INSURANCE SCHEME FOR INDONESIA'S GEOTHERMAL EXPLORATION AND DEVELOPMENT

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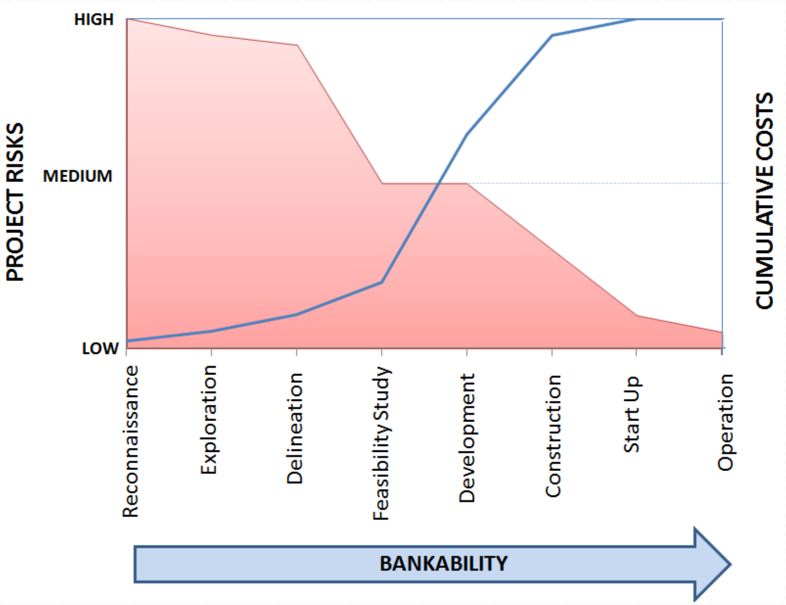
PURPOSE & OBJECTIVE

- Purpose:
  - Investigate the feasibility of setting up in Indonesia an insurance scheme in conjunction with local insurance market and international reinsurance supports, to cover risks in initial geothermal exploratory drilling.
- Objective:
  - Insurance coverage to cover multiple parties that have different tasks in the process.
  - Risk mitigation scheme through insurance that combines both project financing via a credit and the mitigation of exploration risk in one program.

PROJECT CHARACTERISTICS

- Investment in a geothermal power plant depends on a wide array of conditions:
  - Geology
  - Investment environment
  - Political stability
  - Legal certainty
  - Power market; and
  - Infrastructure.
- Inherent risks associated with the geothermal project undertakings:
  - Exploration, not finding the economically viable temperature or flow rate in a geothermal reservoir.
  - Development and operation of geothermal resources are subject to several risk factors which vary between different geothermal systems.
  - The unexpected geology may cause problems with the drilling process.
- Specifications of a geothermal power plant differs site by site or no standardized specifications of power plants



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GEOTHERMAL RISK PARAMETERS

Parameter	Target	Characterization	Project Phase	Mitigation
Temperature	Conventional: Min = 200º -229º C Max = 320º C Binary: 140º C	Hot springs samples, Temperature gradient well	Preliminary Survey Exploration and development)	Given
Reservoir Permeability	Fracture	Geological, geochemical & geophysical surveys, drilling, testing	Exploration and development	Selection of well locations
Fluid Composition	Non-condensable gas is < 5%	Drilling, testing & sampling	Exploration and development	Use of inhibitor during production
Reservoir Capacity and Sustainability	Large	Geological, geochemical & geophysical surveys (3-D modelling), exploratory and development drilling, and operation	Preliminary Survey, exploration, development and operation	Prudent reservoir management, involving data gathering, monitoring, reservoir study (including reservoir simulation and re-injection program).
Environmental Risk	Minimum and meet prevailing laws and regulations	Environmental Impact Analysis (EIA), Environ-mental Management & Monitoring Plan	Survey, drilling & operation	Mandatory by Law

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TYPES OF RISKS IN GEOTHERMAL

Type of Risks	Phase	Probability	Consequent	Class
Geological/Reservoir				
Seismic Survey	Exploration	Frequent	Major	Voluntary
Exploration Drilling	Exploration	Frequent	Major	Voluntary
Development Drilling	Development	Frequent	Major	Voluntary
Low Reservoir Capacity	Development	Frequent	Major	Voluntary
Higher Investment Cost	All phases	Frequent	Significant	Voluntary
Operational:				
Blowout & re-drilling	Drilling	Rare	Major	Involuntary
Pollution	All phases	Occasionally	Significant	Involuntary
Construction Permit	Development	Probable	Major	Involuntary
Construction Schedule	Development	Probable	Major	Involuntary
Equipment Breakdown	Operation	Probable	Significant	Involuntary
Business Interruption	All phases	Probable	Significant	Involuntary
Force Majeure	All phases	Rare	Major	Involuntary
Declining Reservoir Capacity	Operation	Occasionally	Major	Voluntary

Involuntary: Commercial Insurance
Voluntary : Resource Risk Insurance

RISK MITIGATION MEASURES

Country	Programs
Iceland	Establish Energy Fund to promote geothermal resource utilization .
France	Guarantee Facilities (since 1981, reactivated in 2006). Financing fund to cover the geological risks, based on Short-Term Risk for exploration and Long-Term Risk during exploitation, and deep geothermal drilling.
Germany	Drilling Insurance facilities (2009) by Federal Government & Private (> 400 meter depth).
World Bank	Geothermal Energy Development Fund (GeoFund) for the Europe and Central Asia (ECA) region and East African Rift Zone (the ARGeo). As part of the program created Partial Risk Guarantee Facilities (PRGF), which were primarily designed to encourage exploration and drill geothermal exploration wells (electrical generation & direct use).

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INSURANCE SYSTEM

FRANCE

- Introduced in 1981 (Low Temperature):
  - STR: total or partial failure of drilling operations;
  - LTR: for 25 years exploitation phase (against the risk of having geothermal resource decrease and against damages that may occur to the installations.
- First Well Risk:
  - Dry Hole: 90% of the costs are reimbursed
  - Partial success: Negotiated, based on the output and temperature obtained.
- Maximum: 3 Million Euro per well
  - Costs: 3 - 5% of the drilled well cost
- Results (60 projects guaranteed):
  - 12 to 15% of total or 17 to 18% of partial failure
  - 130 notices of claims:
    - 100 claims during exploration phase
    - 30 claims during research phase
    - 24 mio.€ spent by the fund for notices of claims w/10 mio.€ of public money.
    - 500 MWh and 60 geothermal facilities installed

GERMANY

- KfW loans for deep geothermal wells being granted by way of commercial banks.
- Up to a maximum of 80% of the costs that qualify for a subsidy will be financed.
- If no discovery, the investor will be released from having to repay the remaining loan amounts (declared a failure).
- Productivity risk of each deep geothermal project will be examined to qualify for loan.
- Interest = subsidized loans also contain a “risk loading” for the productivity risk.
- Fees must be paid when the loan is applied for and loan contract is signed.
- Expert assessment of the deep geothermal project and technical support before and during the drilling phase.
- System stopped because of high price of contribution paid by developers (2-5% of the guaranteed amount each year. A new sysem is effective since March 2009 (fund = 60 M€).

INSURANCE SYSTEM

ICELAND

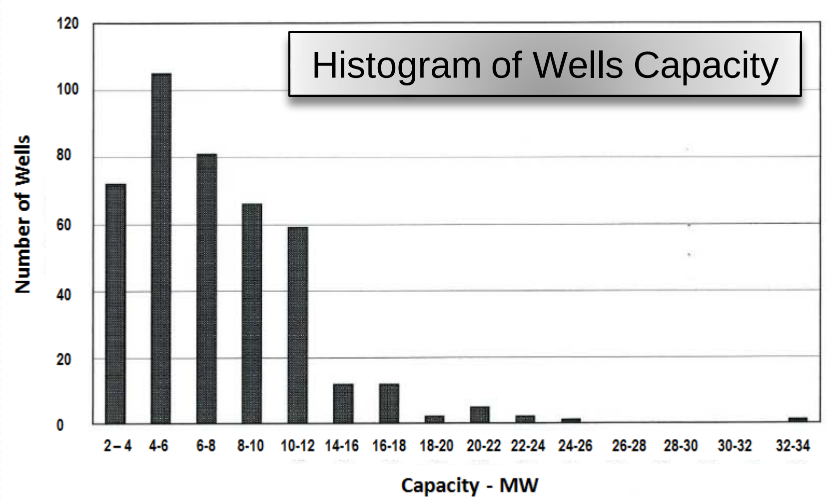
- Public Fund: National Energy Fund (since 2003)
- National Energy Authority and National Energy Council in charge
- Public funding with a yearly state budget and interest incomes
- Geothermal heating:
  - Grants for step one = research and drilling
  - Loans for exploration of geothermal heat in case it could reduce the public's costs of house heating
- Grants and loans:
  - Grants: 50% of the approved costs (geothermal research and drilling)
  - Loans: 60% of the approved costs
- Reimbursement of the loans depending on the success or failure:
  - None if total failure
  - 100% over 10 years if success

SWITZERLAND

- Public fund: State owned RPC Foundation (since 2009)
- Based on the previous public fund (1987-1997): 13 projects, with 5 success, 1 partial success, 7 failures
- SWISSGRID (national grid company) in charge under the supervision of the Swiss Federal Office on Energy
- Public funding from a surcharge over every kWh consumed in the country
- Geothermal electricity and combined systems, but not the heating only
- Guarantee:
  - Up to 50% of the total costs (drilling and tests) depending on the success
  - No maximum amount
  - Developer advances the costs
  - Currently : 2 projects currently

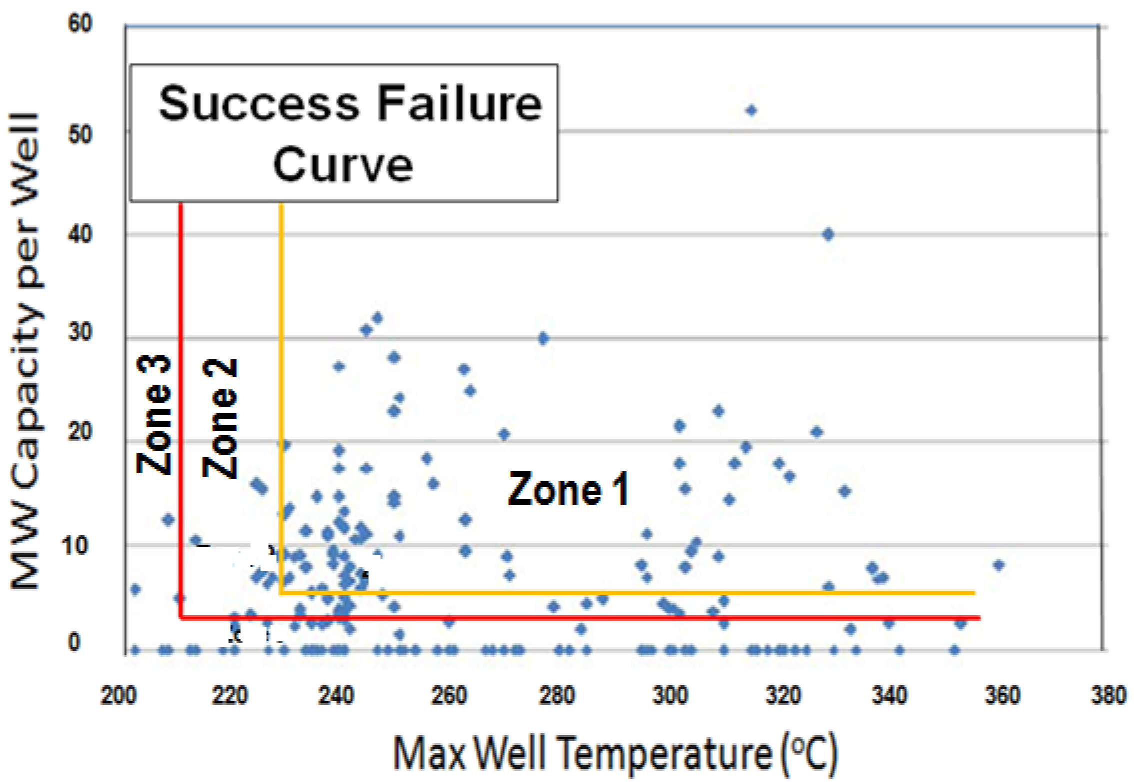
GEOTHERMAL DRILLING STATISTICS (1)

- Field Size:
  - 70% = > 50 MW.
  - 50% of the fields (about 40) > 100 MW.
- Wells:
  - Total wells studied = 215.
  - Depth = 1,000 – 2,800 meter.
- Success Rate = 63% - 73%.
- Cost = USD 300,000 – 400,000 per MW.
- Capacity:
  - 3 – 40 MW (median: 9 MW versus world-wide 4 to 6 MW).
- Classification:
  - 3 to 5 MW: tight wells.
  - 7 - 9 MW: typical wells.
  - 10 - 19 MW: steam-saturated, steam cap, moderate-temp reservoir.
  - 27 MW: ultra-high temp/highly permeable reservoirs (40% of total wells).



Subir K. Sanyal, et. al., *Geothermal Resource Risk in Indonesia – A statistical Inquiry*, 36th Workshop on Geothermal Reservoir Engineering, Stanford University, Stanford, California, 2011.

GEOTHERMAL DRILLING STATISTICS (2)



- Zone 1: Success
  - Temperature: > 230° C
  - Flow Rate: > 4 MW
  - No Compensation
- Zone 2: Partial Success
  - Temperature: > 210° C
  - Flow Rate: > 2 MW
  - Partial Compensation
- Zone 3:
  - Temperature: < 210° C
  - Flow Rate: < 2 MW
  - Full Compensation

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SUCCESS CRITERIA

Prerequisites of First Exploration Drilling

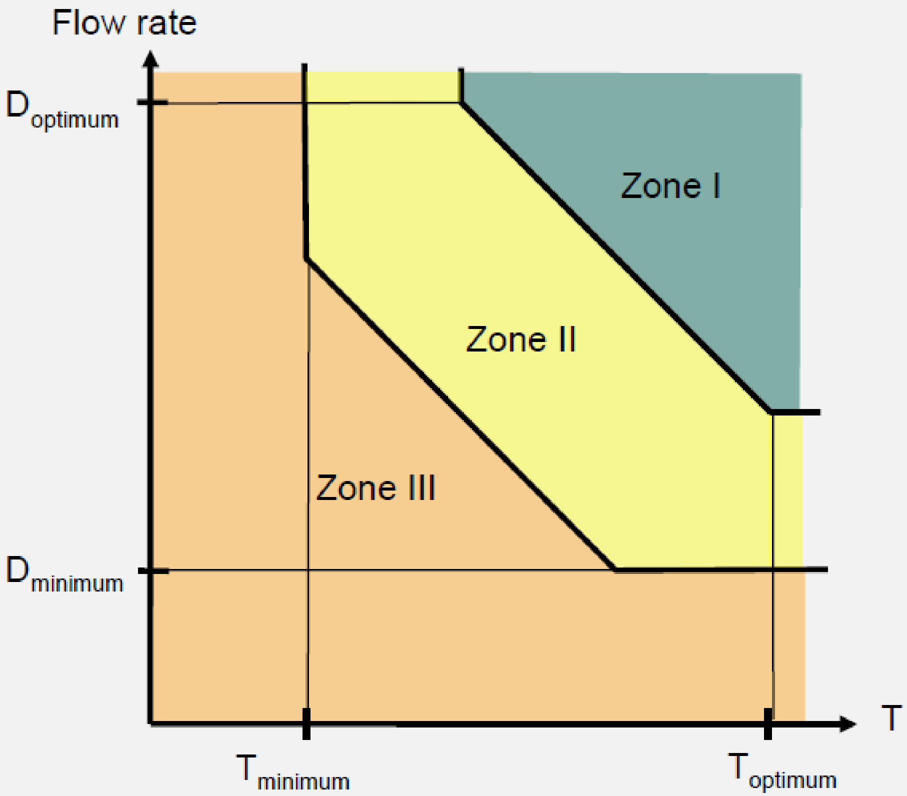
- Before the first deep full size exploration well to target depth is drilled the following information should presumably be available, as part of normal geothermal exploration, and form the basis for the risk mitigation scheme for the first exploration well.
  - Results of literature review, including regional geology, regional tectonic, structural geology and aerial photographs and satellite images;
  - Results from geological field work, showing mapping of important geological features, such as geothermal surface manifestation, fluid chemistry and temperatures profile.
  - Results from geophysical exploration activities, including resistivity measurements (Magneto Telluric - MT) and seismic profiling covering the geothermal; reservoir rocks.
- Results from shallow exploration drilling, including temperature gradient well,

Success Criteria of First Exploration

- The three parameters that may be used as success criteria for the first deep full size exploration well are the temperature, flow rate and fluid acidity:
- The minimum temperature for steam power plan to run efficiently is about 200^{o}C;
- The MW benchmark has to be determined on a case by case basis and based on available information on the geothermal reservoir before the drilling of the well. For example, first exploration well drilled in a geothermal system might for example be considered successful if it provides 3 MW of electrical power with 15 bar well head pressure.
- Fluid with pH value of less than 5 is considered corrosive and could be considered as a benchmark for fluid acidity.

SUCCESS CRITERIA

Success-Failure Curve



Zone I – Success

- Temperature and flow rate ≥ Boundary to the optimum zone
- No compensation payment

Zone II – Partial success

- Temperature and flow rate ≥ Threshold of minimal cost-effectiveness
- Refunding of the balance to the agreed IRR

Zone III – No Success

- Temperature und flow rate ≤ Threshold of minimal cost-effectiveness
- Complete compensation payment

France Short Term Risk.

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HOW TO ARTICULATE ACTUAL SYSTEM?

Government participation in risk mitigation of geothermal resource development

EXISTING

Private Sector

GEOTHERMAL FUND

- Mission: Investment to finance preliminary survey and exploratory drilling in small geothermal prospects and/or preliminary survey data enhancement
- Strategic Objective: Help accelerate small-medium scale geothermal power projects and good return to sustain revolving funds
- Reg. GR No. 23/2005 and GR No. 8/2007
- **Managed by Pusat Investasi Pemerintah (PIP) PMK Nr. 1/2012**

PARTIAL RISK GUARANTEE FACILITY

- Mission: Insurance provider - to provide limited guarantee of reserve discovery or financial losses in geothermal resource development
- Strategic Objective: Help accelerate medium-large scale geothermal power projects, sustainable insurance scheme to attract private participation

INSURANCE CAPACITY

- Local Insurers
- Local Reinsurance
- Overseas Insurance Market
- Insurance Pool
- Other forms

CONCLUSIONS

- Geothermal resources development may be accelerated by providing exploration risk insurance, which will provide the developer with:
  - Financial security for the venture capital needed until the completion of drilling works and successful well testing.
  - Proof of risk coverage in order to facilitate acquisition of loan capital.
  - To get into contact with more financial institutions/banks and access more competitive loans.
- Recommendations:
  - Develop statistical data analysis on probability of success of a geothermal project (depending on geological conditions).
  - INAGA initiates:
    - Capacity Building
    - Financial Modeling