Heliac solar cooker

Solar cooker based on low cost polymer lens
Heliac and Heliac Solar Cooker

- Sedi Byskov, development engineer, Solar Cooker, Heliac
- Karsten Dupont, Construction foreman, Heliac
- Low cost polymer fresnel lens
- District heating 6 people
- Solar cooker 1-2 people
History solar cooker

Nepal 2016

India 2018

Denmark 2016
Refraction of light

\[ \frac{n_1}{n_2} = \frac{\sin(b)}{\sin(i)} \]
Magnifying glass
Heliac lens design
Production of lenses

- Extrusion coating
- Lenses produced at 1m/s
- 10GW/year ≈ 25% district heat

The lens

- New lens design ≈ €40.000
- A production run around 10km lenses.
Small range of lenses

<table>
<thead>
<tr>
<th>Focal length (cm)</th>
<th>Spot size (cm)</th>
<th>Length (cm)</th>
<th>Width (cm)</th>
<th>Weight (g)</th>
<th>Cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>8</td>
<td>140</td>
<td>109</td>
<td>300</td>
<td>10</td>
</tr>
<tr>
<td>73</td>
<td>1</td>
<td>82</td>
<td>48</td>
<td>70</td>
<td>5</td>
</tr>
</tbody>
</table>

The lens
Heliac solar cooker Spec

• Material cost metal small scale €150
• Open source design
• Double axis rotation
• Mirror rotation linked to lens rotation
• Stray light side covers
• For solar altitude 20-90 degrees
• 45% optical efficiency
• 250-370W cooking power (depend on DNI/GHI), dT = 50, GHI = 700W/m2

Demonstration of boiling time at DNI 910W/m2

• https://www.youtube.com/watch?v=V1W5i3muUdo&feature=youtu.be
Boiling eggs

https://www.youtube.com/watch?v=gFbBwuGU1YY

Frying crisps

https://youtu.be/axz_bDJ-hSw
Working principle mirror and lens

- Uncoupled mirror and lens
- To coupled mirror and lens
Mirror and lens coupling

$\theta$, Solar altitude
$b$, Foil normal vs mirror plane

$a = k - \phi$
$b = \theta + \phi$, for $b = a \implies 2b = k + \theta$
$\iff b = \frac{1}{2} (k + \theta)$
Mirror size

Solar altitude (θ)

- 90°
- 20°
- 61°
- 26°

Mirror vs lens plane (90°- b)
From wood to metal

Heliac Solar Cooker
Assembly Manual
(v4.4)
Vision Heliac Solar Cooker

- Easy access to energy for cooking
- Substitute wood when direct normal irradiance >700W/m²
- High efficiency, durability and ease of use
- Solar cooker design kept open source

Execution
- Test prototype
- Test manufacturing options
- Develop prototype and manufacturing
- Certify product
- Identify distribution channels
Global manufacturing and user test

Kinarkumar Patel, India

Clement Musonda, Zambia

Juana María Hernández Jarquín, Mexico

Godfrey Mawira, Kenya

Edward Sembajjwe, Uganda
Rosa Lukonde Katuna cooking tomato soup, rice, potato fries, ugali and fried fish
Lusaka, Zambia

**Partner**
- Construction
- Find users and follow up

**Heliac**
- Supply lens and mirror
- Pay local material cost

**User**
- Receive cooker for 2 months
- Take 50 images from 50 meals
- Receive USD 50 for the images
- Buy cooker for USD 50 or return
India

User test
Zambia

User test
User test Feedback

Use
• Prepares local foods
• Bright sun = happiness and impression
• Clouds = demotivation and disappointment.
• The longer it takes the lower becomes satisfaction
• Not powerfull enough for large household

Manufacturing
• Manual should be very clear and constructor has to have certain manufacturing skills.
• Training in construction is necessary for some.
• Material cost approx €150
Outlook

• Match to market
• Tracking
• Cost breakdown through simplification of design
• Improve durability of lens
• Certify, PEP, Solar cooker standards etc.
• Important to clarify expectations

• Market entry small scale business og refugee emergency aid.
• Sell lens and mirror foil, find central local manufacturers.
Contact: Sedi Byskov
Mail: sb@heliac.dk
Web: www.heliac.dk