

Nonimaging reflector concentrator thru-wall trough solar kitchen studies

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July 7, 2014

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Presentation outline:

Types of thru-wall kitchens

Cookware targets for nonimaging reflectors

Examples of demonstrated reflector-substrates

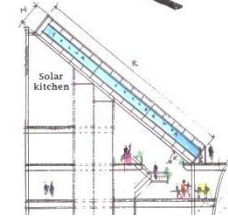
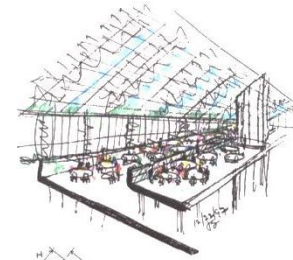
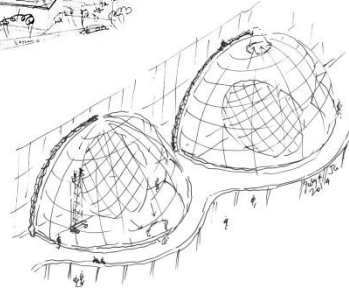
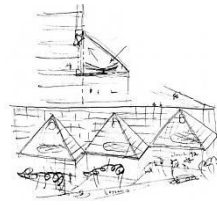
Building-size integrated reflector technologies

HOUSE thru-wall kitchen studies

MID-SIZE and RESTAURANT Thru-wall kitchen studies

TRAILER and CONTAINER Thru-wall kitchen studies

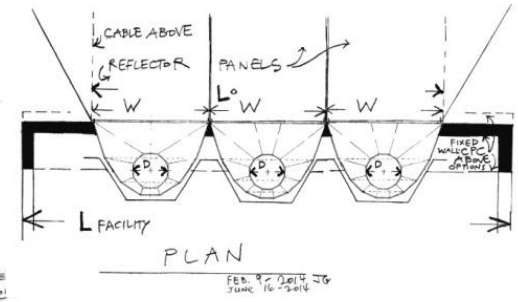
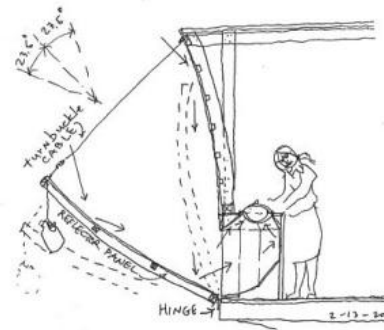
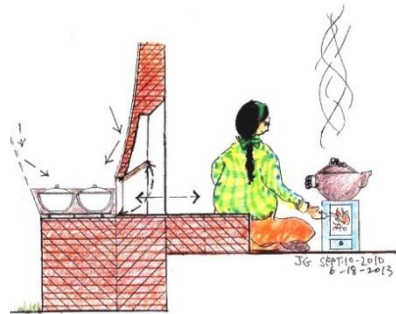
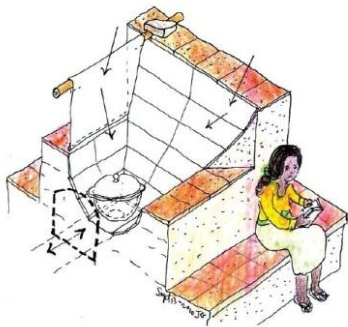
Stand-alone solar cooker LED reflector set



Augmented evacuated tubes

Interior Schefflers High rise solar restaurant

There are several types of building integrated solar kitchen possibilities.

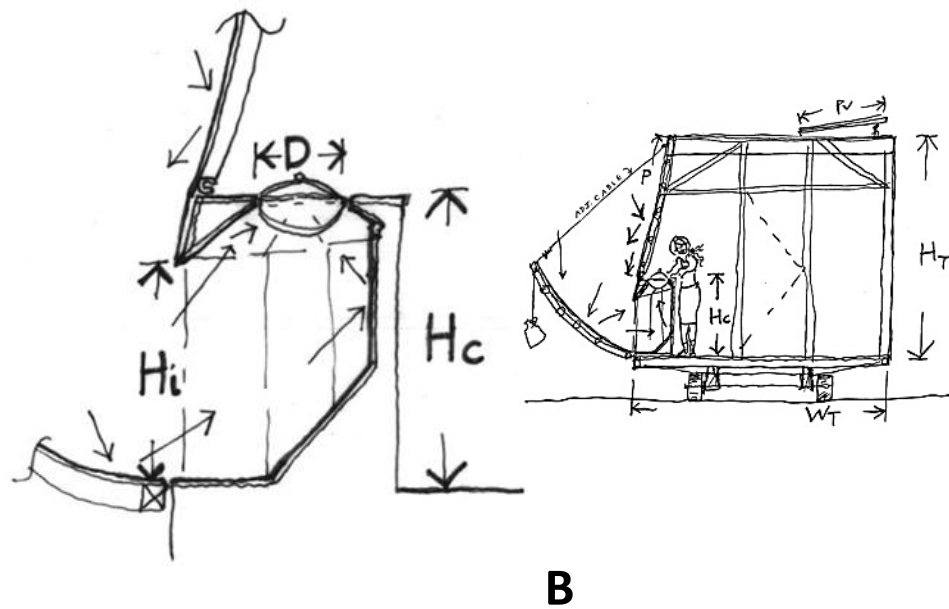
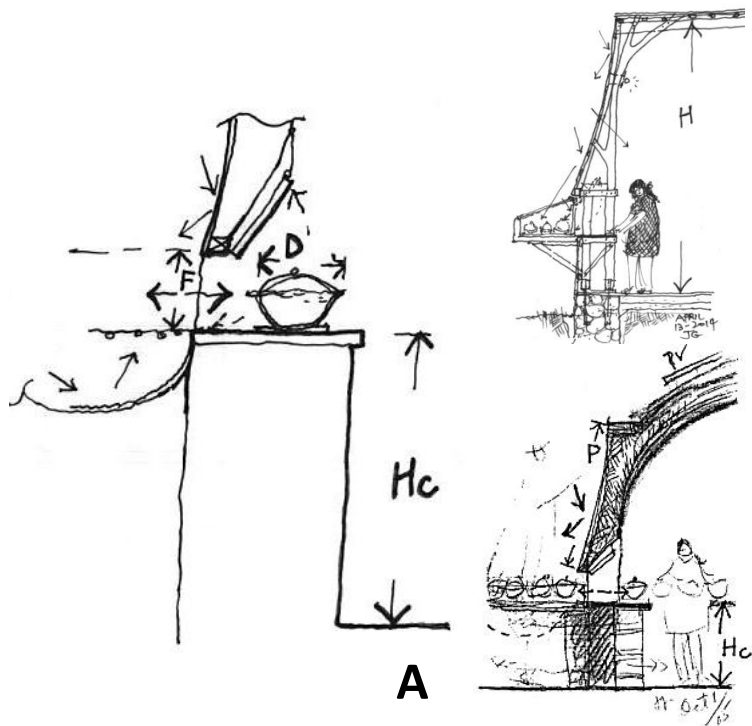


This presentation focus is for thru-wall solar kitchen buildings and trailers.

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Thru-wall solar cooker building-size nonimaging CPC-type trough reflector non-tracking configurations include:

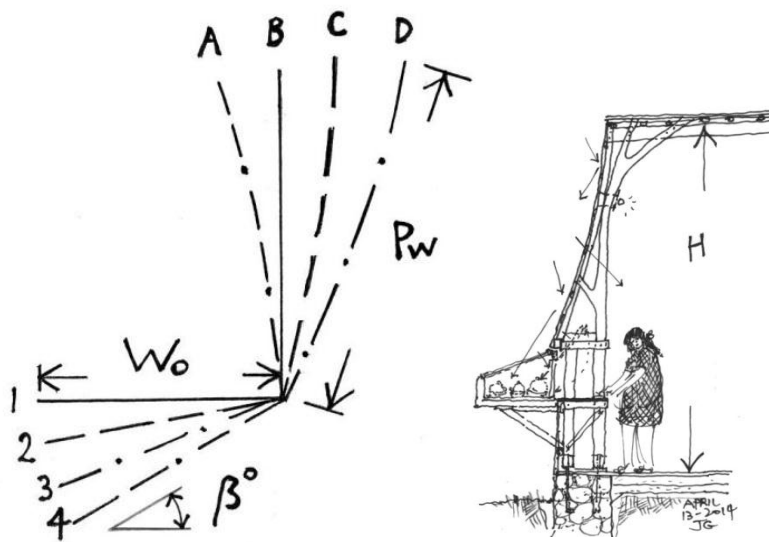
A--Slide in-out food container cookware thru reflector wall.

B --Reflected sunlight thru-wall scoop-up to underside of cookware.

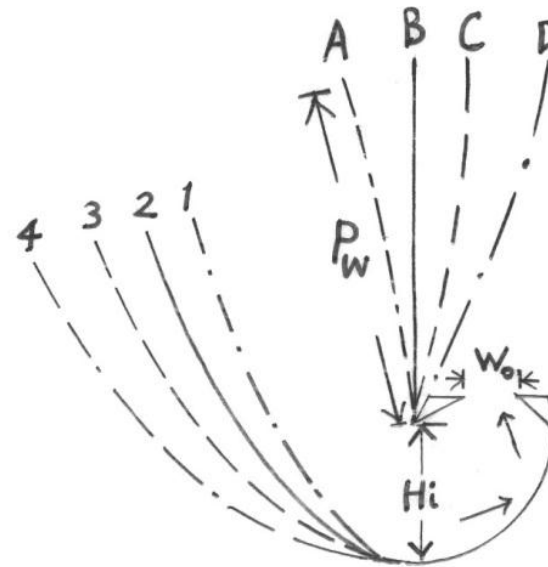
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A



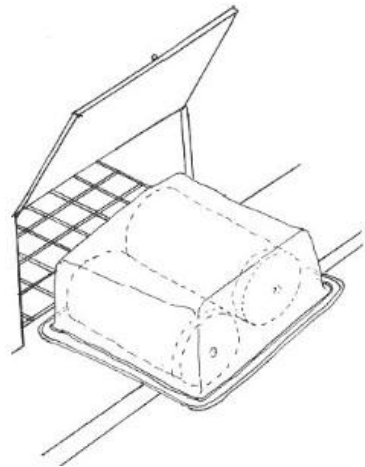
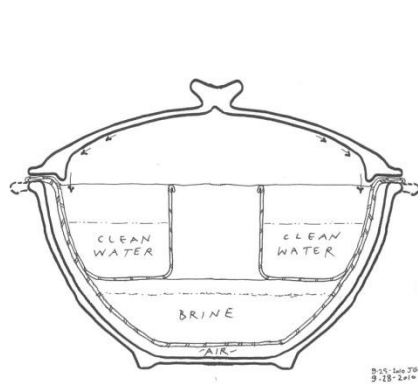
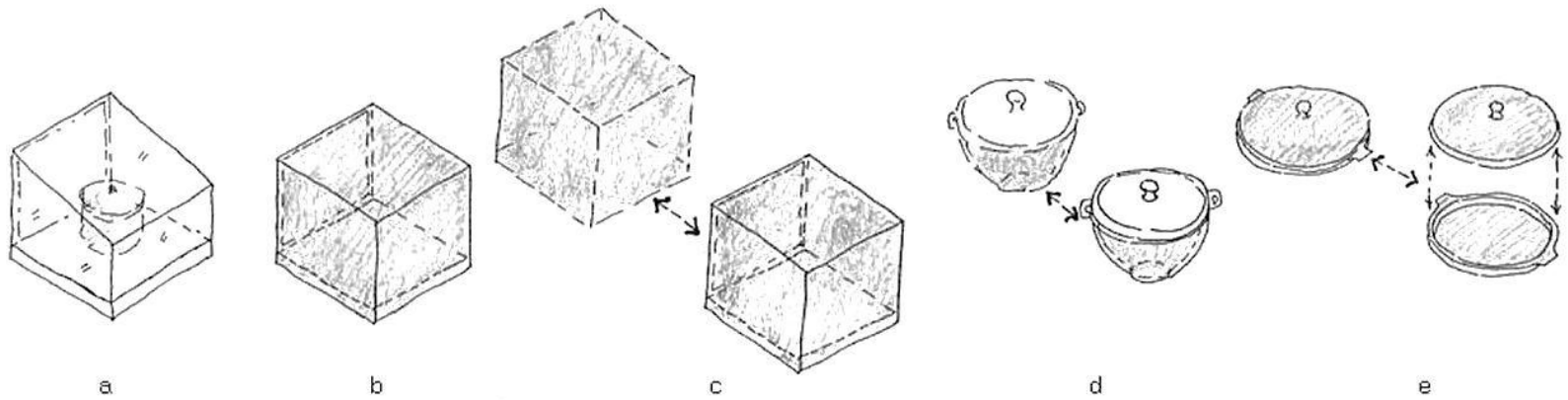
B

Thru-wall nonimaging reflectors optical configuration types

Nonimaging reflectors **optical-thermal design references** for selected regional latitude-range locations based on selected cookware and autoclave targets are needed for building technology studies. The solar concentrating scoop-upward configuration (B) does not require large glass plates used for box cookers (A).

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Selection of cookware, ovens, autoclaves, stills, etc. defines target shapes and sizes for nonimaging reflectors solar thermal-optical design studies

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Reflector-substrate demonstrated materials:

A-- Glass mirrors (flat, curved)

B-- Metal (anodized aluminum, stainless steel)

C-- Film on substrate



Spherical Segment
Bowl, Auroville, India



Portugal, Prof. Ruivo



Tracking parabolic
trough facets

Reflector-substrate demonstrated materials:

A-- Glass mirrors (flat, curved)

Flat glass mirror tiles for fixed nonimaging troughs could be larger tiles than for bowl shaped concentrators.

Nonimaging reflector concentrator thru-wall trough solar kitchen studies

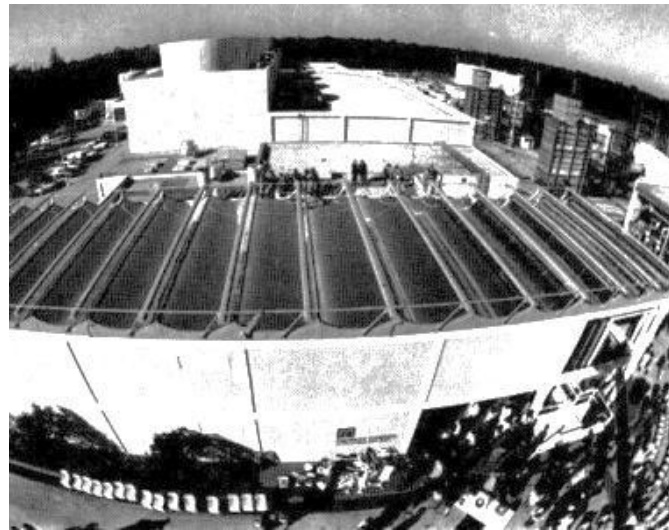
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Strawberry Fields by James Lambeth, AIA c1974, Spring Field, Missouri



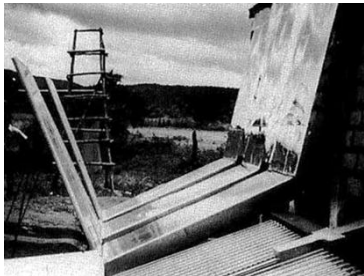
Silo house, New Jersey by Jersey Devils, 1975



Reedy Creek, Disney Orlando c1978



PowerRoof by Solargenix



Africa, Synopsis

**Reflector-substrate demonstrated materials:
B- Metal (anodized aluminum, stainless steel)**



Mexico, E. Rincon

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Exterior tracking parabolic troughs



Interior tracking troughs GlassPoint Solar

Reflector-substrate demonstrated materials:

C-- Film on substrate

Fixed nonimaging reflector walls would have a slightly different parabola segment curvature.

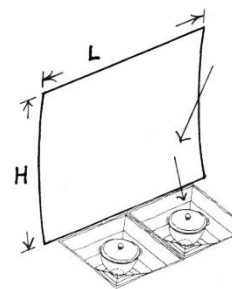
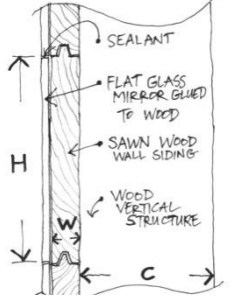
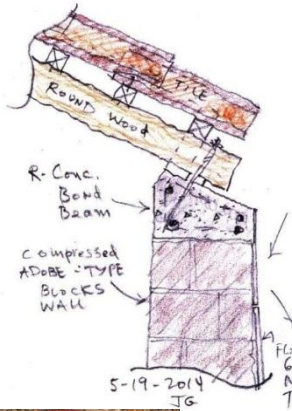
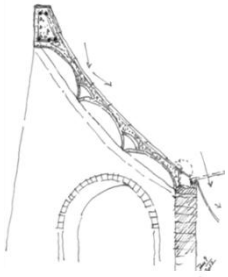
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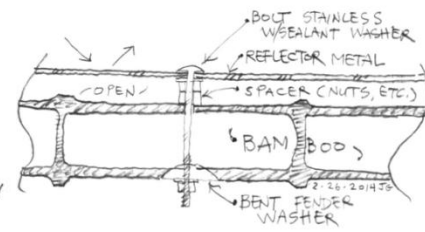
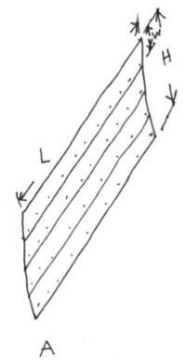
Building-size integrated reflector technology studies

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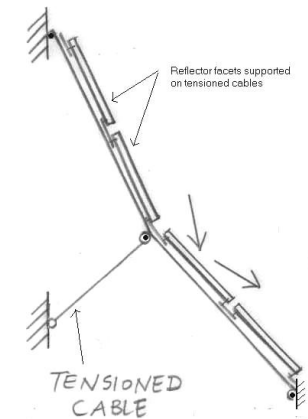
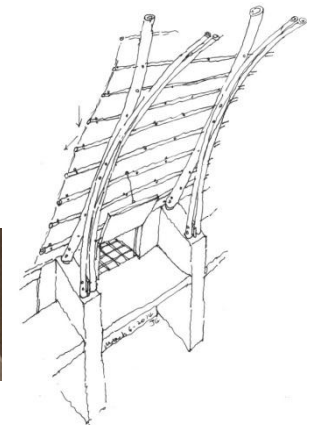
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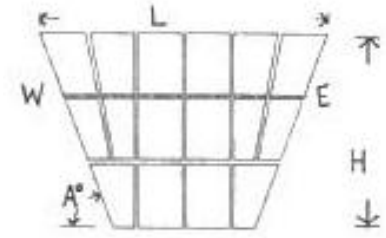
A



B



Schematic SECTION
Joel Goodman Jan 10-10



C

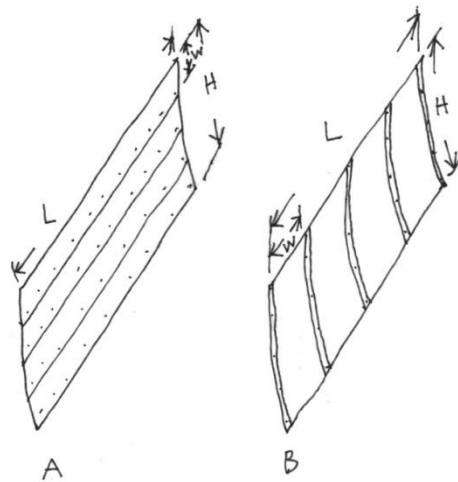
Building-Size Integrated Reflector Technology Studies:

- A-- Reflectors glued to masonry, concrete, wood
- B-- Metal reflector supported on round wood
- C-- Reflector facets supported on tensile cable structures

Nonimaging reflector concentrator thru-wall trough solar kitchen studies

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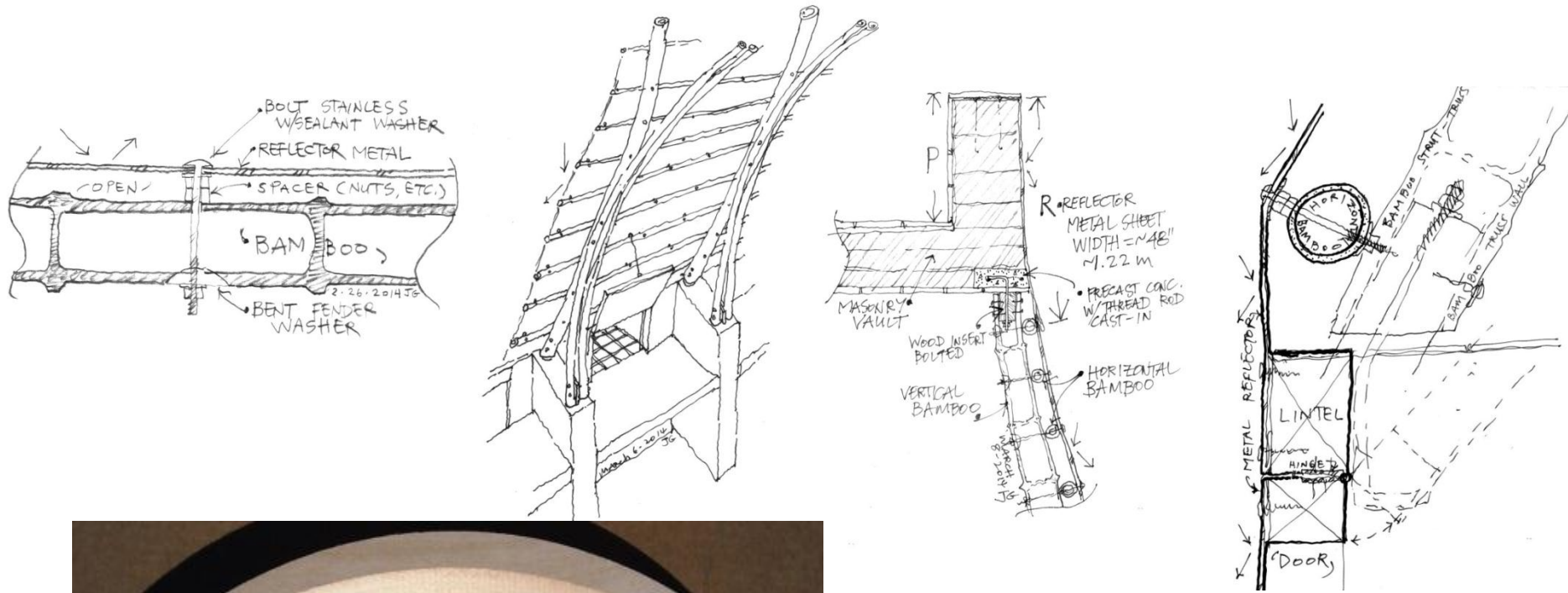
Nonimaging reflector concentrator walls

Nonimaging reflectors can ease construction tolerances and sheet metal reflectors (anodized aluminum, etc.) can withstand some building deformation movements (seismic tremors, etc.) without repair requirements with minor energy gain losses. Anodized aluminum can tolerate some bending and twisting before tearing. Wall reflector sheet patterns: Horizontal with overlapping creased joints (A); and Vertical with vertical cap strips (B). Comparing durability, flat glass mirrors glued to substrates (plywood, etc.) may be better than anodized aluminum reflector sheet for about “10 years”. Lambeth used stainless steel sheets with vertical cap strips pattern B.

References: Hunbae and C. Lambeth, 1993, “Sundancing, The Art and Architecture of James Lambeth”, Miami Dog Press ; and Lambeth, James and John D. Delap, Solar designing, 1977, privately published

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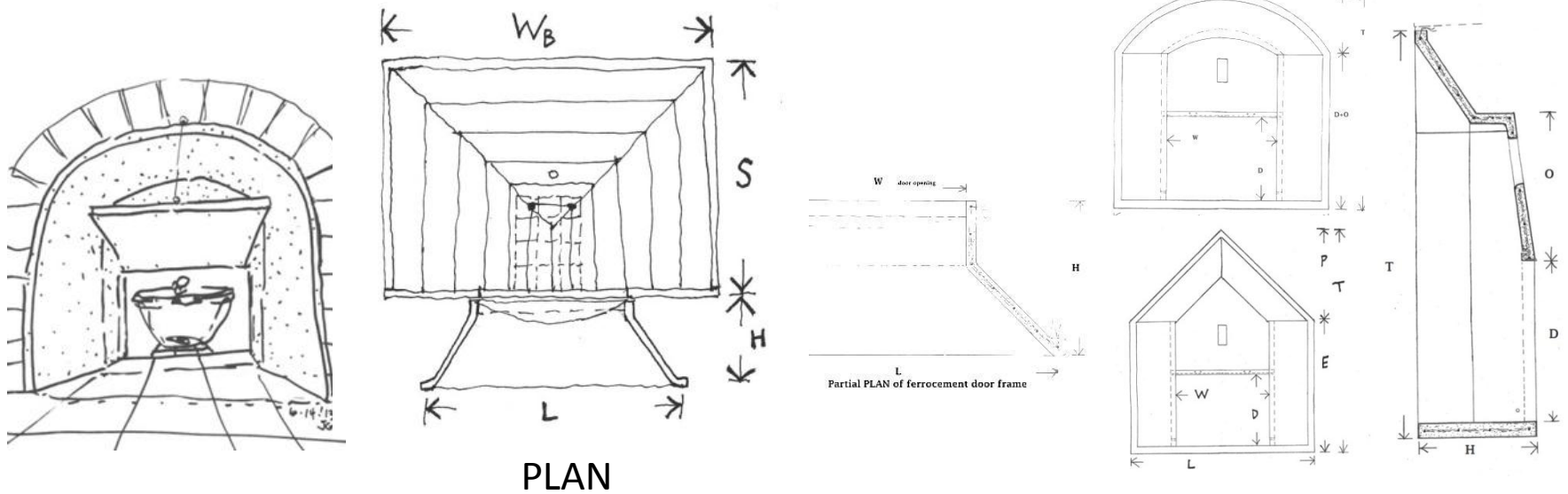


Sheet metal reflector on round wood detail studies

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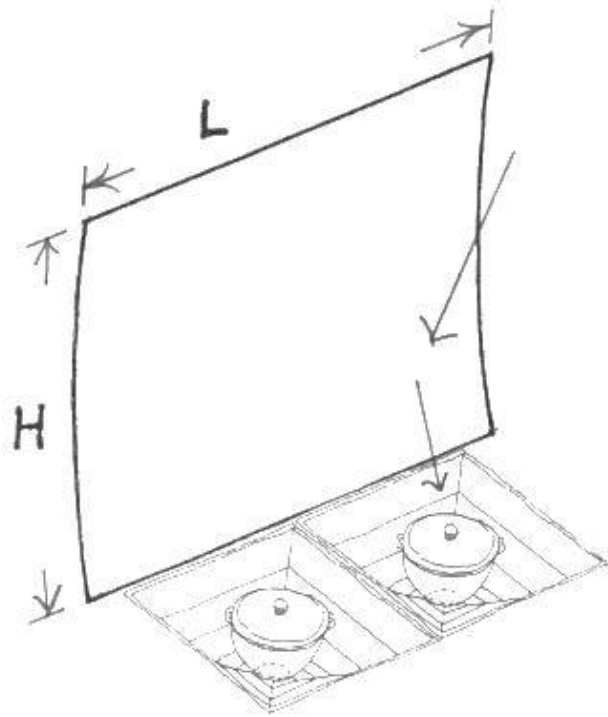
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PLAN

Prefabricated thru-wall (slide in-out) solar oven doorway frame (bio-plastic, ferro-cement) form for masonry walls.

Two prefabricated parts: a fixed reflector concentrator 'box' (WBxS in plan) and a thru wall door frame are secured together for on-site building construction . The lintel above the oven door is a substrate for mirrors which is part of the CPC-type wall. The door frame fits with the NI reflector substrate concentrator 'box' which is about the size of a large wheelbarrow 'box'. The door frame is around 11in/280mm x 23in/580mm x 27in/700mm, related to the size of the selected oven-cooker pot/pans. Various lintel arch types are possible above the thru wall oven door. Shrinkage of different materials is a concern.



Used reflector facets from tracking parabolic trough CSP systems may be retrofitted for fixed trough solar kitchen walls and cookers ($L=1.57\text{m}/5.15\text{ft}$, $H= 1.4\text{m}/4.59\text{ft}$)

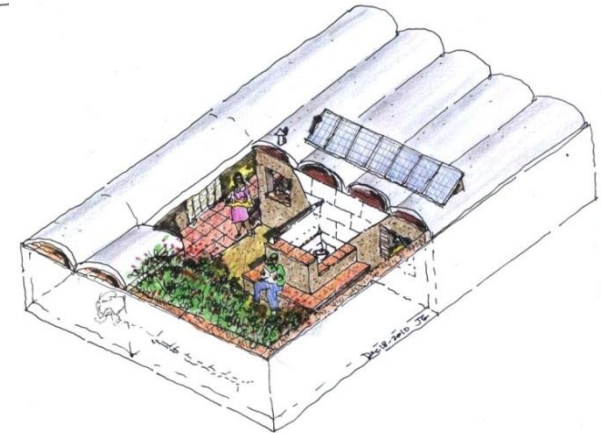
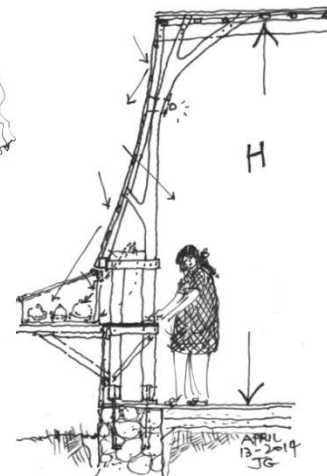
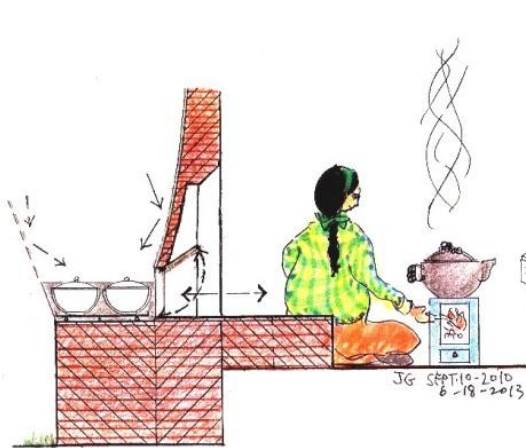
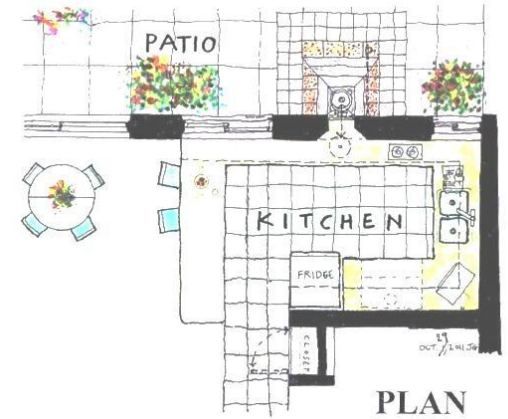
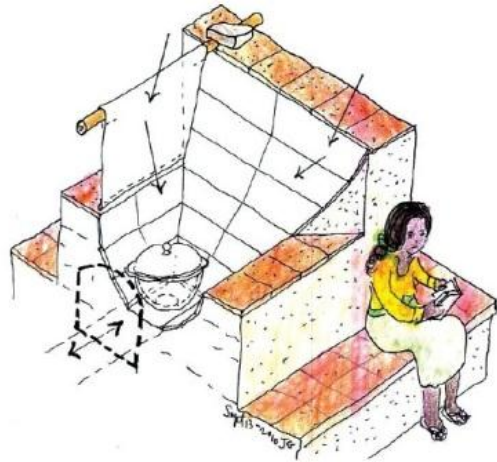
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HOUSE Thru-wall solar kitchen studies

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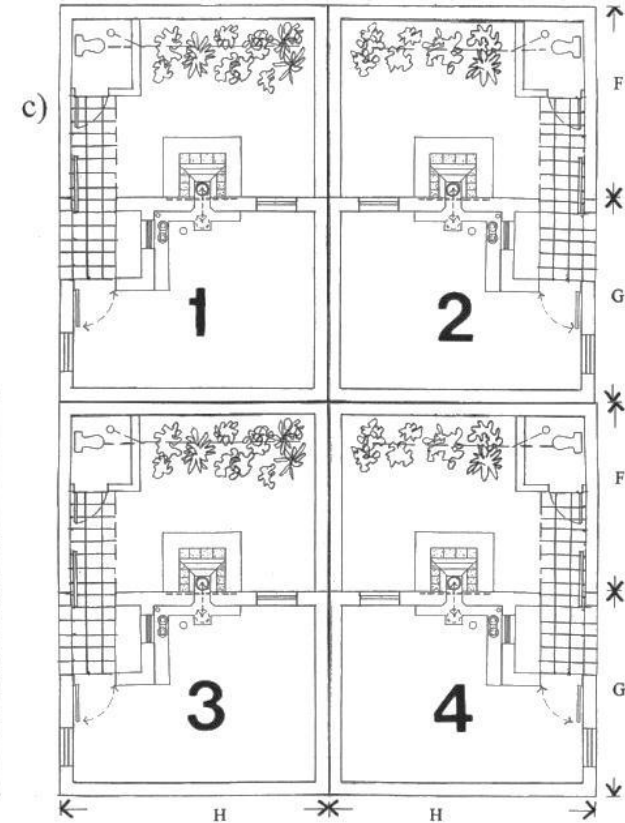
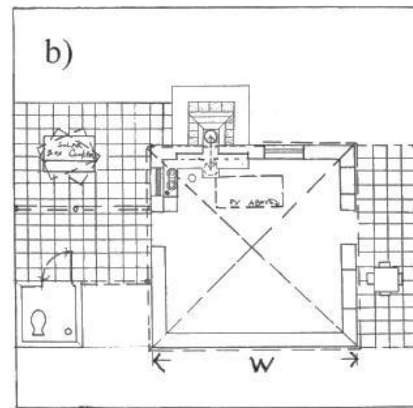
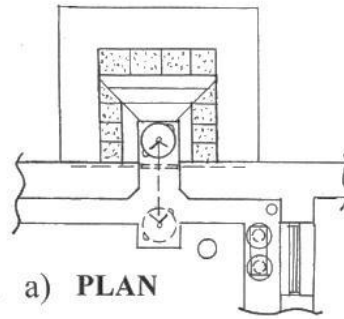
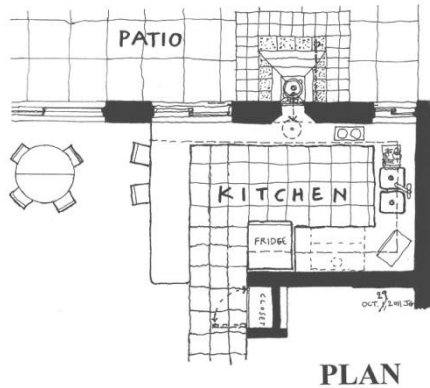


HOUSE Thru-wall slide out-in kitchen studies
Counter height is a design factor.

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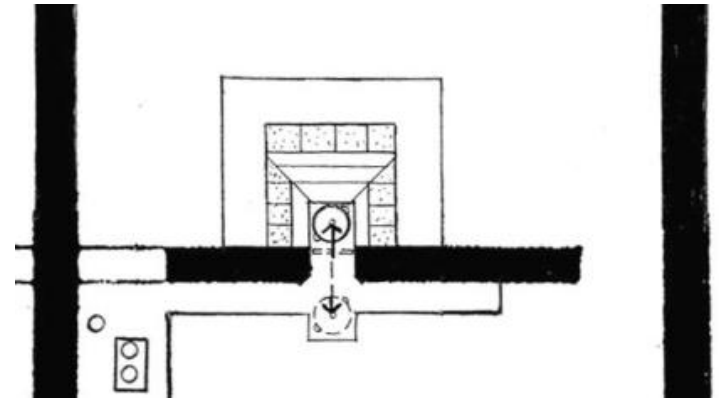
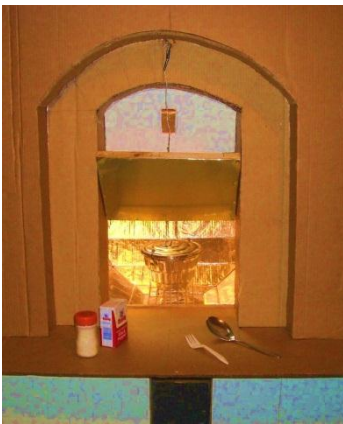
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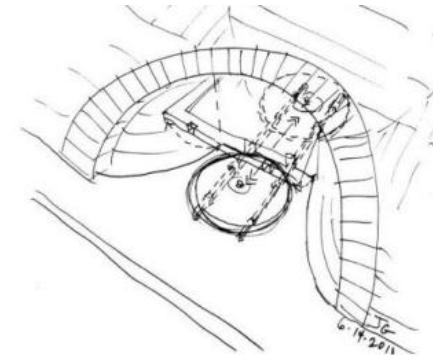
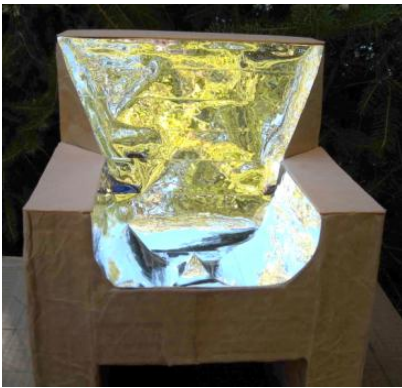
Thru-wall solar cookers have convenience for cooks however, there are significant solar access requirements for kitchens, buildings and site plans. Therefore it is of interest to study house and cluster site planning before finalizing individual thru-wall solar kitchen house plans

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PLAN



Thru-wall fixed concentrator slide in-out oven-cooker

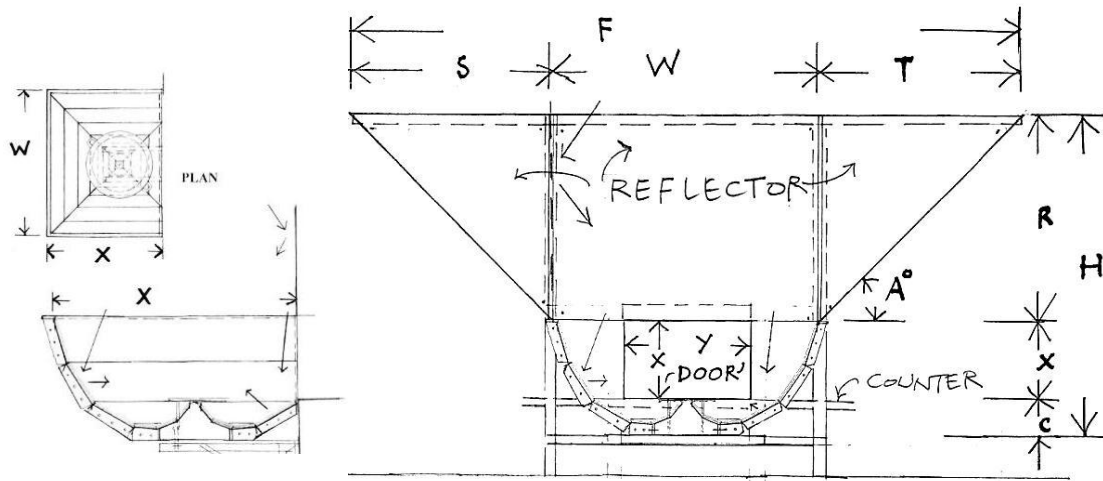
(full size mock-up model photos)

A small window for daylighting is above a top hinged reflector oven door. A rubber-type material surrounds the door frame to keep water and insects outside.

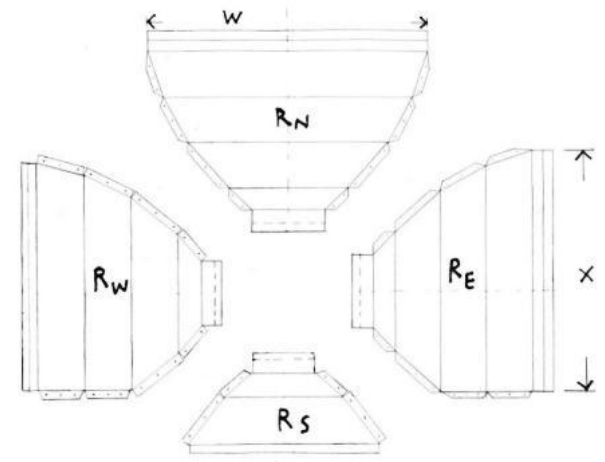
The door is held open by a wire hooked to an eye screw above the door.

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Sept 12, 2013 JHG Goodman



Quadrant reflectors

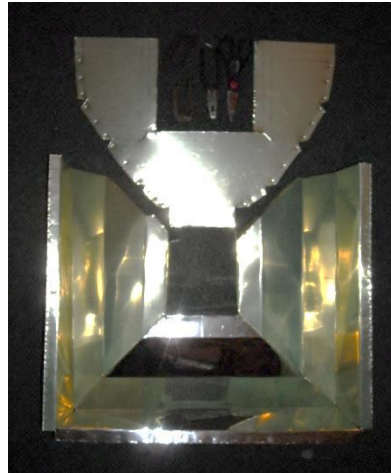
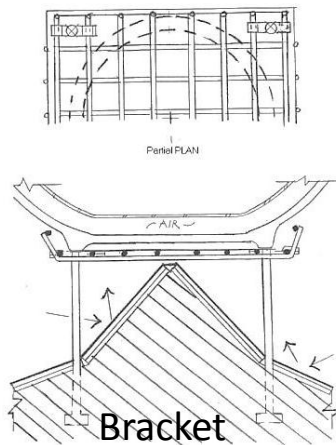
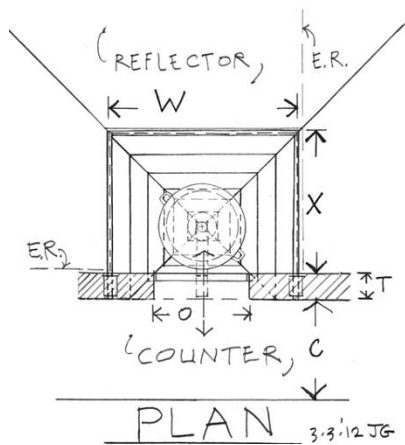


Thru wall fixed concentrator nonimaging reflector box

A reflector box (aluminum or bio-plastic substrate) attaches to a wall (house, trailer) with a ridged reflector bracket with grill posts. A quadrant reflector pattern is similar for all four quadrants of the concentrator box. Four creased aluminum-reflector attached elements are secured to the grill reflector bracket structured to the wall.

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Thru wall fixed concentrator nonimaging reflector box

A full size reflector box prototype was fabricated with lightweight aluminum reflector sheet (0.020 in) with a scissors, pliers, and clamps. After cutting out patterns, and bending, quadrants were clamped together and bolted. The ridged reflector base-bracket reflects solar radiation upwards to the underside of the cooker-oven.

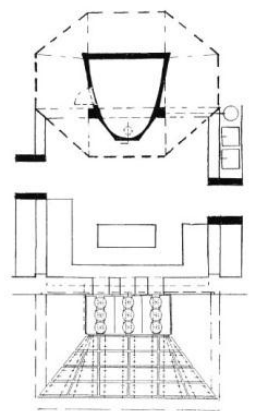
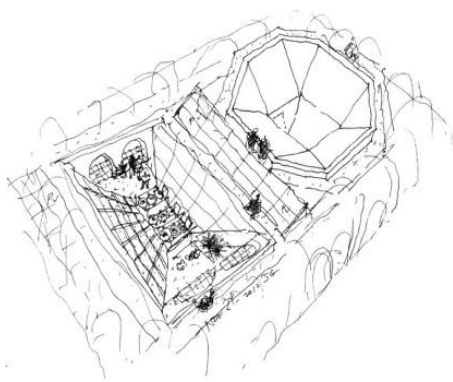
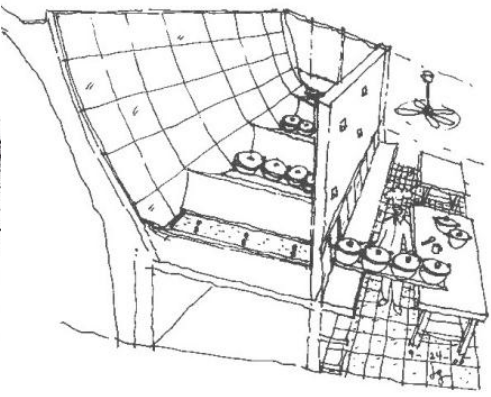
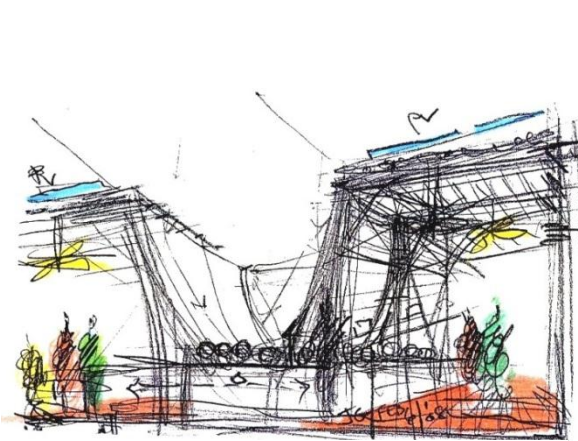
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Joel H. Goodman SCI Solar Cooking Convention July 17-19, 2014 Sacramento

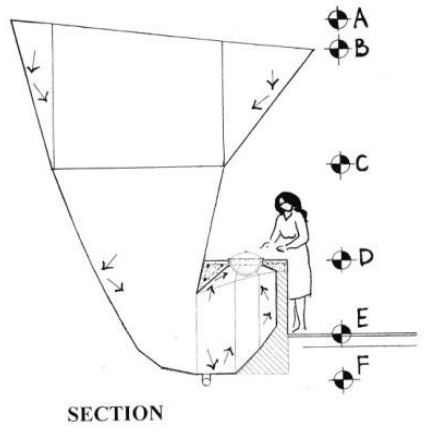
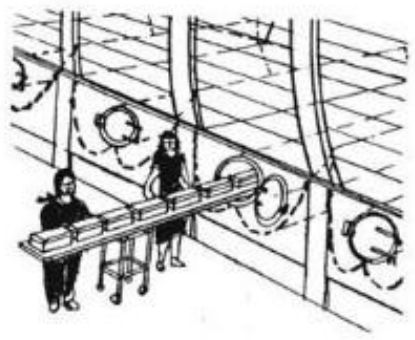
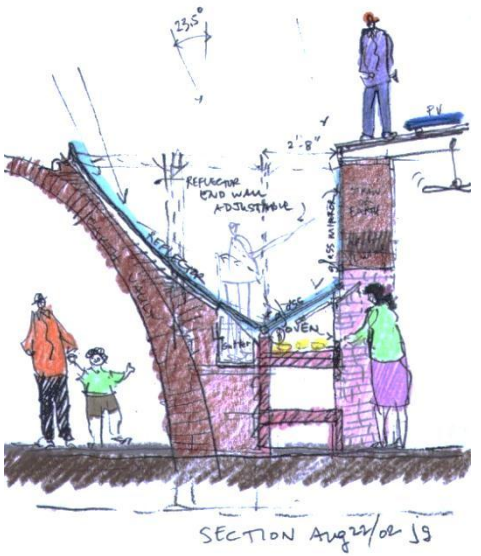
MID-SIZE and RESTAURANT Thru-wall kitchen studies

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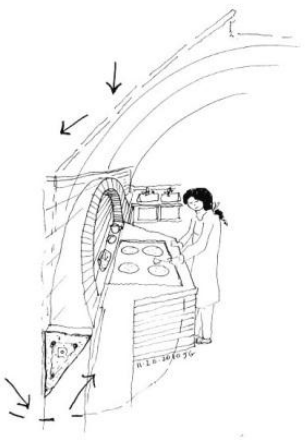
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PLAN



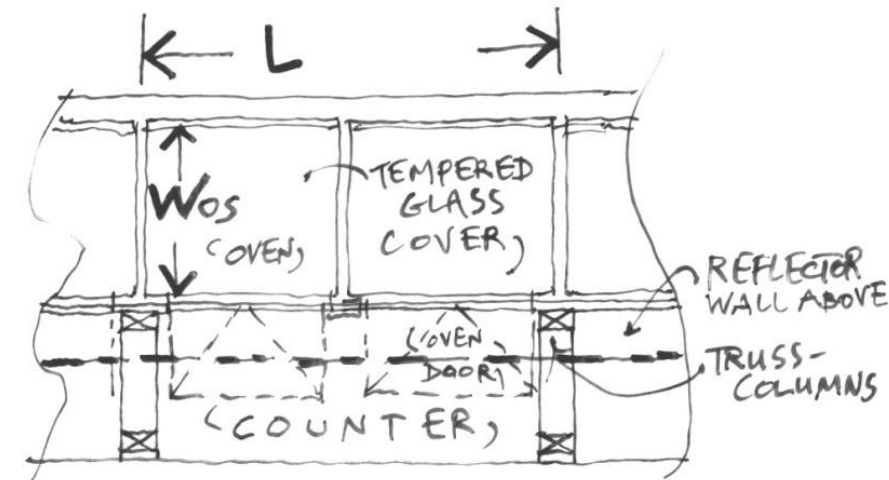
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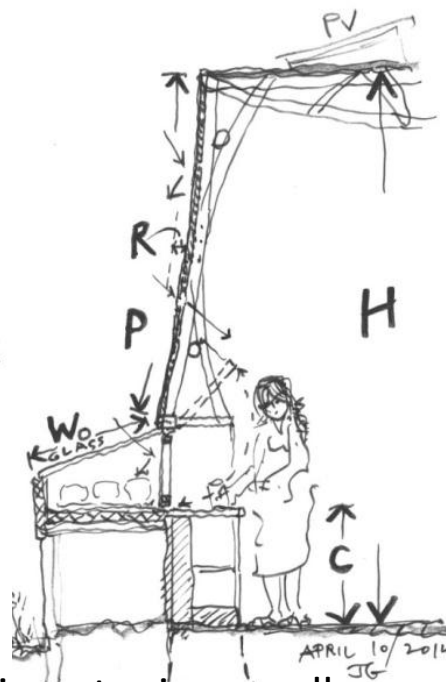
MID-SIZE and RESTAURANT Thru-wall kitchen studies

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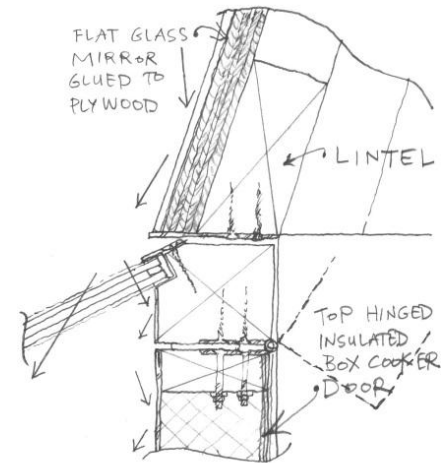
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PARTIAL PLAN
 Partial Plan APRIL 10/2014 JG



Section at mirror wall
 APRIL 10/2014 JG



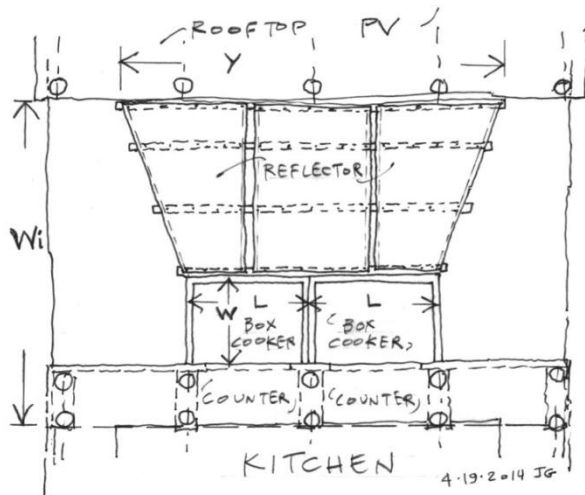
SECTION @ LINTEL
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 APRIL 12-2014 JG

Thru-wall 1-sided CPC trough kitchen with glazed box-type cookers.

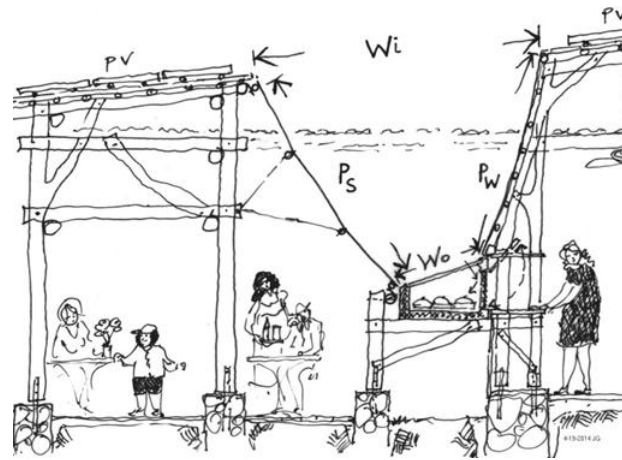
Flat glass mirror tiles (30cm x 60 cm) glued on plywood (120cm x 240cm x 1-2cm). $R = 10.4$ cm., a small curvature and 30cm flat glass mirror tiles approximate curvature with tolerance in the glue. $L = 120$ cm, spacing of truss-columns. The mirror wall slightly inclined, near vertical, avoids overhanging flat glass mirrors for equatorial-tropics latitudes. Box cookers can be made in a workshop and transported to kitchen building sites and installed in an EW line close-packed under mirror wall lintels positioned to fit with the counter height.

Nonimaging reflector concentrator thru-wall trough solar kitchen studies

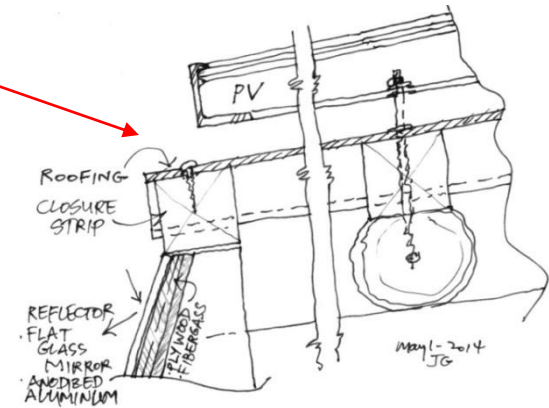
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PLAN



Section



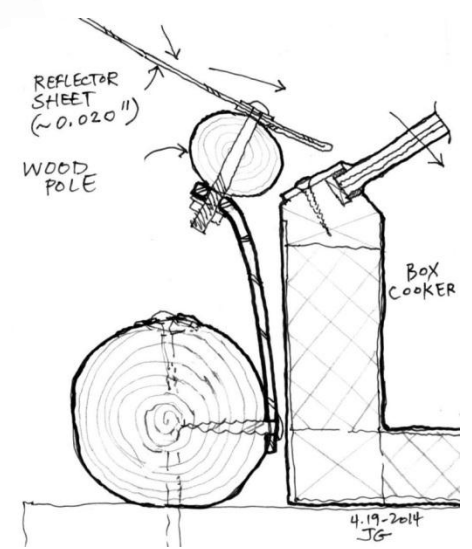
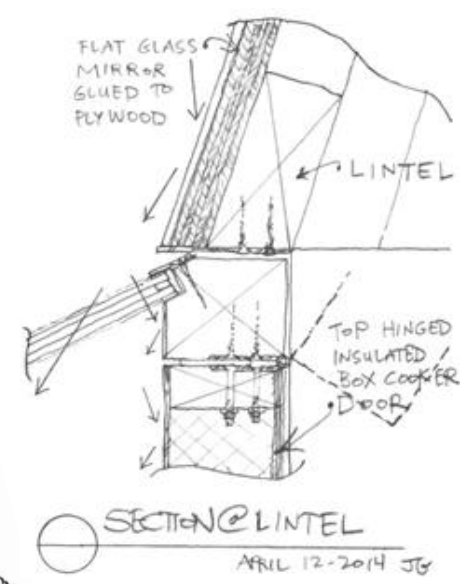
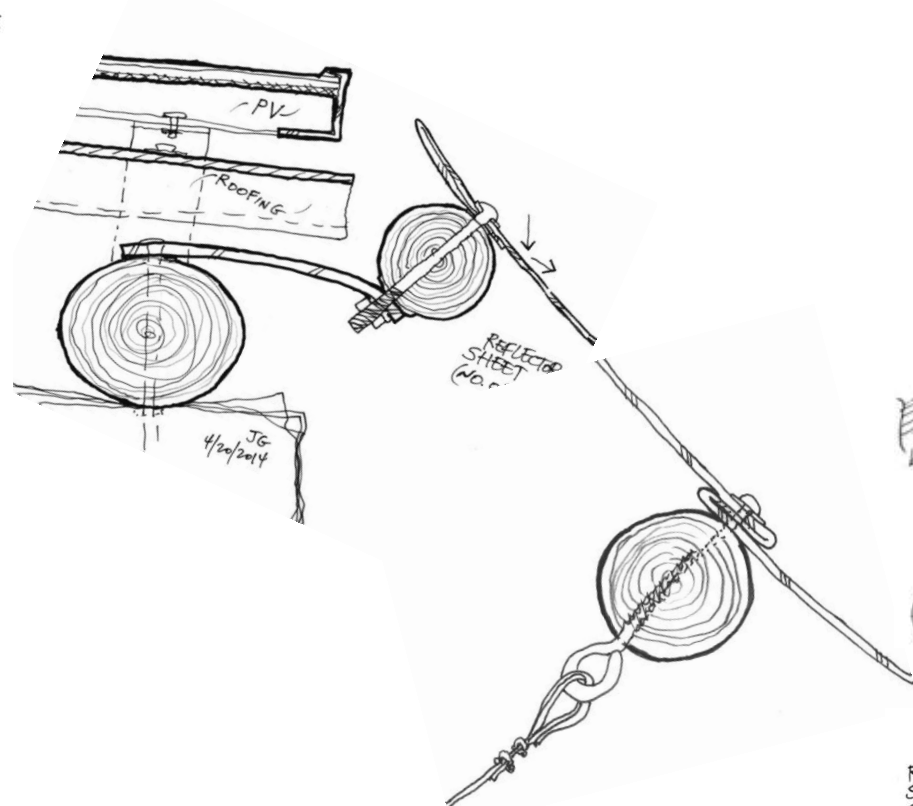
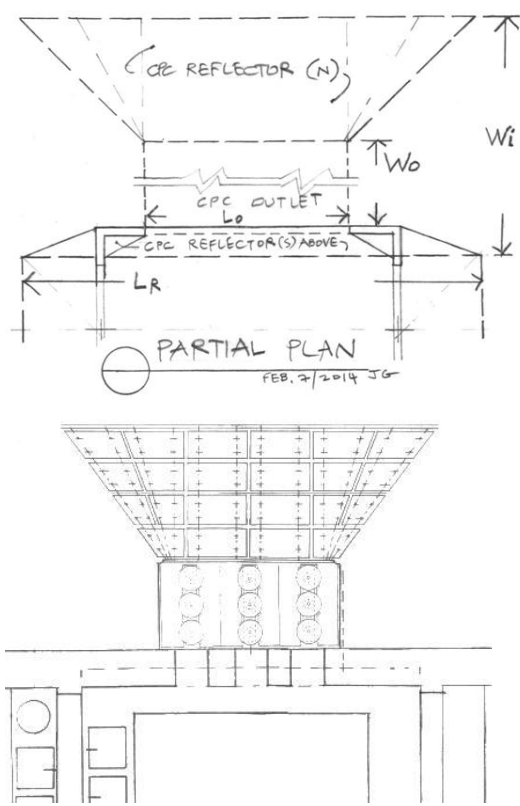
Section at roof

Thru wall two glazed two box cooker CPC-type kitchen studies

Lightweight sheet metal reflector CPC side P_s is a shade above an open air space. The reflector has three sheet segments attached to four poles with open two vertical daylight slots. Two of the poles are cable tensioned approximating the CPC-type profile. The reflector assembly is demountable to be stowed fast when there are big wind storm alerts, and can be used seasonally in snow accumulation regions .

Nonimaging reflector concentrator thru-wall trough solar kitchen studies

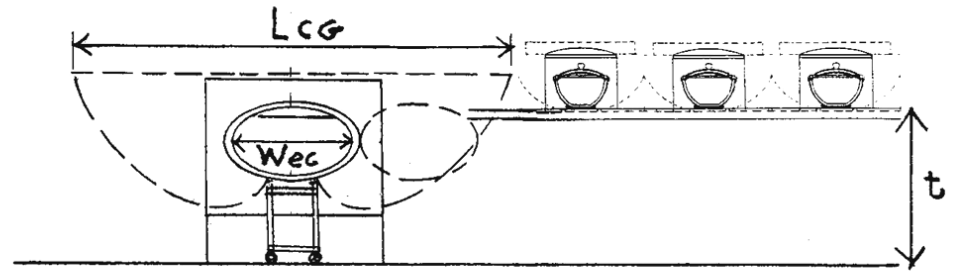
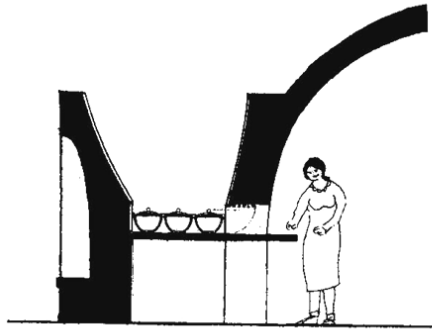
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Sections at top, middle and bottom of tensioned structured reflector sheet with horizontal wood poles above open air space. A middle horizontal pole has adjustable tension cables. The sheet metal acts as a diaphragm to resist shear.

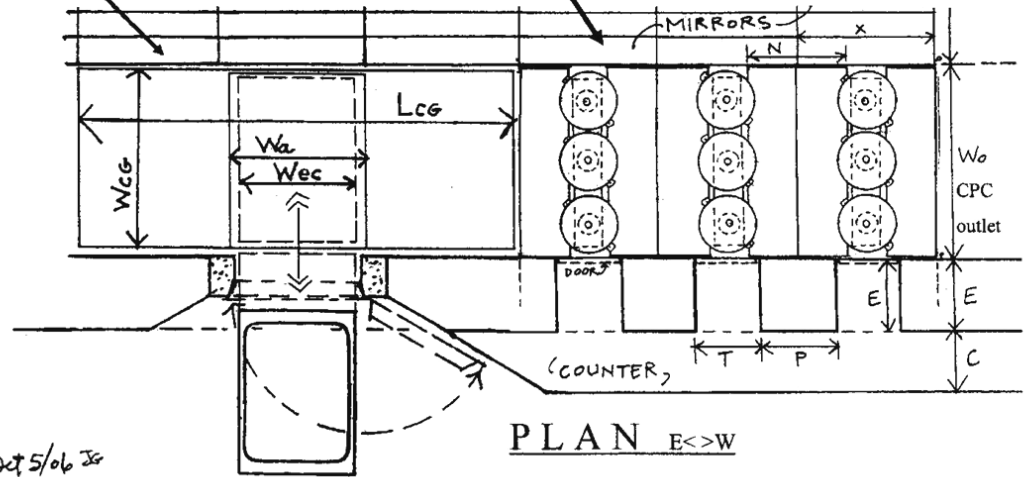
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Roll in & out ellipse batch cooker with interior involute reflector under cover glass(1 or 2)

9 Hotpots, 3 rows, 3 Hotpots/tray



oct 5/06 JG



HotPots and large 'Tolokatsin' type batch cookers at CPC outlet

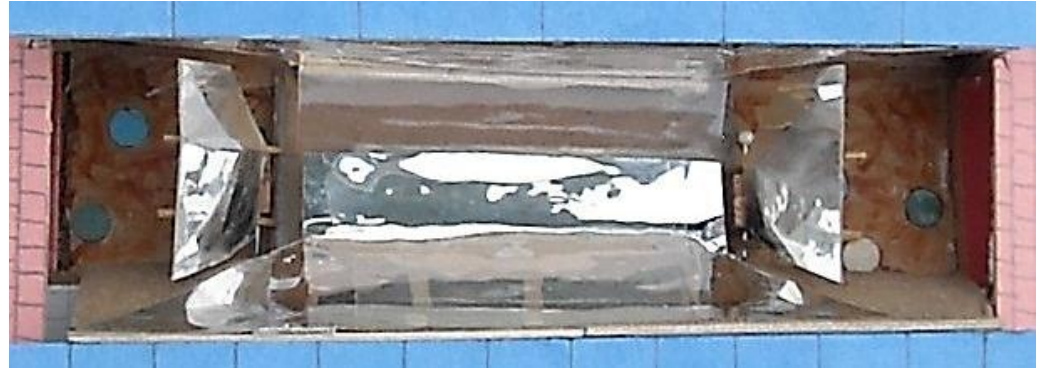
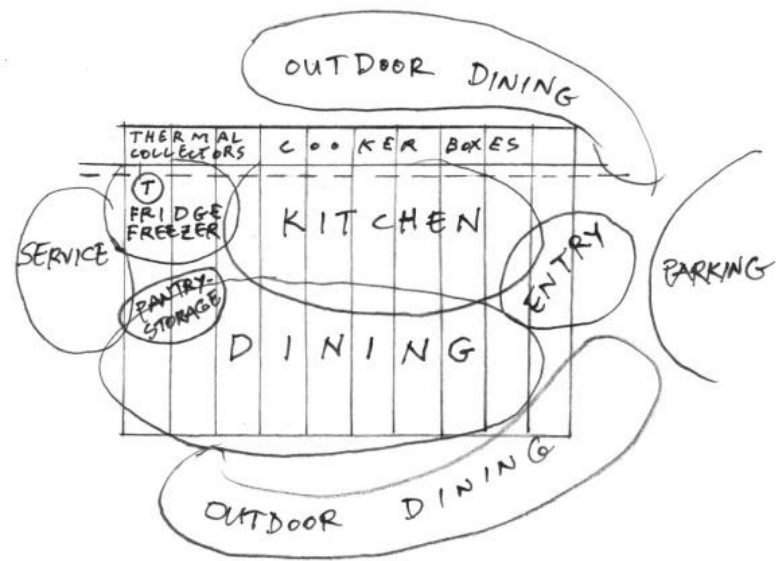
Tropics solar kitchen studies

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CPC mid-size Kitchen with Scheffler concentrator

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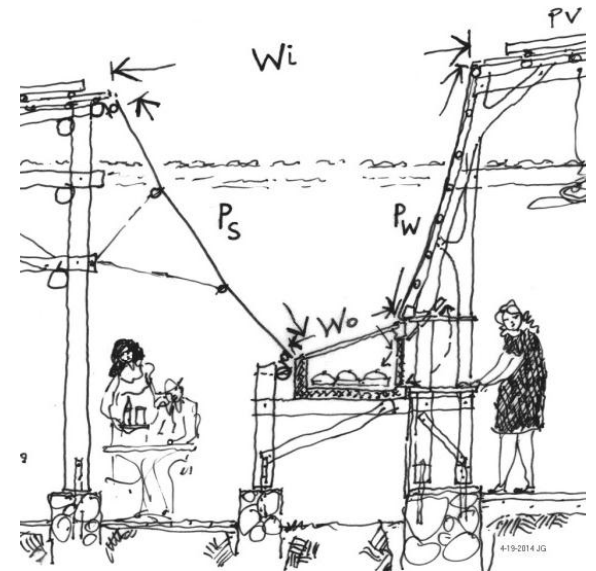


PLAN



Restaurant thru-wall kitchen

EW line reflector nonimaging concentrator trough building has E and W courtyards with adjustable end reflectors. PV solar electric panels cover a kitchen and a dining room with E and W verandahs.



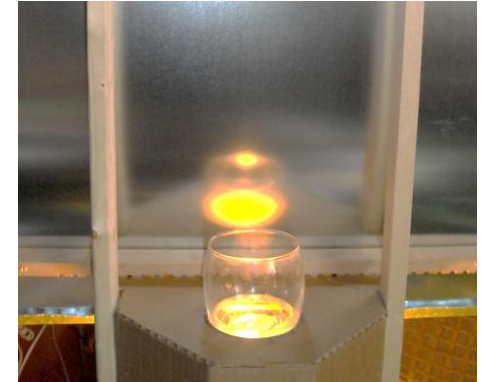
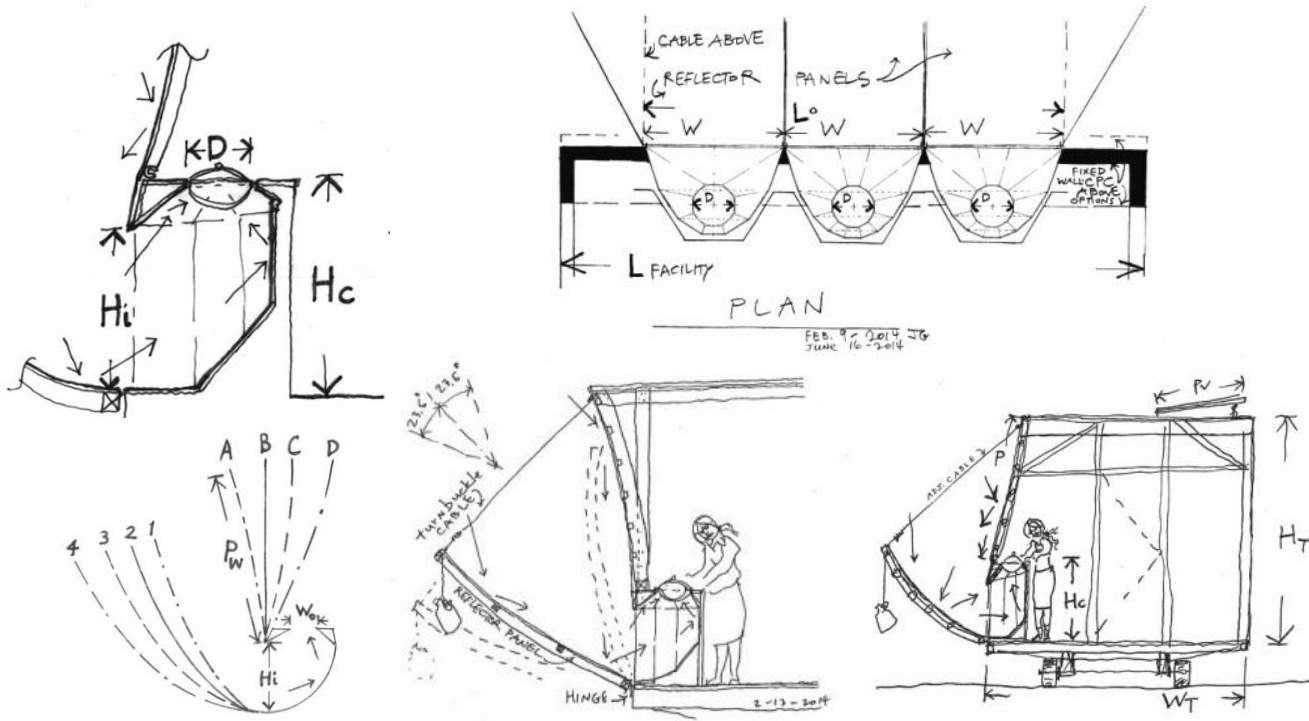
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TRAILERS and CONTAINERS Thru-wall kitchen studies

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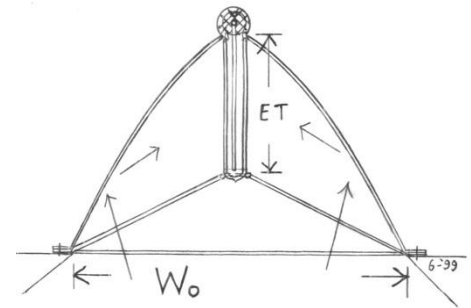
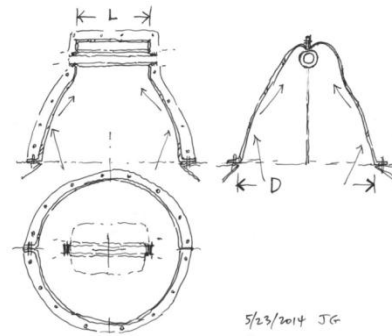
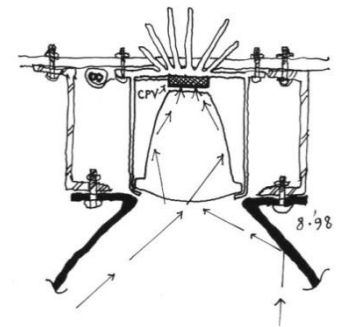
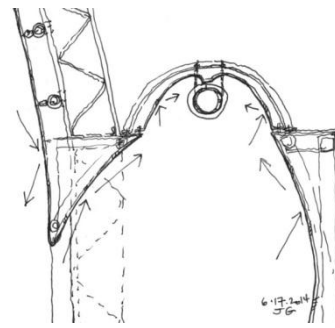
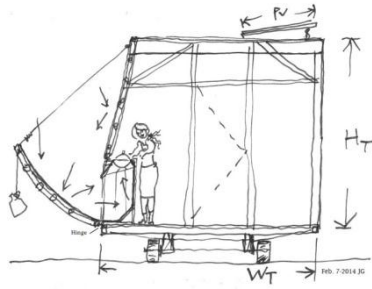
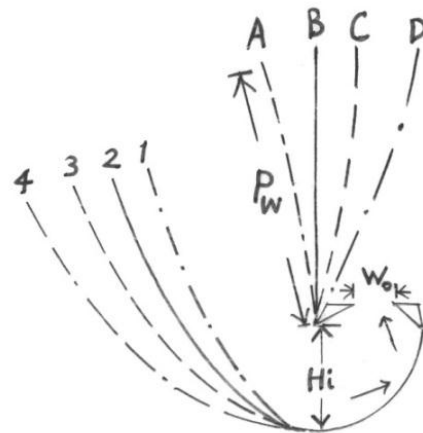
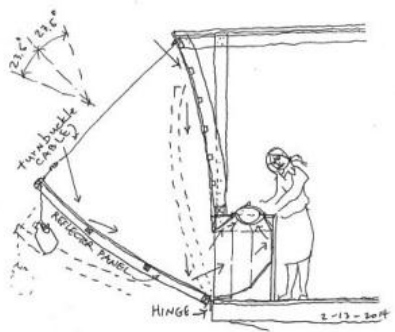


Solar cooker kitchen trailers with fixed CPC-scoop type reflectors

A CPC-type trough solar kitchen trailer has: a fixed reflector wall side ; and an adjustable reflector trough weighted panels side . The CPC-type trough outlets thru vertical inlets reflected-scooped up to the underside of cookware at counter height. Building materials for the reflector walls include: reflectors glued to plywood; thin reflector sheet/film (metal, etc.) attached to round wood/tubes (metal, bamboo, etc.). Selecting cookware, storages, autoclaves shapes and sizes as target of nonimaging solar concentration; size of trailer chassis; and regional latitude-range locations are parts for beginning design studies. An anodized aluminum reflector wall without substrate and non-insulated has a metallic interior expression.

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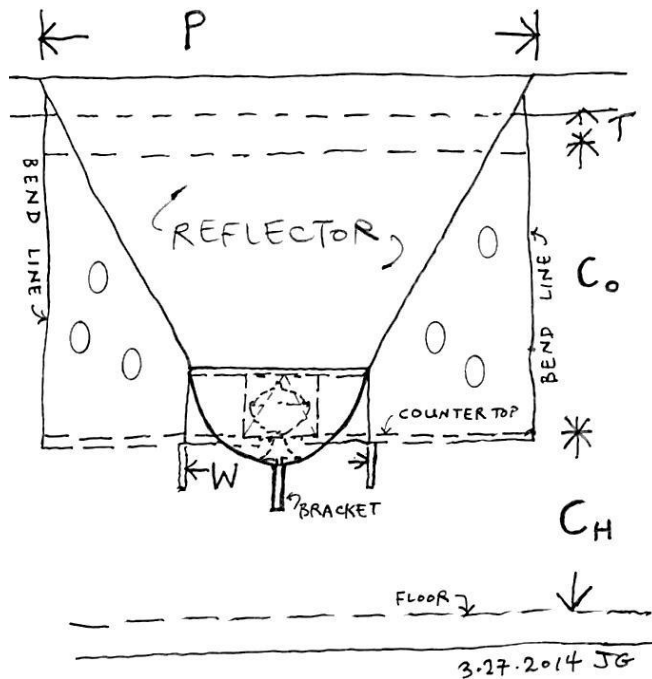


Receiver options for the scoop-upward nonimaging concentrator

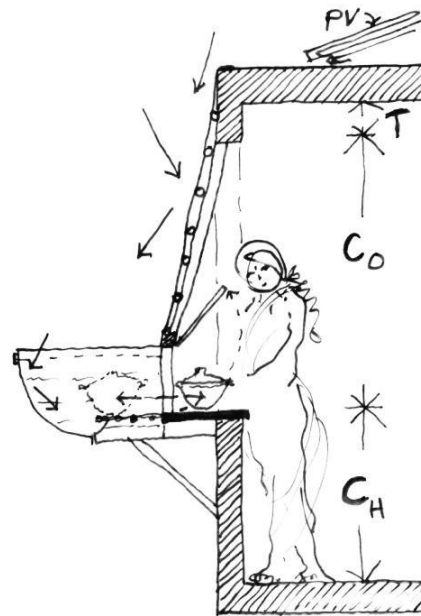
Added reflector-stage augmenting receivers can provide temperatures for refrigeration, air conditioning-cooling, storage and CPV. A 0.60m long linear evacuated tube and CPV with reflector secondary and refractory concentrators are illustrated.

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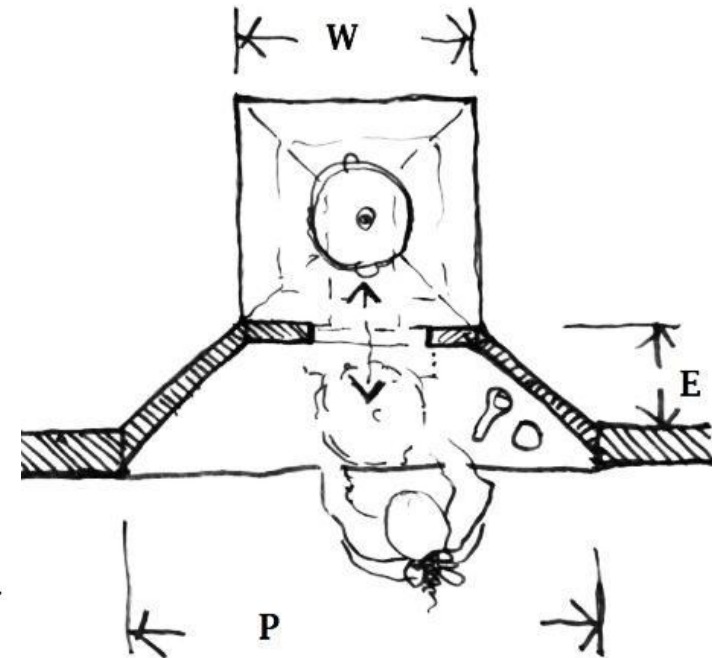
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Elevation



Section



PLAN

Steel Container Thru-wall fixed nonimaging (NI) reflector concentrator solar cooker for equatorial tropics. A shipping steel container wall is cut and bent to support a reflector. Bend lines are indicated on the elevation drawing. Bend lines extended down to floor may provide storage space under the counter top.

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Stand-alone solar cooker LED reflector set

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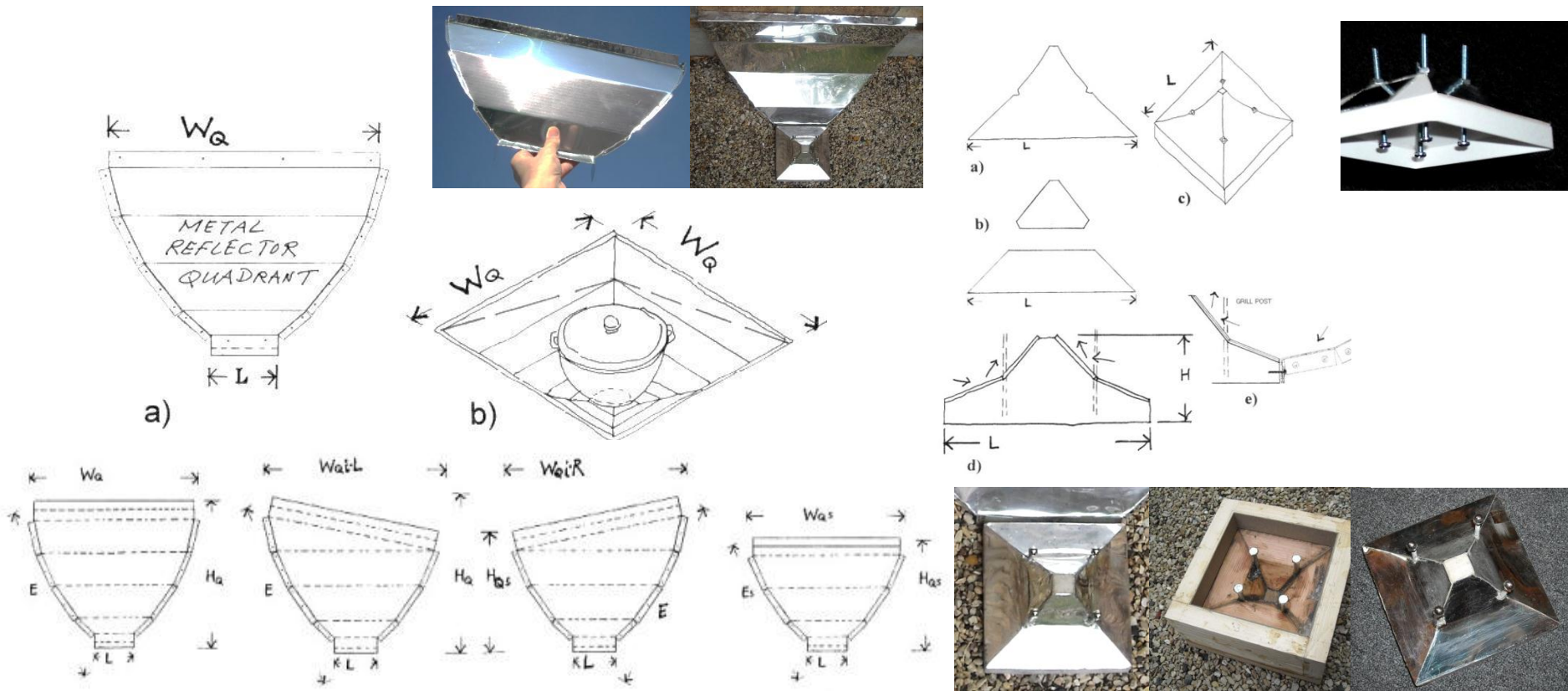


Stand-alone solar cooker and LED reflector set

A Solar Concentrating Cooker LED Lantern Set has a multi-use reflector and a LED PV lantern. The concentrator box-tray has four attached reflector segments with an open bottom square (6.5" x 6.5") for a reflector pyramid-shape heavy base. A lightweight concentrating cooking reflector outside by day, is an inside light reflector at night by hanging it inverted around an LED lantern. A full size mock-up model has aluminum reflectors and 4 post base supporting bent tubes with upturned edges to prevent pot from sliding off. Lightweight aluminum reflector sheet (0.020") was cut with a scissor. After cutting out patterns, and bending, quadrants were clamped together and bolted. Flat lightweight aluminum parts could be transported to local workshops for assembly (bending, pop rivets, etc.), distribution, and creation of local jobs.

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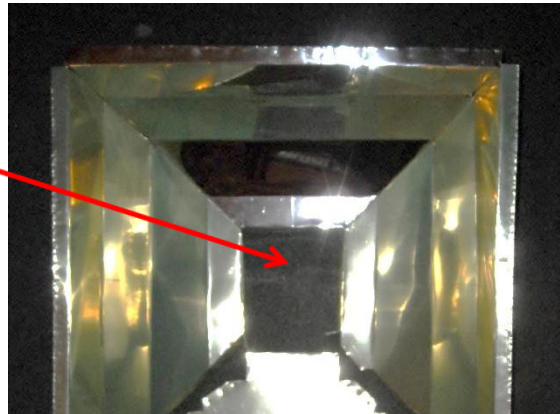
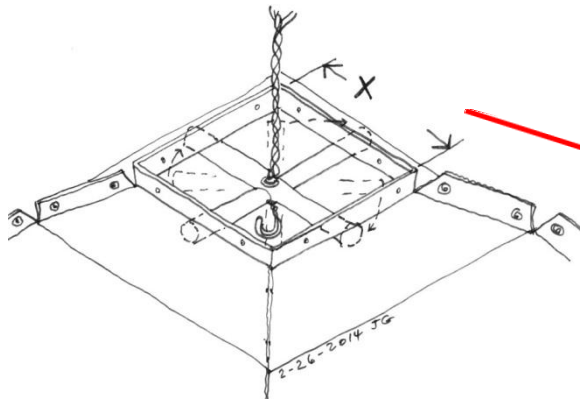


Stand-alone solar cooker and LED reflector set

The reflector 'box' has a standard quadrant-shape with variations of sloped top left and right edge. Reflector substrate pyramid-shape bases (6x6"x 3.5") have been cast with concrete with bolt posts, and may be wood or recycled plastic fence post caps type forms. A two-angles pyramid-base has two flat reflector shapes.

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Stand-alone solar cooker and LED reflector set

The LED lantern has a wire hook and plus-shaped wood hanger for the inverted reflector concentrator box. An open square, $X =$ around 6 to 7"/15-18 cm, and is an optical-thermal fabrication design variable. A thin metal stamping workshop could cut out the patterned elements and punch holes from flat sheets. The flat lightweight aluminum sheets could be transported to local workshops for assembly (bending, pop rivets, etc.) and distributed, a creation of local jobs idea.

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Thank You

Workgroup discussions would be welcome
for

Nonimaging reflector concentrator thru-wall trough solar kitchen studies

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