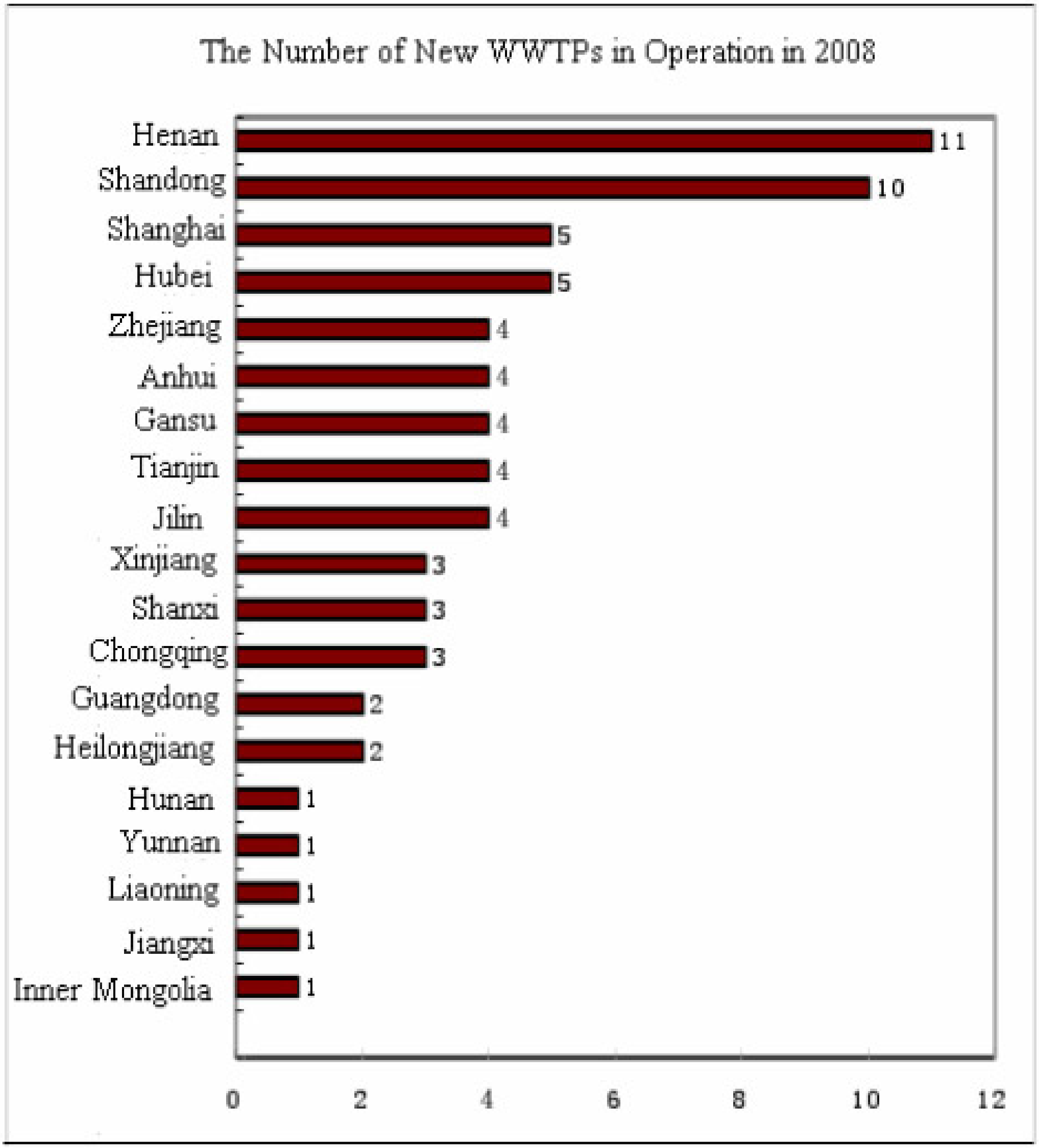
[43] UNFCCC website, project activity evaluation: http://cdm.unfccc.int/Projects/index.html
[44] The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

Annex 4: Chinese Waste water treatment plants in operation[45]



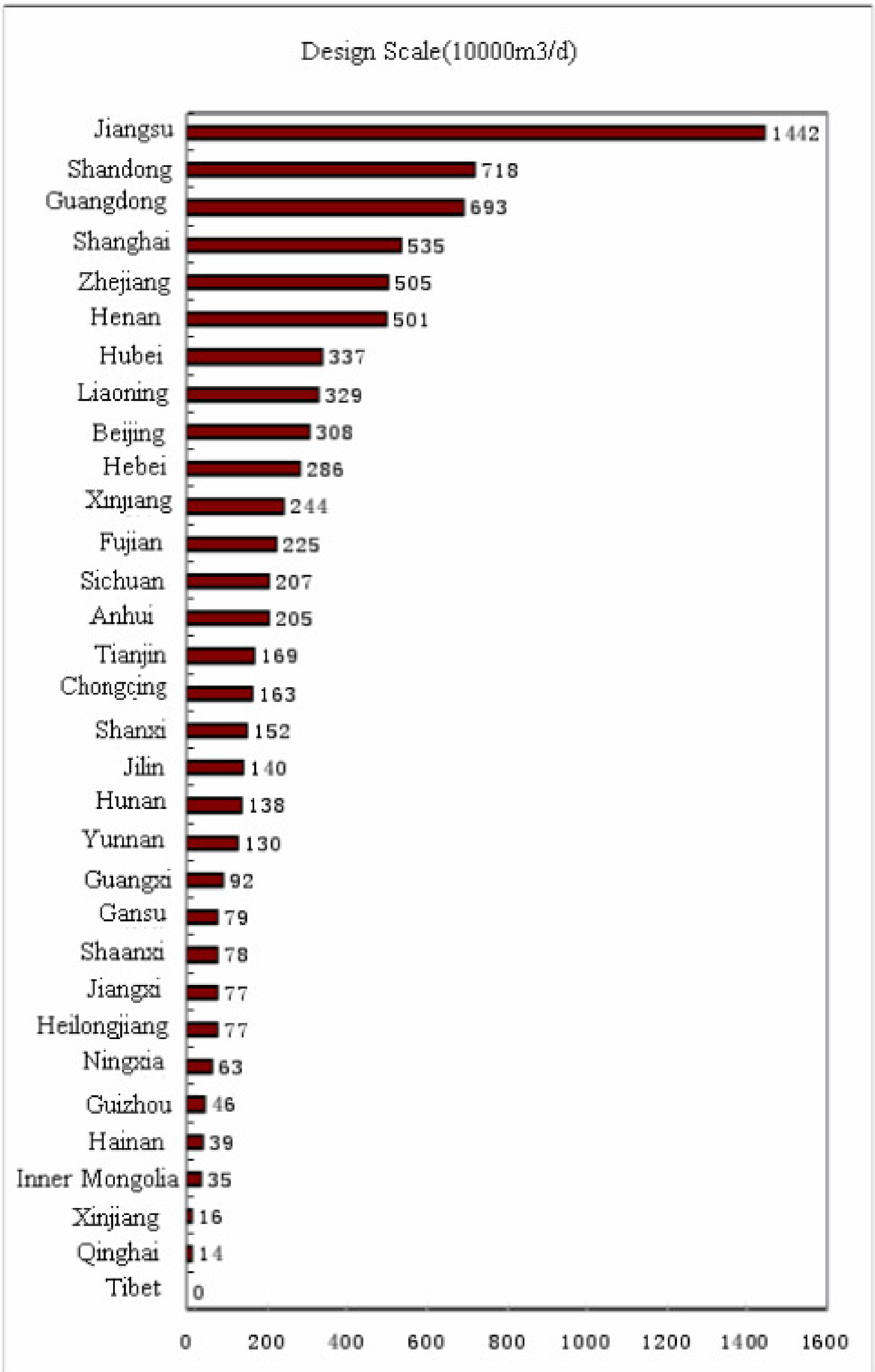
[45]The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

Annex 5: New WWTPs in operation in 2008[46]



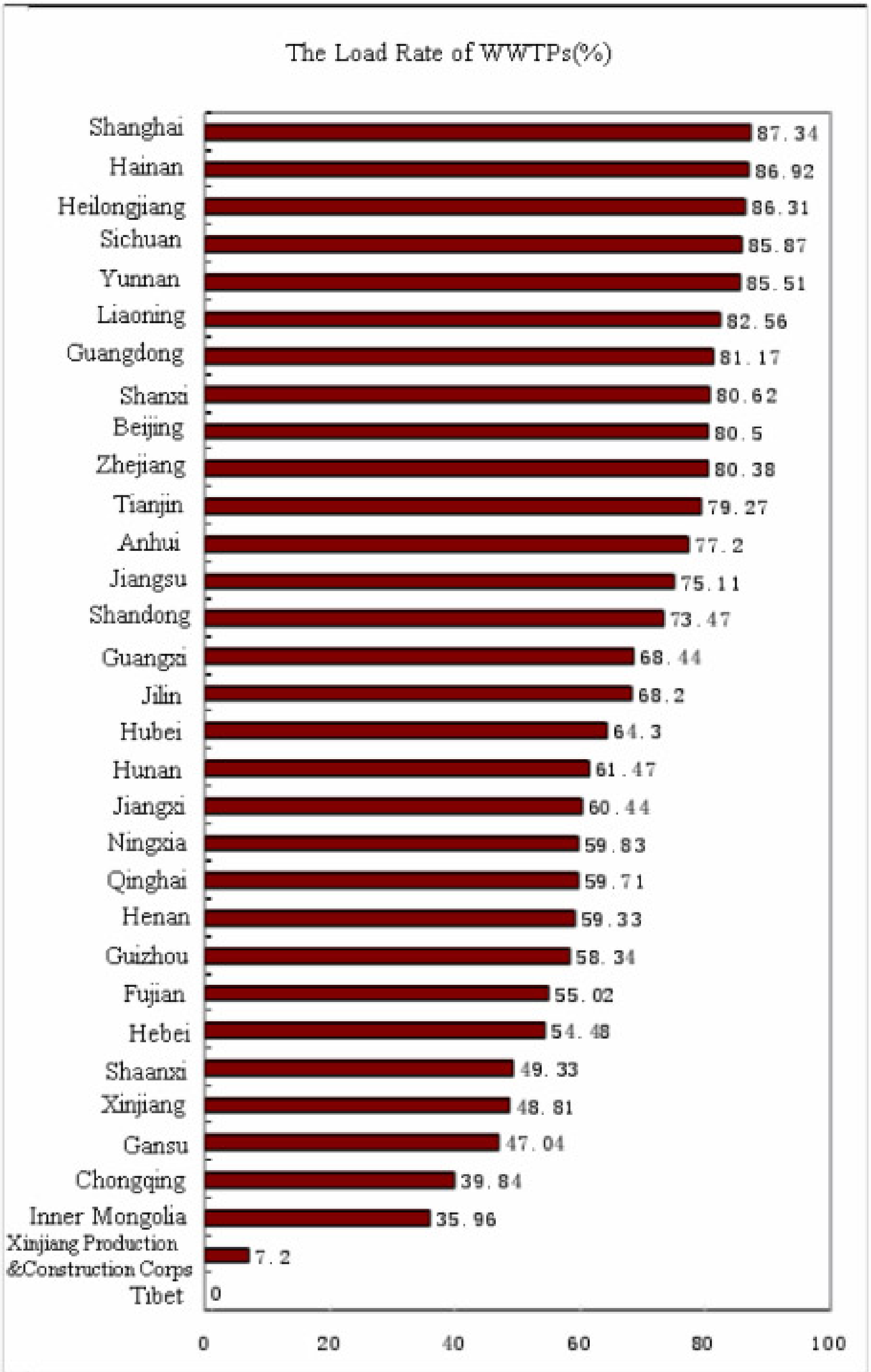
[46] The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

Annex 6: Sewage treatment capacity per each province[47]



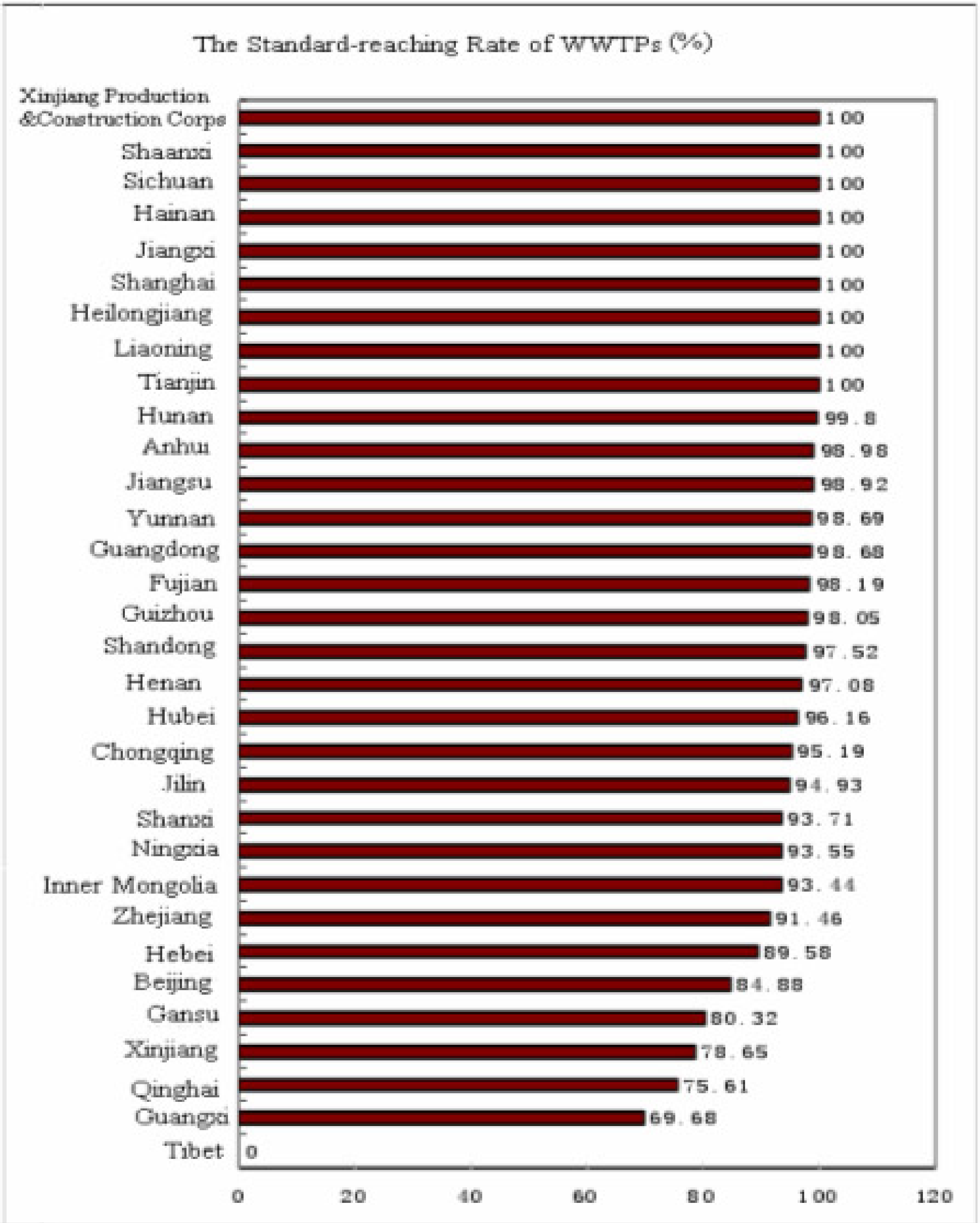
[47]The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

Annex 7: Sewage treatment load rate of each province[48]



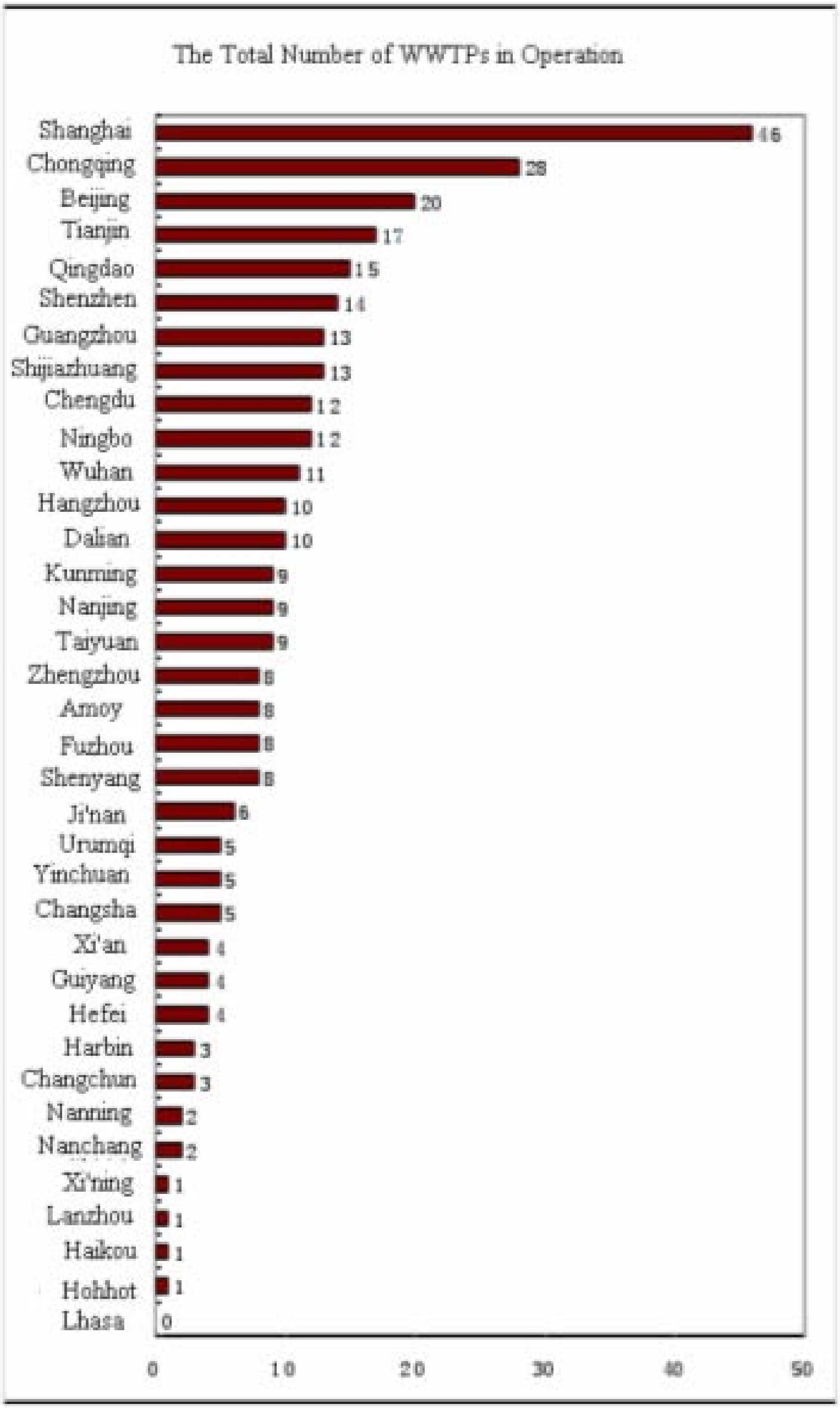
[48]The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

Annex 8: Sewage treatment standard-reaching rate of each province[49]



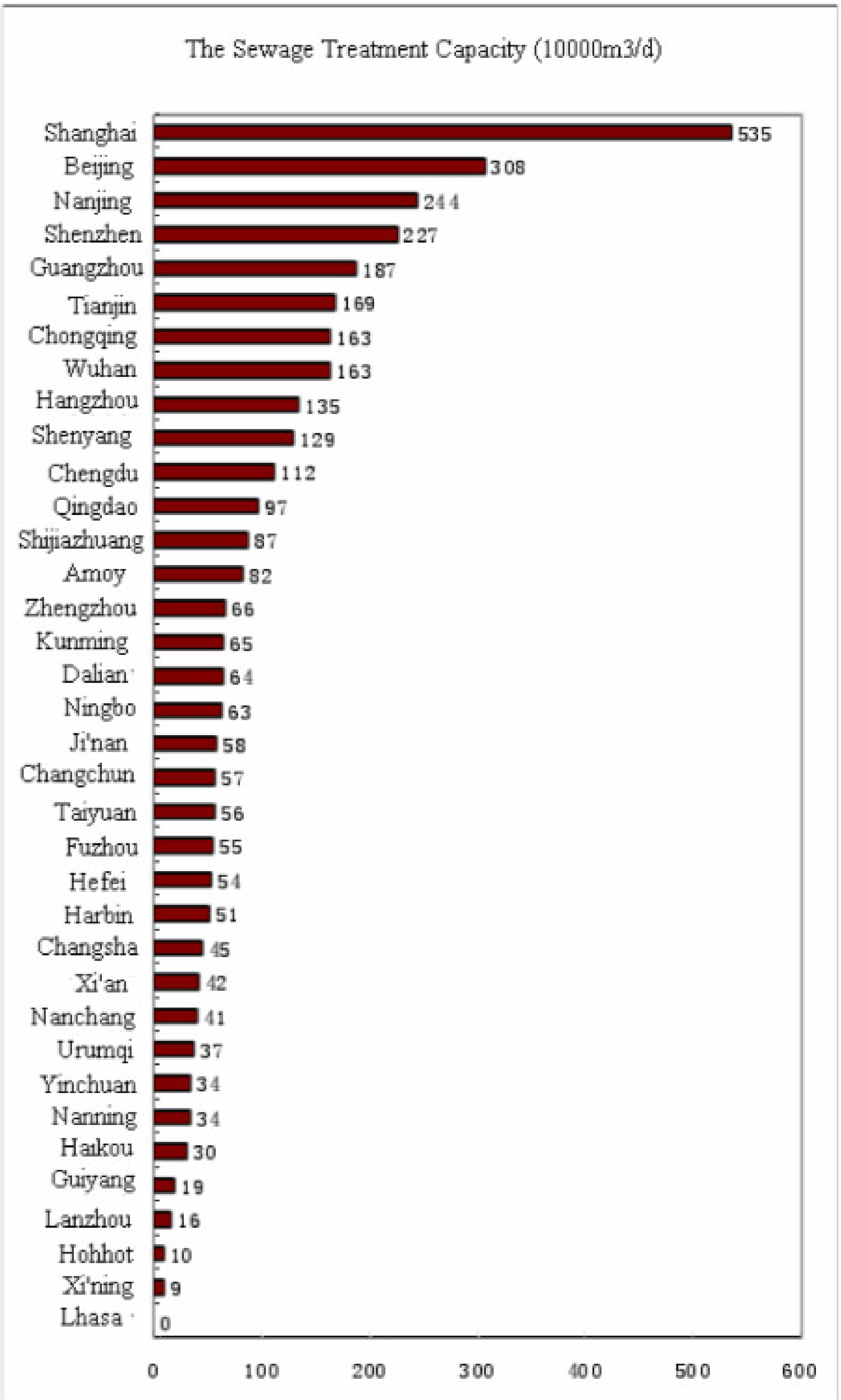
[49] The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

Annex 9: Number of WWTPs (total: 325) in operation in 36 provincial capitals and municipalities with independent planning status[50]



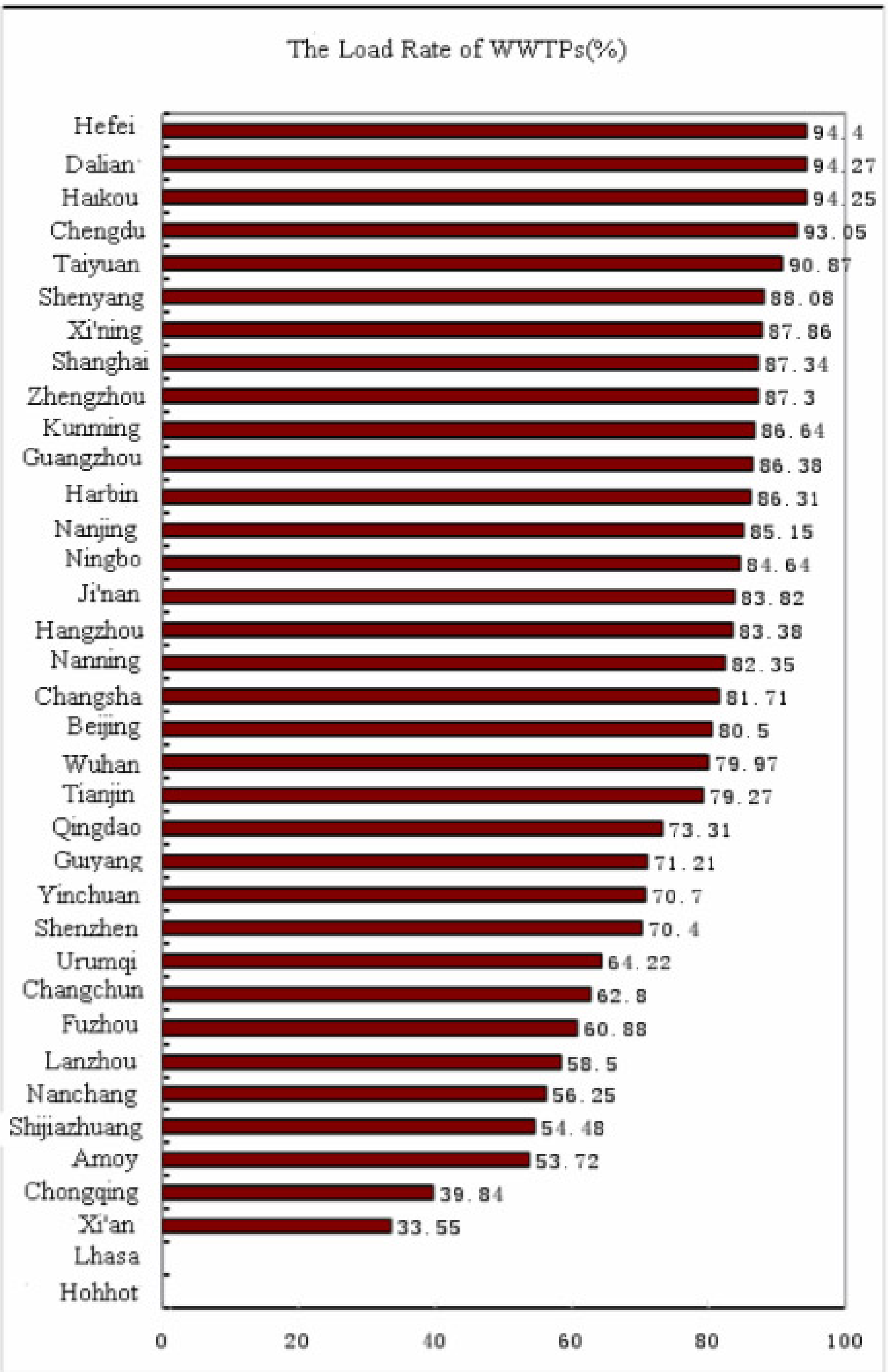
[50]The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

Annex 10: Sewage treatment capacity (total: 76,120,000 m^3 per day) of 36 provincial capitals and municipalities with independent planning status[51]



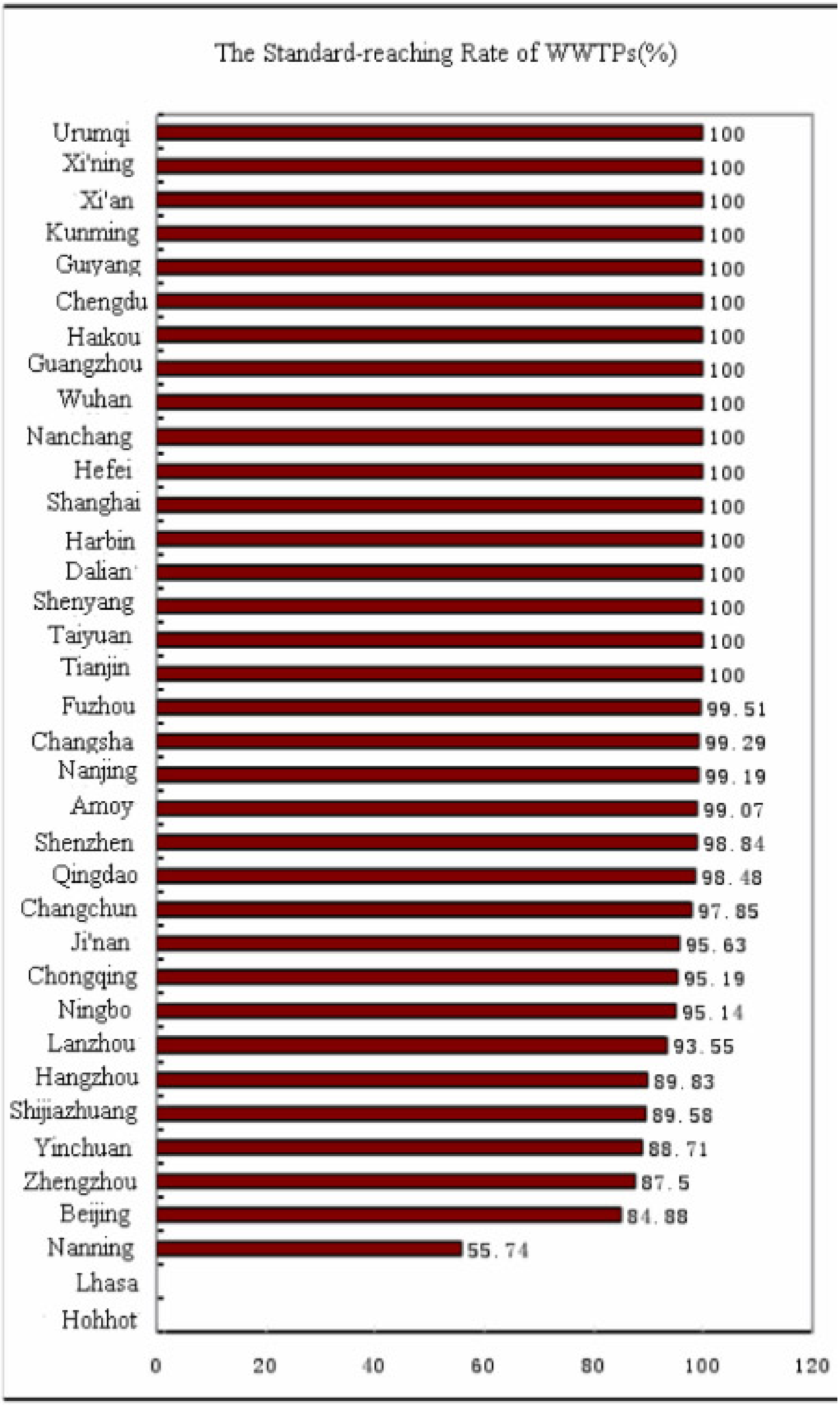
[51]The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

Annex 11: Load rate of WWTPs in 36 provincial capitals and municipalities with independent planning status[52]



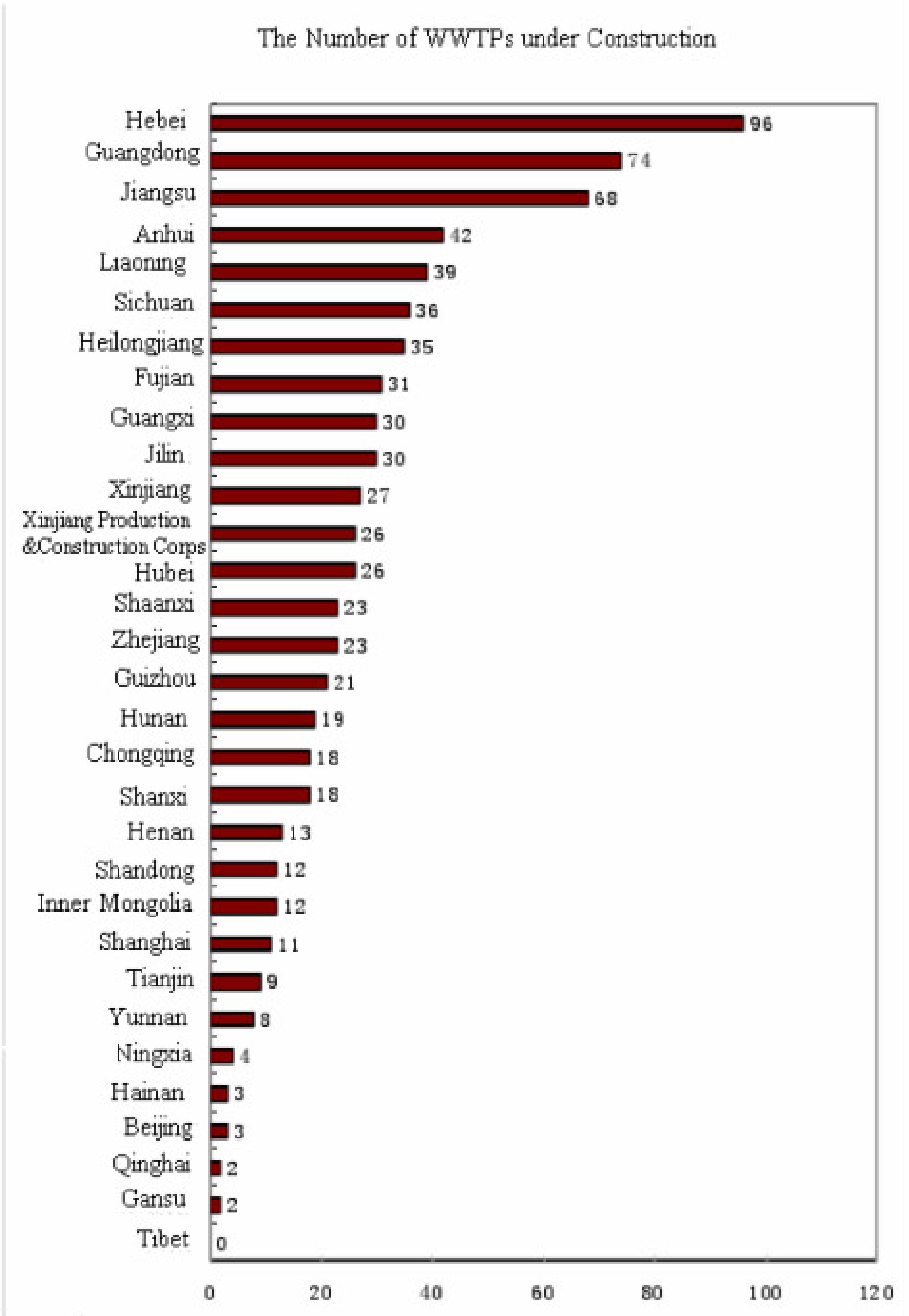
[52]The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

Annex 12: Standard compliance rate of WWTPs in 36 provincial capitals and municipalities with independent planning status[53]



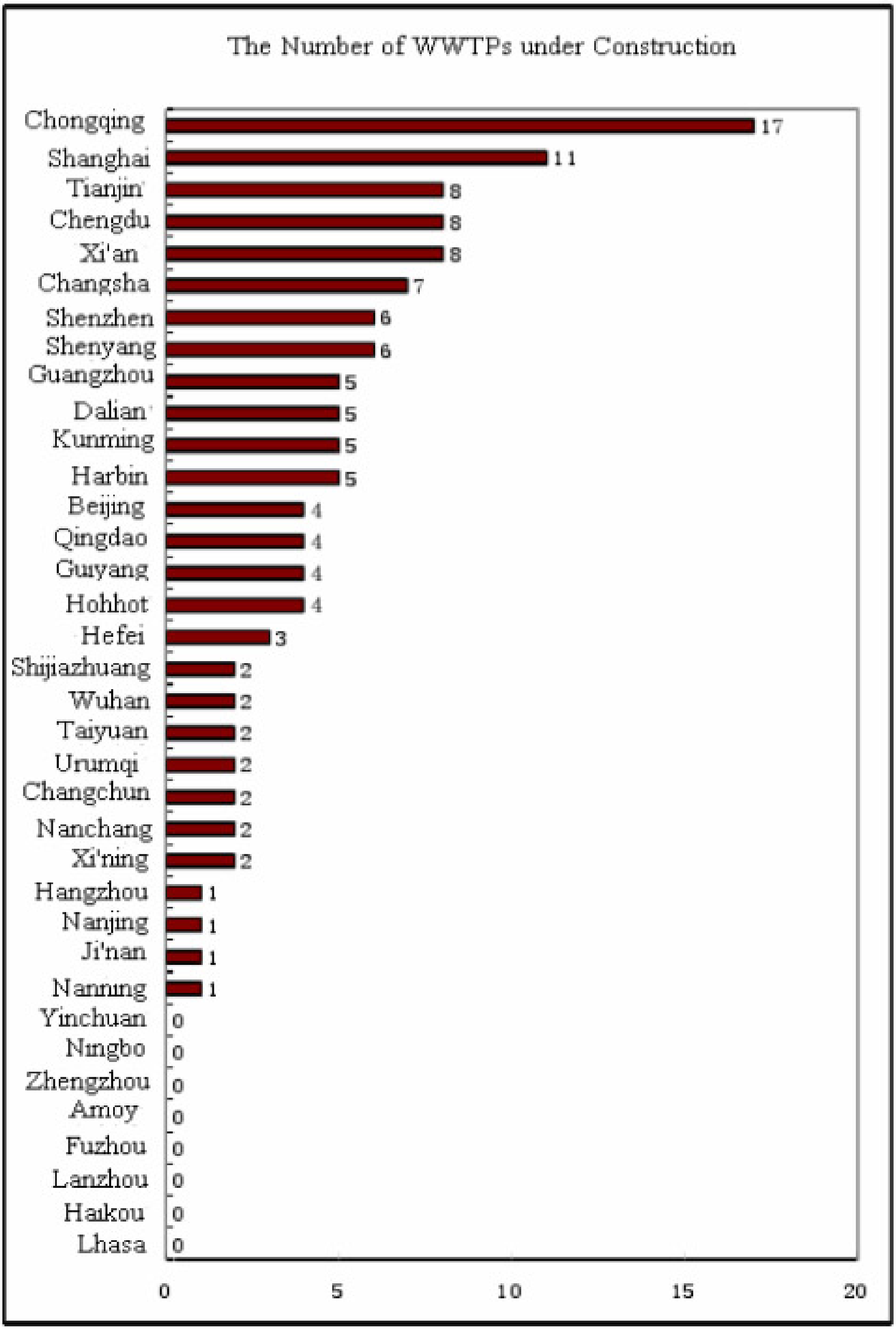
[53]The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

Annex 13: Number of WWTPs under construction[54]



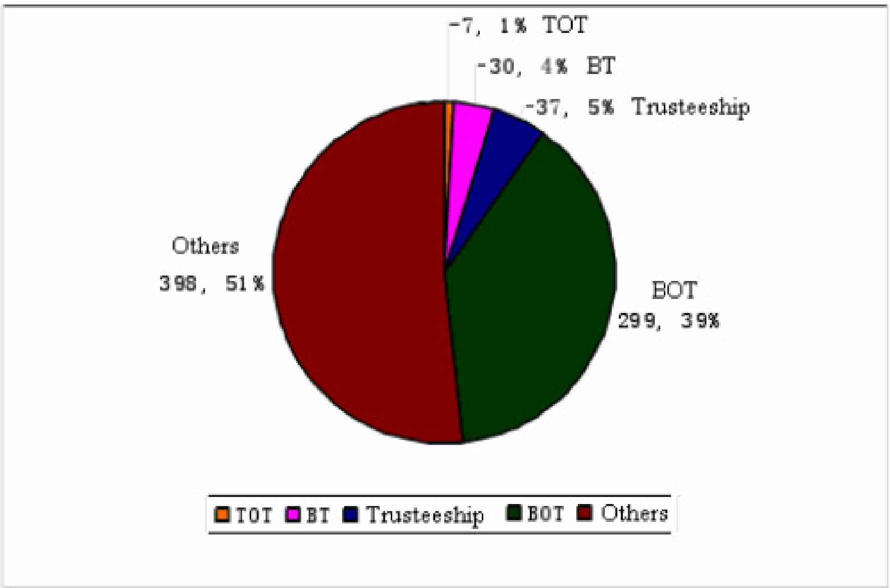
[54] The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

Annex 14: Number of WWTPs under construction in 36 provincial capitals and municipalities with independent planning status[55]

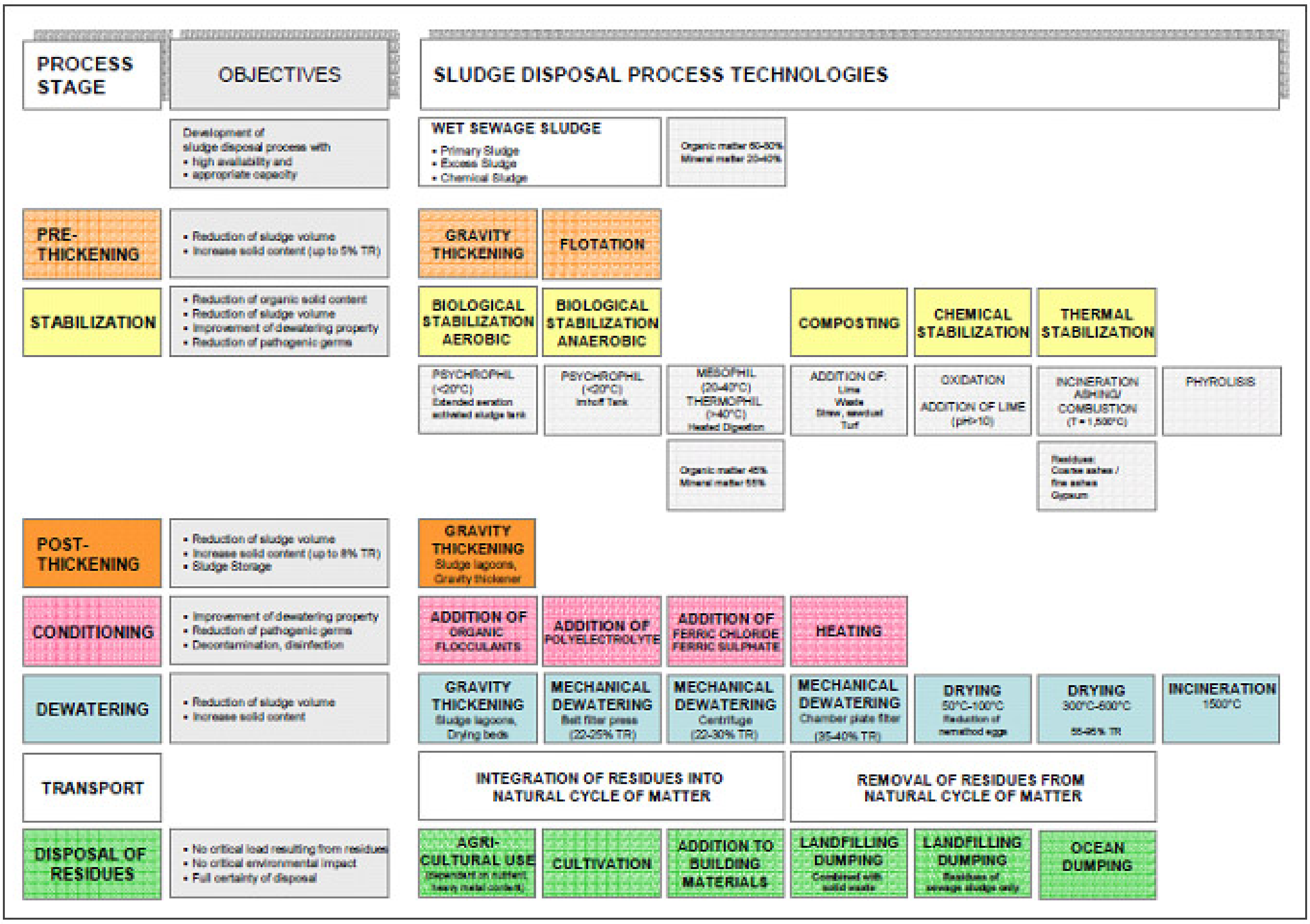


[55] The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf

Annex 15: Waste water treatment plants operation mode in China[56]

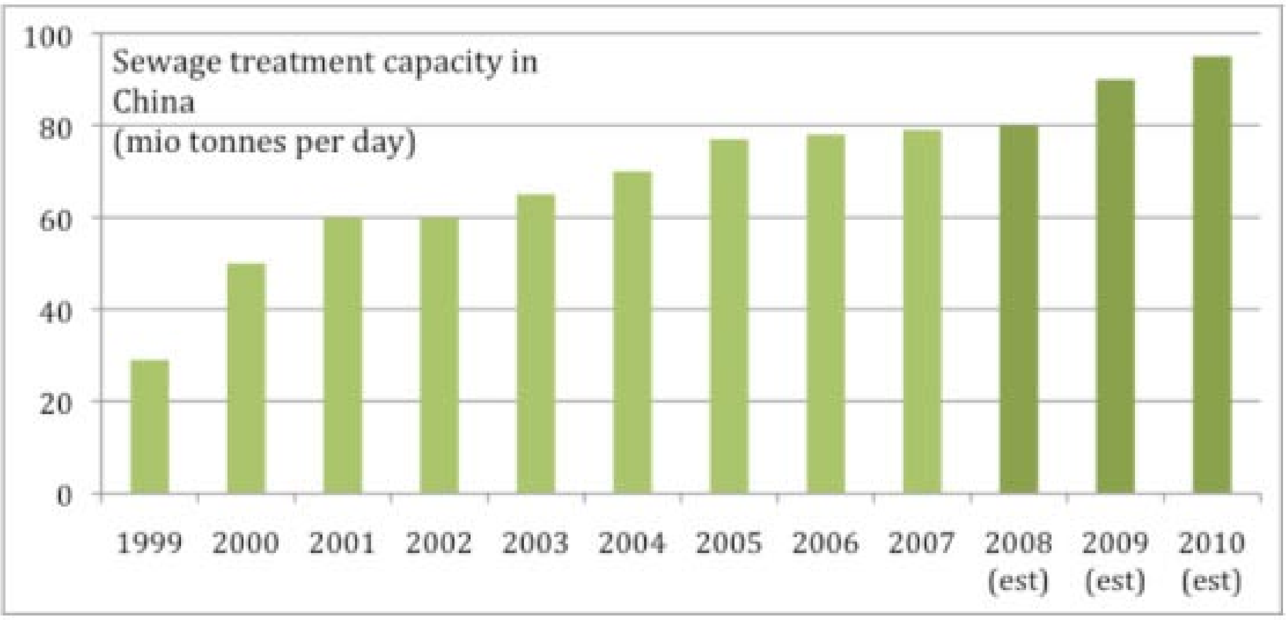


Annex 16: Overview on sludge process and disposal technologies[57]

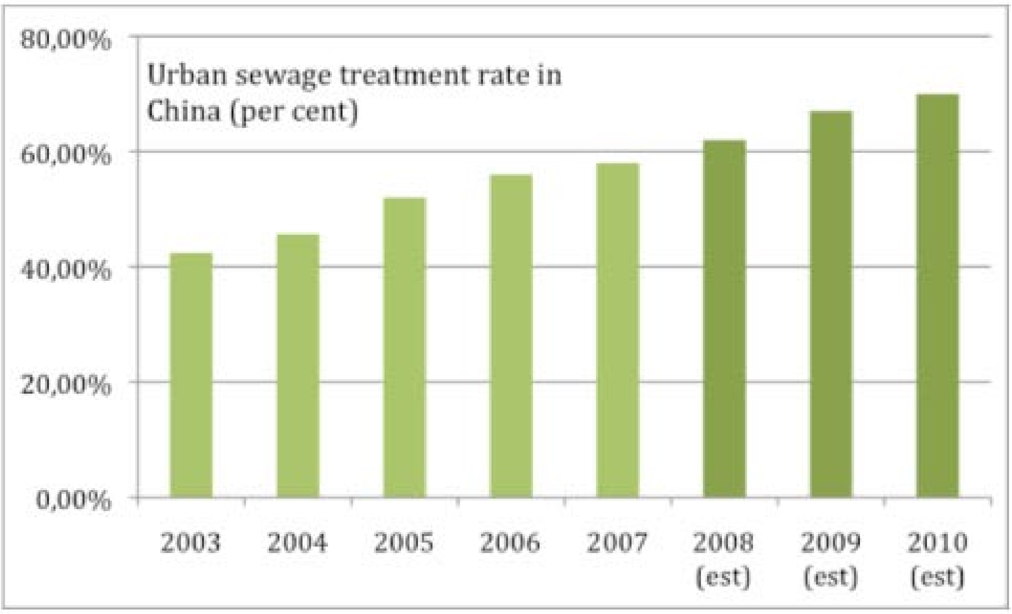


[56] The latest statistical analysis of China's sewage treatment industry, April 18th 2008 http://www.h2o-china.com/download/datum/wushuichulichang.pdf
[57] KfW 2007 - Case Studies Sewage Sludge Disposal in the People's Republic of China and Germany Conclusive Report

Annex 17.1: Sewage treatment capacity in China, 1999 - 2010 (estimated for 2008 - 2010)



Annex 17.2: Urban sewage rate treatment rate in China 2003 - 2010 (estimated for 2008 - 2010)



Annex 18: German contribution to Chinese waste water treatment sector

No	Name	Form of subsidy	Technology	Designed capacity	Treated WW per tones of CO_2e emission reduction
1	Yantai Taoziwan sewage treatment plant	KFW bank grant: 23 mio DM	A/A/O	250,000 tonnes per day	Anaerobic digestion, but equipment of sewage sludge disposal has not been fully put into operation. The remaining sludge undergoes dewatering treatment after pre-thickening.
2	WWTP of Jining city project of sewage sludge		AB	200,000 tonnes per day	Medium temperature anaerobic digestion
3	Yantai Xin'anhe sewage treatment plant		1st phase: BIOLAK, 2nd phase: A/A/O	1st phase: 40,000 tonnes per day, 2nd phase: 80,000 tonnes per day	
4	Qingdao Tuandao sewage treatment plant	German government grant: 25 mio DM	A/A/O	100,000 m^3 per day	Thickening, digestion, and soil disposal
5	Anqing Chengdong sewage treatment plant in Anhui province	German government loan: 32 mio EURO	A/A/O	240,000 m^3 per day	Mechanical thickening, dewatering and soil disposal
6	Wuhu Chengnan sewage treatment plant in Anhui province	Loan: 7 mio EURO			
7	Baotou Nanjiao sewage treatment plant	Total investment: 320 mio CNY (Loans from German government covered part of it)			
8	Zouping sewage treatment plant in Shandong province	German government loans: unknown amount		100,000 tonnes per day and another 50,000 tonnes per day reclaimed water	Ultrasonic liquid level meter, digital controller, the sewage upgrade pumps, multistage centrifugal blowers, sieve-style sludge thickener, filtration systems
9	Hangzhou Sibao sewage treatment plant in Zhejiang province	KFW grant: unknown amount	AO	400,000 tonnes per day	Medium temperature anaerobic digestion, dewatering and landfill. Biogas used for electricity generation
10	Tibet, Changdu sewage treatment plant	KfW bank grant: 6 mio EUR		18,000 tonnes per day	
11	Kashighar sewage treatment plant	German government loans: 45 mio EUR	AO		
12	Huaibei sewage treatment plant	German government loan: 4,9 mio USD	Carrousel 2000 oxidation ditch	40,000 tonnes per day	
13	Inner Mongolia Bayannaoer sewage treatment water reuse	German government loan: 35 mio EUR			
14a	Kunming economic and technological development zone sewage treatment and recycling project	German government loan: 10 mio EUR			
14b	Comprehensive management of environment-project	German government loan: 50 mio EUR			

Annex 19: Haikou Baishamen sewage treatment plant

The waste water treatment plant Haikou[58] was co-financed by the Federal Republic of Germany through KfW Bank. It possesses a design capacity of 300,000 m³ per day, and was designed with a treatment process consisting of mechanical and biological methods. The plant's effluent is discharged into the sea. The waste sludge is stabilized with an anaerobic digestion process and the by-product of the digestion, the biogas, is utilized for electricity production.

While the wastewater component of the plant was commissioned in October 1999, the sludge treatment component could only be commissioned in April 2005, due to the need to coordinate the construction with other infrastructural measures in the city. Therefore, during the initial operation phase the waste sludge was directly dewatered without stabilization.

The dewatering of the anaerobic stabilized sludge achieves total annual savings from operational expenditure of 3.5 million CNY. The savings are achieved mainly due to reduced energy consumption for dewatering and electricity generation.

So not only from a environmental but also from financial point of view the implementation of anaerobic stabilization process was very successful and can be seen as best case scenario for further waste water treatment strategies within the next few years.

Other companies active in the Chinese waste water treatment sector are Passavant Roediger (projects in Shanghai, Shijiazhuang and Fuyang) and P. K. Punec who are active in Pingnan, Qingchengshan and Jiaxing.

[58] Mr. Wu Qingxiong, Mr. Sun Chuanzhi, Mr. Wang Hexiong, Haikou Baishamen Sewage Treatment Plant, Haikou, China; Dr.-Ing. B. Pan, Dr.-Ing. C. Theune, PÖYRY Environment GmbH (Former GKW Consult GmbH), Mannheim, Germany: Operational Experience in Sludge Treatment and Biogas Utilization in the Wastewater Treatment Plant Haikou

Annex 20: Sludge treatment at Yantain Taoziwan sewage treatment plant


Gas Tank in Qingdao Tuandao

Aeration Tank in Yantai

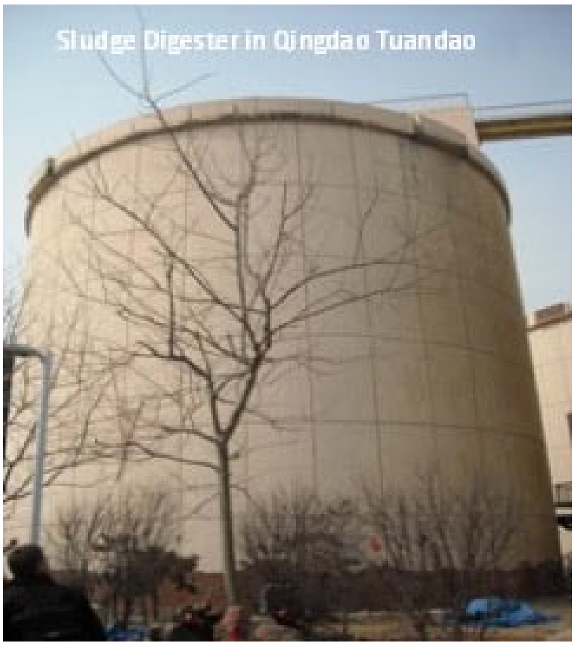
The designed treatment capacity of Yantai Taoziwan sewage treatment plant is 250,000m^3 per day for phase I, including 210,000m^3 discharged into the sea after primary treatment and 40,000m^3 reused for toilet flushing or watering the trees after secondary biologic and advanced treatment. The plant started construction in 1994 and went in operation in 1998. The total investment of the plant is 450 million CNY, among which 117.3 million CNY comes from German government's loan and the remaining 335.9 million CNY are from Chinese funds.

Secondary treatment expansion of the plant has increased the plants size to 200,000 tonnes per day. Besides, the plant plans to improve sludge digesters of phase I and use modified A/A/O process to assure the effluent quality meets emissions standards. The total investment for the expansion is about 239 million CNY. 110 million CNY comes from Sino-German financial co-operation of urban sewage treatment special loan provided by German KfW Bank, and the remaining 129 million CNY will be provided by Chinese funds.

The expansion adopts the improved A/A/O biological treatment process. In order to better enhance phosphorus removal efficiency, the technology adds a pre-anoxic zone in front of the anaerobic zone to eliminate the impact imposed by Nitrate Nitrogen in return sludge on anaerobic Phosphorus release in the anaerobic zone. Technological features are wide adaptable to different influent conditions and effluent demands, high effect of Phosphorus and Nitrogen removal, aeration efficiency, as well as small occupation area. Besides, the expansion project also improves the anaerobic digester system in phase I, gas could transport to biogas boilers for supplying heat required for heating sludge digestion.

Based on the on-site visit and interview, the problems for importing foreign equipments is that overall adjustment is not adapted to Chinese material conditions and therefore need a high grad of maintenance. Maintenance is costly since German experts have to be consulted.

Annex 21: Qingdao Tuandao sewage treatment plant



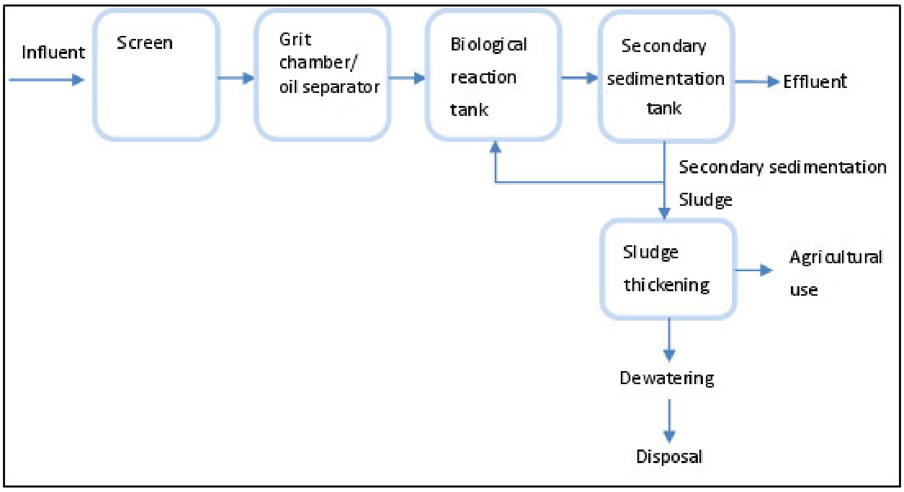
Qingdao Tuandao sewage treatment plant is located in Jiangsu province with a designed treatment capacity of 100,000 m^3 per day. The plant covers an area of 9.6 hectares and mainly treats domestic wastewater that is from south part of Shinan District and part of Shibei District with nearly 260,000 residents.

Tuandao sewage treatment plant is a financial cooperation project between Germany and China. The total investment for the plant is 320 million CNY, in which there are 25 million DM given by German government as a gift loan for purchasing the main process equipments, electrical and automatic control equipments, instruments, laboratory equipments, the engineering documents and the technical service, etc.

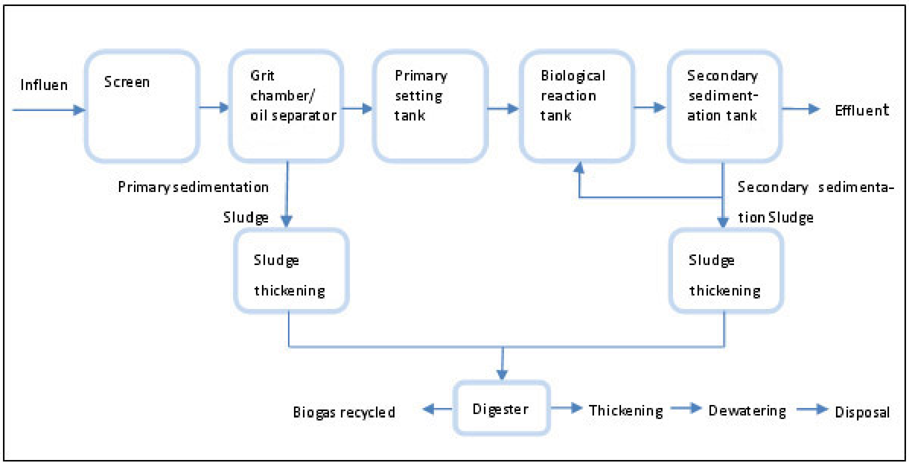
The plant received approval from State Planning Commission in April 1991, started construction in December 1996 and started operation in 1999.

The plant uses Anaerobic-Anoxic-Oxic treatment process for eliminating BOD elements and removing Nitrogen and Phosphorous contained in the wastewater at the same time. The plant maintains a good and stable rate of sewage treatment and sludge disposal. The COD, BOD5, SS, NH3-N and other indicators of the treated wastewater from the plant meet Chinese national waste water discharging standard. Medium temperature digesters are used to treat the sludge and the produced gas is used to energize the gas boilers and gas blowers of the plant. Hence a great amount of energy is saved.

Annex 22: Flow diagram of aerobic stabilization in sewage treatment and sludge treatment processes



Annex 23: Flow diagram of anaerobic stabilization in sewage treatment and sludge treatment processes



Annex 24: Project approval procedure[59]

International investors often have problems to understand the project approval procedures. Below, a standard project approval procedure is given.

Approval procedures for waste water construction projects

Capital construction projects have to be reported to and approved by provincial and national governments. There are different procedures for approval according to the total investment of a project (200,000 CNY), but these vary on province-level and sometimes even on country-level.
The approval process consists of the following five procedure steps:

1. Project proposal,
2. Feasibility study (including a bidding plan),
3. Design of the construction,
4. Construction investment plan, and
5. Permission of construction start.

Construction, agricultural (except for water conservancy projects) and high-tech industrialization projects may be developed on a simplified basis by merging project proposal and feasibility study. All biogas electricity and heat cogeneration projects with imported equipment are considered high-tech projects. Thus, the simplified procedure is applied.
According to the "The information for simplification of the examination and approval procedure of capital construction projects" from the National Development and Planning Committee, the feasibility study is the basis for the approval decision.

[59] GIC German Industry and Commerce (Taicang) Co., Ltd. Beijing Branch: Renewable energies in China – a market study on the wind and solar energy sectors, 2006, chapter 5

1. The project proposal

The project proposal should include the following:

- In case of importing advanced technology and equipment, the general situation of the technology gap between China and abroad has to be prepared.
- An outline of the construction location, size and design has to be included in the project proposal.
- Involved legal and business entities have to be named with all relevant contact data.
- The initial investment plan has to be provided in detail. For projects using foreign capital, the opportunity of using foreign funding and an evaluation of debt repayment capacity as to be described.
- Project developers have to provide the project schedule.
- An impact assessment of economic and social effects on the environment has to be conducted.

2. Feasibility study

For waste water treatment project activities, the project developer is responsible for preparing the feasibility study. The feasibility study has to be prepared regarding technical, finance and cooperation points. The feasibility study report has to include:

1. General introduction of the project opportunity
    - The background of the project. For re-construction and upgrading projects, the current situation of the existing enterprise must be described.
2. Construction scale and design based on market forecast
    - An estimation of market requirements.
    - An estimation of the production capacities of other government-owned companies active in the same business scope.
    - A sales forecast, price analysis, and a competitive analysis of the products. For export products, an estimation of overseas demand and an analysis of the international market are necessary.
3. Supplier situation
    - The amount and composition of the input material that can be expected for the targeted business time frame have to be evaluated and officially be approved by the responsible administrative department.
4. Construction conditions and possible alternative scenarios according for the construction site
    - This includes the geographic location, weather situation, and socio-economical conditions.
    - The present and expected future infrastructure situation. (Traffic, transportation and water, electricity, and gas supply)
    - A comparison of different project locations and a discussion of the reasons for choosing the selected one.
5. Overview over applied technology equipment
    - Equipment features and relevant construction standards.
    - Projects which utilize foreign technology: the arrangement for supplying the materials, country of origin, all relevant domestic and international equipment suppliers. The form of co-operation with the overseas company has to be outlined.
6. Requirements and the necessary measures applied for environmental protection, city planning, earthquake resistance, flood control, air defense, protection of cultural heritage sites and objects, labor safety, hygiene, the prevention of epidemics, and fire protection.

7. Enterprise's organization, labor requirements, and the plan for personnel training.
8. Detailed overview over construction period and construction schedule.
9. Estimated investment requirements and financing.
    - The investment required for main project and (if applicable) auxiliary projects. A line of credit is necessary for foreign capital projects and projects importing technology.
    - An estimation of operating expenditure.
    - Equity and debt capital, finance plan, repayment method for domestic and international loans (including economic investments and enterprise bonds).
10. An estimation of economic and social performance.
11. There should be a detailed description of the financial means, including the investors, the financing approach, the financial resources, and the financing process. Besides, both static and dynamic analyses are necessary not only for the micro economic profit of the project but also for the macro benefit with which the project might reward the national economy and society.

The discrepancy between investment estimation in the feasibility study and the following initial design should be within 10 per cent. If the discrepancy exceeds 10 per cent, the project will be rejected for re-planning.

The feasibility study also requires the following approval documents:
A Recommendation letter drafted by the responsible department (see below) should include an elaboration of the feasibility study report including on what assumptions the size estimation of the project was based, comments on the overall design, the site plan, and the sources of resources and fuel, as well as a description of the public infrastructure, an estimation of the total investment needed, the financing approach, the construction schedule, the project owner and the legal representative structure.

- For provincial projects, the relevant provincial administrative department should issue the Recommendation letter;
- For joint-venture investment projects, the relevant provincial administrative department together with the Municipal Development and Planning Commission should submit the Recommendation letter;
- For municipal projects, the Municipal Development Planning Commission should submit the feasibility study report. In this case the relevant Provincial Department must only assist in the evaluation of the Feasibility study.

The feasibility study draft has to be evaluated by an engineering consulting company.
In case the project has largely obtained outside financing, a decisive credit commitment made by a local or international loan company or bank.
An evaluation report on the legal structure of the dedicated company has to be attached.
In case the project activity is considered to be a high-technology implementing project, a high-technology origin identification certificate should be provided.

3. Design of the construction

The initial design is the concrete project implementation plan based on the approved feasibility study. It includes the overall outline according to the required, basic design documents. It also describes the technical and economic feasibility of the project outlining the investment location, time and total sum. At last, the initial design should meet the requirements for investment control, bidding, material and equipment, soil application and installation preparation.

The following items have to be outlined in the design description:

- Design reference and guidance,
- Construction size, product plan, quantity and source of raw materials, fuel and power,
- Configuration and selection of the technical process and the main equipment,
- Construction plans of major buildings, public infrastructure and residential areas,
- Area of land and utilization plans,
- Infrastructure and accessibility of the project site,
- Comprehensive application, environmental protection and earthquake abatement actions,
- Production organization, overview over required employees and technical parameters, and
- Total estimated investment.

The engineering company, which carries out the construction, should be chosen depending on the size and complexity of the project. According to the existing rules, engineering companies are categorized into four classes. This is to make sure that low class companies will not carry out assignments beyond their work scope. The company should ensure a certain standard of design quality and make sure that each design plan is reasonably made; the design should be based on sufficient and accurate information. The data used should be accurate and reliable; the equipment, materials and installation conditions should be practical; and the design documents should conform to the construction and production requirements.

The initial design should be supervised by the development and planning departments together with the relevant administrative departments for the industry according to national supervision procedures. Once the design is approved, the following items are not subject to change anymore:

- Overall factory design,
- Main technical process,
- Main equipment,
- Construction area and structure, and
- Total investment budget.

The following documents are necessary in order to authorize the initial design:

- An application for authorization of the initial design delivered to the department in charge;
- An investigation report and initial design documentation from relevant certificated institutions or organizations;
- Expert review and comments on the initial design/report, and
- Review meeting report.

4. Construction investment plan

In order to start construction, the project has to be listed in the Construction Investment Plan. Following documents are necessary for the application Construction Investment Plan.

- Permission for the targeted construction site,
- Additional comments from local government or provincial administrative departments,
- Certification of proof of the annual loan capital investment from banks which are authorized to give loans, and
- Approval of the design from relevant institutions.

The project owner shall provide those documents through the provincial administrative department. Local projects shall provide these documents through the Local Development and Reform Commission.

5. Permission of construction start

For project authorization, the project developer needs to prepare the necessary documentation according to the requirements of construction, and provide the Local Development and Reform Commission with the request for permission of construction start. After the request is reviewed, it shall be submitted to the Provincial Development and Reform Commission for final approval.
Following documents should be included:

- Comments on review from the Local Development and Reform,
- Business license or authorizations from all relevant government levels,
- Project proposal, feasibility study, initial design and Construction investment plan,
- Equity and debt capital of the project and annual investment plan,
- Documentation from the planning department,
- Construction print and construction guideline for the project,
- Proof that the construction assignment was distributed through open bidding process,
- Land purchase or lease contracts,
- Delivery contracts for operating material, such as water, electricity, communication equipment,
- Proof that the main components of the project equipment have been ordered, and minimum three months' construction material have been purchased, and
- The monitoring agency of the project construction shall have been determined and relevant contact details have to be provided.

Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ) GmbH

BMU CDM-JI-Initiative
CDM Service Unit China

Dr. Markus Schwegler
Country Manager

Sunflower Tower 1100
37 Maizidian Street, Chaoyang District
100125 Beijing, PR China

T +86 10 8527 5180 ext. 15
F +86 10 8527 5185
M +86 13910506178
E markus.schwegler@gtz.de
I www.gtz.de/china

Dr. Astrid Skala-Kuhmann
Country Director, GTZ China

GTZ Office Beijing
Sunflower Tower 1100
37 Maizidian Street, Chaoyang District
100125 Beijing, PR China

T +86 10 8527 5180
F +86 10 8527 5185
E gtz-china@gtz.de
I www.gtz.de/china