

# **SOLUTIONS IN NEPAL: SOLAR COOKERS, WATER PASTEURIZERS, SUSTAINABLE DEVICES & INTEGRATED APPROACHES WITH EFFICIENT FUELWOOD STOVES**

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## **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. My successful strategy is: find "Champion" organization(s), create Awareness with public/private demonstrations, Build the infrastructure and do Continuous follow-up on programs each year (ABC). I also train how to use, design and fabricate solar cookers, water pasteurizers, dryers, heat-retaining boxes; advise organizations to become successful in solar energy use, help start new NGO's and businesses; identify reliable workshops producing quality solar devices on-time; and teach responsible ECO- tourism with trekking organizations and lodgekeepers. I designed a 400 gram solar backpack cooker for effective dissemination and a 3kg collapsible parabolic (1 m) cooker for remote and rural households and trekking/expedition groups.

### **New initiatives:**

- An INTEGRATED cooking method adds fuelwood-efficient, smokeless "Rocket stoves" to solar cookers. A further integrated approach offers complete health, energy, environment-friendly solutions with solar space heating, Photo-Voltaics, efficient WLED lighting, composting, toilets, and biomass briquettes.
- I initiated a Renewable Energy School teaching all RE technologies, plus carpentry, metalworking and small-business. The skilled workforce of RE entrepreneurs will disseminate RE technologies and create jobs.
- I initiated 9 Rotary Matching Grant programs in 3 years, resulting in training, distribution of solar/sustainable devices, empowering women, improving quality of life for 1700 families (11000 people).

**Keywords:** solar cooker, water pasteurization, health, environment, energy, dryer, Rocket stove, Rotary, trek

## **1. INTRODUCTION**

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 the very critical health, environmental and energy problems of the country. Another nice benefit is the resulting empowerment of women.

## **2. BACKGROUND**

Nepal has a very special place in my heart. When I visited and trekked for the first time in 1979, I fell totally in love with this beautiful country, its people, diverse cultures, scenery, mountains, etc. During frequent visits and solo-treks in remote regions, I observed and documented the severe environmental and health problems. An early retirement incentive from my engineering manager's position at Hewlett-Packard allowed me to follow my dream – 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 to build a sustainable solar cooking and water pasteurization program, later to be expanded to other sustainable technologies. All devices should be made locally (no importing from other countries), providing jobs and income generation. This paper shares my experiences and strategies in building the program. Each year I return to Nepal to follow up for typically 3

months to ensure success, start new initiatives and go trekking. Overall strategy is to create **A**wareness, **B**uild the infrastructure and **C**ontinuously follow-up on programs. Another 2 months per year is typically spent in other developing countries on solar projects.

### 3. PROGRAM STRATEGIES

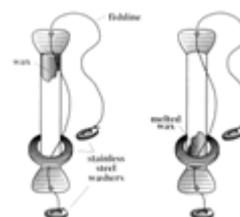
- **Find and create “champions”:** Identify and work with competent organizations that can “champion” the solar cooking cause that would be a natural addition to their programs such as health, renewable energy, water, environment, women empowerment, etc. This champion can be on the national, regional, city, village, organization, or individual level. For example, in 1992 it was extremely critical for initial success that I found and convinced CRT (Centre for Rural Technology) 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 box cookers and SK-14 parabolic cookers are being produced. By convincing many Rotary Clubs to start programs in their “adopted” villages in the Kathmandu valley, they became champions. In last few years I have been working very closely with FoST (Foundation for Sustainable Technologies), a truly passionate and real Champion organization. Many champions became close friends.

- **Awareness creation.** 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 and newspaper coverage. Frequent interviews on various TV and radio programs helped. Many kinds of solar technologies have been shown in science TV programs. Awareness creation 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 hard to build up business relationships. Frequently a knowledgeable “outsider” can act as a “catalyst”, bringing parties together, recommending solar programs, show advantages of working together and possibly sell each others products on a commission basis.

- **Teaching water pasteurization principles/tests.** Heating water to 65°C (150°F) is sufficient to kill all microbes harmful to people (see Ref. 1 and 2). Simple WAPIs (Water Pasteurization Indicators), developed

by Solar Cookers International, indicate water has reached at least 69°C (extra safety margin). WAPIs (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. WAPIs can prevent illnesses caused by contaminated water. Each year I bring WAPIs 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 in the water. WAPIs are now made locally by FoST (Foundation for Sustainable Technologies) out of cut-up, see-through ballpoint pens (fig.2) and with Myverol material that I donate. Low-cost Water Pasteurizers have been developed (fig. 3) in the last 4 years and marketed to people who may not want solar cookers but do want safe drinking water.



**Fig. 1**  
**Water Pasteurization Indicator. WAPI’s made in Nepal**



**Fig. 2**  
**Water Pasteurization Indicator. WAPI’s made in Nepal**



**Fig.3 Water Pasteurizers - different types by FoST**

- **Promote simple solar dryers and water heaters.** These devices are more easily accepted and can serve intellectually as “stepping stones” towards similarly built solar cookers. Drying fruits, herbs, vegetables and meats can provide income generation. 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

energy requirements 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 is still cooking because the heat is retained in the box. The cooked rice will also stay heated for hours.

**- Solar Backpack “Trekking” Cooker (400 gram).**

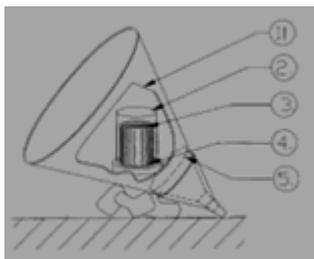
I designed this roll-up backpack cooker to be fast and effective in demonstrating solar cooking in remote and rural areas as well as in the cities. Because of its light weight and small size, I always carry it with me, just in case the right opportunity presents itself to discuss solar or to use it (fig.4,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



**Fig.4 Solar Backpack “Trekking” Cooker (made by FAST) preparing food or melting snow for drinking**



**Fig.5 Lodgekeeper learns about solar cooking**



**Fig.6 Diagram Trekking Cooker**

**- I designed a powerful, collapsible, lightweight (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 would use solar and heat-retaining technologies, they would automatically disseminate solar cooking, providing a nice multiplier effect. Bringing lightweight collapsible parabolic cookers to households in remote villages reduces transportation costs. My design has been made available for free to reputable Nepalese organizations.



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

**- Promoting/teaching 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. Local and international organizations asked me for advice on applying solar for responsible ECO-tourism. Ref. 4, “Fuel wood savings and Carbon reduction through simple, low-tech solar & other sustainable devices” is a 2002 report that I prepared for the Dutch development organization SNV/Nepal as a potential road map towards successful ECO-tourism implementation. During my yearly treks I target lodge keepers to implement these ideas with demos and discussions.

**- Interviews with lodge keepers on fuelwood use:**

An average “typical” lodge (10) with 10 trekkers staying overnight and 10 trekkers having a snack or tea when passing through, will use one backload (40 kg) of fuelwood per day. The fuel needs for lodge personnel are included in this amount.

**TABLE 1. FUELWOOD USE TREKKING LODGES**

	typical lodge(10)	lodge (15)	lodge (5)
Energy use in kg			
Total fuelwood/day	40.0 kg	53.3 kg	25.8 kg
Cooking	20.0 kg	23.3 kg	12.5 kg
Drink.water boiling	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%
Drink.water boiling	12.5%	14.1%	9.7%
* Space heating *	16.7%	18.8%	25.8%
Hot bucket showers	20.8%	23.3%	16.1%

\* NOTE: Dining hall separate from kitchen

Table 1 shows fuelwood for 1) cooking meals and soups, 2) boiling drinking water for tourists and

making tea for all, 3) heating of the dining room (and kitchen if not cooking) in the evening, and 4) hot “bucket” showers assuming that half of the tourists who stay overnight take a hot 15 liter shower. Table shows energy use of “typical” lodge (10 tourists), 15 tourists lodge and 5 tourists lodge.

To verify that these wood consumption numbers are reasonable, I checked out the 1994 ICIMOD reports “Management of National Resources: Assessment of Forest Conservation Program conducted by ACAP in Ghandruk VDC”, (Ref. 5) and “Case Studies from Ghandruk: Impact of Alternative Energy Technology in Reducing Pressure of Forest Resources”, (Ref. 6). Those reports show that the lodges’ average daily fuel wood quantity is 43.5 kg. My numbers are more conservative than the Ghandruk numbers, but they are “in the ball park”.

**- 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, hay boxes, water pasteurization, and Rocket stoves. 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 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 even some time between consecutive batches of water. Noting that 25 liters of boiling water requires 7 kg wood in the typical stoves used here, the 32 liters of water boiled by the sun represents 9 kg of wood savings per day. Table 2. shows fuelwood savings for the 3 types of tourist lodges with adding 1, 2 and 3 solar cookers.

**TABLE 2. ENERGY SAVINGS IN FUELWOOD WITH PARABOLIC SK 14 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 cookers for tourist lodge (5)

In the Langtang, Gosainkund, Helambu trekking areas I counted 185 lodges. Extrapolating the 37% growth in lodges in the area compared to ICIMOD’s 1994 data (Ref.7) results in an estimated total of 1428 trekking lodges in Nepal today. Fuelwood savings for 7 months trekking season would be 2.7 million kg with one SK14 and 5.4 million kg with two SK14’s at each lodge. This is a good CDM (Clean Development

Mechanism) candidate while also improving health and poverty condition in Nepal’s delicate mountain areas. Further reductions are feasible with heat retaining boxes and pasteurizing water instead of boiling.

**- 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. 8, 9, 10, 11). Some additional, more recent approaches follow in Section 4.

**4. NEW PROJECT APPROACHES/STRATEGIES**

I felt that in the new millennium four additional approaches and initiatives should be tried to speed up the “cause” because so much more needs to be done:

- 1) Form new, action-driven, enthusiastic solar NGO’s or businesses.
- 2) Introduce INTEGRATED cooking methods adding very efficient, almost smokeless fuelwood stoves.
- 3) I joined Rotary in 2002, advancing the cause of solar programs through Rotary’s network and humanitarian Matching Grants.
- 4) Start a Renewable Energy School.

**4.1 Help form new, action-driven, enthusiastic solar NGO’s or businesses that can make a difference**

This will provide competition between organizations. Potential customers get more choices of equipment or program implementations.

In 2000 I helped with the formation of a new NGO PECON that disseminated all solar technologies. They produced high quality solar box cookers and dryers. Their carpenters were fed solar food in the mornings and afternoons from the cookers they made. Unfortunately the director left the country in 2004 and the work stopped, at least for now.

In 2001 in Kathmandu, I got to know Mr. Sanu Kaji Shrestha, a solar enthusiast like me. After he retired from the World Bank he formed the Foundation for Sustainable Technologies (FoST) in 2002 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. We were able to solve the “supply” problem that slowed down dissemination progress in the past. For the first time in Nepal, higher volume solar/sustainable devices can be produced in a timely manner by quality workshops. 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.

#### 4.2 Integrated approach to cooking method & projects

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 cookstoves to the solar programs for greater success. These so-called “Rocket stoves” have been developed by Approvecho NGO 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.



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

INTEGRATED approach is carried even further by including additional energy/health/environment-friendly technologies in my projects to provide a more complete solution or choice for the people. Examples are solar space heating, PV (photo-Voltaics), lighting by extremely efficient, long-lasting WLEDs (White Light Emitting Diodes), composting, composting toilets, bio-mass briquettes.

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

#### 4.3 Joining Rotary Club of Los Altos and promoting and 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 3 1/2 years I defined and successfully implemented 9 Rotary matching and other grant projects in Nepal. These projects help 1700 families or 11000 people long-term in solar, health, water, energy, environment, sanitation, women empowerment and income generation. Grants averaged about US\$7000. Rotary Int’l evaluates grant proposals

very closely according to strict guidelines. Progress reports are mandatory; if not submitted on timeclubs will not be allowed to enter new proposals.

Our Matching Grant projects typically allow villagers to choose from solar cookers (box or parabolic), water pasteurizers (including locally made WAPIs), dryers, Rocket stoves, and heat retaining boxes up to a certain amount of money (Fig.10, 11, 12).



**Fig. 10, 11, 12 Handing out solar and sustainable devices of Rotary Matching Grant projects**

Where possible, beneficiaries pay 15 percent of device costs to show a real commitment. Some projects also have an educational component of teaching schools how to make and use simple panel cookers. Another includes making bio-mass briquettes for fuel from any waste material (grass clippings, shredded leaves, newspapers, cardboard) in hand-operated presses. Briquette programs empower women to become micro-entrepreneurs selling briquettes for use in 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. When I am not in Nepal, we communicate through e-mail.

#### 4.4 School of Renewable Energy - a new initiative

The School of Renewable Energy (SRE) was formed to help solve Nepal’s major problems in energy, water, environment, sanitation, poverty, unemployment, and 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, and 5) improve quality of life for the poor and Nepal as a whole. SRE will teach solar thermal (cookers, dryers, water/space, pasteurizers), fuel-efficient stoves, PV, WLED lighting, small-scale hydro, bio-gas, composting (toilets), “green building” techniques, social impacts, plus training in metalworking, carpentry (Fig.13, 14), and small business skills.



**Fig.13,14 Metalworking & carpentry hands-on training**

A Rotary Matching Grant provides machinery, plus enough materials for 80 students to fabricate devices, and learn how to introduce them to 180 families. SRE even set up a temporary workshop in the impoverished village of Alapot to train selected villagers (Fig.15, 16). This could be the start of a “Solar Village”.



**Fig.15, 16 Orientation training of Alapot women group**

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

## 5. CONCLUSION

Spreading solar cooking/water pasteurization is still my main goal. But **faster impact** on poor quality of life is accomplished with **inclusive approaches** to other technologies that have similar health, energy, women-empowerment, environment-friendly objectives. With more solutions to choose from, more people will buy devices that improve their lives and the environment.

By becoming an active member of **Rotary** (or other service organization) you can greatly influence the direction of your Club in humanitarian and community projects, recommending solar/sustainable technologies. Rotary’s Matching Grant program significantly helps

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

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

## 6. 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) Management of National Resources: Assessment of Forest Conservation Program conducted by ACAP in Ghandruk VDC”, ICIMOD report, 1994
- (6) Kamel Banskota & Bikash Sharma, Case Studies from Ghandruk: Reducing Pressure of Forest Resources”, ICIMOD Discussion Paper, 1997
- (7) Dieter Hanck , Trekking tourism in Nepal, 1994, ICIMOD Publ.# 381.459104 HAT
- (8) 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
- (9) Allart Ligtenberg. Feb/March 1995. Solar Cooking in Nepal. Home Power (Hands-on Journal of Home-made Power), **45**: 24-28

(10) Allart Ligtenberg, Solar Cooking Dissemination Approaches and Experiences in Nepal, Mongolia and Peru, 8<sup>th</sup> Peru International Symposium of Solar Energy, Universidad Nacional del Altiplano, Puno, Peru, 13 – 18 November 2000

(11) 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

