

# CHEAPER SOLAR CONCENTRATOR

Maksym Lischchynskyi

student of Cernivtsi Lyceum № 1 Ukraine, [maxim.lish@gmail.com](mailto:maxim.lish@gmail.com)

Supervisor: Oleksandr Voznyy

## Introduction

Climate change requires immediate action in increasing the amount of energy generated by renewable sources. However, further decrease in solar energy generation cost is required in order to become competitive with fossil fuels, especially at Northern latitudes. Solar concentrators offer a route to utilize more efficient (e.g. GaAs) - but more expensive per unit area - solar cells by collecting light from a large surface and focusing it on a small cell. However, most of the concentrator designs are quite expensive or bulky. We tried to minimize the complexity of the structure of concentrator, targeting its cheaper production without the compromise to efficiency.

## Concept

Main idea of our device is the usage of simple materials: organic glass and mirrors. We limit our initial design to only linear cuts, aiming at a lower manufacturing price, as well as simple analytical solutions.

## Construction

The schematic diagram presents a cross-section of the device (it can contain more glass prisms). The optimal parameters for the first (yellow) path come from the analytical solutions to the inequality:

$$2\beta + \arcsin(\sin \alpha \sqrt{n^2 - \sin^2 \gamma} - \sin \gamma \cos \alpha) - \pi/2 \geq 0$$

Second path (red rays) parameters are computed using the previously computed parameters. The concentrator plane is tilted by  $10.5^\circ$  from the vertical axis. Maximal and minimal deviations of rays from the vertical are  $\sim 10^\circ$ , resulting in the active surface:

$$\eta = \frac{\cos(\alpha - 10.5^\circ)}{\cos(\alpha - 10.5^\circ) + \cos(\varphi + 10.5^\circ)} * \frac{15}{16}$$

(15/16 has come from 3D construction)

## Parameters

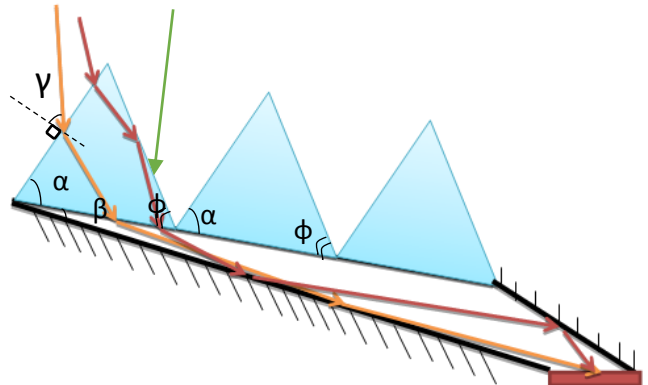


Image 1.

Here is a table with calculated suitable parameters of the system:

$\alpha, ^\circ$	$\varphi, ^\circ$	$\beta, ^\circ$	Active surface	Concentration
68.18	58.4	18.45	56.9%	32.1

## Results

The calculations predict the active surface 56.9% of the whole concentrator (the rays, which fall on the back side of prism (showed by green ray)), and concentration 32 times. This is still beneficial, because it is cheap to produce, and does not demand special technologies. Our ongoing work focuses on the numerical model of ray tracing, which will allow introducing more complex and curved, yet cheap to produce, shapes. This model then will be parametrized and fed into a machine learning model to speed up the optimization with the target of achieving much higher concentration and maximum efficiency.

## Reference

1. Light-guide solar panel and method of fabrication, Patent No.: US 7873257 B2, Jan. 18, 2011 - John Paul Morgan
2. Handbook on Concentrator Photovoltaic Technology, 2017, C Algora, I Rey-Stolle, 2017, John Wiley & Sons, 794p.