

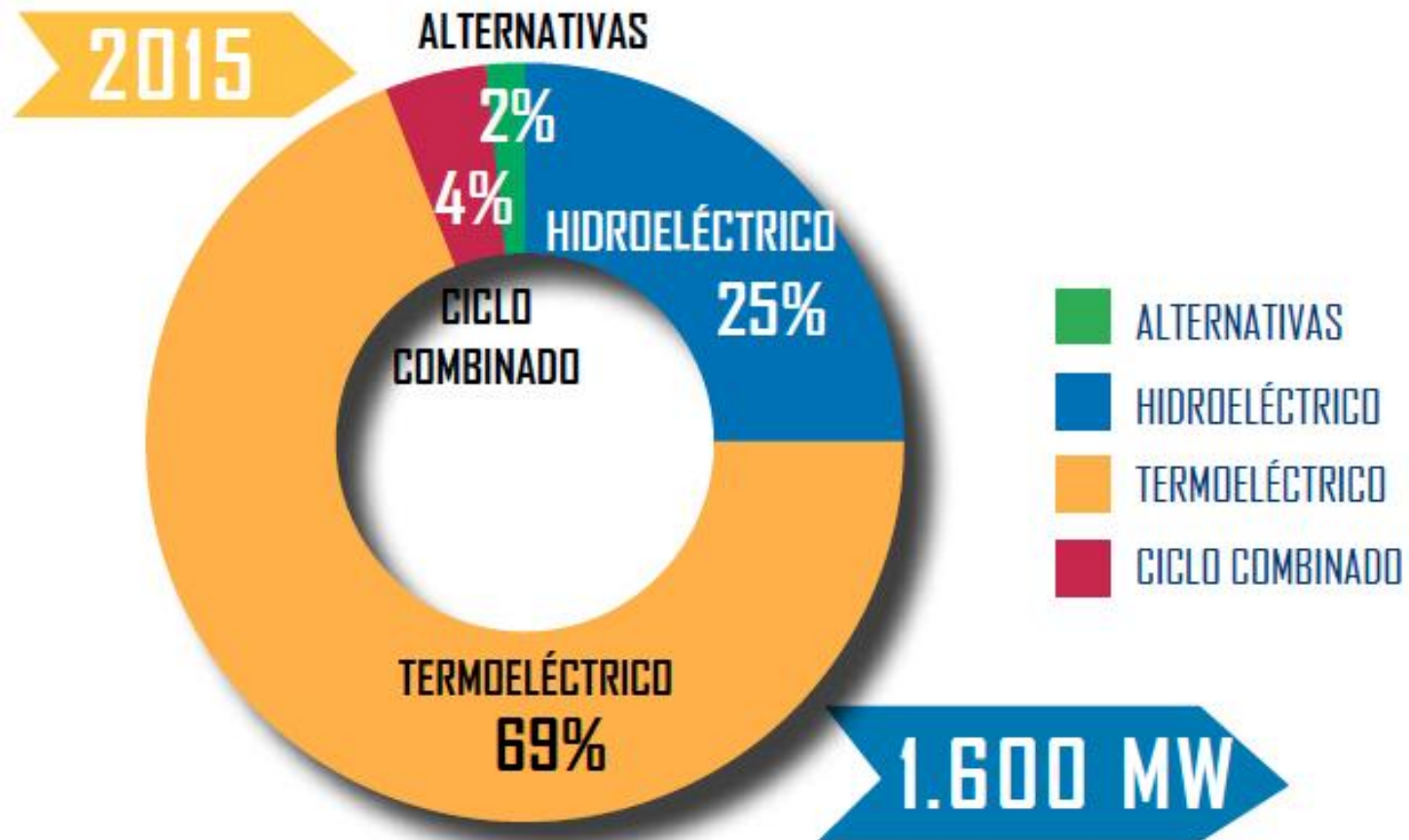


# **INSUMOS PARA CONSTRUIR ALTERNATIVAS AL BALA**

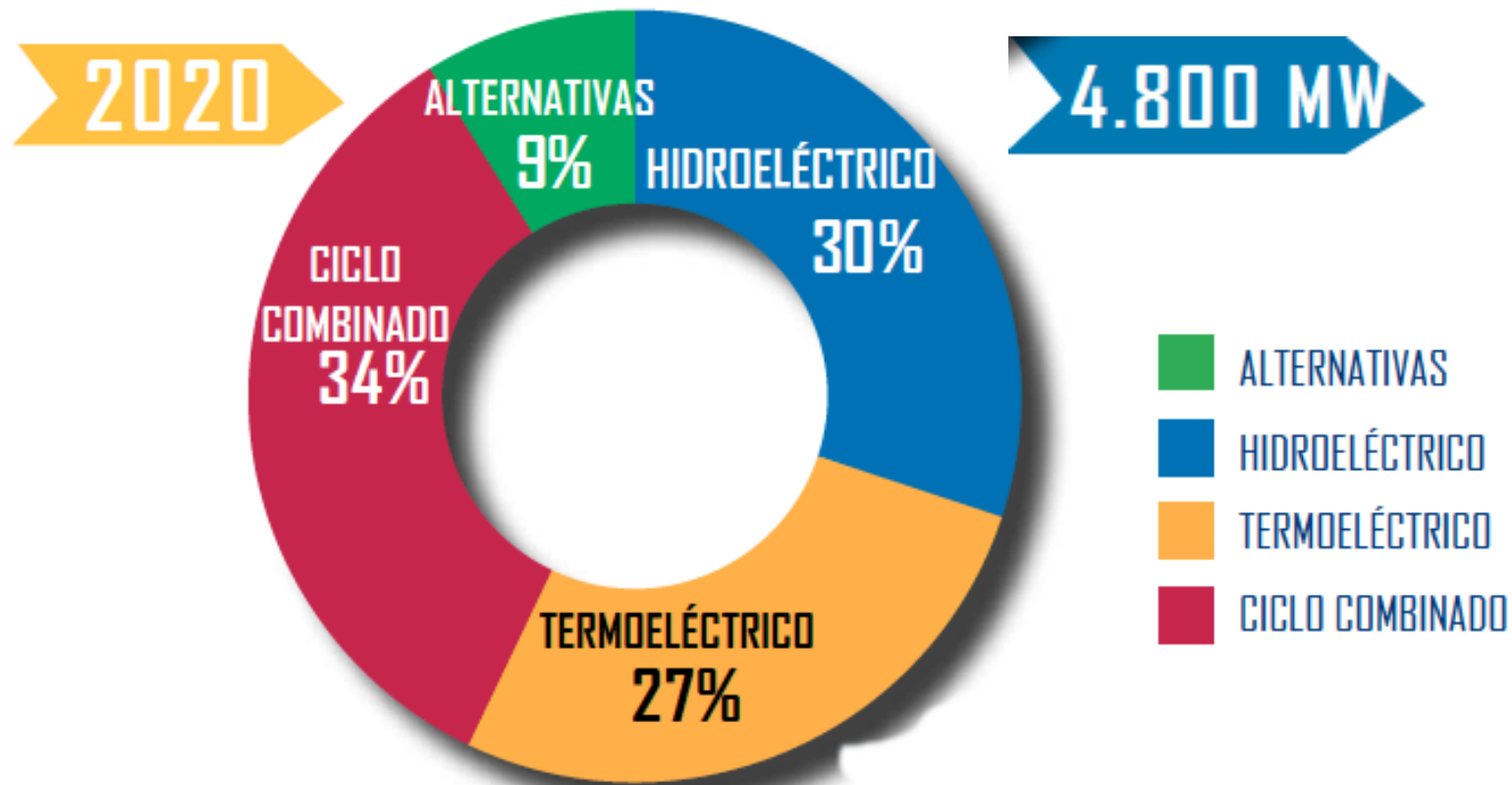
*Pablo Solón*

*Fundación Solón*

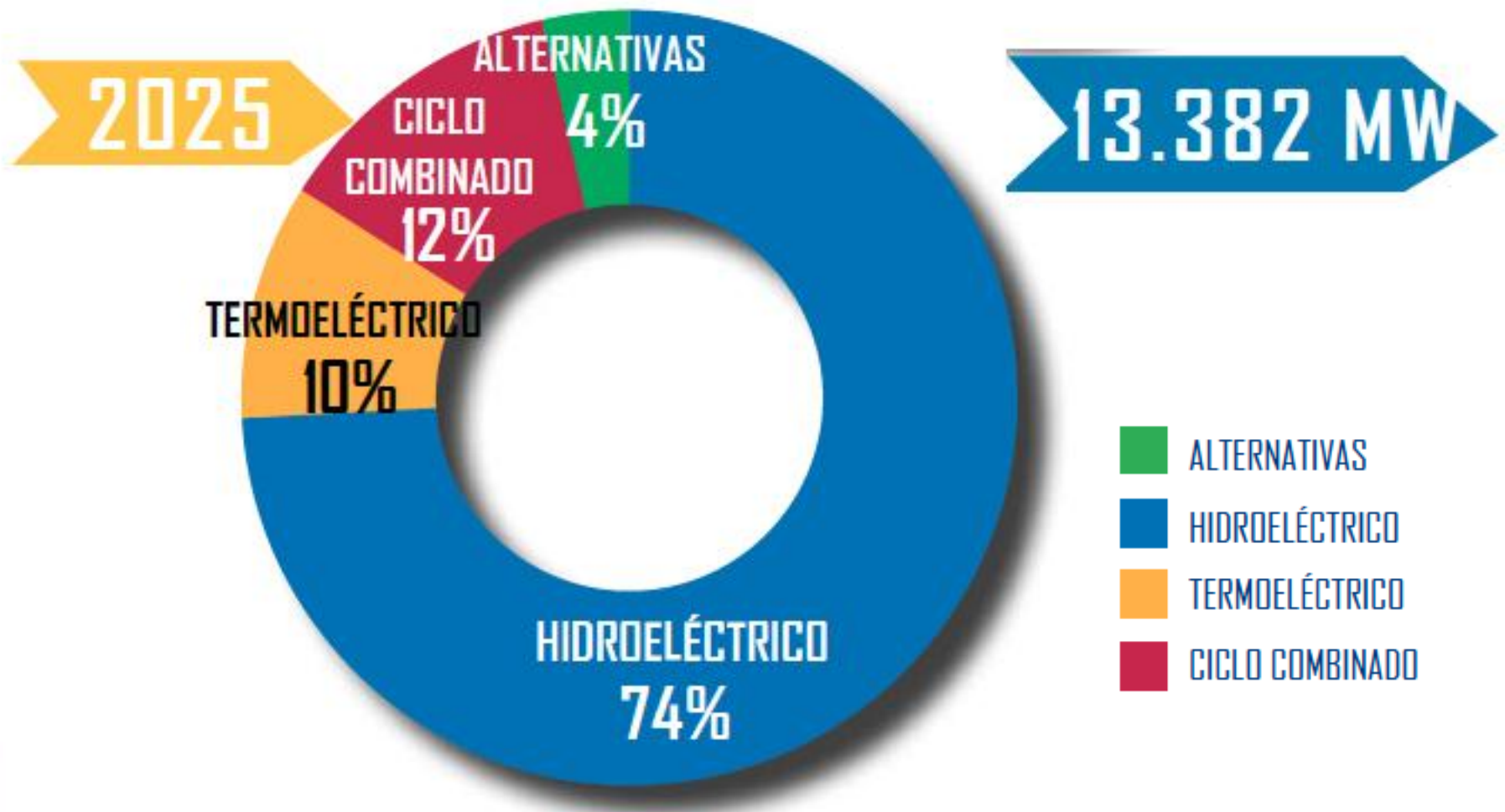
# Bolivia: Cambio de la Matriz Energética 2015 - 2025



# Bolivia: Cambio de la Matriz Energética 2015 - 2025



# Bolivia: Cambio de la Matriz Energética 2015 - 2025





**PARQUE EÓLICO QOLLPANA**



**PLANTA SOLAR FOTOVOLTAICA COBIJA**

PROYECTO	MW
PARQUE EÓLICO QOLLPANA FASE I	3MW
PLANTA SOLAR COBIJA	5MWp

# Bolivia: Proyectos al 2020

ENERGÍAS ALTERNATIVAS		MEGAWATTS AL 2020
Biomasa	San Buenaventura	10
	Cobija	20
	Riberalta	20
Eólica	Qollpana	36
	Warnes	20
	La Ventolera	20
	San Julián	30
	El Dorado	30
Solar	Oruro	100
	Yunchará	5
	Uyuni - Colcha K	60
	Riberalta - Guayaramerín	5
Geotérmica	Laguna Colorada	55
<b>TOTAL</b>		<b>411</b>

## Hidroeléctrica

<b>CAP (MW)</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
Total	143 397	148 002	149 444	150 703	154 253	157 042	159 353	161 784	166 669	172 200
Argentina	9 920	9 945	9 991	10 024	10 025	10 025	10 032	10 054	10 066	10 066
Belize	36	36	36	36	54	54	54	54	54	54
Bolivia	483	485	481	488	488	493	493	493	494	494
Brazil	73 678	76 869	77 545	78 610	80 703	82 457	84 294	86 019	89 193	92 062
Chile	5 230	5 356	5 433	5 452	5 467	5 946	5 992	6 094	5 578	6 513
Colombia	8 950	8 991	8 996	9 010	9 721	9 718	9 778	9 875	10 920	11 503
Costa Rica	1 412	1 500	1 524	1 510	1 553	1 644	1 700	1 725	1 834	1 937
Cuba	48	41	60	58	63	65	62	63	63	61
Dominica	8	8	5	5	7	7	7	7	7	7
Dominican Rep	469	469	472	494	523	523	543	583	588	612
Ecuador	1 786	2 030	2 033	2 030	2 215	2 207	2 237	2 237	2 237	2 401
El Salvador	467	481	481	481	481	481	483	483	486	485
Fr Guiana	114	114	114	114	114	114	119	119	119	119
Guadeloupe	8	8	9	9	9	9	9	9	9	9
Guatemala	743	776	776	778	885	902	986	997	1 001	1 087
Guyana										
Haiti	54	54	54	54	54	54	54	54	54	54
Honduras	503	520	522	527	527	529	539	558	624	632
Jamaica	22	22	22	23	23	23	23	30	30	30
Mexico	10 773	11 564	11 447	11 488	11 611	11 631	11 640	11 653	12 413	12 413
Nicaragua	105	105	105	105	105	105	106	120	120	120
Panama	847	847	869	879	936	1 351	1 468	1 494	1 612	1 612
Paraguay	8 110	8 130	8 810	8 810	8 810	8 810	8 810	8 810	8 810	8 810
Peru	3 216	3 234	3 242	3 277	3 438	3 451	3 484	3 556	3 662	4 166
Puerto Rico	100	100	100	100	100	100	100	100	100	100
Suriname	180	180	180	180	180	180	180	180	180	180
Uruguay	1 538	1 538	1 538	1 538	1 538	1 538	1 538	1 538	1 538	1 538
Venezuela	14 598	14 598	14 598	14 623	14 623	14 623	14 623	14 880	14 880	15 137



## Hidroeléctrica

<b>PROD (GWh)</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>
Total	675 359	695 487	711 399	716 474	728 719	770 917	753 533	728 874	720 288
Argentina	34 665	29 035	28 928	32 398	31 091	29 310	27 497	33 422	33 160
Belize	183	183	211	194	271	252	215	267	264
Bolivia	2 155	2 319	2 309	2 295	2 173	2 346	2 352	2 533	2 233
Brazil	348 805	374 015	369 556	390 988	403 290	428 333	415 342	390 992	373 439
Chile	29 129	23 130	24 193	25 296	21 717	21 009	20 158	19 736	23 099
Colombia	42 558	44 242	46 161	40 837	40 557	48 427	47 582	44 363	44 742
Costa Rica	6 595	6 771	7 384	7 225	7 262	7 135	7 233	6 851	6 717
Cuba	94	121	138	151	97	99	111	127	104
Dominica	28	22	21	23	23	36	27	37	31
Dominican Rep	2 200	2 102	1 728	1 817	1 770	1 892	2 229	2 340	1 584
Ecuador	7 129	9 038	11 293	9 225	8 636	11 133	12 238	11 039	11 458
El Salvador	1 989	1 770	2 075	1 532	2 125	2 051	1 886	1 828	1 789
Fr Guiana	405	405	405	352	459	459	556	490	500
Guadeloupe	19	20	21	21	16	15	14	19	27
Guatemala	3 245	2 985	3 625	2 893	3 767	4 094	4 435	4 631	4 825
Guyana									
Haiti	271	154	181	207	177	121	221	141	141
Honduras	2 070	2 214	2 290	2 801	2 734	2 810	2 786	2 739	2 589
Jamaica	166	160	158	140	152	152	151	124	136
Mexico	30 417	27 315	39 194	26 718	37 131	36 246	31 883	28 002	38 145
Nicaragua	308	307	534	297	503	444	419	456	396
Panama	3 580	3 706	3 972	3 897	4 194	4 098	5 388	5 154	5 034
Paraguay	53 773	53 714	55 455	54 939	54 065	57 624	60 232	60 378	55 276
Peru	19 602	19 559	19 092	19 904	20 097	21 569	22 101	22 309	22 201
Puerto Rico	120	120	120	120	159	146	86	83	81
Suriname	754	891	1 000	1 176	1 065	1 368	1 112	1 103	1 165
Uruguay	3 545	8 021	4 501	5 060	8 407	6 479	5 421	8 206	9 649
Venezuela	81 553	83 170	86 853	85 970	76 781	83 268	81 860	81 503	81 503





## Energía eólica terrestre

CAP (MW)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total	512	547	658	1 556	2 061	2 772	4 961	6 535	10 964	15 516
Argentina	28 o	28 o	28 o	28 o	28 o	60 o	137 o	192 o	217 o	279 u
Aruba					30 o	30 o	30 o	30 o	30 o	30 e
Bolivia					0 u	0 u	0 u	0 u	3 o	3 e
BES Islands				11 o	11 o	11 o	11 o	11 o	11 o	11 e
Brazil	237 u	247 u	341 u	606 u	927 u	1 431 u	2 530	3 480	5 984	8 739
Chile	2	20	20	163	163	184	202	301	731	904 o
Colombia	18 o	18 o	18 o	18 o	18 o	18 o	18 o	18 o	18 o	18 o
Costa Rica	69 o	70 o	70 o	120 o	120 o	133 o	148 o	148 o	198 u	268 u
Cuba	2	2	7	7	7	12	12	12	12	12 e
Curacao	12 o	12 o	9 o	9 o	9 o	9 o	30 o	30 o	30 o	30 e
Dominica			0 u	0 e	0 e	0 e	0 e	0 e	0 e	0 e
Dominican Rep			0 u	0 u	0 u	0 u	33 o	81 o	85 o	85 o
Ecuador		2	2	2	2	2	2	20	21 o	21 e
Falklands Malv	0 e	1 e	1 e	1 e	2 e	2 e	2 e	2 e	2 e	2 e
Grenada		0 u	0 u	0 u	0 u	0 u	0 u	0 u	0 u	0 u
Guadeloupe	21 e	22 e	22 e	22 e	23 e	23 e	23 e	23 e	23 e	27 o
Guatemala										76 o
Honduras						102 o	102 o	102 o	126 u	176 u
Jamaica	21	21	21	21	42	42	42	42	42 e	42 e
Martinique	1 o	1 o	1 o	1 o	1 o	1 o	1 o	1 o	1 o	1 o
Mexico	101	101	101	475	569	601	1 304	1 638	2 359 e	3 073 u
Nicaragua				40	63	63	146	147	186 o	186 o
Panama								20	35 u	270 u
Peru	1 o	1 o	1 o	1 o	1 o	1 o	1 o	1 o	143 o	240 o
Puerto Rico					1 e	1 e	101 e	125 e	125 e	125 e
St Kitts Nevis					2 u	2 u	2 u	2 u	2 u	2 u
Uruguay			15	31	41	44	53	59 o	529 u	845 u
Venezuela							30 o	50 o	50 e	50 e



## Energía eólica terrestre

PROD (GWh)	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total	876	1 463	1 970	2 705	4 778	6 035	11 604	14 460	24 799
Argentina	70 o	62 o	42 o	37 o	25 o	26 o	369 o	463 o	619 o
Aruba					158 o	158 o	158 o	158 o	158 o
Bolivia					0 e	0 e	0 e	0 o	8 o
BES Islands				30 e	30 e	30 e	33 o	37 o	41 o
Brazil	237 o	663 o	1 183 o	1 238 o	2 177 o	2 705 o	5 050 o	6 578 o	12 210 o
Chile	7	9	38	79	332	338	409	554	1 443
Colombia	63 o	50 o	54 o	58 o	39 o	41 o	55 o	58 o	70 o
Costa Rica	274 o	241 o	198 o	326 o	359 o	415 o	528 o	485 o	735 o
Cuba	2 e	2 e	8	3	12	18	21	23	19
Curacao	71 e	71 e	63 e	63 e	63 e	63 e	200 e	200 e	200 e
Dominica			1 u	1 e	1 e	1 e	1 e	1 e	1 e
Dominican Rep			1 e	1 e	1 e	1 e	68 o	197 o	247 o
Ecuador		1	3	3	3	3	2	57 o	80 o
Falklands Malv	1 e	4 e	4 e	4 o	4 o	5 o	5 o	5 o	5 e
Grenada		0 e	0 e	0 e	0 e	0 e	0 e	0 e	0 e
Guadeloupe	35 o	44 o	49 o	51 o	41 o	45 o	51 o	57 o	54 o
Guatemala									
Honduras						117 o	337 o	310 o	397 o
Jamaica	55	52	49	59	53	91	107	115	119 o
Martinique	2 e	2 o	1 o	2 o	1 o	1 o	2 o	2 o	2 o
Mexico	59	262	269	596	1 239	1 648	3 688	4 185	6 124 e
Nicaragua				112	163	211	330	562	846 o
Panama								2	116 o
Peru	1 o	1 o	1 o	1 o	1 o	1 o	1 o	1 o	258 o
Puerto Rico					1 e	1 e	15 o	173 o	218 o
St Kitts Nevis					6 u	5 u	8 u	8 e	8 e
Uruguay			7	42	70	111	112	144	733
Venezuela							53 e	88 e	88 e



# Solar fotovoltaica

CAP (MW)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total	23	30	36	62	114	167	331	449	836	2 224
Antigua Barb				0.1 e	0.1 e	0.3 e	0.3 e	0.4 e	0.4 e	3.4 e
Argentina	0.0 o	0.0 o	0.0 o	0.0 o	0.0 o	1.2 o	6.2 o	8.2 o	8.2 o	8.2 e
Aruba				0.0 e	0.1 e	0.3 e	1.0 e	1.6 e	4.9 e	4.9 e
Bahamas		0.1 e	0.1 e	0.2 e	0.3 e	0.4 e	0.6 e	0.6 e	1.2 e	1.2 e
Barbados	0.2 e	0.6 e	0.6 e	0.8 e	1.0 e	1.7 e	2.2 e	2.8 e	6.5 e	9.0 e
Belize	0.6 e	0.7 e	1.0 e	1.2 e	1.3 e	1.6 e	3.8 e	4.3 e	4.7 e	4.7 e
Bolivia									6.9 e	6.9 e
BES Islands										0.3 e
Brazil					1.0 o	1.0 o	2.0 o	5.0 o	15.0 o	22.9 o
Chile							2.0	15.0	218.0	848.0 o
Costa Rica							1.0 o	1.0 o	1.0 o	1.0 e
Cuba							0.6	11.0	22.0	23.8 e
Curacao	0.1 e	0.1 e	0.1 e	0.1 e	0.1 e	2.5 e	5.0 e	8.0 o	8.0 e	8.0 e
Dominica	0.1 e	0.2 e	0.2 e	0.2 e	0.2 e	0.2 e	0.2 e	0.2 e	0.2 e	0.2 e
Dominican Rep							1.6 e	7.4 e	12.3 e	15.5 e
Ecuador	0.2	0.2	0.2	0.2	0.2	0.4	0.8	3.9 o	26.4 o	26.4 o
El Salvador								0.7 e	1.0 e	1.5 e
Fr Guiana				0.9 o	21.7 o	32.3 o	34.0 o	34.0 o	38.0 o	39.1 o
Grenada		0.0 e	0.1 e	0.2 e	0.2 e	0.2 e	0.3 e	0.3 e	0.3 e	0.5 u
Guadeloupe	1.2 e	2.5 e	3.7 e	10.9 o	22.4 o	28.5 o	60.0 o	66.6 o	66.6 o	67.1 o
Guatemala									5.0 o	85.0 o
Guyana	0.4 e	0.6 e	0.6 e	0.7 e	0.9 e	1.2 e	1.5 e	1.7 e	2.2 e	2.2 e
Honduras										455.0 e
Jamaica	0.2 e	0.4 e	0.6 e	0.7 e	1.0 e	1.5 e	1.8 e	2.1 e	4.1 e	6.3 e
Martinique	2.5 o	4.0 o	7.3 o	14.2 o	26.4 o	48.0 o	60.0 o	62.0 o	62.5 o	62.5 e
Mexico	16.0	19.0	19.0	25.0	29.0	36.0	53.0	67.0	131.0 e	234.3 e
Nicaragua									1.4 o	1.4 o
Panama									2.4 e	14.4 e
Peru							80.0 o	80.0 o	96.0 o	96.0 o
Puerto Rico				3.8 e	3.8 e	3.8 e	6.9 e	57.9 e	72.9 e	88.4 e
St Kitts Nevis						0.0 e	0.0 e	0.4 e	1.4 e	1.4 e
St Lucia				0.0 e	0.0 e	0.0 e	0.1 e	0.1 e	0.1 e	0.8 e
St Vincent Gren						0.1 e	0.4 e	0.4 e	0.4 e	0.8 e
Suriname					0.2 e	0.4 e	0.4 e	0.4 e	5.4 e	5.4 e
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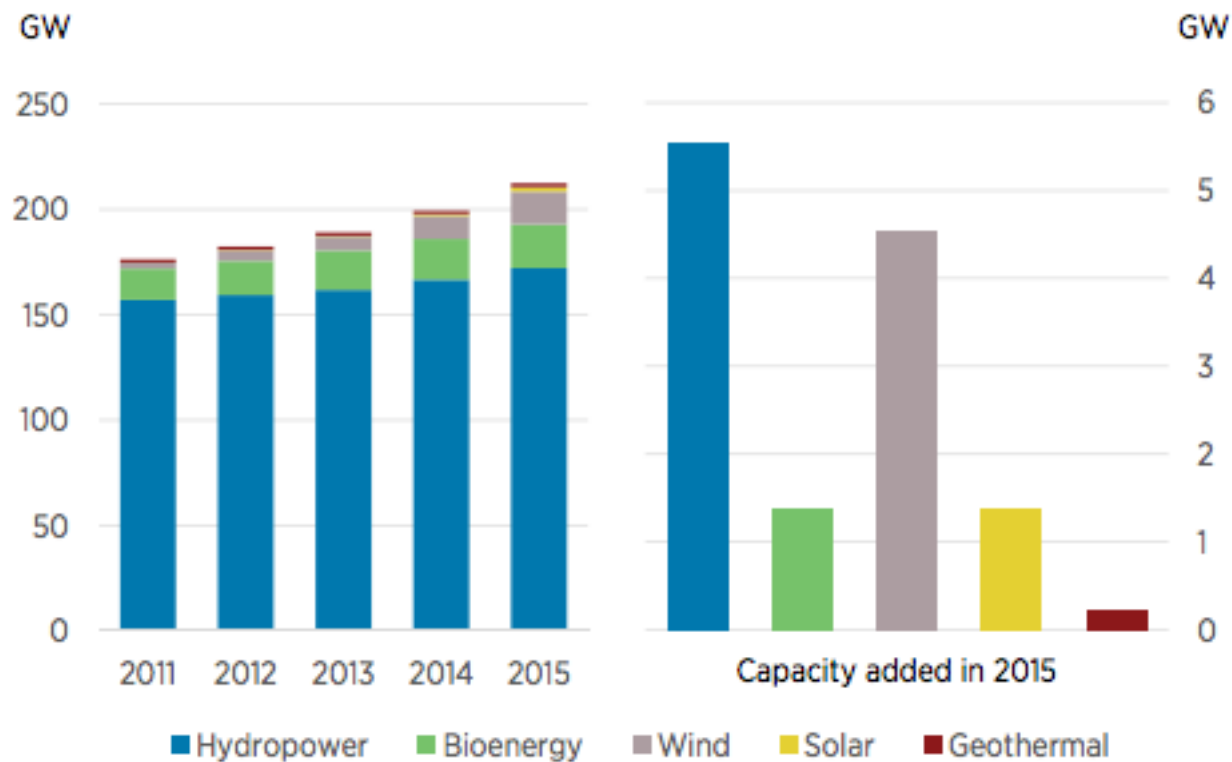
## Solar fotovoltaica

PROD (GWh)	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total	30	32	36	57	86	171	425	682	1 504
Antigua Barb				0.2 e	0.2 e	0.5 e	0.5 e	0.6 e	0.6 e
Argentina	0.1 o	0.1 o	0.1 o	0.1 o	0.1 o	1.6 o	8.2 o	15.0 o	15.8 o
Aruba				0.0 e	0.1 e	0.5 e	1.5 e	2.4 e	7.4 e
Bahamas		0.2 e	0.2 e	0.3 e	0.5 e	0.6 e	0.9 e	0.9 e	1.8 e
Barbados	0.3 e	0.9 e	0.9 e	1.2 e	1.6 e	2.6 e	3.4 e	4.4 e	10.1 e
Belize	0.8 e	1.0 e	1.4 e	1.6 e	1.8 e	2.2 e	5.2 e	5.9 e	6.4 e
Bolivia									e
BES Islands									
Brazil					1.0 o	2.5 o	6.9 o	18.5 o	61.3 o
Chile							0.4	8.0	489.4
Costa Rica							0.3 o	1.4 o	1.5 o
Cuba							1.2 e	18.0	28.9
Curacao	0.1 e	0.1 e	0.1 e	0.1 e	0.1 e	3.7 e	7.3 e	11.8 e	11.8 e
Dominica	0.2 e	0.3 e	0.3 e	0.3 e	0.3 e	0.3 e	0.4 e	0.4 e	0.4 e
Dominican Rep							2.6 e	11.9 e	20.0 e
Ecuador	0.0	0.0	0.0	0.0		0.1	0.3	3.7 o	16.5 o
El Salvador								1.1 e	1.6 e
Fr Guiana				2.5 o	2.5 o	31.0 o	52.0 o	44.0 o	51.0 o
Grenada		0.1 e	0.2 e	0.3 e	0.3 e	0.3 e	0.5 e	0.5 e	0.5 e
Guadeloupe	1.0 o	2.0 o	3.0 o	5.0 o	17.3 o	33.4 o	91.8 o	98.6 o	102.7 o
Guatemala									7.1 o
Guyana	0.6 e	0.8 e	0.9 e	1.0 e	1.2 e	1.6 e	2.1 e	2.4 e	3.1 e
Honduras									
Jamaica	0.3 e	0.7 e	1.0 e	1.2 e	1.7 e	2.5 e	3.0 e	3.5 e	6.9 e
Martinique	3.0 o	3.0 o	5.3 o	11.5 o	19.0 o	38.4 o	79.6 o	75.0 o	84.0 o
Mexico	20.5	19.8	19.0	27.3	31.0	41.3	69.3	106.0	301.9 e
Nicaragua									1.4 o
Panama									1.3 o
Peru							59.7 o	196.9 o	199.3 o
Puerto Rico				0.8 e	0.8 e	0.8 o	17.8 o	39.9 o	48.3 o
St Kitts Nevis						0.0 e	0.0 e	0.6 e	2.3 e
St Lucia				0.0 e	0.0 e	0.0 e	0.1 e	0.1 e	0.2 e
St Vincent Gren						0.1 e	0.6 e	0.6 e	0.6 e
Suriname					0.3 e	0.6 e	0.6 e	0.6 e	7.6 e
Trinidad Tobago	2.7 e	2.9 e	3.1 e	3.5 e	4.0 e	4.0 e	4.0 e	4.0 e	4.0 e
US Virgin Is									

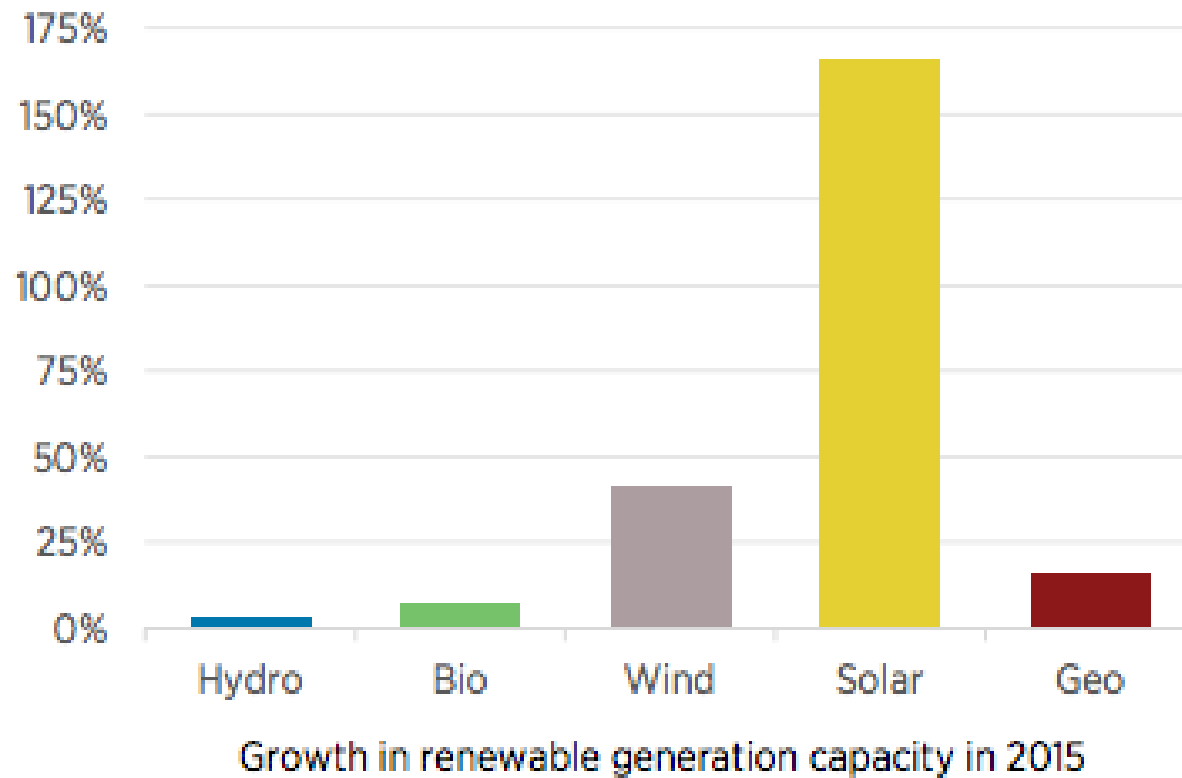


# Crecimiento de la potencia eléctrica América Latina

Capacity growth

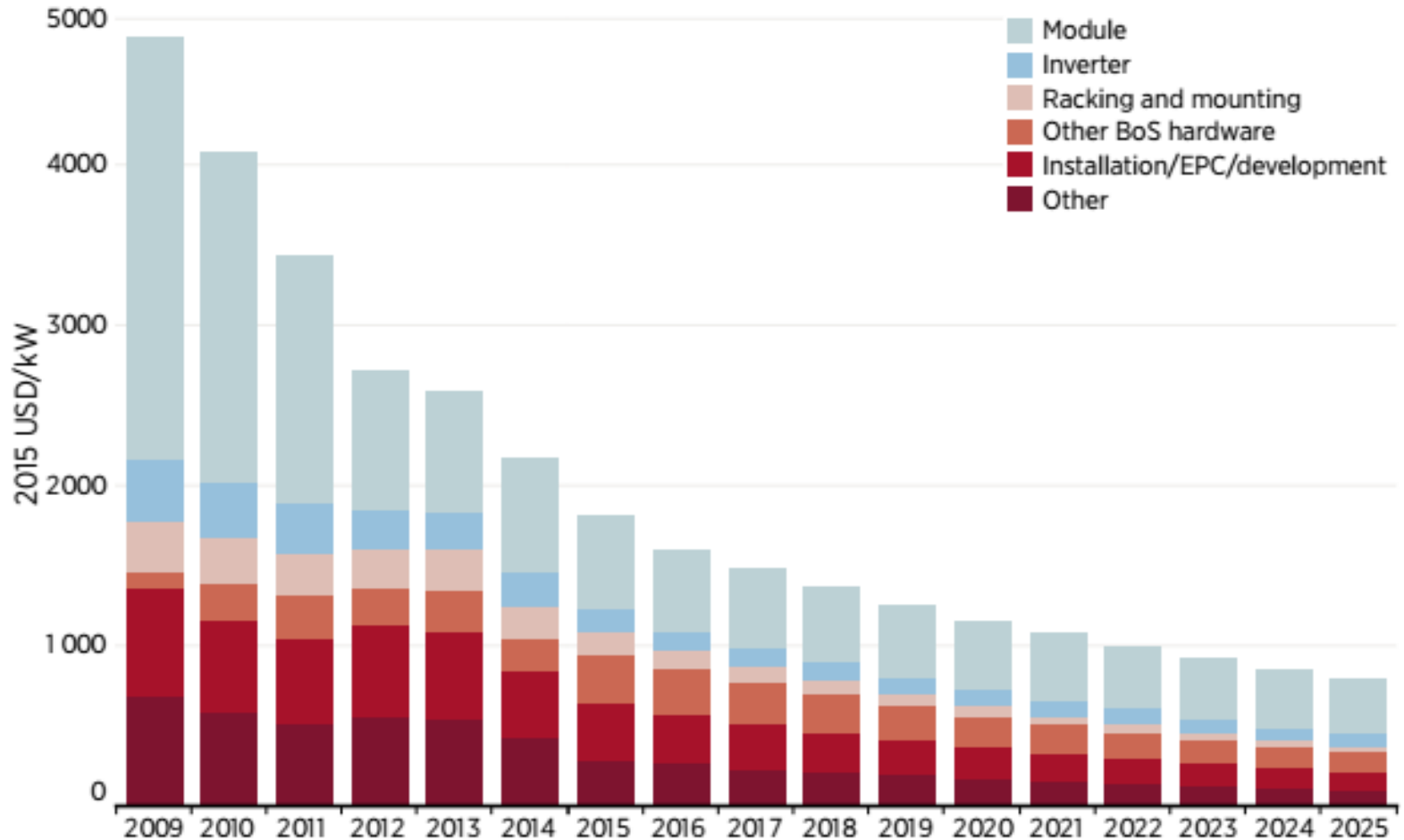


# Crecimiento de la generación eléctrica en América Latina



# Costo de Instalación energía solar FV

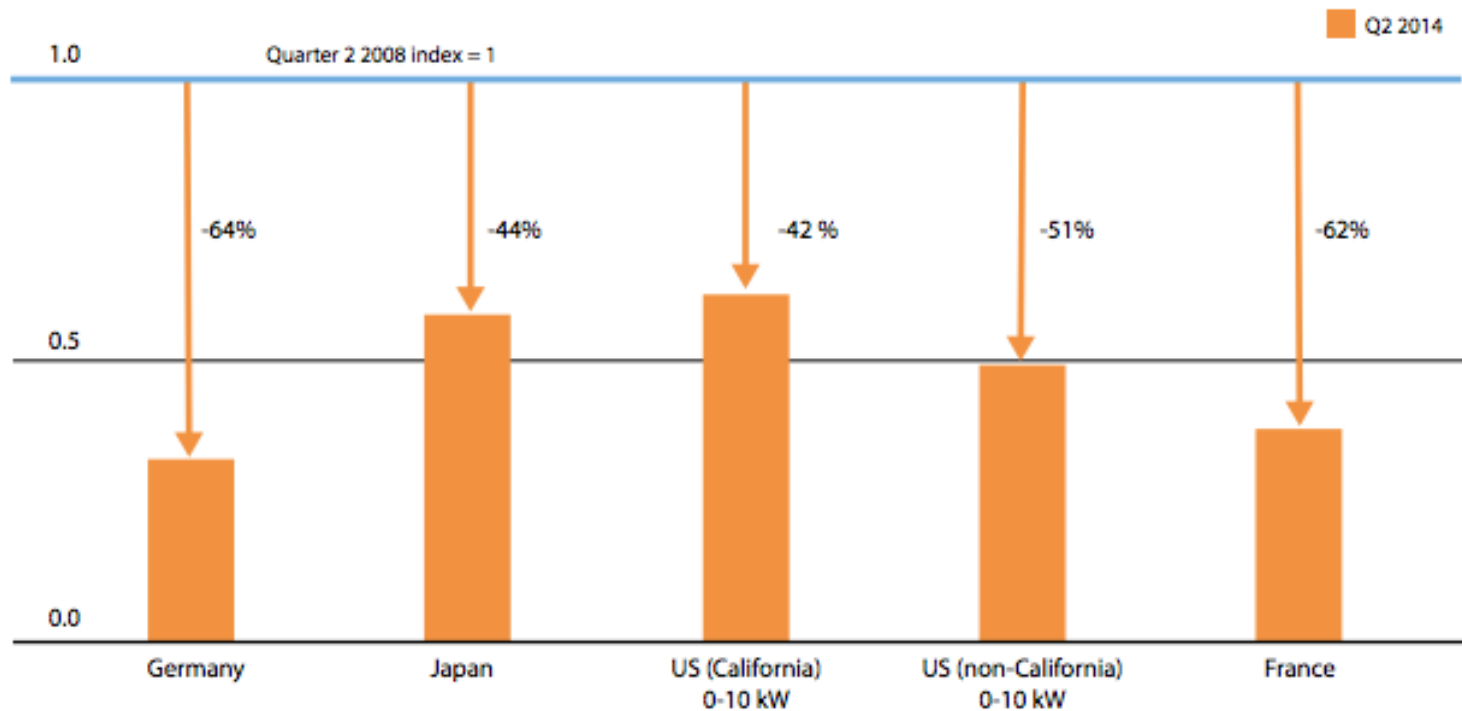
FIGURE ES 1: GLOBAL WEIGHTED AVERAGE UTILITY-SCALE SOLAR PV TOTAL INSTALLED COSTS, 2009-2025



# Reducción de costos medios para pequeña escala energía solar fotovoltaica

FIGURE ES 5: LCOE REDUCTIONS FOR SMALL-SCALE RESIDENTIAL SOLAR PV, Q2 2008 TO Q2 2014

Index of LCOE (Q2 2008 = 1)



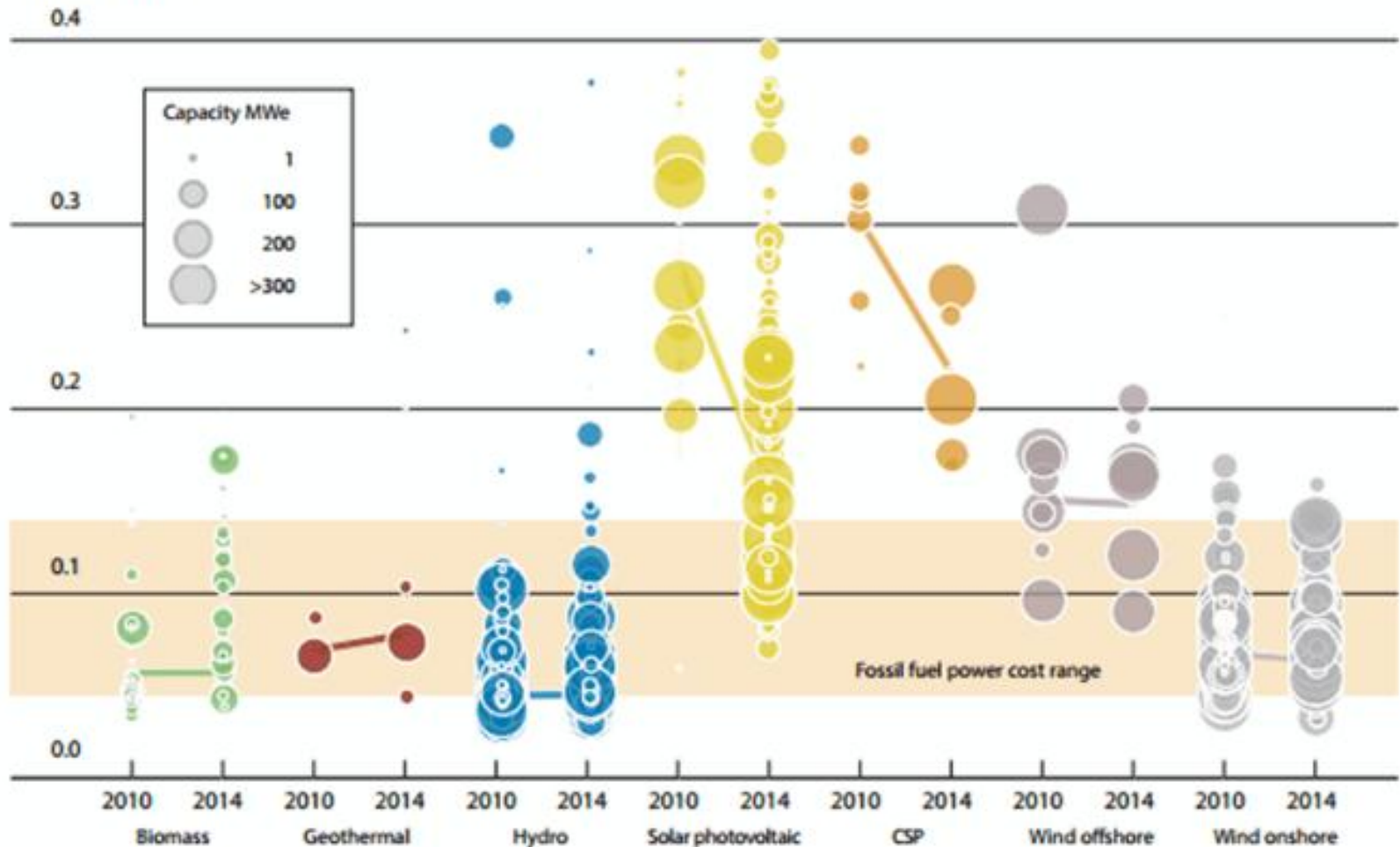
Source: IRENA Renewable Cost Database.



# Costo medio de la electricidad por fuente 2010 - 2014

E.S. 1: THE LEVELISED COST OF ELECTRICITY FROM UTILITY-SCALE RENEWABLE TECHNOLOGIES, 2010 AND 2014

2014 USD/kWh



Source: IRENA Renewable Cost Database.

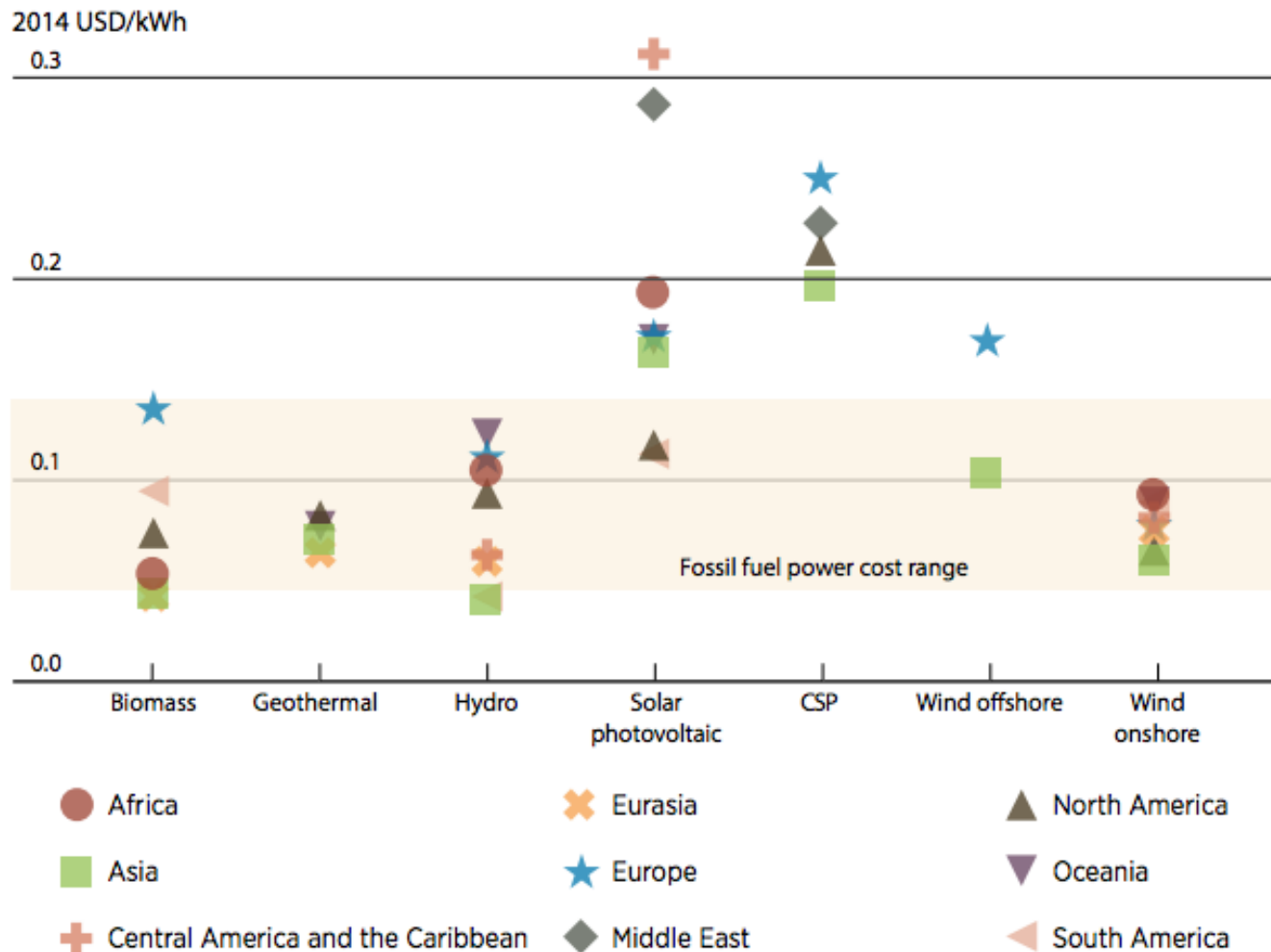
# Costos de la energía solar y eólica 2015 - 2025

Cost reduction potential for solar and wind power, 2015-2025

	Global weighted average data								
	Investment costs (2015 USD/kW)		Percent change	Capacity factor		Percent change <sup>2</sup>	LCOE (2015 USD/kWh)		Percent change
	2015	2025		2015	2025		2015	2025	
<b>Solar PV</b>	1 810	790	-57%	18%	19%	8%	0.13	0.06	-59%
<b>CSP (PTC: parabolic trough collector)</b>	5 550	3 700	-33%	41%	45%	8.4%	0.15 -0.19	0.09 -0.12	-37%
<b>CSP (ST: solar tower)</b>	5 700	3 600	-37%	46%	49%	7.6%	0.15 -0.19	0.08 -0.11	-43%
<b>Onshore wind</b>	1 560	1 370	-12%	27%	30%	11%	0.07	0.05	-26%
<b>Offshore wind</b>	4 650	3 950	-15%	43%	45%	4%	0.18	0.12	-35%

# Costo promedio de la electricidad por región

FIGURE ES 2: WEIGHTED AVERAGE COST OF ELECTRICITY BY REGION FOR UTILITY-SCALE RENEWABLE TECHNOLOGIES, COMPARED WITH FOSSIL FUEL POWER GENERATION COSTS, 2013/2014

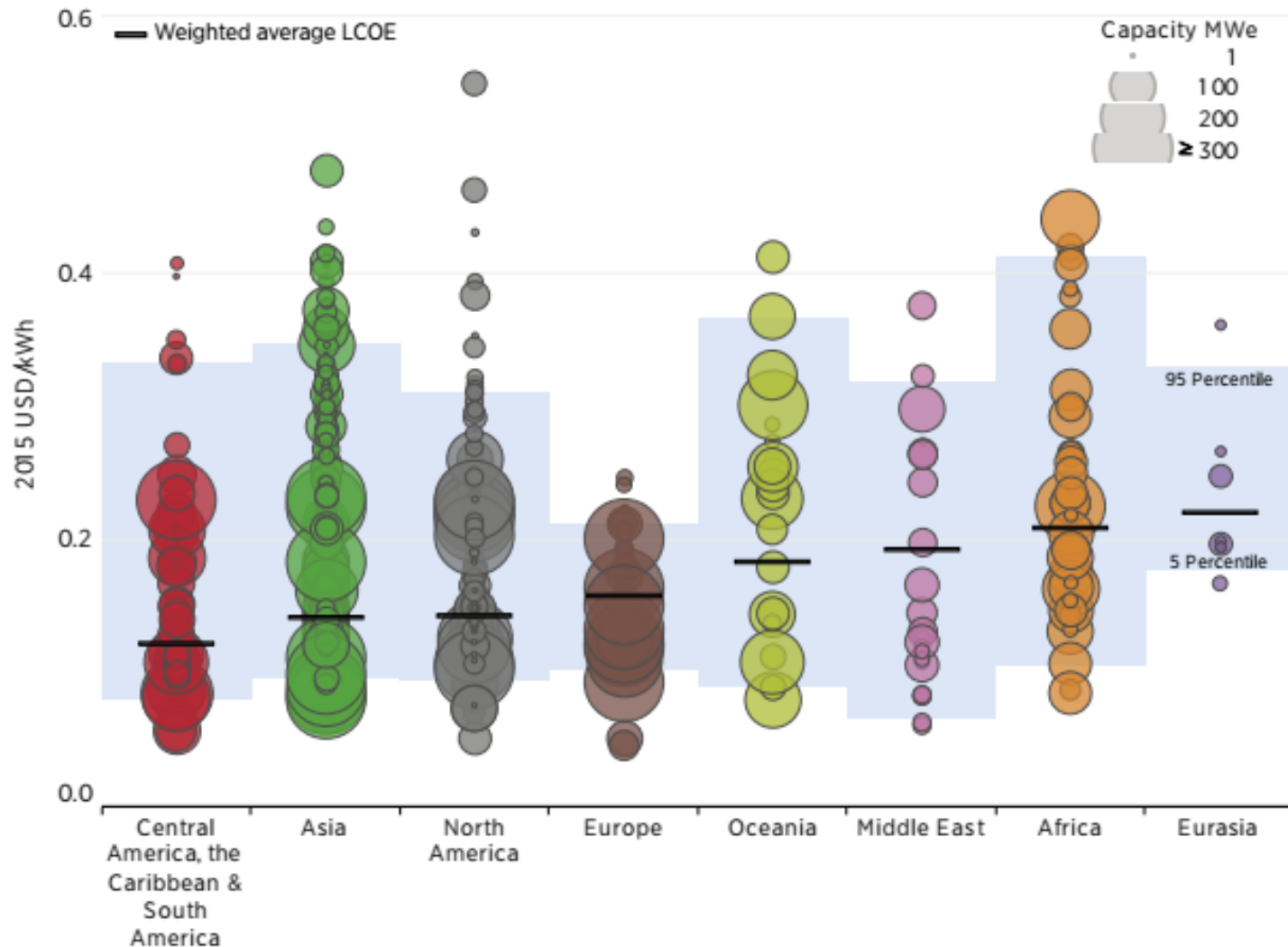


Source: IRENA Renewable Cost Database.

Note: Real weighted average cost of capital of 7.5% in OECD countries and China; 10% in the rest of the world.

# Costo medio energía solar foto voltaica

FIGURE 6: LEVELISED COST OF ELECTRICITY BY PROJECT AND WEIGHTED AVERAGE OF UTILITY-SCALE SOLAR PV SYSTEMS BY REGION, 2014/2015



# Lo privado, lo estatal y la generación distribuida

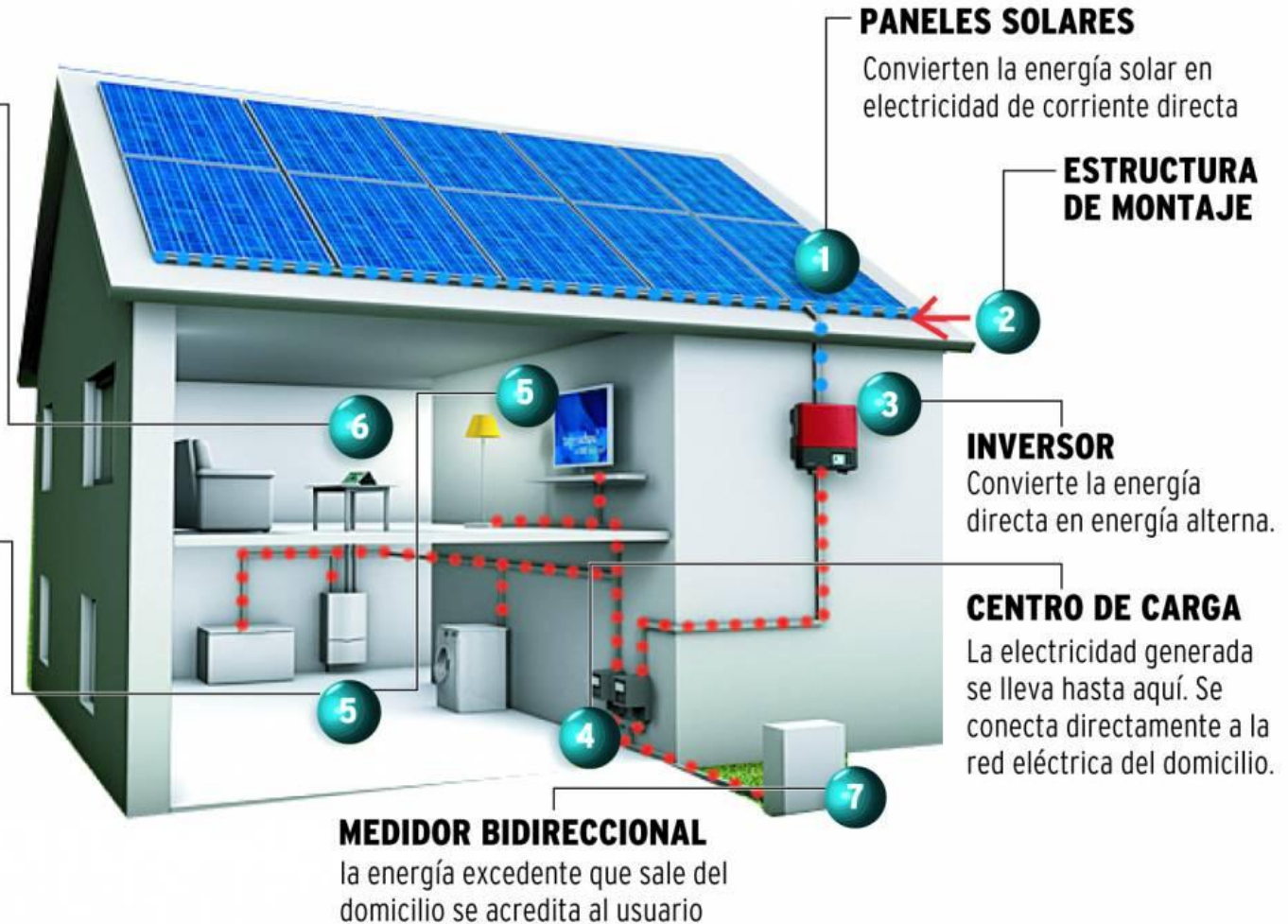
## CARACTERÍSTICAS

### **EQUIPO DE MONITOREO**

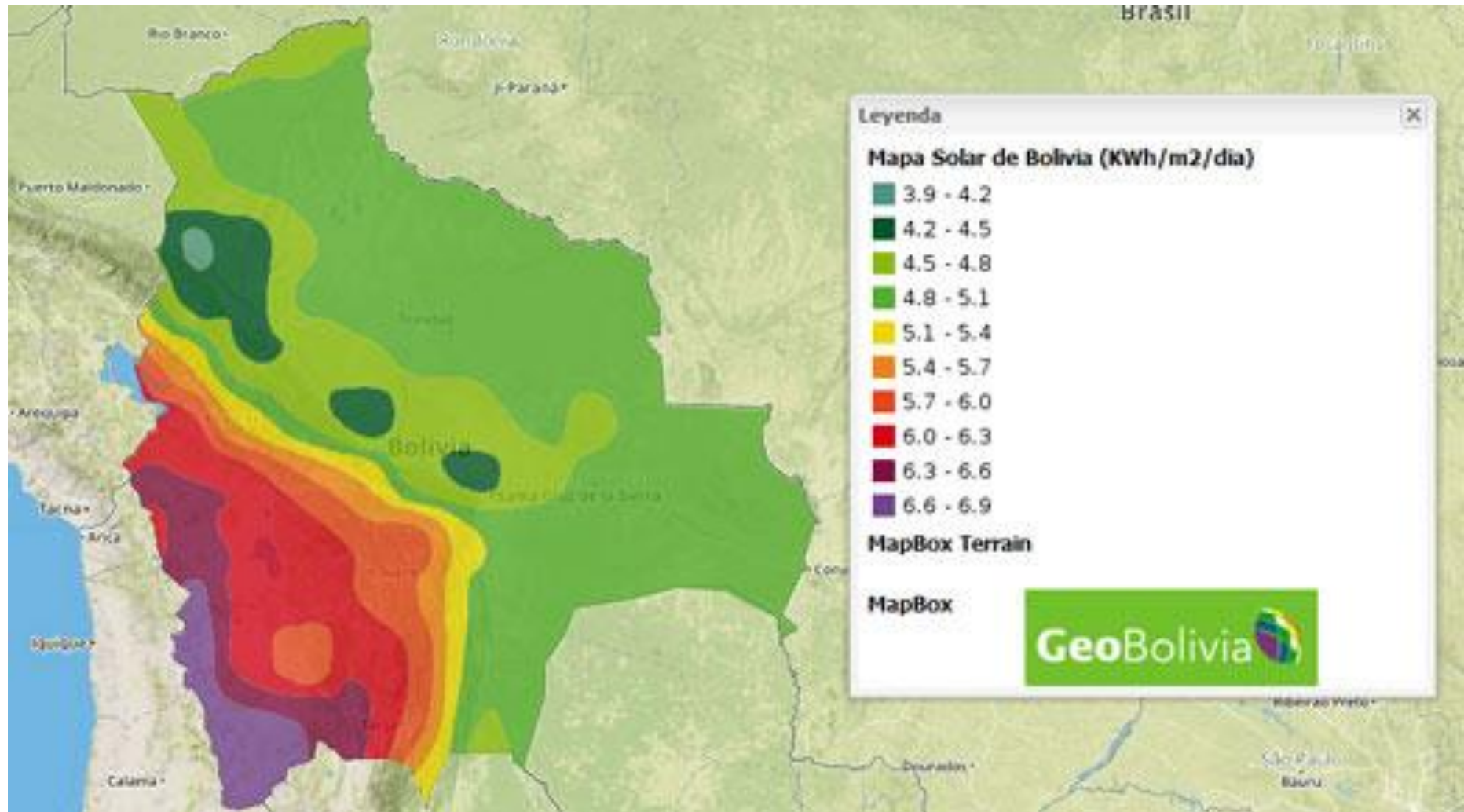
Registra el desempeño de cada panel solar y lo reporta mediante comunicaciones inalámbricas a una ventana de internet.

### **RED ELÉCTRICA**

La energía eléctrica que viene desde los paneles a la entrada de su recién instalado centro de carga se une a la del centro de carga existente en el domicilio.



# Radiación solar



# Velocidad media anual de viento a 80m

