High vacuum flat solar panel development project

(Panneau solaire plat sous vide)

Jagalit

Innopark Lausanne

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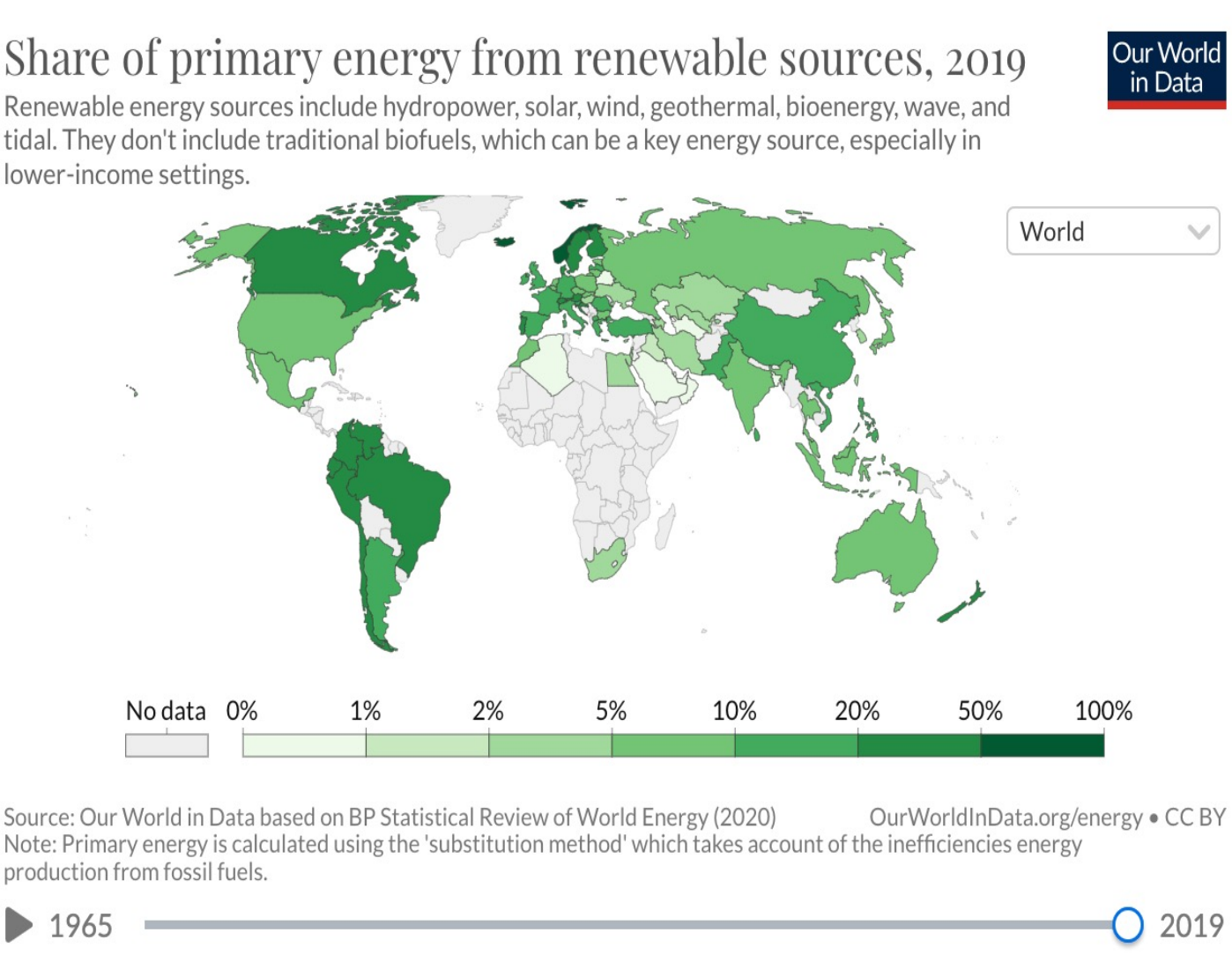
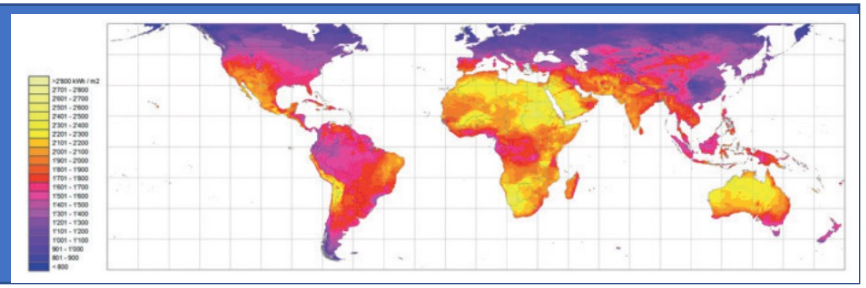
Renewable energy

- To reduce CO_2 emissions and local air pollution, the world needs to rapidly shift towards low-carbon sources of energy – **nuclear and renewable** technologies.
- Replace 90% of Fossil Fuel Usage with **Green Hydrogen and Carbon-Free** base-load Electricity.
- Renewable energy represents (2019) about 11% of the world's total primary energy supply.
- Remember 80% of the worldwide energy use, is based on fossil fuels.



Energy consumption represents the sum of electricity, transport and heating.

Solar energy



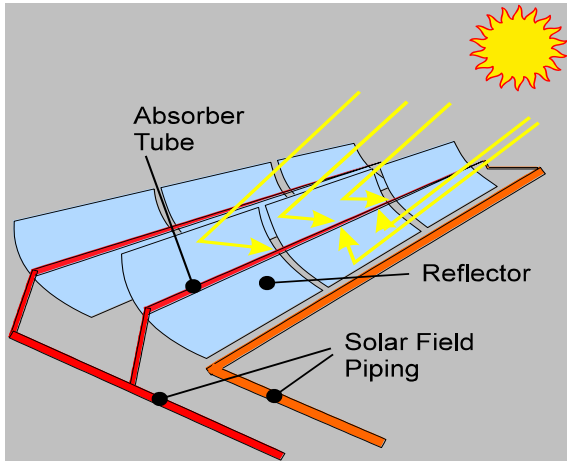
- The amount of solar irradiance, insolation or flux density is about 1.4 kW/m^2.
- Using a factor of 6 due to seasons, losses in passing through the earth's atmosphere we get 220 W/m^2
- When this 220 W/m^2 is integrated over 1 year, the resulting 7.2 GJ on 1 m^2 is approximately the energy that can be extracted from 1.3 barrel of oil, 200 kg of coal, or 190 m^3 of natural gas
- The maximum annual solar energy is about 2000 kWh/m^2 and is distributed over a vast area as the "sun belt".
- On earth we consider 10 million km^2 of terrestrial area of **great insolation**. Therefore, the total energy received from the Sun can be estimated at around 20 million TW-h per year (*approximately 72000 EJ*) .
- Worldwide energy consumption is about 556 EJ (in 2020).
- The total annual solar radiation falling on the earth area of great isolation is about than 130 times the world's total annual primary energy consumption of 556 EJ (in 2020).
- In conclusion the worldwide energy consumption of 556 EJ, which is currently around 9.1 x 10^{10} barrels of oil or 154444 TWh, is indicating that the full use of solar energy in regions with high insolation would cover around 130 times the world consumption.

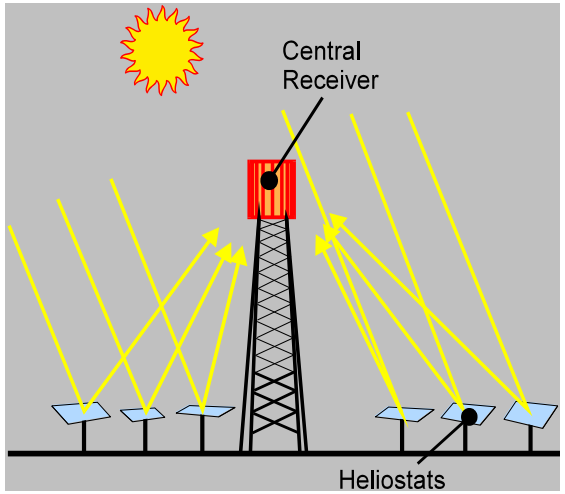
Solar panels installations

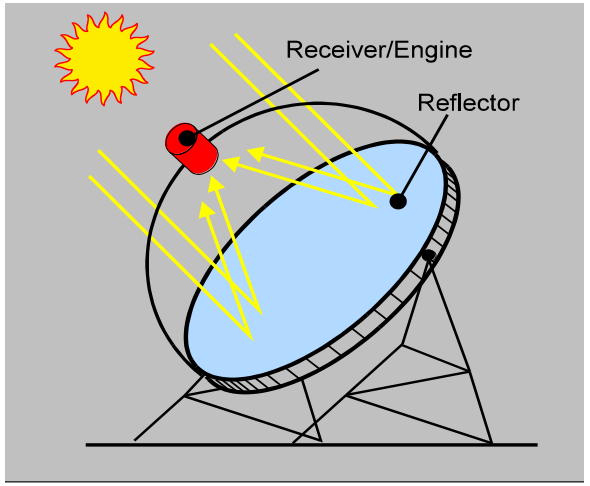
- Without concentration
  - Non-glazed collectors
  - Flat plate solar collectors
  - Vacuum tube collectors

Solar panels installations

- With concentration
  - The parabolic-cylindrical systems
  - The central tower systems
  - Parabolic disks or paraboloid mirrors





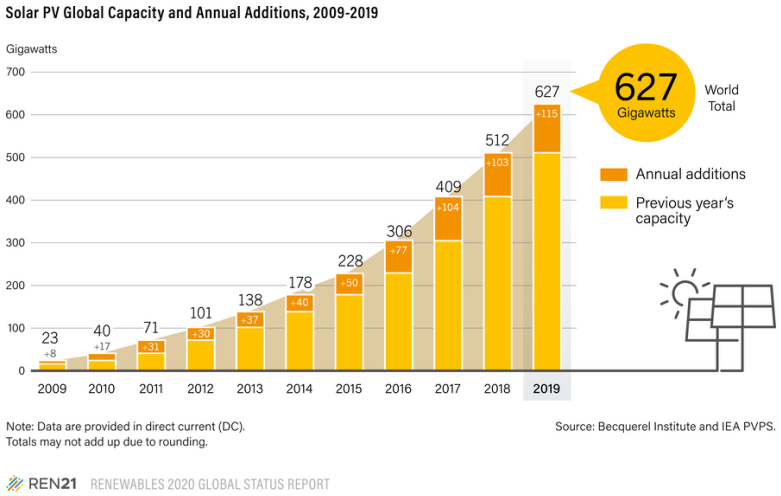


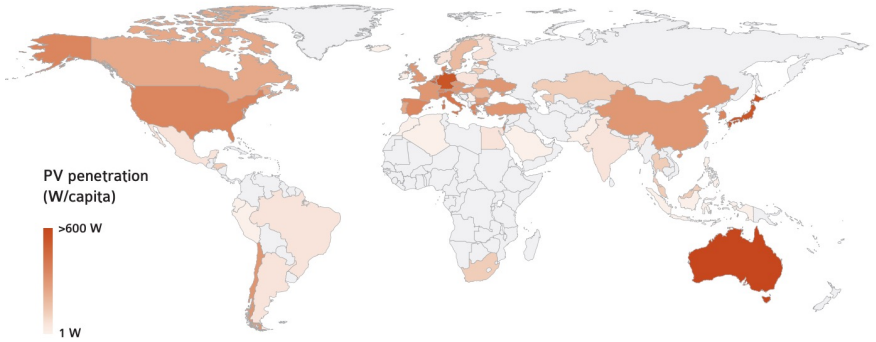
Solar panels installations

- Current solar energy installations range from huge parabolic mirror power plants (as in the California desert) to photovoltaic panels and small roof-mounted water heaters for residential use.

Market for Solar electricity

- Photovoltaic panels represent an important market for solar electricity.
- In 2019, the solar PV market grew by approximately 12% to 115 GW
- The global total of 627 GW, compares with a total 23 GW just 10 years earlier.
- Next generation solar thermal installations will complement and extend this high-growth market.
- Over **6 billion euros**, by 2024.
- Currently, the efficiency PV systems is up to 15% while more than 85% of incoming solar radiation energy is either absorbed or reflected; therefore, significant excess heat is dissipated and wasted.

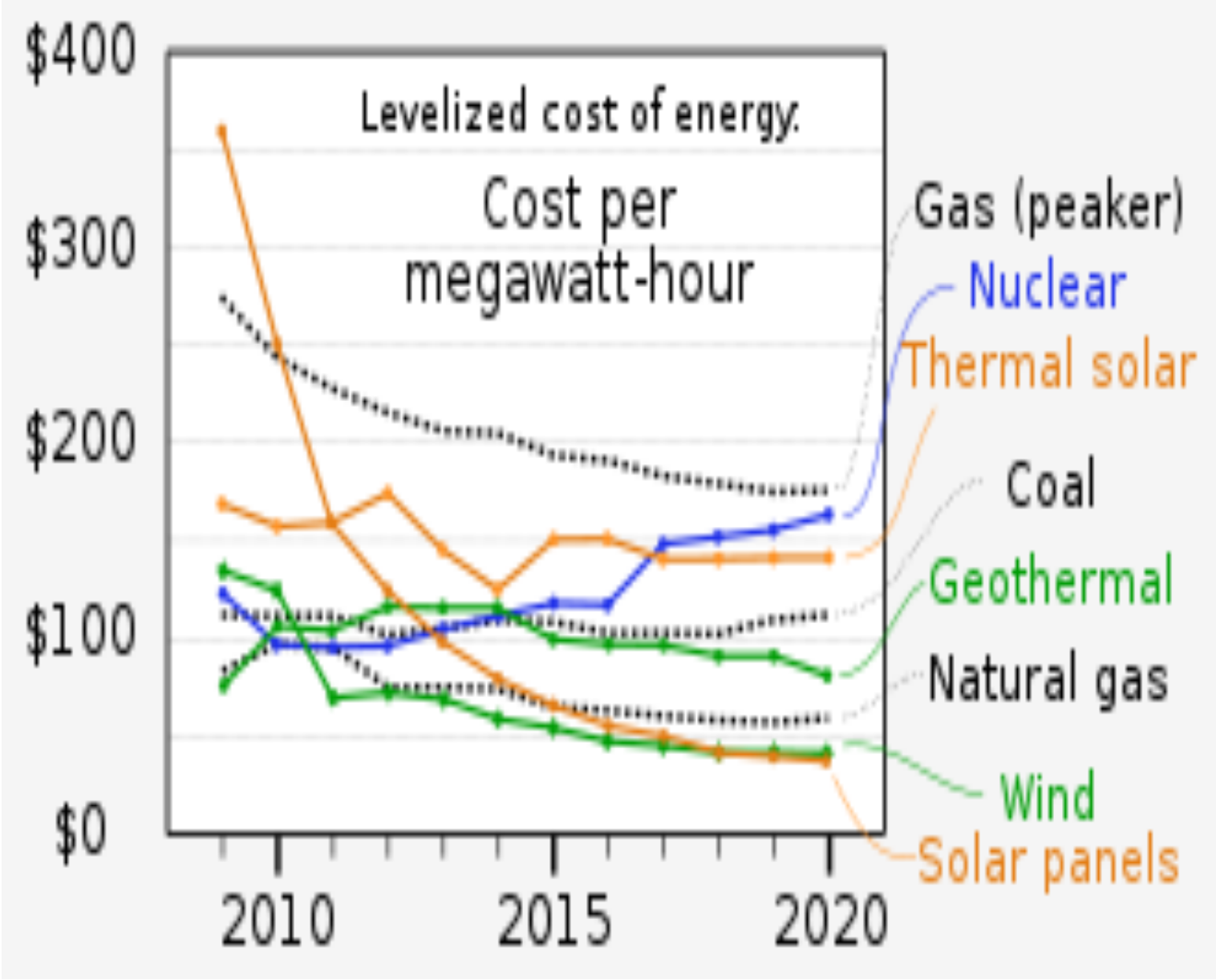




PV penetration per capita in 2019

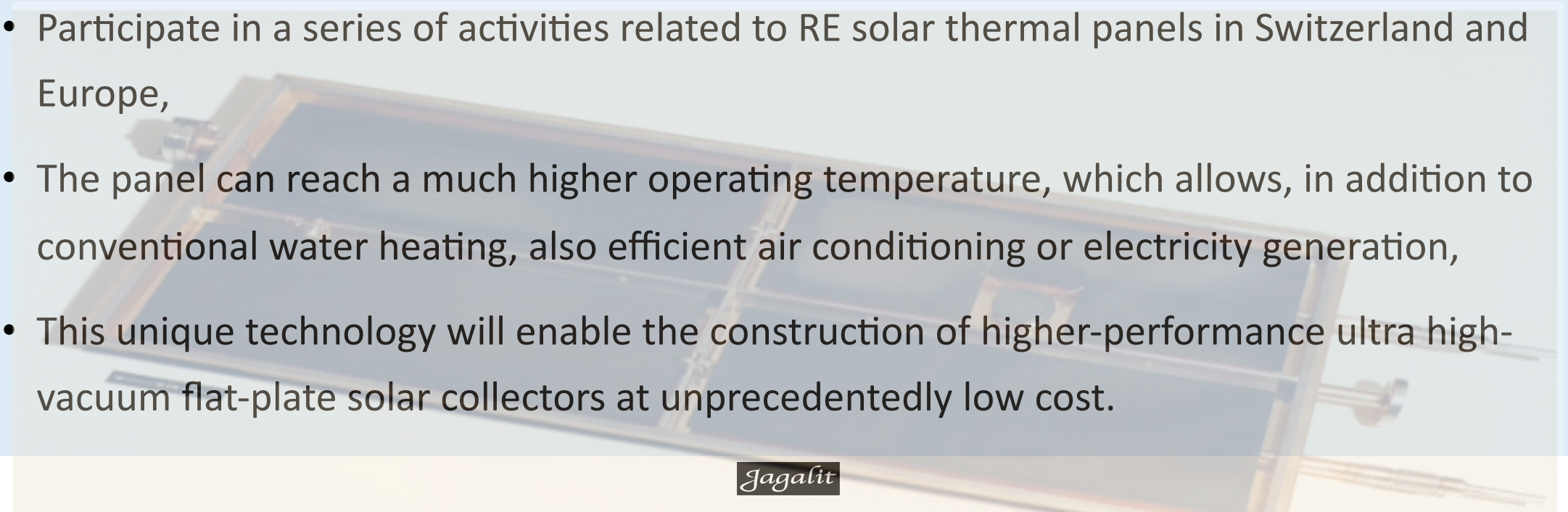
Cost of Solar electricity

- Both solar thermal and photovoltaic technology have experienced significant cost reductions in recent decades,
- There is a strong trend for solar thermal technology to offer a lower overall cost for large-scale electricity production.



Our proposal: High vacuum solar panel

- CERN Technologies: NEG PCT & Palladium Coating & Solar Panel (patents - 2004)
- Create a company for the development of HVSP collector as a innovative technology in the field of RE,
- Participate in a series of activities related to RE solar thermal panels in Switzerland and Europe,
- The panel can reach a much higher operating temperature, which allows, in addition to conventional water heating, also efficient air conditioning or electricity generation,
- This unique technology will enable the construction of higher-performance ultra high-vacuum flat-plate solar collectors at unprecedentedly low cost.



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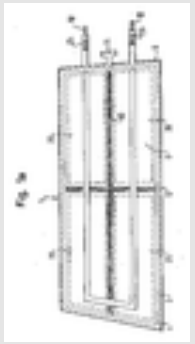
Collector technology

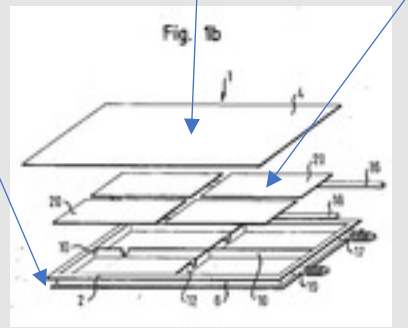
- The collector technology has
  - a large volumet covered with glass and metal under ultrahigh vacuum conditions,
  - continuous on-site vacuum pumping
  - an ultra high quality energy absorber
  - all in a simple and reliable flat panel design

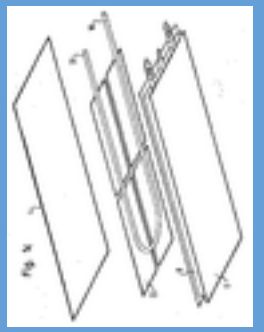
Support structure

Glass window

Energy absorber







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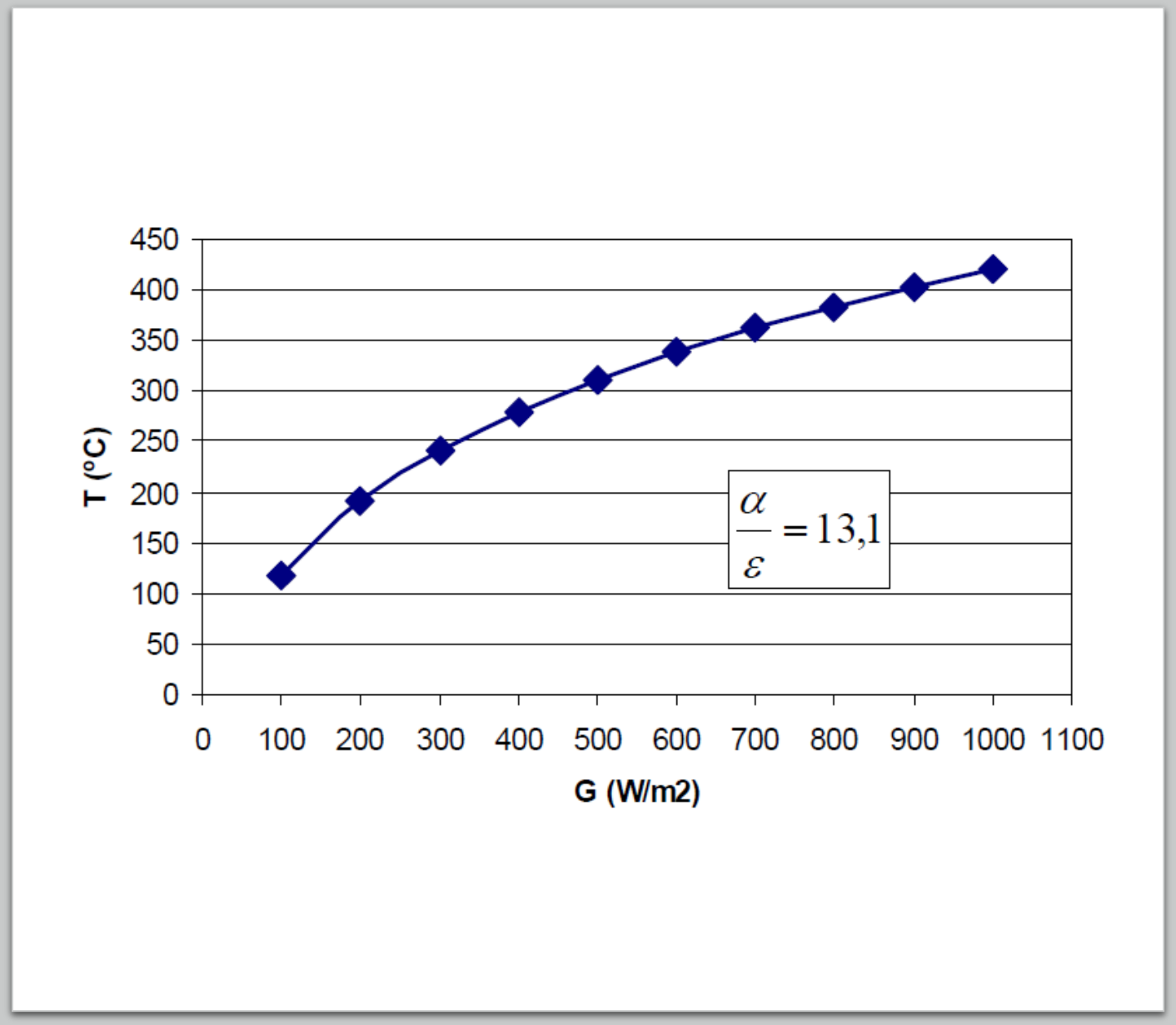
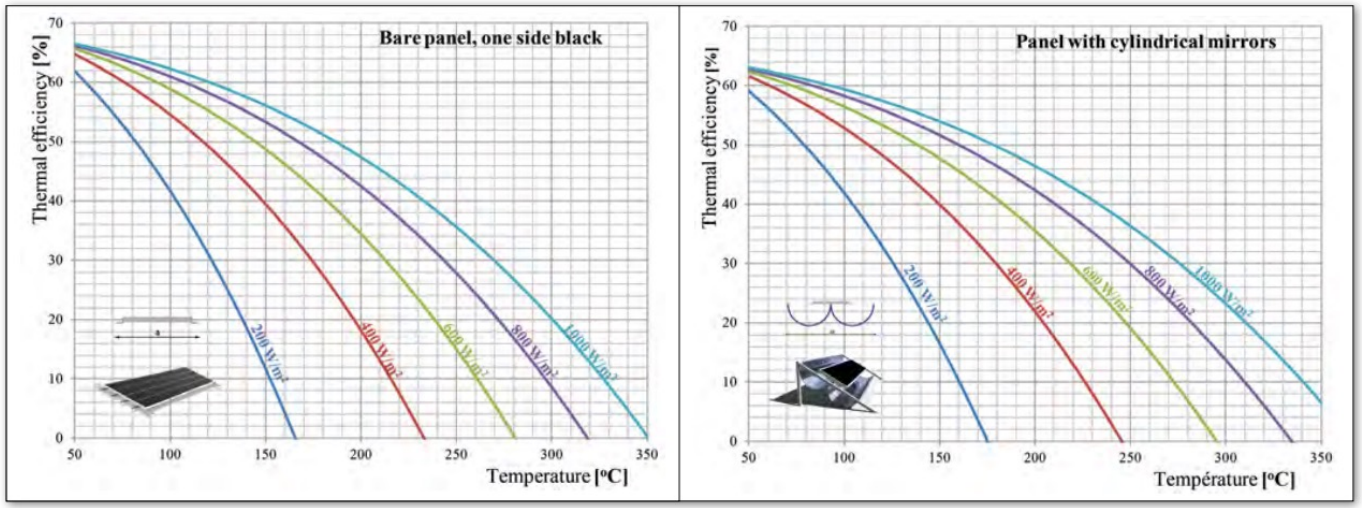
Operating Temperature

- To minimize losses, designs have been developed with the absorbent surface operating under vacuum conditions, thus eliminating the convection mechanism by extracting the fluid surrounding the surface.
- The result of the energy balance defines the maximum temperature that can be reached in the panel.
- in addition to the absorbance (α) and the emittance (ε), the Stefan-Boltzmann constant (σ) and the angle of inclination of the panel (θ); The power of the radiation (G) that falls on the surface plays a primary role.
- It cannot reach temperatures above 420°C in solar panels without concentration (theoretical limit without considering losses).



Electricity generation



- Prototype panels have been able to reach temperatures in excess of 350 °C when subjected to incident solar power density of 900 W/m^2
- The heat absorbed in the collector panel is extracted by means of a circulating high-temperature heat transfer fluid,
- The fluid flows through a system of thermally insulated pipes and reach the steam generators,
- The steam produced drives a conventional Rankine power cycle or a more advanced heat recovery combined cycle system to generate electricity.

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Applications and advantages

- Flat solar panel collectors can be combined with another (**hybrid**) system, thus compensating for their intermittent operating mode, for example with gas and biomass in high-efficiency combined plant cycles.
- Compared to parabolic solar collectors (the benchmark technology for solar power plants), flat panel solar collectors have 3 main advantages:
  - Reduced capital cost due to simpler design,
  - Reduced operating and maintenance costs due to simpler design and relaxed cleaning requirements,
  - Reduced water consumption due to relaxed cleaning requirements

Towards a commercial product

- For residential applications, thanks to the much higher operating temperature, flat panel solar collectors can also be used for reversible heating and cooling of houses.
- Seasonal residential heat storage can be considered, as well as district heating,
- for power plants

Industrial Sector	Unit operation	Temperature range (°C)
Textile Industry	Bleaching	60-100
	Dyeing	70-90
	Drying, De-greasing	100-130
	Washing	40-80
	Fixing	160-180
	Pressing	80-100
Chemical Industry	Soaps	200-260
	Synthetic rubber	150-200
	Processing heat	120-180
	Pre-heating water	60-90
Plastic Industry	Preparation	120-140
	Distillation	140-150
	Separation	200-220
	Extension	140-160
	Drying	180-200
	Blending	120-140
Flour By-products	Sterilising	60-90
All Industrial Sectors	Pre-heating of boiler feed water	30-100
	Industrial solar cooling	55-180
	Heating of factory buildings	30-80

Kalogirou, 2003

50 MW plant

	Parabolic	Flatpanel
Land area	1.5 km^2	1.5 km^2
Solar field area	0.5 km^2	0.5 km^2
Direct costs	3.9 M€/MW	2 M€/MW
O&M costs	0.03 €/kWh	0.02 €/kWh

Amortization plan in 7 years of a solar plant of 20 MW (40 MUSD) and 40 MW (80 MUSD)
If the billing is about 6 & 12 M€/y

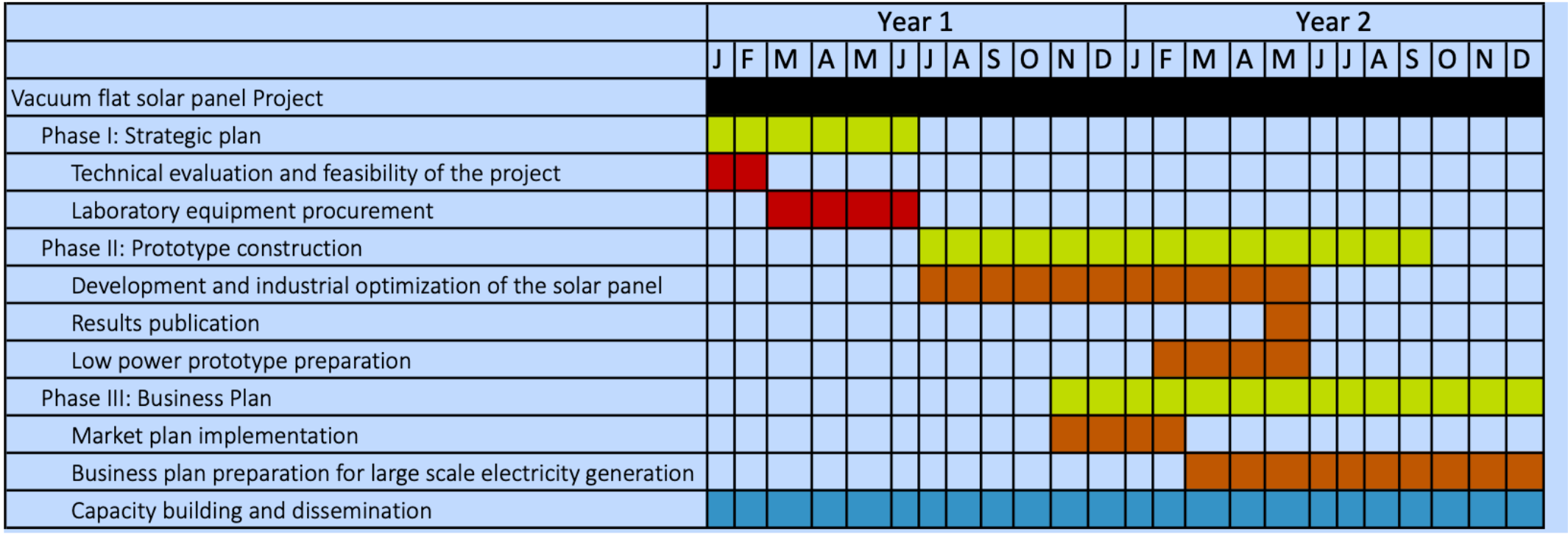
Work Plan

- A R&D Program of 18 months + additional period of 6 months
- An Executive committee to supervise the R&D
- A technical team of few engineers and physicists (2 or 3)
  - Technical specifications: Coating absorber (Cr black)
  - Glass-metal bonding techniques
  - Accelerated aging loss test, thermal cycles
  - Degassing of materials
  - Mechanical study of the panel structure

Knowledge:

- *Vacuum technology*
- *Heat transfer*
- *Mechanics*
- *Chemical surface treatment*
- *Vacuum deposit of thin layers*
- *Electronics*
- *Computing*

Gantt Chart


Year 1
Year 2
J F M A M J J A S O N D J F M A M J J A S O N D
Vacuum flat solar panel Project
Phase I: Strategic plan
Technical evaluation and feasibility of the project
Laboratory equipment procurement
Phase II: Prototype construction
Development and industrial optimization of the solar panel
Results publication
Low power prototype preparation
Phase III: Business Plan
Market plan implementation
Business plan preparation for large scale electricity generation
Capacity building and dissemination

Budget

General coordination of the project for a period of two years	
Description	Price (USD)
General Manager	200,000
Project Technical Coordinator	180,000
Mobilization, interest groups and resources at the national level, costs include support, travel, etc.	50,000
Development and dissemination of the lessons studied, costs include writing, editing and printing results, dissemination, organization of attendance at regional and global conferences and workshops, etc.	70,000
Total	500,000

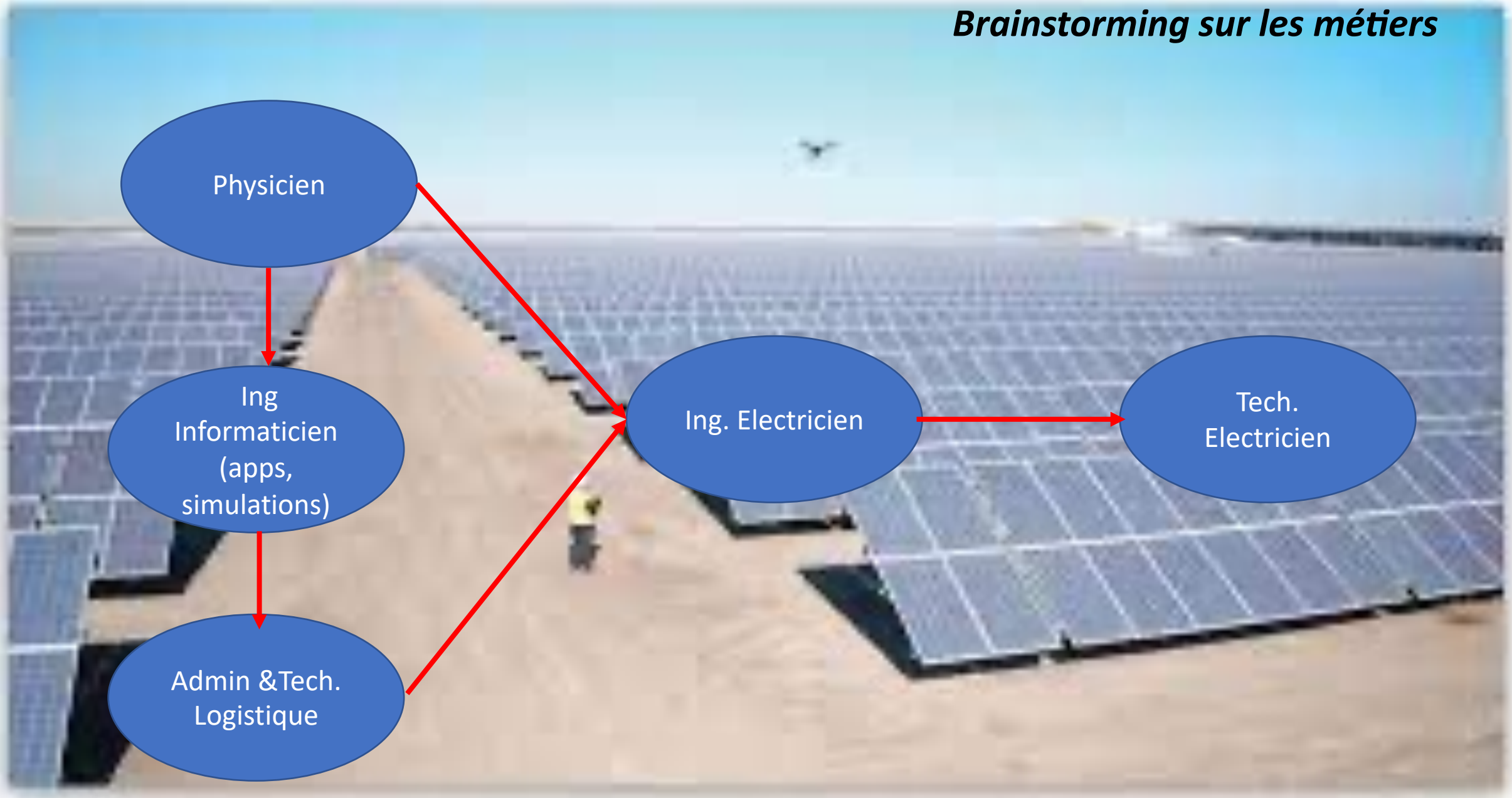
Laboratory cost for two years	
Description	Precio (USD)
Equipment and supplies (include high vacuum pumps)	900,000
Laboratory, Administrative Location	100,000
Technical staff (1 engineers, 2 technicians, 2 students, 1 administrative)	500,000

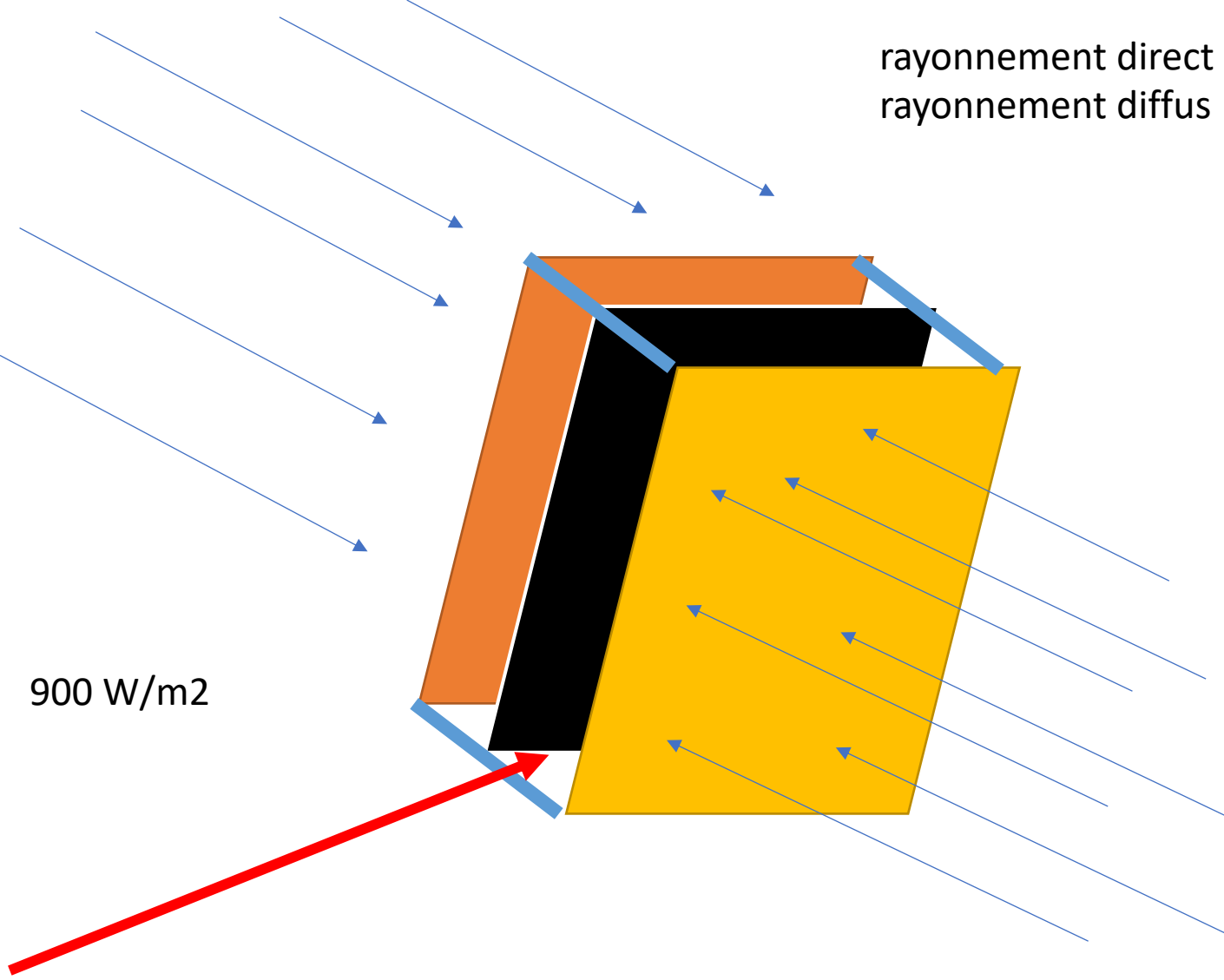
Project Cost for the 2-year period	2,000,000
General expense	200,000
Total cost	2,200,000

Conclusions

- The solar energy industry is on the verge of a revolution due to significant changes in government policies and the overall demand for energy.
- The flat panel solar collector could become a new benchmark in terms of cost and performance for solar technology,
- A company in charge is ready to choose the location to establish the first production plant in Switzerland for the flat solar collector and start commercial exploitation.

Brainstorming sur les métiers





Points forts

1. Bonne isolation thermique avec le vide (T 300°C)
2. Matériaux peu coûteux, fer, verre
3. Très faibles pertes, des rendements énergétiques de l'ordre de 60% pourraient être atteints

Points faibles

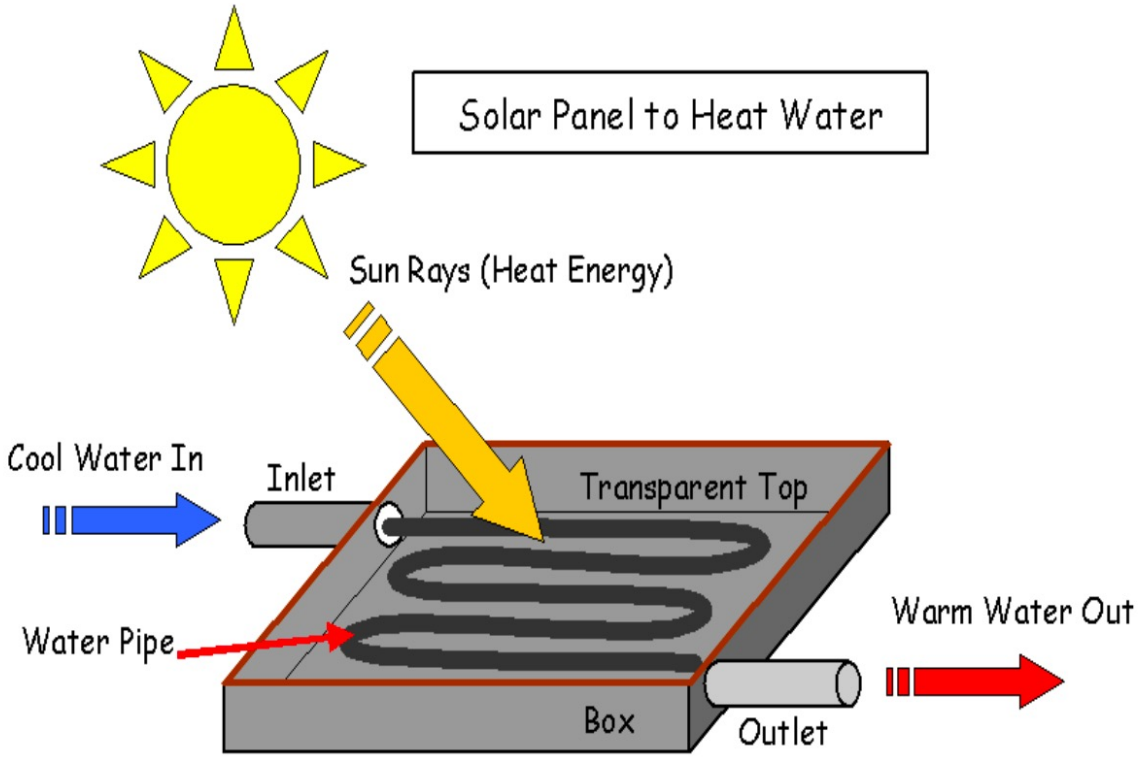
1. défi de fermer le panneau solaire

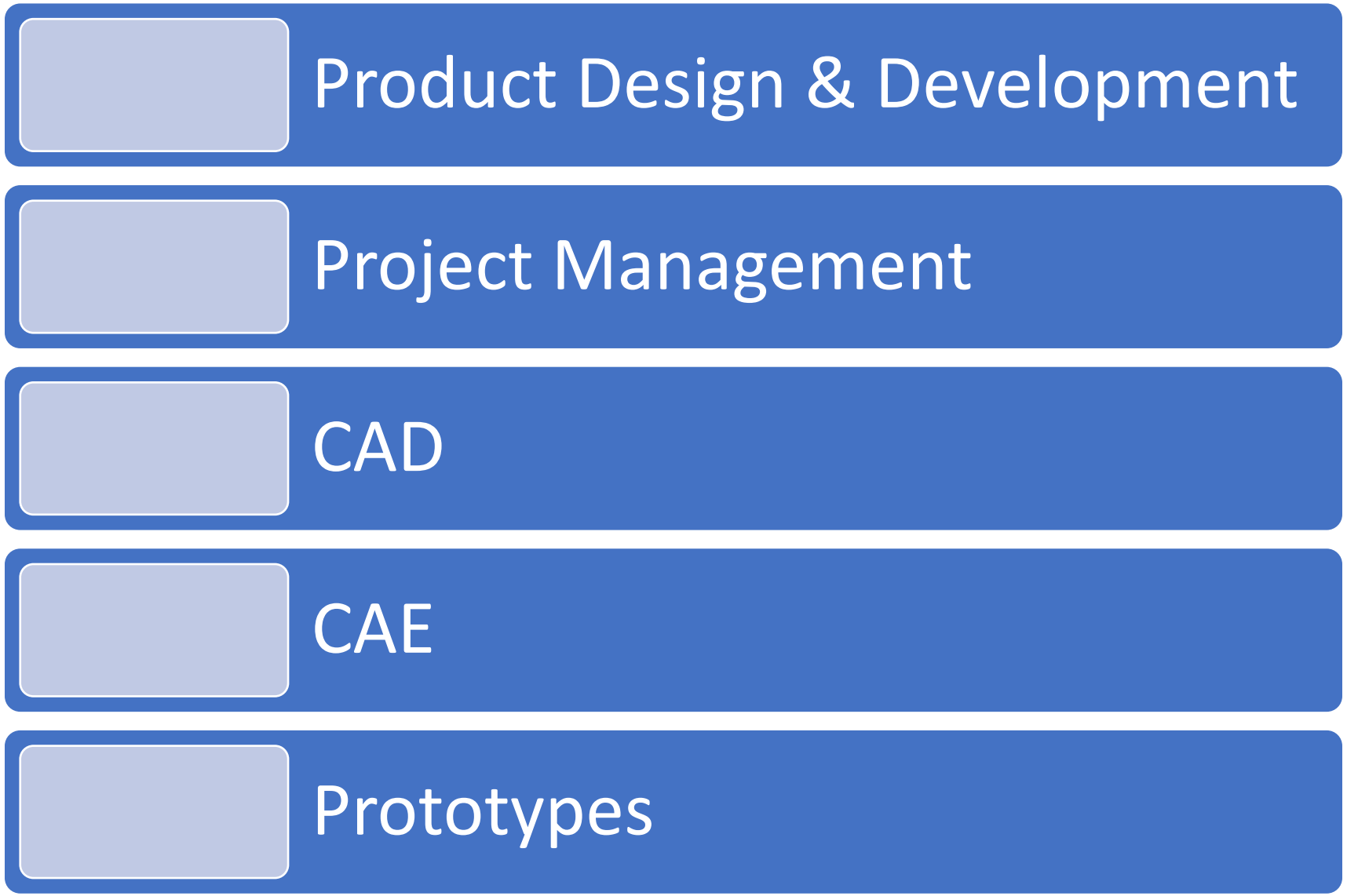
Objectif

1. Produire de l'électricité
2. Chauffer l'eau
3. Dessaler l'eau de mer

Solar Flat Panel

- **Glass-covered framework**
- Inside a series of **copper tubes** with **copper fins** attached
- Entire structure coated in **black substance** designed to **capture** the **sun's rays**
- Rays **heat water**, which **circulates** from the collector to an **isolated tank**




Product Design & Development
Project Management
CAD
CAE
Prototypes

Product realization

- Product design & development
  - ✓ Project Management
  - ✓ CAD
  - ✓ CAE
  - ✓ Prototypes

- Industrialization
  - ✓ Manufacturing process design
  - ✓ Tooling design and construction
  - ✓ Media control design
  - ✓ Homologation
  - ✓ Logistics/Purchasing
  - ✓ Production

Pitch Deck

- The total annual solar radiation falling on the earth (*approximately 340E+4 EJ*) is more than 7500 times the world's total annual primary energy consumption of 450 EJ (450 EJ/s = 450E+9 GW).
- The global total of 627 GW (627E-5 EJ/s) compared to a total of 23 GW just 10 years earlier
- Renewable energy represents (2019) about 11% of the world's total primary energy supply.
- The efficiency PV systems is ~ 15%, significant excess heat is dissipated and wasted.
- Los paneles termosolares de próxima generación complementan y dan solucion a este mercado en alto crecimiento.
- Over 6 billion euros, is expected by 2024.