The most significant problems of our time, poverty in the Third World and the climate change are interlinked through energy supply and can be solved, if we only want to!

- The industrialized countries pollute the worldwide climate with their fossil-fuelled power generation.
- The poor are poor because they cannot afford sufficient energy supply and the population keeps growing. (Fig. 1)
- If the billions of people who must do without sufficient energy supply would have to cover their energy needs with coal, oil and gas, the climate could not be saved and the environment would be destroyed.

Hence, poverty and climate problems can only be solved with global concepts, mutually and equally beneficial to the poor and to the industrialized countries.

- The poor countries on the „southern hemisphere“, especially the African, have one advantage over the rich countries in the „northern hemisphere“: Sun + Desert, i.e. intensive solar radiation on agriculturally futile land. (Fig. 2)

If these poor countries had large scale affordable solar power plants, - affordable because they were built mainly with their own resources and skills -, and which they did not need to import at exorbitant cost, they would profit twice: by their inexhaustible, affordable power supply and by innumerable new jobs.

“The Taliban aren’t fighting for religion but for money. If they had jobs, they would stop fighting!”
Sham Sher Khan from TIME, April 20, 2009

As electric energy can be transported over very large distances with surprisingly little loss they could export their solar electricity to the industrialized countries. (Fig. 3) [3]

- The industrialized countries would also profit twofold: the energy supply companies could develop this new industry in the desert countries and they could transport the solar electricity for local consumption directly via cable for the stationary or possibly via hydrogen for the mobile consumption to their own countries. Furthermore they would benefit from the new prosperity in the poor countries, because these could then purchase their products.

Today there are three novel large scale solar thermal power plants.

**Central Receiver Systems** which concentrate the solar radiation bi-axially with heliostats on a tower top. The fluid heated there is conducted to a conventional power block. (Fig. 4)

**Parabolic Trough Systems** are so far the most successful variant. Solar radiation is concentrated along one axis onto a receiver tube and the heated fluid is conducted to a conventional power plant. (Fig. 5)

The parabolic trough and the central receiver systems are technologically suitable especially for sunny and industrialized countries (USA, Australia…). They need direct radiation and consume much cooling water. The expected levelised electricity costs are at about 12 to 15 Eurocents/kWh. The author’s team under guidance of Wolfgang Schiel is actively involved in developing this technology.

**The Solar Updraft Tower** which “sucks” air heated through solar radiation under a collector roof into a large vertical concrete tube and thus drives turbines with generators installed at the base of the tube. (Fig. 6+7) [12] - [27]  
A simple water tube storage guarantees a 24-hour continuous operation. (Fig. 8)  
Cooling water is not needed for operation.  
It is sustainable and inexhaustible because its most important construction materials, concrete for the tower and glass for the collector roof, can be manufactured from sand and stone directly on site. (Fig. 9)  
Technologically it corresponds to the so far most successful power plant, the hydroelectric power plant –lake, penstock, turbine – and matches its durability and robustness.  
It is ideal for indigenous construction in developing countries.  
Depending on the capacity, solar radiation and labor costs, levelised electricity costs of 6 to 10 Eurocents/kWh can be expected. After depreciation it is a “cash cow” like the hydroelectric power plant.

Contrary to the parabolic troughs, which have been tested in many plants and are built at present (with the participation of the author’s team) at large scale, the Solar Updraft Tower is not considered “proven technology” and this unfortunately deters investors, seeking quick profit.

Large-scale plants are considered to be too expensive for a first-of-its-kind system, the small-scale plants are uneconomical.

Thus it is absolutely necessary to build a prototype which on the one hand is large enough to exclude all possible doubts regarding function and feasibility, and which on the other hand achieves economically justifiable electricity costs at moderate investments, i.e. which is profitable.

Having this prototype, the Solar Updraft Tower – the hydro power plant of the desert – will become fast selling. The world’s sunny deserts will contribute significantly to overcome Third World poverty and will provide a sustainable world energy supply.

It is possible, if we only want to do it!
<table>
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<tr>
<th>Solar Updraft Towers</th>
<th>capacity</th>
<th>30</th>
<th>50</th>
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<tr>
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<td>0.13 €</td>
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<td>€/kWh</td>
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A average labor cost 5 Euro/h
B depreciation time: 25 years, interest rate: 6%
C at 2300 kWh/(m²-yr) global solar insolation
D grant included in calculation
Postscript: Chronology

In the year 1972, the author, Rudolf Bergermann and their team, were invited by the power industry to develop a large scale cooling tower for dry cooling. This resulted in a cable-net cooling tower design and a prototype at Schmehausen, Germany. (Fig.10)

There within the team, including at that time, Michael Simon, the question arose, whether the natural updraft in such chimney tube could not be utilized to generate electricity as against evaporate it largely.

Simple checks quickly made clear that such approach only makes sense, if there is an additional “fire” at the base of the chimney tube, such as a large greenhouse roof collecting solar warm air. This in the year 1979, resulted in what we called the “Solar Chimney” (later Solar Updraft Tower) Aufwindkraftwerk (Fig. 6+7) [12] - [27]. It was already in the same year, when the Ministry for Research and Technology granted us an amount of 3,5 Mio. DM (ca. 1,8 Mio. €) for a feasibility study. However we decided, to use the money for a test Solar Chimney at Manzanares/Spain. (Fig. 11 + 12). This permitted us to confirm our analytical results (Fig. 13) and with further grants, to expand our knowledge [14] - [17].

Originally the plan was to build the prototype in 1980, take measures in 1981 and 1982 and dismantle it in 1983, out of safety reasons because the grant did not permit regular corrosion protection especially for the stay-cables. Years passed away permitting us to take more measurements and to welcome visitors, though we know that corrosion was on the way.

The site was closed at windspeeds beyond 20m/s and so we were prepared for a scheduled and controlled failure in 1990, after 10 years as against originally 3 or 4.

Concerning the main structural issue, the tube or tower or chimney, we studied and compared several solutions (Fig. 14 + 6).

We came to the result that the cylindrical concrete tube stiffened by spoked wheels promises least costs.

Somewhere at the end of the eighties at the last century we got hold of a paper written in 1931 describing the basic principle of the solar updraft power tower [11], (Fig. 15). So we frankly agree that we did not invent but “only” develop the solar updraft tower.
References (Very small selection in chronological order):

a.) On Solar Energy Utilization (the author’s early papers)


b.) Cable-net Cooling Towers


c.) The Solar Updraft Tower – Das Aufwindkraftwerk


IASS-Bulletin No. 78 April 1982

Statusreport Windenergie des BMFT, Oktober 1982


Zeitschrift des VDI und VDI-Bericht, November 1988


[18] Schlaich, Joerg: Das Aufwindkraftwerk / The Solar Chimney

Technical University Berlin, 1997

[20] Weinrebe, Gerhard:


[22] Schlaich, Joerg; Schiel, Wolfgang: Solar Chimneys


Figure 1
Energy consumption and population growth in relation to standard-of-living (per capita gross national product)

Figure 2
Areas needed to cover the world energy demand by solar power
Figure 3
Solar electricity from deserts for transmission to northern countries - a concept today called DESERTEC

Jörg Schlaich:
Figure 4
Central Receiver System with heliostats, Sevilla/Spain

Figure 5
Parabolic Trough System
Figure 6
Solar Updraft Tower, 1980

Figure 7
Solar Updraft Tower – Principle
Figure 8

Figure 9
The solar updraft power feeding a glass and a cement factory:
Glass and cement = sand/stone + energy + labor
Figure 10
The Cable net cooling tower at Schmehausen (1973)

10 a) Cable net before cladding

10 b) The completed tower
Figure 11
Solar Updraft Tower – Test plant in Manzanares, Spain (1979 – 1990)
Diameter of collector roof ~200m; Height of tube ~190m
BMFT, Union Electrica Fenosa/Spain, Schlaich Berghmann und Partner

Figure 12
The collector roof, at Manzanares, indigenous construction
Figure 13
Measurements Manzanares
Global radiation (W/m²) versus electrical output (KW) and upwind speed (m/s)

Figure 14
Development of the tube or tower or chimney during the years 1979-1980

14 a) Cable stayed prestressed membrane, our first Solar Chimney
14 b) The steel tube of Manzanares Prototype

14 c) Free standing conical concrete tubes
14 d) Free standing cylindrical concrete tubes, stiffened by spoked-wheels (also Fig. 6)

14 e) A spoked wheel
Figure 15