中国沼气和生物质炉灶现状和经验

BIOGAS AND BIOMASS STOVES: SITUATION AND EXPERIENCES

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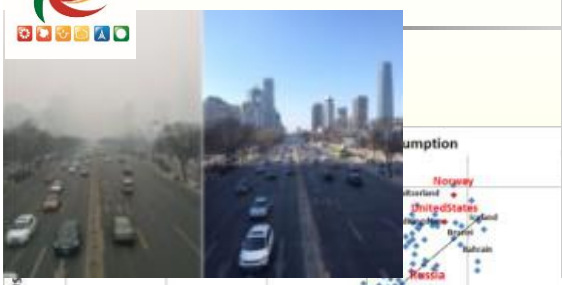
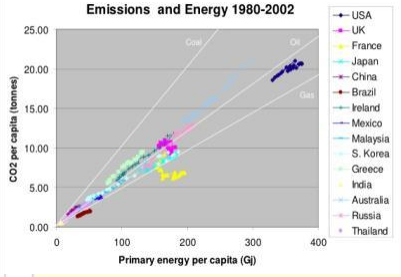
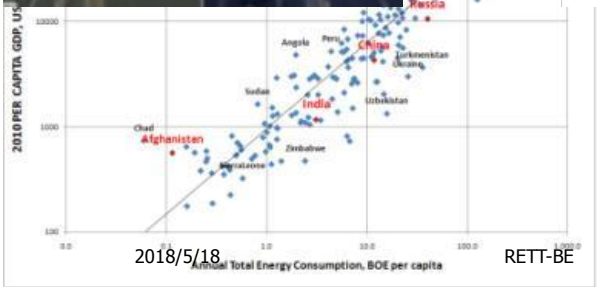
1. 能源与环保是社会发展的制约因素

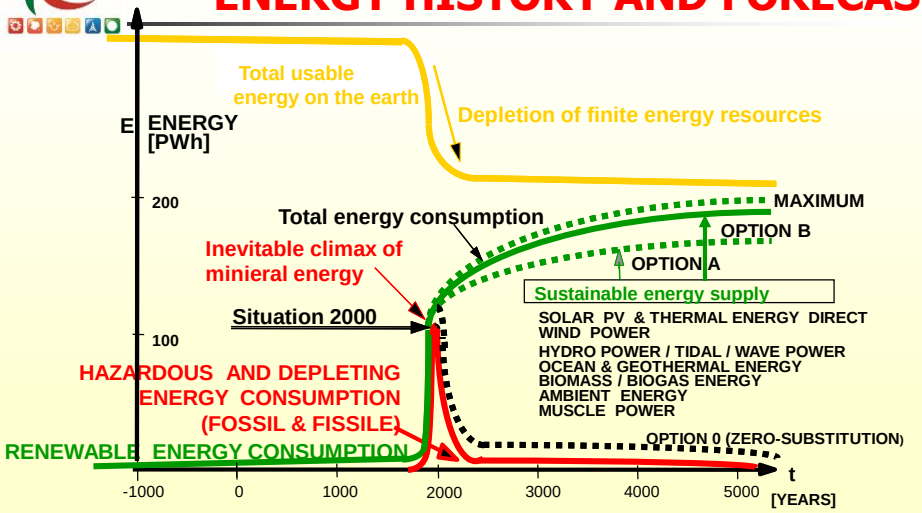
ENERGY/ENVIR FOR DEVELOPMENT





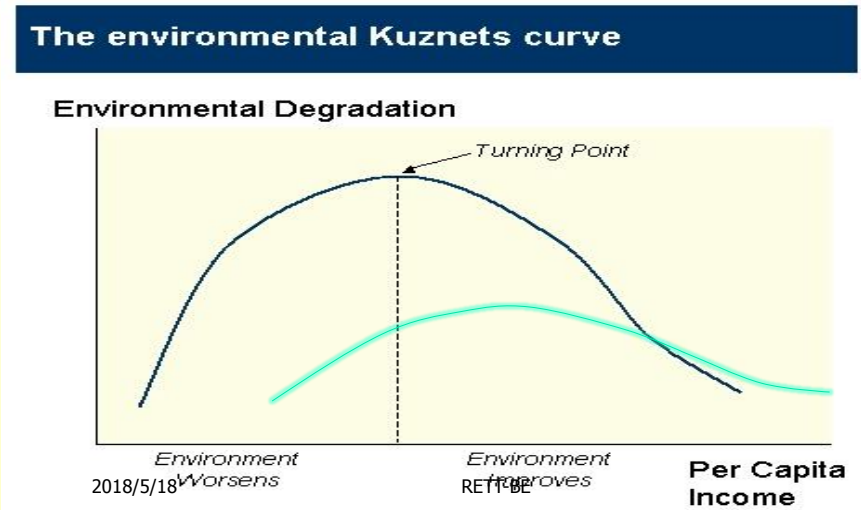


能源的供求历史
ENERGY HISTORY AND FORECAST



SOURCE : ISEO

生产能源、保护环境-必须的选择
ENVIRONMENT PROTECTION AND ENERGY PRODUCTION- A MUST

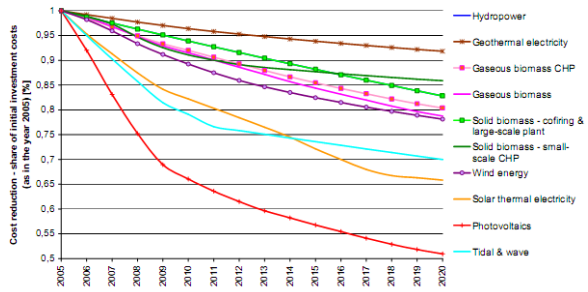


可再生能源
RENEWABLE ENERGY

Energy derived from natural processes (e.g. sunlight and wind) that are replenished at a faster rate than they are consumed.

- ■太阳能 Solar Energy
- ■水力能源 Hydraulic Power
- ■风能 Wind Power
- ■生物质能 BioEnergy
- ■地热 GeoThermal Energy
- ■其它 Others

Figure 3: Estimated rate of unit cost reduction for renewable electricity generation technologies.



Source: Green X balanced scenario

2. 生物质能利用技术
BE TECHNOLOGIES

直接燃烧：direct combustion
- 炉灶燃烧技术 stove combustion technology
- 锅炉燃烧技术 boilers/burners
- 致密成型技术 briquetting
- 垃圾焚烧技术 garbage combustion

物化转化技术 physical conversion technology
- 木材干馏技术 wood carbonization
- 热解气化技术 hydrogenation gasification
- 热解制油技术 oil making by hydrogenation

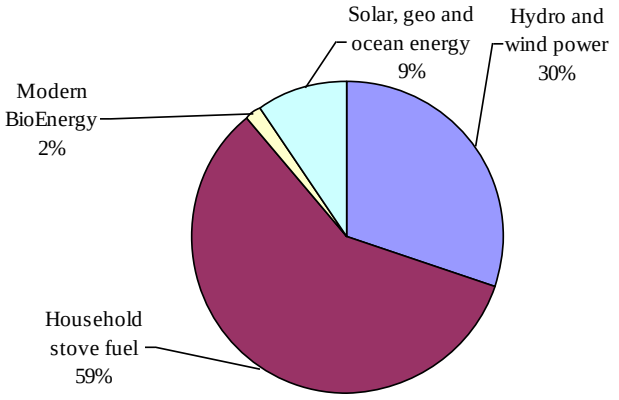
生化转化技术 chemical conversion technology
- 填埋制气与堆肥 landfill and composting
- 小型户用沼气池技术 small-scaled biogas fermentation
- 大中型厌氧消化沼气技术 large/medium scaled anerobic fermentation
- 乙醇制取技术 ethanol making technology

植物油技术（能源植物油的提取）bio-oil (biofuel) technology

生物质转化所形成的最终产品
BIOPRODUCTS

气态：生物制气，如沼气、气化气
Gaseous products: such as biogas, producer gas
液态：生物燃油，如生物乙醇、生物柴油、裂解油等；
Liquid products: biofuels such as bio-ethanol, bio-diesel,
固态：颗粒燃料、生物炭
Solid products: briquettes, pellets, bio-charcoal
电力:一次转换，如燃烧发电；二次转换，如沼气发电
Electricity: one-stage conversion such as biomass combustion power generation, two-stage conversion such as biogas power generation

生物能源在可再生能源中的地位
BIG ROLE OF BIOENERGY

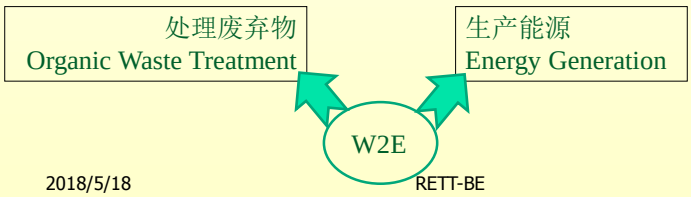


Renewable Energy Structure in China in Recent Years

有机废物生产能源
ORGANIC WASTE TO BIOENERGY

工农业有机废弃物：农作物秸秆、畜禽粪便、工农业产品加工过程中的产生的废弃物，如食品厂、屠宰场、酒厂、糖厂、造纸厂等排出的废水和废渣等；林业废弃物：林产品加工废弃物；
城市固体垃圾。

Organic wastes from agricultural and industrial sectors: crop residues, animal dung, waste water or residues from industrial and agricultural processing plants, such as slaughters, breweries, sugar makers, paper mills etc. Forestry wastes: wastes from wood processing; municipal solid waste (MSW)



3. 炊事和取暖
COOKING (AND HEATING)

开放式柴灶 Open fire

传统柴灶 Traditional biomass stove

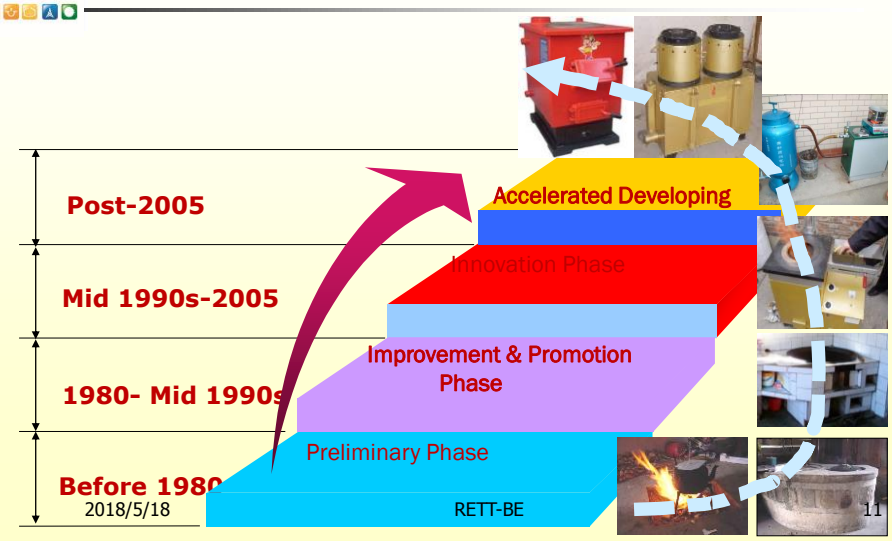
老式省柴灶

Old hi-efficiency bio stove

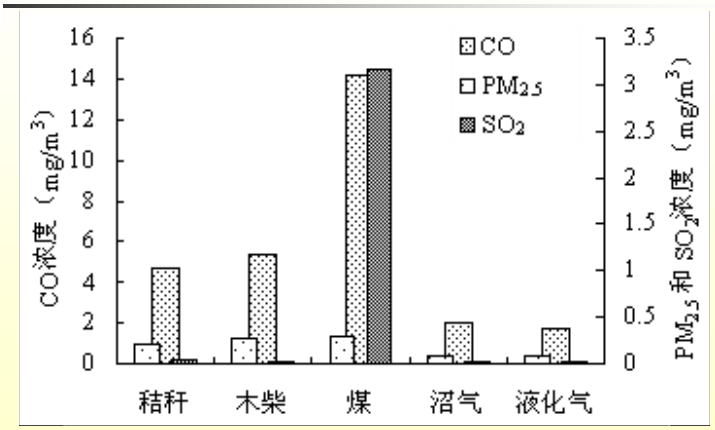
煤炉

Coal stove

生物质炉灶的改良之路
BIOMASS STOVE DEVELOPMENT

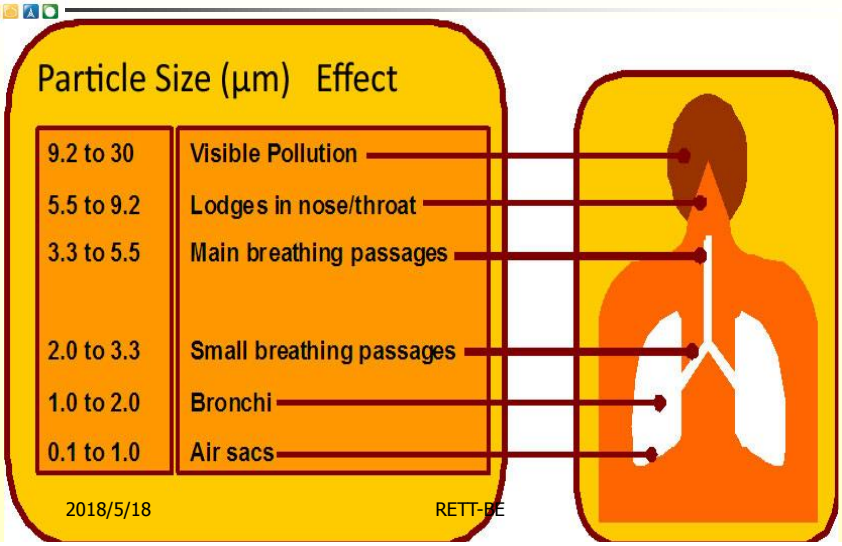


不同燃料对农户室内空气质量的影响
FUELS IMPACTS ON HOUSEHOLD IAQ

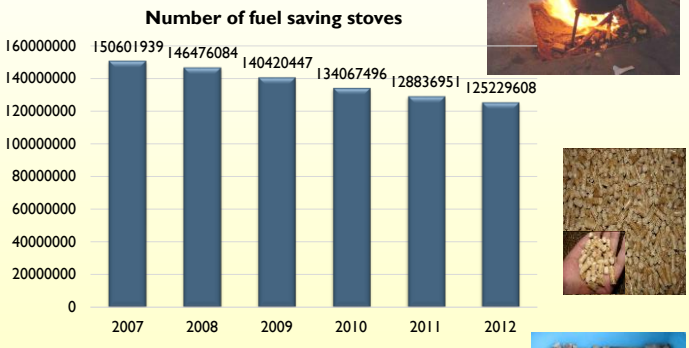


数据来源：中荷政府间合作项目

颗粒物对人体健康的危害
HARMFUL PM



家庭炉灶
FAMILY SCALE BIOMASS STOVES



GHANA/KENYA: IMPROVED BIOMASS STOVES

Photograph of the new efficient Gyapa Stove

- The cost of the stove is low (about 3 - 10 dollars)
- The stove is so popular that it is used in over 50% of all urban homes and about 16% of rural homes in Kenya.

测试秀 TESTING SHOW

村级气化站
VILLAGE SCALE BIOMASS SYNGAS STATION

500户供气管网及配套设施 Syngas for 500 households cooking
日处理能力1.5t/d，产气能力500m³/d。 500m³/d from 1.5t of biomass

4. 沼气池与沼气工程
BIOGAS: MLBP AND HBP

Household Biogas Plants (HBPs)

Medium and Large scale Biogas Plants (MLBPs)

加纳沼气工程
GAS PLANTS IN HANA

沼气工程的作用
THE ROLE OF BIOGAS PLANTS

环保价值
不可或缺
Environment
Protection

能源价值
或隐或现
Energy
Value

肥料功能
Fertilizing Nutrients

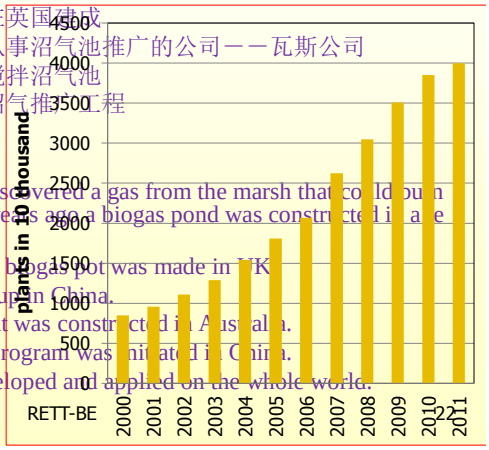
国家高度重视沼气工程
BIOGAS GREATLY SUPPORTED

1958.4 Chairman Mao Zedong.Wuhan, Hubei Province

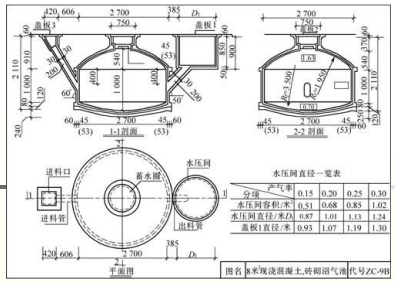
沼气池
HOUSEHOLD BIOGAS PLANTS-HBP

- 中国的先人发现在沼泽地里有一种可以点燃的气泡，于是称之为“沼气”；大约1500年之前，中国人在寺庙建设了一座消化涮米水的沼气池，至今仍然存在
- 1896年西方第一座人工建造的沼气池在英国成
- 1920年中国成立了世界上第一家专门从事沼气池推广的公司——瓦斯公司
- 1940年在澳大利亚建成了第一座连续搅拌沼气池
- 1950年代中国实施了首个国家规模的沼气推广工程
- 从那以来，厌氧技术迅速发展

- In very ancient time, Chinese ancestors discovered a gas from the marsh that could burn and named it as marsh gas. About 1500 years ago a biogas pond was constructed in a temple to digest the rice washing water.
- In 1896 it is recorded the first constructed biogas plot was made in UK
- In 1920 the first biogas company was set up in China.
- In 1940 a continuously stirred biogas plant was constructed in Australia.
- In 1950 the world's first national biogas program was initiated in China.
- Since then, biogas technologies were developed and applied on the whole world.

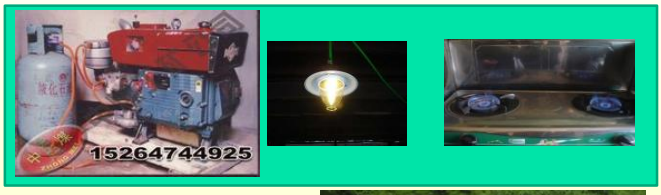


户用沼气池
GB/T 4750-2002

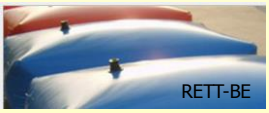


沼气池 类型
HBP TYPES

玻璃钢沼气池
Glass Fibre Biogas Tank

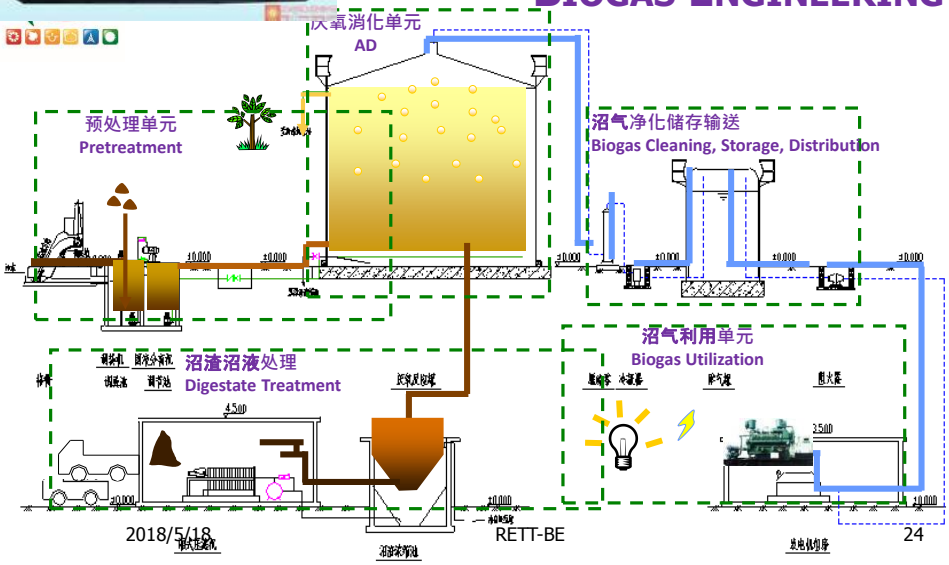


红泥沼气袋
Red-mud plastic biogas tank
350-1100 Yuan



Quoted from Tianren Company presentation made by its President Dr. CAO Man

沼气工程
BIOGAS ENGINEERING



高效高浓度有机废水沼气化技术
BIOGAS FROM MOLASSES

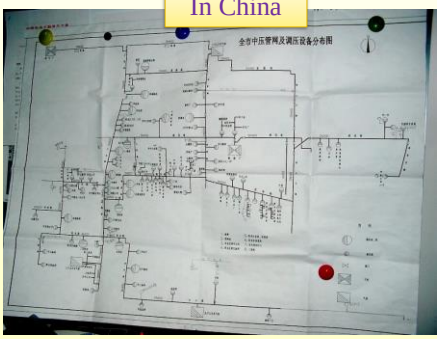
湛江农垦三和酒精厂日排放1300m³ COD为10万mg/L的有机废水，日产沼气3万m³。每吨废水的环保处理费5-6元，现每吨产值30-50元，日产值约100万元。
30,000 m3 biogas from 1,300 m3 wastewater (COD 100,000mg/L) of Molasses-Ethonal. The wastewater treatment cost is 5-6RMB/m3, now producing value of 30-50RMB/m3.

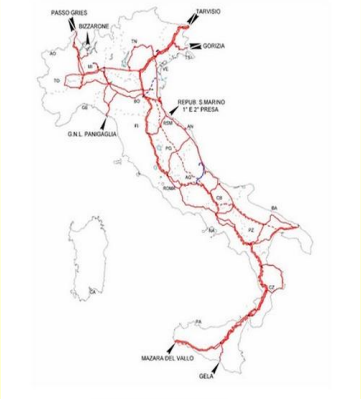
山东沼气发电CDM项目
MINHE-ELECTRICITY AND CDM

1. 鸡粪Chicken manure: 500 t/d, TS 20%
2. 规模 volume: 3,200 m3×8
3. 设计沼气产量 planned biogas production 30,000 m3/d (1,000万m3/年)。
4. 设计发电量 Expected power 60,000 kW·h/d (2,000万kW·h/年)。
5. 年减排温室气体 GHGs reduction: 67,000 tCO2e/a
6. 联合国气候变化框架公约（UNFCCC）批准，与世界银行CDM交易成功。 Successful CDM with World Bank

沼气工程提供城市燃气
BIOGAS AS CITY GAS

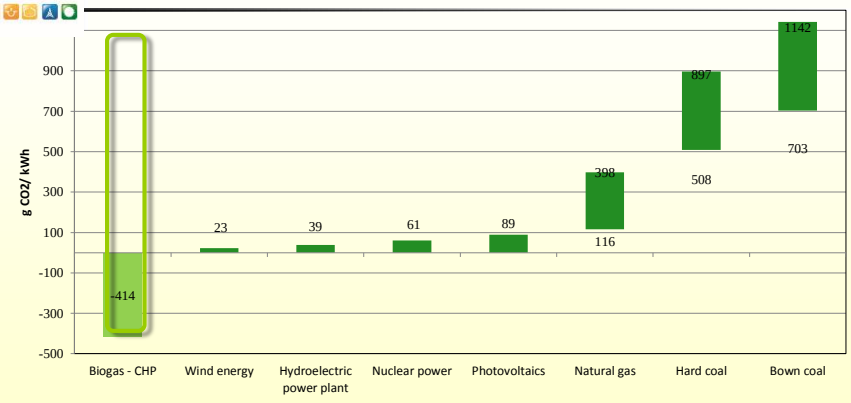
In China





In Europe

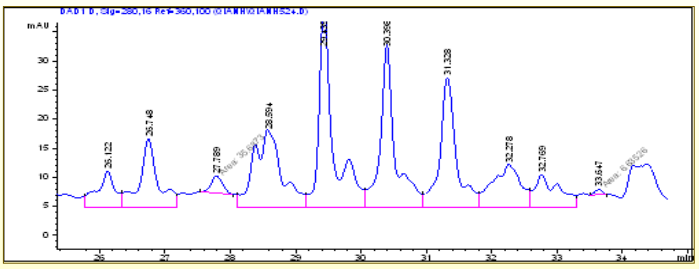
沼气工程是负碳技术
BP-CARBON NEGTIVE

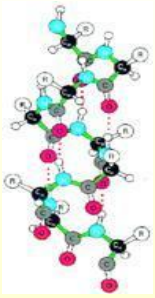


Specific CO_2 Emission Associated with Energy Generation

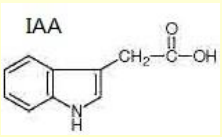
Resource: Poeschl M, S Ward & P Owende. 2010. Prospects for expanded biogas utilization in Germany. *Renewable & Sustainable Energy Reviews*: In Review

HETEROAUXING (INDOLE ACETIC ACID-IAA)
IN DIGESTATE
沼液中的吲哚乙酸





PO1 IAA=36.6ng/ml ABA=0.0233 ng/ml



IAA在低浓度(1~10 ng/mL)时显示各种活性，浓度过高对植物有明显的毒化作用。

1-10 ng/mL IAA has evident activities. Excessive IAA has toxicity.

5. 法律保障-可再生能源法
RENEWABLE ENERGY LAW

第十届全国人民代表大会常务委员会第十四次会议于２００５年２月２８日通过，自２００６年１月１日起施行。

Approved b[illegible]e of People's Congress on [illegible] Jan. 1, 2006.

2007年1月1日国务院发布公告，禁止利用食品和饲料原料生产生物燃料

It has been prohibited to make biofuels from materials for food and feed.

增加能源供[illegible]

改善能源结构；Improve energy supply structure

保障能源安全；Enhance energy security

保护环境。Protect environment

其他法律
RELEVANT LAWS AND REGULATIONS

固体废物污染环境防治法 Law on the Prevention and Control of Environmental Pollution by Solid Waste

环境保护法 Environmental Protection Law

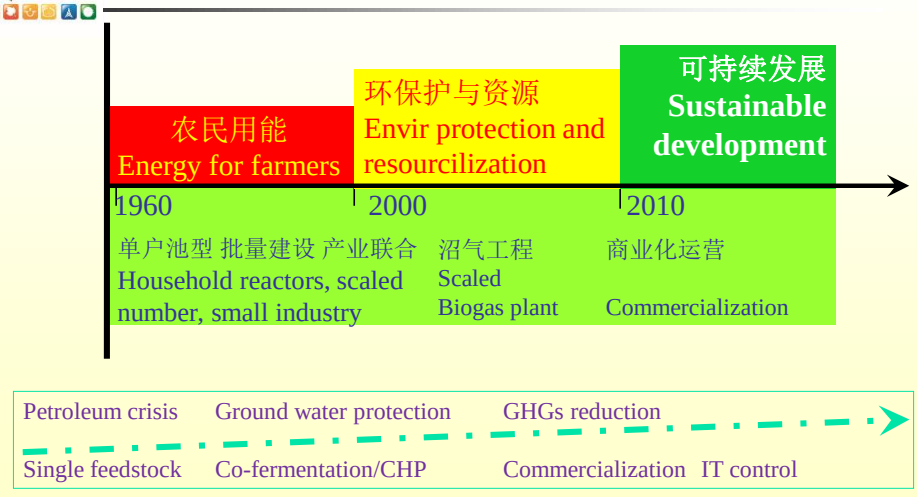
水污染防治法 Prevention and Control of Water Pollution

农业法 Agriculture Law

节约能源法 Energy Conservation Law

农业技术推广法 Popularization of Agricultural Technology

中国沼气工程产业化进程
BIOGAS ROADMAP IN CHINA



中国沼气发展的三个阶段
THREE PHASES OF BIOGAS PLANTS IN CHINA

- China started to develop biogas since the Socialist government has been established. In 1958, New China Father Chairman MAO Tsetung pointed ‘biogas can be used as fuel of the lamps and stoves, the digestates can be used as fertilizer. This technology should be greatly developed and appropriately prompted’.
- People in the rural regions were encouraged by the central government’s call, lots of skill farmers were trained to build the household biogas plants, sometimes with inappropriate construction materials and management/maintenance means. Together with the situation of underdeveloped economy in the first 20 years after the against-Japanese war (II World War), the biogas developed slowly and at the household scale level. In 1979 the Ministry of Agriculture summarized several challenges in biogas development and emphasized again ‘biogas development is one important part of Agricultural Modernization’. A new strategy of Biogas County was launched in 1985 for the “6th Five Year Plan” and first batch of 72 biogas counties were supported by the central government.

中国沼气发展的三个阶段
THREE PHASES OF BIOGAS PLANTS IN CHINA

- The second phase of biogas development in China started from the 1990s when the biogas technologies became mature. Biogas development was well integrated into regional and agricultural development. Two farmer family based biogas/agriculture integration modules were very successful: ‘animal-biogas-orchard’ in South China and ‘four in one’(vegetable-animal-biogas-greenhouse) in North China. Biogas becomes one of the main driving factors for rural economy development.
- The third phase started since 2010s. Two national projects ‘biogas-based Ecohome project’ and ‘treasury bond project for biogas development’ were applied at the beginning of this phase through the whole country except Hong Kong, Marco and Taiwan regions. Several other new financial support policies and tools were developed for stronger biogas promotion.

中国沼气发展的主要政策
MAIN POLICIES FOR BIOGAS IN CHINA

	Ministry	Plan and Policy	Content
2000	MoA	Eco-home Project	Policy and technology support
2002-2	MoA	Public welfare facility construction subsidy –rural energy	Financial support for biogas, biomass gasification, solar energy, mini-power, biomass and coal saving stoves
2003-8	MoA, NDRC	Management measures for rural bi ogas projects supported by government debt	Biogas construction and subsidy
2006-1		Renewable energy law	General support law
2006-1	NDRC	Measures for renewable power generation pricing and cost share	Applying to wind power, biomass power generation. The subsidy is 0.25 Yuan/kWh (higher than coal power price in 2005) for continuous 15 years.
2007-3	MoA	Rural biogas development plan	Aiming for 40mln households to have biogas, which is 30% of the biogas-potential households, for scale biogas plants on 4700 livestock farms, which is 39% of the biogas-potential farms
2007-4	MoA	The national rural biogas service system construction plan	

中国沼气发展的主要政策
MAIN POLICIES FOR BIOGAS IN CHINA

2007-5	MoA	Agricultural bioenergy development plan	General plan
2007-8	NDRC	Middle and long term development plan for renewable energy	General plan
2007-9	MoA, NDRC	Instructions on further strengthening rural biogas developemnt	Encourage the biogas development in a better and faster way; encourage biogas plants construction on livestock farms; support development of biogas technical service system; emphasize the subsidized projects inspection and verification
2009	MoA, NDRC	Rural biogas development projects application	Central government subsidy for biogas development is increased since 2009, slowing shifting to support the scale biogas plants
2012	Central governm ent	12th five-year Renewable Energy Plan	General plan
2015	MoA	Rural biogas transformation and upgrading work plan in 2015	Biogas shifting slowly from household scale to large scale

中国沼气发展的补贴政策
SUBSIDY FOR BIOGAS PLANTS IN CHINA

Type	Construction	Subsify	
Household biogas plant	One biogas plant construction for upgrading of kitchen, toilet, and animal residence	1000 Yuan in 2008, 1000-1200 Yuan in 2009, 1200-1500 Yuan since 2010	Biogas stoves, desulfuration,pipes, pressure meter
Small scale biogas plants	Biogas plants volume is 5*household number. If exceeded 50 m3, a gas storage tank of biogas plants volume * 0.2 is added	Household number * subsidy per household * 1.2	As above
Biogas plants	Feedsock pretreatment, AD, gas storage tank, post treatment, digestates application facilities	Subsidy is 35% of construction cost, but not exceeding 1.5mln Yuan; in West region, 45% of construction cost, but not exceeding 2mln Yuan	
"replace subsidies with awards"	Biogas plants on farms with more than 3000 pigs sold per year	400-700Yuan * (plants+ storage volume), plus 50% * power generator and digestates truck cost	Provincial financial support
Village service	Machines, testing and inspection facilities, plants maintenance, technician training, office	15k yuan by 2009; 35k-45k yuan since 2009	Facilities purchased and supplied by government

中国沼气补贴政策的未来
FUTURE SUBSIDY POLICY

policy makers are getting united to have a more functional political tool; Policy is more and more reflecting the rural practical needs; policy making is shifting from faster and better to better and faster.

The subsidies wll come from four sectors:

(1) waste treatment

(2) biogas plants construction

(3)Biogas-based energy,

(4) Digestates returning to crop field

6. 生物能源可转移的技术
TRANSFERABLE TECHNOLOGIES

- 简单、廉价、实用的生物质炉灶-节约50-100%木材，保护森林
  Simple, Affordable, Suitable biomass cookstoves- save 50-100% wood fuel
- 简单、廉价、实用的家庭沼气-炊事、照明、微型发电
  Simple, Affordable, Suitable household biogas-cooking, lighting,tiny-power
- 依托大型蔗糖厂的规模沼气工程-发电自用（售电？）-可储存的电能
  Molasses-based biogas-power self-sufficient, (or possible feeding the grid) STORABLE power
- 碳交易-VER (Voluntary or Verified Emission Reduction)、CER
  Carbon trade- VER/CER (Certified Emission Reduction)

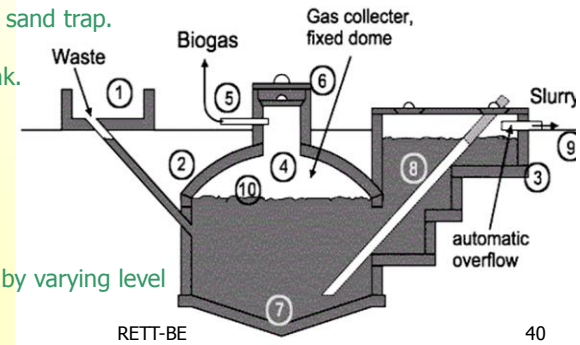
RIGHT time to take ACTION

AFRICA EXAMPLE-KENYA

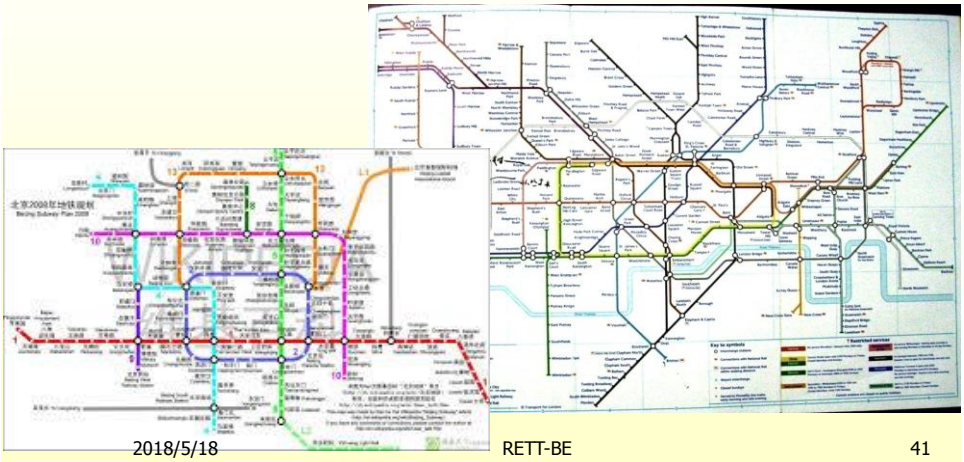
- Daudi M Nyaanga,
- Egerton University
- dmnyaanga@gmail.com
- Mo: +254721285231

- Total number: 20063
- Including 70 with capacity >1000 m3

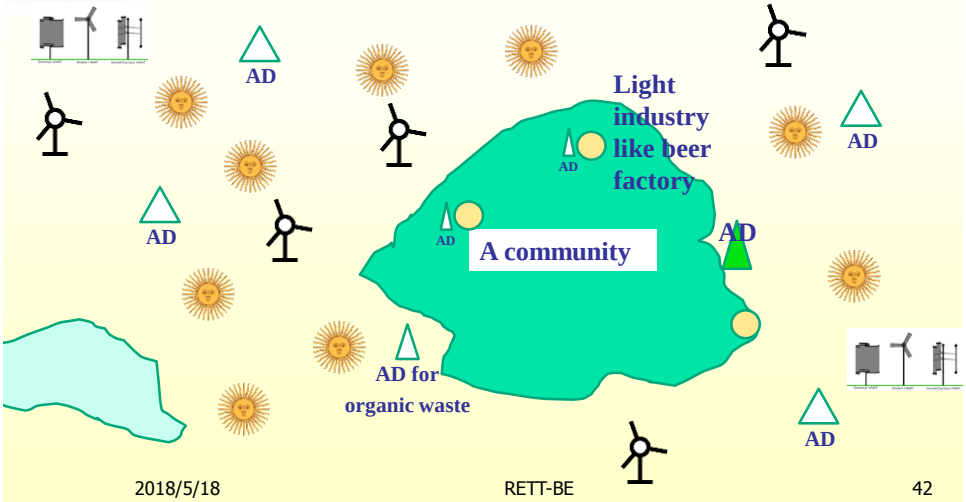
1. Mixing tank with inlet pipe and sand trap.
2. Digester.
3. Compensation and removal tank.
4. Gasholder.
5. Gas pipe.
6. Entry hatch, with gastight seal
7. Accumulation of thick sludge.
8. Outlet pipe
9. Reference level
10. Supernatant scum, broken up by varying level



中国不是发达国家但是最好兄弟
CHINA IS NOT DEVELOPED YET BUT THE BEST BROTHER

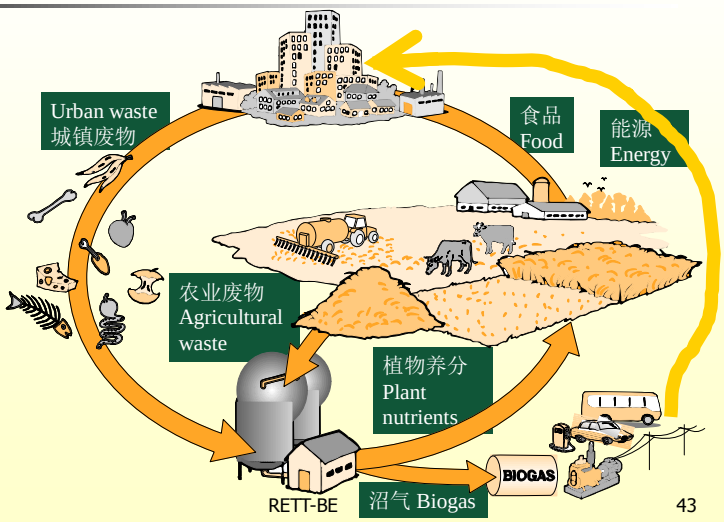


CAPACITY BUILDING CENTER
MINI-GRID/ OFF-GRID SYSTEM: WIND-SOLAR-HYDRO-BIOENERGY



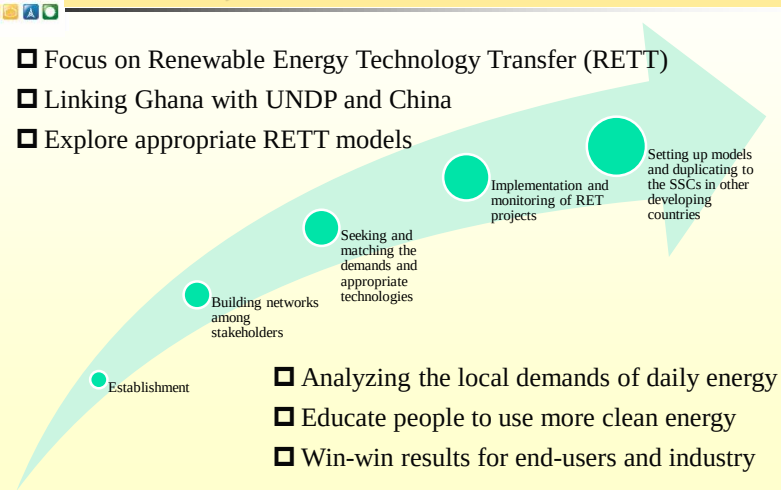
城乡一体化资源循环的关键
GREAT CYCLE: INTEGRATION OF TOWN AND COUNTRYSIDE

- 能源 Renewable energy
- 废物处理 Waste treatment
- 养分循环 Sustainable recycling of nutrients



CHINA-GHANA RENEWABLE ENERGY TECHNOLOGY TRANSFER COOPERATION CENTER, BIOENERGY

- Focus on Renewable Energy Technology Transfer (RETT)
- Linking Ghana with UNDP and China
- Explore appropriate RETT models



- Analyzing the local demands of daily energy use
- Educate people to use more clean energy
- Win-win results for end-users and industry



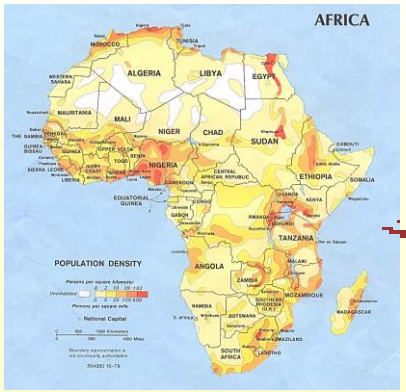


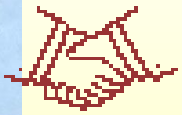


YOU WILL BE THE HEROES WHEN YOU TOUCH THE GREAT WALL

非洲-中国：给世界的最好机会

ChinAfirca: Best Opportunity for the Planet





中非友谊万岁！

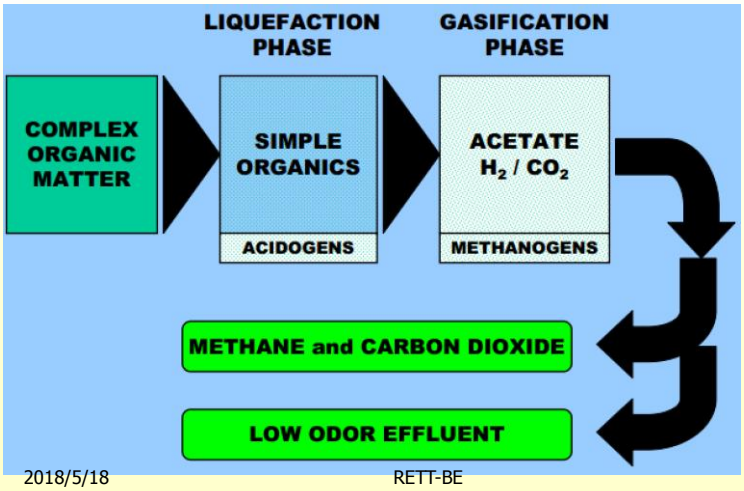
Long live the China-Africa friendship!

WELCOME TO BEST

+86 13601387967

rjdong@cau.edu.cn

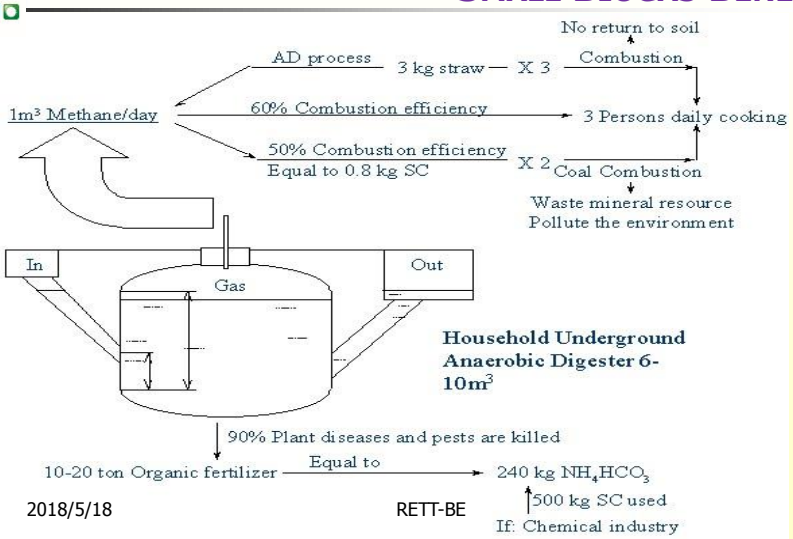
沼气工程的基本原理
FUNDAMENTALS



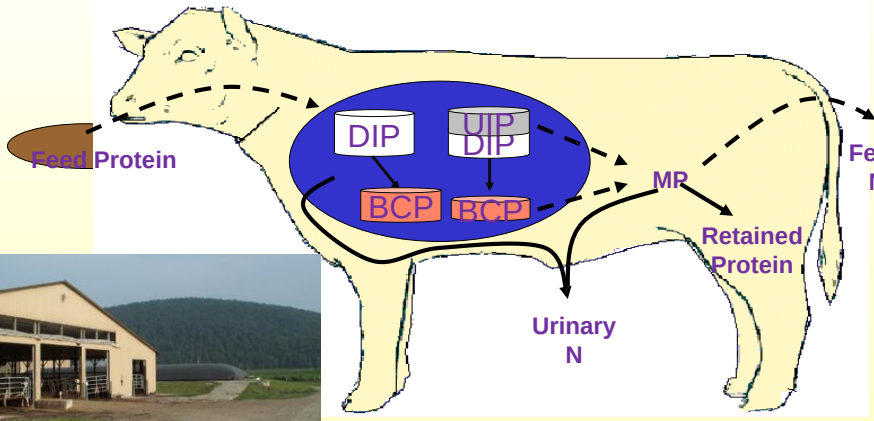
原料的沼气生产潜力
BIOGAS POTENTISAL

Type of waste	Methane yield (l/kg vol. Solids)	Methane concentration in biogas (%)
Cow manure	180-250	60-70
Pig manure	210-300	58-60
Poultry manure	350-400	58-65
Rumen content	160-300	60-65
Green plants	250-450	55-62
Straw	150-180	60-62
Potato pulp	270-300	58-60
Fruit press cake	300-450	60-65

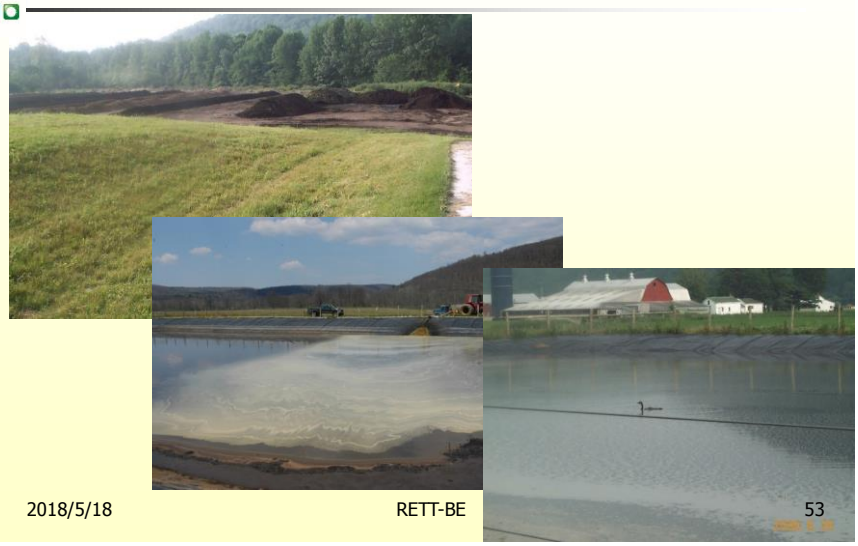
沼气池的效益
SMALL BIOGAS BENEFIT



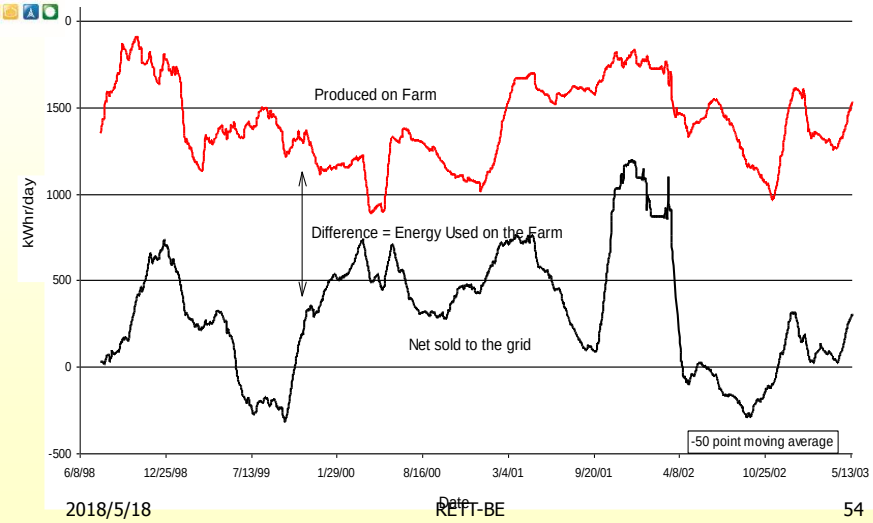
“奶牛发电场”
DAIRY POWER STATION



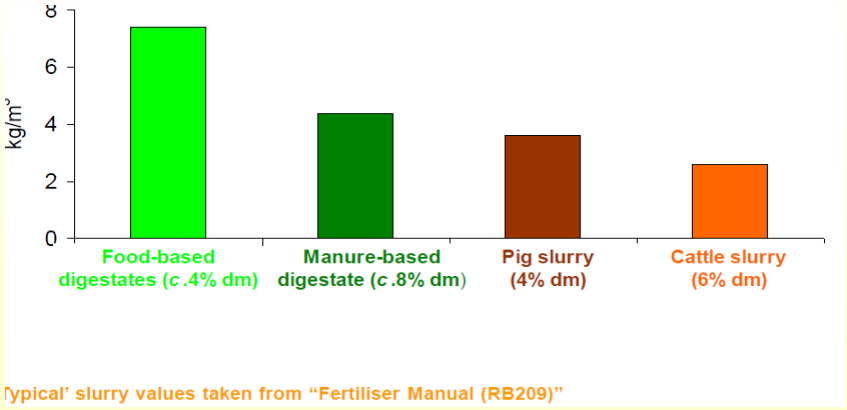
沼渣堆肥和沼液贮存
COMPOSTING AND EFFLUENT STORAGE



发电与售电
ELECTRICITY GENERATION AND NET SELL



沼液中的N
NITROGEN IN BIOGAS EFFLUENT

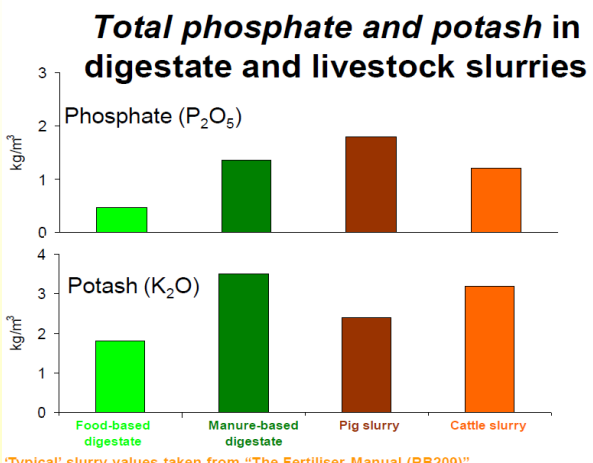


'ypical' slurry values taken from "Fertiliser Manual (RB209)"

Fertiliser Manual (RB209) Defra June 2010 (http://archive.defra.gov.uk/foodfarm/landmanage/land-soil/nutrient/documents/rb209-rev-100609.pdf)

沼液中的P 和K
P2O5 AND K2O IN DIGESTATE AND MANURE

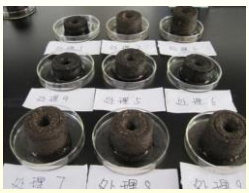
Fertiliser Manual (RB209) Defra June 2010 (http://archive.defra.gov.uk/foodfarm/landmanage/land-soil/nutrient/documents/rb209-rev-100609.pdf)

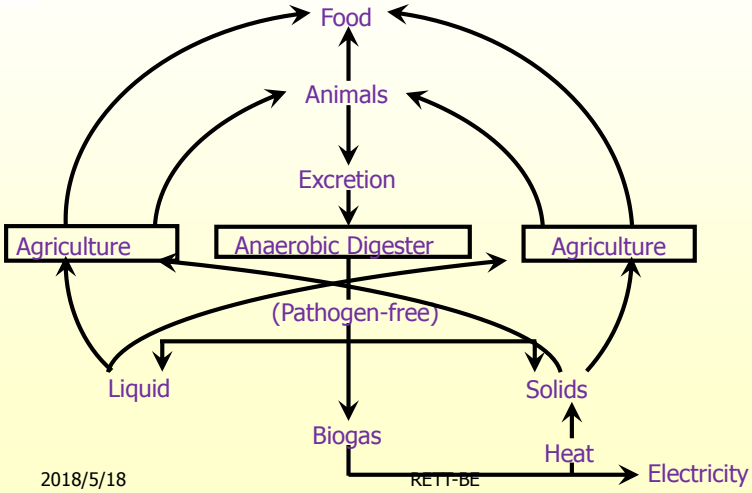


'Typical' slurry values taken from "The Fertiliser Manual (RB209)"

沼液土地利用
EFFICIENT LAND USE

沼渣人工基质
ARTIFICIAL MEDIUM FROM DIGESTATES





AD Substrates in Kenya

Table 2: Major substrates (biomass sources or feed stocks for bio-digesters) for biogas production and their estimated percent prevalence in Kenya

Biomass source	*Percent Prevalence*	*Remarks and Examples*
Cow dung	90.0	Small scale household biogas units
Molasses waste from distilleries	5.0	Mainly Industrial Large plants (such as AgroChemicals & Spectre Ltd)
Waste from agricultural processing	2.5	Mainly Industrial Large plants (KBL, Kilifi plantations, VegPro, Bixa)
Human waste	1.5	Medium biogas plants (prisons & schools)
Sewage	0.2	Some hospitals & schools (Kinangop & Nyeri)
Pig manure	0.5	Household plants (combined with cow dung)
Poultry manure	0.1	Household plants (combined with cow dung)
Slaughter house waste	0.2	Slaughter houses
Total	100	

AD NUMBERS IN KENYA

Table 3: Estimated cumulative number of biogas systems in Kenya between 1957 and 2014

Type of biogas system	*Year*								
	1957	*1986*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Kendbip* Household (6-12m^3)	-	-	7	10	847	4,093	7,603	12,433	15,933
Other Household (3-60m^3)	1	200	1,050	2,150	2,350	2,600	2,960	3,460	4,010
Institutional (100-1000 m^3)			10	20	25	30	35	40	50
Industrial (>1000m^3)		3	10	20	30	40	50	60	70
Total	***1***	***203***	***1,077***	***2,200***	***3,252***	***6,763***	***10,648***	***15,993***	***20,063***

*Kendbip – Kenya domestic biogas programme

AD RRUNNING EFFICIENCY IN KENYA

Table 4: Estimated biogas conversion coefficient

Type of biogas system	*Average (Avg) Digester vol (m^3)*	*Avg biogas produced m^3/m^{3}of Dv*	*Avg Gas Production constant (m^3/number of digester)*
Kendbip Household	8	0.23	1.84
Other Household	24	0.20	4.80
Institutional	124	0.28	34.72
Industrial	4,400	0.35	1, 540.00