

GGA Nairobi June 15 2015



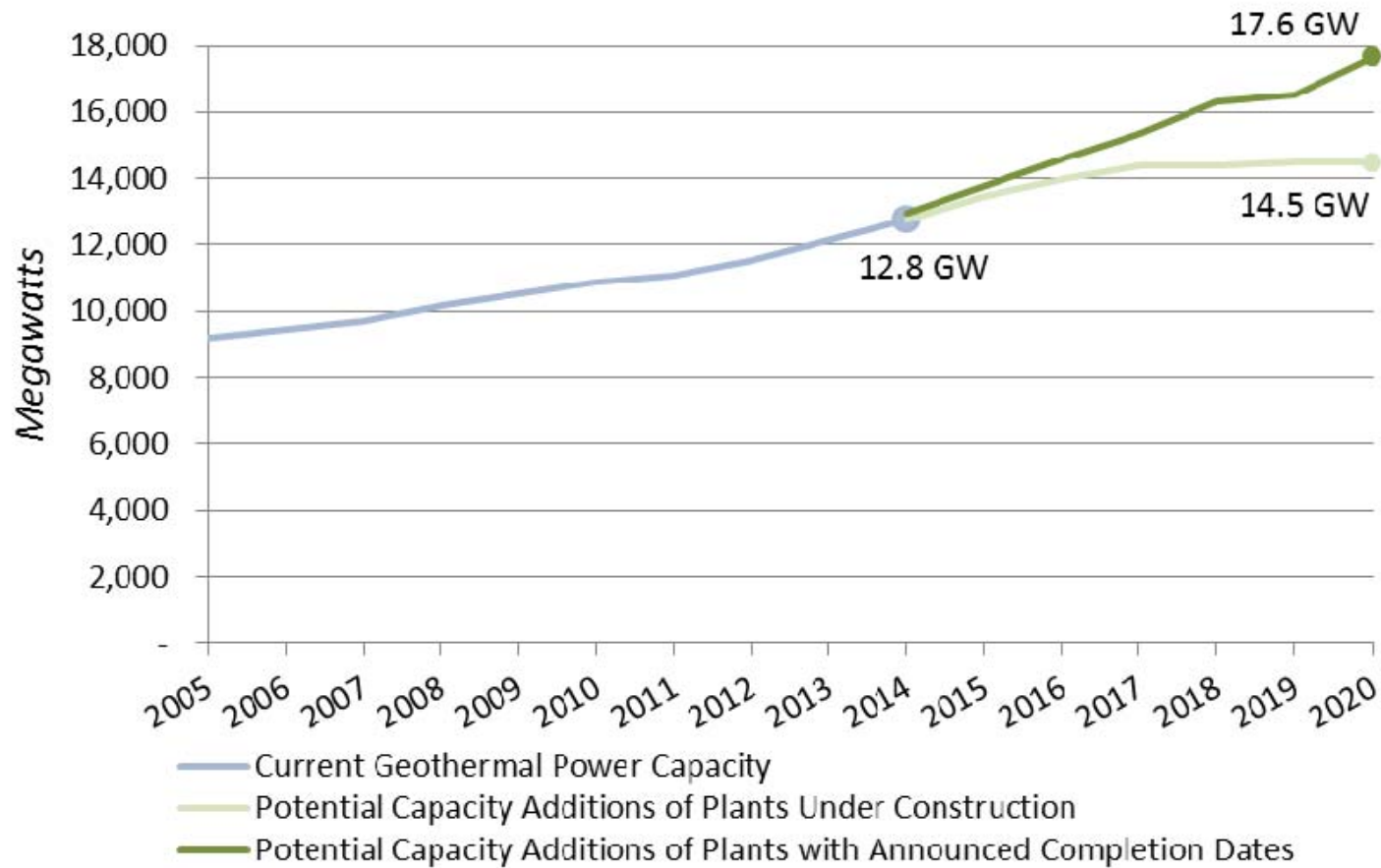
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Geothermal power continues sustained growth internationally

International Geothermal Power Nameplate Capacity (MW) Forecast Based on Plants Under Construction



Note: pilot plants are not included in the above time series. Gap in lines at year 2014 represents plant still yet to be completed this year.

Source: GEA, EIA

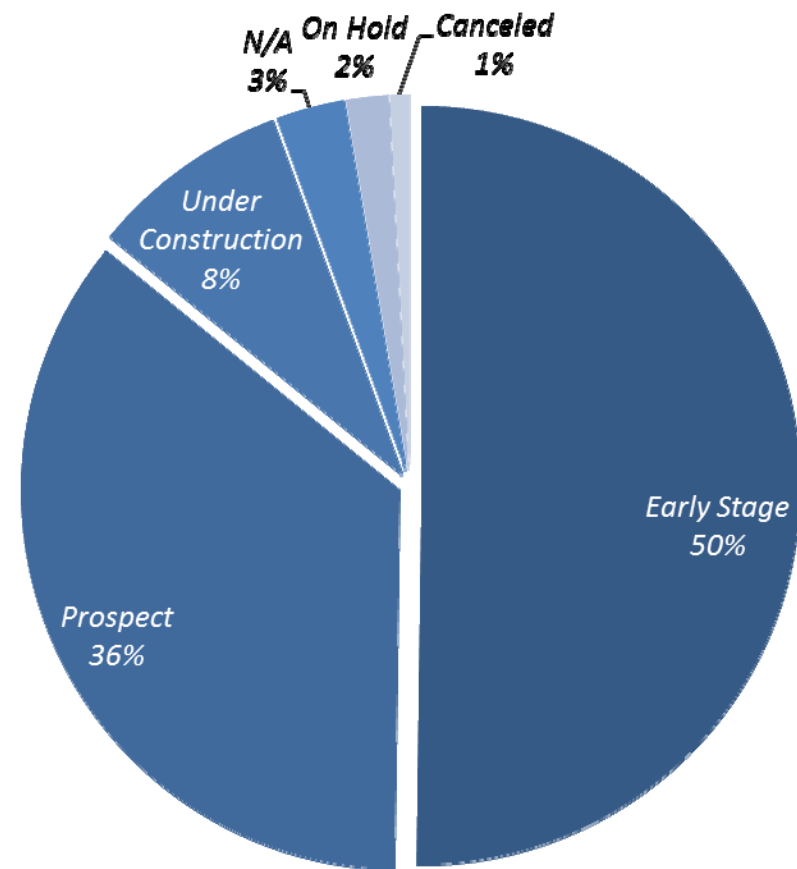
Source: GEA

About a tenth of global sites are already under construction with about a half of global sites approaching that stage.

As of Winter 2014:

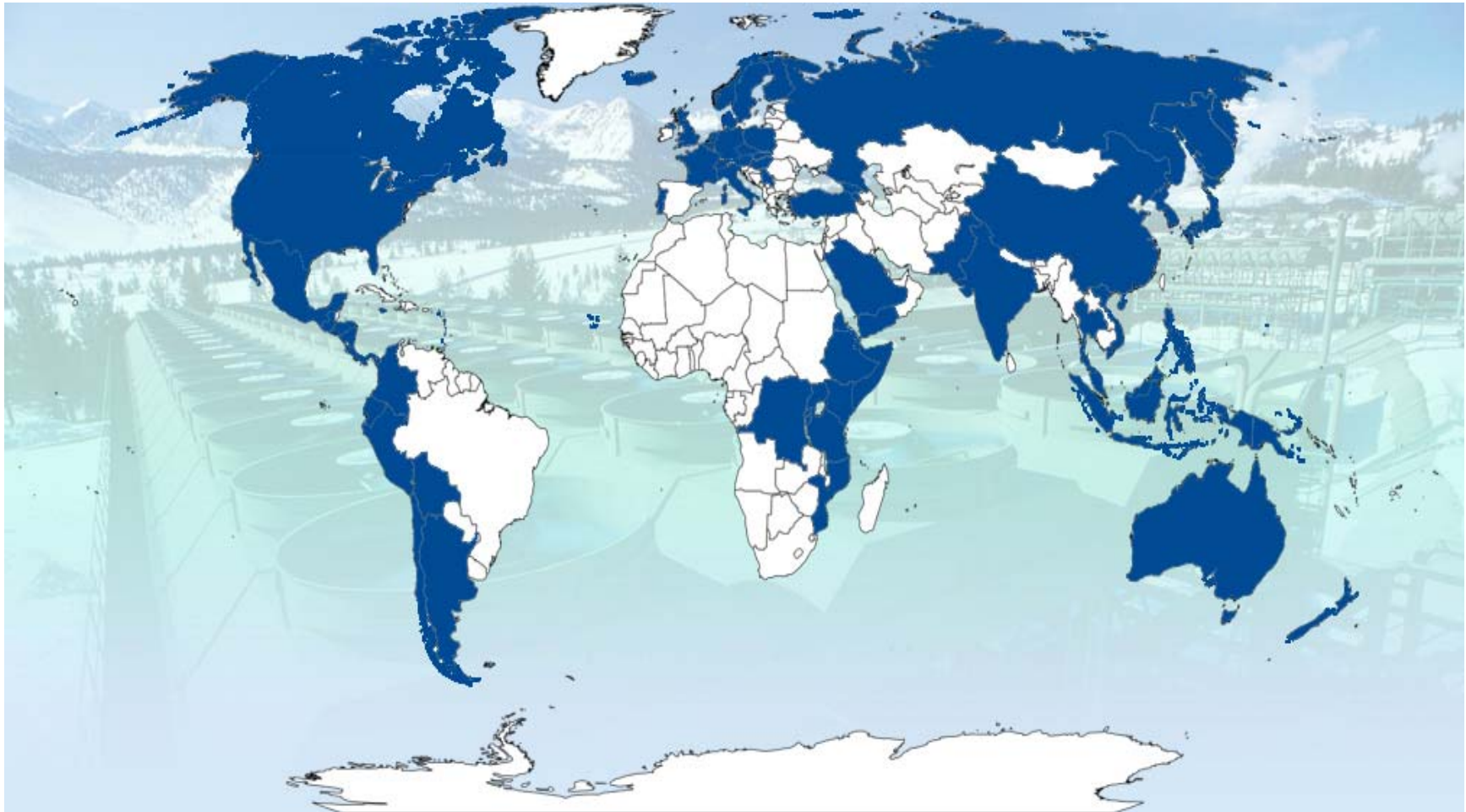
- ~720 Global Sites –
Prospects and Projects
- Located in nearly 80
countries

Percent of Global Activity by Stage*



*Source: GEA, EIA

Countries Where GEA Companies are working – 80% of world geo market



Geothermal Innovation Continues

GEA Honors 2015:

- Advancing Frontiers in Power Flexibility – Ormat – first fully dispatchable power plant
- Advancing Hybrid Geothermal Power Systems – Enel Green Power- geo and PV, solar, biomass
- First Geothermal Electric Plant in New Mexico – Cyrq Energy, Lightning Dock

Cutting Edge DOE FORGE Initiative

- The Energy Department envisions Frontier Observatory for Research in Geothermal Energy (FORGE) as a dedicated site where scientists and engineers will be able to develop, test, and accelerate breakthroughs in enhanced geothermal system (EGS) technologies and techniques.
- Five Teams Selected: partnering industry, laboratories and government
 - Idaho National Laboratory - Snake River Plain, Idaho
 - Pacific Northwest National Laboratory – Newberry Volcano, Oregon
 - Sandia National Laboratory – Coso, California
 - Sandia National Laboratory – Fallon, Nevada
 - University of Utah – Milford City, Utah

Geothermal as a Firm and Flexible Power Source

- With well-structured and appropriately priced contracts, geothermal plants can provide both flexible and baseload power production. Although traditionally operated as a source of baseload power, the advancement of power plant and control technology allow geothermal power plants to work in several variable modes, such as grid support, regulation, load following, spinning reserve, non-spinning reserve, and replacement or supplemental reserve. These modes are commonly referred to as “ancillary services,” which are performed by entities that generate, control and transmit electricity in support of the basic services of generating capacity, energy supply and power delivery. While baseload power has its advantages and unique benefits (*see: The Benefits of Baseload Renewables: A Misunderstood Energy Technology*) the future electricity grid, dominated by variable energy resources (primarily wind and solar), will have particularly important values for technologies that can be flexible. (<http://geo-energy.org/reports.aspx>)

Geothermal Risks

Major Points for Risk and Risk Mitigation

- Exploration and Exploration Drilling
- Production Drilling
- Legal, Regulatory and Policy Framework
- Project Management




Best Practices Workshop

available at <http://geo-energy.org/reports.aspx>

Authors: John Armstrong, Magnus Gehringer, John McKinsey, Ann Robertson-Tait, Doug Hollett, Patrick Dobson, Dr. James E Faulds, Bob Sullivan, Tim Williamson, Mike Long, Doug Blankenship, Sam Abraham, Louis Capuano, Jr.

Best Practices for Geothermal Power Risk Reduction Workshop Follow-Up Manual

Workshop held April 23rd, 2014
Published on July 8th, 2014



What Can We Do: Exploration Risk

Some recommendations:

- Develop better models and analytical methods
- Develop new, better imaging tools and a systematic understanding of where they work effectively
- Risk Insurance?
- Better geologic information/data (and make sure its available)
- Quantify success rates

Production Drilling

- Have enough exploration data and analysis to model what you think the system looks like
- Hire a qualified, experienced driller
- Best way to improve the cost effectiveness of drilling is to improve the target precision – Don't drill wasted holes!

Policy Framework

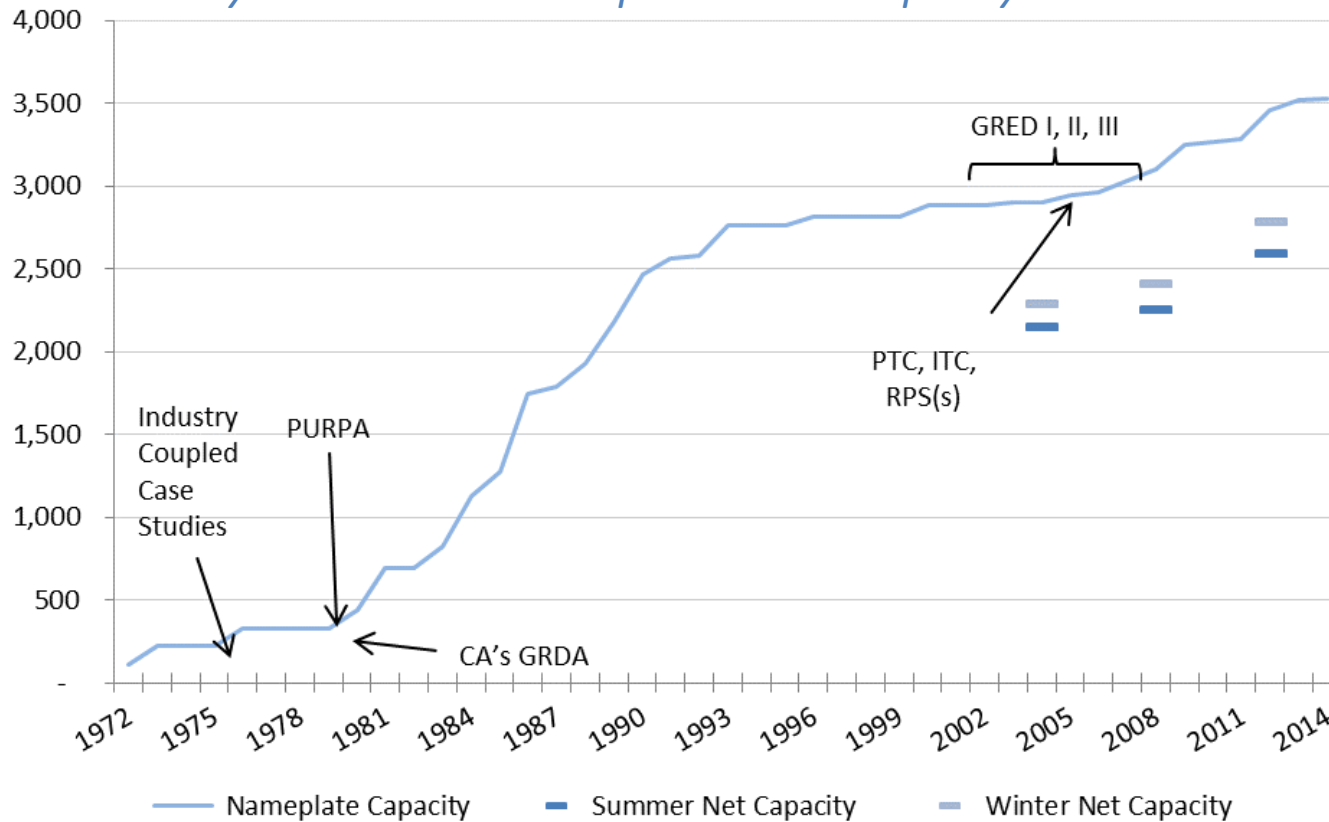
- Government as explorer/developer
- Cost-shared drilling
- Risk Insurance
- Early Stage Incentives
- RPS, Tax Incentives, Feed-in Tariff, Loan Guarantee
- Legal and Regulatory Issues as well!

Project Management

- Finding a geothermal resource is just the beginning
- Proper implementation of a Project Management program is a key tool for the Developer to manage and mitigate the risk factors in a geothermal program

Market growth and government policy have always had a close relationship – We should learn from our history

U.S. Industry Geothermal Nameplate & Net Capacity



Source: EIA & GEA

Source: GEA



Footnote: What does EGS have to do with risk?

From *Fortune*, May 20, 2015:

- *A troubled geothermal plant finds a savior in a startup and Vinod Khosla*
- *It's an important step for the next-generation of geothermal energy tech.*
- *as of last Thursday, [Blue Mountain] finally has a new owner with a new plan to get it back up and running at full capacity.*
- *AltaRock has more recently focused in the short term on using its technology to stimulate under performing traditional geothermal power plants like Blue Mountain.*

Thank You! Questions?



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