CSP Yield Optimisation

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- Operating thermo-solar plants with energy storage
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A STRONG ALLIANCE

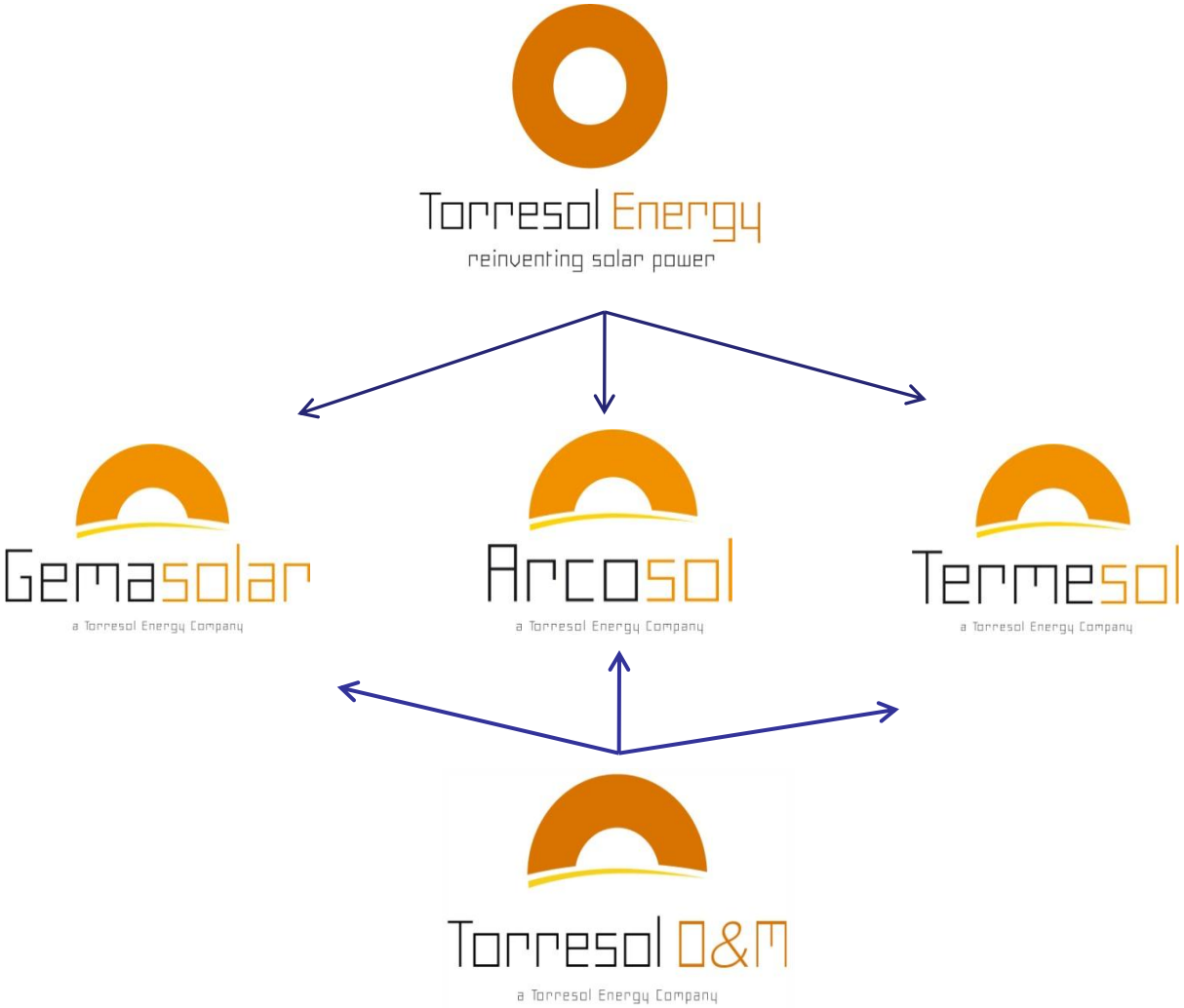
60%

40%

- Engineering, consulting, and systems integration company. Founded in 1956.
- Very active in Solar Energy since 2000.
  - Technology developer: SENERtrough collector system, Sensol software, heliostats, heliostat axis drive mechanisms, molten salt technology (as storage system and as heat transfer fluid) central tower receiver… amongst many other innovations.
  - PSA Tower Prototype
  - Turn Key Projects: Andasol 1 & 2, in Granada; Extresol 1, 2 & 3, in Badajoz; one plant in La Garrovilla (Badajoz); one plant in Alvarado (Badajoz); GemaSolar, Valle 1, Valle 2 and two plants in Navalvillar de Pela (Badajoz).
  - 17 solar fields .1500 KM of SENERTROUGH

- 100% "Mubadala Development Company" stockholding.
- Mubadala Development Company" belongs to the Abu Dhabi Emirate.
- Goal: development and commercialization of innovative technologies in renewable, alternative and sustainable energies.

ALREADY PRODUCING RESULTS



Torresol's strategy - mission & vision

Our Mission

- To develop solar energy globally through investments in profitable and efficient Concentrating Solar Power (CSP) plants
- To pioneer new thermal solar energy technologies to drive down the future costs of generation.

Our Vision

- To become a leading global company for the generation of reliable power from solar energy
- Contribute to the protection of the environment for future generations

Aerial View of Gemasolar (April 2011)

Torresol Plants

TORRESOL PLANTS
Valle 1&2. Parabolic Trough 2x50MW

GENERAL DATA	
Name of the Plant	VALLE 1 & 2
Location	San José del Valle - Cádiz (Spain)
Owner	Arcosol 50, S.A. (100% TORRESOL) Termesol 50, S.A. (100% TORRESOL)
EXPECTED OUTPUT	**2*180 GWh/yr**
Status	Construction
Start of operation	Dec. 2011
TECHNICAL DATA	
Total mirror surface	2 x 510.000 m2
Number of SCA/loops	2 x 624/156 (SENERtrough v1)
Field surface area	2 x 198 Ha
Nominal solar field thermal output	2 x 262 MWt
Thermal Storage Capacity	2 x 1.010 MWhth (7 h)
Turbine capacity	2 x 50 MWe
Thermal Cycle Efficiency	38%
Annual normal direct radiation	2.057 KWh/m2
OPERATION	
NG hibridation	15%
Annual equivalent hours	3.600 h/year
Annual Capacity Factor	41%

TORRESOL PLANTS
Gemasolar. Central Tower 17MW

GENERAL DATA	
Name of the Plant	GEMASOLAR
Location	Fuentes de Andalucía - Seville (Spain)
Owner	TORRESOL
EXPECTED OUTPUT	**110GWh/yr**
Status	**Start up**
Start of operation	Apr. 2011
TECHNICAL DATA	
Total mirror surface	310.000 m2
Number of heliostats	2.650
Field surface area	142 Ha
Nominal receiver capacity	120 MWt
Tower height	140 m
Thermal Storage Capacity	670 MWhth (15 h)
Turbine capacity	19.9 MWe
Thermal Cycle Efficiency	40%
Annual normal direct radiation	2.172 KW h/m2
OPERATION	
NG hibridation	15%
Annual equivalent hours	6.500 h/year
Annual Capacity Factor	74%

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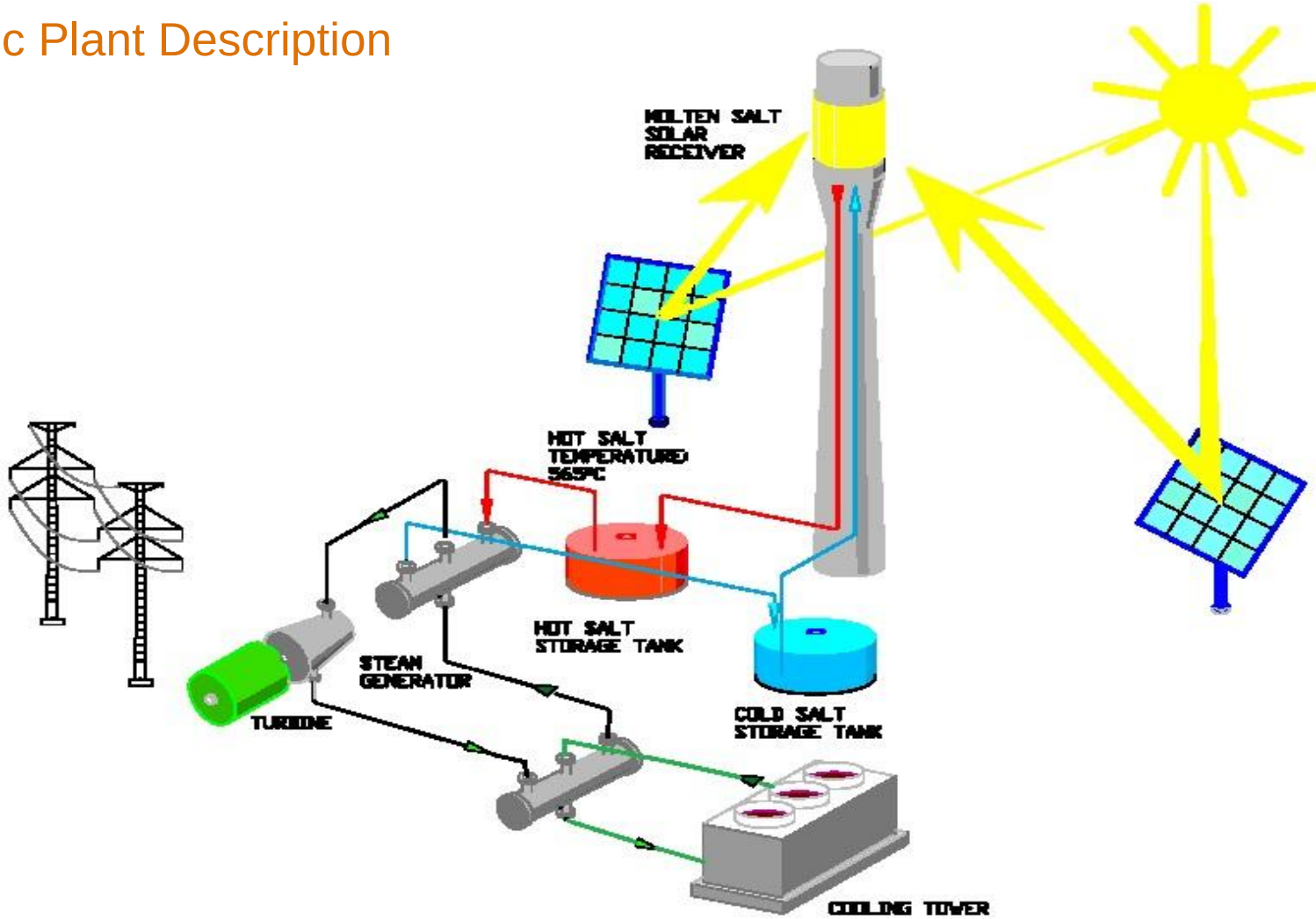
CSP today

Operating GEMASOLAR

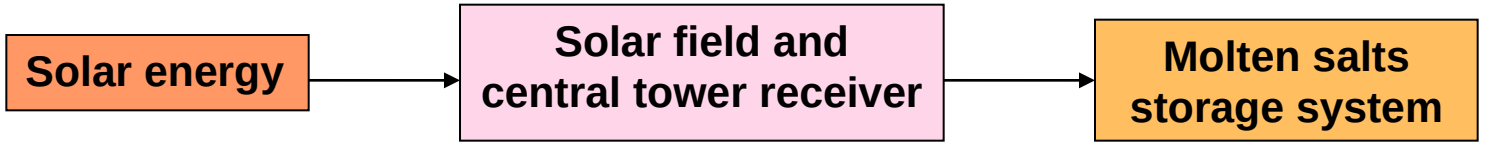
GEMASOLAR PLANT

Basic Plant Description

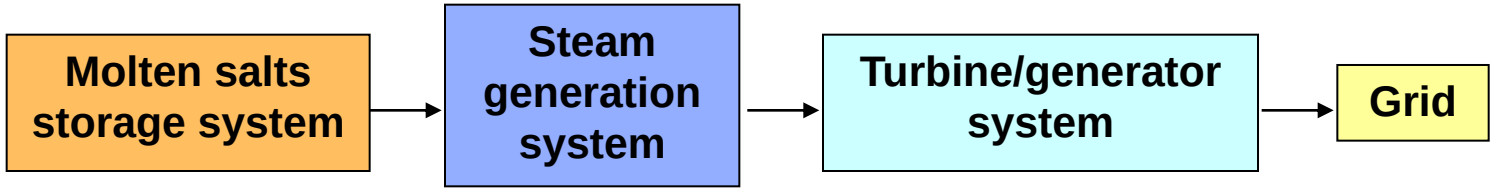


Storage and generation: Two independent systems

- Storage system



- Generation system



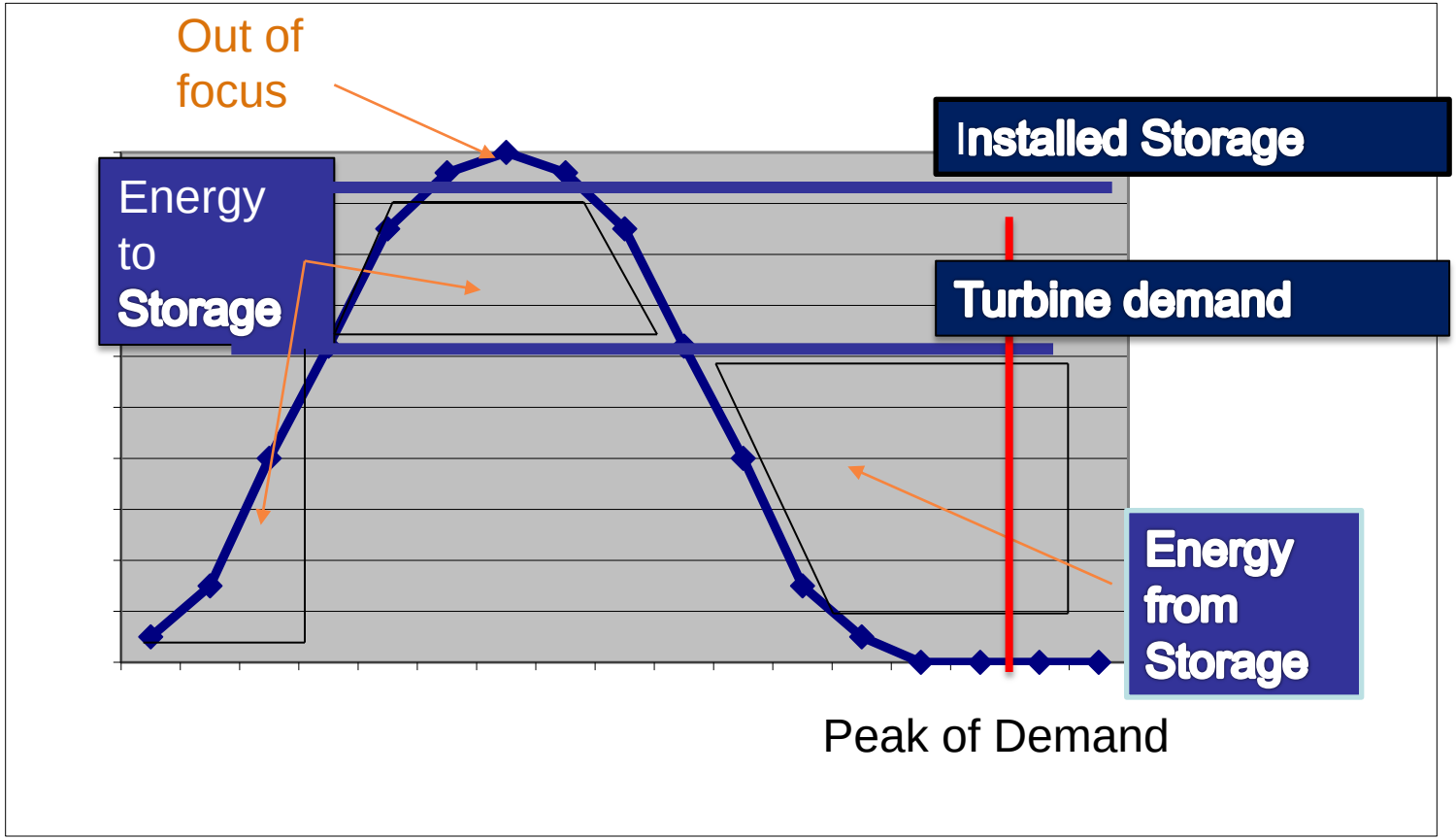
Operating a Central Tower with Molten Salt Technology

Advantages

- High thermal storage capacity.
  - Due to the storage system, the turbine operation is not affected by a cloud or a sudden high speed wind. A cloud will affect the production 6-15 hours later.
  - The turbine will not stop every night. Longer expected life.
  - The turbine power is manageable. We may choose to reduce the output during the night, at valley time, to reach 24 h of continuous operation at lower rate.
  - We maximize the asset utilization. In case of GS will are expecting to produce 6400 h/year, maximizing the profitability.
- Lower operational risk
  - No mobile piping system. No swivel joints. No thermal oil. No potential fire nor spillage risks.
  - All fluids concentrated in an small area. Lower thermal loses and maintenance costs. Self draining piping.
  - The same fluid is used for heat transfer and storage. Less thermal interexchange.
- Highest cycle efficiency.
  - The steam reaches 550ºC maximizing thermodynamic efficiency.

The Energy Storage

Why storing energy?: Dispatch-ability and Economics

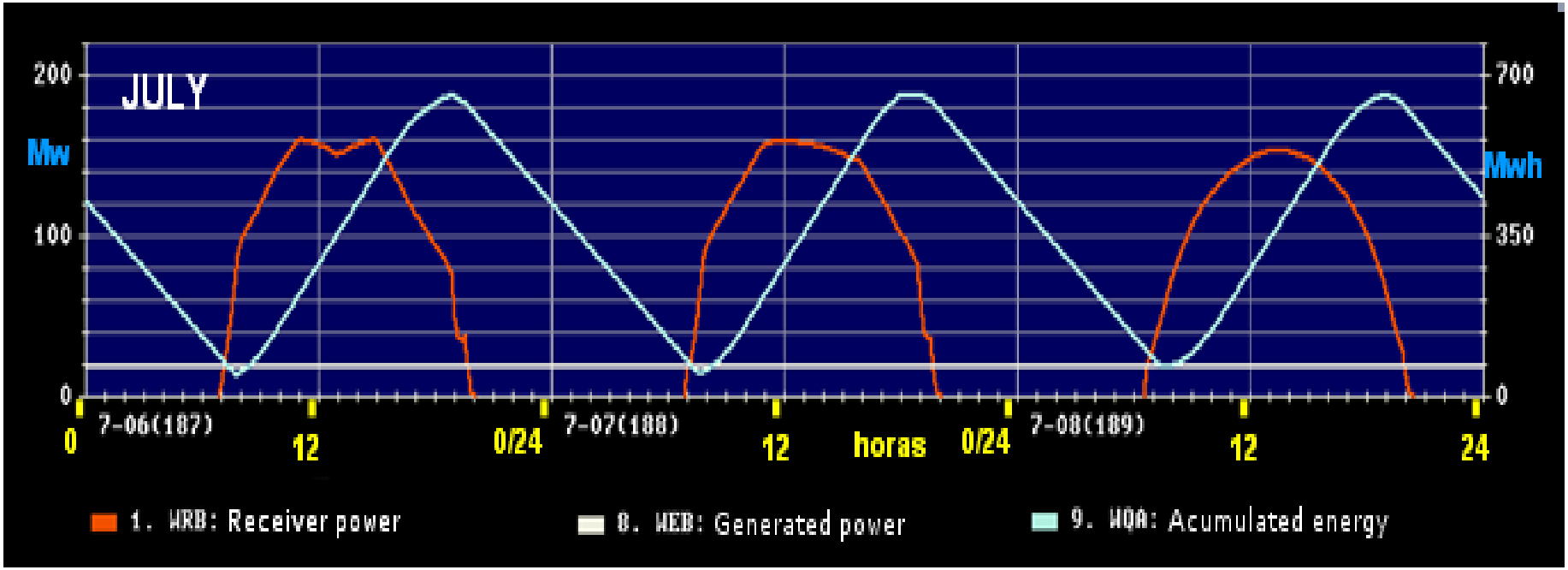


Spanish Electric demand

- Winter time:
  - Typically two peaks of demand at 10.00 and 20.00h (GMT + 1)
  - Radiation at Gemasolar (GMT + 1) from 9.00 to 18.00 h
- Summer time:
  - Two peaks of demand at 12.00 and 22.00h (GMT + 2)
  - Radiation at Gemasolar (GMT +1) from 7.00 to 20.00 h

In both cases the mid-daily demand is supplied by solar radiation. The nightfall demand is supplied by using the molten salt storage system.

Continuous electric energy generation



During the summertime, the plant will supply continuously energy to the grid

*Gemasolar computer simulation for July

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CSP today

Torresol O&M
a Torresol Energy Company

A service Company

Why TOM was created?

- Evident synergies in operating Valle 1 and Valle 2
  - Common management team including shift managers
  - Common maintenance
  - Common spare parts and workshop
  - Common water collection and water treatment systems
  - Shared control room operators . Higher flexibility
- Less evident, but relevant, synergies with Gemasolar
  - Common specialists
  - Recruiting and Training
  - Benchmarking
  - Maintenance Stops
  - Some shared spares

TOM OBJECTIVES

- Short Term
  - Achieve excellence in operating our Thermo Solar Plants
  - Differentiation Factors
    - People recruited from Thermo-Solar plant Start up and specifically trained
    - Operating philosophy
    - Unique vinculums with the Engineering Company
    - Focus on Thermo-solar technology

- Middle Term
  - Maximize efficiency in CSP Plant operations and become the reference company in O&M services, to cover the needs, not only our present and future plants, but to offer the service to third parties as well.

OPERATING PHILOSOPHY

The safe and optimized operation (and maintenance) of CSP plants is as important as the technology itself.

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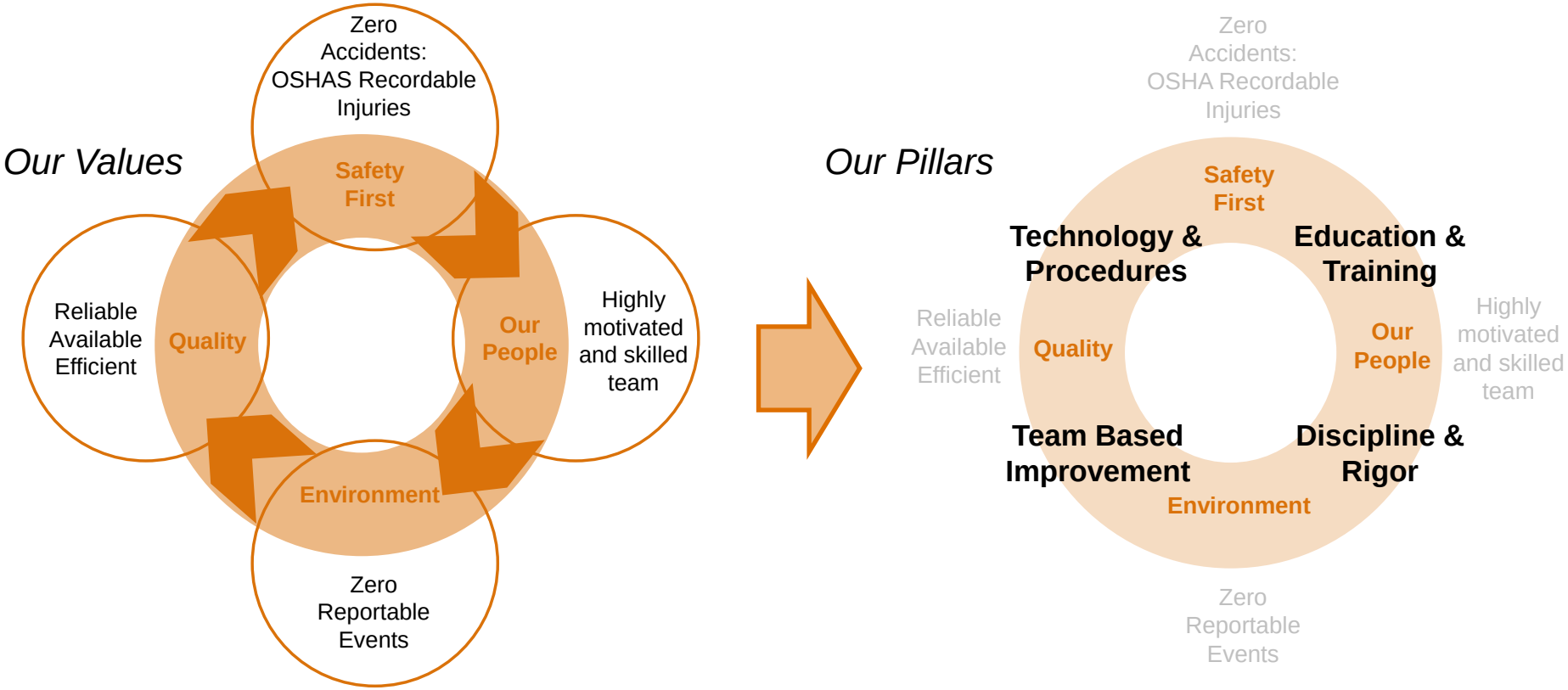
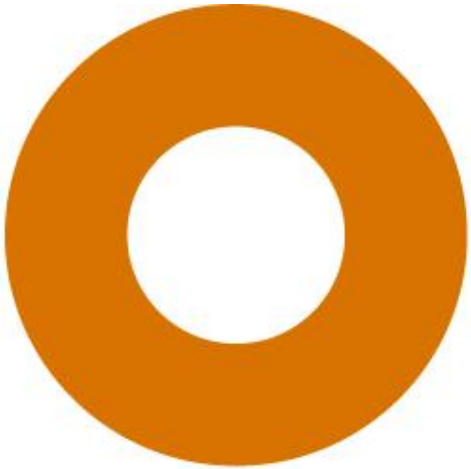


Synergies when operating multiple plants

Synergies in operating multiple plants

Initial phases and Start-up	**Information**	Exchange of project information. Improvements…
	Organization and recruiting	Common selecting process. Filtering candidates
	Hiring	Common Standard contract
	Training program	Common training program
	Operating procedures	Common operating procedures
O&M	**Information**	Share of detail O&M records. Benchmarking Share incident and accident records Share remedial methods.
	Spare parts	Share "safety" Spare stock
	O&M team	Sharing resources



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