Institut für Solarforschung

HYMENSO: Hybrid CSP-PV power plants for MENA Region

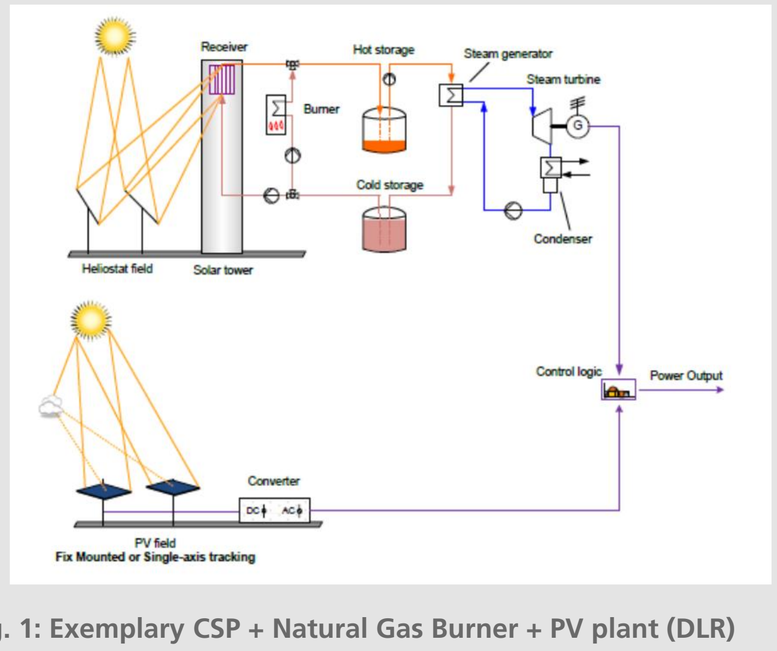

Fig. 1: Exemplary CSP + Natural Gas Burner + PV plant (DLR)

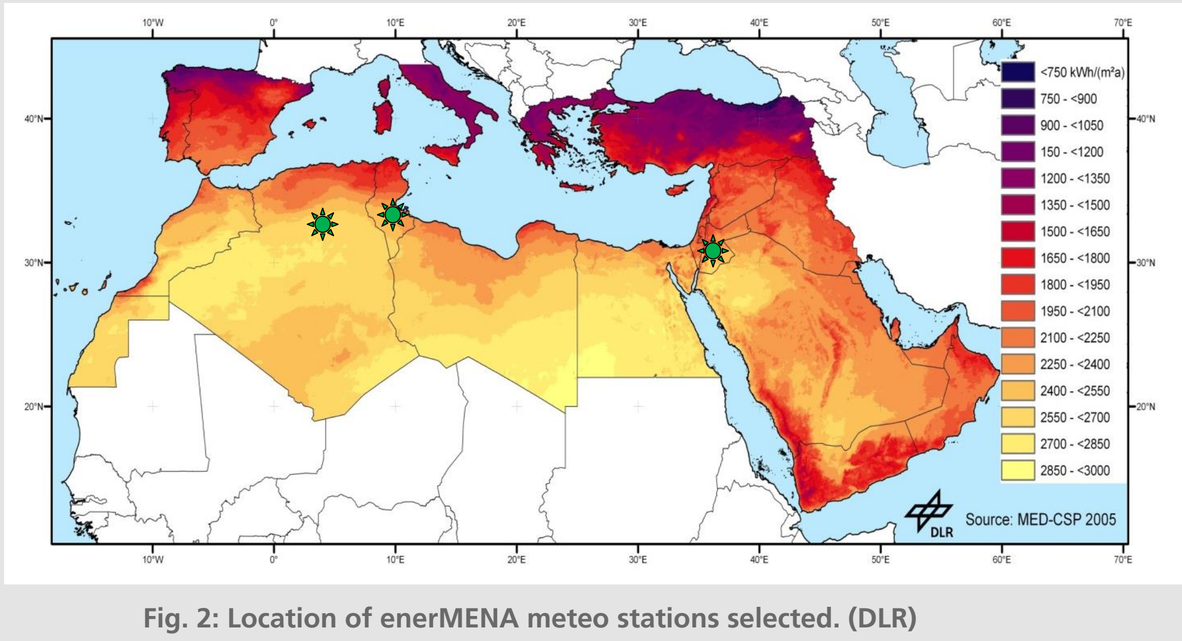

Fig. 2: Location of enerMENA meteo stations selected. (DLR)

Project goals:

Within the project HYMENSO (Nov. 2016 – Oct. 2018) **combinations of PV and CSP systems are investigated**, in order to harvest the advantages of both systems: easy installation and low levelized cost of electricity (LCOE) of PV, versatility and dispatchability of CSP. Furthermore, back-up systems with Natural Gas are considered.

The project has the main goal to investigate the **optimal configurations depending on local boundary conditions such as solar resource, costs, water availability and grid demand for locations in Algeria, Tunisia and Jordan**.

The main work packages focus on simulation of plant performance and cost calculation, demonstration of sub-systems at partner's sites, knowledge transfer and dissemination activities.

Cooperation and networking between researchers from Germany, Jordan, Tunisia, Algeria and Greece give an added value to the project.

Main results until now:

- ✓ **Local data collected** such as ground meteorological data, electrical demand curves, water and fuel costs.
- ✓ **Global and direct normal solar irradiances based on satellite-derived atmospheric products** from MODIS instrument and radiative transfer model outcomes proposed and validated (Fig.3).
- ✓ **Selection of relevant plant configurations**:

1) Parabolic trough plants with thermal-oil HTF + PV polycrystalline single axis tracked

2) Parabolic trough plants with molten salt HTF + PV polycrystalline single axis tracked

3) Solar tower plants with molten salt HTF + PV polycrystalline single axis tracked

*) All CSP plants include molten salt thermal energy storage and natural gas heater

- ✓ **Automatic parametric simulation** of over 12.000 combinations of hybrid plants and search for optima as function of CO_2 emissions or demand covered of solar-only plants.

Methodology and simulation results:

The approach is to cover the electrical demand with CSP-PV hybrid plants and determine for each technology case and site the best configuration by minimizing the levelized cost of electricity (LCOE). Fuel backup is considered in a limited amount. Additionally, solar-only cases were also analyzed.

A net power output of 100 MWe was selected. It is important to notice that some components of the CSP are fixed for this nominal load in order to cover the demand during the night too. Therefore, although the electricity cost from PV is lower than that of CSP, hybrid plants with a high energy fraction from PV have a higher combined LCOE (see Figure 5). For solar-only mode, if the electricity demand is to be covered in a large fraction (>80%) the cost of the electricity increases considerably (see Figure 4). On the other side, if the demand to be covered can be 50% or lower, the most economic solution is to use PV alone. Therefore, **the load curve and demand to be covered is crucial for selecting the combination of CSP + PV.**

Fig. 3: Daily energy production, 7 days example

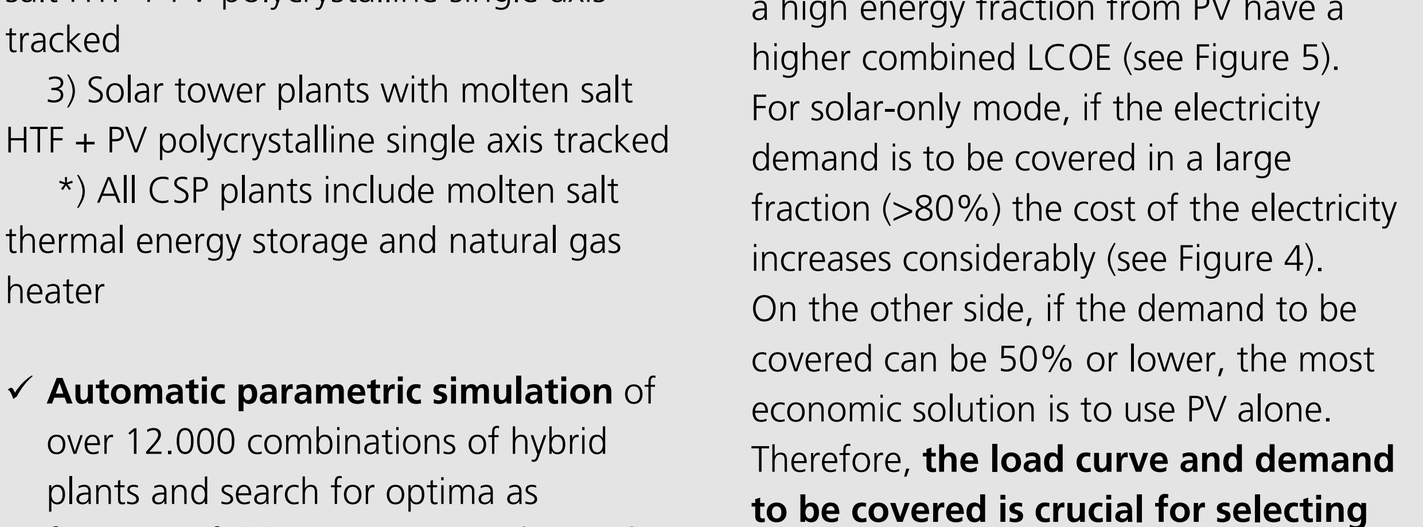

Fig. 4: Simulation results for solar tower with molten salt + PV (Solar-Only)

Fig. 5: Simulation results for solar tower with molten salt + PV (back-up natural gas)

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Daniel Benitez[1], Andreas Kazantzidis[2], Ahmed Al-Salaymeh[3], Sofiane Bouaichaoui[4], AmenAllah Guizani[5]
[1] Institute of Solar Research, German Aerospace Center (DLR), Germany, E-mail: daniel.benitez@dlr.de
[2] University of Patras, Greece. [3]The University of Jordan. [4]CDER, Algeria. [5]CRTEn, Tunisia.

DLR Deutsches Zentrum für Luft- und Raumfahrt