

INTEGRATED STRATEGIES TO SOLAR COOKING/ WATER PASTEURIZATION, THAT INCLUDE OTHER SUSTAINABLE TECHNOLOGIES THAT ADVANCE MDG'S IN NEPAL

Drs. Ir. Allart Ligtenberg

Friendly Appropriate Solar Technologies (FAST)
800 Loyola Drive
Los Altos, CA 94024
USA

aligtenber@aol.com , www.fast-solar.com , http://solarcooking.wikia.com/wiki/Allart_Ligtenberg

INTERNATIONAL WRERCE CONFERENCE "RENEWABLE ENERGY FOR OUR FUTURE"
NOVEMBER 5-7, 2007 JAKARTA, INDONESIA

ABSTRACT

My objective in 1992 was to start a sustainable solar cooking and water pasteurization program solving Nepal's severe health, environmental and energy problems. Solar cooking was not practiced at the time. Successful strategy: Find "Champion" organization(s), create Awareness with public/private demonstrations, Building the infrastructure and Continuous follow-up on programs each year. Train how to use, design and fabricate solar cookers, water pasteurizers, dryers and heat-retaining boxes. Advise organizations how to become successful in solar. Help start new NGO's and businesses. Identify reliable workshops producing quality solar devices on time. Teach responsible ECO-tourism with trekking organizations and lodge keepers. Design a 400-gram solar backpack cooker for effective dissemination and 3 kg collapsible parabolic (1 m) cooker for remote and rural households, and trekking/expedition groups.

New initiatives:

INTEGRATED COOKING method adds fuelwood-efficient, smokeless "Rocket stoves" to solar cookers.

FURTHER INTEGRATED STRATEGIES ADVANCING MDG'S (Millennium Development Goals): solar space heating, Photo-Voltaics, efficient WLED lights, biomass briquettes, composting, toilets, offer complete health, energy, environment, women empowerment solutions.

Initiating a Renewable Energy School teaching all RE technologies, plus carpentry, metalworking and small-business skills. A skilled workforce of RE entrepreneurs will disseminate RE technologies and create jobs.

Initiating 12 Rotary Matching Grant programs (10 in Nepal) in 5 years, resulting in training, fabrication and distribution of solar/sustainable devices, empowering women and improving quality of life for 2200 families (14000 people).

Keywords: solar cooker, water pasteurization, dryer, renewable energy, health, environment, Rocket stove, heat retaining box, biomass briquettes, ECO tourism, trek, Rotary, women empowerment, MDG's, Millennium Development Goals, CDM, Clean Development Mechanism

1. INTRODUCTION and BACKGROUND

Nepal's rapid growth in population and tourism has increased demands on a very delicate environment. Scarce natural resources such as fuelwood, which provides almost all of Nepal's energy needs, are being depleted rapidly. Deforestation and landslides result. Smoky interiors cause severe lung and eye problems. Open fire burns can affect and scar people for life. Many die from waterborne diseases, or have prolonged health problems due to contaminated drinking water. There is a loss of productivity when people are sick and when people (usually women)

have the burden of collecting firewood at increasing distances. Solar cooking and water pasteurization can significantly solve Nepal's very critical health, environmental and energy problems. Another nice benefit is the resulting empowerment of women.

After trekking in Nepal in 1979, I fell totally in love with this beautiful country, its people, diverse cultures, mountains, etc. During subsequent visits and solo-treks in remote regions, I documented severe environmental deterioration and health problems. An early retirement incentive from my engineering managers job at Hewlett-Packard in 1992

allowed me to follow my dream of promoting solar in developing countries, with emphasis on Nepal.

In 1992 solar cooking and solar water pasteurization was not being practiced in Nepal. My objective was building a sustainable solar cooking/water pasteurization program, later to be expanded to other sustainable technologies. All devices should be made locally providing jobs and income. Each year I return to Nepal to FOLLOW-UP for 2 - 3 months to ensure success, start initiatives and go trekking. Another 2 months of solar projects is spent in other developing countries such as Mongolia (Ref. 7), Indonesia, South America and Mexico.

2. PROGRAM STRATEGIES

Find and create “champions”.

Identify and work with competent organizations that can “champion” the solar cooking cause that would be a natural addition to their existing programs. This champion can be on the national, regional, city, village, organization, or individual level. For example, in 1992 it was extremely critical for my initial success to find and convince CRT (Centre for Rural Technology - www.crtnepal.org) to be the first organization in Nepal willing to put solar cooking/water pasteurization into their programs. On the regional level I got solar cooking started in the Annapurna Conservation Area through an ACAP office in Manang. In the Mount Everest region, lodge keepers, religious Buddhist leaders (including the Rimpoche of Tyangboche monastery) and Himalayan Rescue Association doctors became my champions. I helped the Vajra Foundation initially with contacts in Nepal and they have done a great job in the Bhutanese refugee camps where solar cookers are being produced and used. By convincing many Rotary Clubs to start programs in their “adopted” villages in the Kathmandu valley, they became champions.

Since 2002 I work very closely with FoST (Foundation for Sustainable Technologies -

www.fost-nepal.org), a truly passionate and real Champion organization. Many champions became close friends.

Create awareness.

Give demonstrations and presentations to any organization or individual who is willing to listen to you. Many times they turned into solar champions or they bought solar cookers and other devices. Repeated public solar cooking demonstrations have created awareness, particularly with television, radio, newspaper coverage and interviews. Many kinds of solar technologies have been shown in science TV programs. Awareness efforts should continue at all levels till solar cooking becomes mainstream.

Promote good organizations and create links between them, expanding into collaborative working relationships.

In Nepal’s culture with its many casts and ethnic groups it is often hard to build up new business relationships. Frequently a knowledgeable “outsider” can act as a “catalyst”, bring parties together, recommend solar programs, show advantages of cooperating and even selling each others products on a commission basis.

Teach water pasteurization principles and tests.

Heating water to 65 Degrees Centigrade (149 F) is sufficient to kill all microbes harmful to people (see Ref. 1 and 2). Simple WAPI’s (Water Pasteurization Indicators), developed by Solar Cookers International indicate water has reached at least 69 C (extra safety margin). WAPI’s (fig.1) are made out of polycarbonate tubing with Myverol soybean “wax” inside that melts at 69 C. This reduces the required energy more than 50 percent compared to boiling. WAPI use can prevent illnesses caused by contaminated water. Each year I bring WAPI’s and a set of 100-200 water test tubes from IDEXX Laboratories (Ref. 3). These 20 ml test tubes can test drinking water in the field for Coliform and E-coli microbes by simply incubating water samples at body temperature. Just keep them

on your body in the dark for 24 hours. When samples turn yellow, water is contaminated. If they become fluorescent when shining an UV light on them E-coli or fecal material is present. FoST now makes WAPI's locally out of cut see-through ballpoint pens (fig.2) and Myverol material that I donate.

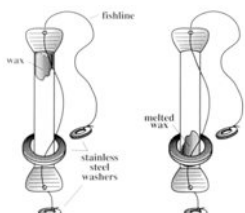


Fig. 1
Water Pasteurization Indicator (WAPI)



Fig. 2
WAPI's made in Nepal



Fig.3 Water Pasteurizers - different types made by FoST

Low-cost Water Pasteurizers have been developed and marketed (fig. 3) in the last 5 years.

Promote simple solar dryers and water heaters.

These devices are more easily accepted and can serve intellectually as “stepping stones” towards similar built solar cookers. High quality dried fruits, herbs, vegetables and meats can provide healthier food, generate income and empower women.

Solar showers are getting somewhat popular now on certain trekking routes. Solar water heaters have been “mainstream” in Kathmandu valley and the bigger cities for many years.

Promote “heat retaining boxes” also called “hay boxes”, or “retained heat cookers”. They reduce required energy as follows. After water is brought to boil (any method) the rice is added, and the pot is taken away from the solar or other stove, to be placed inside a well-insulated box (or basket or blanket). The rice keeps cooking since the heat is retained in the box (Fig 9). The cooked rice will also stay hot for hours.

Solar Backpack “Trekking” Cooker (400 gram):

I designed this roll-up backpack cooker to be fast and effective in demonstrating solar cooking in remote and rural areas as well as in the cities. Because of its lightweight and small size, I always carry it with me, just in case the right opportunity presents itself to discuss solar or to use it (fig.4, 5, 6). It pasteurizes a beverage can-size pot of water, or prepares soup or tea in 20 minutes. Rice takes only 35 minutes to cook.



Fig.4 Drinking solar soup and preparing lunch with Solar Backpack “Trekking” Cooker (made by FAST), Everest view



Fig.5 Lodgekeeper learns solar cooking

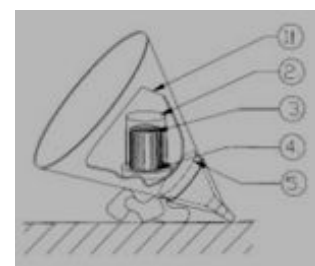


Fig.6 Diagram Solar “Trekking” Cooker

□ **I designed a powerful, collapsible, light weight (3.5 kg) parabolic solar cooker for trekking agencies and households.** In the year 2000, I installed this 1-meter diameter cooker at Everest Base Camp for use of the Everest 2000 Environmental Clean-up Expedition (fig.7). If trekking groups and expeditions use solar and heat-retaining technologies, they would automatically disseminate solar cooking, providing a nice multiplier effect. Bringing lightweight collapsible parabolic cookers for households in remote villages minimizes transportation costs.

My design is available for free to reputable Nepalese organizations such as FoST that is fabricating them now.



Fig.7 Parabolic “Sagarmatha” solar cooker (made by FAST) in action at Everest base camp

□ **Promote/teach responsible ECO tourism to minimize environmental deterioration.** I have given workshops to trekking agencies, Nepal Tourism Board, as well as tourist groups on solar cooking, drinking water pasteurization, retained heat cooking, solar showers and space heating, low-cost insulation concepts, efficient WLED solar lighting. Ref. 4, “*Fuel wood savings and Carbon reduction through simple, low-tech solar & other sustainable devices*” is a 2002 report that I wrote for the Dutch development organization SNV/Nepal as a road map towards successful ECO-tourism. During treks I demo and promote these ideas with National Park personnel and lodge keepers.

□ **Interview lodge keepers on fuelwood use.** An average “typical” lodge (10) with 10

trekkers staying overnight plus another 10 trekkers having a snack or tea when passing through, uses one backload (40 kg) of fuel wood per day. Table 1 shows extrapolated fuelwood needs when different numbers of trekkers stay and pass through.

TABLE 1. FUELWOOD USE IN TREKKING LODGES

Energy use in kg	“typical” lodge(10)	lodge (15)	lodge (5)
Total fuelwood/day	40.0 kg	53.3 kg	25.8 kg
Cook meals/soups	20.0 kg	23.3 kg	12.5 kg
Boil drinking water & tea	5.0 kg	7.5 kg	2.5 kg
Space heating	6.7 kg	10.0 kg	6.7 kg
Hot bucket showers	8.3 kg	12.4 kg	4.2 kg
Energy use in %			
Cooking	50.0%	43.8%	48.4%
Boil drinking water & tea	12.5%	14.1%	9.7%
* Space heating *	16.7%	18.8%	25.8%
Hot bucket showers	20.8%	23.3%	16.1%

□ **Fuelwood savings potential with solar cookers in trekking lodges.** There are different methods to calculate savings for cooking food and heating water using solar cookers. The easiest method to understand and probably most practical to use, is calculating the savings for producing boiling water, regardless if that water is going to be used in cooking, drinking water, or hot bucket showers. One SK 14 (1.4 m diameter) parabolic cooker boils 4 liters of water in 25 minutes in Kathmandu and faster at higher altitudes due to higher intensity of sunlight and lower boiling temperatures. Assuming 4 hours of sunshine per day this will produce at least 32 liters of boiling water allowing plenty of time between consecutive batches of water. That represents about 9 kg of wood savings per day in the typical stoves used here.

Table 2. shows wood savings for 3 sizes of tourist lodges when adding 1, 2 or 3 SK14 solar cookers.

TABLE 2. ENERGY SAVINGS IN FUELWOOD WITH PARABOLIC SK 14 SOLAR COOKERS

	"typical" lodge(10)	lodge (15)	lodge (5)
1 Solar Cooker	9 kg	9 kg	9 kg
% savings	22.5%	16.9%	34.8%
2 Solar Cookers	18 kg	18 kg	18 kg
% savings	45.0%	33.8%	69.7%
3 Solar Cookers	27 kg	27 kg	* 18 kg
% savings	67.5%	50.6%	* 69.7%

* same savings with 2 or 3 solar cookers for tourist lodge(5)

For an estimated total of 1428 trekking lodges, wood savings in 7 months trekking season would be 2.7 million kg with one SK14 and 5.4 million kg with two SK14's per lodge. Further reductions are feasible with heat retaining boxes and pasteurizing water. This is a good CDM (Clean Development Mechanism) candidate that will improve health and poverty in Nepal's delicate mountain areas.

□ Continuous FOLLOW-UP on all programs and organizations year after year is critical for success.

Results of my solar cooking and water pasteurization programs have been documented from 1992 to 2001 in conference papers, articles and Solar Cookers International's newsletters, (Ref. 5, 6, 7, 8). Some additional and more recent approaches follow in Section 3.

**3. NEW PROJECT STRATEGIES
ADVANCING MDG'S:**

Because so much more needs to be done I wanted to speed up the solar "cause" as well as MDG's (Millennium Development Goals)

and try four additional approaches and initiatives:

- 1) Form new, action-driven, enthusiastic solar NGO's or businesses.
- 2) Introduce INTEGRATED cooking method adding very efficient almost smokeless fuelwood stoves, and INCLUDE all other sustainable technologies that advance MDG's.
- 3) Join Rotary in 2002, advancing the cause of solar programs through Rotary's network and humanitarian Matching Grants.
- 4) Start a Renewable Energy School.

3.1 Help form new, action-driven, enthusiastic solar NGO's or businesses that can "make a difference"

This will increase solar dissemination and also competition between organizations. Customers will get more choices in selecting devices or project proposals.

In 2000 I helped with forming a new NGO PECON that produced high quality solar box cookers and dryers. Carpenters were fed solar food from the cookers they made.

In 2000 in Kathmandu, I got to know Mr. Sanu Kaji Shrestha, a solar enthusiast like me. After he retired from the World Bank in 2002 he formed the Foundation for Sustainable Technologies (FoST) to promote and disseminate sustainable technologies that improve quality of life. As a volunteer consultant expert of the Dutch government's NMCP program, I helped advise FoST in technical, marketing and business matters for a period of 3 months. Matching Grant projects of my Rotary Club helped FoST to get "off the ground" and become a very successful champion organization. By identifying quality workshops we solved the major "supply" problem of limited device production of the past. For the first time in Nepal, higher volume quality solar-sustainable devices can be produced on time. FoST's close cooperation with these workshops also allows for rapid prototyping, which is key in innovating and improving devices. FoST's tireless work, dedication and creativity guarantee successful implementation of programs.

3.2 Integrated approaches to solar cooking and other technologies/projects

3.2.1 When there is not enough sun to solar cook, it is important to have an alternative, environment-friendly cooking solution that is healthy, minimizes smoke, and saves fuelwood, kerosene, gas or electricity. Therefore I now follow an INTEGRATED approach to solar cooking and water pasteurization, adding very efficient, almost smokeless, fuelwood cook stoves to the solar programs for greater success. These so-called “Rocket stoves” have been developed by Aprovecho Research Center NGO (www.aprovecho.org) in the USA. Rocket stoves in combination with heat-retaining boxes (Fig.8, 9) reduce fuelwood consumption by more than 50 percent compared to traditional stoves. Only 3 twigs of wood are needed to cook a meal for a typical family. One has to slowly feed the wood into the stove. Using a “skirt” around the pot increases the efficiency even more by guiding the hot flue gases between pot and skirt. Heat-retaining boxes do more than just keeping food warm, they can actually cook: after water is put to a boil using any type of stove, one can add rice or lentils and then place the pot in a heat-retaining box (sometimes called hay box). The box is so well insulated, that the cooking still goes on inside and will be completed without adding any energy.



Fig.8 Rocket stove Fig.9 Heat-retaining box both used in rural villages

3.2.2 INTEGRATED approach is carried even further by **including other energy/health/environment-friendly technologies in my projects that advance MDG's**, for a more complete solution or choice to the people.

Examples are solar space heating, PV (photo-Voltaics), lighting by extremely efficient, long-lasting WLED's (White Light Emitting Diodes), composting, composting toilets, bio-mass briquettes.

For example:

- **WLED lighting** is a clean alternative to dangerous and polluting kerosene light sources, resin-soaked twigs and candles used in rural areas. Efficient WLED's in torches reduce discarded batteries (often polluting soil and streams) by a factor of 10, or even 1000 when rechargeable batteries are used. PV panels for solar home-lighting systems can be smaller with WLED's.

- **Briquettes** made from biomass waste, compressed in hand presses burn clean and can provide income thus empowering women. First, shredded biomass from leaves, grass clippings, paper, cardboard, or sawdust needs to be soaked in water, after which it will be compressed into donut shaped briquettes using simple hand presses (Fig.10). After solar drying (Fig.11), these briquettes can be sold to provide fuel to cook on clean burning stoves (Fig.12).



Fig.10 Making biomass briquettes in press



Fig.11 Solar drying



Fig.12 Briquette stoves

- **Composters** turn kitchen waste into useful fertilizer. Composting toilets improve health, hygiene and environment.

3.3 Joining Rotary Club of Los Altos and promoting & implementing Rotary “World Community Services” solar sustainable projects in Nepal.

Rotary International through its humanitarian Matching Grants program encourages Clubs to assist developing countries. Over the last 5 years I successfully defined and implemented 12 Rotary matching and other grant projects (10 in Nepal). These projects help 2200 families or 14000 people long-term in solar, health, water, energy, environment, sanitation, women empowerment and income generation. Projects averaged about US\$ 8000. Rotary International evaluates grant proposals according to strict guidelines. Progress reports are mandatory; if not timely submitted, Rotary Clubs cannot enter new proposals. Our Matching Grant projects typically allow villagers to choose from solar cookers (box or parabolic), water pasteurizers, dryers, Rocket stoves, heat retaining boxes, briquette presses,

etc. up to a certain amount of money (Fig.13, 14, 15). Where possible beneficiaries pay 15 percent of device costs to show a real commitment. Some projects have educational component of teaching schools how to make and use simple panel cookers. Others include making bio-mass briquettes for fuel, empowering women to become micro-entrepreneurs selling briquettes and efficient stoves. I selected FoST as the primary organization responsible for training of the villagers, fabricating the devices and coordinating with Village Development Committees and Rotary.

3.4 School of Renewable Energy - initiative:

I initiated forming School of Renewable Energy (SRE) to solve Nepal’s major problems in energy, water, environment, sanitation, poverty and unemployment, by stimulating income generation and micro-enterprises The school will 1) develop a skilled workforce, 2) create major awareness in alternate sources of energy, 3) disseminate Renewable Energy (RE) devices creating high demand, 4) stimulate small RE businesses, 5) improve quality of life for the poor. SRE will teach solar thermal (cookers, dryers, water, space, pasteurizers), fuel-efficient stoves, Photo-Voltaics, WLED lighting, small-scale hydro, bio-gas, composting (toilets), “green building” techniques, social impacts, plus training in carpentry, metalworking (Fig.16, 17) and small business skills. A Rotary Matching Grant provided machinery, plus enough materials for students to fabricate devices, and learn how to introduce them to 150 families.



Fig.16 Carpentry & Fig.17Metalwork training

Fig. 13, 14,15 Distributing solar & sustainable devices of Rotary Matching Grant projects

SRE even set up a temporary workshop in the impoverished Alapot village to train selected

villagers (Fig.18, 19). Other workshops are planned for East Nepal.



Fig.18,19 Training in solar cookers & Rocket stoves – Alapot village

If successful, SRE's dissemination of Renewable Energy devices and increased employment will address the severe Maoist insurgency problem that has its origin in the abject poverty of the country.

4. CONCLUSION

□ Spreading solar cooking/water pasteurization is still my main goal. However, **faster impact** on MDG's and improving poor quality of life is now accomplished with **inclusive integrated approaches** of other technologies that have similar health, energy, women-empowerment, and environment-friendly advantages. With more solutions to choose from, more people will use devices that improve lives and environment.

□ By becoming an active member of **Rotary** (or other service organization) you can greatly influence the direction of your Club's humanitarian and community projects, recommending solar/sustainable technologies. Rotary's Matching Grant programs significantly help making a difference in developing countries in areas of health, water, literacy, poverty, hunger, environment, etc. The Rotary network is very powerful. Key components for success are 1) a reliable and knowledgeable organization that executes the project, 2) an enthusiastic Village Development Committee, and 3) motivated Rotary Community Corps (RCC) members of the village that benefits from the project.

Volunteers from Rotary Interact Clubs (high school age) and Rotaract Clubs (young adults) often help with demonstrations, training, etc.

□ Encourage **business driven dissemination** of solar technologies and products so

programs rely less on donations and are better able to sustain themselves.

□ **Follow up, follow up and try new approaches.**

5. REFERENCES:

(1) Paul S., M.D. Auerbach (Editor), Wilderness Medicine : Management of Wilderness and Environmental Emergencies, Hardcover-3rd edition (1995) Mosby; ISBN: 0801670446

(2) Ciochetti, D.A., and R.H. Metcalf. 1984. Pasteurization of naturally contaminated water with solar energy. Applied Environmental Microbiology. **47**:223-228

(3) IDEXX Laboratories Inc. , One IDEXX Drive , Westbrook , ME , 04092 , USA, www.idexx.com

(4) Allart Ligtenberg, May 2002, Fuelwood savings & Carbon reduction through simple low-tech solar & other sustainable devices, SNV Eco-tourism report

(5) Allart Ligtenberg. July 12-15, 1994. Solar Trekking and Other Dissemination Strategies in Nepal. Second World Conference on "Solar Cookers - Uses and Technologies", at the University of Heredia, Heredia/San Jose, Costa Rica

(6) Allart Ligtenberg. Feb/March 1995. Solar Cooking in Nepal. Home Power (Hands-on Journal of Home-made Power), **45**: 24-28

(7) Allart Ligtenberg, Solar Cooking Dissemination Approaches and Experiences in Nepal, Mongolia and Peru, 8th Peru International Symposium of Solar Energy, Universidad Nacional del Altiplano, Puno, Peru, Nov 2000

(8) Allart Ligtenberg. Nov 2001. Nine years of solar Cooking in Nepal. Solar Cooker Review, SCI, [http://solarcooking.org/newsletters/scrnov01.htm#Nine years of solar cooking in Nepal](http://solarcooking.org/newsletters/scrnov01.htm#Nine%20years%20of%20solar%20cooking%20in%20Nepal)

(9) Allart Ligtenberg. July 2006. Solutions in Nepal: solar cookers, water pasteurizers, sustainable devices & integrated approaches with efficient fuelwood stoves. International Conference on Solar Cookers and Food Processing, Granada, Spain