HIGH TEMPORAL AND SPATIAL RESOLUTION SIMULATION OF SOLAR HYBRID POWER PLANTS – PHOTOVOLTAIC AND CONCENTRATED SOLAR POWER

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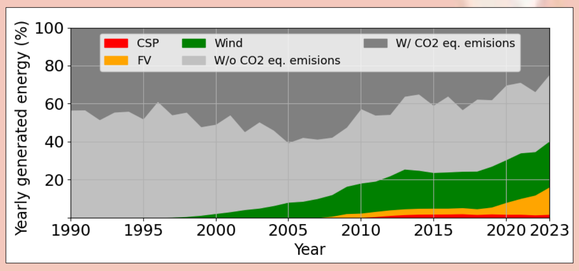
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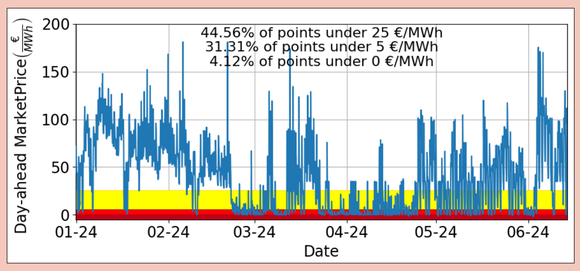
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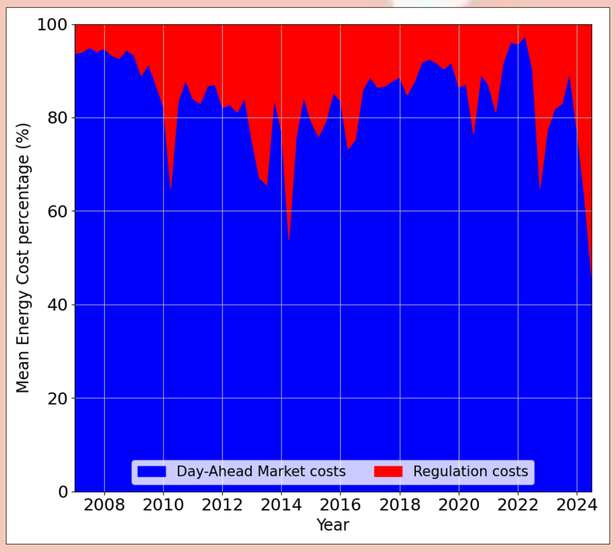
PVPerformance MODELING COLLABORATIVE

INTRODUCTION

- Generation of energy from renewable sources has increased in recent years.
- Main renewable generation sources (wind and PV) have not been designed as manageable sources. This causes the following problems:
  - **Curtailment**: The maximum permissible power of the transformer station can be limited, forcing to reduce the energy produced
  - **Overproduction** at certain times of the day reduce the electricity price, which can produce even negative prices.
  - **Power fluctuations** affecting grid stability and increasing regulation costs.

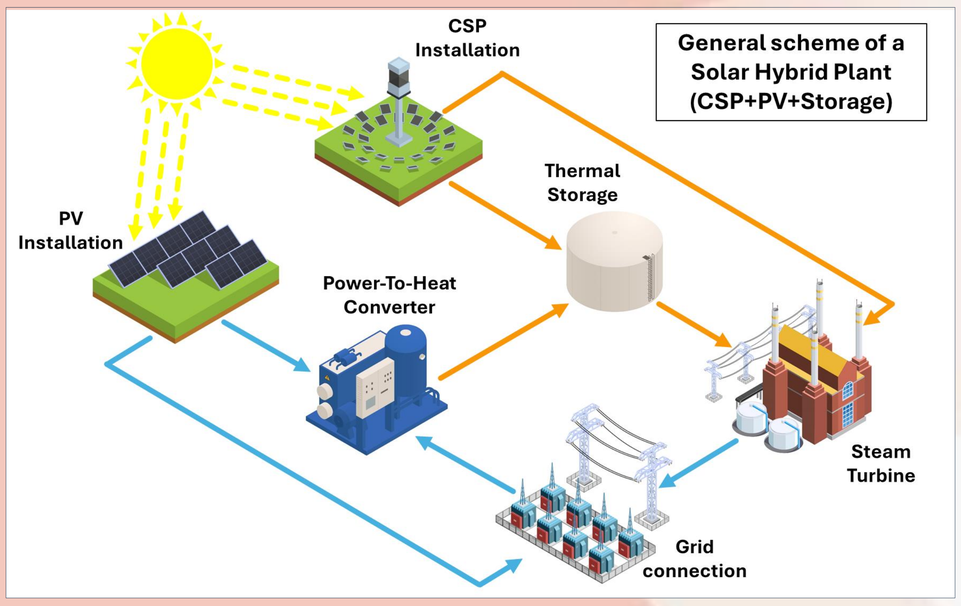






PROPOSED SOLUTION

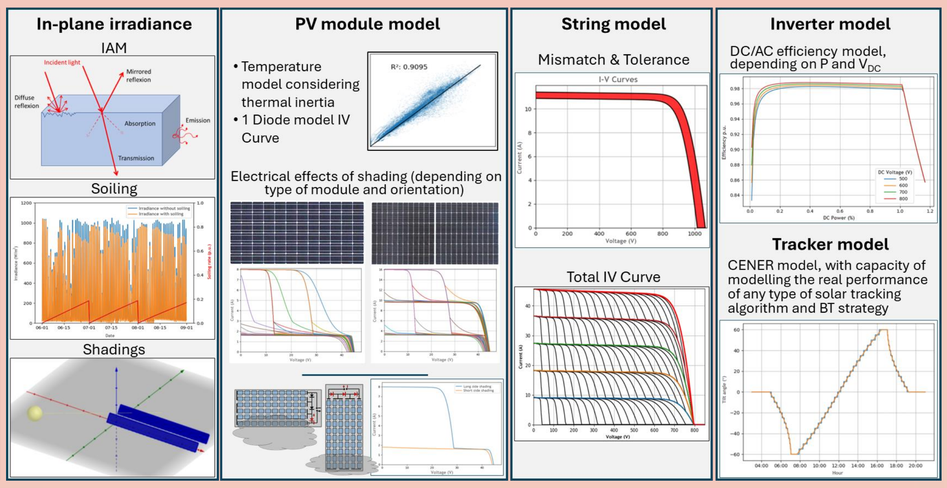
- The installation of storage on overloaded nodes allows to reduce grid issues and increase grid stability.
- Carnot Batteries (thermal energy storage) has been used on CSP installations to manage the generated energy.
- A Power-To-Heat stage is needed to store photovoltaic energy.
- **Highly accurate photovoltaic and thermal simulation tools are required to characterise the integration.**



CENER TotalSOLAR

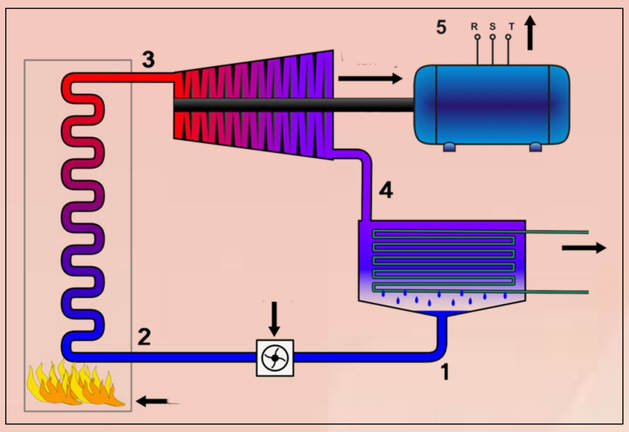
SIMPV

- In-house tool for simulating PV plants (based on PVLib).
- No configuration or composition restrictions.
- Suitable for high temporal resolution simulation and high level of details.



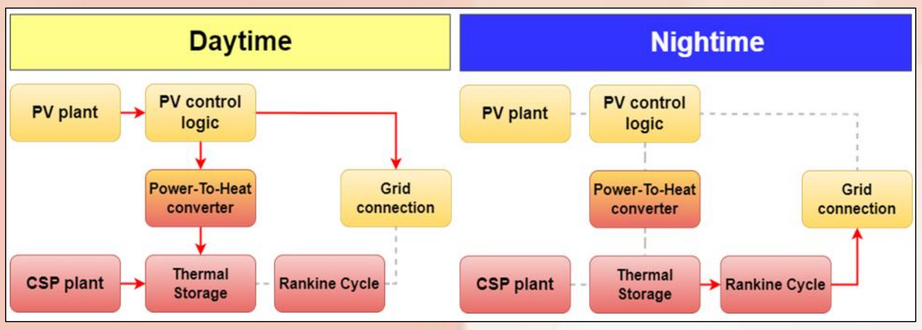
CSTLibrary

- Proprietary library for the simulation of CSP and storage plants.
- It allows both stationary and dynamic simulations.



TotalSOLAR

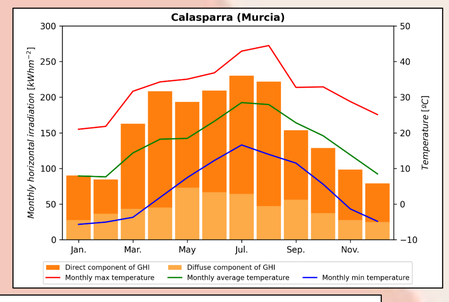
- Integration of both tools for developing hybrid simulations.

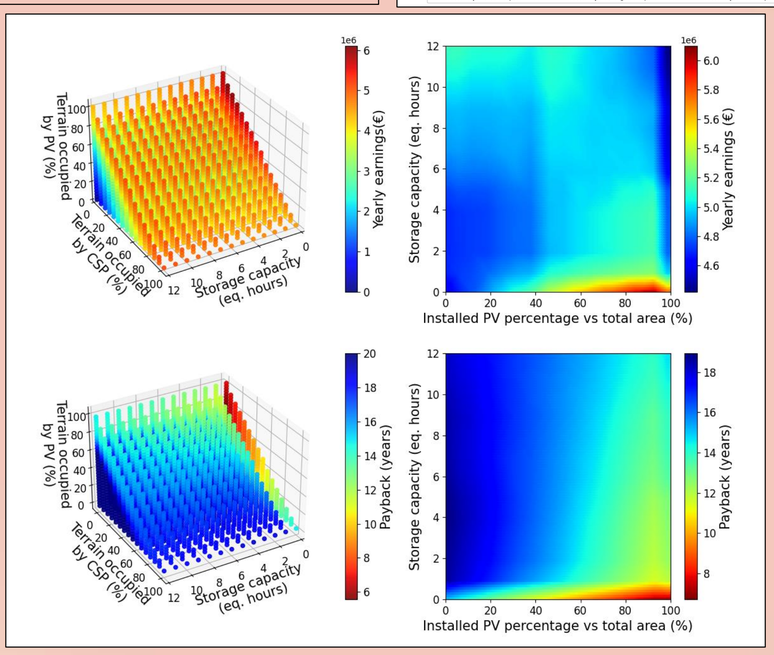


RESULTS

CASE STUDY Calasparra

- *Location*: 38°15'N, 1°41'W (Murcia, SPAIN)
- *Max. power in grid*: 30 MW
- *Surface available*: 56.5 ha





		No Storage		Storage: 6 eq. hours		Storage: 12 eq. hours	
CSP (%)	PV (%)	Earnings (M€)	Payback (Years)	Earnings (M€)	Payback (Years)	Earnings (M€)	Payback (Years)
0	100	6.10	6.71	4.97	12.77	4.79	13.90
25	75	5.84	8.13	4.99	14.01	4.95	14.77
50	50	5.47	10.12	4.97	15.65	5.09	15.92
75	25	4.99	12.20	4.85	17.16	5.08	17.02
100	0	4.59	14.73	4.81	18.67	5.12	18.20

CONCLUSIONS

- The problems of renewable energy generation systems can be reduced or even eliminated (depending on the location) by combining PV, CSP and thermal storage.
- For a correct design and dimensioning of these systems, advanced calculation tools are necessary. **CENER TotalSOLAR** is presented as a joint tool for these systems, based on the developments made in PV and CSP.
- In most of the cases studied, CSP is better as energy source for storage than PV due to its higher efficiency. Nevertheless, thermal storage has not yet reached a competitive price if other benefits are not considered (secondary/tertiary control, grid integrity, etc.).
- Production and energy price forecasting can help increase profit by replacing the sale of energy for storing during sunshine hours.

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