EnergyFarming

as contribution to regional development in South Asia

Walter Danner, Jai S. Menon, Prof. Dr. Kanoksak Eam-o-pas

Background

The author is working since many years on projects with energy generation from Biomass as the content in Germany, Thailand and India. Therefore datas and statements included here are based on this experience.
While trasfering the conclusions to other countries and regions the conditions prevailing in these countries have to be taken into account.

The intention of this paper is to give an overview of the possibilities and advantages of energy generation from Biomass – especially through digestion in Biogas plants. Certain aspects are not dealt with in detail, this is deliberate so as to ensure easy reading.
Details can be discussed with the author under w.danner@t-online.de.
This publication is not meant to satisfy scientific demands.

Situation and problems in rural areas in South Asia

Impoverishment of farmers

In the rurural areas impoverishment of farmers is increasing.The farmers are the last link in the marketing procedure. Declining prices in the world market for agricultural products are handed over down the line. The farmer is at the end of the line and cannot pass on these low prices any further. Many have to pledge their land to purchase the seeds for the next crop; many do this without a realistic chance to pay back the debts. They finally leave for cities in the hope to earn a living as working on the farmland is not rewarding.

Absence of jobs

Many seasonal agricultural workers do not find regular employment and they also migrate to cities, always with the hope to find a job and a better living.

Shortage of energy in suburban areas.

Electrification and supply in the suburban areas are often more than deficient. Power failures are frequent and strech sometimes over days. In remote areas there is generally no electricity grid.
Regular electric supply is however a basic requirement for settling down industry and trade which in turn would create employment in the rural areas.

The concept of EnergyFarming

Todays agricultural production basically aims at consumables or raw material for industry. Due to leaps in productivity achieved in the last few decades, the problem of underproduction has shifted to overproduction. The prices for agricultural products have declined world wide. In certain cases it has reached such a level that agricultural activity is no more attractive.

The quantities of overproduction and land not cultivated for consumables can be utilised to grow Biomass for energy generation.

There are three main methods of using Biomass to generate energy in Asia.

Incineration.

Biomass is here burnt to produce heat that is used for example in households for cooking or in the industry as process heat. This method will not be dealt with here as it is well known and is beeing practiced widely.

Anaerobic Digestion

This is known and is beeing practiced in Asia in Biogas plants processing cow dung, pigslurry etc. The digestion in chambers in the absence of oxygen produces Biogas which contain mainly Methane and CO^2. The Biogas can be burnt directly or in engines. A generator connected to the motor produces elctricity and heat.
In a Biogas plant various plants can also be directly digested, for ex. Grass, cereals and oilplants.

Gasification

Since many decades the metod of gasifying wood is known. Wood and other biomass containig cellulose are heated at high temperaturs . This generates producer gas with high percentages of CO anh H2 and also CO^2. This gas can be used in an engine to generate electricity.

The concept of EnergyFarming combines the digestion and Gasification technologies to compliment each other. Different possibilities are described in the chart below.

	Anaerobic Digestion	Gasification
Input materials	Biomass containing water and with low cellulose and lignin content like grass, green cereal plants, oil plants	Dry Biomass with high cellulose and lignin content like wood, bush cut, reed,coconut shell
Reaction product	Biogas with Methane content between 55 and 70%. Biogas is storable and compressible.	Producer gas with about 10% H_2 and 20% CO. Due to the Hydrogen content producer gas is explosive and cannot be stored.
conclusion	Both processe use different types of Biomass. Therefore they do not compete with each other. Producer gas must be used up immediately in an engine. Biogas can be compressed, stored and transported for other purposes. Both processes could be used to compliment each other.	

Regional closed cycle economy through EnergyFarming

Solar energy in form of Carbon is stored in all Biomass, whether wood, grass cereals or oil plants. Biomass as a sustainable raw material is not defenit like mineral oil and other fossil resources.
When the biomass is utilised it grows again. This procedure is infinit; as long as the sun shines and the soil is productive.
Till now the farmers sold their biomass as value added products such as grains and meat.In this process nutritional factors are lost. Through the sale of products these go out of the agricultural cycle. By buying fertilisers- generally sythetic- the farmers must make up the loss of the nutritional fraction.
It is not so in the case of EnergyFarming. During the digestion and gasification process only the carbon stored in the plants through photosynthesis is used up. The nutritional part- N,P and K and other trace elements remain in the cycle.Farmers can keep on selling, no operational material is to be purchased. All that is used up in generating energy is replenished by the üplants from sunlight.

Biomass EnergyFarming as source of electricity supply in comparison to other forms in rural areas.

Photovoltaic,minihydel,wind or supply from central power stations can be alternative sources to Biomass.The following tabulated comparison shows the advantages and disadvantages of different sources of energy supply.

Table 1 Comparison of forms of energy with regard to their suitability as contribution for regional development in rural areas of south Asia.

	EnergyFarming with Biomass	**Photovoltaic**	**Wind energy**	**Mini Hydel**	**Central power stations Oil,gas,coal,atomic**
Energy form produced	Gas,elctricity and heat	Only electricity	Only electricity	Only electricity	Only elctricity
Dependability	Biomass can be made availble throughout the year and can be converted to energy Large kW capacities for industry and trade can be generated	Electricity generation only during daytime and the storage is very costly.	Electricity generation only by sufficiently strong winds	Electricity generation throughout the year possible if sufficient water available.	Electricity supply throughout the year depending on the quality of the grid.
Possible yearly production time	8670 hours	About 3000 hours depending on the location and sunshine period	About 2000 full load hours depending on location and wind pattern	8670 hours	8670 hours
Investment needed per KW installed capacity in USD	1000- 2000	Very high	800- 1000	600-800	600-800
Employment effects	High due to • Biomass production • Staff for the plant operation However qualified people will be required	Low, because • No local production • Maintenance is low • Local people cannot do the maintenance work	Low because • No local production • Low maintenance • Local people cannot do the maintenance work	Low because • No local production • Low maintenance	Low as there os no local content involved

	EnergyFarming with Biomass	Photovoltaic	Wind energy	Mini hydel	Central power stations Oil, gas,coal,atomic
Who profits from the regional production. Netto capital flow into the region or out of the region	During the construction period local contractors and during the operational period the local farmers are benefitted. Money remains in the region in a closed cycle.	Investors are beneficiaries. Capital flows out of the region.	Investors are beneficiaries. Capital flows out of the region	Investors are beneficiaries. Capital flows out of the region.	Investors are beneficiaries. Capital flows out of the region.
Applicability	Anywhere where agricultural cultivation is possible.	Anywhere with enough sunshine	Anywhere with good wind speeds of 7 – 8m/s And evacuation to Grid is possible.	Only at rivers and larger creeks.	Only at places with good infrastructures.
Local and regional participation	In the beginning the local content can be upto 80%. Later, step by step this can become 100% within 5 years	Local content is very low High Tech components are to be imported from industrialised nations.	Local content is very low High Tech components to be purchased fron specialised industry.	Local content low , the equipment is to be purchased from specialised industry	Local content is practically zero as the plants are situated at places far from the region.
Macro-economic effects	As and when the expertise has developed locally the equipment can be exported to developed countries as the labour cost is much less. Costly imports of energy carrieres like Oil, Gas, Coal etc can be avoided.	Costly recurring imports of energy carriers like mineral oil and gas can be avoided	Costly recurring imports of energy carriers can be avoided	Costly recurring imports Of energy carriers can be avoided.	Oil, coal, gas etc may have to be imported causing outflow of valuable foreign exchange

Evaluation

The comparison shows that

- The biomass can give the maximum benefit to the region out of all other forms of energy generation.
- EnergyFarming can be established at mostly everywhere
- Employment can be promoted
- EnergyFarming can help to make the region independent of industrialised nations and oil producing countries
- EnergyFarming can make the region independent of central power stations and grid.

Therefore renewable energy generation projects should initially start with establishing facility for biomass production. EnergyFarming can then earn the capital required for the next step of installing photovoltaic.

The disadvantages of EnergyFarming are

- Considerably high initial investment / kW_{el} installed
- Training of the local people to operate the plants

Further effects of biomass utilisation

Wind energy generation needs a stable grid for feeding the generated electricity into.In remote areas cogenerators run on Biogas can provide a stable grid independent of the wind situation.

Estimate of the financial viability of EnergyFarming

For South Asia no experience and data is available on energy generation from agricultural biomass by digestion in a biogas plant. Therefore a financial viability analysis cannot be made. There are however data available on Mini-Biogas plants – Gorbergas plants – at cattle farms and private houses; these are not of interest here.

In the following an analysis of basic costing parameters and a comparison of the situations in Germany, India and Thailand is attempted. The intention is to work out whether EnergyFarming is economical in India and Thailand under the there prevailing conditions.
It is assumed that energy generation by biomass digestion is profitable under the prevailing EEG rules and regulations. If the investment, operating cost, biomass supply cost and the income from sale of the elctricity are similar or better, energy generation by biomass digestion in India and Thailand can be taken as profitable.

Table 2 Comparison of the economic parameters of EnergyFarming in Germany,India and Thailand

Parameters	Germany	India	Thailand	Conclusion
Investment cost	In Germany only one crop per year is possible.Biomass must be stored in silos over the winter (about 6 months) No fertiliser can be applied on the fields other than in the vegetation period. Fertilisers from the digesters must therefore be stored for months.	Biomass is available throughout the year. No storage and silos are needed. Fertilisers can be brought out to the fields continuosly and do not require storage facilities.	Biomass is available throughout the year. No storage and silos are needed. Fertilisers can be brought out to the fields continuosly and do not require storage facilities.	The investment cost in India and Thailand are lower than in germany by about 20% as no storage facility for biomass and fertiliser is required.
Operational cost	Labour cost is a major factor in Germany. The hourly wages are around 10€. Each kWh electricity has, depending on the size of the biogas plant a labour content of 0.01 – 0.025 €	Labour cost in India is a much lower factor than in Germany. Daily wages vary depending on the regions from 100-250 IRS (2,0 – 5,0 €) The labour cost content is about 90% lower.	As in India the labour cost is much lower than in Germany – about 150THB = 3,0-4,0 €. The labour cost content is therefore about 85% lower	Low labour cost in India and Thailand lead to a much higher financial viability of biomass digestion plants.
Cost of elctricity	The renewable energy law of 1.04.2000 guarantees a rate of 0,102 € per kWh for all plants upto 500kW capacity.	In India export of energy to grid is generally possible; the rates paid by the SEBs is however low and is therefore not profitable. For industrialists on the other hand is profitable to set up captive power plants. The price they have to pay for elctricity that they buy from the grid is at present as high as 5 IRS / kWh (0,10 €).This rate is expected to escalate rapidly to about 10 IRS / kWh in the next 5 years.	In Thailand it is not possible to export electricity to the grid except in very special cases. Industrial concerns however can set up captive power plants. Cost of elctricity for the industrial consumer is about 4 THB (0,10€) and higher.	On the income side the rate per kWh electricity in Germany is practically equal to those in India and Thailand. Therfore an Investment in India and Thailand will be financially viable.
Biomass supply	In Germany only one crop is possible. For biogas plants grass and maize are the main crops.Cost of Biomass per kWh el produced is minimum	In rainrich areas of India three crops per year is usual. If the plants are harvested before they are ripe, even 4 crops can be achieved. Cultivation of hybrid napier grass is	In Thailand also three crops per year is normal.The yield can be compared to that in India. So the cost of biomass supply is in thailand also much lower than	Biomass for digestion can be produced at much lower cost than in Germany. A detailed study is

Parameters	Germany	India	Thailand	Conclusion
	0,05€ by intensive cutivation	supposed to yield upto 800 to fresh biomass per hectare in a year by intensive cultivation. The low wages in India lead to a much lower cost of biomass supply in comparison to Germany	that in Germany.	howevr neede to clearly define the actual costs in different regions of these countries.

Evaluation of the overview of financial viability

Biomass digestion can be considered as financially viable in India and Thailand, because

- The investment cost in India and Thailand is at least 20% lesser compared to Germany
- The labour cost for operation and maintenance of the plants is much lesser
- The technical operation cost not more than in Germany
- Cost of biomass supply is much lower
- The income from the electricity produced is equally high as in Germany according to EEG regulations.

Special factors to be considered:

- At the stage of planning itself arrangements for supply to an industrial consumer must be finalised as long as the sale to the grid is not attractive.
- Contracts with the industrial partners should be flexible and (" belastbar " – was ist gemeint???)

Outlook

The profitability is the dominating argument for investments in South Asia; ecological factors are insignificant. This is the personal impression the authour had after discussions with businessmen in South Asia.

One can expect that the viability of biomass digestion further improves because

- Regional participation in the investment will increase and therefore the cost per kW will decrease.
- Increasing experience will improve the efficiency of the plants.

Political economics of EnergyFarming in South Asia

Energy generation instead of falling prices for agricultural products.
Many countries in Southeast Asia are still agriculturally based. Agricultural products dominate in the export sector.
Due to the overproduction of rice, rubber etc the prices in the world market have fallen considerably. The countries, their exporters and the farmers are dependent on the world markets.
This dependancy can be reduced or eliminated through EnergyFarming. Instead of selling rice as grain at low price in the world market the whole rice plants can be harvested before rice is ripe and converted in biogas plants to elctricity, heat and organic fertilisers and thus also reduce costly imports of oil, gas etc.
With the help of half yearly projections overproduction can be eliminated.
This will help to improve the price situation in the world markets and lower volumes of export can earn equal or even higher returns.
It must also be said here that there is a shortage of elctricity in all these countries with increasing demand and shortage tendency.Therefore energy produced by EnergyFarming can be sold easily at stable or increasing prices as against falling prices and oversupply of traditional agricultural products .

A look at the hunger problem

In India many people suffer hunger, not because there is not enough supply of consumables, but as they cannot afford them. EnergyFarming can not change this situation: it cannot reduce the cost of edibles nor will the prices go up due to it.EnergyFarming is neutral to this major problem.

Energy production by EnergyFarming instead of import of oil, gas etc

In the tropical and subtropical regions biomass production is much higher
than in regions with moderate climate. High temperatures along with good supply of water and the absence of winter guarantee high biomass yields throghout the year.
Till date biomass is however rarely used as an energy carrier.
Mineral oil and Gas and hydro are the backbones of electricity generation. The fossil fuels are imported at high cost.
Utilisation of biomass for electricity generation can considerably reduce these heavy expenses.

Nitrogen production instead of import of fertilisers.

Using biomass for electricity generation only the carbon and hydrogen contained in the plants are used up. Nitrogen, Phosphates and Pottassium are retained in the fertilisers. They can be permanently recycled.
One season with liguminous plants will even produce further nitrogen.
Therefore after 2 or 3 years fertilisers can be sold to other farmers who cultivate rice and vegetables and need NPK inputs.

Regional economical advantages of EnergyFarming

EnergyFarming is deliberately aimed at giving maximum advantages for the region and it’s inhabitants.

Reversing the cash flow for energy supply

Presently the energy business is organised centrally. Electricity is generated centrally and distributed over long distances – with huge distribution losses of up to 25%. The cash flow is in the other direction. Citizen and companies pay individually to the central electricity producer.
Thus the capital flows from the regions to industry centers.
In the case of EnergyFarming investments are made in the regions. The flow of capital is into the region. Biomass is produced locally and the money flows to the farmers.
EnergyFarming plants are installed in the area and money flows to local contractors. Payment is made as also earlier by the consumers.

Decentralised investment for the benefit of regional entrepreneuers.

It is sensible to run EnergyFarming decentralised to keep the cost of transport of biomass and fertilisers from the plants low. If biomass processing plants are centralised with large volumes of input, the biomass has to be transported over long distances which is costly. The fertilisers generated also have to be transported over long stretches as the quantities cannot be absorbed in the vicinity.

Contracts for regional companies for the operation and maintenance of the EnergyFarming plants.

During the construction regional companies and workers are benefited. Contracts for construction companies, electricians, fitters and metal industry will be available. When the plant is running it needs permanent maintainance that can be carried out by local skilled labour.

Steady income for the farmers

Presently the farmers are dependent on the Word market prices. For biomass used for electricity generation they get a guaranteed price which results in a steady income.
The risk for the farmer is reduced as he can harvest the grass etc upto 8 times a year, the risk of a good or bad crop is eliminated.
Financial stability for the farmer is better as he need not invest in seeds and fertiliser. Earlier the farmer was the looser if he had a bad crop or if the prices have fallen and could not pay back loans taken.

New rural employment through EnergyFarming

Farmers have work throughout the year as the biomass has to be cut daily and supplied to the plant.
For setting up and running the plant workers are needed.

Ecological advantages of EnergyFarming

Soil rehabilitation through varying crops and use of organic fertiliser.
Through monocultures like rice and the then essential application of synthetic fertilisers the soil is degraded. Soil is compressed and the yield declines. More and more fertilisers are used which increases the expenses and reduces the profits.
EnergyFarming permits a variety of crops that can be rotated as many types of biomass can be economically used.
This rotation of crops gives the soil possibility to regenerate.

The organic fertilisers from the digestion plants improves the quality and health of the soil. If for two years only grass is grown the humus content increases and this results in better yield levels.

Leguminous plants as “natural” Nitrogen factories

These are plants like beans and peas which absorb Nitrogen from the air and convert and store it with the help of bacteria in their roots. This Nitrogen is available as nutrition for the next crop. There is no need to buy and apply mineral Nitrogen any more. Farmers save money and earn more per Hectare by lesser effort.

Strategy for implementation of EnergyFarming

A new system or technology invariably create resistance. Doubts are expressed whether the new technology would work at all or in that particular country. Therefore the concerned people have to be convinced every time.

Demonstration system for EnergyFarming.

This has to situated and run near a densely populated region so that it is easily accessible for many interested people. The required biomass can be procured from farmers in the suburbs and converted into electricity.
The system must be modular so that step by step the plant can be extended.
In Thailand the demonstration plant is planned in Nakom Prathom, north of Bangkok.
In India one demonstration plant has successfully worked in the premises of a Gelatine factory and two more are planned in different areas.

EnergyFarming training

The farmers, industry and investors have to be informed of the advantages of EnergyFarming through seminars and training workshops.

Outlook

The fossil energy reserves are diminishing. The prices for Mineral Oil and Natural Gas will increase considerably - whether in 5, 10 or 15 years is immaterial.
Generation of energy from Biomass will under any circumstances become more and more competitive.
The following questions must be answered:

- Who has the advantages from EnergyFarming? The farmers, the people, the industry? or just a few large multinational corporates?
- Is energy from biomass ecofriendly or disastrous to environment?

It is upto each one of us to answer these.

Walter Danner
BMK AG
Haberskirchner Strasse 16,
D-94436 Simbach / Ruhstorf w.danner@t-online.de