X CONGRESO INTERNACIONAL
BOLIVIA
GAS ENERGÍA 2017

WOOD GROUP

Gas natural versus energias renovables en Latinoamerica

Desafios y competitividad

23 de agosto de 2017

Carlos St. James

(38 slides)

X CONGRESO INTERNACIONAL

BOLIVIA GAS ENERGÍA 2017

WOOD GROUP

Gas natural versus con las energias renovables en Latinoamerica

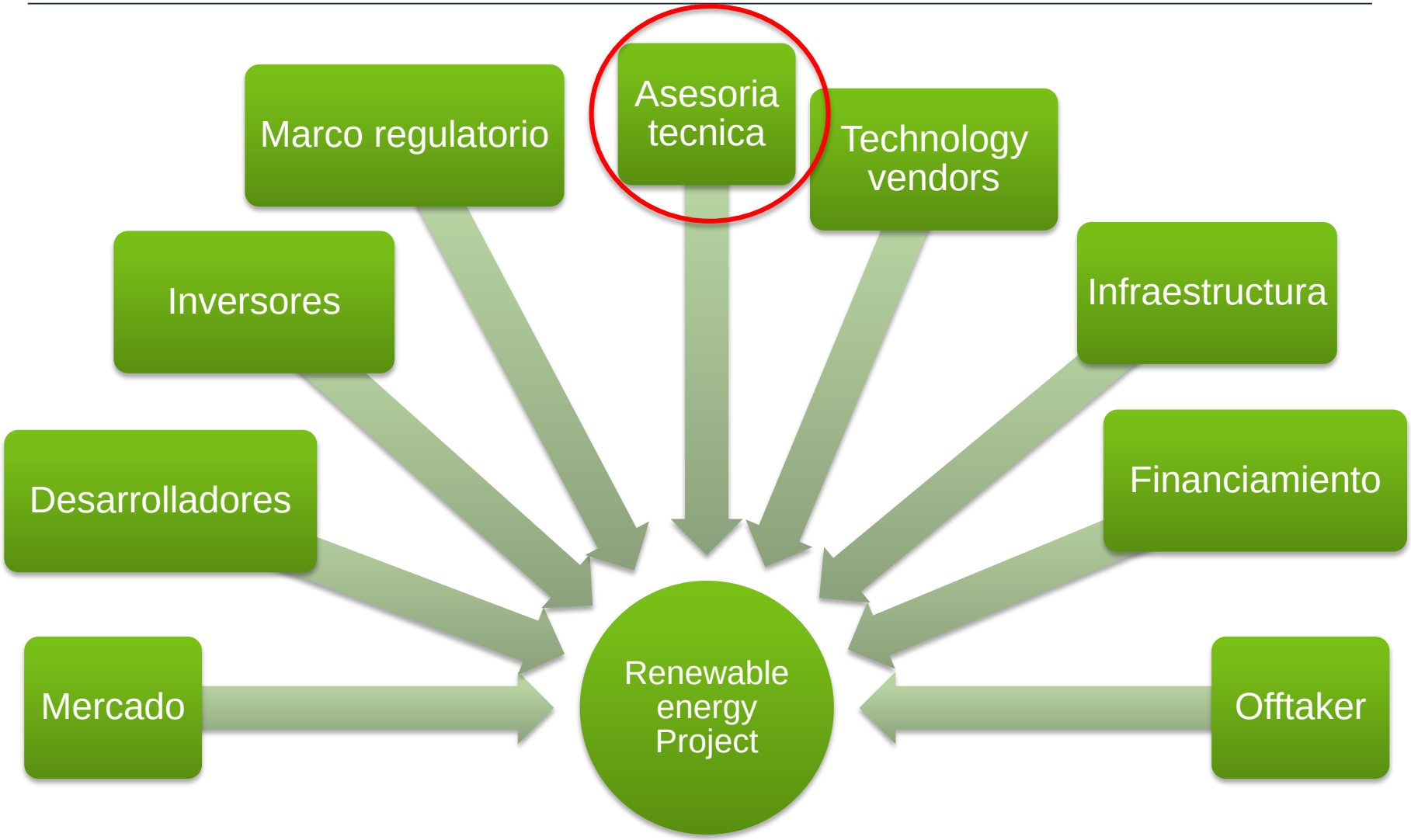
Desafios y competitividad

23 de agosto de 2017

Carlos St. James

(38 slides)

Stakeholders



About Wood Group: asesoria tecnica

- Leading international engineering consultancy
- Formed in Scotland in 1912
- Annual revenues US$4 billion+
- 35,000+ personnel
- Listed on LSE
- SgurrEnergy joined Wood Group in 2010

Global Track Record: over 90 countries

Europe

- Belgium
- Bulgaria
- Estonia
- Finland
- France
- Germany
- Greece
- Ireland
- Italy
- Latvia
- Lithuania
- Malta
- Netherlands
- Norway
- Poland
- Portugal
- Russia
- Romania
- Slovakia
- Spain
- Sweden
- UK
- Ukraine

Asia

- China
- India
- Israel
- Korea
- Mongolia
- Pakistan
- Philippines
- Sri Lanka
- Turkey
- United Arab Emirates
- Vietnam

North America

- Canada
- Mexico
- USA

Oceania

- Australia
- New Zealand

Latin America

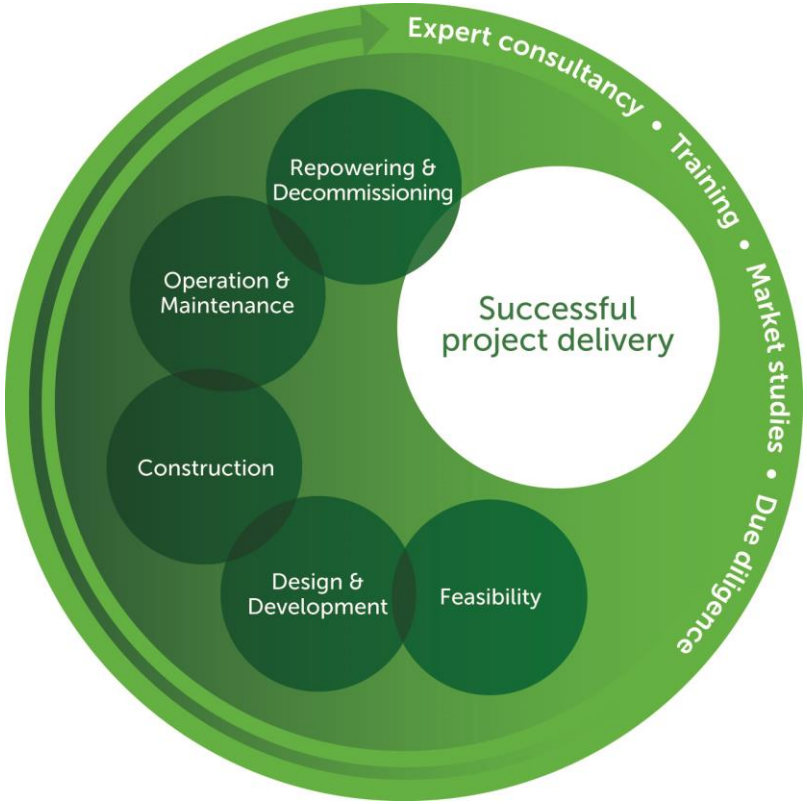
- Brazil
- Chile
- Argentina
- Mexico
- Panama
- El Salvador
- Honduras
- Uruguay
- Paraguay
- Peru
- Ecuador
- Costa Rica

Africa

- Angola
- Ethiopia
- Kenya
- Malawi
- South Africa

What We Do: Project Life Cycles – every phase

Wood Group Clean Energy personnel hold unparalleled engineering knowledge across the full project lifecycle.



What We Do: Wide array of technologies

We provide expert advice for a diverse range of stakeholders including utilities, developers and investors on multiple technologies.

Onshore wind

Offshore wind

Solar

Wave & tidal

Bio-energy

Hydro

Key technical concerns in Latin America/Caribbean

1) Equator Principles compliance
2) Overestimation of energy yields (EYs) and grid accessibility
3) Technology review: right technology for location
4) Contract review: inexperienced engineering, procurement & construction (EPC) contractors
5) Need for optimization of assets

Tech concerns: (1) Equator Principles compliance

#	Company	Project	Technology	Capacity (MW)	State	Price USD/Mwh
1	ENEL	Villanueva	solar	330	Coahuila	$35.43
2	ENEL	Villanueva 3	solar	250	Coahuila	$38.27
3	Sunpower	Guajiro 2	solar	100	Guanajuato	$44.21
4	ENEL	Don Jose	solar	207	Guanajuato	$45.05
5	Jinko	Las Vibonillas	solar	100	Jalisco	$47.18
6	Canadian Solar/Recurrent	Aguascalientes Potencia 1	solar	63	Aguascalientes	$47.85
7	Thermion	Sol de Insurgentes	solar	23	Baja California	$47.90
8	Sunpower/Vega Solar	Ticul 1	solar	500	Yucatan	$56.28
9	Jinko	Concunul	solar	70	Yucatan	$58.23
10	Sunpower/Vega Solar	Ticul 1	solar	500	Yucatan	$58.59
11	Jinko	San Ignacio	solar	18	Yucatan	$63.24
12	Alarde/Photomeris	Kambul	solar	30	Yucatan	$68.10
13	Acciona	El Cortijo	wind	168	Tamaulipas	$42.81
14	Aldesa	Chacabal	wind	30	Yucatan	$59.66
15	Aldesa	Chacabal II	wind	30	Yucatan	$59.66
16	Envision/Viva Energia	Energia Renov. de la Penin.	wind	90	Yucatan	$65.83
17	Consorcio Energia Limpia	Tizimin	wind	76	Yucatan	$66.86

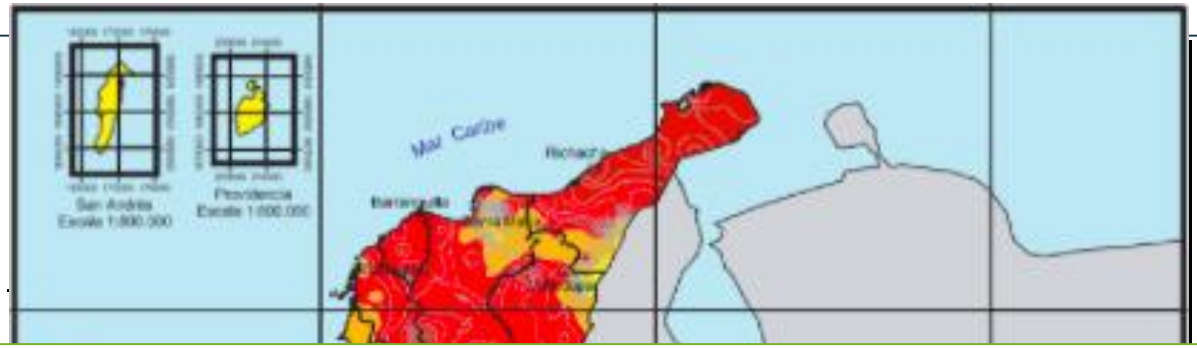
- Developed by IFC – minimum social & environmental standards
- Most lenders require EP compliance
- Most national environmental regulations do *not* meet EP criteria
- ✓ *Result: increased development costs after-the-fact and project delays*

Tech concerns: (1) Equator Principles compliance

E&S technical DD solar	InterEnergy	Costa Rica
E&S technical DD solar	Real Infrastructure	Panama
E&S technical DD wind	InterEnergy	Honduras
E&E technical DD solar	Santiago Solar	Chile
E&S technical DD wind	InterEnergy	Panama
E&S technical DD solar	InterEnergy	Nicaragua

Authorship	Client	Scope
Utility Scale Solar PV Power Plants: A Projects Developer's Guide	IFC	Emerging markets
Revised Environmental, Health & Safety (EHS) Guidelines for Wind Energy	IFC	Global

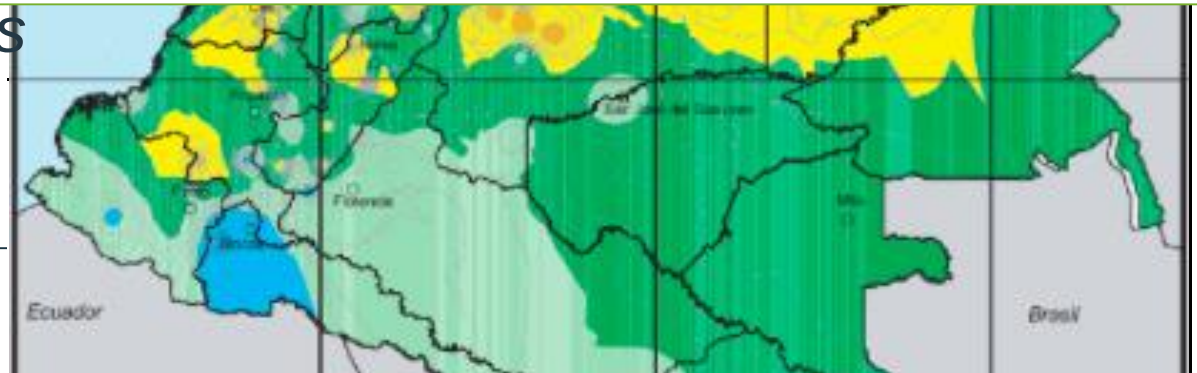
Tech concerns: (2) Overestimation of EYs & grid accessibility



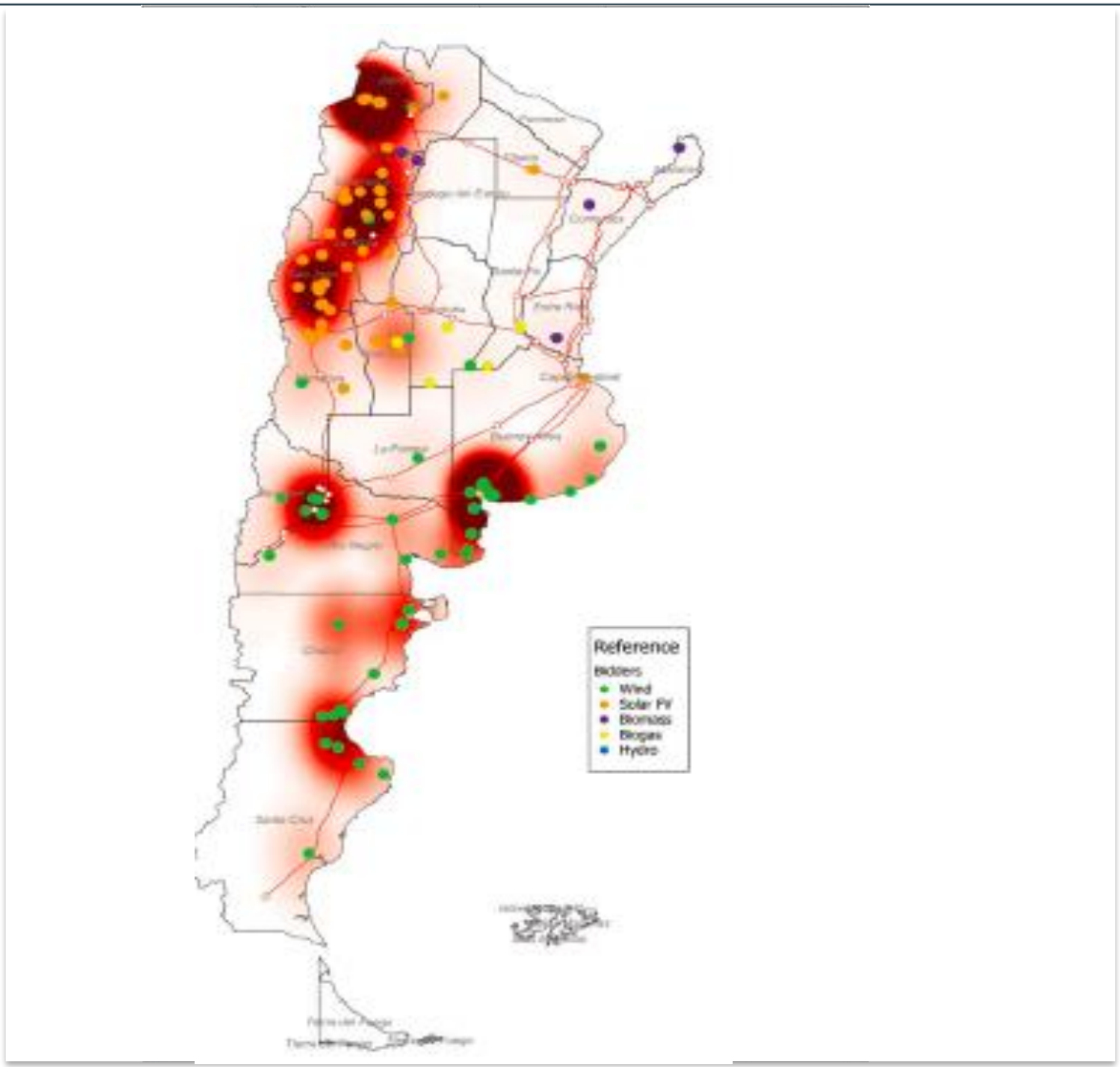
- Tendency for developers to overestimate energy yields (EYs)
- Over time projects underperform; cash flow reductions

✓ *Independent EY & grid access analyses important to assess true resource*

✓ *Analysis to ensure the right technology is being used for site characteristics*



Tech concerns: (2) Overestimation of EYs & grid accessibility

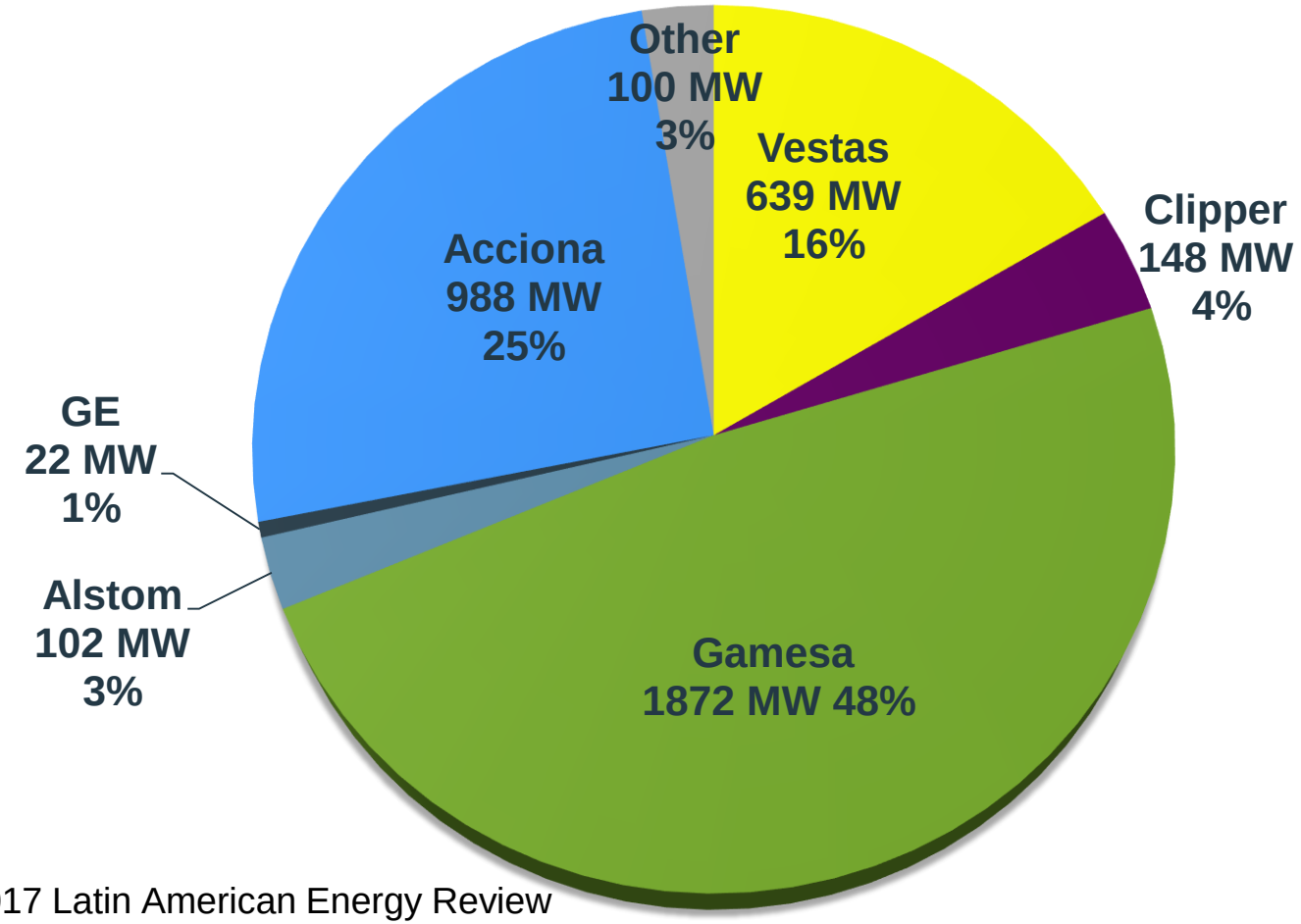


Tech concerns: (3) technology review

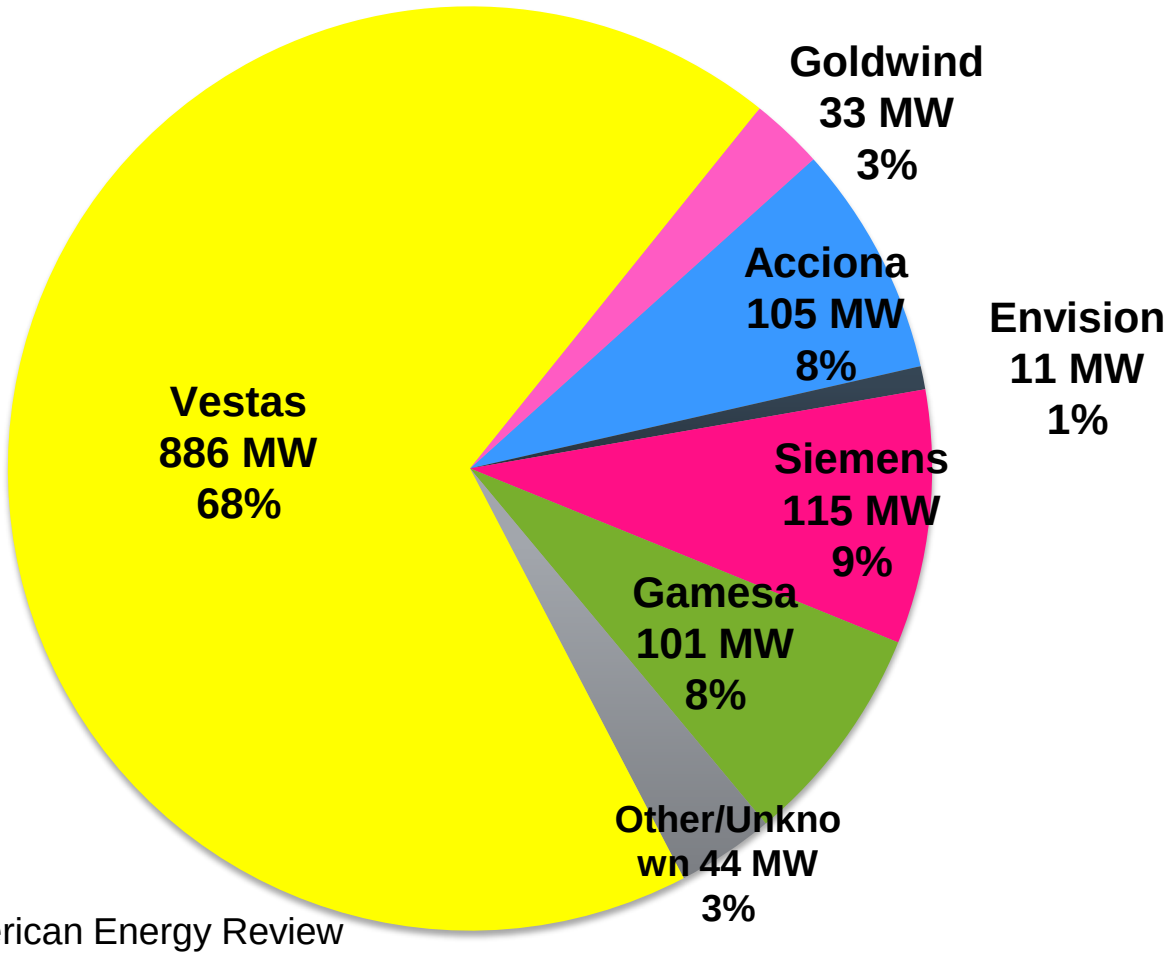
- Climate varies greatly among and within countries across LatAm & Carib
- Different turbines operate differently depending on climate

✓ *May need options to maximize productivity, such as Good Climate Package*

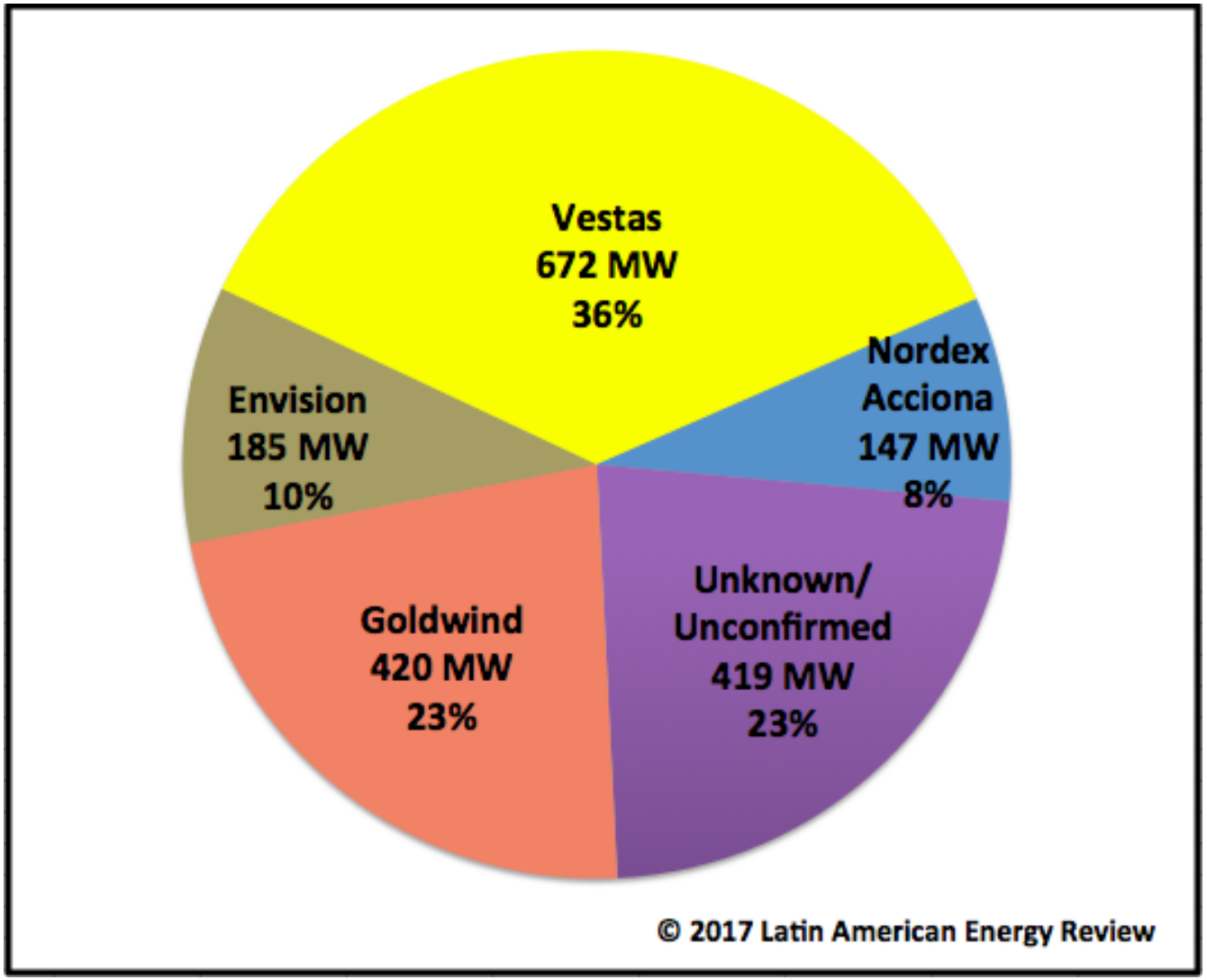
Wind turbine market share in 2016: Mexico



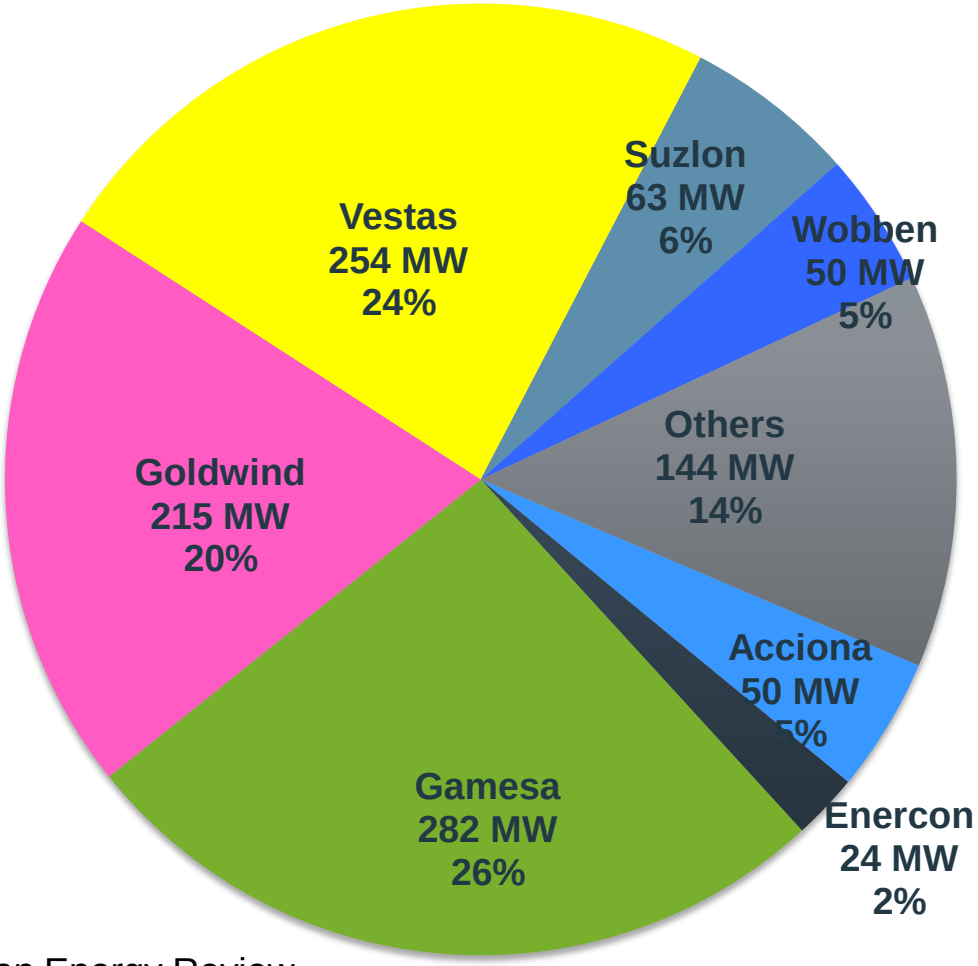
Wind turbine market share in 2016: Chile



Argentina's RenovAr wind turbine orders



Wind turbine market share in 2016: Central America



Tech concerns: (4) contract review

- EPC contracts may be signed with international companies -- which then subcontract to locals short on experience
- In different climates you may find unexpectedly higher corrosion, mold, or invasive vegetation on technology

✓ *A Project Participants Review can assess experience of locals plus determine if warranties are adequate*

✓ *O&M provisions merit review*

Tech concerns: (5) asset optimization

INSTALLED WI

#	Country	Name
1	CR	Central Tilara
2	CR	Viento del Arena
3	CR	Aeroenergia
4	CR	Tejona
5	CR	Western Lake Ar
6	GT	Viento Blanco
7	CR	La Gloria
8	NI	Amayo I
9	NI	Amayo II
10	CR	Los Santos
11	CR	Montes de Oro
12	HN	Cerro de Hula I
13	CR	Valle Central
14	CR	Guayabo
15	NI	La Fe - San Marti
16	NI	Eolo
17	CR	Chiripa
18	CR	San Buenaventu
19	NI	Alba Rivas
20	CR	Tila Wind I
21	CR	Orosi
22	GT	San Antonio El S
23	HN	San Marcos I
24	PA	Penonome I & II
25	PA	Nuevo Chagres
26	PA	Portobelo
27	HN	Cerro de Hula II
28	HN	San Marcos II
29	HN	Ocean View

Chile Wind Energy Installed Capa

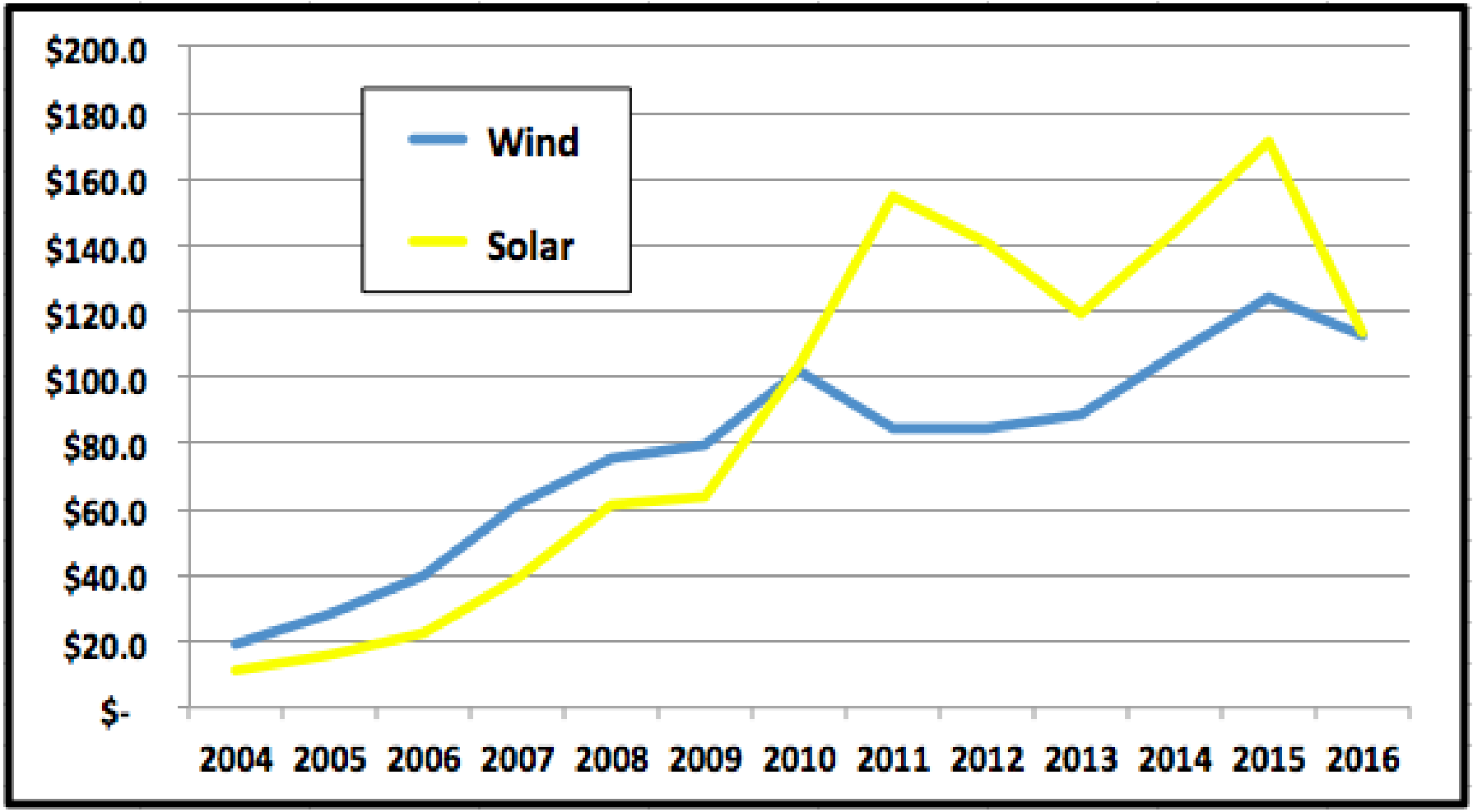
#	Name	MW	COD	Vendor	
1	Alto Baguales	2	2001	Vestas	
2	Canela I	18.15	2007	Vestas	V
3	Lebu	6.5	2009	Hewind	
4	Canela II	60	2009	Acciona	AV
5	Monte Redondo I	38	2009	Vestas	V
6	Cabo Negro	2.55	2010	Vestas	
7	El Toqui	1.65	2010	Vergnet	GEV
8	Totoral	46	2010	Vestas	V
9	Punta Colorada I	20	2011	Dewind	
10	Monte Redondo II	10	2011	Vestas	V
11	Talinay Oriente	90	2013	Vestas	V
12	Punta Palmeras	45	2014	Acciona	AV
13	El Arrayan	115	2014	Siemens	SV
14	Los Cururos Pacifico	70	2014	Vestas	V
15	Valle de los Vientos	90	2014	Vestas	V
16	San Pedro	36	2014	Gamesa	G
17	Cuel	33	2014	Goldwind	GV
18	Los Cururos Cebada	39.6	2014	Vestas	V
19	Ucuquer II	10.5	2014	Envision	
20	Huajache	6	2015	Vestas	V
21	Raki	9	2015	Vestas	V
22	Taltal	99	2015	Vestas	V
23	Talinay Poniente	60.6	2015	Vestas	V
24	Ucuquer I	8	2015	Vestas	
25	Renaico	88	2016	Vestas	
26	Los Buenos Aires	24	2016	Vestas	
27	Las Penas	8.4	2016		
28	Alto Baguales 2	1.8	2016		
29	Lebu III	5.25	2016		
30	San Pedro II	65	2017	Gamesa	G
31	San Juan	184.8	2017	Vestas	V

#	Name	MW	Vendor	COD	State
1	La Venta I	1.6	Vestas	1994	Oaxaca
2	Guerrero Negro	0.6	Gamesa	1999	Baja California
3	La Venta II	83.3	Gamesa	2006	Oaxaca
4	La Ventosa I	49.3	Gamesa	2008	Oaxaca
5	La Ventosa II	30.6	Gamesa	2008	Oaxaca
6	Eurus I	37.5	Acciona	2009	Oaxaca
7	La Rumorosa	10	Gamesa	2009	Baja California
8	Parques Eolicos de Mexico	80	Gamesa	2009	Oaxaca
9	Eurus II	212.5	Acciona	2010	Oaxaca
10	Cancun	1.5	Acciona	2010	Quintana Roo
11	La Mata - La Ventosa	67.5	Clipper	2010	Oaxaca
12	Bii Nee Stipa I	26.35	Gamesa	2010	Oaxaca
13	Fuerza Eolica del Istmo I	50	Clipper	2011	Oaxaca
14	Oaxaca I	102	Vestas	2012	Oaxaca
15	Oaxaca II	102	Acciona	2012	Oaxaca
16	Oaxaca III	102	Acciona	2012	Oaxaca
17	Oaxaca IV	102	Acciona	2012	Oaxaca
18	Fuerza Eolica del Istmo II	30	Clipper	2012	Oaxaca
19	La Venta III	102	Gamesa	2012	Oaxaca
20	Piedra Larga I	90	Gamesa	2012	Oaxaca
21	Arriaga	28.8	Vestas	2012	Chiapas
22	Eoliatec del Istmo (Bii Stinu)	164	Gamesa	2013	Oaxaca
23	Bii Nee Stipa II, Phase III	74	Gamesa	2013	Oaxaca
24	Bii Nee Stipa III/Dos Arbolitos	70	Gamesa	2013	Oaxaca
25	La Ventosa III	22	Gamesa	2013	Oaxaca
26	Santa Catarina	22	GE	2013	Nuevo Leon
27	Los Altos	50.4	Vestas	2013	Jalisco
28	Eoliatec del Pacifico	160	Gamesa	2014	Oaxaca
29	Bii Hioxo Norte	120	Gamesa	2014	Oaxaca
30	Bii Hioxo Sur	114	Gamesa	2014	Oaxaca
31	Bii Nee Stipa IV	74	Gamesa	2014	Oaxaca
32	Dominica I	100	Gamesa	2014	San Luis Potosi
33	El Porvenir	54	Vestas	2014	Tamaulipas
34	Ventika I	126	Acciona	2015	Nuevo Leon
35	Ingenio	49.5	Acciona	2015	Oaxaca
36	Sureste I, Phase II La Mata	102	Alstom	2015	Oaxaca
37	Pier II	66	Gamesa	2015	Puebla
38	Dominica II	100	Gamesa	2015	San Luis Potosi
39	Sierra Juarez	155.1	Vestas	2015	Baja California
40	Palo Alto	129	Acciona	2016	Jalisco
41	Ventika II	126	Acciona	2016	Nuevo Leon
42	Coahuila	197.4	Gamesa	2016	Coahuila
43	Piedra Larga II	138	Gamesa	2016	Oaxaca
44	Vientos del Altiplano	100	Unknown	2016	Zacatecas
45	Tres Mesas I	62.7	Vestas	2016	Tamaulipas
46	Tres Mesas II	85.8	Vestas	2016	Tamaulipas
47	La Mesa	49.5	Vestas	2016	Tamaulipas
48	Ciudad Victoria	49.5	Vestas	2016	Tamaulipas

Why Wood Group Clean Energy?

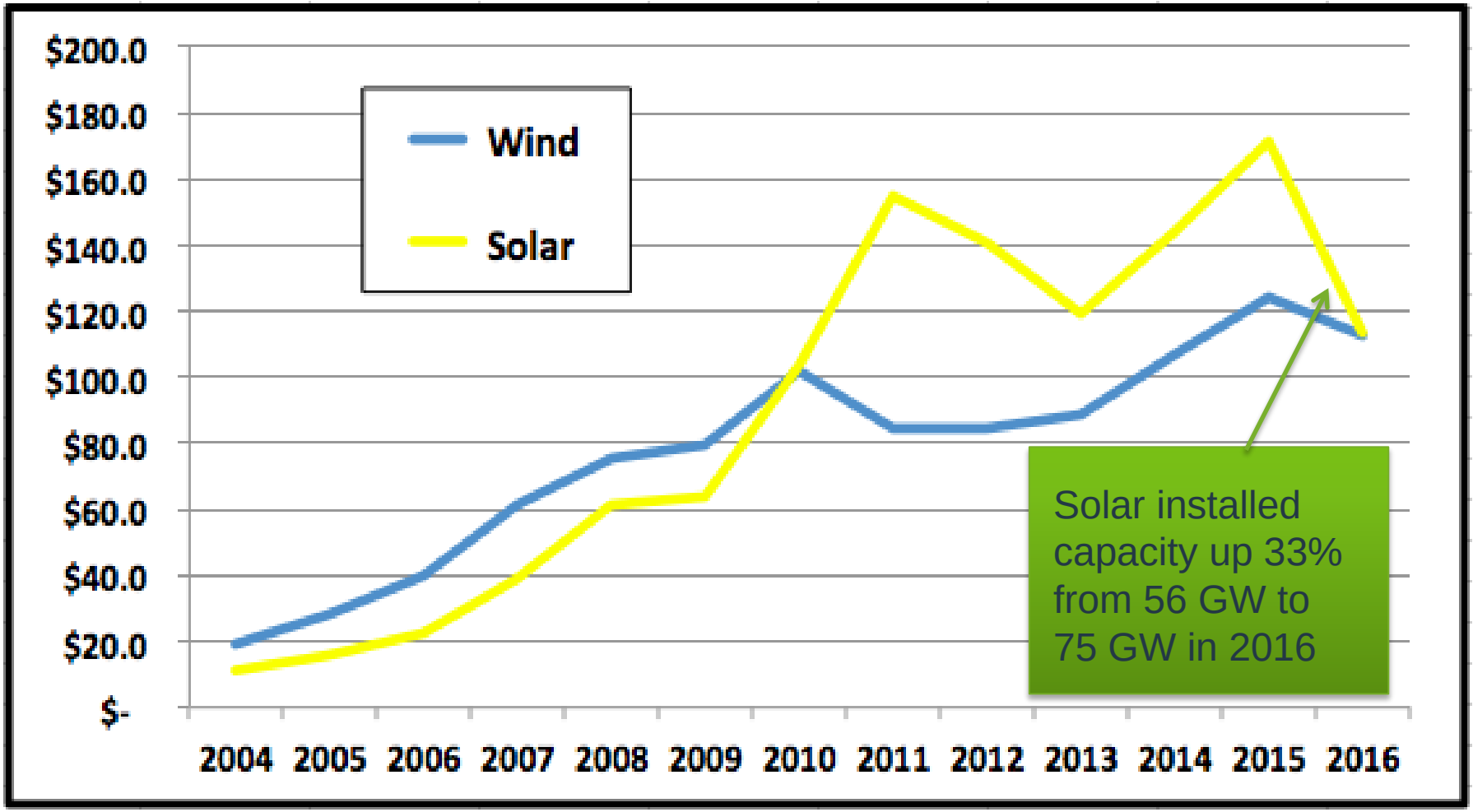
- *Impartial proactive assessment of all stages of your project*
- *A trusted advisor to*
  - Leading utilities and developers
  - Project finance banks
  - Global investment and infrastructure funds
- *Expert teams, covering all major/leading renewable energy technologies*
- *Proven track record*
  - Truly global track record
  - Over 160 GW of renewable energy experience worldwide
  - Involvement in over 80% of current offshore wind project finance deals
  - Multiple solar due diligence in every continent

Capacidad instalada de solar y eolico se duplicara…

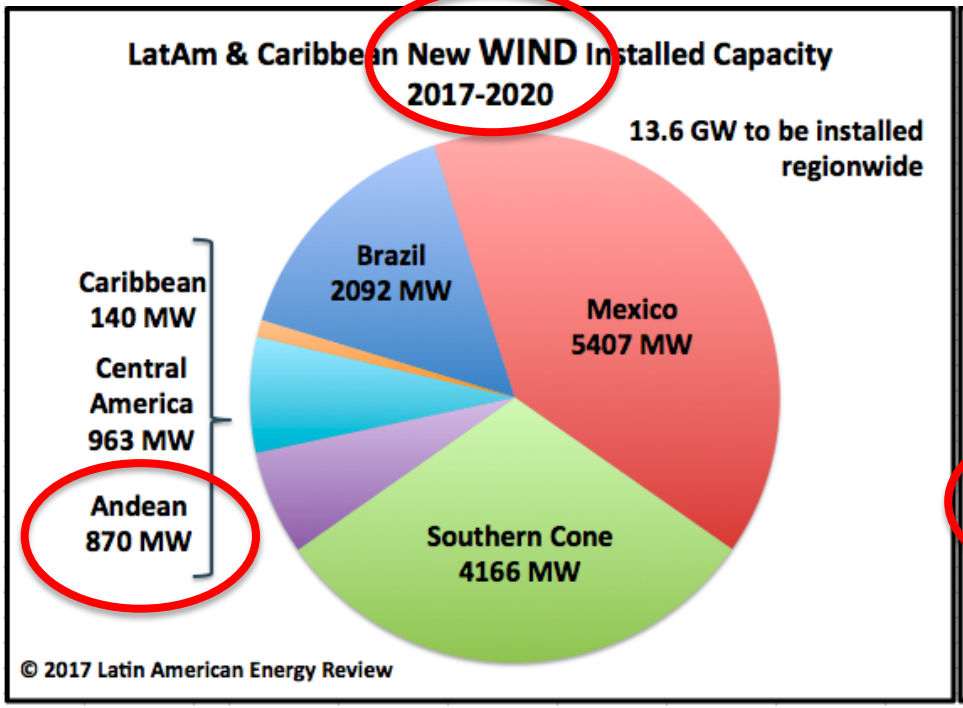


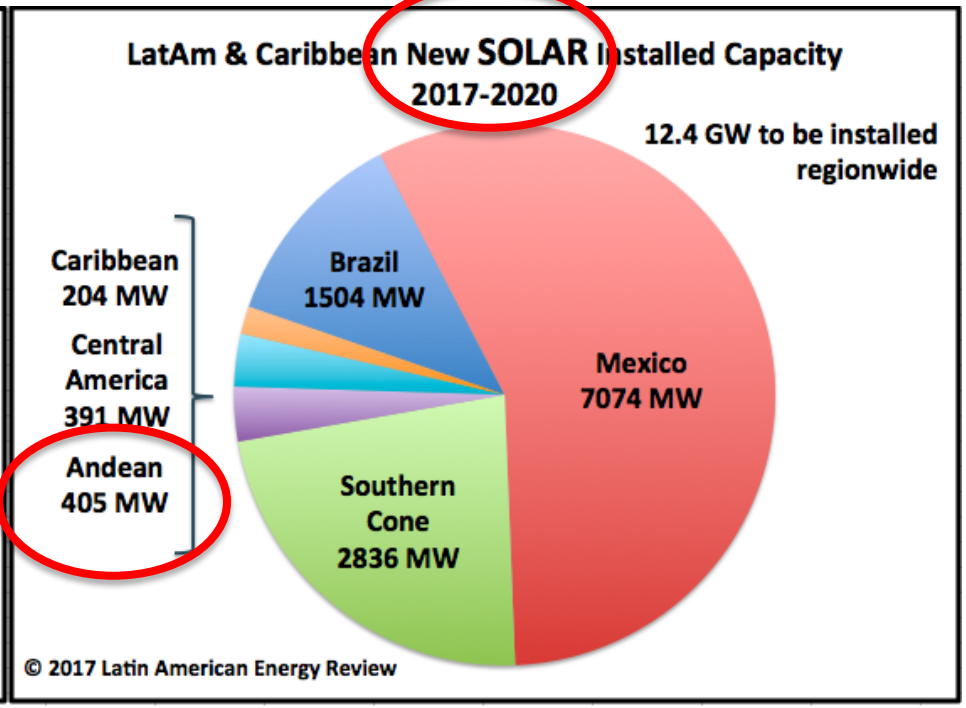
Source: composite Bloomberg New Energy Finance (BNEF) and author data

Inversion global en energia eolica versus solar FV



… visto lado a lado, tendencias pueden verse





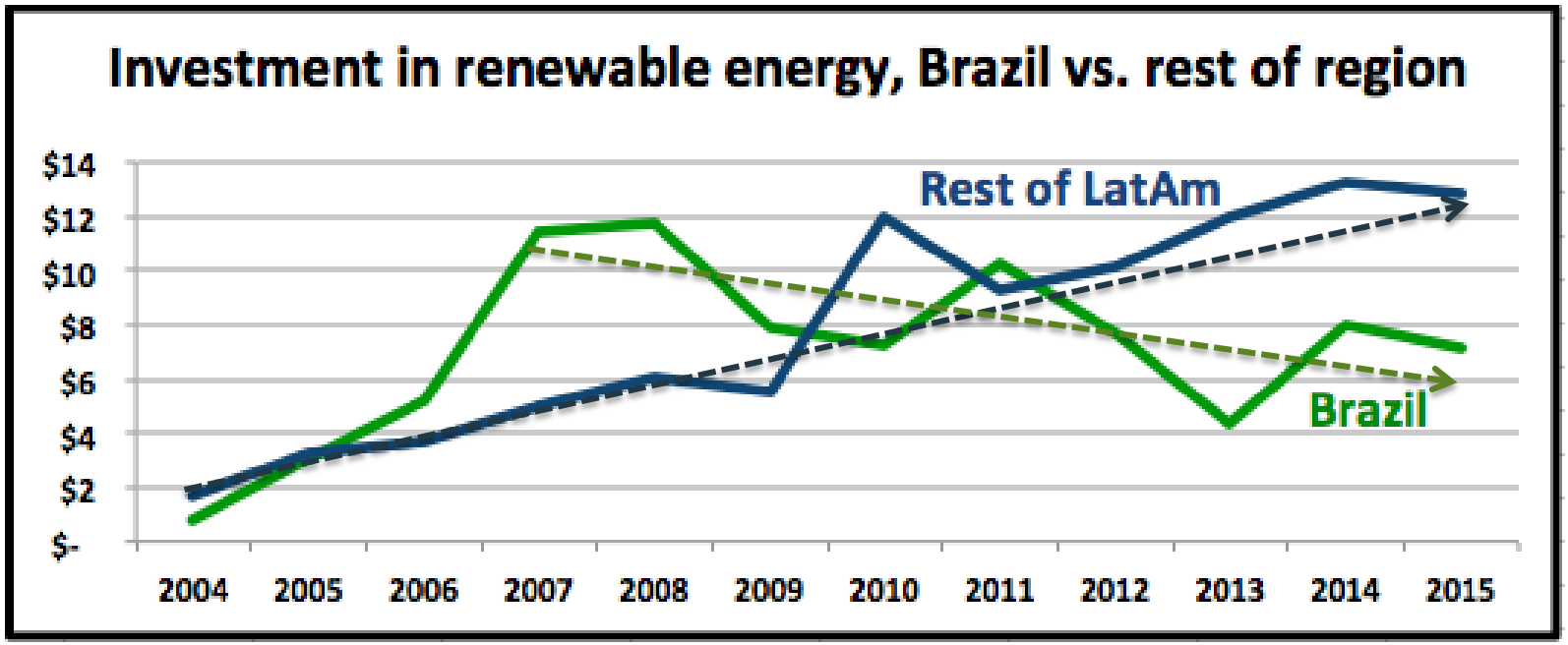
Source: composite Bloomberg New Energy Finance (BNEF) and author data

New installed capacity in LatAm/Carib, 2017-2020

Wind New Capacity 2017-2020			
Sub-region	Country	Growth	
		MW	%
	Mexico	5407	158%
	Brazil	2092	21%
Southern Cone	Argentina	2358	1030%
	Chile	1470	127%
	Uruguay	338	29%
Andean	Peru	467	195%
	Colombia	200	1111%
	Bolivia	153	567%
	Ecuador	50	238%
Central America	Panama	199	73%
	Guatemala	90	122%
	Costa Rica	243	70%
	Honduras	342	178%
	El Salvador	50	NA
	Nicaragua	39	21%
Caribbean	Jamaica	32	41%
	Dominican Republic	108	38%

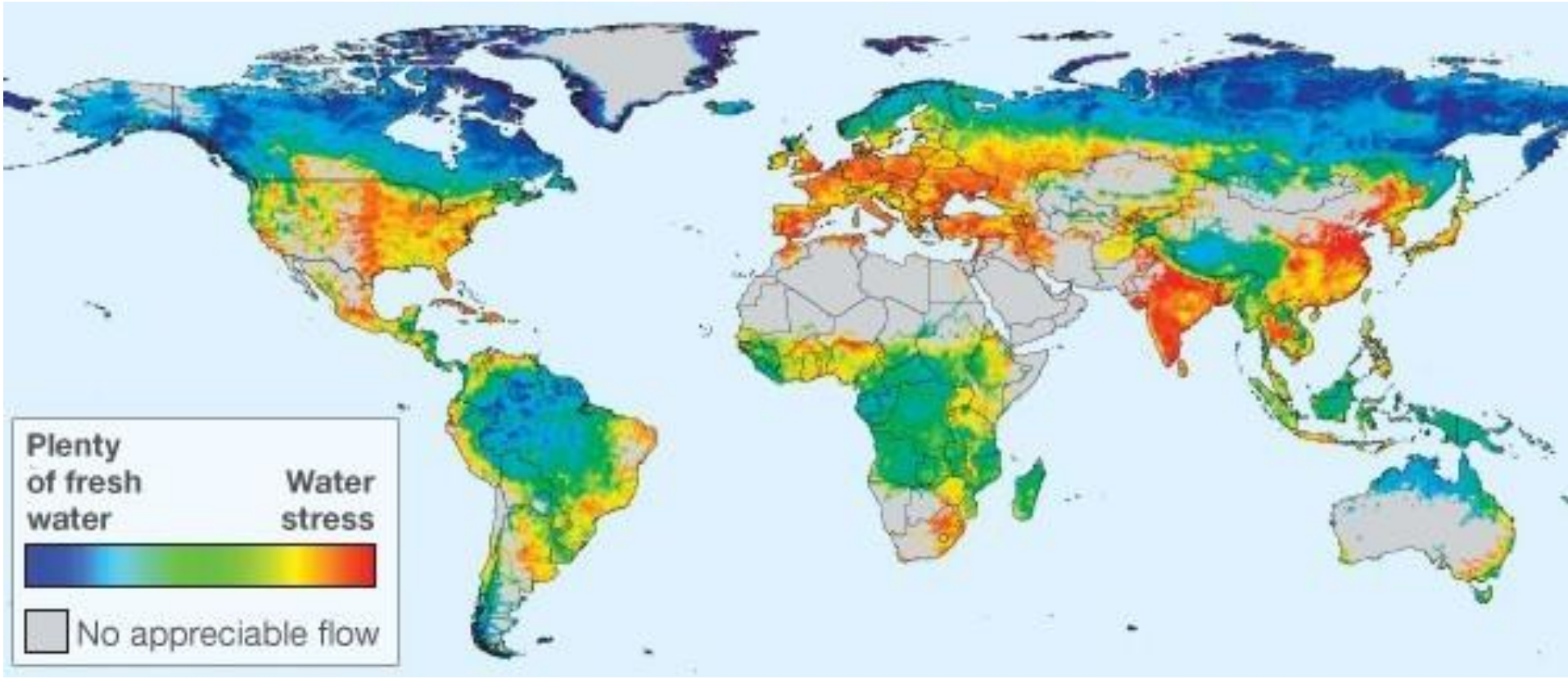
New Solar Capacity 2017-2020			
Sub-region	Country	Growth	
		MW	%
	Mexico	7074	4913%
	Brazil	1504	6539%
Southern Cone	Chile	1913	122%
	Argentina	772	9650%
	Uruguay	151	153%
Andean	Peru	280	280%
	Ecuador	101	594%
	Colombia	24	200%
Central America	El Salvador	188	184%
	Panama	55	75%
	Nicaragua	48	400%
	Honduras	40	10%
	Guatemala	36	40%
	Costa Rica	24	2400%
Caribbean	Dominican Republic	74	206%
	Rest of Caribbean	130	191%

Brazil is no longer the regional driver of investment

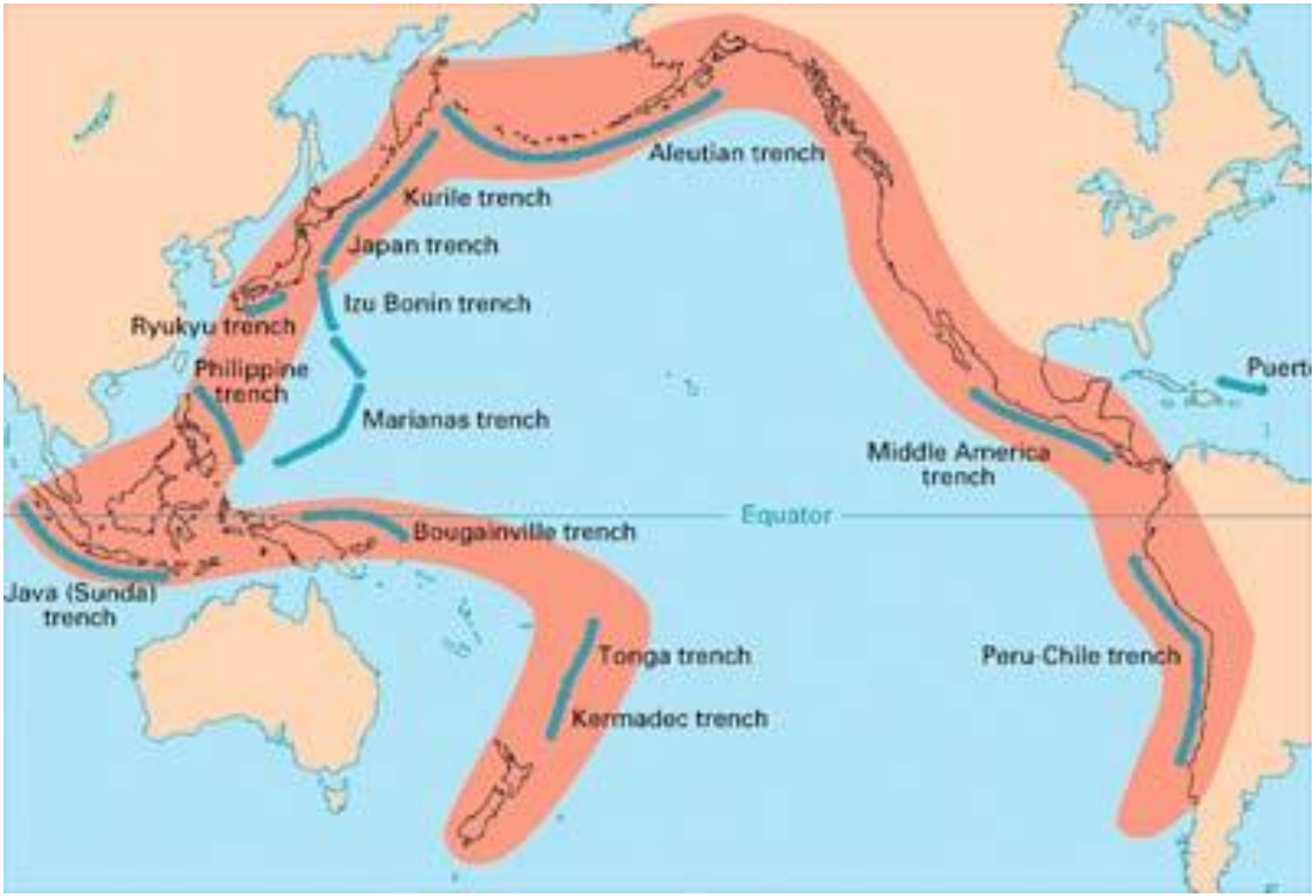


Source: BNEF

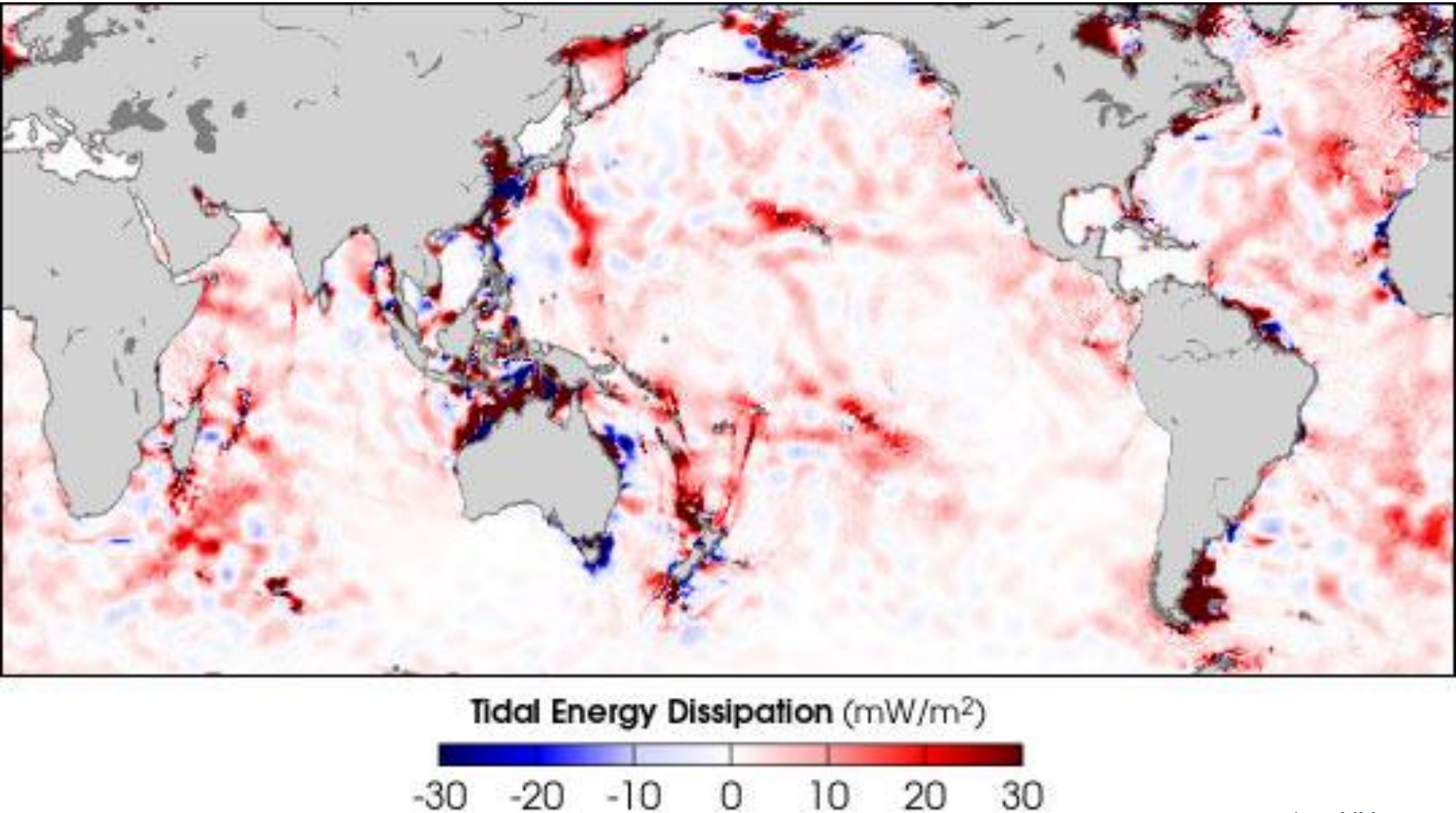
Potencial energia hidrica



Potencial geotermico

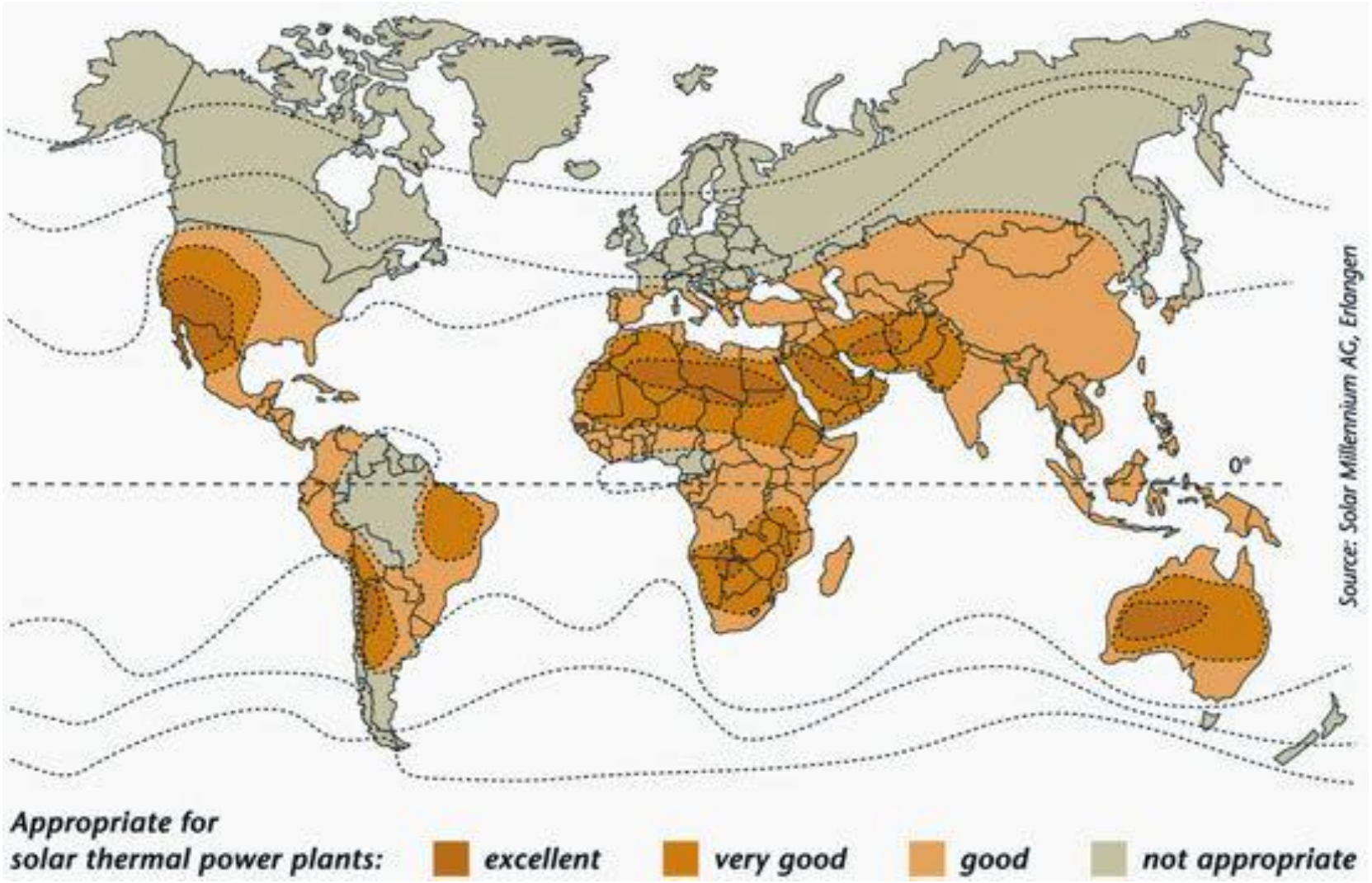


Potencial mareomotriz

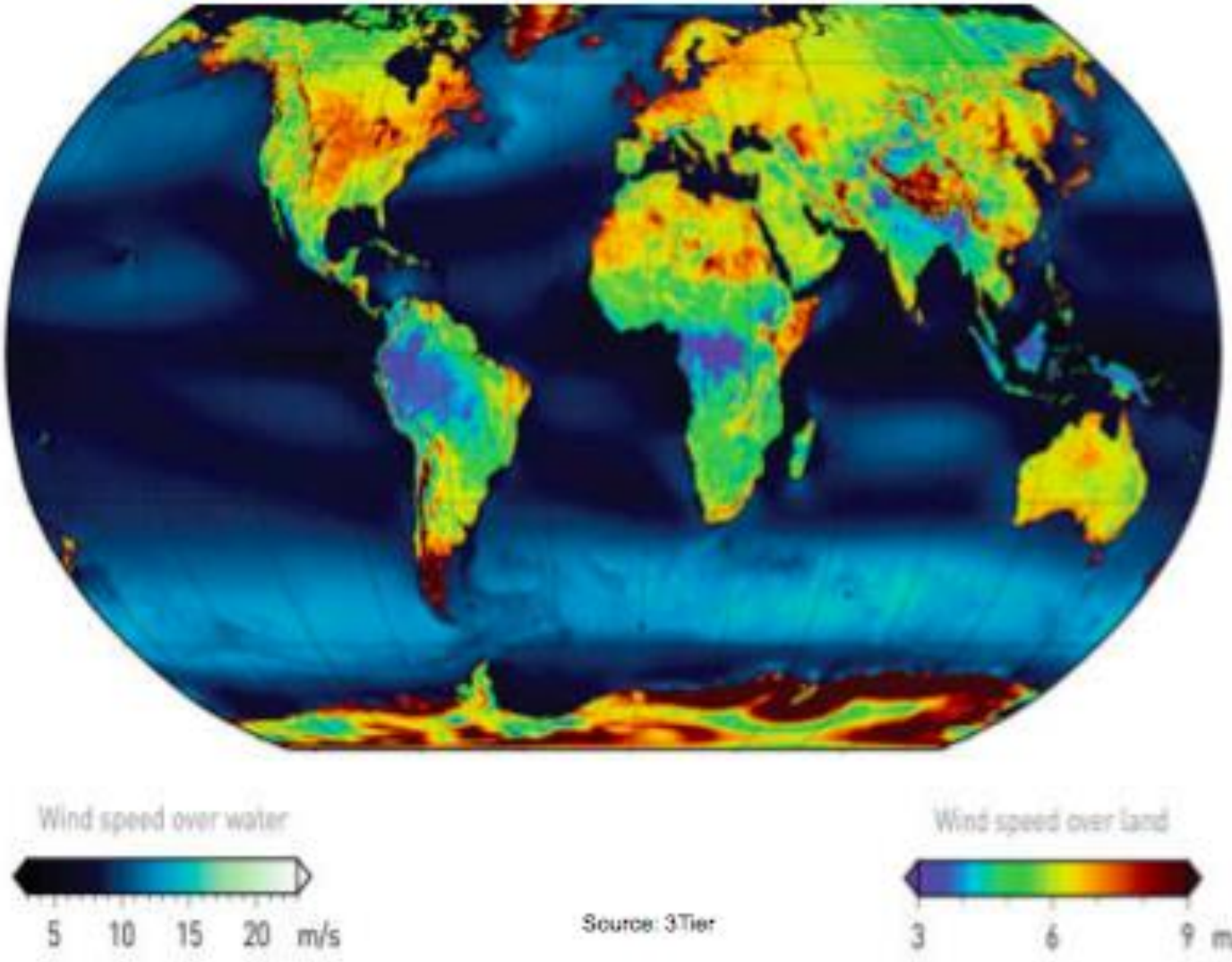


Prototipo de generacion mareomotriz

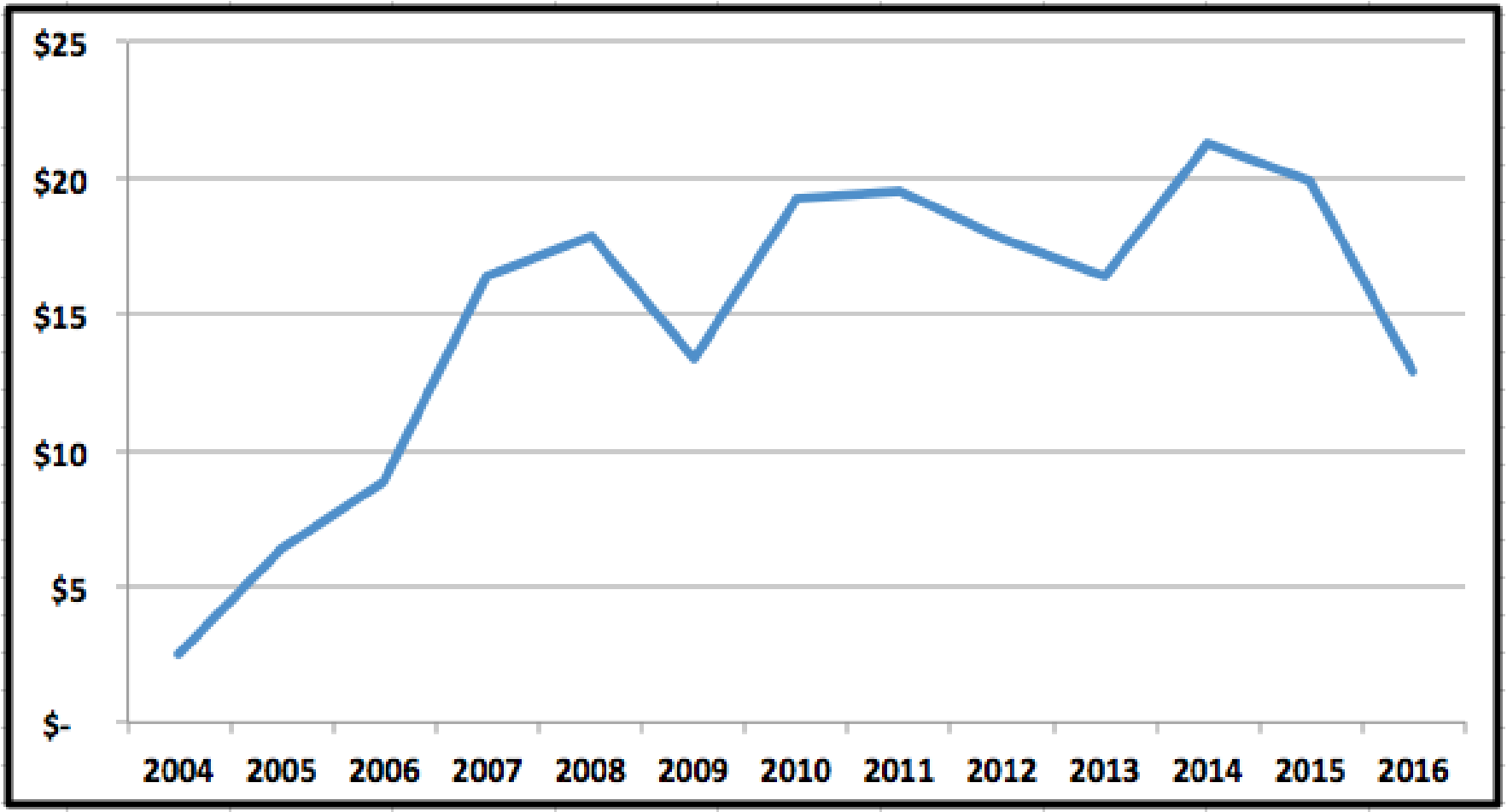
Potencial solar



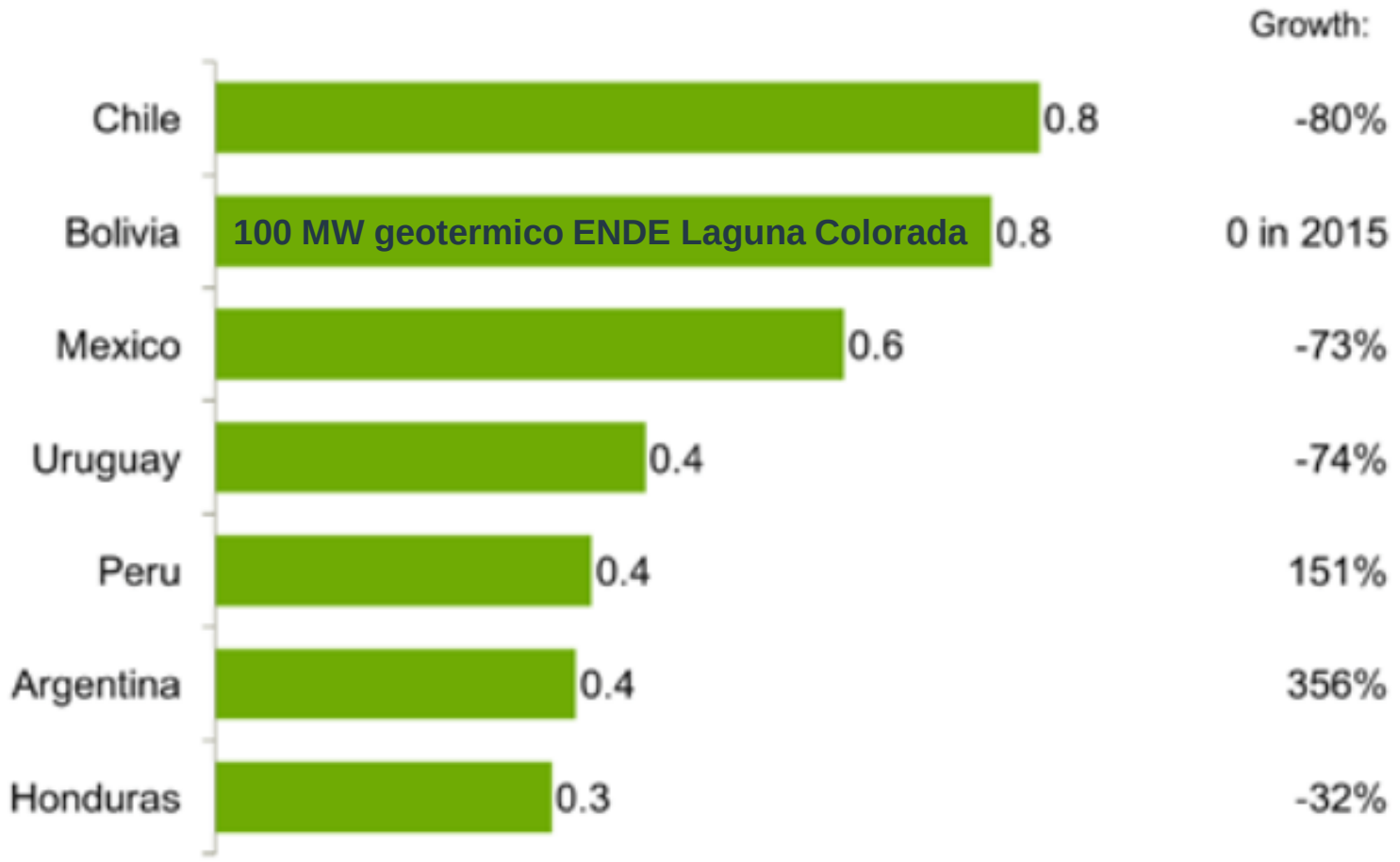
Potencial eolico



Inversion en energias renovables en Latinoamerica

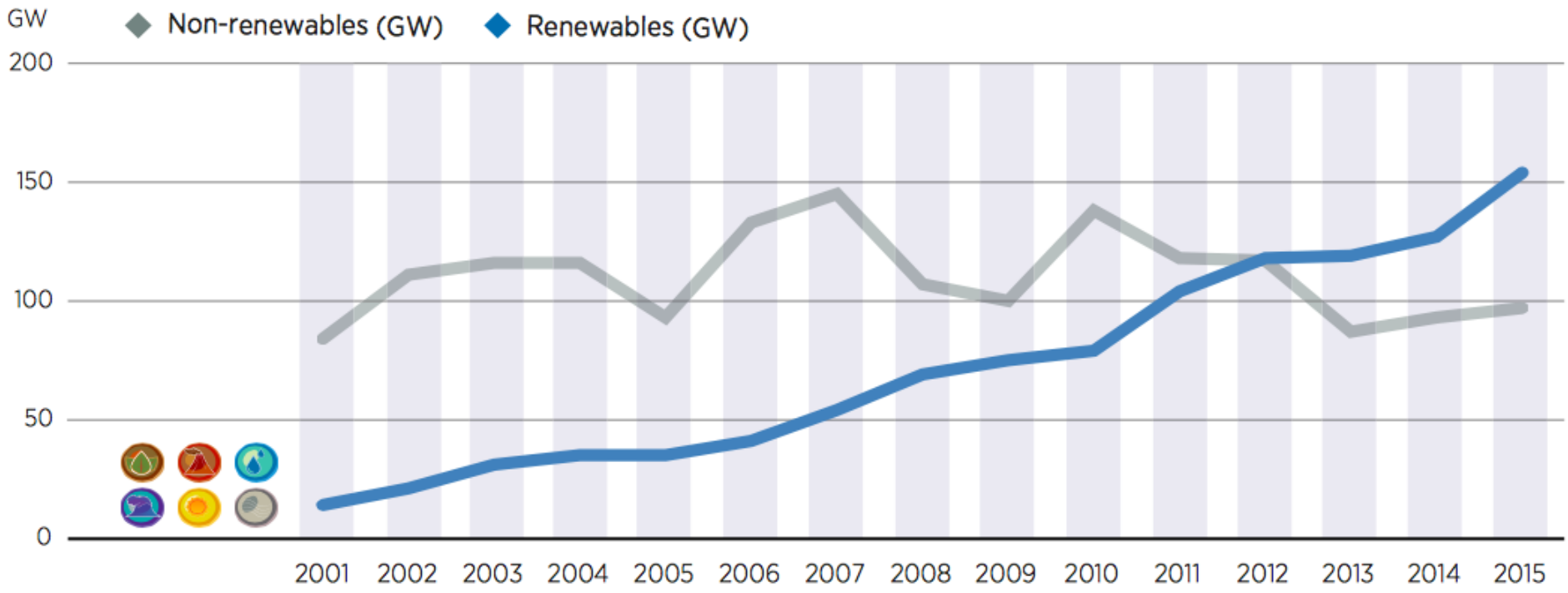


Renewable energy investment in Latin America (excl-Brazil) 2016



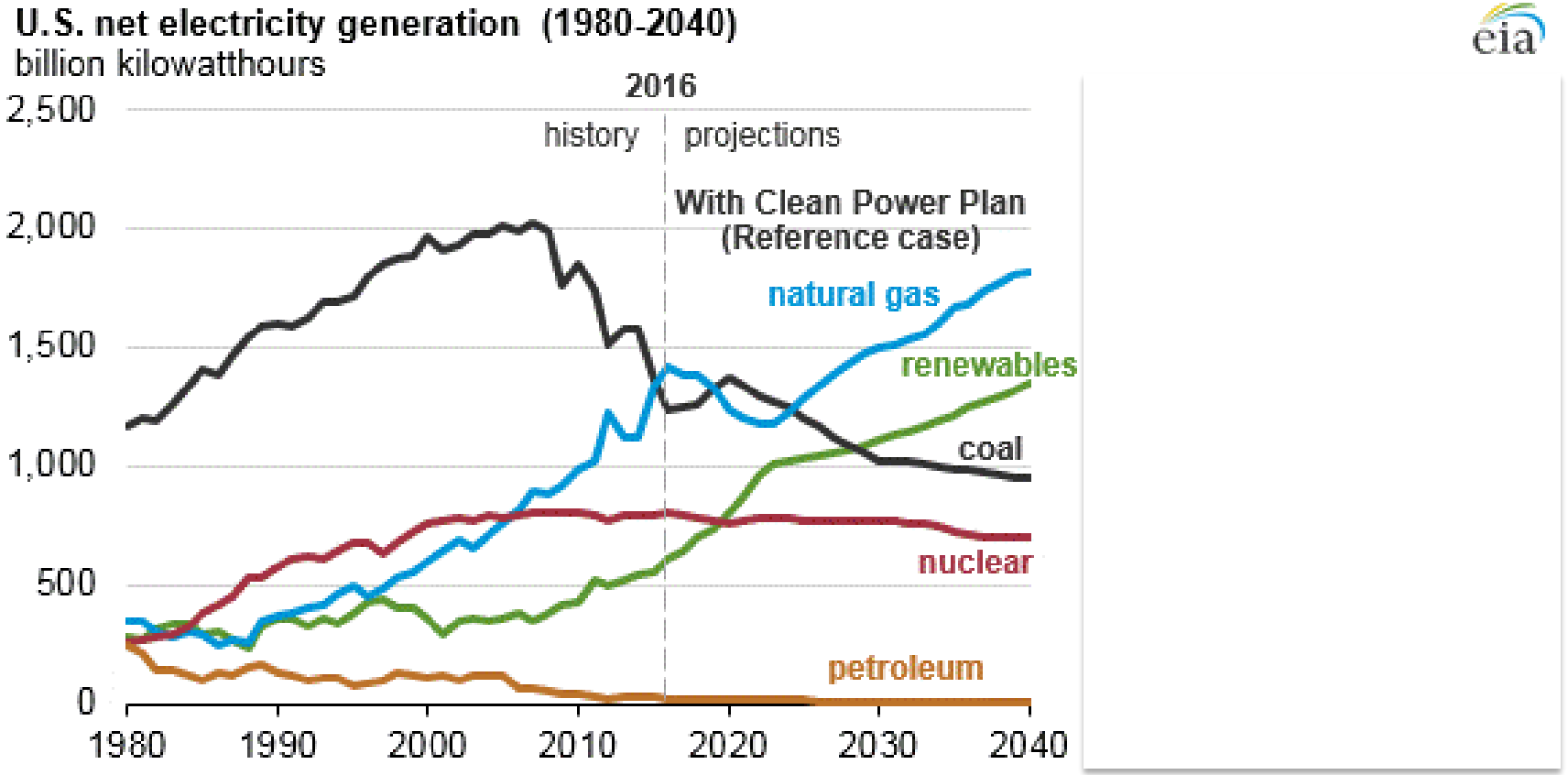
Source: UN Environment, Bloomberg New Energy Finance

Power capacity additions, 2001-2015



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Renewables (GW)	14	21	31	35	35	41	54	69	75	79	104	118	119	127	154
Non-renewables (GW)	84	111	116	116	93	133	145	107	100	138	118	117	87	93	97

Comparativo de capacidad instalada energia eolica Centroamerica



Unsubsidized Levelized Cost of Energy Comparison

Classification of power plants: *storage as disrupter*

$	$$	$$$
BASE LOAD	**LOAD FOLLOWING**	**PEAKER PLANTS**
Coal	Natural gas	
Nuclear	Wind	
CCGT/Combined Cycle Gas Turbine		
Large Hydro	Small Hydro	
Geothermal		
Biomass	Solar	
Tidal & Wave		

Thanks!

Carlos St. James
Director, Strategic Development
Clean Energy
Wood Group
Carlos.StJames@woodgroup.com
+1 (980) 333-2951