

Biogas Technician Training and Establishment of Biogas-
Laboratories (TCLs) on provincial and national level
沼气技术人员培训以及省级和国家级沼气实验室的建立

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Background背景

- The 'SINO-GERMAN Biomass Utilization Project', aims to provide TA and support to set up about 106 middle and large scale biogas plants. The focus is mainly on large scale animal husbandries and agro-industries financed under an ADB sector loan in 4 selected Provinces in China.
中德生物质能利用项目，旨在为106个大中型沼气厂提供技术援助和支持。集中在四个亚行贷款省的大型养殖场和农产品加工业。
- One activity is to support Biogas Training Laboratories as part of the future Provincial Training Centers established at demonstration projects in the 4 selected provinces at a German-Sino demonstration biogas plant:
其中一项工作是支持四个中德示范项目省份的沼气培训实验中心的建立，并作为将来省级培训中心：
- Shandong Province, Heilongjiang Province, Jiangxi Province, Henan Province 山东省，黑龙江省，江西省和河南省

Goal of TCLs 培训中心实验室的目标

Enables operators to operate the biogas plant stable and at a high performance 使操作人员能够稳定、高效地运行沼气厂

- Provide understanding for the biological biogas process
理解沼气生产的生物过程
- Describes technical components of a biogas plant and their purposes 介绍沼气厂的各个组成部分及其用途
- Describes maintenance routines 介绍日常维护内容
- Defines action in the case of malfunctioning
明确发生故障时应采取的措施
- Provide capacity to analyze the biogas process relevant parameters from input (feedstock) to output (biogas, effluent, emissions) 具备分析整个沼气工艺过程相关参数的能力：从进料（原料）到输出（沼气、沼渣沼液、气体排放）

Existing biogas trainings in China

中国现有沼气培训

- Training for construction of household scale biogas plants
户用规模的沼气厂施工培训
- Training for operation and maintenance /servicing of household biogas plants by property management staff
服务于户用沼气厂的物业管理员/操作和维护培训
 - CAAE (Chinese Academy of Agricultural Engineering) is in charge of setting up this vocational qualification. CAAE (农业部规划设计研究院) 负责制定职业培训规范
 - Both existing training have been recently under renewal
上述两个培训均在更新中

Situation in Germany/Austria

德国和奥地利现状

- Most of the state owned training laboratories are located close to a University 大多数国有培训实验中心位于大学附近。
- Only one has an own biogas plant 只有一个实验室拥有自己的沼气厂。
- Usually they offer laboratory services to private customers as well 通常他们为私人客户提供实验室服务。
- Such training laboratories usually have a certain budget from the Province for their basic equipment and staff 这些培训实验中心通常得到省政府的补贴用以配备基本设备和人员。
- Additional activities depend on additional resources (projects, own initiative) 另外的工作取决于额外的资源（项目，主动性）

Situation in Germany and Austria

德国和奥地利现状

- Most research focused training laboratories are state owned
大多数重点研究的培训实验中心是国有的。
- More private companies organize courses on basic biogas knowledge 多数私人公司组织的课程是关于沼气基本知识。
 - Such courses for operators are required e.g. in Provinces in Austria but also in Germany (esp. for safety)
这些课程是操作人员必修的，例如：在奥地利各省，在德国也是（特别是安全）
 - Dependend on the course duration and organizer, training courses are offered for: 根据课程的时间和组织者，培训课程提供：
290,-€ (2 days) – 1.500,- € (5 days) 欧元290（2天）--欧元1500（5天）
- Private companies offer laboratory services
私人公司提供实验室服务

Training courses – Organizers

培训课程—组织者

- In Germany: 德国:
 - Either held by state owned training centres
由国家培训中心举办
 - Private companies 私人公司
 - Sometimes, there is a mixture of both
有时，两种方式结合

Example: Landesanstalt für Agrartechnik und Bioenergie, Hohenheim

例1: Hohenheim 农业技术和生物能源研究所



Owned by the state (like a Province) Baden-Württemberg 巴登州政府所有

- Located at the University of Hohenheim 位于Hohenheim大学
- Topics (among others): 主要课题:
 - biogas production 沼气生产
 - biogas use 沼气利用
- Dissemination via: 通过以下方式宣传:
 - Publications, presentations, training courses 刊物、简报和培训课程
- Equipment: 设备:
 - Continuous flow fermenter (28 with 17 – 400 l) 连续进料发酵器 (28套, 容积17-400L)
 - BATCH fermenter (438) 序批式发酵器
 - Biogas-Laboratory with fermenter for dry fermentation and fixed bed fermenter 用于干发酵和固定床发酵器沼气实验室
 - Experimental biogas plant (two fermenter with 923 m³ each) and a CHP with 186 kW electr. (operation started a few years ago)
试验的沼气厂 (2个发酵器, 每个923立方), 一台186千瓦热电联产机组 (几年前开始运行)

Example 2: Private Training Centre: IBBK: International Biogas and Bioenergy Center of Expertise

例2：私人培训中心IBBK：国际沼气和生物能源专业中心



- Private company 私人公司

Selection of activities: 选择的活动:

- Creation of an information- and exhibition platform for manufacturers, traders, industry and operators
为制造商、贸易商、行业 and 操作人员创造信息交换和展示的平台
- Planning and holding of qualifying training courses, seminars and conferences about biogas and bioenergy for operators, manufacturers, technicians, and farmers
 - www.biogas-training.com 为操作人员、制造商和技术人员和农场主计划和举办高质量关于沼气和生物能源的培训课程、研讨会、会议。
- Active dissemination of information 积极传播信息

<http://www.biogas-zentrum.de/>

Example 3: Biogas Laboratory

例3：沼气实验室

- Private company 私人公司
- Laboratory specialised on biogas 专业沼气实验室
 - Fermenter samples 发酵罐样品
 - Biogas yields 沼气产量
 - Special gas test 专门气体实验
- Accredited according DIN EN ISO / IEC 17025
通过 DIN EN ISO / IEC 17025 认证
- Receives samples from all over Europe (and some from other continents)
接受全欧洲的样品（有些来自其他国家）

TCLs – Minimum Requirements

培训实验中心-最低要求

- Located at a SINO-German Demonstration biogas plant
位于中德示范项目沼气厂
- (Accommodation) (住宿)
- Lecture room 教室
- Laboratory 实验室
 - with a biogas plant close by 附近有沼气厂
- Administration 行政管理
- Skilled staff 熟练员工
 - Head of the training Center is an experienced expert in the field of biogas from the PIO 培训中心的负责人应该是省项目办的沼气行业的有经验的专家
 - One skilled laboratory head (biogas plant staff) 一名熟练的实验室负责人 (沼气厂的员工)
 - One skilled head of the mechanical division (O&M technician of the biogas plant) 一名熟练的设备负责人 (沼气厂操作和维护技术员)



Location of TCLs 培训实验中心的地点

According to the ADB/GIZ agreement: 根据亚行/德国国际合作机构的协议:

- Located at an existing outstanding biogas plant, a German-Sino demonstration biogas plant 位于中德示范沼气厂，或已有的有突出代表性的沼气厂
- Attraction for participants 对参加培训者有吸引力
- Onsite training is possible 可以进行现场培训
- Laboratory equipment can be used for biogas plant analysis if not used in the courses 如果没有培训课程时，实验室设备可以用于沼气厂的分析工作
- Staff of the training center is working at the biogas plants when no courses are given 没有培训课程时，实验室的员工为沼气厂工作
- Attraction for staff of the training center
对培训中心的员工有吸引力

- **Training of operators** 操作人员的培训
- Laboratory 实验室
- Staff 员工
- Advisory Board 咨询委员会

Service: Train operators – Curriculum:
a combination of theory, on site and laboratory training!

服务：培训操作人员-

课程：现场、实验室培训和理论的结合！

- Safety aspects 安全方面
- Biogas biology 沼气生物学
- Technology in a fermenter: agitator, pumps, gas storage
发酵技术：搅拌器、泵、储气罐
- Start up phase 启动阶段
- Pretreatment of material 原料预处理
- Daily operation and maintenance of the plant , trouble shooting
沼气的日常操作和维护，排除故障
- Effluent management 沼渣沼液的管理
- Requirements how to use biogas 沼气利用的要求

Eligible candidates for the training

培训候选人的资格 (under development制定中)

From ADB projects 来自亚行项目

- Operators that are employed by the biogas plant management 沼气厂的员工

Following the National Vocational Education Standard (CAAE) 国家职业培训标准

- *continues working experience in the sector of more than 5 years after they have achieved the Junior Professional level (Professional level 5) for Biogas Plant Operation;*

取得沼气操作初级资格（5级），并连续从事本职业工作5年以上；

- *continues working with the in the sector of more than 2 years after they have achieved the Middle Junior Professional Credentials (Technician level 4) for Biogas Plant Operation;*

取得沼气操作中级资格（4级），并连续从事本职业工作2年以上；

Eligible candidates for the training

培训候选人的资格 (under development制定中)

• *Continues working with the profession more than 6 years after having past the High Professional Training for the required study hours, as well as obtained the Certification;*

通过高级职业培训，取得合格证书，并连续从事本职业工作6年以上；

• *Continues working with the professional more than 1 year after having graduated obtained the relevant college subject*

相关专业大学毕业，并连续从事本职业工作1年以上；

General Strategy for the Training

培训策略 (under development制定中)

- Parallel structure to existing trainings in order to be approved as an acknowledged vocational training by MOA and MOHRSS. (additional qualification of professionals) 为了得到农业部及人力资源和社会保障部的职业培训资格证书，培训应与现有架构平行（额外的专业资格证书）
 - There are modules of about five days 有几个5天的培训单元
 - Module I: basics on advanced biogas technology 单元1：先进沼气技术基础
 - Module II: in depth training on advanced biogas technology 单元2：先进沼气技术进阶培训
 - (Module III) （单元3）
 - After every module there is an examination 每个单元结束后有考核
 - Successful participants may have a final examination under MOHRSS (after 2013) and receive an **official approval** of their vocational training by MOA and MOHRSS 成功的参加者要参加人力资源和社会保障部的结业考试（2013年后），得到农业部及人力资源和社会保障部的职业培训合格证

- Training of operators 操作人员的培训
- **Laboratory** 实验室
- Staff 员工
- Advisory Board 咨询委员会

Service of a Laboratory 实验室服务

- Training facility 培训设施
- Monitoring of biogas plants 沼气厂检测
- Laboratory to test biogas yield from substrate 测试底物沼气产量的实验室



Laboratory Equipment – Training

实验室设备-培训

- pH: **pH-meter** pH仪
- COD (chemical oxygen demand) COD (化学需氧量)
- Electric conductivity: **EC-meter** 电导率测试仪
- drying oven (105° C, 550° C) 干燥炉 (105度, 550度)
- DM/oDM (Dry matter/organic dry matter) 干物质/有机干物质

Laboratory Equipment – Training

实验室设备-培训

- Volatile fatty acids (VFA): **titration** 挥发性脂肪酸：滴定
- Total inorganic carbon (TIC): **titration** or **volumetric system**
总无机碳：滴定或体积测定系统
- Ammonium (NH_4^+): to calculate NH_3 in the substrate; photometer or **volumetric system**
氨 (NH_4^+)：计算氨在原料中含量；光度计或体积测定系统



Laboratory Equipment – Training Gas yield

实验室设备-沼气产量测试培训

- Batch fermenter 序批式发酵罐
- Thermometer 温度计
- Inoculum 接种细菌
- Gas collection device (e.g. gas bag) 沼气收集装置（例如：气袋）
- Heater for the batch fermenter 序批式发酵罐加热器
- Device to analyse gas amount 沼气产量分析装置
- Device to analyse gas quality 沼气质量分析装置



Preparation 准备

- Sieving 筛选
- Homogenizing 均质
- Milling 研磨



Basic analysis – substrate 基本分析—原料 (as well: parameter for a training) (以及： 培训用的参数)

- pH pH值
- EC 电导率
- Dry matter 干物质
- Organic dry matter 有机干物质
- Chemical oxygen demand 化学需氧量
- Alkalinity and volatile fatty acids 碱度和挥发性脂肪酸
- Ammonium 铵



Advanced analysis – substrate 高级分析—底物

- GC (Gas Chromatography) or HPLC (High Pressure Liquid Chromatography): single component analysis
气象色谱仪或高压液相色谱仪：单一组分分析
- ICP (inductively coupled plasma): trace elements
电感耦合等离子体光谱仪：微量元素



Biogas analysis 沼气分析

- H₂S and explosion limit detectors 硫化氢和爆炸极限探测器
- Biogas quality 沼气质量
- Batch fermenter 序批式发酵罐
- Continuous fermenter 连续发酵罐



Rooms for a full service laboratory 提供全面服务的实验室房间

- Sample Arrival, packing 样品到达，包装
- Storage 储存
- **Preparation 准备**
- **Basic analysis 基本分析**
- **Advanced analysis 深入分析**
- **Biogas test room 沼气检测室**
- **Sum: around 60-100 m²**
总计：约60-100平米



Service: Biogas Plant Monitoring

服务：沼气厂监测

Samples are analysed 分析的样品

- to guarantee high performance of the plants

保证沼气厂的高效运行

- to improve the methane yield per ton substrate

增加每吨底物的甲烷产量

- to avoid ammonia or H₂S inhibition

避免氨或硫化氢的抑制作用

- to avoid acidification 避免酸化

- to fight micro nutrient deficits

避免微量营养物质的缺失

Service: Determination of Biogas Yields

服务：沼气产量测定

Substrates are analysed using 原料用以下方法进行分析

- Batch tests 批量测试

- to determine the biogas potential 确定产沼能力

- Continuous fermenter 连续发酵罐

- to study influence of hydraulic residence time and organic loading rate 研究水力停留时间和有机负载率的影响
- to overcome biological problems in the fermenter such as acidification, micro nutrient deficits, high NH_3 concentration, the effect of antibiotics

克服发酵罐中生物问题，例如：酸化，微量营养物质不足，氨浓度过高，抗生素影响

Skilled Staff for the Laboratory 实验室熟练操作员

- The basic analysis and basic biogas tests can be performed by one skilled person (experienced BSc or MSc).
基本分析和沼气基本测试由一名熟练操作人员完成（有经验的学士或硕士）
- For advanced analysis a second staff is necessary (experienced BSc. or MSc.). 深入分析需要另一个人员（有经验的学士或硕士）
- Example: a well running biogas laboratory in Germany may handle more than 100 samples per day with 6-10 persons.
例如：德国，运作良好的沼气实验室有6-10名员工，每天处理100多个样品。
- This could be a size for a well running Provincial/National laboratory, too
运作良好的省级/国家实验室也应该具有同样规模。

Equipment list 设备清单

Purpose 目的	Equipment 设备
Safety 安全	Gas warning system 沼气报警系统
Test unit for biogas production, batch 沼气生产、批量式测试单元	small bottle test 小测试瓶
	balance (0.1 g) 0-2000g 平衡
Biogas production, continuously 沼气生产、连续式测试单元	CSTR 全混合厌氧工艺
dry matter 干物质	drying oven (105°) 干燥炉
organic dry matter 有机干物质	muffle oven (550°) 马弗炉
	balance (0.01 g)
Salt 盐	EC-meter 电导率测试仪
pH	pH-meter pH值测试仪
Volatile Fatty Acids 挥发性脂肪酸	Titration 滴定仪
Total inorganic carbon 总无机碳	Titration 滴定仪
Total inorganic carbon 总无机碳	BiogasPro
N-detection 测定氮	Kjeldahl凯氏测氮法
NH ₄ 铵	Kjeldahl凯氏测氮法
NH ₄ 铵	BiogasPro
Single VFA单一挥发性脂肪酸	gas chromatograph with flame ionisation detection to analyse 带有火焰离子化检测器的气相色谱仪进行分析
	Centrifuge 离心机
Chemical Oxygen Demand (COD) 化学需氧量	COD analyser 化学需氧量分析仪
Storage of samples 样品储存	Freezer 冷藏室
Pretreatment 预处理	Mill 磨碎机
trace elements 微量元素	Inductively coupled plasma 电感耦合等离子体光谱仪

Potentials for Training Laboratories

培训实验中心的潜力

- There are thousands of medium and large scale biogas plants in China 中国有数以千计的大中型沼气厂
- If they are managed professionally, then there is a big demand for training courses, advice, laboratory service...
如果具备专业化管理，将有大量培训，咨询和实验室服务的需求
- There is a big opportunity for professionally operated training centres!
对于专业运作的培训中心有巨大的机遇

Overview 概况

	Training 培训	Service 服务	Research 研究
Staff 员工	Depends on organisation 根据组织结构	Skilled expert + 熟练专家+ technicians 技术员	Skilled expert + 熟练专家+ technicians 技术员
Equipment 设备	+	++	++
Investment 投资	rather Low 相当低	rather high 相当高	rather high 相当高
My opinion 我的意见			
Current need in China 目前中国需求	Very urgent 非常急需	Very urgent 非常急需	Urgent 急需
Financial sustainability 财务可持续性	++	+ (?)	?
Provincial laboratory 省级实验室	++	++	+?
National laboratory 国家级实验室	++	++	++

- Training of operators 操作人员的培训
- Laboratory 实验室
- **Staff** 员工
- Advisory Board 咨询委员会

Staff: Head of TCL

员工：培训中心负责人

- Minimum Provincial level accepted biogas expert
至少是省级沼气专家
- Organization of training courses 组织培训课程
- Employed by the biogas plant or PIO
由沼气厂或省项目办雇用
- Continuous development of the training 持续完善培训
- Promotion of the biogas technology. 提升沼气技术
- Trouble shooting for operators in case of problems.
解决操作人员遇到的问题

Head: Requirements 负责人：要求

- University degree (e.g. environmental engineering, microbiology, biotechnology)
大学程度（如：环境工程，微生物学，生物技术等）
- English skills to communicate with international trainers
与国际培训专家用英语沟通
- Employment by Province or biogas plant
由省或沼气厂雇用
- During the first Training courses responsible for training the staff of ADB biogas plant project and German-Sino demo plants 第一次培训中，负责培训亚行和中德示范项目沼气厂的员工
- Cooperation with other biogas trainers and biogas organizations in China and abroad 与其他沼气培训专家和中外的沼气机构合作

Staff: Head of the mechanical/hardware division

员工：设备/硬件负责人

- After international trainings in 2011 and 2012 the candidate should be familiar with the relevant biogas technologies and mechanical equipment from the biogas plants that are in the ADB project. 经过2011和2012年的国际培训，候选人应该熟悉亚行项目的相关沼气技术和机械设备
- The candidate should be familiar with operation and maintenance of the biogas plants. 候选人应该熟悉沼气的操作和维护

Staff: Head of the mechanical/hardware division

员工：设备/硬件负责人

- Excellent knowledge in the field of operation of fermenters 现场操作发酵罐的优秀技能
- University degree (e.g. environmental engineering) or equivalent 大学学位（如：环境工程）或其它同等学位
- Employment by Province, biogas plant 由省、沼气厂雇用
- Responsible only for ADB biogas plant project and German-Sino demo plants 专门负责亚行沼气项目和中德示范项目

Staff: Head of the laboratory

员工：实验室负责人

- Excellent knowledge in the field of biogas analysis. 在沼气分析方面知识丰富
- After international trainings in 2011 and 2012 he is familiar with all necessary analytical devices. 经过2011和2012年国际培训后，熟悉所有的分析仪器
- Maintenance and calibration of laboratory equipment and biogas analysis 实验室仪器维护和校准以及沼气分析
- Sampling at biogas plants 沼气厂的样品
- Storage and shipment of samples 样品的存储和运输
- Interpretation of results 结果分析解释

Requirement for the whole potential staff: 对所有潜在的员工的要求

- Willingness to participate in a selection process (two of four nominated candidates of each Province). The selection process includes: 愿意参加筛选过程（从每个项目省的4个候选人中选2个）
 - Successful Participation in the trainings to be held in autumn 2011, spring 2012 and the training in Germany 成功通过2011年秋季、2012年春季和德国的培训
 - Successful presentation of a 20 minutes lecture to be held during the international training in autumn 2011 (currently scheduled for mid of October) 在2011年秋季国际培训结束时，准备一个20分钟的演讲（目前计划在10月中旬）

Trainers at TCLs 培训实验中心的培训师

- Technical trainers can be from the demonstration projects (e.g. Heads of TCL, mechanical division, laboratory) 培训师可以来自示范项目（如：培训实验中心的负责人，设备负责人，实验室）
 - Employed by the demonstration projects or PIO
由示范项目或省项目办雇用
 - Responsible for lab. Training and technology of the on site biogas plant
负责实验室培训，沼气厂现场技术
- External trainers 外部专家
 - Can be suggested by the demonstration projects
由示范项目建议
 - Can be suggested by the PIO 由省项目办建议
 - Expert in a field of biogas technology: e.g. design, mechanical equipment, biogas use
沼气技术方面的专家，如：设计、机械设备、沼气应用
 - Can be a member of a Research Institute or University
可以是研究机构或大学的成员

Train the trainer concept

培训培训师的概念

Trainers participate at the training modules

对培训师的培训模式

- Module I (autumn 2011) 模式1（2011年秋季）
- Module II (spring 2012) 模式2（2012年春季）

Additionally 另外

- Specific training in Germany (spring 2012) 去德国专业培训

Then TCL-trainers will take over the training
培训实验中心的培训师将承担培训工作

Regular (inter)national trainings for the staff
员工定期国内国外培训



- Training of operators 操作人员的培训
- Laboratory 实验室
- Staff 员工
- **Advisory Board 咨询委员会**

Advisory Board for all TCLs

所有培训实验中心的咨询委员会

- A management board accompanies TCLs 培训实验中心的管理委员会
- Activities 工作内容
 - Keep the training up to date 保证更新培训
 - Advances in the curriculum 更新课程
 - Joint actions of all TCLs 所有培训实验中心联合活动
- Members: 成员
 - Ministry 部委
 - University 大学
 - Users (e.g. Biogas Association etc.) 用户（如：沼气协会等）

Thank you 谢谢