PV SYSTEMS EVOLUTION: CONSIDERATIONS ON PV DC CABLES UNDER INCREASING VOLTAGE AND ENVIRONMENTAL CHALLENGES

Lluís-Ramon **SALES CASALS**, Joan **NARBONA**, Gabriel **MORENO;** Prysmian Cables and Systems (Spain)
lluis.sales@prysmiangroup.com, joan.narbona@prysmiangroup.com , gabriel.moreno@prysmiangroup.com
Jean Louis **Pons**, Serge Serge Colombier **COLOMBIER,** Francesc **Padillo** Prysmian Cables and Systems (France)
jean.louis@prysmiangroup.com, serge.colombier@prysmiangroup.com, francesc.padillo@prysmiangroup.com
Riccardo **BUCCI,** Prysmian Group (Italy) riccardo.bucci@prysmiangroup.com

ABSTRACT

Photovoltaic market is growing as never, with huge amount of GW's of power to be installed in the coming years.

The evolution of power electronics leads to the use of greater voltages up to 1500V DC.

The combination of these higher voltages with water that can be present in the field more often than expected, are showing some weakness on the performance of some PV system components.

In this paper we will analyse some field failures and suggest a new test methodology that can help to distinguish cables that will have better performance in this harsh environment.

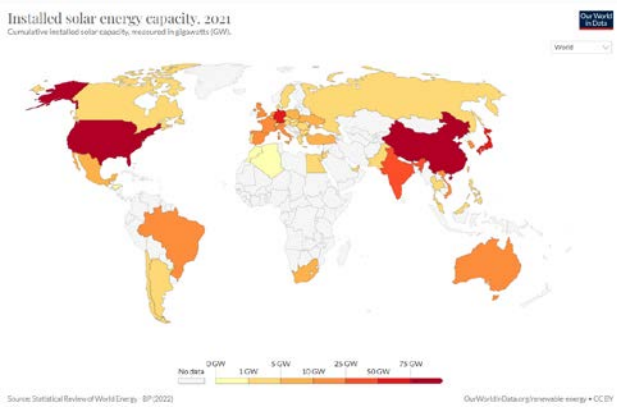
KEYWORDS

PV cables, dc cables, water, failure, test methodology, waterproof, AD8.

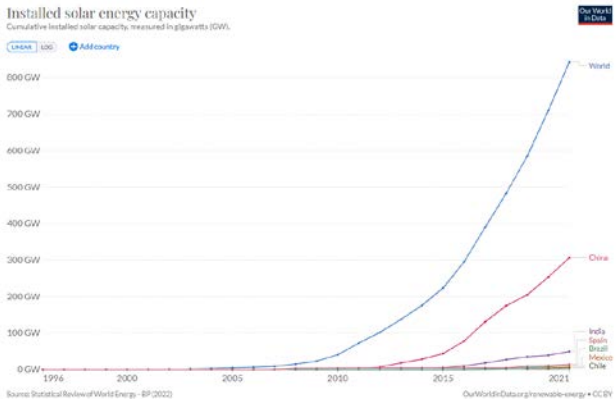
INTRODUCTION

Albert Einstein obtained the Nobel price after his interpretation of the photoelectric effect. Thanks to this very important phenomenon today we can enjoy from PV energy.

But it was not till late nineties that photovoltaic industry started to take-off, the first countries to have more than 1GW were Japan and Germany and this figure was reached only in 2004 when total power installed worldwide was 3.05GW; in 2010 USA, Spain, France, Italy, Belgium, Czechia, China and Australia were surpassing this threshold, and in 2021 the total power installed was 843GW [1].



The PV installed power is growing at exponential rate led by China that in 2021 exceeded 306GW [1]



PV CABLE INTERNATIONAL STANDARDS

The development of the PV market led to the arrival of international standards, EN 50618:2014 [2] and IEC 62930:2017 [3] define photovoltaic cables for an AD7 condition and require for the cable to pass successfully the named "long term resistance of insulation to d.c." where cable is placed in water at 85°C with permanent electrical voltage at 1.8kV during 10 days. This test is coming from EN 50264 series of rolling stock cable standards where those cables may face humid environment.

In EN 50525 standard series, only one cable family has AD8 condition performance, this is H07RN8-F cable according to EN 50525-2-21 [4]. Annexes D and E define the tests to perform in water, but those trials are limited to 100 days (2400h) with water heated at 50°C under AC voltage.

Most of the cables have been certified worldwide according to those standards, and cables installed in 2010 are still today under operation showing good performance on the field under voltages ranging from 300 to 1000V.

EVOLUTION OF THE INVERTERS VOLTAGE ALONG THE YEARS

The maximum voltage of inverters has been increasing along the time with a clear target, to make the PV system more economic and efficient so that for the same power higher voltages means:

- less current → lower cable losses
- higher number of panels connected → reduced number of strings for same power, less cables, less connectors.

First commercial inverters in the market started with