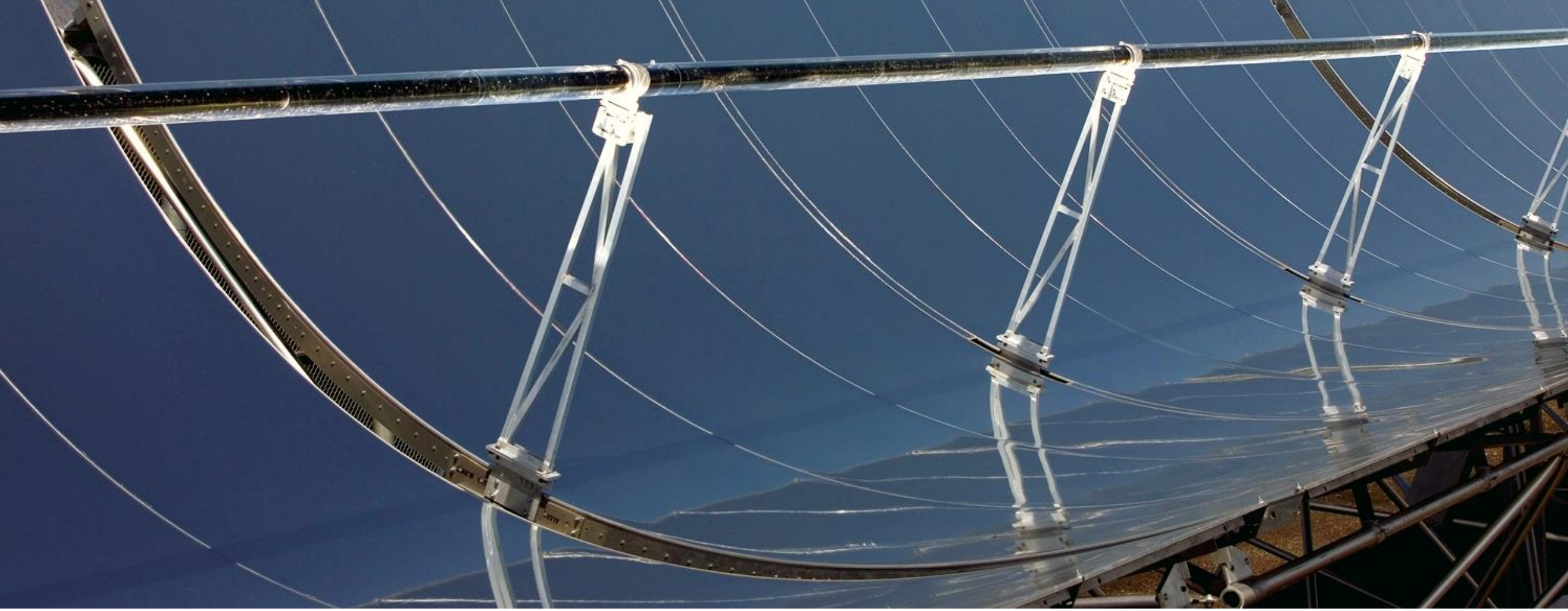

CSP trigeneration feasibility

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GEICO TAIKI-SHA

Politecnico di Milano

Project Scope

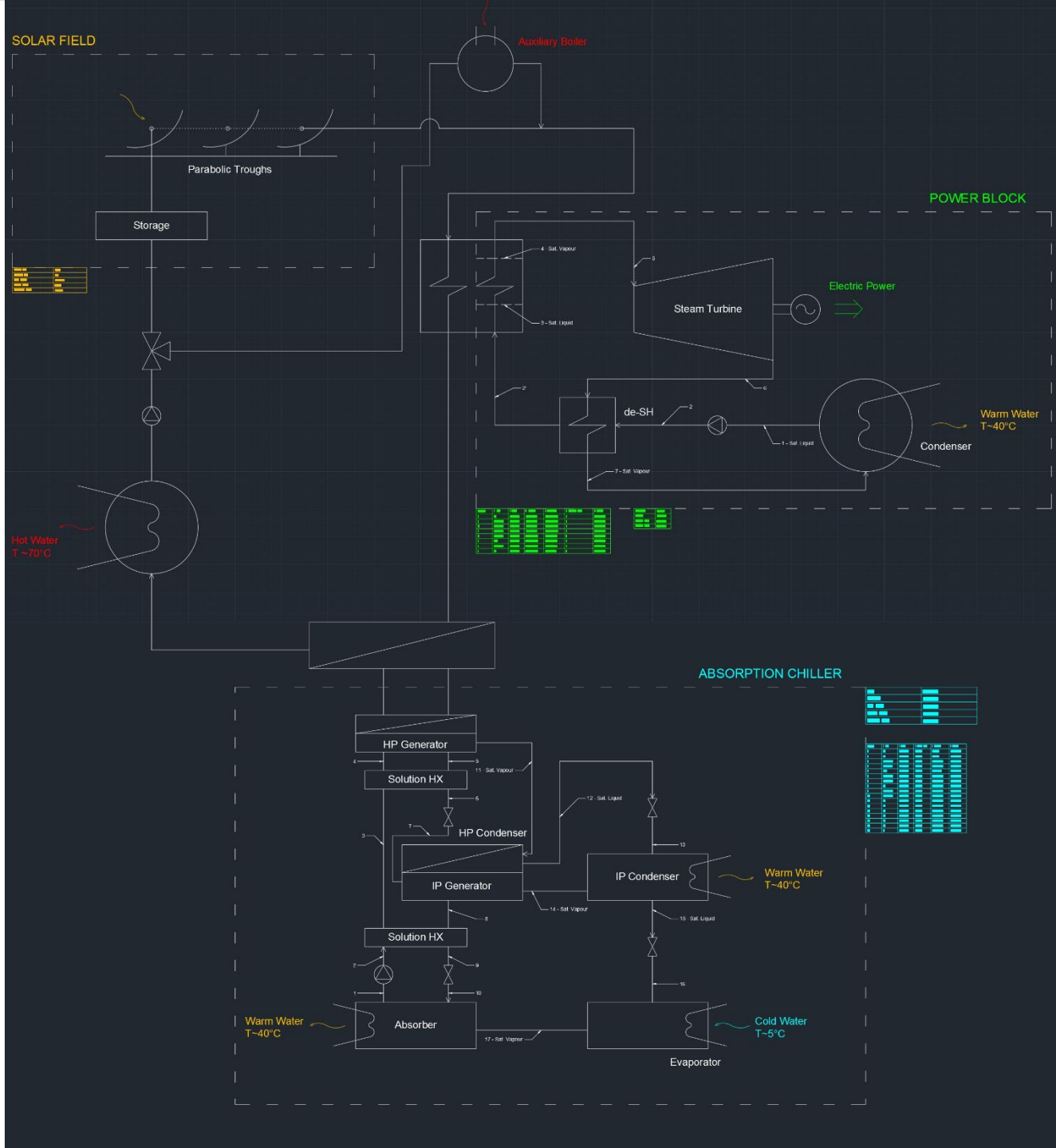
- Introduce an "advanced system of **renewable** energy production in order to decrease energy consumption from grid and CO_2 emissions"
- Exploit the heat source in an **optimal** way
- Meet the very **diverse demand** of the paint shop
- **Minimise** the cost of the **investment**
- Maximise its **returns**
- Ultimately envision a **self-sufficient paint-shop** design → commercial product

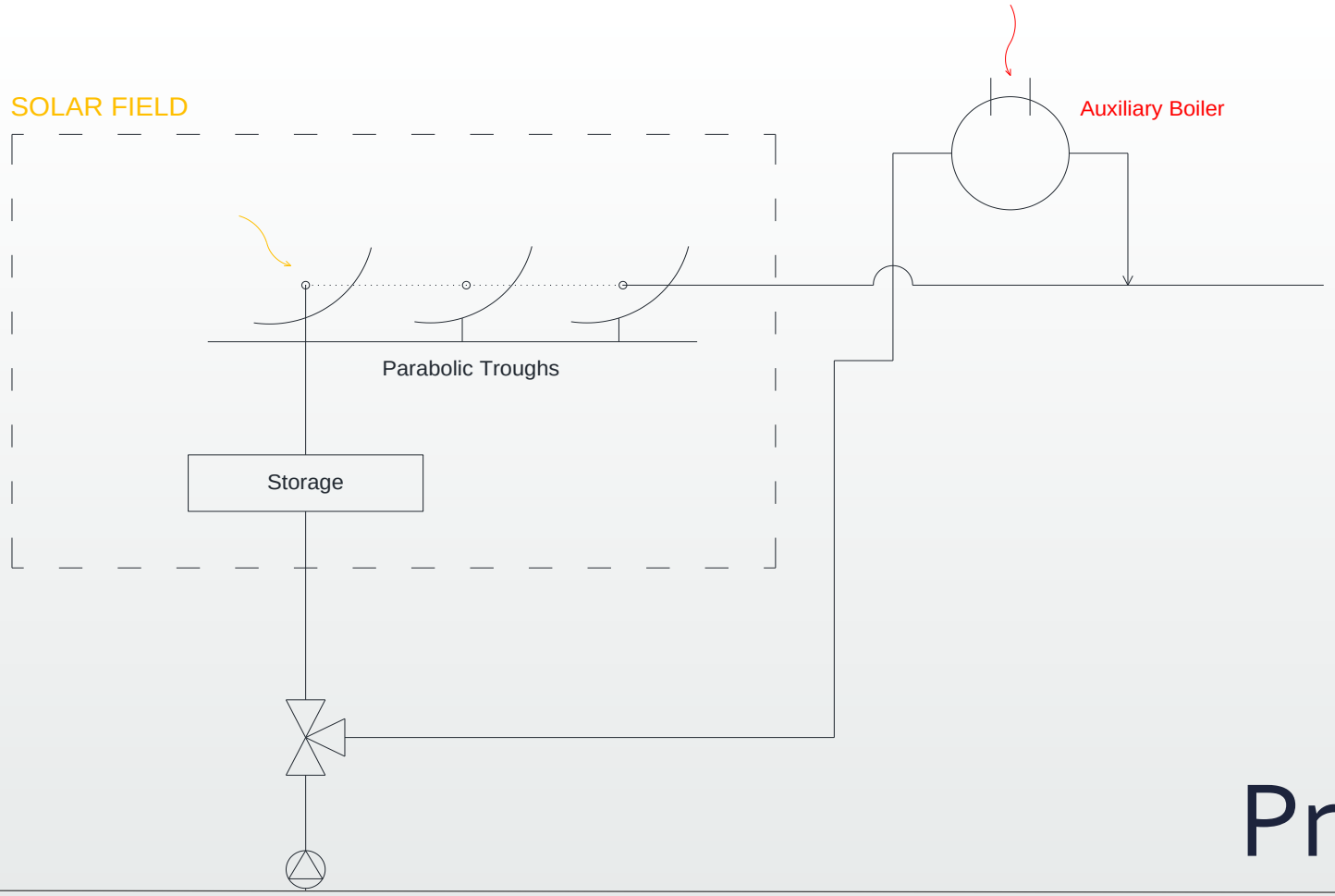
Project Description

Solar Field

- Parabolic Trough Collectors field
  - Roof mounted
  - Limited area
- Linear Fresnel reflectors field
  - Purchase of additional land
  - Demand completely fulfilled
  - Lower cost

- Organic Rankine Cycle power block
- Double-effect LiBr-H_2O absorption chiller
- Hot water heating





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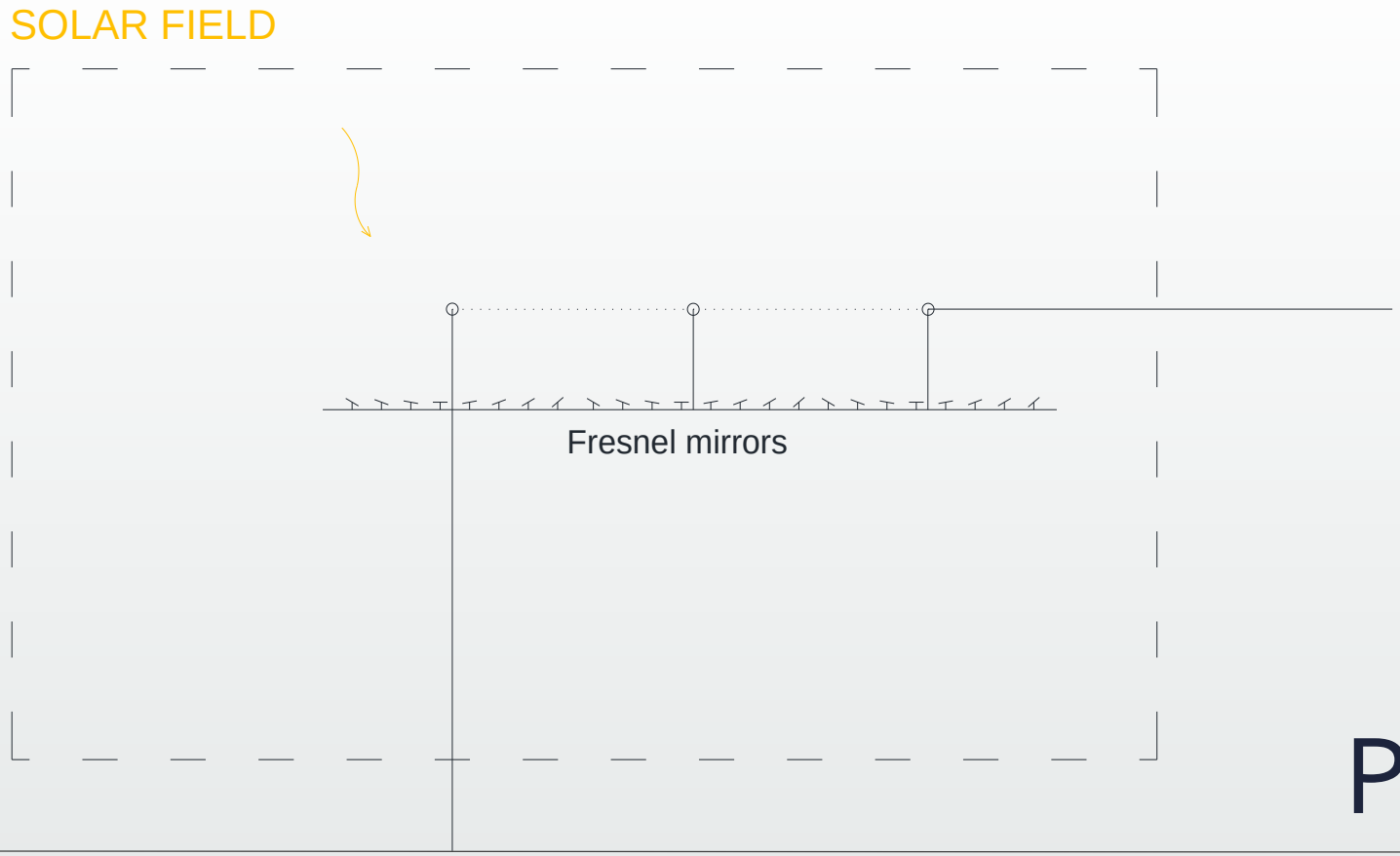

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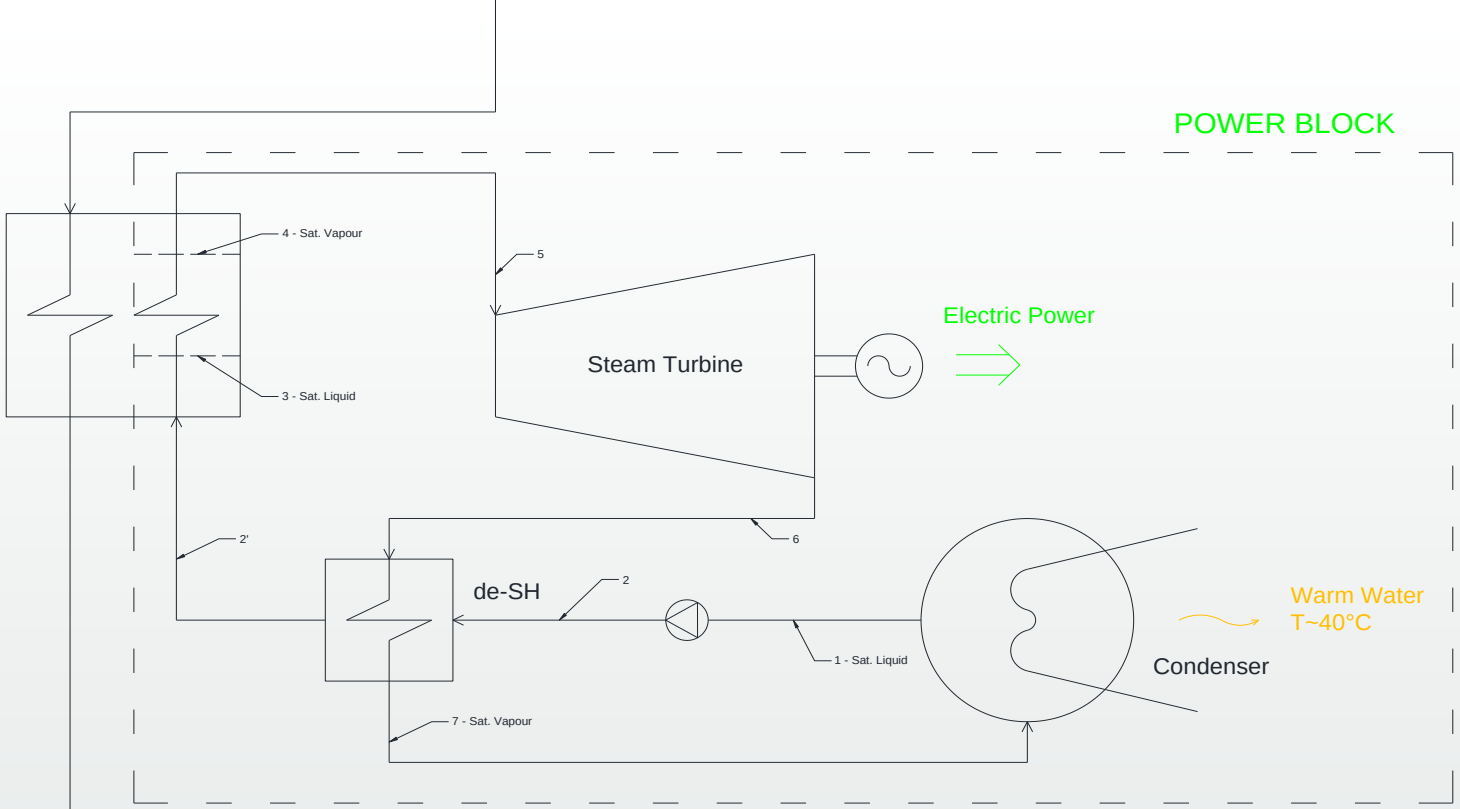

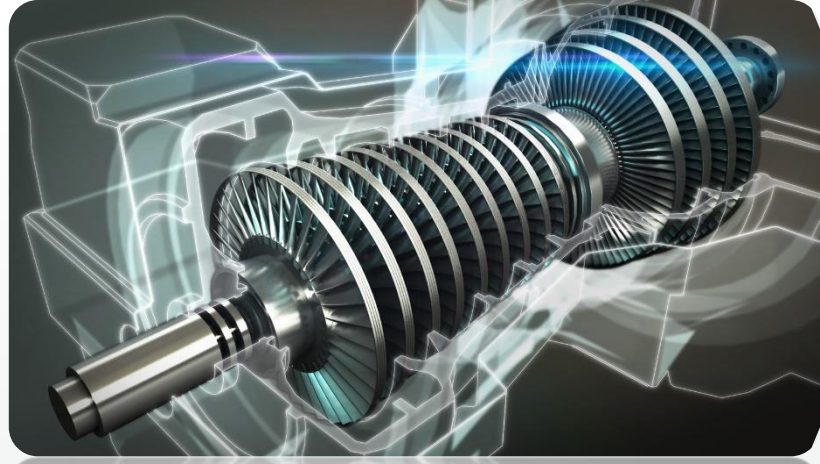

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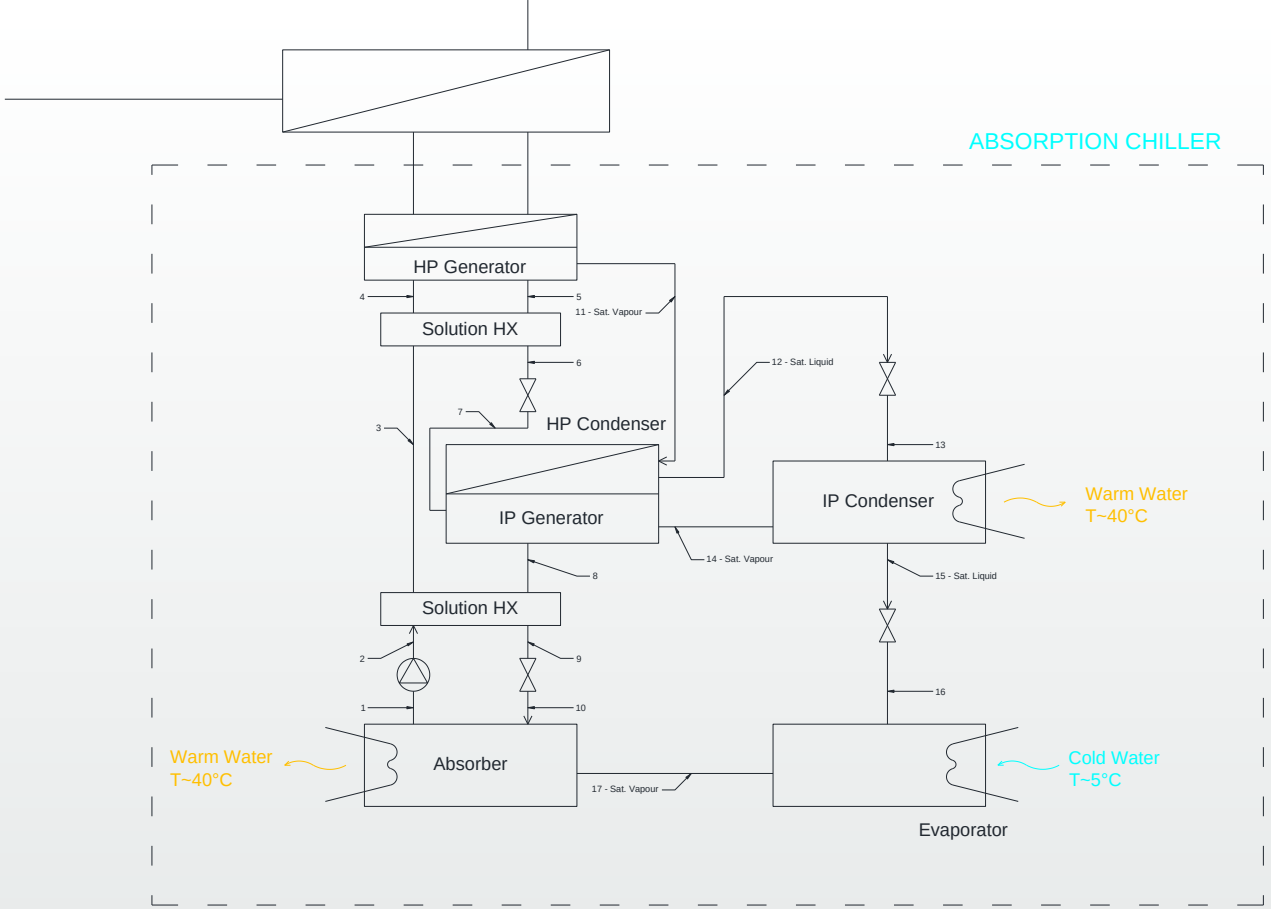

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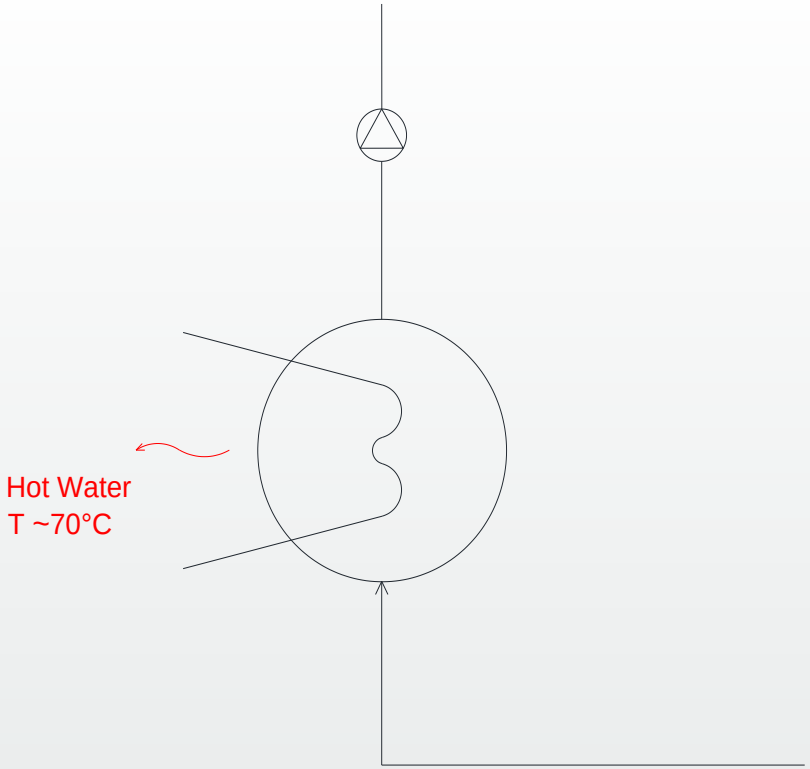

Project Description

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Why CSP?

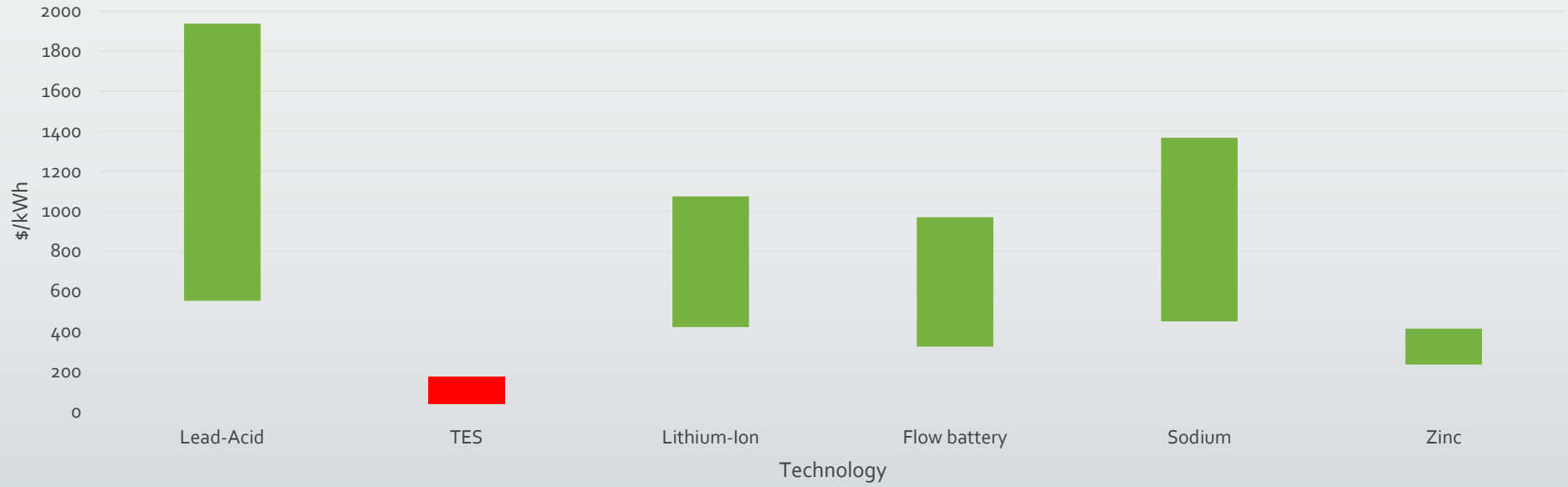
- Photovoltaics **only** meets **electricity** demand, storage is **unreasonably expensive**
- Wind farms are ill-suited for an **industrial complex**
  - speed distributions are disturbed
  - noise concerns
  - strongly affected by geography
- Hydro power and geothermal are **site dependent**
- Biomasses are **morally controversial**, due to repurposing of fields that could be devoted to food production → they don't match well with Geico's **governing ethics**

"Loyalty, Transparency, Consistency, Determination and Passion are the values that drive our team towards the mission we have set for ourselves, that is, to understand and pursue customer expectations with respect for people, the local community and the environment."

GOAL: Energy Independence Day

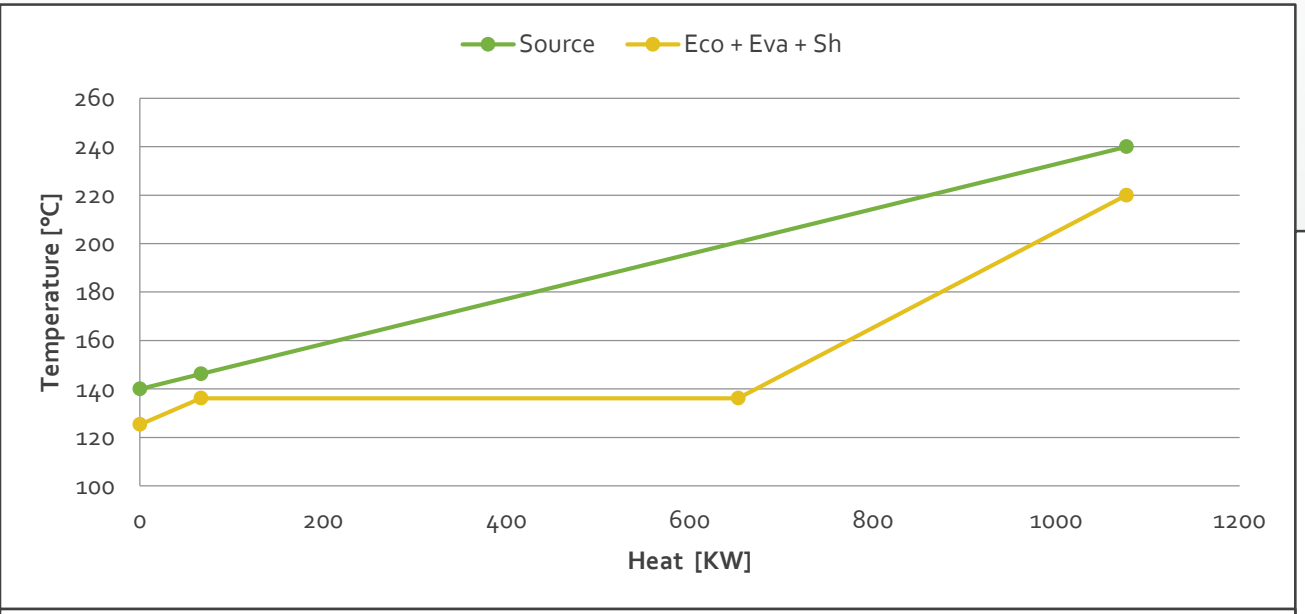
"The goal of Geico is to achieve a fully sustainable growth and innovation, while protecting the environment. Our aim is to be able to create a paint shop that is able to save 70% of consumption and to fill the remaining 30% using renewable energy."

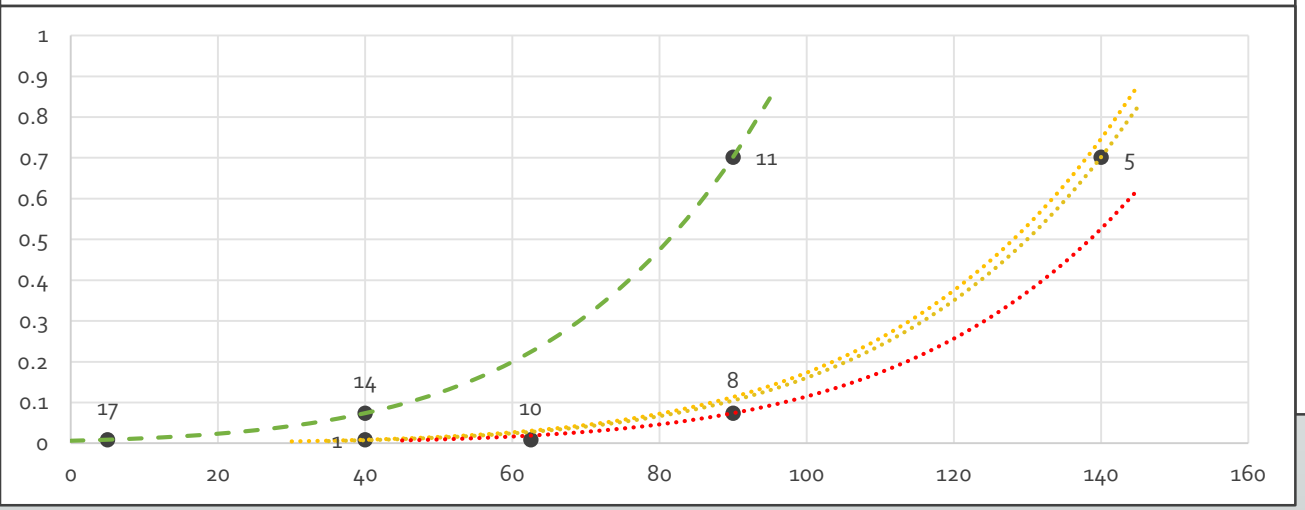
To reach independence **storage** is a must.



Sources: IRENA, Lazard & PowerTech Systems

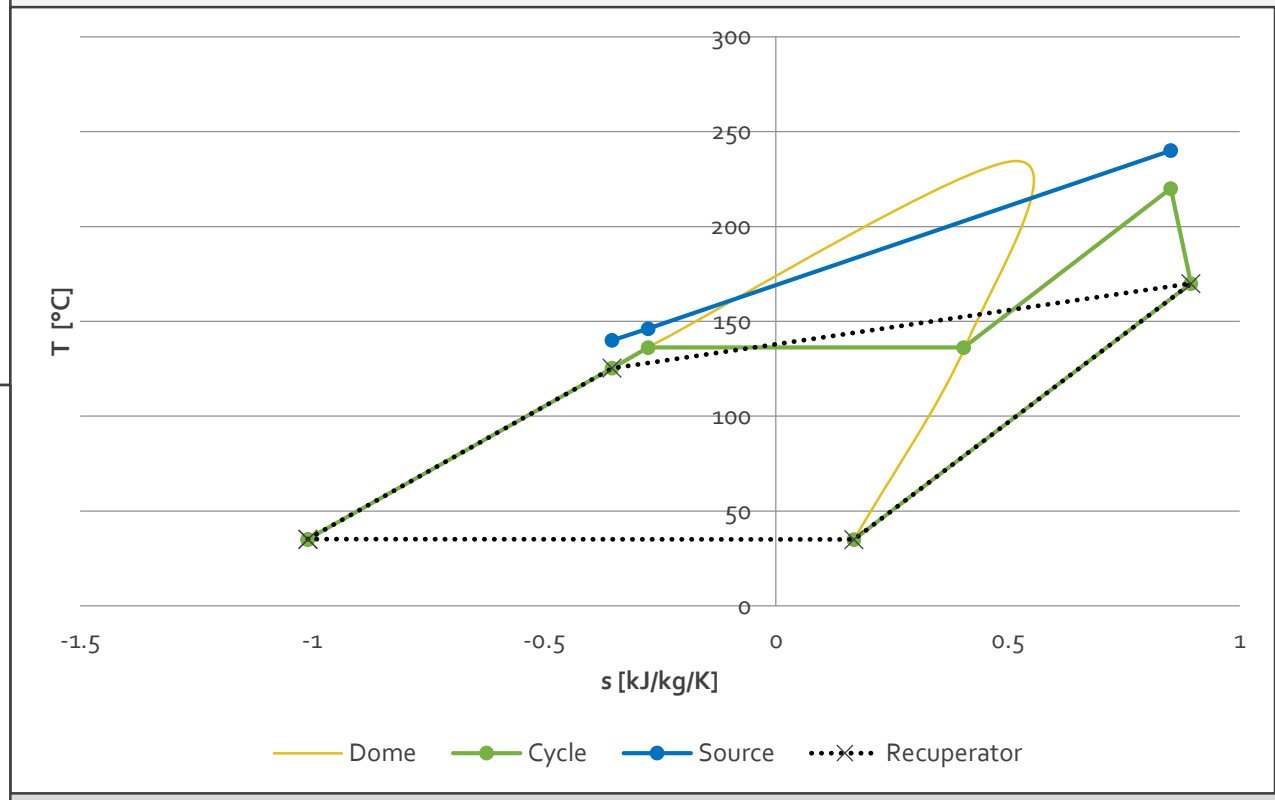
Objectives





II. Cycle design → P_{MAX}

III. Optimization of source inlet temperature → $T \uparrow, \eta \uparrow \dot{m}_{\text{hexane}} \downarrow$



Trigeneration advantages

Solar power from **collectors**

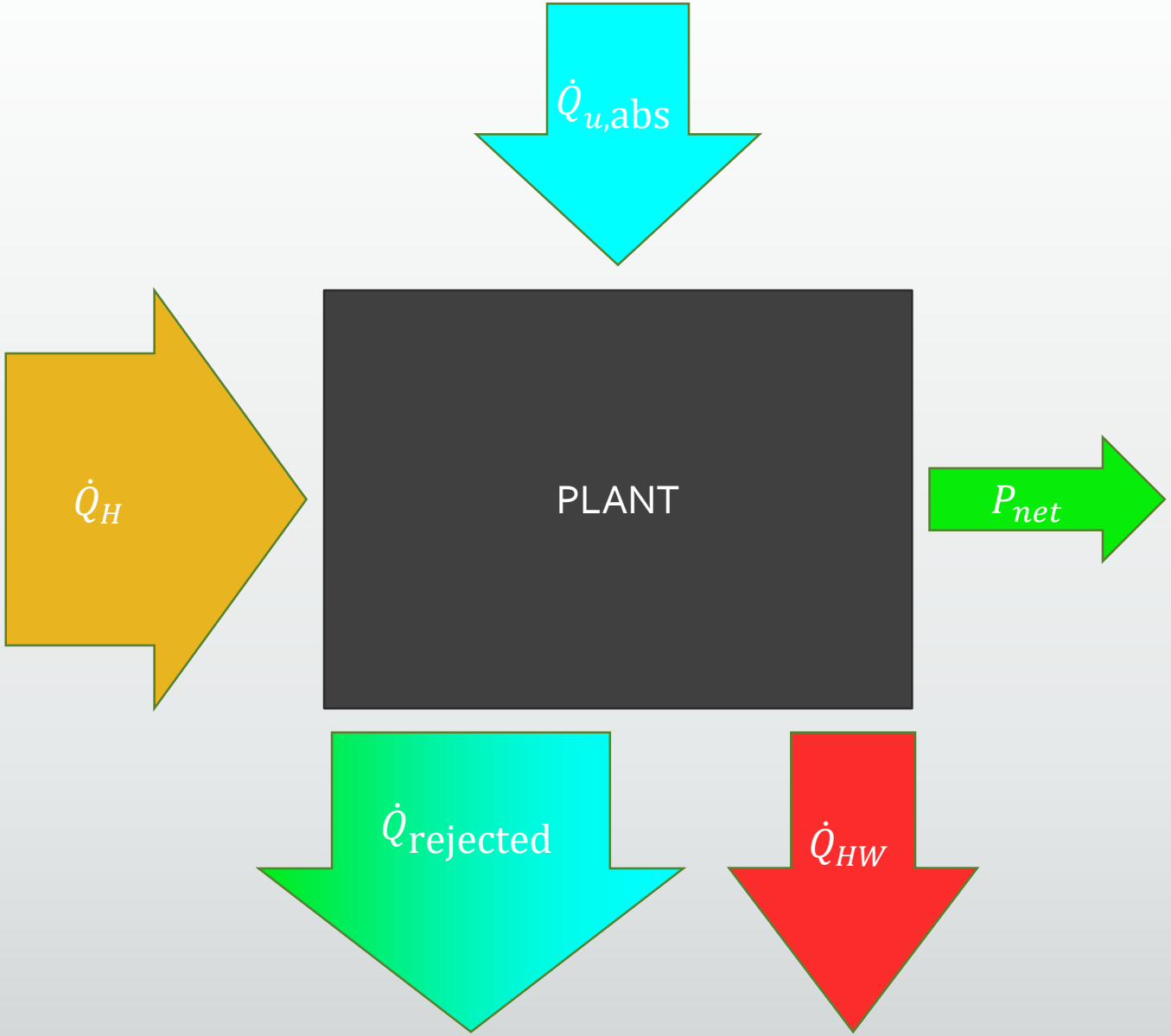
Useful heat contributi

- Chilling power $\dot{Q}_u$ th
- Absorption chill eje = 745.8 kW $_{u,abs} = 475.7\ \mathrm{kW_{th}}$
- Heat exchange v water Q 5 $\mathrm{kW_{th}}$
- Power at turbine or P_{net} =
- Heat rejection at ndenser $\dot{Q}_{cond}$ 64

Efficiency: useful *gain* / $\eta = \frac{\sum_i \dot{Q}_{u,i}}{\dot{Q}_H} =$ **48!!!**

IMPOSSIBLE!

Trigeneration advantages

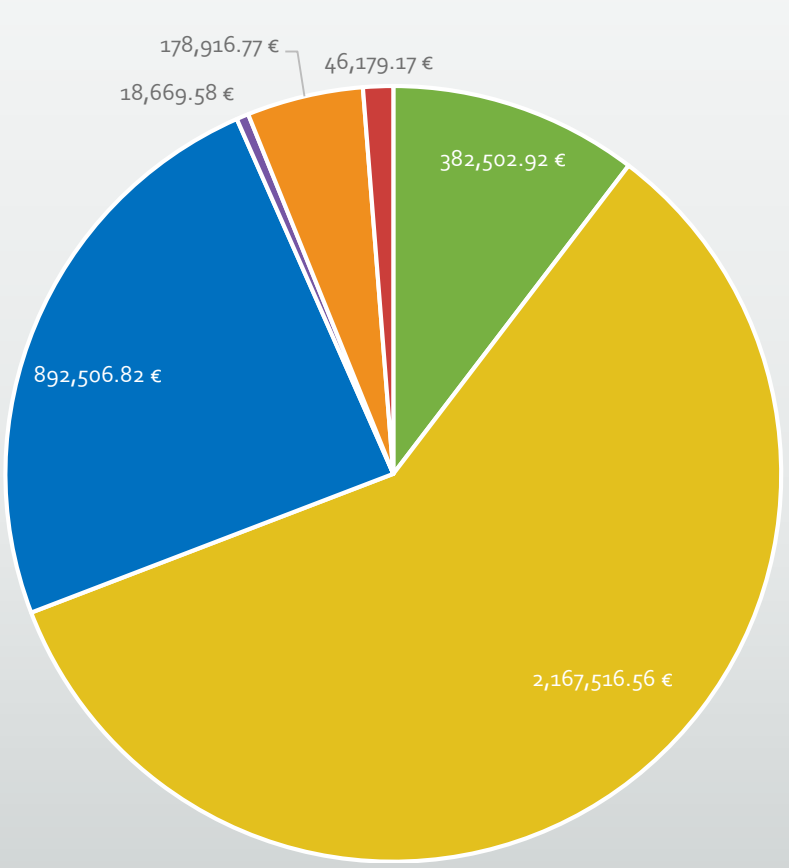


Considering signed values instead of module:

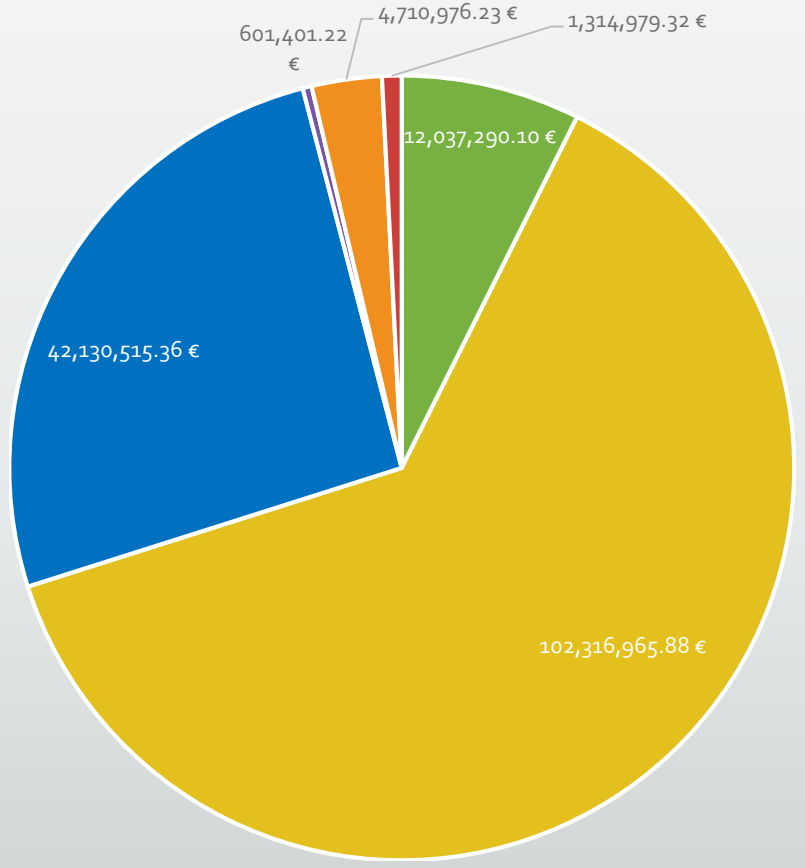
$$\eta = \frac{P_{net} + \dot{Q}_{HW} + \dot{Q}_{\mathrm{rej}}}{\dot{Q}_{u,\mathrm{abs}} + \dot{Q}_H} = 0.7$$

Investment Cost Analysis

Parabolic Trough configuration $C_{\text{inv}} = \mathbf{3{,}686{,}291.82\ €}$



Linear Fresnel configuration $C_{\text{inv}} = \mathbf{163{,}112{,}128.12\ €}$

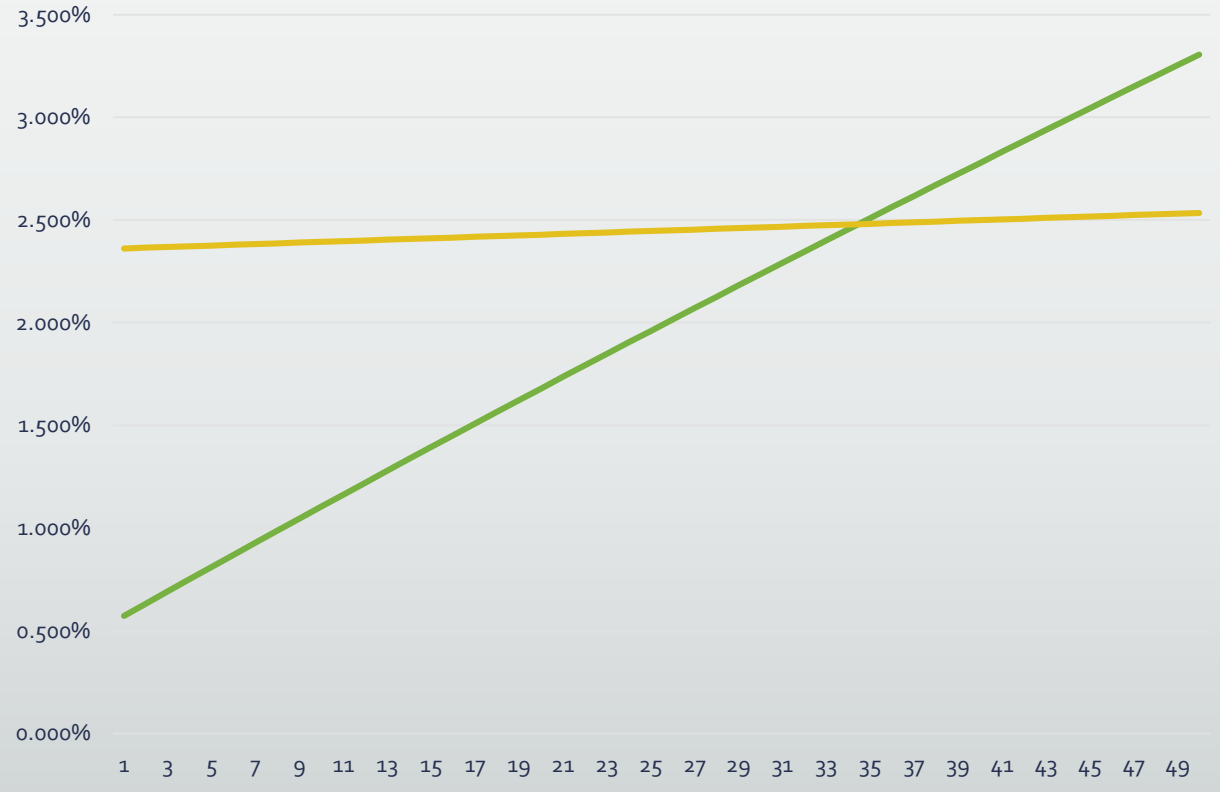


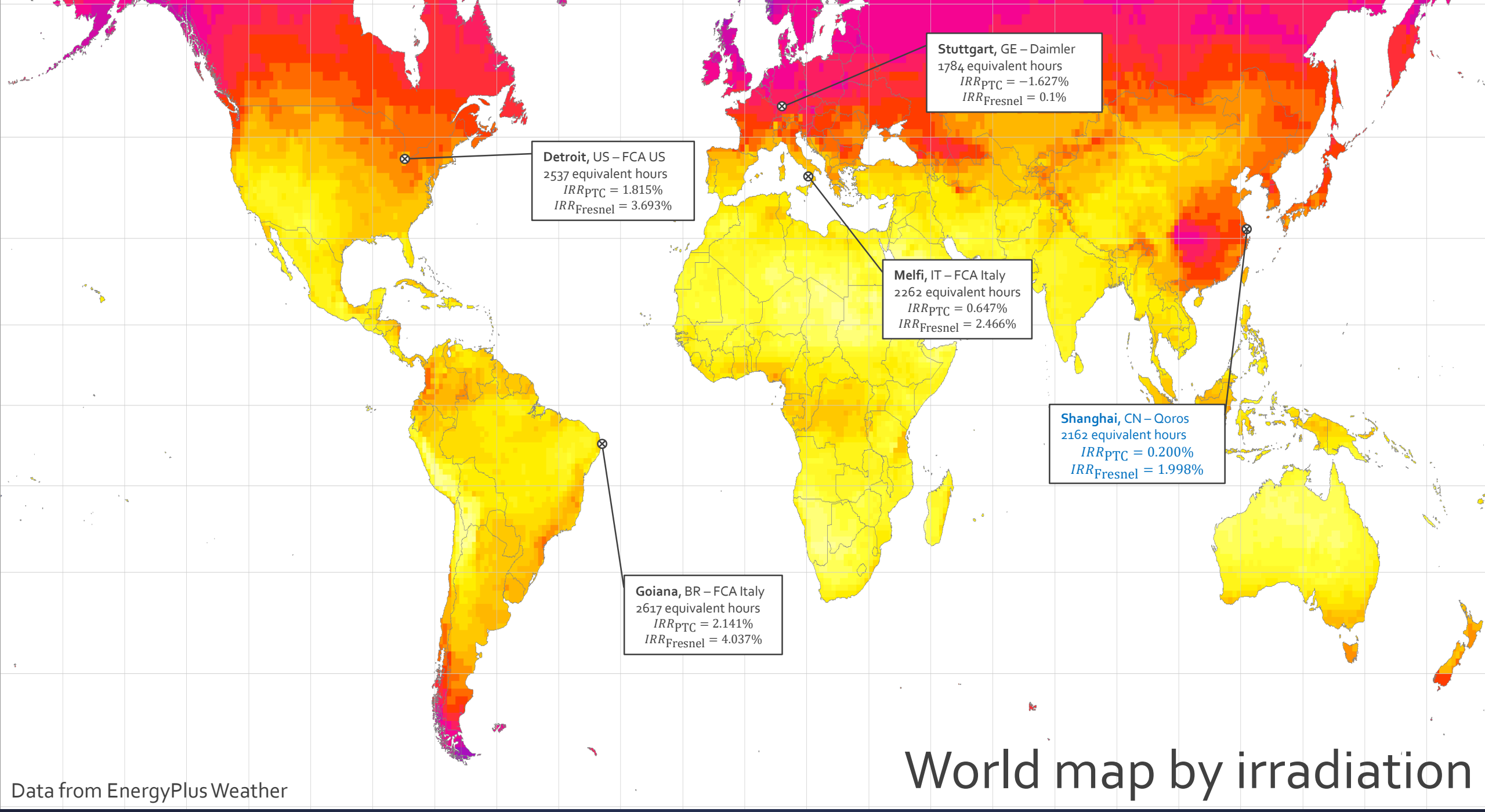
- Site Improvements
- Solar Field
- HTF
- Balance of Plant
- PB
- Storage

Internal Rate of Return

function of **equivalent hours**

function of **Carbon Tax**





World map by irradiation

Data from EnergyPlus Weather

Conclusions

- Integration of renewable proves to be a difficult task, but feasible given enough **effort**
- Like any other renewable source, CSP is very site dependent, but it shows interesting **features**
  - inexpensive storage solution → key to energy independence
  - flexible energy production mix, can easily **follow load** requirements
  - employs more **proven** and reliable technologies
  - large **margin** for growth and improvement
- Absorption chiller would be an **interesting** inclusion even regardless of the CSP field