

The state of the innovation in solar energy

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China-Spain Renewable Energy Promotion Centre

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⌘ Source of energy

⌘ History of innovation in solar energy

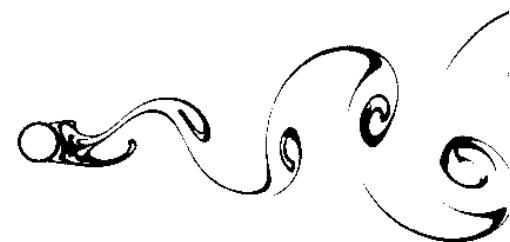
⌘ Technologies

⌘ Research

⌘ Development

⌘ Innovation

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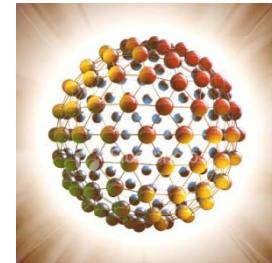
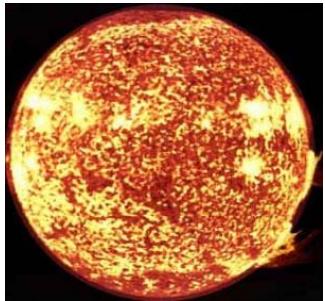
- # Strategy on energy
- # R&D&i on Solar Thermal and biomass:
 - ↗ Selective coating (air stable 500°C)
 - ↗ Hybrid plants
 - ↗ New concepts on linear concentration
- # Technology development
- # Energy production plants
- # Large infrastructure engineering
- # Technology integration
- # Technological project partner



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Life needs energy

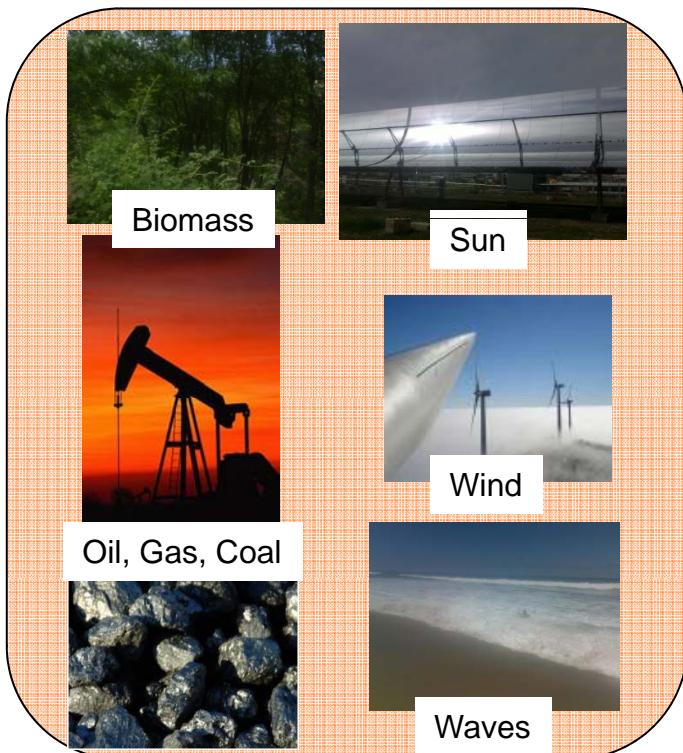


Sun

Gravity

Geothermal

Nuclear



Sun energy creates: wind, waves, biomass, oil, coal.

Heat is more sublime in sun than in fire, Tomas de Aquino Summa Theologica, I, 6,2 (1225-1274)

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Others than PV



Solar furnace



Tower



Stirling dish

Point concentration



Parabolic trough

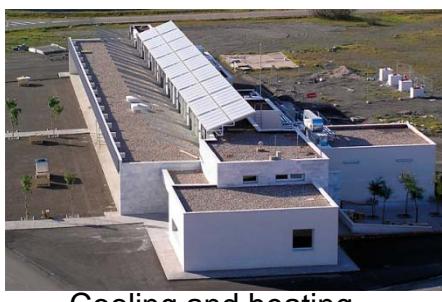


Fresnel linear

Linear concentration



All pictures from Plataforma Solar de Almería, Spain but Manzanares solar chimney



Cooling and heating

Desalination
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Arquimedes in Siracusa 213- 211 B.C. ?

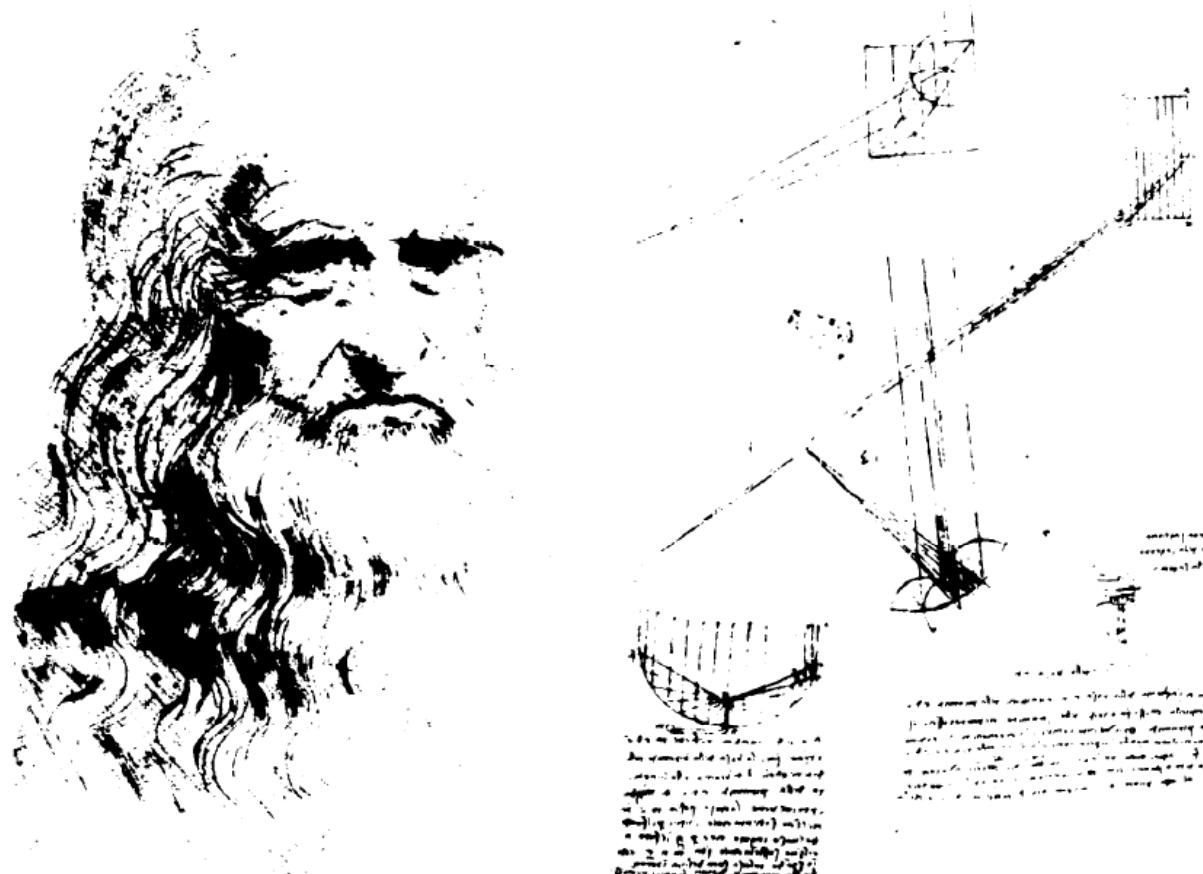


Ibn al-Haytam
(965-1039)



Frontispicio de los Opticae Thesaurus de Ibn al-Haytam. El empleo de espejos incendiarios para fines militares fue tema favorito entre los cruditos del Renacimiento.

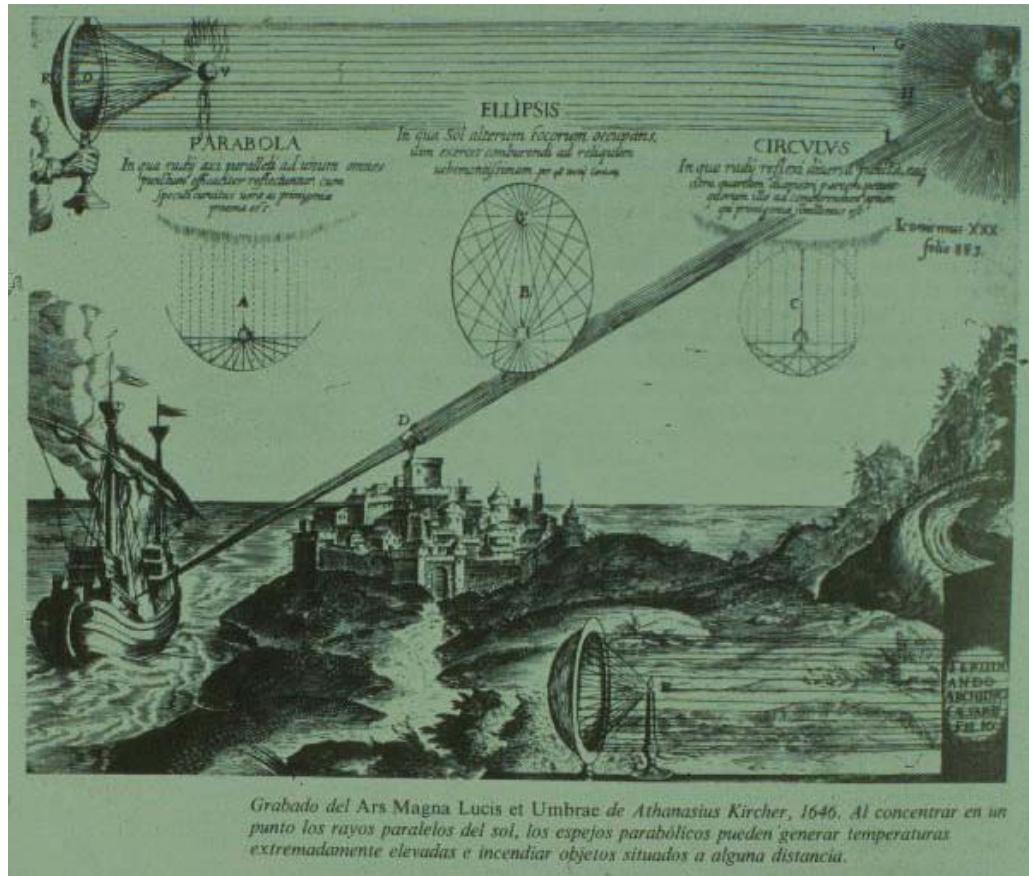
Leonardo Da Vinchi (1452-1559)



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Athanasius Kircher, 1671



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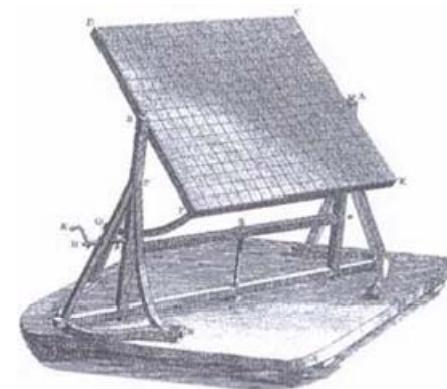
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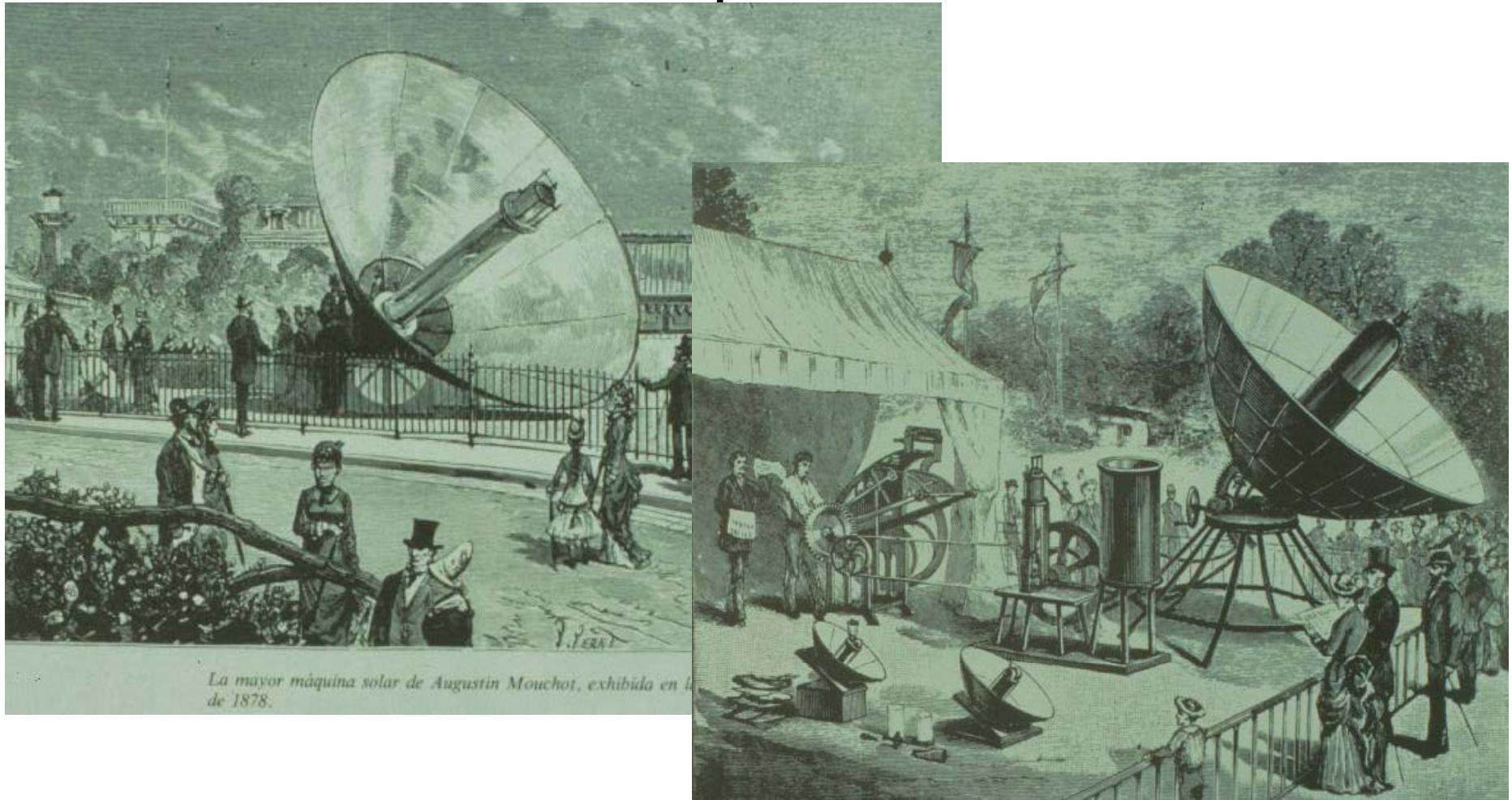
XVIII century

⌘ Georges-Louis Leclerc,
comte de Buffon (1707-
1788)

⌘ Augustin-Jean Fresnel
(1788-1827)



Agustin Muchot France, Paris international expo 1878



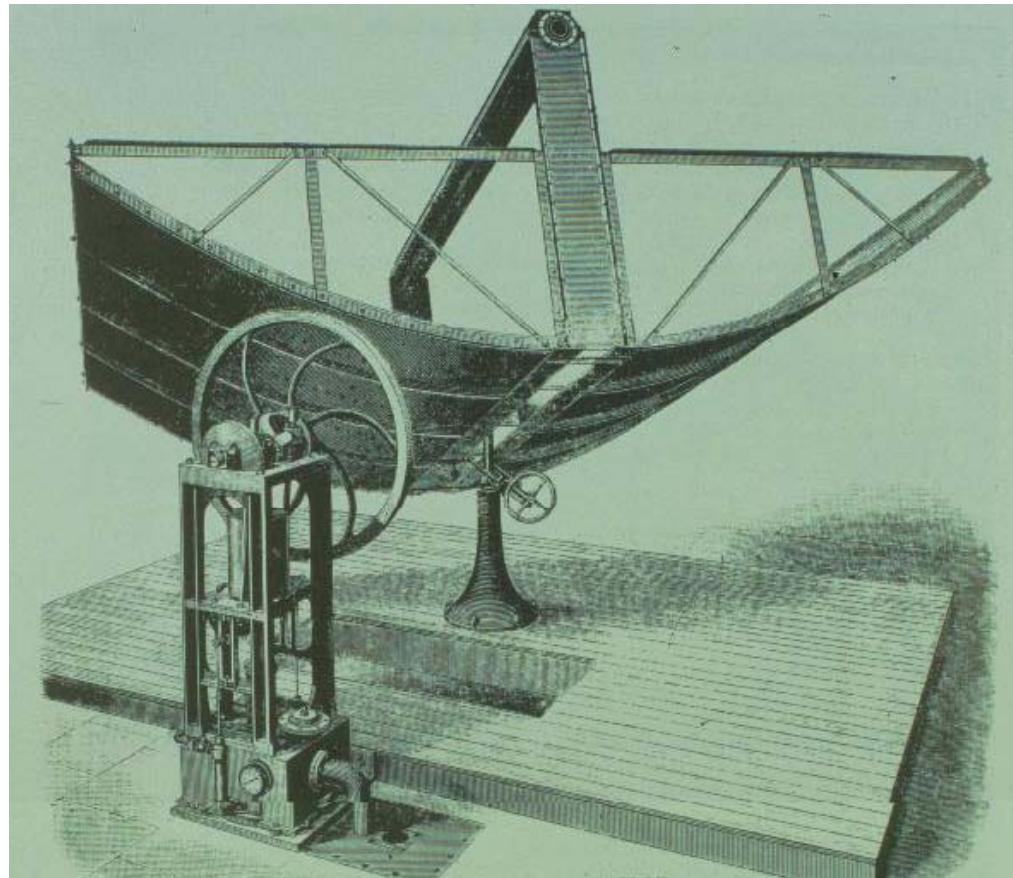
La mayor máquina solar de Agustín Mouchot, exhibida en la Exposición Universal de París de 1878.

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Ericsson, engine. 1870

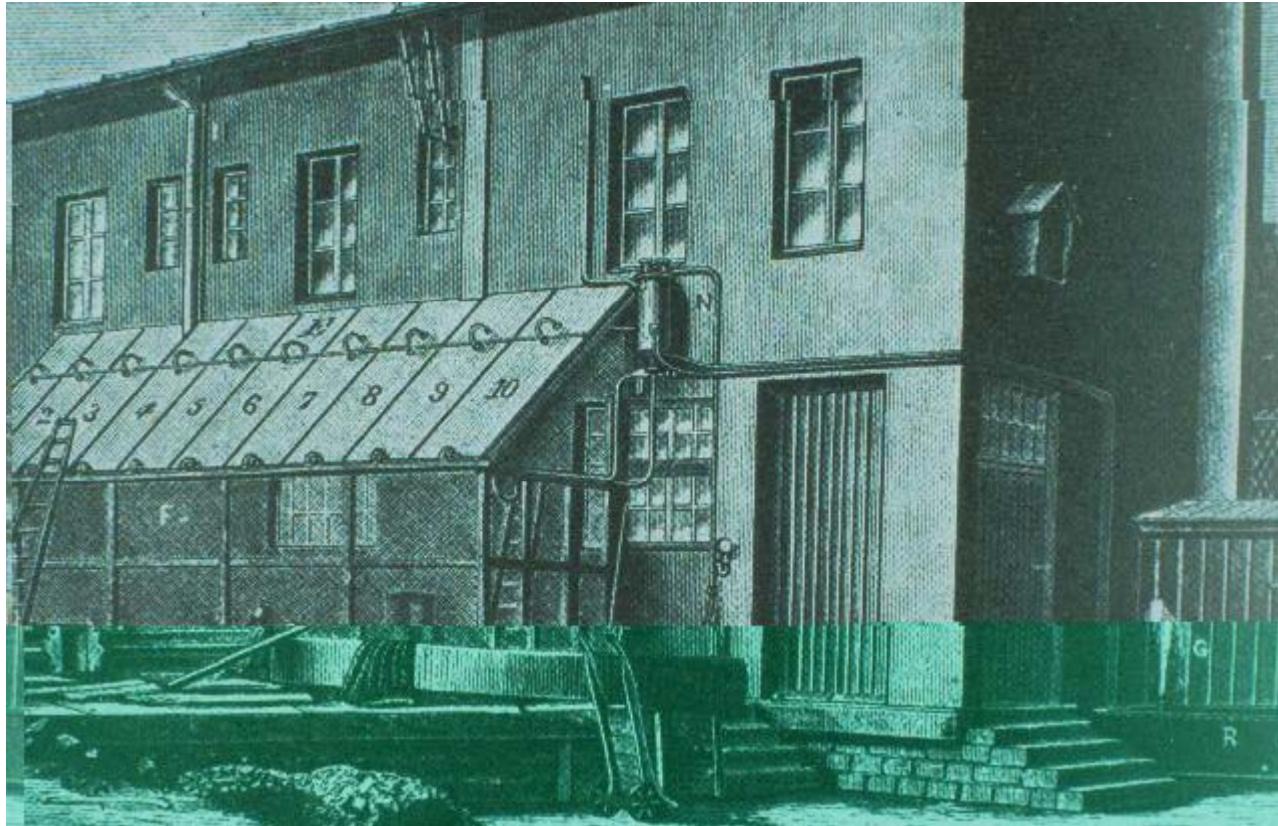


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Tellier, 1880

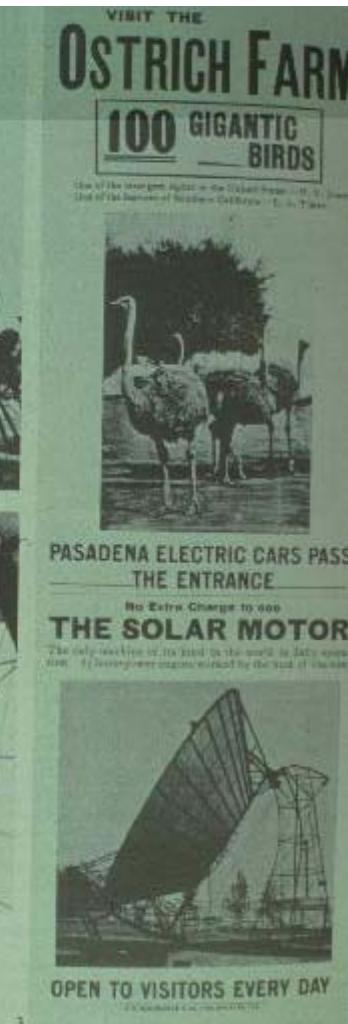
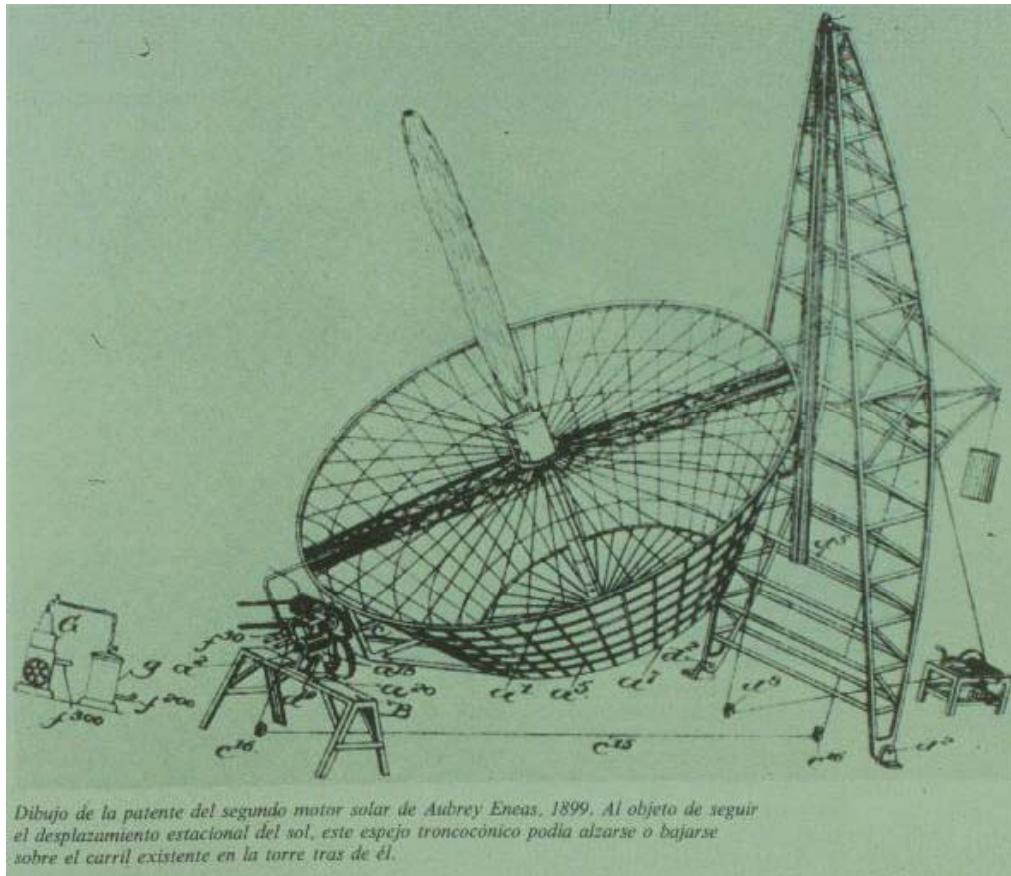


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Aubrey Eneas, 1899



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中西
心

TC

Madí solar plant, Egipt, 1912, Schuman



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“Solar power is now a fact and no longer in the “beautiful possibility” stage. [It will have] a history something like aerial navigation. Up to twelve years ago it was a mere possibility and no practical man took it seriously. The Wrights made an “actual record” flight and thereafter developments were more rapid. We have made an “actual record” in sun power, and we hope for quick developments” Schuman February 1914

Shuman hoped to build 20 250 square miles of reflectors in the Sahara, giving the world in perpetuity the 270 million horsepower per year to equal all the [coal] fuel mined in 1909

Solar Energy Generating Systems SEGS 1984-1991



“Investors in the renewable energy projects (e.g., the owners of the SEGS projects) were forced to bear the full risk of future energy prices, making the nature of the investment one of speculation in energy price futures rather than one focusing on the risks and rewards of renewable energy”(Michael Lotker, Luz’s former Vice President of Business Development.)

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Innovation in Spain

- ⌘ Stable feed in tariff during 25 years.
- ⌘ 60 power plants under this model
- ⌘ Advantage:
 - ☒ Projects can be developed
 - ☒ Critical mass of companies and professionals is created
- ⌘ Disadvantage:
 - ☒ Lower interest on new technologies
 - ☒ High cost for society and lowers country energy competitiveness.



ACS Andasol



Acciona Alvarado 1
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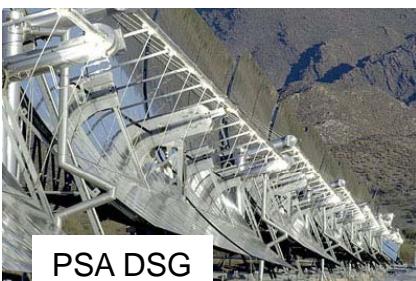
Abengoa PS solar towers



Which technology will succeed?



Abengoa PS sola towers



PSA DSG



PSA Stirling

⌘ Tower:

- ⌘ Air (Atmospheric, pressurized), water, molten salt,
- ⌘ Brayton or Rankine Cycle, hydrogen product.
- ⌘ Large or small heliostats, Multi –single tower

⌘ Linear concentration:

- ⌘ Oil, molten salt, water, CO₂
- ⌘ Cylinder, Fresnel, others
- ⌘ Steam or Organic Rankine Cycle.

⌘ Parabolic dishes

- ⌘ Stirling engine
- ⌘ Heating a Fluid

⌘ Thermal storage

⌘ Hybrid with coal, gas, biomass. Manzanares Solar Chimney



⌘ Water/Dry cooling

⌘ Fuels production

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Financial innovation

- ⌘ Feed in Tariff
- ⌘ Tax credits
- ⌘ Grid stability
- ⌘ Green quota
- ⌘ CO2 market
- ⌘ Pull price
- ⌘ Other markets

Research

- ⌘ Selective surfaces
- ⌘ Coatings
- ⌘ High temperature materials
- ⌘ Working fluids
- ⌘ Hydrogen production and permeation
- ⌘ Chemistry associated to the sun



Development

- ⌘ Hybrid power plants
- ⌘ Poly generation (electricity, water, heat, cold)
- ⌘ Industrial heat and cooling
- ⌘ Grid integration
- ⌘ Operation and Maintenance
- ⌘ Storage
- ⌘ New concepts on solar
boilers
- ⌘ Control systems
- ⌘ Water use



Huiyin Tosca lineal receiver

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Almería Solar Platform (PSA)



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Conceptual innovation

- ⌘ Private public partnership, how risk and profits are shared?
- ⌘ Cooperation between R&D and Companies, an example
Solar Technology Advisors
- ⌘ Long term focus
- ⌘ Countries cooperative advantage cooperation
- ⌘ O & M
- ⌘ Different products for different needs and markets



China-Europe

- ⌘ Bright minds together
- ⌘ Reduce time to the market
- ⌘ Reduce development costs
- ⌘ Reduce production cost
- ⌘ Increase volume

An example Huiyin uses antireflecting coating from CIEMAT

- ⌘ CIEMAT (Spain) has licensed a coating to Huiyin (China) for its high temperature vacuum tubes now being tested at PSA.



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Solar winter or Solar summer

⌘ Learning from the past
29 c€/KWh

⌘ Innovative and new ideas

⌘ Win-Win global strategies

⌘ A new era and industry:

☒ Water

☒ Energy

☒ Clean environment

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谢谢



Cofete beach at Fuerteventura, Canary Islands, Spain
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