Investigation of the stochastic nature of solar radiation for renewable resources management

Giannis Koudouris, Panayiotis Dimitriadis, Theano Iliopoulou, Nikos Mamasis and Demetris Koutsoyiannis

European Geosciences Union General Assembly 2017
Vienna, Austria, 23-28 April 2017
ERE3.7/HS5.11 - Renewable energy and environmental systems modelling, control and management for a sustainable future

School of Civil Engineering
National Technical University of Athens

The poster can be downloaded at: http://www.itia.ntua.gr/
2. Potential of horizontal solar irradiation over Europe

3. Area of interest

The study area is the remote island of Astypalaia, south east of the Aegean Sea, with over 3,000 residents and a popular destination for summer holidays. We extract the solar irradiation data at the Hellenic National Meteorological Service station of Astypalaia, which is adjacent to the island of Astypalaia, with over 8,000 thousand days of data and of approximately 22 years of length.

4. Marginal distribution

We estimate the marginal distribution for each month in a daily scale (640 days for 12 months) from daily solar irradiation data. We analyze one year hourly observations and split them to 12 timeseries (one for each month).

5. Estimated marginal distribution parameters (I)

Since solar irradiation right boundaries vary in an annual scale, we divide all values of the timeseries varying from approximately zero to one.

6. Estimated marginal distribution parameters (II)

In order to generate hourly solar radiation from daily solar radiation data we analyze one year of solar irradiation, since solar irradiation right boundaries vary in an annual scale, we divide all values of the timeseries varying from approximately zero to one.

7. Statistical moments and dependence structure

8. Double cyclostationarity

By adopting the same hourly scale and split monthly distribution, we find the dependence of the hourly solar irradiation, which illustrate the dependence structure of the hourly solar irradiation.

9. Generation stochastic model

We compare observed timeseries of solar irradiance with the corresponding ones from the NASA-SSE database, with over 8,000 thousand days of data and of approximately 22 years of length.

10. Renewable Energy Sources in Astypalaia

A potential goal is to study Astypalaia energy independence from non-renewable energy sources such as fuels. We consider many scenarios using only solar energy but we encounter many difficulties, i.e., increase of energy demand during winter season due to tourism, solar irradiation is highly uncertain especially during winter due to cloud coverages.

11. Suggested solution

A suggested solution is to install various solar panels through an autonomous system, which were considered very expensive. For example, a 5,300 installed solar energy system requires more than 23,800 solar panels of 210 W each, is expected to be full-metre during winter, energy demand 62.2% in an annual basis.

Based on our analysis, the overall suggested system can be paid in full after 8 years. In this solution, we can provide more than 140 MW of drinkable water per year, covering the excessive needs of the remote island residents as well as economic needs.

References