Novel strategies (2) to slow climate change and fight global warming

New ideas on how to cool Gaïa

Favoring radiative thermal bridges for cooler temperatures at the Earth surface

Open access paper **http://ac.els-cdn.com/S1364032113008460/1-s2.0-S1364032113008460-main.pdf?_tid=d9dc4802-940d-11e3-89f8-00000aab0f27&acdnat=1392227476_7697a033c6ab47e5cec0f7085517288d**

MING, Tingzhen, DE_RICHTER, Renaud, LIU, Wei, *et al.* Fighting global warming by climate engineering: Is the Earth radiation management and the solar radiation management any option for fighting climate change?. *Renewable and Sustainable Energy Reviews*, 2014, vol. 31, p. 792-834.

To avoid permafrost melting 124,000 **Heat Pipes transfer heat** from the oil, to aerial fins on the Trans Alaska Pipeline.

This Pipeline conveys crude oil over 800 miles (1287 km) from Prudhoe Bay to Valdez, Alaska, USA.

The pipeline is 122 cm diameter and needed over 0.5 million tons of steel to be built.
The capacity of the filled pipeline is 9 million barrels.
Proposed LNG gas Pipeline will need 1.7 million tons of steel.

Photos by C. Jeff Dyrek

http://www.yellowairplane.com/global_warming/4-Trans_Alaska_Oil_Pipeline_Problems.html

Photo from http://photoseek.photoshelter.com/image/I0000V5tJ.Z9eZL4

Permafrost cooling

Alaska pipeline support legs are cooled by
heat pipe thermosyphons to keep permafrost frozen

http://en.wikipedia.org/wiki/Heat_pipe

Building on permafrost is difficult because heat from the structure can thaw the permafrost. Heat pipes are used to avoid the risk of destabilization.

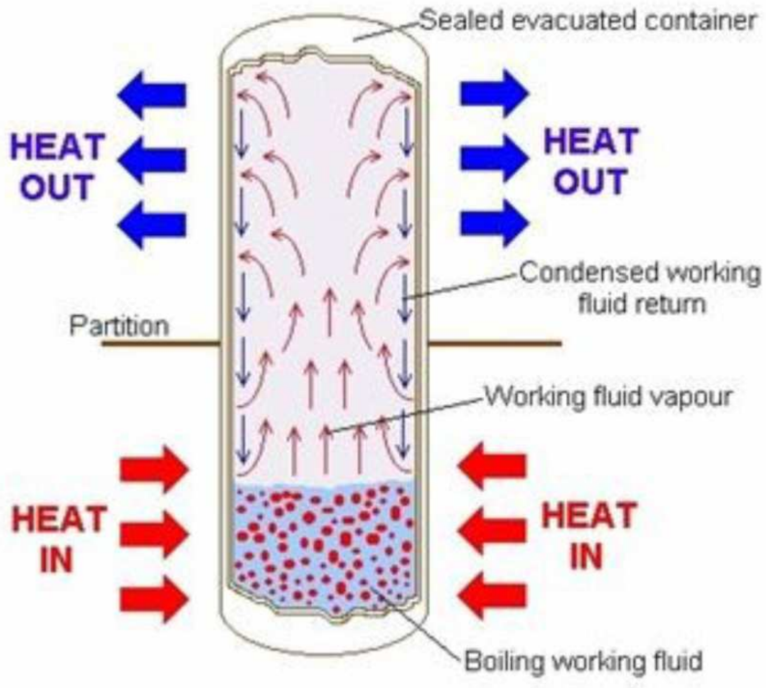
For example, in the Trans-Alaska Pipeline System residual ground heat remaining in the oil as well as heat produced by friction and turbulence in the moving oil could conduct down the pipe's support legs and melt the permafrost on which the supports are anchored. This would cause the pipeline to sink and possibly be damaged.

To prevent this, each vertical support member has been mounted with four vertical heat pipe thermosyphons. C.E. Heuer, "The Application of Heat Pipes on the Trans-Alaska Pipeline" Special Report 79-26, United States Army Corps of Engineers, Sept. 1979 http://www.dtic.mil/dtic/tr/fulltext/u2/a073597.pdf

During the winter, the air is colder than the ground around the supports. The liquid ammonia at the bottom of the thermosyphon is vaporized, cooling the surrounding permafrost and helping to keep it frozen. The ammonia vapor is condensed by the colder air surrounding the condenser. During the summer, the thermosyphons stop operating, since there is no liquid ammonia available at the bottom of the heat pipe.

Heat pipes are also used to keep the permafrost frozen alongside parts of the **Qinghai–Tibet Railway** where the embankment and track absorb the sun's heat. Vertical heat pipes on either side of relevant formations prevent that heat from spreading any further into the surrounding permfrost.

Two phase gravity assisted Heat Pipe Thermosyphons

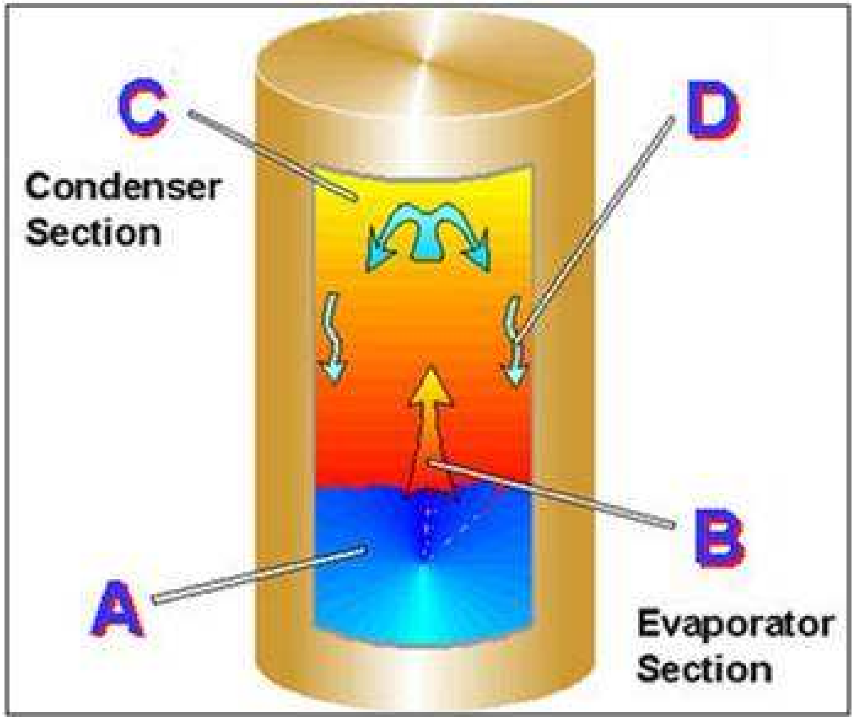


Schematic Representation of the Heat Pipe

In a thermosyphon heat pipe, liquid working fluid is vaporized at the heat source by heat supplied to the bottom of the heat pipe (the evaporator). The vapor travels to the cold source at the top of the heat pipe (the condenser), where it condenses. Due to partial pressure build up, the vapor transforms back into liquid thus releasing latent heat. The liquid then drains back to the bottom of the heat pipe by gravity, and the cycle repeats. Due to very high latent heat of vaporization a large quantity of heat can be transferred very rapidly. A thermosyphon heat pipe can transfer up to 100 times more thermal energy, than copper, the best known conductor; and with small temperature drop per meter

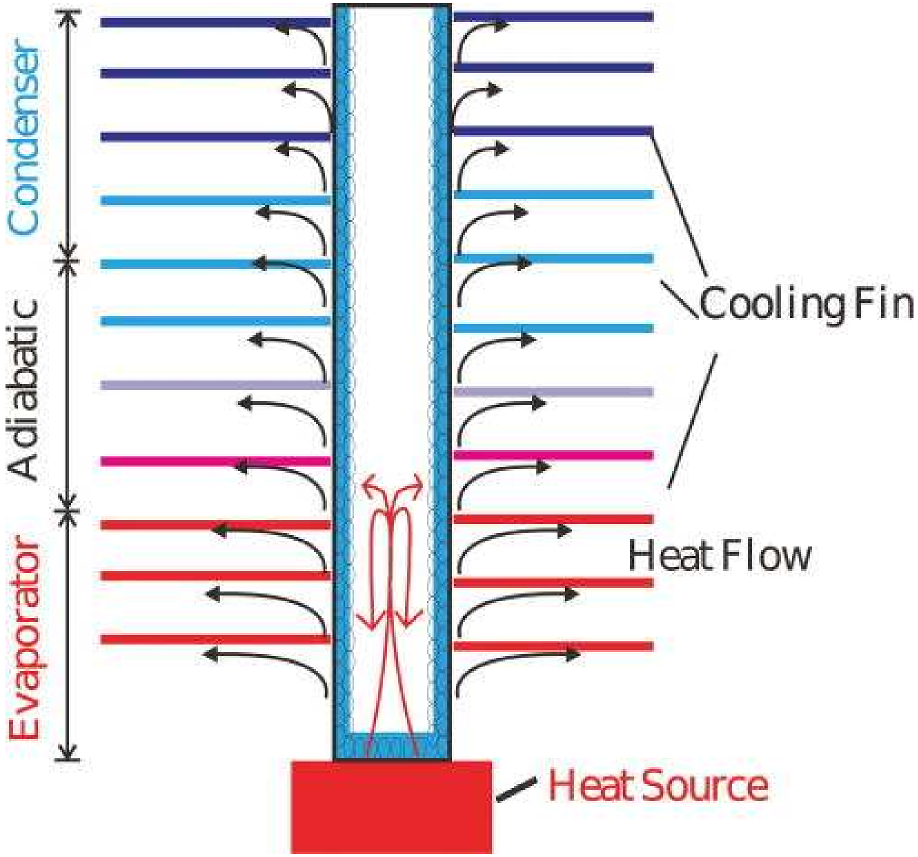
The heat pipes used to prevent permafrost melting and cool the trans Alaska oil pipeline are **12 m long.** Much longer thermosyphons have been proposed for the extraction of geothermal energy.

(93 m long propane thermosyphon, carring 6 kW of heat by T. Storch et al., “Wetting and Film Behavior Of Propane Inside Geothermal Heat Pipes”, 16th Int. Heat Pipe Conference, Lyon, France, May 20-24, 2012.



From the condenser section, IR is released to the environment: heat is taken away by means of air cooling with fins, etc.

A traditional heat pipe is a hollow cylinder filled with a vaporizable liquid and functions as follows:
A- Heat is absorbed in the evaporating section.
B- Fluid boils to vapor phase.
C- Heat is released from the upper part of the cylinder (condenser section) to the environment, vapor condenses to liquid phase.
D- Liquid returns by gravity to the lower part of cylinder (evaporating section).
http://www.manorenterprises.com/product_heat_pipe.html



A heat pipe thermosyphon is a heat transfer device

that can transport large quantities of heat with a very small difference in temperature between the hotter and colder interfaces.

Heat pipes employ evaporative cooling to transfer thermal energy from one point to another by the evaporation and condensation of a working fluid or coolant. The latent heat of evaporation absorbed by the vaporisation of the working fluid reduces the temperature at the hot end of the pipe. The latent heat of condensation released at the cold end in then evacuated there by fins.

Advantages:

Self-contained passive energy recovery devices.

Can transfer up to 100 times more thermal energy, than copper, the best known conductor, with very low temperature drop.

They have no moving parts and hence require minimum maintenance.

Completely silent and reversible in operation and require no external energy other than the thermal energy they transfer.

Ruggedly built and can withstand a lot of abuse.

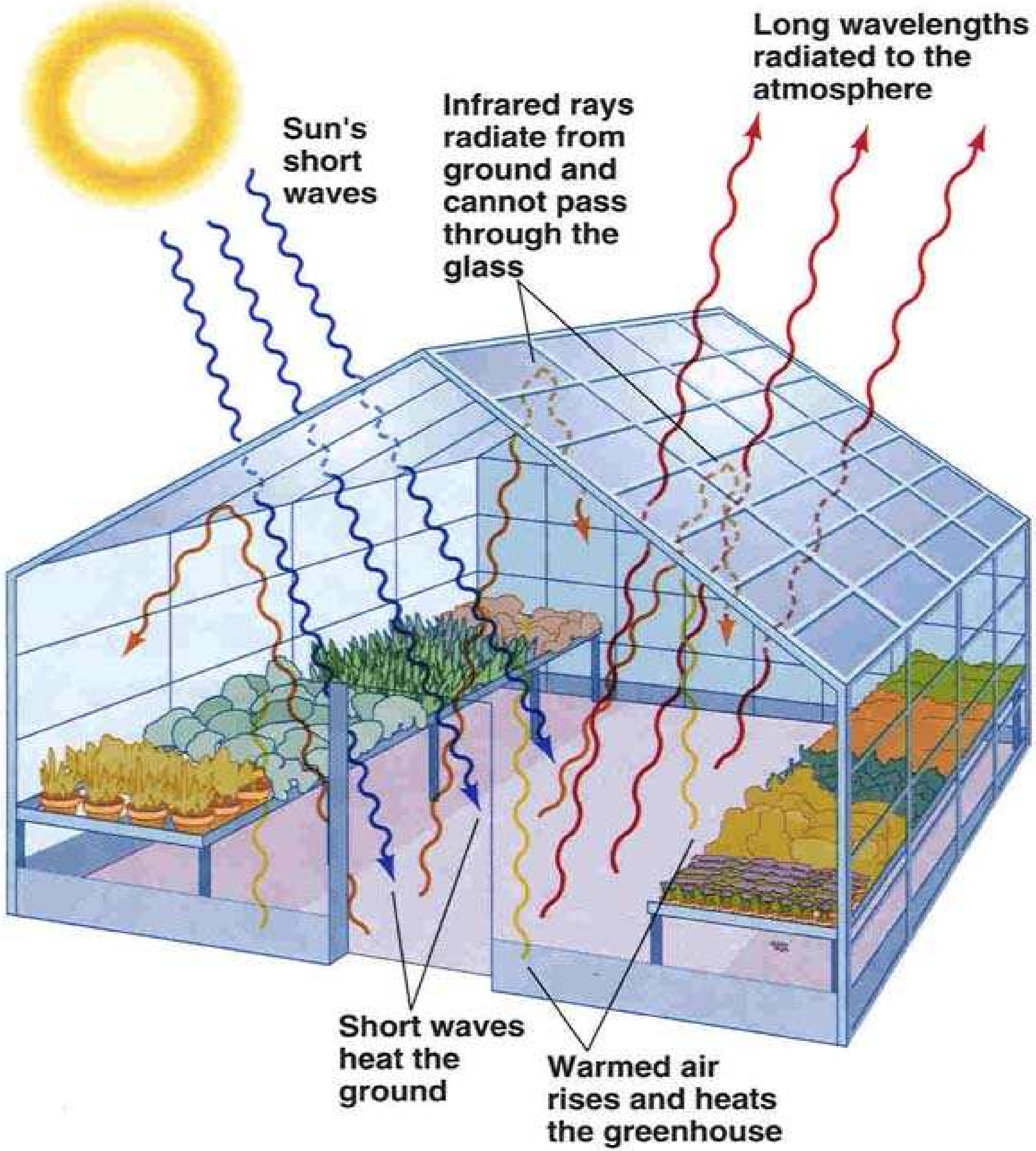
Disadvantages:

Must be tuned to particular cooling conditions.

When heated above or below a certain temperature, the heat pipe's thermal conductivity is effectively reduced.

In practice, the speed of the vapour through the heat pipe is limited by the rate of condensation at the cold end and far lower than the molecular speed. In theory the speed of molecules in a gas is approximately the speed of sound, and in the absence of non-condensing gases (if there is only one gas phase present) this is the upper limit to the velocity with which they could travel in the heat pipe.

The greenhouse effect is due to long wave radiation (Infra-Red)



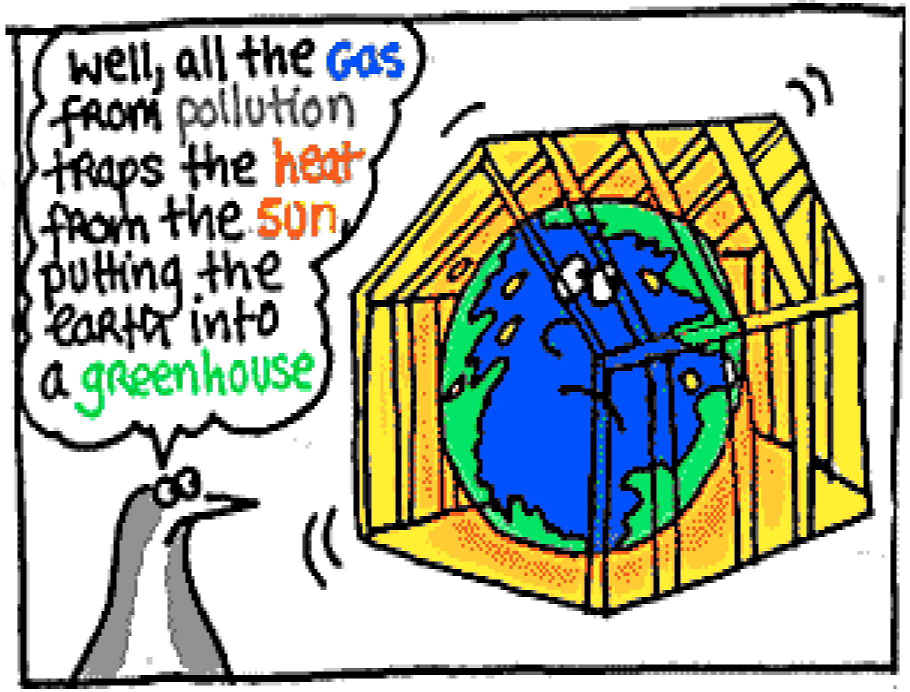


Image from http://www.realscience.org.uk/science-discussion-climate-change-clouds.html

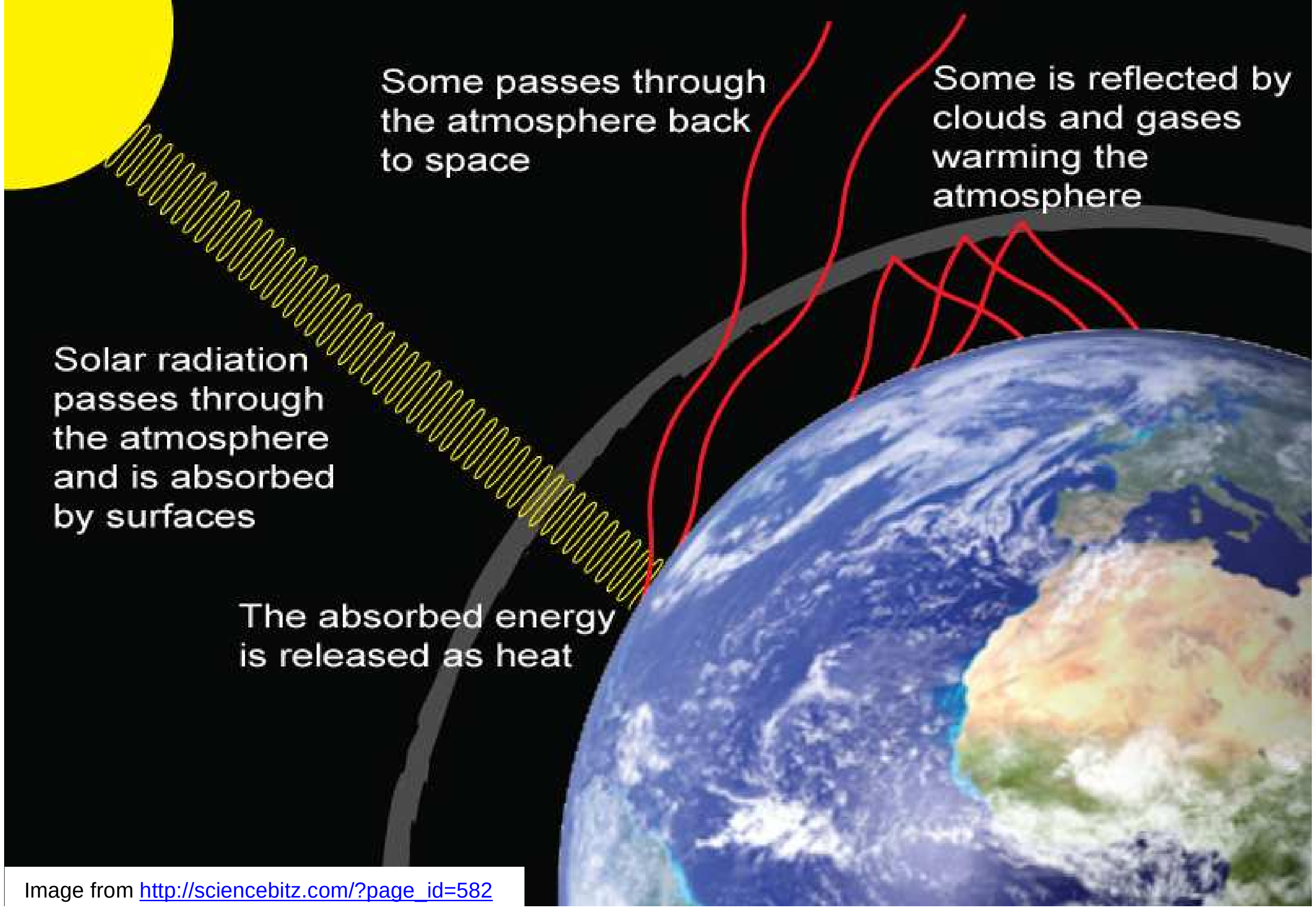


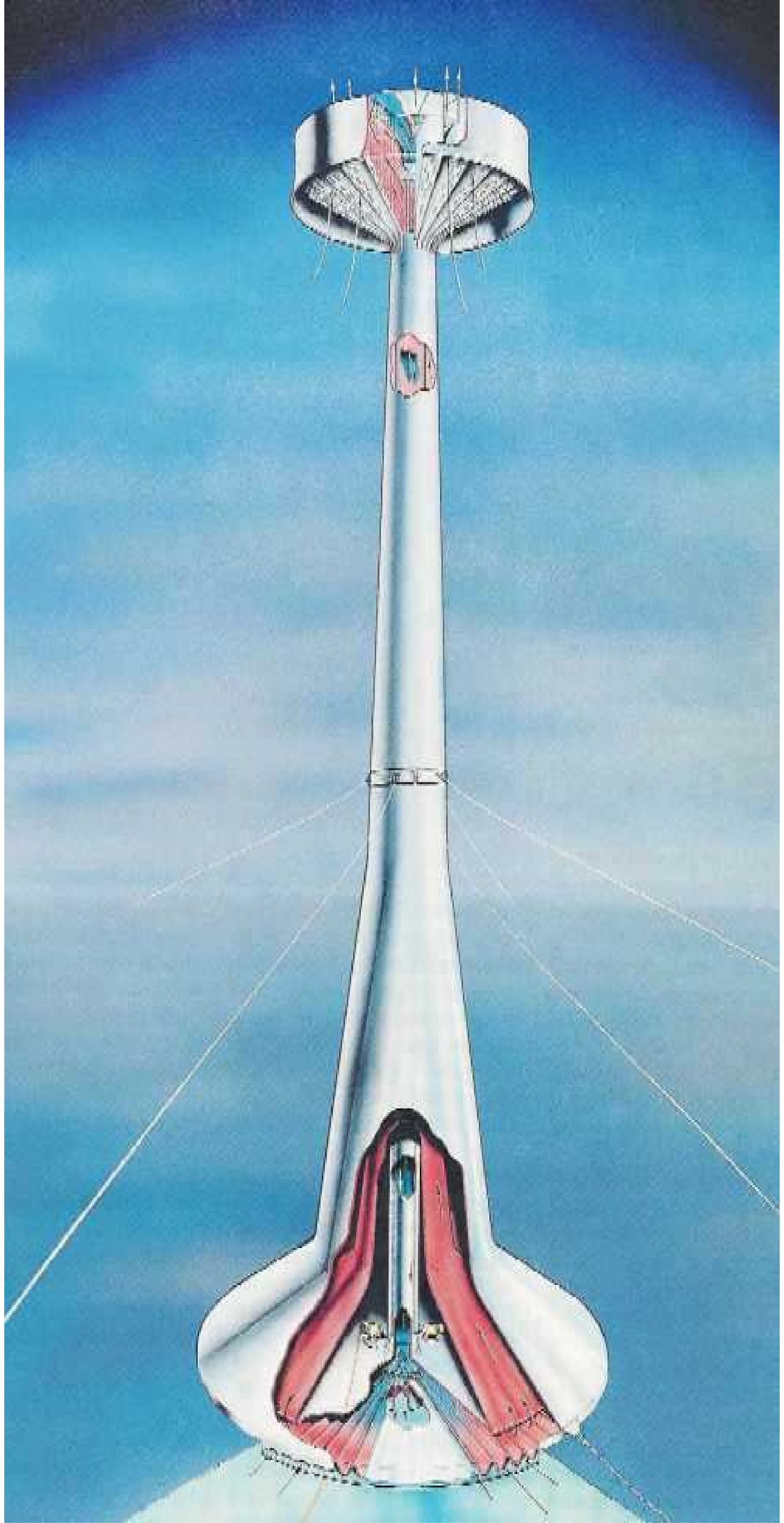
Image from http://sciencebitz.com/?page_id=582

Greenhouse gases in the troposphere act on the Earth as a "continuous insulation".

Increasing the concentration of GHGs in the atmosphere is like **increasing the insulation** by preventing thermal bridging and replacing the single glass by double glass, then triple glass…

In order to fight global warming we need to "**cool down the Earth"**.
We propose to voluntarily create "**thermal bridges**" or "**paths for heat loss"** (by Infrared long wave radiation) from the planet surface to the outer space.

We call this "**thermal shortcut**" strategies:
Earth Radiation Management (ERM)
by analogy to Geoengineering
Solar Radiation Management (SRM).



Mega high heat pipe to cool the Earth

Researchers in the Netherlands, proposed in 1996 the MegaPower Heat Pipe -- an enormous power station which they claimed may one day be a major source of pollution-free energy.

While the scheme may sound crazy, the working cycle that the tower would use to generate electricity, is similar to the cycle that underlies hydroelectric power.

The turbines in a hydroelectric power station harness the potential energy of water as it falls from a lake or reservoir towards the sea.

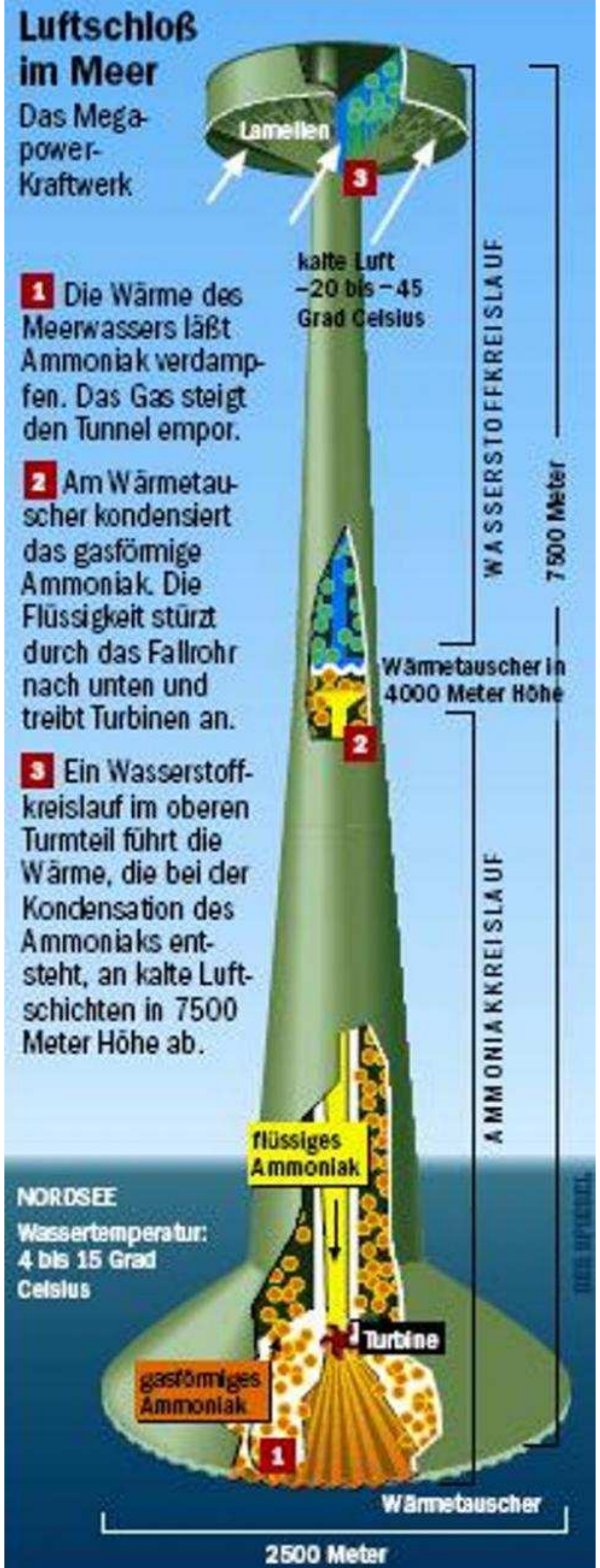
But this is only half the story. The water gained potential energy when it evaporated from the ocean and rose into the clouds where it cooled down and condensed to form rain that replenished the lakes.

The MegaPower heat pipe would enclose the system inside a giant tower and replace the water used for hydroelectric power with another fluid.

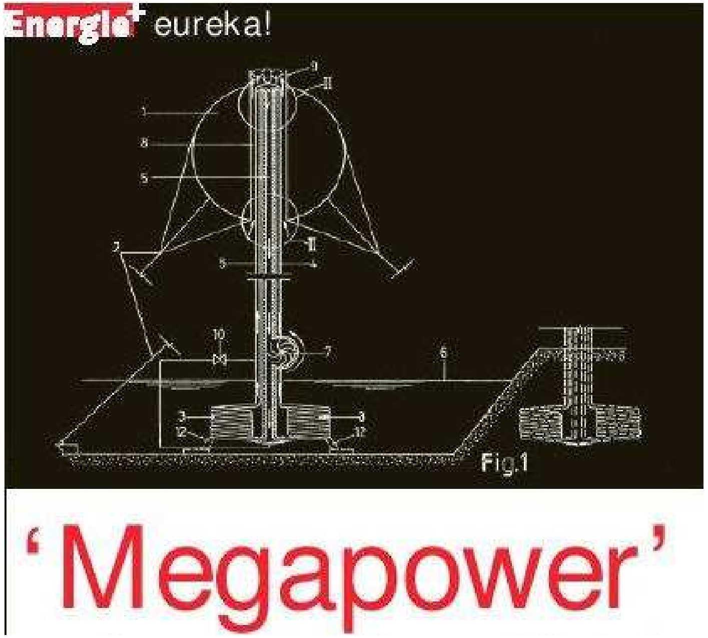
At the top, the fluid would condense in the cold of the upper atmosphere.

From there it will fall through a turbine to the upper atmosphere to the bottom of the tower where energy from the sea would evaporate the fluid, and start the cycle again.

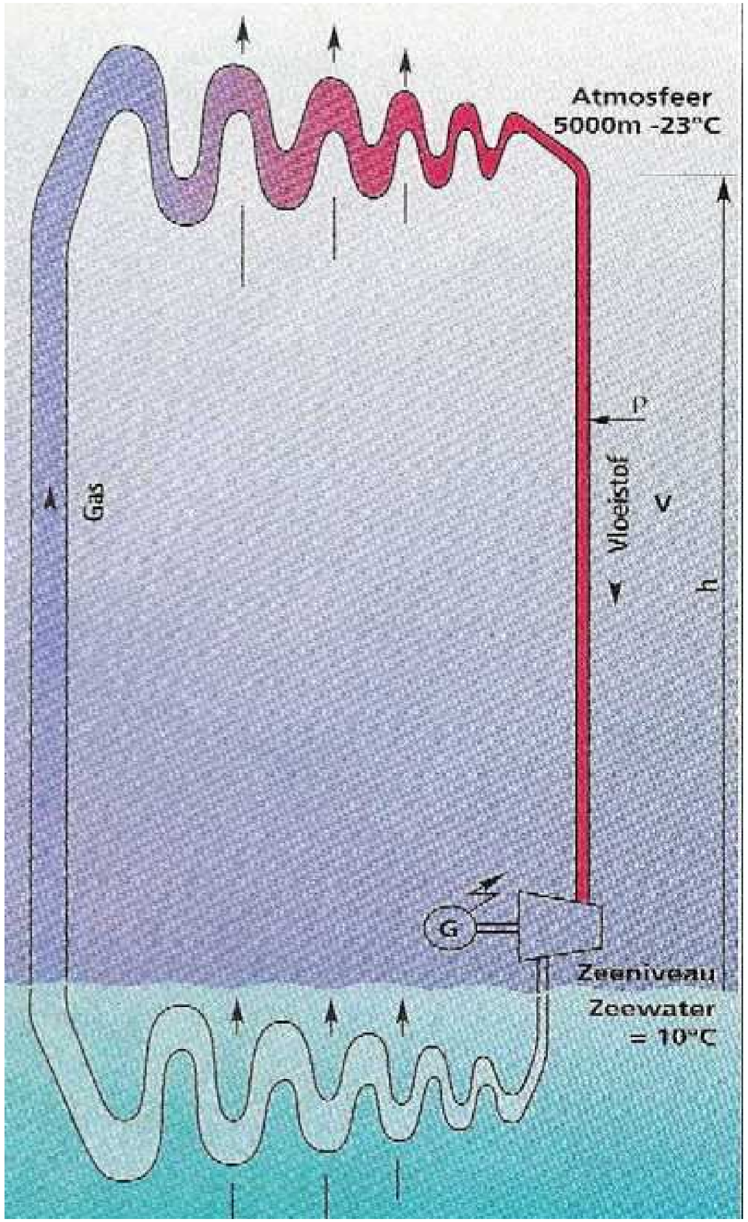
It was claimed that the cost of the scheme could be ‘within the costs of providing equivalent conventional generating capacity’.



A Megapower Heat Pipe can create a "**thermal bridge**" from the planet surface to the outer space (by Infrared long wave radiation) .



BRON: De Ingenieur nr. 20 - 6 december 1995
http://www.lgwkater.nl/energie/megapower/megapower.htm
29.01.1996 DER SPIEGEL 5/1996
http://www.spiegel.de/spiegel/print/d-8871103.html
Aufbau und Funktionsweise eines Megapower-Kraftwerkes im Meer / DER SPIEGEL / Frank HOOS
http://wissen.spiegel.de/wissen/image/show.html?did=8871103&aref=image017/SP1996/005/SP199600501510151.pdf
Sky-high tower of power may ride the waves, NewScientist magazine N°2012, January1996
http://www.newscientist.com/article/mg14920123.800-skyhigh-tower-of-power-may-ride-the-waves.html
'Megapower' produceerde slechts publiciteit, Energie+ 2006/4
http://www.energieplus.nl/megapower_produceerde_slechts_publiciteit



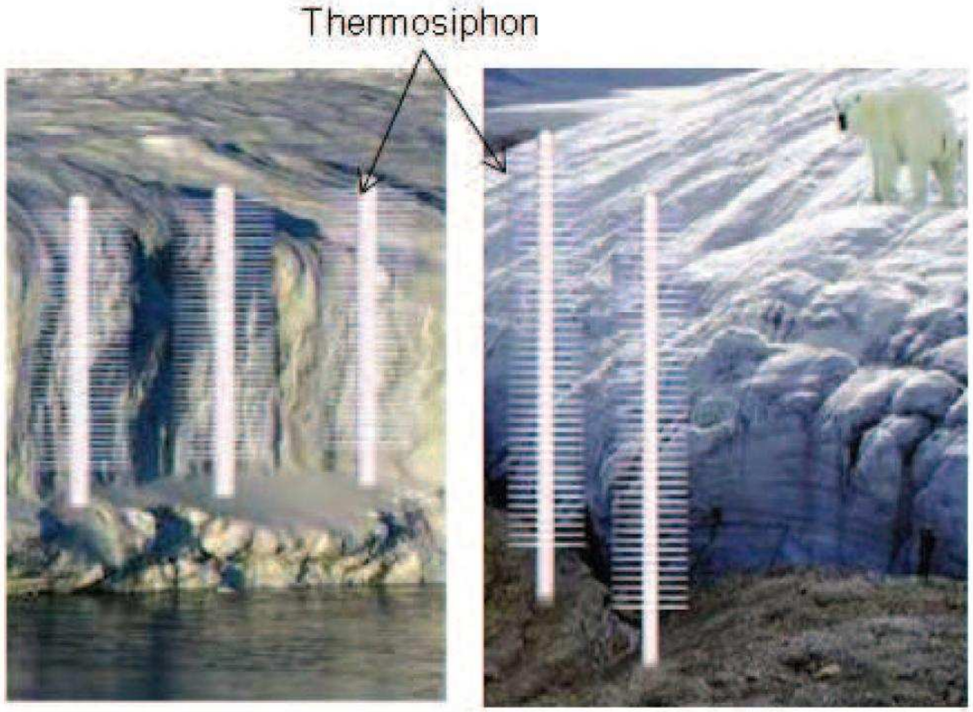
Butan / NH_3 cycle process

The thermosyphons or heat pipes can be very useful to save the arctic and prevent massive methane release.

An enormous amount of two phase thermosyphons are currently used to prevent permafrost melting along pipelines, roads and train-rails over Alaska, Siberia, and Chinese Mongolia. They allow to decrease the permafrost temperatures by 3℃ and more.

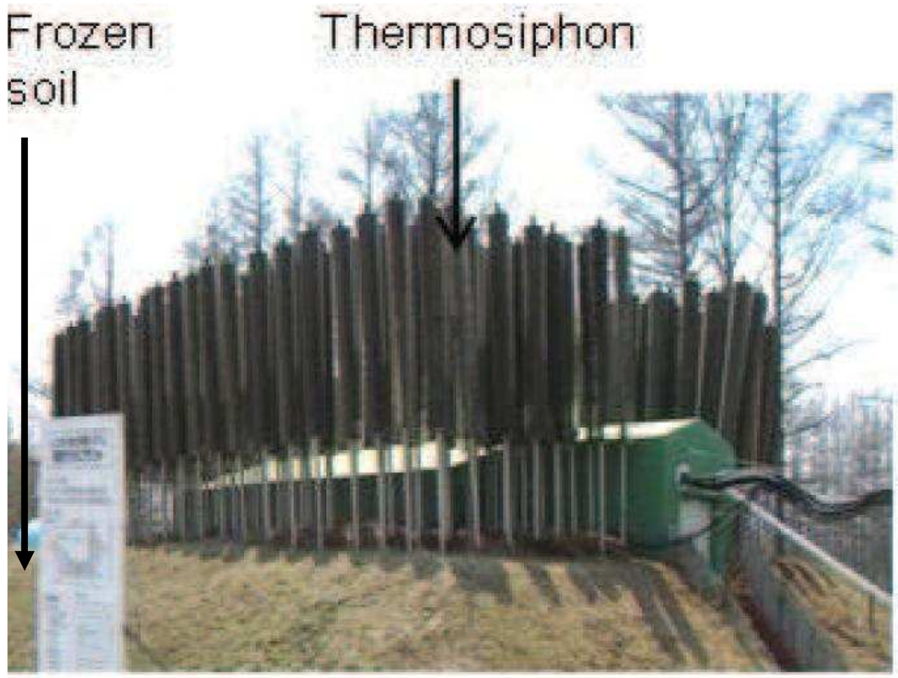
The thermosyphons remove heat from the soil and transfer it to the air during the winter. The concept is that thermosyphons remove as much heat as possibly in the wintertime, so that it can carry through that frozen ground till the end of summer.

Large scale use of numerous, more efficient and cheap heat-pipes can help relive the side effects of global warming induced problems, as well as for glaciers and for the Arctic melting.



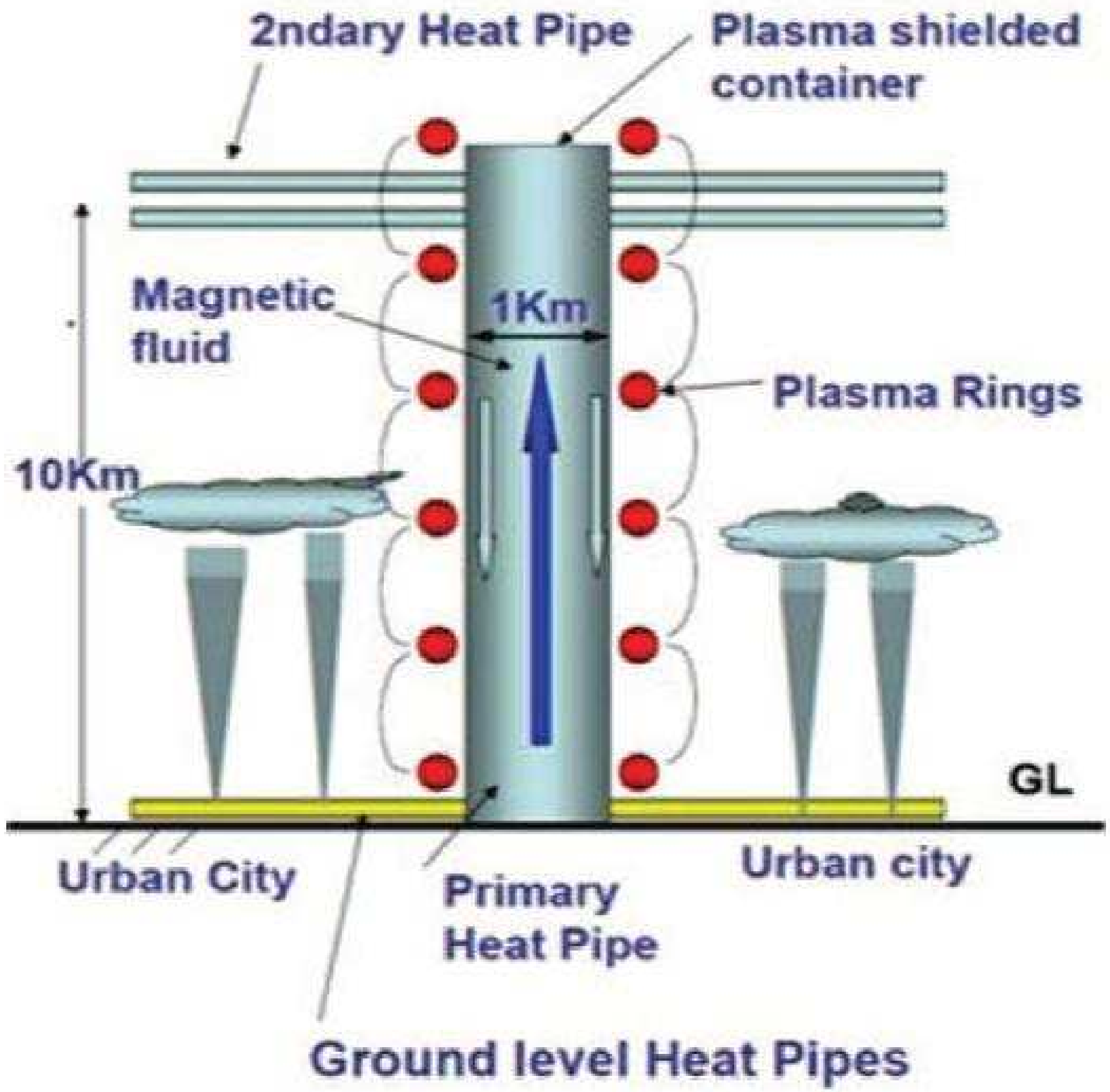
Figures from Mochizuki et al

Use of thermosiphon to prevent iceberg and glacier melting



Permafrost storage system

Very big size heat pipe thermosyphons can help cool down the planet



Concept of ultralarge-scale heat pipe for cooling the earth.

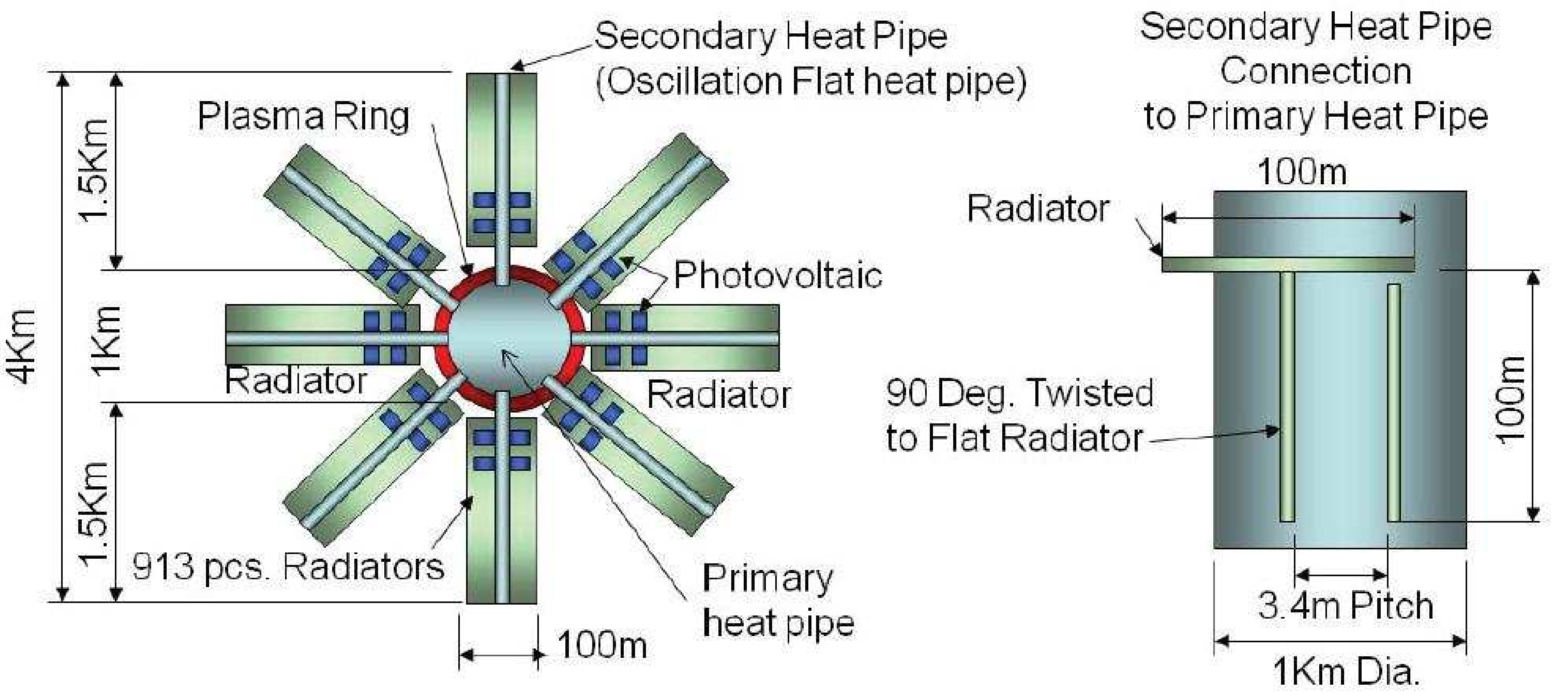
Mochizuki et al proposed ultralarge-scale heat pipes for cooling the Earth

(Mochizuki, M., Akbarzadeh, A., & Nguyen, T. (2013). A Review of **Practical Applications of Heat Pipes and Innovative Application of Opportunities for Global Warming**. Chapter 5 p145-. In "Heat Pipes and Solid Sorption Transformations: Fundamentals and Practical Applications", Editors L.L Vasiliev, Sadik Kakaç, CRC Press, 536 pages)

In 2009, Daniel Asturias and Isaac Harwell proposed "motion less thermal generators" (MoTGens) which are also heat pipe thermosyphons. *BBC* 23 December 2009 *http://news.bbc.co.uk/2/hi/technology/8417192.stm*

Very big size heat pipe thermosyphons can curb climate change

Mochizuki et al proposed giant thermosyphons **to fight global warming**



Q= 1 x 10³ W, T-radiator= 273K, T-black body= -273K
Stefan-Boltzmann Eq.   q=73Kw/m²
Radiator Size: 100mW x   1,500m L, 913 pcs.

Mochizuki, M., Nguyen, T., Mashiko, K., Saito, Y., Nguyen, T., & Wuttijumnong, V. (2011). A Review of Heat Pipe Application Including New Opportunities. *Frontiers in Heat Pipes (FHP)*, *2*(1).

Design of ultralarge-scale heat pipe for cooling the earth.