



AIRLIGHT ENERGY

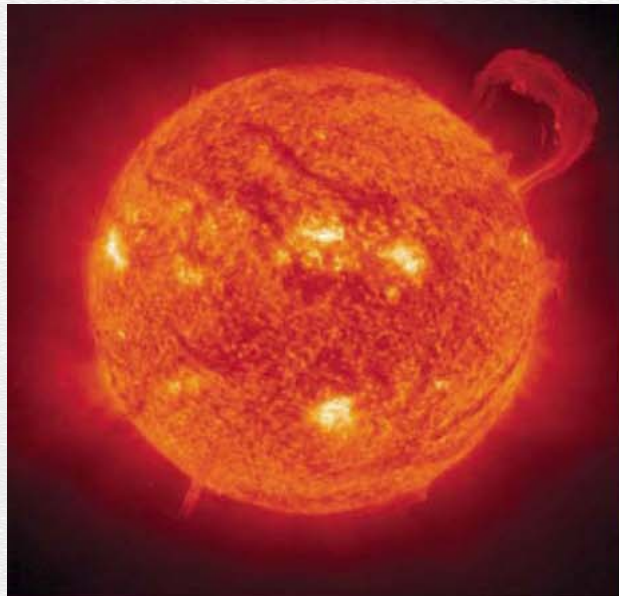
NOVEMBER 2011

Airlight Energy, Biasca – Switzerland

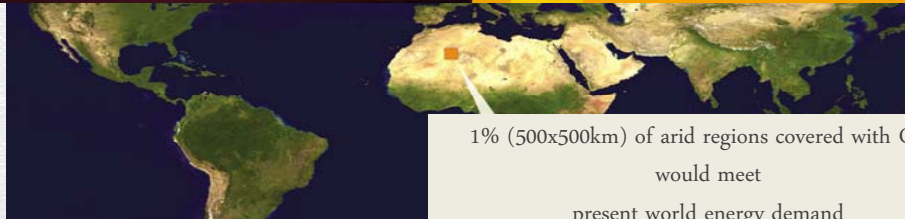
www.airlightenergy.com

SOLAR ENERGY

SOLAR ENERGY EXCEEDS $1\text{GW}/\text{km}^2$ AT NOON



In any given year, solar radiation
reaching the earth's surface is
10'000 times the world's energy
requirements!



1% (500x500km) of arid regions covered with CSPs
would meet
present world energy demand

Spain	1'900 kWh/m ² /yr
Southern US	2'500 kWh/m ² /yr
Switzerland	1'100 kWh/m ² /yr

CONCENTRATED SOLAR POWER TECHNOLOGIES

THE CONCEPT OF FULLY SUSTAINABLE



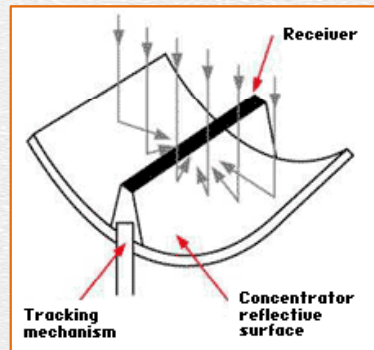
A true and fully sustainable clean energy resource must:

- Be efficient, cost competitive, modular and scalable
- Be easily accessible and flexible in power production
- Be smart in land occupation and smooth in landscape integration
- Employ locally abundant, easy to transport and non-toxic raw materials, avoid scarce resources
- Have a long useful life, be simple and clean in construction, operation and disassembly
- Provide short and long term positive impact on local economies

CONCENTRATED SOLAR POWER TECHNOLOGIES

EXISTING SYSTEMS

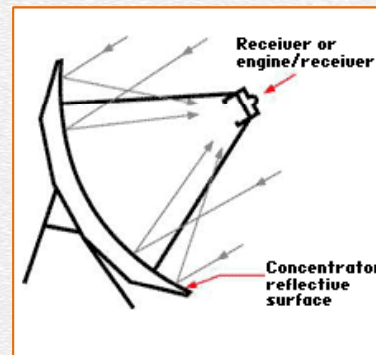
Commercial



Parabolic Trough



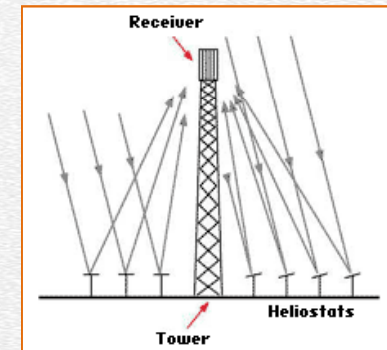
Commercial



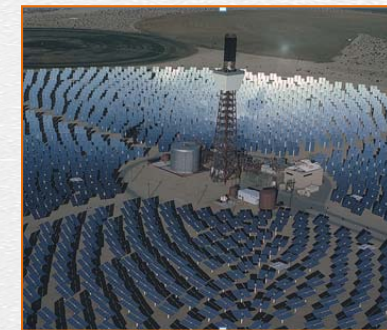
Stirling Dish



Developmental



Solar tower



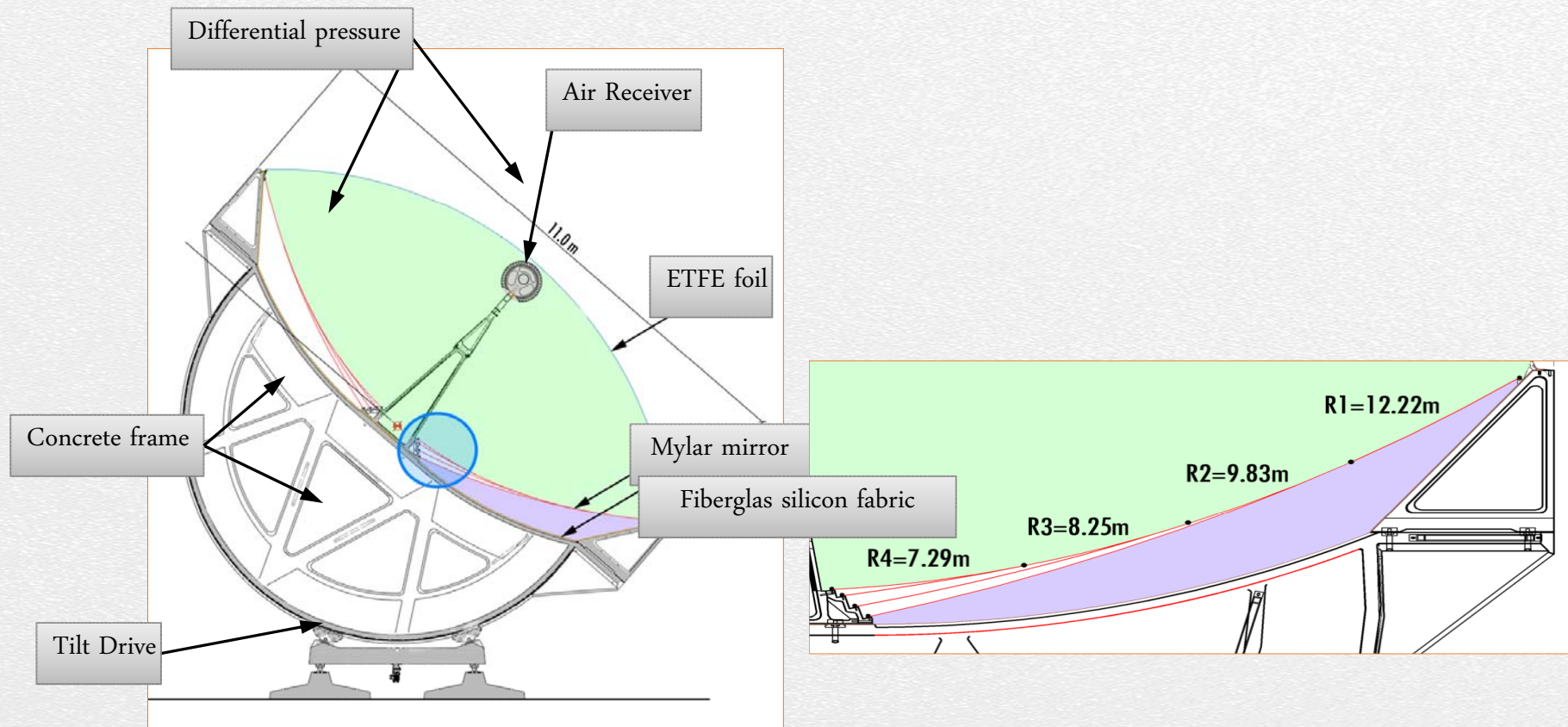
CONCENTRATED SOLAR POWER TECHNOLOGIES

KNOWN ISSUES OF CURRENT SYSTEMS



- **Steel frame collector:**
 - Expensive in investment and maintenance
 - Low stiffness, wind sensitive
 - Limited aperture (6 m with multi mirror)
 - Limited concentration factor (40-60 suns)
- **Mirrors:**
 - Expensive and difficult to align
 - Prone to dust and scratching
 - Water consumption for washing
- **Heat transfer fluid (Oil):**
 - Expensive and operation near thermal stability limit 380°C (715°F)
 - A pollutant in case of leakage
- **Molten salt thermal storage:**
 - Expensive and corrosive
 - Requires fossil-fuel backup system with fuel Boilers.

AIRLIGHT ENERGY COLLECTOR CONCEPT



2011 AIRLIGHT ENERGY COLLECTOR

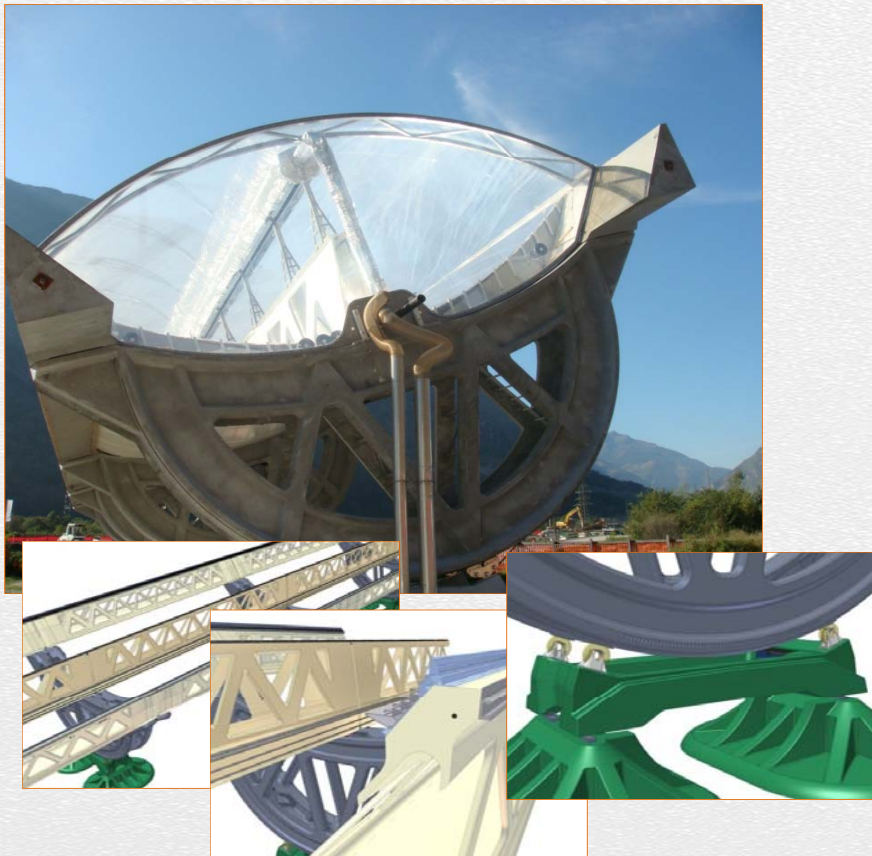


2011 AIRLIGHT ENERGY COLLECTOR



ALE MAJOR COMPETITIVE ADVANTAGES

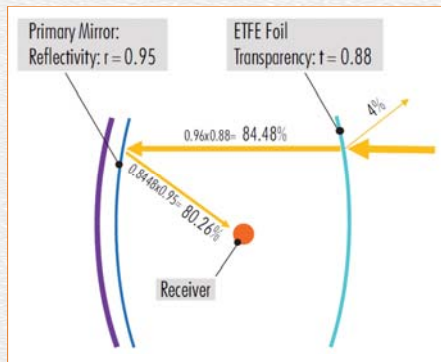
PRE-CAST FIBER REINFORCED CONCRETE



- Worldwide most used and proven construction technology
- Competitive production costs
- No steel reinforcement for high durability and usage of sands existing locally
- Extremely stiff frame, no mirror shape variation (defocusing) under wind loads
- Simple manufacturing, on site resource usage
- No maintenance required (no painting)
- Constant quality
- Low grey energy content

ALE MAJOR COMPETITIVE ADVANTAGES

MULTIARC PNEUMATIC MIRROR



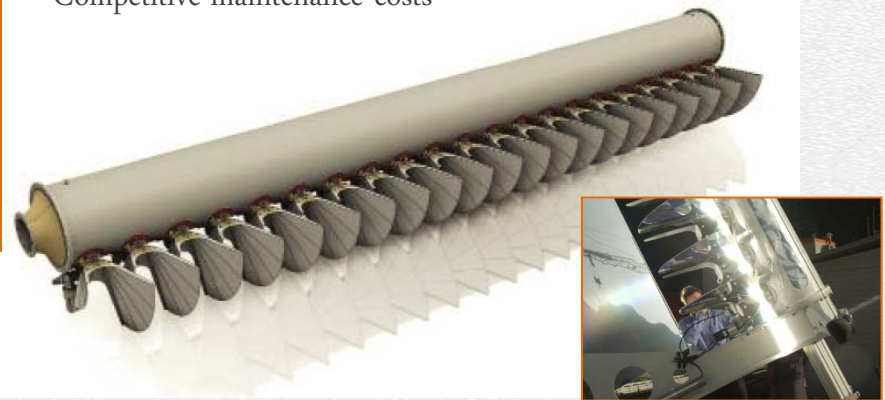
- Large aperture (9.5 m with 2 mirrors) achieving high optical concentration
- Great wind stability
- Low material costs, mirror is protected inside pneumatic enclosure with a controlled atmosphere: no dust and low humidity
- Large industrial production capacity
- Reduced transport volumes and weight, no fragile material
- Simple and fast installation and replacement
- Excellent self cleaning properties of ETFE film and grater resistance than glass against scratching
- Simple automatic washing system with built in water collection system

ALE MAJOR COMPETITIVE ADVANTAGES

AIR AS THERMAL FLUID & 2-AXIS RECEIVER

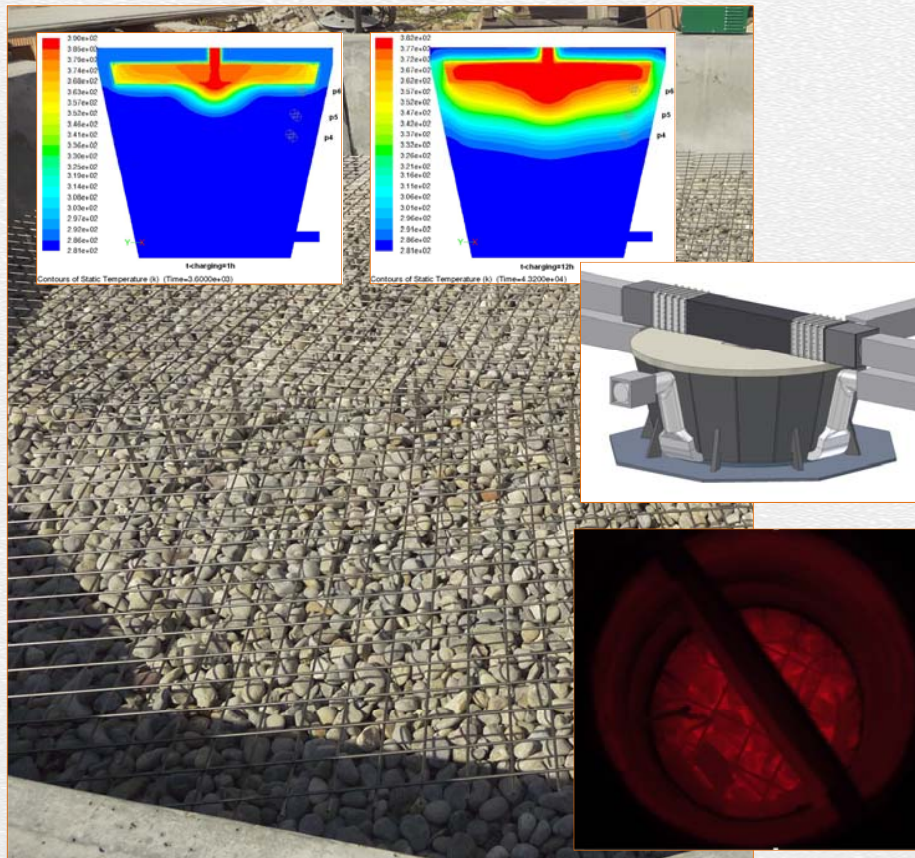


- 2-Axis concentrator achieving 2'500 suns concentration factor
- High operating temperature $> 650^{\circ}\text{C}$ ($1'200^{\circ}\text{F}$) at low back radiation losses, allowing higher efficiency of the steam cycle
- Non-polluting thermal fluid in case of leakage
- Temperature management with large tolerances due to combined storage flow control
- Competitive maintenance costs



ALE MAJOR COMPETITIVE ADVANTAGES

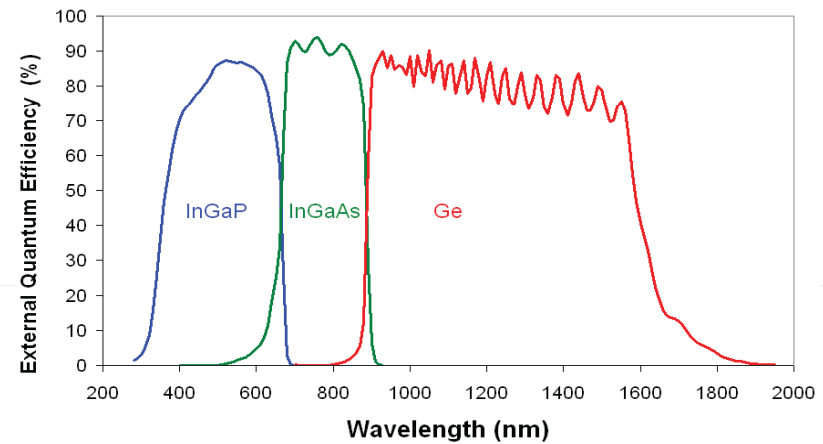
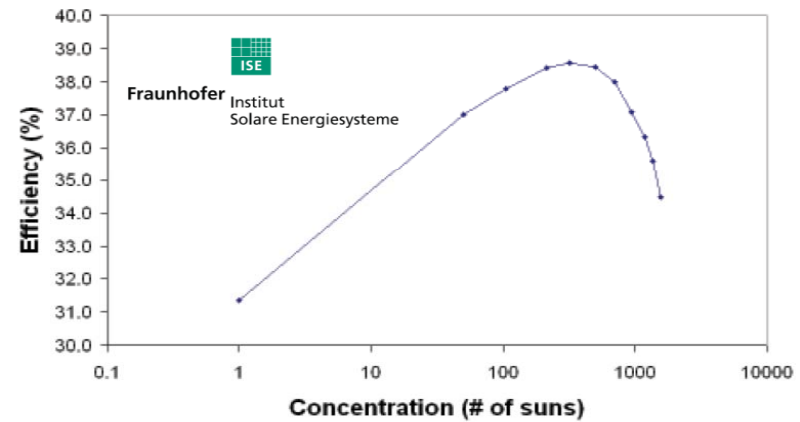
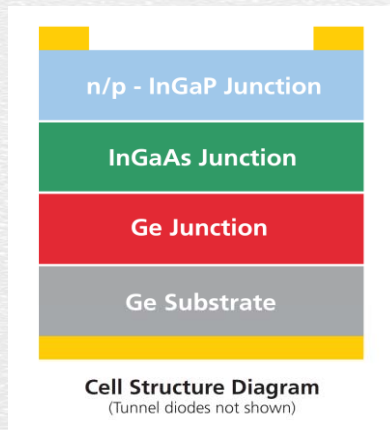
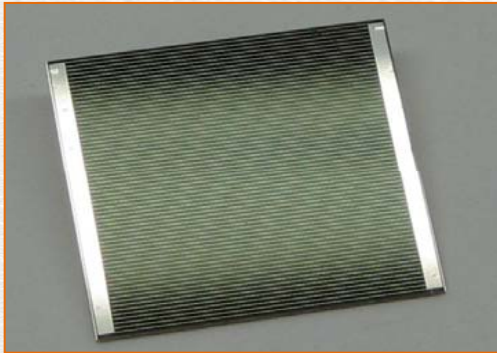
STORAGE



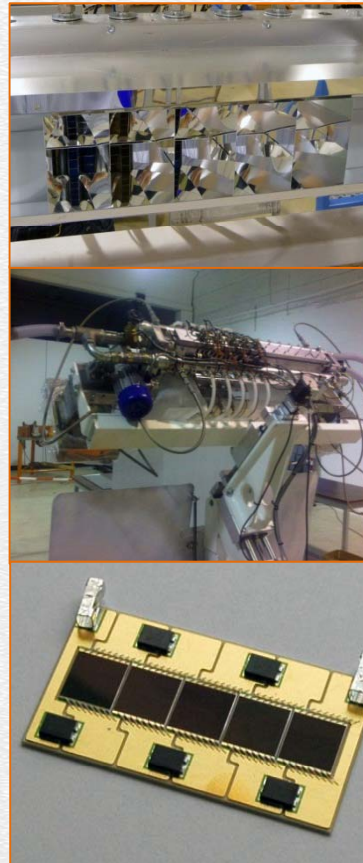
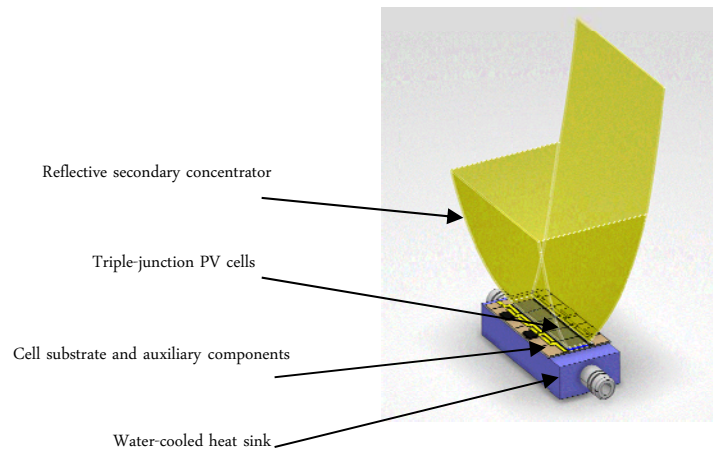
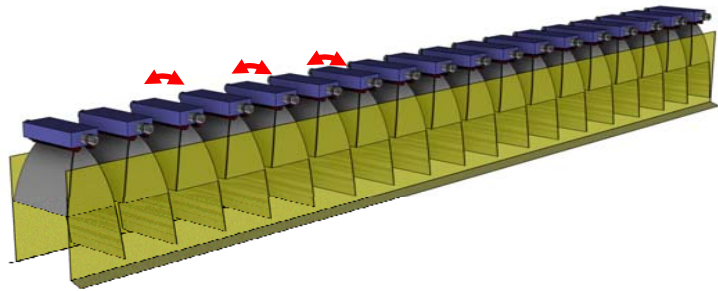
- Continuous operation (7'000 h/year) as well as power production on demand to take advantage from electricity price fluctuations
- Simple, proven and effective technology (1929)
- Similar thermal losses as molten salt solutions (thermal losses in the range of 1%/24h)
- Highly competitive, robust, fail safe technology
- Allows steam cycle operation near optimum performance level at higher than competition efficiency due to higher steam temperatures 600°C (1'100°F)
- Filler material locally available, non-polluting, non-corrosive and minimal maintenance requirements

TRIPLE JUNCTION SOLAR CELLS

DERIVED FROM SPACE APPLICATIONS, VERY HIGH EFFICIENCY

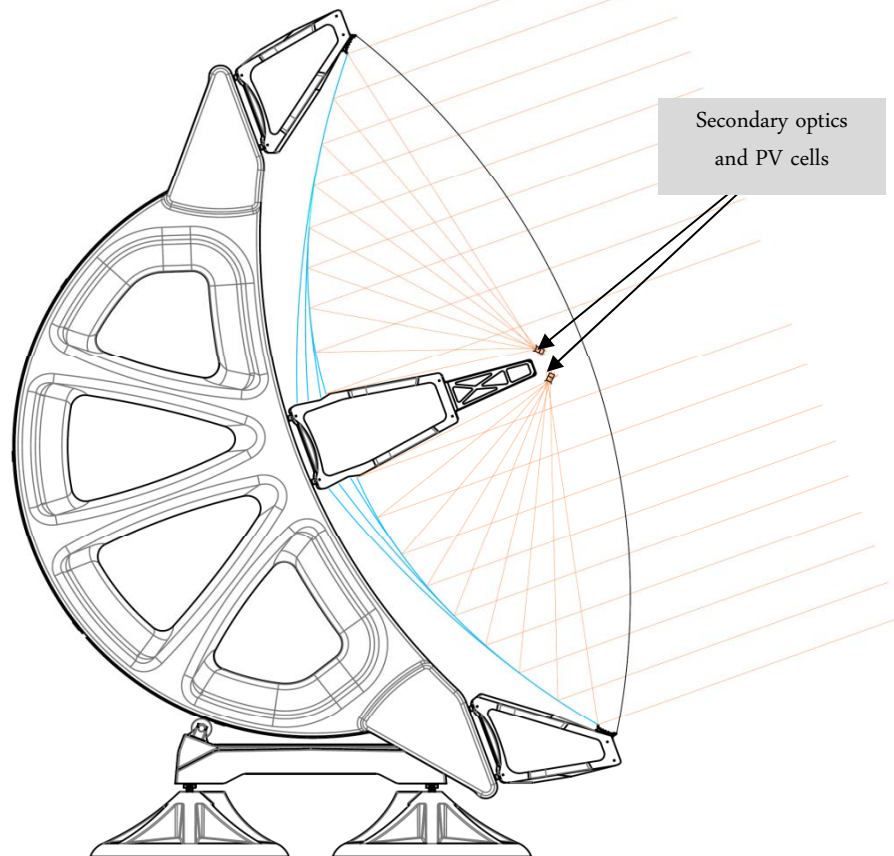


CPV RECEIVER PROTOTYPE



AIRLIGHT ENERGY CPV CONCENTRATOR

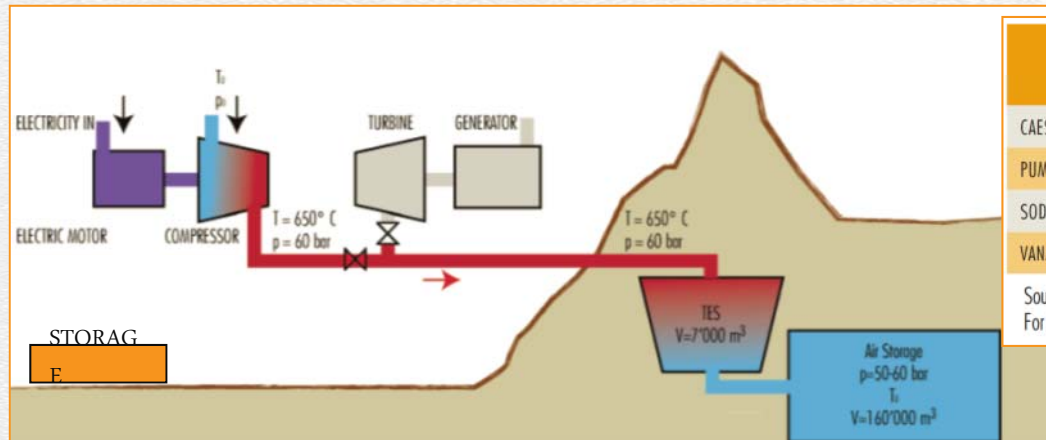
PNEUMATIC PARABOLIC TROUGH PRIMARY MIRROR WITH TRACKING SECONDARY OPTICS



Tree of the major innovations of the Airlight Energy CSP collector are directly harvested for CPV:

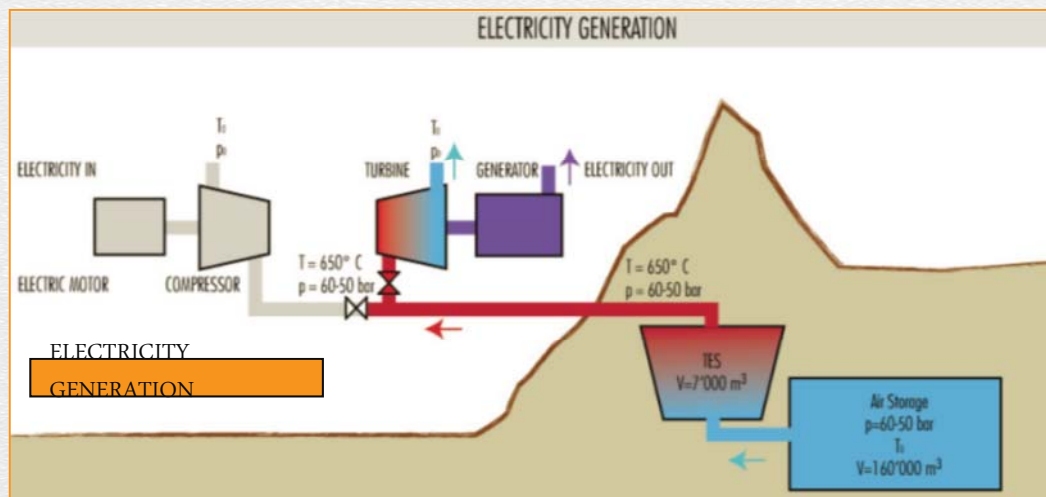
- Concrete structure
- Primary pneumatic mirror
- Tracking secondary concept

ELECTRICITY STORAGE

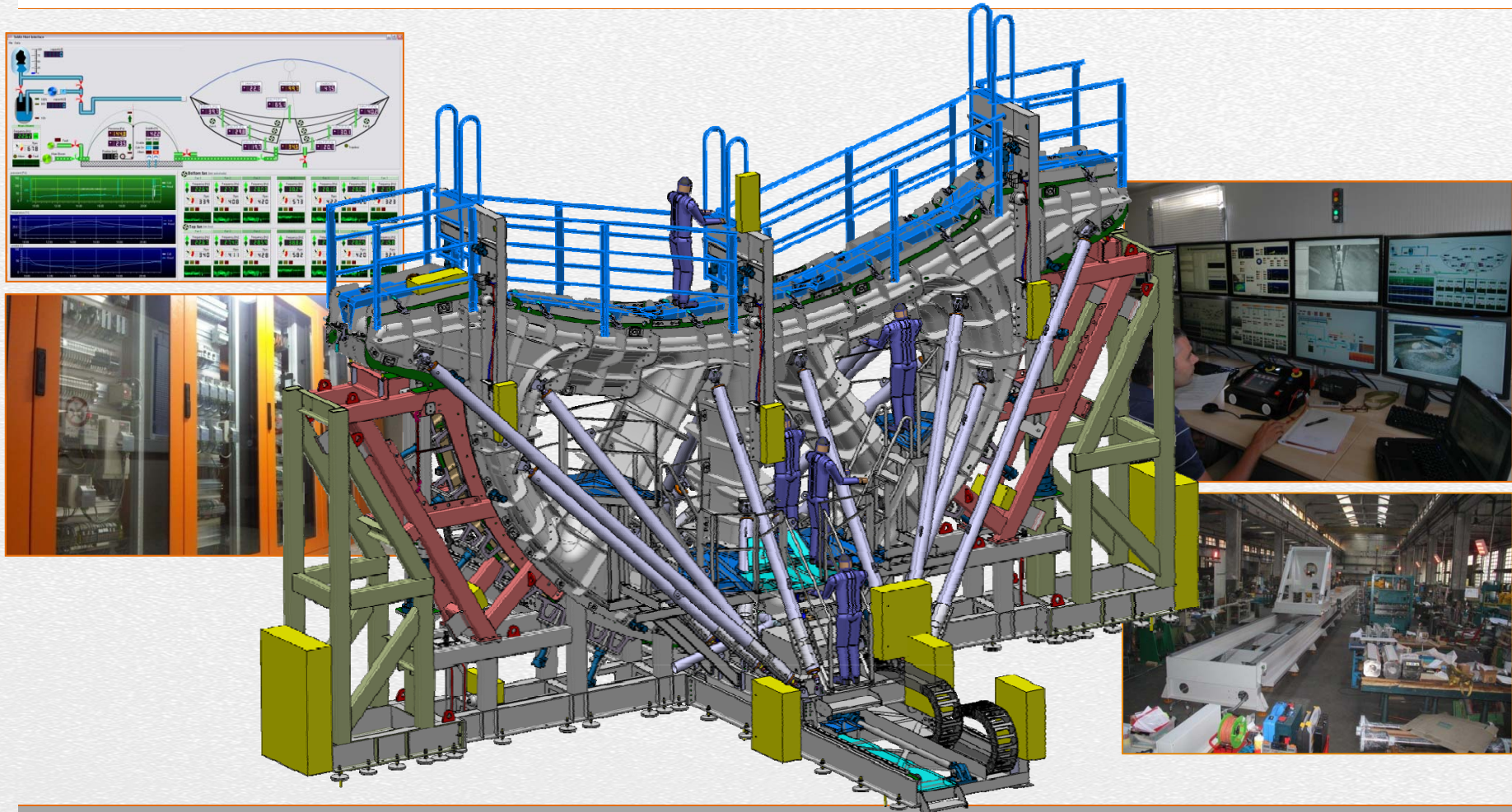


TECHNOLOGY	COST PER POWER UNIT (S/KW)	COST PER ENERGY UNIT (S/KWH)	HOURS OF STORAGE	TOTAL CAPITAL COST (S/KW)
CAES (300MW)	580	1.75	40	650
PUMPED HYDROELECTRIC (1,000MW)	600	37.5	10	975
SODIUM SULFUR BATTERY (10MW)	1720-1860	180-210	6-9	3100-3400
VANADIUM REDOX BATTERY (10MW)	2410-2550	240-340	5-8	4300-4500

Source: Princeton University Report: Succar and Williams, Compressed Air Energy Storage: Theory, Resources, And Applications For Wind Power, 2008



INDUSTRIALIZATION



MARKET APPLICATIONS

Stand-alone CSP plant



Main application today.
Includes a dedicated power block
to produce electricity.

Typical plant size: 40-100MW

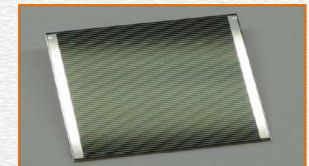
Main selling point:
dispatchability

Concentrated PhotoVoltaic

By substituting the air receiver with multi-junction PV modules,
ALE collector technology can be used 1:1 to efficiently built CPV
systems and plants

Typical plant size: 0.5-100MW

New market !



Integrated Energy Production (IEP)

To boost electricity production or **integrate
waste heat to generate electricity**

Typical plant size: 2-20MW

Main selling point:
increased efficiency,
additional production in peak times conversion
to cleantech



Industrial Process Heat and Desalination Plants

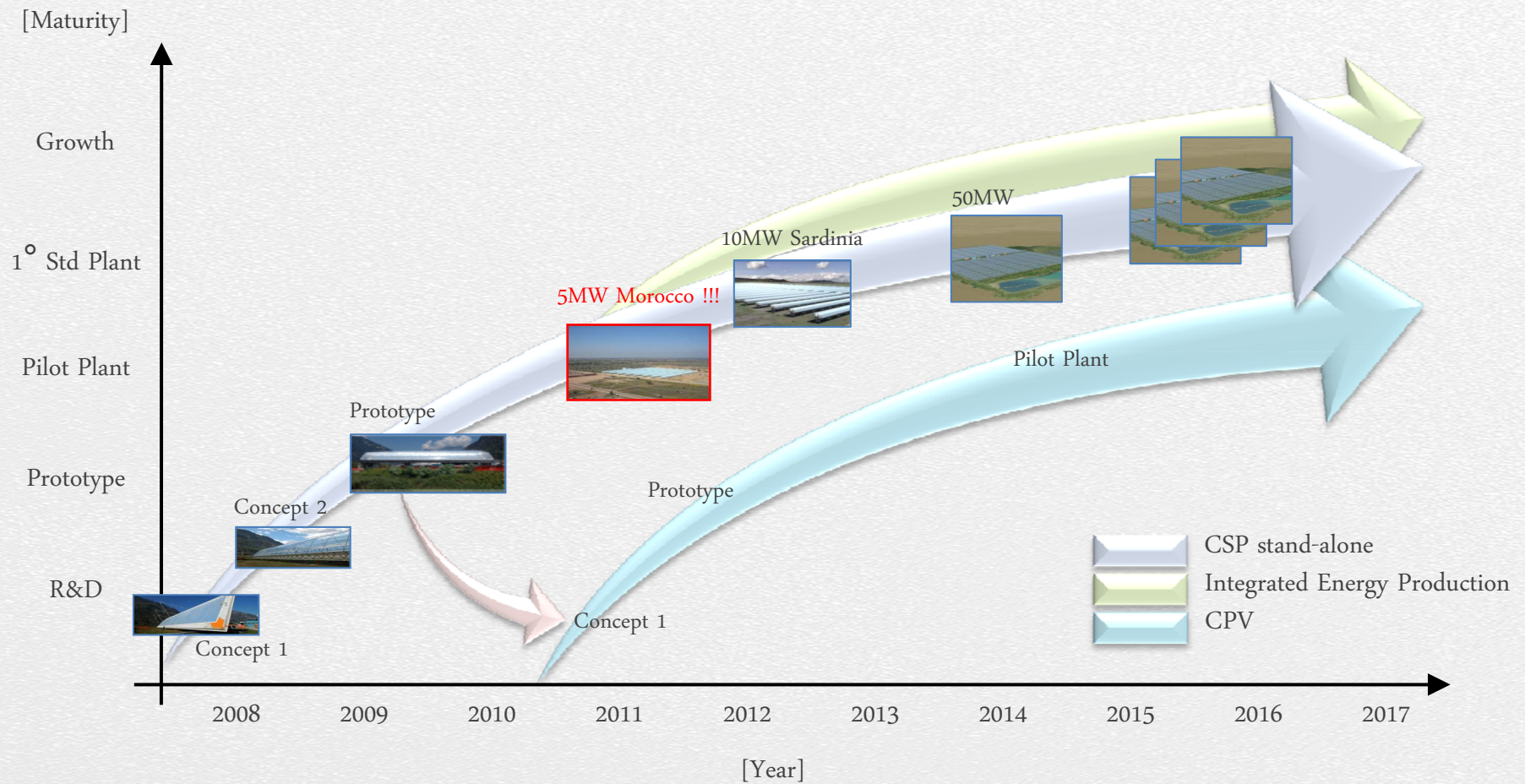
Hot air can be also directly to supply heat for industrial processes:
cement, ceramic, paper, plastic, metallurgy, ...

Another interesting application is the use of the collected energy
to be used in desalination plants

Typical plant size: 1-20MW

Future market, huge potential !

ROADMAP TECHNOLOGY



THERE'S



ENERGY
IN THE AIR

Airlight Energy, Biasca — Switzerland

www.airlightenergy.com