Develop Geothermal Electricity in Europe to have a renewable energy mix

Workshop Spain & Portugal

High Enthalpy Geothermal Potential in Spain

Rubén González Cereijo
APPA High Enthalpy Geothermal Department
President

Valencia. November 10th, 2011

INDEX

- About APPA.
- APPA High Enthalpy Geothermal Department.
- Existing geothermal studies.
- APPA geothermal study.
- Geothermal areas.
- Geothermal resource.
- Cost assessment.
- Proposed support Schemes.
- Proposed remuneration framework.
- Potential Installed Capacity 2020.
- Current development.

- National Association

- Represents close to 500 producers, businesses and other associations in the renewable energy sector

- Role:
  - Coordinates, represents and defends the interests of the Sector in politics, civil society and to the media.
  - Participates in the development of Spanish energy and environmental policy.
  - Participates in commissions:
    - Regulation
    - Industry
    - Economy

- Representative in:
  - Spanish National Energy Commission
  - CIEMAT (Center for Environmental and Energy Technology Research)
  - Committee of Agents of the Electricity Market
  - Other public entities
- Presence in Europe:
  - Member of:
    - ESHA → European Small Hydropower Association
    - EWEA → European Wind Energy Association
    - AEBIOM → European Biomass Association
    - EGEC → European Geothermal Energy Council
    - EU-OEA → Ocean Energy Association
  - Lobby EU institutions

APPA REPRESENTS:

- Biofuels: Bioethanol and Biodiesel
- Biomass and Biogas
- Geothermal Energy (High and Low Enthalpy)
- Hydropower
- Marine Energy
- Small-scale Wind Installations
- Solar Photovoltaic
- Solar Thermoelectric
- Wind Energy

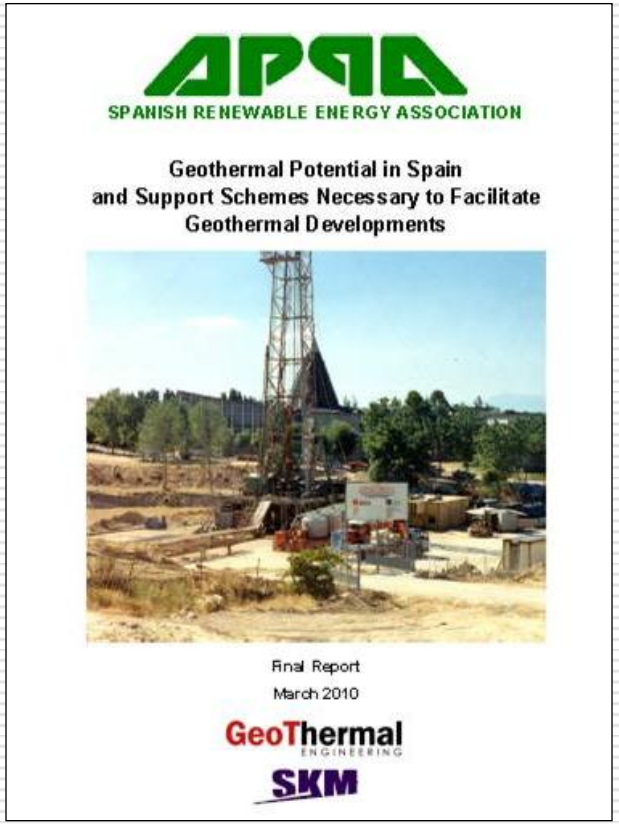
HIGH ENTHALPY GEOTHERMAL DEPARTMENT

EXISTING GEOTHERMAL STUDIES

- NATIONAL:
  - IDAE → Spanish Renewable Enery Plan (PER) 2011-2020
  - IGME (80's)
- REGIONAL:
  - Andalucía
  - Basque Country
  - Catalonia
- PRIVATE:
  - APPA

APPA GEOTHERMAL STUDY

- July 2009 / march 2010
- GeoThermal Engineering GmbH (GeoT) & Sinclair Knight Merz (SKM)
- Spain's deep geothermal resources assessment.
- Concept projects key features.
- Concept projects costs assessment.
- Suitable support schemes proposal.
- Potential development @ 2020.



GEOTHERMAL AREAS

CONVENTIONAL GEOTHERMAL SYSTEMS		✓ Canary Island
SYSTEMS ASSOCIATED WITH DEEP SEDIMENTARY BASINS	Cenozoic basins	✓ Tajo Basin: Madrid ✓ Duero Basin: León, Burgos, Valladolid ✓Guadalquivir Basin
	Alpine Chain Systems	✓ Catalan Coastal Ranges: Vallés, Penedés, La Selva, Ampurdán ✓ Betic Cordillera: Granada, Guadix, Baza ✓ Pyrenean Chain: Jaca-Sabiñánigo
ENHANCED GEOTHERMAL SYSTEMS (EGS)		✓ Granitic basement underlying deep sedimentary basins. ✓ Granites with a high degree of deep fracturing: Galicia

GEOTHERMAL RESOURCE

Distribution of geothermal areas in Spain (modified by Haenel & Staroste, 1998)

THE RESOURCE: HEAT IN PLACE

Area	Sub-area	Acumulated heat PJ_{th}		Clasification by Temperature[b]
		Most probable	Best Case	
Cordillera Bética	Hidrotermal – todas las cuencas	188.355	2.097.728	100 - 150
Cordillera Costero-Catalana	Hidrotermal – todas las cuencas	111.300	1.276.939	100 - 150
Zona pirenaica	Hidrotermal – todas las cuencas	115.008	1.328.275	100 - 150
Macizo Ibérico	Hidrotermal de poca profundidad	10.974	180.233	100 - 150
Cuenca del Duero	Toda la cuenca	119.115	1.487.793	<100
	EGS - Salamanca	252.458	1.182.093	100 - 150
Cuenca del Ebro	Toda la cuenca	122.114	1.159.410	<100
	Hidrotermal - Jaca-Sabiñanigo	12.600	40.381	>150
Cuenca del Tajo	Toda la cuenca	284.843	2.996.559	<100
	EGS - NE Madrid	18.619	109.303	100 - 150
	EGS de profundidad - Madrid	146.878	1.323.771	100 - 150
Guadalquivir	Toda la cuenca	301.157	4.186.383	<100
		1.683.421	17.368.868	

Resource areas: 20 % (most probable) y 100 % (best case) of the mapped anomally

European Geothermal Atlas – Haenel & Staroste, 1998

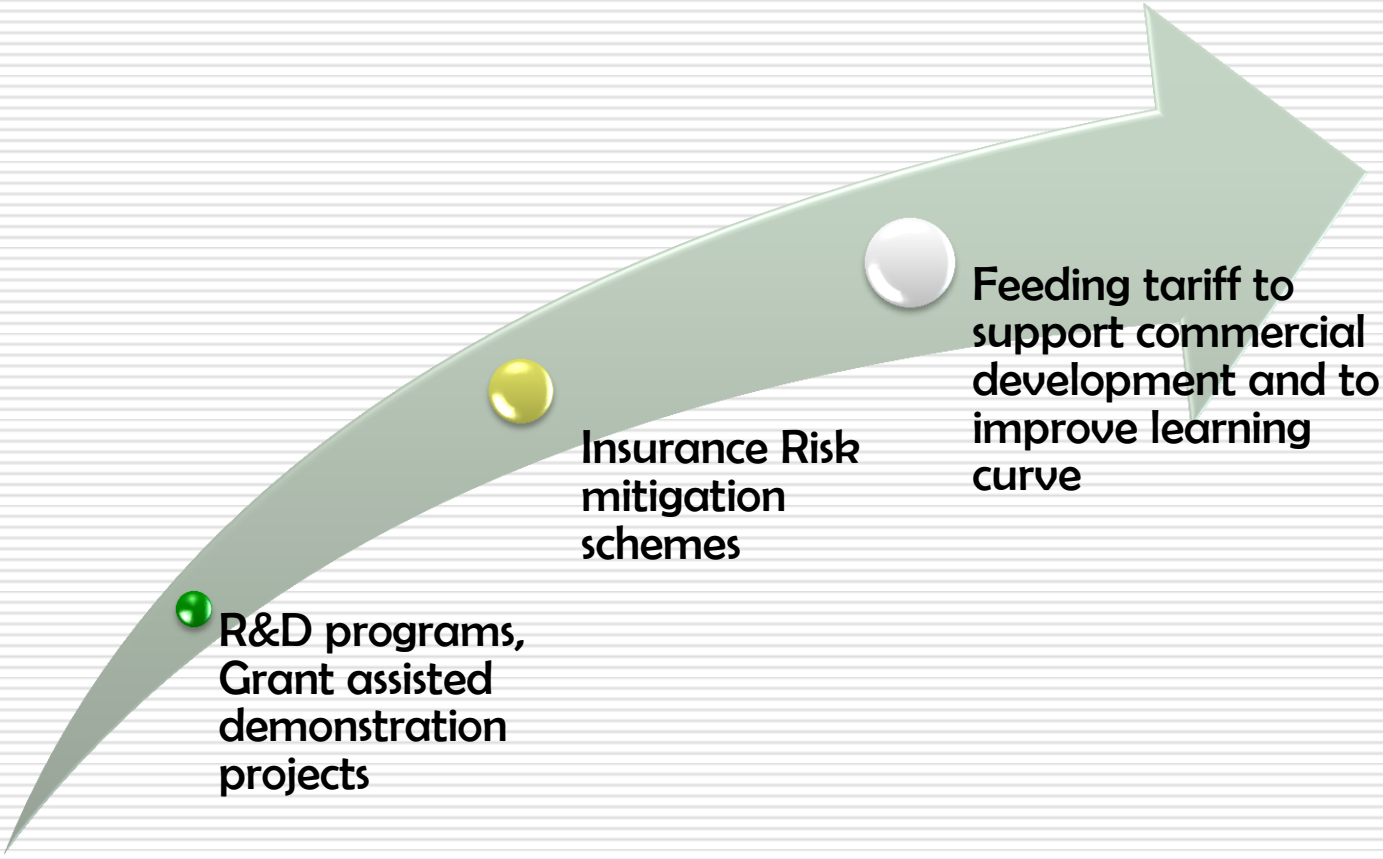
THE RESOURCE: POWER

Prospect Area	Best case [MWel] 20%	Most probable [MWel] 100%
Canarias	255.00	500.00
Betic Cordillera	69,706.00	2,458.00
Catalan Coastal ranges	43,444.00	1,452.00
Pyrenees	45,542.00	1,501.00
Iberian Massif		
Duero Basin	7,380.00	1,343.00
Ebro Basin	1,439.00	200.00
Tajo Basin	1,730.00	129.00
	4,471.00	917.00
Guadalquivir		
	176,212.00	**8,500.00**

COST ASSESSMENT

Plant Type		20 MW flash	20 MW binary	10 MW EGS
Resource Type		Active Volcanic	Hydrothermal	Petrothermal
Temperature	ºC	220-250	150-180	100-150
Well depth	m	2500	3600	4000
Planta Net Capacity	MW_{el} net	18,8	16	7
Capacity Factor	%	95	90	90
Ouput tp grid	GWh	156	126	55
Opex	€m/y	1,6	2,2	2,2
Capex	**€m**	**72**	**129**	**106**
Development Duration	Years	5	5	5

PROPOSED SUPPORT SCHEMES



PROPOSED REMUNERATION FRAMEWORK

Power generation → Feed-in Tariff

- ✓ 85 €/MWh for high enthalpy projects
- ✓ 370 €/MWh for low enthalpy projects
- ✓ A bonus of 40 €/MWh for "petrothermal" projects (EGS)
- ✓ A bonus of 30 €/MWh for thermal uses

Thermal generation → Feed-in Tariff

POTENTIAL INSTALLED CAPACITY 2020

Power generation (MW_e)

High Enthalpy Resources	255
Low Enthalpy Hydrothermal	554
EGS	239
Total	1048

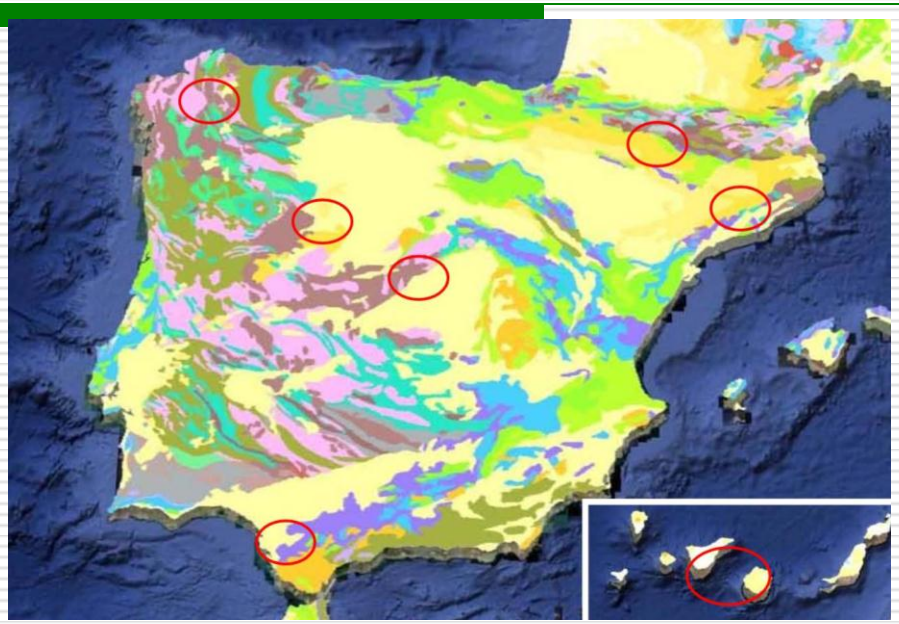
Direct uses (MW_t)

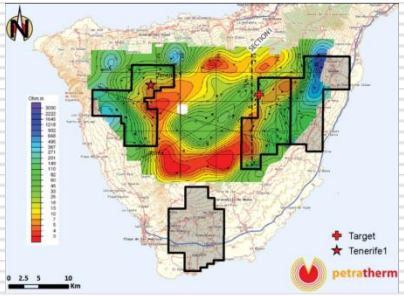
Heat from combine heat and power plants	500
Direct heat use (Heat and Cold)	200
Total	700

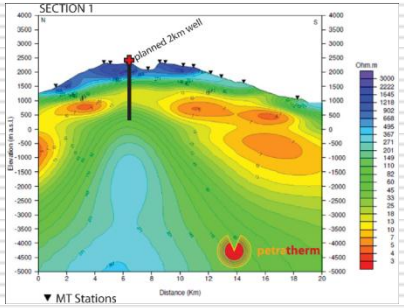
Equivalent to:

- 5 high enthalpy geothermal plants
- 39 hydrothermal projects
- 24 EGS projects

CURRENT DEVELOPMENT: POWER GENERATION







- Several projects in initial and advanced exploration stages.
- More than 50 research permits in licensing process.
- > 10 M€ expenditure commited.

CURRENT DEVELOPMENT: DIRECT USES

- Large sedimentary basins.
- Hot aquifers associated, which could be exploited for direct thermal use.
- Cantoblanco in Madrid (center), 8MW thermal district heating grid.
- Villalonquejar project in Burgos (NW) to provide heat for industrial processes.

Thanks for your Attention

SPANISH RENEWABLE ENERGY ASSOCIATION

geotermica@appa.es

www.appa.es