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“EU-GCC Challenges and opportunities for collaboration in CSP, current trends and future visions”

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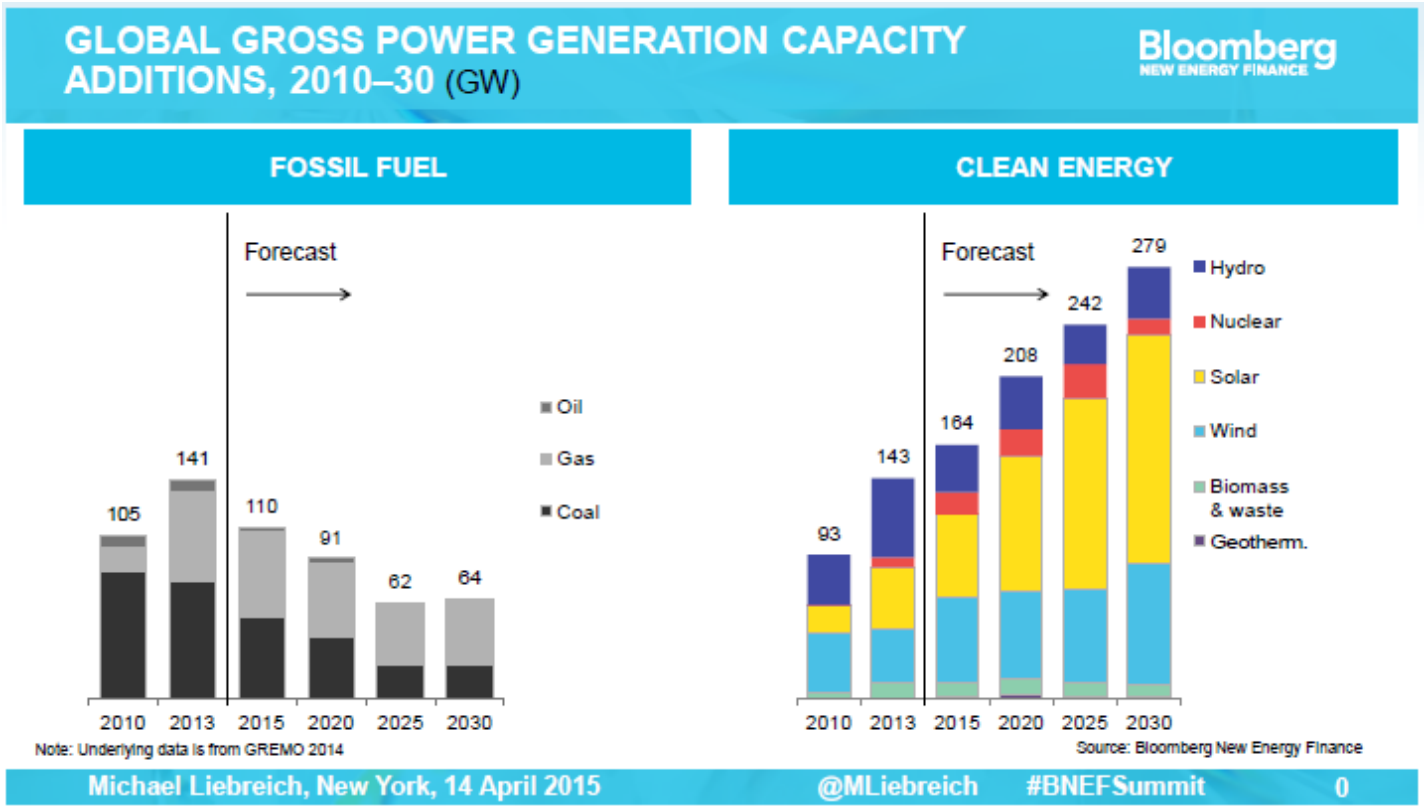
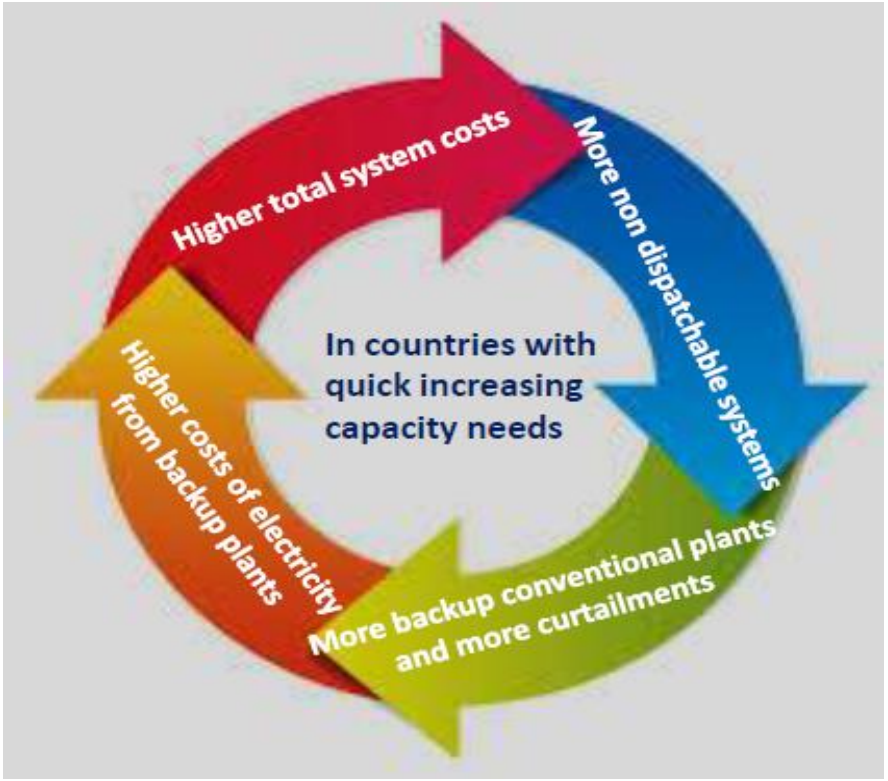
1.- Introduction and context

World's transition to a sustainable energy system is already happening

- **Since 2014**, **renewables** account for **more than half of the world's new installed capacity** and this contribution is growing exponentially. Renewables **will represent soon more than 90%** of the worlds new installed capacity.



What happens when intermittent RES reach a high penetration in a power system?

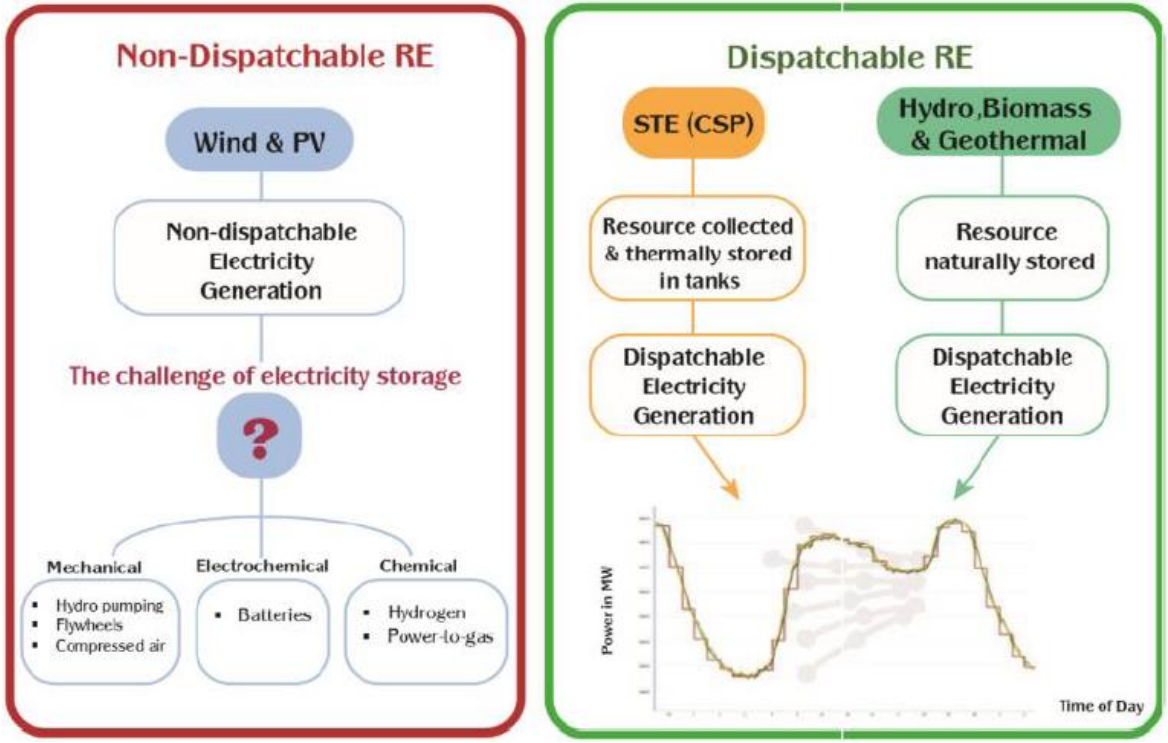


Source: ESTELA European Solar Thermal Electricity Association

- They do account for saving of fossil fuels, but the do not account for **capacity**.
- This make system operation more costly or unreliable.

Energy storage is a key technology in the world's transition to a sustainable energy system

- **What's the challenge then?**
  - ✓ The challenge is to produce dispatchable clean electricity at a competitive price.



Source ESTELA

- **CSP** technologies are **available** to meet this challenge **TODAY**

Source Torresol Energy

Cost Reduction:

Cost reduction announced the GCC region (700 MW @ **US¢7.30/kWh**) will have an **strong impact in CSP development and deployment**

By achieving the necessary cost reduction **additional market opportunities** will appear.

The **contribution of solar heat** to global energy demand is estimated at **14 EJ in 2030** and 97 EJ in 2050[1].

New applications such as Industrial solar heat, solar cooling and desalination will **emerge**

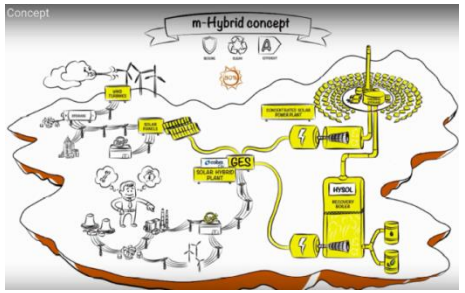



[1] The Potential of Solar Thermal Technologies in a Sustainable Energy Future: Results from 32 Years of International R&D Co-operation (2010).

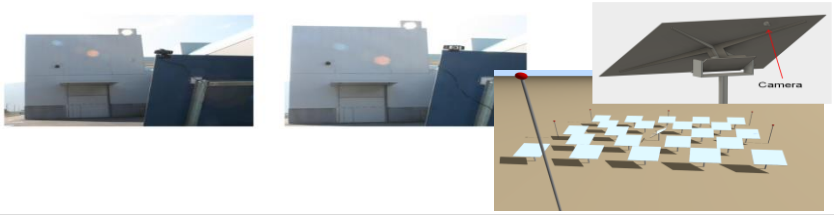
2.- Future Vision

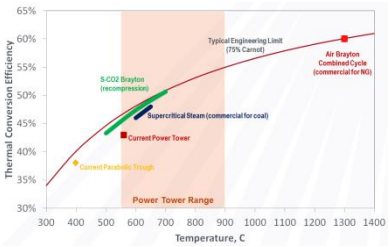
Electrical applications

- **Renewable energies** will play a **leading** role in the **energy mix of the future.**
- **CSP technology**, due to its **dispatchable** nature, will be **key** for the indispensable **transition** to a more **sustainable energy system.**
- There will be a **higher level of hybridization** concepts and plants suitable to **customer needs.**
- **Future plants** will be **modular** with **multitower** systems incorporating innovative **high-temperature thermodynamic** cycles such as supercritical CO_2 cycles.
- **Solar fields** will be **smart,** wireless, stand-alone and with **reduced O&M.**



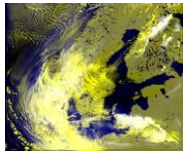
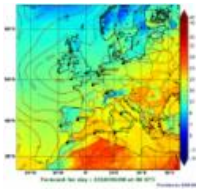
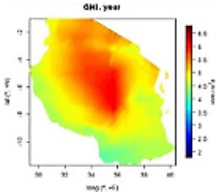
Calibration of the kinematic heliostat system

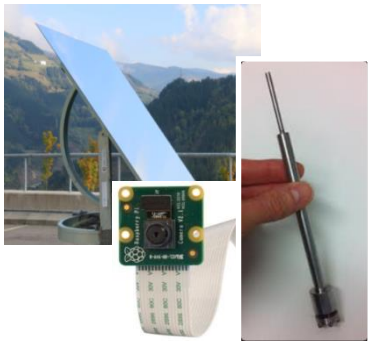




Electrical applications

- **Solar resource prediction systems** will be more precise and **advanced**, allowing an optimum **integrated management of renewable resources** according to **consumers needs** .



- **Intelligent smart and autonomous plants** with more precise monitoring systems, incorporating new sensors to the plants as well as automatic and robotic inspection systems will **increase plant performance and reduce O&M cost.**

- **Systems based on artificial vision** will allow surveillance and **more automatic operation and maintenance at lower cost**.

- Plant components will be factory-made using lean manufacturing and **mass production technologies that enable high quality at low cost.**

Thermal applications

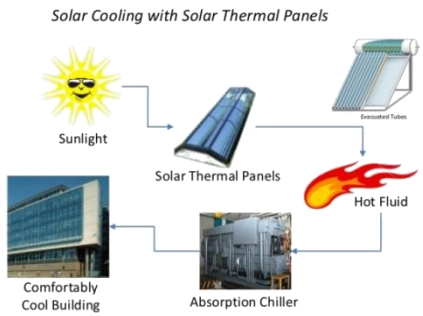
Countries with an **adequate solar resource** (i.e. **GCC**), most **thermal processes will be solar powered** providing a **competitive advantage** to productive processes .

- The use of **solar process heat** will be applied extensively in all industrial processes that require heat (food industry, transformers, mining, etc.).

- **Solar cooling** will be the most widespread option for the areas with the greatest potential **GCC** MENA, Mexico, Australia, Chile, etc.

- One-third of the world's population will be affected by fresh water scarcity by 2025. Problems will be severest in the Middle East, northern India, northern China, and the western United States (1).

➢ **Solar desalination** will be the way to reverse this trend by guaranteeing universal access to drinking water.

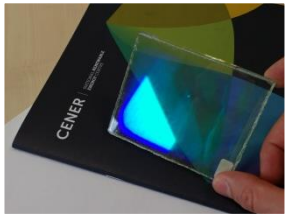


[1] Financial crisis, the world is running out of fresh water (Nestlé 2009,wikileaks)

Building applications

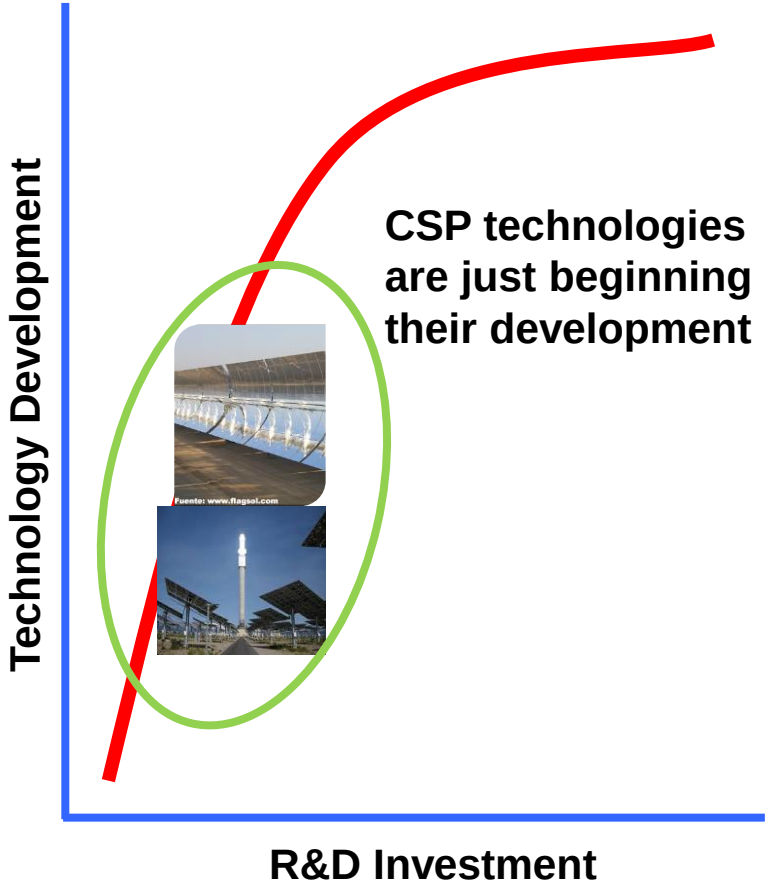
- New architectural concepts will appear. New buildings will be Smart adapted to society needs. **Solar collectors will be integrated as a common constructive element.**

- **New materials, smart components and collectors** (i.e. the use of electrochromic glass) will allow an **active control of solar energy capture**. This will lead to **a new concept of space** more global and **integrated from all perspectives**, environmental, artistic, functional and energetic.



3.- Opportunities for R&D collaboration EU-GCC

Relationship between R&D Investment and Technology Development



- Despite being already **commercially mature** technologies, **solar thermal technologies** are still in an **incipient stage** of technological development with a **high potential for improvement**.

- **Cost reduction** will continue making **significant** progress over the next few years providing massive and **cost-effective energy storage**, increasing **dispatchability** and **enhancing of the penetration** of other Renewable Energies.

Main research lines in CSP technologies

1. Increase efficiency and reduce generation, operation and maintenance costs.

1. Improve dispatchability

1. Improve environmental profile

Short Term

Focused on R&D needs of current commercial plants.

- *Reduce O&M Cost*
- *Increase efficiency and performance along operational live.*
- *Improve plant monitoring*

Mid and Long Term

Subsystems improvements:

- *Collectors*
  - ✓ *Heliostat,*
  - ✓ *Parabolic Trough*
- *Receivers*

New cycles and /or plant schemes

- *Supercritiical Cycles*
- *Decoupled Solar Combined Cycles (DSCC)*

Materials Breakthough

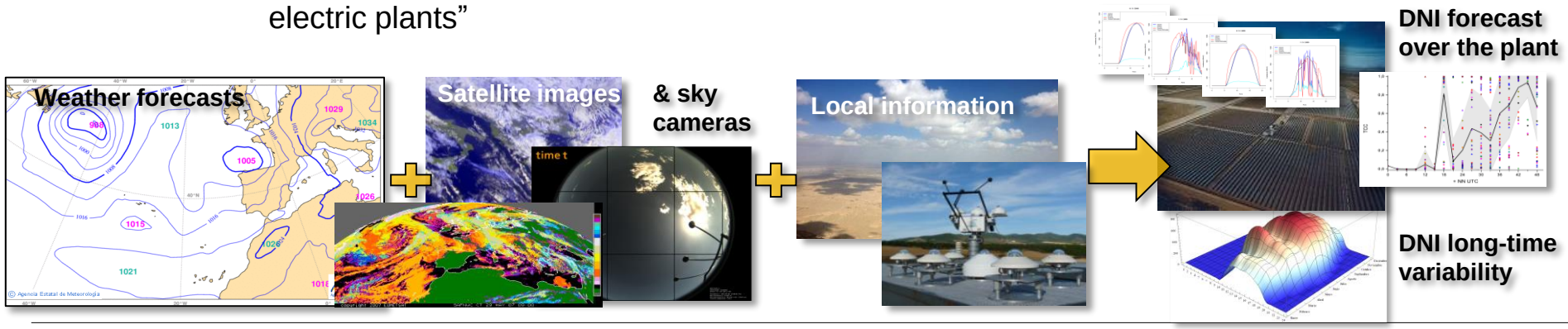
- *Storage*
- *HTF*

Examples

R& D Needs common to all technologies

1. **Developments of New tools for forecasting and Nowcasting.**
   - CENER has been involved in the project ***DNI CAST*** *"Direct Normal Irradiance Nowcasting methods for optimized operation of concentrating solar technologies"* funded by EU-FP7
   - CENER is currently involved in the project **PREFLEXMS** "*Predictable Flexible Molten Salts Solar Power Plant funded by H2020"* *funded by H2020*

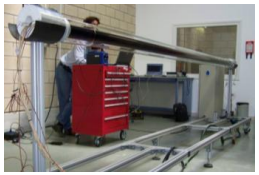
2. **Methodology for analyzing and predicting degradation and lifetime.**
   - CENER is currently participating in the creation of national and international standards for concentrating solar thermal power plants in the committees
     - ✓ AEN/CTN 206/SC "Thermoelectric Solar Energy Systems" (IEC TC 117) "Solar thermal electric plants"

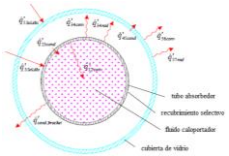


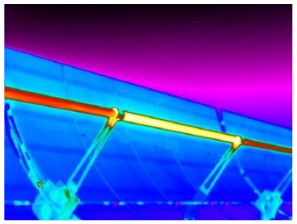
Examples

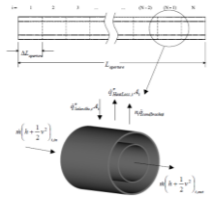
Main R & D Needs to Improve Parabolic Trough technology

1. On site inspection of Parabolic Trough Receivers



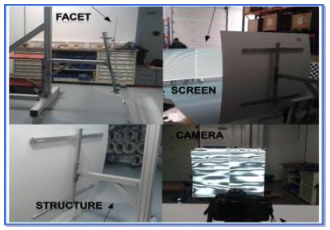






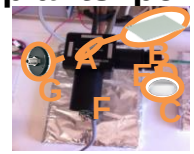
On site receiver inspection system developed by CENER

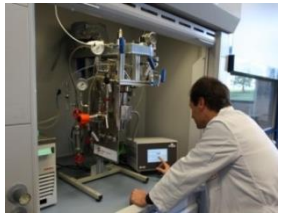
2. Optical Characterization of Surfaces (collectors)



"FOCuS" Fringe Optical Characterization of Surfaces developed by CENER-UNAM

3. Development of an on line hydrogen detection system (HTF Degradation) to enhance PT plants performance





Patent CENER-UCM P201200359 - Method of detection and quantification of hydrogen in a heat transfer oil.

Examples

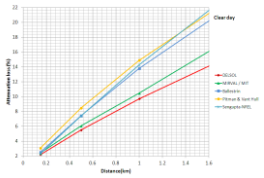
Main R& D Needs to Improve Central Receiver

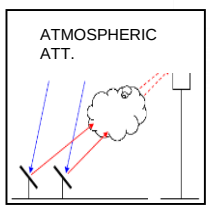
1. **On line Flux measurement in commercial towers**

   CENER is currently coordinating the project **EFECTO** aiming to develop a system to accurately measure the concentrating flux in commercial Solar Towers. (This project is funded by Spanish national funds from CDTI).

2. **Measurement and modeling of the Atmospheric Attenuation ATM**

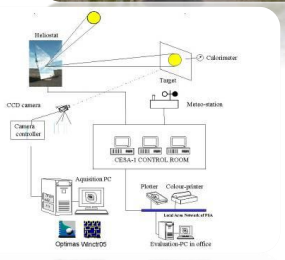
   CENER is currently developing a system to accurately measure the ATM on site. First prototype will be ready by September 2018.





3. **Automatic calibration of heliostat fields**

   CENER and IK4-TEKNIKER are developing a new approach for a computer vision based online calibration system Patent “Calibration method for heliostats” P201531419.



Specific action lines for countries in GCC Region

Durability and reliability under extreme weather conditions is one of the highest priorities

Abrasion
- Solar Field efficiency and long term durability

Maintenance
- Mirrors end receivers cleaning

Operation
- Power block efficiency reduction due to extreme temperature conditions

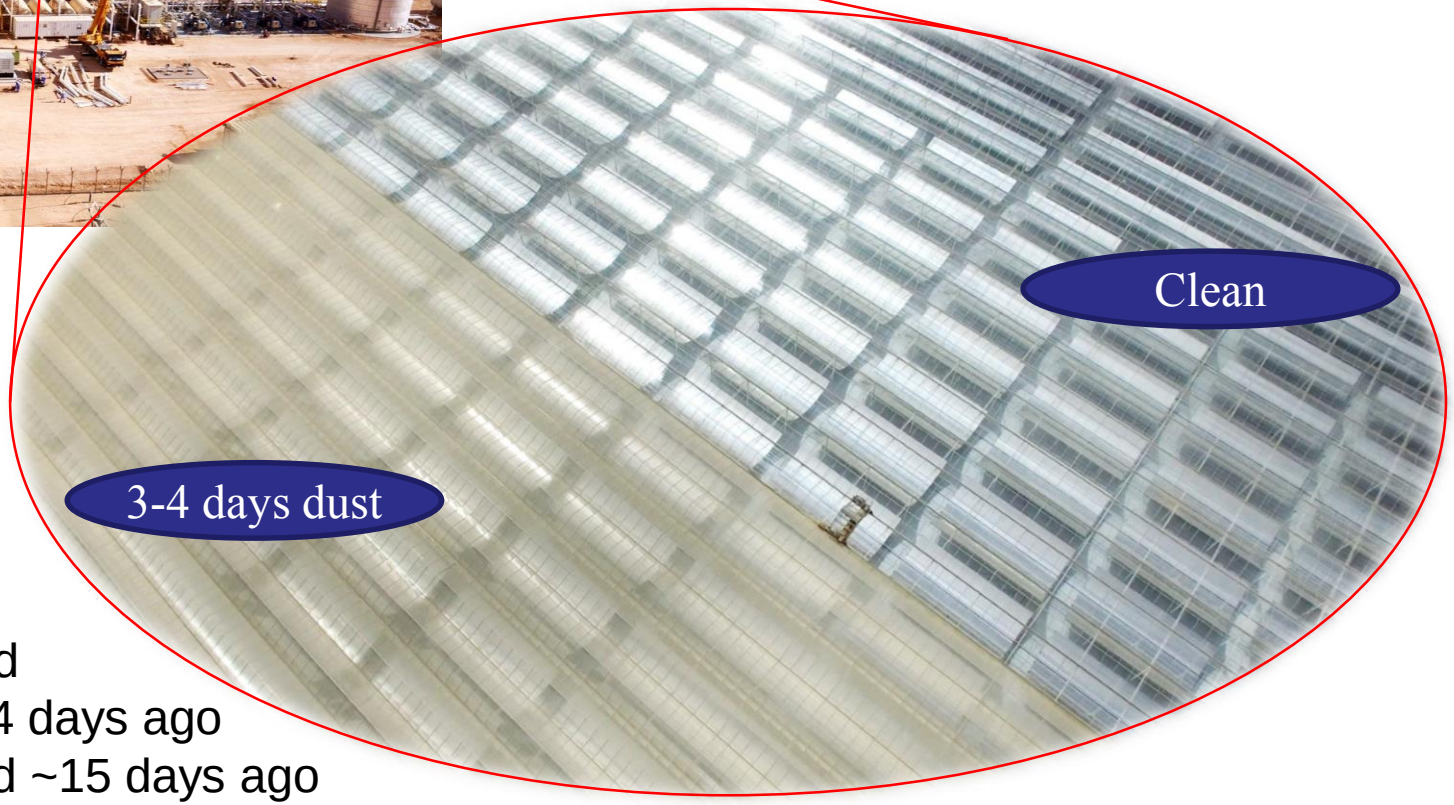
Water consumption (1)

Atmospheric Attenuation ATM

(1) Water consumption is mainly due to cycle cooling needs

3. Opportunities for R&D collaboration EU-GCC

- *Source:* ***GlassPoint Solar***
- *At: MENA CSP KIP Webinar October 2017: Harnessing opportunities for concentrating solar thermal in industry*



- SF 1: just cleaned
- SF 2: cleaned 3-4 days ago
- SF 3 & 4: cleaned ~15 days ago

4.- Conclusions

4. Conclusions

- **Since 2014**, **renewables** account for **more than half of the world's new installed capacity**
- **Cost reduction** announced the GCC region (700 MW @ **US¢7.30/kWh**) will have an **strong impact in CSP development and deployment**

- **CSP** will play a **significant role** in the generation mix providing:
  - **Energy security** and **power output guarantee,** due to its **dispatchable** character
  - Improvement of **grid management** helping the grid operator
  - **Enhancing of the penetration** of other Renewable Energies.

- **High CSTP potential is mainly based in three facts:**
  - High level of **solar radiation available** in many arid areas.(i.e.**GCC**)
  - High **growth on energy demand**.
  - **Dispatchability**

4. Conclusions

- CSP technology is still very **young as a commercial choice** and represent a good **opportunity for sustainable energy development in GCC**.
- There are as **many opportunities for EU-GCC collaboration** as technological **challenges**
- Although **some specific** technological **challenges** should be addressed at **GCC**.
- Most Technology needs and R&D lines are **common to EU-GCC**
- In addition to electricity, **emerging applications** such us, Industrial solar heat, solar cooling and solar desalination **will enter the market** sooner rather than later.
- An effective **collaboration between EU and GCC** could lead to **competitive advantages** into market

REMEMBER:
By working together EU-GCC could enhance and optimize technology deployment and performance, leading the world's transition to a sustainable energy system

Thank you very much for your attention!!!

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