Solar Thermal Desalination for Rural Applications

A few current views upon an old technology and its possible new role in the global Water Crisis

By Stefan Thiesen, on behalf of Zonnewater

The Solar Still - a simple copy of Nature

- Around since the late 19-hundreds
- Wide spread application and production until the 1960s
- Simple technology using evaporation/distillation in single chamber
- Displaced by large volume centralized fossil energy operated systems

Global Water Situation beyond 2000

- Increased population densities
- Increased industry & agriculture
- Exponential global economic growth (impossible goal?)
- Increased pressure on and degradation of water – and most other – resources
- Fossil fuel scarcity (peak oil, ever rising energy costs)
- Diverse impacts of climate change

A few considerations

- Western Nations use 3 to 5% of GDP for central water treatment and freshwater infrastructure (barely enough)
- For Western EU: ca. € 800 to € 2000 per capita, up to € 8000 per household
- No foreseeable fully centralized option for most developing countries!

Is Privatization a solution?

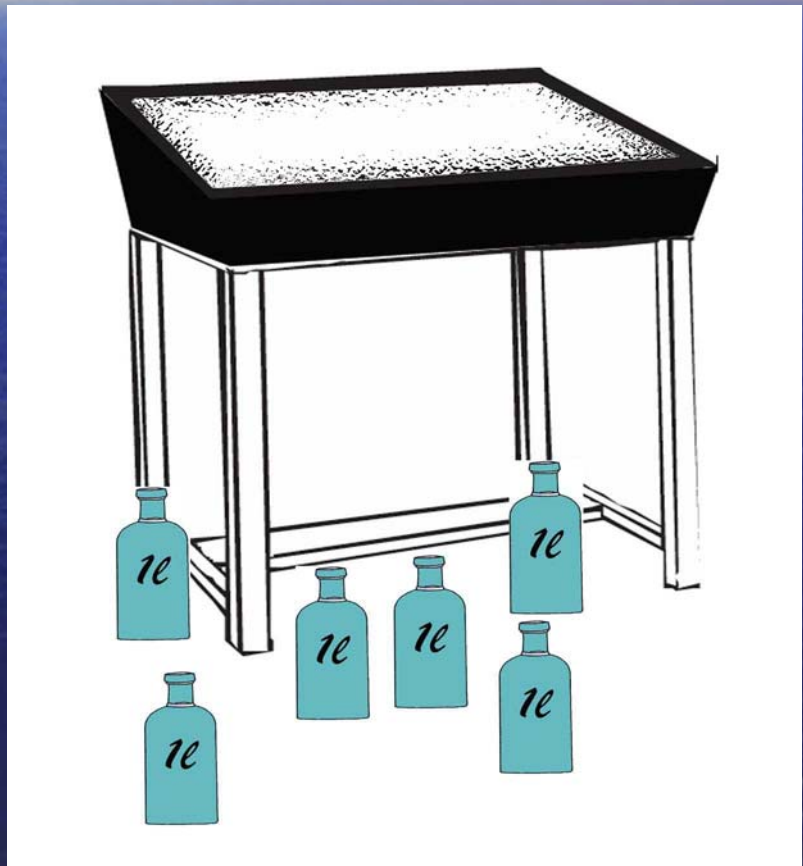
- Large scale Privatization will not benefit the poor due to „market driven" prices
- Small scale privatization is interesting option (e.g. the Solco water business model)
- Single household solutions are privatization, too!
- Access to drinking water is ***absolute human right!***
- But: price incentives can also help to establish a culture of conservation

Technical Solutions

- Wide spread application of renewable energy for Water treatment is a mid term must
- Different technologies on different scales must be applied parallel (e.g. affordable filters, sand filtration, nano filtration, simple PV UV sterilizers etc.)
- For desalination: various types of large and small scale RO systems with energy recovery (Wind, PV powered), various solar thermal systems

Simple solar distillation: A dead technology?

- Single chamber still
- To date in various forms in occasional use for emergency purposes and in rural settings e.g. in India
- 2 sqm deliver ca. 10 litres in (sub) tropics
- Drinking water for small family



A few Classic Solar Still Pros:

- Low initial investment
- Relatively simple operation & maintenance
- No high tech exchange parts like batteries, filters or membranes
- Simple production (often locally)
- Independent drinking water supply for individual families

A few Classic Solar Still Cons:

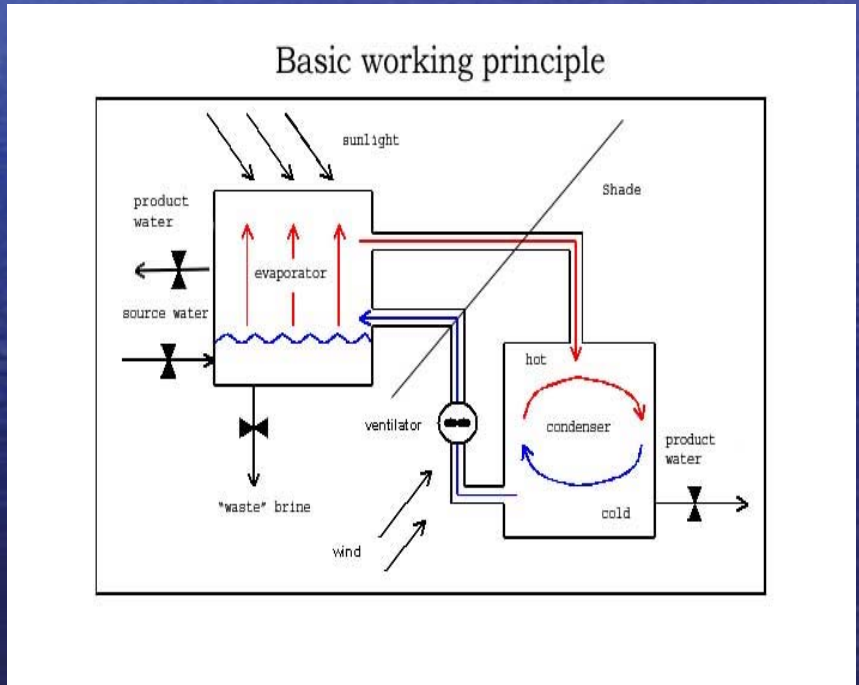
- Low yield (limited amount of drinking water only) because of two conflicting processes (evaporation and condensation) combined in one chamber
- Yield very sensitive to solar irradiation variations
- Prone to microbial contamination during low temperature operation
- Requires a certain operational discipline by individual operator
- Sensitive (transportation, operation: glass)
- Continuously decreasing effectiveness (white scaling = backscattering)

Jan de Koning's (Zonnewater's) Aqua Solaris

- Separation of evaporation and condensation
- Increased collector aperture and evaporation surface
- Mikro controlled, PV powered airflow (feedback)
- High operation Temp.

Aqua Solaris Diagramm:

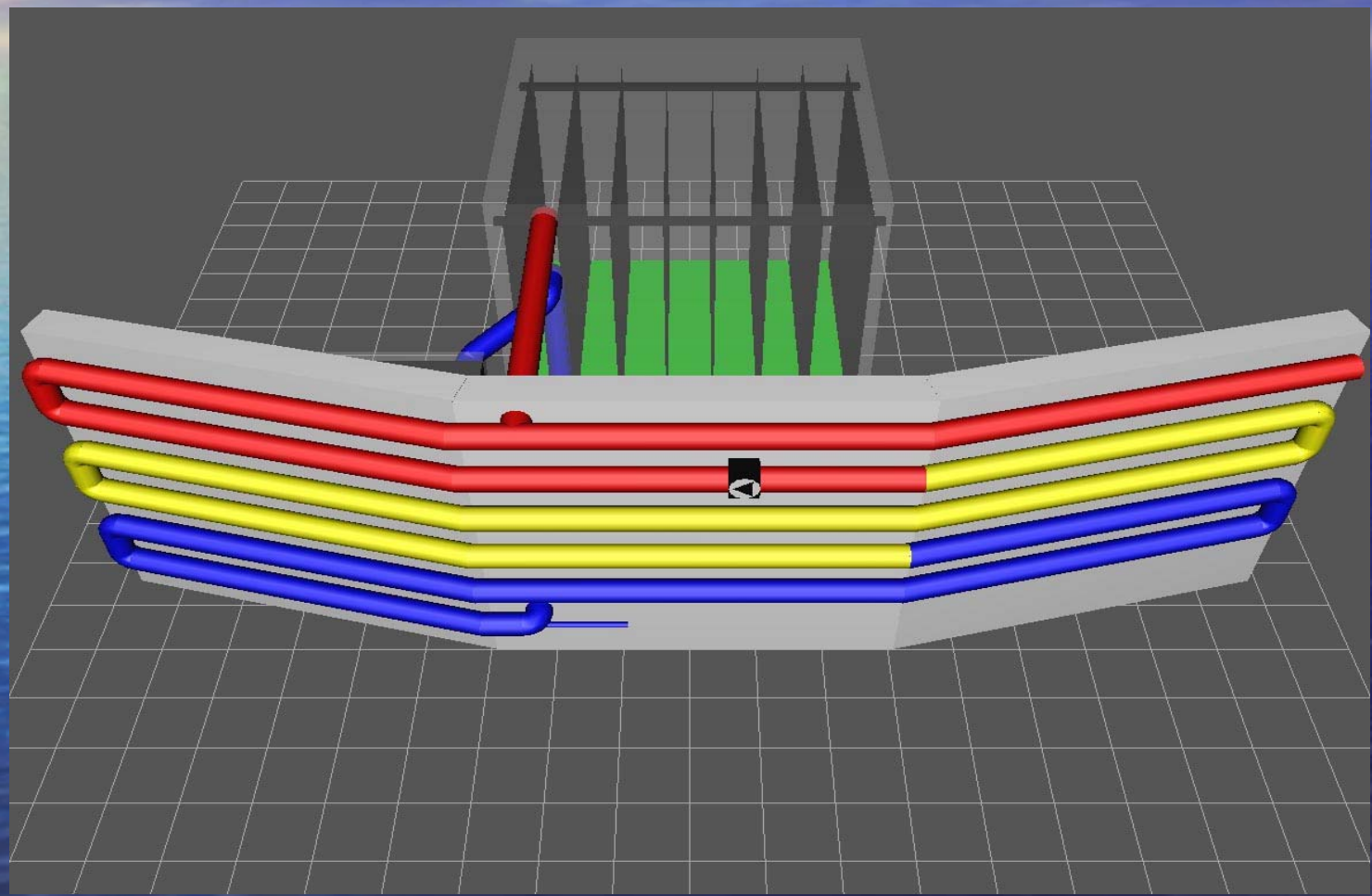
- Operation always above 70 °C
- Heat & humidity recovery
- Product water collection in both „chambers“
- Optimized utilization of temp. gradiant



The Bonaire test facility:

- Ambient Temp. Average 30 °C
- Production measured to be 40l/day with pre-heated water & trade winds (cooling)
- Regular Operation at above 80 °C, mostly around 85 °C (near sterile)

Sketch of Bonaire Setup



Tests in New Delhi, August 2005:

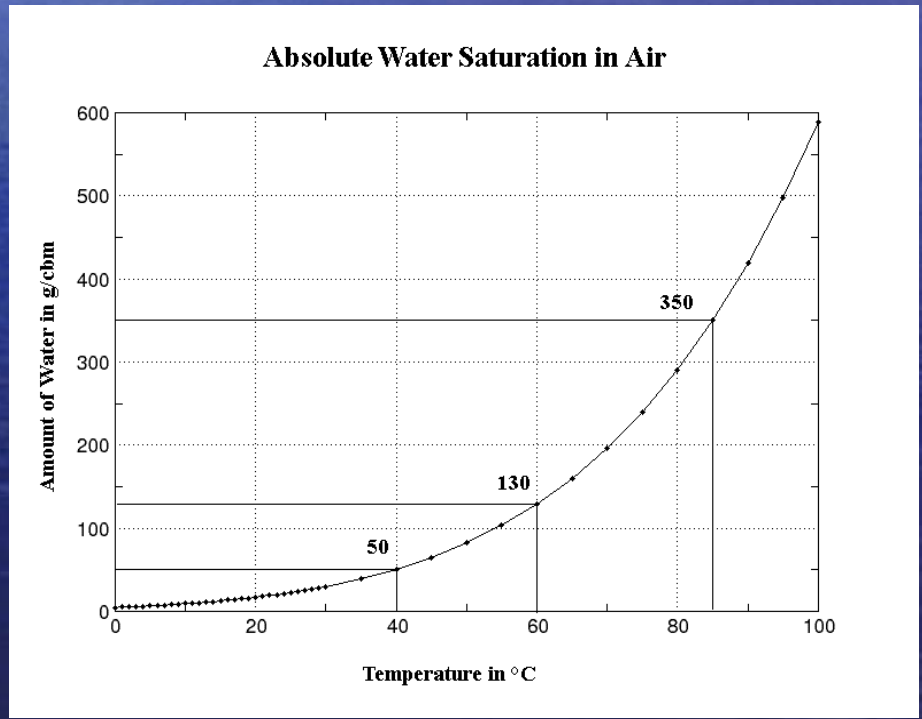
- To determine sensitivity to irradiation and other variables
- Result: too sensitive to radiation variations
- Op. Temp only max.
  60 °C @ ambient T 40 °C
- Yield far below Bonair measurements

Steps towards market readyness:

- Better heat trapping (modern selective absorbers and transparent insulation)
- Continuous operation temperature above 70 °C must be assured
- $\Delta T > 30$ K is required for optimal condensation
- Considerations to economically increase temperature gradiant by other simple means (cooling)
- Jan de Koning‘s goal remains: 40l/day below 1000 € investment and a 20 year lifetime

Why so high? The Temperature

- Nonlinear increase of saturation amount with temperature
- Partly explains yield limitation of classic still (operation T generally under or around 60 °C)
- Increased T gives more yield than increased classic collector area
- And: Water safety / sterilization!



Economics of Solar Distillation

- Regionally very diverse and wildly scattered market
- Makes sense where water supply is expensive (bottled water on islands; in arid settings with brackish ground water and degraded wells)
- Individual solutions have price damping effect in crisis and in regions with corporate control over water (Ebaye example)
- Suggested indicator for technologies: Investment per litre normalized yield

A few solar still comparisons

RSD Solar, Germany, (patented, commercial, high tech, up to 12 litres per sqm)	Water Cone, Germany, (patented, commercial)	Solaqua Rainmaker, USA, (patented, commercial)	Solaqua solar still "do it-yourself" Kit (non profit, public domain, USA)	UNIDO Study (Non-profit, assuming local labor and material in Sudan); System not built	Aqua Solaris at € 975, Netherlands, price for glass system as tested on Bonair, (patented, commercial)	Aqua Solaris at € 800
€ 70	€ 170	€ 63	€ 22	€ 10.5	€ 24.40	€ 20

In India classic low yield (< 5 l / 1 sqm collector) and low temperature stills are available at less than 8 Euro investment / litre output, but with the known problems.

The Zonnewater Target

- Provide safe, independent and affordable drinking water supply with one system for a large family, including storage capacity for low yield periods, potential extra yield for selling/trading water

Conclusion

- Solar distillation has a future as a complementary intermediate technology
- Modern approaches (simulations during development, mikro controlling of operation, optimized heat bridges, transparent insulation etc.) increase effectiveness of the classic still process, have downsides
- High- and lowtech systems both will have their market niches

Weij – Ji: Danger and Chance?

- Free market alone is no solution: it leads to more money, not to more water.
- Crisis offers potential for new thinking (non-commercial community solutions complementing commercial ones?)
- Best solution will be renewable energy based multi level approach with many existing tech-nologies & organisations

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