Proposed USAID Geothermal Resource Assessment in Pakistan

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January 10, 2018

Mud Volcanoes & Geothermal Fluids in Makran Coastal Area, Baluchistan Province, Pakistan

Source: Energy Foundation of Pakistan

Who/ What is USAID

- USAID is the primary foreign assistance arm of the US Government
- USAID works along with US State Department developing/ implementing programs of technical and financial assistance to US allies supporting economic growth and development
- USAID foreign aid assistance to its partner countries typically consists of a combination of TA/ capacity building, some construction, and/or government-to-government grants
- Increasingly, USAID assistance seeks to leverage increased private investment and opportunities -- if possible -- for US business *(using very limited budgets)*

USAID and Pakistan Energy

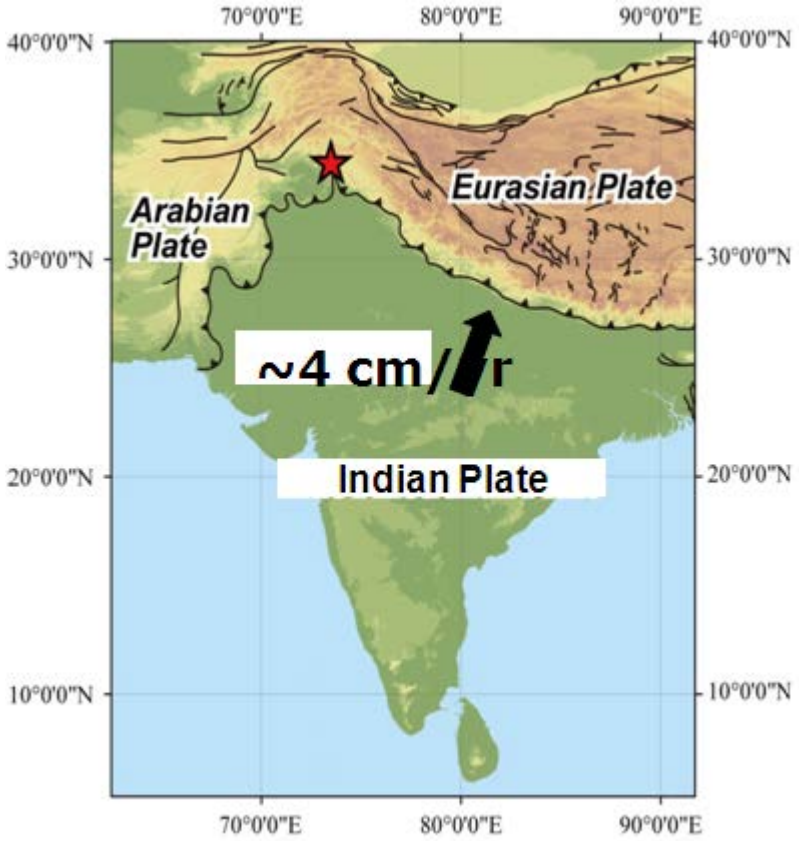
- **Since 2009, the US Government Has Committed Close to $1 Billion to Support Pakistan's Electricity Sector:**
  - Pakistan has been a key strategic partner to US efforts in South Asia
- **USAID Assistance Has Focused on:**
  - Reducing losses and improving collections, profitability, and performance of Pakistan's nine distribution companies
  - Funding strategic transmission lines connecting $1.2 billion, 680MW of private wind projects to the grid
  - Improving energy sector policy and regulatory governance
  - Constructing and/or retrofitting select thermal and hydro-electic plants
- **USAID Support Has:**
  - Added about 2,800 megawatts (MW) to the Pakistan national grid
  - Increased distribution company revenues by $460 million
  - Improved electricity service to over 38 million Pakistanis
  - Supported construction/ negotiation of Pakistan's 1st $ LNG imports

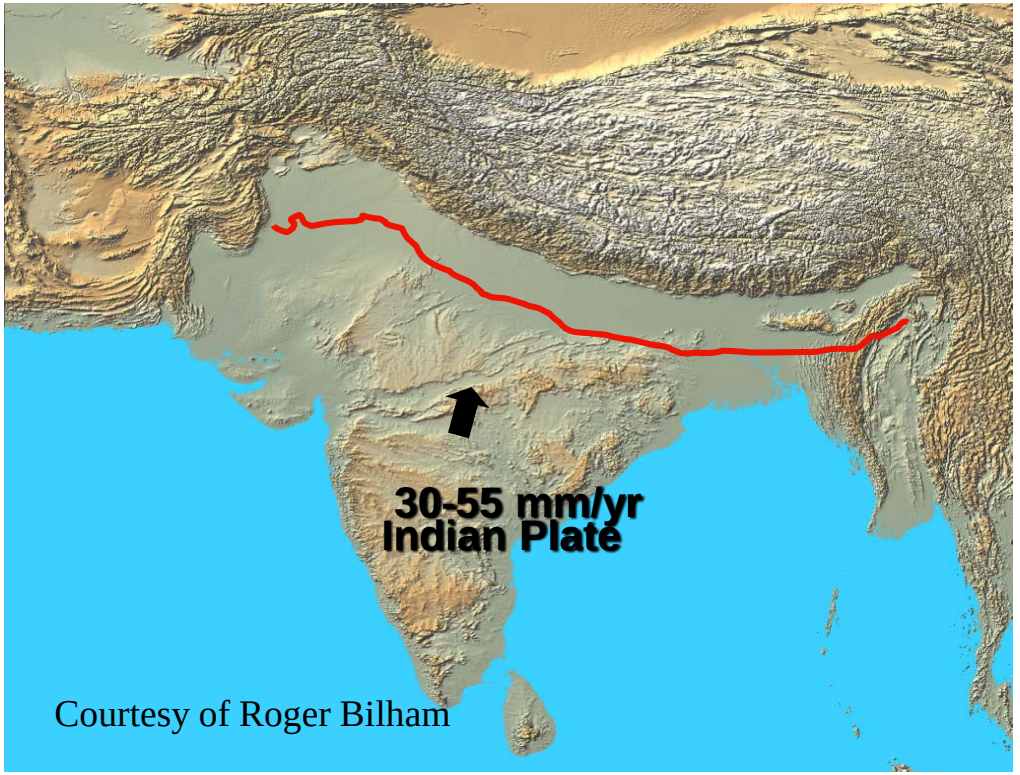
Direction of Future USAID Energy Assistance to Pakistan

Going Forward, We Plan to Focus More Heavily on Increasing/ Accelerating Private Investment in Clean Energy by:

- **Strengthening Government of Pakistan (GoP)** governance, policy, and investment enabling environment
- **Providing Technical and Capacity Building Assistance** to GoP agencies/ sub-units responsible for negotiating/ closing private sector deals
- **Providing Select Government Grants to Leverage Private Projects**
  - E.g. NTDC upgrades of transmission lines connecting wind, hydro, and solar generation to the national grid
- **Strengthening Distribution and Transmission Systems**
- **Supporting Grid and Off-Grid Private Business Opportunities**
  - Direct Business-to-Business Sales
  - Renewable Energy Zones **AND**
  - **Geothermal Energy Development**

Why Might Pakistan Have Geothermal Potential?





The seismic boundary of Pakistan has been formed by the interaction of the Arabian, Indian and Eurasian Plates.

Source: Javed Ahmed, Energy Foundation

WHERE ARE PAKISTAN'S GEOTHERMAL ENERGY RESOURCES?

GILGIT BALTISTAN PROVINCE (Northern Himalayan Valleys)
- GEOTHERMAL SPRINGS & GEYSERS & FUMERSOLES

AZAD KASHMIR
- GEOTHERMAL SPRINGS

KHYBER PAKHTUN KHAW (KPK) PROVINCE
- CHITRAL VALLEY GEOTHERMAL SPRINGS
- POTOHAR – KOHAT GEOTHERMAL BASIN

PUNJAB PROVINCE
- POTOHAR GEOTHERMAL BASIN
- CO-PRODUCED GEOTHERMAL WATERS IN OIL & GAS FIELDS

SINDH PROVINCE
- BADIN – SANGHAR RIFT BASIN
- UPPER SINDH GEOTHERMAL BASIN
- CO-PRODUCED GEOTHERMAL FLUIDS IN OIL & GAS FIELDS

BALOCHISTAN PROVINCE
- CHAGAI VOLCANIC ARC MAGMATIC SOURCES
- PISHIN BASIN GEOTHERMAL SPRINGS
- MAKRAN COASTAL AREA GEOTHERMAL SPRINGS & MUD VOLCANOES

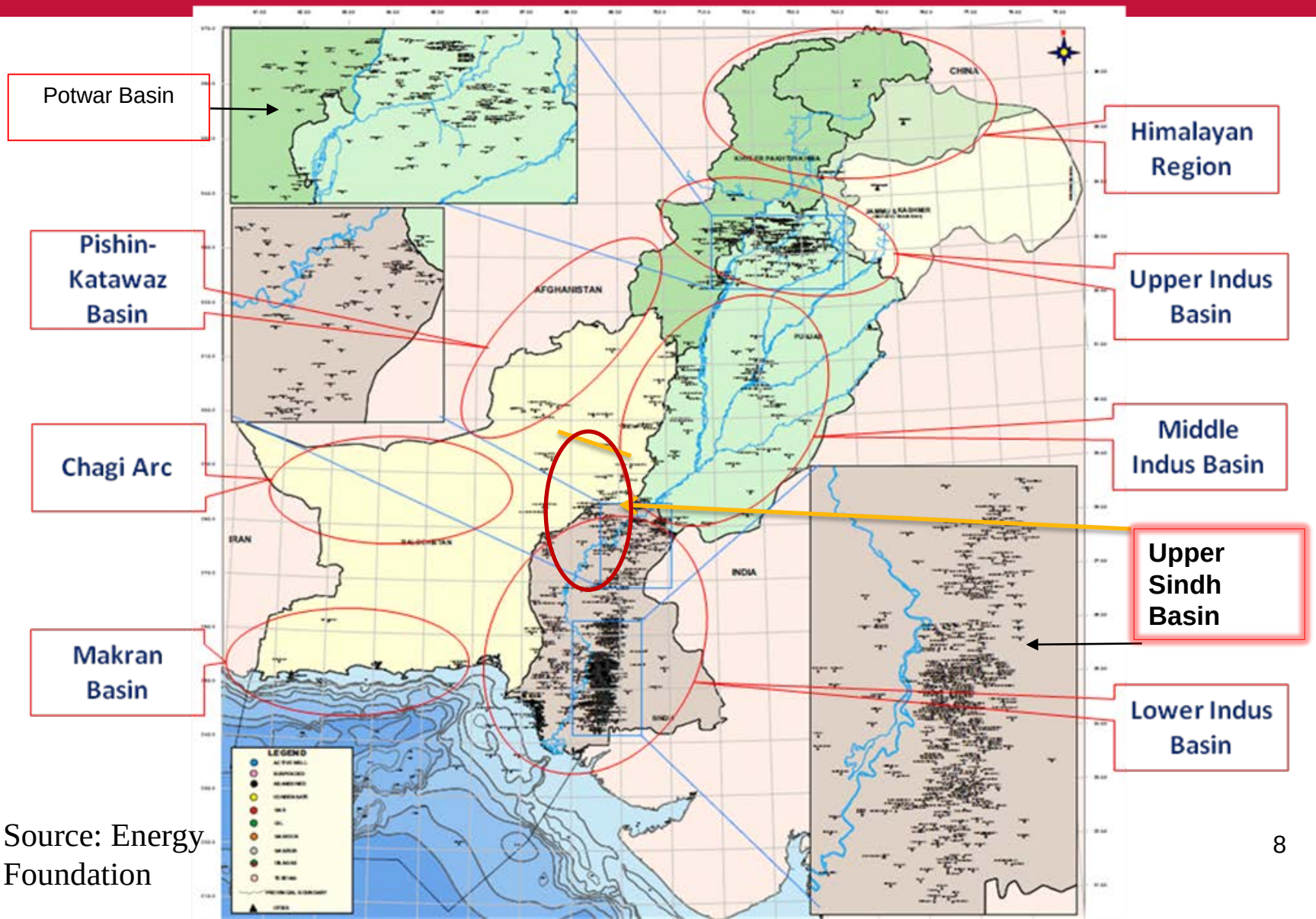
SHALLOW GEOTHERMAL AVAILABLE FOR HEAT PUMPS THROUGHOUT PAKISTAN

Source: Javed Ahmad, Energy Foundation

Oil and Gas Exploration and Development Wells

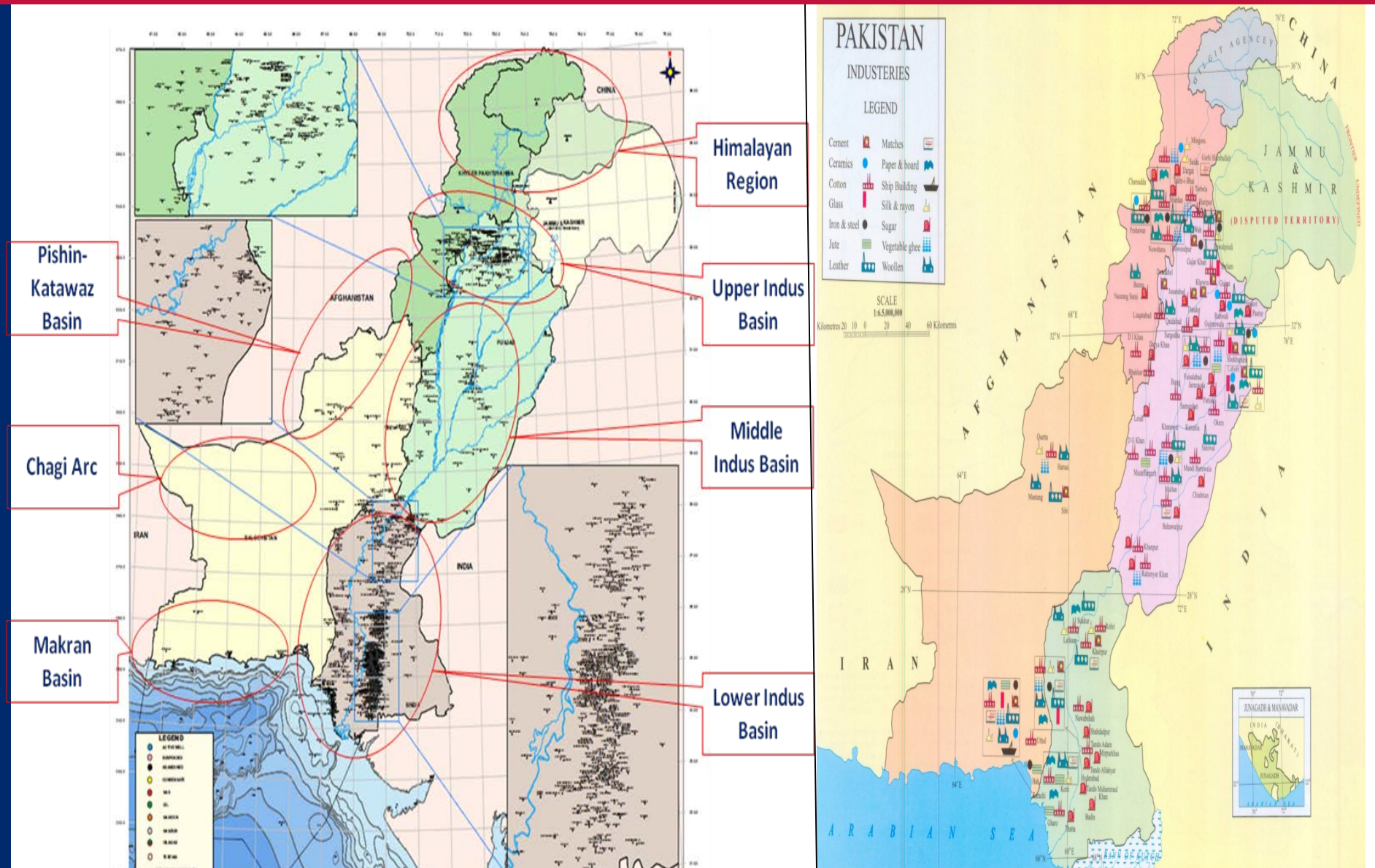
➢Exploratory Wells	850
➢Development wells	1145
➢Abandoned wells	600
➢Wells Available for Geothermal Energy Development	300

PAKISTAN'S GEOTHERMAL ENERGY ZONES AND LOCATION OF DRILLED AND ABANDONED O&G WELLS



Source: Energy Foundation

Co-Location of Pakistan Industry and O&G Wells



Abandoned Oil Exploratory Well Near Islamabad Capital

Geothermal Water flowing with Artisan Pressure @ 5000 Barrel/ Day with + 100 °C Temp, since 1980 from sedimentary Acquire at 1500 Meter Depth.
Location 33 04 ‘ 44 N 72 56’ 50’E

Source: Energy Foundation

LOWER INDUS BASIN SINDH PROVINCE PAKISTAN
BADIN SANGHAR GEOTHERMAL RIFT BASIN
Temperature in Drill Wells

Site	Depth	Temperature C°	Temperature F°	Well Status
1	3877	**151**	**304**	P/A
2	3651	**158**	**316**	P/A
3	3598	**153**	**307**	P/A
4	3350	**161**	**321**	P/A
5	3420	**151**	**303**	P/A
6	4034	**164**	**327**	P/A

LOWER INDUS BASIN SINDH PROVINCE PAKISTAN
UPPER SINDH GEOTHERMAL BASIN
Temperature in Drill Holes/ Hot water

Site	Depth	Temperature C°	Temperature F°	Well Status
1	141	**176**	**348**	GAS
2	3400	**132**	**270**	P/A
3	3700	**143**	**290**	CONDENSATE
4	3700	**146**	**296**	GAS
5	3800	**137**	**280**	GAS
6	3800	**149**	**300**	P/A
7	3800	**139**	**280**	CONDENSATE
8	3800	**139**	**280**	GAS
9	1448	**90**	**195**	GAS
10	2700	**176**	**<350**	GAS
11	`2700	**168**	**335**	GAS

(Note: The names of the sites are not being identified to advance further studies
Source: Javed Ahmad, Energy Foundation.

UPPER INDUS SEDIMENTARY BASIN: PUNJAB & KPK PROVINCES, PAKISTAN, POTWAR GEOTHERMAL BASIN

Temperature in Drill Wells

Site	Depth (m)	Temperature C°	Temperature F°	Well Status
1	5730	**160**	**320**	
2	5840	**139**	**282**	P/A
3	4814	**125**	**257**	P/A
4	4223	**119**	**246**	P/A
5	3711	**99**	**202**	Hot Water Flowing
6	4940	**136**	**277**	P/A
7	4814	**125**	**257**	P/A
8	4900	**137**	**279**	P/A
9	4739	**130**	**266**	P/A
10	4020	**101**	**213**	P/A

MIDDLE INDUS BASIN PUNJAB (South) PROVINCE

Temperature in Drill Wells

Site	Depth	Temperature C°	Temperature F°	Well Status
1	3631	**112**	**233**	P/A
2	3000	**101**	**214**	P/A
3	3682	**113**	**236**	P/A
4	2226	**105**	**221**	P/A
5	3601	**116**	**240**	GAS
6	4406	**125**	**257**	P/A
7	4798	**137**	**279**	P/A
8	3034	**127**	**260**	P/A

(P/A) Drill Holes Plugged & Abandoned

Source: Javed Ahmed, Energy Foundation Pakistan.

Scope of Work for Pakistan Geothermal Resource Assessment

1. **Identify and Review Available Geothermal Data --** from existing, abandoned, and capped oil and gas wells, volcanism, geothermal outcroppings along faults, and geothermal spring resources.

2. **Conduct Initial Technical Review of Potential Opportunities in Three Target Markets:**
   - Grid-scale geothermal production
   - Geothermal co-production from O&G Wells
   - Potential Direct Use geothermal opportunities

3. **Develop Short- and Medium-term Development Strategy for Subsequent Development**
   - If Step #2 is encouraging, initially quantify potentials of opportunities, and develop priorities and strategy for further study and development
   - If the Step 2 indicates very limited potential, then cease work

Scope of Work for Pakistan Geothermal Resource Assessment (2)

4. **Further Analysis and Investigation of Select High-Value Short- and Medium-term Commercial Market Opportunities**
   - Estimate potentials of high-value target markets
   - Further identify and analyze **specific** priority geothermal fields and wells
   - Evaluate commercial opportunities and markets
     - Co-locate industrial, commercial, and agricultural locations with specific geothermal sites
     - Identify potential business-to-business applications

5. **Review Legal and Regulatory Framework/ Barriers to Geothermal Development**

6. **Review Commercial Issues Associated with Geothermal Development**

Geothermal fumaroles, Geysers Hot water & Steam Springs with more than 140 ^{0}C temperature, flowing year-round in the Northern Himalayan Valleys, Pakistan

Source: Energy Foundation

Thank You!

Questions?

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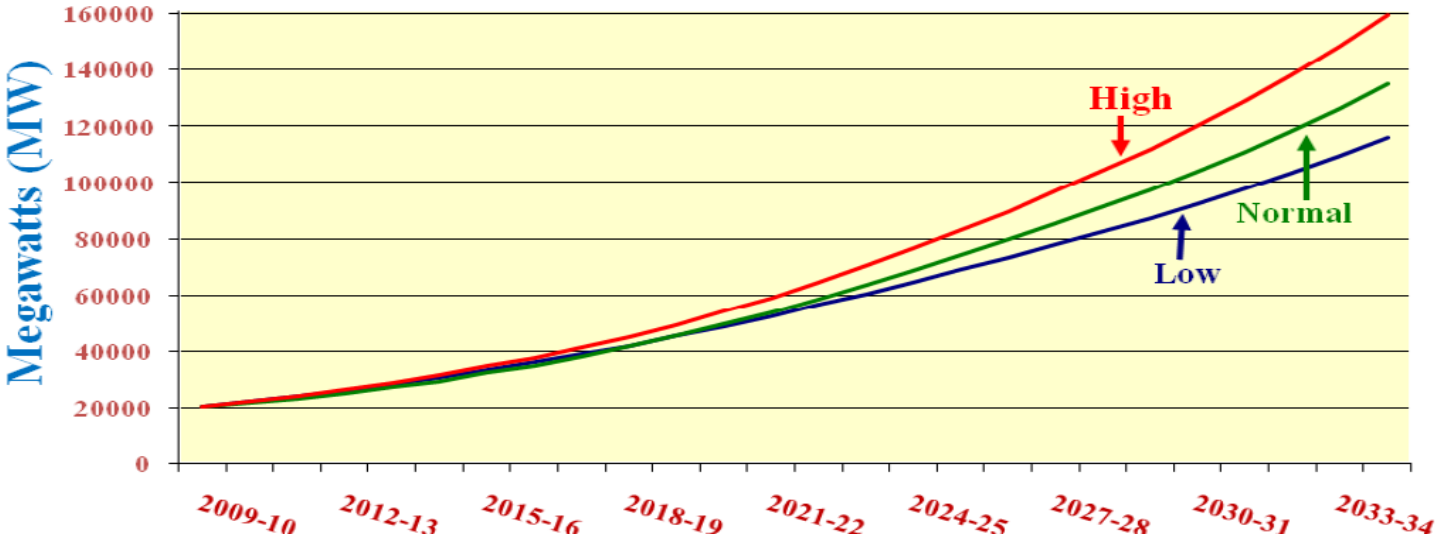
Pakistan's Current Energy Crisis: A Business Opportunity?

- Power load shedding (6-10 hours) currently is biggest economic issue for Pakistan
- Prime Minister Sharif set solving Pakistan's energy problems as the nation's number one priority, essential to improving its economy
- Pakistan's Energy fuel mix is inappropriate and not sustainable
- Per Capita power consumption is expected to increase from 800 to 2,538 kWh/yr by 2035, requiring the installation of over 100,000 MW of new generation capacity.
  - In comparison, Malaysia per capita use is currently 3,724 kWh/yr



Pakistan: An Attractive Market for Private Investment

- **GoP Has Significant History with Independent Power Producers (IPPs)**
  - Nearly 50% of installed Pakistan generation owned by IPPs
  - Investment framework and bankable security agreements designed 20 years ago, observe international standards, and are continually refined

- **Private IPP Projects Get Done in Pakistan**
  - Over 800 MW of privately-owned, wind, hydro, and solar energy projects reached financial closure over the last 2 years
  - LOIs signed for an additional 2,000 MW of wind

- **Sharif/ Abassi Government Is Very Supportive of Private Investment**
  - Also, GoP receives major support from MFIs and bi-lateral donors (e.g. USAID)

- **Pakistan Offers Sovereign Guarantees On Payments**
  - *GoP has never defaulted on NTDC/DISCO payments to IPP* (occasional delay)
  - *One of few remaining countries in world offering sovereign guarantees*

Attractive Features of Pakistan IPP Market

- **One Stop IPP Development Window** (thru AEDB or PPIB)
  - Standardized processes and guidelines for IPP developers

- **Deal Terms**
  - GOP Sovereign Guarantee on PPA purchase obligations
  - Guaranteed 17-20% IRR, tariff indexation, and equity repatriation
  - Bankable, standardized, internationally-accepted security agreements (PPA, IA, EPC, FSA, etc.)
  - Protection against political risk & change in law
  - Tax free regime (no corporate income, sales, withholding, customs, dividend taxes)
  - Connection to the Grid is Responsibility of Purchaser

- **Guaranteed Repatriation of Equity and Shareholder Dividends**

- **Guaranteed Remittance of Pakistani Rupees into USD**

Attractive IPP Framework (3)

Attractive Renewable Energy-specific Investment Incentives:

- GoP provides sovereign guarantee on electricity purchase
- GoP guarantees return on investment between 17% to 20% (IRR)
- Front-end loaded, tariff regimes for power projects
- Net metering and banking of electricity allowed

Pakistan Local Attractions

- Karachi -- a growing financial market with energy deal experience
- Available strong, local, IPP partners (e.g. HUBCO, Sapphire, and numerous Pakistan industrial groups)
- Growing local banks with clean energy lending experience for local finance

Availability of Strong Local Partners to Offshore Investors

- Experienced in Hands-on Country Political Risk Management
- Possess Regulatory Know-how
- Increase Ability to Attract Quality HR in Pakistan
- Experienced in Bidding, Tariff and Security Package Negotiations, and History With Various GoP Decision-makers

On the Other Hand, There are Risks.... But With Viable Solutions

- **Domestic Security Concerns** -- Both Perceived and Real
  - Localized security risks
  - GOP aggressively and successfully cracking down on terrorism
  - Highlights the value/need for experienced local Pakistani partners
  - IPP projects have been successfully operating for 20 years
- **Risks Presented by GoP Circular Debt**
  - Pakistan's successful adherence to terms of IMF Standby Loan
  - Strong donor pressure/ support to Pakistan's energy sector
- **Lack of In-Depth GOP Institutional Capacity**
  - "Lack of capacity", nevertheless GoP managed to financially close over 800 MW of IPPs in 2014
  - Strong donor support in improving capacity