Upstream Geothermal Development

Narendra Widjajanto

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Skyline Building Lt. 11
Jl. MH. Thamrin No. 9, Jakarta Pusat
Telp: 021-39833222 Fax: 021-39833230
www.pge.pertamina.com

PERTAMINA
GEOTHERMAL ENERGY

Outline

- Overview of Indonesia Geothermal Potential
- Overview of Geothermal Cycles
- Exploration and Resource Confirmation
- Key Factor for Geothermal Development
- Next Step

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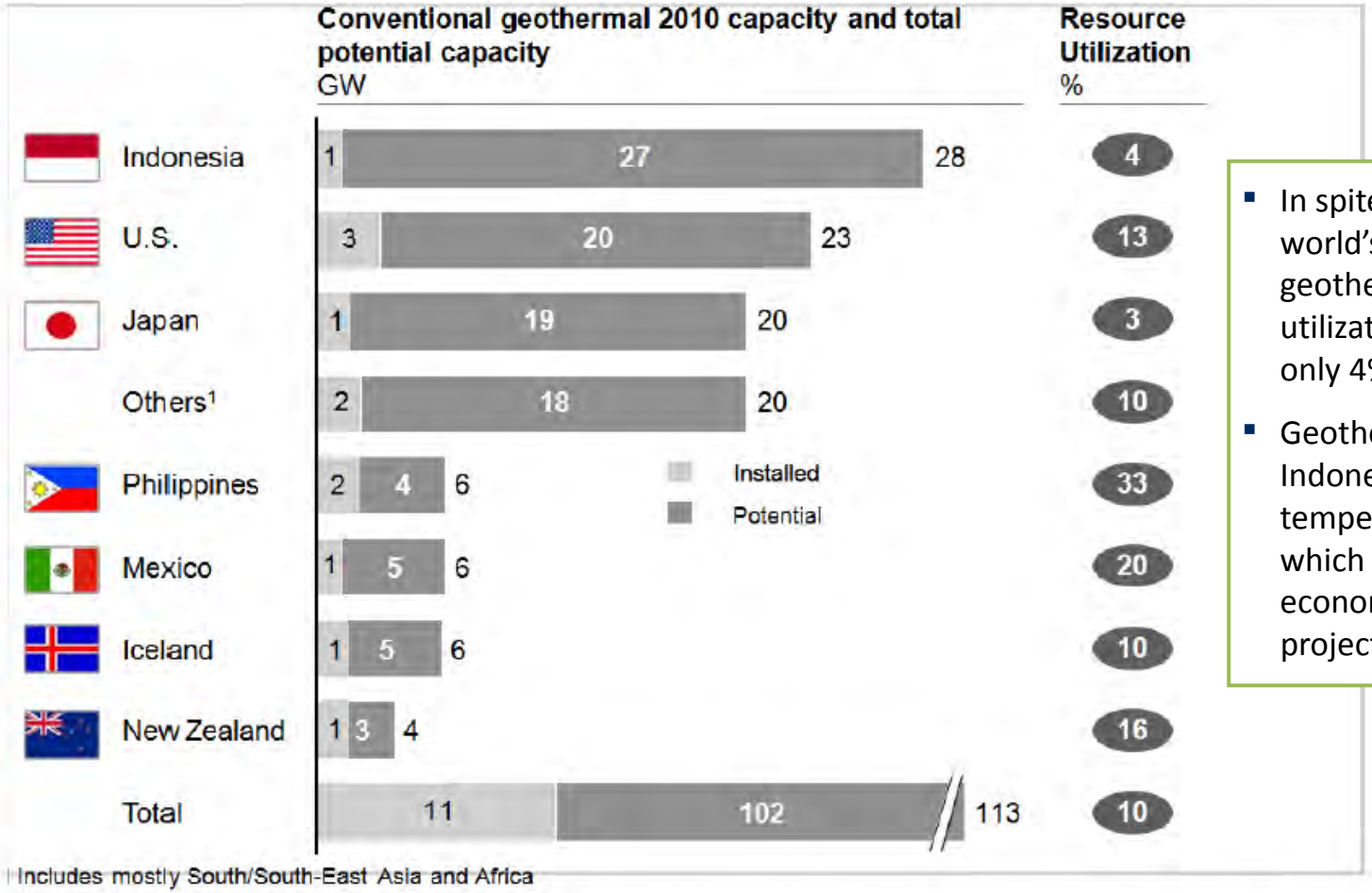
Indonesia has the highest potential for geothermal energy in the world, which remains largely untapped



- In spite of having the world's largest geothermal resource, utilization remains low at only 4%
- Geothermal resource in Indonesia is high temperature resource, which enables more economical geothermal project development

Source : Indonesia's Geothermal Reserve and Utilization Status, Compared to Other Countries (PT. Pertamina Geothermal Energy, PIT API XII November 2012)

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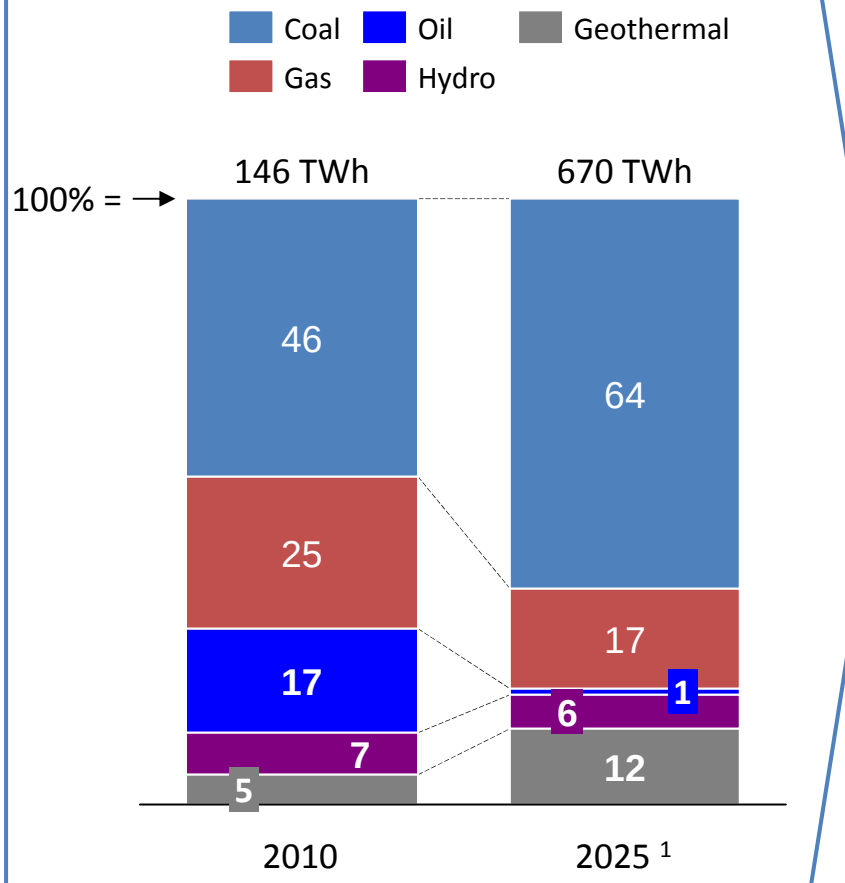
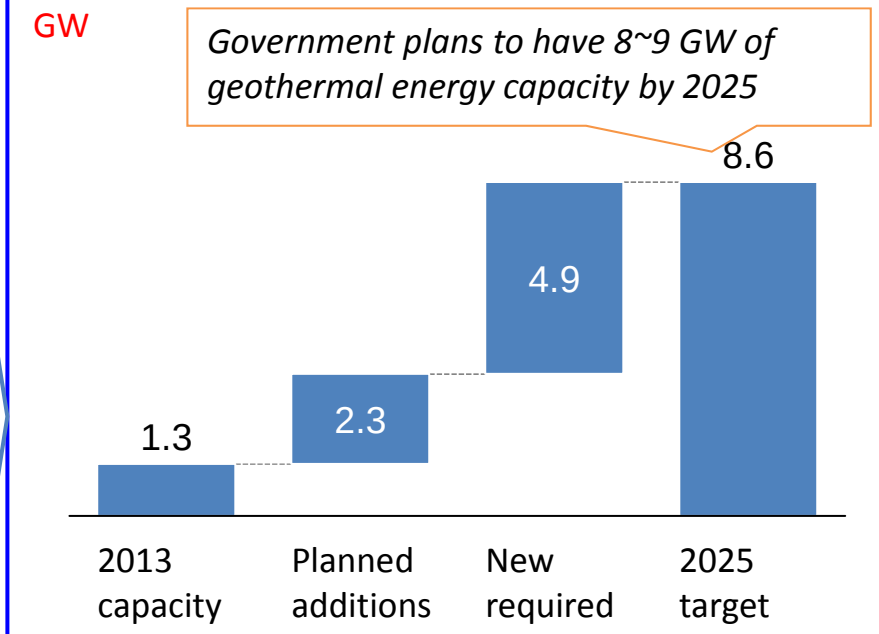
GoI is making a strong push for renewable energy, with plans to significantly increase geothermal power generation

Target energy mix in Indonesia



Target geothermal capacity



- ~7 GW of additional geothermal capacity is needed by 2025, to reach RUPTL's projected 12% share of power generation
- Current capacity expansion plans will only cover 1/3 of the gap

[1] 2025 proposition is assumed to be the same as shown in RUPTL 2020

SOURCE: PGE annual report, Press reports, Team analysis

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Geothermal Resources Map of Indonesia

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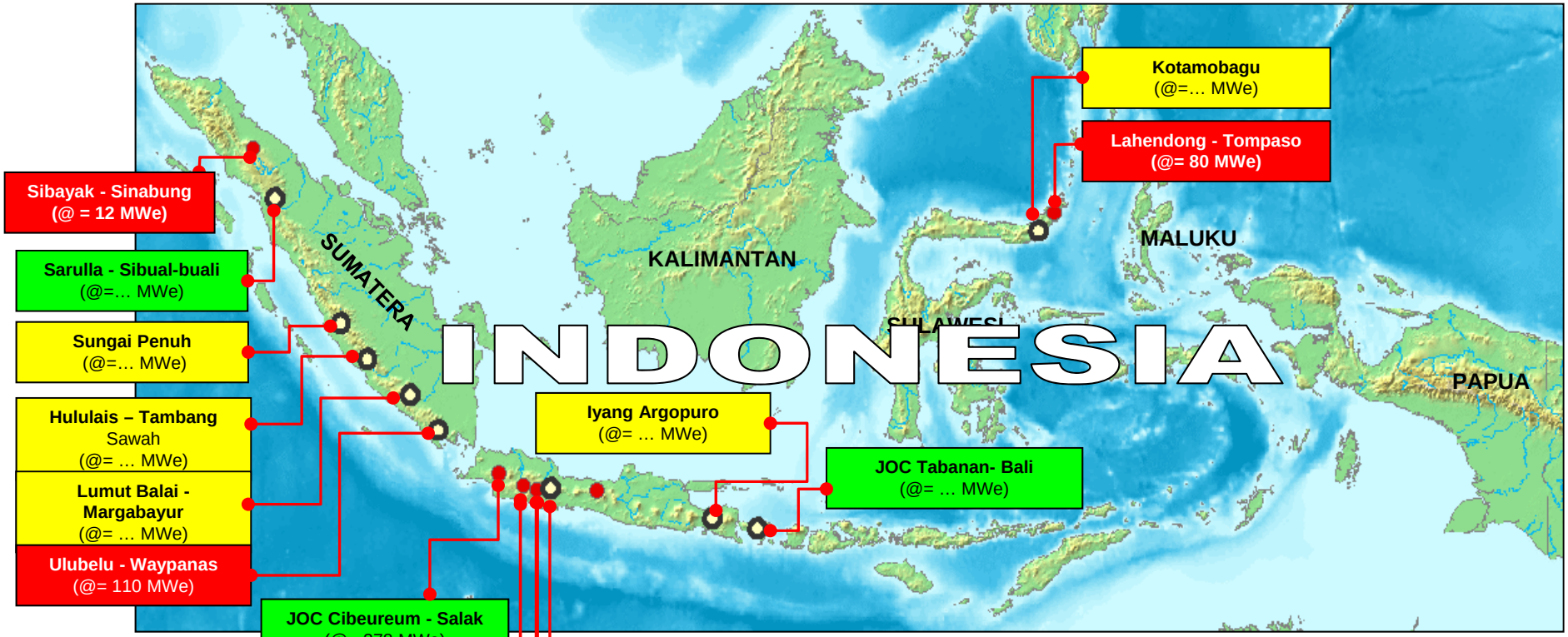
PGE's Working Areas

Concession Area = 14 (MEMR Decree No 2067K/30/MEM/2012
Total Installed Capacity PGE = 402 MW

STATUS : 2013



Legend :

- Production
- Exploration/pengembangan
- JOC : Joint Operating Contract
- @ : Installed Capacity

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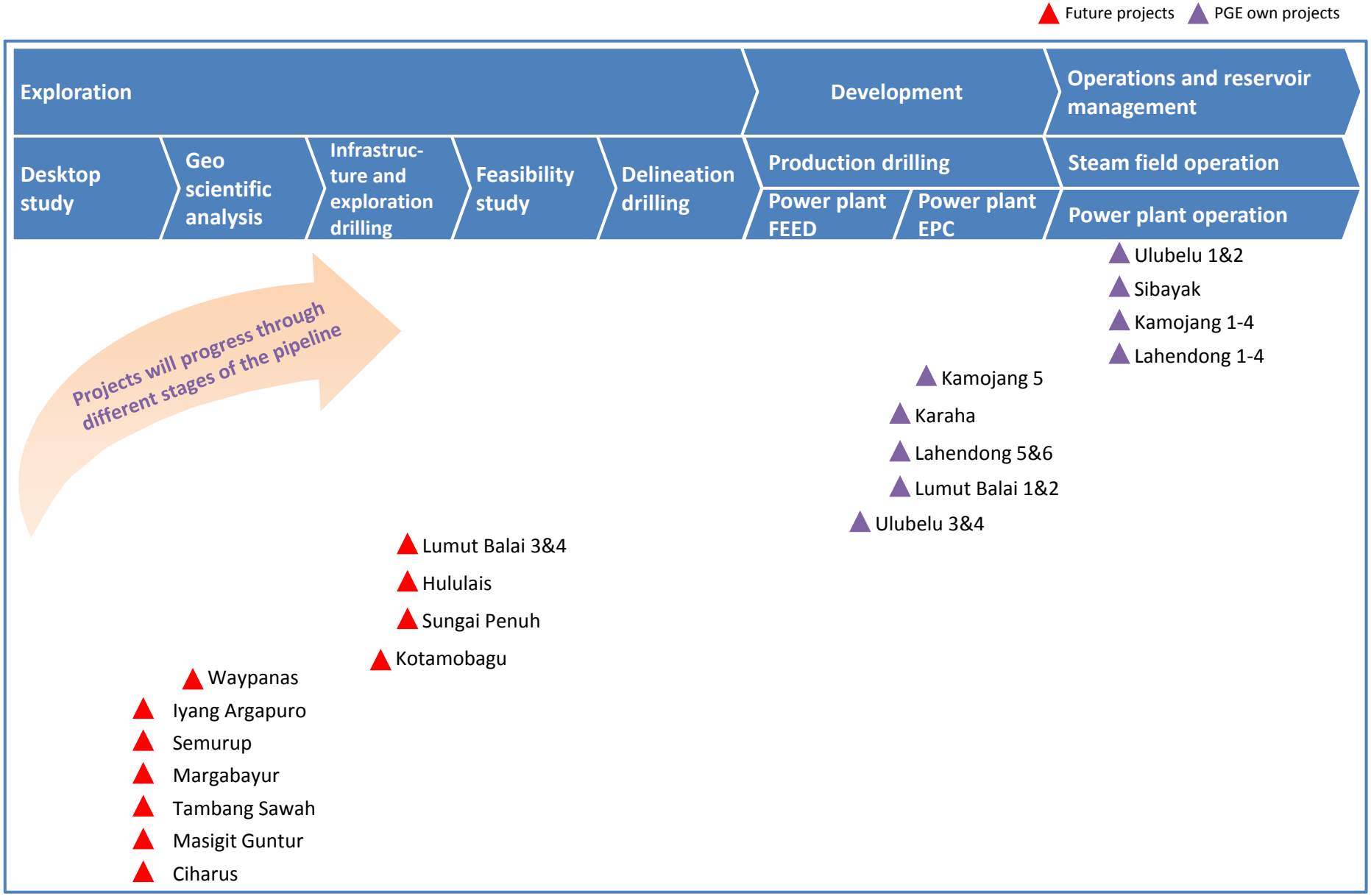
PGE projects are in different stages of project development

PRELIMINARY



SOURCE: PGE

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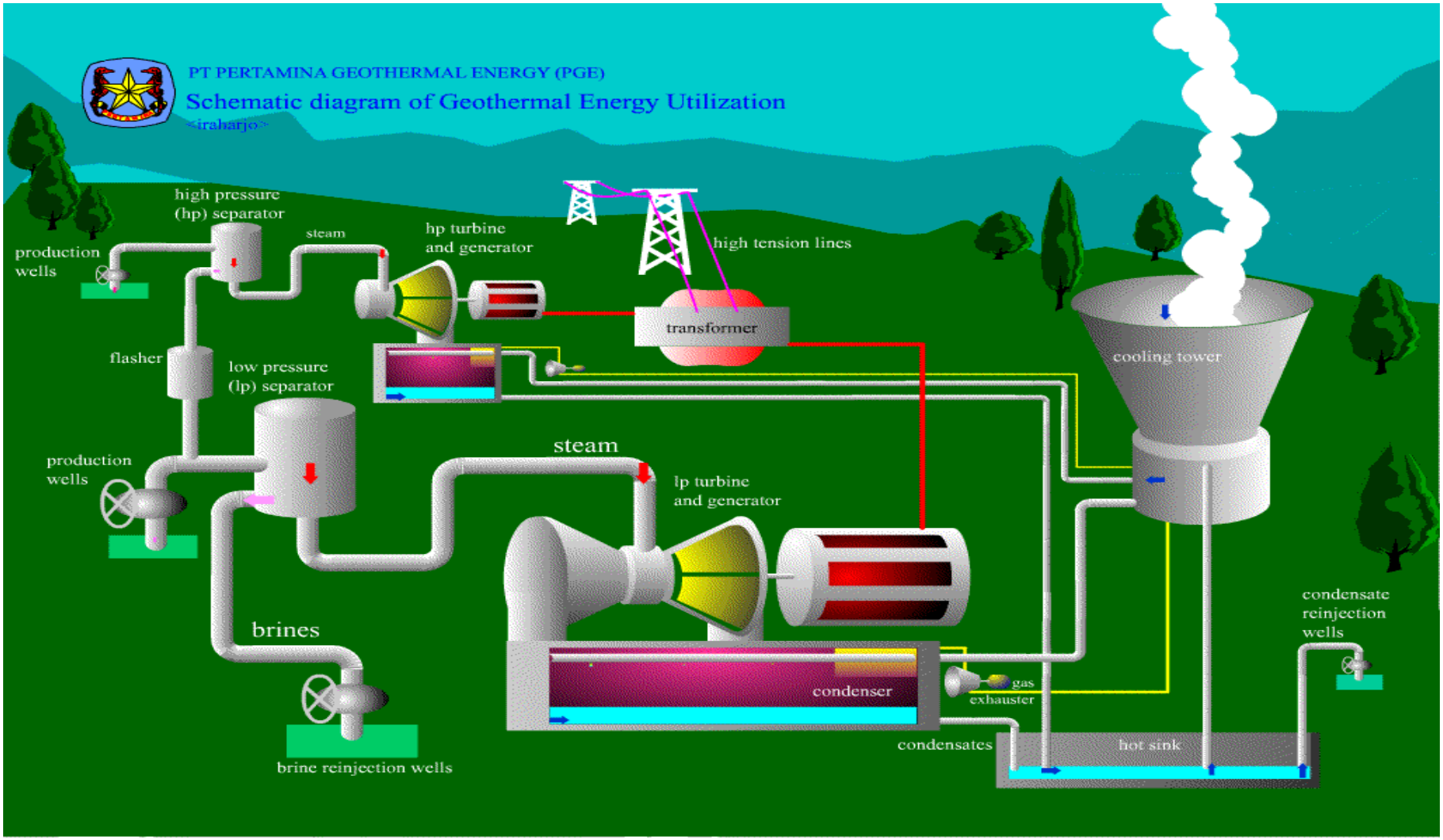
GEOTHERMAL PROCESS



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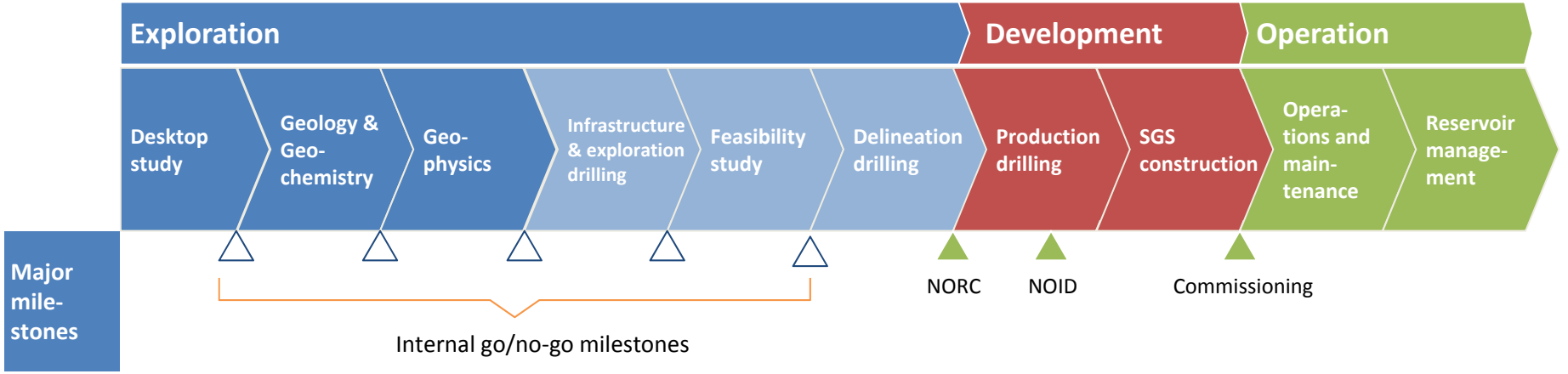
A typical Geothermal Project has 3 Phases Upstream

Approximate figures

TYPICAL 50 MW PROJECT



Key activities			MT survey	Drill up to 3 discovery wells			Drill 4-7 production and injection wells	Construct steam gathering systems and piping	Regular operations	
Approx duration (months)	1	3-4	6-9	12-15	2-3	0-6	Up to 15 months	In parallel with production drilling	N/A	N/A
Approx cost ($)	$5k	$30-50k	$300-500k	$15-25m	$300k	(If needed)	$25-50m	$10-15m	N/A	N/A

SOURCE: Expert inputs

Exploration & Resource Confirmation Phase

No	Phase	Activites	Potensial Risk
1	• Geology & Geochemistry • Geophysics • Infrastructure & exploration drilling	• Prepare exploration program • Process project approval for Environment • Process local and regional permit for land and forest usage • Procurement process and execution • Bridges dan roadways preparation • Land clearance with locals	• Geological Hazards (Landslide Subsidence vs “Cut & Fill”) • Civil Works (Technology & Competency) • Uncertainty for various permit approvals
2	Drilling (exploration & production)	• Prepare detailed drilling program • Rig Mobilization & Logistics • Rig review • Dilling process execution	• Drilling execution risk • Geological risk (hard rocks, fracture, permeability) • Gas / steam leakages
3	Production Testing	• Prepare testing facilities • Heating up period • Final testing	• Steam result confirmation delay due to long heating up period. • Resource risk leads to steam availability/reinjection well below target

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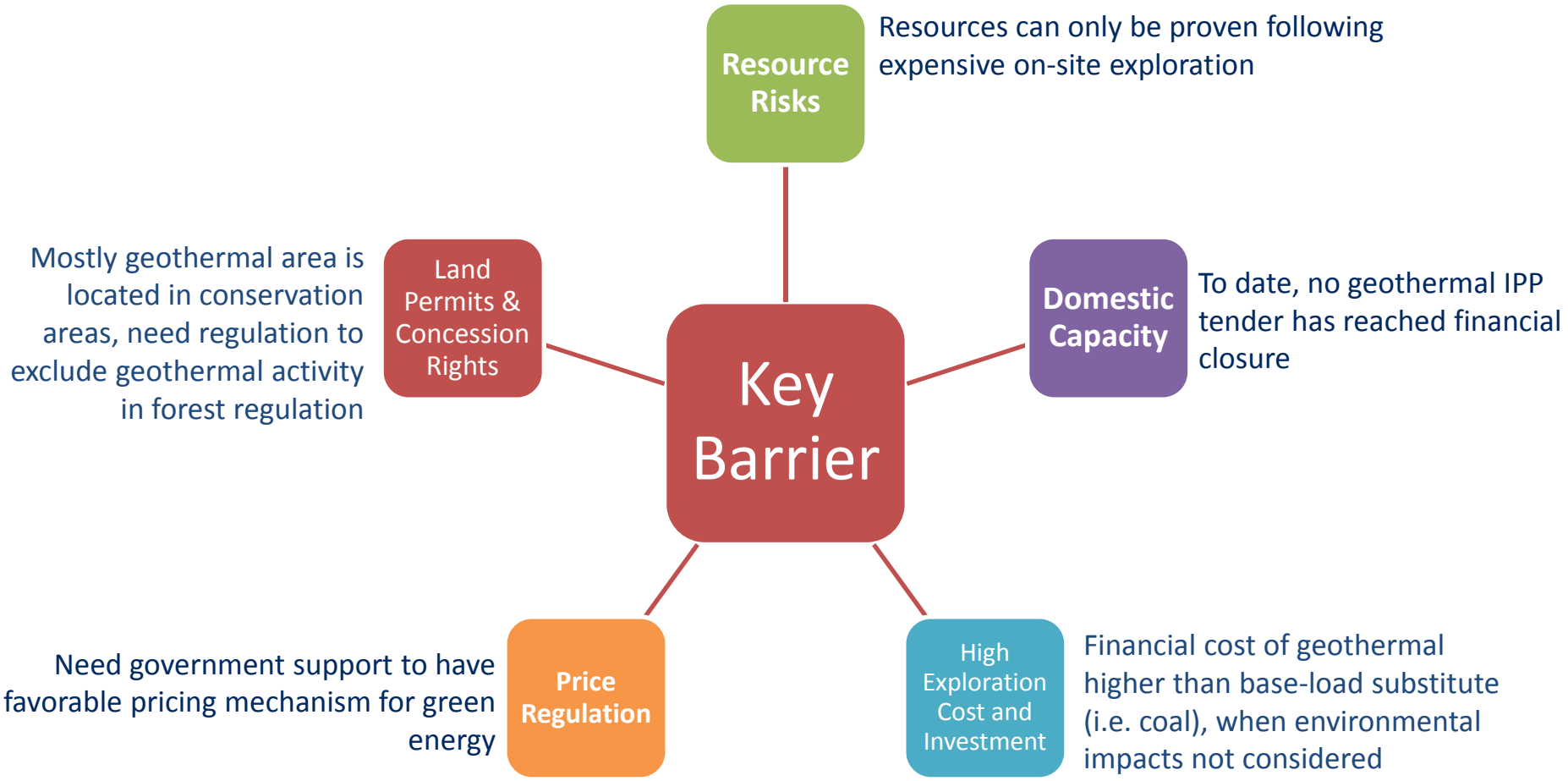
Key Barriers For Developing Indonesia's Geothermal Potential



Barriers make it challenge to mobilize significant investments for achieving GoI target

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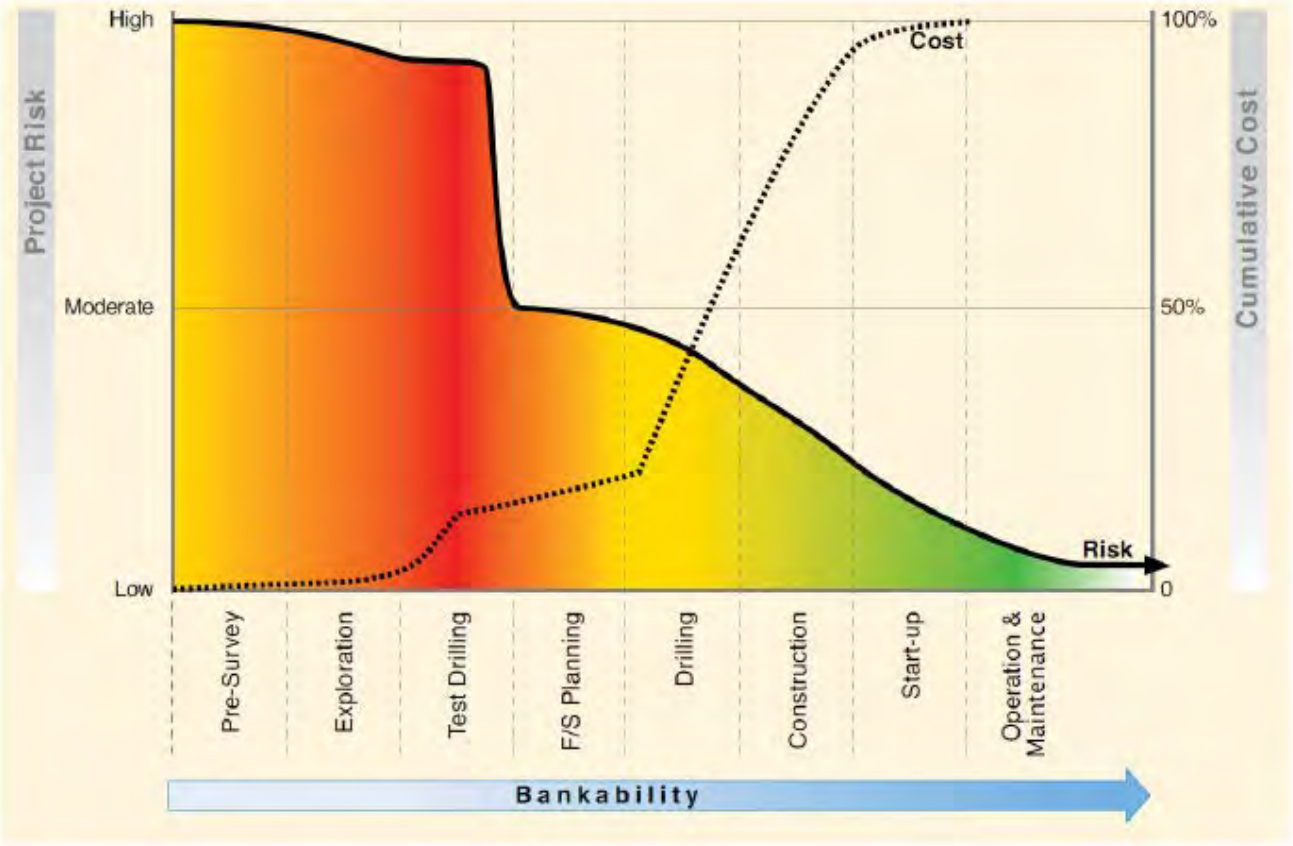
Resource Risk Make it More Challenging To Mobilize Investment

- Uncertainties associated with geothermal field conditions and resource characteristics during the initial stages of field development will cause developers to require a price premium for taking on this risk



SOURCE: ESMAP World Bank Geothermal Handbook 2012

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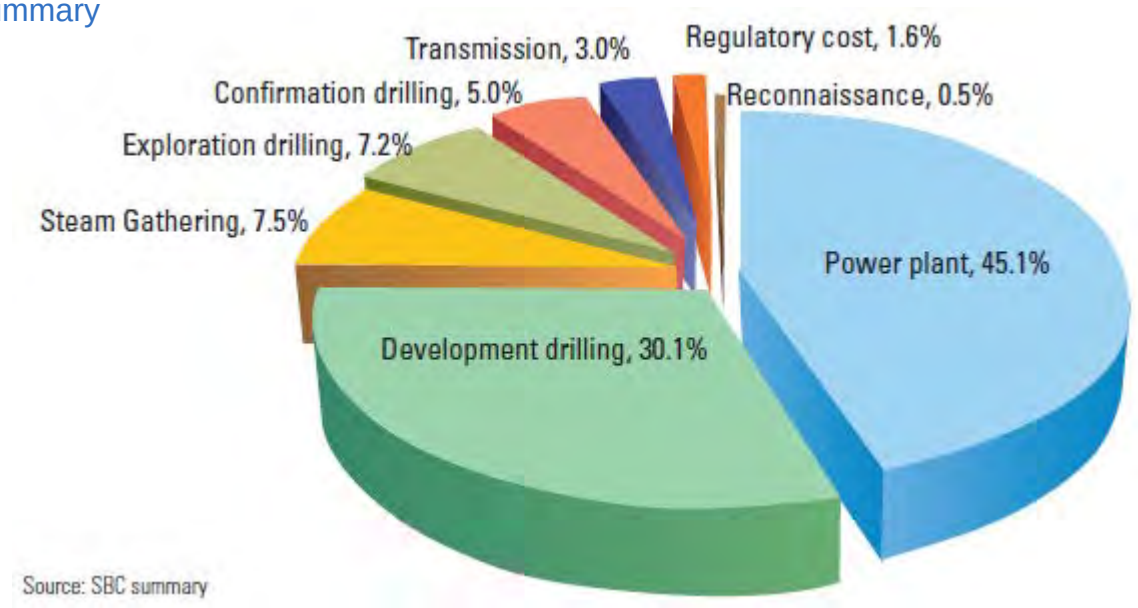
Geothermal Project Cost Structure

For 50 MW Flashed Steam Geothermal Plant, % of total
Source: SBC Summary



- Cost ranges can vary depending a variety of factors such as: depth of the resource, geologic characteristics and temperature
- Upstream Cost less than Dowstream Cost but having the most riskiest part.
- The upstream phases, (drilling phase), can be considered the riskiest parts of geothermal project development.

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Next Steps for Managing Geothermal Barriers

No	Barriers	Explanation	Next Steps
1	Project delayed due to Various Permits uncertainty	• Uncertainty for acquiring apporvals from local and national government agency	• Project socialization • Revised related procedures / regulation to support green energy development especially for geothermal activities
2	Resource and Upstream Risks	• Steam availability below target • Difficulties in getting injection wells	• Expert and technology enhancement • Operational excellence • Prepare sufficient time to develop geothermal fields properly (5-7 years) • Increase risk mitigation in developing upstream projects in parallel • Upstream Risk beared by Government

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Next Steps for Managing Geothermal Barriers

No	Barriers	Explanation	Next Steps
3	Offtake uncertainty and financial risk	• Adequate pricing for steam and electricity	• Propose more attractive new tariff to the government to increase certainty in geothermal investment projects • Includes environment cost in coal tariff in order gain comparability with geothermal tariff

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