Field evaluation and degradation analysis of a-Si system after 13 years of exposure to a hot-humid climate in Huitchila, Mexico

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Background

Water pumping system in Mexico where installed in 90's due government initiative. Most agriculture people from Morelos installed autonomous water pumping system. Some installation used thin film modules from the company Grundfos (through BP-Solar) offering a full water pumping system with multiple modules. One of the modules was the G-50 a-Si PV module. Thermal dependency of the total efficiency of the module is critical in these kind of climate. Multiple changes of the climate condition might accelerate the degradation rate for thin film (TF) technology.
In these work a field evaluation and degradation analysis of a 13 years old installation was performed.

Table 1. Nameplate data and climate parameters from Huitchila, Morelos.

Parameter	Value	Parameter	Value	Units
Isc	0.410	Latitude	18	º
Voc	202.000	Altitude	1250	m
Imp	0.320	Insolation	6.05	kWh/m²/day
Vmp	156.000	Temp interval	22-35	ºC
Pmax	50.000	WindSpeed	3.46	m/s
FF	0.603	RH	61.7	%

Evaluation methodology

To do a field evaluation, multiple steps need to be followed.

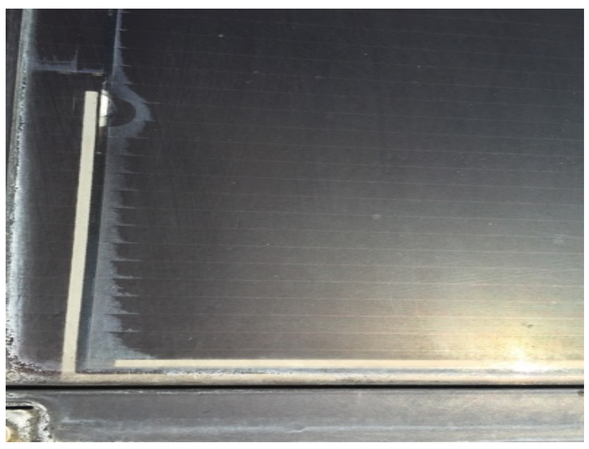
1. Field visual inspection [1]
2. IR image
3. Electrical performance (STC 1000 W/m² @ 25 ºC IV curve using IEC-60891 method 1)
4. Degradation analysis

PV Installation

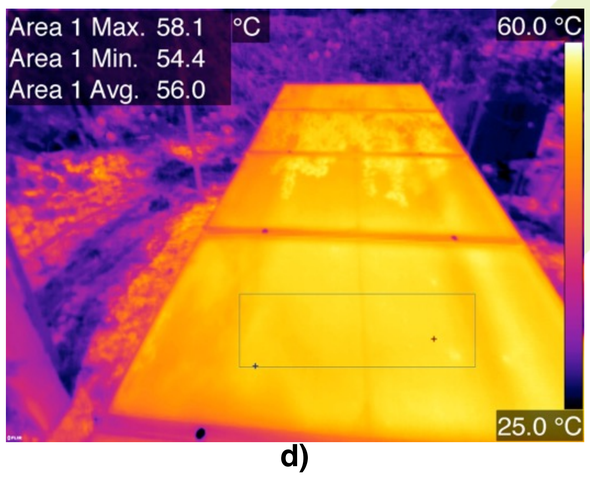
The installation consist in 1S x 5P a-Si module used for a stand alone system for water pumping. The system was installed in 2001 and it still in operation. Temperature coefficient parameters was take from the manufacturer: α = 0.004 mA/ ºC, β = -0.46 V/ ºC.

a)

b)



c)



d)

Figure 1. a) Front view of the installation, b) side view of the installation, c) Electro-chemical corrosion, d) Infrared Image

Results

Visual inspection detected Electro-Chemical corrosion near the junction box in all the modules. IV curves measured are shown in the Figure 2. Light induced degradation causes ~30 % [2] of the losses in a-Si technology leaving an ~10% of remaining losses due exposure. The fill factor does not change considerably between 2015 and 2011.

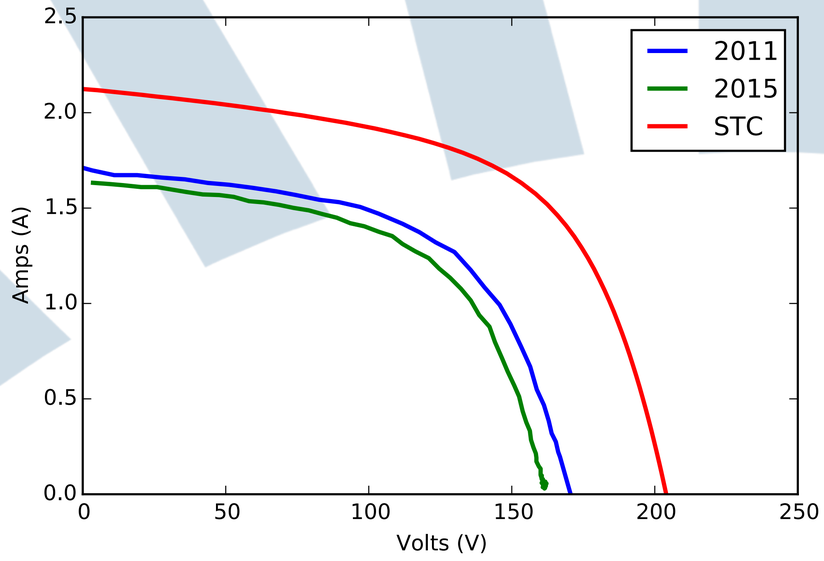


Figure 2. IV Curves from 2011 and 2015 and nameplate curve from the a-Si installation at Huitchila, Morelos

Degradation results

Table 2. Degradation result from field evaluation study

	Isc	Voc	Imp	Vmp	Pmax	FF
Nameplate	0.41	202.00	0.32	156.00	50.00	0.60
System STC	2.12	204.00	1.60	156.00	249.60	0.58
2011	1.70	169.51	1.27	129.96	165.02	0.57
2015	1.63	161.66	1.18	126.51	149.68	0.57
Total degradation	23.38	20.75	26.05	18.90	40.03	1.23
Annual degradation	1.80	1.60	2.00	1.45	3.08	0.09

Conclusion and remarks

- Total degradation rate was 3.08% and a 2.3% degradation rate per year between 2011 and 2015.
- Electro-chemical corrosion was present in all the modules, these might indicate high humidity reaching the module from the junction box.
- System still in operation and with a good performance in these climate conditions.

References

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