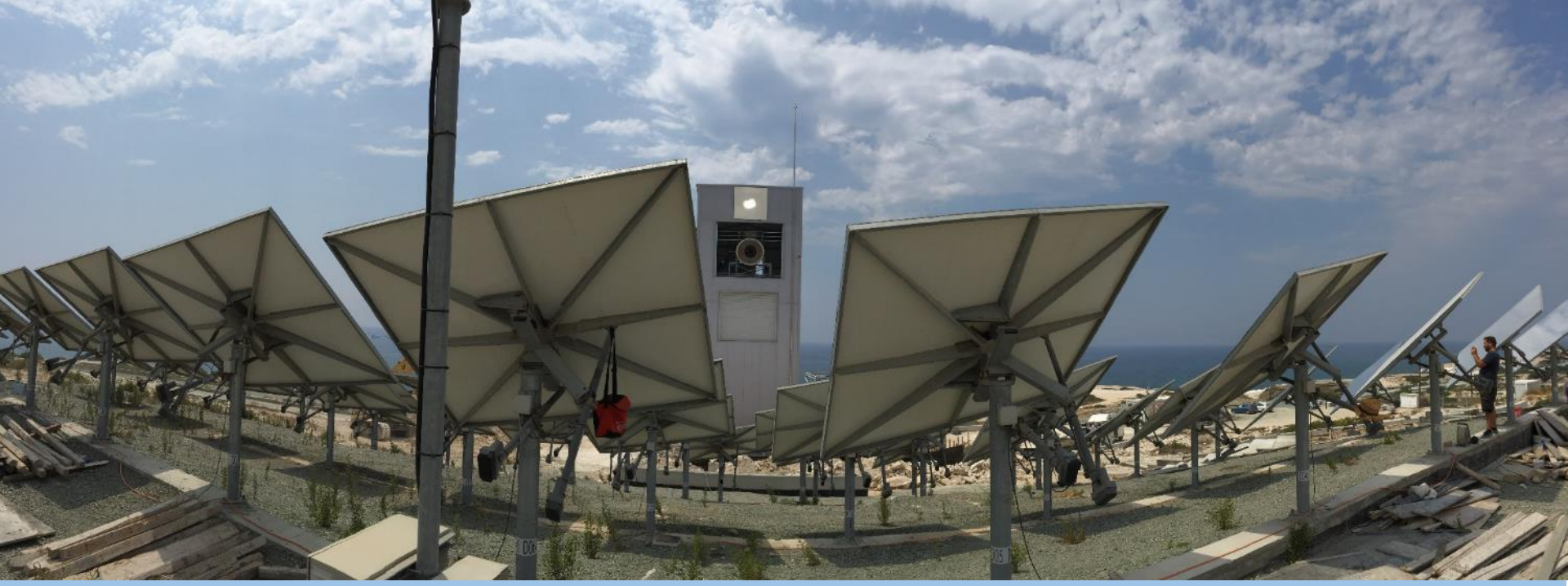


CySTEM: Cyprus Solar Thermal Energy for the Mediterranean

Prof. Manuel J. Blanco

European Research Area Chair

in Solar Thermal Technologies for the Eastern Mediterranean

Concentrating solar thermal (CST) technologies

Foto: Miguel Hidalgo García

CST technologies

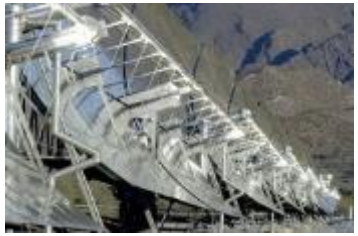
Solar Energy → Heat → Useful Energy







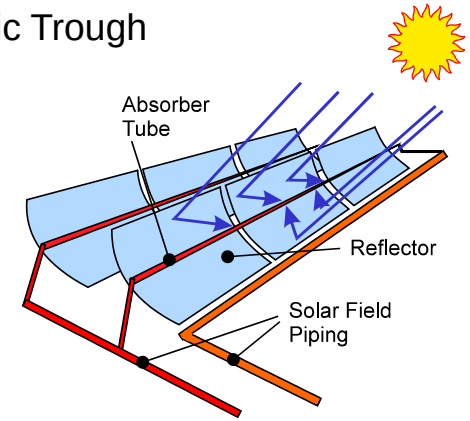




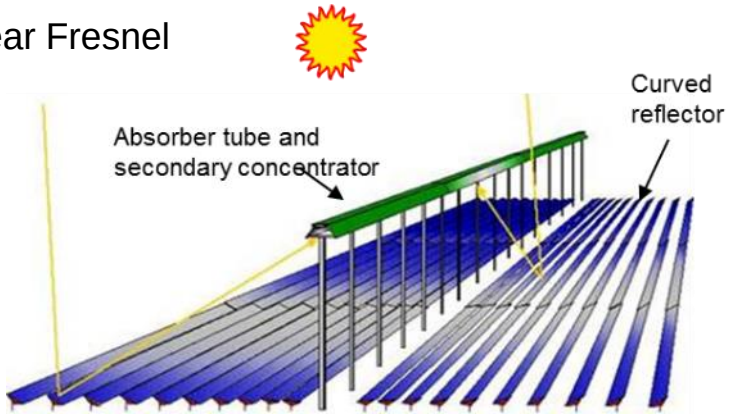

Temperature of heat is critical

CST technologies

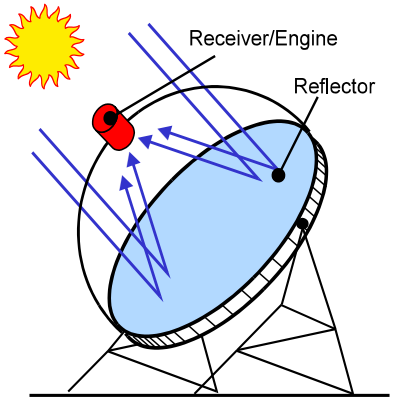
Parabolic Trough



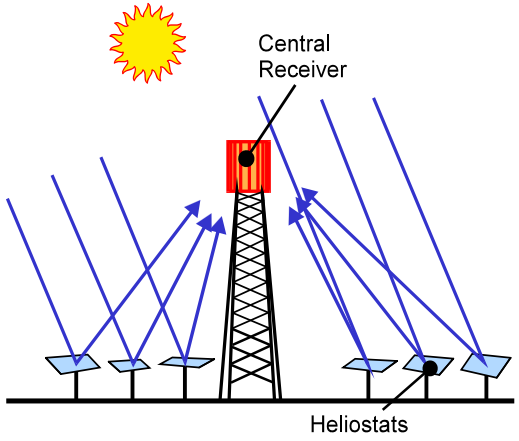
Linear Fresnel



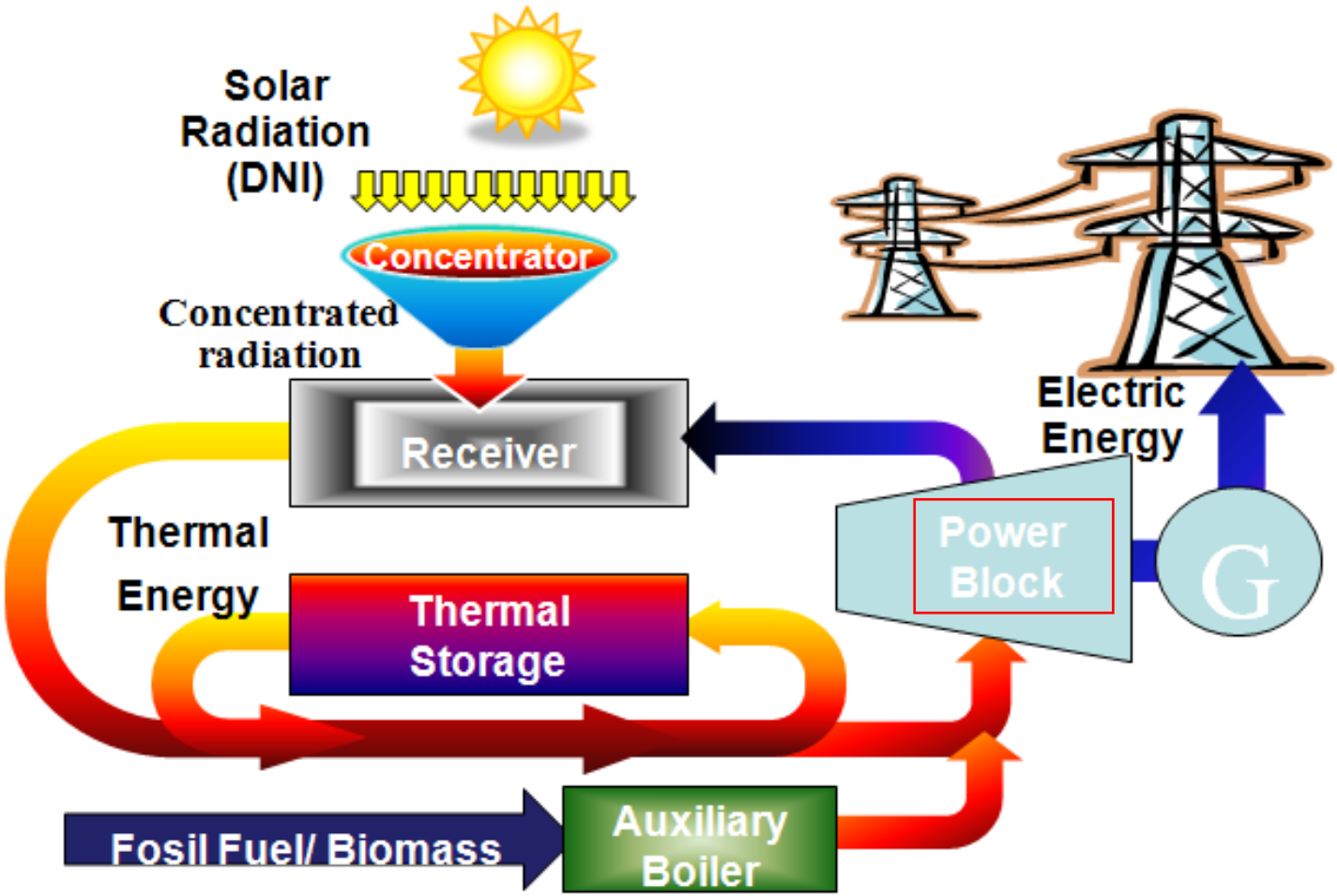
Parabolic Dish



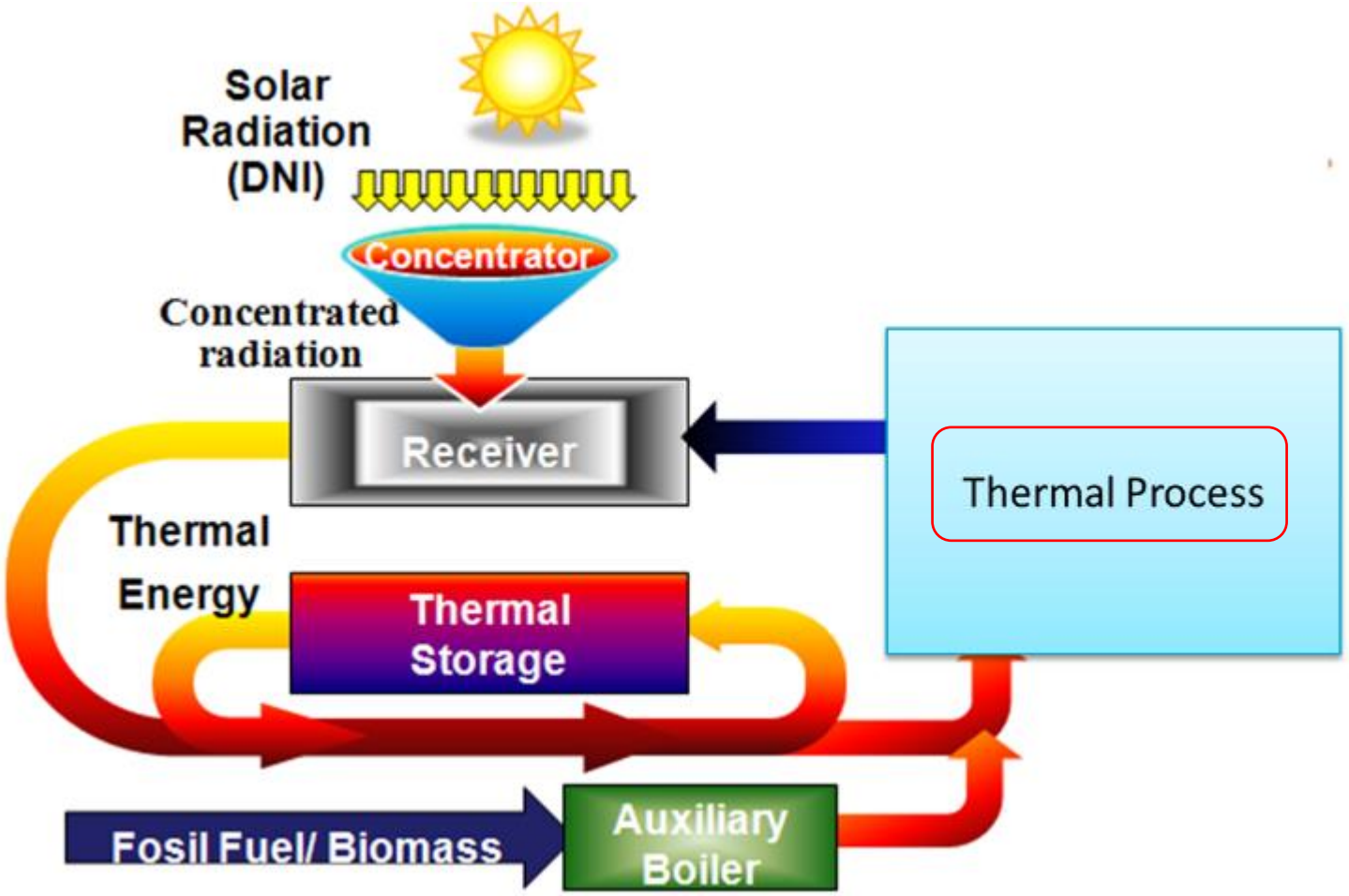
Central Receiver (tower) systems



CST technologies



CST technologies



- Heat process
- Electricity
- Solar fuels
- Solar desalination
- Solar detoxification
- Solar Oil Recovery
- Solar mineralogy
- ……

CST technologies

- High temperature is attractive due to high cycle efficiency, and lower thermal energy storage cost.
- Thermal energy storage can be:
  - Feasible,
  - Environmentally friendly,
  - Cost effective
    - **35 €/kWhe Capacity**

CST technologies

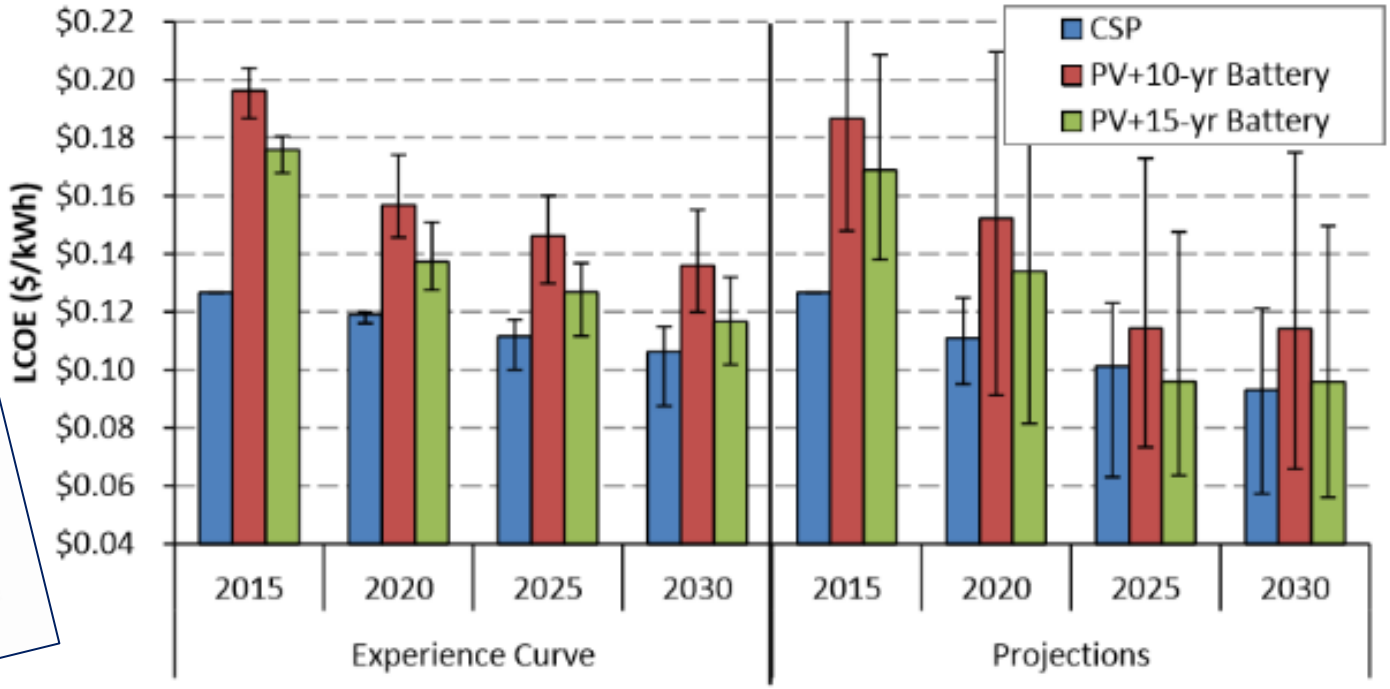
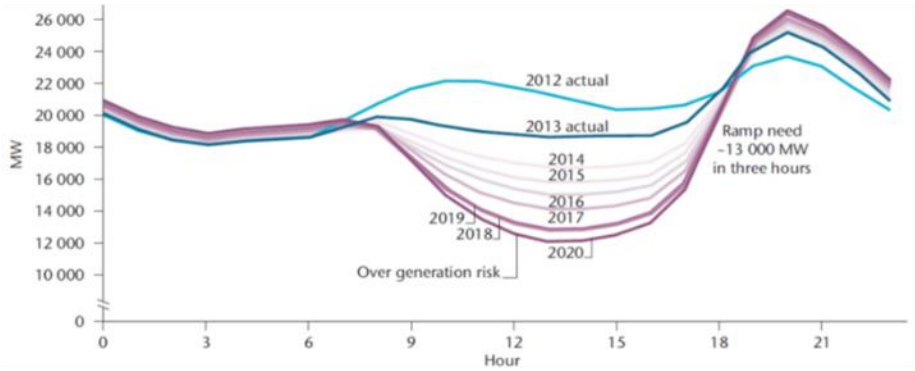


Figure 26. LCOE comparison: CSP versus PV (six hours of storage), 2015–2030

Mid case is shown with uncertainty bars representing the span of the low to high cases.

CST technologies

Generation needs in California, discounting PV, in a Spring day

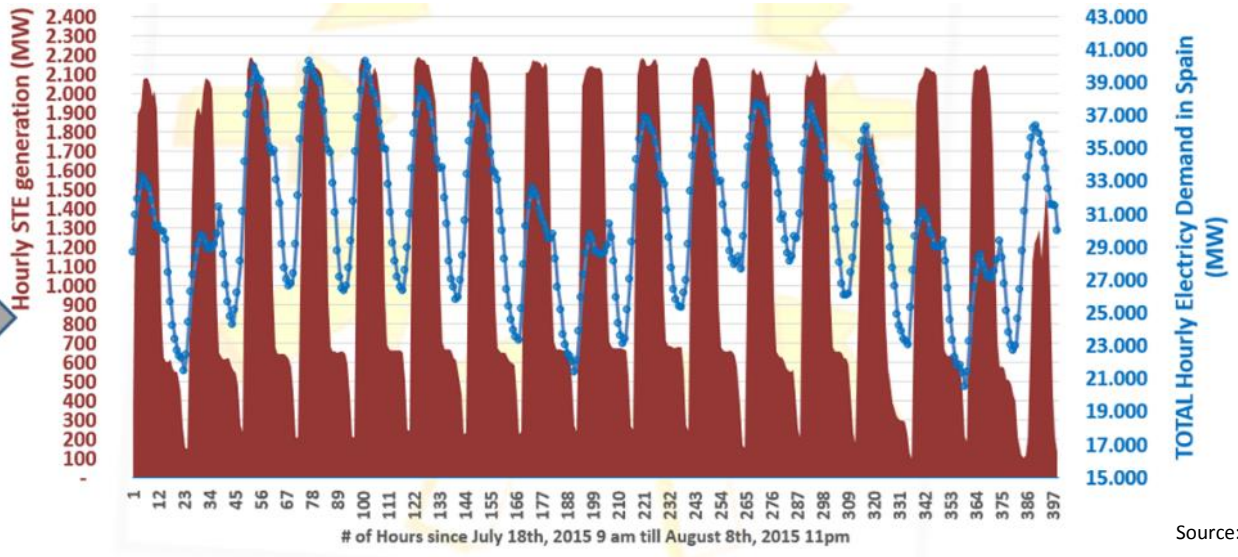


Source: California ISO, 2014

Value component	33% renewables		40% renewables	
	STE with storage value (USD/MWh)	PV Value (USD/MWh)	STE with storage value (USD/MWh)	PV Value (USD/MWh)
Operational	46.6	31.9	46.2	29.8
Capacity	47.9-60.8	15.2-26.3	49.8-63.1	2.4-17.6
Total	94.6-107	47.1-58.2	96.0-109 ⇧	32.2-47.4 ⇩

Source: Jorgenson, Denholm & Mehos, 2014

870 MW with TES

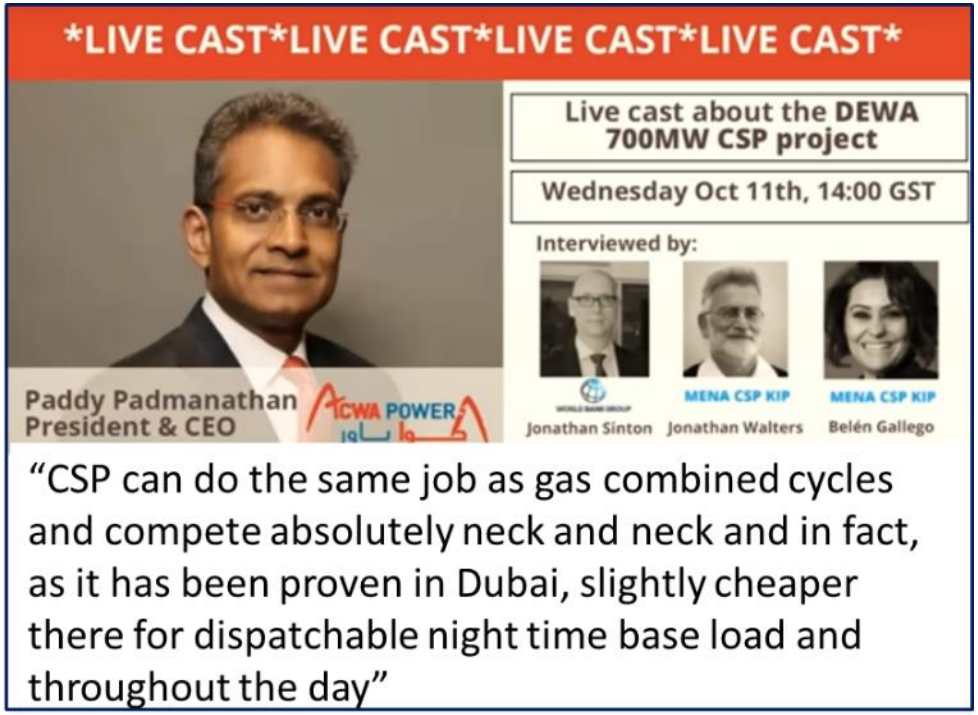


Source: PROTERMOSOLAR

CST technologies

700 MW concentrated solar power plant in Dubai hits a new record bid with $7.3 cents per KWh

19-09-2017 | Categories: BREAKING NEWS, Documents,



Value Proposition

Value proposition of CST technologies

- CST provides a very large range of energy service options
  - Heating and cooling
  - Heat processes at high temperatures
  - Electricity
  - Solar fuels and other chemistry applications
- CST is easily hybridized and stored
  - If hybridized with biomass can provide a continuous 24/7 clean and renewable heat process or electricity production operation
  - If combined with a thermal storage system can provide the heat for the heat process application or for the deliver of electricity when is most needed or most economically profitable.
- When deployed with conventional power block
  - CST delivers dispatchable clean and renewable electricity and ancillary services to the grid

Value proposition of CST technologies

- CST utilises expertise already available in many countries
  - High potential for conversion or expansion of existing manufacturing capabilities in a country to serve the CST sector
  - Local content of CST projects
  - Positive impact on employment, tax revenues and GDP
- CST has all the attributes to become the backbone of the highly decarbonized energy system of the future
  - Electricity sector:
    - don’t need any conventional backup
    - roles as needed; from base-load to peaking plants
    - provide critical grid stability to increase penetration of non-dispatchable renewable technologies
  - Industrial and transport sectors:
    - provide process heat, fuel and solar chemistry solutions needed to highly decarbonize these sectors

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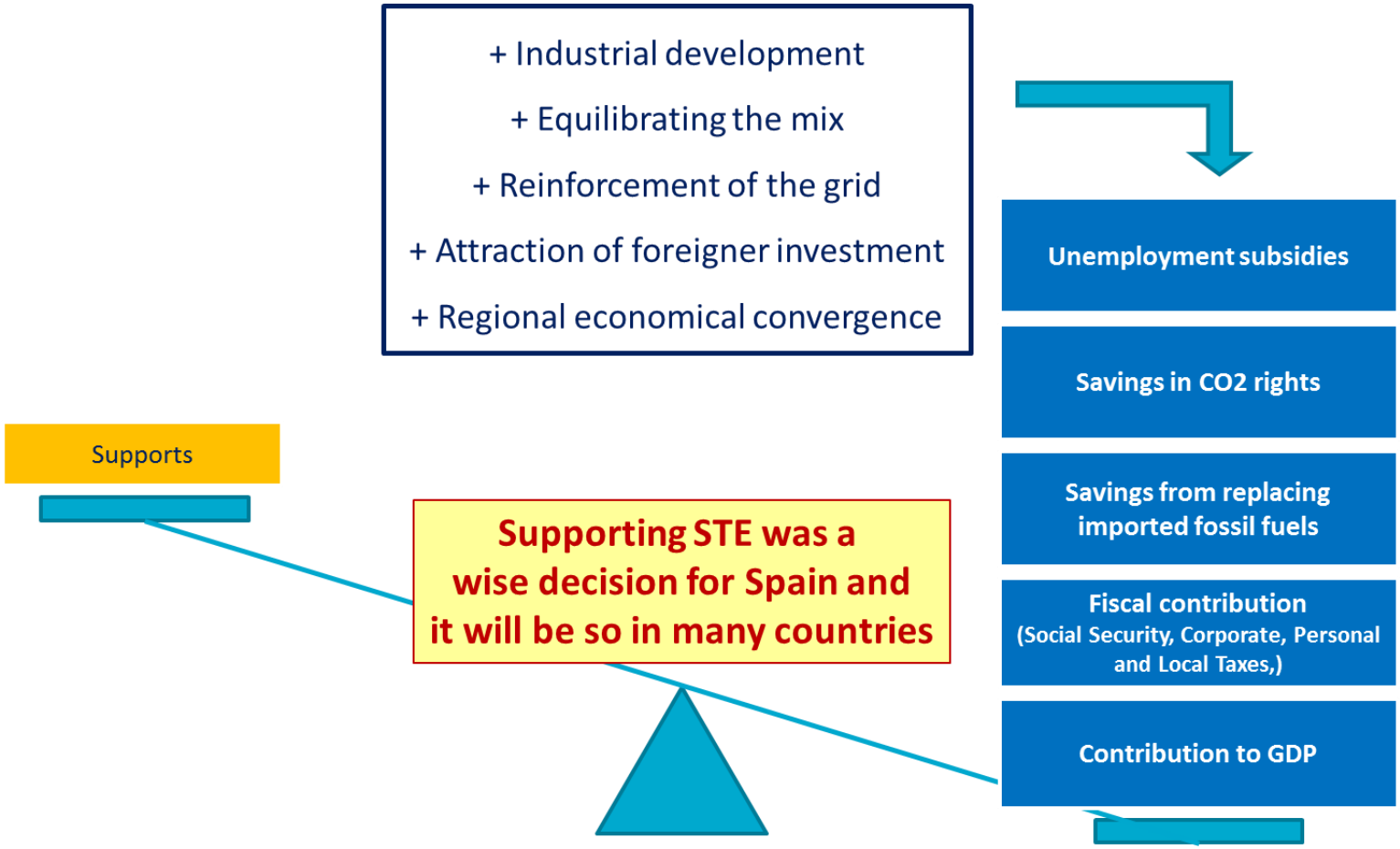
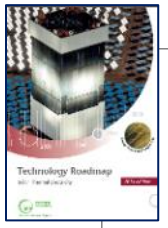
Value proposition of CST technologies

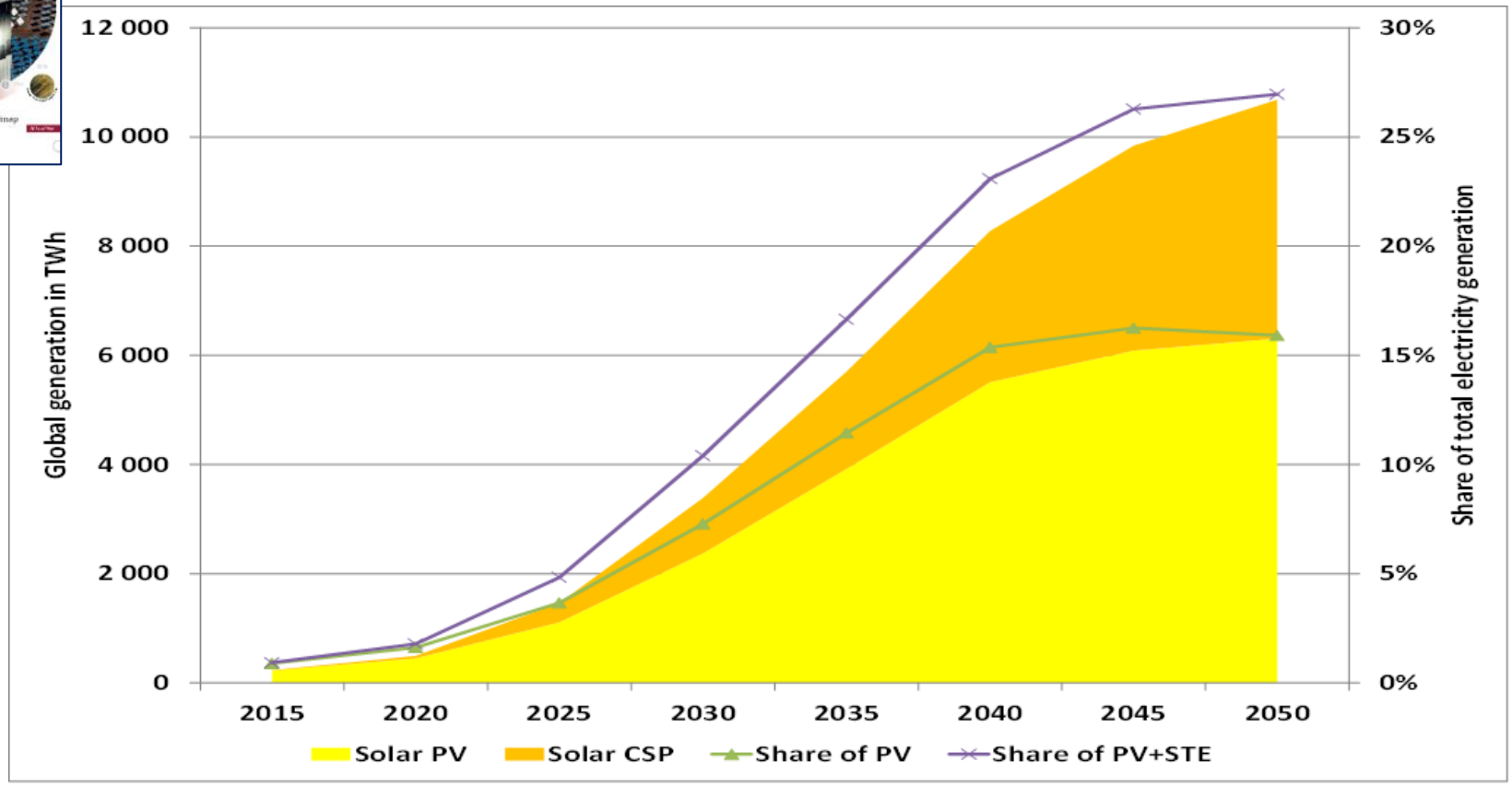
Positive Macroeconomic Impact - Spanish experience



Global opportunities

CST technologies have a bright future

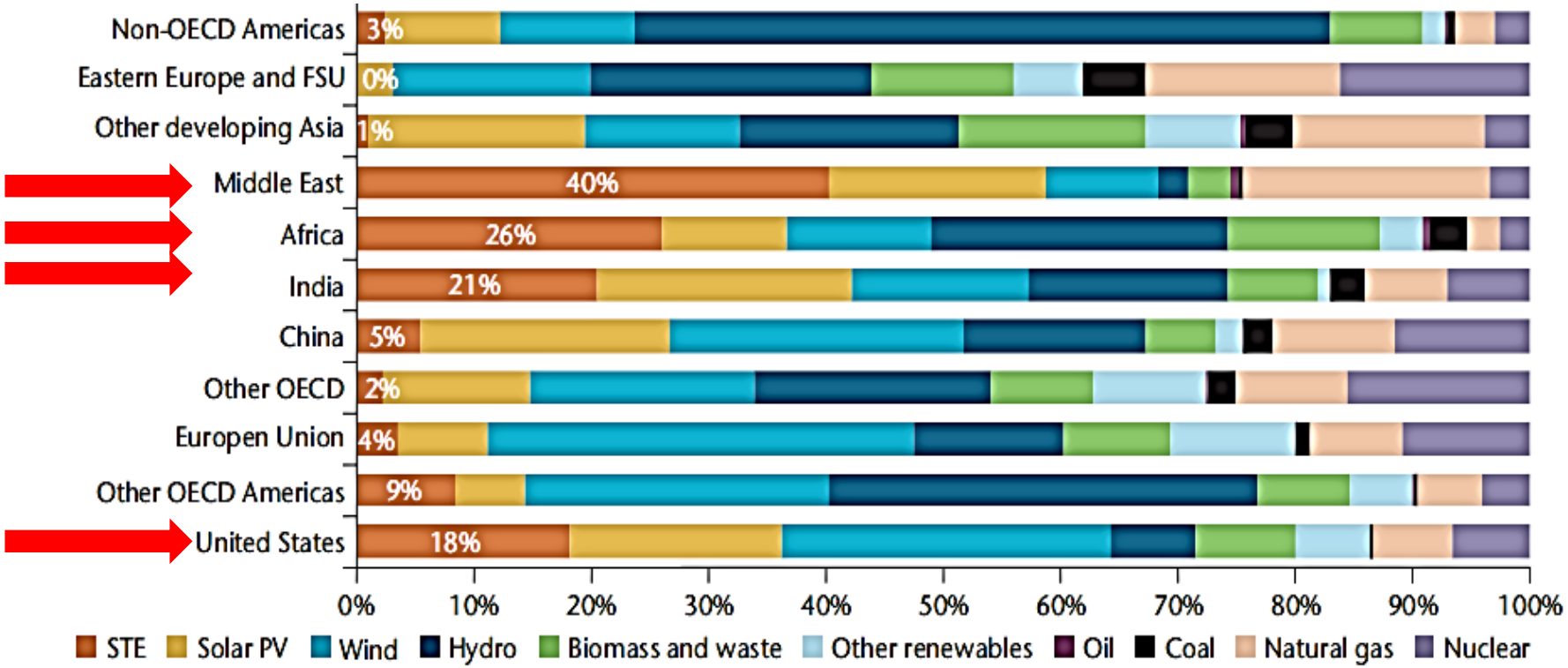




Together, PV (16%) and CST (11%) could become the largest source of electricity worldwide before 2050

IEA road map

CST plants will be the dominant technology in the future for Middle East and African countries and they will play a significate role in other regions



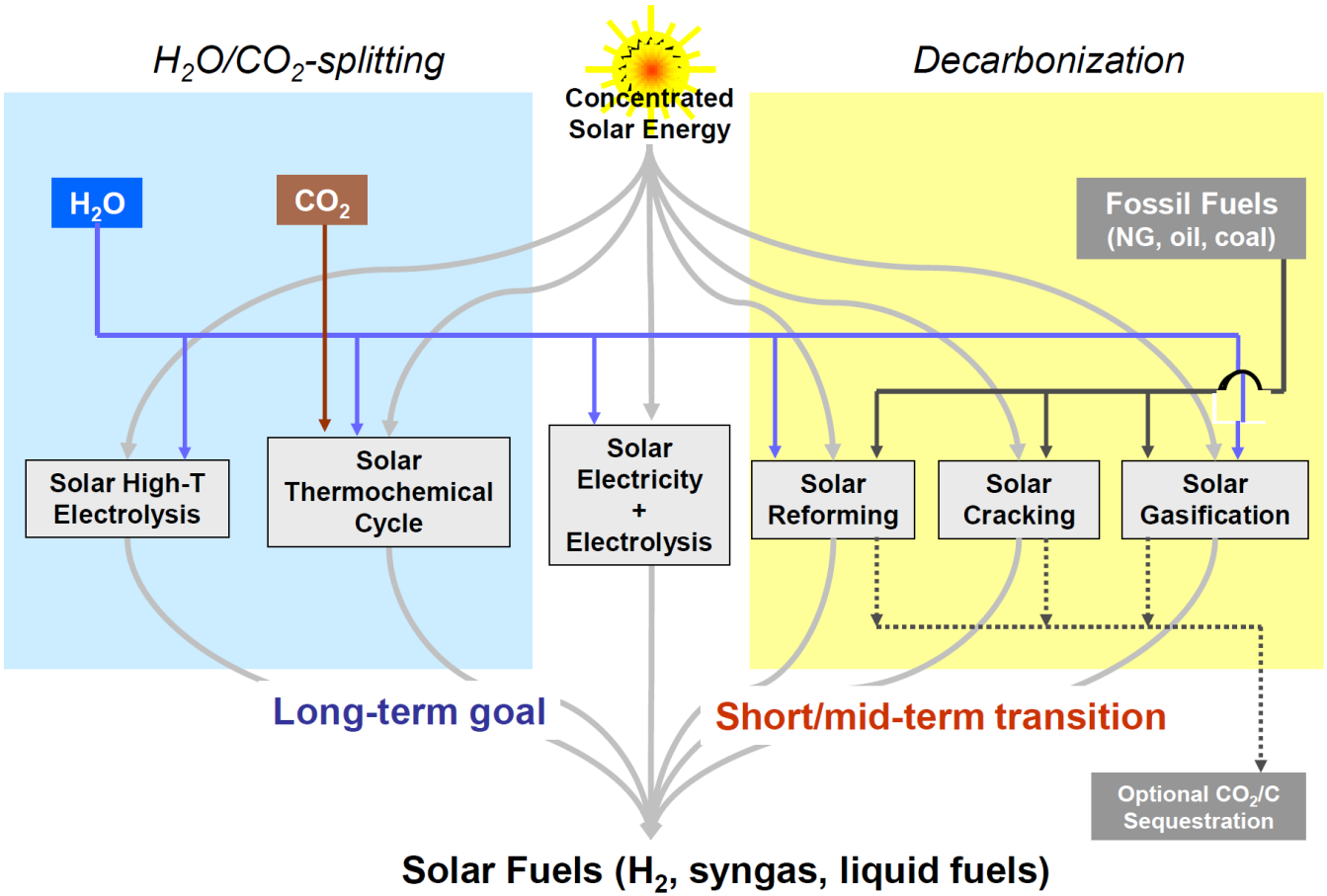
PV and CST can be combined

Lesidi and Jasper PV plants in operation since 2014 in RSA. Redstone CSP plant with storage (rendered) to be commissioned in 2018.

Heat process more than a niche

Enhanced Oil Recovery (EOR): 1 GWth, Mirrah, Oman, 2017 (GlassPoint)

Fuels and solar chemistry more than a niche



Source: Dr Anton Meier, PSI Switzerland

Background to the CySTEM ERA Chair

Background

The Cyprus Institute (CyI) mission:

- To help foster the development of a knowledge-based economy in Cyprus through cutting edge scientific research and education that has local, regional as well as international significance.
- To act as a gateway for research and technology in the Eastern Mediterranean Region to and from the EU.

Background

Vulnerability of critical infrastructures

- The Cyprus Institute almost since its creation in 2007 has address the question of how to mitigate the problem of the vulnerability of energy and water infrastructures in the island.

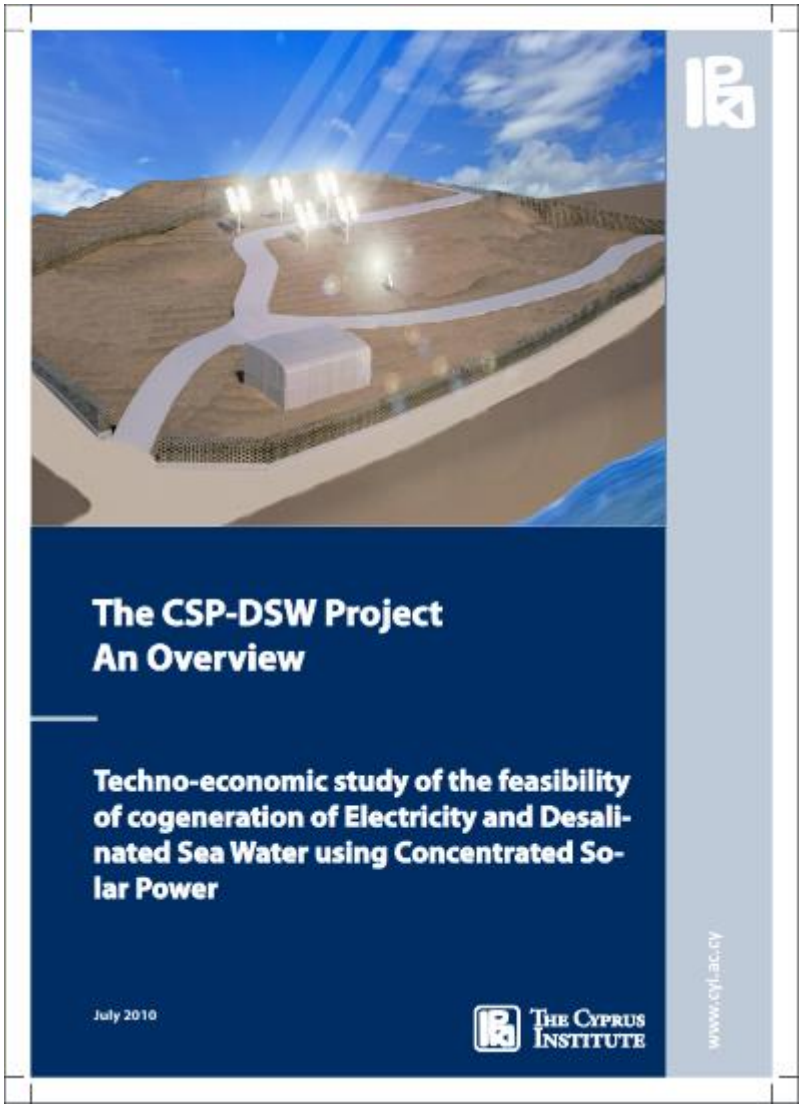
Kouris Dam reservoir, the largest in Cyprus. In 2008 fresh water had to be imported in tankers due to severe drought

Vassiliko Power Station, 2 days after the explosion in July 2011

Background

CSP-DSW Project

- Completed in 2010 in collaboration with MIT, Electricity Authority of Cyprus.
- In-depth analysis of state-of-the-art in small scale solar thermal cogeneration systems
- Similar overview on desalination methods
- Robust financial model concluded that technology can be profitable under current (at the time) support schemes



Background

STEP-EW Project:

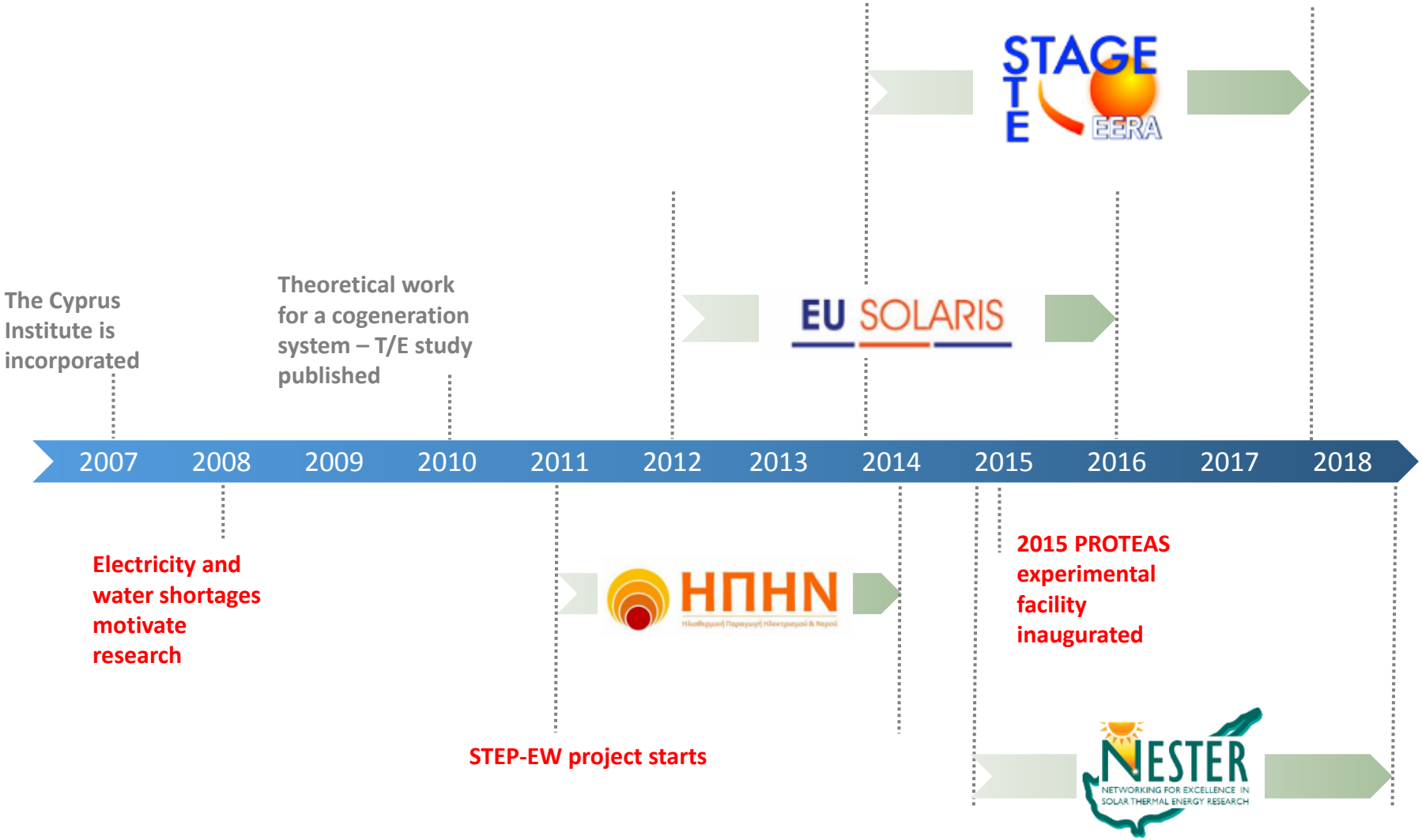
- Start date: 1st October 2011
- End date: 21st December 2014
- Funding source: INTERREG Greece-Cyprus 2007-2013
- Coordinator: The Cyprus Institute
- Partners:
  - Electricity Authority of Cyprus,
  - Water Development Department,
  - Foundation for Research and Technology Hellas (Diktyo Praxi)

Solar Thermal Experimental Production of Electricity and Water (STEP-EW)

Main Goals:

- **Develop a renewable energy solution specially suited for islands**
- Construct a small (demo) scale experimental solar thermal cogeneration unit
- Gather experimental data to refine the technology, identify problems and adapt for large-scale deployment.

Background


STAGE STE
EERA
EU SOLARIS
The Cyprus Institute is incorporated
Theoretical work for a cogeneration system – T/E study published
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Electricity and water shortages motivate research
ΗΠΗΝ
2015 PROTEAS experimental facility inaugurated
STEP-EW project starts
NESTER
NETWORKING FOR EXCELLENCE IN SOLAR THERMAL ENERGY RESEARCH

The CySTEM ERA Chair

Foto: Miguel Hidalgo García

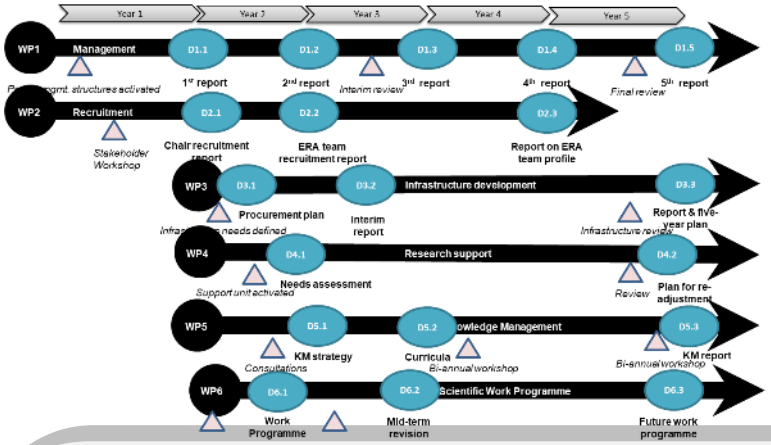
CySTEM Overview

Goal of the CySTEM ERA Chair

- **Consolidating and upgrading** the already substantial **activity** at the Cyprus Institute (CyI) in **Solar Energy**, principally solar-thermal and related activities.

Accomplished by

- Attracting and installing a cluster of **outstanding researchers**,
- Led by a **professor of international stature**
- To maximally **utilize and upgrade the existing facilities**, and
- **Pursue a program of excellence** in Cyprus with **local and regional focus** in the region of Eastern Mediterranean and Middle East (EMME).



CySTEM Overview

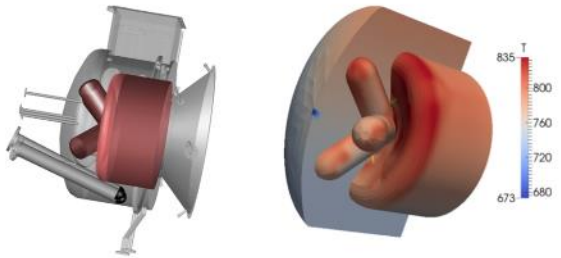
CySTEM ERA Chair SWP focus:

a) Small CST poly-generation systems concepts based on tower technology aimed at islands, and other niche markets.

b) Solar receivers as key components of small CST poly-generation system concepts.

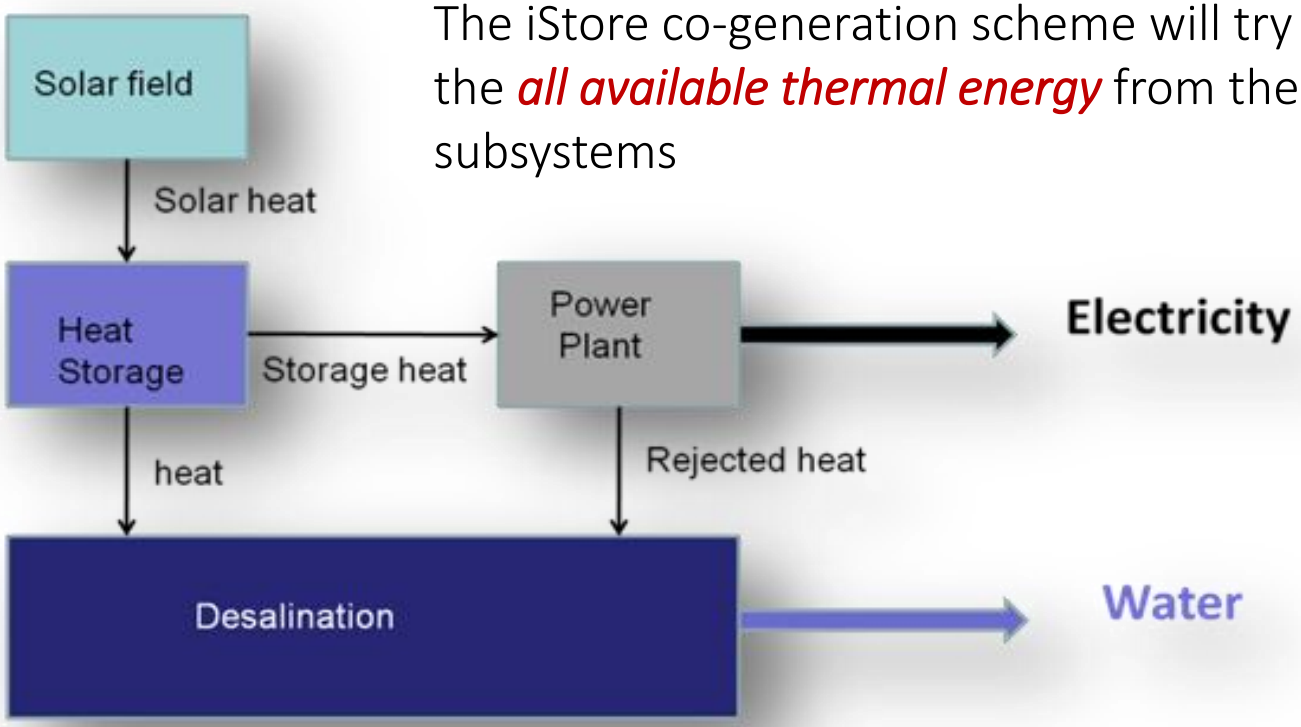
c) Heat process applications based on Linear Fresnel technology.

d) Solar radiation characterisation drawing upon the expertise in atmospheric modelling.



iStore technology

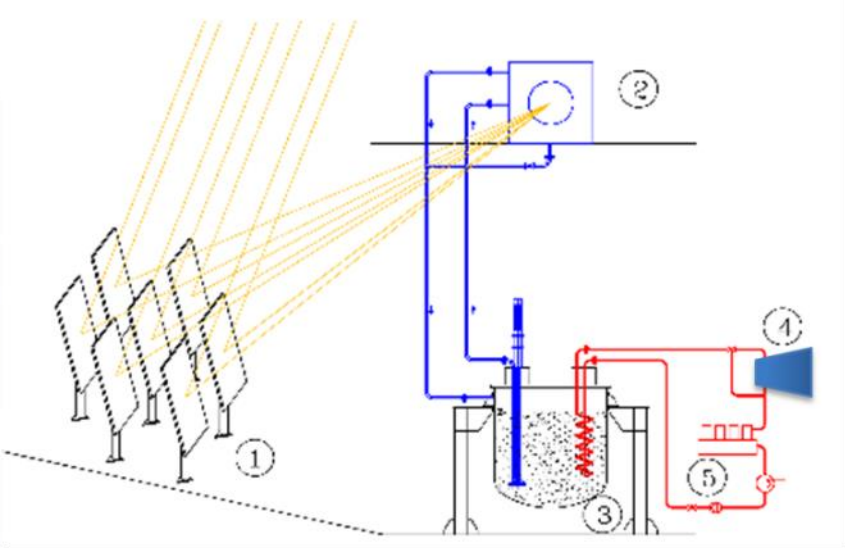
The iStore technology



The iStore co-generation scheme will try to utilise the *all available thermal energy* from the various subsystems

The advantages of the technology are realized only when the power and desalination cycles are integrated thermally and optimized together.

The iStore technology

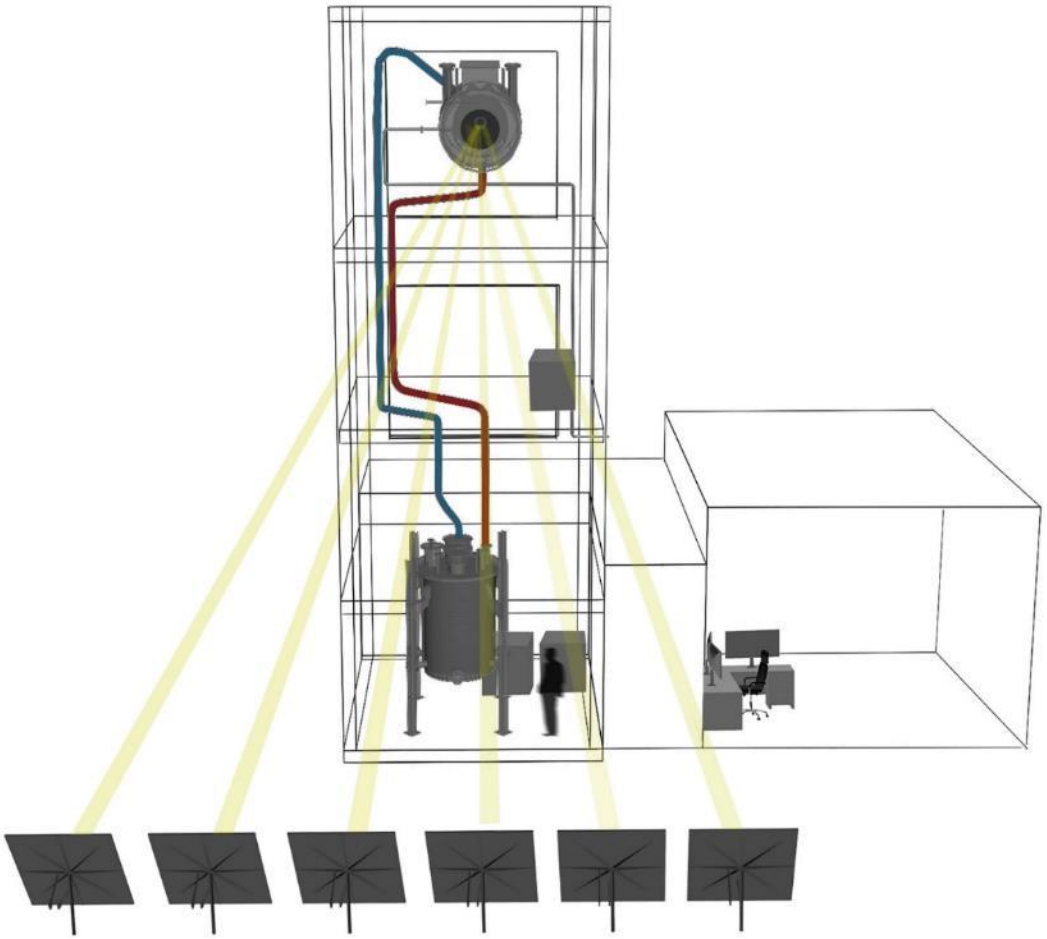


PROTEAS CST Facility

The PROTEAS Facility

- Situated on the coast near Pentakomo village, Limassol
- A solar field of 50 heliostats, 5m^2 each
- Rated power of 150 kWth
- 15-h molten salts storage practically capable of continuous operation
- Patented integrated receiver and storage (ISTORE)
- Integrated MED desalination module

Heliostats and Tower

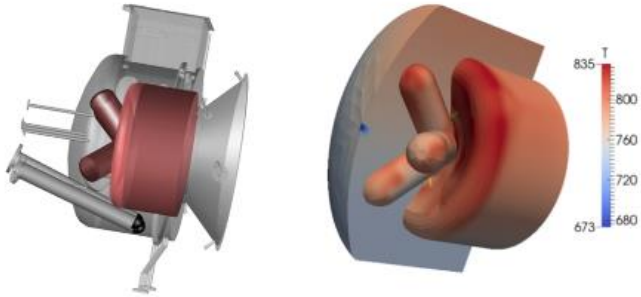


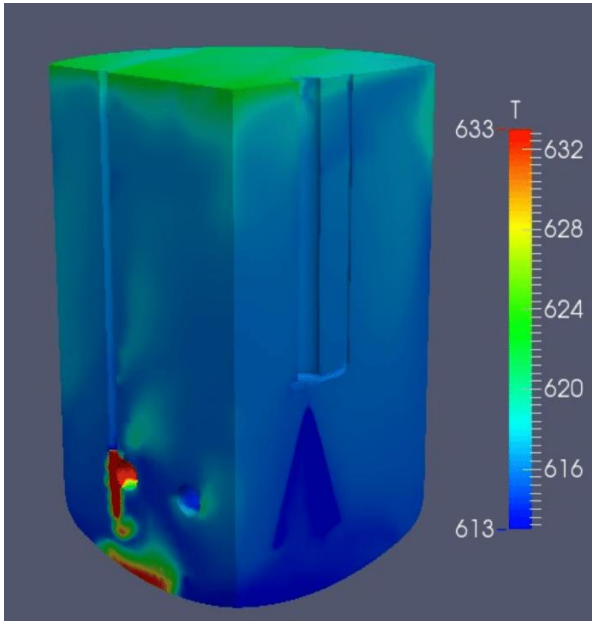
Aerial View of the PROTEAS Field Facility

Current status and future work

Current status and future work

- The complete “proof of concept” of the iStore technology at PROTEAS is about to be finalized.
- Test of the key components of the new technology have been carried out proving that the technology works.
- Under CySTEM the testing capabilities at PROTEAS are being upgraded and the modelling capabilities of CyI’s Solar and Desalination Group are being substantially expanded.
- In 2018 we plan to:
  - Finalize the setting up and testing of the “proof of concept”
  - Finalize the specification of the commercial iStore plant and its design
  - Finalize the business case and technology development road map.





Thank you!

Prof. Manuel J. Blanco
European Research Area Chair in
Solar Thermal Technologies for the Eastern Mediterranean
m.blanco@cyi.ac.cy