

Abstract

The good diagnosis and monitoring of PV systems are key points to maximize PV production. The main objective of this work is to develop a new tool capable of detecting faults of PV systems in real-time, with a particular care for the detection and identification of shadows. The proposed detection method is based only on DC power measurements.

Introduction

The PV arrays may be completely or partially shaded, decreasing performances. The duration of the DC power drop is related to the type of shadow on PV modules such as soiling, building environment, leaves, etc.

The aim of this work is to create a real-time fault detection by analyzing the DC power output and more particularly the impact of shadows. This detection method is designed to minimize the use of sensors due to economic constraints. The measurement of output current and voltage of the PV array is carried out by a monitoring system. With these measurements, the method is able to detect DC power losses and identify the nature of faults on PV arrays.

PV system description



Shadow source

Figure 1 : ADREAM platform, LAAS-CNRS, Toulouse, France

Field	Power	PV modules	Inclination
Facade	38kWp	Bi-glass 529Wp	65° South
Experimental roof + walls "R+1"	35kWp	TE2200 250Wp	0° to 90° South
Roof "R+2"	24kWp	TE2200 250Wp	10° South

Table 1 : List of PV equipment of ADREAM platform

DC power measuring box and DC power analysis

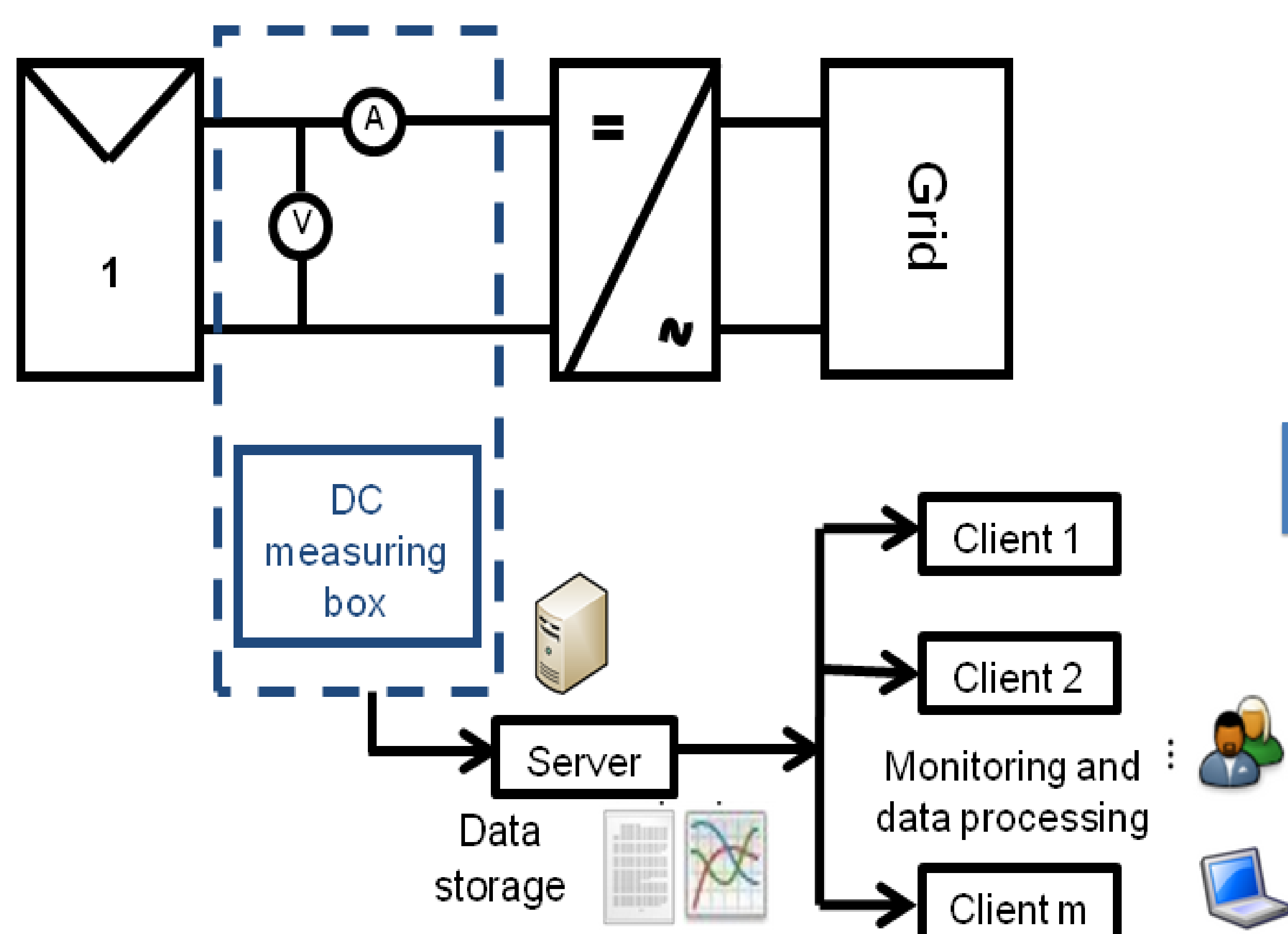


Figure 2 : Schematic bloc of test bench for DC power measurement with measuring box

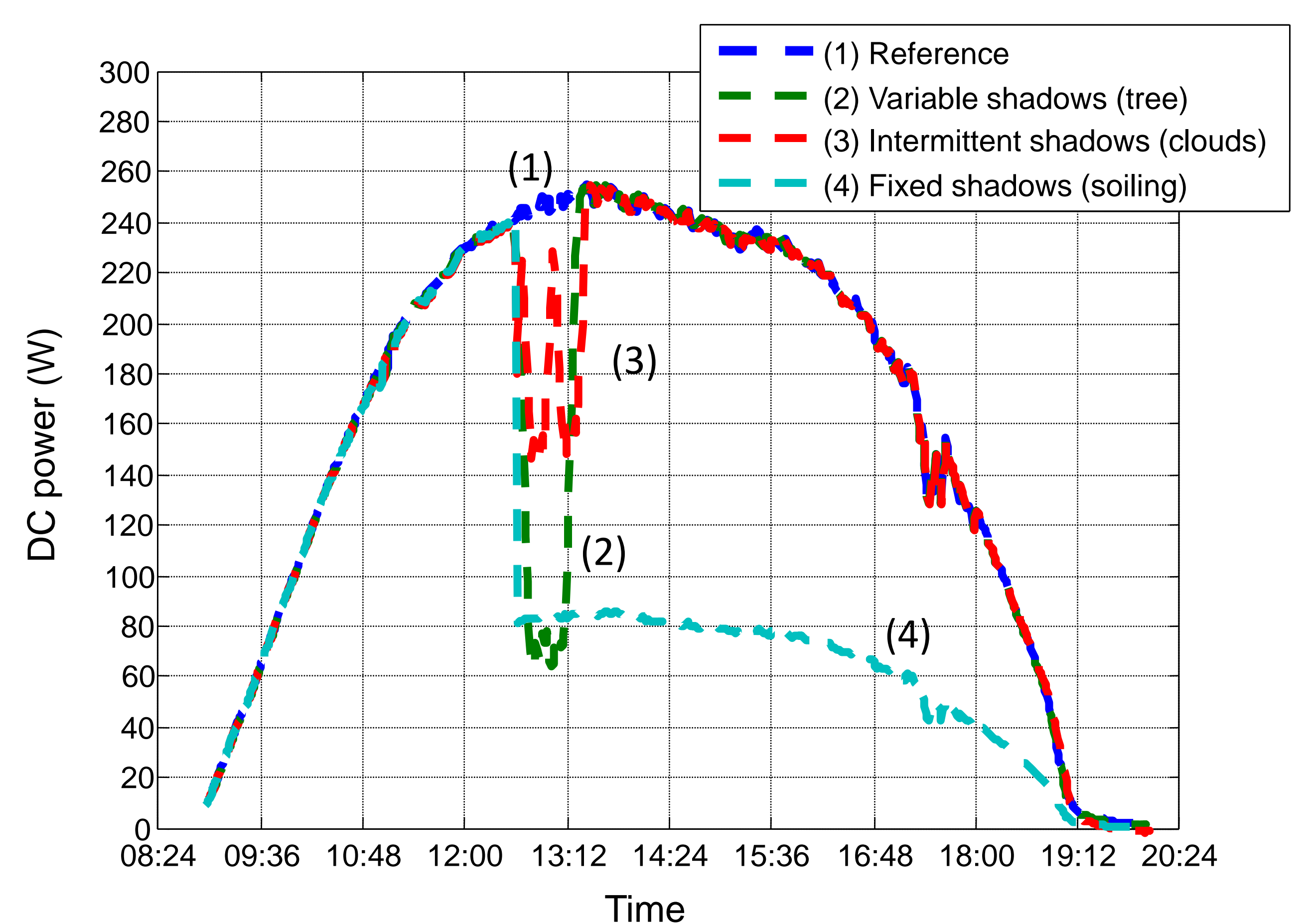


Figure 3 : Analysis of the power behavior for each case of shadows

DC Voltage Input max	1500V
DC Current Input max	30A

Table 2 : Maximum input specifications of the DC measuring box

Necessity to develop a DC power fault detection in function of types of shadows on PV modules



Fault detection algorithm

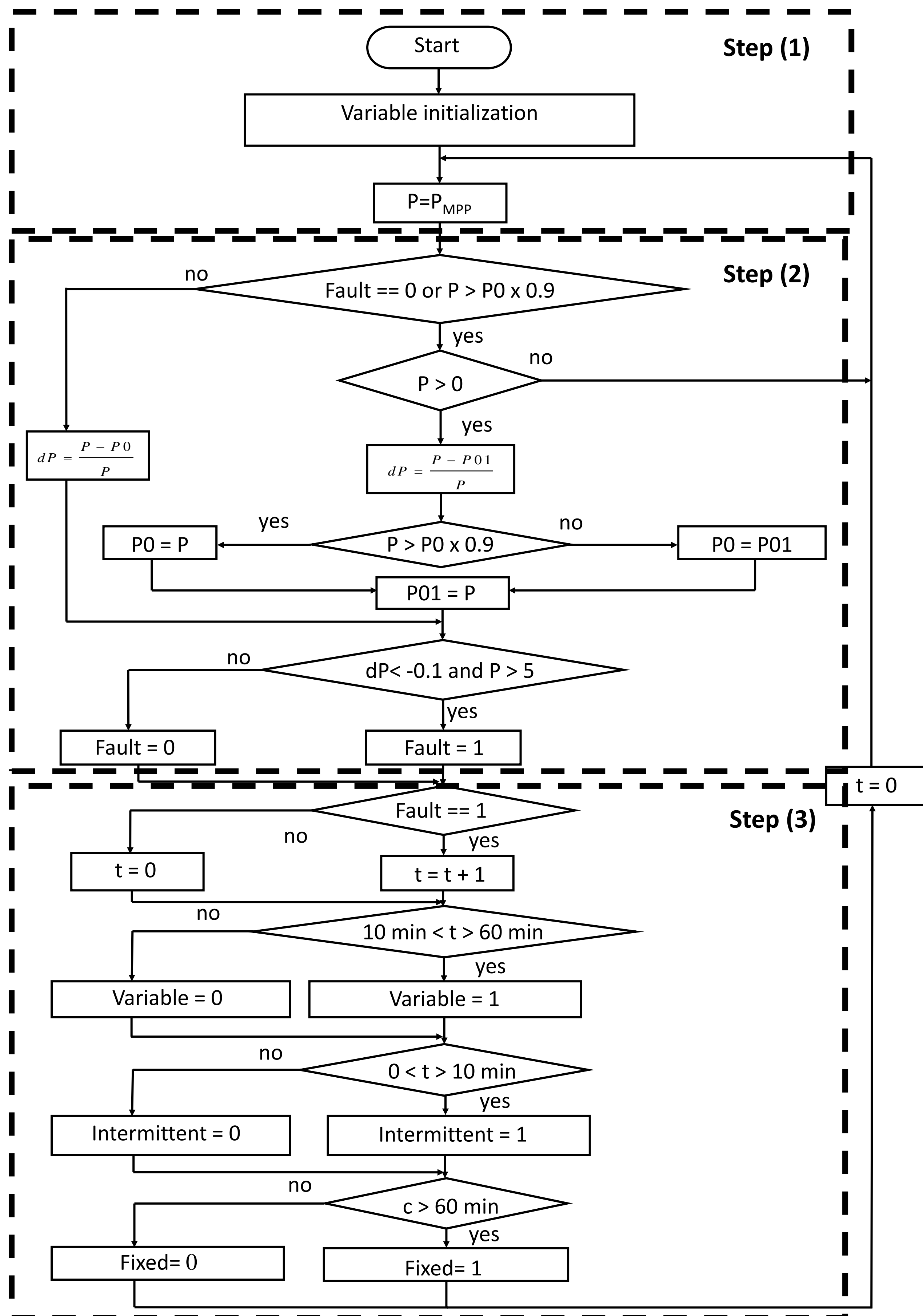


Figure 4 : Flowchart for fault detection and identification of shadows

Simulation results

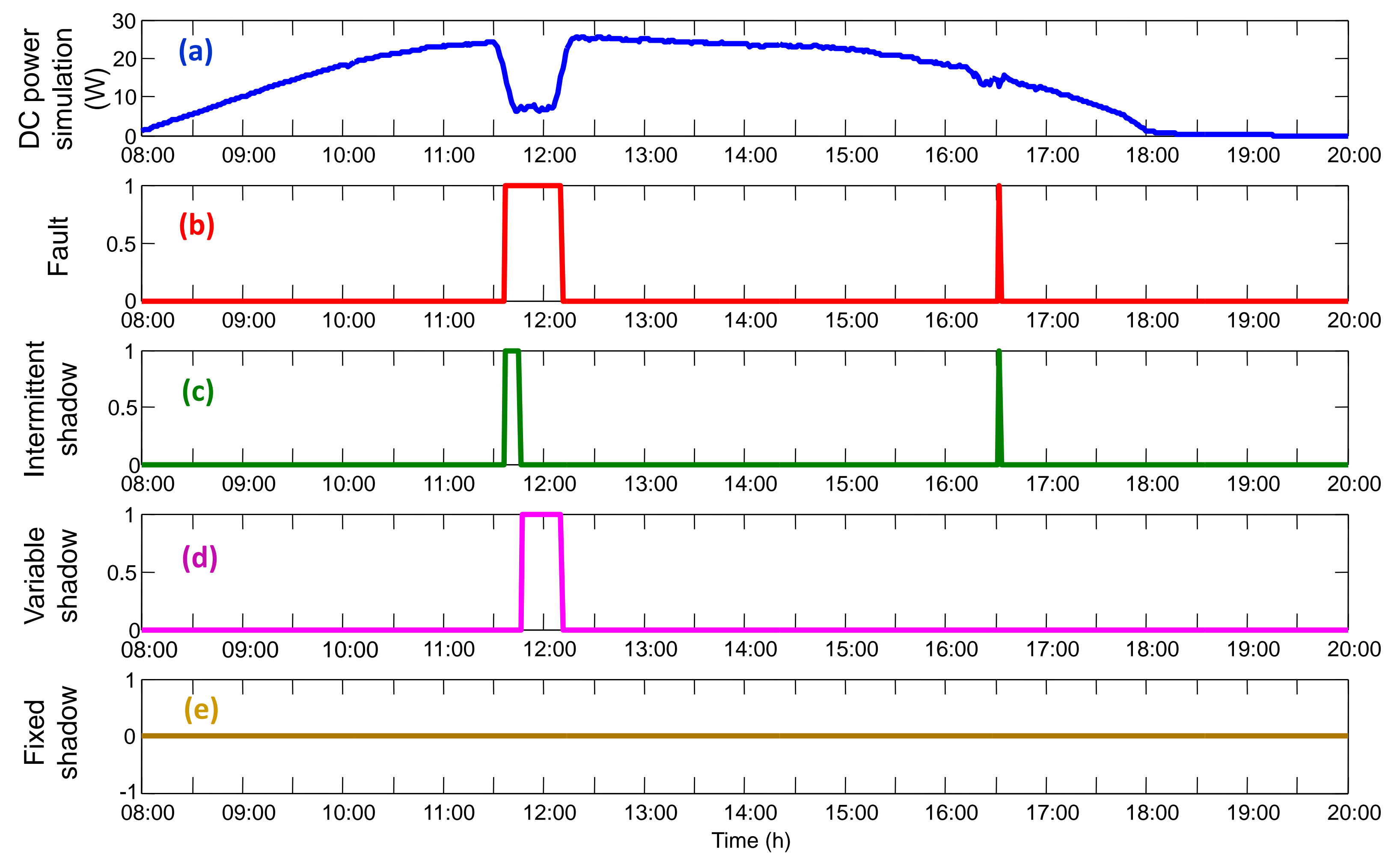


Figure 5 : Drop DC power analysis in simulation and fault detection

- (a) DC power simulation on one day with two kinds of fault
- (b) Fault detection without identifying its nature
- (c) Identification by default that the shadow is intermittent and supposed to be present during a short time
- (d) Identification of a variable shadow if the duration of the failure is longer than 10 minutes
- (e) Identification of a fixed shadow if the duration of the failure is longer than 60 minutes

Experimental results

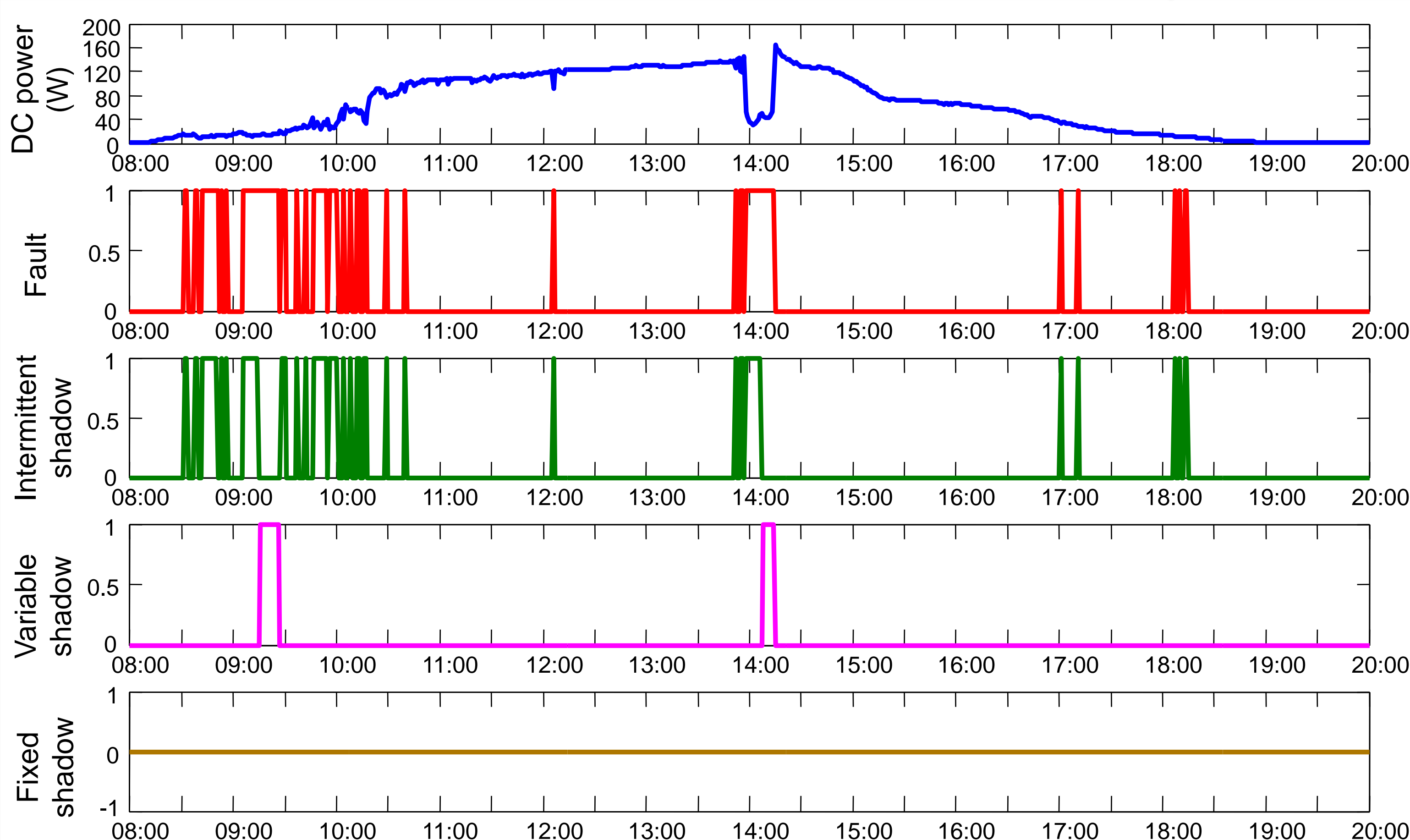


Figure 6 : DC power output measurements and fault detection analysis for a clean sky (October 2014)

Module TE2200 Mono crystalline	P_{mpp}	V_{OC}	I_{sc}	V_{mpp}	I_{mpp}
Value	250Wp	37.5V	8.8A	30.05V	8.4A

Table 3 : TE2200 PV module specifications (TENESOL)

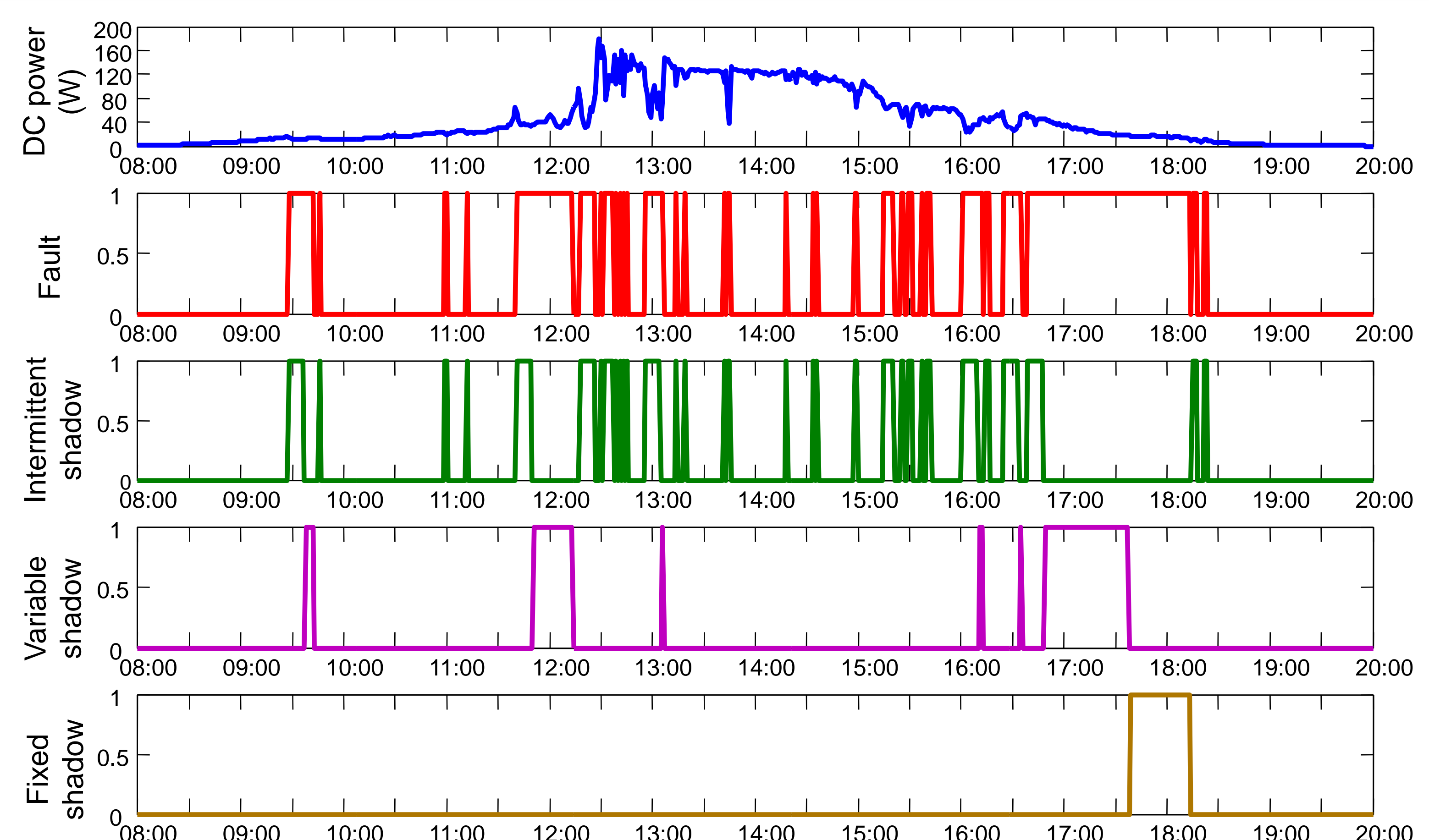


Figure 7 : Drop DC power output measurements and fault detection analysis for very cloudy weather (October 2014)

Conclusion

Photovoltaic facilities are most affected by shadows such as antennas, chimneys, trees, soiling, etc, especially in urban areas. A method of detecting, locating and identifying several types of shadows is given by DC power output analysis which allows accurately and timely maintenance of solar field. This method could inform PV users or PV manufacturers of the robustness of PV modules against presence of shadows despite the protection of diodes included in the PV modules.