

Report No: ACS2258 v5

**ISLAMIC REPUBLIC OF PAKISTAN**

**BALUCHISTAN NEEDS ASSESSMENT**

**DEVELOPMENT ISSUES AND PROSPECTS**

***PART II – ALTERNATIVE ENERGY SOURCES***

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**JANUARY 2013**





# Balochistan: Development Issues and Prospects

## Energy Sector

### Key Issues, Challenges, and Opportunities

#### Background

1. The level of commercial energy<sup>1</sup> use in Balochistan is lower than in the country as a whole. In 2010-11, it accounted for about 2.2% of the nation-wide use of commercial energy.
  - a. The province's share in Pakistan's consumption of petroleum products was about 2.8%, for natural gas it was 1.5%, and for electricity 5.25%. Since Balochistan has about 5% of Pakistan's population, its share of electricity use is slightly above the national average, but that of gas and petroleum products consumption is substantially lower.
  - b. Per capita electricity consumption in Balochistan was 446 kilowatt hours (kWh) in FY11; the national average is 426 kWh. The corresponding numbers for natural gas are 126 Tons of Oil Equivalent (TOE) in Balochistan, and 146 TOE in the country as a whole.

| <b>Table A</b>  |              |                 |                   |                 |                    |                  |                      |                  |                            |
|---|--------------|-----------------|-------------------|-----------------|--------------------|------------------|----------------------|------------------|----------------------------|
| <b>Final Energy Consumption by Sector 2010-11 (Excluding Power &amp; Fertilizer Feed stock)</b> |              |                 |                   |                 |                    |                  |                      |                  |                            |
|   |              | <i>Domestic</i> | <i>Commercial</i> | <i>Industry</i> | <i>Agriculture</i> | <i>Transport</i> | <i>Others /Gov't</i> | <i>Total</i>     | <i>Balochistan's Share</i> |
| <b><u>Balochistan</u></b>   |              |                 |                   |                 |                    |                  |                      |                  |                            |
| Oil   | <i>bbtu</i>  | 50              | 0                 | 1,093           | 5                  | 11,628           | 184                  | 12,961           | 2.75%                      |
| Gas   | <i>mmcf</i>  | 9,019           | 649               | 197             | 0                  | 827              | 0                    | 10,693           | 1.49%                      |
| LPG   | <i>tonne</i> | 10              | 5                 | 1               | 0                  | 0                | 0                    | 16               | 3.44%                      |
| Electricity   | <i>GWh</i>   | 464             | 94                | 114             | 3,265              | 0                | 111                  | 4,048            | 5.25%                      |
| Coal  | <i>tonne</i> | 0               | 0                 | 0               | 0                  | 0                | 0                    | 0                |                            |
| <b>Total</b>  |              | <b>9,544</b>    | <b>748</b>        | <b>1,406</b>    | <b>3,270</b>       | <b>12,456</b>    | <b>295</b>           | <b>27,718</b>    | 2.18%                      |
| <b><u>Pakistan</u></b>  |              |                 |                   |                 |                    |                  |                      |                  |                            |
|   |              |                 |                   |                 |                    |                  |                      | <i>Total</i>     |                            |
| Oil   | <i>bbtu</i>  | 3,693           | 0                 | 56,827          | 1,772              | 392,711          | 16,440               | 471,442          |                            |
| Gas   | <i>mmcf</i>  | 232,325         | 36,479            | 335,499         | 0                  | 113,095          | 0                    | 717,398          |                            |
| LPG   | <i>tonne</i> | 259             | 182               | 25              | 0                  | 0                | 0                    | 465              |                            |
| Electricity   | <i>GWh</i>   | 35,885          | 5,782             | 21,207          | 8,971              | 1                | 5,253                | 77,099           |                            |
| Coal  | <i>tonne</i> | 0               | 0                 | 7,558           | 0                  | 0                | 0                    | 7,558            |                            |
| <b>Total</b>  |              | <b>272,161</b>  | <b>42,443</b>     | <b>421,115</b>  | <b>10,743</b>      | <b>505,806</b>   | <b>21,693</b>        | <b>1,273,962</b> |                            |

#### Issues and challenges

2. However, the pattern of consumption of these fuels is lop-sided. Agriculture tube wells account for more than 75% of electricity consumption, while about 90% of gas use in

<sup>1</sup> Commercial Fuels include Electricity, Natural Gas, Petroleum products and Coal.

Balochistan is for power generation. These patterns represent significant distortions, and present a number of issues, for commercial energy use in the province.

- a. Since the bulk of natural gas and electricity use in Balochistan is in these two activities, the level of commercial energy use in the other sectors of the economy is very low – both in absolute terms and relative to the national average (Table B).

| <b>Table B</b>  |         |                       |                       |          |
|---|---------|-----------------------|-----------------------|----------|
| <b>Per Capita Electricity Consumption during 2010-11, kWh</b> |         |                       |                       |          |
|   | Overall | Excluding Agriculture | Domestic & Commercial | Industry |
| Balochistan   | 446     | 86                    | 61                    | 13       |
| Country-wide  | 426     | 376                   | 230                   | 117      |
| Ratio   | 1.05    | 0.23                  | 0.27                  | 0.11     |
| <b>Per Capita Gas Consumption during 2009-10, TOE</b>         |         |                       |                       |          |
|   | Overall | Excluding Power       | Domestic & Commercial |          |
| Balochistan   | 126     | 28                    | 25                    |          |
| Total for the Country   | 147     | 111                   | 35                    |          |
| Ratio   | 0.86    | 0.25                  | 0.72                  |          |

- b. Excluding the quantum of electricity and gas used for tube wells and power generation, the per capita consumption of these fuels in Balochistan is about one quarter of the national average. The situation is even more adverse for electricity use by industry in the province – where the per capita level in Balochistan is only 11% of the national average.
- c. Electricity consumption per tube wells in Balochistan is disproportionately high. In FY11, the average consumption of electricity in Balochistan was more than 12,800 kWh per month – 4 times the national average, more than 6 times the average consumption in Punjab, and nearly 16 times the average consumption per tube well in KPK. While the water table in Balochistan is much lower than other provinces, this factor does not fully explain the very high rate of power consumption in Balochistan. It is reported that the extensive pumping of groundwater in Balochistan is depleting the sub-surface water table at an alarming rate.
- d. Pricing policies adopted for more than a decade provide a more cogent explanation for this distortion. Till recently, the consumers paid a fixed amount (Rs 4,000 per month) as their electricity bill; the remaining amount was paid by the Federal and Provincial Governments and Quetta Electric Supply Company (QESCO) in the ratio 40%: 30% and 30%. The Governments and QESCO were therefore incurring large expenditures for subsidizing power consumption by tube well owners. However, the tube well owners had no incentive to conserve power. This has led to pumping of groundwater at a rate which is excessive, and therefore unsustainable.
- e. While this policy was discontinued a few years back (and consumers, on paper at least, now have to pay the full cost of electricity they consume), the experience of QESCO in recovering the full bill from consumers is far from satisfactory.

## Resources and Potential

3. Balochistan currently accounts for about 20% of the country’s total gas production. While the share has fallen over time – from well above 50% in the 1980s to 25% by the middle of the last decade – it is still substantially lower than the province’s share in gas consumption. Despite the decline in Balochistan’s share of gas produced in Pakistan, the province still accounts for nearly 35% of Pakistan’s proven and recoverable gas reserves.

4. Much of the provincial acreage (which according to industry sources holds a high potential for oil and gas discoveries) has not yet been awarded for exploration. Substantial additions to the province’s (and the country’s) oil and gas reserves could therefore be achieved, if the factors – notably the security conditions – which are constraining exploration activity in the province can be addressed.

| Table C: Natural Gas Production |           |           |           |           |           |           | mmcf      |
|---------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|                                 | 2004-05   | 2005-06   | 2006-07   | 2007-08   | 2008-09   | 2009-10   | 2010-11   |
| Balochistan                     | 336,493   | 330,032   | 318,188   | 319,578   | 305,359   | 288,393   | 280,072   |
| T. Country                      | 1,344,953 | 1,400,026 | 1,413,581 | 1,454,194 | 1,460,679 | 1,482,847 | 1,471,591 |
|                                 | 25%       | 24%       | 23%       | 22%       | 21%       | 19%       | 19%       |

5. The gas resources of the province, specifically of the Sui gas field, also present a significant opportunity for resource mobilization for the Government. The producer price of gas from this field is currently notified as “50% of the applicable zone 3 price”. The price of gas produced from Sui during January-June 2011 was around Rs 150 per Million British Thermal Units (MMBTU) – the corresponding price for other concessions/producing fields in Zone III would, therefore, be around Rs 300 per MMBTU. All taxes, royalty payments, etc are determined on the basis of the notified producer price. If the producer price for gas from the Sui field was determined and notified on the same basis as for all other fields in Zone 3 (and the producer price for this field were to double from its current level) it would mean substantial additional revenues for the owners of the field; taxes, royalties, and other charges which are levied on the producer price, would also be proportionately higher.<sup>2</sup>

6. The installed power generation capacity in Balochistan is about 650 MW. Two combined-cycle power plants were installed by the private sector under the 1994 Private Power Policy in Balochistan – Uch Power Project (585 MW) in Dera Bugti, and Habibullah Coastal (50 MW) in Quetta. The former receives gas from Uch gas field through a dedicated pipeline, while the latter is supplied from Sui Southern Gas Company’s network. The Uch field’s reserves are larger than what is required by the power plant; the government has therefore sanctioned, and the owners are constructing, a second power plant (Uch II) in the same area.

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<sup>2</sup> The Sui field produced about 196 Billion Cubic Feet of gas in FY11; if the producer price of this gas was Rs 150 per MMBTU higher than currently, it would imply additional revenues of Rs 29.4 billion to the company. Part of this surplus would accrue to the government as corporate income and other taxes.

However, it is recognized that an adjustment in the producer price for any gas field has implications for gas consumer prices also, since consumer prices are determined by adding gas transmission and distribution costs, and taxes, to the weighted average producer price of gas from all fields.

7. The renewable energy resource potential of Pakistan was assessed through a comprehensive study financed by USAID, in 2007.<sup>3</sup> This study found that three regions of the country have significant potential for developing wind energy resources. These included the Nokkundi region in the north-western corner and ridges in the Chagai area of Balochistan; large tracts in the Badin and Thatta areas of Sindh province; and the North Indus valley – including northern Punjab, Mardan and areas around Islamabad.

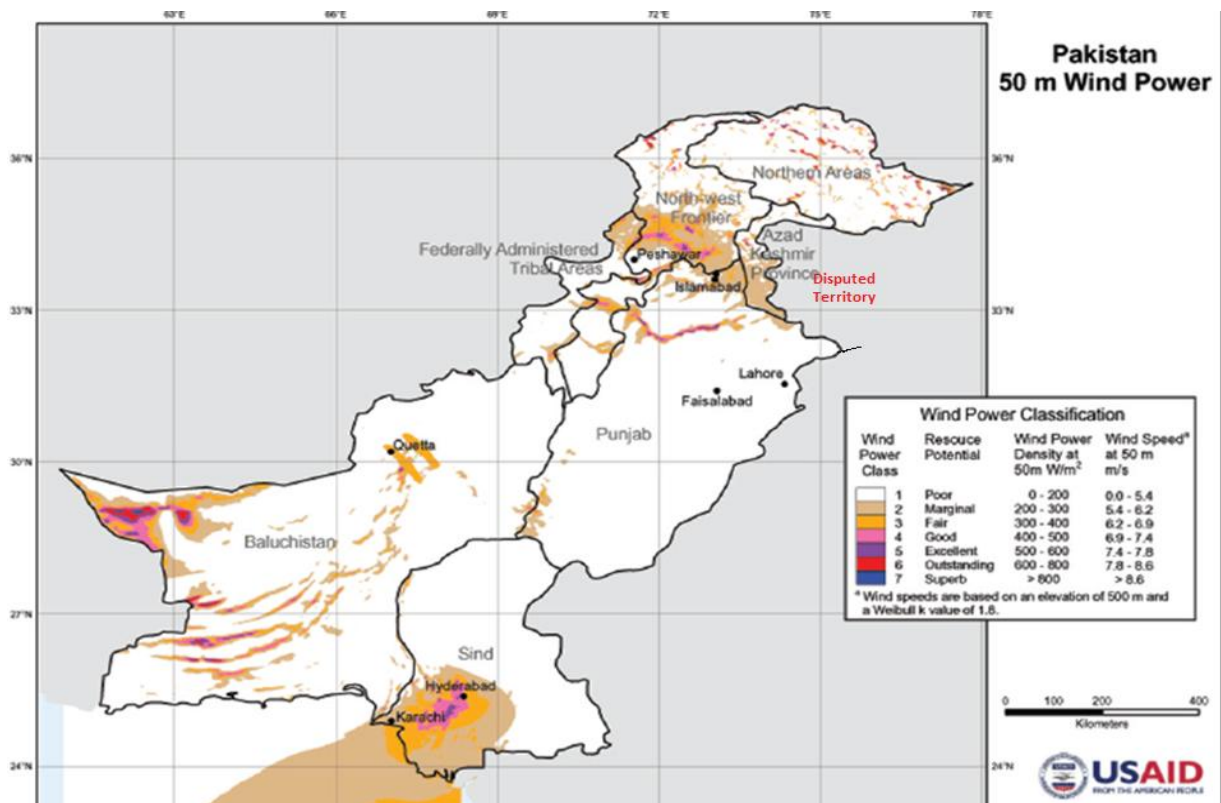
8. Balochistan's wind resource potential was estimated to be more than 20,000 MW,<sup>4</sup> the Nokkundi and Chagai area, and hills and ridges in Makran have a very high potential for developing the wind power resources. The development of these resources is, however, constrained by a number of factors:

- a. The estimates prepared by NREL were based on GIS/Satellite imagery. Subsequently, Alternate Energy Development Board (AEDB) has carried out tests to confirm the wind resource estimates (essentially, to document wind speeds, durations, etc, over a period of time) by installing wind monitoring masts. However, such monitoring stations/systems have been installed only in Sindh. The wind resource potential of Balochistan has to be verified through similar wind monitoring stations/masts. A PC-II for installing five such monitoring stations – at a cost of Rs 170 million – has been prepared and submitted to the Alternate Energy Development Board.
- b. Many of the areas that have a high or very high wind potential in Balochistan are not connected, or close, to the transmission grid. The province's demand for electricity is also scattered over very large geographic areas. Therefore, one consideration while preparing proposals for exploiting wind resources is how to transmit that power to the load centres.
- c. Developing the wind potential on a large scale will also require significant amounts of financial resources, since – like all other renewable energy technologies – wind power projects are also capital intensive. In view of the constrained fiscal situation of the federal and provincial governments, the private sector will need to be attracted for developing the province's wind resources.

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<sup>3</sup> Wind Resource Assessment for Afghanistan and Pakistan, National Renewable Energy Laboratory (NREL), Golden, Colorado, USA - 2007.

<sup>4</sup> To place this figure in context, Pakistan's total installed generation capacity in 2011 was about 22,000 MW. Estimates of (wind or other renewable) energy potential which are prepared through satellite imagery and other remote sensing methodologies need to be treated with caution, particularly since: (a) all areas where such potential is identified may not be accessible, feasible to develop, etc; and (b) such estimates only indicate the scale of the resource, which requires confirmation through ground level investigations and analysis.



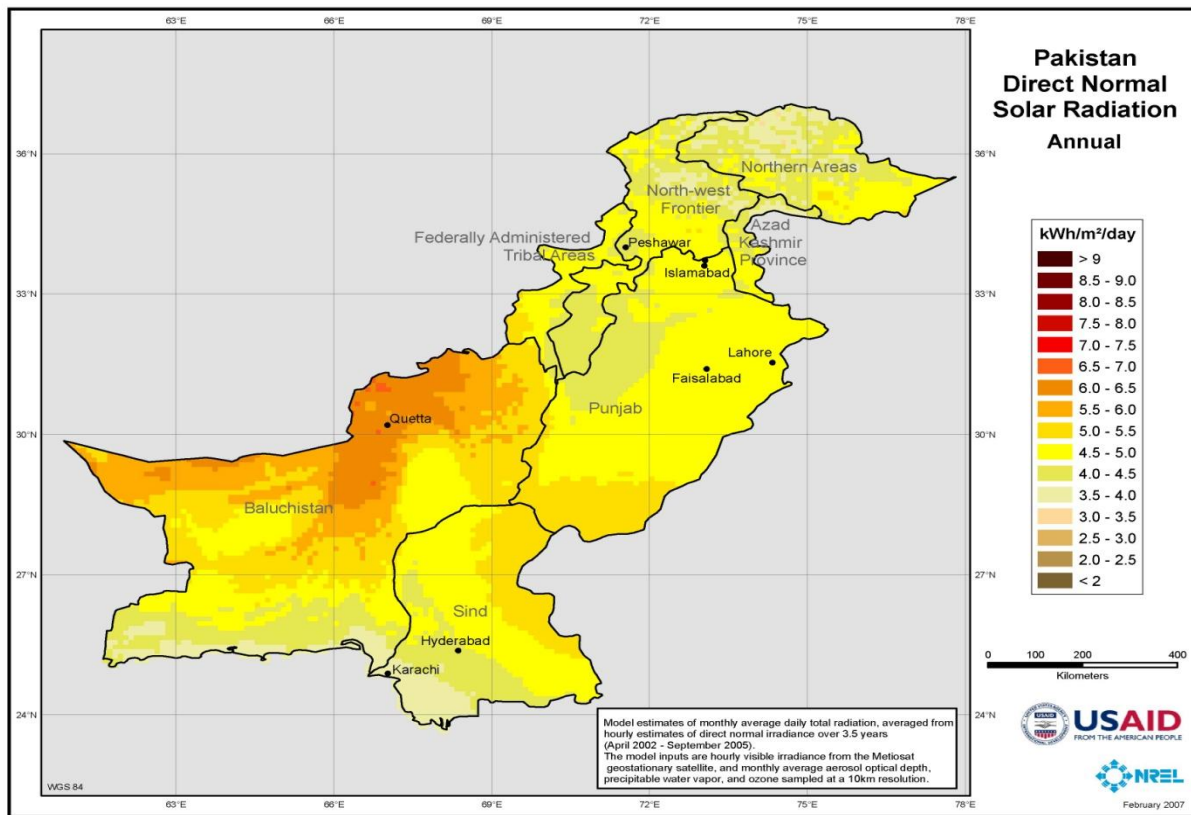
9. The same study<sup>5</sup> also estimated the national and province wise potential of solar energy. Again, the resource potential of Balochistan ranks very high, in fact the highest in the country. Around 40% of the land area of Balochistan receives direct solar insolation with an energy potential of more than 6 kWh per square meter per day, while the rest of the province receives direct solar radiation with an energy potential of 4.5 kWh per square meter per day. Simple extrapolation from these numbers yields a total power generation potential of as much as 1.2 million MW. However:

- a. These estimates of the solar energy potential of various regions of the country – including Balochistan – are based on GIS data and/or Satellite imagery. These (raw) estimates need to be verified through ground level investigations, before specific projects are prepared and/or implemented.
- b. Many of the areas of Balochistan are not connected, or close, to the transmission grid. The province’s demand for electricity is scattered over very large geographic areas. Therefore, one consideration while preparing projects to exploit Balochistan’s solar resources for power generation is how to transmit that power to load centres.
- c. Developing the solar potential on a large scale will also require significant amounts of financial resources, since – like all renewable energy technologies – solar power projects are also capital intensive. In view of the constrained fiscal situation of the federal and

<sup>5</sup> NREL 2007.



provincial governments, the private sector will need to be attracted for developing the province's solar resource potential.



10. Balochistan also has some coal and geo-thermal resources; in addition, the province could benefit from energy imports – including electricity and natural gas (where the Federal Government has already initiated specific programs and/or projects), and Liquefied Natural Gas (LNG).

- a. Balochistan has 55 million tons of measured coal reserves – about 1.6% of national coal reserves<sup>6</sup> (3450 million tonnes). Balochistan's coal reserves are sub-bituminous to bituminous, with heating values of 9700 BTU<sup>7</sup>/lb to 15500 BTU/lb. Annual coal production was 1.3 – 1.5 million tons during FYs10 and 11 – this is about 40% of nationwide coal production (3.5 million tons) during those years. Nearly half of Pakistan's coal consumption is in cement and other industries, and brick kilns account for about 30% of consumption. While the Provincial Government is keen to develop its coal resources for power generation, the quantum of reserves is not sufficient to support any large scale efforts; therefore, the Provincial Government wants to evaluate the potential for small scale projects (5-20 MW each), which could complement power supply from the grid for its cities and towns.

<sup>6</sup> Source: Energy Yearbook, 2010-11.

<sup>7</sup> British Thermal Unit.

- b. Some areas of Balochistan (e.g. Koh-i-Sultan in Chagai District) may also have geothermal energy.<sup>8</sup> No surveys have been carried out to discover and/or determine these resources, and the indications of geothermal energy were in fact a by-product of other mining activities in the area. While the geothermal energy can be developed for extending electricity to local areas, there does not appear to be much prospect for large scale development – partly because the areas where indications of geothermal energy have been found are very remote and thinly populated. A clarification on whether the federal or provincial governments are mandated to develop geothermal energy has to be provided before any exploration efforts are initiated. Presently, oil and gas exploration and development is coordinated by the Federal Government, while all other mining activities are regulated by the provinces; the existing legislation and rules/regulations do not refer to geothermal energy.
- c. The Government of Pakistan is working on a number of projects for energy imports, to supplement domestic supplies. These include plans to import: (i) natural gas from Iran and Central Asia; (ii) electricity from Iran and Central Asia; and (iii) LNG from international markets. Currently, Pakistan imports about 100 MW of power from Iran, in the Gwadar area. Projects under preparation include import of 1000 MW from Iran, and a similar quantum from Tajikistan and Kyrgyz Republic. Balochistan will be able to supplement its current energy supplies, through these import schemes.

### **Responding to the issues and challenges**

11. A strategy to address these challenges/constraints has to cover three dimensions – meeting the growing demand of households for cooking and space heating/cooling purposes, expanding electricity supplies over the short- to medium-term, and developing the province’s renewable energy potential on a long-term sustainable basis.

- a. The least cost option of meeting the demand by households for modern fuels (and also, to a degree, the demand for such fuels for commercial activities) would be to expand gas supply – since natural gas is currently the cheapest of all such fuels. The large distances involved in expanding the gas network (and the dispersed population) in Balochistan would, however, make such expansion an expensive proposition. The same is the case for expanding electricity networks. Since the use of LPG does not require transmission networks, the prospects for increasing the availability and use of LPG in Balochistan need to be explored.
- b. In the short- to medium term, the province’s endowment of renewable energy resources can be developed – specifically through off-grid and isolated networks – for enhancing electricity supply to remote villages and settlements. AEDB has initiated a Project for installing solar home systems. This Project was originally scheduled to cover in 100 villages in Sindh and 300 villages in Balochistan;<sup>9</sup> however, the solar home systems have

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<sup>8</sup> Source: Letter dated Feb 3, 2012 from Lake Resources, Australia, to Secretary, Department of Energy, Government of Balochistan.

<sup>9</sup> These projects are funded by the Government’s Rural Electrification Program and Parliamentary Program for Village Electrification.

been installed in Sindh only, and funds allocated for Balochistan have reportedly been re-programmed. The average cost of a solar home system under those programs ranges between US\$ 300 and US\$ 700, for 6-8 lights, one DC fan, and a mobile phone charger.

- c. Developing the province's renewable energy resources of Balochistan could also involve large scale power generation based on solar and wind energy. For such programs to be economically and financially viable, and to cover the cost of connection to the electricity grid, these would have to large scale projects – e.g. 1000 MW or more.

12. The key issues to be addressed, and the approaches and projects that the Government of Balochistan could pursue, in each of these areas are discussed in the following paragraphs.

13. **Expanding LPG supply:** About 500,000 tons of LPG was consumed in Pakistan in FY11; around 90% was produced by local refineries or gas fields, and the balance was imported. LPG is used for cooking and/or space heating largely by households, but also by commercial establishments. It is cheaper than kerosene (and gasoline) but generally costs more to use than firewood – therefore, firewood prices have to rise significantly before households consider switching to LPG. Other factors that influence the switch to LPG include:

- education – awareness of harmful health and environmental effects of using firewood;
- household income – cross county evidence indicates that household expenditures need to be above US\$ 350 per month before households can afford the switch; and
- up-front costs – US\$ 20-50 for LPG stoves, US\$ 20-40 for cylinder deposit fees, etc.

14. Many countries have subsidized LPG, even though worldwide evidence indicates that such subsidies are highly regressive. A few countries have also attempted to lower the up-front costs – by introducing smaller cylinder sizes, etc. However, safety issues have precluded wide-spread adoption of this practice.

15. The LPG market is well developed in Pakistan. The private sector is involved in the production, import, distribution and marketing of LPG. The Oil and Gas Regulatory Authority (OGRA) issues licences, and sets standards – for cylinder size/quality, safety etc – which are enforced through the provinces. Expanding LPG supplies in Balochistan would require the Provincial Government to work closely with OGRA, to ensure that it has (or acquires) adequate expertise and resources for enforcing the Rules and Standards. LPG prices are de-regulated, and vary seasonally – as demand expands significantly in winter. The Federal Government notifies the formula (based on an import parity price) for LPG producer prices, and OGRA is empowered to monitor retail prices – mainly to check collusive practices.

16. LPG pricing is deregulated, the market includes private companies and public sector entities, and domestic production is supplemented by imports during the high demand winter season. Since the market appears to be functioning efficiently, any government interventions – to accelerate LPG use in the province – need to be carefully designed. Specifically, attempts to reduce prices (which may be driven by justifiable concerns to reduce the cost of energy for the

poor) could create artificial distortions in the operation of the market; also, as mentioned above, worldwide evidence suggests that attempts to reduce LPG prices end up benefitting the rich much more than the poor.

17. ***Short and medium term projects:*** Balochistan’s renewable energy potential (both solar and wind) can be exploited for expanding electricity supply to small and medium sized consumers, and to remote areas that cannot be connected to the grid immediately. AEDB’s pilot project for installing solar home systems in 300 villages in Balochistan can be replicated on a larger scale. The key consideration is the quantum of resources which the Provincial Government can allocate for such projects. Assuming a cost of US\$ 700 per household (the upper limit of costs under the AEDB project) the cost of providing solar-based electricity to, e.g., 10,000 un-served households would be US\$ 7 million. Extending the grid to connect new and remote areas is estimated to cost around US\$ 900 per household, implying a capital cost of US 9 million for connecting the same number of un-served households. Therefore, electrification of remote areas through solar home systems can be a “least cost” alternative for enhancing the use of electricity. Some other issues that need to be kept in mind include:

- a. Consultation with NEPRA, to ensure that extending power supply through off-grid schemes does not conflict with the license issued by NEPRA to the Quetta Electric Supply Company (QESCO) – e.g. on the exclusivity of QESCO’s franchise area; and
- b. Ensuring that there is adequate capacity for the manufacture and/or supply of solar panels and other required equipment, and (in the contractor industry) to install and maintain such systems.

18. ***Long term prospects:*** Long term exploitation of Balochistan’s renewable energy potential could involve large scale generation projects, which would be connected to the national grid. If the verification of wind and solar potential of some areas of the province confirms that generation of e.g. more than 1000 MW is possible at any location, then connecting such sites to the grid (e.g. through 500 kV transmission lines) would be feasible.<sup>10</sup> The capital cost of such projects would, however, be very large (a 1000 MW generation project based on wind or solar energy may require investment of US\$ 1.5-2 billion or more). Consequently, the private sector will need to be involved, both for mobilizing financial resources from non-budgetary sources and for the technical and managerial expertise required for installing and operating projects of this magnitude.

19. Attracting the private sector for large scale generation projects in Balochistan will require:

- a. Developing and adopting a Policy Framework and Security Package – Implementation Agreement, Power Purchase/Sale Agreement etc – for private investment in the power sector in Balochistan; and

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<sup>10</sup> This may require an amendment to the existing policies for private investments in the power sector – under which the provinces are restricted to power generation projects of 50 MW or less; projects involving a larger capacity are, under that policy, implemented solely by the Federal Government.

- b. Ensuring adequate institutional capacity – to propagate the Policy, attract private investors, negotiate the Security Package Agreements, etc.

20. The Provincial Government could avoid duplicating such policies, capacity and expertise by utilizing the capacity available in the Federal Government – specifically in the Private Power and Infrastructure Board (PPIB), under the Ministry of Water and Power. PPIB has had a reasonably successful track record of mobilising private investment for power generation, under the 1994 (and subsequent) Private Power Policies. It has also developed the standard Security Package documents, and has the institutional expertise to negotiate the Security Package agreements with private sponsors. Government of Balochistan could therefore, consider assigning the responsibility to attract private investment in the province’s renewable energy sector to PPIB.

21. Further development of the other energy resources (i.e. coal, geothermal, imports) depends upon; (i) further investigations of the potential resource base(s); (ii) attracting investments for extraction – particularly for coal; and (iii) enhancing the Provincial Government’s capacities to oversee and regulate the development of such resources. Action Plans, including indicative financing requirements for each of these stages, have been prepared. Messrs Lake Resources has informed the provincial Government that a 3-5 year program (comprising remote sensing studies, field work, sampling and geophysical surveys, and drilling – estimated to cost as much as \$ 20-30 million) would be required for discovering, confirming and appraising the geothermal resources in the Koh-i-Sultan area.