الشركة القابضة لمياه الشرب والصرف الصحى

برنامج إدارة مياه الشرب و الصرف الصحى

Water and Wastewater Management Program

gtz

Since the 1st of January 2011

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Report on:

Potential Analysis for Utilization of effluent from Qena Wastewater Treatment Plant

By:
Prof. Dr. P. Heck & Dr. P. Roesch

April 2008

Report on:

Potential Analysis for Utilization of effluent

From Qena Wastewater Treatment Plant

Prof. Dr. P. Heck and Dr. P. Roesch

April 2008

GAIATECH
Prof. Dr. Peter. Heck and Dr. Petra Rösch GdBR
Mainzerstrasse 84
D-66121 Saarbrücken

Project Leader:
Prof. Dr. Peter Heck
CEO IFAS

Penned by:
Dipl. Business Economist (FH) Felix Flesch

Collaborated by:
Water Specialist Joachim Böttcher

Final Report

Potential Analysis for Exploitation of Effluent from Qena Waste Water Treatment Plant

Within the KV framework program of Water and Waste Water Management, Egypt

Saarbrücken, Friday, 11.04.2008

Abstract

Use of waste water as a form of marginal quality water for irrigation is neither new nor restricted to special countries. Today especially areas with high scarcity of water show an increase in projects using marginal quality water. The production of non food biomass in desert areas could help to overcome hygienic and pollution questions related to the use of none or only marginally treated waste water.

Within the WWTP of Qena city, 45.000m^3 of waste water per day are treated, with growing tendency. This treated waste water to a certain extend is already used to cultivate trees in the desert. Different problems referring to the cultivation occur. On the one hand cropped areas may die totally after a couple of time due to flooding and management problems. Therefore right now further investment for the use of more treated waste water cannot be done. On the other hand waste water production increases, due to population growth and higher living standards. Recently Nopwasd started the construction of a second treatment plant to be able to treat the growing capacity in the future with a capacity of 55.000m^3/day. Anyway so far there seems to be no plan to use the additional treated waste water in the near future. The irrigation of desert areas for non-food-biomass indicates a possibility to solve the impasse.

Regarding this study an area of 3,000 feddan is available to be used for non-food biomass production. The cultivation of *Jatropha curcas* plants in combination with e.g. date palms (*Phoenix dactyliferia*) and other crops offers a huge potential to gain a high-quality product and store carbon while fighting desertification and create new regional jobs. First calculations show, that by cultivating 3,000 feddan of desert area with Jatropha crops using waste water, approximately 150 jobs could be created, up to 2.5 million litres of plant oil could be produced annually and about 15.000 t of CO_2 Emissions per year could be saved. The estimated growth rates of Jatropha as well as the estimated yields per ha need to be verified by a practical project. Furthermore additional incomes through the local use of secondary primary products and the reception of know-how and technology will contribute to strengthen the rural structures and local economy. The first rough economic considerations give a positive perspective for the establishment and

operation of a Jatropha plantation. To ensure the proposed benefits an overall investment of 15 Million Euros is necessary if all recommended installations in regard to maximum exploitation of synergetic effects are constructed. The total project activity is determined to 21 years while first pessimistic and prudent calculations promise an annually payment of interest about 10%, which constitutes an auspicious bargain position to convince presumptive investors. With economy of scale approaches the economic benefits could even be increased.

Table of contents

Table of figures

Table of abbreviation

BCM	Billion Cubic Meters
BFI	Biofuel Initiative Rhineland-Palatinate
BGP	Biogas Plant
BIE	Biofuel Initiative Egypt
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CHP	Combined Heat and Power Plant
CO_2	Carbon dioxide
ECP	Egyptian Code of Practise
EP	Egyptian Pound
Feddan	Unit of area in Egypt, 1 feddan = 0,42 ha
GAIA-Tech	
HCWW	Holding Company Waste Water Egypt
IfaS	Institute for applied Material Flow Management
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal Rate of Return
ISTA	ISTA Mielke GmbH, Oil World
KV	Kings Valley
MFM	Material Flow Management
N_2O	Nitrous oxide (Laughing gas)
QHWW	Qena Holding Waste Water
SME	Small Medium Enterprises
SWTP	Solid Waste Treatment Plant
UNFCCC	United Nations Framework Convention on Climate Change
WWTC	Waste Water Treatment Company
WWTP	Waste Water Treatment Plant

A. Introduction

A.1. Background

The costs for imports of fossil fuels skyrocketed in Europe between the year 2000 and 2005 to an up to 107% increase. Moreover the current discussion about security of supply on the basis of fossil fuels indicates the political direction. Especially for the already often strong burdened communal households, increase of energy costs is difficult to finance. Due to the decrease of fossil energy sources and the global warming issues new sources for fuel and energy must be developed. These new sources should be sustainable and regional value adding as well as affordable for the potential customers in industrialized and transition countries. The local cultivation of oil plants saves and creates new jobs in agriculture and biomass processing and contributes to the preservation of cultural landscape and biodiversity. Furthermore a big contribution for CO_2 savings can be done.

The production and use of bio fuels in Germany is under heavy criticism because of the energy balance and overall ecological problems (logging of rain forest, excessive water demand) as well as the contribution to the greenhouse effect (N_2O emissions). The import of palm oil from non-certified sources implies a risk for further deforestation especially in the tropical rain forest areas. The cultivation of bio fuels on agricultural land competes with food production thus leading to higher grain and meat prices world wide.
Therefore it is necessary to develop new systems in new areas to store solar energy in biomass. The desert areas in Egypt for example are not used for food production. Neither is the waste water. To use the waste water to store solar energy in biomass on desert lands seems to be one contribution to the growing demand of clean and sustainable fuels. In addition a significant contribution to climate protection can be achieved.

A.2. Contract award by GTZ (Gesellschaft für technische Zusammenarbeit) - Egypt

The KV water and waste water management program supports the Holding Company for Water and Wastewater (HCWW) as well as the Qena Company for Water and Wastewater (QCWW) to strengthen its competences in different sectors of water management. A really important working sector of the water company is to treat waste water and organise an environmental friendly discharge. The WWTP of Qena has been constructed to treat waste water of the city Qena. Unfortunately since many years the plant has been out of service. The non-treated effluent is discharged more or less untreated into the adjacent, irrigated forest. Problems because of the discharge of waste water have been occurring resulting in flooding of the whole treatment facility. In the frame of an emergency measure the water will be pumped up into a three km distant lagoon. The mayor quantity of the waste water will be used in irrigation of a new forest by gravity or pumping as future project approach. The construction of this pond already is decided and given to a local company.

Within the international discussion waste water is not any longer seen as useless. This starts with new conceptions for avoiding waster water by separation of rain, grey, brown and yellow water at source with the extraction of phosphorous, and a biogas process for generating energy and compost. And it ends with the reuse of the water for various purposes like toilet flushing, laundry, garden watering etc.

Effluent basically is an important substrate supplier and should be considered as a high-value resource. Of course high tech solutions will not all be suitable for use in all regions. However, this potential study will investigate, if a resource-oriented solution for the discharge of waste water on a sustainable economic base in Qena can be found. Basic aim of the study is to show whether the use of waste water for irrigating energy crops is technically and financially feasible.

A.3. Political situation and governmental objectives concerning waste water utilisation in Egypt.

Egypt is subdivided into 27 governorates each represented with one governor in the ministry position. The distinctive centralism of Egypt due to water supply of the river Nile and hence centralisation of urbanism ought to be reduced step by step in support of a bigger decentralized self-administration on regional level. As part of the agreed reform in the water supply and wastewater management sector in Egypt, responsibilities are being progressively transferred from governorates water departments to newly established water supply and wastewater management companies. These new corporations are gradually grouped under the Holding Company for Water and Wastewater (HCWW) founded in the year 2004, driven by the Ministry of Housing, Utilities and Urban Development.

The overall objective of the Water and Waste water Management Program (WWM) is to improve water supply and wastewater management services in selected governorates. Furthermore the Holding Company is appointed to manage and monitor the development of the water and waste water sector in Egypt. Actually 19 of the 27 governorates are already affiliated to the Holding Company also trying to form water alliances for decentralised future waste water treatment. The focal areas of the technical cooperation programme between GTZ, HCWW and QWWC are:

(1) Advice to the management of the Holding Company for Water and Wastewater
(2) Improvement of the management capacities in selected regional water supply and wastewater management companies
(3) Further development and promotion of appropriate rural sanitation systems.

The present contract focuses on Qena Governorate with the aim to enhance the management and operational efficiency in water supply and wastewater management in Qena Governorate and to improve wastewater management in selected rural communities in the governorate.

With growing population and growing living standards in Egypt the amount of waste water is increasing. Like everywhere else waste water in Egypt is considered to be waste which has to be treated as far as possible and finally discharged into the desert or -by fulfilling all requirements of quality- pumped back to the Nile river.

But technically waste water also can be used as a key resource for producing biomass. Many projects do exist to use biomass production as a sink for waste water. In Egypt the appropriate used of waste water as water resource (non-conventional resource) to irrigate available acreage has been approved for some time. In the year 2005 the Egyptian Guideline and Code for the reutilisation of treated sewage in agriculture was published. The following table indicates the quality standards of treated waste water concerning the ECP 501-2005 guideline to be adequate for application on farm land.

Category Parameter	**A** Tertiary Treatment	**B** Secondary Treatment	**C** Primary Treatment
BOD/mg/l	< 20	< 60	< 400
SS/mg/l	< 20	< 50	< 250
Faecal caliform/l	< 1,000	< 5,000	Not applicable
Intestinal Nematodes/l	< 1	< 1	Not applicable

Figure 1: Egyptian Guideline (ECP 501-2005) for waste water application
Source: Prof. Dr. Mohammed Abd El-Naim, Re-use of Treated Wastewater in Agriculture, 2004, page. 2

Water requirements for the agriculture sector represent the largest component in the national water use. The total cultivated land in 2002 is estimated at about 8,300,000 feddan (3,486,000 ha) which is approximately 3% of Egypt's area. Gross water demand of this cultivated area is around 53 BCM/a[1]. There exists a plan to expand the cultivated area with more than 2,250,000 feddan by the year 2010. This ambitions plan requires that irrigation water supplies be augmented by 15 BCM/a.[2] Agriculture in Egypt is almost entirely depending on irrigation sourced by the Nile. Every year 55.5 billion cubic meters (BCM) of Nile water is allocated to Egypt from Sudan, guaranteed by an agreement be-

[1] BCM/a = billion cubic meter per year
[2] M.A. Abdelkhalek, Water Quality Status In Egypt, Ministry of Water Resource and Irrigation 2005, page 2

tween Egypt and Sudan from the year 1959. Nearly 84% of the provided Nile water is used in agriculture. Necessary rest quantities are supplied by aquifers underlying the western desert, Nile river alluvium and scare occurring rainfall in the northern coastal area.

To be allowed to use treated waste water in agriculture further conditions have to be fulfilled. Concerning the ECP 501-2005 directive for plant and crop growing with treated effluent the following applications are possible:

Degree of treatment	Agricultural Groups	Category	Exposed groups
Tertiary (A)	Plant and trees For sports field And public parks	Seedlings of Forests and greenbelt	Workers; Consumers public
Secondary (B)	Fodder crops	Sorghum	Workers
	Crops of human Consumption the Peel of which is Not eaten and Fruits grown Exclusively for Canning	Lemmon Mango Olive Dates	
	Greenbelt and Nurseries	Nurseries of fruits trees	
	Cut flowers	All types of cup-flowers	
	Fibre crops	Flax, sisal	
Primary (C)	Afforest trees	Casuarinas, Khaya, Eucalyptus	None
	Industrial oil crops	Jatropha, Jojoba	

Figure 2: Crops and plants allowed to be irrigated with treated effluent according the ECP 501-2005
Source: Prof. Dr. Mohammed Abd El-Naim, Re-use of Treated Wastewater in Agriculture, 2004, page. 3

There are several ministries and institutes playing different roles in the wastewater management and reuse in Egypt.

- The Ministry of Land Reclamation and Agriculture manages agricultural aspects.
- The Ministry of Housing Utilities and Urban Communities is concerned with the planning and construction of municipal wastewater treatment plants.

- The Ministry of Health and Population assumes responsibility for sampling and analysis of all wastewater effluents. It is also responsible for setting water and wastewater quality standards and regulations in addition to its central role as the custodian of public health.
- The Ministry of Water Resources and Irrigation allocates water for reclamation areas.
- The Ministry of the Environment and the Egyptian Environmental Affairs Agency caters for environmental aspects.
- Scientific institutions and universities conduct basic and applied research activities.

NOPWASD

NOPWASD is the **N**ational **O**rganization for **P**otable **W**ater and **S**anitary **D**rainage. It is the responsible agency for design, review and construction supervision (public invitation to tender) of any WWTP going to be build up in Egypt. After the design and construction of the facilities the responsibility of operation and maintenance is given HCWW.

B. Qena

B.1. Qena city and Waste Water Company (QWWC)

The Governorate of Qena is located in central Egypt where the river Nile forms a significant curve. The Governorate has approximately three million inhabitants. The Qena Water and Wastewater Company (QWWC) is responsible for the supply of fresh water, waste water services and the maintenance of water- and waste water infrastructure in the Governorate of Qena. In this sector the QWWC is working closely together with the Holding Company for Water and Wastewater (HCWW). The QWWC employs more than 4,000 people and was founded in 2006 by the Ministry of Housing, Utilities and Urban Development.

Figure 3: Map of Qena
Source: GTZ 2006, Water Supply and Sanitation – Technical Information Paper, page 2

The aim of QWWC is to improve management structures as well as utilisation and dissemination of water resources through the implementation and encouragement of decentralised structures. The support of those activities is a focal point of GTZ-Egypt in the sector of water resource management.

Figure 4: Entrance gate of QWWC and fresh water treatment facility
Source: GAIA-Tec, February 2008

Fresh water is gained from the river. The Nile water is pre-processed in the QWWC fresh water treatment facility and later on distributed all over Qena to the households. The following scheme visualized the Qena water supply and wastewater treatment chain.

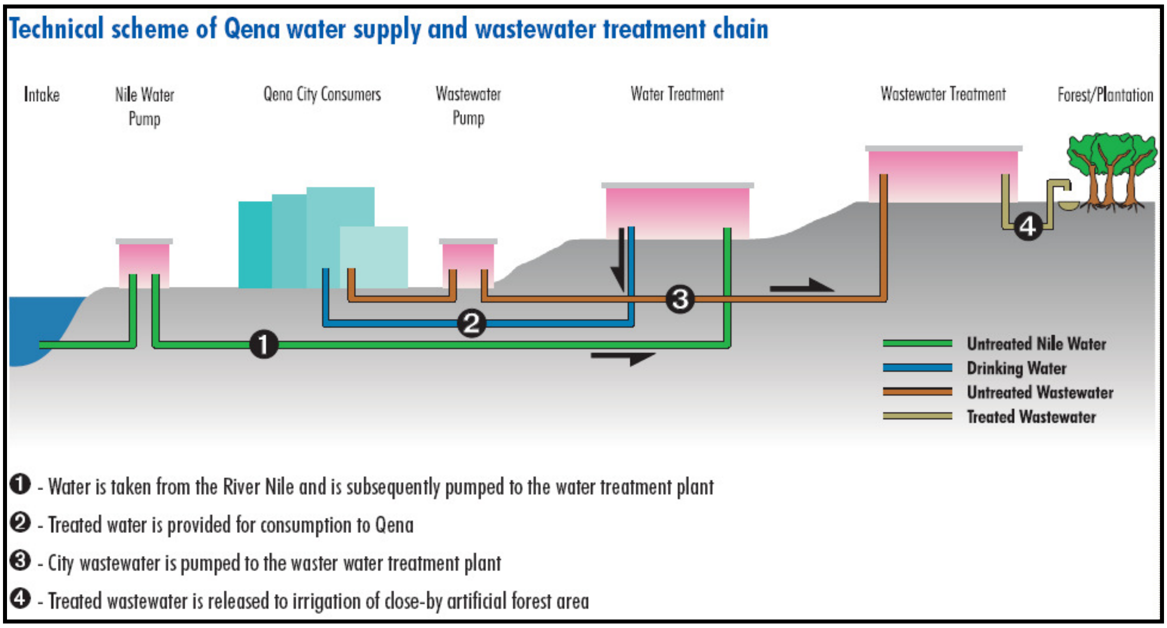

Figure 5: Technical scheme of Qena water supply and wastewater treatment chain
Source: GTZ 2006, Water Supply and Sanitation – Technical Information Paper, page 1

B.2. Qena Waste Water Treatment Plant

The existing WWTP of Qena city was stated up in two stages. First, in 1984 the facility was constructed, designed by a British company named **"Farrer Limited, Birmingham & London"** and enlarged in 1998. The plant is operated by the Qena WW Company recently established in 2006. The plant was designed to treat a capacity of 25,000m^3/day while actually the capacity rose to approximately 45,000 m^3/day. On the following pictures it is well notable, that the capacity of the facility is extremely overloaded. The water-bearing concrete-shafts have been enlarged by brickwork to avoid water flush over in times when daily waste water input is particular high.

Figure 6: Advanced water-bearing shaft by brickwork QWWTP
Source: GAIATECH, Jan. 2008

Due to the fact that the capacity of the plant is overloaded by nearly 80% almost all treatment steps are out of service, with the exemption of the primary screening and the final secondary settlement tanks for sedimentation. At present almost only municipal household effluent is connected to the WWTP. A small amount of effluent is coming from the industrial zone located near the treatment facility, but does so far not pose a problem for high contamination of water with heavy metals or other highly toxic substances.

The actual prices for the water consumption in Qena governorate are:

Water cost of Qena Water and Waste Water Holding			
	Public stratum	Industry	Tourism
EP/m^3	0.23*	1.00	1.20
€/m^3	0.028	0.12	0.15

* freshwater for the first 30 m^3 – which corresponds to the average annual consumption, 35% of the costs refer to the waste water

Figure 7: Water cost of Qena Water and Waste Water Holding
Source: Qena WWTC, Oral information Fayez Badr

Treatment process and occurring problems:

The entire treating process starts at the seven pumping stations located in the downtown city district, where the waste water is collected in catchments basins. Two of the pumping stations are main pumps and the other existing five pump stations are subsidiary pump station.

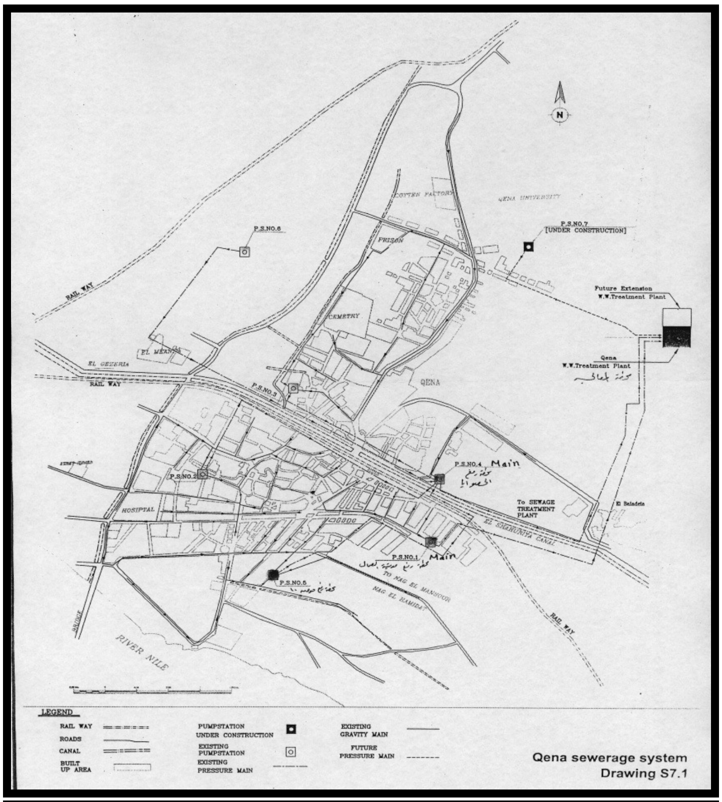

Figure 8: Map of pumping stations Qena[3]
Source: Qena WWTC, Oral information Fayez Badr

[3] The map is attached within the appendix II for a better interpretation.

From here the collected effluent is pumped to a pond. Subsequent the effluent is directed through concrete, long and slender basin-channels into the screening where plastic, bigger wood chips and other solids are separated from the effluent. The screenings are operated manually and discharged immediately to the ground. This causes odour nuisance and waste disposal problems. After passing the screening, the effluent is channelled into five pre-settlement grit chambers to take out sand and other medium sized solids. Afterwards the waste water is channelled into four primary settling tanks equipped with scrapers. These scrapers actually are not working, due to the total blocking of the reamers which are deadlocked because of the not working outtake of sewage sludge and the overloading. Hence the whole liquid passes without separating the sewage sludge. The following pictures show the blocked sludge scrapers.

Figure 9: Sludge scrapers (out of service)
Source: GAIA-Tec, Jan. 2008

Usually the sewage sludge is pumped to drying beds for solar dehumidification. These beds meanwhile are totally disconnected because sewage sludge is not separated from the effluent. Now the dry beds are out of service. The existing old sewage sludge remaining in the beds is used by farmers as fertilizer.

Example sewage sludge treatment in Luxor

Now, the example of Luxor treatment plant is going to give an impression how normally the sludge treatment is handled. The sludge is separated by the sludge scrapers and thereafter pumped into the drying beds in different intermittent. In Luxor 40 drying beds are installed and each size 40*9 meters. Every bed is filled with 75 m^3 sewage sludge (dry matter 25%) in one cycle until the common feeding thickness of 50 cm is reached. After solar dehumidification, which requires in winter an average dwell period of 50 days and in summer only 20 days, the dry (30% of rest humidity) sewage sludge records an average thickness of 15 cm when it is finally displaced by farmers. Here the sewage sludge with high value of nutrition and almost no toxic fractions and heavy metals is sold by 2 - 3 EP/m^3 to local farmers. According to the law it is possible to deploy 5 m^3/feddan/year on suitable acreage. The following pictures exemplify the process.

Four years ago 16 new concrete shafts have been constructed but they never have been utilised (size: 20*30*1,6 m). Now they are totally flooded and provide a basis to store overcapacity of effluent which cannot be treated or discharged into the forest. In the next chapter **"B.3. Forest of Qena"** pictures illustrate the situation.

Subsequent to the sludge scrapers the effluent is given to six trickling filters (diameter 30m, depth 2 m) which are also currently not in operation. At a stretch two trickling filters are exhausted. Palpably the solidified lava (gravel) is blocked by sand, sludge and algae. Until now the whole treatment process from the swelling-pot to the trickling filters runs autonomous by gravity. The following pictures demonstrate the situation the trickling filters are provided.

Figure 10: Trickling filters (out of service)
Source: GAIA-Tec, Jan. 2008

The waste water is collected underneath the trickling filters and pumped to the final treatment stage into four secondary settlement tanks where the effluent is pacified and ex-post sedimentation can be proceed. Unfortunately also all four settlements are out of service due to the overloading mode of the whole system. Finally the "treated water" runs by gravity into two little ponds (estimated to 1.000 m^2 each) which are used as buffer storage until the water is pumped into the forest. The following pictures show the secondary settlement tanks.

Figure 11: Secondary settlement tanks (out of service)
Source: GAIA-Tec, Jan. 2008

Intermediary summary

The WWTP of Qena cannot be considered as a well-operating plant. Almost all treatment steps are out of service or not operating to 100%. The main reasons for the malfunction are the capacity overload (see designed and actual capacity), the non replacement of non functioning system elements of the facility and the lack of maintenance.

The solid fractions separated by the screening should not be dumped directly in the plant area. The first and easy step would be to collect it in a waste container and transport it to the nearby solid waste dumping area.

If possible the waste water connection from the industrial zone should be separated from the whole WWTP to avoid mixtures with chemicals and heavy metals in the future. A pre-treatment only for the industrial waste water should be implemented if more and likely polluting companies are set up in the industrial zone.

Sewage sludge and water are in effect not used efficiently. These two main “ingredients” of the waste water have a high energetic and nutrient value and should be utilised as far as possible instead using them suboptimal (non managed forestation without material use) or even wasting them. How to do this in a more sustainable way is explained in detail in **chapter D**.

B.3. Forest of Qena

At the moment the whole effluent from the treatment plant is discharged in effect more or less untreated into the forest area. The forest of Qena has been in place for 12 years. 100 feddan are at present under cultivation. 3,000 feddan of land are available for farming. The main cultivated crops are trees and reed. The types of trees are basically *Magoni* and *Sanigali*. The plants are irrigated partly by drip irrigation but mainly by flooding. The irrigation interval is one time a week in summer and every 20 days in winter time. On average 15,000 m^3 water per day are pumped up to the forest area (41.5 m^3/feddan/day). The water is pumped and distributed in two different ways from the WWTP to the forest area.

Currently 32 people are employed to operate and maintain the WWTP including the forest area. 13 of the 32 employees are workers responsible for the forest area. The cost for maintaining the forests (and caring about the waste water disposal) are 8,000 EP[4] per month. A worker earns 400 EP (approx. 50 Euros) a month.


Figure 12: Balance tanks bonds with pump station (left) and outflow by gravity (right)
Source: GAIA-Tec, Jan 2008

[4] EP = Egyptian Pound

Management seems to pose the biggest problem because of various reasons. The lack of knowledge in sustainable forestry, and the permanent dispute about property rights, responsibilities, funds and affiliations between the local government and the city council cause the biggest headaches.

Unfortunately maps or plans about the extension of the forest do not exist due to administrative obscurities and constant changing responsibilities. Within the following month the HCWW and the governorate of Qena are going to discuss about the land distribution.

Furthermore by the fact of over flooding a part of the forest is constantly drowned and suffers or is already starving. The forest areas which still remain are going to share the same destiny. At the moment reed grass is growing intensively and starts to overgrow and substitute the trees. Another problem is the illegal outtake of waste water by private farmers to irrigate food crops. It is impossible to control the illegal outtakes and to confine the illegal land occupation.

Figure 13: Buffer bonds with pump station (left) and outflow by gravity (right)
Source: GAIA-Tec, Jan 2008

B.4. New Qena WWTP - Strategy to extent capacity

Due to the fact, that the currently existing WWTP is totally overloaded and forecasts propose an increase in waste water quantities in the next years through expected growth of population, the Qena Holding is going to enlarge the WWTP by a second facility. This additional WWTP will have a capacity of 55,000 m^3/day, together with the old WWTP (installed capacity 25,000 m^3/day) the totally capacity of Qena to treat effluents is 80,000 m^3/day. The applied technology is an activated sludge treatment system including sludge management in drying beds. The construction project already started in 2006. The problem of this solution approach is the expected construction time. Actually the construction and final start of operation will need three to five years.

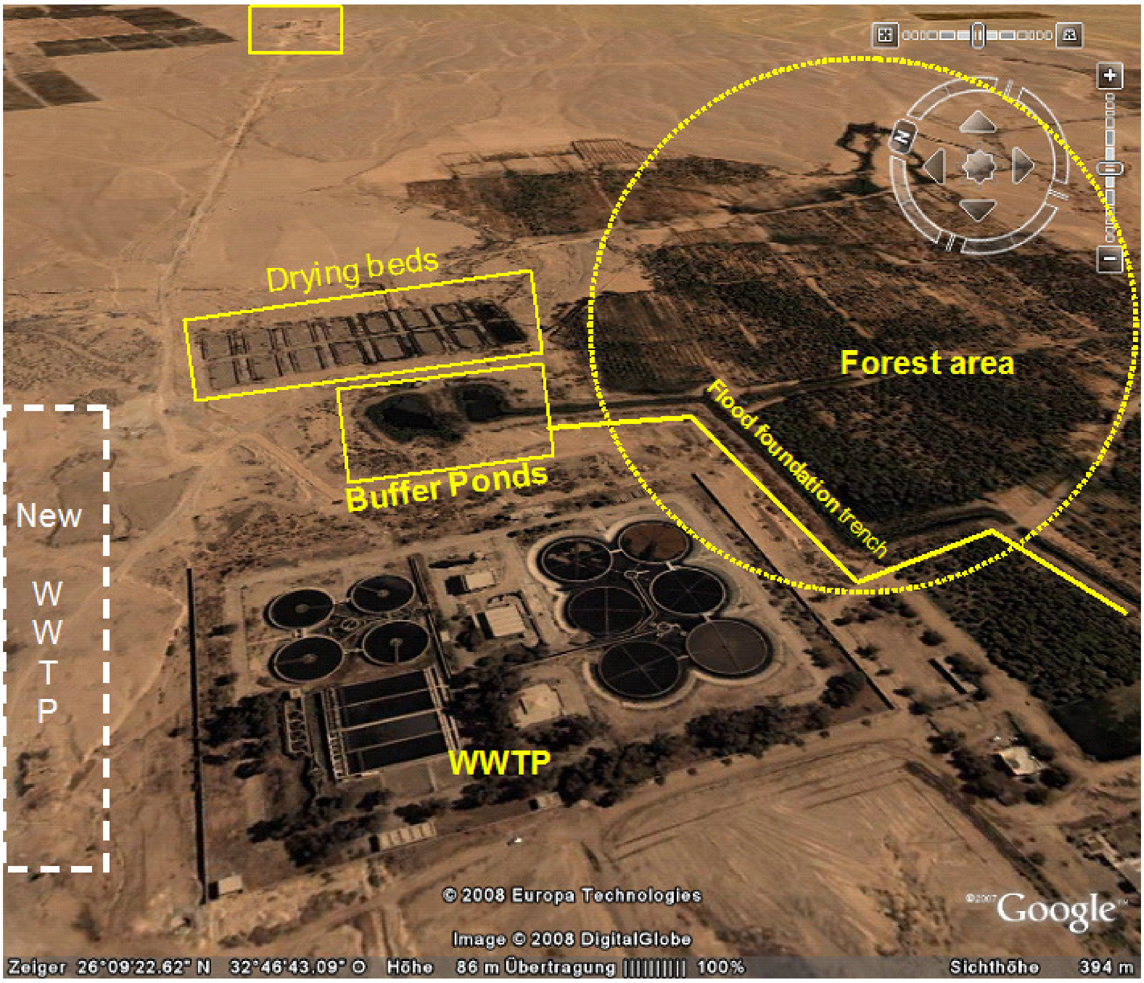

Figure 14: Bird view - total are of Qena WWTP, New WWTP, Forest, etc.
Source: Google Earth, marks by GAIA-Tec Jan. 2008

B.5. Final treated waste water storage dam – "Qena Lagoon"

Treated water is pumped uphill to the 3 km distant mountain in the area of the WWTP. For this reason, in a natural valley there will be a dam with a volume of 3 mill m^3. This lagoon is going to be located above the probably irrigated areas. The construction time is fixed to 12 month. The project construction will start in summer 2008. The costs for the whole lagoon including planning and construction (dam, pipe, pumping station) are estimated to 8 Million EP (1 Million Euros).

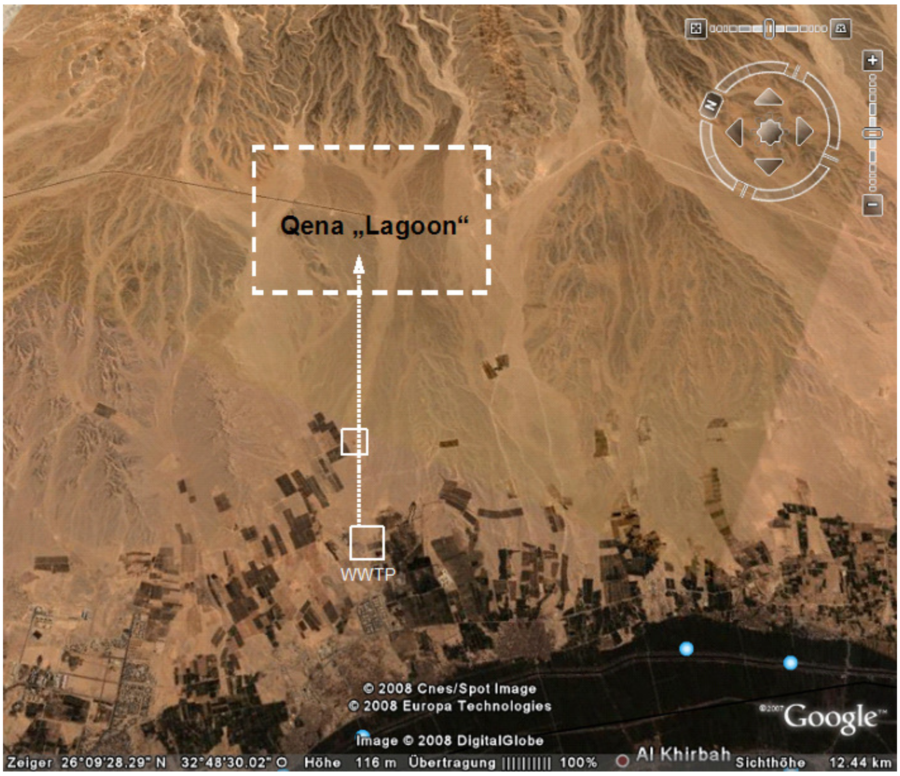

Figure 15: Bird view Qena-Lagoon
Source: Google Earth, marks by GAIA-Tec Jan. 2008

C. Kom El Dabaa

C.1. Location Kom El Dabaa and NGO's

Kom El Dabaa is a village located in the markas of Naqada. Kom El Dabaa has approximately 10.000 inhabitants. In general the waste water of villages like Kom El Dabaa is discharged directly without treatment into the septic tanks. By the time recognition about environmental pollution finally makes people understanding the importance of waste water treatment. Regarding to this circumstances small NGO's develop in self-responsibility house connection systems for effluents to substantiate the organization of a waste water treatment plant. Higher population stratums with a higher income and purchase power firstly are included into the system. Those are going to pay a users contribution (cash, land, etc.) per month for the fresh water that is used. The rest of the financing costs are paid by organizations activated by the NGO. Bit by bit the entire population can be included into the system.

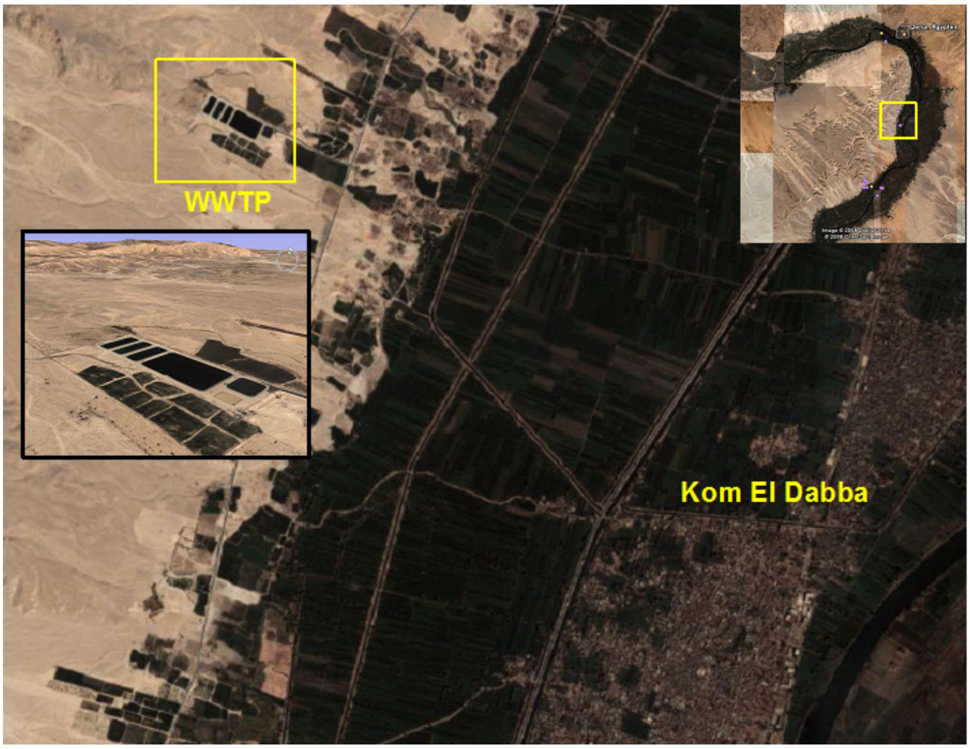

Figure 16: Bird view Kom El Dabba
Source: Google Earth, marks by GAIA-Tec Jan. 2008

The NGO of Kom El Dabaa was founded in 2003, with the overall goal to cover the village with waste water services. In the year 2004 was the start up for construction of the

WWTP. Actually 800 houses are connected to the system and they have to pay 5 EP / month. The allocation rate is about 60%. The total cost for the WWTP has been financed by the care organisations and the user contributions. During construction time the total cost has been 4 million EP (3 million by care organisations and 1 million by user's contribution).

C.2. WWTP Kom El Dabba

The WWTP was constructed in 2004. An established collection system located downtown in the village of Kom El Dabba, which has an approximately total length of 10 km, channels the waste water from the 800 houses by gravity to pumping station with 40 l/s and an operation time of 12 hours each day and then to the WWTP. The actual flow is nearly about 560 m^3/day (10.000 head x 0,07 m^3/capita x 0,8 leakage factor) and the outflow of treated water to the forest is about 392 m^3 (evaporation rate 30%).

Figure 17: Kom El Dabba maturation pond (left) and diesel pump (right)
Source: GAIA-Tec Jan. 2008

In place of the water income primary solid waste fractions are separated from the effluent by a little manual screening. These screenings presently are finally disposed to the surrounding. Subsequent the water is leaded into the second treatment step, namely an anaerobic pond (5 m profundity). After that the waste water runs into a facultative pond (3 m profundity). Now, the treatment material is spread into three maturation ponds (1 m profundity) and from here the water is pumped again by two old diesel pumps (operating time 4 hours each day) to the forest area. Sewage sludge is pumped into a drying bed (27.5 x 27.5 x 2 m) and dehumidified sludge is used as fertilizer. The costs to maintain and operate the WWTP are about 2,000 EP/month. (Workers: 7 x 150 EP = 1,000 EP; Electricity = 700 EP; Consumable = 300 EP)

C.3. Forest of Kom El Dabba

The forest has an overall area of 50 feddan. The actual cultivated area is about 3 feddan. The total water "consumption" of one feddan is approx. 20 m^3/day. Hence 60 m^3 of water are used for cultivation, the rest is discharged to the adjacent area which was allocated for future extension. The main irrigation system installed is drip irrigation, but several problems regarding a suboptimal maintenance occur. The major cultivated crops are trees and shrubs. The types of trees are basically *Magoni* and *Sanigali*.

Figure 18: Kom El Dabba forest
Source: GAIA-Tec Jan. 2008

C.4. Problems and solution proposals

The WWTP of Kom El Dabaa is operating fine. Also the technology implemented is concerning the purposes needed almost optimal. Significant problems referring the WWTP cannot be considered. In regards to the forest different proposals for improvement are necessary. Actually the water utilisation efficiency cannot be considered as really high. Drip irrigation is available but not used efficient. Many outlets are not based near to the trees, the piping system has a couple of wholes losing water where it is not utilised.

Figure 19: Kom El Dabba forest flooding
Source: GAIATECH, Jan. 2008

D. Project idea

Biomass is a perfect storage for solar energy. Given a high solar radiation and enough land it only needs water to use plants for collecting solar energy. This collected solar energy will be crucial for the international energy mix. Biomass can be stored and transported easily, creates jobs and helps to develop regional business activities.

But biomass production for energy purposes competes with food production if normal arable land is used. Due to the population growth in the year 2025 almost 330 million ha acreage is missing. Despite yield increase potential the annual average loss of 7 million ha fertile agriculture land will lead to missing acreage of 780 million ha by 2050.

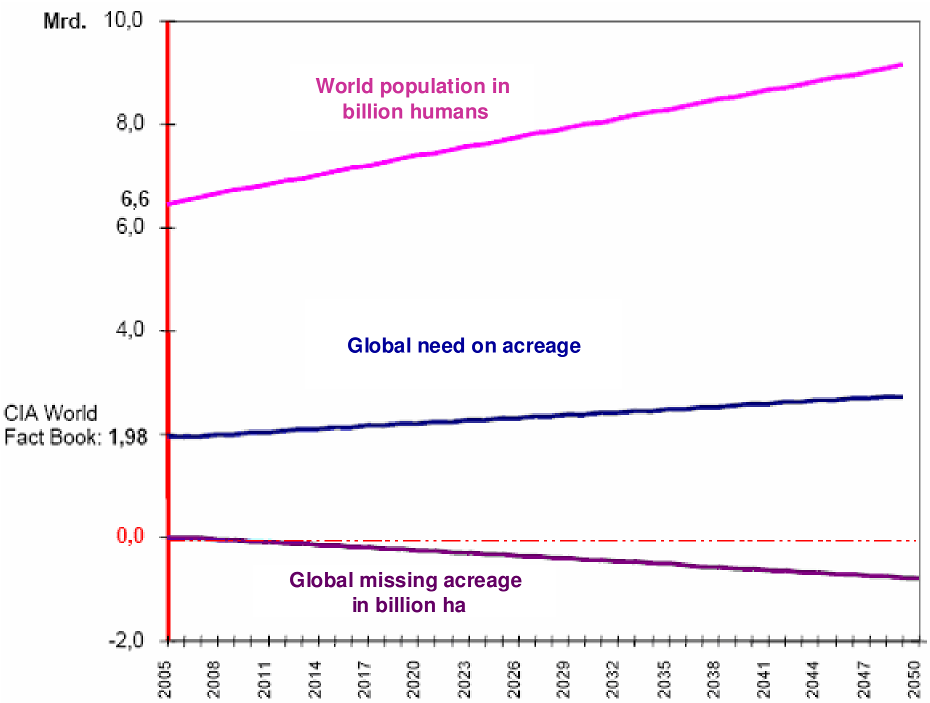

Figure 20: Global Development of available acreage
Source: Prof. Dr. Huetmann, Getreide AG

And within the production of bio energy the total energy balance has to be considered. Planting, maintaining, harvesting, processing, and deliverance consume a lot of energy. In climatic areas with low radiation like Europe the energy balance of producing bio fuel has at least to be questioned. In Egypt with more than double the solar radiation energy per square meter the overall energy balance is much better.

In the Maghreb states as well as in Egypt solar radiation and desert land (free of competition) is of ample supply. What is clearly missing is fresh water. On the other hand due to increasing population the amount of water used and of pollution resulting from production and discharge of waste water is increasing quickly.

Therefore it seems to be feasible and suitable to use waste water as a key source for storing solar energy in biomass. This procedure is far from being new or very innovative. Waste water has been recycled in agriculture for centuries as a means of disposal in cities such as Berlin, London, Milan, and Paris. In China, India, and Vietnam waste water has been used to provide nutrients[5] and improve soil quality. In recent years waste water has gained importance in water scarce regions. In Pakistan 26% of national vegetable production is irrigated with waste water, in Hanoi 80%.

In Ghana informal irrigation with waste water occurs on an estimated 11.500 ha, an area larger than the reported extent of formal irrigation in the country. In Mexico about 260.000 ha are irrigated with waste water, mostly untreated[6]. Urban drainage systems in developing countries often mix domestic and industrial waste water, often discharging the waste water into natural water ways, polluting water used by farmers and other downstream users.

Both demand and supply of waste water for irrigation are increasing all over the world. Demand is driven by the attractive returns farmers can get from producing fruits and vegetables in urban and semi-urban settings. Considering the worldwide depletion of water sources and the expected changes due to global warming the request for use of marginal quality water[7] will continue to increase. The use of waste water nevertheless is not without risk. Although the link between specific pathogens and risk is not always clear policy must give a clear framework of rules and regulations in order to protect the consumers as well as the farmers from spreading of diseases through the application of waste water.

Aside form the immediate risk for people waste water also can pose a threat to the ground water as well as to the soil fertility if applied without proper management. In Taiwan in the 80s for example many rice paddies were heavily polluted and made useless for agriculture by increasing levels of heavy metals.

One possible solution for minimizing the risks within the waste water irrigation scheme is to produce energy crops on non agricultural land, like desert land. In the Qena region

[5] The amount of nutrients in waste water can vary considerably: 16-62 kg total nitrogen, 4-24 kg phosphorus, 2-69 kg potassium, 18-208 kg calcium, 9-110 kg magnesium and 27-182 kg sodium per cubic meter. (Molden, David (ed.): Water for food. Water for life, 2007, p. 438.

[6] Molden,2007, p.430

7 Treated waste water

the desert starts immediately after the Nile river valley. Aside from small farming attempts using groundwater or (illegally) waste water in these areas there is not much agriculture going on.

The study describes a project which aims at developing up to 3,000 feddan of agricultural land irrigated by waste water and planted with energy crops. We assume that the plantation will:

- provide renewable fuel like plant oil and biogas
- develop and improve farmland
- produce compost and fertilizer
- create no second pollution problems like groundwater pollution and soil contamination

D.1. Future project conception- BIE (Biofuel Initiative Egypt)

One of the basic aims of European policy in the field of energy supply consists in providing bio fuels instead of fossil fuels for mobility. To make this happen high quality, ecological standards, sustained production and reasonable prices of bio fuels must be assured.

In the federal state Rhineland Palatinate (South-West Germany) a bio fuel initiative should be developed which aims at establishing a partnership between the potential production areas, like Qena in Egypt, and potential consuming areas, like Rhineland Palatinate cities and companies.

A network between actors on the national and international stage could support and enhance this intention. This network ought to provide those biofuels quantities, which cannot be supplied through regional and national production, by international sustainable cultivation partnerships. In particular the focus of the project cooperation is based on countries in transition or developing countries of the African continent, due to big potentials concerning unused areas (deserts) and solar insolation. The main problems, which are always mentioned on the part of implementing countries, are lack of technology, know-how, investment capital, reliable project partners, and price stability in the consumer market to accomplish an effective and efficient valorization of unused potentials. In addition the introduction of proper management and training schemes will be necessary to start and maintain a complex bio fuel production.

The consumer market in Europe will benefit from the oil imports from for example the Qena region. In addition small and medium sized companies from the field of biomass processing can benefit from selling or using their technology (milling, biogas, composting, irrigation etc.). Considering the many mutual benefits as well as the expected sustainability in ecological, economical and social terms bio fuel production in desert areas with waste water irrigation should become a mayor business. The following project description for Qena will give more insight in the organization, technology and economics of such a project.

Through the formation of partnerships the **B**iofuels **I**nitiative **E**gypt can be initiated. The partners ought to come from the field of innovative service companies operating in sectors like project management and technology-development as well as medium-sized industry- and agriculture-enterprises operating in sectors like waste water treatment, cultivation, energy generation and logistics. The partnership will have a positive, environmental-technical and socio cultural effect on the different parties. Service providers and producers could enlarge there export fields and investors could receive nice return on investments. Political stewardship by the government of Rhineland Palatinate will help to assure companies to embark on such a mid and long term investment.

The partnership could provide missing know-how, technology and start up capital to the individual cities and communes of the countries in transition. The recipients can start to analyze there potentials and elaborate concepts to transform those potentials into social, ecological and financial values. **The main focus** lays on the use of **conditioned waste water**. The currently idle desert land will be turned into highly productive land in the future. That this basically is possible is shown in many places in Africa and also in some places in Egypt. Jatropha grows in desert soil without amelioration measures and irrigated by waste water.

To guarantee plant growth in deserts, adequate water supply has to be warranted. Thereby the quantity is more important then the quality of the water, what in turn correlates with high cost of provision. Cities and communes discharge their waste water with high disposal costs into lakes, rivers, oceans or the desert.

Due to the losses opportunity costs are generated, which from a macroeconomic point of view is not a **sustainable** waster water **management**. The follow-up costs are creating more and more pressure on the communal households and are not in favor of the financial situation of the communes. Therefore waste water should be handled as a resource. Waste water can be sanitized and stabilized as far as necessary to use it for irrigation of adequate desert plants. Even though the cultivation of biomass can be modified to gain different products from food to resources for new materials and fine chemistry (e.g. enzymes), the main focus lies on the extraction of exportable plant oils (biofuels). Secondary biomass (press cake, loopings, fodder, wood, coferments) will find regional markets, hence expensive imports can be substituted, which conforms a regional sustainable development- and resource policy. Further effects through the BFI in the production countries are:

- Securing and crating new jobs in new regional structures using available renewable resources
- Improvement of people quality of life, by reduction of negative environmental impacts, participation in new supply and disposal structures and increase of incomes
- Active contribution to climate protection trough innovative technology and abatement of harmful climate emissions,
- tax revenues in communes and increase of citizens purchasing power

Due to intensive demand for fuel-alternatives of the industrialized countries, for instance Germany could appear as purchaser and guarantee fixed long-term prices within long term consumer- producer contracts. In the future industrial countries could become more independent from price increases in the crude oil market and thus may want to diversify its existing “energy-monoculture”, to be able to act more flexible in the global economy. At the same time regional producers are encouraged, through price- and purchase-guarantees, to develop bilateral partnerships where win-win-effects can be generated and guaranteed. Further advantages are:

- Reduction of carbon-dioxide emissions trough substitution of fossil fuels in the traffic sector and direct cost savings within the communal households.
- Compliance with the German biofuel quota act as well as the EU directive 2003/30 (Avoidance of penalties and fines)
- Guarantee of resource-supply for processing industry
- Direct and active development aid trough sustainable finance transactions
- Education and know how transfer to Egypt

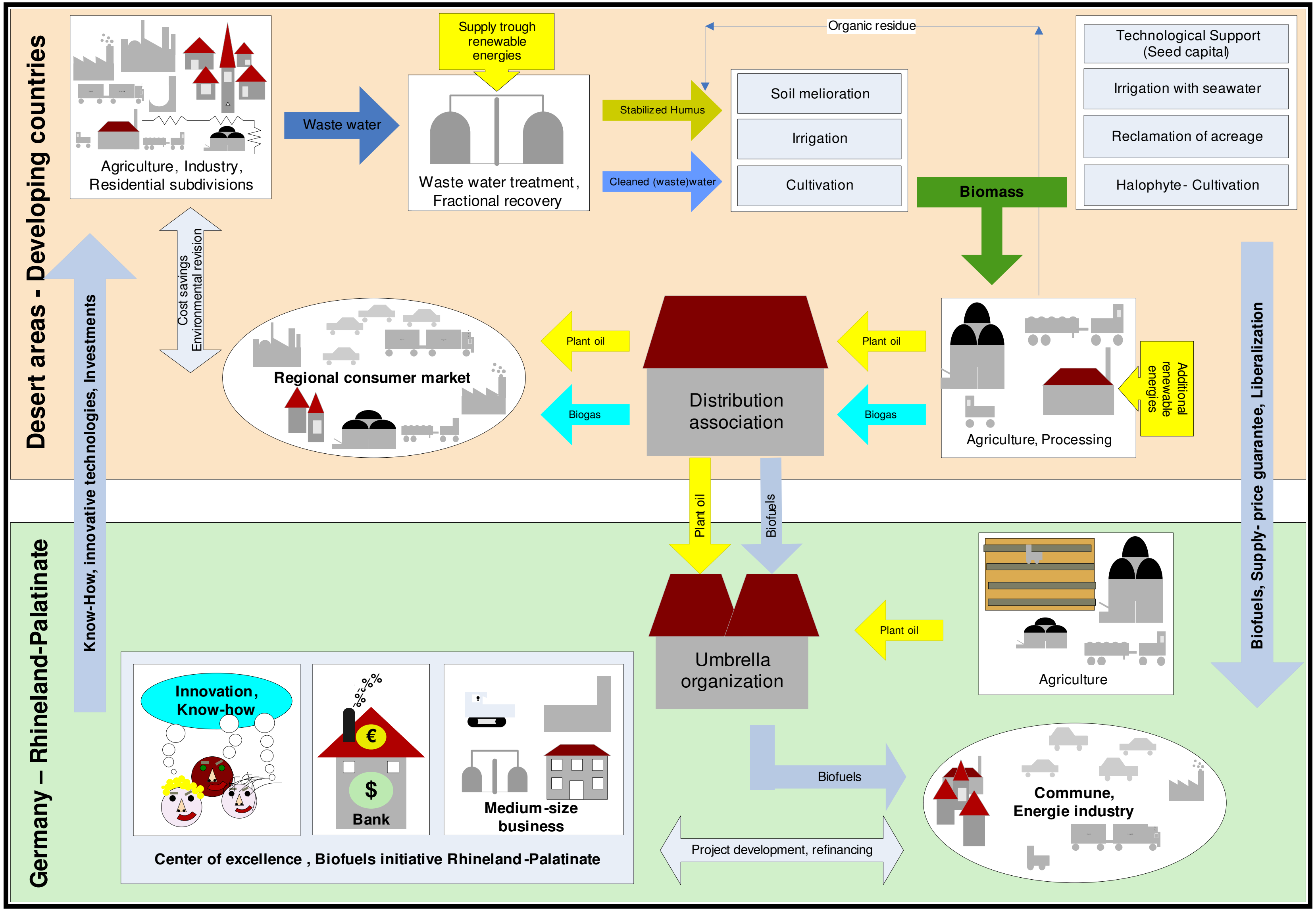

Figure 21: Biofuel Initiative Egypt
Source: IfaS 2008

D.2. Sustainable mode for waste water utilisation Qena

Assuming that waste water in the future is available in relative constant quantity a sustainable cultivation of the farmland in Qena in an agro-forestry-farming-system can be implemented. A drip irrigation system including an automatically feed forward control and smart distribution is the first step to comply with the requirements of an efficient irrigation. To our estimates by using an efficient drip irrigation system more than the double area available at that time in Qena could be irrigated. To use drip irrigation the treated waste water has to be almost totally free of solids. Minimum it must be free from algae and sand. Salt also could pose a problem for the drip irrigation technology. To achieve this purity it is necessary to install e.g. a reed-/sand bed filter before using the waste water for irrigation. The growing biomass of the natural filter finally can be used to produce fertilizer and/ or energy.

Fertilizer is very important for high yields. Usually desert soils are poor in minerals, nutrients and micro-organisms. To improve soil conditions, a highly-efficient humus-substrate will be produced on site by using sewage sludge from the WWTP, the bio-waste-fraction from the solid waste treatment plant (SWTP) and the biomass residues from the Jatropha plantation management like leafs and branches. Through a gasification process charcoal will be produced from lignite structures. This charcoal will be mixed with the sludgy and the organic household waste. **The knowledge to produce this special humus-product was developed by "areal" Ltd. company specialised on sustainable waste water treatment and fertilizer production and is protected by international industrial property rights.** The features of this humus-substrate are:

- Organic soil substance is 3-5 times higher then in average soils
- Nitrogen- and phosphor content is 3-5 times higher then in average soils
- High water storage capacity
- High buffer capacity
- High persistence
- Ability of reproduction
- Share of carbonized material 70 times higher than normal agricultural soil

The potentials of the application of this humus-substrate are:

- amelioration of farm land
- increase of production in arid and humid areas
- active climate protection through CO_2 sequestration
- climate protection through reduction of methane and nitrous oxide (laughing gas)

Furthermore the cropping system should not be mono-culture. It is demonstrated in many field research that intercropping and mixed cultures have synergism leading to higher yields, less consumption of nutrition and to a lower demand of pesticides. The *Jatropha curcas L.* plant is the most known plant for desert bio fuels production. But there are other crops having higher yields per hectare suitable to be cropped together with Jatropha like date palms (see appendix: *Euphorbia tirucalli*). The objective must be to optimize the biomass yield per ha with a low water demand. This could end up in oasis like cultivation system, where different plants interact to create a long-term **self-sustaining production system**.

Secondary raw materials like press cake, branches, cores, damaged flesh, and the bio-waste fraction from the surrounding area (like sewage sludge and solid bio-waste from the SWTP) can be fermented to gain biogas for heat and electricity production. The fermented residues will be turned into highly valuable compost. Thus we save on purchase of mineral fertilizer for the Jatropha plantation. Hence the whole material flow cycle is closed and no potentials are going to be wasted.

Summarized this system part consists of the following components:

- sand bed filter for pre-treatment of waste water from the lagoon
- drip irrigation system
- highly efficient humus-substrate
- technical processing centre (Biogas, Oil-press, gasification, composting etc.)
- training and maintenance

The following chart shows the whole material flow of the proposed project including the secondary raw materials.

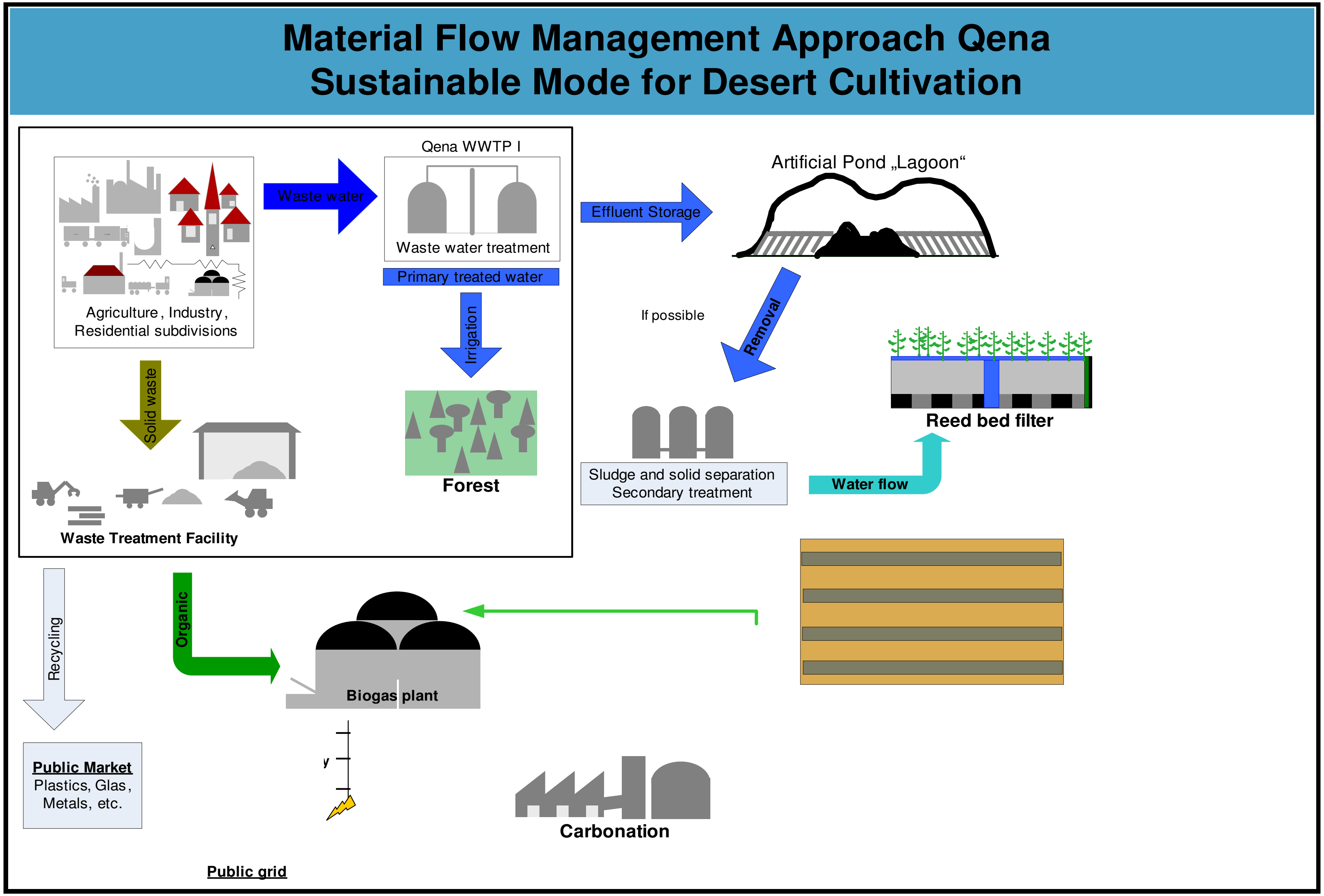

Figure 22: MFM Approach Qena, Sustainable Mode for Desert Cultivation
Source: IfaS 2008

D.3. Possibilities for Certified Emission Reduction

There are several possibilities to generate certificates for emission reduction under the flexible mechanism of the Kyoto-Protocol in order to financially support the project in Qena. In principle the country Egypt itself fulfils all requirements to participate as a host country in the emission trading, especially in the field of CDM (Clean Development Mechanism), for projects with Germany as investor (Annex 1) country. By now there are four Egyptian projects registered under UNFCCC and among them one with German participation. The “Designated National Authority” (DNA) for Egypt is the Egyptian Environmental Affairs Agency (EEAA). Theoretically there are following possibilities for CDM- and JI- Projects in Qena:

1. Methane avoidance by the use of the waste water for afforestation: The calculation of this emission reduction is relatively simple to manage, since a suitable methodology certified under UNFCCC is already available. A permission of this emission reduction under the CDM depends to a large extent on the sustainability classification of the project of the Egyptian "DNA" and on the proof of additionality. By using the "Small Scale Methodology" AMS III.I. „Avoidance of methane production in wastewater treatment through replacement of anaerobic lagoons by aerobic systems“ an emission reduction of 11.468 t CO_{2eq} is obtained.

2. A second possibility for the production of CERs offers the certification of the sink-potential of the afforestation project. Since however world-wide there is still no project planned with similar cropping activities registered by UNFCCC, a statement to the quantities of CERs possible to generate can only be made very roughly. Prof Becker (University of Hohenheim) who is taking part in a pilot project in Madagascar estimates the capacity for carbon storage of Jatropha at 2.5 tons of CO_2 in the standing biomass per hectare of cultivated area. Projected onto our project aim in Qena this estimation would produce theoretically 3,150 CERs each year.

3. The substitution of fossil fuels by vegetable oil offers another opportunity to generate CERs. Since there are most different alternatives for the use of the oil here only two examples with a high probability to be certified under UNFCCC are given:

    a. Utilisation of the oil in CHPs (Combined Heat and Power Plants) in Egypt to produce electricity and heat or coolness. Even with support by the clean development mechanism this alternative is - because of a feed in tariff for electricity of only 0.0172 € - most likely not economically feasible. Nevertheless it would produce 5,643 CERs only in the field of electrical substitution. In advance a purchaser for heat and cold ought to be identified. Depending on his baseline for the generation of his energy demand additional CERs can be calculated.

    b. If the oil is exported to Europe there is no opportunity to generate CERs anymore. The use of the plant oil in Joint-Implementation (JI) projects would in this case build an alternative to benefit from the Kyoto-Protocol mechanism with the creation of Emission Reduction Units (ERUs).

4. Another CDM-approach for the substitution of fossil fuels is offered by the planned biogas plant. Also here, as seen already in the case of plant oil utilisation, the profitability due to low energy prices in Egypt and the comparatively high technical investment biogas even with support of the CDM is not a good business. The amount of CERs created is highly depending on the utilisation of substrates used for the fermentation process and lies between 5,000 and 30,000 t CO_{2equ} per year.

5. Furthermore the development of a new CDM-Methodology dealing with the substitution of artificial fertiliser through humus-substrate demonstrates a potential alternative. So far there is no accepted methodology for this procedure. With the product in existence such a methodology could be developed and handed in for approval with the UNFCCC.

D.4. Cost Calculation

The basic assumption for the cost-benefit-calculation is, that primary treated waste water and the available desert area (acreage) is provided for free. Sewage sludge is contained in the waste water but contrary to the waste water the sludge can be probably sold for a certain price to agriculture. Concerning this argument the free delivery of sludge would cause opportunity costs for the WWTP, hence sludge is not calculated with zero price, far from it with 50 PE/m^3 representing a huge cost factor on the one hand but contemporaneous a fixed income for the Holding Company. Due to very complex calculation approaches depending on local circumstances and implementation statuses concerning the crops and their interactions which are difficult to estimate, the following cost calculation is done under the precondition that only Jatropha crops are cultivated. The investment costs are partially given by areal-GmbH (e.g. sand bed filter, processing centre) and partially estimated during the on-site visit from GAIATECH (e.g. set up investment, crops, labour costs, running costs). The Jatropha yields and the secondary primary products (press cake, sewage sludge, etc.) are taken from literature and face to face discussions with Prof. Dr. Mohamed Abd El-Naim. Additional incomes are estimated (in regard to literature) and cannot yet be proven by practical experience.

Within the used numbers of the calculation many different factors in different variations influence the result. The calculation does not include economies of scales (which for sure will occur if the plantation is enlarged) and market volatility.

The cost estimation of the Qena project intention is designed in Excel (Appendix II) as following. The total calculation starts from the first table **"Initial position"**. This table is the basic starting point responsible for all further accounts and results arise from. On the basis of the table "initial position" all pink coloured boxes (input boxes) are used to insert basic data into the calculation sheet. The entire calculation process runs automatically, hence changes are only to be made within the first table if variances concerning the project are desired. The initial table is separated into five main sectors namely:

- Waste Water and Acreage in Qena
- Investment

- Operating costs (staff)
- Operating costs (material)
- Revenues

Each of them represents a calculation fundament as starting position for results in the following tables affected by the "general data" (inflation rate, etc.).

The first results calculated automatically through the Excel sheet is the **"Investment"**. The costs e.g. come about the multiplication of material costs per ha for irrigation installations with the proposed acreage available or the assumption of cost for an overall facility like the biogas plant in regard to size of treatment. All assumed basic costs refer to gained experience from previous project activities.

The second results are the annual operating costs shown in the table **"operating costs"**. These costs are annual fix costs for work, maintenance, etc. of the whole project activity. The figures are calculated by using the basic data determined beforehand within the table of initial position. All costs assumed refer to gained experience from previous project activities, the on-site inspection in Luxor and Qena as well as profound knowledge exchange with resident specialists and plant operators (see table of participants).

Following the table determined **"revenues"** represents all aspect incomes generated from the cultivation, further processing and treatment facilities and Emission Trading. Incomes expressed in monetary item (€) are as following:

- **Jatropha oil**
  The oil extracted from the seeds is going to be exported to Germany. We estimate a selling price per litre of about 30-40 €cents, due to the fact that prices per litre comparable vegetable oils (rape seed, soja, palm oil) in Germany are actually about 80-100 €cent excluding tax. To guarantee a long term purchase intensive the Jatropha oil price has to stay at least 5% underneath the competitive product while contemporaneous transport costs have to be covered too. We expect that

the overall export costs (transport, marketing, duty, etc) per litre will not break through the 50 % boarder of the selling price.

- **Humus-Substrate**

  In Germany the described high-effective-humus-substrate actually is sold and dealt for 60-100 €/m^3. In regard to export costs and purchasing power parity the price is pessimistically and carefully determined to 20-25 €/m^3 in Qena.

- **CO_2-Certificates**

  Concerning the avoidance of methane emissions there are several options to generate Emission trading certificates exemplified within the chapter "D.3 Possibilities for Certified Emission Reduction" in the report. All certificates can be sold on the market with an estimated pessimistic price perception of 15€.

- **Additional incomes**

  E.g. intercropping. According to the topography, soil profile and prevailing agro climatic conditions in an area, Jatropha can be combined with other suitable species comprising the agricultural, horticultural, herbs, pastoral and/or silvicultural components to result in an ecologically viable, economically profitable and socially acceptable agro forestry system.[8] Hence the rumour that Jatropha poisons the soil is not true.

The most important table to refer about this calculation is the table of **"Net-present-Value (NPV)"**. In this case the NPV shows over the whole project time of 21 years if the total investment costs plus the annual operating costs can be refinanced through the annual revenues under consideration of a certain interest rate given to the investor. This interest rate is the so called hurdle rate. Furthermore the internal rate of return (IRR) indicates the height of the maximum hurdle rate. Actually the IRR is about 10-11% displaying that the net present value of the project with an interest rate of 10-11% is zero. If the NPV (all annual operating costs including investments subtracted by all annual revenues and financing of the hurdle rate) over the entire project time is zero (or a positive value), the project is "counterbalanced". Hence the investment possibility is economical interesting or not. In the case of the Qena project, the hurdle rate is about <=10-11%. In regard to actual market situations this interest rate implies a potential project investment.

[8] http://www.jatrophabiodiesel.org/intercropping

The investment of approximately 15 Million Euros is calculated for the total cultivation of 1260 ha available acreage in Qena, including all technical installations representing a sustainable resource management (closed loop recycling management). Due to the IRR to be interpreted as positive, to our opinion it is possible to convince investors to fund the project.

The next important table is the **"Cash-Flow"** statement. The cash-flow indicates the project liquidity over the total project time under consideration of depreciations, taxes and annuities. To guarantee a trouble-free project activity concerning repayments (amortisation) it is indispensable necessary to confirm liquidity. Hence it can happen that the NPV and IRR are economically positive but the project breaks due to liquidity problems.

All other tables are auxiliary calculations necessary to count investments, annual costs and possible revenues contributing directly to the projects financial ratios (NPV, IRR, cash-flow) which eventually state the project intension from an economical point of view.

Like already mentioned, different factors within the costs calculation have a strong or weak influence on the result. A sensitivity analysis shows that on the one hand the project time, total yields, revenues for certificates and humus-substrate have a high influence on the project result whereas the oil price seems to be of less importance. On the other hand costs for workers and the inflation rate (consumer-price-index) have a strong effect on the result whereas irrigation and electricity costs per ha do not control the project effectiveness. The worst case scenario for the project intention is an IRR about 8%. If the IRR is lower, it is probably becoming difficult to convince potential private investors. For ecological reasons and for local policy aspects it still would be a very interesting project.

Net present value (NPV) and Internal Rate of Return

Hurdle Rate	10,50%									
Investment		**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Investment costs	€	15.193.705	1.688.006	0	0	0	0	742.350	0	1.657.783
Operating costs	€	942.978	861.229	901.967	945.352	991.557	1.040.766	1.093.173	1.148.987	1.208.429
Revenues	€	568.991	1.494.020	2.937.126	3.357.020	3.456.676	3.559.747	3.666.354	3.776.621	3.890.676
Surpluses	€	**-15.567.691**	**-1.055.216**	**2.035.159**	**2.411.668**	**2.465.118**	**2.518.981**	**1.830.831**	**2.627.634**	**1.024.464**
Discount factor	%	1,0000	0,9050	0,8190	0,7412	0,6707	0,6070	0,5493	0,4971	0,4499
Cash value	€	-15.567.691	-954.946	1.666.763	1.787.437	1.653.441	1.529.021	1.005.714	1.306.258	460.891
NPV	€	547.331								
Internal Rate of Return	%	11%								

The chart is a cut out of the NPV calculation for roughly overview of cost calculation. It shows the first eight years of the project activity. Investment cost plus operating costs minus revenues leading to the annual surpluses. The **discount factor**, is the number which a future cash value, to be received at time T, must be multiplied by in order to obtain the current present value. In other words the cash value is the value needed to be able to pay 10,5 % interest to the investor in-between a certain project time. The discount factors includes the time, hence decreases every year. The sum of all annual cash values over the entire project time results in the NPV.

Further comments to the plant oil price

The market price for Jatropha-oil is difficult to estimate for two reasons. First, Jatropha oil actually is not traded on the global vegetable oil or bio fuels market, due to the fact that a market entrance did not happen yet (large –scale trading). Second the costs for transport from Egypt to e.g. Germany differ in large scale depending on quantities transported (economies of scale), handling procedures and logistic companies. Additional logistic-costs occur for customs (in this case TAREC-Code number 1515110000 – corresponds to 3,5%), storage in huge plant oil tanks at the harbour (costs per hour of storage) and merchants commission. Prices per litre cannot be exactly determined, due to the fact that plant oil entered into the commodity market, hence prices are fixed after transport by ship unloading affected by market volatility and actual market circumstances.

Concerning all the arguments we propose a chance to annul presumptive Jatropha-biofuel-producer from the common, stringent and unpredictable market situation. If prices for Jatropha-oil will be fixed in regional bilateral agreements between the investors and the potential customers beforehand, first income security for investors refinancing is guaranteed, second the cooperation is partly independent from market requirements and strong, short-time and volatile amplitudes and third no external interested parties can interrupt the cooperation (the project activity) by proposing other economical interesting offers.

Within the cost calculation the plant oil price is calculated pessimistic. Depending on the transport costs, especially accruing during exports, the price for the Jatropha oil has to be lower than the actual market prices including the costs for transport and contemporaneous as high as possible for the producer to be able cover investment and operating costs. To our opinion this is possible.

The following chart exemplifies the channels of distribution interesting for the vending and product placement of the gained yields by the project intention.

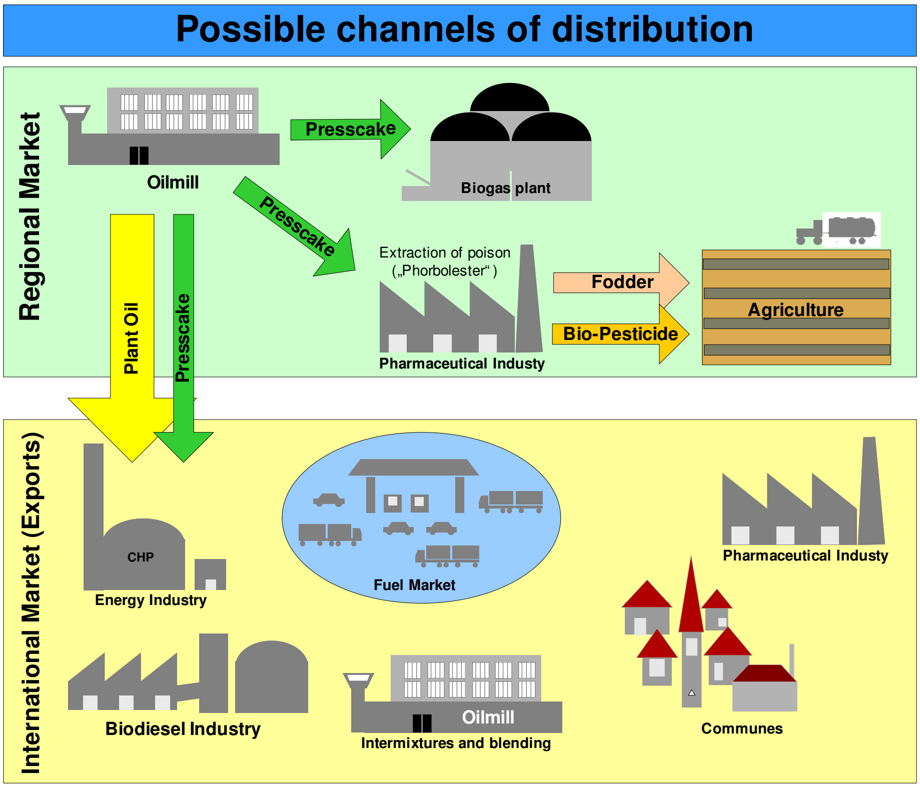

Figure 23: Channels of distribution for plant oil vending
Source: IfaS 2008

The following chart is showing the actual price situation for plant oils.

World Market Prices in US-$/T		
	Feb 28	Feb 27
Soybeans, U.S., cif Rott.	612 Mar	604 Mar
Soya oil, Argentina, fob	1495 Feb/Mar	1450 Feb/Mar
Rapeseed, Europe, 00, cif Hamburg	767 Mar	740 Mar
Rape oil, Dutch, ex-mill	1579 Feb/Apr	1545 Feb/Apr
Palm stearin RBD, Malaysia, fob	1170 Mar	1170 Mar
Coconut oil, Phil./Indon., cif Rott.	1475 Mar/Apr	1470 Mar/Apr

Figure 24: Actual market prices for plant oils in Europe
Source: www.oilworld.biz, ISTA Mielke GmbH, Sunday 02.03.2008

D.5. Further (ecological) benefits

The most effective dissipative cooling process (temperature absorbability process) on earth is the evaporation and condensation of water through tree-vegetation. Plants, especially tress, have the ability to create a bigger evaporation surface with its foliage, able to evaporate more water than the surface of the oceans. Requirement for a high continental evaporation rate is that water is locally available in sufficient quantities, that water over the development of hawser hot-wired condenses and is stored in the soil, that the soil has enough minerals and nutrition and that an environment to permit a microbial diversity exists to guarantee crops pleasant growing conditions. The humus-complex to be produced within the project complies with all these requirements to implement an effective climate protection strategy. The important influencing climate regulation factor soil can stabilize the water-soil-vegetation-cycle, which is responsible for the physical energy distribution (dissipation) to guarantee the indispensable cooling of our earth. Desert regions to this argument should be made habitable with stable cover of vegetation. The humus-complex therefore is an appropriate tool. The overall goal is to create over a long term period of irrigation a self-sustaining ecosystem! **Hence the re- cultivation or afforestation of arid areas implied a sustainable approach to combat climate change.**

D.5. PPP - Project Intention

The above shown cost benefit calculation shows a positive project result. Therefore it is highly recommended to plan the next step. In cooperation of several companies form Germany the first practical steps form starting the plantation should be organized. As the data of this report stem from a few practical pilot projects and literature sources, we need to install, operate and optimize an own plantation to show the real potential. For example in literature and according to Prof. Abdel Naim up to 10 t of yield per ha is possible with Jatropha. We only calculated:

- Maximum sustainable yield per hectare
- Matter flow- and energy-balance
- Training, education and transfer of knowledge

- CO_2 sequestration
- The quality of the plant-oil in regard to ISO-norms (DIN-norms)
- Logistics and handling
- Commercialisation possibilities and profitability scenarios

Adequate Private-Public-Partnership Project Partners could be:

- HCWW
- Qena Holding Company
- Governorate Qena
- areal GmbH (Mr. Joachim Böttcher)
- IfaS (Prof. Dr. Peter Heck)
- GTZ (Dr. Hans-Werner Theisen)
- Agric. Res. Centre University of Cairo (N.N.)
- Stadtwerke Mainz (Municipality utilities of Mainz) (has to be confirmed)
- Ökobit (Biogas) (has to be confirmed)
- Westerwald-Pellets (Mr. Mann) (has to be confirmed)

Total investment needed for the PPP would be around 1.5 Mill. € for 100 – 200 ha.

Time schedule would be:

- Application and approval from GTZ and companies till end of July.
- Planning and infrastructure till end of September
- Approval from HCWW and Quena Holding Company in October 08.[9]
- On site project start in October 2008

The coordination of the project will be done by IfaS Germany together with SME from Rhineland Palatinate and the Qena Company for WWT.

[9] Very important to notice that we need the approval fort he whole project. The first 200 ha will be only an intermediate step to get experience and train local worker. In 2009 the extension of the plantation should go on.

E. Summary and Outlook

Concerning the analysis of Qena waste water conditions, infrastructure, key-persons and overall land circumstances it can be stated, that Qena has a good precondition to become an innovative operator in the sector of waste water utilisation, sustainable biomass production and creation of regional added value systems. Qena has a sufficient amount of waste water which according to our information is available for use in irrigation of Jatropha. For the business feasibility study only costs for sludge where calculated. Land use und water utilisations are free of cost. Thus benefits for the Qena Waste Water Company are gained from sales of sludge and a potential share of the net profit of the whole investment. It seems important to motivate the local partner to help guiding the project to success. Therefore a part of the net benefit seems to be more appropriate that paying for water or land.

A high solar insolation and sufficient land (3,000 feddan) can be used to create a model bio energy production for desert areas. Through the utilisation of pre-treated effluent as resource it is possible to avoid further contamination and second pollution problems. The future project can operate on an economic base and thus help to alleviate poverty while providing a sustainable fuel for a reasonable market price.

Problems to be solved and questions to be answered remain in the field of logistics, proper irrigation, high investment and oil yield per ha. To activate the most value added an initial investment of roughly 15 Mio € for the whole available area is necessary. Question will be whether international investors consider Egypt's upper Nile valley to be secure enough to pour that much money into an agricultural project.

European customers for the oil do exist. We talked to three utilities which would most likely give purchase options for oil under special conditions. German SME would be willing to be part of the investment and operation team for the second step of the project. The cultivation of Jatropha would generate local jobs (around 150) and contribute largely to climate protection. Through the utilisation of pre-treated effluent as resource it is possible to avoid further contamination as the case may be enabling the self-purification of public waterbodies. City and rural district conquer a structural gulf while the urban region as circular flow partner not only emerges as consumer but also as a supplier in agriculture. The future project can contribute formidable, that the topic recycling and resource-efficiency becomes a central topic in the economy and the population in Egypt. The Qena waste water company could benefit form the sale of sludge to the plantation operator which will turn this sludge into biogas and compost. Different benefit sharing options have to be discussed in the second step of the project.

References

Molden, David (ed.): Water for Food Water for Life. A comprehensive Assessment of Water Management in Agriculture, IWMI and Earthscan, London 2007.

M.A. Abdelkhalek: Water Quality Status in Egypt – The Causes. The Impact, The Measures, Ministry of Water Resources and Irrigation - Water Quality Management Unit

GTZ: Water Supply and Sanitation. Technical assistance to Qena governorate for creation of a new affiliated company. PDF; Egypt-Trips-Qena-Water-Sanitation-final-indd 2003

Prof. Dr. Mohamed Abd El-Naim: Re-use of Treated Wastewater in Agriculture; Agricultural Research Centre. Proceedings Conference on Sustainable Wastewater Management 10-11, Egypt September 2007

Ripl/Scheer: Memorandum zum Klimawandel; Notwendige gesellschaftliche Reformen zur Stabilisierung des Klimas und zur Lösung der Energiefrage. PDF, Berlin 2007

Appendix I

Waste Water utilisation in Qus city	
Site	Qus city
Treatment capacity of WWTP	34,000 m^3/day
Treatment capacity to population$_{eq}$	300,000 inhabitants
Overall project costs (approx.)	160 Million EP (19.5 Mill. Euros)
Existing forest	350 feddan
Available area for afforestation	1,150 feddan

Figure 25: Further possible area I of Qena Governorate to be irrigated with sewage
Source: GAIA-Tec Jan. 2008

Waste Water utilisation in Abotesht city	
Site	Abutesht city
Treatment capacity of WWTP	20,000 m^3/day
Treatment capacity to population$_{eq}$	200,000 inhabitants
Overall project costs (approx.)	100 Million EP (12.2 Mill. Euros)
Existing forest	325 feddan
Available area for afforestation	750 feddan

Figure 26: Further possible area II of Qena Governorate to be irrigated with sewage
Source: GAIA-Tec Jan. 2008

Appendix for intercropping opportunities and mixed cultures

Salicornia bigelovii

Figure 27: Salicornia europaea, Europäischer Queller
Quelle: www.diskusjon.no (18.06.2007)

Euphorbia tiruccali

Figure 28: Euphorbia Tiruccali - Bleistiftstrauch
Source: The New York Botanical Garden, Prof. Dr. Huchzermeyer, University of Hannover

Euphorbia tirucally was mentioned in the literature, as a potential biofuel plant, already some 40 years ago. However, the cost of production at that time was almost $20 a barrel, when the price of crude fossil oil was less than $5 a barrel. Now that the price of oil reached the heights of $130 a barrel and the know-how of new technologies has increased, we can anticipate that fuel production from such a plant can be economically worthy.

	Salicornia/Atriplex Halophytes	**Euphorbia Tirucalli**	**Date Palm**
Irrigation tolerance ***Leaching Fraction beachten***	Saltwater max. 40 g/l	Fresh-/Saltwater max. 10 g/l	Freshwater max. 12 mg S./l
Water requirement l/qm/a	1.200 – 1.600	250 - 500	1.500 – 3.600
Cost of cultivation ø $/t/a	77,70	25,50	430,00
Total Biomass t/ha/a	10 - 20	30 – 40	max. 24
Seeds-/. fruit t/ha/a	max. 2 (ca. 9%)	3 – 4	3,5 – 4 Seeds
Carbon sequestration t/ha	< 1	< 1	?
LULUCF ø $/ha (15 US$/CER)	-	-	?
Oil content seeds in %	28 - 32	8 – 12	7 - 12 Seeds
Calorific value in kWh/l	8,77	8,77	11,3
Secondary benefits $/ha/a	-	-	109
Woody Biomass t/ha/a	-	-	-
Presscake ø t/ha/a	< = 1	-	3,2

Figure 29: Table of crop types with requirements and potentials
Source: IfaS 2008

Group	Degree of Treatment	Plants	Environmental & Health Precautions	Suitable Irrigation Methods	Proposed Kind of Soils
First	Primary	Trees for Timber	Fencing farms No direct contact with water and entrance of farm workers only Prohibit from entering farms Take health measures required for the protection from infection with pathogenic organisms and treatments	Furrow	Light texture authorized for use in desert land 5 km away from dwelling communities while complying with periodical assessment of the environment
Second	Secondary	Palm trees, cotton, flax, linen, jute Fodder crops & dried cereals Husky fruits & crops Cooking vegetables Heat processed fruits Flower nurseries Raw edible plants Husky plants	Cattle not yielding milk, and producing met could be used Food should be cooked prior to eating	Furrow & sprinkling	Light medium texture
Third	Advanced	All kinds of horticulture crops Fodder & green grasses	None	All methods except spraying	All kinds for soil

Figure 30: Decree 44/2000; Reusing Treated Wastewater in Agriculture; Degree of Treatment, Kind of Plant & Soil, and Method of Irrigation
Source: Dr. Seham M. H. Hendy (Under secretary - Environmental Affair's; MOHP - Egypt), "Wastewater Management and Reuse in Egypt", Regional Workshop on Health Aspects of Wastewater Reuse in Agriculture, October 2006, PPP page 14

Ser.	Description	Unit	First Group Preliminary Treated Water	Second Group Secondary Treated Water	Third Group Advanced Treated Water
1	B.O.Ds	Part per million	300	40	20
2	C.O.D. Dichoromate	Part per million	600	80	40
3	T.S.S.	Part per million	350	40	20
4	Oils and Grease	Part per million	Undetermined	10	5
5	Number of Enteric Nematode Cells or eggs	Number/litre	5	1	1
6	Number of Fecal Coliform Cells	For every 200/m2	Undetermined	1000	100
7	Maximum Concentration of Total Dis-solved Salts (according to plant endurance degree)	Part per million	Until 2500	Until 2000	Until 2000
8	Rate if sodium Adsorption (permeability according to type of soil & plant)	9	25	20	20
9	Chlorides Concentration	Part per million	until 350	300	300
10	Boron Concentration	Part per million	until 5	Until 3	Until 3

Figure 31: Maximum Standards Permitted for Reusing Treated Sanitary Drainage Water & Degree of Treatment Egypt
Source: Dr. Seham M. H. Hendy (Under secretary - Environmental Affair's; MOHP - Egypt), "Wastewater Management and Reuse in Egypt", Regional Workshop on Health Aspects of Wastewater Reuse in Agriculture, October 2006, PPP page 15

Category	**Re-use Conditions**	**Exposed Group**	**Intestinal nematodesb** (arithmetic mean no. of eggs/litre)	**Faecal coli-forms** (geometric mean no./100 mlc)	**Wastewater treatment expected to achieve required microbiological quality**
A "Unrestricted"	Irrigation of crops likely to be eaten uncooked, sports fields, public parksd	Workers, consumers and public	<1	<1000d	A series of stabilization ponds designed to achieve the microbiological quality indicated, or similar treatment
B	Irrigation of cereal crops, industrial crops, fodder crops, pasture and treese	Workers	<1	<1000	Retention in stabilization ponds for 8-10 days or equivalent helminth and faecal coliform removal
C	Localised irrigation of crops in category B if exposure of workers and the public does not occur	None	Not applicable	Not applicable	Pretreatment as required by the irrigation technology, but not less than primary sedimentation

Figure: 32: Decree 44/2000 :Egyptian Microbiological Quality Standards for Treated Wastewater Use in Agriculture
Source: Dr. Seham M. H. Hendy (Under secretary - Environmental Affair's; MOHP - Egypt), "Wastewater Management and Reuse in Egypt", Regional Workshop on Health Aspects of Wastewater Reuse in Agriculture, October 2006, PPP page 16

Company Institution University	**Title**	**Name**	**Responsibility Department Branch**	**E-Mail**
GTZ	Dr.	Hans-Werner Theisen	Chief Technical Advisor	hans-werner.theisen@gtz.de
	Eng.	Fayez Badr	Project Assistent	fayezbadr@hotmail.com
Qena Holding Company	Gen.	Mohamed Badry	Chairman	
		David Banner	Project Team Leader	Rodeco.quena@yahoo.com
Ministry of Agri-culture	Eng.	Yahia	Representativ MoA in Qe-na	
HCWW	Eng.	Abd El Mohsen A. Baky Mostafa	General Manager for Waste Water Sector	mohsenbaky@hotmail.com
areal-GmbH		Joachim Böttcher	CEO	j.boettcher@areal-gmbh.de
IfaS	Prof. Dr.	Peter Heck	CEO	p.heck@umwelt-campus.de
	Eco.	Felix Flesch	Employee	f.flesch@umwelt-campus.de

Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GmbH
Water & Wastewater Management Program
Holding Company for Water and Wastewater (HCWW),
Corniche El Nil, Water Treatment Plant-Road El Farag
Tel.: +2 02 245 98 405/411
Fax: +2 02 245 98 405/411
Website: www.gtz.de

الوكالة الألمانية للتعاون الفني
برنامج إدارة مياه الشرب و الصرف الصحي
الشركة القابضة لمياه الشرب و الصرف الصحي،
كورنيش النيل محطة مياه روض الفرج
تليفون : ٠٠٢ ٠٢ ٢٤٥ ٩٨ ٤٠٥/٤١١
فاكس: ٠٠٢ ٠٢ ٢٤٥ ٩٨ ٤٠٥/٤١١
موقع إلكتروني: www.gtz.de