Overview of the Global Geothermal Market and Investment




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Global Geothermal Trends - Power

- 5 Top geothermal power producers are: USA, Philippines, Indonesia, Mexico, New Zealand
- Installed global capacity: 12.6 Gwel, 24 countries
  In 2010 only 10.897 GWel were installed.
- Technology innovations: Binary systems, Enhanced Geothermal Systems

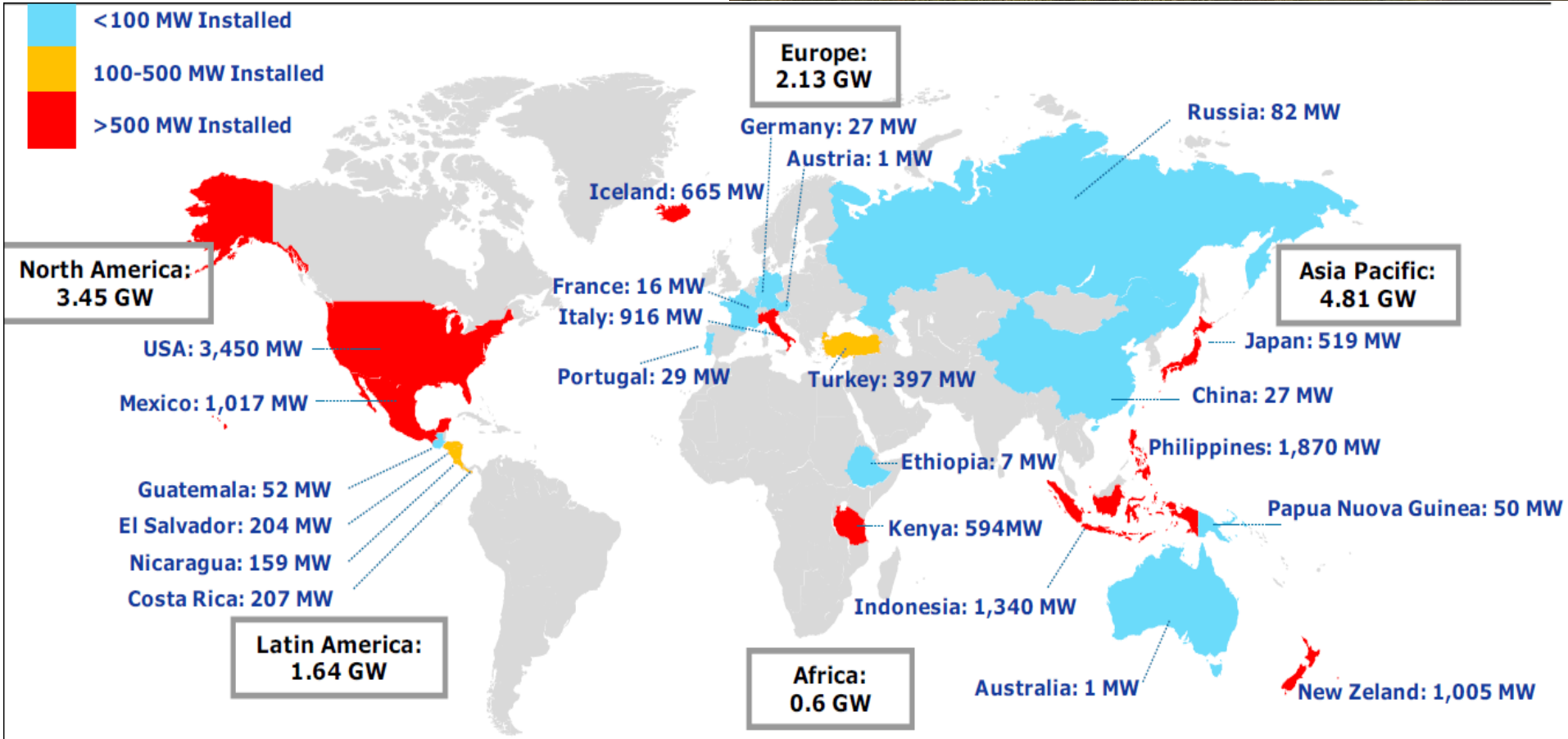


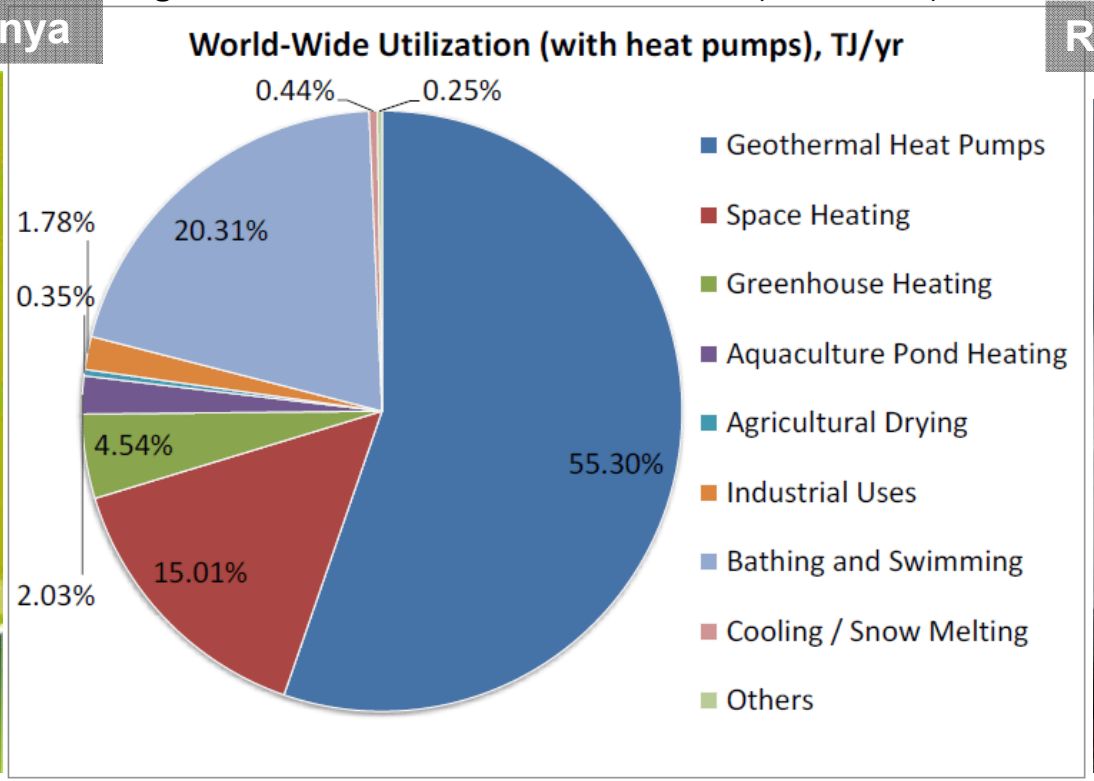
Figure: Geothermal global installed capacity in 2015: 12.6 GW (Bertani 2015)

Global Geothermal Trends – Direct use

- **Direct use applications** exist in **82 countries**
- Geothermal direct use applications for **heating** are growing in the northern hemisphere (Sweden, Denmark, China, Germany, Japan are forerunners)
- Increasingly, **geothermal heat** is fed into **district heating networks** (>230 networks in Europe) and/ or supplies larger public complexes (malls, offices)

Figure: Geothermal direct use in 2015 (Lund 2015)

Oserian farm, Kenya



Rittershofen Oct. 2015

Hotspot Regions for Geothermal Investment

Steady growth rate of 5% over last 3 years (Source: GEA Int. Market at a Glance, May 2015)

Africa/ Middle East: 611 MW installed power capacity - 60 projects in progress, of which 20 are located in the East African Rift System (Kenya and Ethiopia).

Asia: 568 MW installed in China, Japan, Taiwan, Thailand - 70 projects in some stage of development.

Europe: 2,178 MW installed power - 1,770 MW under development – 140 projects in progress in 20 European countries. In Turkey 60 projects are in progress. Direct use for space heating and heating networks are becoming more important.

Mine water use for space heating, Germany

Olkaria, Kenya

Hotspot Regions for Geothermal Investment

Caribbean: 15 MW installed, 78 MW additions are expected – 20 projects in development. Cork Hill in Montserrat and Wotten Waven in Dominica under construction.

Central America: 563 MW installed. Additions of 444 MW expected – 20 projects in progress.

North America: In the US 3,548 MW of power capacity are installed, in Mexico 883 MW are operational - 80 projects are in development in North America.

South America: Developing potential capacity of 2,500 MW – 100 projects in development, in Chile about 50 projects.

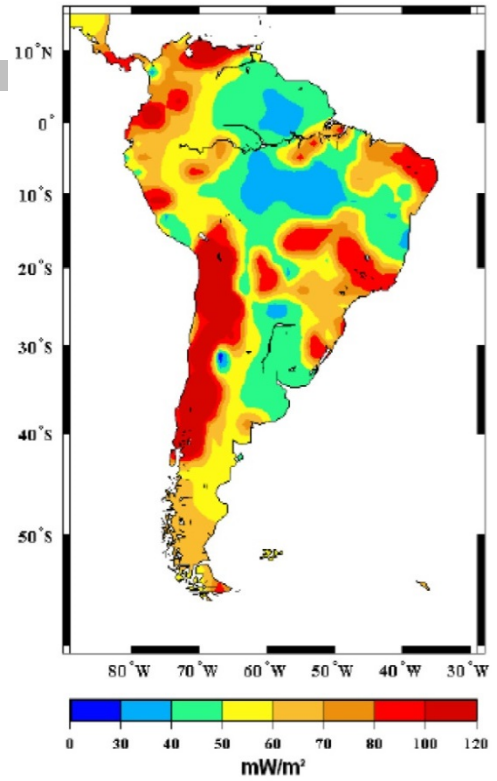


Figure: Continental heat flow map of Cardoso, Hamza and Alfaro (2010)

South Pacific: 4,318 MW are installed mainly in Indonesia, the Philippines and New Zealand. Over 60 projects are underway with 20 projects in the Philippines.

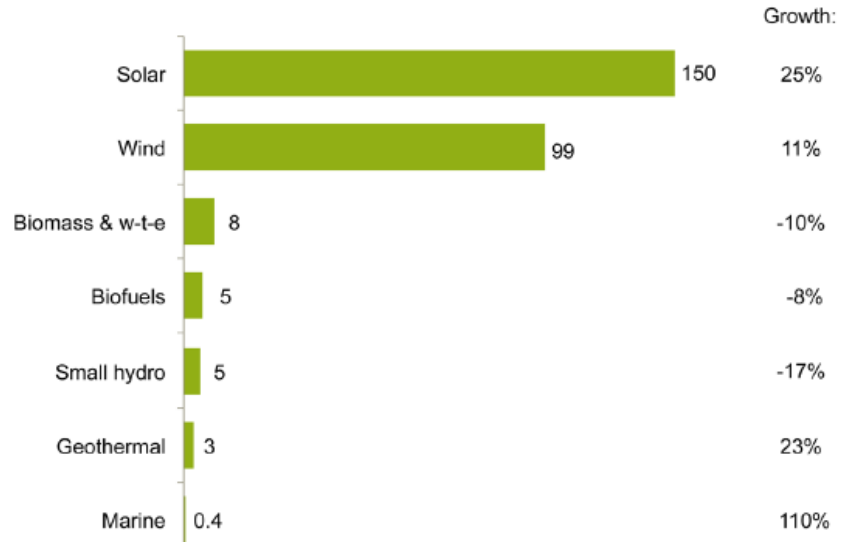
(Source: GEA Int. Market at a Glance, May 2015)

Investment News in 2014

Wind and solar outweigh the other renewable energy technologies. In 2014, these two sectors accounted for 92% of overall global investment in renewable power and fuels, while biomass and waste-to-energy made up 3% of total, with $8.4 billion invested, biofuels and small hydro each contributed just under 2%, with $5.1 million and $4.5 billion respectively, geothermal was responsible for 1%, with $2.7 billion committed.

Global investment in renewable power and fuels (excluding large hydro-electric projects) was $270.2 billion in 2014, nearly 17% higher than the previous year. This was the first increase for three years, and reflected several influences, including a boom in solar installations in China and Japan, totalling $74.9 billion between those two countries, and a record $18.6 billion of final investment decisions on offshore wind projects in Europe.

FIGURE 5. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2014, AND GROWTH ON 2013, $BN



Source: Bloomberg New Energy Finance

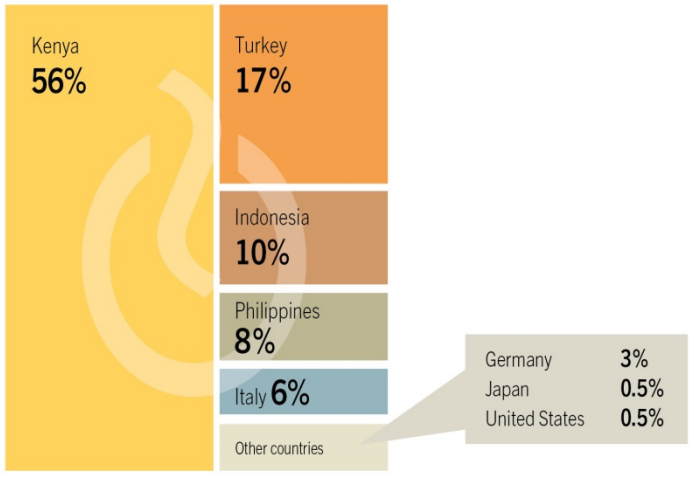
Source: Frankfurt School-UNEP Centre/BNEF. 2015.
Global Trends in Renewable Energy Investment 2015, http://www.fs-unep-centre.org (Frankfurt am Main)

Investment News in 2014

REN21 confirms that geothermal power investment in 2014 grew by 23% over 2013.

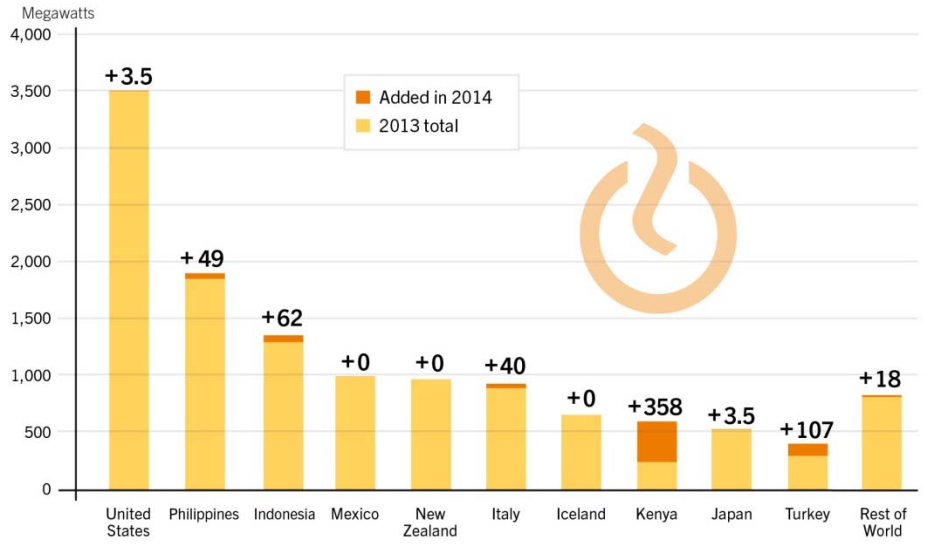
In 2014 two new South-South development banks were created:
The 100 billion USD New Development Bank created by the 5 BRIC countries & the Asian Infrastructure Investment Bank created by 23 Asian countries. Also new investment vehicles for renewables, such as green bonds or crowdfunding might attract new classes of capital providers.

Geothermal Power Global Capacity Additions, Share by Country, 2014



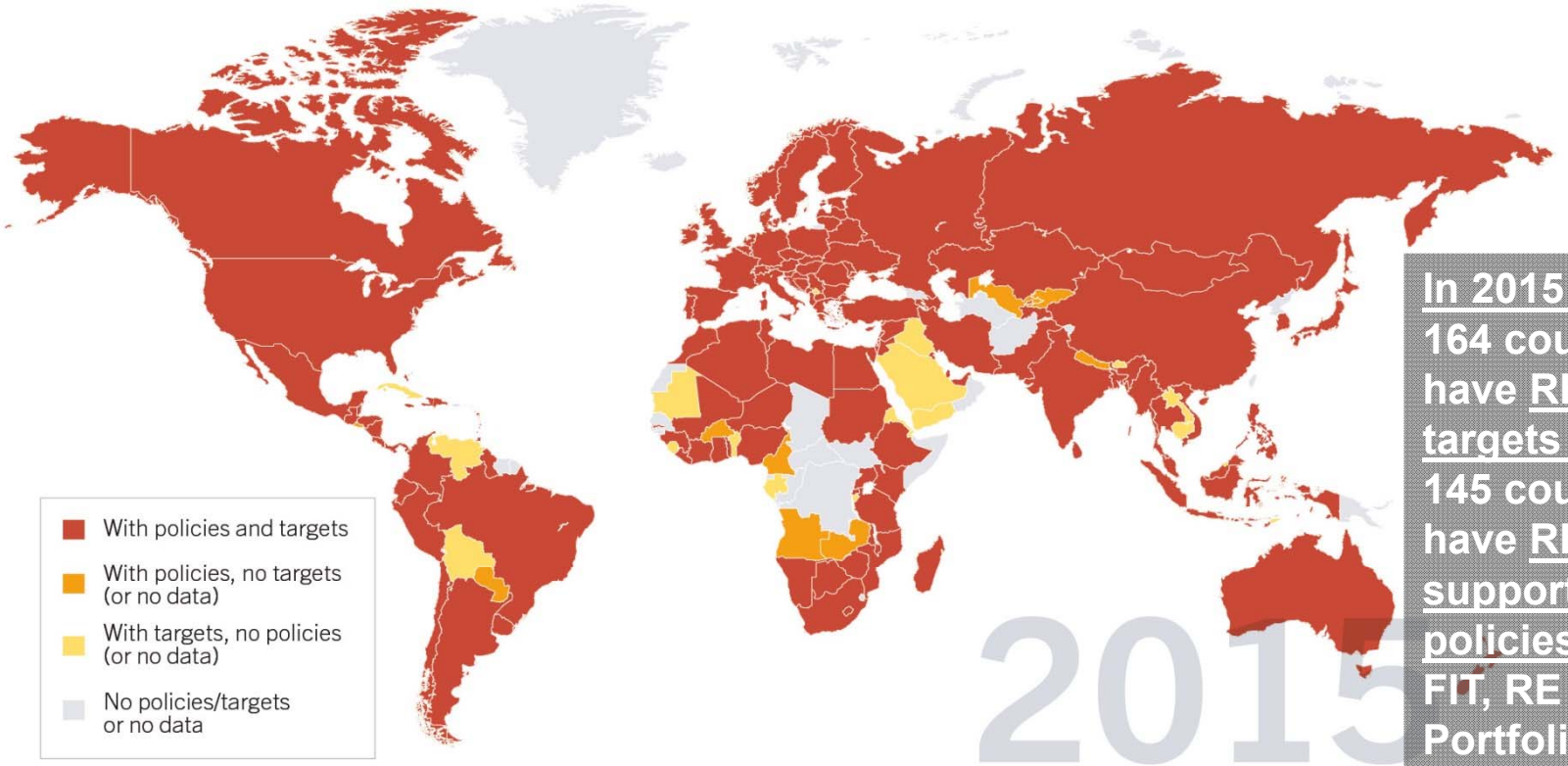
REN21 *Renewables 2015 Global Status Report*

Geothermal Power Capacity and Additions, Top 10 Countries and Rest of World, 2014



REN21 *Renewables 2015 Global Status Report*

Countries with Renewable Energy Policies and Targets, Early 2015



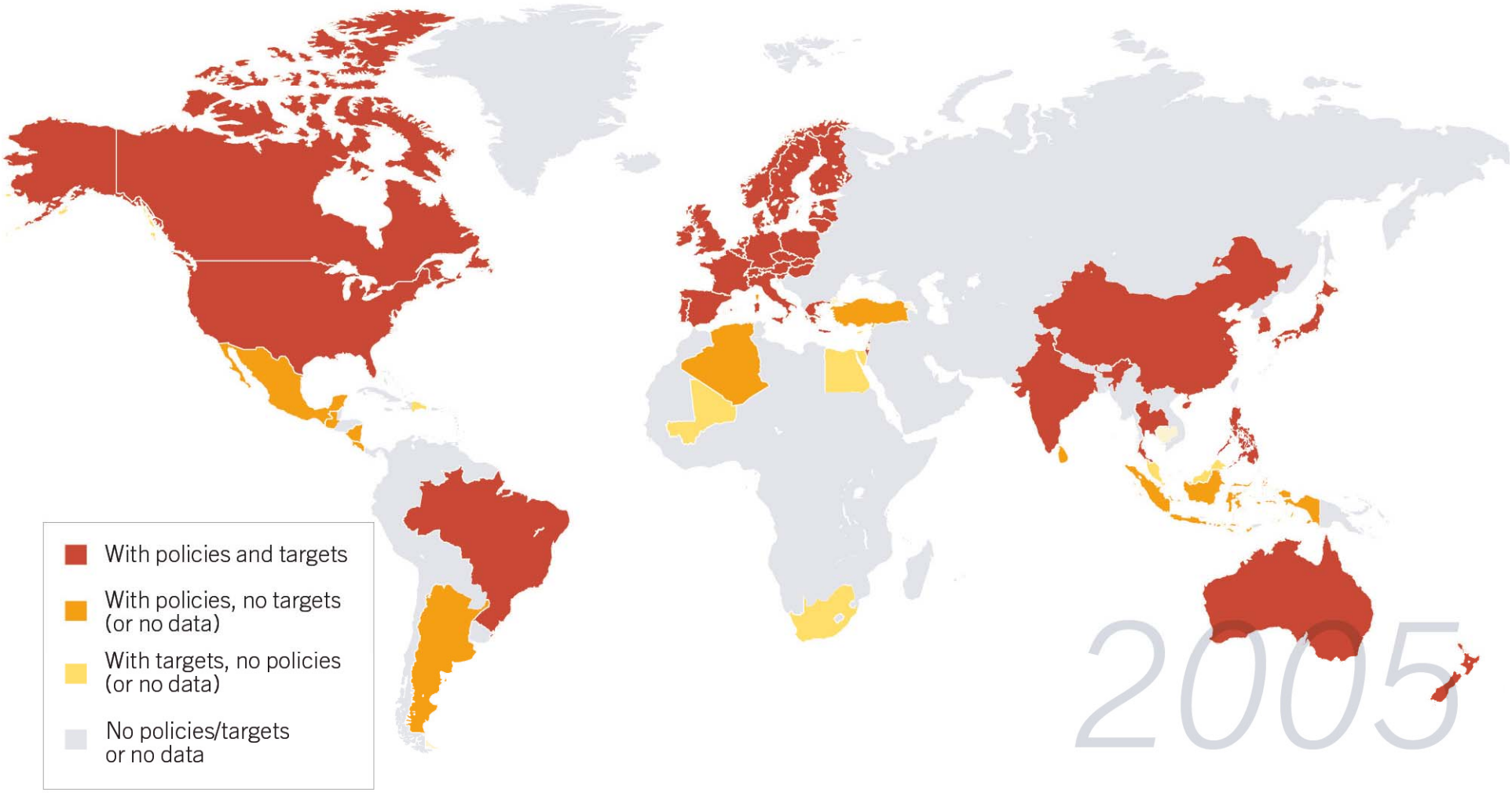
Countries are considered to have policies when at least one national or state/provincial-level policy is in place.

REN21 *Renewables 2015 Global Status Report*

In 2015:
164 countries have RE targets &
145 countries have RE support policies (i.e. FIT, RE Portfolio Standards)

REN21 Renewable Energy Policy Network for the 21st Century

Countries with Renewable Energy Policies and Targets, 2005



Countries are considered to have policies when at least one national or state/provincial-level policy is in place.

Geothermal Players in the Andes

Source: GEA Project list (Feb. 2015)

Bolivia	South America	unconfirmed project	Sur Lipez				Prospect
Bolivia	South America	National Electricity Company (ENDE)	Sol de Mañana geothermal field	Laguna Colorada	2019	50	Under Construction
Bolivia	South America		Oruro region		2020		Prospect
Columbia	South America	Ministry of Electricity and Renewable Energy (CELEC), ISAGEN & Andean Community of Nations (CAN)	Tufiño-Chiles-Cerro Negro (Binational Equador Project)		2018	80	Prospect
Columbia	South America	Isagen	Villamaría project			50	Early Stage
Columbia	South America	RESPEC Consulting & Services and Dewhurst group	Nevado del Ruiz Volcano				Early Stage
Columbia	South America	ISAGEN - CELEC	Nevado del Ruiz Volcano				Prospect
Ecuador	South America	Ministry of Electricity and Renewable Energy(seeking Private Investment)	Plio-Quaternary Chacana				Prospect
Ecuador	South America	Ministry of Electricity and Renewable Energy(seeking Private Investment)	Chachimbiro				Prospect

Geothermal Players in the Andes

Chile	South America	Origin Energy Chili SA	Chodhuen	Prospect
Chile	South America	Enel Green Power	Colorado	Prospect
Chile	South America	Energia Andina	Colpita Project	Early Stage
Chile	South America	Hot Rock Limited* Possbily sold to EDC	Copahue	Early Stage
Chile	South America	Energia Andina	Generative Project	Early Stage
Chile	South America	Zaldivar Mining Company	Gorbea	Prospect
Chile	South America	Energia Andina	Holy Lela	Prospect
Chile	South America	Energia Andina	Juncalito Project	Early Stage
Chile	South America	Infinergeo SpA	Licancura III	Early Stage
Chile	South America	Energia Andina	Lirima Pampa Project	Early Stage
Chile	South America	Hot Rock Limited* Possbily sold to EDC	Longavi Project	Early Stage
Chile	South America	Alterra Power	Los Cristales	Prospect
Chile	South America	Infinergeo SpA	Manflas	Early Stage
Chile	South America	Enel Green Power	Mares Dead	Prospect
Chile	South America	Ormat Technologies	Mariman	Prospect
Chile	South America	Alterra Power	Maule	Prospect
Chile	South America	Zaldivar Mining Company	Negrillar	Prospect
Chile	South America	Energy Development Corp.	Newen	Prospect
Chile	South America	Energia Andina	Paniri Project	Early Stage
Chile	South America	Energia Andina	Pecan Project	Early Stage
Chile	South America	Infinergeo SpA	Peucos	Early Stage
Chile	South America	Energy Andina	Pircados Hoyos	Early Stage
Chile	South America	Energia Andina	Polloquere Project	Early Stage
Chile	South America	Energia Andina	Proyecto Polloquere	Early Stage
Chile	South America	Energy	Punt	Prospect

Geothermal Players in the Andes

From GEA Project list (Feb. 2015)

Chile	South America	Origin Energy Chili SA	Aucan 2	Prospect
Chile	South America	Energia Andina	Aucán Project	Early Stage
Chile	South America	Energy Andina	Banos del Torro	Early Stage
Chile	South America	Minera Escondidd Limitada	Bay	Prospect
Chile	South America	Hot Rock Limited* Possbily sold to EDC	Caleris Project	Early Stage
Chile	South America	Infinergeo SpA	Callaqui	Early Stage
Peru	South America	Hot Rock Limited* Possbily sold to EDC	Achumani	Prospect
Peru	South America	Alterra Power JV Energy Development Corporation	Atarani	Prospect
Peru	South America	Dakotta Territory Resources Corp/ Andean Geothermic Energy S.A.C	Atecata	Prospect

Financing options in Emerging and Developing Countries

Several developing countries are among the top 15 geothermal countries. However, developers are faced with additional barriers:

- Credit risk barriers and currency instability
- Institutional barriers
- Political uncertainty

As country's risk profiles are a major issue for debt financiers, **multilateral institutions** are often the only source available for financing geothermal projects in emerging markets.

Multilateral Development Banks (MDBs):

- The World Bank Group (WB)
- Inter-American Development Bank Group (IDB)
- European Bank for Reconstruction (EBRD)
- African Development Bank (AfDB)

Multilateral Finance institutions (MFIs) have a narrower ownership/ membership structure or focus on special sectors/ activities. Examples include:

- European Commission (EC)
- Nordic Development Fund (NDF)
- European Investment Bank (EIB)
- OPEC Fund for International Development

Sub-regional banks are often owned by a group of countries. Examples are:

- Caribbean Development Bank (CDB)
- Banco de Desarrollo de America Latina (CAF)
- Central American Bank for Economic Integration (CABEI)

=> other support programs (ARGeo, GeoFund, carbon credits, GCF)

Bilateral Development Banks are set up by individual countries. i.e.:

- Agence Francaise de Développement (AFD), JICA, German Development Bank (DEG)

Investment News Latin America

Plant in Chile Opens South America's Doors to Geothermal Energy
By Marianela Jarroud |

OLLAGÜE, Chile, Aug 26 2015 (IPS) - Chile, a land of volcanoes and geysers, has started building South America's first geothermal plant, which would open a door to this kind of renewable energy in this country that depends largely on fossil fuels.
The **Cerro Pabellón** geothermal project is "immensely important for the Chilean state, which started geothermal exploration and drilling over 40 years ago," but no initiative had taken concrete shape until now, Marcelo Tokman, general manager of the state oil company, ENAP, told IPS.
The Italian company Enel Green Power has a 51 percent stake in the project and ENAP owns 49 percent. The plant consists of two units of 24 MW each for a total gross installed capacity of 48 MW in the first phase, but with the advantage of being able to generate electricity around-the-clock.

Comoros Islands continue exploration of geothermal development

Costa Rica

Today, Costa Rica is taking every opportunity to exploit its renewables and has decided to go for a target of 100% renewable energy by 2021. In 2013, some 10,100 MWh of electricity was generated, out of which 87 per cent were from renewable energy sources. Although the majority came from hydropower generation, around 20 per cent of the total renewable electricity was generated from non-hydropower renewables. One decade ago, the total installed capacity of geothermal power in Costa Rica was 145 MW. By 2012, it grew to 217 MW. An additional 210 MW is expected to be in operation throughout the next decade

Isagen seeks partners for 50-MW geothermal project in Colombia
Feb 19, 2015 08:54 CET by **Diana Hristova** (SeeNews)
Colombian state-run power company Isagen SA (CLB:ISAGEN) will evaluate a strategic alliance with **Toshiba Corp** (TYO:6502) and two other partners to jointly develop a 50-MW geothermal plant in Colombia by 2020.
The companies announced on Wednesday the signing of a memorandum of understanding for what could be the first geothermal power plant in Colombia. As part of the alliance, **West Japan Engineering Consultants Inc** will carry out engineering and the feasibility study, which is expected to take two years. **Schlumberger Ltd** (NYSE:SLB) will drill the well and will supply the steam transport system, while Toshiba will be responsible for construction of the plant and the main equipment.
Colombia's geothermal energy potential has been estimated at 2,210 MW, according to a presentation by Isagen in 2014. Apart from Villamaria, the country has started pre-feasibility studies for a 138-MW geothermal project on its border with Ecuador.

Global Investment News

MAY 23, 2013

A GLOBAL DRILLING FUND COULD SOLVE GEOTHERMAL'S CATCH-22

The mature and zero-carbon technology of geothermal power is being held back by the cost and uncertainty of drilling wells, but new research suggests a possible answer

Washington DC, 23 May 2013. The Catch-22 problem that is holding back world investment in geothermal power could be addressed via the establishment of a "global geothermal exploration drilling fund", with either private investors and banks or government entities and development banks as the capital providers.

A new White Paper, published today by research firm Bloomberg New Energy Finance and analysis provider Rinova International, examines how a possible $500m fund could help geothermal developers. At present, the industry faces the problem that that even though the sector as a whole can offer attractive returns, it is very difficult to raise the capital to drill individual wells because of the high risk of failure.

Bloomberg NEW ENERGY FINANCE

http://about.bnef.com/press-releases/a-global-drilling-fund-could-solve-geothermals-catch-22/

St. Kitts expects initial work on geothermal exploration to start early 2016

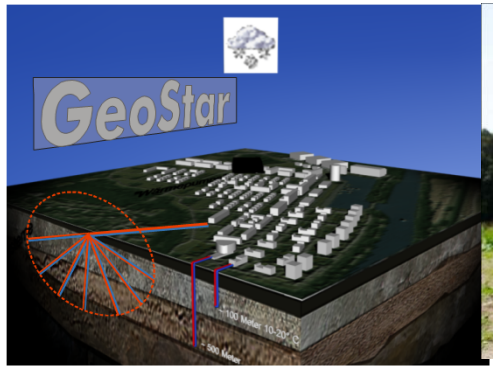
Bloomberg: Asia to see more than 50% of overall geothermal investment

Bloomberg sees fossil fuel development at loss towards renewables

Geothermal uses in the Ruhr area, Germany

At the former coal mine **Robert Müser** the City Utility of Bochum & RAG pump mine water to the surface, use heat pumps and supply a school and fire station with heat

Exzenter house in Bochum is heated and cooled with geothermal energy (39 wells, Borehole heat exchangers for heat and cold storage, 5.000m^2 office space on 15 floors



GEOSTAR drilling project provides the **International Geothermal Centre, Bochum** with heating & cooling: 17 borehole heat exchangers, 200m depth

REN Alliance
(International Renewable Energy Alliance

International Renewable Energy Alliance

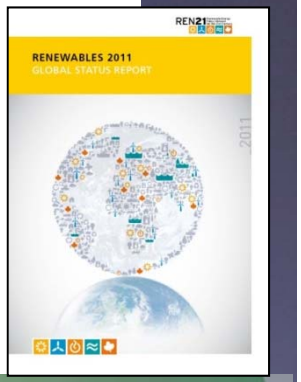
- **History:**
  REN Alliance was formed during the Bonn 2004 International Renewable Energy Conference

- **Aims:**
  - To advance policy
  - To provide information on renewables with a combined voice
  - To bridge the gap between policy & practice
  - To advice decision makers

- **Areas of work:**
  - Technical input & recommendations on the set-up & use of the Global Climate Fund
  - Actively contribute to climate change negotiations (UNFCCC) with side events, interviews and booth

- **Collaboration partners:**
  - International bodies like UN entities, UNFCCC, IRENA, ILO, REN21, etc.

- **Instruments:**
  - Presentations, side events, webinars, press releases, website



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