

FROM RESEARCH TO INDUSTRY

The logo for CEA (Commissariat à l'énergie atomique et alternative) consists of the lowercase letters 'cea' in a white, stylized, rounded font. Below the letters is a thick white horizontal line.The logo for LITEN (Laboratoire International de Technologie de l'Énergie Nucléaire) features the word 'liten' in a bold, blue, lowercase sans-serif font, set against a white rectangular background.

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DAILY FORECASTS FOR FRESNEL POWER PLANT PRODUCTION

SOLARPACES 2012

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12th SEPTEMBER, 2012

Solar energy is an intermittent energy supply

But :

The grid must be balanced at any time

Operators want to optimise their storage capacity

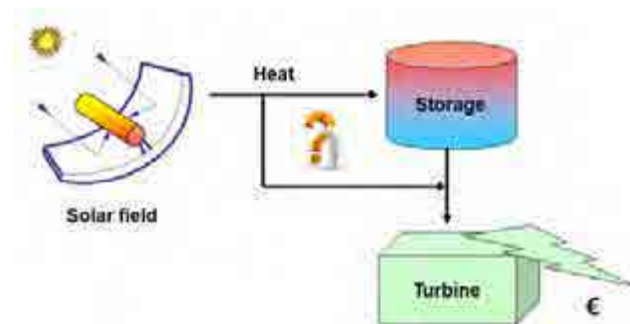
The selling price of electricity varies during the day

So :

We need to predict the output of solar power plants (thermal or electrical)

Our work :

Coupling DNI previsions with solar plant models to predict the output



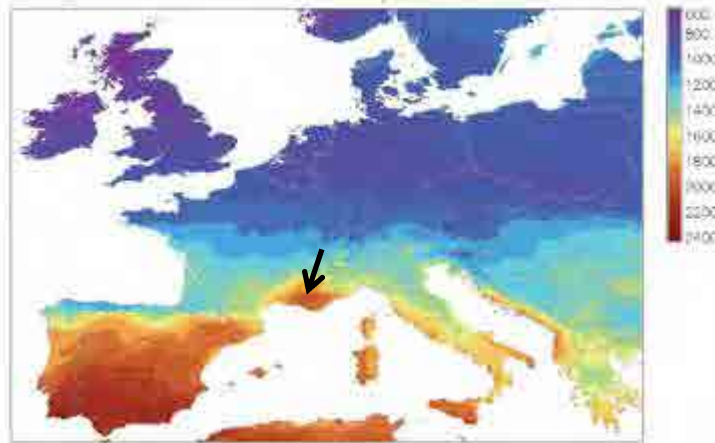
1-DESCRIPTION OF
THE FRESNEL
PROTOTYPE

2-METEOROLOGICAL
MODEL

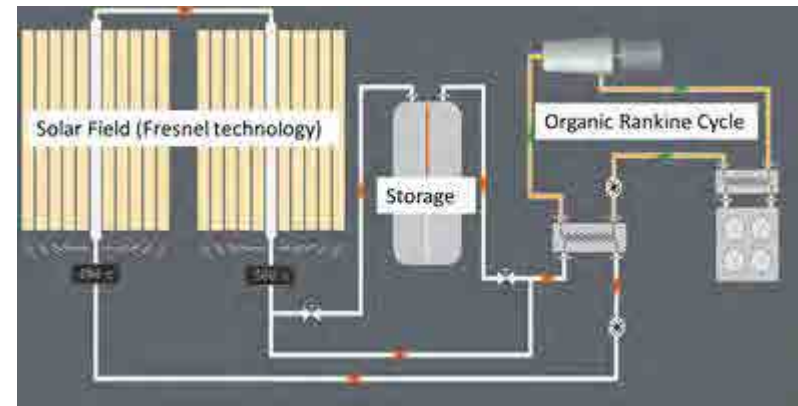
3-FRESNEL
PERFORMANCE
MODEL



1 - DESCRIPTION OF THE FRESNEL PROTOTYPE



Localisation : Cadarache
 Southern France
 Latitude=43.69°
 Longitude=5.76°
 DNI(Meteonorm)=1610 kWh/m²/year

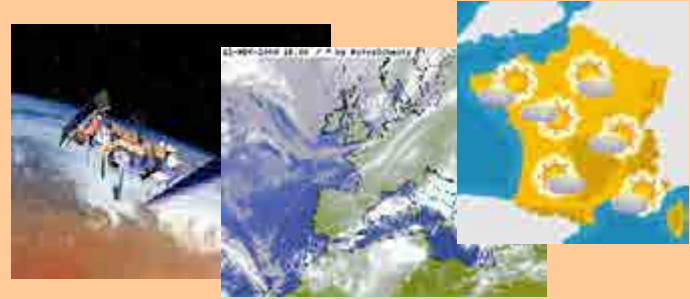


Fresnel technology
 1000 m² of mirrors
 Thermal oil
 Maximum working temperature 300°C
 Organic rankine cycle
 Thermocline thermal storage

1-DESCRIPTION OF THE FRESNEL PROTOTYPE

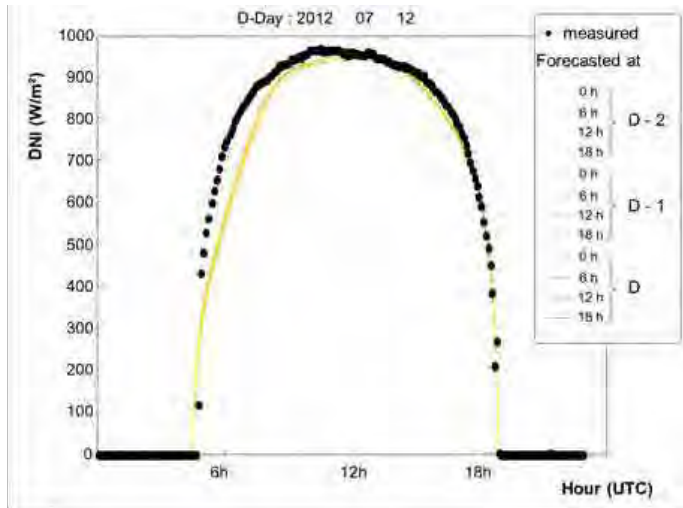
2-METEOROLOGICAL MODEL

3-FRESNEL PERFORMANCE MODEL

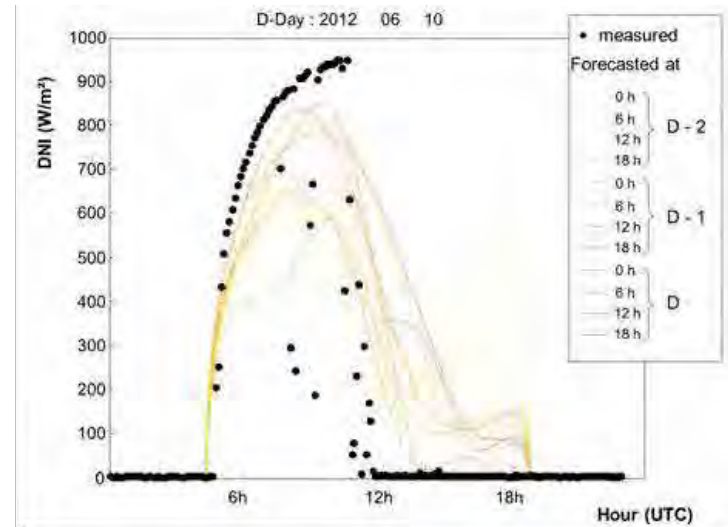


2 - METEOROLOGICAL MODEL

NOAA (National Oceanic and Atmospheric Administration) gives free prediction of global irradiance, the model estimates the DNI.



Good agreement between measured and predicted DNI for a sunny day

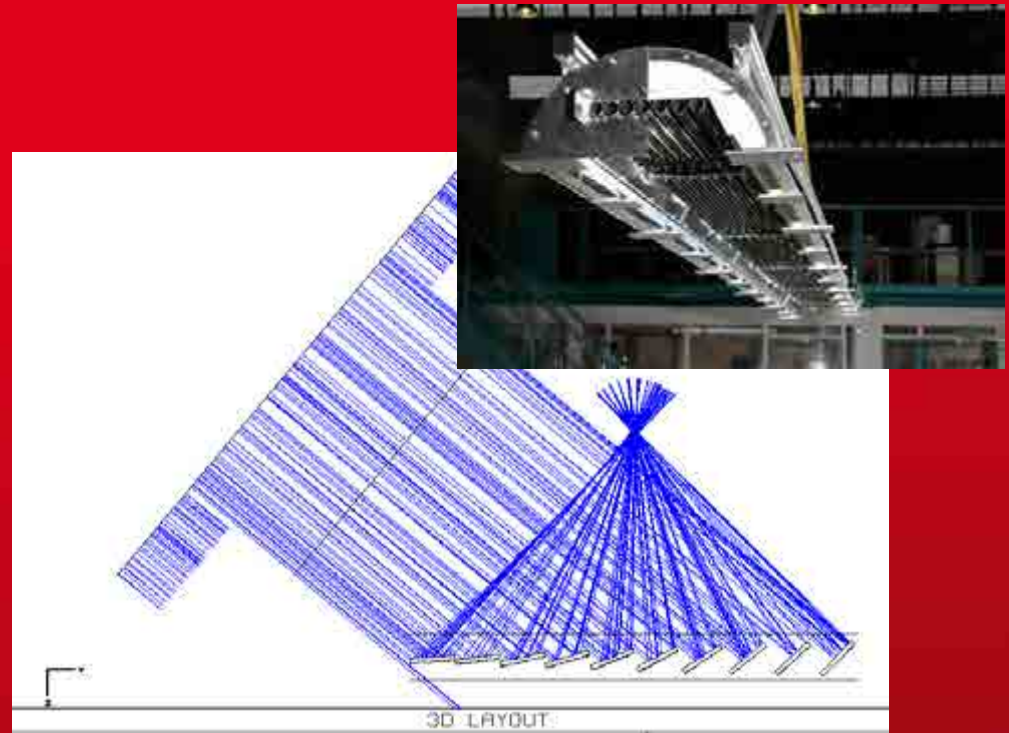


The prediction is much more difficult for cloudy days and the prevision is improved with time

1-DESCRIPTION OF THE FRESNEL PROTOTYPE

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The model is composed of two modules :

1-Optical module : optical efficiency matrix of the prototype obtained with discretised 3D ray-tracing simulations for a 10° step on longitudinal and transversal angles

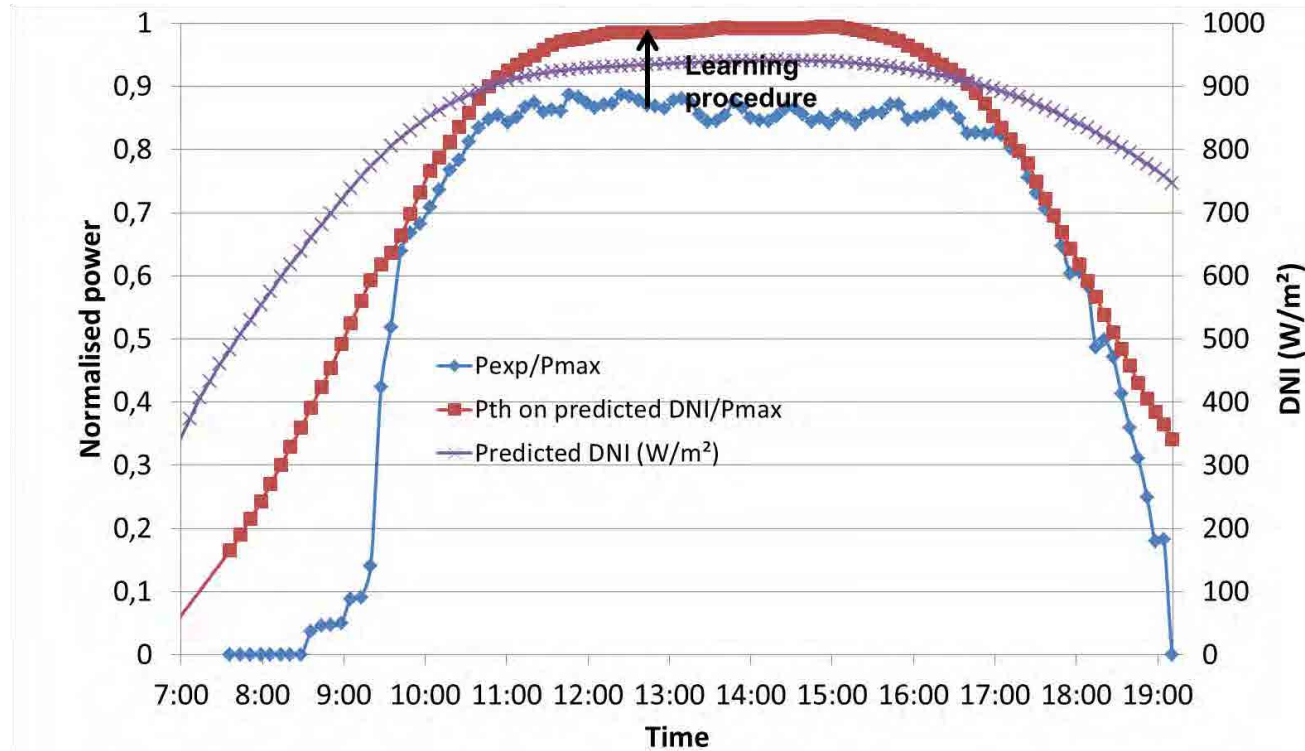
2-Receiver module : polynomial form obtained with an iterative simulation with VBA and validation with the package STARCCM+

$$\eta_{receiver} = \eta_0 - a1 * \frac{(T_{fluid} (^{\circ}C) - 25)}{Flux} - a2 * \frac{(T_{fluid} (^{\circ}C) - 25)^2}{Flux}$$

Finally, knowing the working fluid mean temperature and the flux, the thermal power output can be calculated :

$$P_{th} = S_{mirrors} \cdot DNI \cdot \eta_{optical} \cdot \eta_{receiver}$$

Results :



The thermal output can be estimated with less than 15% deviation 24h in advance. The tool is based on very simple models with a learning procedure that will improve the results without additional parameters.

A model coupling DNI prediction with a solar plant model is currently studied.

The objective is to support operators who need to give estimation of their forthcoming production for grid regulators, who need also to optimize their storage capacity and profit.

The tool is based on simple parameters and will be able to learn.

It can also be used for diagnostic purpose.



THANK YOU FOR YOUR ATTENTION



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CONCLUSION

