

Overview of Enel Green Power Activities in the renewable energy sector

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 Geothermal Center of Excellence
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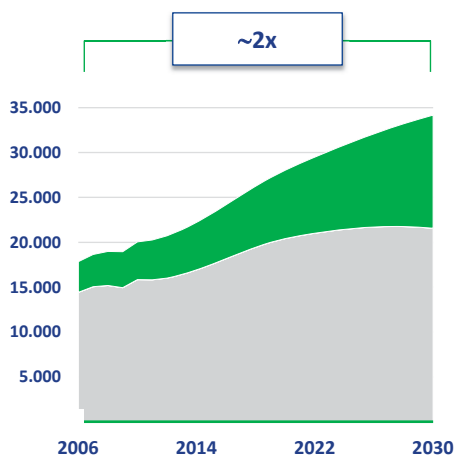
エネル・グリーン・パワー社
 エンジニアリング&建設部 地熱研究所
 ルッジェーロ・ベルターニ



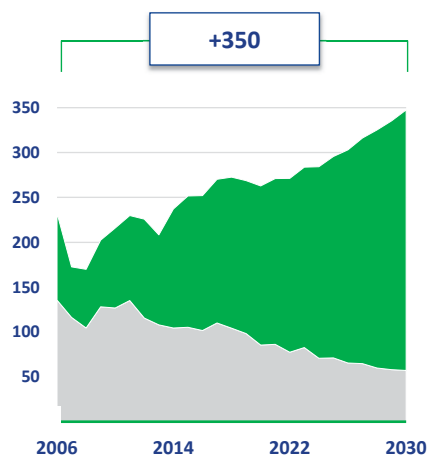
Expected growth in renewables
World electricity demand evolution



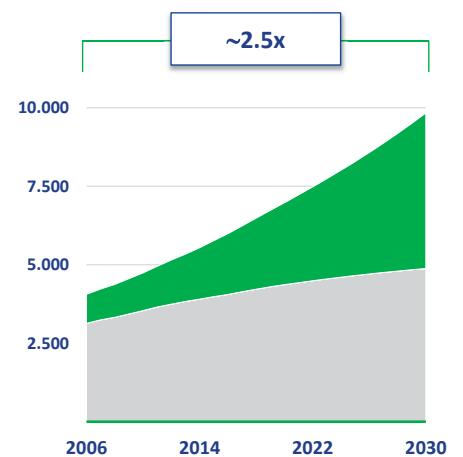
Electricity demand (TWh)



Additional capacity (GW)



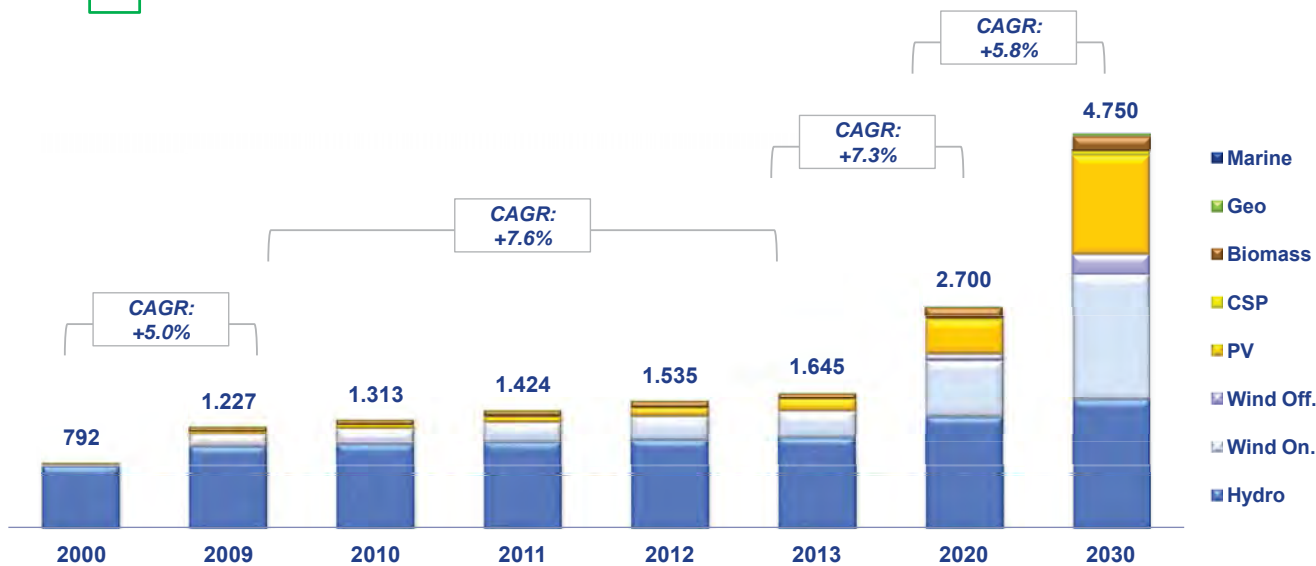
Total installed capacity (GW)



Renewable energies will account for 70% of the expected new power generation capacity up to 2030



Renewables Market Growth 2000 – 2030 Installed Capacity by Technology



- › Renewable energies show intact growth corridor with CAGR between 5% and 8%
- › Most important growth contributions are expected from wind, solar PV and hydro



Enel Green Power FY 2013 consolidated results Global leadership in renewables development



North America

- Capacity: 1,683 MW
- Production: 5.4 TWh
- Technologies:



Iberia&Latam

- Capacity: 3,072 MW
- Production: 8.8 TWh
- Technologies:



Italy&Europe

- Capacity: 4,128 MW
- Production: 15.3 TWh
- Technologies:



Capacity by technology



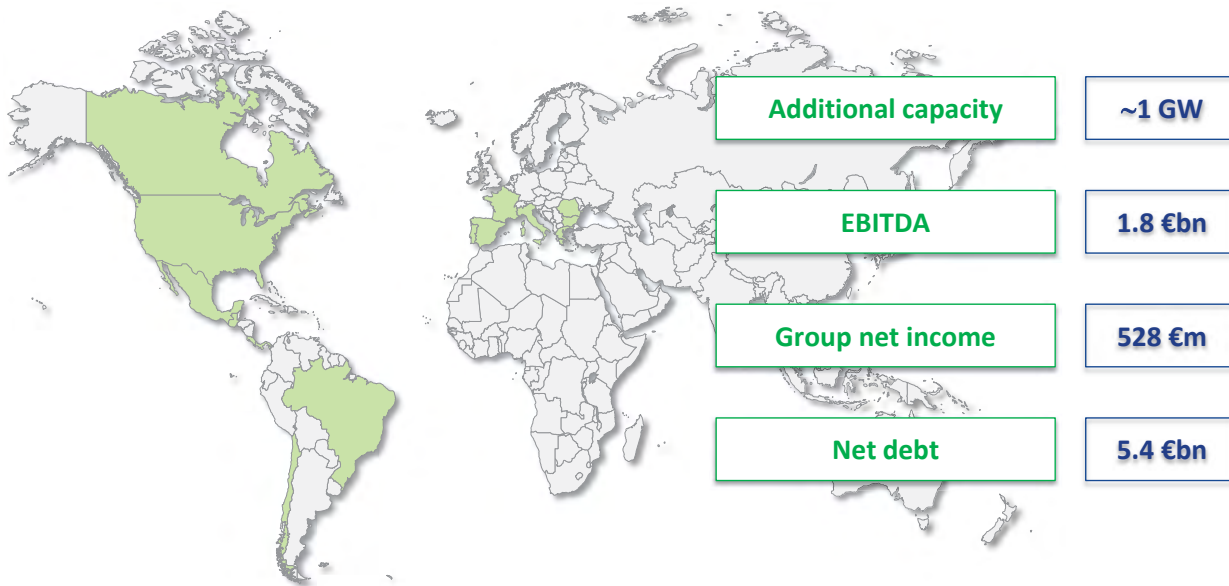
Total = 8.9 GW

Production by technology





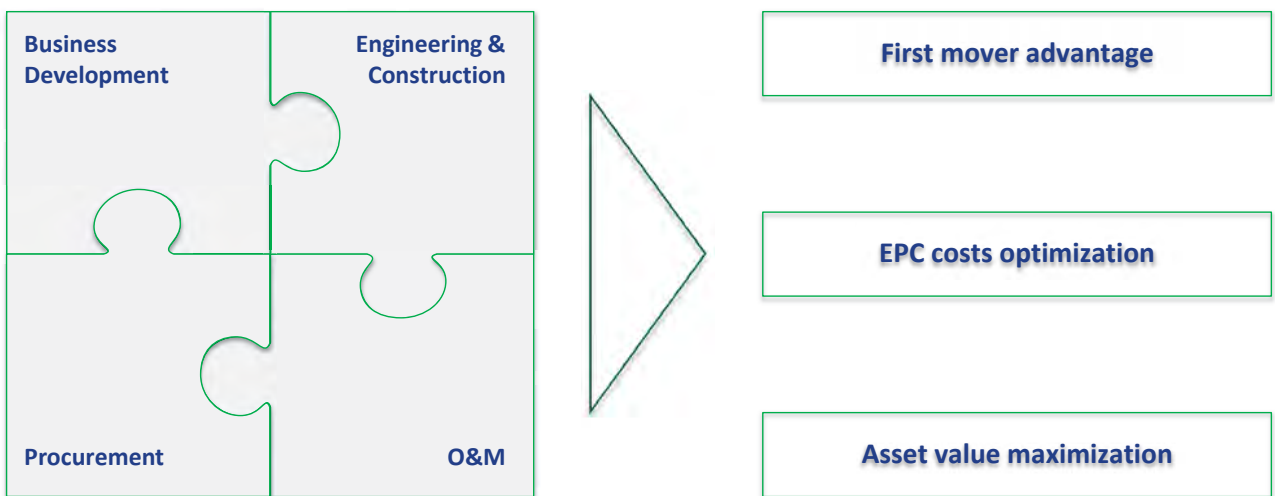
EGP 2014-2018 business plan Executing on business plan: 2013 highlights



Strong growth coupled with safe and sound financial discipline



EGP 2014-2018 business plan Integrated business model – Striving for Excellence



Identification of top sites, EPC and O&M are crucial to succeed

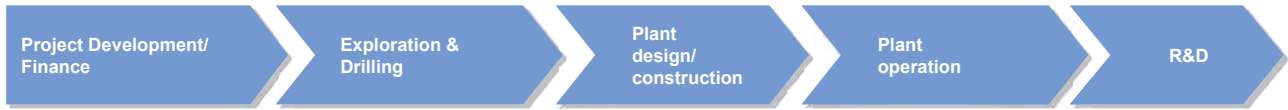


EGP 2014-2018 business plan

Integrated business model – Striving for Excellence



Centennial experience (since 1904) in geothermal electricity generation and fluid use



- | | | | | |
|--|---|---|---|--|
| <ul style="list-style-type: none"> • Acquire land rights • Risk evaluation depending on country and technology • Transmission System Access • Power sales contract negotiation • Acquisition of concessions | <ul style="list-style-type: none"> • Best practice in drilling target identification • Geological Model and reservoir evaluation • Predictive methodology for exploration of deep geo resources • Skills and equipment to drill vertical and deviated geothermal wells • Innovative flow testing programs to forecast well performance | <ul style="list-style-type: none"> • Well proven concept design in diverse technologies: dry steam , flash and binary • Provide an environment of competition in equipment procurement and construction • Standardize where possible | <ul style="list-style-type: none"> • Fully developed internal safety and operations procedures • Optimized geo-resource management (reservoir and power plant) for sustainable exploitation • In house maintenance and repair capability • Plants remotely monitored and controlled from a centralized location | <ul style="list-style-type: none"> • Low Enthalpy Innovative Geothermal Plants • Developing hybrid system • Plant improvement: acid gas components abatement • Improved efficiency and flexibility |
|--|---|---|---|--|

EGP growth in traditional high temperature resources and also in binary technology



EGP Structured process to select new growth markets

Future potential growth markets

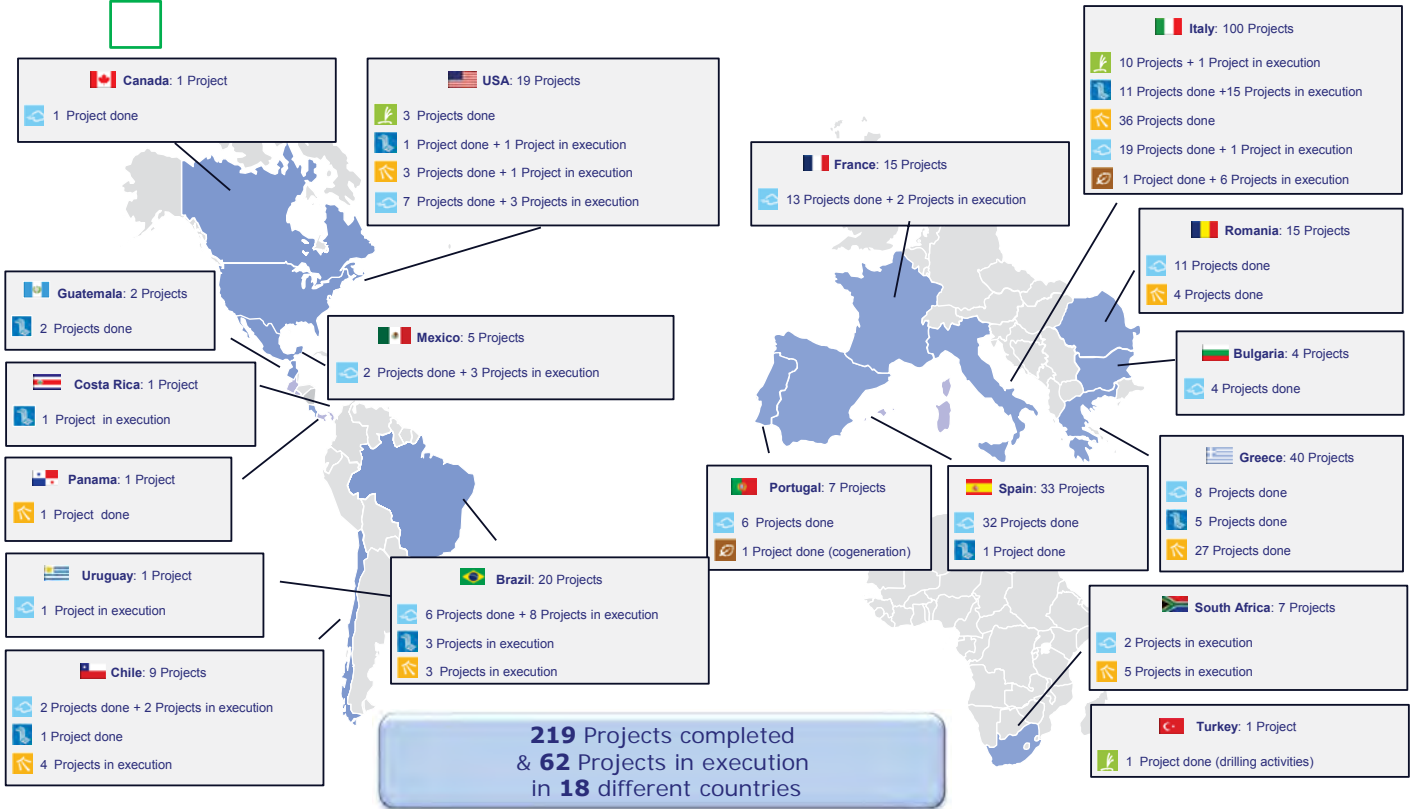


Anticipation of market trends is core to profitable growth



Engineering & Construction

Projects realized from 2009 & in execution 2014



Investor Relations

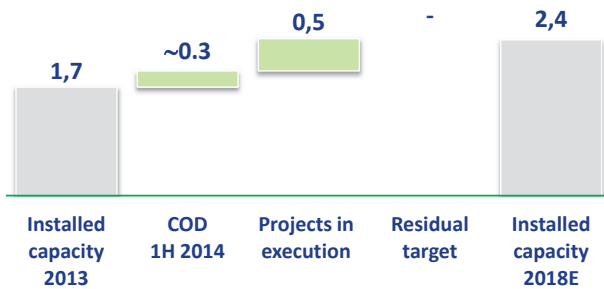


EGP 1Half 2014 consolidated results

Focus on projects in execution: North America



2014 – 2018 additional capacity (GW)



Projects in execution



USA
Wind **500 MW**

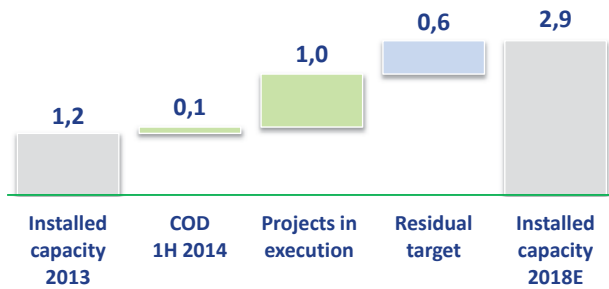
Potential to exceed planned growth

EGP 1Half 2014 consolidated results

Focus on projects in execution: Latin America



2014 – 2018 additional capacity (GW)



Projects in execution

	Brasil	
	Wind	198 MW
	Hvdro	102 MW
	Solar	12 MW
	Chile	
	Wind	160 MW
	Solar	124 MW
	Mexico	
	Wind	302 MW
	Costa Rica	
	Hydro	50 MW
	Uruguay	
	Wind	50 MW

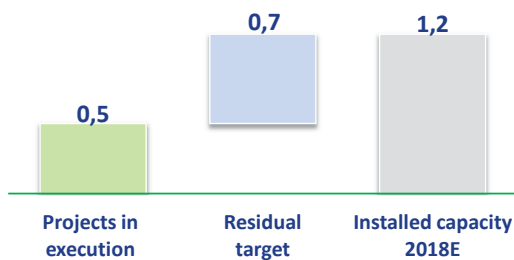
Leveraging on increasing demand and abundance of resources

EGP 1Half 2014 consolidated results

Focus on projects in execution: New Market



2014 – 2018 additional capacity (GW)



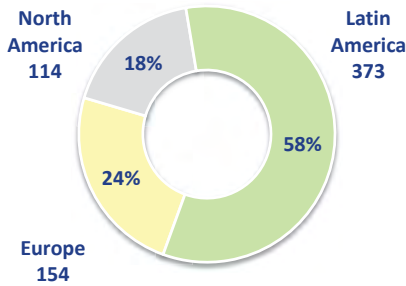
Focus on South Africa



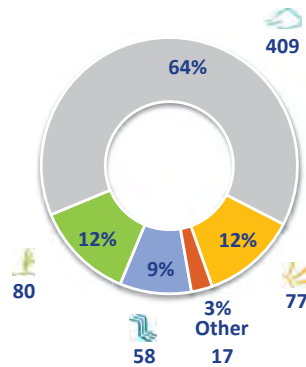
	South Africa	
	Wind	199 MW
	Solar	314 MW

South Africa: scouting for further development through Round IV auction

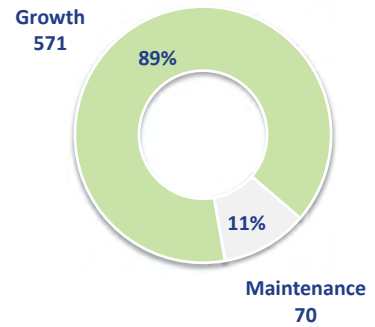
By geography



By technology



By activity

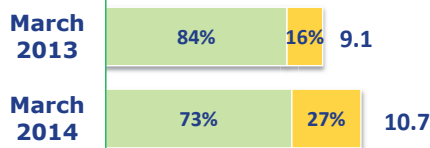


Total operating capex for the period = 641€m

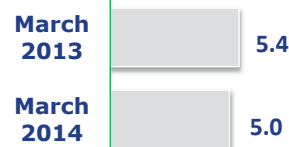
EGP Gross Pipeline – March 2014 (1/2)

Pipeline diversification in tune with strategic guidelines

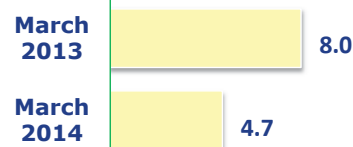
Emerging markets



North America

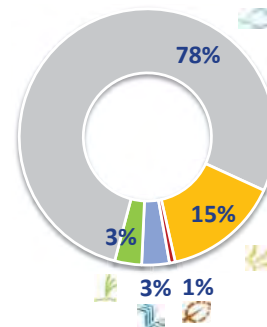


Italy & Europe



New markets Latin America

March 2014 gross pipeline 20.4 GW



Emerging markets take the lead with over 50% of the pipeline

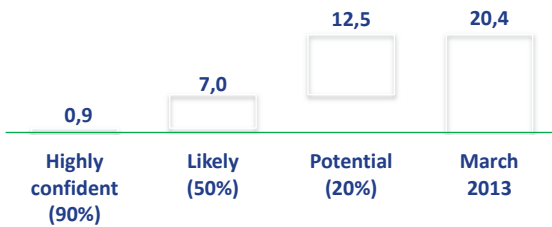


EGP Gross Pipeline – March 2014 (2/2)

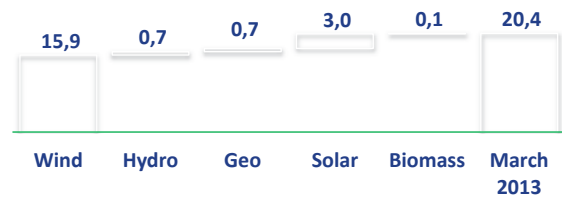
Pipeline diversification in tune with strategic guidelines



By probability of success



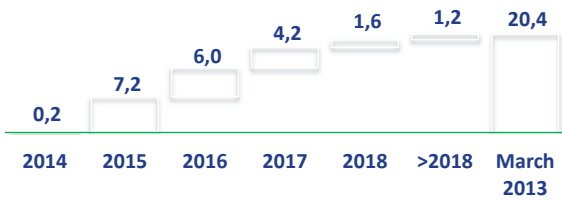
By technology



By geography

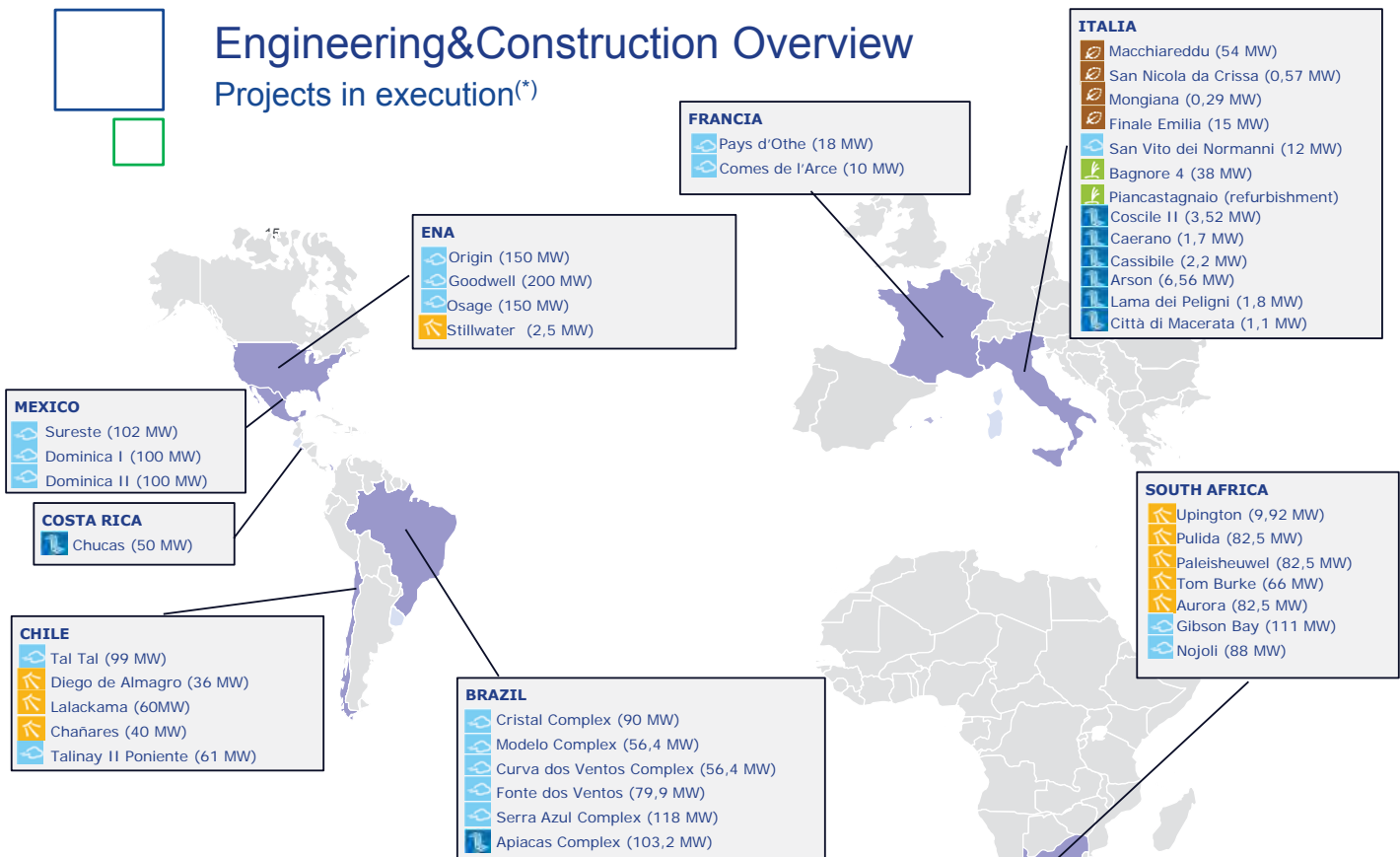


By COD



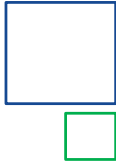
Engineering&Construction Overview

Projects in execution(*)



40 projects in 8 countries

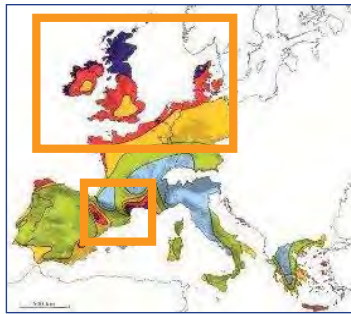
(*) Updated @May 2014



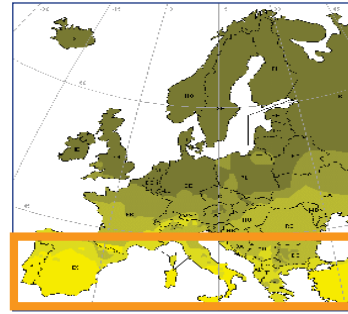
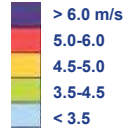
Availability of Renewable Resources Europe



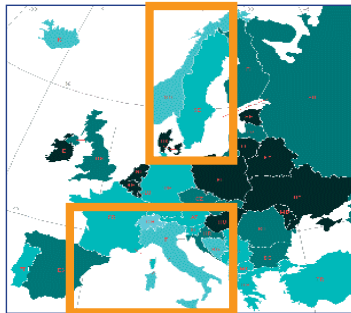
Areas with greatest availability of resources



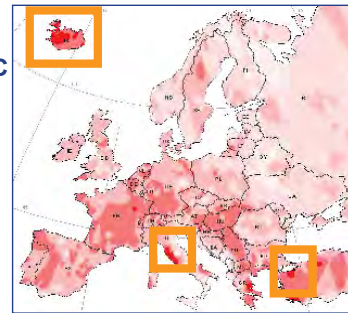
WIND (Average wind speed at 50 m)



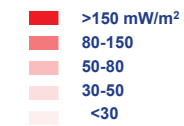
SOLAR (Irradiation)



HYDROELECTRIC (Theoretical hydraulic potential)



GEO THERMAL (Thermal Flow Density)

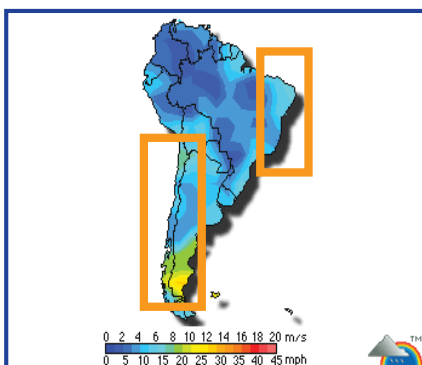
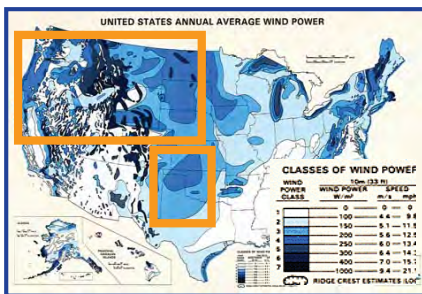


Availability of Renewable Resources Americas

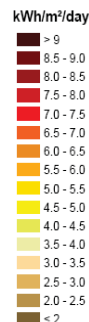
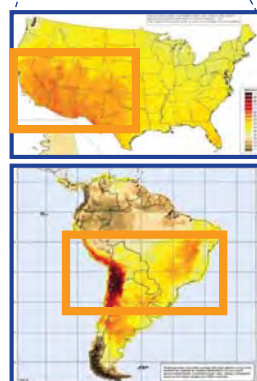
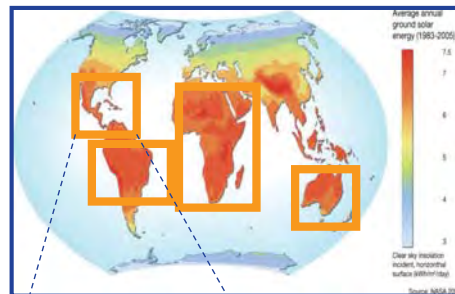


Areas with greatest availability of resources

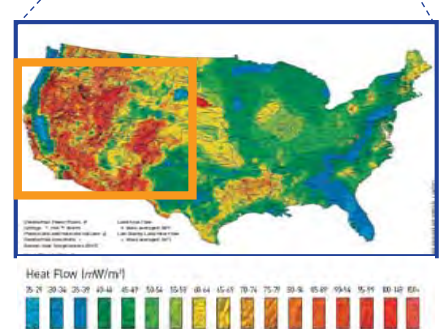
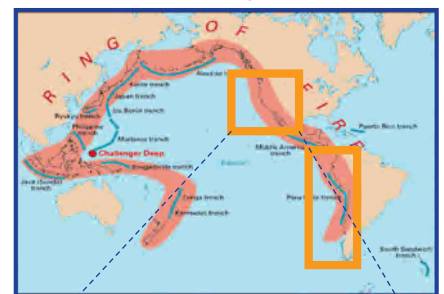
Wind (intensity)



Solar (irradiation)



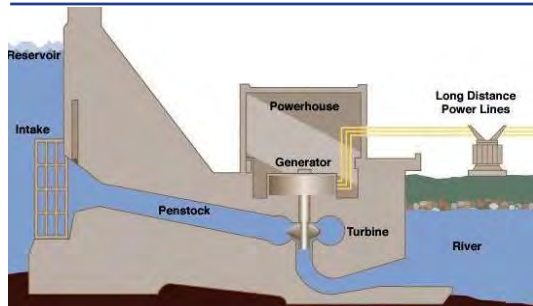
Geothermal (thermal flow density)





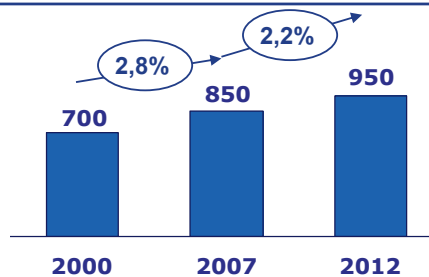
% CAGR

State of the art and future evolutions



- Two types of power plant:
 - Large basins, natural or artificial, large height differential (10-300 MW)
 - Flow, small ht. differential (<10 MW)
- Mature technology, large scale use in many countries since the start of the 20th century. Limited room for development.
- Development focused on flow and small scale plants.

Installed Capacity (Worldwide, GW)*



Factors affecting development

- High potential sites running out in many countries
- Opposition to developing new large scale plants due to the high impact on environment (Industrialized countries)
- Incentive schemes for small power plants

* Enel Analysis

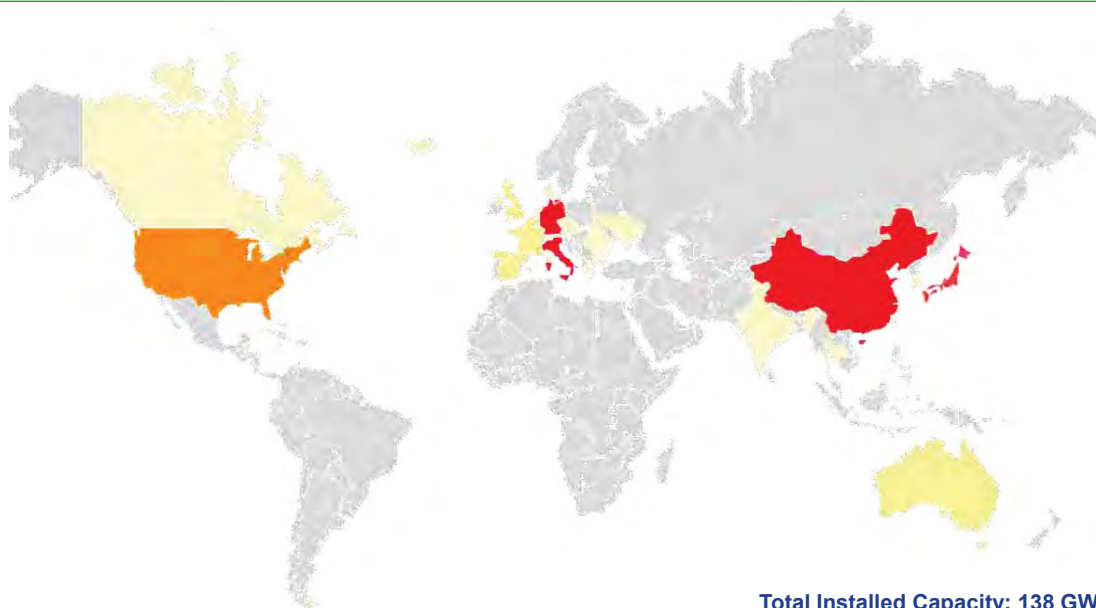


2013 PV Installed Capacity

Global Distribution



PV Installed Capacity Globally - 2013



Total Installed Capacity: 138 GW





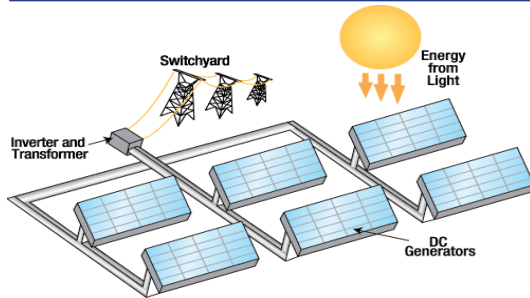
Technology of Renewable Resources

Solar



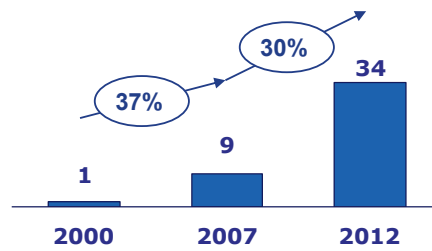
% CAGR

State of the art and future evolutions



- **Traditional technologies: silicon “mono-” and “poli- cristalline”**
- **New “thin film” technology:** reduces the use of silicon (main cost component of the system) and the cost of energy production
- Enel’s commitment to developing concentrated solar

Installed Capacity (Worldwide, GW)*



Factors affecting development

- **Technological developments (incremental or discontinuous)** reduce the costs of the panels and increase efficiency, getting closer to “grid parity”.
- **Bottleneck in the production of silicon** (consensus: up to end of 2010)
- **Incentive schemes** (ex. Italy; Spain and Germany being reviewed)

* Enel Analysis

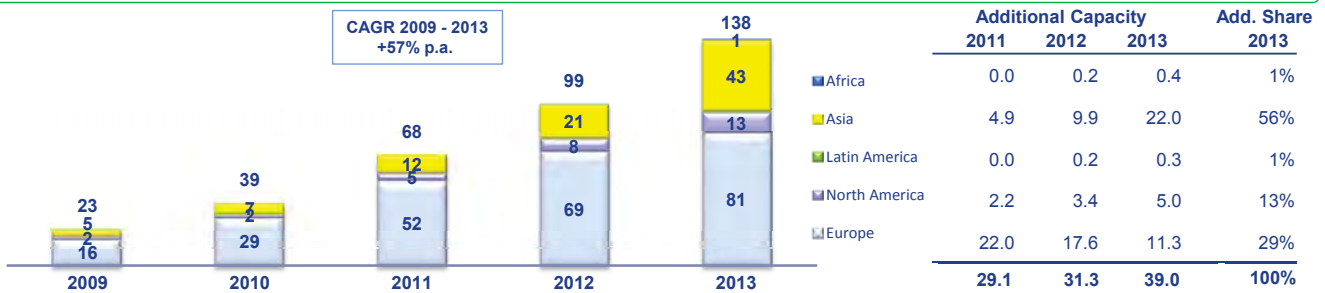


2009-2013 PV Installed Capacity

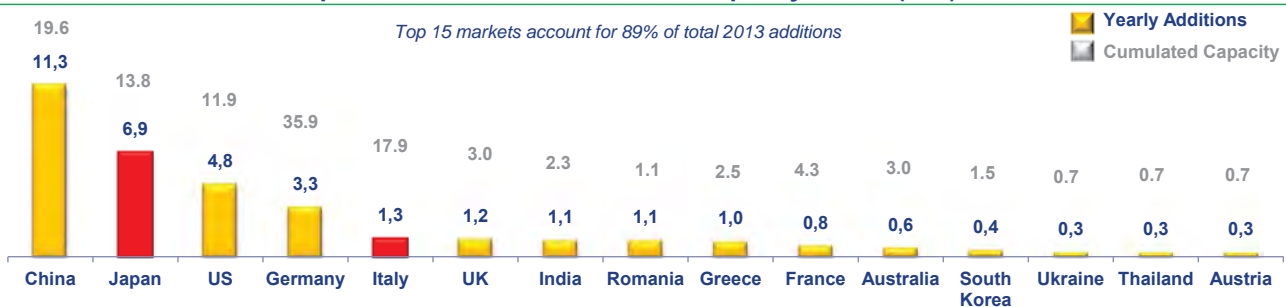
Top 15 Additional Markets in 2013



Global PV Cumulative Capacity 2009 – 2013 (GW)



Top 15 PV Markets for Additional Capacity – 2013 (GW)

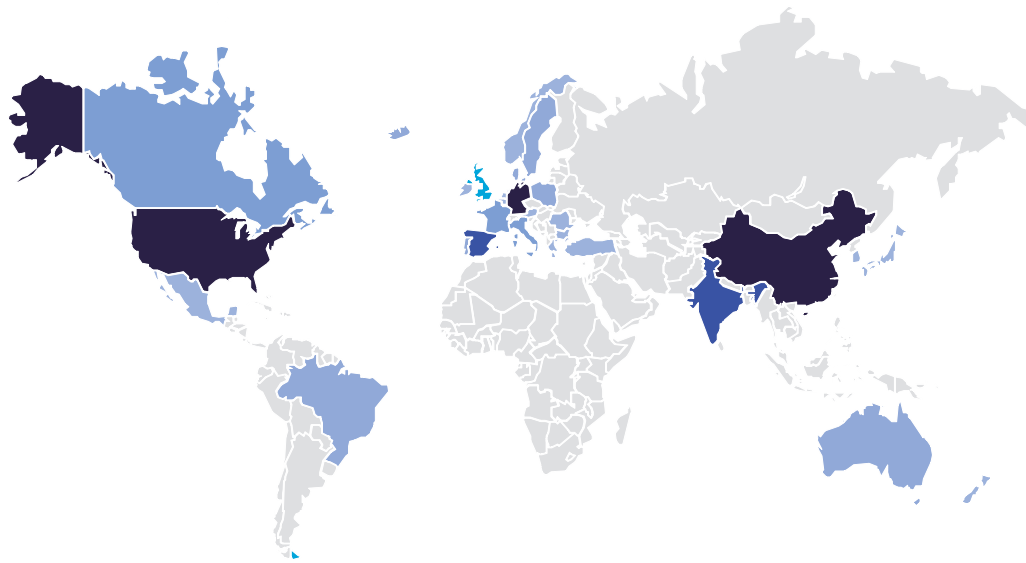




2013 Wind Installed Capacity Global Distribution



Wind Cumulated Installed Capacity Globally - 2013



Total Installed Capacity: 319 GW



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Technology of Renewable Resources Wind



% CAGR

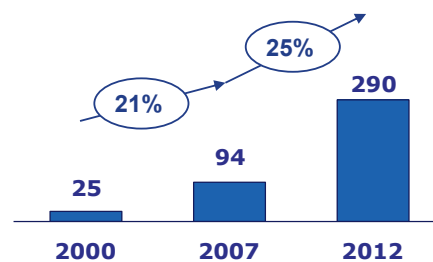
State of the art and future evolutions



1981 → 2008
0,06 MW → 3,0 MW

- **On-shore:** new materials and more efficient designs allow for a greater dimension and efficiency of the turbines
- **Off-shore:** the dimensions tend to be increased (up to 5-6 MW) in order to exploit the stronger winds available

Installed Capacity (Worldwide, GW)*



Factors affecting development

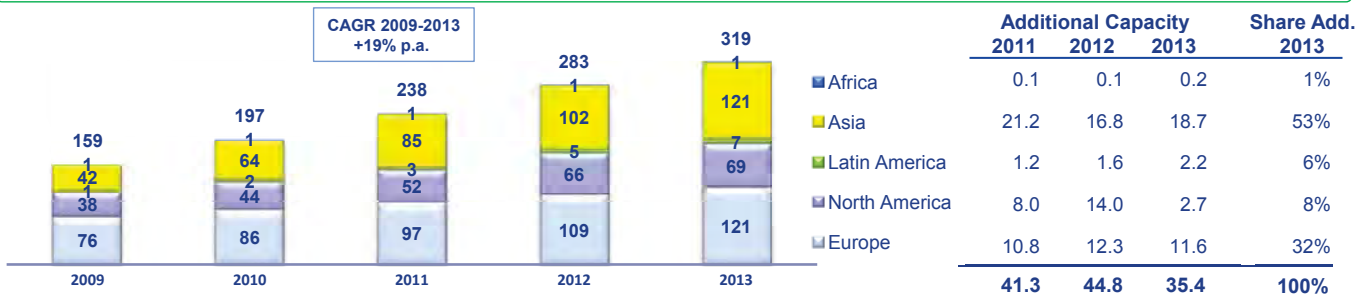
- Greater turbines resulting in **reduction in costs** of production
- **Bottleneck in the production** of turbines (consensus: up to end of 2010) which affects prices
- **Incentive schemes in many countries**

23

2009-2013 Wind Installed Capacity Top 15 Additional Markets in 2013

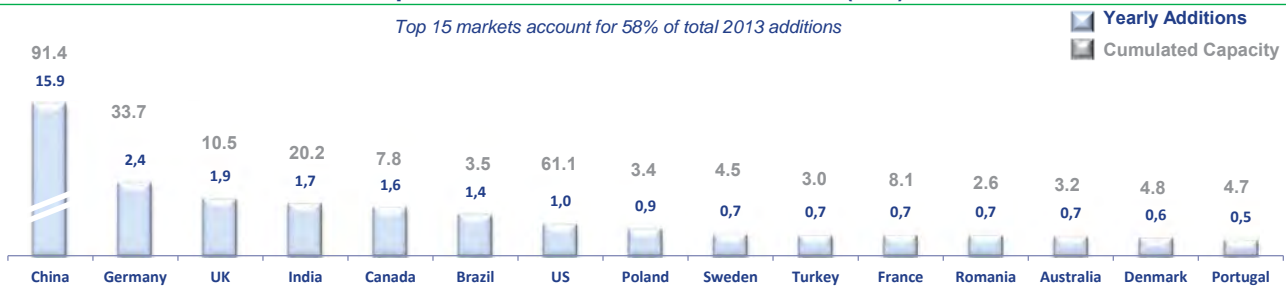


Global Wind Cumulative Capacity 2009 – 2013 (GW)



Top 15 Wind Additional Markets – 2013 (GW)

Top 15 markets account for 58% of total 2013 additions

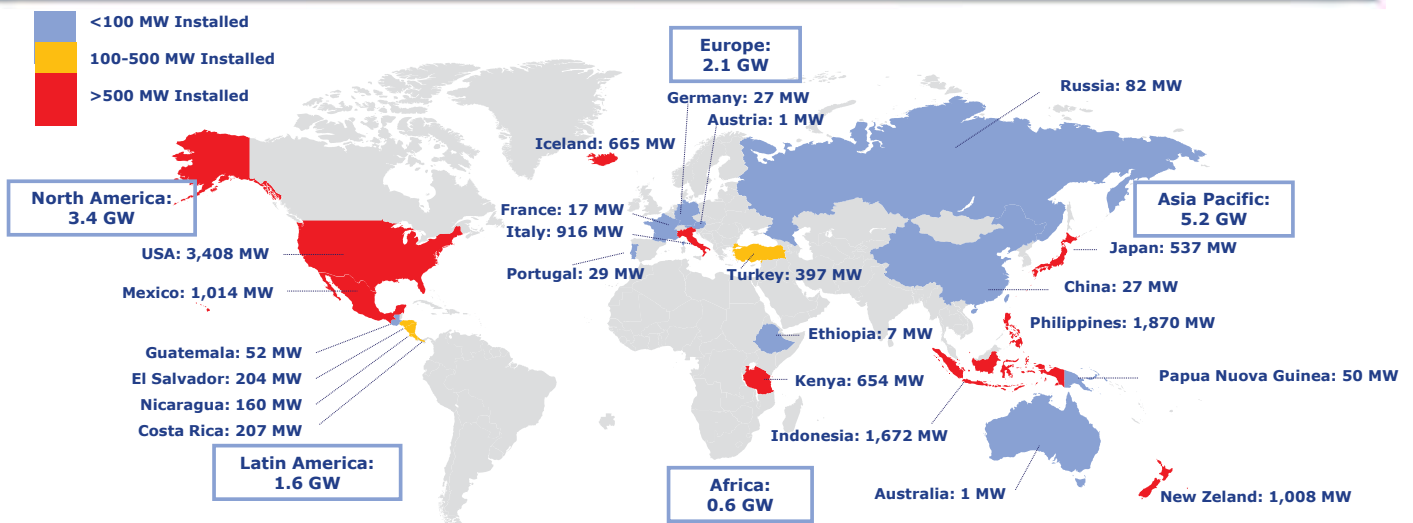


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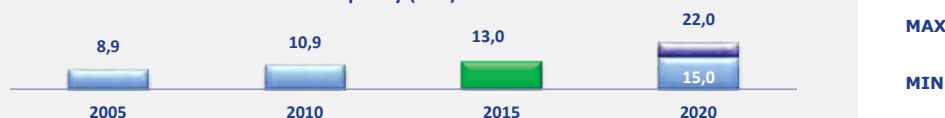
GEOTHERMAL WORLD at-a-glance Geothermal electricity map



2015 Geothermal Installed Capacity (MW)



2005-2020 Installed Capacity (GW)



Source: NEF, EGR estimate

25



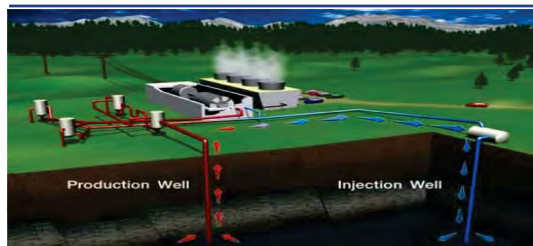
Technology of Renewable Resources

Geo



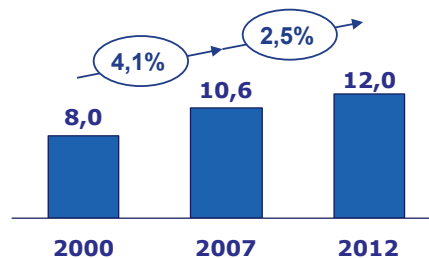
% CAGR

State of the art and future evolutions



- **“Direct Steam” or “Flash” technologies:** steam extracted from the earth powers the turbine (ex. Larderello).
- Few areas with characteristics that can be exploited using traditional technology (ex. Italy, Island, USA, Philippines)
- New technologies:
 - **“Binary Cycle”:** allows thermal sources to be exploited at lower temperatures
 - **“Dry Rocks”** (experimental): allows the use of thermal sources without steam
 - **“Supercritical fluids”**, a new field of research

Installed Capacity (Worldwide, GW)*



Factors affecting development

- **New technologies** are at the forefront of the “re-birth” of geothermal energy, due to the fact that previously non economically viable resources can now be exploited
- **Risk in the drilling phase** (cfr. “Exploration” phase in Oil & Gas)
- High oil prices increase the drilling costs

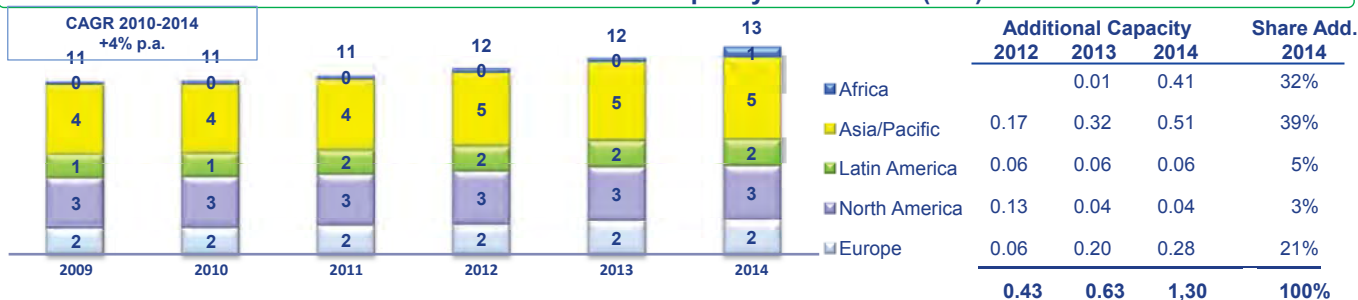
* Enel Analysis



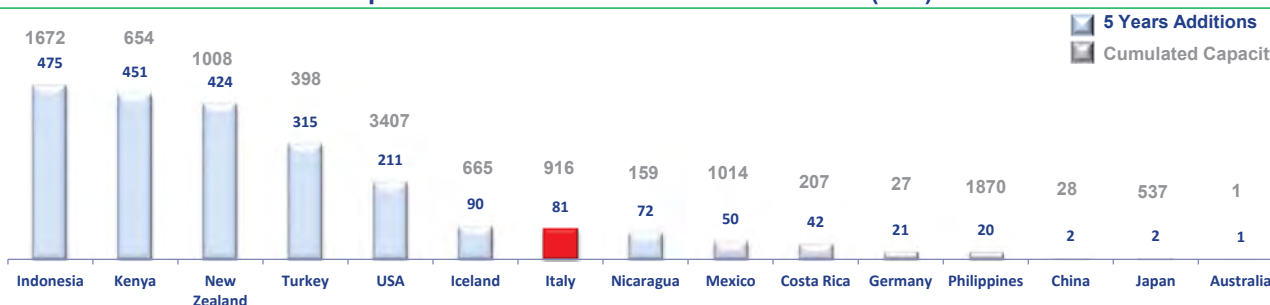
2009-2014 Geothermal Installed Capacity Top 15 Additional Markets in 2014

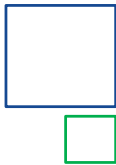


Global Geo Cumulative Capacity 2009 – 2014 (GW)



Top 15 Geo Additional Markets – 2009-2014 (MW)

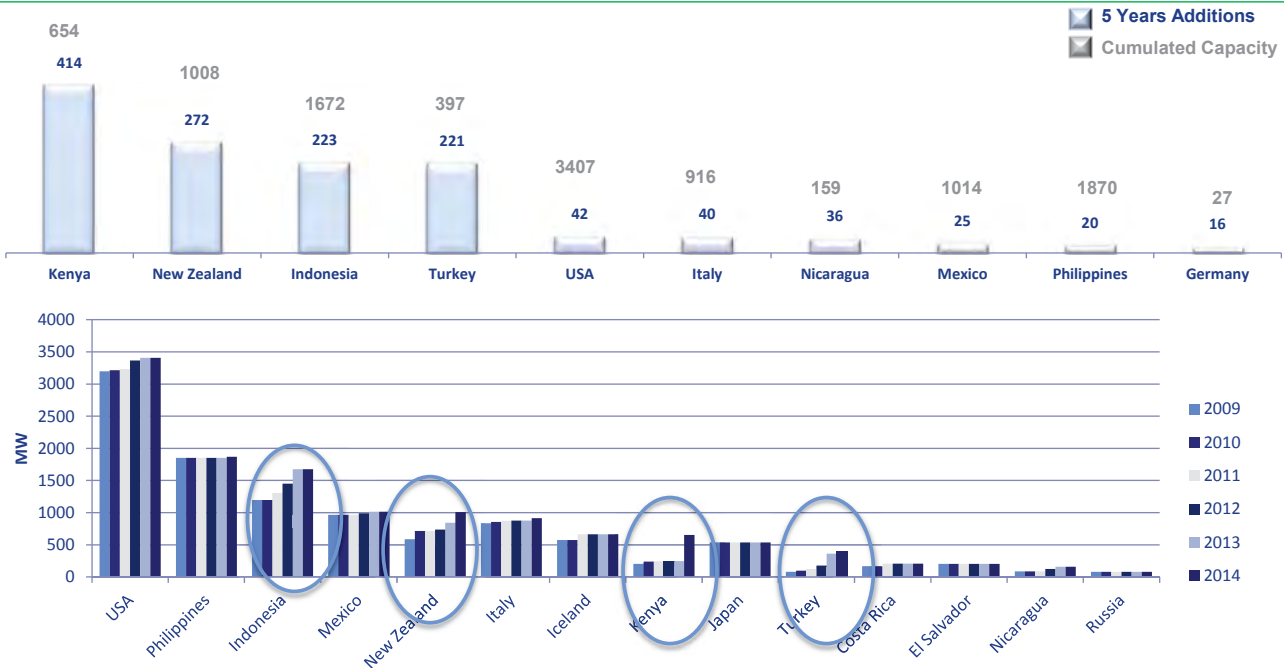




2009-2014 Geothermal Installed Capacity Top Countries



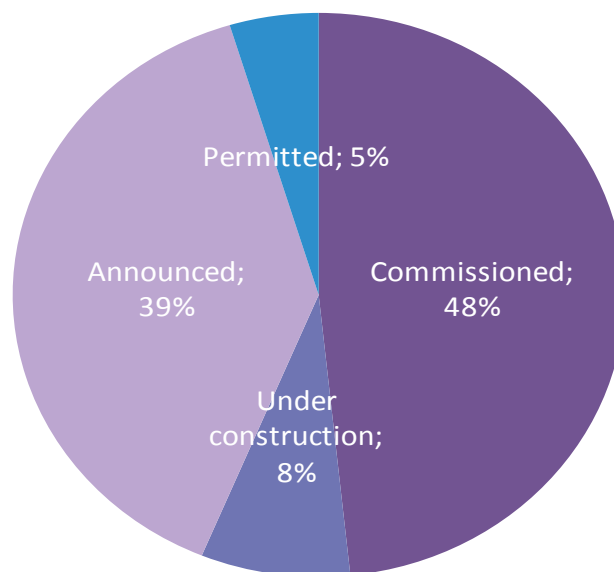
Top 10 Geo Additional Markets – 2012-2014 (MW)



28



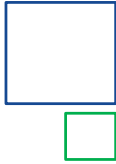
Geothermal World at-a-glance Geothermal electricity Projects



Bloomberg New Energy Finance 2012

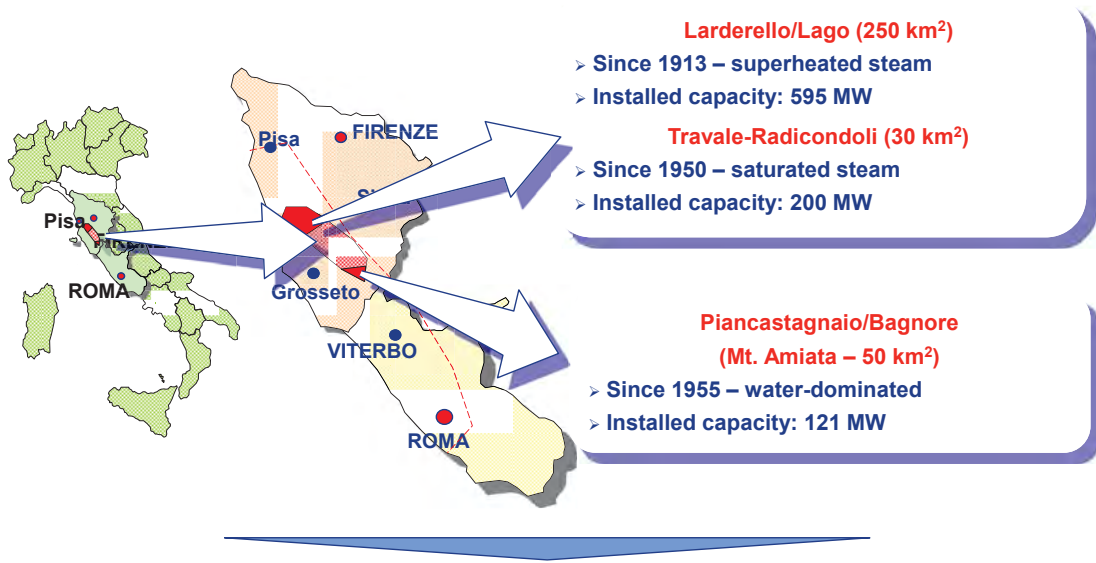
The global project pipeline totals
20 GW
across all development stages

29



EGP Geothermal Italy

Italian geothermal fields in operation



916 MW gross generating capacity



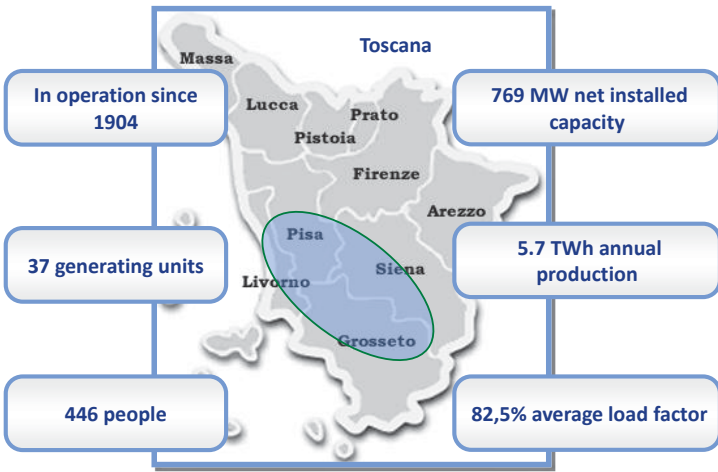
EGP Geothermal Italy

100 Years of success



Asset

EGP key pillars in Geo



- EGP is the biggest **fully integrated geothermal operator**
- **Long experience** in geo sector supports EGP international leadership in geo innovation and operation
- **Geothermal fields management “culture”**: use of reinjection wells to recover natural resource depletion
- **Leadership in efficiency** performances and power plants **availability**

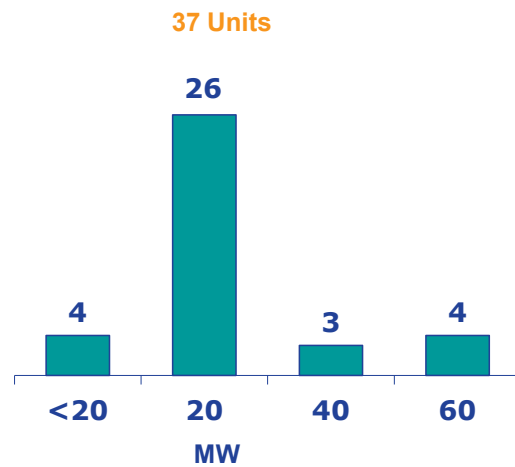
100th anniversary of electricity production



EGP Geothermal Italy 100 years of success



- 2013 **net** generation: 5.7 bill. kWh
- Avg. steam rate: 8.2 kg/net kWh
- Produced steam: ~43 millions metric tons/yr (~4,800 t/hr) from ~250 active wells, with over 280 km of gathering steam lines
- NCG emitted: ~2 millions metric tons/yr (~230 t/hr)
- H₂S in NCG: ~26,000 metric tons/yr (~3 t/hr), nearly 85% of which are treated (100% within 2014-5) with ~85% overall abatement efficiency (due to H₂S partitioning in the DC condenser)



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EGP Geothermal Italy 100 years of success

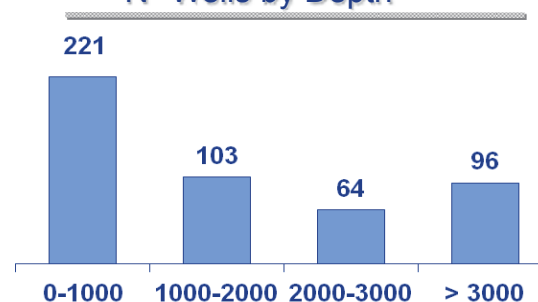
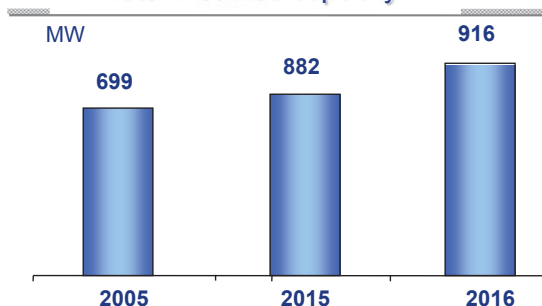


- **500 km pipelines**
 - **Steam** 207 Km
 - **Reinjection** 298 Km

- **About 500 wells**

Total installed capacity

N° Wells by Depth



33



EGP Geothermal Italy 100 years of success



Increase the complexity

The evolution is due to:

- reduction of noise
- separation of condensate
- treatment of fluids inside wells



Production n. 304 Reinjection n. 62 Control n. 125



EGP Geothermal Italy 100 years of success



Steam 205 Km Reinjection 294 Km



Increase the complexity

The evolution is due to:

- reduction of visual impact
- transportation of condensate and fluid needed for steam treatment



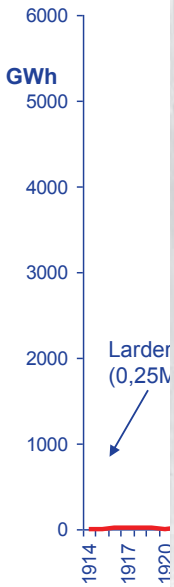
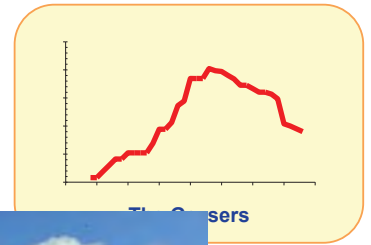
Pipelines



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299 Tcal heat supply



1931: Soffionissimo



1999: Montieri 1

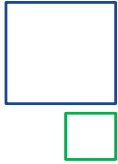


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Larderello: the birthplace of geothermal industry Before the beginning....

The Devil Valley in Larderello
No exploration activity needed.....



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1904: first experiment

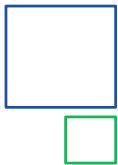


1913: first 250 kW unit

Larderello: the birthplace of geothermal industry

The initial steps

38

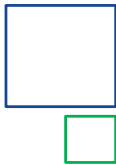


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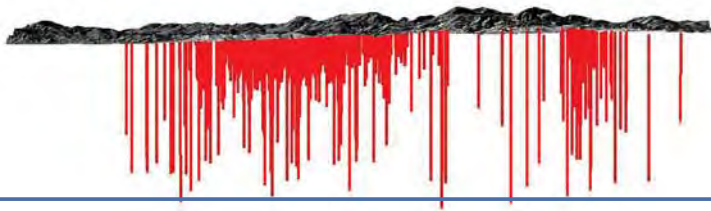
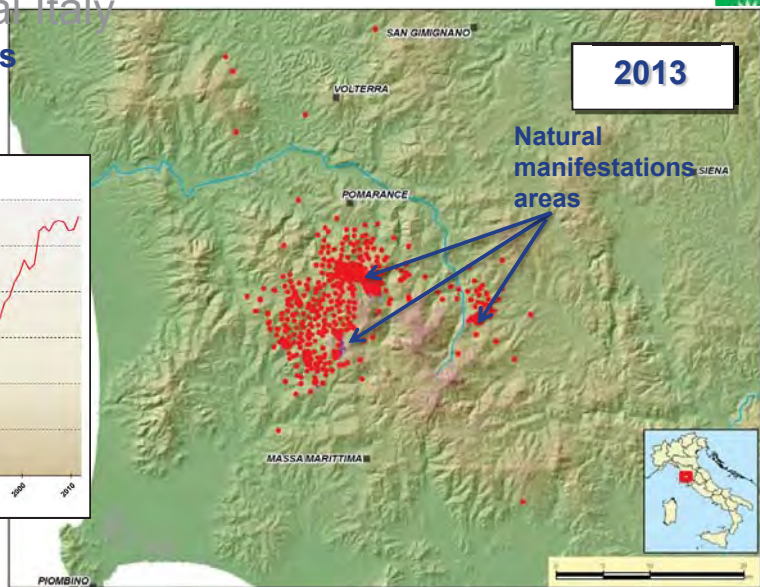


The pioneering stage

39



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New production reaching the 2013 level of 5659 GWh

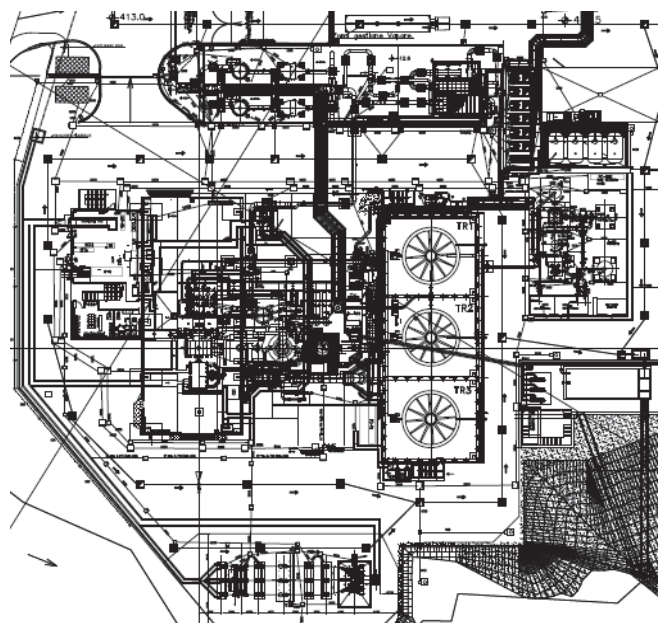


Chiusdino 1 Project Geothermal Power Plant, Italy



Plant Technical Features

Concrete	4.600 [m3]
Steel	1.080 [t]
Plant area	11.000 [m2]
Aggregate man hours	140.000 [h]





Chiusdino 1 Project

Geothermal Power Plant, Italy



Construction Progress



February 2010



April 2010



June 2010



October 2010



Chiusdino 1 Project

Geothermal Power Plant, Italy



Site preparation



Building machinery erection



Steam separation system



Main machinery erection

Chiusdino 1 Project
 Geothermal Power Plant, Italy

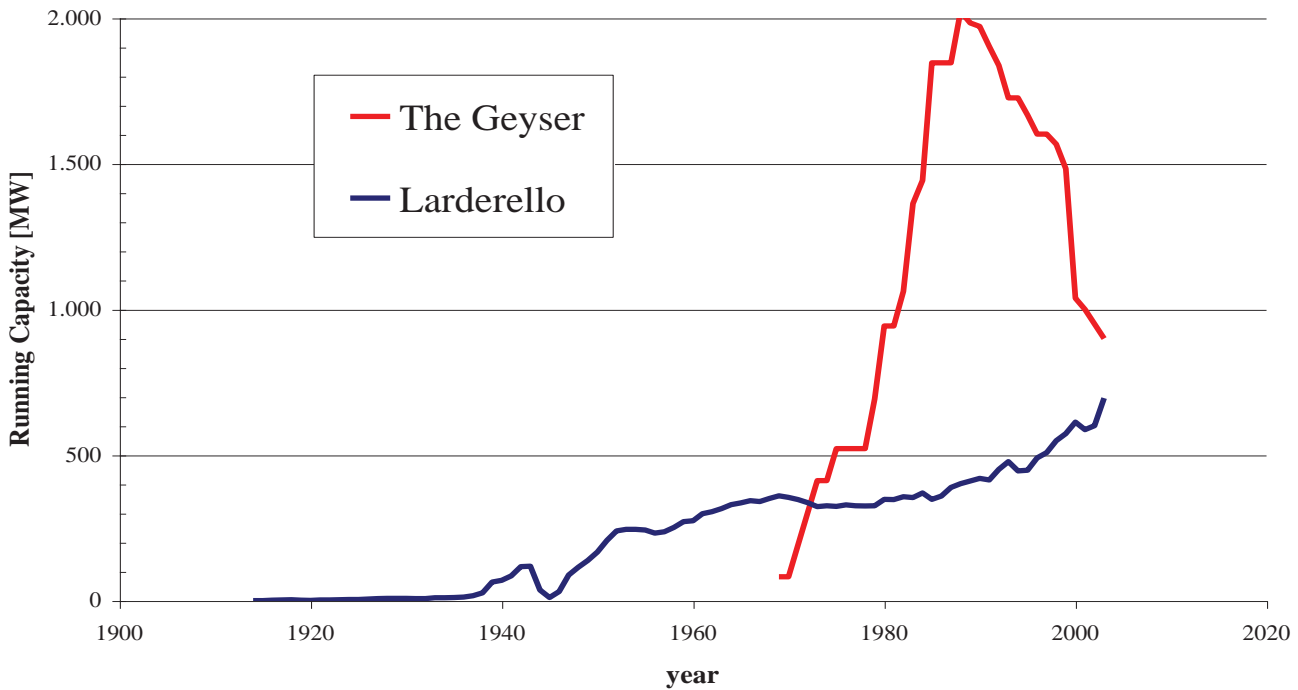


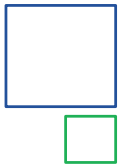
Power Plant completed

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**Larderello and The Geyser:
running capacity comparison**





The challenge: sustainability

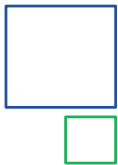
Production

- Deep Exploration
- Reinjection
- Stimulation jobs
- Plants efficiency improvement

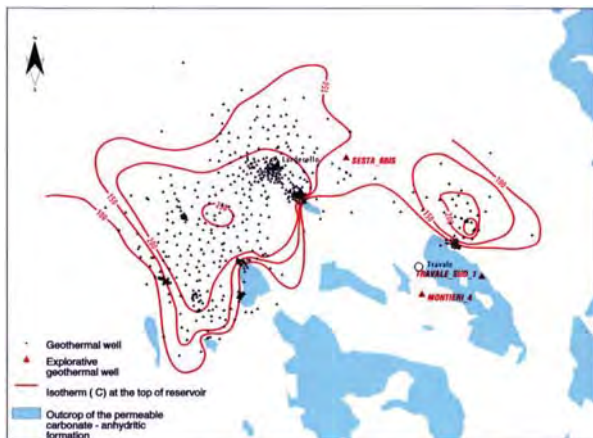
Environmental – Social acceptance

- Pollutants treatment
- New design criteria to minimize visual impact
- Promotion of direct uses for local economic growth

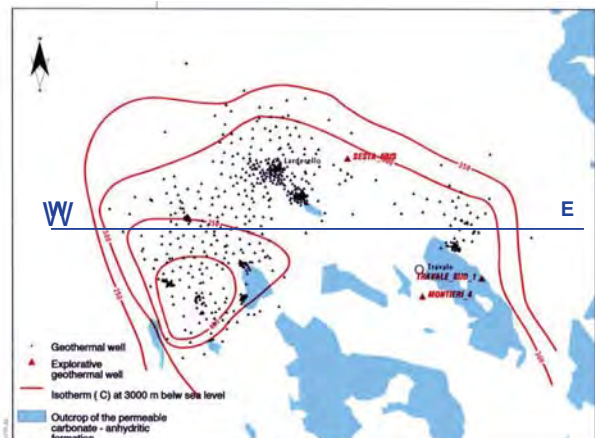
The third phase Finding new ways to growth



Production sustainability Deep exploration

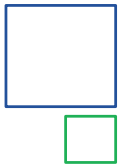


Temperature at the top of the shallow Carbonate Reservoir



Temperature at 3000 m b.g.l.

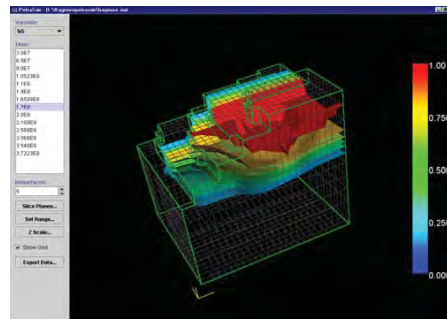
A unique system at great depth



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High temperature logging tools

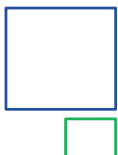


New exploration techniques

Deep drilling
Technological improvements were required



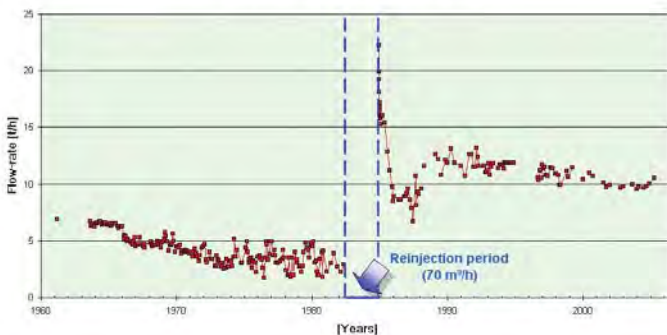
Fluid treatment



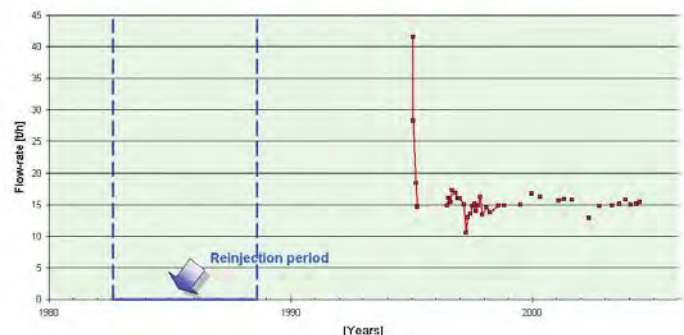
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Reinjection effects in the OLIVETA well



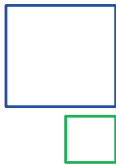
Reinjection effects in the SASSO_21 well



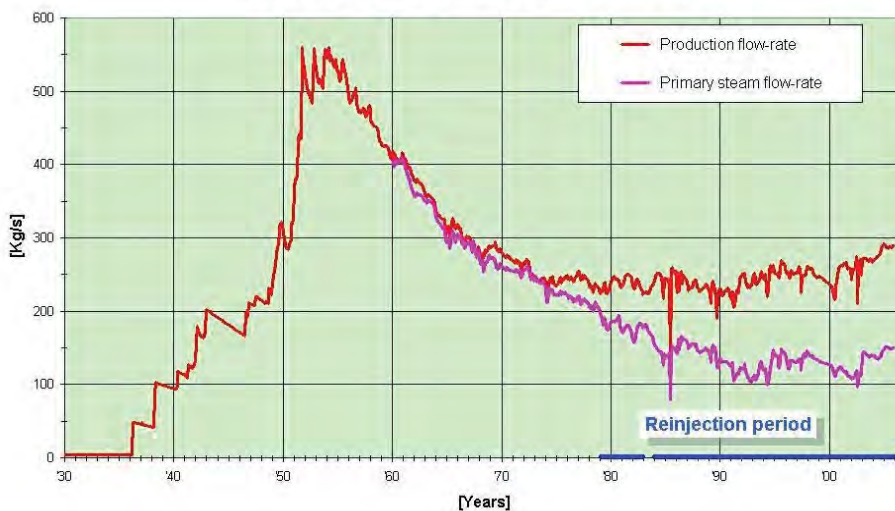
Injection of water and acid mixtures produces self-propping effects in the fractures:

- Microslippage of the fracture faces
- Removal of cuttings and mud deposition inside the fractures
- Acid leaching of hydrothermal mineralizations present in the fractures
- Contraction and consequent cracking of hot rock formations due to thermal stress

Production sustainability
Stimulation methodologies



Steam flow-rate of 82 wells in the Valle Secolo area

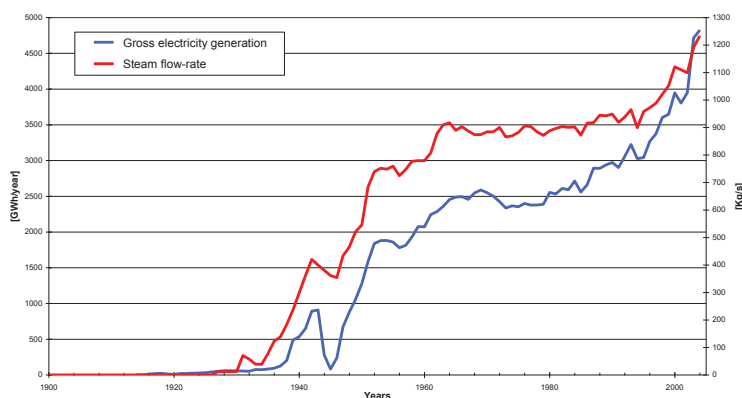


Reinjection represents by now an “exploitation strategy”

Production sustainability
Reinjection in the Valle Secolo area



37 new units with a capacity in the range 8 - 60 MW have been started up in the Larderello-Travale area in the period 1979 -2005



12 new units (314,5 MW) were installed and started up in the period 2000-2005 in the area of Larderello-Travale/Radicondoli

8 units, for a total of 214.5 MW, replaced old units in operation from many years and considered “obsolete”. The new units are characterized by higher efficiency and lower environmental impact.

4 units, for a total of 100 MW are new capacity installed both in marginal and central areas

Production sustainability
Power plants efficiency improvement



Environmental sustainability

Plant design innovation

- Design and construction of a specific plant, known as AMIS® (*Abbattimento Mercurio e Idrogeno Solforato*) for the abatement of H₂S (hydrogen sulphide) and Hg (mercury) from the gases emitted during power plants operation



Architectural innovation

- New design solution and criteria for minimizing visual impact of the power plants in order to make geothermal presence more acceptable to the local community



Innovation also possible to reduce environmental impact



Environmental Sustainability



Reduction of gas emission AMIS (process for H₂S and Hg removal)

Abatement

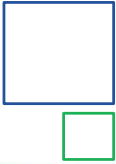
✓ Hg

>90%

✓ H₂S

70-80%

New design criteria finalized to minimize the visual impact



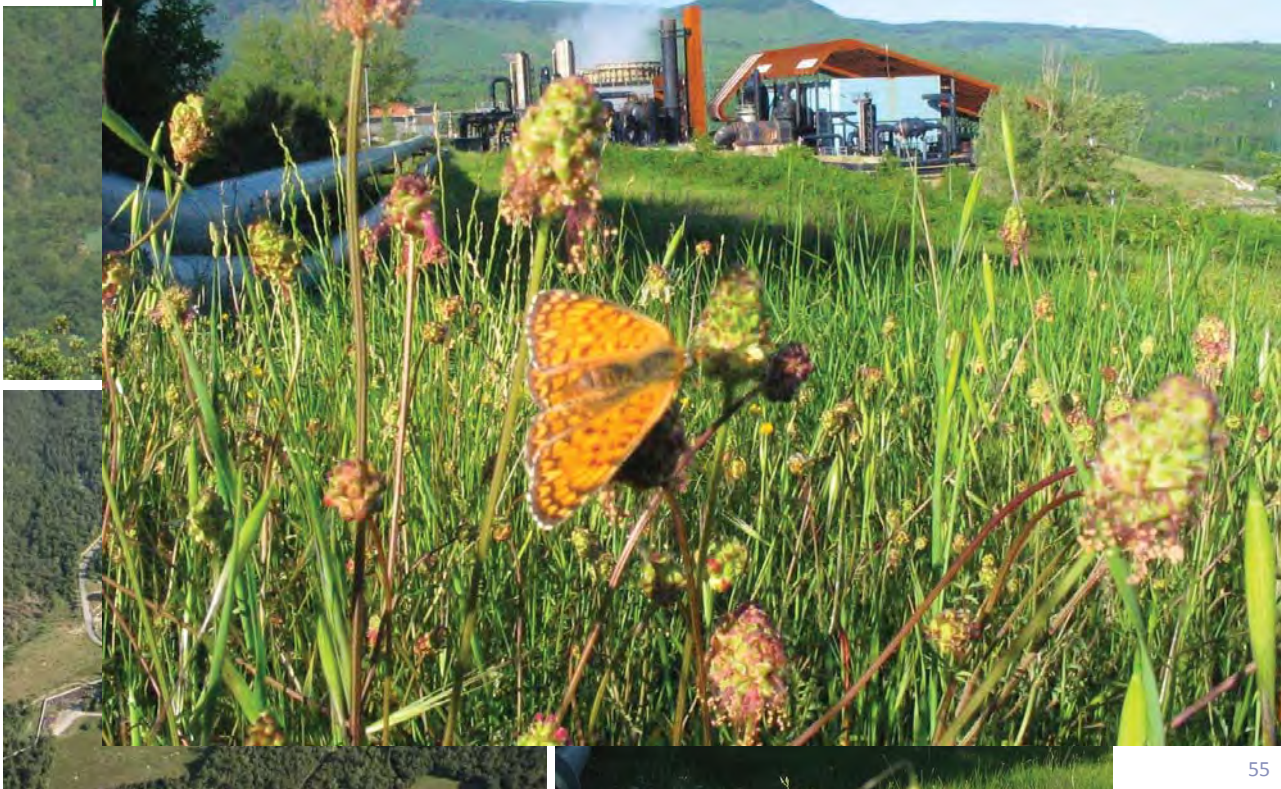
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- Construction at minimal height above ground level and/or in trenches, along roads or woods
- External color blends with landscape

Steam gathering systems





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Direct use promotion

37% of the heat is delivered to
greenhouses

56



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100 years of success

Direct use promotion



Arcadia
Podere Casetta
Strada per Vecchienne, Km 3
56041 Sasso Pisano (PI)
www.arcadia.info
e-mail: bamjunior2@tin.it

Arcadia
Tel./Fax: 039 2450563
Cell: 348 3054403
Tel: 0566 917041

ARCADIA
Azienda agricola

Nell'alta
Maremma
toscana...

Cell. 333.6007915
AZIENDA BIOLOGICA

1% of the total heat is used in cheese and salami production activities

57



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100 years of success



Forniture Calore	uso	Contratto del	Potenza nominale Gcal/h	utenze servite		Consumo Gcal/anno	risparmio annuo		CO ₂ evitata t
				n°	m ³		TEP	CH ₄ [m ³]	
TOT. COMUNE CASTELNUOVO V.C.				1097	291.681	26.913	2.691	3.588.458	8.343
CASTELNUOVO V.C.(capolugo)	TR	25/01/1985	6,24	827	223.000	20.942	2.094	2.792.220	6.492
SASSO PISANO	TR	25/10/1993	2,00	173	42.500	4.657	466	620.891	1.444
SEI - TR villaggi aziendali	TR	2001/2002		93	23.031	1.231	123	164.119	382
ALTRE UTENZE ISOLATE	TR		0,11	4	3.150	84	8	11.229	26
STOLFI (pod. Caspeci)	TR	13/12/1993	0,01	1	300	22	2	2.965	7
CIOMPI (pod. S. Francesco)	TR	23/12/1998	0,01	1	350	20	2	2.667	6
TADDEI (Pian della Colombaia)	TR	12/11/2001	0,03	1	900	29	3	3.827	9
FRANCHI (pod. Le Franate)	TR	01/10/2005	0,06	1	1.600	13	1	1.769	4
TOT. COMUNE POMARANACE				2020	584.444	39.876	3.988	5.316.792	12.362
POM. (Ina casa)	TR	09/02/2001	1	78	19.865	1.070	107	142.702	332
POM. (Montecerboli)	TR		3	400	108.232	5.691	569	758.818	1.764
POM. (Serrazzano)	TR		2	223	54.321	2.827	283	376.885	876
POM. (Lustignano)	TR		1	94	20.056	901	90	120.151	279
POM. (San Dalmazio)	TR		1	96	22.763	6.483	648	864.344	2.010
POM. (Capolugo)	TR		10	843	273.323	19.032	1.903	2.537.640	5.900
SEI - TR villaggi aziendali	TR	2001/2002	3	283	83.784	3.693	369	492.358	1.145
ALTRE UTENZE ISOLATE	TR		0	3	2.100	179	18	23.893	56
SALVADORI (Mulino La Perla)	TR	20/03/1998	0	1	600	40	4	5.333	12
BERTI (pod. Le Mulina)	TR	31/12/1993	0	1	300	24	2	3.160	7
CARAI (pod. S. Marco)	TR	19/12/2002	0,04	1	1.200	116	12	15.400	36
TOT. COMUNE MONTEROTONDO M.mo	TR	25/10/1993	2	399	102.524	8.917	892	1.188.967	2.764
COMUNE MONTEROTONDO M.mo	TR	25/10/1993	2,00	350	92.000	8.246	825	1.099.447	2.556
SEI - TR villaggi aziendali	TR	2001/2002		49	10.524	671	67	89.520	208
TOT. COMUNE SANTA FIORA *	TR	21/12/1999	13	400	94.118	6.353	635	847.059	1.969
totali riscaldamento Toscana				3.916	1.072.766	82.060	8.206	10.941.276	25.438

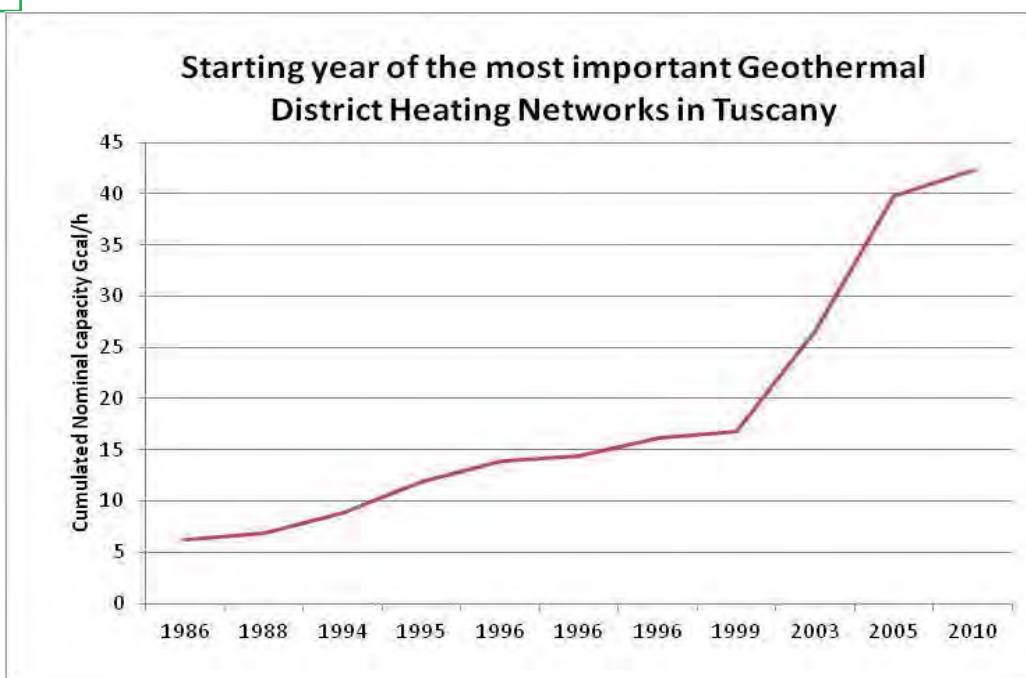
Total production of heat 273 Tcal → 85000 avoided ton CO2

Direct use
District heating in Tuscany

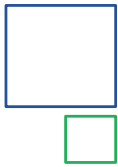


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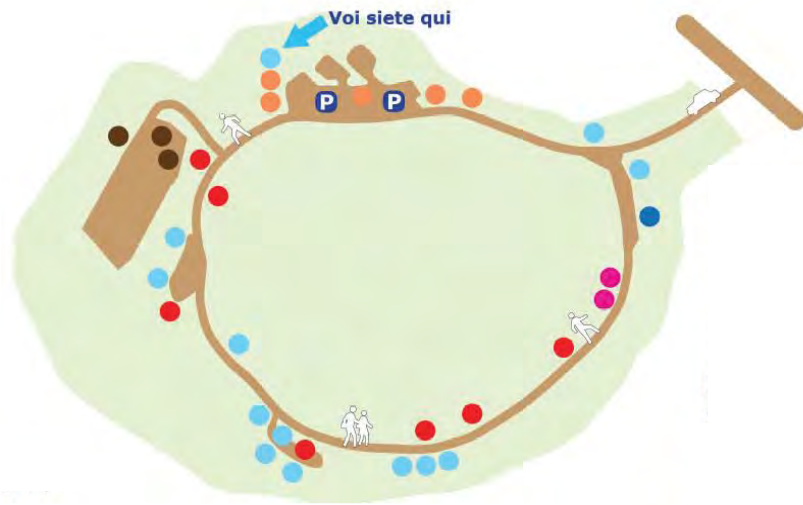
Direct use
District heating in Tuscany



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- Territory features
- Drilling
- Generation cycle
- Emission abatement
- Direct uses
- General info



San Martino visitors pathway

Touristic attraction (educational pathways)

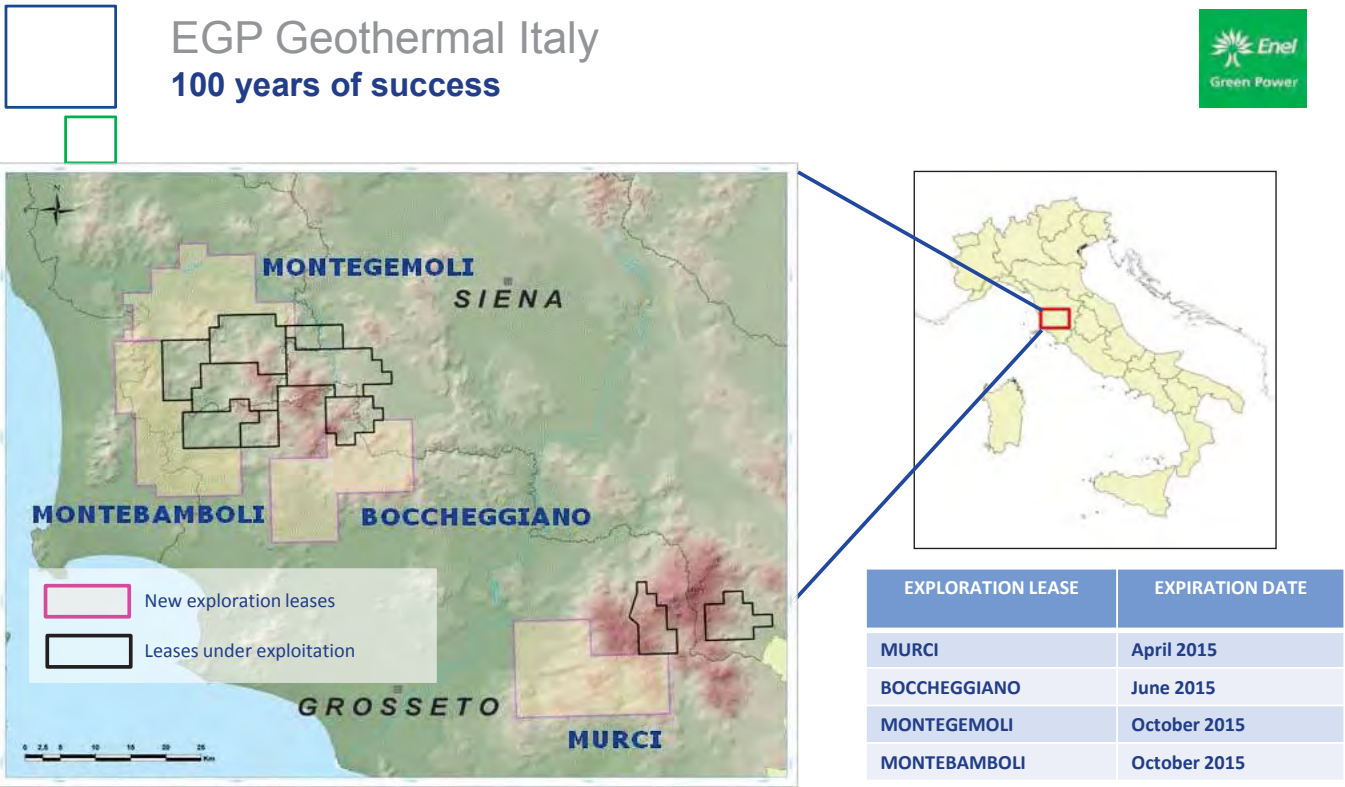
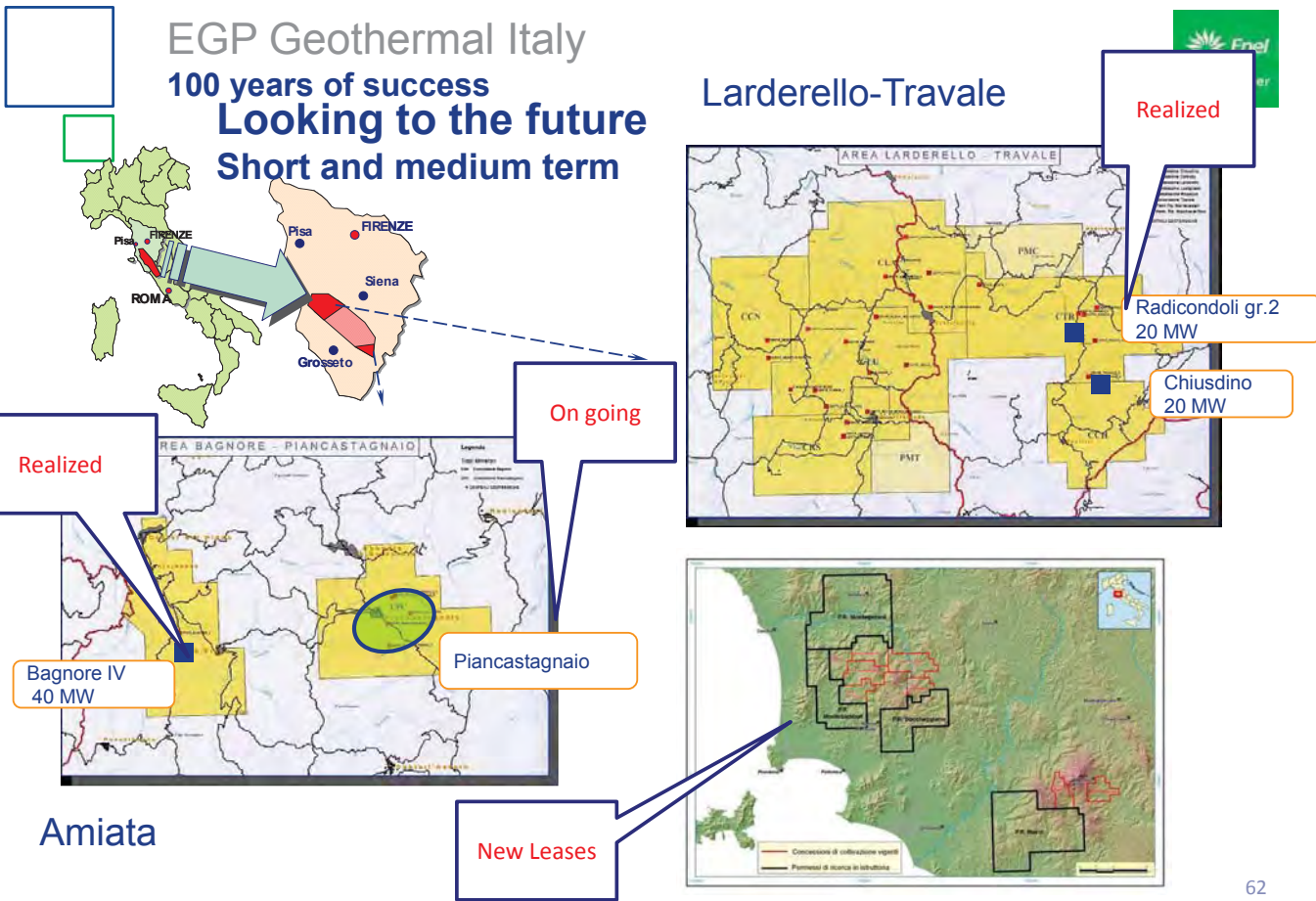


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An opportunity for tourist business..





EGP is also evaluating 4 new exploration areas



Ministerial Decree of July 6, 2012 - Incentives for renewable sources

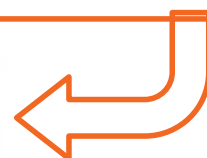
Allegato 1 – Vita utile convenzionale, tariffe incentivanti e incentivi per i nuovi impianti

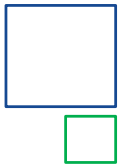
Fonte rinnovabile	Tipologia	Potenza	VITA UTILE degli IMPIANTI	tariffa incentivata base
		kw	anni	€/MWh
Eolica	On-shore	1<P≤20	20	291
		20<P≤200	20	268
		200<P≤1000	20	149
		1000<P≤5000	20	135
	Off-shore (1)	P>5000	20	127
		1<P≤5000	25	176
Idraulica	ad acqua fluente (compresi gli impianti in acquedotto)	P>5000	25	165
		1<P≤20	20	257
		20<P≤500	20	219
		500<P≤1000	20	155
		1000<P≤10000	25	129
	a bacino o a serbatoio	P>10000	30	119
		1<P≤10000	25	101
		P>10000	30	96
Oceanica (comprese maree e moto ondoso)	1<P≤5000	15	300	
	P>5000	20	194	
Geothermal source		1<P≤1000	20	135
		1000<P≤20000	25	99
		P>20000	25	85

Additional premiums

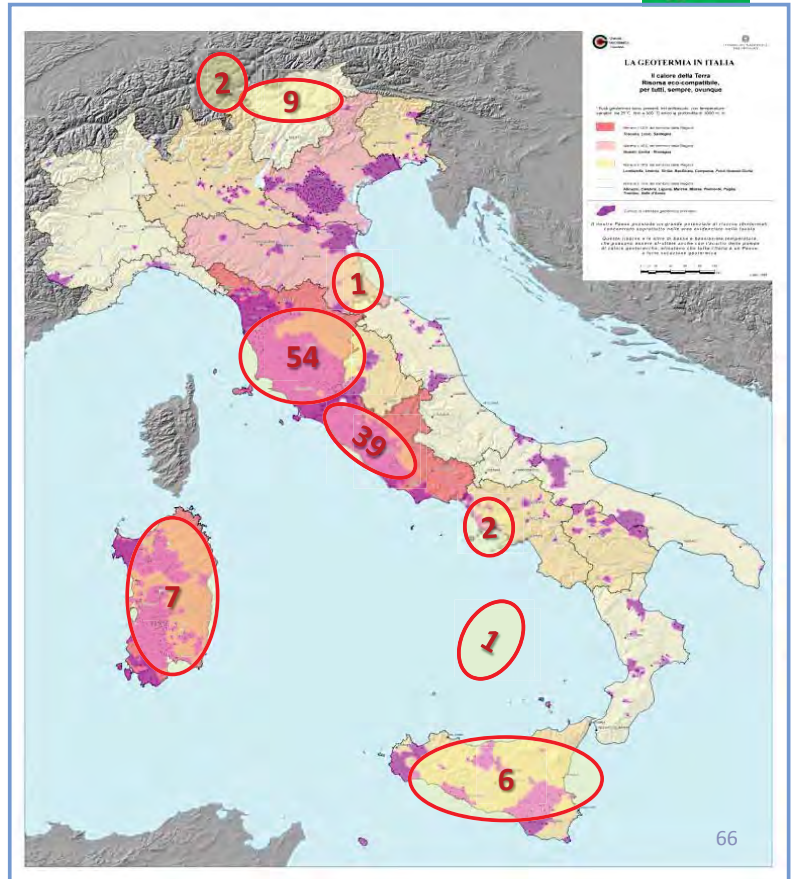
30 €/MWh for the first 10 MW in each new area

30 €/MWh in case of total reinjection and zero emission





Geothermal Italy New Exploration

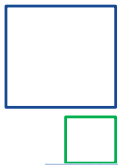


121 new Exploration Permit requested:

Released: 46

Rejected: 35

Under evaluation: 40



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90 MW in a snapshot: Carboli, San Martino & Monte Rotondo



ご清聴ありがとうございました。