

# Santerno inverter uptime: a case study and benchmark

# Objective of this study



This study is aimed to compare the historic behavior of 480 Santerno solar inverters Santerno over more than 3 years with respect to a case study published by Sunedison in 2010

Units analysed:

- No. 406 TG145, 100kWac w/ LV trafo
- No. 74 TG385, 300kWac w/o LV trafo

Total installed power : 63MWac

## PV Plants analysed with Santerno

1. Calasparra1
2. Calasparra2
3. Calasparra3
4. Fuente Alamo1
5. Fuente Alamo2
6. Fuente Alamo3
7. Ute La Sesa
8. Solfuture Alcardete

## Benchmark:

SOLAR ENERGY SERVICES AS RELIABLE AS THE SUN

Owner/Operator Perspective on Reliability  
Customer Needs and Field Data

Sandia National Laboratories  
Utility-Scale Grid-Tied PV Inverter Reliability Technical  
Workshop, January 2011

Dr. Tassos Golnas  
Sr. Mgr, Energy Analytics  
SunEdison/MEMC

The SunEdison logo, featuring a stylized sun icon to the left of the text 'SunEdison' in a bold, sans-serif font, with 'simplifying solar' in a smaller font below it.

The data :

Santerno:

- 1- Santerno inverters **Service Rates** are better than Sunedison suppliers.
- 2- **Designed Service Rates** (MTBF) are validate
- 3- **Designed Repair Time** (MTTR) are validate

# PV plants analysed



Impianto	Proprietario	O&M	Costruttore	EPC
<b>Calasparra1</b>	GA Solar	GES	GA Solar	E:Apia XXI PC: GA Solar
<b>Calasparra2</b>	Fotowatio	GES	GA Solar	E:Apia XXI PC: GA Solar
<b>Calasparra3</b>	Fotowatio	GES	GA Solar	E:Apia XXI PC: GA Solar
<b>Fuente Alamo1</b>	Heliasetym	GES	GA Solar	E:Apia XXI PC: GA Solar
<b>Fuente Alamo2</b>	Fotowatio	GES	GA Solar	E:Apia XXI PC: GA Solar
<b>Fuente Alamo3</b>	Fotowatio	GES	GA Solar	E:Apia XXI PC: GA Solar
<b>UTE la Sesa</b>	69% Comunidad Regantes 31% Dalkia	Viñaresol Dalkia	Avanzit+ Viñaresol Avanzit+Dalkia	Avanzit+ Viñaresol Avanzit+ Viñaresol
<b>Solfuture Alcardete</b>	50% Abantia 50% Ga Solar	Abantia GA Solar	Abantia+GA Solar+UTE Comsa	Abantia+GA-Solar+Comsa

# Santerno assistance data



From September 2008 to October 2011 we registered 91 calls for downtime events in the plants that on these analysed 480 inverter with more than 1400 inverter years.

	A	B	C	D	E	F	G	H	I	J
1	DATE	Richiesta n°	Client	PLANT	Code Material	Material description	Jl	OLD s	SENT FROM SP	TRANSPORT
54	16/10/2009	090-EES-SE1-CO-2468	ECOSTREAM	AZNALCOLLAR	Z20101061 MY242	Sinus P-F 150-162	1	804258	SENT 18/11/2009	AL 055-09 18/11/20
55	16/10/2009	090-EES-SE1-CO-2469	ECOSTREAM	AZNALCOLLAR	Z20101061 MY242	Sinus P-F 150-162	1	804247	SENT 18/11/2009	AL 055-09 18/11/20
56	21/10/2009	090-EES-SE1-CO-2591	DALKIA SOLAR	MECANOVA	RL0200961	RELE	1		SENT 04/11/2009	AL 052-09 04/11/20
57	21/10/2009	090-EES-SE1-CO-2590	DALKIA SOLAR	MECANOVA	RL5001999	ZOCOLO X DIN RELAY	1		SENT 04/11/2009	AL 052-09 04/11/20
58	22/10/2009	090-SRO-SE1-CO-2517	GA Solar	FUENTE ALAMO 3	Z20101094 RY242	RY242 SUNWAY 385-800V	1	8000540	SENT 04/11/2009	AL 052-09 04/11/20
59	28/10/2009	090-EES-SE1-CO-2633	DALKIA SOLAR	PITIEGUA	Z20095620	ES848/2	1		SENT 04/11/2009	AL 052-09 04/11/20
60	03/11/2009	090-EES-SE1-CO-2679	ENERG.SOLAR.TECNICA		Z20069008,3200	SUNWAY M XR 5300	1	68511	SENT 18/11/2009	AL 055-09 18/11/20
61	04/11/2009	090-EES-SE1-CO-2715	GA Solar	FUENTE ALAMO 3	AC1832701	FILTRO	1		SENT 04/11/2009	AL 052-09 04/11/20
62	04/11/2009	090-EES-SE1-CO-2716	GA Solar	FUENTE ALAMO 3	XXFL00084	TEMPORIZADOR	1		SENT 04/11/2009	AL 052-09 04/11/20
63	04/11/2009	090-EES-SE1-CO-2717	GA Solar	FUENTE ALAMO 3	Z20085906	ES768	1		SENT 04/11/2009	AL 052-09 04/11/20
64	04/11/2009	090-EES-SE1-CO-2714	GA Solar	FUENTE ALAMO 3	Z24080905	ES809	1		SENT 04/11/2009	AL 052-09 04/11/20
65	17/11/2009	090-EES-SE1-CO-2835	UTE ABANILLA	ABANILLA	Z24500520	DATA LOGGER	1		SENT 18/11/2009	AL 055-09 18/11/20
66	18/11/2009	090-EES-SE1-PR-2842	GA-Solar	Fuente Alamo 3	Z20101094 RY242	RY242 SUNWAY 385-800V	1	815654	SENT November 2009	
67	05/10/2010	100-EES-SE1-CO-0003	Solaer	solaer	Z20101061 MY242	Sinus P-F 150-162	1	800032	SENT 12/10/2010	AL 063-10 12/10/20
68	20/10/2010	100-EES-SE1-CO-0090	ECOSTREAM	El Viso (Córdoba)	Z24080905	ES809	1		SENT 16/03/2010	AL 070-10 16/03/10
69	26/10/2010	100-EES-SE1-CO-0143	GA Solar	CALASPARRA 1	RL5001999		2		Given 10/02/10 to Laura / Bedeschi	
70	26/10/2010	100-EES-SE1-CO-0142	GA Solar	CALASPARRA 1	XXRL00109		2		Given 10/02/10 to Laura / Bedeschi	
71	01/02/2010	100-EET-SE1-CO-0509	COMSA	Viso del Marqués	XXCE00311	Interruttore sezionadore	1		SENT 16/03/2010	AL 070-10 16/03/10
72	08/02/2010	100-EET-SE1-CO-0511	ECOSTREAM	Los Cabezos	Z20101061 MY242		1	800250	SENT 01/04/2010	AL 074-10 01/04/10
73	22/02/2010	100-EES-SE1-CO-0397	DALKIA SOLAR	IBI	Z20101085 HD242	Sunway 135 - 600V	1	900772	SENT 16/03/2010	AL 070-10 16/03/10
74	04/03/2010	100-EET-SE1-CO-0510	Ecostream	El Viso (Córdoba)	XXCE00095	SGANC.APERT PER S3-S4-S5	1		SENT 16/03/2010	AL 070-10 16/03/10
75	04/03/2010	100-EET-SE1-CO-0701	Dalkia Solar	PITIEGUA	Z24500520	ES851	1		SENT 16/03/2010	AL 070-10 16/03/10
76	04/03/2010	100-EET-SE1-CO-0704	Dalkia Solar	PITIEGUA	Z24500520	ES851	1		SENT 16/03/2010	AL 070-10 16/03/10
77	09/03/2010	100-EET-SE1-CO-0702	Dalkia Solar	IBI - ONIL	XXVN00031	Griglia Ventilazione	1		SENT 16/03/2010	AL 070-10 16/03/10
78	15/03/2010	100-EET-SE1-CO-0703	Ecostream - PV Sol	Aznalcollar	Z20101061 MY242	Sunway 145 - 800V	1	800210	SENT 01/04/2010	AL 074-10 01/04/10
79	22/03/2010	100-EET-SE1-CO-0512	Accener	Accener (Cuenca)	XXRL00109	Rele	1		AL 067-10 08/02/10	
80	06/04/2010	100-EET-SE1-CO-0847	AYANZIT	LA SESA 2	RL0200807 - RL5001	Rele CR-M024DC4LG ER 595	1-1		SENT 3/05/10	AL 082-10 3/05/20
81	06/04/2010	100-EET-SE1-CO-0848	AYANZIT	LA SESA 2	RL0200807 - RL5001	Rele CR-M024DC4LG ER 595	1-1		SENT 3/05/10	AL 082-10 3/05/20
82	06/04/2010	100-EET-SE1-CO-0850	ICS Renovables	LIDERFIL	Z20101061 MY242	Sunway 145 - 800V	1	804117	SENT 8/04/2010	AL 077-10 08/04/10
83	15/04/2010	100-EET-SE1-CO-0889	ACCENER	CUENCA	XXFL00024	CONT.TRILA 145-30-11	1		SENT 1/06/10	AL 099-10 31/05/10
84	15/04/2010	100-EET-SE1-CO-0887	I-D ENERGÍAS	CIUDAD REAL	Z20069044 32001	SUNWAY MPLUS 6400	1	916127	SENT 3/05/10	AL 082-10 3/05/20
85	23/04/2010	100-EET-SE1-CO-1198	Viñaresol	La Sesa 2	RL0200807	Rele CR-M024DC4LG ER 595	1	802442	SENT 3/05/10	AL 082-10 3/05/20
86	23/04/2010	100-EET-SE1-CO-1199	Viñaresol	La Sesa 2	RL0200807	Rele CR-M024DC4LG ER 595	1	802297	SENT 3/05/10	AL 082-10 3/05/20
87	23/04/2010	100-EET-SE1-CO-1200	Viñaresol	La Sesa 2	RL0200807	Rele CR-M024DC4LG ER 595	1	802277	SENT 3/05/10	AL 082-10 3/05/20
88	23/04/2010	100-EET-SE1-CO-1197	Viñaresol	La Sesa 3	Z24080905	ES 809	1	802294	SENT 3/05/10	AL 082-10 3/05/20
89	28/04/2010	100-EET-SE1-CO-1201	Viñaresol	La Sesa 2	TR0113200	TRANSF 1F. 500VA 230-400V/	1	802306	SENT 1/06/10	AL 099-10 31/05/10
90	28/04/2010	100-EET-SE1-CO-1000	GA Solar	Calasparra 2 CT1	VW0030530	Sonda PT100 TESAR TRP-100	1		SENT 3/05/10	AL 082-10 3/05/20
91	28/04/2010	100-EET-SE1-CO-1017	Viñaresol	La Sesa 2	XXVN00051	TORRINO VENT TB25000220	2		SENT 1/06/10	AL 099-10 31/05/10
92	28/04/2010	100-EET-SE1-CO-1016	Viñaresol	La Sesa 2	Z20101061 MY242	Sunway 145 - 800V	1	810304	SENT 1/06/10	AL 099-10 31/05/10
93	30/04/2010	100-EET-SE1-CO-1656	COMSA	MAIALS	Z20101085 GO242	Sunway 135 - 600V	1	711808	SENT 3/05/10	AL 082-10 3/05/20
94	04/05/2010	100-EET-SE1-CO-2	GA Solar	ABANILLA	Z20101061 MY242	Sunway 145 - 800V	1	700650	SENT 24/05/10	AL 082-10 24/05/20

## 6 Inverter every 100 require 1 repair year

480 Inverter

Commissioning: 26 Agosto 2008

Data collected up to October 14th 2011 → 1113 days = 3,05 Years

Total Inverter Yeras =  $480 \times 3,05$  → 1464 inverter years

10 working hours each day means → 4800 hours

Total UP TIME in 1113 days → 5.342 kWh

Total calls to repair → 91

Probability to repair = 91 Events/ 480 Inverter → **0,19**

Repair rate (per Inverter-year) =  $91/1464$  → **0,06**

# Sunway TG – designed for uptime !



## Designed MTBF and MTTR for solar inverters

<b>Model</b>	<b>MTBF [h]</b>	<b>MTTR [h]</b>
<b>SUNWAY TG</b>	150k	1.05
<b>SUNWAY TG TE</b>	150k	1.05

**Designed MTBF has been validated by hystorical data on operating PV fields !**

**MTTR** is the repair time in hours that one skilled technician take from when he is in front of the inverter cabinet with all tools, instruments and spare parts

Real probability to repair = **0,19**

→ **Actual MTBF is 127kh**

Dettagli del calcolo:

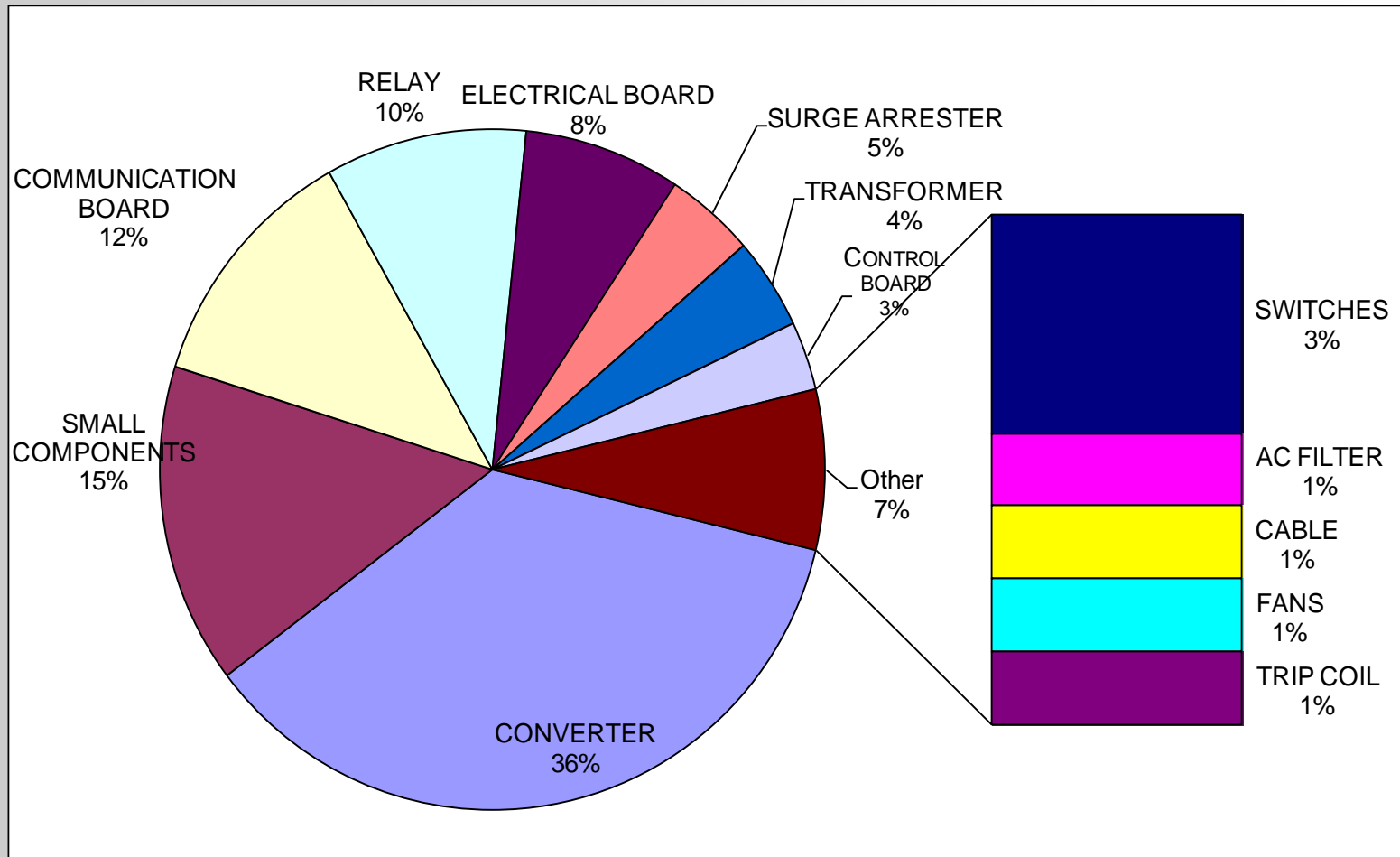
Real MTBF	= <b>127000</b> h
X = 3,05 anni	= 26718 h
1/λ	= 126000 h
Probability	= $1 - \exp(-\lambda * x) = 1 - \exp(-26718h / 127000h) = $ <b>0,19</b>

Design MTBF	= <b>150000</b> h
X = 3,05 anni	= 26718 h
1/λ	= 150000 h
Designed Probability	= $1 - \exp(-\lambda * x) = 1 - \exp(-26718h / 150000h) = $ <b>0,16</b>

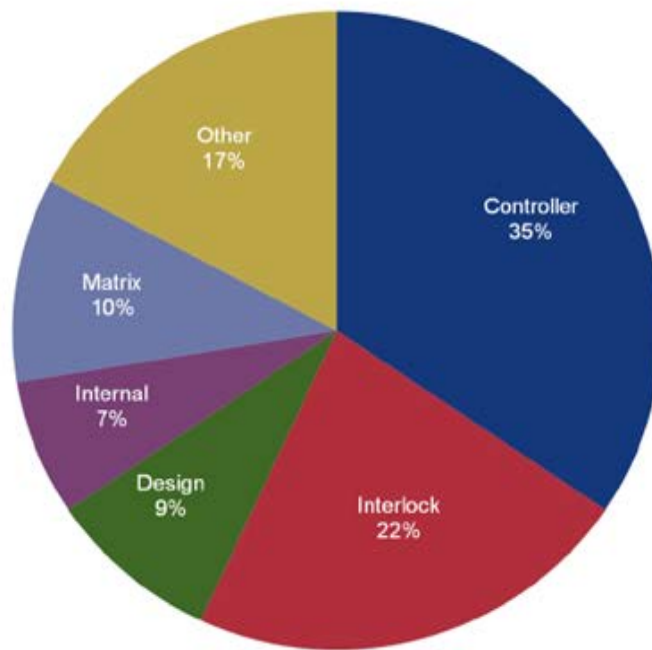
[http://en.wikipedia.org/wiki/Exponential\\_distribution](http://en.wikipedia.org/wiki/Exponential_distribution)



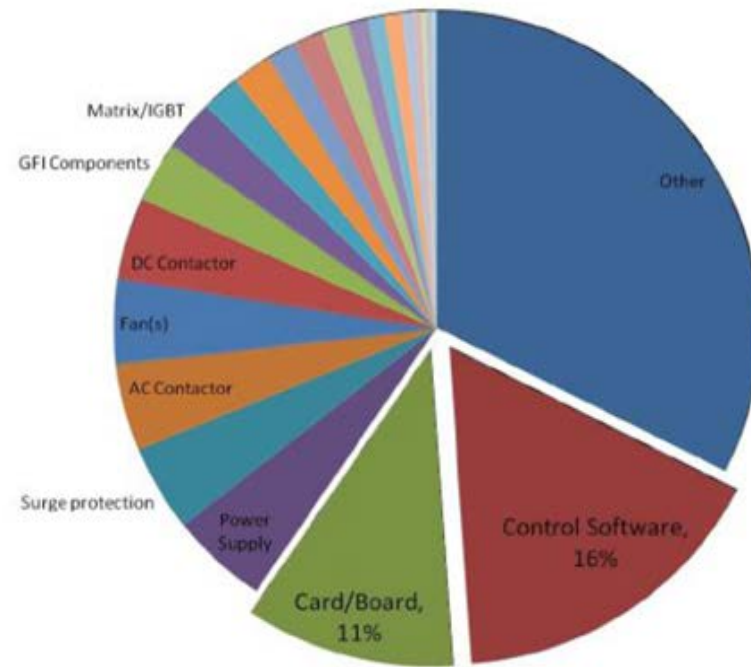
## Santerno: Calls for inverters repair



## SunEdison: Call for inverter repairs



Source: Sandia National Laboratories



Source: SunEdison



Case #1: **Spare parts available in the field, skilled technicians in the field**

MTTR = 29.63 Minuti **(Mean Time To Repair: skilled technician )**

Total Downtime =  $29,63 \times 90 \text{ Min} = 2667 \text{ Min} = 111,12 \text{ h}$

Uptime :

→  $(1 - 111,12\text{h}/5342\text{kh}) = \mathbf{99,998 \%}$

Caso #2: Spare parts available in the field, 23 ours to arrive in the field

MTTR = 24 h

Total Downtime = 24h\*90 = 2160 h

Uptime :

→  $(1 - 2160h / 5342kh) = 99,96 \%$

Case #3: 48 hours to get spare parts, 23 hours to arrive in the field

MTTR = 72 h

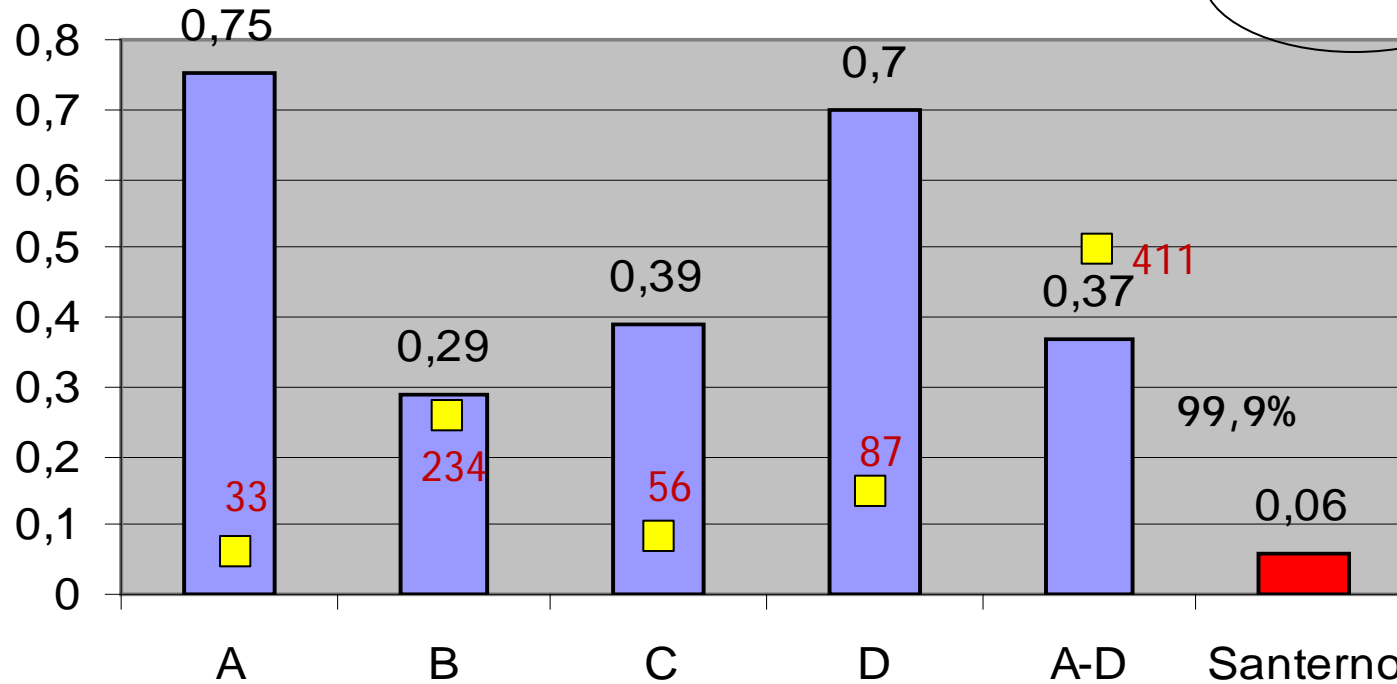
Total Downtime = 72h\*90 = 6480 h

Uptime :

→  $1 - 6480h / 5342kh = 99,87\%$

## SunEdison vs **Santerno**

### Fault Rate & Uptime projection



1464 8 plants in Spain

■ Inverter years

Hypotesis: same MTTR for all the brands

Data from: Sunedison, Santerno