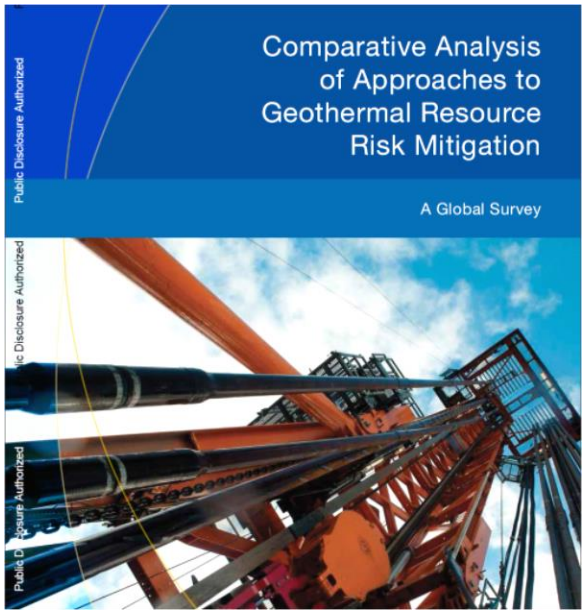

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THRAINN FRIDRIKSSON

REGIONAL WORKSHOP ON GEOTHERMAL FINANCING AND RISK MITIGATION IN AFRICA

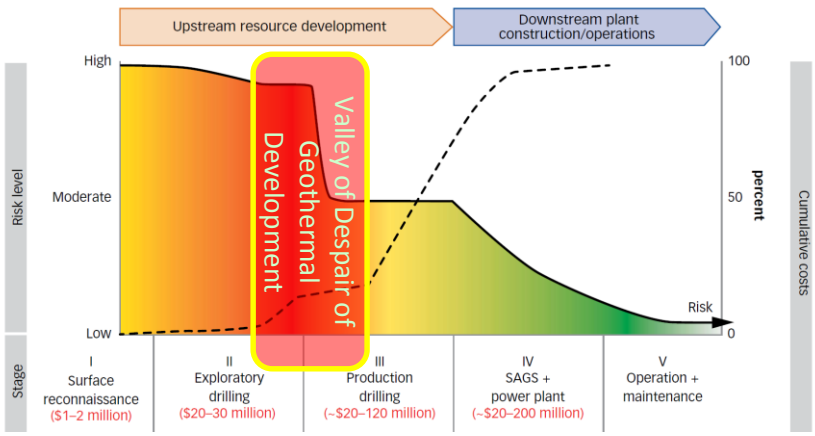
Comparative Analysis of Approaches to Geothermal Resource Risk Mitigation





Global Geothermal Development Plan

- Launched in 2013
  - Goal to scale up investments in geothermal development
  - $250 million of concessional finance raised
  - Focus on:
    - Reducing upstream risk
    - Leveraging private investments



- Pillars of the GGDP

Partnerships for Investment / Knowledge Sharing

- Reducing Drilling Risk course (WGC, 2015)
- Definition of Global Standards for Geothermal Resource Classification
- Geothermal Resource Risk Mitigation Mechanisms report
- Greenhouse Gases and Geothermal Utilization Technical Report
- GGDP Roundtables
- *Gender and Geothermal Guidance Note*
- *Best Practices in Geothermal Exploration Data Management*

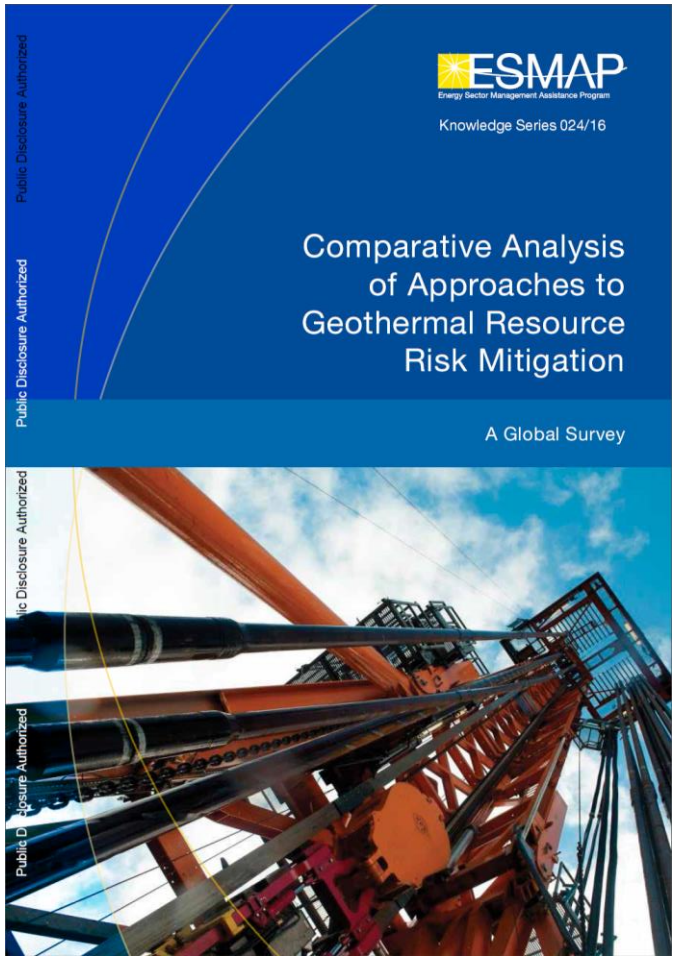
Lending operations and TA to developing countries with geothermal potential

- Armenia
- Djibouti
- Chile
- Colombia
- Dominica
- Fiji
- Indonesia
- Kenya
- Mexico
- Nicaragua
- St Lucia
- Tanzania
- Turkey

Comparative Analysis of Approaches to Geothermal Resource Risk Mitigation

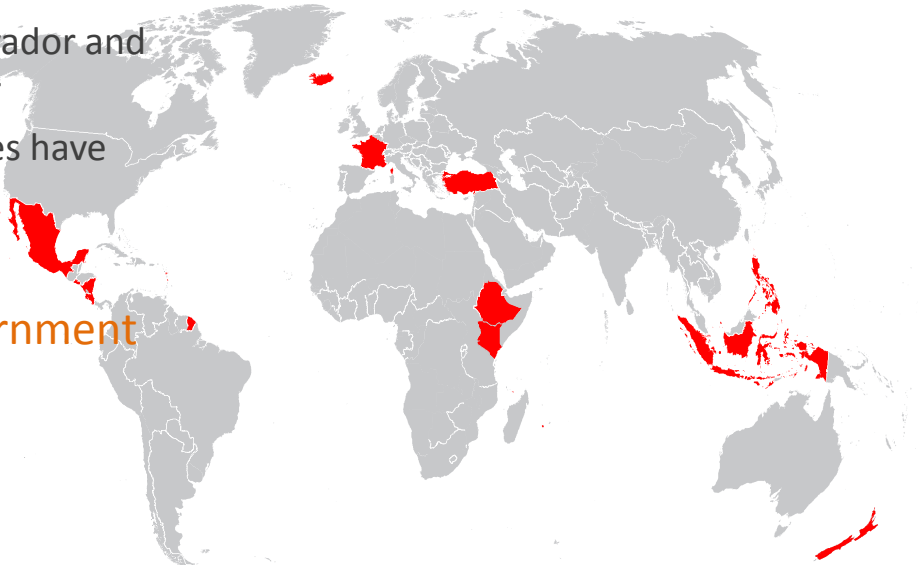
PUBLISHED BY ESMAP IN APRIL 2016

- Authored by sector experts and World Bank specialists
  - Subir Sanyal, Ann Robertson-Tait, Migara Jayawardena, Jerry Huttrer, and Laura Berman
- Historical review of geothermal risk mitigation approaches around the world
  - Analysis includes the global portfolio of geothermal power projects commissioned before 2014 – about 12 GW
  - Support mechanisms for geothermal development analyzed for each project
  - Focus on upstream support
- Four main approaches to upstream support emerge
  - Fully Public Development
  - Public-Private Cost Sharing
  - Geothermal Resource Risk Insurance
  - Early Fiscal Incentives
- Other modes of public support include
  - Feed-in tariffs, Renewable Portfolio Standards, tax credits, public investment in of infrastructure



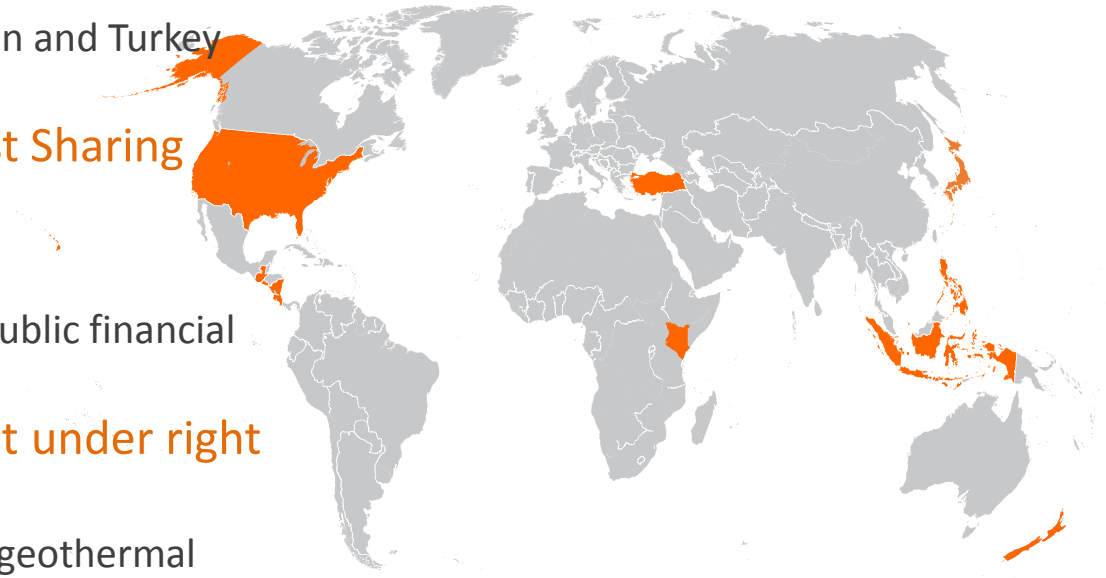
Fully Public Development

- This approach has been used in 12 countries
  - Most capacity in Mexico, Iceland, Kenya, El Salvador and Costa Rica has been developed by public sector
  - Originally the main approach but most countries have now opened up for private developers
- Over 3.6 GW developed by Public Model
- Requires a strong commitment from Government
  - Human and technical capacity
  - Financial resources
- Not easily scalable
- This approach used by KenGen and EEP (formerly EEPCO)

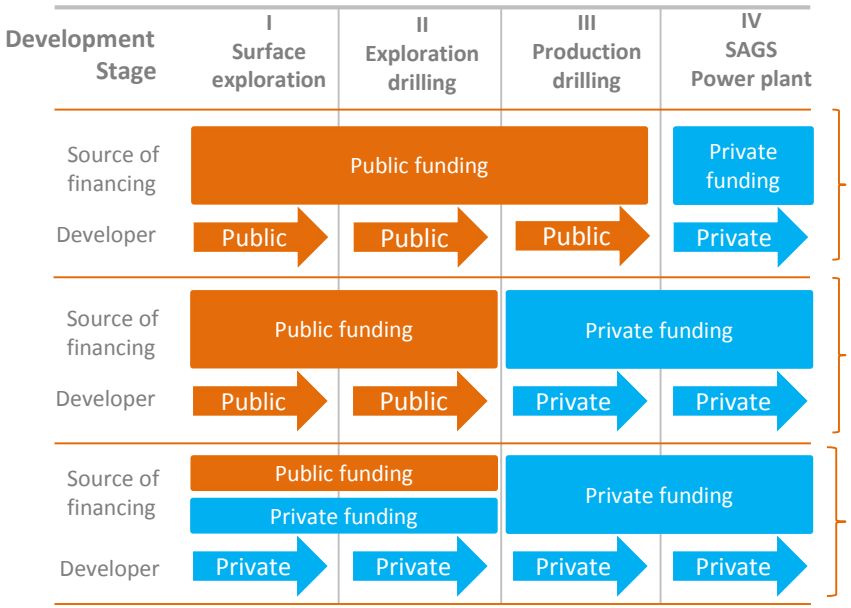


Cost Sharing

- Cost Sharing has been used in 11 countries
  - Most capacity in Philippines, Japan and Turkey developed through this approach
- 3.0 GW developed through Cost Sharing
- Two main approaches
  - Public exploration drilling
  - Private exploration drilling with public financial support
- Allows more rapid development under right conditions
  - Government committed to rapid geothermal development
  - Qualified and committed developers
  - Transparent selection of developers key to success
  - If government carries out exploration drilling quality is critical



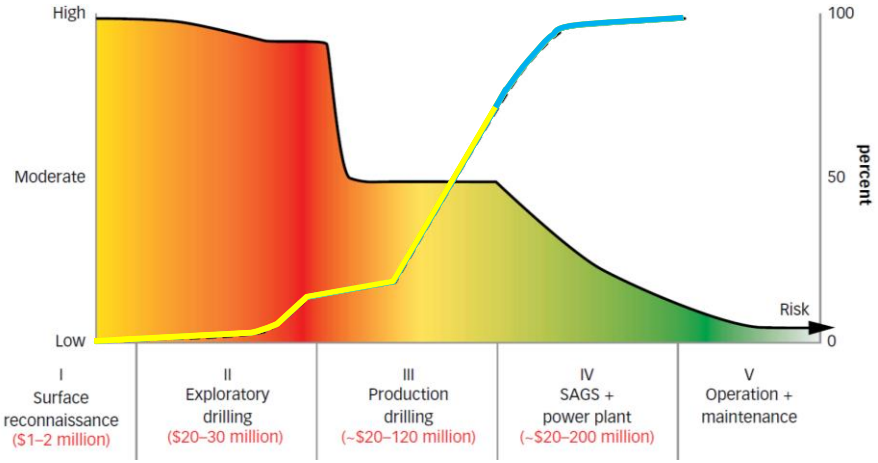
Cost Sharing Modalities



GDC steam sales model
ICE Costa Rica

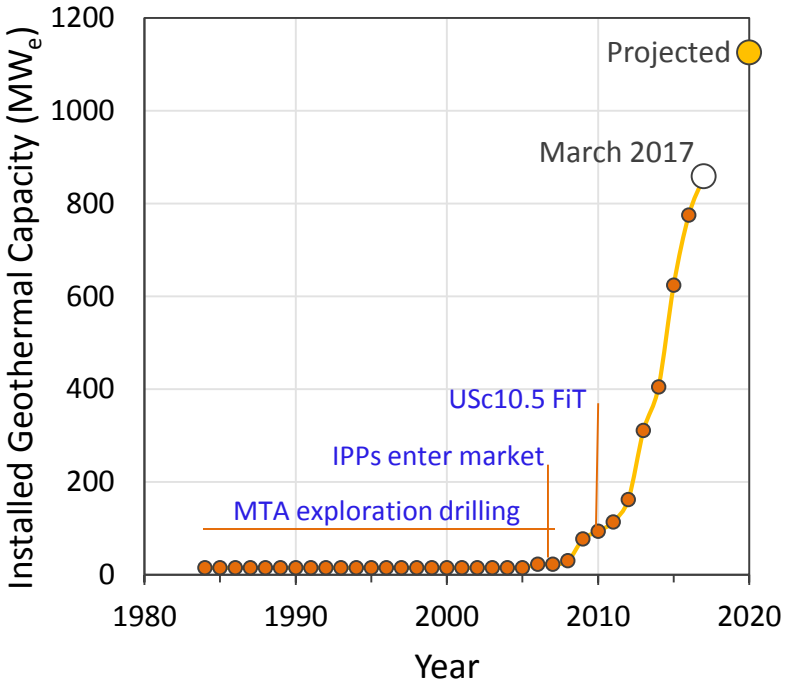
Turkey, Nicaragua, Kenya (Olkaria III)

USA, Japan, GRMF, GDF-LAC



The Turkish Geothermal Boom

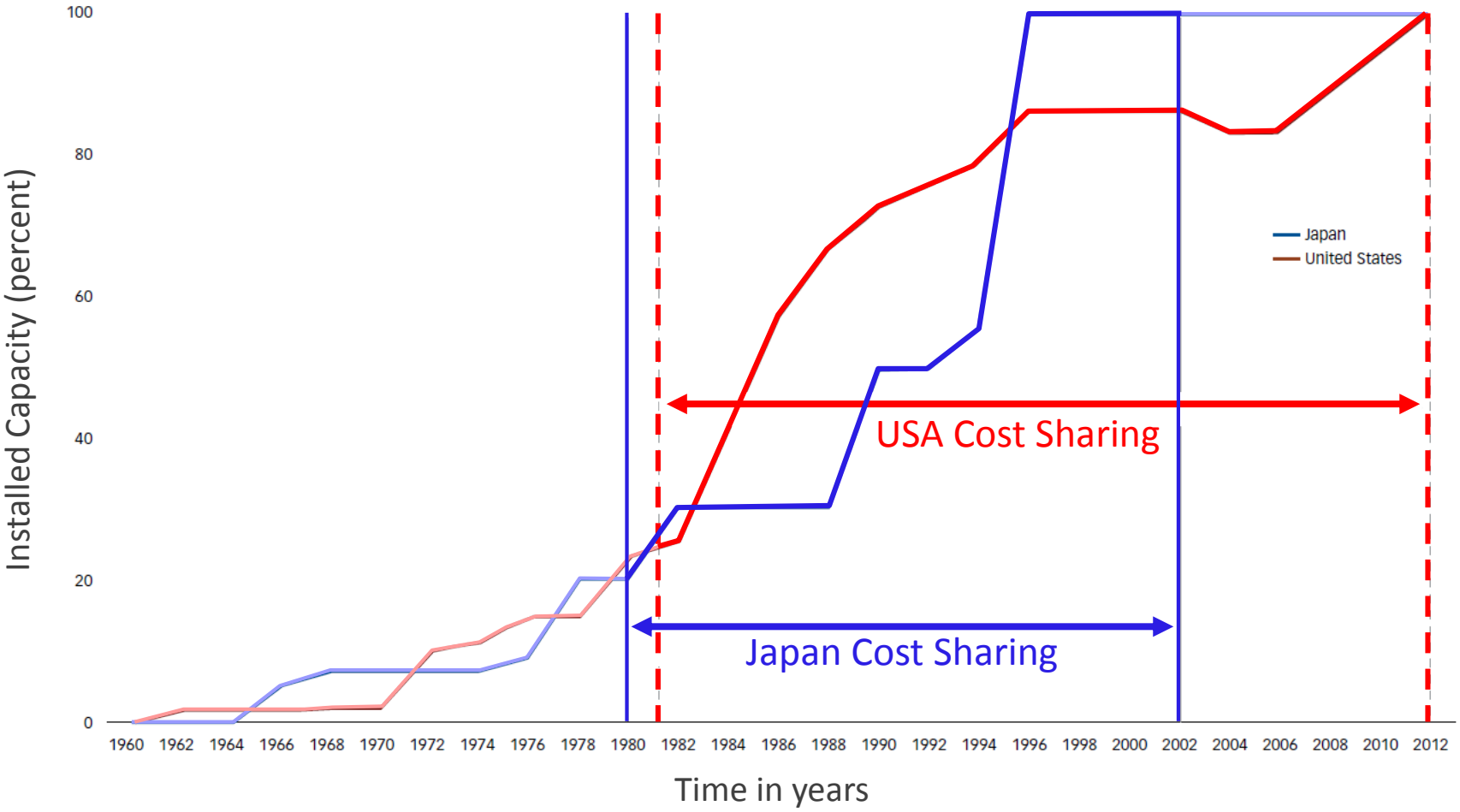
- The growth of the Turkish geothermal sector since 2007 is unparalleled
- Government target of 1000 MW before 2023 will surely be exceeded
- Several key enabling factors
  - Legal reform (Geothermal Law 2007)
  - Feed-in-Tariff (2010)
  - Strong local private sector
  - Technical and human capacity
  - Commercial financing for renewable energy projects (with support from IFIs)
  - Availability of publicly derisked geothermal fields through MTA exploration drilling



Based on: Alexander Richter (GeoLAC2017) - Source: ThinkGeoEnergy Research (2017), JESDER (2017), EnerjiAtlasi (2017), IGA (2015)

Japan and USA – Two examples of successful cost sharing

CURVES SHOW GROWTH OF INSTALLED CAPACITY OVER TIME



Modified from La Roca et al (2017)

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Geothermal Resource Risk Insurance

- Insuring specific well productivity
- Successful modality has not been rolled out globally
  - Only a few tens of MWs developed using Resource Risk Insurance
  - Geothermal insurance fund in place in France
  - Examples of application in Germany
  - Failed attempts in US, Turkey,
- High premium and high transaction cost major obstacles
  - Small market and relatively high resource risk
  - Each project requires intense due diligence
- Efforts underway to explore different insurance scheme designs
  - Portfolio approach (insuring specific productivity of a number of wells)
  - Backstopping by public concessional funds (Mexico)

Early-Stage Fiscal Incentives

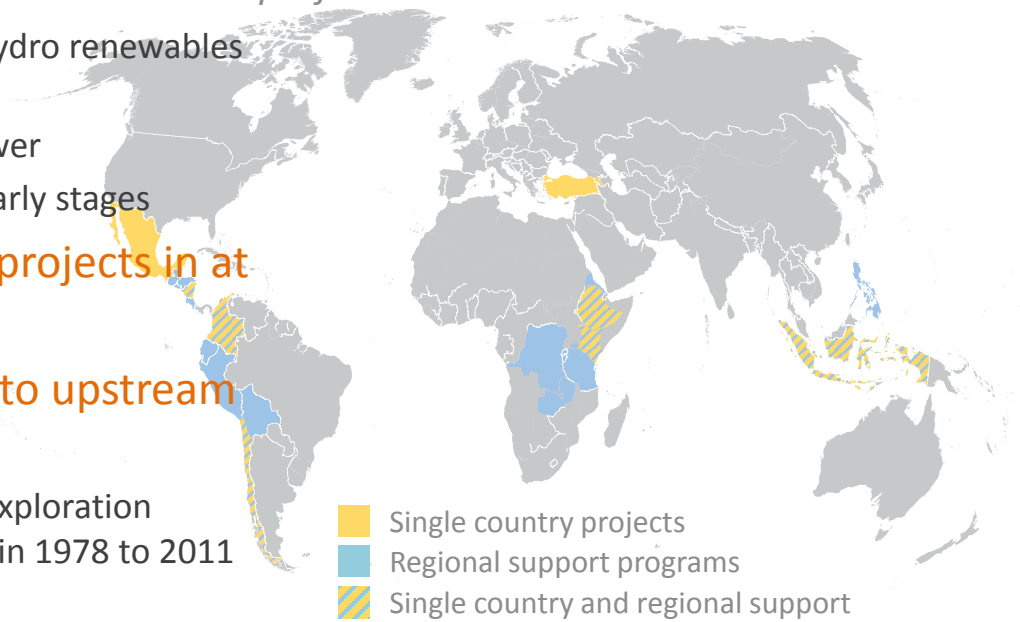
- Typically exemptions from import duties and taxes
- Akin to the cost sharing schemes
  - More modest impact on developers
  - No up-front public support (lost revenues)
- Widely used on different levels
  - Reduction in taxable income (Indonesia)
  - Tax deductions for investments (Mexico)
  - Exemptions of taxes on imported machinery (Indonesia and Philippines)
  - Exemption from all taxes other than income tax (Philippines)
- Hard to quantify impact
  - Likely accelerated development in some cases

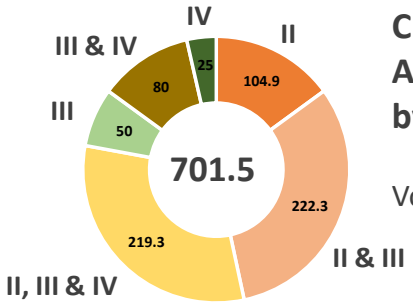
Current MDB support to Geothermal Development

FOCUS ON UP-STREAM ACTIVITIES UNDER COST SHARING APPROACH

- Strong focus on geothermal
  - Since 2011 ~14% of WB financing for non-hydro renewables to geothermal
  - Understanding of the value of baseload power
  - Understanding of the need for support at early stages
- Currently active geothermal support projects in at least 33 countries
- Attention is shifting towards support to upstream activities
  - In 2012 to 2017 28% of MDB financing for exploration drilling and risk mitigation compared to 6% in 1978 to 2011

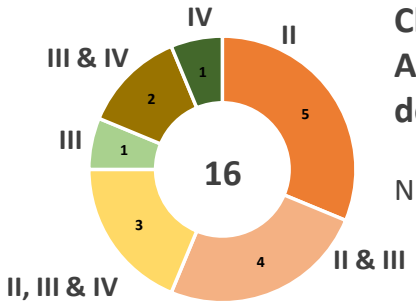
CIF projects and GRMF and GDFLAC





Climate Investment Finance
Active geothermal projects by development stage

Volume of funding in US$ million



Climate Investment Finance
Active geothermal projects by development stage

Number of projects

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Key-messages

- High resource risk and relatively high upfront investment cost are the **key barriers** to scaling up of geothermal power development globally
- Development of geothermal resources for power generation at competitive costs **requires public intervention** to absorb some of the resource risk
- There are different ways to structure this intervention but some are effective than others at **scaling up** development
  - Cost sharing at exploration drilling stage
  - Public development at exploration stage
- These approaches:
  - Optimize the use of public resources
  - Leverage substantial private investments
  - Draw on the private sector technical expertise
- MDBs increasingly promoting cost sharing as the appropriate approach to geothermal development

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Thank You.

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