Assessment of the model proposed by Zanesco, I. et al. (2005) for the calculation of the Loss of Load Probability

Sonia Rueda and Mónica Gutiérrez

University of Oldenburg, Department of Physics, Energy and Semiconductor Research Laboratory
Carl-von-Ossietzky Str. 9-11, 26129 Oldenburg, Germany

Motivation

Stand Alone Systems could be an alternative for electricity supply in isolated areas. Indicators like Loss of Load Probability (LOL), defined as the percentage of total energy demand that won't be supplied by the system, are crucial for design optimization in order to ensure reliability and cost effectiveness.

Furthermore if the behavior of an specific system is wanted to be assessed in detail, it is useful to have a model that could give plausible results in a wide range of irradiation resolutions.

This indicator is also useful to test the performance of a system with a known load. The aim of this contribution is to assess the model for LOL prediction proposed by Zanesco, I et al. Some limitations were found and a strategy to adjust the performance of the model under periods with lack of irradiation is proposed.

Model proposed by Zanesco, I. et al. (2005)*

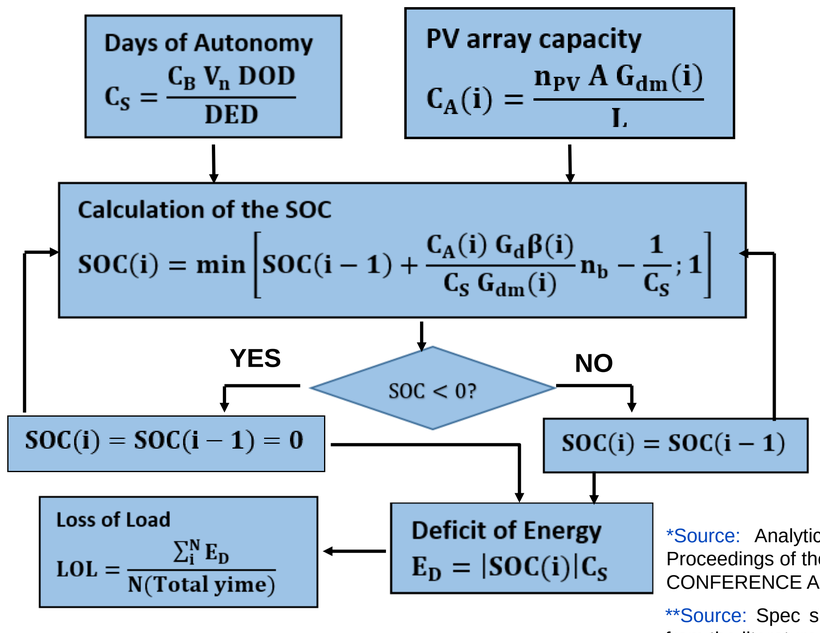


Table1. Input parameters

n_{PV} - PV array efficiency (Different Efficiencies Analyzed – See Table 2)
A - PV array area (0.85 m^2)**
$G_d(\beta)$ - Irradiation on the tilted plane
G_{dm} - Irradiation on the horizontal plane
L - Load (38.35 W)
DOD- Depth of discharge of the battery (0.5)**
DED - Daily Energy Demand (920.4 Wh -24 hours)
C_B - Nominal capacity of the battery (120 Ah)**
V_n - Nominal Voltage of the battery (12 V)**
SOC(0) - 0.18**

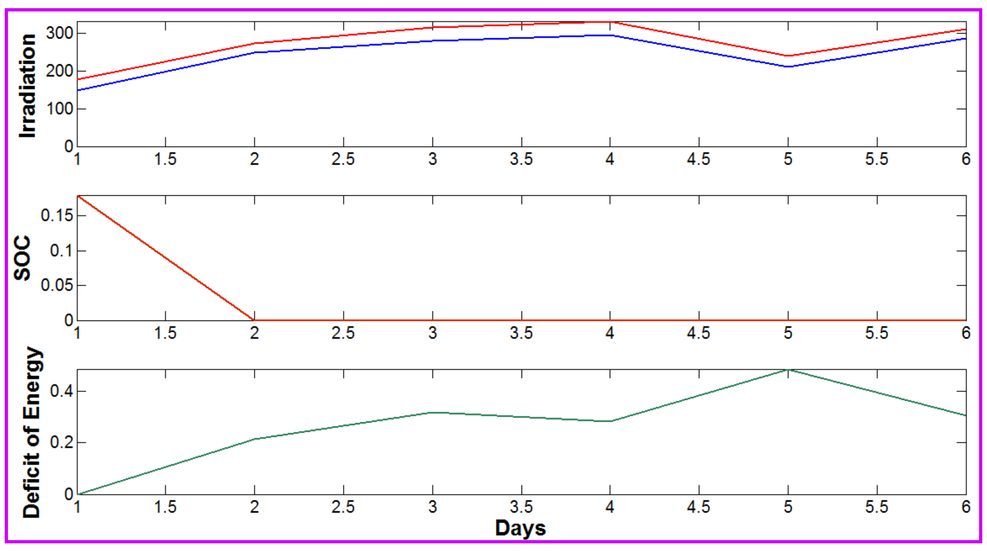
*Source: Analytic Method for Sizing Stand-Alone Systems in Brazil. Proceedings of the 19TH EUROPEAN PHOTOVOLTAIC SOLAR ENERGY CONFERENCE AND EXHIBITION, 2004, Paris. p.2375-2378.

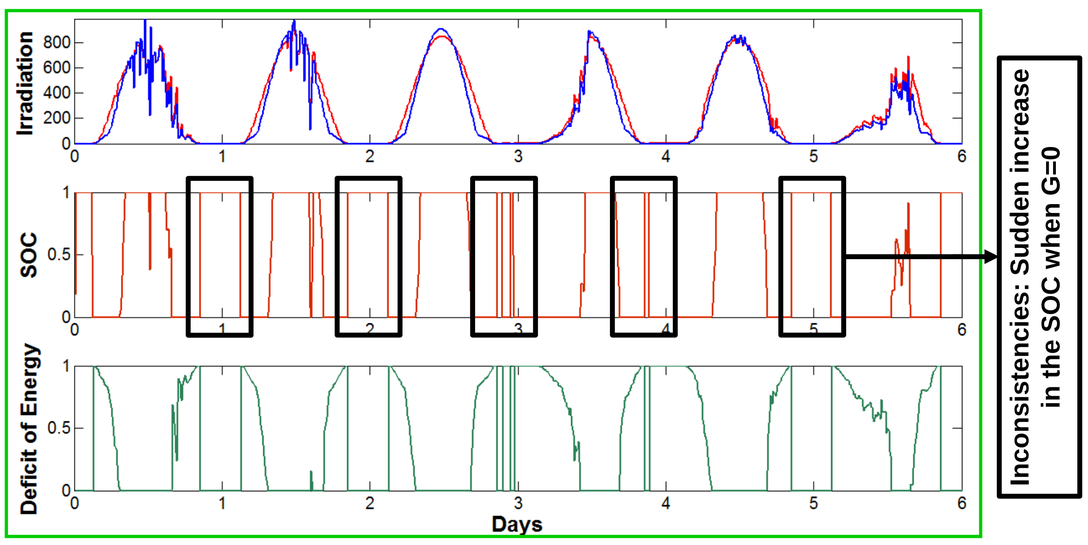
**Source: Spec sheets of the system components and typical values from the literature.

Results obtained from the model

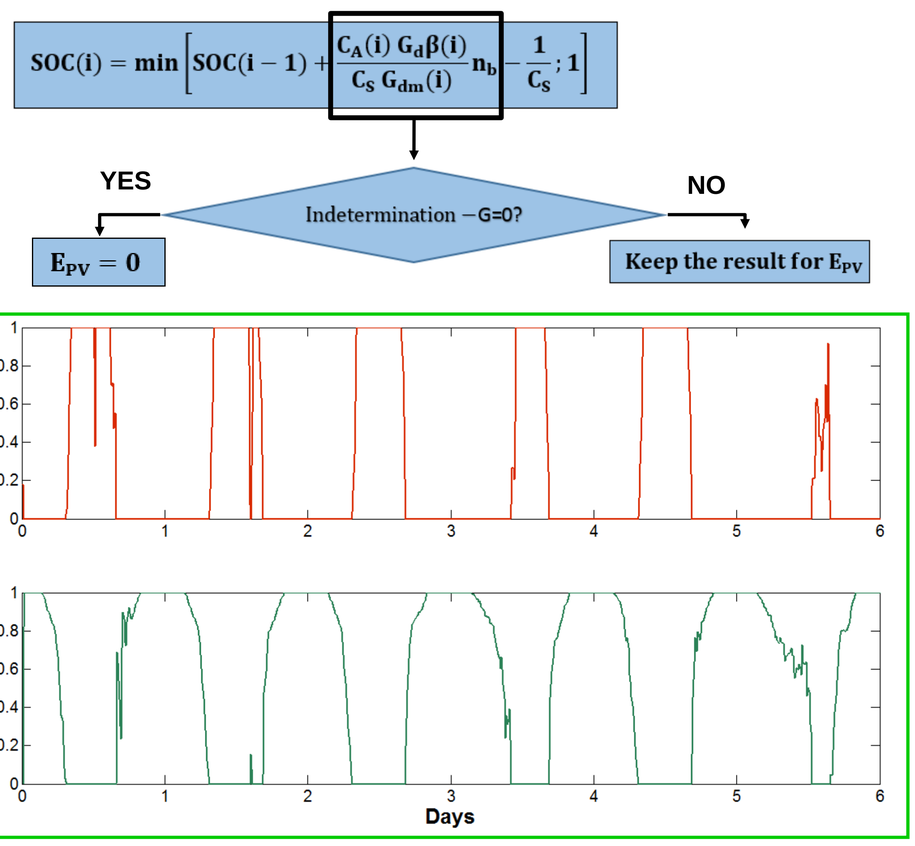
Two sets of irradiation data used (June 3th to June 8th)

- Daily average irradiation (**horizontal** and **tilted**).
- 10-min average irradiation (**horizontal** and **tilted**).





Solving the inconsistencies



General findings

- Under the conditions proposed by Zanesco, I. et al, the model has been supported. Small deviations from the reference were obtained.
- Inconsistencies on the model were found where G=0 (high resolution irradiation).
- An strategy for solving the inconsistencies was implemented. Deviated results of LOL were still obtained.

Results - Impact of the efficiency on the model

LOL from measured values (Reference)	0.26

Table 2. Results of LOL

Set of Irradiation Data	LOL	Deviation from the measured values
Daily Average (n=6%)*	0.50	49%
Daily Average (n=11%)**	0.27	5%
Daily Average (n=15%)***	0.09	65%
10 min Average (n=11%)**	0.39	34%
10 min Average (Adjusted model -n=6%)*	0.68	62%
10 min Average (Adjusted model -n=11%)**	0.59	57%
10 min Average (Adjusted model -n=15%)***	0.55	53%

High sensitivity of LOL respect to efficiency.

*Typical efficiency of a Solar Home System
**Gel battery efficiency(91%)*PV array efficiency(12%)
*** Ideal Solar Home System (Only taking into account the PV cell efficiency)

Conclusions & Outlook

- Under daily average irradiation and the conditions proposed by Zanesco, I. et al, the predicted LOL showed around 5% of deviation from the reference. The model was supported with the obtained results.
- If resolutions of irradiation data higher than one day average are wanted to be used, it is necessary to improve the present model or to select another model.

Further findings

- The model proposed by Zanesco, I. et al is highly sensitive to variations on the system efficiency.

PRES 2016

Acknowledgements:
The authors gratefully acknowledge Andreas Günther for his support during the experiment and for his help for understanding the model here presented.

Postgraduate Programme Renewable Energy

University of Oldenburg
Department of Physics
Energy and Semiconductor Research Laboratory (EHF)