First Summer School

Part A: Line-focus Solar Thermal Technologies

September 20-24, 2021

Lecture 5:

Linear Fresnel Collectors

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Linear Fresnel Collectors

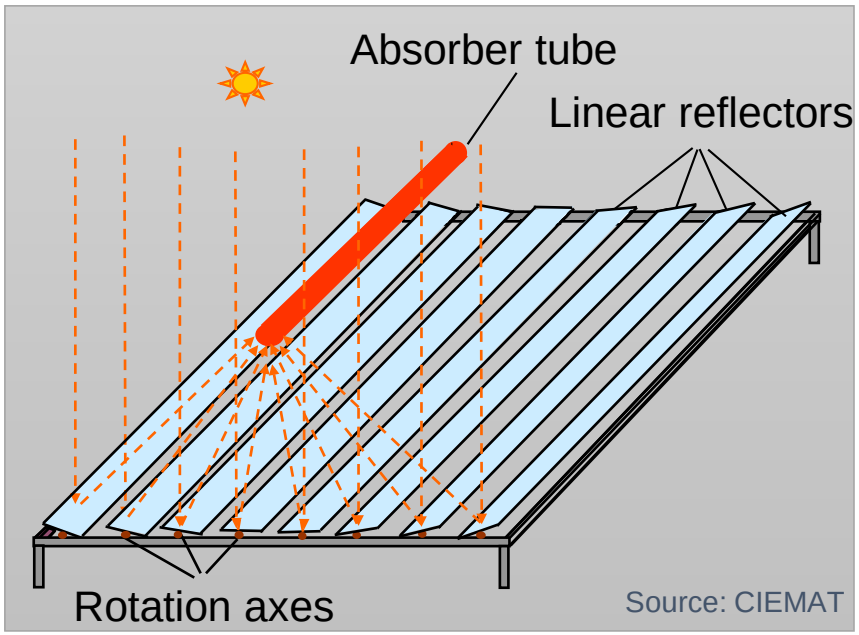
Contents

- Introduction
- Working principle
- Efficiency of Fresnel collectors
- Components
- Summary

Linear Fresnel Collectors

Introduction

- It has a fixed receiver pipe while mirrors track the Sun
- The concentrator is divided into multiple linear reflectors
- It presents lower optical performance than PTCs
- Cheaper than PTC technology due to simplicity of some of the components.



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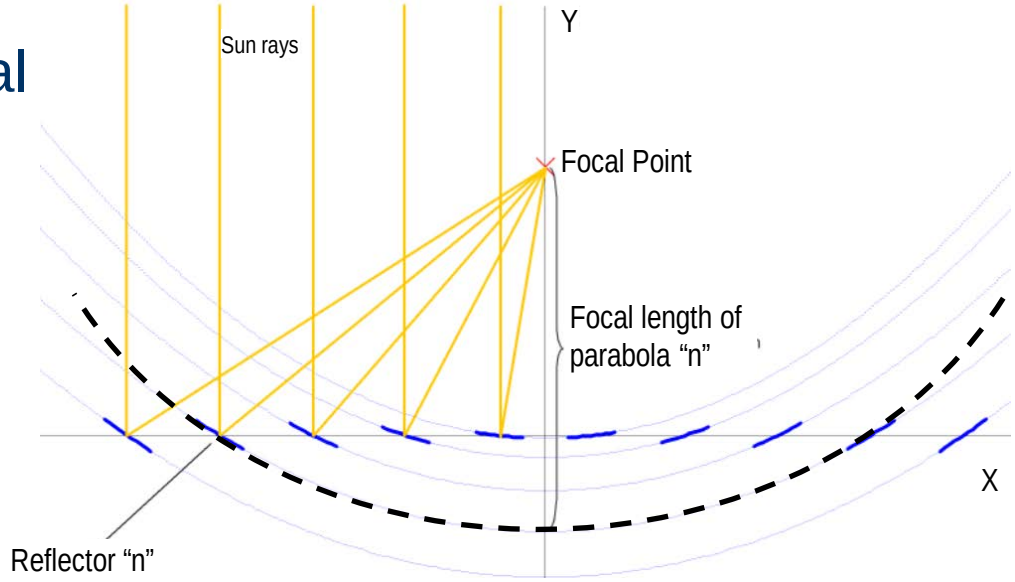
Linear Fresnel Collectors

Working Principle

- Compared to parabolic-trough collectors, mirrors are located in the same plane.

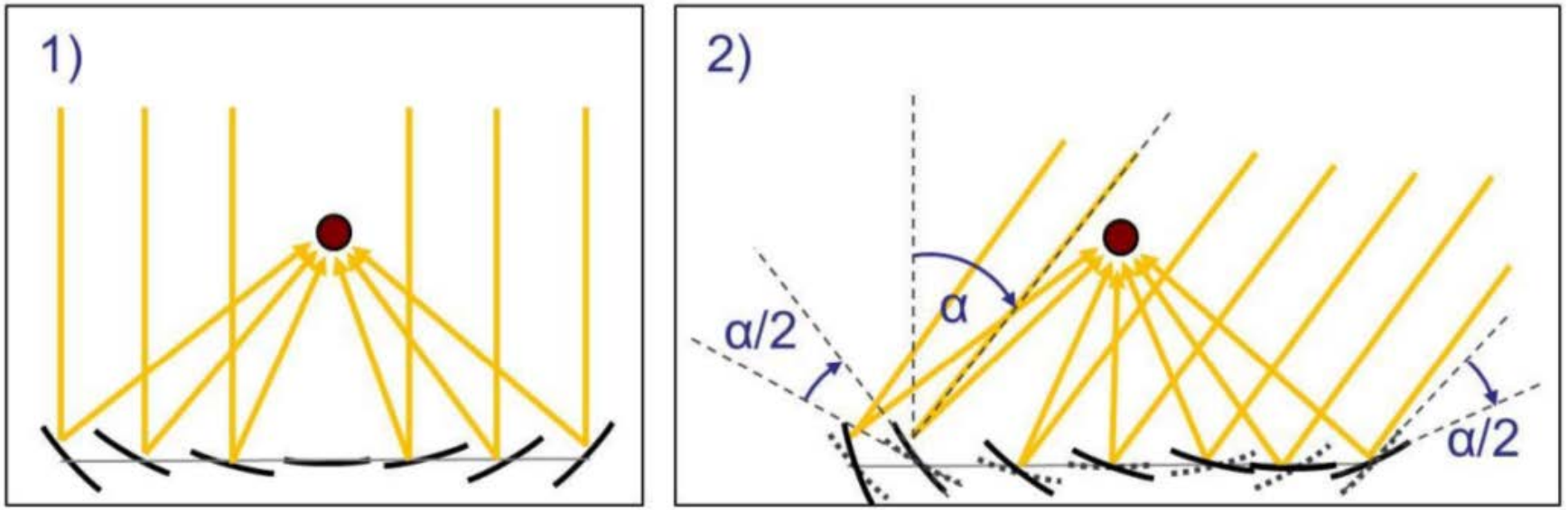
- Linear reflectors are segments of parabolas with different focal lines.



Linear Fresnel Collectors

Working Principle

- Sun-tracking principle



Linear Fresnel Collectors

Working Principle

- Sun-tracking principle:
  - Individual actuators (1) or one single actuator for the whole (2) system

(1) Individual actuator for each reflector

(2) Common actuator for the whole system

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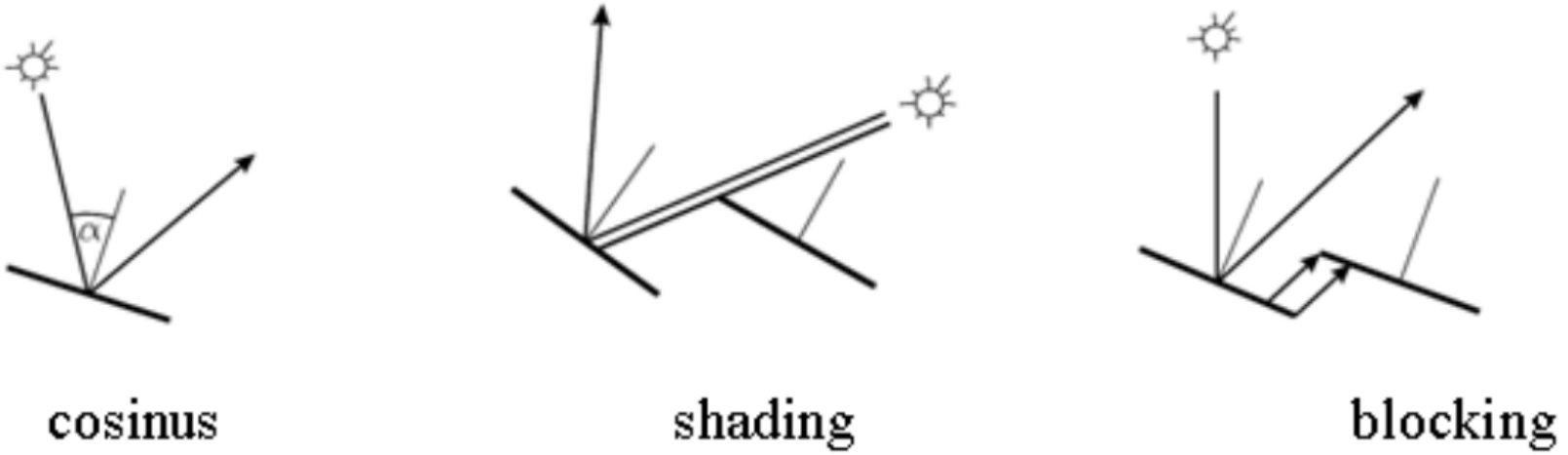
Optical and Geometrical losses

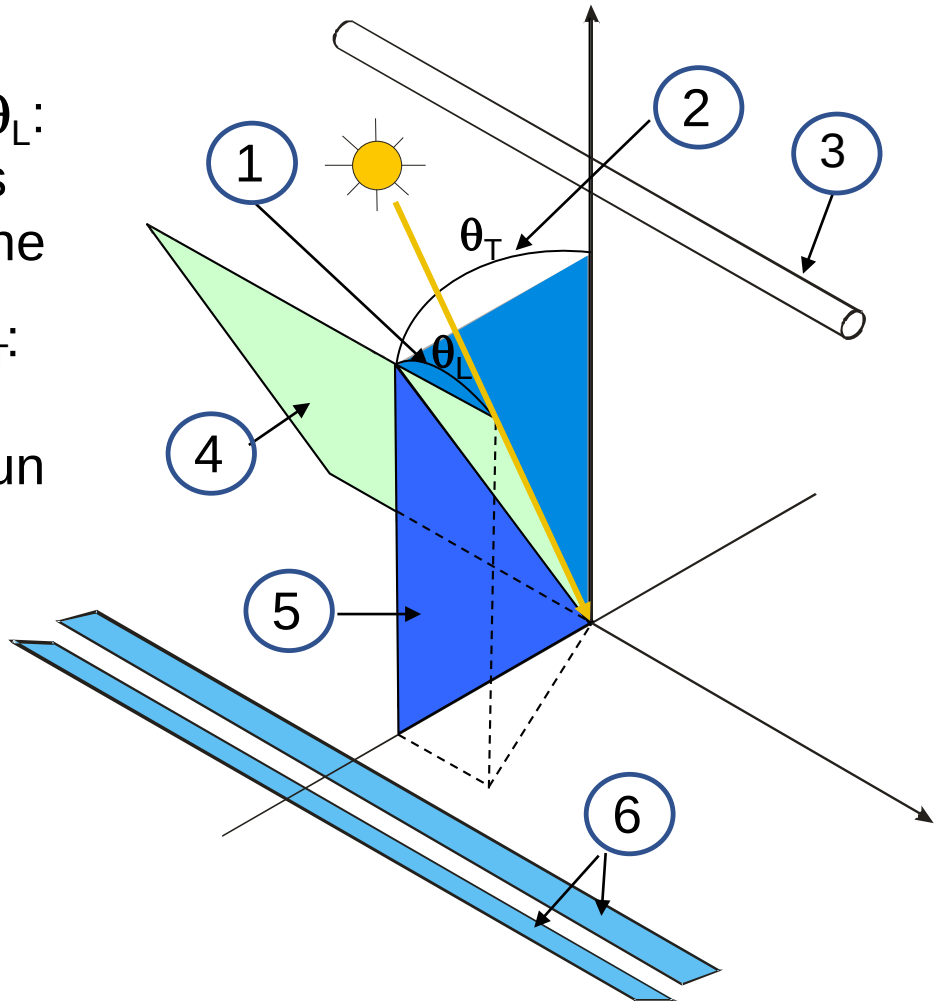
The optical and geometrical performance of a LFR is governed by:

- **Incidence angles**, which reduce the efective area of reflection
- **Shading effects**
- **Blocking effects**



Incidence angles in LFR

1. **Longitudinal incidence angle, θ_L:** angle between Sun vector and its projection into de transversal plane
2. **Transversal incidence angle, θ_T:** angle between zenith and projection of straight line to the sun into the transversal plane
3. Receiver tube
4. Incidence plane
5. Transversal plane
6. Solar reflectors



LFR versus PTC: Optical performance

- Transversal and longitudinal angles have a significant impact on the optical performance of LFR
- Optical efficiency:

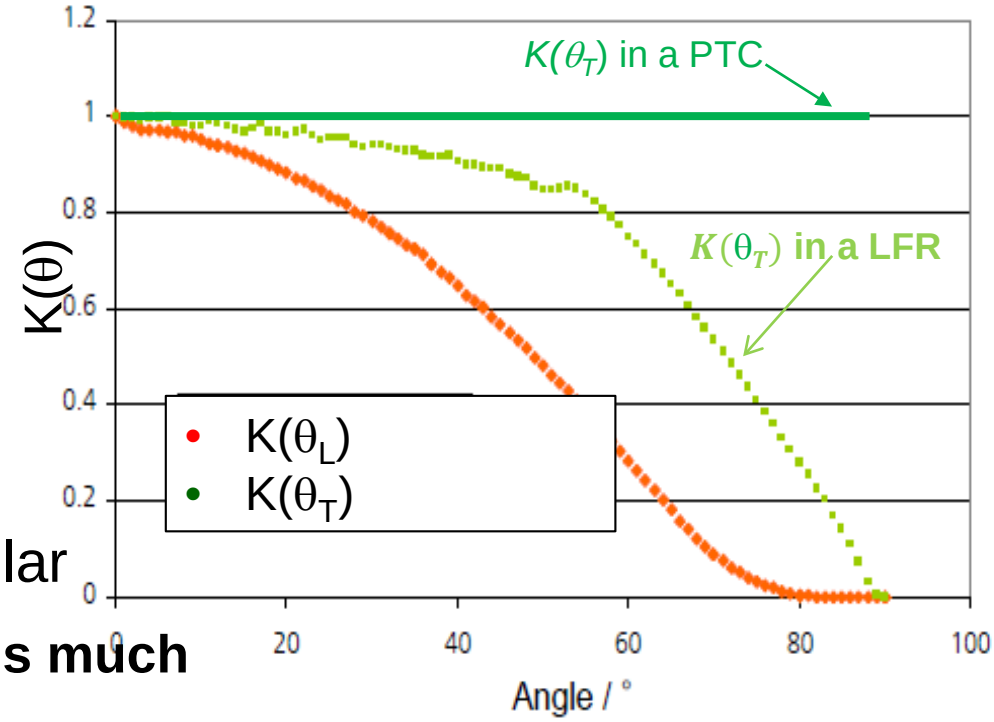
$$\eta_{opt} = \eta_{opt,0°} \cdot K(\theta)$$

$$K(\theta) = K(\theta_L) \cdot K(\theta_T)$$

PTC: $K(\theta_T) = 1$

LFR: $0 \leq K(\theta_T) \leq 1$

PTC & LFC: $K(\theta_L)$ is quite similar

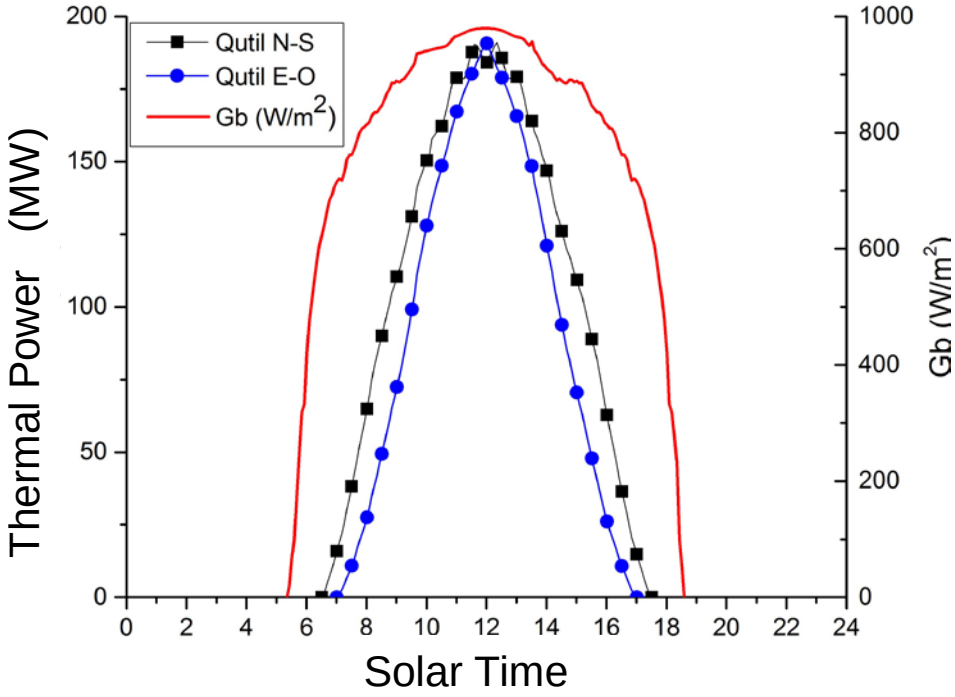


The Optical Efficiency of a LFR is much lower than in a PTC

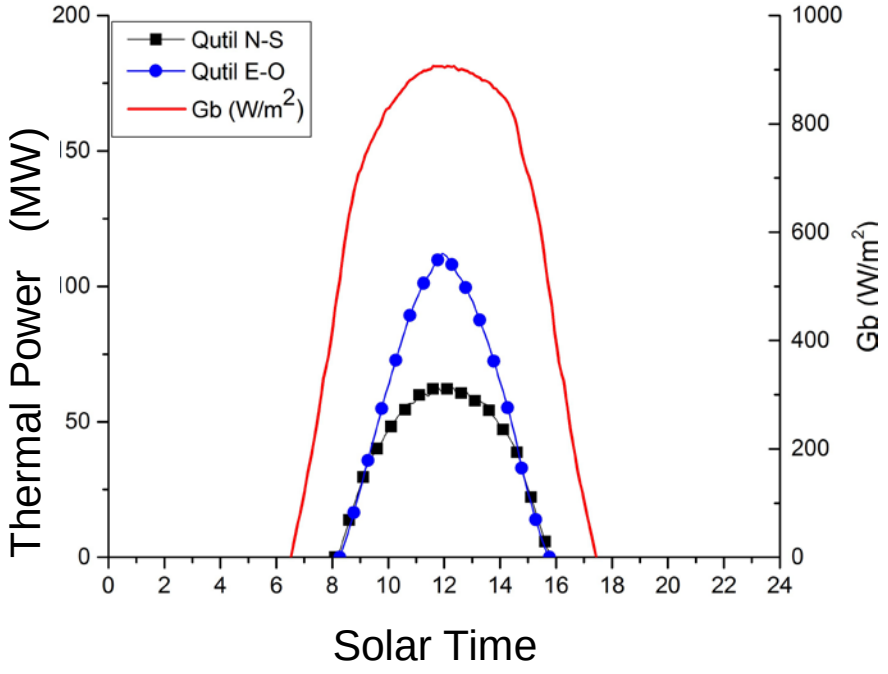
Linear Fresnel Collectors

Influence of the axis orientation on the seasonal performance

(Simulation of a LF-11 Fresnel collector



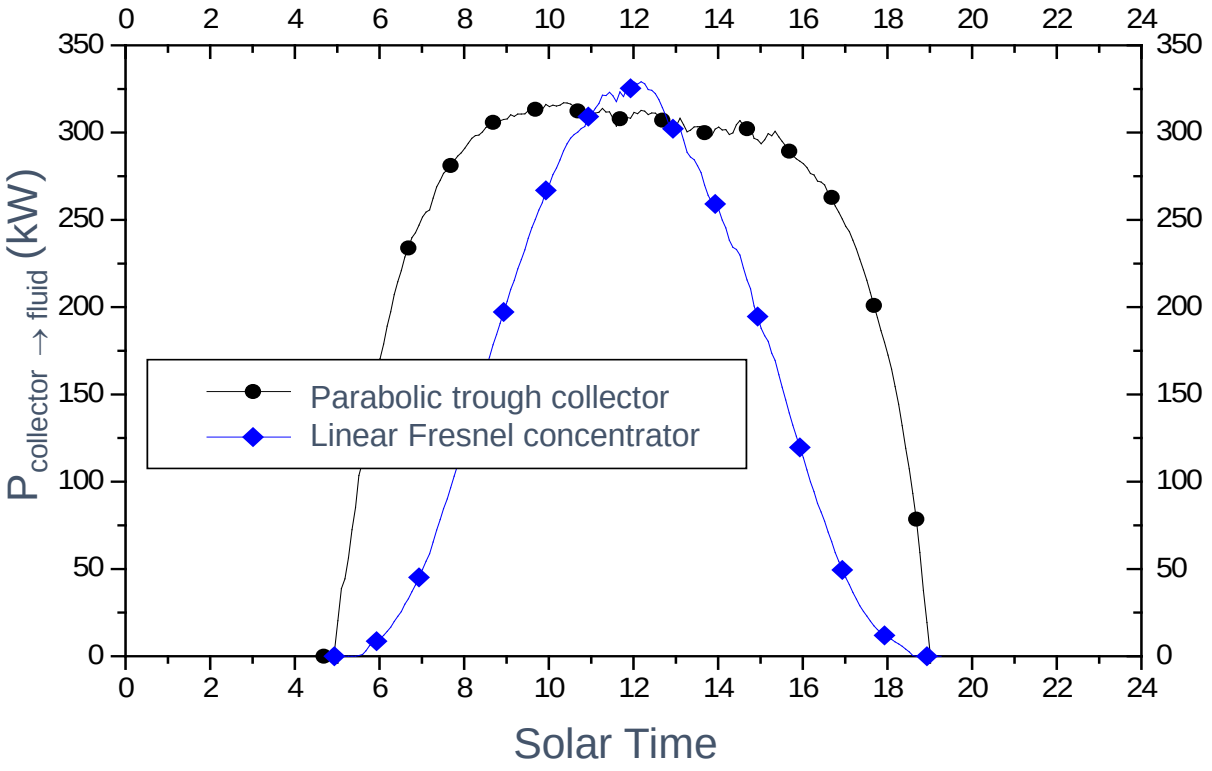
Daily performance in a clear Summer day



Daily performance in a clear Winter day

LFR versus PTC: Daily Power output

Daily thermal power output in Summer time



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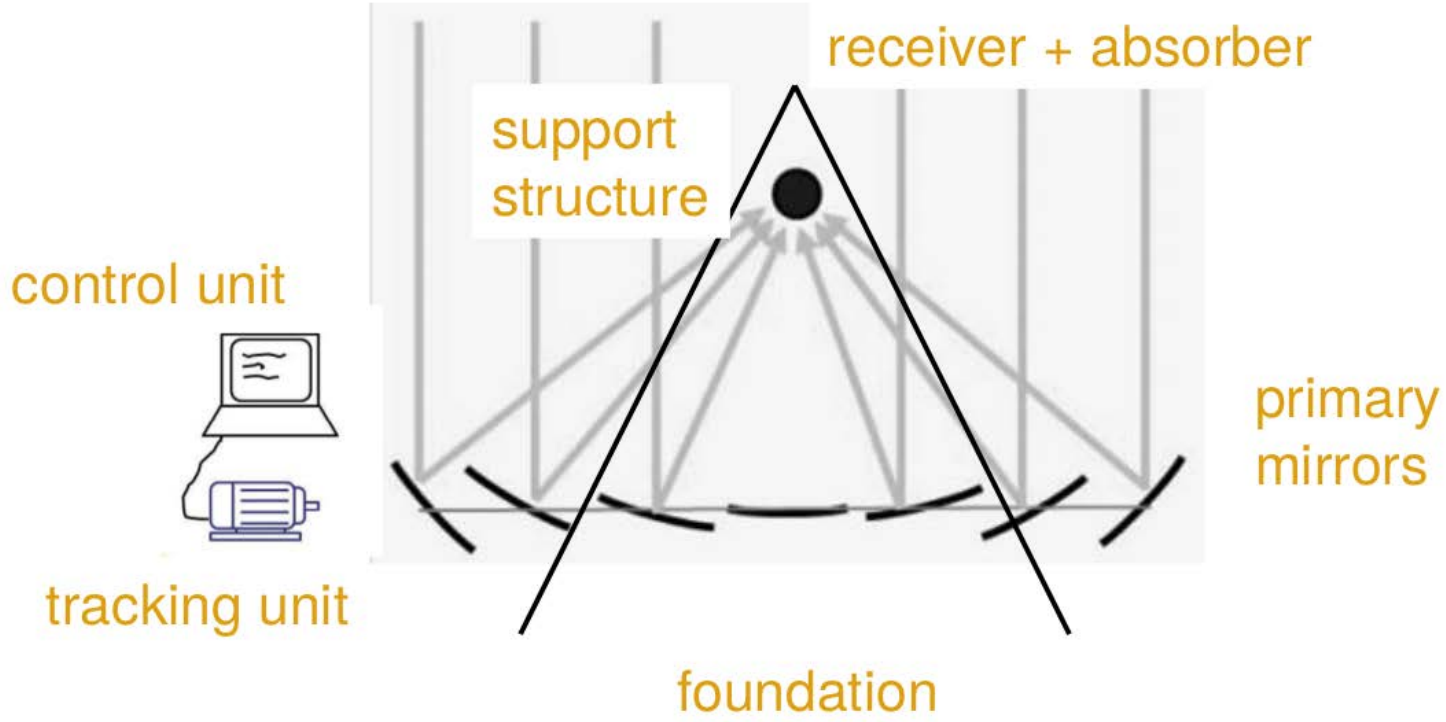
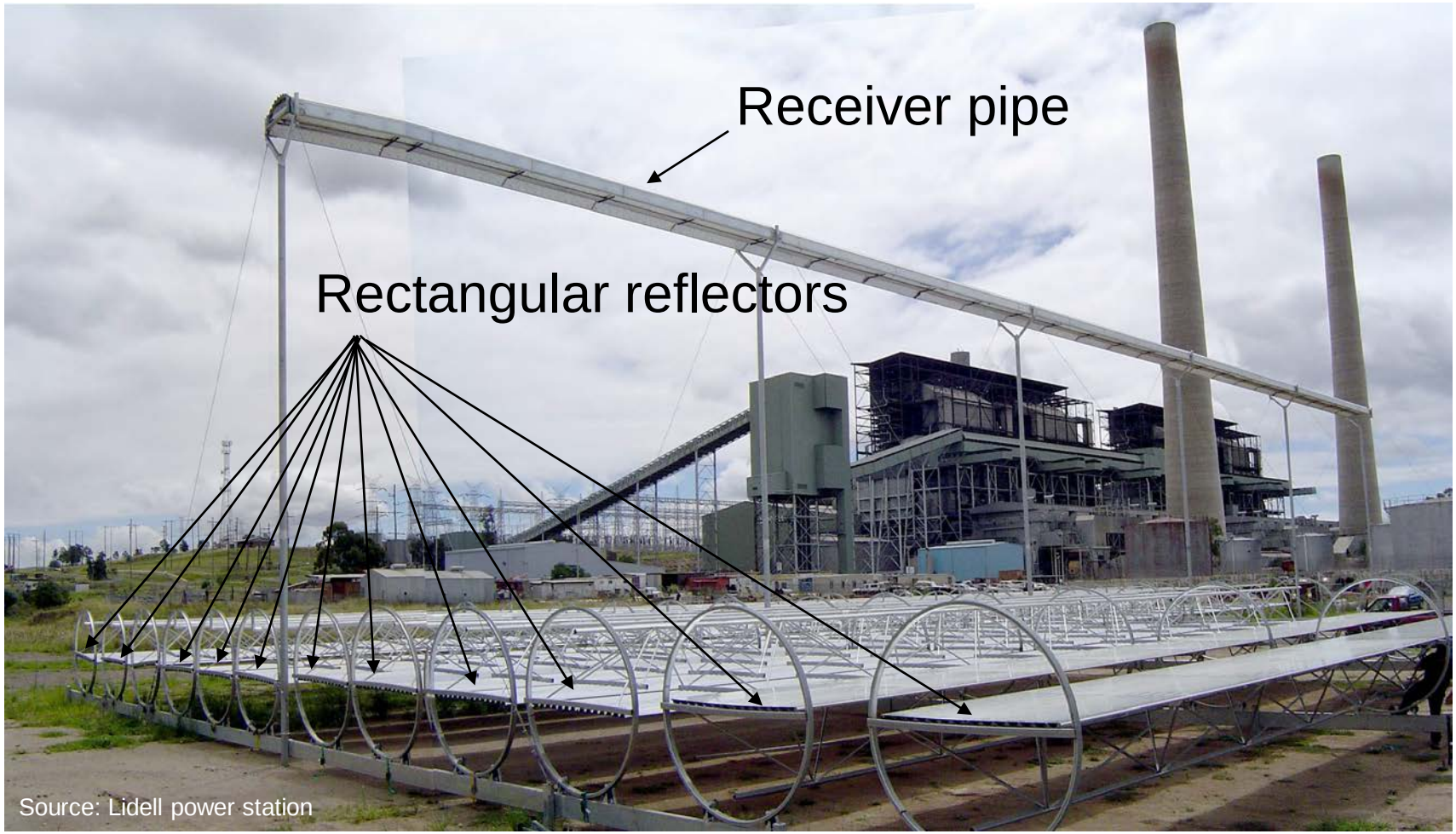
Linear Fresnel Collectors

Components



Linear Fresnel Collectors

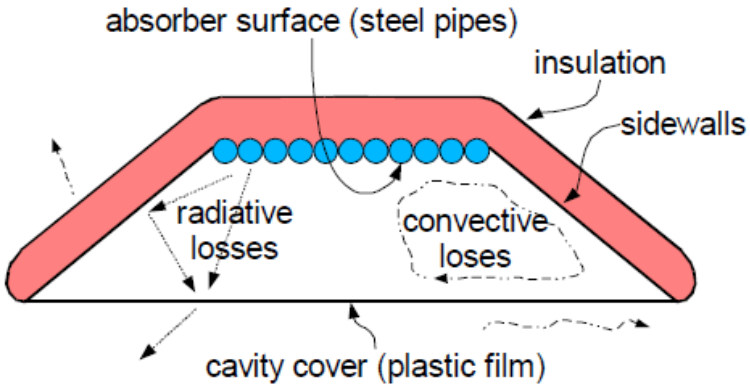


Linear Fresnel Collectors

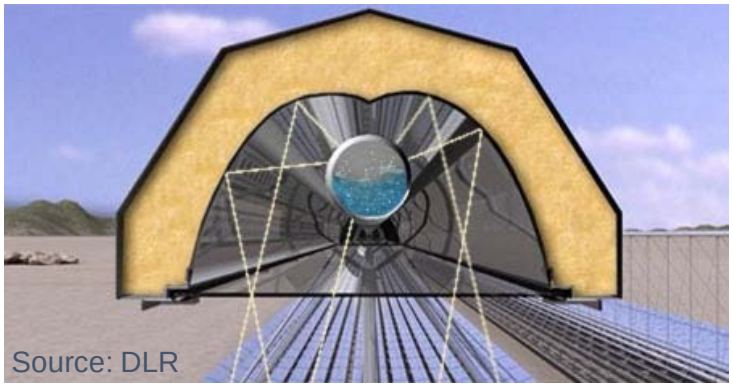
- **Reflectors:**
  - Flat or slightly curved mirrors (in support structure)

Linear Fresnel Collectors

- **Reflectors:**
  - Flat or slightly curved mirrors
- **Receiver:**
  a) Cavity with parallel pipes
  b) Non-evacuated pipe + secondary concentrator
  c) Evacuated pipe + secondary concentrator



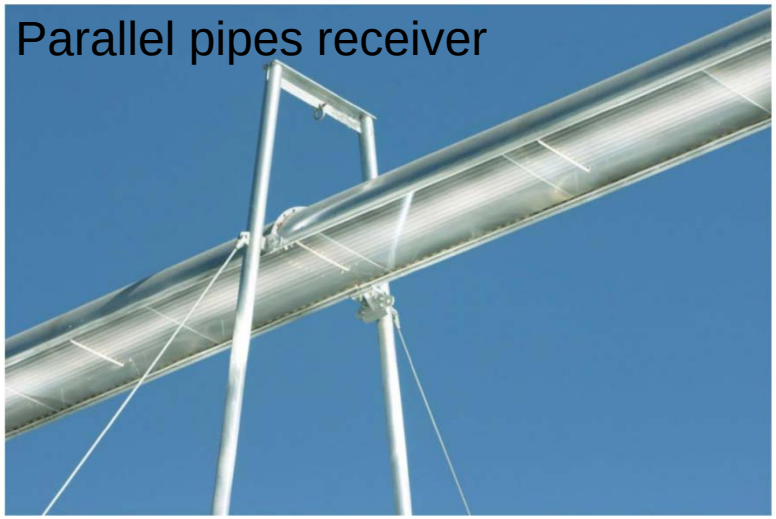
Source: Pye et al. ANZSES, 2003

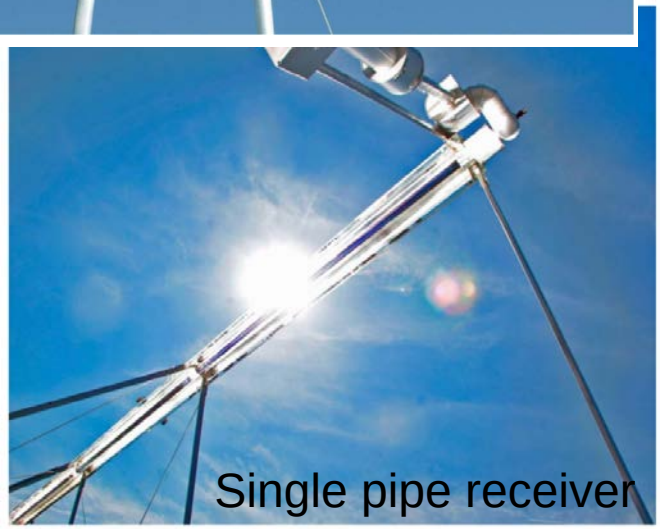


Source: DLR

Linear Fresnel Collectors

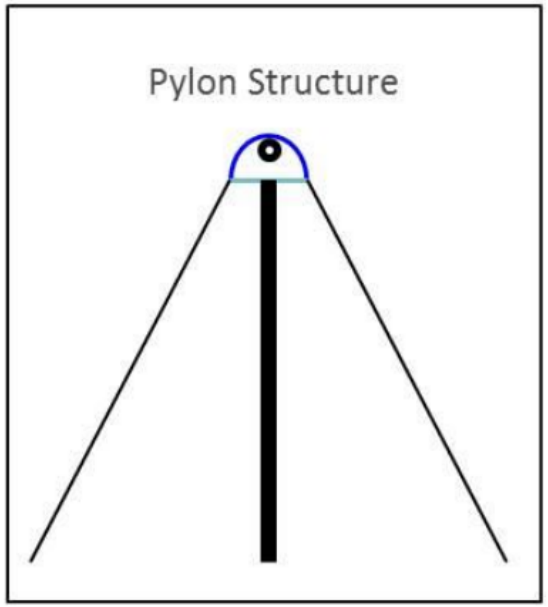
- **Reflectors:**
  - Flat or slightly curved mirrors
- **Receiver:**
  a) Cavity with parallel pipes
  b) Non-evacuated pipe + secondary concentrator
  c) Evacuated pipe + secondary concentrator
- **Heat transfer fluid:**
  - **Water/steam**
- **Fluid temperature** ≤ 450°C

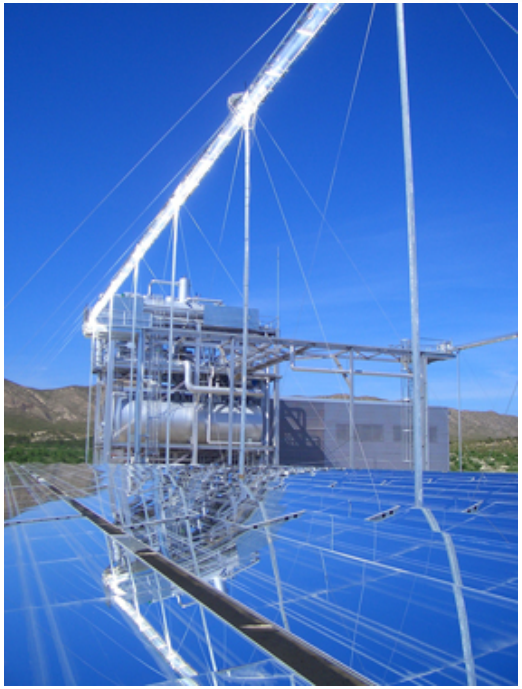




Linear Fresnel Collectors

- Foundation are lighter and cheaper than in PTC
- There are three different support structures for the receiver:





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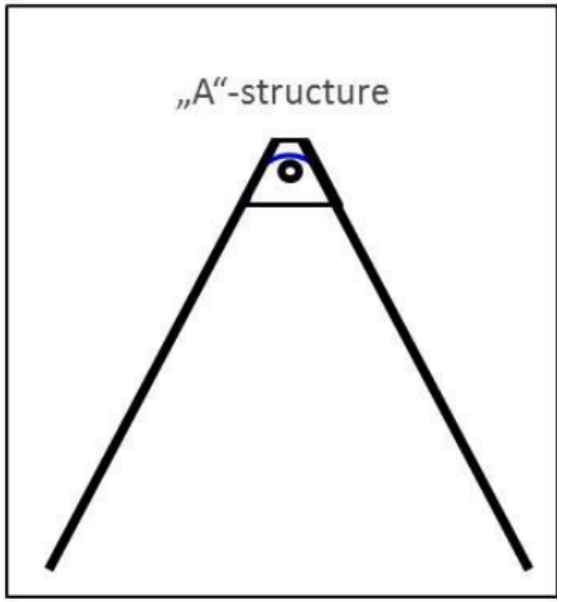

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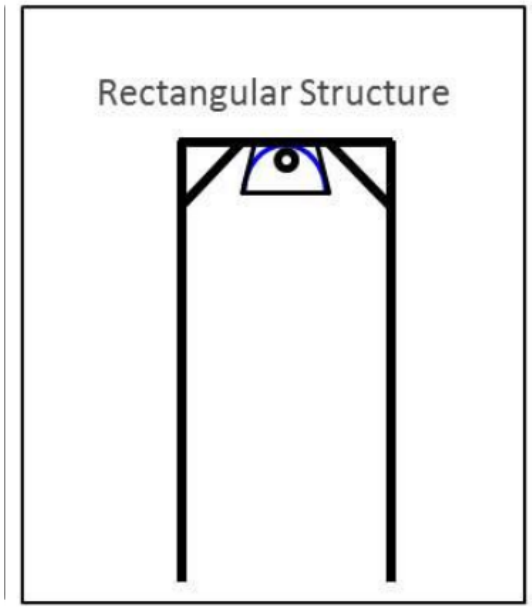

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LFR versus PTC

- Mirrors and support structure are lighter and cheaper
- Receiver tubes do not need flexible connections (they do not move)
- Optical efficiency is lower due to the existence of 2 incidence angles
- Solar fields with more compact lay-out of rows

Aerial view of two parallel LFR rows

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- Thank you very much for your attention

- Questions?

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