The „Solar Power Village“

Technology

SolarVillage

Tamera

SUNVENTION SOLAR POWER VILLAGE

Autonomous energy and food supply, the core of future peace settlements
First model installation at Tamera, Portugal
September 2006

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Text: Jürgen Kleinwächter, Charly Rainer Ehrenpreis
Layout: Roland Luder, Sabrina von der Thannen
Photos: Sunvention, Projectgroup SolarVillage
Publisher: Projectgroup SolarVillage
Monte do Cerro
7630 Colos, Portugal
Tel: +351 / 283 635 313
solarvillage@tamera.org

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Introduction

The readers of Herman Scheer's book "Energy Autonomy" (Energie-Autonomie) will know that said autonomy or self-sufficiency represents the most important generic term in the presently unfolding solar era. Regionally used energies, produced from self-sufficient resources, not only allow the liberation from heteronomy especially to the poorest and most sun-intensive areas of the world, but also serve the development of autonomous inter-linked structures right down to village level.

These structures generate local and stable workplaces and at the same time cover the population's food and energy demands.

Looking at the growing stream of migrating poor from the South, seeking employment in the affluent countries of the North, and at the same time looking at the inhumane, unproductive and money-devouring defence measures taken at the borders, the question arises, whether these funds would not be better invested in sensible undertakings for the development of the South as suggested by the new structures mentioned above.

During decades of working on R&D, we have developed a variety of solar systems and components which we have now assembled to form an integral, multi-functional overall system – the "Solar Power Village".

This system, a symbiosis for plant growth and solar energy production, is designed in such a way to be able to be constructed almost entirely in the user-countries.

To effectively use the enormous and positive "potential of thrust", of this and/or other developments of the early evolution of balanced energy and material cycles in solar society, it is of paramount importance that the user/inhabitant is not only technically, but also socially and culturally integrated. A modern type "back to nature" is about to be generated, though stripped of the worldly innocent aftertaste of Rousseau's dream, since it is based on the feasible, realistic and technologically gentle use of sun power.

At Tamera, an international research settlement in the Alentejo in Southern Portugal, the model of a "Global Peace Village" has been developed during the past years. It offers ideal conditions for the installation of a "Solar Power Village".

On the one hand, the approx. 100 co-workers, around the founders Dieter Duhm, Sabine Lichtenfels and Rainer Ehrenpreis, have built up a humane model community with strong integrative powers for the development of international peace settlements to be generated from the grass roots which today, more than ever before, are urgently needed.

On the other hand, the "Tamera Model" will only achieve its intended effectiveness when the energy and food production becomes autarkic and self-sufficient.

Amongst the inhabitants and co-workers of Tamera there are engineers, architects, biologists, medical doctors, clay- and strawbale builders, perma-culture specialists and excellent crafts people. The "Youth School of Global Learning" is attended by many inspired, committed and highly talented adolescents.

At the annual "Summer University", frequented by international visitors groups especially from world regions of conflict, the "Solar Power Village" met with much resonance and palpable need.

Tamera specialists have introduced the technologies of "Sunvention" to various Portuguese universities and institutions where they raised a lot of interest.

For these reasons the first "Solar Power Village" is presently (2006) being installed at Tamera. The Tamera workshop, serving as a model for future production places in Southern countries, has adapted the individual components of the system in such a way that local production can realistically be accomplished.

Thus a real platform for demonstration, training and transfer will have been created.

Around this core installation a complete ecological “Solarv illage” will be developed which comprises all aspects of passive and active solar technology; of ecological construction (i.e. clay and straw bale constructions); of permaculture in terms of self-sufficient energy and food production and social design. The infrastructure of a corresponding training centre (Aula (university hall), study rooms, workshops, etc.) is presently under construction.

In the near future Tamera is to receive the status of a “Campus of the Gaia University”, a university active worldwide, with an accreditation to IMCA (International Management Centers Association, GB) and to the Revan’s University (with Bachelor and Masters degree).

One element of the “Solar Power Village” – the energy greenhouse “Envelope” – has the potential to produce the basic food supply (for a vegan diet) for one person on a surface of 200 m^2.

In case of further optimisation, which will basically lead to a bionic system, the plants themselves will constantly give steering impulses to the physical system (optics, filters, humidifier etc.) which in turn will set the “bio-parameters“ that are responsible for the growth of the plants (light, temperature, humidity, CO2 concentration in the air etc.) to the optimum at any given time.

This again will reduce the amount of surface needed to feed one person to <= 50 m^2 - an essential objective for the feeding of an exponentially growing world population.

The energy greenhouse developed by us has a minimum surface of 150m2. Under the solar conditions of Southern Spain and Southern Portugal it produces approx. 50kWh/day of electric power, plus approx. 24kWh/day of heat energy for cooking (220 °C), plus approx 65 kWh/day of low-temperature energy, e.g. for heating purposes or for the production of warm water.

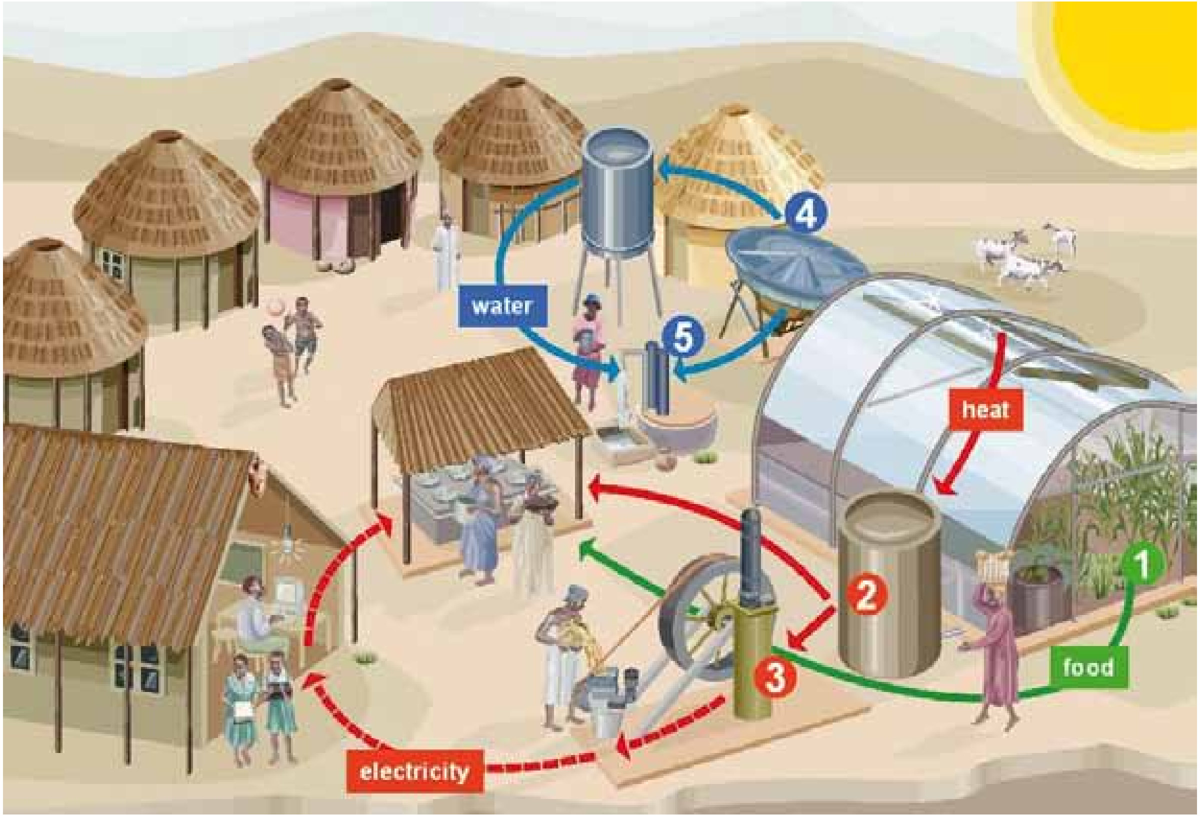
The full development of this potential at the “Solar Platform” Tamera - in close cooperation with international partners and the simultaneous development of a sustainable network for a peaceful solar age - is our mutual aim and represents the political power of the future of “Energy Autonomy” in terms of Hermann Scheer.

Jürgen Kleinwächter, dipl.phys. **Rainer Ehrenpreis, dipl.phys.**

for Sunvention **for Tamera**

September, 2006

The Solar-Power Village – the Technology



The Core Components of the "Solar Power Village" are:

- (1) The greenhouse with its „Sunray" and „Sunflower" lens systems
- (2) The hot oil storage tank and the cooking places
- (3) The medium temperature Stirling engine
- (4) The water pump
- (5) The water disinfection system

1. The "Envelope" Greenhouse

The greenhouse (SolarEnvelopeTM) is a light-weight structure covered with a specially resistant fluorpolymer foil. The foil is transparent for the full spectrum of the solar radiation including the UV segment, thus there is no need for pesticides, which are normally employed in conventional greenhouses. Besides that UV-radiation is what generates the aroma, thus greatly improving the quality of the produce.

The optical systems, mounted in the roof of the greenhouse are protected from wind and weather, are designed extremely light and inexpensive.

The „Sunflower" and/or „Sunray" modules are mounted parallel to the shading system under the roof of the greenhouse. The optical systems concentrate the direct solar radiation onto receivers thus extracting heat from the greenhouse and protecting it from overheating. Extra cooling systems become thus dispensable; the nightly need for heating can be covered system-internally; the remaining diffuse enables an optimal growth of the plants.

Vegetable oil is used as the heat-carrying medium. An insulated pipe system transports the oil to a hot-oil storage tank.

The covered horticulture allows for the modification of the growth factors (temperature, humidity, radiation situation and CO2 concentration).

While higher temperatures enable a prolongation of the season in the north, cooling is decisive for the harvest results in the south. Nowadays, the largest greenhouse surfaces are to be found in the Mediterranean countries and in East Asia, but also in the dessert regions the significance of covered planting grows aiming at the increase of the local supply with vegetables (United Arab Emirates: 1'450 ha).

For heating purposes about 300-500 kWh of thermal energy per square metre are necessary while up to 3 kg CO2 per kilogramme of produced tomatoes are emitted. The prevalent evaporation cooling needs about 20 times as much water as is necessary for irrigation thus contributing significantly to water scarcity in southern areas.

Further reaching application potentials:

The focal lines of the two optical systems can both be equipped with:

- **Concentrating photovoltaic**

A small row of solar cells is cooled from both sides and produces electricity at a high efficiency rate. The cooling aid supplies a heat storage with heat energy thus reducing the expense for heating at night.

Attractive alternatives to the roof-integrated photovoltaic flat modules for the production of solar energy are available. Already today more than half of the worldwide solar electricity production comes from solar-thermal large-scale power plants. In Almeria in Spain solar power plants are being built. At the same time the region disposes of the highest greenhouse density (30'000 ha). In future, the different systems are to no longer compete with one another but symbiotically accomplish each other.

Regarding the supply shortages for photovoltaic modules material-economic, concentrated applications will gain more and more significance.With highly efficient triple junction cells (efficiency ratio up to 36%) in the focal line of the lenses prime costs of significantly below 10 €-Cents per kWh are to be expected when producing a larger quantity of energy.

- **Thermal Absorbers**

With the help of vacuum tubes high temperature heat energy is produced, which can be transformed into electric energy via heat-power-coupling or serve for heating.

- **Spectrum Modifying Pigments**

The cultures in a greenhouse can only use specific wave lengths of the optical spectrum for photosynthesis. With the help of colour pigments the dispensable light is transferred to the absorption maximum of the chlorophyll which stimulates the growth of the plants. Again, absorbed heat can be stored.

2. The hot oil storage and the cooking places

The "Solar Power Village" offers solutions for the supply with heat for cooking, warm water production and electricity using vegetable oil as heat carrier and storage. The oil which is heated in the „Sunray" or the „Sunflower" (up to 220°C) circulates from the absorbers to the cooking places or to the Stirling machine which in turn produces electricity. The hot oil storage enables a 24-hours-energy use and is dimensioned in such a way that it secures energy autonomy for several days.

To be able to compete with the existing systems (traditionally: stones around open fireplaces but also improved stoves) the solar cooker must be adapted to the eating habits and to the cultural and social conditions of the target countries. It is not enough to produce thermal energy at a high efficiency rate. For a good acceptance of the solar cooker further requirements must be fulfilled like e.g. an easy and safe handling or a solid and simple construction. The cooker must correspond to the social structures: it must be expandable as per customers' wishes and flexibly usable (indoor and outdoor kitchen), it must take the role of the kitchen as a place of communication into consideration and it must be possible to cook the traditional meals at the usual time of day and within the usual time span. A solar cooker in combination with a heat storage should meet these needs. The experience gathered in Mali and India with the "black cooker" confirm this. Our central cookers function along the same principle but do allow for an extended number of cooking places, higher temperatures with a good efficiency and longer autonomy.

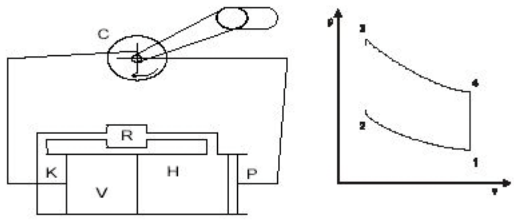
The cooking place consists of a double-walled aluminium pot through which the hot oil flows. A manually regulated valve opens and closes the hot oil cycle as per the actual need and enables a fine regulation of the cooking heat. The oil shall have a temperature of at least 150°C in a way that deep frying, roasting and baking become possible. For boiling water 100°C would be enough.

3. The medium temperature Stirling machine

A Stirling machine is a mechanical system basing on a closed thermo-dynamic cycle between two fix temperatures with a cyclic expansion and compression of a so-called working gas. It is able to transform heat energy into (physical) activity energy or vice versa to transform power into warmth and cold.

- **The principle of a classical Stirling machine**

A closed cylinder, filled with a working gas is permanently heated on the hot side (H) and permanently cooled at the cold side (K). The displacer (V) periodically pushes the gas through the regenerator (R) from the hot to the cold side and back. The function of the regenerator is to temporarily store the heat. The gas is thus periodically heated and cooled in a thermo-dynamic reversible interplay. Thereby, fluctuations of pressure are created in the closed piston. These pressure fluctuations produce the energy which moves the working piston (P) that releases the thermo-dynamic energy from inside of the cylinder to outside of the cylinder thus producing physical work.



The ideal Stirling machine has the following characteristics:

- No thermal losses happen.
- The four phases consist of: isothermal expansion (3-4), isothermal compression (1-2) each with two finalizing isochoric phases (2-3, 4-1).
- The regenerator is ideal and reversible without loosing any pressure of the gas flowing through.
- No power input is necessary to move the gas within the cylinder from cold to hot and vice versa.

Of course, all real machines produce losses. The challenge is the optimal choice of geometries, space ratio, mechanisms and material which enable the closest approach to the ideal process.

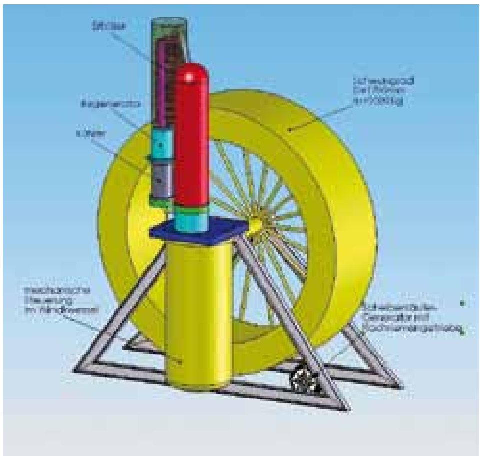
Since energy is input and output in this process a cynematic energy storage is necessary which takes up and releases energy in an alternating cycle. The solution that suggests itself would be a crankshaft (C) which connects the working piston (P) and the displacer (V) – typically with a phase shift of 90 degrees transforming the linear into a rotating movement at a constant angular speed. When displacer and working piston are steered by crankshaft drives they execute continual, sinusoidal movements. This means a deviation from the ideal Stirling process, i.e. a weakening of the performance. With slowly rotating machines though, more favourable discontinual movements are possible.

- **Our "Third World" Machine**

The technology developed by BSR Solar Technologies for medium and low temperature Stirling engines moves away from the conventional engines, which work with high temperatures, frequencies and pressures. Our technology works with low frequencies and pressures and reaches efficiency degrees at low temperature which conventional machines only reach at rather high temperatures. This opens new application potentials as for example energy production from exhaust heat, and allows for simpler and less expensive systems.

They produce at a lower cost, need less maintenance and start to be rentable when produced in relatively small quantities.

While the classical Stirling engine works with temperature differences of between 300 and 600 K, a low temperature (NT-) system works with a temperature difference of as little as 50 to 100 K. Looking to the



formula for the thermal efficiency degree of the Carnot process one realizes the heat-dependent nature of such machines: A Stirling engine which works with a heating temperature of 873 K and a cooling temperature of 373 K (T=500 K) could thus achieve a thermal efficiency of 57%.

A low temperature machine with a heating temperature of 373 K and a cooling temperature of 293 K (T=80 K) in comparison only reaches an ideal thermal efficiency of 21%. From the technical point of view it is therefore important to realise as much as possible of the ideal efficiency degree. Slowly moving, discontinually working machines have an advantage: In the p-V-diagram four phases are visible while continually working machines reveal oval diagrams, which signifies a loss of surface and thus a loss of performance under the same conditions. Since the low temperature machine works with air and low pressures the use of the expensive helium is avoided. It produces electricity for light and communication apparatuses with the help of a generator as well as mechanical energy, e.g. for the direct operation of grain mills.

4. The Pumping of Water

The majority of the population in the sunny developing countries lives off agriculture. High productivity of the small lots and the preparation of new land for agriculture are essential - and both requires irrigation.

Intensive efforts for the amplification of the watering potential lead to the insight that large-scale projects are outdone by individual solutions when it comes to efficiency and costs. While investment intensive canalisation systems lead to conflict-bearing distribution problems small farmers go for reasonable individual solutions where the ownerships are unambiguous and no large-scale interventions in nature are necessary.

The solar water pump „Sunpulse“ meets these requirements as a sustainable means. Sunpulse pumps water from storage lakes or ground water of up to 60 metres deep thus ensuring the irrigation of an average family business. As energy source it simply needs the sun – which is not only protecting the environment but also saving operational expenses.

Pumping water in agricultural countries uses a large part of the produced electric energy. With the low temperature Stirling machine the growing need for energy in southern countries can be supplied by renewable resources.

5. Water Disinfection

Next to drinking water purification the UV disinfection also serves industrial application and special applications like: process water recycling, cooling water cycles, waste water disinfection. Regarding private use it can serve to keep swimming pools and ponds clean.

UV systems are increasingly used in air-conditioning appliances, too, since the biocides which are ejected by normal ACs get into the air that we breathe and cause stress for the human health in the long run.

In warm water systems the UVitt systems can efficiently fight legionels thus preventing the legionnaires disease. The air chamber around the UV radiator and the glass tube through which the water flows enable the disinfection of warm water without affecting the lamp's efficiency. The patented system enables a quick, turbulent flow through thus preventing microbiological debris.

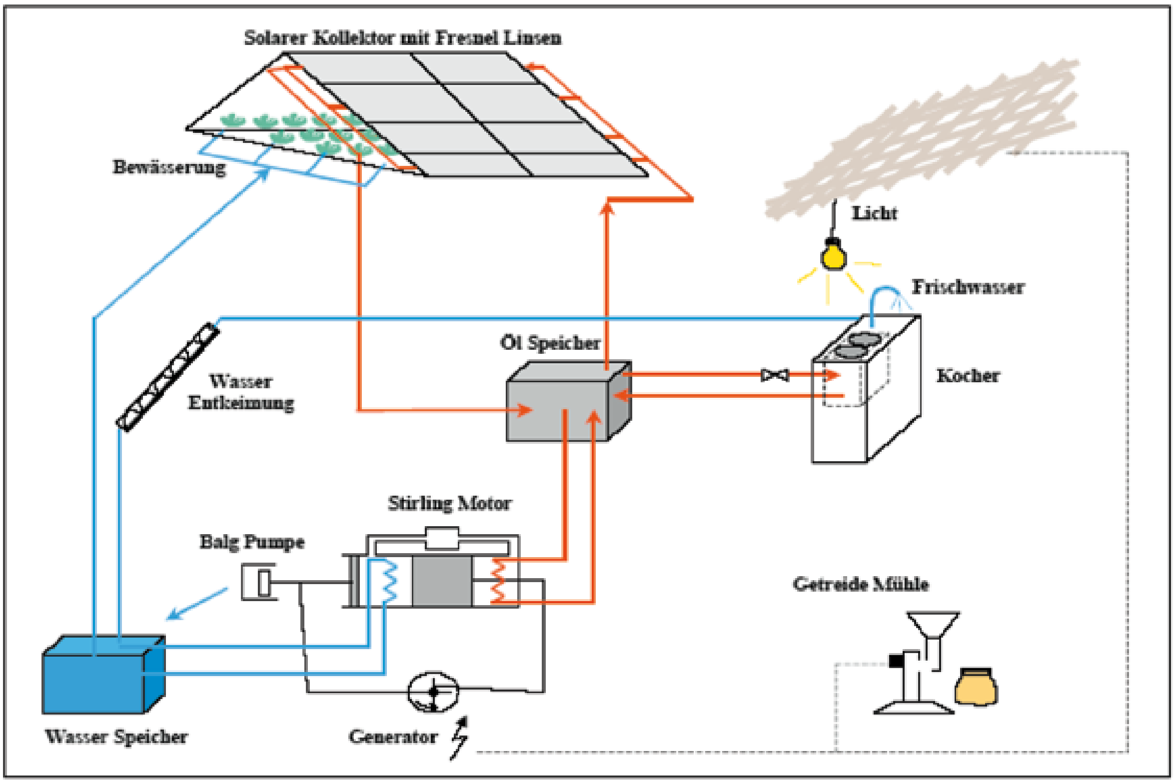
Ultraviolet light has a strong germ-killing effect in an area of 254 nm. The energy intensive radiation causes a damage to the cells by changing the DNA. Micro organisms which cause diseases die within a short period of time.

Another method of water recycling or purification consists in adding ozone, which oxides organic compounds thus neutralising them. While the ozone is normally produced externally the UVitt system allows for a combined production within the UV chamber. The O_3 developing at a wave length of 200 nm is added to the disinfection chamber, the residues are then detracted.

From this results a reliable drinking water purification which can contribute to the worldwide improvement of the hygienic situation in an efficient, inexpensive way without requiring specific expert knowledge.

Economical Realization

The „Solar Power Village" is structured in a modular way, in a way that the equipment and the performance can be completed as per the individual user(s) need. It can also be accomplished by cooling or water purification systems via solar UV radiation.



For the most part the "Solar Power Village" technologies can be produced in the countries of their application. This allows for local economic development and the acquiring of skills; the dependency on foreign countries decreases. The "Solar Power Village" can be realized as a supply coop, where the users as members of the co-operative pay for the services/commodities they use (heat, water, electricity). The system remains in the ownership of the co-operative which assures the maintenance and acquires further financial means. Jobs are created within the region in a way which maintains the buying power. The coop structure can be enlarged and applied on further economic activities like food production and distribution as to further a decentralized and independent development basing on self-aid.

Final observations – further steps

Not only shall the technology, training and transfer centre (TTT-Plattform) Tamera continually expand and demonstrate the idea of autonomy at village level all over the world during the coming years, thereby cooperating with research and development groups from all over the world, via training and (know-how) transfer Tamera shall also help to build up real, self-sufficient settlements, particularly in the poorest crisis areas of the world. Simultaneously, the "Solar Power Village" technology, exemplarily described for arid zones in the present pamphlet, shall also be adapted to other (tropical or subtropical) climatic situations. In the dialogue with the latter users and with the help of their direct co-development a variety of locally adapted technologies will be developed this way.

The building up of another "SolarVillage" as a Peace Village in the Middle East (www.prvme.org) is under preparation.

In its company agreement the internationally operating U.S. business „Sunvention", whose intention is to leverage the technological principle of multifunctional energy greenhouses to a breakthrough in the market in the wealthier countries, established the ethic stipulation to give 10% of their profit for the sponsoring of "Projects for the South" as described in this brochure.

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For further information:

www.tamera.org

Tamera, Monte do Cerro, 7630-932 Colos, Portugal
Tel. Office Tamera: +351 / 283 635 306
Tel. Office SolarVillage: +351 / 283 635 313
Fax: +351 / 283 635 316

Projectgroup SolarVillage
Your contact person: Barbara Kovats
solarvillage@tamera.org