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Financial Instruments and Funding of RD&D and Geothermal Projects

The Role of the Private Sector in the Development of Geothermal Power – EBRD GPP Financing

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Energy Efficiency and Climate Change (E2C2)

European Bank
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EBRD's experience in the geothermal sector

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Tuzla GPP (2010) (2)
- Capacity: 7.5 MW
- Investment size: $22m
- Ormat ORC

Gümüşköy GPP (2012) (3)
- Capacity: 13.2 MW
- Investment size: $50m
- TAS ORC

Pamukören GPP (2012) (4)
- Capacity: 45 MW
- Investment size: $63m (**)
- Atlas Copco ORC

Babadere GPP (2014) (5)
- Capacity: 7 MW
- Investment size: $33m
- Atlas Copco ORC

Germencik GPP (2015) (6)
- Capacity: 123 MW
- Investment size: $800m
- Dual flash + Ormat 3 binary

EBRD has participated in financing eight geothermal power projects so far, seven of which are in Turkey (231MW)

Mutnovsky IPP (1997) (1)
- Capacity: 40 MW
- Investment size: $150m
- Feature: first IPP(*) in the Kamchatka region
- Dual flash technology

Kamchatka

Alaşehir GPP (2015) (7)
- Capacity: 24 MW
- Investment size: $100m
- Ormat ORC

Umurlu GPP (2015) (8)
- Capacity: 12 MW
- Investment size: $52.9m
- Exergy ORC

(*) IPP: Independent Power Plant
(**) Resource development costs were financed separately

Global overview

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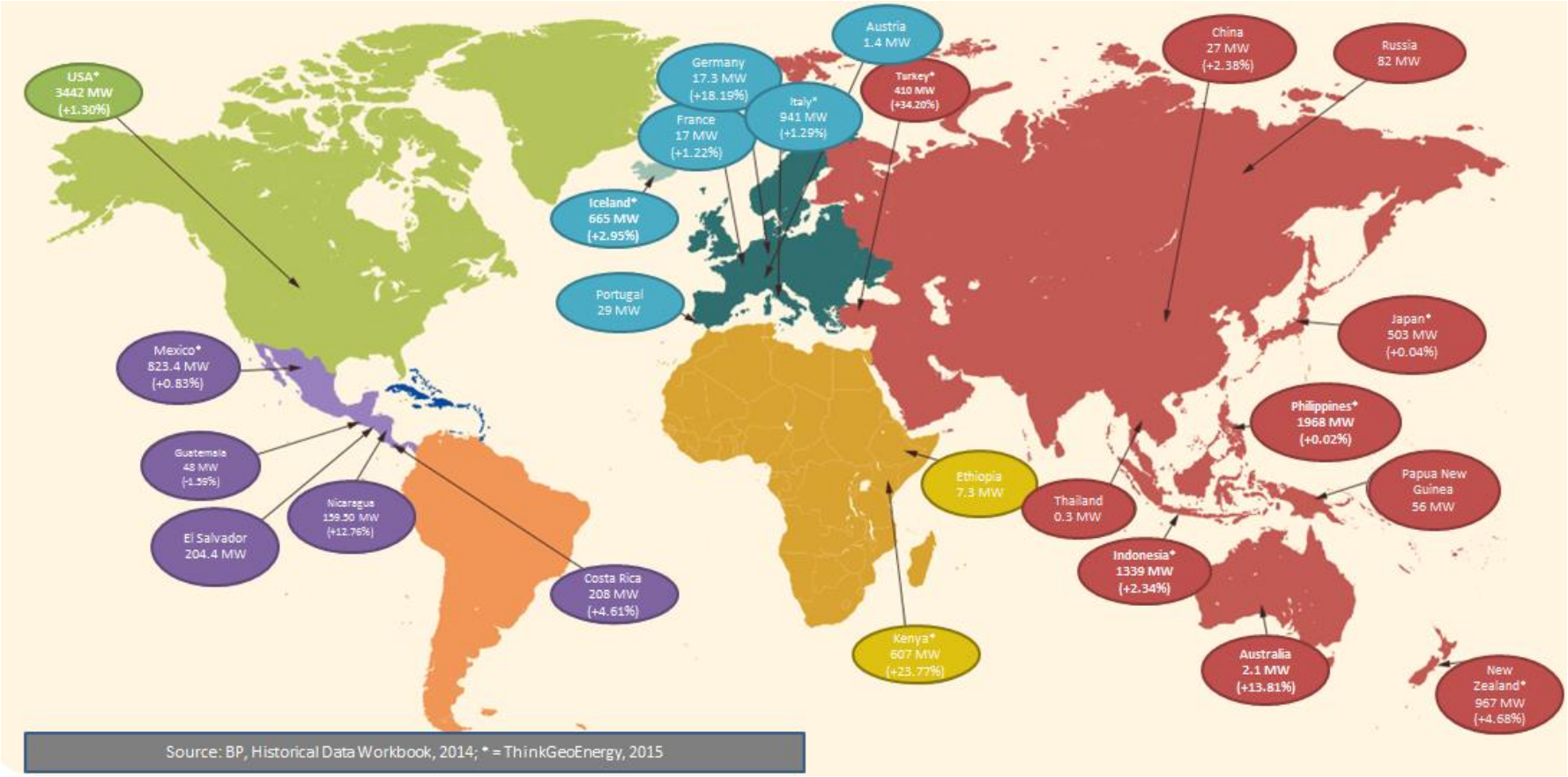
World Geothermal Power Installed Capacity, 2014 and 2010 – 2014 CAGR



Global installed capacity is *circa* ***13 GW$_e$*** and expected to reach 19 GW$_e$ by 2016

Estimated global potential ***70 GW$_e$*** with present technology, and up to 140 GW$_e$ through the use of enhanced geothermal systems[1]

(1) Bertani, Ruggero, 2009, "Geothermal energy: an overview on resources and potential."

Global Overview –
GPP installed capacity evolution

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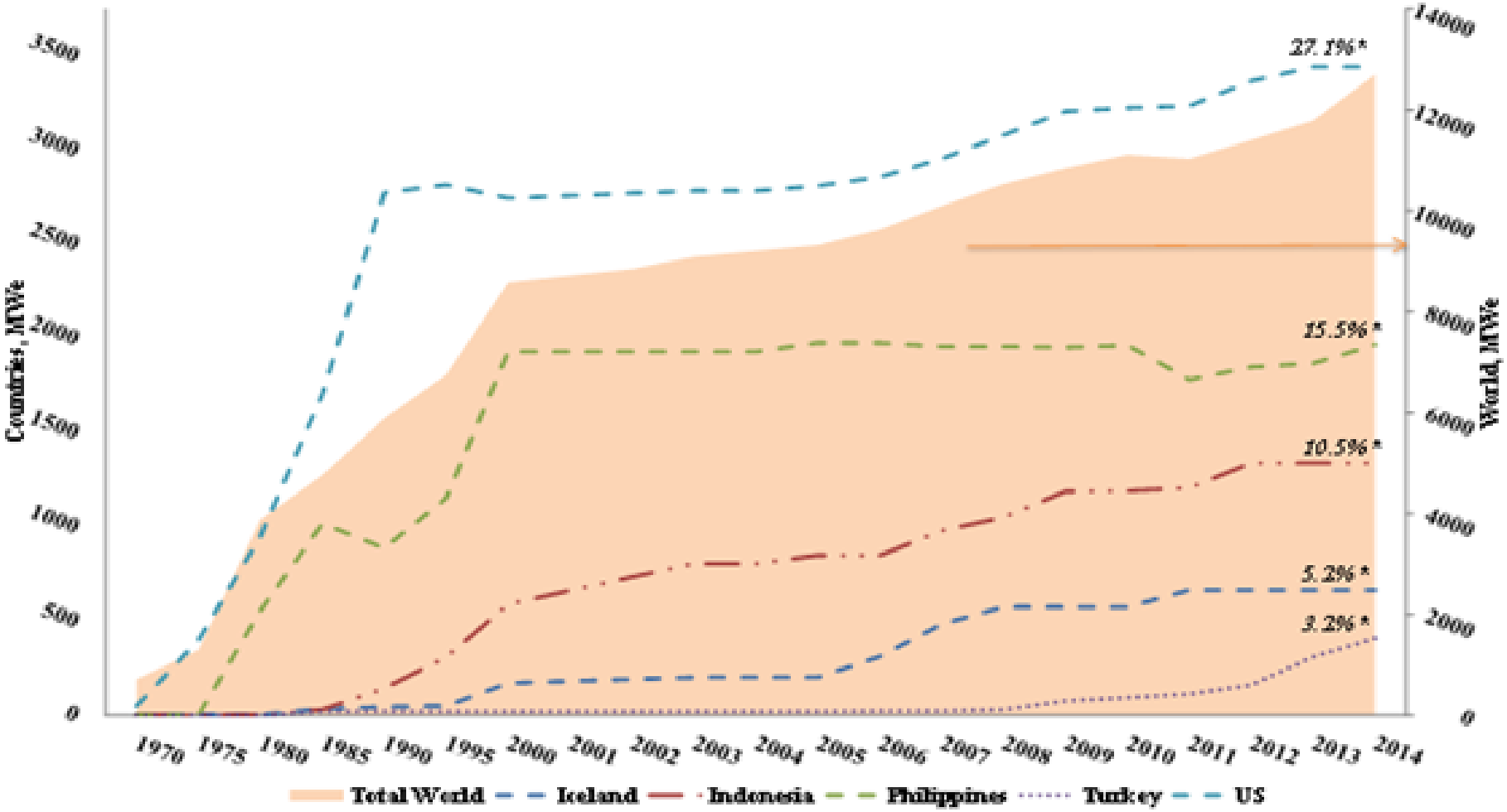

Source: World Geothermal Council, 2014; BP Historical Data Workbook, 2014; ThinkGeoEnergy, 2015
*= Share of Global Installed Geothermal Capacity as of 2014

Global overview – USA

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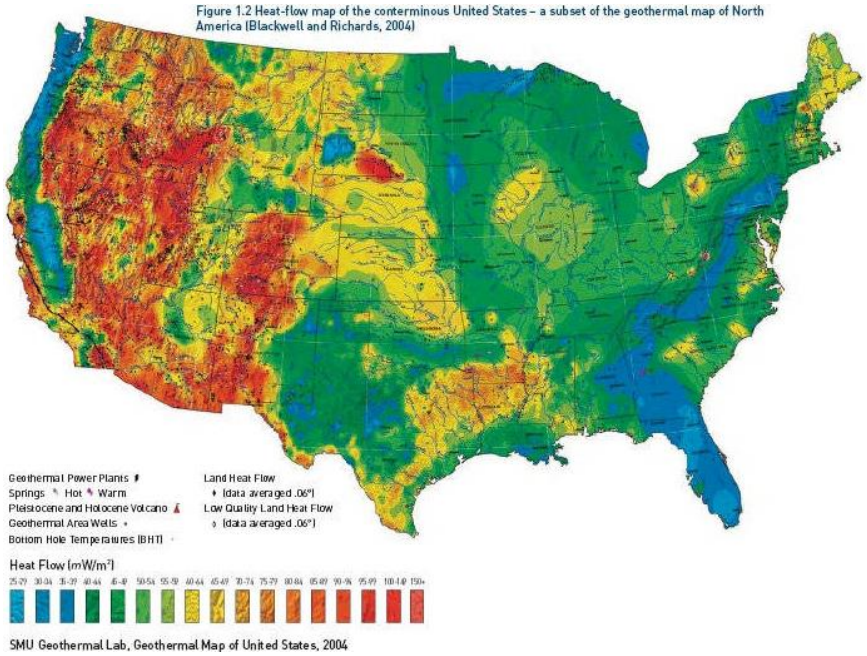

Figure 1.2 Heat-flow map of the conterminous United States – a subset of the geothermal map of North America (Blackwell and Richards, 2004)

Total Electricity Production, 2012 – (share of geothermal)	4,290 TWh - (0.4%)
Installed Capacity, 2014	3,442 MW_e
Growth, 2010-2014	7.2%
Share of Global Installed Geothermal Capacity, 2014	27.1%

History

- *1958*: Magma Power Co. drills first modern GPP in North America at The Geysers in California (12 MW)
- *1967*: **Competitive leasing** conditions decreed; 40% of US installed capacity is on public land as of 2014
- *1974*: National **loan guarantee** established to incentivise exploration drilling by covering 75% of project costs
- *1987*: Reservoir pressure at The Geysers declines, oil prices fall, geothermal investment decreases
- *1989–2014*: Installed geothermal capacity increases by ~1,400 MW with recovery at The Geysers and discovery in other parts of the western US

Global overview – Iceland

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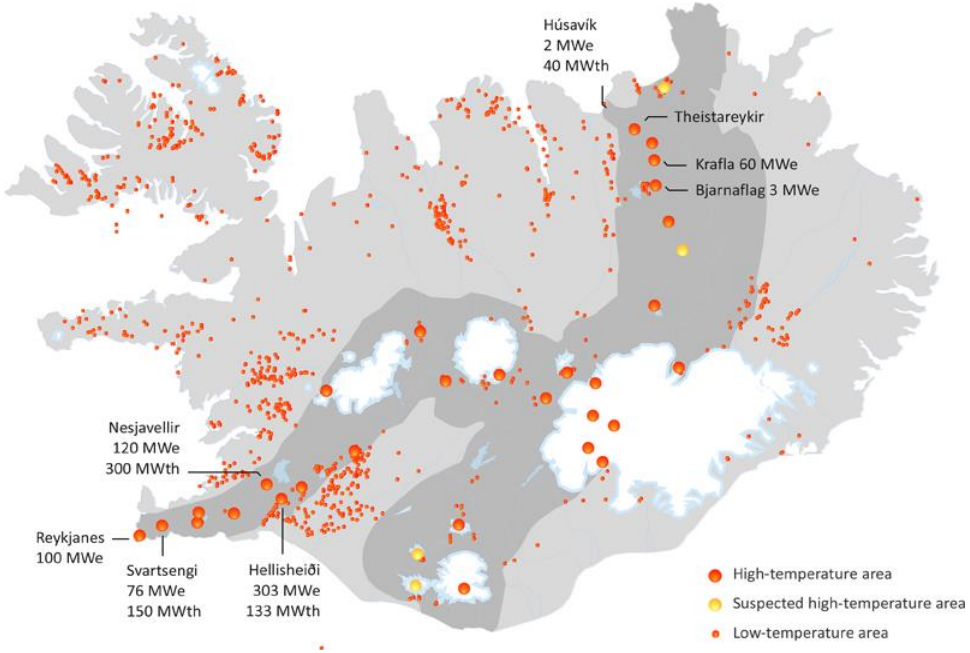

ISOR, 2015.

Total Electricity Production, 2012 – (share of geothermal)	18 TWh - (29%)
Installed Capacity, 2014	665 MW_e
Growth, 2010-2014	15.6%
Share of Global Installed Geothermal Capacity, 2014	5.2%

History

- *1928*: 1st district heating system installed in Reykjavík
- *1967*: Energy Fund created for **cost-sharing** in drilling and exploration (convertible loans for up to 80% of unsuccessful drilling costs)
- *1999*: *Master Plan for Geothermal and Hydropower Development in Iceland* initiated
- *2006*: Market opened to private developers; to date, 100% of power generation has been developed by public companies/utilities
- *2007*: Private developers HE Orka, Orkusalan enter the market
- *2009*: Iceland Deep Drilling Project becomes hottest producing geothermal well in the world by harnessing **supercritical hydrous fluids** (over 450°C)

Geothermal power in Turkey

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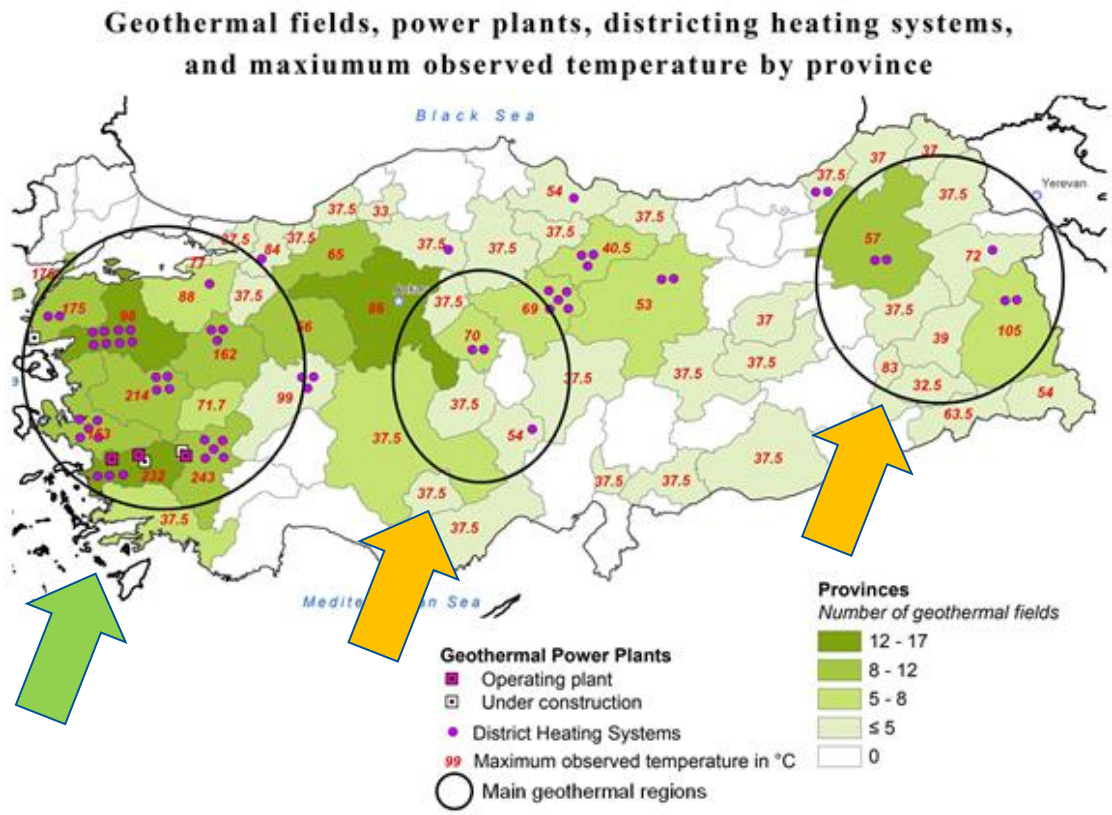
Turkey

Installed geothermal capacity:
410 MW_e or ~10% of the 4 GW_e
estimated potential

Western Turkey currently holds the greatest potential for development of geothermal resources, with Central and Eastern Anatolia largely unexplored

Total Electricity Production, 2012 – (share of geothermal)	240 TWh - (0.4%)
Installed Capacity, 2014	410 MW_e
Growth, 2010-2014	210%
Share of Global Installed Geothermal Capacity, 2014	3%



Sustainable Resource Initiative (SRI) – *business model for geothermal scale-up*

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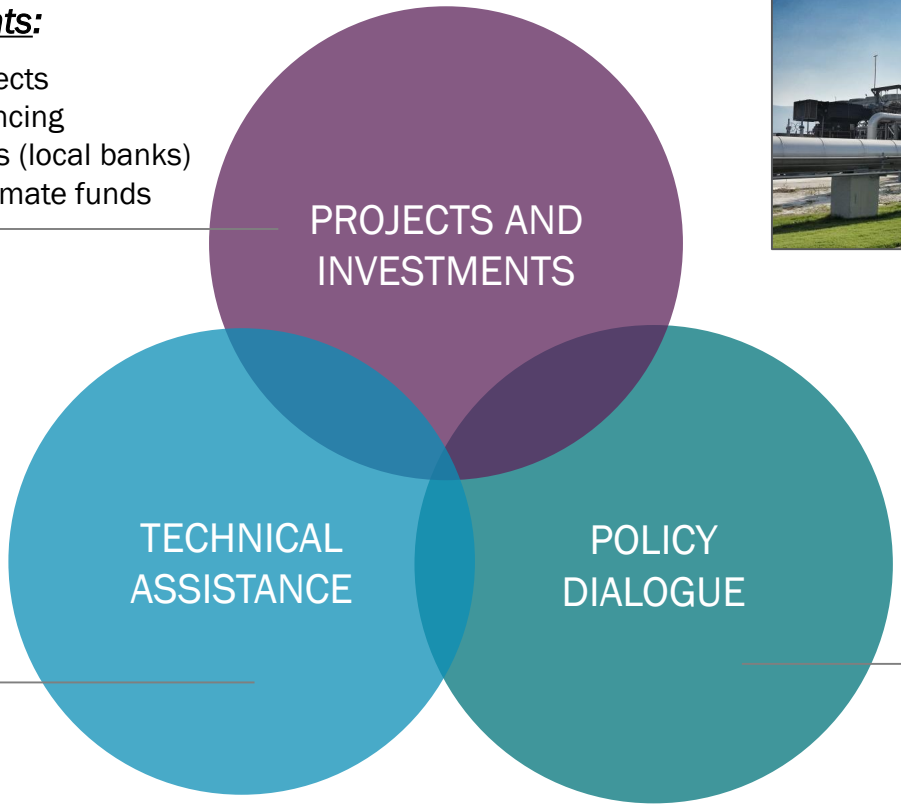
Various financing approaches that suit small and large projects alike

Tailored financial instruments:

- Direct financing for large projects
- Syndicated loans and co-financing
- Small scale projects via SEFFs (local banks)
- Concessional finance from climate funds

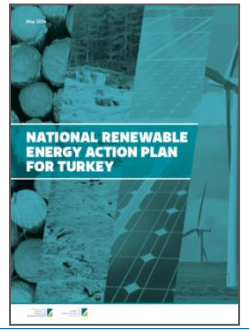


Industry best practices:

- Review of market potential
- Project development support
- Environmental assessment

Renewable Energy Action Plan:

Roadmap to achieving the 2023 1,000 MW GPP target



EBRD support for geothermal development

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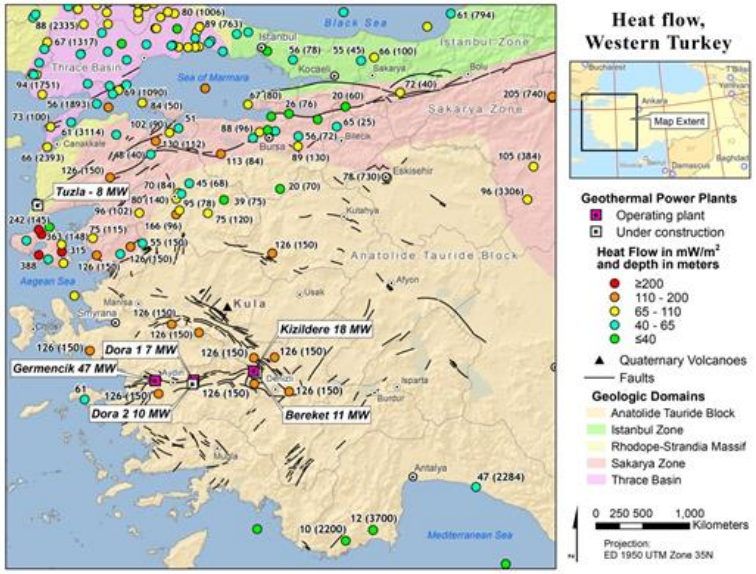
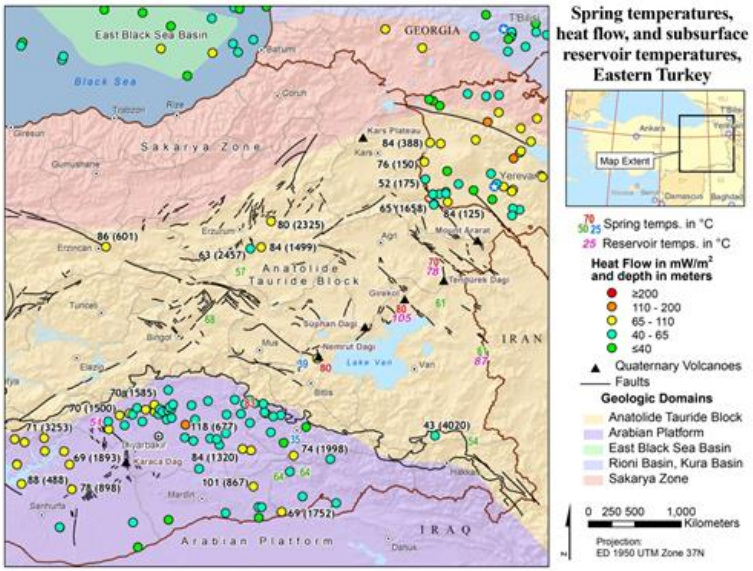
PROJECT FINANCE

- Direct project finance: 123 MW in the Aydın-Germencik province
- Financing existing projects through local banks
- Engaging blue-chip developers in Turkey to support future greenfield projects



POLICY DIALOGUE

- Support MoENR in further developing legislative frameworks & licensing procedures
- Launching a market study and mapping key players, resources and market perspectives
- Defining centralised approach on key issues such as sustainable resource management



http://www.ebrd.com/news/2015/ebrd-supports-turkeys-shift-to-renewable-energy.html

GPP cost and risk profile at stages of development

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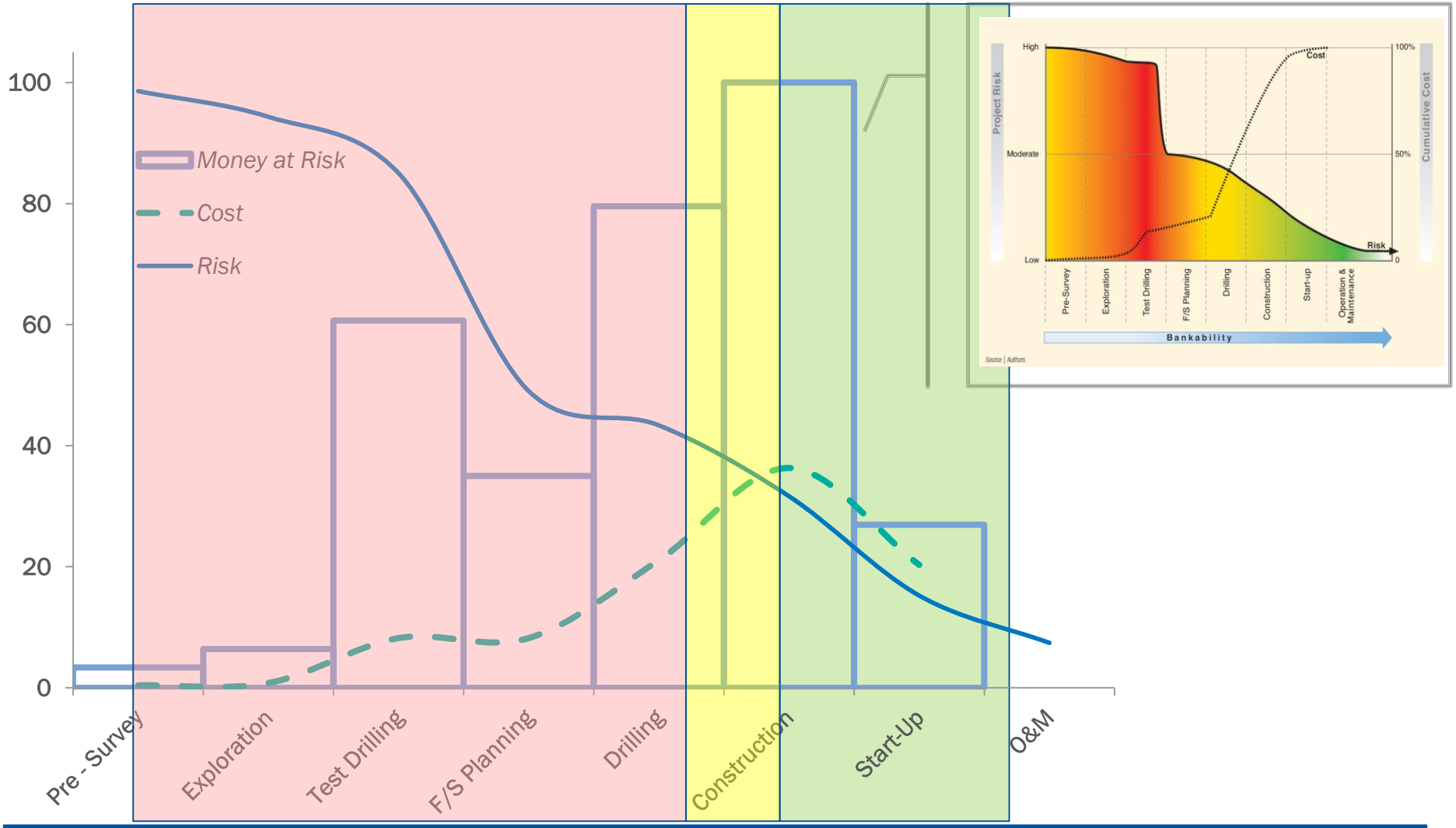

Adapted from ESMAP, 2012, Geothermal Handbook: Planning and Financing Power Generation, *Technical Report 002/12.*

Financing mechanisms for exploration

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Illustrative Assessment of Leverage Capability by Policy

Low leverage	Medium leverage	High leverage	Very high leverage
Government-led exploration: government incurs full cost of exploration and investment forfeiture in the case of dry wells	**Lending support mechanisms:** interest from loans could help defray costs, provided that the default rate remains low	**Loan guarantee:** high leverage in the case of limited guarantee payouts	**Quasi-equity support** (concessional financing) at early stage Conversion to **commercial financing** for GPP construction
Grants and cooperative agreements: represent a liability in either the case of direct payouts or foregone tax income		**Drilling failure insurance:** high leverage in the case of limited claims	Use of **revolving fund** for concessional portion after 2 years

EBRD framework

1. *addresses the equity gap at early stage;*
2. *tackles technical risks by utilising global experts; and*
3. *uses fast turnover of concessional funds to enhance the leverage capacity of climate finance*

Adapted from Speer et al., 2014. "Geothermal Exploration Policy Mechanisms: Lessons for the United States from International Applications."
The assessments of leverage provided here are general comparisons across the five policy types. Actual leverage will depend on the specifics of policy design.

Indicative cost pyramid for geothermal energy projects

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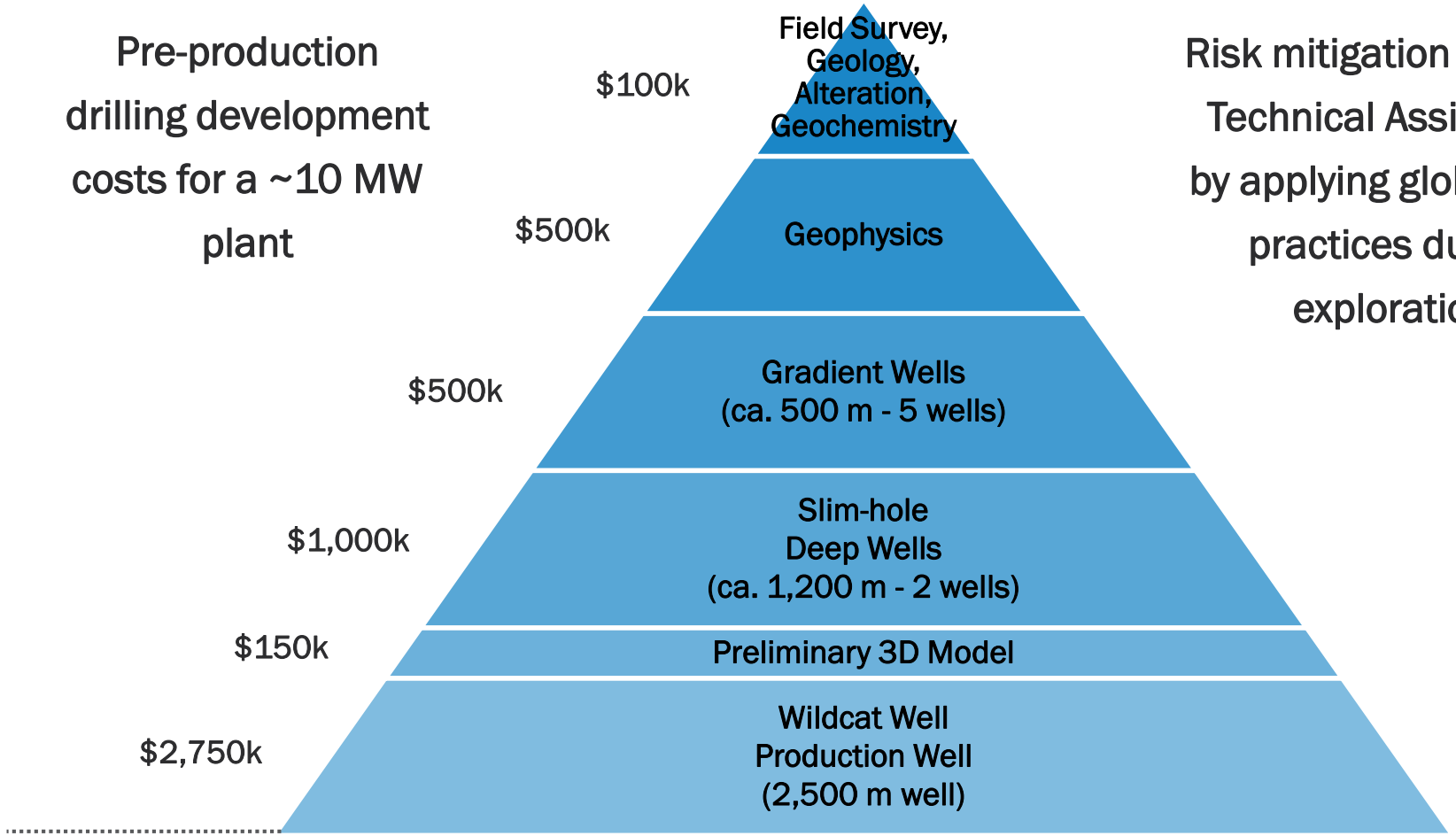
Pre-production drilling development costs for a ~10 MW plant



Risk mitigation through Technical Assistance by applying global best practices during exploration

Total:
$5 million

Subsequent production wells cost *circa* $1 million/km
In Turkey, 4 production + 2 re-injection wells
are typically required to run a 10 – 15 MW plant

PLUTO: EBRD early stage geothermal framework

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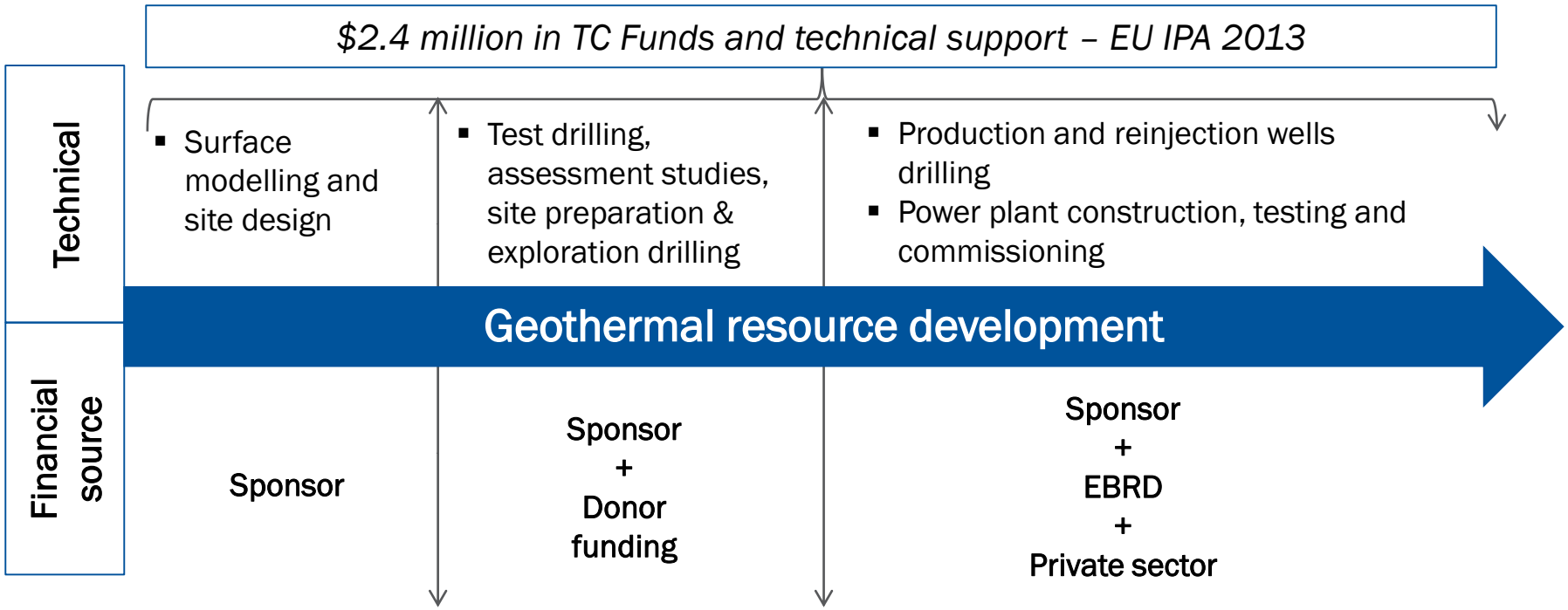
Currently developing a framework to ***support private sector early stage development***:

- Deploying $25 million of CTF concessional funds to partially mitigate early stage risk and unlock commercial direct financing
- Mobilising $100 million in EBRD financing and over $200 million in private sector resources to finance site and plant development
- Engaging global experts as to implement best industry practices at all stages



For more information: http://www.ebrd.com/pages/project/psd/2014/46809.shtml

Contingency flowchart

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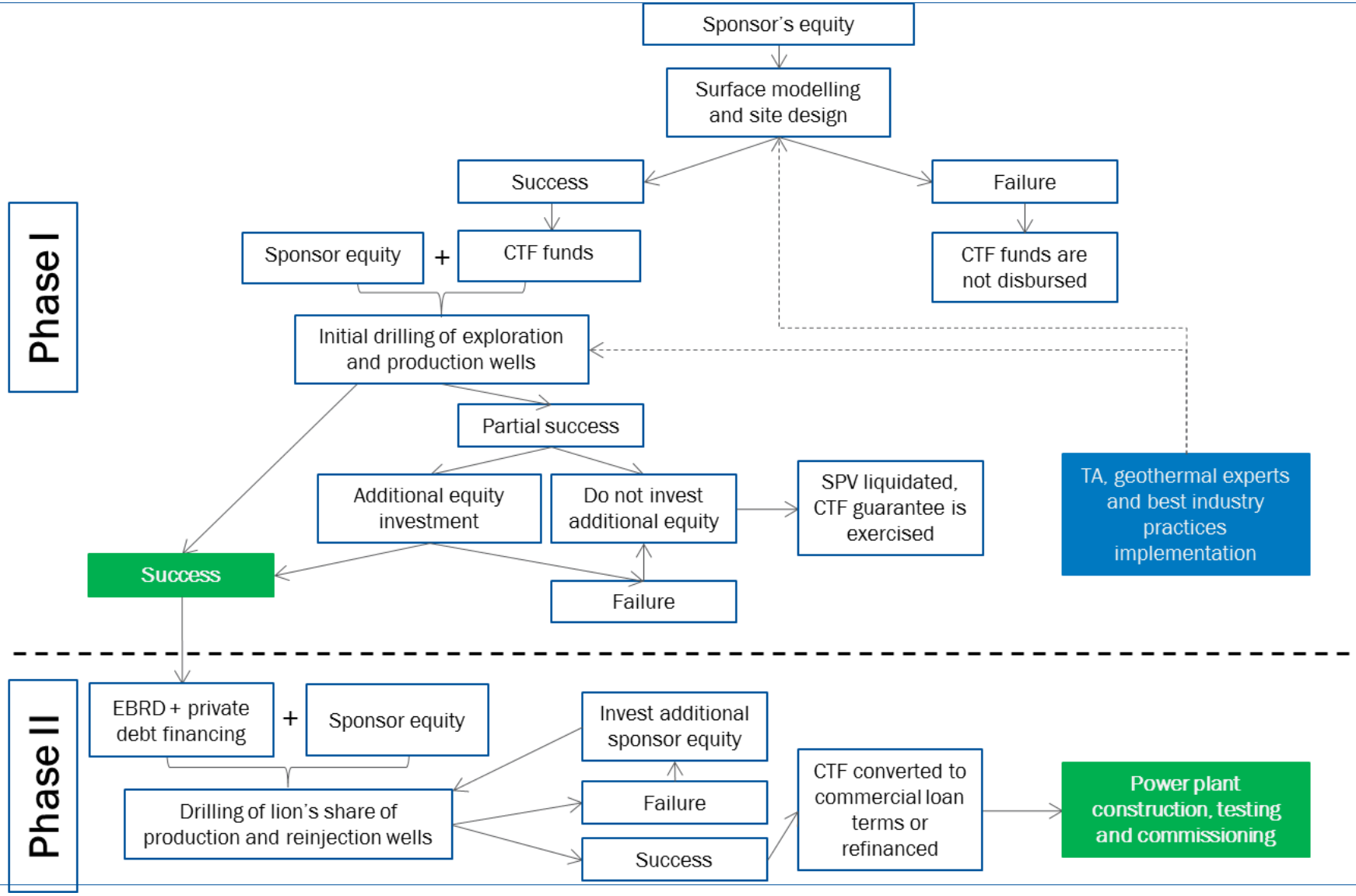

Non-condensable gases (NCGs)

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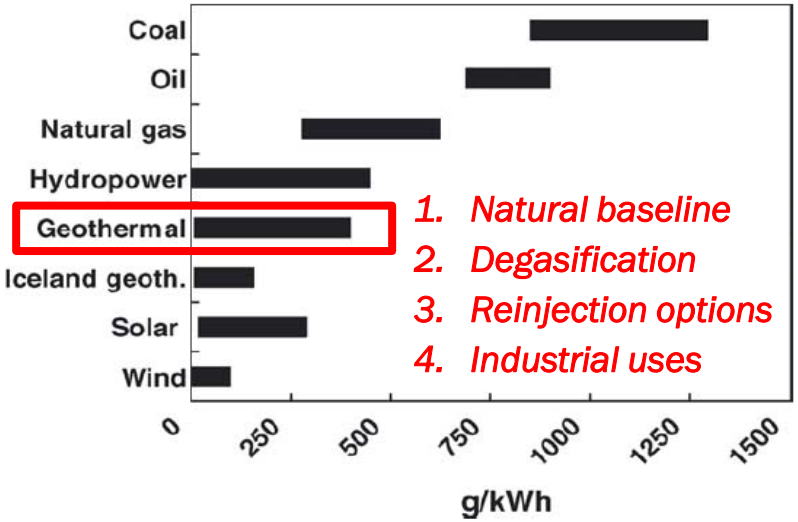
- GPP projects must address the release of CO_2, even though emissions are *relatively low* compared to fossil fuel-based power plants
- Potential solutions to NCGs
  - Reinjection (in binary and combined cycle GPPs)
  - Sale of the CO_2 to potential industrial clients
  - Agriculture sector (greenhouses)
- EBRD framework includes technical assistance to address the issue in its GPP investments

Greenhouse gas emissions from various types of power plants



Assessing the use of CO_2 from natural sources for commercial purposes in Turkey

- Initial technical characterisation of the CO_2 supply available for commercial use in Turkey
- Mapping of the existing CO_2 value chain & identification of bottlenecks in supply and demand
- Assessment of the current market & legal/regulatory framework
- Financing and grant options to expand industrial use of CO_2 from geothermal resources

Source: Hunt 2000.

For more information

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Global Overview –
GPP development evolution and key events

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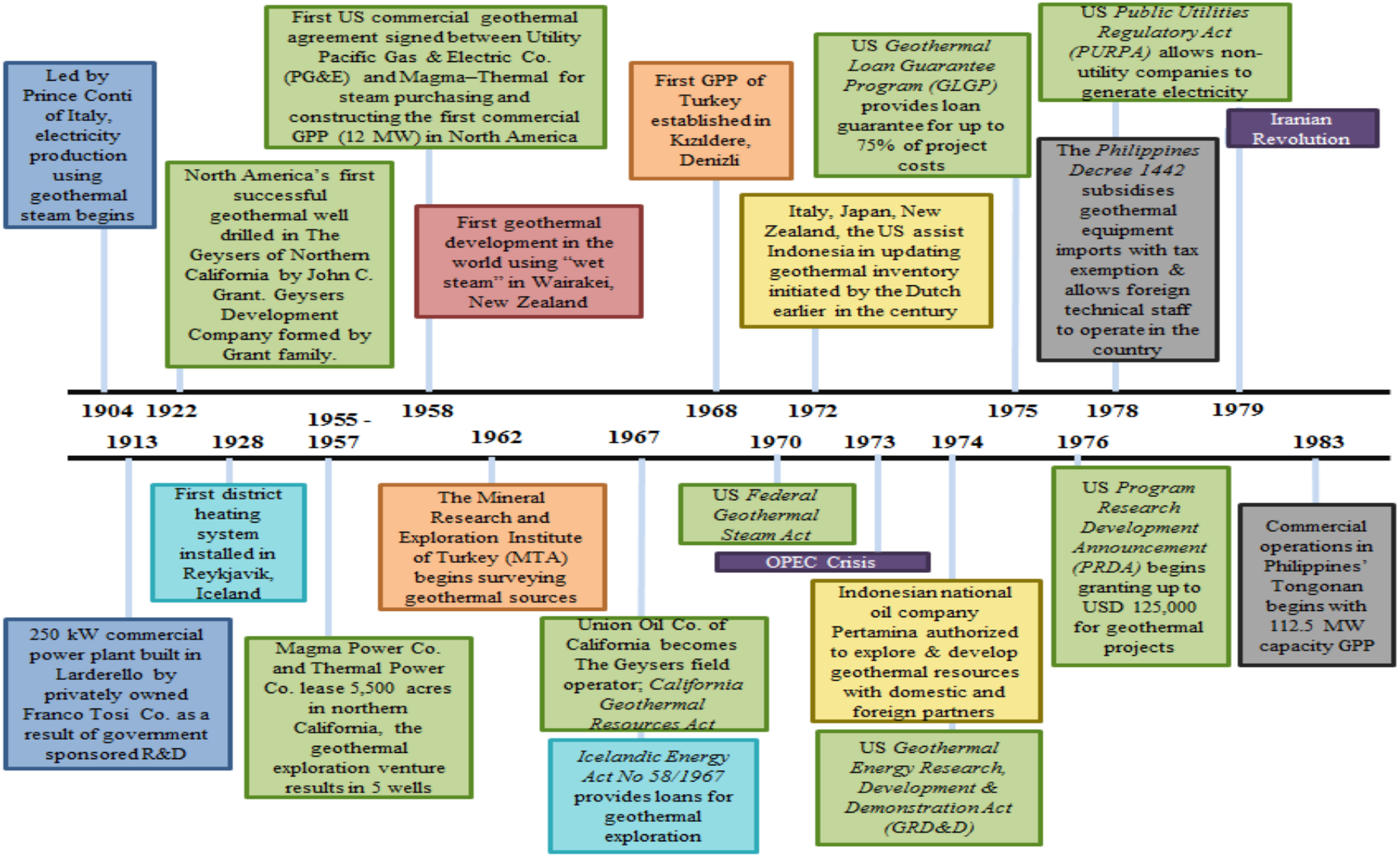

Global Overview – Indonesia

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Source: Geological Agency.

Total Electricity Production, 2012 – (share of geothermal)	196 TWh - (4.8%)
Installed Capacity, 2014	1339 MW_e
Growth, 2010- 2014	12.43%
Share of Global Installed Geothermal Capacity, 2014	10.5%

History

- *1974*: State-owned oil company Pertamina to explore and develop geothermal energy
- *1981*: Pertamina to enter joint operating contracts with with *domestic and international partners*
- *1991*: Pertamina partnerships allowed to **build and operate GPPs**
- *201*1: World Bank approved the *Geothermal Clean Energy Investment Project* – CTF, IBRD, Indonesian government made a combined commitment of **$574.7 million**

Global overview – The Philippines

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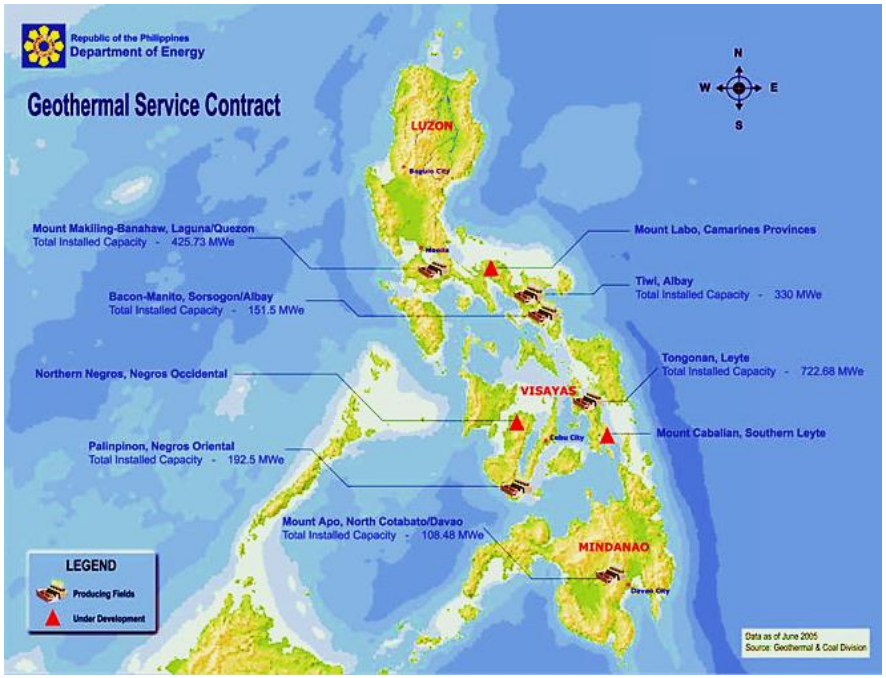

Total Electricity Production, 2012 – (share of geothermal)	73 TWh - (14%)
Installed Capacity, 2014	1,968 MW_e
Growth, 2010-2014	-1.4%
Share of Global Installed Geothermal Capacity, 2014	15.5%

History

- *1974*: Philippine National Oil Company created
- *1978*: **Competitive bidding** for geothermal fields established
- *1987*: **Private sector** allowed to finance, build and operate power plants; foreign ownership limited to 40%
- *1990*: Philippines **Build-Operate-Transfer** law enacted, contracts last 10 years
- *2006*: **IPO** of state-owned Philippines Energy Development Corporation; divestiture of 40% of government shareholding
- *2008*: **Renewable portfolio standards** introduced – utilities required to purchase from renewables generators
  - 7-year income tax holiday
  - 10% corporate tax rate
  - Duty-free renewables machinery imports for first 10 years
  - Investment support for providing electricity outside of main grid

Concluding remarks

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- Geothermal is a promising technology for providing ***base-load low carbon renewable energy*** in countries with significant seismic/magmatic activity
- Geothermal electricity generation is far from reaching its potential (ca. ***13 GW_e*** out of ***70 GW_e globally***) and significant growth is expected in the coming years
- Need for ***experienced project developers*** and solid ***equity investors***
- The EBRD is active in the sector through:
  - Direct and intermediary ***financing***
  - ***Policy dialogue*** with governments to improve legal and regulatory frameworks
  - Engagement of technical advisors to implement ***best industry practices*** and catalyse knowledge transfer
- Upcoming EBRD support to geothermal private sector energy developers by promoting ***early stage geothermal*** financing and implementation

References

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