ENERGY RESOURCES IN AFGHANISTAN AND MEASURES TO IMPROVE FOR SUSTAINABLE DEVELOPMENT

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Abstract: Afghanistan's energy sector and its economy are at a crossroads. Energy is a very important input in the sustainable development of Afghanistan. If it is not supplied imprudently it will pull down the Government's development efforts and be a drag on economic growth. The availability of secure energy within Afghanistan was significantly disrupted by the conflicts of the past two decades. The release of new estimates showing that Afghanistan may possess substantial reserves of oil and gas may shake up Central Asia's increasingly competitive energy contest and alter the region's geopolitical balance. The energy sector in Afghanistan is predominately state owned and operated with little private sector participation. Although encouraging private investment is a stated goal of the IROA, the substantive work that is required to create the enabling environment for meaningful private sector participation is absent. The energy sector and its sub-sectors are undergoing significant expansion. However, poor infrastructure, insufficient budgetary resources, lack of trained personnel and weak government policies have complicated and in some instances significantly delayed energy resource development and deployment. The result is that each sub-sector's entities often are not able to effectively maintain, repair, manage or expand the system to meet the country's needs. The findings of the study describe the important energy resources available to the country and suggest measures to improve it. Development of Afghanistan's require large capital investment and significant private sector participation to reach fruition. Major objective of the paper is to describe the existing energy resources and suggest measures to improve these resources.

Key Words: Energy Resources, possess substantial reserves, private sector participation, energy resource development, enabling environment, measures

1. INTRODUCTION

Ref [1]"Afghanistan's economic outlook has improved significantly since the fall of the Taliban regime in 2001 because of the infusion of over $8 billion in international assistance, recovery of the agricultural sector and growth of the service sector, and the reestablishment of market institutions. Real GDP growth is estimated to have slowed in the last fiscal year primarily because adverse weather conditions cut agricultural production, but is expected to rebound over 2005-06 because of foreign donor reconstruction and service sector growth. Despite the progress of the past few years, Afghanistan remains extremely poor, landlocked, and highly dependent on foreign aid, farming, and trade with neighboring countries. "Ref[2]"It will probably take the remainder of the decade and continuing donor aid and attention to significantly raise Afghanistan's living standards from its current status, among the lowest in the world. Much of the population continues to suffer from shortages of housing; clean water, electricity, medical care, of the highly prolific, natural gas-prone Amu Darya Basin, has the potential to hold a sizable undiscovered gas resource base, especially in sedimentary layers deeper than what were developed during the Soviet era. Afghanistan's crude oil potential is more modest, with perhaps up to 100 million barrels of medium-gravity recoverable from Angot and other fields that are undeveloped. Afghanistan also may possess relatively small volumes of gas liquids and condensate.

"Ref [2]"Outside of the North Afghan Platform, very limited oil and gas exploration has occurred. Geological, aeromagnetic, and gravimetric studies were conducted in the 1970s over parts of the Katawaz Fault Block (eastern Afghanistan – along the Pak border) and in the Helmand and Farah provinces. The hydrocarbon potential in these areas is thought to be very limited as compared to that in the north.The Soviets had estimated Afghanistan's proven and probable natural gas reserves at up to 5 trillion cubic feet (Tcf) in the 1970s. Afghan natural gas production reached 275 million cubic feet per day (Mmcf/d) in the mid-1970s. The Djarquduk field was brought online during that period boosted Afghan natural gas output to a peak of 385 Mmcf/d by 1978-79. After the Soviet pullout and subsequent Afghan civil war, at Sheberghan area fields were shut in due to technical problems and the lack of an export market in the former Soviet Union. At its peak in the late 1970s, Afghanistan supplied 70%-90% of its natural gas output to the Soviet Union's natural gas grid via a link through Uzbekistan. In 1992, Afghan President Najibullah indicated that a new natural gas sales agreement with Russia was in progress. However, several former Soviet republics raised price and distribution issues and negotiations stalled. In the early 1990s, Afghanistan also discussed possible natural gas supply arrangements with Hungary, Czechoslovakia, and several Western European countries, but these talks never progressed further. Afghan natural gas fields include Djarquduk, Khowaja Gogerdak, and Yatimtaq, all of which are located within 20 miles of the northern town of Sheberghan in Jowzjan province. In 1999, work resumed on the repair of a distribution pipeline to Mazar-i-Sharif.

Spur pipelines to a small power plant and fertilizer plant also were repaired and completed. Mazar-i-Sharif is now receiving natural gas from the pipeline. The possibility of exporting a small quantity of natural gas through the existing pipeline into Uzbekistan also is reportedly being considered. "Ref [3]"Soviet estimates from the late 1970s placed Afghanistan's proven and probable oil and condensate reserves at 95 million barrels. Most Soviet assistance efforts after the mid-1970s were aimed at increasing gas production. Sporadic gas exploration continued through the mid-1980s. The last Soviet technical advisors left Afghanistan in 1988. After a brief hiatus, oil production at the Angot field was restarted in the early 1990s by local militias. Output levels, however, are though to have been less than 300 b/d. Near Sar-i-Pol, the Soviets partially constructed a 10,000-b/d topping plant, which although undamaged by war, is thought by Western experts to be unsalvageable.

Table 1 Energy Infrastructure at a Glance

Oil	
Angot Oilfield	Produces a small quantity of crude oil; located in Sar-i-Pol province. Primitive retorts used at the field and near Sheberghan to refine produced oil.
Natural Gas	
Sheberghan Area Gas Fields	The Djarquduk, Khowaja Gogerak, and Yatimtaq natural gas fields are all located within 20 miles of Sheberghan.
Pipeline to Mazar-i-Sharif	A pipeline connects these natural gas fields to Mazar-i-Sharif. Limited amounts of gas currently are supplied to a 48-MW power plant near Mazar-I-Sharif (which is operating at less than one-third full capacity) and for the 100,000 mt/y fertilizer plant, which is partially operational.
Local pipelines	Small-diameter pipelines supply gas to the Khwaja Gogerdak and Djarquduk gas fields with Sheberghan and nearby villages .
Electricity	
Kajaki Dam	Located in Helmand province near Kandahar; transmission lines to Kandahar repaired in early 2002, after being damaged by airstrikes in November 2001. Upgrading and expansion program is underway.
Mahipar Dam	Installed capacity of 66 MW. Near Kabul. Operational only two to three months out of the year (springtime) but currently lacking adequate water.
Naghlu Dam	Installed capacity of 100 MW. Operational. Provides most of the electricity used in Kabul.
Darunta Dam	Installed capacity of 11 MW. Operational. In Nangarhar province near Jalalabad.
Sarobi Dam	Installed capacity of 22 MW.
Dahla Dam	Kandahar province. Operational.
Mazar-i-Sharif Power Plant	Small natural gas-fired power plant near Mazar-i-Sharif, partially operational at under 30 MW.
Note: This listing of Afghanistan's energy infrastructure was compiled from information available in press and media sources, and should not necessarily be considered comprehensive. Only facilities which have been reported to be functional or under repair have been included.	

2. METHODOLOGY AND OBJECTIVE OF THE STUDY

The major objective of the study is to make a descriptive review of the existing energy resources in Afghanistan and at the end suggest some important measures in order to make the best possible use of these resources. The methodology of the study was observation and interviews conducted with the respondents related to the study. The nature of the study was descriptive so the data was collected from the Afghan government reports, World Bank, Asian development Bank reports, research papers and other sources.

3. MATERIAL AND METHODS

The State of the Energy Sub-sectors in Afghanistan detailed Analysis

Electricity

"Ref [4]"Electricity drives modern economies and per capita consumption of electricity in Afghanistan is one of the lowest in the world. After a long period of decline, generating capacity, is beginning to grow again as are generation and consumption. Hydro plants account the largest share of capacity with imports in second place and growing. The most promising long-term resource for power generation in Afghanistan is hydropower, which accounts for over 50% of grid-connected installed capacity6**.** Following hydropower, thermal generation, primarily diesel generation, supplies power mainly to urban areas. Utilization of indigenous fossil fuels (natural gas and coal) for power generation is very limited as is utilization of solar, wind and other renewable energy resources. Reliance on diesel is both expensive and environmentally hazardous. Diesel generation costs almost 30 US cents per khw compared to natural gas at 3.5 US cents per kWh. Efforts are underway to utilize local natural gas for power production and this should remain a top priority

Table 2 Historical Electricity Data

	1980	1990	2000	2001	2002	2003	2004	2005
Generation (billion kWh)	**0.94**	**1.10**	**0.47**	**0.39**	**0.69**	**0.81**	**0.76**	***0.75***
Imports (billion kWh)	**0.00**	**0.00**	**0.10**	**0.20**	**0.15**	**0.10**	**0.10**	***0.10***
Consumption (billion kWh)	**0.88**	**1.02**	**0.53**	**0.56**	**0.79**	**0.86**	**0.81**	***0.80***
Capacity (million kW)	***0.426***	***0.494***	***0.405***	***0.265***	***0.264***	***0.323***	***0.323***	***0.320***

Source: US EIA

Table 3 Afghanistan electricity Production

YEAR	ELECTRICITY - PRODUCTION (BILLION KWH)
2000	**0.43**
2001	**0.42**
2002	**0.375**
2003	**0.3348**
2004	**0.3348**
2005	**0.54**
2006	**0.905**
2007	**0.7343**
2008	**0.839**
2009	**0.839**

Source: CIA World Fact Book

Table 4 Afghanistan Electricity Consumption

Year	Electricity - consumption (billion kWh)
2000	**0.51**
2001	**0.4806**
2002	**0.45375**
2003	**0.5114**
2004	**0.5114**
2005	**0.6522**
2006	**1.042**
2007	**0.7829**
2008	**1.088**
2009	**1.418**

Source: CIA World Fact Book

Rural power supply continues to rely mostly on micro-hydro plants (MHPs), limited diesel (mostly privately owned), and batteries, with very limited availability to the rural population.7Most rural power generation efforts are funded by donors with limited cost-sharing by the Government. The financial condition of the sector and the utility is going from bad to worse because there has been little improvement in tariffs and operations while at the same time substantial assets have been added to the system. Maintaining and operating these is expensive and if the Government does not shift its focus from building new infrastructure alone to efficiently operating and maintaining what is has, the burden on the economy will be enormous.

"Ref [5]"Energy in Afghanistan in recent history can be categorized as a period where supply has always been short of demand, as it has in many similar countries. The demand for energy outstrips current supply in every category of energy, including traditional energy which is unsustainably harvested. Much of the deficit in supply can be blamed on the lack of investment, cannibalization and carnage that has accompanied Afghanistan's civil crises since 1978. As civil strife strains financial resources new investment is abandoned, routine maintenance is postponed; spares are taken from one plant for another; skilled human resources that are needed to maintain the capital stock leave; and soon parts are stolen and sold for other uses. Sad and unpreventable as this is, a large share of the gap can be blamed on faulty resource allocation policies.

PETROLEUM

Relative to other forms of energy and to the region, Afghanistan has minimal oil and gas resources and consumption at this time is mainly transportation fuels and liquid fuel for power. Currently petroleum products such as diesel, gasoline, and jet fuel are imported, mainly from Pakistan and Uzbekistan, with limited volumes from Turkmenistan and Iran. Natural gas holds potential for power generation but suffers from a severe lack of investment

NATURAL GAS

Natural gas it not yet a significant energy resource, although it has the potential to be a significant source of energy for the country and an important source of revenue to the Government. The consumption of natural gas is supply constrained just as it is for all other energy resources. Consumption and production of gas is estimated at about 21.2 million cubic feet/day, although it is likely that this is an overestimate8. In 2003, the World Bank reported that Afghanistan ―meets only 40% of increasing domestic natural gas demand, produces gas at 25% of its peak level in the 1980's, and loses 30% of that production to leakage - posing revenue and safety issues. By 2006, this had fallen to about 20% of gas demand being met. To increase production, both the complete infrastructure must be re-built and/or constructed as new and new exploration and development must be undertaken.

Table 6 Natural gas - production: 20 million cu m

Year	Natural gas - production	Rank	Percent Change	Date of Information
2004	220,000,000	68		2001 est.
2005	220,000,000	68	0.00 %	2001 est.
2006	50,000,000	76	-77.27 %	2003 est.
2007	20,000,000	84	-60.00 %	2004 est.
2008	20,000,000	87	0.00 %	2006 est.
2009	20,000,000	86	0.00 %	2006 est.

Source: CIA World Fact Book

Table 7 Natural gas - consumption: 20 million cu m

Year	Natural gas - consumption	Rank	Percent Change	Date of Information
2004	220,000,000	92		2001 est.
2005	220,000,000	92	0.00 %	2001 est.
2006	50,000,000	101	-77.27 %	2003 est.
2007	20,000,000	107	-60.00 %	2004 est.
2008	20,000,000	108	0.00 %	2006 est.
2009	20,000,000	109	0.00 %	2006 est

Source: CIA World Fact Book

"Ref [6]"Like other energy prices, current gas prices are too low to cover costs of rehabilitation, O&M and expansion of production and infrastructure. For incremental gas production, tariffs may be less than half of the level needed to cover costs. Moreover, the IROA collects no taxes or royalties from the natural gas sector, missing out on a potentially major source of revenue. As a result, sector entities have been unable to effectively operate, repair and maintain the system. A large part of the infrastructure for storage, transmission and distribution has been damaged while the remaining capacity is in need of rehabilitation. There is no incentive to conserve or to optimize use of gas resources as the present cost is so low and operations are so inefficient.

There is a good deal of uncertainty about reserves that can only be resolved with further exploration. Studies put proven reserves between 1 trillion cubic feet (tcf) and 15 to 20 tcf. Other studies estimate additional probable reserves of 15 or 20 tcf. Regardless, of the whether reserves are 1 tcf or more, there is still sufficient gas to justify immediate exploration and develop and utilization in power and, possible, for compressed natural gas (CNG) vehicle.

"Ref [7]"Development of Afghanistan's natural gas resources has the potential of improving domestic energy resources, reducing environmental impacts and supporting economic growth. Natural gas reserves are potentially large enough to support development of electricity generation as well as a fertilizer plant and local commercial and residential markets in the Sheberghan area. Plans are underway to rehabilitate the gas fields to expand production and to upgrade the existing gas pipeline network to supply the fertilizer plant and the local market. Activities to promote exploration and development of additional gas resources have been underway for some time.

Progress in developing these resources is being delayed by a number of factors that affect the ability to develop this resource and attract private investment. Technical assistance and training activities provided through donor funding have been ongoing for a number of year to help resolve this impediments. To date, results have been mixed and many of the activities are behind schedule.

Due to the importance of the natural gas sector as a significant contributor to Afghanistan's domestic energy production, as well as provide an important revenue source to the GOA, efforts to develop the sector need to be given a high priority within the IROA _s overall Energy Sector Strategy.

CRUDE OIL

"Ref [8]"Afghanistan has only limited supplies of oil. According to the USGS reserves are 13-14 million tons. Domestic oil production is insignificant with current production is about 400 barrels/day (Technical Annex, January 2004).

As a result, Afghanistan depends on imports for most of its consumption. Oil is produced in limited quantities primarily from the Angot oil field, located in Sar-i-Pol province. The U.S. government estimates that total oil reserves could be as much as 270 billion barrels.

If investments take place as envisioned, it is estimated that oil production could increase from the current 400 bpd (barrel of oil production per day) to 3,000 bpd by 2008; 5,000 bpd by 2010 and 10,000 bpd by 2015.

COAL

Like all other in Afghanistan, the demand for coal does not drive production but rather production limits consumption. The table below illustrates the production and consumption position since 1980. The Afghan coal industry is operating at low production rates, less than 200,000 tons reported per year; devastation of more than 2 decades of war and years of neglect, Afghanistan's coal mines struggle to sustain current levels of production. The supply of coal is essential for domestic energy / heating and industrial uses. The quantity and quality of coal resources remains relatively unknown and programs

to assess alternatives could take up to three years. As such, there will be a continued reliance on existing producing mines in Baghlan province as well as small mines in Bamyan provinces.

Table 8 Coal Energy Data (million short tons)

	1980	1990	2000	2004	2005	2006	2007	2008
Production	**0.131**	**0.116**	**0.089**	**0.092**	**0.096**	**0.099**	**0.103**	**0.099**
Consumption	**0.131**	**0.116**	**0.089**	**0.092**	**0.096**	**0.099**	**0.103**	**0.099**

Source: US EIA

Until the end of 2006, Afghan coal operations were primarily contained in state enterprises of Northern Coal Enterprise and Sabzak Coal with oversight of the Ministry of Mines. Some recent lease arrangements to private operators have since been put in place that provide private firms with coal mining rights affiliated with cement operations. In May 2007, President Karzai announced the establishment of a Coal Commission. The genesis of this commission is the increasing discussion within Government to promote indigenous energy resources for power use as well as to examine the industry demand for coal as a fuel source. No programmatic assistance has been provided to the Afghan coal sector.

COAL DEPOSITS AND COST

"Ref [9]"In general terms there are 11 coal mines in Afghanistan with approximately 5 that have been deemed to be reasonably safe for operation and viable for local production and use. Considerable coal reserves have yet to be explored in Afghanistan. Coal is used in these mining areas as well as transported into Kabul and other cities; transport of coal is generally conducted by private market entities although some mines maintain their own transportation as well. The current price of coal is indicated to be $65-$90 per ton depending on transport costs – the actual coal price per ton is estimated to be around $20-$25.00. In terms of regional coal costs, this is high.

The health and safety conditions at the mines, many of which are underground, are horrific. An example is the ongoing fires at the Dahne Tor coal mine. US Geological Survey (USGS) experts visited the site in 2006 and indicated that unregulated mining observed is conducted in a seam that is several hundred feet (stratigraphically and topographically) higher than the main seam that was mined decades ago. The main mine was semi-mechanized, but everything is now collapsed, attributed by Afghan coal managers to landslides, poor technical oversight and general subsidence. It is estimated that millions of dollars are required to sufficiently upgrade the health and safety conditions at these mine operations.

Longer-term strategies for growth in the Afghanistan coal sector remain several years away but consideration of coal power is underway; the Ministry of Mines has included a 100MW coal fired power plant in its 1386 budget figures; this presents interesting inter-ministerial issues as the Ministry of Energy and Water is responsible for state power generation which is implied in this budget proposal. The confirmed quantity and quality of coal resources remains relatively unknown but appears good.

COAL USES

Afghan coal is primarily used for home cooking and heating needs. The estimated demand for coal in Afghanistan is approximately 250,000 tones per year (for residential, commercial, and light industrial uses nationwide). Over the next three years it is expected that demand for coal will also increase as a result of the manufacture of cement and possible coal power development. Therefore, recovery of the cement industry will significantly alter the total demand for coal. Mechanisms are not in place to transparently and rapidly address winter coal issues.

COAL FOR POWER

"Ref [10]"In addition to the Aynak copper power needs, Government has begun to assess the power needs of the proposed Hajigak Iron Ore deposit as well as simply the generation of coal for power to supply the central and western parts of the country that now have no or limited power access. This is a topic where both the Ministry of Mines and the Ministry of Energy and Water have important roles but have yet to determine strategic priorities for development of coal for power including methods to attract sustainable investment. Opportunities such as this argue for the development a cogeneration policy and simplified power purchase agreements for co generated power.

RURAL AND RENEWABLE ENERGY

Renewable energy offers the greatest hope for Afghanistan in general and rural energy in particular. Renewable energy includes hydro, solar, wind, geothermal, biomass and wood. Hydro, both large and small, represents significant untapped resources. According to the ADB, there is 18,400 MW of untapped hydro potential in the country.

Afghanistan has excellent wind potential in many areas and is economical compared to diesel as shown in the table below.

Table 9 Wind Potential

Wind Resource Utility Scale	Wind Class	Wind Speed m/s	Total Capacity Installed (MW)
Good	**4**	**6.8-7.3**	**75,970**
Excellent	**5**	**7.3-7.7**	**33,160**
Excellent	**6**	**7.7-8.5**	**33,100**
Excellent	**7**	**> 8.5**	**15,800**
Total		**158,100**	

Source: National Renewable Energy Laboratory

"Ref [11]"Not all of this potential wind energy can be economically converted into electricity because of a number of factors such as distance from population centers and wind speed. However, the first initial survey indicates that there is significant potential which can be tapped at around US$ 0.09 per kWh.

There is significant solar potential but it still remains a high cost energy resource for electricity. The Indian Government has funded a solar village initiative. While solar PV is expensive compared to the cost of generation for other alternatives, there is strong evidence that with the proper enabling environment of micro credit and training, solar home systems are a viable electricity source. Solar cookers have shown significant promise in other countries and may have widespread application here. Solar cookers were deployed in Afghan refugee camps in Pakistan.

"Ref [12]"It is important to note that there are many environmental benefits from using renewable energy such as reduced emissions (both indoor and outdoor) but the development of renewable energy must also consider the potentially negative environmental impacts. It is important that EIA guidelines be followed and the as with any energy project, public debate is an important tool.

There is an overwhelming view that rural areas need electricity and that providing access is the best use of resources for energy. An Asia Foundation survey in 2006 concluded that at the local level electricity was the second most important problem behind unemployment. When survey respondents were asked what were the largest problems at the national level, they citied electricity as the ninth most important problem The Asia Foundation sample was not representative of the country from an energy perspective and used a definition for rural that obfuscates the real patterns of importance in planning development assistance The results from other countries consistently indicate that there is a hierarchy for demand to services and electricity is usually further down on the ladder than services such as an all weather road, water supply, schools, and clinics. For example, if the preponderance of survey respondents already has access to road, water and schools, then electricity may well be their next choice of service. In rural-remote Afghanistan, if Afghans are similar to the peoples of the region, then access to electricity will not be their most urgent priority.

"Ref [13]"Additionally, experience the world over has provided an important lesson with regard to blindly providing access to electricity.

There is no guarantee that increased access to electricity will bring economic benefits. Simply look around in Kabul and other urban areas where residential access has increased. If access to electricity is not targeted to or coupled with income generating activities, then rural access brings lighting and little else.

Demand

"Ref [14]"Although there is little data for Afghanistan on rural energy use, inferences can be drawn from similar countries in the region. There is a tendency to assume that grid connected electricity offers the best form of energy for rural populations. Experience throughout the world has shown that there is a progression in the use of energy. Due to the dispersed nature of the rural population, renewable energy offers the best solution for electrification for the majority of Afghanistan's rural population that currently does not have access to electricity and has no real expectation of connection to the grid

It is very important that the economic conditions and opportunities of rural population be fully understood when devising a rural energy strategy. Too often donors and Government officials have blindly followed a policy of rural electrification. The result has been much higher cost energy delivered than people can afford and little, if any, associated economic activity. The goal of increasing energy is poverty reduction and economic growth. Electricity alone in rural areas is unable to do that job.

What is not known about rural Afghan's economic and energy characteristics? First, rural Afghani's are poor by most countries'standards. —Over 20.4% of the rural population cannot meet the minimum level of dietary energy required to sustain a healthy life.□ 19 Unemployment is rampant. Average household income is estimated to be no greater than $231 a year.

"Ref [15]"Probably less than 4% of rural households have access to electricity. Of those with access, 7% use electricity for lighting. Kerosene lamps are the major source of lighting, representing roughly 86 percent. It is highly likely given what is known about other countries, that the main source of cooking fuel is from self collected fire wood from which there is no monetary outlay or charcoal. This information is valuable because it tells us how much of a rural household's money income is devoted to energy. Using detailed data for Balochistan, the average rural household spends only 3.5% of its budget on energy and this includes imputed or no cash outlays. Clearly, for many families on the lower end of the income spectrum, the vast majority of energy services are self supplied – that is through the gathering of fuel wood, crop residues, and other biomass. Energy expenditures were dominated by wood, charcoal, and kerosene. Wood and charcoal are used mainly for cooking and heating, while kerosene is the main source of lighting. Rural Afghanistan is similar.

Extreme poverty in rural areas also is related to lack of income earning opportunities. The productive use of energy helps reduce poverty by providing alternative sources of livelihoods and increase educational and training opportunities. The remoteness of rural locations and the rough terrain make expansion of the electricity grid into these areas economically infeasible. Therefore, the application off-grid technologies to these areas— including renewable energy resources— and other forms of energy is the primary focus of IROA activities.

Supply

"Ref [16]"There is no reliable data on traditional energy use in rural Afghanistan. The bulk of commercial energy is supplied by kerosene, Hydro power and diesels. Hydro, wind and solar offer opportunities for small scale supply. Following hydro, solar energy has the greatest potential as a renewable energy source but cost remains a major barrier. Estimates indicate that in Afghanistan solar radiation averages about 6.5 kWh per square meter per day and the skies are sunny about 300 days a year. Consequently, the potential for solar energy development

is high, not only for solar water heaters for homes, hospitals and other buildings, but also for generating electricity. In addition, some 125 sites have been identified for micro-hydro resource development with the potential to generate 100 MW of power.

Other renewable energy technologies, particularly micro-hydro and wind energy, have broad applicability within rural areas of Afghanistan and offer employment opportunities directly through operation and maintenance requirements, and indirectly through businesses like agro□processing that provide off farm work.

Hydropower, solar, wind and biomass offer the most potential to contribute to energy supply. Development, however, requires sound institutional and financial support, sustained commitment and a long-term development horizon. Use of renewable energy is beset by a number of factors, including high upfront costs, lack of suppliers, inadequate financing mechanisms, and weak institutional and technical capacity.

Role of the Private Sector

"Ref [17]"Throughout the world, the role of the private sector in energy is growing and is significant in most countries. In Afghanistan, it is virtually nonexistent. The roles of the private sector vary from managing government owned assets to outright ownership and operation. There are examples where all these mechanisms coexist in one country. There are other examples where countries have chosen one model and yet, others where the country transitions over time from the simplest model (management contract) to complete ownership and operation.

To be sure, there are obstacles in Afghanistan to greater private sector involvement, primarily to investment, but some of these obstacles can be completely overcome and others offset with innovative mechanisms. The private sector can be called upon to manage, operate, invest and/or own energy entities and operations. Each different mechanism has its advantages and disadvantages. Often, there is a progression from management through ownership that takes into account the current situation. Take the electricity sub-sector for example. It is highly unlikely under the current security, institutional, policy and legal/regulatory situation, that private investors will be attracted to invest in a large-scale power plant. However, until these issues are resolved, there are many other ways to use the private sector. Billing can be outsourced. Individual power plants could be given on management contract. There are a variety of mechanisms available now for the IROA to tap the private sector as it prepares the enabling

frameworks and other requisite mechanisms to foster full private sector ownership and operation.

The single most important challenge facing energy is attracting the private sector in a meaningful way. The sector is plagued by inefficiency and under investment. Private sector participation in Afghanistan's energy sector is crucial to achieving its long term objectives of the sector. Efforts to attract private investment are incorporated with IROA programs and projects, but there is no coordinated approach to achieving this goal. In particular, options for private participation beyond equipment and supplies and management contracts need to be explored, and effective policies put into place.

Perhaps the single biggest constraint in the sector is the very limited capacity given the tasks that need to be accomplished. Both the Ministries and the SOEs are characterized by limited capacity, the low numbers of trained/skilled personnel below the senior levels. It is imperative that basic managerial skills be provided and that training in accounting and finance also take place.

IV. SUGGESTED MEASURES TO IMPROVE ENERGY SECTOR IN AFGHANISTAN

There is a time in Afghanistan's future when energy will be abundant, blackouts will be a thing of the past, and most of its energy needs will be provided directly by the private sector. Private investors will develop power plants, operate and own distribution systems and develop in situ resources, just as they have begun to do in many countries. But that is the distant future. For now, Afghanistan must work hard to increase energy production, doing so efficiently and in a cost effective manner. It can do this by building new capacity and by improving the efficiency of existing infrastructure, building capacity in its workforce, and reorganizing its energy operations to make them more transparent, increase operating efficiency and prepare them for eventual entry into the private sector. At the same time though, it must begin laying the ground-work for the eventual large-scale participation of the private sector.

"Ref [18]"The time has come that Afghanistan must not only focus on the immediate energy needs but turn attention to the longer run. It knows where it is going and but not necessarily how to get there. This strategy will address the questions of where we are going and how we get there. What this means for energy is that as we continue to focus our efforts on short run options to increase supply, one must begin developing the foundation that will support long run sustainable growth. Afghanistan must be laying the legal, regulatory, commercial and institutional foundations to unleash the power of the private sector when conditions are appropriate.

The following factors will help in the improvement of the energy sector.

- Increased Private Sector Provision of Energy
- Better Sector Governance
- Increased trade with neighboring countries, focusing on the transmission of energy
- Expand the availability of electric power
- Develop a Master Plan for Rural Energy; and,
- Establish market-based tariffs with a clear timetable to phase out subsidies

Electricity

Afghan government should rehabilitate hydro and thermal generating facilities; increase power imports and develop PPAs with Central Asian countries; purchase small diesel generating sets for supplementing power supply in selected urban areas; develop selected transmission lines to maximize deliverability from domestic generation sources and increase use of imported power; and develop micro-hydro and other energy resources in rural and remote areas. Through these combined efforts, the supply of electricity throughout

Afghanistan has increased by 66% albeit from a very low base.

A key objective of these initiatives is to increase the number of connections, adding about 850,000 residential and non-residential connections by 2010 to increase access in urban areas from an estimated 27% currently to 65% by 201031; and, country-wide from 6% currently to almost 25 % by 2010. By 2015 the goal is to increase urban access to 90% and achieve an overall national access rate of 33%.

Natural Gas

"Ref[19]"Development of Afghanistan's natural gas resources has the potential of improving domestic energy resources, reducing environmental impacts and supporting economic growth. Natural gas reserves are potentially large enough to support development of electricity generation as well as a fertilizer plant and local commercial and residential markets in the Sheberghan area. Plans are underway to rehabilitate the gas fields to expand production and to upgrade the existing gas pipeline network to supply the fertilizer plant and the local market. Activities to promote exploration and development of additional gas resources have been underway for some time.

Afghanistan needs to develop indigenous energy resources, including natural gas reserves in the Sheberghan area. Data on gas reserves indicate that there is sufficient low-cost gas reserves available to operate a combined cycle turbine plant at Sheberghan for 25 years and that the cost per kWh of power generated would be in the 2.8 to 3.5 cent range. While this is more expensive than the cost of imported power, which currently is in the 2.0 to 2.5 cents/kWh range, future prices are expected to be 4.0 cents/kWh or more. Also,it is important to note the domestic benefits resulting from developing the gas fields and gas-fired power plant. USAID is exploring options for some funding of a 100MW gas-fired power plant to be located near the Khwoja Gegertak, Jarkaduk and Yatimtaq gas fields and an associated urea plant. USAID is confirming the size of the reserves, quality of the gas and delivery prospects for the plant and plans to move forward with construction of the generating plant pending results of these assessments.

"Ref [20]"In addition, current gas prices are too low to cover costs of rehabilitation. For incremental gas production, tariffs may be less than half of the level needed to cover costs. Moreover, the IROA collects no taxes or royalties from the natural gas sector, missing out on a potentially major source of revenue. As a result, sector entities have been unable to effectively operate, repair and maintain the system. A large part of the infrastructure for storage, transmission and distribution has been damaged while the remaining capacity is in need of rehabilitation.

The majority of more than 12,000 residential customers and more than 700 business customers are not metered. Afghan Gas management indicates that metered and non-metered customers generally pay the same rate for gas. No meaningful data is available to adequately present the costs of operating and maintaining the system at this time.53 Moreover, the technical standard of Afghan gas operations is extremely low. There is no incentive to conserve or to optimize use of gas resources as the present cost is so low and operations are so inefficient.

The operational strategy of the Government for the gas sector is to promote economic growth by removing impediments to the reconstruction and modernization program and to open the sector to private investment, particularly for gas exploration and development. Efforts to attract private investment depend on developing policy reforms and structural changes to support longer-term sector development and expansion. Progress to date has been slow, thereby limiting investor interest. Options to speed up this process and to increase private sector involvement need to be explored.

Crude Oil and Petroleum Products

"Ref [21]"Afghanistan has only limited supplies of oil. Domestic oil production is insignificant and current production is about 400 barrels/day.55 As a result, Afghanistan depends on imports for most of its consumption. Oil is produced in limited quantities primarily from the Angot oil field, located in Sar-i-Pol province. Given the serious supply shortfall, in order to meet country's needs, most petroleum products—diesel, gasoline and jet fuel included—are imported primarily from Pakistan and Uzbekistan.

Infrastructure for local production of oil is largely non-existent and what infrastructure is present is functioning inefficiently and suffers from chronic under-funding. In addition, the level of local expertise in oil exploration and development is limited. As a result, sector entities have been unable to operate effectively, to repair and maintain the system, nor engage effectively in new exploration and development. A large part of the infrastructure for storage, transmission and distribution of petroleum products has been damaged, while the remaining capacity is in need of rehabilitation.

Much of the petroleum resource potential of Afghanistan and all of the known crude oil and natural gas reserves are in northern Afghanistan, located in parts of two geologic basins – the Amu Darya Basin to the west and the Afghan-Tajik Basin to the east. Most of the undiscovered crude oil is in the Afghan-Tajik Basin, and most of the undiscovered natural gas is in the Amu Darya Basin. The U.S. government estimates that total oil reserves could be as much as 270 billion barrels.

If planned investments take place as envisioned, it is estimated that oil production could increase from the current 400 bpd (barrel of oil per day) to 3,000 bpd by 2008; 5,000 bpd by 2010 and 10,000 bpd by 2015. Clearly, however, the increased investment will require changes in the laws, rules and regulations in the sector and creating an environment conducive to expanded private sector involvement. Total revenue streams from these investments are estimated to increase, at a minimum, from $5.1 million in 2004 to about $292 million/year by 2015 assuming a price of $80 a barrel. These revenue estimates do not include additional revenue from value added taxes that could be derived from converting the crude oil to refined petroleum products.

Coal

"Ref [22]"Afghanistan has reasonably good quality coal resources and is estimated to have significant coal reserves (probable reserves estimated at about 400

million tons), most of which are located in the northern part of the country in the region between Herat and Badashkan58. Although Afghanistan produced over 100,000 short tons of coal annually as late as the early 1990s, production had fallen to only around 1,000 short tons in 2000.

The primary coal resources in Afghanistan occur in the Katawaz Basin south and west of Kabul. Prospective economically viable coal deposits are found in four coal districts: Karkar, Ishpushta, Dara-i-Suf, and Chalow. However, the real extent of coal deposits in the country is not known and there is an urgent need to assess the resource base.

Some current coal operations are taking place at Karkar and Ispushta mining districts. The literature indicates that Dara-i-Suf appears to have the greatest potential for significant reserves, estimated to be over 84 million tons. This coal is believed to be of coking grade with a high calorific value in the range of 7,000 kilo-calories/kg. The mines at Kalich in the Ispushta district are active. Coal in these districts is extracted by either crude, inefficient, mechanized mining methods or by ―artesian methods. Current production from all operations is estimated to be about 110,000 short tons.

The existing industrial sized coal mines are marginal (if not out of operation) due to antiquated machinery and lack of maintenance and new investment. However, there is considerable small scale production. At present, the small scale mining sector, including coal is wholly unregulated and occupies large numbers of persons in difficult security, health, and environmental conditions. Moreover, coal demand and prices in urban centers have risen due to domestic energy needs during the winter months and also due to increasing industrial demand to fire construction bricks.

Development of coal and other mineral resources requires investments in excess of government abilities. Therefore the IROA_s policy is to establish an enabling environment conducive to attracting and retaining investment by both private local and international groups. However, privatization and/or leasing of existing state owned mining enterprises to private groups is, at present, held up by the lack of adequate mining legislation and the need for a clear policy on sector development. Enabling legislation and a proper mineral concession system is needed to establish clear lines of authority and responsibility for the Government and for private developers.

"Ref [23]"To develop the coal sector and increase production to support new electricity generation, the Government needs to adopt appropriate policies and programs to stimulate private sector investment, rather than direct government investment in operations. To achieve these objectives internationally competitive mining legislation and fiscal measures are necessary. Afghanistan's coal sector requires immediate capital investment to support development of resources as well as for development of power plants that utilize coal for fuel.

Rural and Renewable Energy

"Ref [24]"Due to the dispersed nature of the rural population, renewable energy offers the best solution for electrification for the majority of Afghanistan's rural population that currently does not have access to electricity and has no real expectation of connection to the grid.

Most of Afghanistan's 25 million people have no access to modern forms of energy. Fuel wood accounts for an estimated 75% of total rural energy supplies. This is having an adverse impact on forests and watersheds. In addition, burning these fuels increases indoor air pollution, which adversely affects the health of women and children in particular.

Extreme poverty in rural areas also is related to lack of income earning opportunities. The productive use of electricity helps reduce poverty by providing alternative sources of livelihoods and increase educational and training opportunities. The remoteness of rural locations and the rough terrain make expansion of the electricity grid into these areas economically infeasible. Therefore, the application off-grid technologies to these areas including renewable energy resources are the primary focus of IROA activities.

The role of the IROA is to provide policy and regulatory frameworks to encourage and facilitate participation by the private sector and civil society in rural electrification and application of renewable energy technologies. Ultimate responsibility for renewable and rural electrification resides in the Ministry of Energy and Water (MEW), although other entities, particularly the MRRD and its program, NSP, CDCs, NGOs, and donors are active in rural development projects. MEW also is charged with establishing a renewable and rural energy policy in conformance with the development objectives of the IROA.

Hydropower, solar, wind and biomass offer the most potential to contribute to energy supply. Development, however, requires sound institutional and financial support, sustained commitment and a long-term development horizon. Use of renewable energy is beset by a number of factors, including high upfront costs,61 lack of suppliers, inadequate financing mechanisms, and weak institutional and technical capacity.

Afghanistan as Energy Transit Route

"Ref [25]"Due to its location between the oil and natural gas reserves of the Caspian Basin and the Indian Ocean, Afghanistan has long been mentioned as a potential pipeline route, though in the near term, several obstacles will likely prevent Afghanistan from becoming an energy transit corridor. During the mid-1990s, Unocal had pursued a possible natural gas pipeline from Turkmenistan's Dauletabad-Donmez gas basin via Afghanistan to Pakistan, but pulled out after the U.S. missile strikes against Afghanistan in August 1998.

"Ref [23]"The Afghan government under President Karzai has tried to revive the Trans-Afghan Pipeline (TAP) plan, with periodic talks held between the governments of Afghanistan, Pakistan, and Turkmenistan on the issue, but little progress appears to have been made as of early June 2004 (despite the signature on December 9, 2003, of a protocol on the pipeline by the governments of Afghanistan, Pakistan and Turkmenistan). President Karzai has stated his belief that the project could generate $100-$300 million per year in

transit fees for Afghanistan, while creating thousands of jobs in the country.

"Ref [24]"Afghanistan is well positioned to be a transit route for electricity produced in CAR countries and exported to South Asia, and perhaps eventually it might also become a net exporter of power produced from its own hydro, natural gas, and coal resources. Efforts are currently underway to increase electricity imports from Uzbekistan, Tajikistan, Turkmenistan and Iran and to upgrade cross-border transmission links

"Ref [25]"Given the obstacles to development of a natural gas pipeline across Afghanistan, it seems unlikely that such an idea will make any progress in the near future, and no major Western companies have expressed interest in reviving the project. The security situation in Afghanistan remains an obvious problem, while tensions between India and Pakistan make it unlikely that such a pipeline could be extended into India and its large (and growing) gas market. Financial problems in the utility sector in India, which would be the major consumer of the natural gas, also could pose a problem for construction of the TAP line. Finally, the pipeline's $2.5-$3.5 billion estimated cost poses a significant obstacle to its construction.

V. Conclusion and Recommendations

The above energy resources and the measures to improve it have provided a base for better planning and management of this sector. However in order to implement these measures there is some cutting issues which should be kept in mind. These include the environment, counter narcotics, anti-corruption, gender and regional cooperation in addition to capacity building.

Capital investment in energy is rising rapidly attesting to the efforts to the Islamic Republic of Afghanistan (IROA) and the donor community. At the same time though, the efficiency of energy operations is not increasing. If left unchecked, much of the investment that is being made will be wasted. Post-conflict efforts by the Islamic Republic of Afghanistan (IROA) and international donors to date have focused on expanding the availability of energy resources throughout the country. Particular emphasis has been on expanding and rehabilitating the electricity sector in the major economic hubs of the country and providing basic service in rural areas. Efforts also have been taken to improve the supply of natural gas, increase availability of hydro-electric generation, rehabilitate and expand electricity and natural gas transmission and distribution systems, develop renewable energy resources in rural and remote areas and improve the capability of energy sector institutions. According to the findings, undiscovered petroleum resources in northern Afghanistan range from 3.6 to 36.5 trillion cubic feet (TCF) of natural gas, with a mean of 15.7 TCF. Estimates of oil range from 0.4 to 3.6 billion barrels (BBO), with a mean of 1.6 BB0. Estimates for natural gas liquids range from 126 to 1,325 million barrels (MMB) with a mean of 562 MMB. These estimates represent an 18-fold increase in the country's potential oil resources, and more than triple the natural gas resources.

Focusing on policies and projects that improve the operating efficiency of energy production It strives to get the most energy delivered for the minimum environmental impact. For example, reducing technical losses or cogeneration Years of neglect cannot be overcome until the Afghanistan government has the capability to recover costs, expand its capabilities, and conduct operations and maintenance of the energy sector.

The energy sector directly tackles corruption in several ways. One of the most important measures for reducing corruption is limiting the role or influence of Government. In energy, we are promoting increased private sector participation; we are reducing the role of Government. Additionally, in SOE's, such as DABM, we introduced loss reduction programs that are targeted at finding and deploying ways of controlling corruption. Furthermore, increasing private investment in the energy sector requires rule-of-law and increased transparency and accountability; thereby indirectly strengthening anti-corruption, and anti-narcotics measures. Finally, the introduction of a multi-sector regulator outside the concerned ministries and under the Ministry of Economy will provide greater oversight.

The most important areas furthering regional cooperation include expansion of energy trade by upgrading electricity transmission ties with Central Asian countries and exploring options for transport of electricity and natural gas through Afghanistan for regional supply.

Finally, the major emphasis within the Energy Sector Strategy placed on institutional strengthening and capacity building—and on institutional reform, such as consolidating authority over rural electrification and rural energy projects and separating policymaking from regulatory authority—will result in fostering a professional, open environment and increase opportunities for participation in energy sector activities on behalf customers and other stakeholders.

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