GREENTOWER STOPS CLIMATE CHANGE BY CO_2 SEQUESTRATION

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ABSTRACT

Despite the Kyoto Protocol being stopped the CDM is currently revived by the EU und other countries. This opportunity for solar investments in southern Africa is exemplified by the GreenTower technology. In addition to avoided CO2 emissions the GreenTower and related agricultural projects can sequestrate large amounts of CO2 by manufacturing humus and burying it in the soil. By the CDM they can also earn a sound return on capital. Humus-based, clean power driven irrigation projects can eventually reverse global warming.

1. INTRODUCTION

With the Kyoto protocol expected to come into force soon trading in CO_2 certificates started at prices between US$3 and US$15 per ton CO_2. When Russia decided last year not to sign, the Protocol came to a halt. However, many developed countries and the entire EU, concerned about the climate change, decided to continue the CDM independently. During correspondence on this matter with the German Federal Ministry of the Environment, the author was informed that legislation to this effect was in preparation at German and EU level and could be expected to be in force by 2006 [1]. This is good news for prospective solar IPPs in SA.

The motive behind this is that the German and EU goals of CO_2 reduction through avoidance of CO_2 emissions can be achieved much faster and cheaper by solar power plants in sun-rich countries like South Africa with 2,4 times the power output of sites in Central Europe. EU power companies will thus be encouraged to invest in power stations in sun-rich countries where they will receive their own CDM payments back via their share holding in emission-free solar power plants. This is a strong incentive and could channel big investments to power generation in southern Africa.

The GreenTower goes one step further by sequestrating large amounts of CO_2 through burying humus in the soil, being produced from the large quantities of plant matter from the GreenTower's greenhouse and related irrigation schemes.

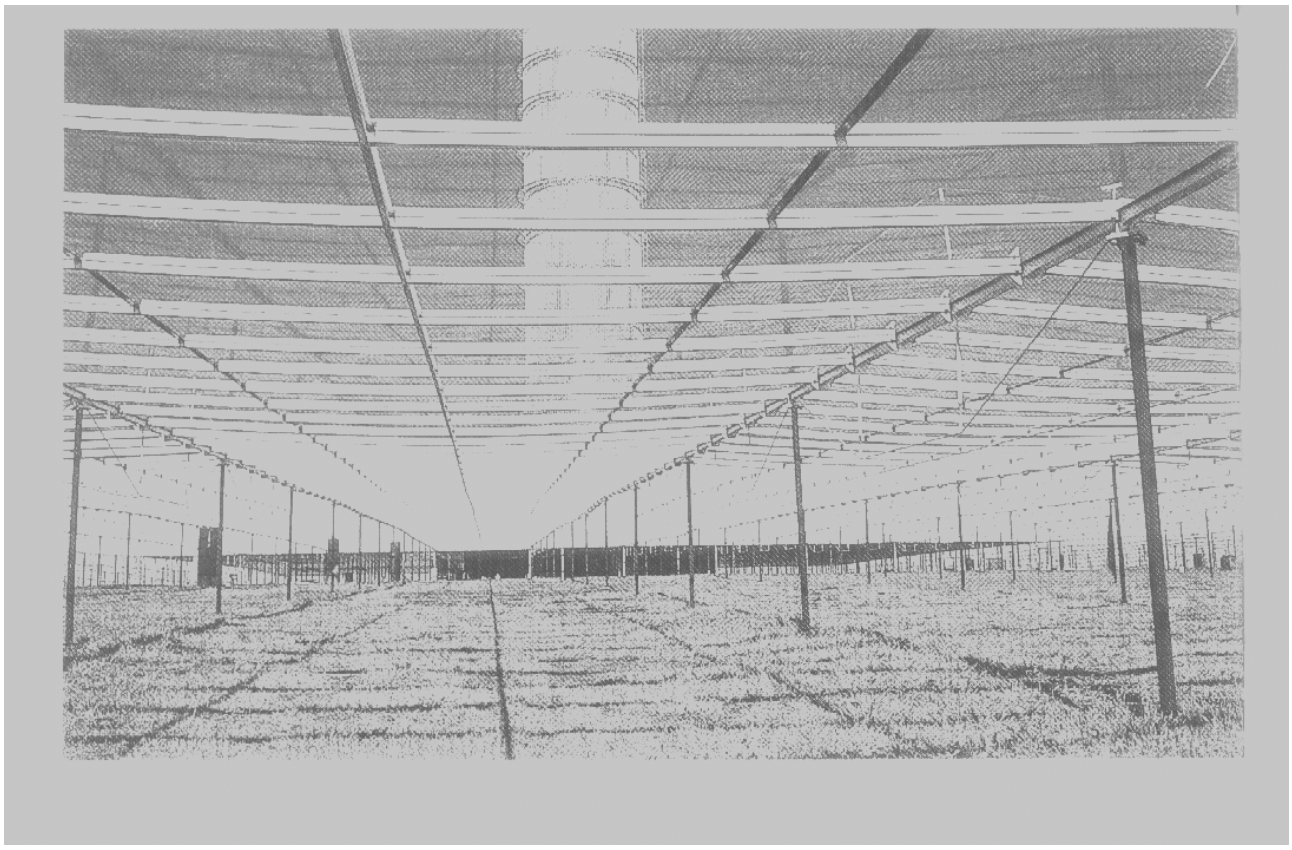

Figure 1: Natural Plant Growth in the Collector of the Solar Chimney Pilot Plant in Spain

2. WORKING PRINCIPLE

The working principle will answer the question why a greenhouse can work inside this power plant: Visible radiation passing through the collector glass is absorbed by the floor, heating the air in the large, glass covered collector (∅ = 6,9km) by convection, i.e. hot air layers adjacent to floor rise in small turbulent vortices and mix with the rest of the air. The hot air causes an updraught by buoyancy in the large, centrally situated chimney (height = 1 500m) and drives a turbine with a generator.

The hot floor also emits infrared radiation at a rate proportional to T^4, T in K, which is absorbed by the glass cover and reradiated to outer space through an "optical window". This loss mechanism critically depends on the floor's temperature. If the "floor" consists of vegetation, the heat transfer is five times as high as that of a flat floor, i.e. the "floor" stays considerablycooler with significantly lower infrared losses. This effect more than balances the evaporational losses through vegetation in the collector, as conclusively proved theoretically and experimentally [2], so that greenhouse production does not hinder power production and vice versa. The outer two thirds of the collector are hence used as a greenhouse (2 500ha) with high yields, as shown in Figure 1.

The GreenTower also utilizes diffuse light from an overcast sky and can be used in the tropical belt. Little power production is lost due to the clouds´ high infrared radiation, so that it is much less affected by bad weather than other solar technologies. It possesses controllable thermal water storage for up to six days of full power production. The envisaged base load power production is 400MW for the specifications above.

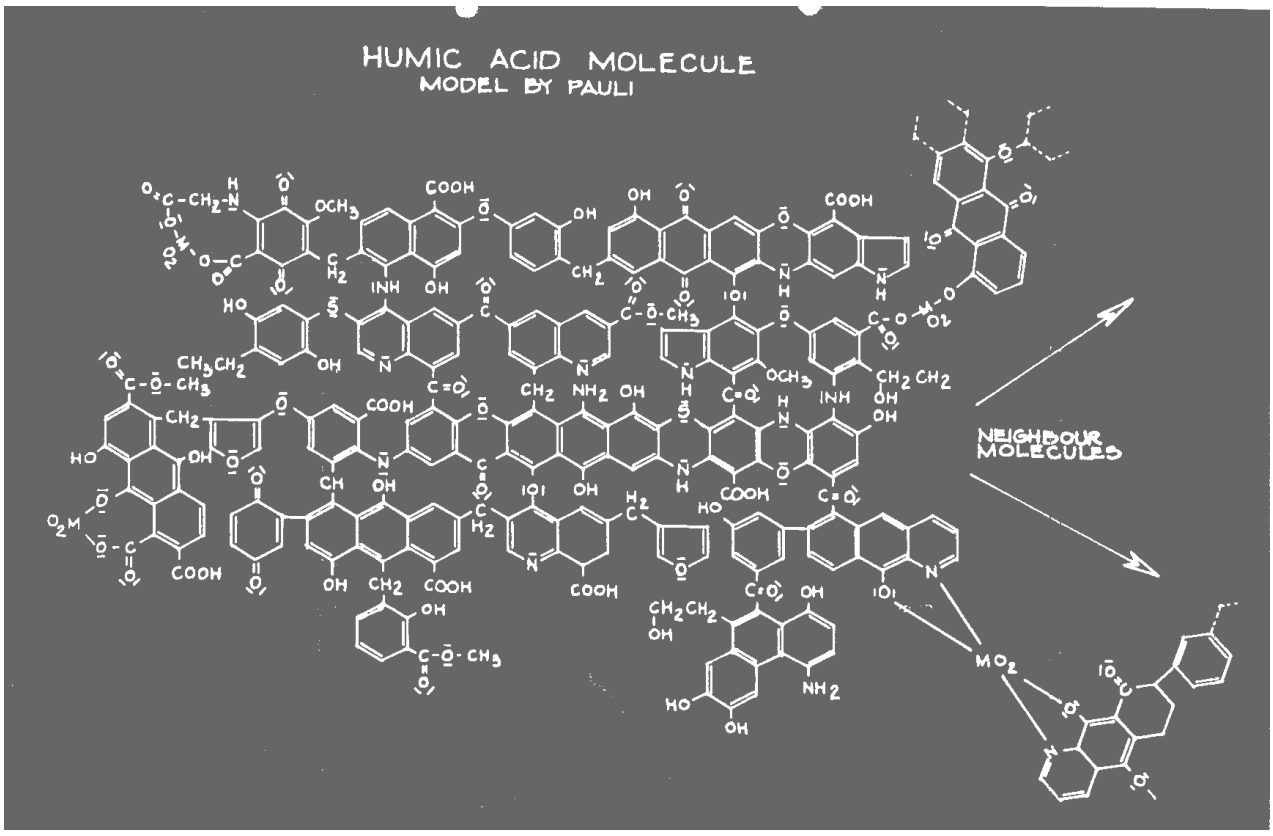

Figure 2: Humic Acid Molecule according to Pauli

3. GREENHOUSE AND HUMUS

The reason for the very high yields in the GreenTower´s greenhouse lie in drip-irrigation and humus. Humus is a highly but not densely polymerized steric material with large interstitial pores, made up from humic "aromatic" monomers and acids, as seen in figure 2. It shows a distinctive, mechanically strong crumb structure with an extreme network of fine capillaries for water transport/retention and coarse capillaries for air transport. The internal surface of good forest humus is about 57.000m²/g, i.e. much greater than that of activated carbon. This structure ensures a very high water retention also under dry conditions. The large-scale adsorption prevents the nutrients from leaching out and ensures fast root growth and high fertility. This is due to the fine capillaries, wherein the roots find a high concentration of nutrients and water but experience no mechanical resistance. Even rice can be grown in (soaked) humus

soil. Root growth in humus is faster than in hydroponics. The advantages of mature compost/humus are in short [3]:

- Improved soil structure and fertility, root growth up to 1m in three days
- no nitrogen fertilizer required
- water retaining capacity very high (swelling)
- no leaching out of nutrients or salts, which remain plant available
- strong buffer working keeps pH between 7 and 8
- completely hygienized and free of seeds, poisons, detrimental germs and virusses
- heavy metals finally trapped and not plant accessible, except as trace elements
- Vegetation protected by antibiotic action of humus germs, little or no pesticides required.

The humus will also act as a water sponge for energy storage and as a substrate to increase fertility. Large-scale application of GreenTowers will thus never end in excessive land usage, since fourfold agricultural production will virtually add 170% to the land used. By not inhibiting the daily updraught caused by the sun but only concentrating it up to 1 500 m the GreenTower will not disturb the atmosphere like other (concentrating) solar devices [4].

Since humus does not develop naturally in (semi-) arid areas, good humus in arid countries requires intensive high-temperature compostation in aerated and controlled containers. The GreenTower‘s proprietary compostation process will produce roughly 0,9m ton dry humus p.a. from the greenhouse´s waste plant matter which relates to 0,8m ton carbon p.a.. All this humus will be buried in the soil and remain there for a very long time.

4. CO_2 SEQUESTRATION AND CDM

A 400MW modern coal-fired power station also relates to 0,8m ton carbon p.a. which is emitted as CO_2. Hence the 400MW GreenTower avoids not only 400MW in CO_2 emissions by coal-fired power generation through its pure solar, emission-free, energy storage supported power generation but it sequestrates the same amount in its greenhouse and up to 2 000MW in CO_2 emissions by including related irrigation projects [5]. The GreenTower’s CO_2 compensation and CDM income is thus up to six times that from other emission-free solar technologies, whilst the high-quality compostation is an integral part of the GreenTower technology.

To the GreenTower’s high pre-tax profits of 31% return on capital despite the low price of power of 1,0 €c/kWh an expected high CDM return of up to 24% might be added (US$136m p.a., 1ton CO_2 = US$10,00) [6]. The GreenTower will thus be a rewarding investment in sun-rich areas for utilities from industrialized countries (EU) so that they will very likely take up equity in the GreenTower technology, especially once the planned new legislation regarding CDM certificates is in place.

A short period of loan repayment will also be very attractive for these European utilities. Two examples are given below in Table 1 and 2 showing the big contribution of the CDM certificates to these repayments shortening the pay-back period to less than 10 years [7]:

Table 1: Cash Flow Forecast: Pay back on Loan Capital Offered, pay-back period = 9,5 years
(95% pay out, nom. at 5% , 10 year period, nom. debt = US$611m, max. debt = US$649m)

Million US$ \ Year	1	2	3	4	5	6	7	8	9	10
GreenTower loan	5,00	5,00	130,00	110,00	155,00	155,00				
Glass factory loan	0,50	16,50	34,00							
Accum. debt/**profit**	5,79	28,71	202,78	330,52	498,52	648,69	581,82	436,61	148,14	**154,80**
Interest 5%	0,29	1,44	10,14	16,53	24,93	32,43	29,09	21,83	7,41	
Insur.+ O&M(el) etc.			1,81	2,91	5,64	7,30	7,30	7,30	7,30	7,30
GreenTower profit					28,96	92,00	167,00	167,00	167,00	167,00
Kyoto CDM credits								136,00	136,00	136,00
Glass factory profit				14,60	14,60	14,60	14,60	14,60	14,60	14,60

Table 2: Cash Flow Forecast: 50% Loan, 50% Equity
(Equity investment = US$305,50 million ; nominal loan = US$305,50 million at 5%, 100% pay out)

Million US$ \ Year	1	2	3	4	5	6	7	8	9	10
GreenTower loan	5,00	5,00	130,00	110,00	155,00	155,00				
Glass factory loan	0,50	16,50	34,00							
Accum. **cred.**/debt	**300,00**	**278,50**	**112,69**	**2,69**	140,62	264,73	178,67	13,30	**296,33**	**606,63**
Interest 5%					7,03	13,24	8,93	0,67		
Insur.+ O&M(el) etc.			1,81	2,91	5,64	7,30	7,30	7,30	7,30	7,30
GreenTower profit					28,96	92,00	167,00	167,00	167,00	167,00
Kyoto CDM credits								136,00	136,00	136,00
Glass factory profit				14,60	14,60	14,60	14,60	14,60	14,60	14,60

5. NEW CAPACITY FOR SOUTH AFRICA

This very favourable outlook for solar energy as a whole and for the GreenTower in particular must be seen against the dwindling resources of affordable coal in South Africa which will only last another 40 years [8]. Taking into account that many of the big SA mining projects will last longer than that and that southern Africa will need power thereafter anyway, it is imperative that the window of opportunity for CDM certificate trading which is now opening again by the new EU legislation, will be fully utilized so that this unique chance to make the SA economy grow through cheap, externally financed RE power is not missed. In this context it is disturbing that the SA legislation on IPPs is far from being in place.

This is the more important as Eskom faces a big gap in power supply between 2007 and 2016 due to growing demand and lead times of 11 years for new coal-fired power stations. De-mothballing of presently mothballed, older type power stations will not bring great relief, since the pace of capacity adding will not match growing demand. One expert from Cape Town University already in 2002 warned that "South Africa faces power crisis", "peak demand will exceed capacity before 2007 and might do so next year (i.e. 2003)" [10]. In 2003 he warned that Eskom's present nominal capacity of 36 314MW cannot meet the expected 33 000MW for winter 2003 [11]. Since three turbine/generators (2 000MW) exploded in April 2003 [12] and since coal shortages at Tutuka and Majuba plants forced production below 50% [12], true capacity very likely stood at 30 300 MW and could surely not match the 33 000MW peak demand in September 2003.

However, South Africa is also facing a price hike: Another expert from Cape Town University stated in 2003: "To build a new coal-fired power station … means that its power will cost 25c/kWh" (up from 10c/kWh) [13]. The expected gap in power supply and the expected sharp price increases will be very detrimental for the SA economy. Hence the entrance of new, privately financed IPPs has to be encouraged to utilize the EU's CDM initiative as far as possible.

Fears that such externally financed, privately owned IPP power stations would cause price increases is not true for the GreenTower, since its power sales yield the least profits in the different profit areas [9]. The high greenhouse and CDM profits in combination with the EU legislation create a tendency to increase the number of GreenTowers even beyond power demand, a tendency which will force power prices down. The ratio of IPPs should be increased above the presently envisaged 30% of total SA generation. BEE status should be attributed to all GreenTowers issuing corresponding share capital to their workforce of 25 000 in the greenhouse.

6. CONCLUSION

The EU's new CDM legislation, expected to be in force by 2006, offers a great chance to close Eskom's expected generation gap by bringing overseas investment capital to southern Africa´s power generation. The GreenTower technology qualifies for European investment due to its high profits in combination with its generic low price of power, which has the potential to save the SA economy from a serious recession. The short building time of four years allows much faster increase of generation than by coal-fired capacity.

In terms of the EU's new CDM legislation the greatest attraction lies in the GreenTower's very high CO_2 sequestration. If the SA government facilitates the entrance of IPPs to the power market, a wave of Green-Towers is to be expected which might create hundreds of thousands of new jobs. The associated CO_2 sequestration would be high enough to make South Africa the first country to reverse the greenhouse effect.

7. REFERENCES

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Presenter: W.W. Stinnes presents the paper himself