

FORGOTTEN RISKS OF THOSE PESKY RENEWABLES:

- Land Use
- Energy Density
- **Processed Water Requirements**

...and then there was....the Cost per MW hour for electricity

ABOUT WATER:

Clean drinking water is in short supply

It is estimated that the lack of pure water is the single greatest killer in the world: Four children die each minute from illness caused by a lack of drinking water. The world is not running out of water – there is exactly the same amount of water today as there was a million years ago, but the soaring global population and groundwater pollution is creating an acute shortage of supply based on the demand. Only 2.5% of the world's water is fit for human consumption and two-thirds of that is locked away in icecaps and glaciers. This percentage has been fixed since the last ice age. According to the International Water Management Institute (IWMI), one-third of the world's population is short of water. In fact, water is expected to become so scarce in the future that the vice president of the World Bank has warned that “the wars of the next century will be about water.”

South Africa is largely a semi-arid, water-stressed country. The country's average rainfall of about 450mm a year is well below the world average of about 860mm a year. To overcome the problem of variable river flows, many large storage dams have been built. The available water supply is reduced by evaporation from dams, and by commercial afforestation and sugar-cane farming. The total net abstraction of water from surface-water resources amounts to about 10 200 million m³ a year for the whole country, after allowing for the re-use of return flows. This represents about 20% of the total mean annual run-off of 49.2 billion m³ per year (all standardised to 98% assurance of supply). A further 8% is estimated to be lost through evaporation from storage and conveyance along rivers, and 6% through land-use activities. As a national average, about 66% of the natural river flow (mean annual run-off) therefore still remains in the country's rivers.

Water Policy

The first edition of the National Water Resource Strategy (NWRS) was approved in September 2004. The NWRS describes how South Africa's water resources will be protected, used, developed, conserved, managed and controlled in accordance with the requirements of the National Water Policy, 1997 and the National Water Act of 1998. These documents are based on government's vision of a transformed South African society in which every person has the opportunity to participate in productive economic activity and lead a dignified and healthy life.

www.southafrica.co.za/about-south-africa/environment/energy-and-water/

7.5 The True Picture of Water in South Africa

South Africa's water boards are proposing increases of between 6.2% and 43% to the cost of the potable bulk fresh water they supply to the country's municipalities. Such tariff increases, if accepted, are likely to push up the cost of drinking water. The department's media liaison director, Linda Page, said, “The increases that the water boards are proposing are the normal annual increases linked to the CPIX because they operate on a cost recovery basis.” This document, tabled at the committee meeting by Chief Director for Institutional Oversight, Thoko Sigwaza, includes a table of bulk water (abstracted from rivers and reservoirs, treated, and supplied to municipalities) tariff increases proposed by the 13 water boards in SA.

Ranging from 6.2% for Umgeni Water (a rise from R 3.24 a kilo-litre to R 3.47) to 43% in the case of Namakwa (from R 6.37 to R 9.11 per kilo-litre). One thousand

litres is equivalent to one cubic meter of water. A consultation process has been held with municipalities about the proposed tariff hikes. Water boards need to raise funds to finance capital expenditure on infrastructure over the next five years “estimated to require in excess of R 10 billion”.

What this really means is that municipalities now owe the water boards (who are the bulk suppliers of SA’s drinking water) in excess of 100 million rand. In order for the water boards to recover their costs they need to increase their tariffs -- the municipalities simply need to pay more. Municipal coffers can certainly not grow overnight and they need to be filled by rates and taxes, speeding fines, and yes, water bills. It seems as though South African consumers are in for another shock when it comes to paying for basic services. “Water Rhapsody: Re: Thinking Water,” <http://www.greywatersystems.co.za./2010/05/24/increase-in-water-prices-on-the-cards/>

South Africa's available freshwater resources are already almost fully-utilised and under stress. At the projected population growth and economic development rates, it is unlikely that the projected demand on water resources in South Africa will be sustainable. Water will increasingly become the limiting resource in South Africa, and supply will become a major restriction to the future socio-economic development of the country, in terms of both the amount of water available and the quality of what is available. At present many water resources are polluted by industrial effluents, domestic and commercial sewage, acid mine drainage, agricultural runoff and litter.

To augment supplies, South Africa is looking towards water sources in other southern African countries (e.g., Lesotho) to assist in providing sufficient water for projected future demands. However, the risks of international dependency on such a priority resource are high. Other possible sources of water, such as desalinisation of seawater and water from icebergs, may be potential options in the long-term, although currently they are too expensive to exploit. It is imperative that South Africa develops both a water-efficient economy together with a social ethic of water conservation and ultimately a culture of sustainable water resource usage.

South Africa is an arid country with only 8.6% of the rainfall available as surface water. This is one of the lowest conversion ratios in the world. The mean annual runoff (MAR) for South Africa is estimated at some 50 million m³ a⁻¹. This is not distributed evenly throughout the country, with the Eastern seaboard having some 80% of the country's runoff, whilst the western regions tend to have low runoff. Nor is it consistent over time, with great variability between years. Similar to surface waters, South Africa's groundwater resources are relatively limited compared to world averages.

The scarcity of freshwater resources and highly variable hydrological conditions have led to every major river in South Africa being regulated in order to ensure adequate water supply for development. However, because of the spatial variability of water resources and the scarcity of water throughout the country, in many catchments the need for water exceeds the supply. This situation is likely to worsen as the discrepancies between water requirements and availability in other water-scarce catchments increase.

At the present population growth and economic development rates, it is unlikely that the projected use of water resources in South Africa will be sustainable. Water supply will become a major restriction to the future economic development of the country, in terms of the amount available and the water quality, as well as improving the quality of life.

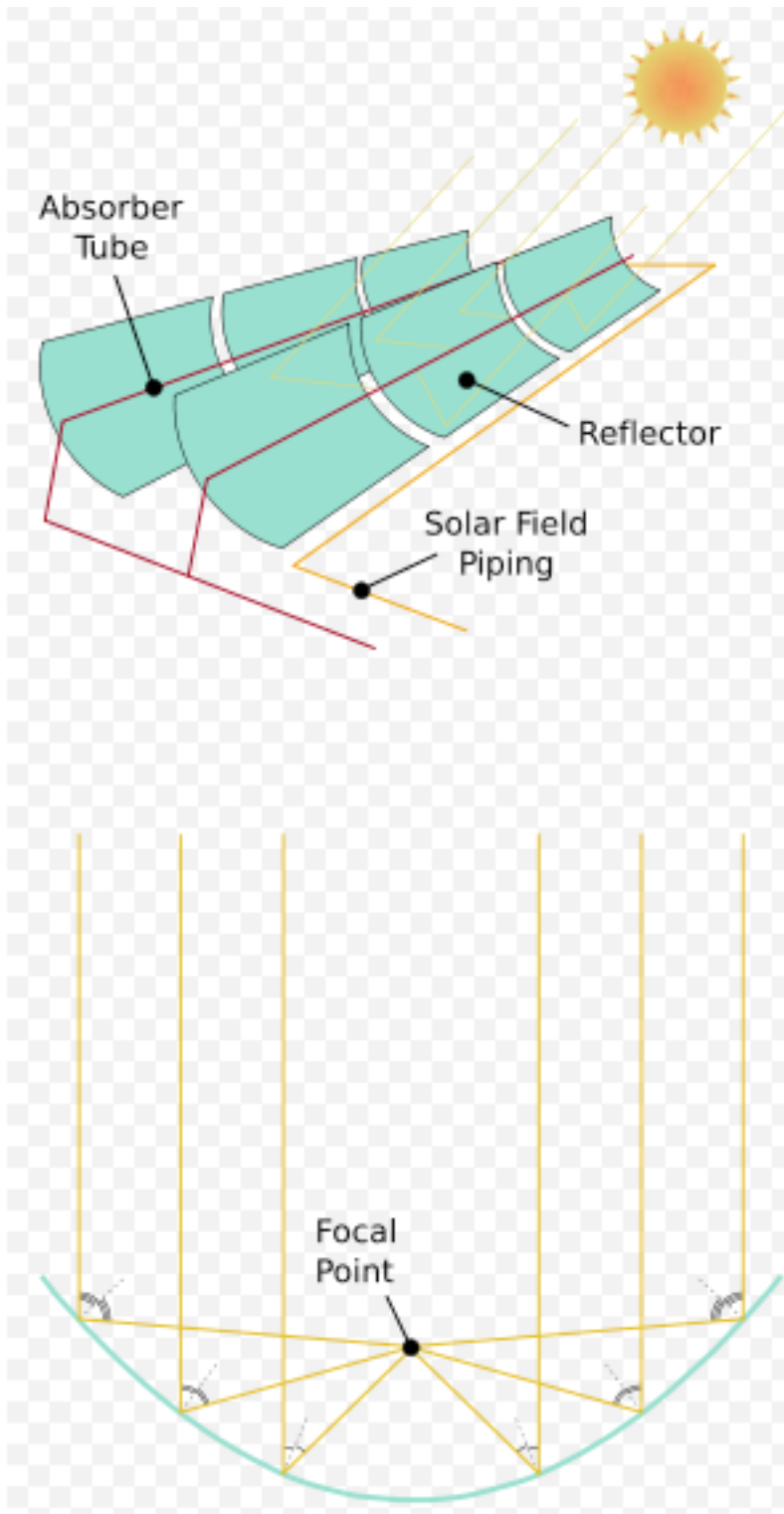
“Freshwater Systems and Resources,” National State of the Environment Report – South Africa, Walmsley, Dr. R.D., Walmsley, J.J., Mzuri Consultants, Silberbauer, M.

Water and Concentrated Solar Trough Based Power Generation



Reference: <http://www.seao2.com/solarsphere/csp.htm>

Cleaning the solar troughs with water spray -- Dust and debris can significantly reduce the energy output from concentrating solar power systems. The volume of water and economic costs should be considered, as these are maintenance costs associated with energy generation performance.



Solar Trough Example: These plants have a 354 MW installed capacity, making it the largest installation of solar plants of any kind in the world.[1] The average gross solar output for all nine plants at *SEGS* is around 75 MWe — a capacity factor of 21%. In addition, the turbines can be utilized at night by burning natural gas.

NextEra claims that the solar plants power 232,500 homes and displace 3,800 tons of pollution per year that would have been produced if the electricity had been provided by fossil fuels, such as oil. Of course, this does not take into account the backup power generation required from gas fueled power.

The facilities have a total of 936,384 mirrors and cover more than 1,600 acres (6.5 km²). Lined up, the parabolic mirrors would extend over 229 miles (370 km).

The parabolic mirrors are shaped like a half-pipe.

The sun shines onto the panels made of glass, which are 94% reflective, unlike a typical mirror, which is only 70% reflective.

The mirrors automatically track the sun throughout the day.

The greatest source of mirror breakage is wind, with 3,000 typically having to be replaced each year. Operators can turn the mirrors to protect them during intensive windstorms.

An automated washing mechanism is used to periodically clean the parabolic reflective panels:





How much water does a parabolic trough power plant use?

It usually depends on what type of technology a parabolic trough power plant uses to cool its condenser.

Table 1. shows water use with wet and dry cooling for conventional steam, combined-cycle, gas turbine, and parabolic trough solar power plants. The water use for conventional plants is based on a California Energy Commission report. The water use for the parabolic trough plants is based on data from the SEGS (solar electric generating station) plants operating in the Mojave Desert.

Table 1. Water Requirements for Power Generation (in Gallons per MWh of Plant Output)

Plant Type	Steam Condensing	Auxiliary Cooling and Hotel Load	Total
Stand-alone steam plant	720 ⁽¹⁾	30 ⁽²⁾	750
Simple-cycle gas turbine	0	150 ⁽³⁾	150
Combined-cycle plant (2/3 CT + 1/3 steam)	240 (1/3 x 720)	110 (2/3 x 150 + 1/3 x 30)	350
Combined-cycle plant with dry cooling	0	110	110
Stand-alone steam plant with dry cooling	0	30	30
Parabolic Trough with wet cooling	920 ⁽⁴⁾	80 ⁽⁵⁾	1000
Parabolic Trough with dry cooling	0	80	80

(1) evaporation + blowdown = 12 gpm/MW

(2) estimated at ~5% of evaporation + blowdown

(3) mid-range of 75-200 gal/MWh for turbine cooling, emissions control and hotel load.

(4) based on historical data from SEGS (higher than conventional because of lower net steam cycle efficiency of SEGS, in part due to HTF pumping and night time parasitics.

(5) Includes make-up water requirements for steam cycle (60 gal/MWh) and solar field mirror wash (20 gal/MWh) data from KJCOC.

For more information, see parabolic trough power plant [wet and dry cooling](#).

Water Use on Solar Trough Concentrated Power Generation

solar field mirror wash (20 gal/MWh)
(Demineralized Water Is Used)

University of Wisconsin's KJC Operating Company generated this water requirement from their
extensive Solar Trough Operations / Materials Research

	MegaWatts Output	Operating at 30% Capacity in MWhr	Gals. Of Demineralized Water Required for Cleaning Per Year	Either Parabolic Trough with dry cooling	Or Parabolic Trough with Wet cooling
Khara Hais (Eppington)	100	1,839,600	36,792,000	147,168,000	1,839,600,000
Eskom CSP (Eppington)	100	1,839,600	36,792,000	147,168,000	1,839,600,000
Group Five (Northern Cape)	600	11,037,600	220,752,000	883,008,000	11,037,600,000
Clinton Climate Initiative (Northern Cape)	5000	91,980,000	1,839,600,000	7,358,400,000	91,980,000,000
SKA MeerKAT / Univ. of Stellenbosch	100	1,839,600	36,792,000	147,168,000	1,839,600,000
Siemens Demo Plant, (Northern Cape)	50	919,800	18,396,000	73,584,000	919,800,000
Industrial Development Corp.	50	919,800	18,396,000	73,584,000	919,800,000
Exxaro, Lephalale, Limpopo	200	3,679,200	73,584,000	294,336,000	3,679,200,000
			2,281,104,000	9,124,416,000	114,055,200,000

Gallons of Demineralized Water Used Per Year

QUESTIONS:

Where will all this demineralized water come from at at what price?

How much will the base load gas generation capability to backstop the CSP Plants during down time will cost per MWh?

What is the total cost (CSP + Gas backup) per MWh -- assuming 30 year amortization of build cost at 8% interest per annum?