ESMAP
The Energy Sector Management Assistance Program

# Planning Geothermal Power Generation – Lessons learned

*"Taller Regional "*

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# Key Questions

- Huge potential for geothermal power generation in Central-America , 4,000 MW or more. **Why have the countries only developed around 500 MW of geothermal power?**
- If the development of geothermal power is as time- and capital consuming here as in other countries, **could the CA countries learn from the experience of successful countries like Iceland, Kenya or Philippines?**

# Characteristics of Geothermal used for Power Generation

- Environmentally friendly / Option of carbon credits
- Limited and “reversible” impacts of power plants on nature and society
- Usually amongst the least cost options for power generation
- Indigenous resource, saves foreign currency
- Mature technology, high reliability
- Base load power (availability >90%)

# Barriers to Geothermal Development

1. High upfront costs for exploration and drillings; access to funding and guarantees
2. Legal & regulatory framework; Commercial risks, incentives, feed-in tariffs
3. Institutional and technical capacity
4. Information and data base on resources
5. Location of geothermal fields in protected or rural areas (grid connection costs)

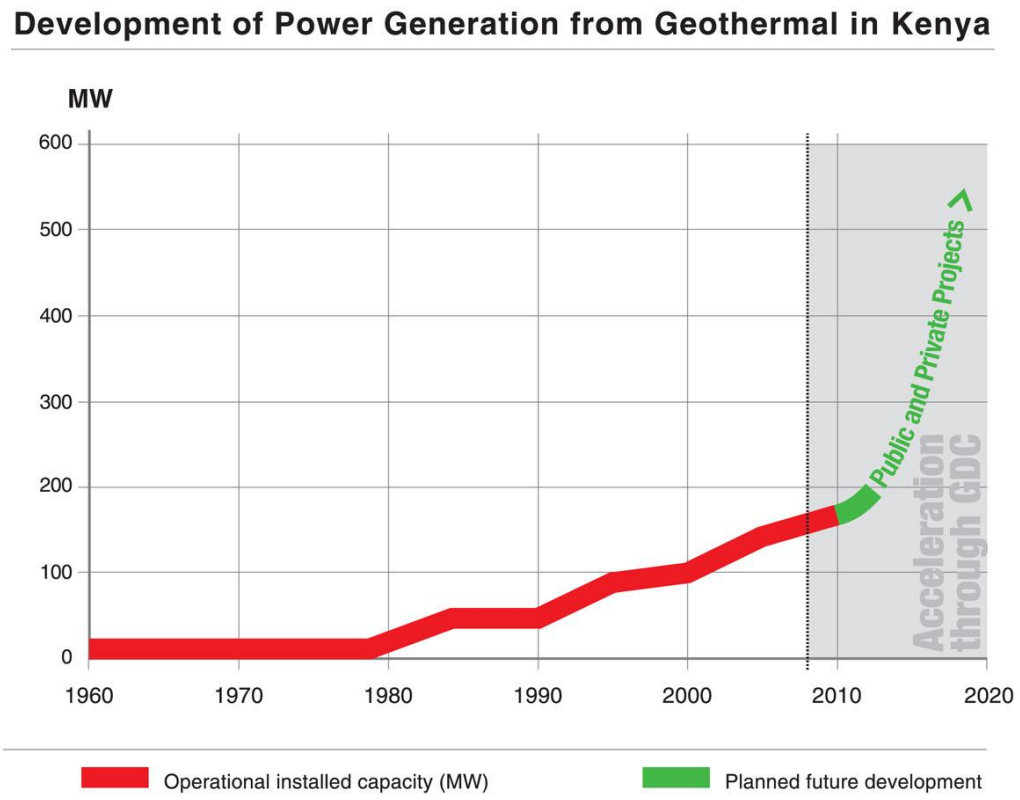
# Three geothermal countries
# No. 1: Kenya

- 40 m. people, 1.600 MWe installed, 170 MWe geothermal (11%)
- Residual (waste) heat and CO2 from fluids used for flower production
- Heavily dependent on hydro power (ca. 50%). Droughts!
- Rest is fossil fuels, mainly Diesel. High consumer tariffs, low consumption, fluctuating prices for 100% imported fuel
- GoK plans to diversify energy mix and focus on indigenous resources, mainly geothermal. Own drilling rigs, experts for geothermal exploration
- Extension of  Olkaria field by 280 MW (4 x 70 MW)
- Other fields  likely to provide several hundreds of MW's
- Capacity in 2015 likely to reach 500 MW

# Kenya's geothermal build-up

- 1956: First interest and drillings
- 1972: First successful drilling at Olkaria, World Bank loans for surface exploration and exploratory drillings
- Extensive resource mapping
- Olkaria I 45 MW (1981-85), Olkaria II 70 MW (2003), Olkaria III 48 MW binary cycle, IPP, (2009)
- All power plants are within Hells Gate National Park Mitigation measures by KenGen to protect the park
- Sophisticated geothermal law and regulations allowing feed-in tariffs up to US$ 8.5 cents per KWh

# Geothermal in Kenya




- Data Source: KenGen / Mwangi, M. 2005

# Kenya II

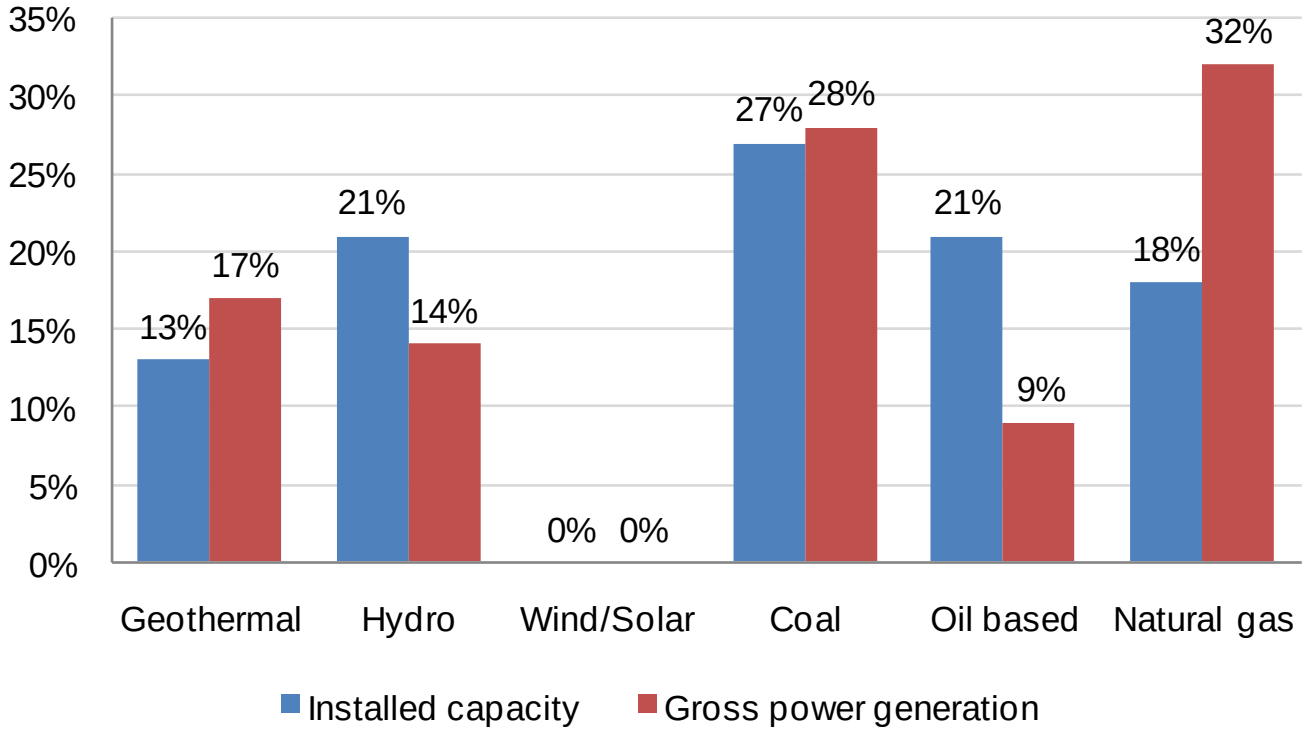
- KenGen, has up to now taken all development risks. Too weak to satisfy power demand
- Extensive study shows that geothermal power is Kenya's least cost option
- 2008: GoK decides to found GDC (Geothermal Development Company), a public company to develop geothermal fields, confirm the resource and then tender out fields to private sector (or transfer to KenGen to develop)
- In future, KenGen will develop its own projects and maybe some of GDC's projects. Other projects to private sector
- GDC resolves the issue of investors' risk perception due to exploration and test drillings

# Olkaria II in Kenya

# Philippines

- Located on Pacific Ring of Fire, >80 million people, 16,000 MW installed, thereof 2,000 MW geothermal (13%). Over 7,000 islands
- Limited indigenous resources of fossil fuels (oil & gas) make country dependant on imports
- Coal, hydro and oil based power plants account for 69% of installed capacity
- Private power companies have received several “Service Contracts” for geothermal fields including building the power plants. Transmission connection by State

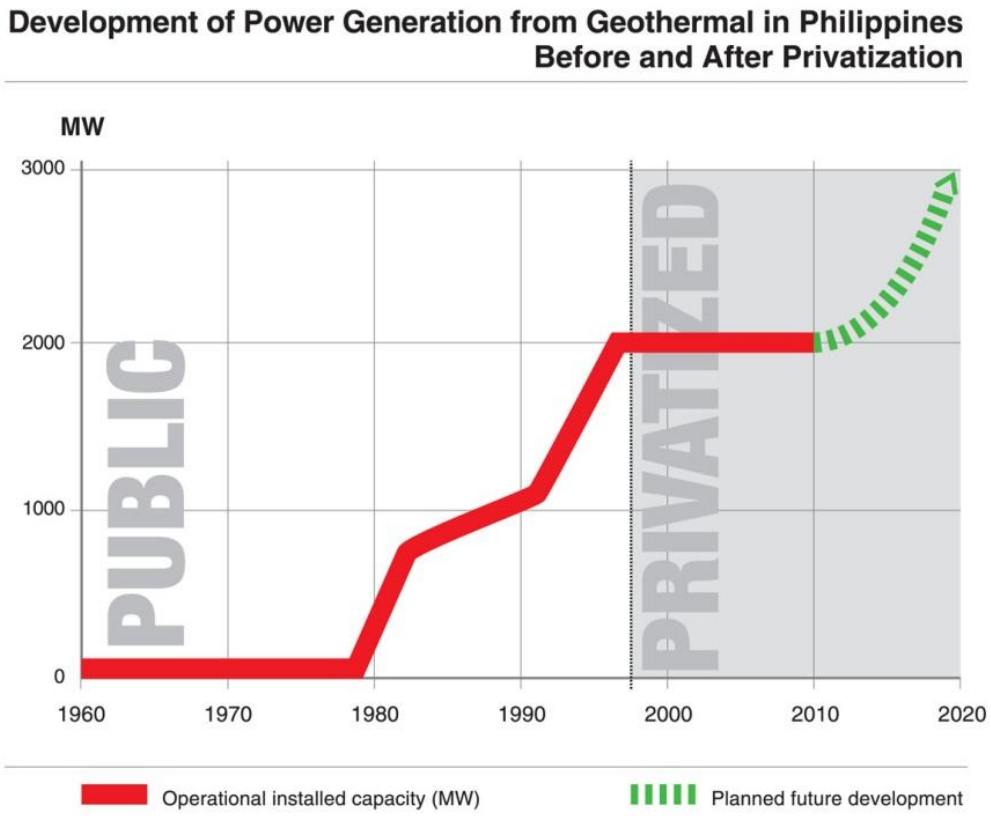
# Installed capacity and gross power generation by fuel source



# Philippines geothermal build-up

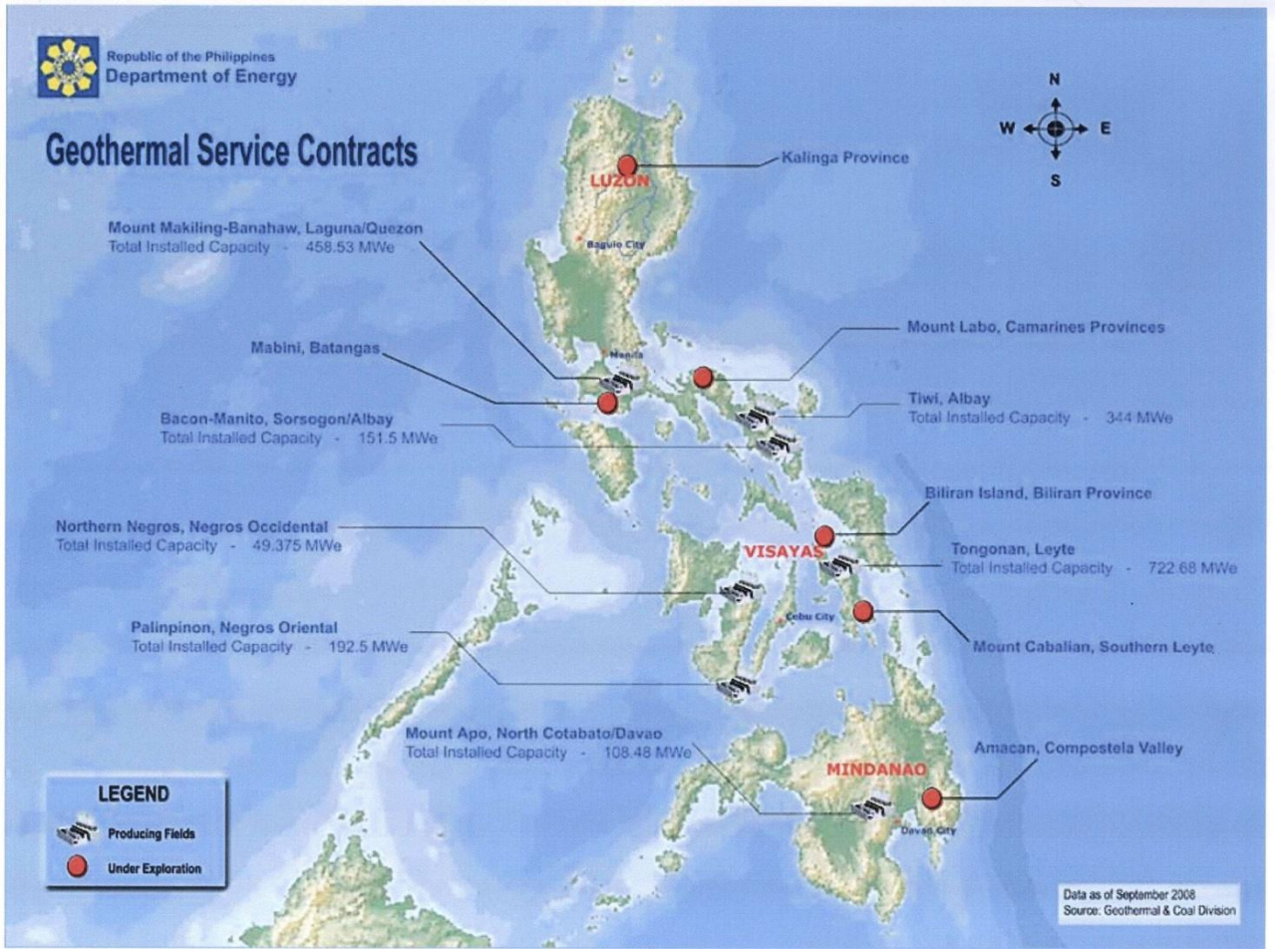
- 1967: Geothermal Law passed
- 1969: Steam from geothermal well at Tiwi drives a 2.5 kW turbo-generator
- 1979: Tiwi (110 MW) commissioned
- 1983-84: Leyte and S.-Negros, both 112 MW
- Until 1990 other public projects up to 1,000 MW
- Next step 1993 to 1998 added 1,000 MW
- Full privatization of power sector in 1998
- Since then 49 MW

# Philippines privatize GPP's and establish new legal and regulatory framework




- Data source: doe.gov.ph

# Existing and planned geothermal power generation



# Incentives by Philippines' RE Act of 2008

- Subsidies for R&D
- Rural electrification cash incentive
- Fiscal incentives (VAT zero-rating, income tax holidays, tariff exemptions etc.), Financial Assistance Program
- Renewable Portfolio Standards
- Priority dispatch of RE, including geothermal
- Tax rebate and duty free import
- Zero % VAT on sale of power from RE
- Royalties 1.5% of gross income for geothermal
  Corporate tax rate fixed to 10% after the 7 years tax holiday period

Source: DoE, 2009

# Gaps, Challenges and GoP Initiatives to Promote Geothermal

- **Lack of awareness and interest** in investment opportunities → DOE's aggressive investment promotion campaigns. Public awareness campaigns
- **Environment and socio-cultural concerns** → Harmonize regulations on protected areas and ancestral lands
- **Technological constraints** (acidic fluids etc.)
- Lack of investment in **non-power applications** → multi-crop dryer projects (fruit & produce), promoting hot spring areas for possible spa resort development for Tourism and Health Care

Source: DoE Portal, doe.gov.ph

# And finally….

# Iceland

- 5 major geothermal power plants, total installed capacity 570 MW. Plants from 70's are 60 to 80 MW, newer plants 100 to 215 (max. 400) MW
- A "Kalina" binary power plant (2 MWe) in rural area on 124°C with18 km pipiline to wells
- Geothermal provides 25% of the total installed capacity of 2,500 MW, the rest is hydro power
- Geothermal provides heating and hot water to 90% of all buildings and industries

# Electricity Generation from Geothermal Source: NEA.is

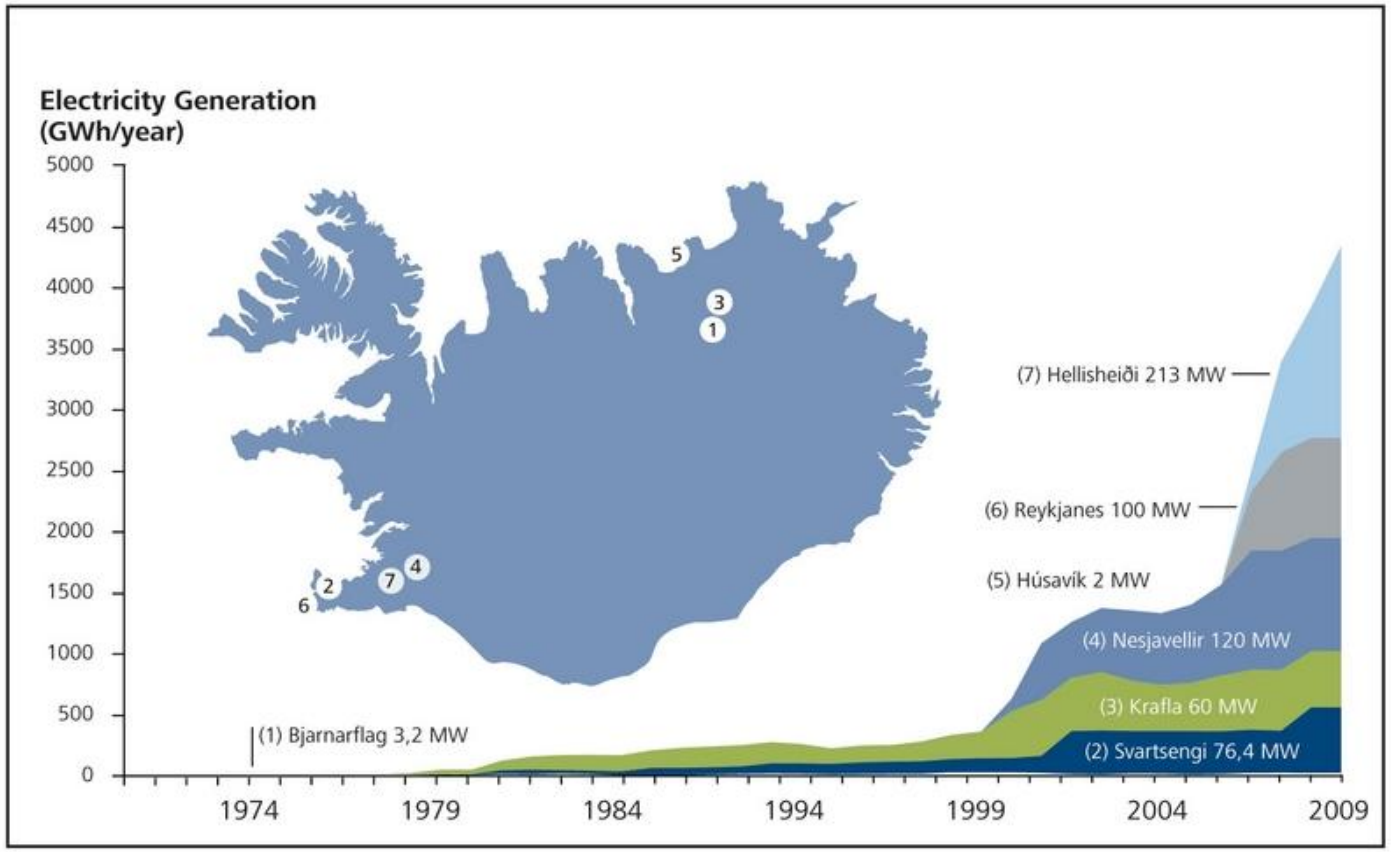



*Fig. 9. Generation of electricity using geothermal energy 1969–2009.*

# Iceland

- In 1960, Iceland decided to develop geothermal for heating and power generation, but project companies and banks could not take the risk of failures in exploration and drillings
- The GoI implemented “The National Energy Fund”, which insured drillings with a 80% refund
- Many failures and GoI had to replenish the fund often
- Later, with more experience and fewer failures, the fund could also support exploratory activities
- The NEF is the key to Iceland’s success in geothermal

# Key Answers: What can be learned from others?

- Developing geothermal is not fast and easy. Important to get funding for the first project phases
- When a geothermal resource is confirmed and proven, projects risks decrease
- Then, geothermal **power plant projects** should be bankable for both public and private sector: risk level / proven technology /pay-back time
- At least 5 options that can sometimes be combined…..

# Summary of the options

1. Risks mostly assumed by Government; a **public fund** mitigates the exploration and drilling risk of all geothermal drillings, thereby leaving project developers with only a minimal risk
2. Steam field development is done by a separate **GDC**. Fields then tendered out to private or public sector for further development
3. **Build up capacity** in exploration and drilling (KenGen now finances new projects through its government and several development banks and bilateral donors)

# More options

4. Public development and assuming all risks, involve the **private sector as EPC contractor**, delivering turnkey equipment tobe publically owned and operated
5. Focus on letting the **private sector** do the job from exploration to operation. This implies that the country should offer a convincing package of incentives and subsidies, even refunding R&D costs, in order to attract  private sector investors

- Whatever combination is chosen, an important factor for success is the **determination** of the Government!

Questions?

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# THANK YOU FOR YOUR ATTENTION