The Afghanistan Engineering Support Program assembled this deliverable. It is an approved, official USAID document. Budget information contained herein is for illustrative purposes. All policy, personal, financial, and procurement sensitive information has been removed. Additional information on the report can be obtained from Firouz Rooyani, Tetra Tech Sr. VP International Operations, (703) 387-2151.

TETRA TECH

November 8, 2010

[redacted] COTR
[redacted] ACOTR
USAID – Office of Infrastructure, Engineering and Energy (OIEE)
Café Compound
U.S. Embassy
Great Masood Road Kabul, Afghanistan

Re: WO-A-0053 ACEP Report Review

[redacted]

Per the administrative work order scope, attached is a mark-up of the ACEP Afghanistan Energy Efficiency Assessment Report dated October 15, 2010. Tetra Tech has suggested adjustments to the report to focus it directly on demand side management. Tetra Tech has also suggested editorial changes.

Upon concurrence, Tetra Tech can forward these comments to Ramesh Nepal of ACEP (IRG) and then work can commence with IRG to finalize the ACEP report.

Please contact [redacted] in our office if you have any questions or comments regarding this review.

Respectfully,

[redacted]
Chief of Party (OIEE-AESP)
Tetra Tech EM Inc.

Cc: [redacted] (USAID-POC)
[redacted] (TT-Technical Lead)

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AFGHANISTAN CLEAN ENERGY PROGRAM

AFGHANISTAN ENERGY EFFICIENCY ASSESSMENT REPORT

October 15, 2010

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List of Exhibits

ACRONYMS

ACEP	USAID-supported Afghanistan Clean Energy Program
ADB	Asian Development Bank
AEIC	Afghan Energy Information Center
AERA	Afghanistan Energy Regulatory Agency
AIRP	Afghanistan Infrastructure Reconstruction Program
ANSA	Afghanistan National Standard Agency
CFL	Compact Fluorescent Lamps
DABS	Da Afghan Breshna Sherkat (the state-owned monopoly – but commercialized – utility)
DSM	DSM demand side management
EE	Energy Efficiency
EEAC	Energy Efficiency Advisory Committee
EEWG	Energy Efficiency Working Group
ESCO	Energy services industry
FTLs	Fluorescent tube lights
GERES	Groupe Energies Renouvelables, Environnement et Solidarités
GIRoA	Government of the Islamic Republic of Afghanistan
GLS	General Lighting System
GTZ	Gesellschaft für Technische Zusammenarbeit
IBs	Incandescent bulbs
ICS	Integral collector-storage
ICE	Inter-ministerial Committee for Energy
IEA	International Energy Agency
IMF	International Monetary Fund
IPMVP	International Project Monitoring and Valuation Protocol
IRG	International Resources Group
IRR	Internal Rate of Return
KED	Kabul Electricity Directorate
KESIP	Kabul Electricity System Improvement Program
KPU	Kabul Polytechnical University
KU	Kabul University

kW	kilowatt
kWh	Kilowatt hour
LED	Light Emitting Diodes
MEW	Ministry of Energy and Water
MH	Metal Halide
MIC	Ministry of Industry and Commerce
MOE	Ministry of Economy
MOPH	Ministry of Public Health
MOUD	Ministry of Urban Development
MRRD	Ministry of Rural Rehabilitation and Development
MW	Mega Watt (1,000 kW)
NEPA	National Environmental Protection Agency
NEPS	Northern Electric Power System
NPV	Net Present Value
NSP	National Solidarity Program
O&M	Operation and Maintenance
PRTs	Provincial Reconstruction Teams
RE	Renewable Energy
ROI	Return on Investment
SARI	South Asian Regional Initiative
SEPS	South East Power System
SPP	Simple Payback Period
SPV	Solar Photovoltaic
SV	Sodium Vapor
SWH	Solar Water Heater
T&D	transmission and distribution
TFL	Tubular fluorescent lamp
TOD	Time of day
USAID	United States Agency for International Development
USD	United States Dollar
W	Watt

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TOD page 59

TERMS OF REFERENCE AND BASIC CONCEPT DEFINITIONS USED IN THIS REPORT

USAID's Terms of Reference: This report aims to:

1. Provide an overview of the electricity use (primarily on-grid) throughout Afghanistan and identify major sources of potential savings
2. Provide an analysis of the distribution company customer categories to ascertain consumption and payment patterns
3. Identify and provide an analysis of major customers, including large industrial operations, government buildings, street lighting, water facilities, and military installations (later eliminated from scope)
4. Review any energy conservation or energy efficiency (EE) initiatives, policies, or agencies
5. Provide analysis of the potential for improving EE across the following energy-consuming sectors: industry, public sector/municipalities, commercial/services, agriculture, residential
6. Identify technical, financial, legal/regulatory, market, and institutional barriers to implementation of EE activities.

This report will focus on these last two activities as they will be the foundations of any future large-scale EE implementation program.

Units: Throughout the report we have used metric units and, because of a chronic lack of reliability in the data – often with a range of variation in excess of +/- 15% (population, economic growth, number of customers per class, estimated electricity consumption, appliance prices all vary by such a percentage depending on the official source used), we have rounded all numbers, including exchange rates, kWh, MW, and tariffs in US cents/kWh. As a result, economic and financial analyses will be restricted to simple pay back periods because of (1) these uncertainties and those on the proper rate of discount to use (10-20 percent!) and (2) the fact that most recommended measures pay for themselves in two and a half year or less.

Scope: This report focuses on the end-use efficiency of energy (also called Demand Side Management or DSM in the organized electricity distribution sector), and does not cover the efficiency of Generation, Transmission and Distribution, which are addressed by other donor programs (USAID, Asian Development Bank, and the World Bank). It also focuses on Urban On-Grid, particularly the Kabul area, as it represents the vast majority (80 percent) of regular connected load susceptible to be positively and significantly affected by utility-sponsored programs and other large EE initiatives. It must be remembered that only about half of Afghan electricity customers are formal, paying ones. In addition, the scope – as understood by the Ministry of Energy and Water – is broader than DSM per se, as it addresses the needs at a national level for greater awareness nationwide and capacity building at multiple levels, including universities and the private sector.

ACEP Energy Efficiency Definition: In this report we use the following definition (slightly modified from that used by the US Environmental Protection Agency):

> **"Energy Efficiency refers to the combined effect of using products or systems consuming less primary energy to do the same or better job than conventional products or systems."**
>
> ***Energy efficiency saves energy and natural resources, saves money on utility bills, saves capital in energy production, transportation and distribution systems and helps protect the environment by reducing the demand for electricity and other energy resources.***
>
> ***As a result, Energy Efficiency delivers more useful energy for less and in less time.*** ~~***Energy Efficiency within the electricity distribution sector is also called Demand Side Management or DSM, but Energy Efficiency is a much broader field which includes all other parts of the Energy Sector.***~~

DSM includes the efforts to reduce the need for power generation, transmission and distribution and therefore is a natural product of energy efficiency.

DSM however can be produced from other components. Shifting energy use in time can result in DSM, so can power factor correction.

In summary, EE focuses on reducing energy use while DSM focuses on reducing peak power requirements.

J-bad not yet on NEPS
K-har not on NEPS

EXECUTIVE SUMMARY

In 1993, only approximately 6 percent of Afghanistan's population had access to electricity, and current estimates put this figure between 16 and 36 percent (a consensus estimate is in the low twenties), with the increase having mainly occurred in urban areas. However, there has been real progress in the power sector over the past three years though limited mostly to the supply side, due to the completion of high-voltage transmission lines from the northern energy-rich neighbors to the cities of Mazer-i-Sharif, Pul-i-Khumri, and Kabul. Rehabilitation of several key domestic hydro and thermal power plants and the commissioning of the Tarakhil 105 MW diesel-fired power plant near Kabul have also contributed to this increase in supply. According to the Afghan Energy Information Center (AEIC), the Ministry of Energy and Water (MEW) and the state-owned (but commercialized) monopoly utility *Da Afghan Breshna Sherkat* (DABS), the total domestic operational on-grid capacity is now in excess of 400 MW, and the total domestic operational capacity, including off-grid capacity may exceed 500 MW. Additional available imports bring this number closer to 600 MW; however, there are many constraints attached to these imports, including the lack of reactive power compensation.

Demand for electric power is highly concentrated in the North/Northeast of the country, with over 85 percent of the demand found in the greater Kabul area. Most of the remaining balance is in the four cities of Jalalabad, Kandahar, Herat, and Mazer-i-Sharif. These urban centers make up the fastest growing areas, with a projected power demand growth rate (on North East Power System or NEPS) of over 15 percent annually. Afghanistan's residential sector accounts for more than 80 percent of total energy consumption and demand, followed by the commercial and government sectors with 5-10 percent. The lowest consumer remains the industrial sector, which is responsible for less than 5 percent of the total demand. There are two demand peaks for Kabul, one in the morning and the other (the highest one) during the evening hours of 6-10 p.m. Although the total "nameplate" national generation capacity is over 1,000 MW (1,041 MW) supplemented by 82-85 MW of imports, it is estimated that less than 300 MW actually reach customers' meters, and this is due to several technical failures in generation and transmission, and technical and non-technical losses at the distribution level. In addition, many household appliances and commercial/industrial equipment are old or inefficient; their replacement with state-of-the-art technologies – e.g.,compact fluorescent lamps (CFLs), light-emitting diodes (LEDs), and insulation – could save an additional 30 percent of "losses" that currently stand at a staggering, yet theoretical, 400 MW in total absolute terms (600 MW operational -200 MW of useful end use).

Potential energy savings, however, can never be fully realized because of various technological, economic, financial and institutional/cultural barriers. Based on experience from similar countries – e.g., Nepal, Pakistan, Bangladesh, India, and Sri Lanka – it has been demonstrated that only about 35 percent of potential savings can actually be realized. For Afghanistan this would be equivalent to more than 150 MW of capacity (half of that in distribution and half in end use), possibly avoiding hundreds of millions of dollars in costs for new generation and savings in foreign exchange for imported power and fuel. However, **these numbers are meaningless unless they are translated into specific projects and programs that will actually achieve real savings.**

Through a number of recent studies sponsored by USAID and the World Bank, a number of *short-term* priority programs have been identified as highly cost effective and applicable for most of the major cities of Afghanistan (Kabul, Kandahar, Jalalabad, Mazer-i-Sherif, and Herat). These programs include:

1) **An Information, Awareness and Outreach Initiative**

2) **A series of targeted Efficient Lighting Initiatives**, such as a CFL lamp exchange program in low income households

3) **A mass production and local installation of Solar Hot Water Initiative**

4) **A Large User Initiative** to replace old motors and pumps with new high efficiency motors, especially in water pumping;

5) **An Energy Efficiency Building Initiative**, with new Energy Efficiency Building Code for envelope and appliance components and a focus on HVAC)

Combined, these programs can cut the peak demand in NEPS alone by 30-50 MW in three years (30-50 percent of the end use savings potential), save in excess of 150 GWh/year in 2013, and differ hundreds of millions of dollars in capital for new generation and transmission. However, there are a number of reasons why these activities are not happening at this time. There are both market and non-market barriers to the successful implementation of these programs include.

The market barriers include:

- **A lack of commercial and economic drivers** for energy efficiency implementation The DABS incentive structure ties company financial performance to energy sales, not energy service or avoided costs.

- **A lack of financial incentives in the form of tariffs** that do not reflect the full costs of providing supplies.

- **A lack of finance from existing capital sources** and from within enterprises

- **Sub-standard technologies** such as CFLs that are counterfeit or manufactured to unacceptably low standards.

The non-market barriers include:

- **A lack of information, knowledge and experience** amongst residential, commercial, industrial, low-income, and small business energy consumers.

- **A general absence of the cadres of trained technicians and engineers**

- Broader institutional obstacles to the increased use of energy efficient technologies and practices

International experience has demonstrated that identifying the most promising programs and barriers to address is not sufficient to ensuring overall program success. In addition to sound technical, economic, financial, social, and institutional analysis and a systematic approach to removing the main market and non-market barriers, a number of prerequisites are needed.

To overcome these barriers in tandem with efforts to satisfy these imperatives, the following three-pronged approach is recommended:

A. **Develop a series of short-term (1-3 years) high impact, highly replicable, and high return activities**

B. **Initiate a longer term institutional and reforms process**

C. **Implement high impact, highly replicable demonstration projects**

In addition, concerned organizations must have clear roles and responsibilities in the design, implementation, funding and monitoring processes of all projects. An aggressive ~~energy efficiency~~ DSM strategy is needed to capture most of the current and future potential savings identified in this report. Between now and 2012/2013, Kabul and other cities throughout Afghanistan have a remarkable window of opportunity to virtually free themselves from the burden of having to draw on costly diesel thermal power. This can be accomplished by reducing the evening peak load by 30 MW in 2013 and 50 MW by 2015.

SECTION 1: THE STATUS OF THE AFGHAN POWER SECTOR

Afghanistan has one of the lowest overall energy and per capita use in the world (20 Watts/capita vs. world average = 700 Watts/capita), ranking it 176 out of 212, below Congo and Rwanda, according to the International Energy Agency. Estimates of the rate of electrification (percentage of the population having access to electricity) range between 16 and 36 percent, with a consensus in the low twenties.

Still, there has been significant progress in power generation and distribution over the past three years with the rehabilitation of some hydro and thermal power plants and the commissioning a new 105 MW diesel-fired power plant near Kabul. In other sectors of the economy and public services, measurable improvements have also been made, including in transport, social services, and electric power distribution systems. Based on the latest statistics, as provided by the Afghan Energy Information Center (AEIC), the Ministry of Energy and Water (MEW) and its subsidiaries, *Da Afghan Breshna Sherkat* (DABS) and local distribution companies, the total installed on-grid operational capacity is in excess of 505 MW, and the total installed capacity, including off-grid generation, may exceed 630 MW. It is to be noted that there is no agreement on these numbers (nameplate, operational, operating, firm, dispatchable, available and on line capacity, as shown later in this report, ACEP has retained the following respective assumptions for on-grid power: 1041MW, 620, 400, 319, 115, 400 and 405 MW, including imports)

But these numbers can be misleading in terms of the amount of electricity actually available to end-users because there are many barriers that prevent customers from being able to utilize available power resources. Many constraints exist in the distribution systems, and the slow rate at which new service connections can be made available to consumers, particularly in Kabul. The USAID-supported Afghanistan Clean Energy Program (ACEP) estimates that the maximum "usable" domestic grid capacity in 2010 is only about 319 MW, whereas the actual load peak is only 220 MW for Kabul, the largest regional customer center by far (Source: AEIC)

At any rate and by any standard, the above-stated estimate of 20 Watts per capita is a very low figure. Accordingly, the Government of the Islamic Republic of Afghanistan (GIRoA) and donors have placed a high priority on investments in new transmission and distribution (T&D), where more than $2 billion is planned for the next five years. This level of investment in T&D is also needed to accommodate increasing power imports for the northern countries of Uzbekistan, Tajikistan, and Turkmenistan.

A SECTOR ORGANIZATION

The power sector consists of (1) the Ministry of Energy and Water, (2) the vertically integrated but commercialized utility DABS and its regional distribution companies such as the Kabul Electricity Distribution company, (3) the soon-to-be established Afghanistan Energy Regulatory Agency (AERA), and (4) other organizations. DABS was separated from MEW in 2009 and is a limited liability company whose shares are entirely owned by four ministries of the GIRoA. DABS is now responsible for the operation and management of electric power generation (over 100 kW), imports, transmission, and distribution throughout Afghanistan on a commercial basis. In the next paragraphs, we describe each organization in more detail.

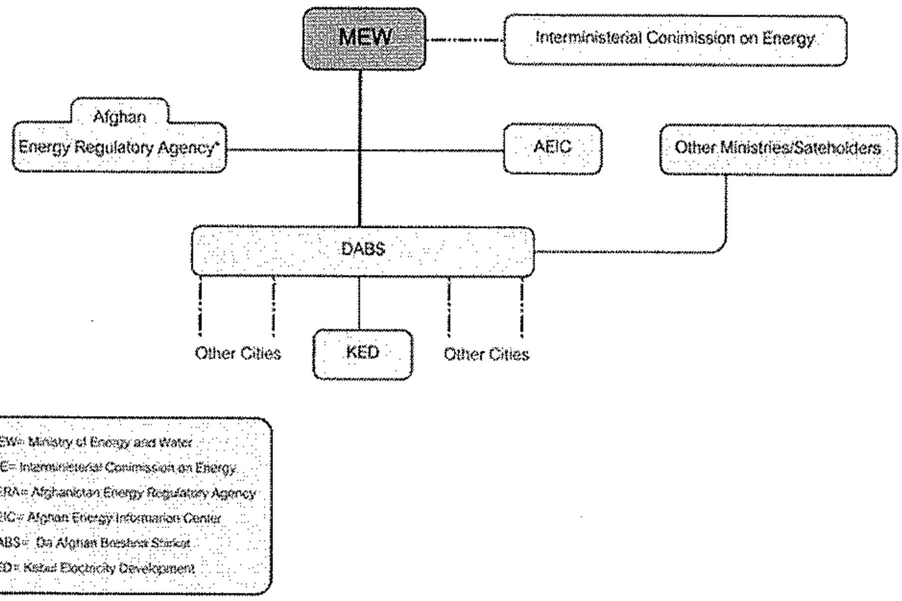
Neither DSM or

DSM

A.1 THE MINISTRY OF ENERGY AND WATER

In supporting the socio-economic growth of Afghanistan, the MEW is responsible for preparing and managing national policies of the energy sector with the exception of those management or implementation policies that are assigned to the yet-to-be established AERA by the Electricity Law. The guiding and development direction of the planned energy sector of Afghanistan is subject to the policies under this law. Factors to be considered in determining and evaluating needs of the energy sector include the use of coal or natural gas as fuel sources for energy production, capacity of renewable energy, energy efficiency (EE), and assessing financial issues that impact electricity enterprises in Afghanistan. EE is not yet fully incorporated into the MEW mandate, but ACEP is making efforts to have the draft text of the law changed accordingly.

Exhibit 1. Energy Sector Organization 2010 (In Reorganizaiton)

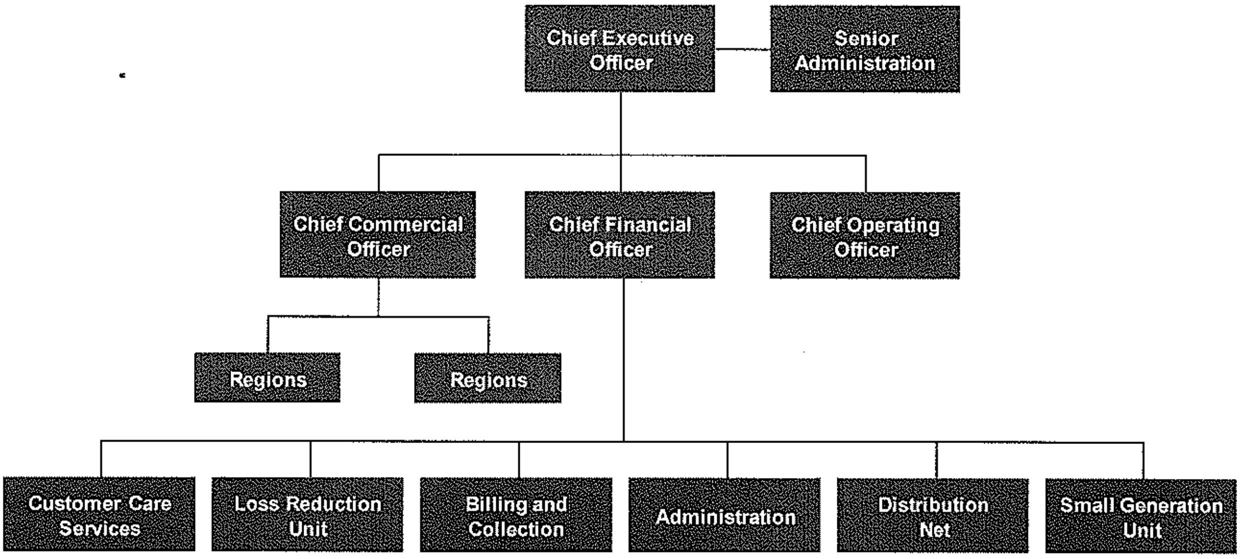


For the responsibility of MEW see Annex III.

A.2 DABS AND ITS SUBSIDIARIES

~~As mentioned above~~, DABS is the national, yet commercialized, electric utility, which operates and manages electric power generation (units of over 100 kW), imports, and T&D throughout Afghanistan on a commercial basis. The company remains in a precarious financial state, and in 2008 it had to be rescued from collapse by donors. Improvements in collections and reductions in fuel costs due to higher imports have also contributed to an improvement in its finances. The utility is now organizing itself along the lines of a commercial company (see below).

Exhibit 2: DABS Organization



A.3 AFGHANISTAN ENERGY REGULATORY AGENCY

The GIRoA intends to establish the AERA in the near future. It will carry out typical regulatory functions such as issuing licenses, providing oversight of all DABS operations, setting tariffs, and regulating utility DSM activities. As far as ~~EE~~ is concerned, the AERA will be responsible for demand-driven tariffs e.g., Time of day (TOD) and mandatory demand side management (DSM) programs, when they become available.

A.4 OTHERS

- **Ministry of Rehabilitation and Rural Development (MRRD):** The MRRD oversees power operations for non grid, "rural" generated sources. Such sources are usually small-scale renewable energy supplies, and provide less than 100 kW ~~on average~~
- **Provincial Reconstruction Teams (PRTs):** PRTs are involved in the reconstruction of off-grid systems, including distribution and end-use efficiency
- **Other**: Private, unlicensed ~~mini-grids~~ operate independently both in rural and urban areas

B MAIN SECTOR CHARACTERISTICS

In addition to the national generation capacity of 1,000 MW nameplate (565 MW operational, of which 505 MW is under DABS (see Section I, Chapter D for details), Afghanistan's power sector also has access to more than 320 MW of imports. These imports, however, are currently limited to only 160-180 MW due to a number of technical challenges that inhibit the overall potential of the North East Power System (NEPS) e.g., reactive power. Most of this supply originates in Uzbekistan and Turkmenistanm but an increasingly amount of energy now comes from Tajikistan as well. Today's actual "draw" is 82-85 MW on average.

B.1 TARIFFS

Electric tariffs are set by class of customers and level of consumption in the residential sector.

Exhibit 3: Current DABS Tariffs (June 2010)

		Afs/KWh	Cents/KWh (rounded)
Residential			
	0 – 300 KWh	1.5	3.1 (3)
	300-700 KWh	3.0	6.3 (6)
	>700 KWh	6.0	12.5 (12)
Commercial/Industrial			
	Registered	6.0	12.5 (12)
	Unregistered	10.0	20.8 (21)
Government		10.0	20.8 (21)
Exchange Rate		48.0 Afs/USD	

Note that consumption brackets are based on a bi-monthly billing cycle.

B.2 ECONOMIC GROWTH

Fortunately for Afghanistan, according to the International Monetary Fund, the economy has recently started to grow and in 2010 and the real GDP is expected to increase by 15 percent, driven by a rebound in agriculture. In addition, higher spending by the GIRoA and coalition forces has boosted other sectors of the economy. Inflation dropped from 43 percent in May 2008 to 13 percent in November 2009, when core inflation (excluding food) was essentially zero. Short-term interests declined from 15 percent in May 2008 to 5 percent in November 2009. Still, 43 percent of the Government's operating and development budget is financed by donor grants.

The country's now rapid rate of economic growth exerts increasing pressure on the power system, especially in urban areas (Kabul, Kandahar, etc.) where the service sector and the upper middle class are expanding at a rapid rate. The latest statistics from the Ministry of Economy (MOE) and the Bureau of Statistics show that the rate of increase of electricity demand may outstrip that of economic growth. If the economy, especially in the Kabul-Kandahar corridor, is going to grow at 9-10 annually, driven by the construction and small industry activities, power demand will expand at a 12-15 percent annual rate over the next 10 years (consensus with DABS, AEIC, Inter-ministerial Committee for Energy [ICE]) and Afghanistan will need an additional 1,000 MW of generation capacity and related T&D investment over the next 10 years. This is expected to cost a minimum of $5 billion, or $500 million per year, an amount that will not be sustainable in the near future with Afghanistan's annual GDP remaining in the range of $15-20 billion. However, it is expected that increased imports will be able to meet some of the increased demand, at least in the short term.

C. THE DILEMMA FOR FUTURE INVESTMENTS

Afghanistan is now confronted with the following critical questions:

1. How much new generating capacity to build in the next few years to satisfy exploding customer demand?
2. To what extent can it rely mostly on increased imports?
3. How much existing consumption can be reduced without decreasing the level and quality of provided services?
4. How can DABS optimize its operations while faced with these constraints?

As shown is other countries, e.g., India, greater EE and aggressive DSM programs can be the answer. The need for EE may not appear in mid-2010 as critical as it was last year because of the sudden increase in supply created by both the commissioning of the 105 MW diesel-fired Tarakhil power plant and the increase in imports (combined increase of over 250 MW), but the following factors still exist to make a strong case for EE:

1. Unmet urban demand remains estimated at over 200 MW and consumers are "crying" for more power to the point that they are still relying on diesel-based private mini-grids selling power at over 50 cents/kWh.

2. Even at the low rate of new connections, DABS will soon have connected most large users (10 kW), including all embassies, industries, large commerce, and residential customers, and will have no excess supply.

3. Although the current rate of connection is not clear, one can estimate that over 100 MW of new load may be connected over the next 12 months and that the load in the Kabul area, including organic demand growth, will then exceed 350 MW, a number above current combined hydro and import capacity.

4. As a result, it is likely that the Tarakhil power plant will run on an almost daily basis, making the marginal cost of power during evening peak hour 21 cents or more, depending on the fuel price.

The dilemma that the GIRoA will then face is often referred to as **"Negawatt vs. Megawatt,"** which is common in countries with a deficit of capacity and where investment is needed to meet increasing demand. This is not a theoretical question. Indeed, in the average Kabul household (seven people), the peak load is around 200 W in the early evening hours, most of which is for lighting. If, for example, the current incandescent bulbs (IBs) are replaced with compact fluorescent lamps (CFLs), the total load would be reduced by 30-40 percent. On the other hand, if light-emitting diodes (LEDs) are chosen instead of CFLs, the load can be reduced by 50 percent or more. Additional savings can be achieved by the use of other key home energy efficient appliances, of which water heating, ironing, and TV constitute the major consumers of electricity.[1]Under such conditions, Afghan households could have a choice between two attractive options: either "pocket the savings" or add one more needed appliance, such as a new refrigerator, at no cost increase in the monthly power bills.

The dilemma and options are the same on the national level. Over the next 10 years, the Government can choose to either create an additional 1,000 MW of new generation/ transmission at a cost of well over $5 billion (assuming no increase in imports) or embark on an EE path where this need could be reduced by 10 to 20 percent, with far less investment needed and additional fuel savings for peaking power plants.

C.1 POTENTIAL

As mentioned above, the potential for improving the efficient use of energy with new technologies and better awareness of the Afghan user is significant. Indeed, the total nameplate capacity is over 1,000 MW and the actual power available for end-users is around 400 MW (on-grid and off-grid). Whereas little potential exists for efficiency improvements per se in generation (largest plants have just been built – Tharakil – or rehabilitated, i.e., Naglu) and transmission, a very large potential exists both in distribution and end use.

---

1 2007 SARI report "2006 Household energy use in Kabul." Prepared by Winrock International and Kabul Polytechnic University under a small grant from USAID.

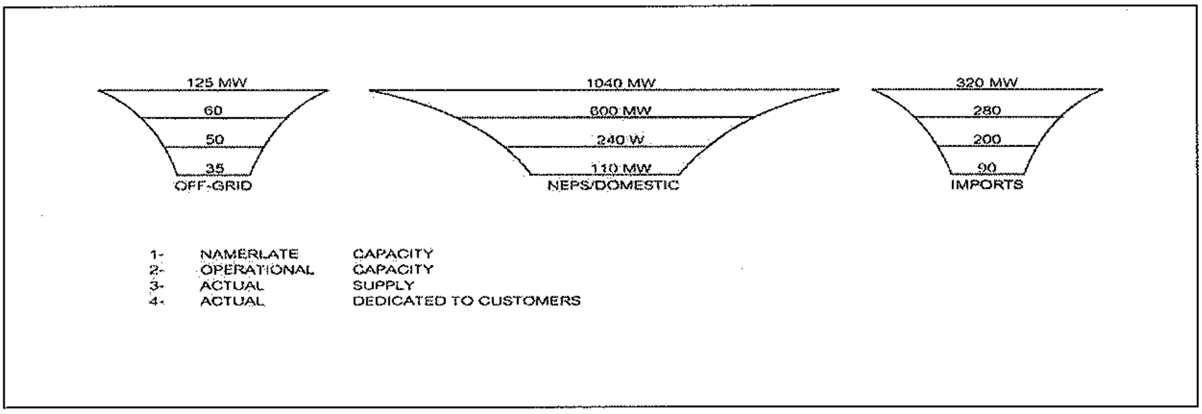
While this assessment report is tasked with identifying the potential for savings at the end use, i.e., "after the meter," the potential for efficiency improvements in distribution is the object of another USAID contract (Kabul Electricity System Improvement Program (KESIP), implemented by PA Consulting).

Based on the work carried out by the Kabul Electricity Directorate (KED) and KESIP on distribution to date, it appears that total losses (commercial and non-commercial, including non-collection) are 51 percent of inputs, which is a staggering 111 MW for Kabul, and over 150 MW nationwide. Naturally, all this potential cannot be totally captured, but if we use as a benchmark 15 percent as a target for total losses, then the potential for total savings is in excess of 100 MW and 350 GWh/year.

At the end-use level and over the next five years, based on the preliminary results of our Kabul survey, it can conservatively be estimated that today's saving potential is 10-20 percent of the current level of use, or no less than 30 MW at 2010 conditions and probably 50 MW by 2013. New EE activities and programs will lead to very tangible, verifiable, and meaningful energy cost savings to the end-users and to the nation as a whole, as we will show in the remainder of this report.

We therefore conclude that from the current 505 MW of on-grid generation capacity existing within the country, no more than 200 MW actually reach the customers and only a fraction of this figure is "useful energy," that is, the amount of energy that would only be needed if efficient appliances were used (see Exhibit 4).

Exhibit 4: Afghan System Losses



C.2 CURRENT STATUS OF ~~ENERGY EFFICIENCY~~ ACTIVITIES IN AFGHANISTAN

As of June 2010, there is no organized national program or activity in the sphere of EE or conservation. The current draft electricity law mentions EE only once and does not offer any specific policy recommendations in this field. The current draft of the Afghan Building Code makes no reference to energy and the Afghan National Standard Agency (ANSA) is only at the stage of planning activities for electro-mechanical equipment and appliances, with a target of 2010-2011 to develop draft standards.

In February 2010, the MEW established an EE Sub Department in its Policy Department and is currently recruiting four engineers to staff it. The establishment of the **MEW EE Advisory Committee** mentioned above has been a major development. Nevertheless, there is currently no EE activity or plan, nor does DABS or any of its electricity distribution companies have such as plan. As is the case in many other areas, donors and NGOs have taken the lead (see table below), with a number of programs related to the building envelope (GERES) or appliances (World Bank). ACEP is now starting to assist the MEW in initiating meaningful programs, as under this USAID program.

C.3 KEY PLAYERS AND ACTIVITIES

and DSM

As shown below, a number of organizations are involved in various EE activities in the power sector, but without proper coordination until the recent creation of the National EE Advisory Committee.

Exhibit 5: Current Players' Activities

Organization	EE Activities
MEW	Creation and staffing of an EE sub department within the Policy Department; establishment of the EE Advisory Committee, projected construction of a "green policy building" for AEIC with EE technology show room under ACEP financing
MOUD	2007-2009 detailed household surveys, including energy supply questions; interest in adding energy chapter/volume in new Afghanistan building code
MOE	EE mentioned in National Afghanistan Strategy, Energy section. Interest in incentives
MOC	Working with ANSA on construction material standards
MOPH	Interest in EE and renewable energy (RE) technology applications, particularly SWH
NEPA	New EE department under development within MEW
ANSA	Number of activities on appliances and electrical equipment norms and standard development (target= 2010), with testing laboratory financed by EU. Commitment to work on end use home appliances norms, standards and labeling in 2011
KABUL POLYTECHNIC UNIVERSITY	20 years of experience in RE and contractor for 2006 Winrock International/SARI Household energy survey
KABUL UNIVERSITY	20 years of experience in RE, especially solar applications. Interested in EE curriculum development and hosting pilot EE projects
AFGHAN ENGINEERING ASSOCIATION	Interested in establishing EE chapter with National EE engineer association and certification of Energy Auditors. Professional organization for the development of an Afghan EE private industry (assembly, manufacturing, audits, Energy services industry [ESCO])
WORLD BANK	Energy audits at large user facilities (Government) and Residential re lamping in Kabul
USAID AIRP	Training activities; coordination with ICE and Energy Data base activities (IRD)
USAID SARI	National assessment study; 2006 survey; training of MEW staff in India
GERES	Multiple activities in passive solar of on grid and off grid housing; cottage industries; insulation, weatherization; new and traditional building materials, building codes, zero energy buildings
GTZ	Elements of EE activities in MOU; support to ANSA for appliance and electrical equipment testing, norms and standards

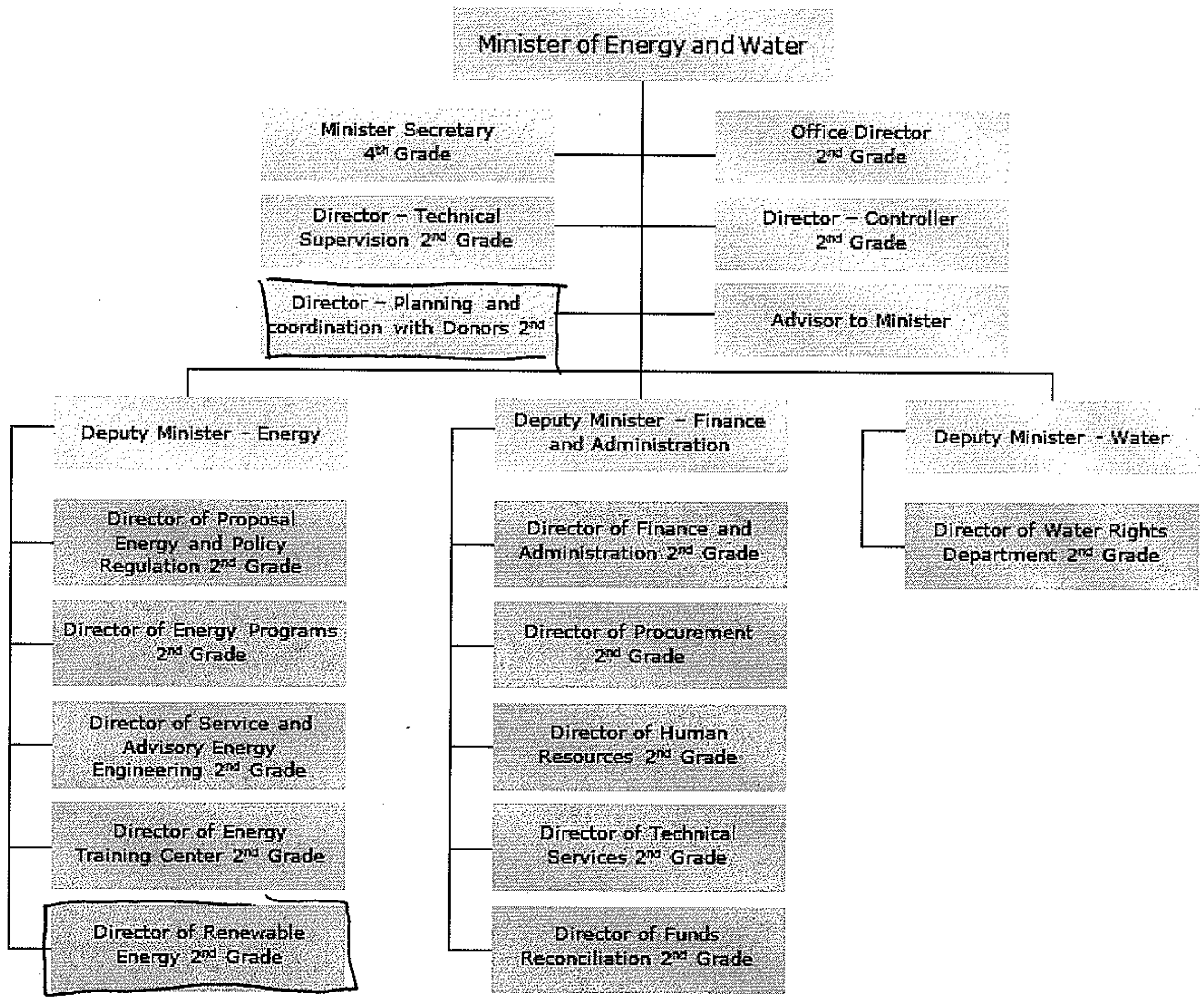
C.4 IMPLICATIONS

Although the concepts of EE and demand side management are new in Afghanistan, they are rapidly gaining interest at the MEW, DABS, KED and academic bodies, NGOs, and private sector entities. The newly established EE Advisory Committee (EEAC), which includes more than 15 national stakeholders from representatives of the MOE, the Afghan Engineering Association, and the ANSA, is now leading the way. Implementing a nationwide EE program would have the key benefits of:

1. Reducing the bills to customers
2. Freeing power for new applications or new customers and increase the electrification rate
3. Improving DABS finances by cutting losses from non paying customers
4. Reducing the need for new investments in generation, transmission, and distribution
5. Improving the environment by reducing emissions resulting from running thermal power plants

In the next chapter we summarize the objectives of this study and present our approach to meet these objectives.

Exhibit 6: Proposed Organizational Structure for MEW Policy and Strategic Planning Department



Where is this exhibit referenced from?
Where is 'EE Advisory Cmte'?

D. CURRENT POWER SUPPLY SITUATION

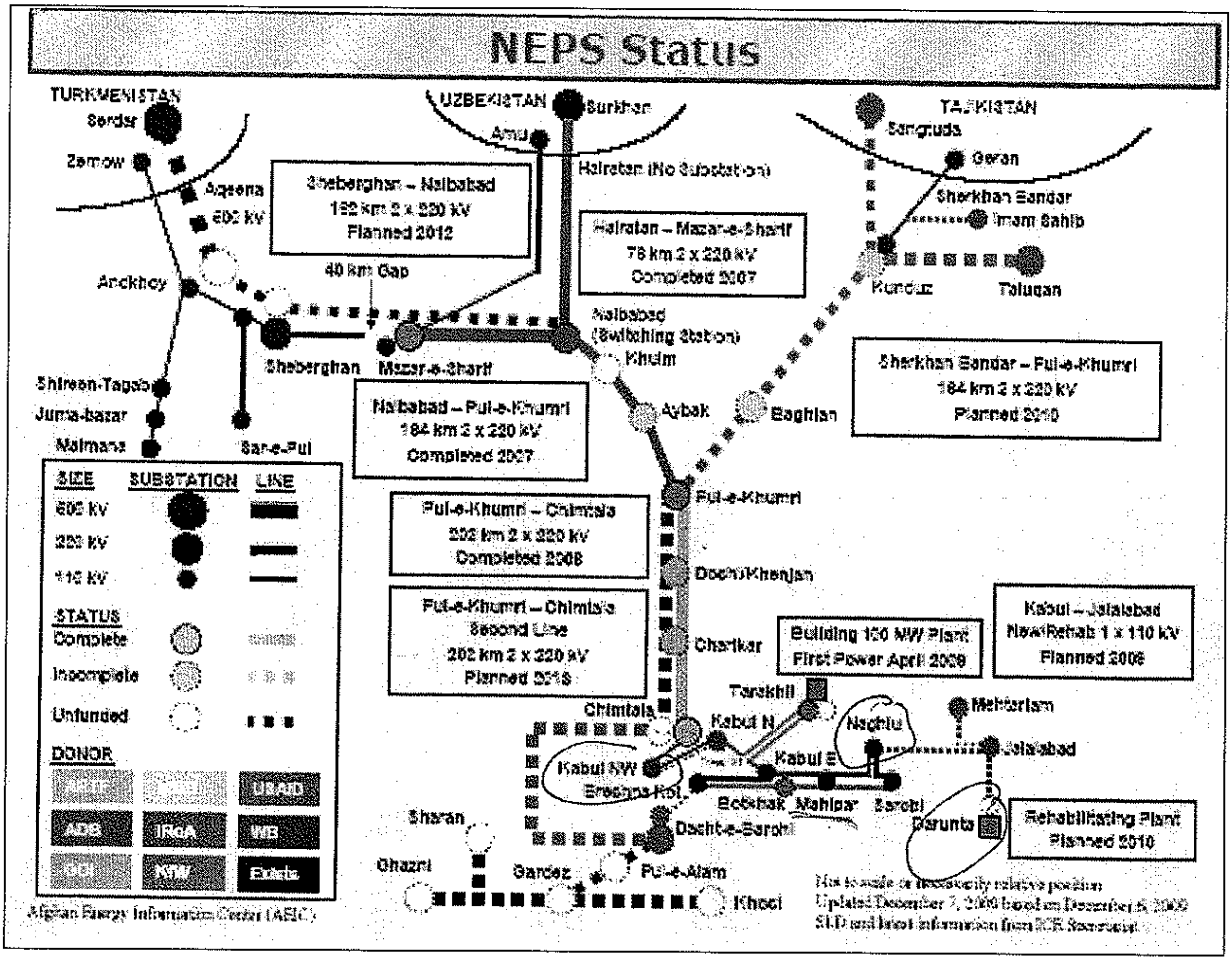
~~As mentioned above~~, electricity supply in Afghanistan today is about 50 percent domestic (a combination of hydro and thermal power plants), and 50 percent imported from Uzbekistan, Tajikistan, and Turkmenistan.

When all NEPS high voltage lines are at full capacity (with Reactive Power Correction), imports may actually exceed 300 MW during peak demand. The attractiveness of these options rests in their low cost as a marginal source of power ($20/MWh in the Northwest from Turkmenistan to about $60/MWh in the North-NEPS). When compared to a peaking power cost of over ~~US~~ $210/kWh for the Tharakil and North West Kabul thermal power plants, it is expected that imports of cheap hydro power will only go up to meet increased level of demand from Kabul and other urban areas in northern Afghanistan.

Exhibit 7: On-Grid Generation Power Plants

			Current	Max (End of 2010)
1 HPP	NEPS	Nagla	75	100
		Sarobi	22	22
		Mahipar	12	20
		Darunta	9	9
		Puli - Khumri	6	2
		Total	125	153
	Others	Kajaki	31	51
		Other (MHP)	10	15
		Total	41	66
		GRAND TOTAL	166	219
2 TPPS	NEPS	Tharakhil	33	105
	Others	Kandahar	6	9
		Other	30	37
		Total	71	151
3 IMPORTS		Imports	84	120 (260 After RPC)
		GRAND TOTAL	321	440 (630)

Exhibit 8: Northern Electrical Power System Chart – April 2010



Exhibits 7 and 8 clearly show that the Tarakhil power plant will remain the marginal generation plant for years to come because of its high fuel cost.

D.1 EXPANSION PLAN (ON-GRID)

At the time of writing, there is neither an official generation expansion plan nor any power master plan for Afghanistan. The last comprehensive plan was prepared by the Nordic Consulting Company in 2006 and was published in 2007. This plan never materialized and was overly ambitious with a predicted load in 2010 of over 600 MW in NEPS vs. an actual figure of half that size. The Australian firm SMEC is currently under contract with the Asian Development Bank (ADB) to develop Terms of Reference for a new study, but results will not be available until late 2011 at the earliest. For the sake of this study, ACEP has reviewed all data available at the ICE, MEW, DABS, and AEIC, and interviewed the most knowledgeable people at the MEW's Planning Department, Black and Veach, SMEC, and AEAI. Subsequently, ACEP arrived by consensus that given the temporary surplus of imports, Tharakil power generation, the security problems in SEPS, the availability of imports in the North (Herat, NEPS), no significant addition of generation capacity (perhaps 10–12 MW of hydro only) will take place before 2015 (end of our study horizon). Therefore, Tharakil will remain the marginal power plant for the peak evening hours ($210/kWh) and imports from Uzbekistan – the marginal source of supply for the rest of the day ($60/MWh), making low income customers (less than 100 kWh/month at 3 cents/kWh) the only subsidized class. The associated load curves and dispatch forecast to 2015 are presented in the chapter on Demand.

D.2 SMALL DIESEL POWER

As opposed to previous technologies, small diesel generator sets are not exclusively used in rural areas. Unfortunately, they are also widespread in urban areas, such as Kabul, and contribute to a large extent to air pollution and act as disincentives for expansion for the national grid.

Diesel power is heavily promoted by the NSP, resulting in around 66 MW installed capacity in rural villages (see Exhibit 9 for a broader description of the overall off-grid generation in Afghanistan). However, promotion was stopped after the first round of the program due to operation and maintenance (O&M) problems and low acceptance among the users due to the high fuel prices.

GTZ estimates that outside of the grid-based cities and towns, there are about 5,000 mini-grids, of which half use diesel generating sets (in villages, towns, and large cities). Although their total operational capacity is probably in the 50-100 MW range, there is no reliable data about these systems and they are not a priority in the scope of this study, unless they belong to the group of small and middle scale new or rehabilitated min grids, e.g. Bamiyan.

D.3 SUMMARY

As shown in the summary table below, the total (on grid + off grid+ import) nameplate capacity may be in excess of 1,000 MW. However, the total operational on-grid and off-grid capacity is probably only 400 MW (plus up to 300 MW of imports when full synchronization is achieved).

Exhibit 9: Total Power Generation Capacity in Afghanistan (On-grid and Off-grid)

	On Grid	Off Grid	Total
Hydro	219	59 (GTZ)	278
Thermal	151	46 ***	197
Other	120 (Import)	1**	121
Total	490	106	596

*** Wind and Solar

** MRRD, GTZ

E. CURRENT POWER DEMAND SITUATION

Unmet demand for affordable power is very large. In order to reach Pakistan's level of 512 kWh/ year/capita, for instance, the country would need 15 million MWH/year as opposed to the current 3 million MWH, a five-fold increase.

In Kabul, total estimated economic (unmet) demand is conservatively estimated to be in excess of 400 MW vs. the current system peak of 220 MW, as demonstrated during the 2009-2010 winter, a 50 percent shortfall. However, "unmet demand" is an elusive concept in Afghanistan. According to the DABS and MRRD, if all customer demands for connections were met it would take at least two years and this would just absorb the existing excess capacity in NEPS.

Due to existing technical constrains (lack of synchronization in NEPS and lack of connections in Kabul and on the NEPS system), the marginal system generation unit is and will remain **a marginal Kabul Thermal Power Station, either Tarakhil or Kabul North West.** As a result and in any case, **the marginal cost of generation is and will remain for several years above $210/MWh** (see Exhibit 10: Cost of Power/hours in NEPS). With this in mind, we will use the following references for the purpose of our load and EE options economic and financial analysis:

Economic analysis: Morning peak time (5-14 hours) marginal cost=imports=$60MWh; Evening peak time (17:00-23:00 hours) marginal cost= Tarakhil fuel= $210/MWh. For off peak (23:00-5:00 hours), marginal cost is run of river hydro or $5/MWh

Financial analysis: Respective values are prevailing tariffs that do not take into account TOD (from $30 to $200/MWh, depending on the class of customer).

Exhibit 10: Cost of Power

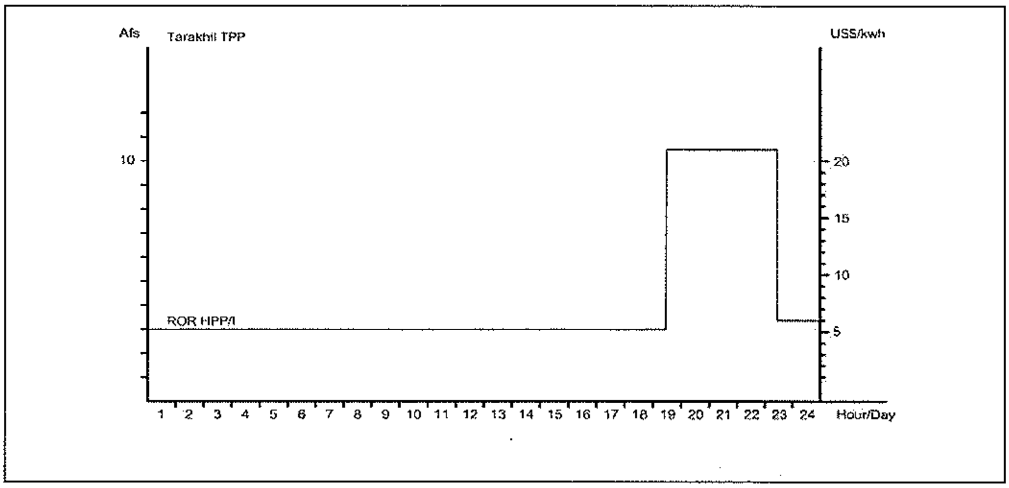
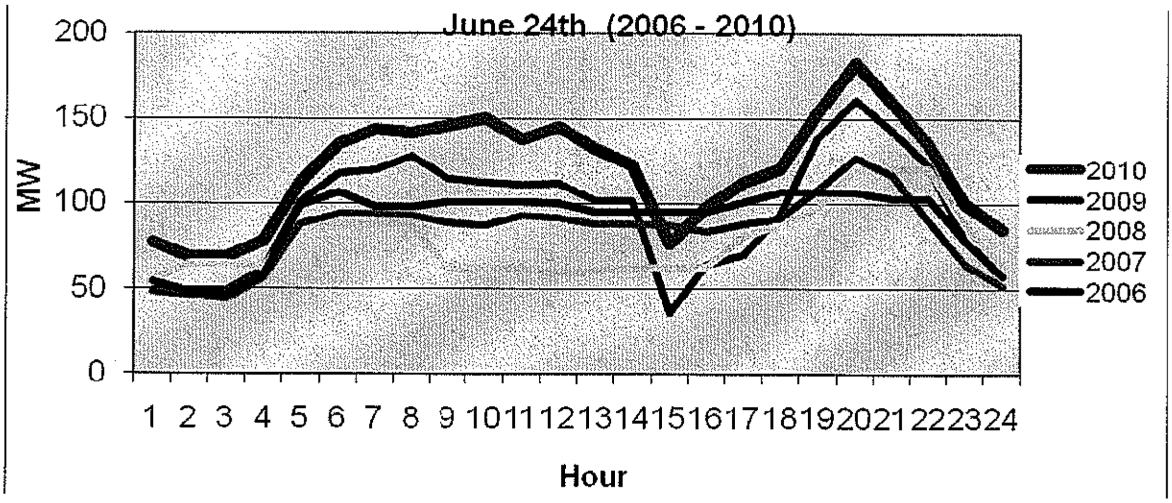


Exhibit 11: Kabul Power Output (MW)



Source: AEIC

E.1 STRUCTURE OF DEMAND

As shown in Exhibit 11, a summer day load curve for Kabul has a trough between 13:30 and 18:30 and a peak of around 200MW (40 MW peak per se) between 18:30 and 22:30 hours. This peak is a major target for DSM as it corresponds to the period of highest supply cost (Tarakhil or imports). Geographically, demand for electric power is highly concentrated in the North/Northeast part of the country and for residential users.

E.2 REGIONAL DEMAND

With the exception of the Herat and Kandahar areas, most on-grid demand is within NEPS, with over 80 percent of the national demand. The Kabul/Jalalabad corridor, which represents over 70 percent of national demand, is the fastest growing area, with a projected power demand growth rate (on NEPS) of over 15 percent annually. Other cities outside of NEPS are seeing no increase in supply, mostly due to lack of security, especially in places like Kandahar. As a result, unmet demand continues to rise, contributing to increased frustration among customers.

E.3 SECTORAL DEMAND

According to AEIC, DABS, and the MRRD and previous surveys, Afghanistan's residential sector accounts for more than 70 percent of total consumption and demand, with the commercial sector and the government sector accounting for a further 5-10 percent and the industrial sector responsible for less than 5 percent of the total national consumption.

Exhibit 12: National Consumption by Customer Class in GWh/y (2009)

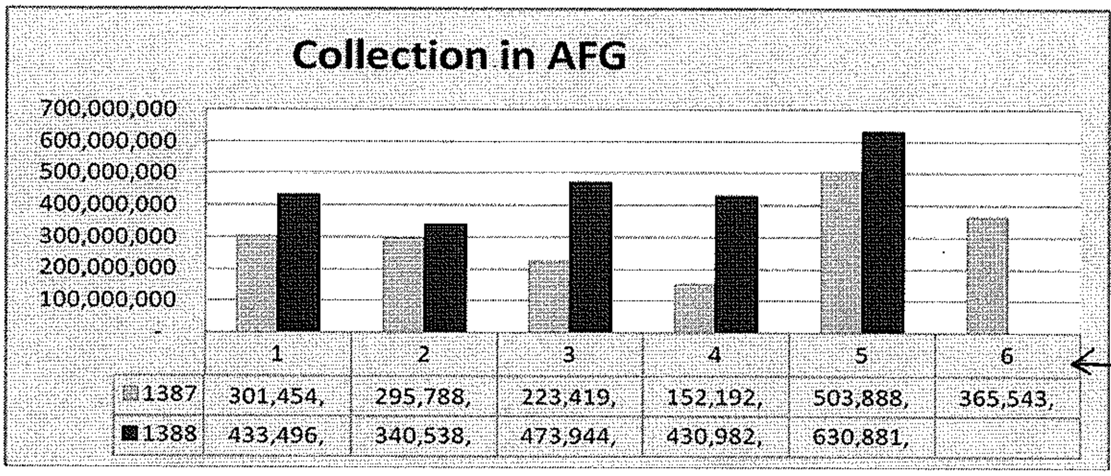
	Kabul	Country	Percentage
Household	491.2	1,026.1	72.99
Commercial	74.5	124.3	8.84
Industrial	32.0	87.4	6.22
Government	98.6	149.3	10.62
Other	6.7	18.7	1.33
Total	703.0	1,405.8	100.0

Nationwide, the residential demand accounts for over 70% followed by government and commercial both are around 10%, industrial sector still remains quite low around 5% and the same patter has been found in most of other Afghanistan main cities such as Jalalabad, Herat, and Kandahar. Looking forward to 2015 and based on interviews with MOUD and Kabul Municipality, we forecast a large increase in industrial and commercial load, driven respectively by economic growth and the need for more air-conditioning in buildings, and power demand in Kandahar and Herat for their economical development.

E.4 COLLECTION OF REVENUE

Based on the information from DABS, the collection of revenue has improved as compared to the previous year. In the year 1387 (2008) the collection was only 1839 million Afs and, in 1388 (2009), the collection was more than 2,300 million Afs within a 10-month period. More recent data indicates a continuation of this trend over the past few months. The exhibit below shows the collection of the last two years:

Exhibit 13: Collection of DABS in Afs



Source: DABS

E.5 NATIONAL ENERGY DEMAND SCENARIO: BASELINE PROJECTION

As our time horizon is only five years and our program three years (FY 2011-13) and because of the unreliability of all basic data (economic growth, construction, connections, etc.) to establish future contrasted demand scenarios, we have decided to work from one single baseline, based on a consensus of data from DABS, MEW, AEIC, AIRP and KESIP. Within three years, the shape of the basic load curve is not expected to change significantly, as most of the growth will be will large residential and commercial buildings, all contributing to the evening peak (as opposed to small commerce and industry).

rest from where?

Exhibit 14: Study Flow Chart

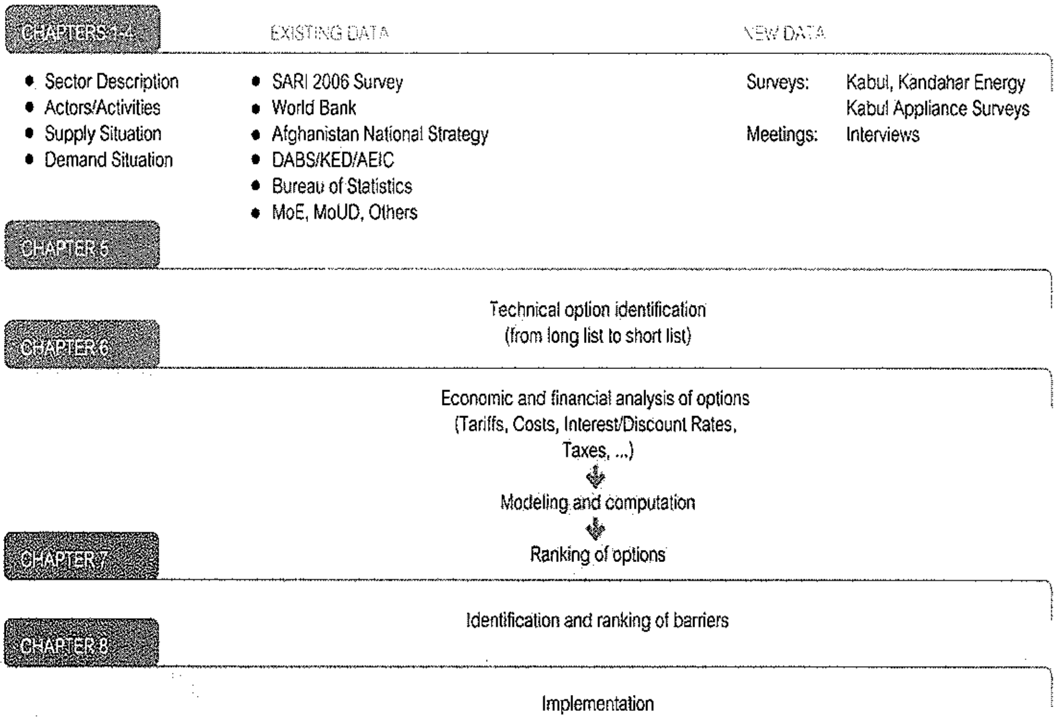
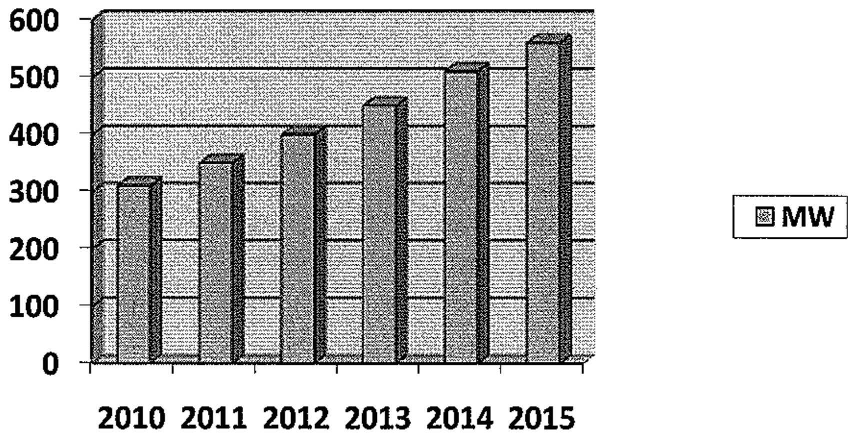


Exhibit 15: Kabul Load Growth projection



I thought it was 220-MW this year, not 305-MW

SECTION II. ENERGY SAVINGS OPPORTUNITIES

The full potential of savings estimated in Section I (100-150 MW and 350- 600GWh/y) cannot be totally captured within the period because of a number of technological, economic, financial, and institutional/cultural barriers. **More importantly, all of these macroeconomic numbers are meaningless if not translated into specific, well documented activities, projects and programs.** This why we did not spend much time in refining these estimates of potential savings as they often prove irrelevant in similar studies IRG has done in other countries (e.g., Pakistan, Thailand, and Indonesia). Rather, we will identify and screen a number of technical and managerial activities that can effectively reduce either peak demand or consumption. When dealing with the power sector, EE measures are often called Demand Side Management options, although DSM should apply only to utility driven or mandated activities. In Afghanistan, more than 50 percent of the electricity consumption falls within the informal sector – that is, customers that are not recognized by DABS as official customers. However, for simplicity reasons, we will refer to DSM for all activities aimed at saving electricity but trigerred by outside parties: utility, government, agencies or other outside organizations

In this chapter, we will first review some useful concepts that are used throughout the report. We then present a "long list" of "DSM options" (according to our definition above) that can technically be applied to the various sectors of the Afghan economy. Finally, we narrow down this long list into a "short list" using multi-criteria DSM screening techniques. A more detailed discussion of DSM is shown in Annex II. We have drawn on accepted definitions of DSM used by the Renewable Energy Institute Demand Management (see: info@RenewableEnergyInstitute.org) and www.DemandSideMangement.com.)

A. DEMAND SIDE MANAGEMENT: WHAT IS IT?

DSM is used to describe the actions of a utility, beyond the customer's meter, with the objective of altering the end-use of electricity – whether it be to reduce demand or shift it between high and low peak periods, or manage it when there are intermittent load demands – in the overall interests of reducing utility costs. In other words, DSM is the implementation of those measures that help the customers to use electricity more efficiently. DSM can be achieved through:

- Improving the efficiency of various end-users through better housekeeping, correcting energy leakages, system conversion losses, etc.
- Promoting use of energy efficient technologies
- Demand management through adopting soft options, such as higher prices during peak hours, concessional rates during off-peak hours, seasonal tariffs, interruptible tariffs, etc.

DSM, in a wider definition, also includes options such as renewable energy systems, and combined heat and power systems.

The terms EE and DSM are not interchangeable. It is important to point out that DSM explicitly refers to all those activities that involve deliberate marketplace intervention by the utility in order to alter their consumers' behavior. EE practice includes any activity that would lead to a reduction in losses, such as upgrading overloaded distribution lines. To further make this distinction , a program that encourages

Page break

customers to install energy efficient lighting systems through a rebate program or a free bulb exchange would fall under DSM. On the other hand, when customers purchase energy efficient lighting as a reaction to the perceived need for conservation this is not DSM, it is an EE event.

B. DSM OPTIONS FOR AFGHANISTAN: A LONG LIST AND KEY CHARACTERISTICS

The comprehensive identification of suitable and practical DSM options requires a detailed study of users and end-uses of electricity. An understanding of end-uses of electricity helps to identify end-use options that offer maximum DSM potential. The study of users and end-uses of electricity enables the identification of generalized DSM options – i.e., which end-use and/or which customer sector and/or segment can be targeted. The need for more specific options, for the purpose of DSM implementation, would require identification of alternatives. In other words, a listing of all available options that can replace existing conditions in order to achieve DSM objectives is required.

Based on the outcome of the assessment report, ACEP is preparing to implement a number of initiatives aimed at reducing peak load demand on electricity network. In this direction, a comprehensive list of DSM measures has been prepared based on the available information and by visits to residential, commercial, and industrial units. A process of screening was then applied to that list and it is described in the next paragraph.

Exhibit 16: Long List of DSM Measures

No.	DSM Measures	Availability	Applicability	Adoptability	Demo Success Track record	Awareness	Potential Benefits	Selection (not in order)
A	**Residential**							
1	CFL	H	H	H	H	H	H	1
2	FTL (T5)	L	H	M	L	M	H	2
3	Electronic Ballast	L	H	L	L	L	M	2
4	EE Refrigerator	H	H	H	H	L	H	4
5	Solar Water Heater	H	H	H	H	M	H	3
6	EE TV	H	M	M	L	L	M	
7	EE Computer & printer	H	M	M	L	L	M	
8	EE Air condition	H	H	M	M	L	H	5
9	EE Fan	H	H	H	H	M	H	5
10	EE Electric Pump	H	H	L	M	L	M	
11	EE Rice Cooker	H	H	L	M	M	M	
12	EE Iron	H	H	L	M	L	M	
13	EE Micro Oven	H	M	L	L	L	M	
14	EE Vacuum Cleaner	H	H	L	L	L	M	
15	EE Washing machine	H	H	M	M	L	M	
16	EE Electric Kettle	H	H	H	H	L	M	
17	EE Electric Heater	H	H	H	M	L	M	
18	Pre-paid Meters	L	H	L	L	L	H	6
19	LED	L	L	L	L	L	H	7
B	**Commercial**							
1	CFL	H	H	H	H	H	H	1
2	FTL (T5)	L	H	M	L	M	H	2
3	Electronic ballast	L	H	L	L	L	M	2
4	Solar Water Heater	H	H	H	H	M	H	3
5	EE Computer & printer	H	M	M	L	L	M	
6	EE Air condition	H	H	M	M	L	H	5
7	EE Fan	H	H	H	H	M	H	5

8	EE Electric Pump	H	H	L	M	L	M	
9	Sodium Vapor Lamp	H	L	H	H	M	M	
10	Mercury Vapor Lamp	H	L	H	H	M	M	
11	Energy Audit	L	H	H	H	L	H	8
12	EE Motor	L	H	H	H	L	H	9
13	Power Factor	L	H	H	H	L	H	10
14	EE Electrical Cooking Range	M	H	M	M	L	L	
15	EE Refrigerator	H	H	H	H	L	M	
16	TOD	L	H	H	H	L	H	11
17	Load Management	L	H	H	H	L	H	11
18	Municipality Water EE Pumping	L	H	H	H	L	H	12
19	LED	L	L	L	L	L	H	7
C	**Industrial**							
1	CFL	H	H	H	H	H	H	1
2	TFL (T5)	L	H	M	L	M	H	2
3	Electronic Ballast	L	H	L	L	L	M	2
4	Solar Water Heater	H	H	H	H	M	H	3
5	EE Computer & Printer	H	M	M	L	L	M	
6	EE Air condition	H	H	M	M	L	H	5
7	EE	H	H	H	H	M	H	5
8	Electric Pump	H	H	L	M	L	M	
9	Sodium Vapor Pump	H	L	H	H	M	M	
10	Mercury Vapor Pump	H	L	H	H	M	M	
11	Energy Audits	L	H	H	H	L	H	8
12	EE Motor	L	H	H	H	L	H	9
13	Power factor	L	H	H	H	L	H	10
14	TOD	L	H	H	H	L	H	11
15	Load Management	L	H	H	H	L	H	11
16	Variable speed drive	L	M	M	H	L	M	
17	Co-generation	L	M	M	H	L	H	12
18	Bio-mass Utilization	L	H	M	H	L	H	13
D	**Others**							
1	EE Policy	L	H	M	H	H	H	14
2	Standard & Labeling	L	H	M	M	L	H	15
3	Buildings Codes (EE)	L	H	L	M	L	H	16
4	Awareness & Outreach	L	H	H	H	L	H	17
5	House Keeping	L	H	H	H	L	H	18
6	Training & capacity Building	L	H	H	H	H	H	19
7	ESCO	L	M	L	L	L	H	20
8	Fuel switching	L	M	L	M	L	M	
9	Tariff Structure	L	H	H	H	H	H	21
10	Taxes & Duty Reduction	L	M	H	H	H	M	
11	Subsidy	L	H	H	H	H	M	

H: High M: Medium L: Low Blank: Not Selected

B.1 DSM SCREENING

The process of DSM option screening is the first stage in the preparation of an actual DSM project. The purpose of the screening process is to identify the main potentials for DSM activities. The screening process generally refers to six adopted variables, such as availability, applicability, adoptability, demo success track record, awareness, and potential benefits. In doing so, we have used experience from neighboring countries, especially Pakistan, India, and Sri Lanka. All savings potentials are eventually applicable – it is just a matter of customer awareness and incentives. The basic level of "applicability" of a DSM measure can be rated by estimating the effort needed to realize the savings, seen from DSM prospective. Similarly, in the case of availability – it is consideration of the technology available in the country with the affordable cost and easily adoptable by the customers. Demonstration success track record refers to the technology and/or programs implemented in the country or neighboring countries and shows a successful benefits track record, added the value for its selection. Awareness is a very important variable and requires intensive campaigns, as electricity savings are the main argument. While screening the DSM options, it has been considered that customers generally do not have large resources to consider energy savings, and therefore options need to be delivered on a "silver plate" and must have significant economic benefits to the customers vis-à-vis utilities.

Exhibit 17 shows the result of the screening of DSM options. The options which have high potential benefits have been considered for further analysis. Potential benefits reflect all other variables in principle. The result is as follows:

Exhibit 17: Result of Screening of DSM Options (not in hierarchical order)

1. Compact Fluorescent Lamps (CFL)
2. FTL/Electronic Ballast
3. Solar Water Heater
4. EE Refrigerator
5. Air-conditioning/Fan
6. Pre-paid Meters
7. Light Emitting Diode (LED)
8. Energy Audits
9. EE Motor
10. Power Factor
11. TOD/Load Management
12. Co-generation
13. Bio-mass Utilization
14. EE Policy
15. Standard & Labeling
16. Building Codes (EE)
17. Awareness & Outreach
18. House Keeping
19. Training and Capacity Building
20. ESCO
21. Tariff Structure and rebalancing

A short description of the major DSM options is presented below.

B.2 Promoting Use of Compact Fluorescent Lamps

Overview

The power sector in Afghanistan is severely stressed because of generation supply deficits and high fuel costs. It is expected that the electricity supply-demand gap will increase rapidly due to the fast-growing demand for electricity to meet economic growth in the next few years. This increased demand is attributed to a greater degree of urbanization, rapid economic growth, continued generation capacity deficits, and the high costs of new domestic generation capacity. Fuel supply issues have not been resolved and this affects the continuity of supply. In response, ACEP has increased its efforts to implement cost-effective demand-side EE options that will reduce the need for electricity generation and use of peak power generation. A choice of demand-side, energy-efficient lighting technologies offers one of the most promising solutions in bridging the supply-demand gap in Afghanistan into the future.

According to the International Energy Agency, lighting end-users use 19 percent of global electricity energy supply and nearly one-third (31 percent) of this amount is for residential lighting. In Afghanistan, lighting is the most important use of electricity in the domestic sector, and the evening lighting loads contribute significantly to the local electric utility's peak load. Although the use of modern, energy-efficient lighting technologies has been increasing over the last few years, particularly in the commercial sector, most of the lighting in the domestic sector still continues to come in the form of incandescent lamps ~~bulbs~~, which are very energy inefficient in comparison to linear fluorescent tube lights (FTLs), CFLs, and LED-based systems.

Very little load research analysis has been conducted to establish an appropriate breakdown of the various customer sectors, segments, end-uses, and the range of technologies to deal more efficiently with system peak as well as periods of normal demand. Consequently, the rationale for implementation of a CFL distribution program is largely based on some less sophisticated analysis as well as available anecdotal evidence. For example, a very large proportion of low income households, small retail outlets, restaurants, and small hotels use IBs as their main lighting technology. The program aims to replace 40W, 60W. and 100W IBs with appropriately sized CFLs.

Benefits of Energy Efficient Lighting

The benefits to residential customers include energy savings, reduced electricity bills, and mitigating the impacts of higher electricity tariffs. Utilities, on the other hand, benefit from energy efficient lighting through peak load reduction, reduced capital needs for future generation expansion, reduced cost of supplying electricity, and utility losses are brought down n supplying electricity to low-tariff and/or low-collection customers. Government's benefits include reduced fiscal deficits, reduced public expenditures, reduced energy price volatility, and improved energy security. In terms of the advantages to local environment, energy efficient lighting initiatives can help reduce environmental pollution and global greenhouse gas emissions.

Despite these obvious benefits, the penetration in Afghanistan of more efficient CFLs (which can offer savings of 75-80 percent compared to IBs) although relatively high (about 70 percent in urban areas), has still not happened in a number of important subsectors, such as low income housing and government This data comes from the ACEP Kabul Household Energy Survey. Some of the reasons for relatively low penetration of CFLs in these particular subsectors are attributed to the poor quality (for example, lower life, lower power factor, or lower lumens per watt) of some of the CFLs currently on the market and perhaps more importantly, to the low quality of the electric current (large voltage fluctuations) and the purchasing decisions still made on first lowest cost basis. The price factor can also be considered, as there is a relatively higher market price of the good-quality CFLs.

Furthermore, such products are more expensive than may be necessary and the retail price is inflated by taxes and customs duties. All such items must be imported and this will continue to be the case. Even though using CFLs leads to reduced electricity bills and improved reliability, perceptions of poor quality and high prices still prevail. It is thought that they remain unattractive to many consumers, particularly among lower and middle-income consumers. Inferior-quality CFLs are ineffective in helping electric utilities, since expected potential savings in energy and peak load reductions are not actually achieved. Even worse, poor quality CFLs also risk destroying the future market for this technology. Consequently, there is a need for energy-efficient lighting programs that assure high-quality CFLs at a reasonable and affordable price in bringing about large-scale acceptance of such forms of efficient lighting technology.

The need for energy efficient lighting programs has also been highlighted by a study conducted by The World Bank (June 2009). Aside from addressing a myriad of barriers, such as financial, institutional capacity, awareness and outreach, and sustainability, the study also recommends the use of solar photovoltaic (SPV) systems for off-grid areas. For grid-connected areas, the study recommended a number of programs such as energy-efficient lighting technologies, awareness, capacity building, etc.

The South Asian Regional Initiative for Energy Cooperation and Development (SARI/E) conducted a limited survey in September 2006 that highlighted the problems of quality energy supply, inefficient billing system, repairs by utilities taking a longer time to restore power supply, etc.

The conference held in Herat, Afghanistan in April 2010 also emphasized the importance of EE improvements both at the utilities' end and consumers' end. Much emphasis was placed on the implementation of energy efficient equipment such as CFLs for lighting, power factor improvement for utilities, energy efficient appliances, etc. It has also been learned that in some cases, individuals residing in areas of relative poverty are changing back to IBs due to the low quality of power from utilities and cheaper quality of CFL now available in the market. CFLs in general are vulnerable to frequent voltage fluctuations and, due to reduced working life, some users have found them to be uneconomical.

Clearly, professional testing and improvement in the power quality are two critical prerequisites to a successful and lasting market for CFLs.

Environmental issues

A CFL bulb is made of glass, a ceramic and metal base, a powder called phosphor, and a small amount of mercury. The amount of mercury in a CFL is very small. The mercury in the bulb is in the form of an invisible vapor or a mercury bead. A mercury fever thermometer has about 100 times more mercury than a CFL bulb. Similarly, fluorescent lamps also contains small amount of mercury. The contents of mercury determine the quality of CFL manufactured. Many manufacturers now manufacture CFLs with only 1.0 mg or less than 1.5 mg of mercury per bulb. Although the amount of mercury vapor that is released from one broken bulb is not enough to make anyone sick, it is best to avoid any release of mercury.

Because there is such a small amount of mercury in CFLs, the greatest risk if a bulb breaks is getting cut from glass shards. Research indicates that there is no immediate health risk to the people when a bulb breaks and it's disposed of properly.

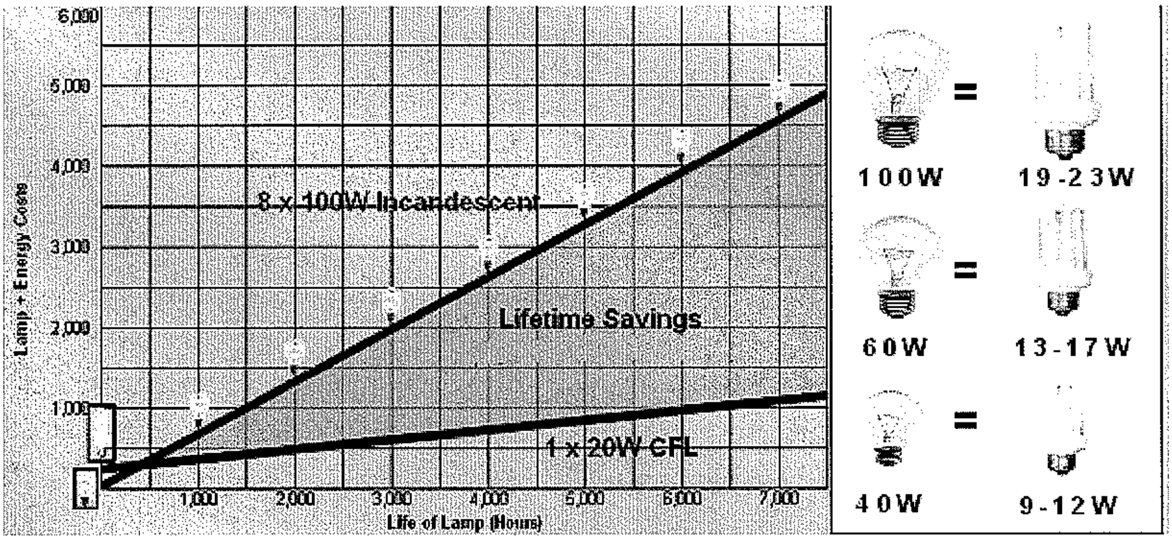
However, the public and the government are very concerned about the mercury issue and an appropriate strategy for recycling or disposal is needed (attractive cash payment for sale of spent bulb, cash back at vendor's etc., as many different options have been developed in the region).

Prospects

Since Afghanistan's electrical energy demand is expected to grow rapidly, the aim of this program is to promote the use of CFLs to bring about energy savings in the country's residential, commercial, and industrial sectors. The program will be concentrated on:

- CFLs in low income housing
- CFLs in government building
- CFLs in street lights
- CFLs in road lights

The benefits can be demonstrated through the following graph:



Based on the computation of the data obtained from the market, the life span of 7,000 hours of one good quality CFL is equivalent to eight ILBs; the energy uses are also reduced.

Based on the above discussion, the following program outline has been prepared for implementation:

Program Outline

Program Overview:	To encourage the use of good quality CFLs to save energy in residential, commercial and industrial sectors
Program Objectives:	To promote the concept of electricity EE among consumers, importers and suppliers To induce customer adaptation of CFL technologies among residential, commercial and industrial buildings
Program Design and Implementation:	National Electric Utility driven program Private sector participation – light vendors and retailers National electrical utility purchase the CFL in bulk under competitive procurement procedures from manufacturers, receiving significant cost reduction over retail market price and waive import duty and taxes under this scheme

Program savings:	Demand Saving – 88 MW (Approximately $258 million) Energy Saving – 96 GWH/year (Approximately $ 25 million/year)
Key lessons learned:	The utility distribution mechanism tends to have dampening effect on market development at the retail level It appears that wealthy consumers are leaders in technology adaptation due to their ability to pay and knowledge Main target group should be poor and medium consumers as compared to large
Program Description	Designed to reduce the cost of CFLs by passing along discounts through bulk purchase from participant manufacturers and waive import duties/tax Focus mainly on CFLs for residential, commercial and industrial consumers
Customer / Market Characteristics	The program may take place in two phases with a total of 2.0 million CFLs and Phase I could be implemented in Greater Kabul, where approximately 60 percent of the electricity is consumed, and Phase II could be the rest of the country's electrified areas. Low and medium income consumers shall be targeted by the program
DSM Measures	Energy efficient CFLs with 7,000 working hours, more than 0.65 power factor etc under ELI certification Anticipated that CFLs will be sold at 40 percent less costly than what is the regular market price Utility DSM program with extensive consumer marketing and outreach activities
Program Period **Steps Forward**	September 2011 – August 2013 CFL Program – Design, Procurement and Distribution Plan such as: • Develop a CFL program implementation plan • Prepare lamp specification and tender documents • Estimate peak demand reduction and energy savings • Perform economic and financial analysis • Prepare program monitoring plan
Program Costs	Total program budget is estimated at $5 million
Benefits	• Reduce customers cost of electricity • Provide low cost CFLs to the customers • Save in replacement of incandescent bulbs verses CFL • Peak load reduced • Energy savings • Contributing environmental benefits to the society
Barriers	• Lack of awareness; sustainability depends on consumers replacing expired CFLs with new ones, and not with IBs • Technological barriers • Availability in the market • High price of quality CFLs • Lack of utilities promotional activities

A government and donors supported program will need to address the two key constraints of quality and mercury disposal. ACEP therefore recommends the following two institutional initiatives to facilitate a larger CFL market presentation and a protection of its users:

1) A national testing laboratory after having accepted internationally adopted norms and standards as recommended by ANSA (such as ELI)

2) A comprehensive national recovery and recycling program, designed from the most proven successful in the region (India, Nepal, Thailand) and adapted to the Afghan culture

In the strategy report and its implementation plan produced in August 2010, these two critical initiatives are presented in more detail.

B.3 PROMOTING USE OF SOLAR WATER HEATING (SWH)

Overview

Solar water heating is a technology that every homeowner can utilize in saving money on utility bills where electricity is used to heat water. SWH systems usually cost a little more to purchase and install than conventional water heating systems. However, the savings achieved over the life of a system (now 15-20 years) greatly exceed the initial costs. Payback times will improve as DABS' tariffs reach full-cost recovery.

On average, and based on experience with older SWHs in the Kabul area, the water heating bills should drop 50-80 percent. Also, as the sun is an endless source of energy, SWH users are protected from future fuel shortages and tariff hikes.

Effective SHW systems include storage tanks and efficient solar collectors. There are basically two types of SWH systems: active – those which have circulating pumps and controls and passive – those which don't.

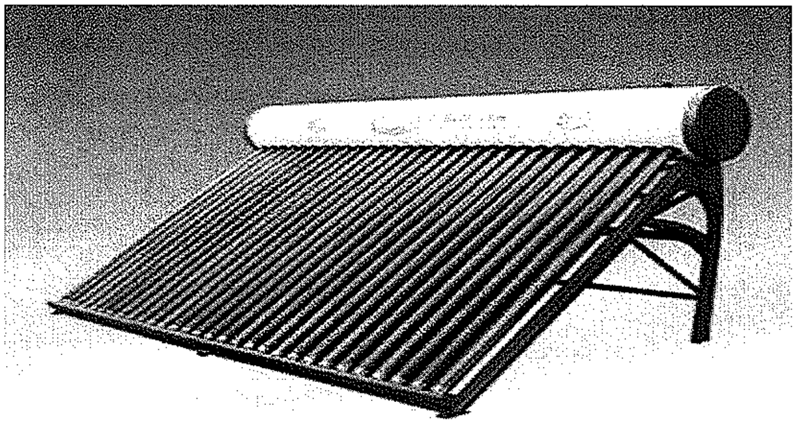
Most SWHs require a well-insulated storage tank. Solar storage tanks have an additional outlet and inlet connected to and from the collector. In two-tank systems, the SWH preheats water before it enters the conventional water heater. In one-tank systems, the back-up heater is combined with the solar storage in one tank.

Three types of solar collectors are used for residential applications:

Flat-plate collector: Glazed flat-plate collectors are insulated, weatherproofed boxes that contain a dark absorber plate under one or more glass or plastic (polymer) covers. Unglazed flat-plate collectors – typically used for **solar pool heating** – have a dark absorber plate, made of metal or polymer, without a cover or enclosure.

Integral collector-storage (ICS) systems: These systems, also known as ICSs or *batch* systems, feature one or more black tanks or tubes in an insulated, glazed box. Cold water first passes through the solar collector, which preheats the water. The water then continues on to the conventional backup water heater, providing a reliable source of hot water. They should be installed only in mild-freeze climates because the outdoor pipes could freeze in severe, cold weather.

Evacuated-tube solar collectors: These feature parallel rows of transparent glass tubes. Each tube contains a glass outer tube and metal absorber tube attached to a fin. The fin's coating absorbs solar energy but inhibits radioactive heat loss. These collectors are used more frequently at present.



Benefits

The following are the major benefits realized from using SWH systems:

- Increased renewable energy mix for the city
- Curtailed city peak demand electricity load
- Reduced energy spending by residents
- Reduced city's contribution of greenhouse gases emissions and improved health of residents..

Such activities will spur employment creation, as well as economic development opportunities for city residents, which will promote and ultimately lead to poverty reduction.

Purpose

The purpose of this program is to promote SHWs and as a replacement of electrical water heaters with vacuum tube type. These will be imported, though local assembly will be the ultimate objective.

Market situation

Official orders for SHWs have been slow to be realized due to a lack of capacity to complete more than one project per month and because of a shortage on the local market. Most SHW projects have been installed in governmental locations, especially for the purpose of supplying hot water in bathrooms and kitchens. Below are some SHW projects:

S/N	Location	Capacity (LIT)	Purpose	Number of collectors	Remarks
1	Military high school	5000	Bathrooms	96	Each collector's is 2.1m^2
2	Watan Orphanage	5000	Bathrooms and cooker		Each collector's is 2.1m^2
3	Second Orphanage	1000	Bathrooms	32	Each collector's is 2.1m^2

4	Military University	5000	Bathroom and kitchen	96	Each is 2.1m^2
5	Ministry of Women's Affairs	1000	Bathrooms	32	Each collector's is 2.1m^2
6	Shir pur kindergarten	500	Bathroom and kitchen	16	Each collector's is 2.1m^2
7	Khair khana kindergarten	600	Bathroom and kitchen	17	Each collector's is 2.1m^2
8	Shashdarak kindergarten	1000	Bathroom and kitchen	32	Each collector's is 2.1m^2
9	Makrorayon's kindergarten	1000	Bathroom and kitchen	32	Each collector's is 2.1m^2
10	Kindergarten/Ministry of Education	1000	Bathroom and kitchen	32	Each collector's is 2.1m^2
11	Logistic Department of Ministry of Security	1000	Kitchen	32	Each collector's is 2.1m^2
12	Badam bagh Green house	4000	Heating of green house	96	Each collector's is 2.1m^2
13	Police Academy	500	Kitchen	16	Each collector's is 2.1m^2

Small manufacturing workshops in Kabul and Kandahar have the capacity to produce two to three large collectors per day and five household sizes. In terms of installation capacity, upwards of 40 collectors can be installed in the field each month.

However, the locally made hot water systems are comparatively primitive and have been designed as direct systems without heat exchangers and capacity for antifreeze. Protective insulation material is only used in the piping subsystems as well around the tanks. Their water capacity is designed for daily consumption, and the systems do not have any additional hot water storage capacity to provide for cloudy days. The capacity of the systems depends on their daily hot water consumption. Such design requires the operators to drain out the remaining water from the solar collectors during the evening hours.

The manufacturing facility can produce tanks with a capacity between 150 to 1,500 liters. The larger water heaters are used in bathrooms or kitchens, as this is where the bulk of hot water is needed.

Solar water heaters could actually be manufactured locally – a little additional training for the local workforce would be needed. It would be expected that such a cottage industry would be a great provider of jobs and that they could provide a much needed product and service for the country. Moreover, with expanded manufacturing the unit price could be reduced. However, manufacturing vacuum tube collectors will be beyond local capabilities, and the best that can be hoped for is local assembly of imported components.

The following Program Outline has been developed for the implementation of this program:

DSM in Large Consumer and Municipality Water Supply

Program Outline	
Program Overview:	To encourage the use of SWH to save electrical energy in residence and industrial sector
Program Objectives:	To promote the concept of electricity EE among residential customers for water heating
	mainly domestic consumers, importers and suppliers

	To induce customer purchase of SWH technologies in the residential, commercial and industrial buildings
Program Design and Implementation:	National Electric Utility (DSM) driven program
	Private sector participation – light vendors and retailers
	Implementation package for entrepreneurs to develop their skill and knowledge for building SWH locally
Program savings:	Demand Saving - 65 MW (Approximately $ 195 million)
	Energy Saving - 47.5 GWH/year (Approximately $ 9.5 million/year)
Key lessons learned:	The utility distribution mechanism tends to have a dampening effect on market development at the retail level
	It appears that wealthy consumers are leaders in technology adaptation as they have the ability to pay and the necessary knowledge
	Main target group should be poor and medium consumers as compare to larger and better off
Program Description	Promote the use of SWH especially to medium and large electricity consumers
	Emphasis placed on building local entrepreneurs' capabilities and reducing the cost of SWH
	Focus mainly on residential, commercial and industrial consumers
Customer / Market Characteristics	Medium and high income consumers shall be targeted by the program
DSM Measures	Utility DSM program with extensive consumer marketing and outreach activities
Program Period	September 2011 - August 2013
Steps Forward	Develop a SWH program implementation plan
	Prepare SWH specification suitable for residential and commercial enterprises
	SWH technology importing and development
	Estimate peak demand reduction and potential energy savings
	Develop local entrepreneurship
	Perform economic and financial analysis
	Prepare program monitoring plan
Program Costs	Total program budget is estimated at $ 125.0 million
Benefits	Reduce customers use and outlay for electricity
	Supply larger area of the cities and increase customer base by generating employment
	Saving in the replacement of electrical water heater with Solar Water heater
	Reduce the consumption of conventional energy
	Bringing down peak loads (reduced)
	Developing renewable energy technology
	Savings of conventional energy
	Environmental benefits for society
Barriers	Lack of awareness
	Technological barriers; lack of trained installers
	Availability in the market
	High price of the SWH
	Lack of promotional activities

B 3.5 Hi-Eff Water Pumps

Overview

Demand-side management has been traditionally seen as a means of reducing peak electricity demand so that utilities can delay building further capacity. In fact, by reducing the overall load on an electricity network, DSM results in various beneficial effects, including mitigating electrical system emergencies, reducing the number of blackouts, and increasing system reliability. Other benefits can also include reducing dependency on expensive fuel imports, which is an important consideration for Afghanistan in reducing energy prices and reducing harmful emissions to the environment.

Finally, DSM has a major role to play in deferring high investments in generation, transmission, and distribution networks. Thus, DSM applied to electricity systems provides significant economic, reliability and environmental benefits.

We now turn to DSM measures that can reduce energy demand of large consumers that can be managed by the utility the utility.

Prospects

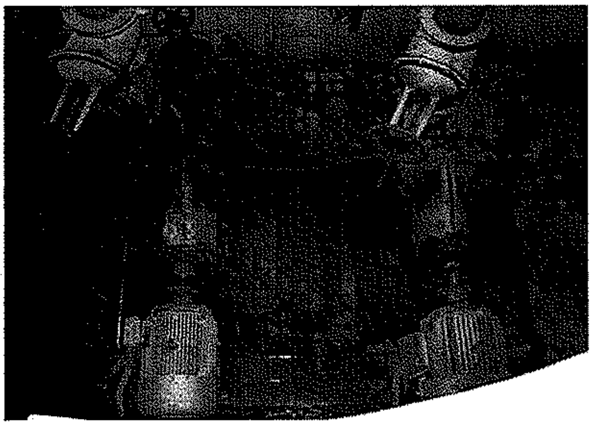
The aims under this program are:

- To introduce the concept of demand-side management mandatory to the large consumers especially for those non-paying but who cannot be disconnected
- To provide an overview of the different types of demand-side measures
- To demonstrate how housekeeping and preventative maintenance can be used in reducing energy demand

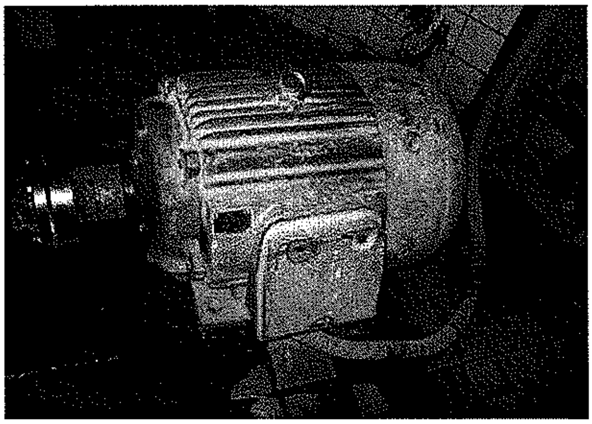
The above concept can be explained with a case study of Municipal Water Supply.

Pumping System Efficiency Improvement Program

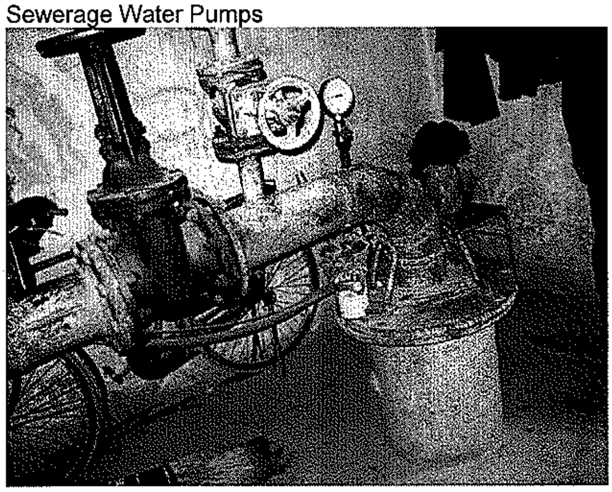
Program Overview:	Improving EE of water pumping system in municipal water supply
Program Objective:	To improve the pumping system efficiency in order to reduce the peak demand and to bring about energy savings
Program Design and Implementation:	• Utility driven program • Promote pilot projects for energy efficient pumping systems • Demonstrate actual energy savings achieved through the implementation of energy efficient motors, installation of capacitors and remote load management
Program Savings:	• Demand Saving 115KW (Approximately $ 345,000) per installation • Energy Saving 280 MWH (Approximately $ 56,000/year) per installation
Key lessons learned:	• Hands–on demonstration under this pilot project • Considerable EE potential in water pumping which can save electricity • Water pumping hours, pumping system and its schedule that coincides with peak loads could be shifted during off peak hours (load management) • Program will be replicable across various municipalities and large consumers
Program Description:	Pilot project designed to demonstrate the energy savings achieved from demand side management concept as is applicable to other large consumers
Costumers / Market characteristics:	• Municipalities are the bulk consumers of DABS • Additionally, all government offices and large non-paying customers that cannot be disconnected will be targeted
DSM Measures:	• Energy Efficient motors • Power factor correction • Load management • Housekeeping



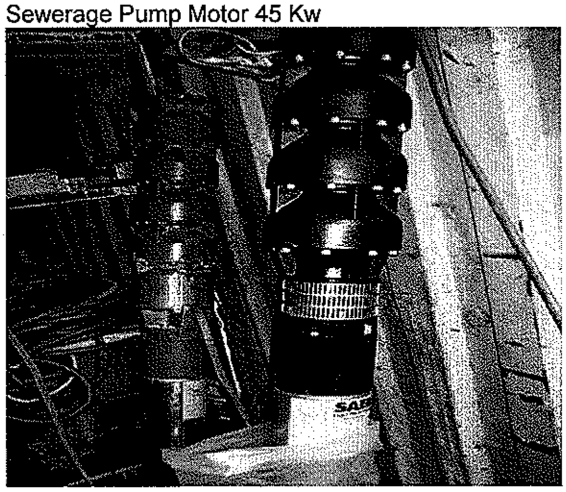
Sewerage Water Pumps



Sewerage Pump Motor 45 Kw



Water Pumping Station



Submersible Pump

Based on the above discussion and case studies, we conclude that DSM measures should be mandatory among larger consumers, especially non-paying ones who are not subject to being disconnected, which includes municipality water supply systems.

Program Period	**September 2010 – August 2013**
Steps Forward	• Develop an inventory of large consumers including government non-governmental consumers, and to define which DSM is the most suitable for them for implemented, and whether it should be mandatory or voluntary • Prepare housekeeping measures • Develop technology importing and development • Estimate peak demand reduction and energy savings • Perform economic and financial analysis • Prepare program monitoring plan
Program Savings	• Demand Savings 10 MW (Approximately $ 30 million) • Energy Savings 44 GWH (Approximately $ 8.8 million)
Program Costs	Estimated as $ 1.0 million
Benefits	• Reduce demand load and energy • Shift peak demand to off peak hours • Improve quality of current and voltage to the consumers

	• Enhance utilization and EE • Contribute environmental benefits to the society
Barriers	• Lack of awareness • Lack of energy auditors • Lack of EE/DSM facilitating institution • High price of EE motors • Lack of utilities promotional activities

B.4 NEW LARGE BUILDINGS

New large building construction is the fastest growing energy-related activity in Afghanistan today. Unfortunately, no reliable statistics of ongoing and future construction are available. We have contacted the Ministry of Construction, the Ministry of Urban Development (MOUD), and the Kabul Municipality, but the statistics are not consistent. We understand that about 700,000 square meters (sqm) of land are built on each year in Kabul alone and that this number could be as much as one million sqm nationwide, especially when taking into consideration Jalalabad and Mazeri-Sharif. Based on our site visits as well as audits carried out by the World Bank, it appears that most buildings lack insulation, efficient doors and windows, HVAC controls, and do not use efficient air conditioners. Consequently, specific electricity consumptions are estimated at 150-200 kWh/SQM/year vs. less than 100 kWh/sqm/y for better designed buildings in neighboring countries e.g., India and Thailand, which indicate a theoretical potential of up to 100 GWH/year savings (see table below for Indian benchmarks). Currently, the MOUD is preparing a new building code, but this code does not deal with EE.

Number of Buildings	Building Type	Floor Area (m2)	Annual Energy Consumption (kWh)	Benchmarking Indices	
	OFFICE BUILDINGS			kWh/m2/year	kWh/m2/hour
145	One shift Buildings	16,716	20,92,364	149	0.068
55	Three shifts Buildings	31,226	88,82,824	349	0.042
88	Public Sector Buildings	15,799	18,38,331	115	0.045
224	Private Sector Buildings	28,335	44,98,942	258	0.064
10	Green Buildings	8, 382	15,89,508	141	-
	HOSPITALS			kWh/m2/year	kWh/m2/hour
128	Multi-specialty Hospitals	8721	24,53,060	378	13,890
22	Government Hospitals	19,859	13,65,066	88	2,009
	HOTELS			kWh/m2/year	kWh/m2/hour
89	Luxury Hotels (4 and 5 Star)	19,136	48,65,711	279	24,110
	SHOPPING MALLS			kWh/m2/year	kWh/m2/hour
101	Shopping Malls	10,516	23,40,939	252	0.05642

Source: ECO-3

Page break

Although ACEP was not able to carry out a detailed analysis of this sector, it was determined, based on these early observations, that a specific EE initiative in the new building sector should be made a priority after lighting, SWH, and large motors. As a next step, we recommend carrying out a specific study and organize a professional workshop with leading local architects, builders, and equipment vendors in order to identify the specifics of a meaningful EE program in the building sector.

B.5 SUMMARY

Twenty DSM options have been selected out of an extensive list of 67 options, and then further reduced to 10, with efficient lighting options showing the most promise (See table). The selection process was based on specific criteria as discussed above, and a short description of each DSM options is presented. We provide an analysis of these options in the next chapter, taking into consideration various economic and financial factors. The following chapter will also provide recommendations from among the most viable measures and options that can be implemented in a timely and cost effective fashion.

C. ANALYSIS AND SELECTION OF MOST EFFECTIVE DSM MEASURES

C.1 INTRODUCTION

In the previous chapters we presented the overall technical, economic, financial, and institutional environment needed to lay the foundation for a robust and aggressive EE/DSM initiative in Afghanistan. We have selected a "short list" of measures and programs that exhibit a number of positive attributes for successful initiatives within the Afghan context. We then applied rigorous financial, economic, and institutional risk and screening analysis to this short list in order to identify those options that (i) can be implemented under prevailing conditions and (ii) will be able to bring about the most benefits to the Afghan people, at the lowest cost, and in the shortest possible timeframe. We demonstrate that despite the conditions in Afghanistan appearing to present unprecedented obstacles to energy savings, they do in fact present a remarkable opportunity for all stakeholders in the Kabul district because of the structure of demand and the recent availability of low-cost hydro imports.

C.2 SCREENING ANALYSIS METHODOLOGY

The three elements of our methodology are approach, key assumptions, and best available data sources:

APPROACH

Our approach uses financial and socio/economic analyses of energy demand reduction options subject to data constraints.

KEY ASSUMPTIONS:

1. Realistic number of possible measures based on international experience of IRG and others
2. Tariffs: DABS (Exhibit 2)
3. Potential savings per measure
4. Hours of operation (per year): Kabul Energy End Use Survey
5. Load period (AM peak, Off Peak, PM Peak): Kabul Survey
6. Savings by load period: Kabul ACEP Energy End Use Survey and KED data
7. Savings by measure (kWh/year): ACEP calculations based on (3), (6)
8. Unit costs: MEW Appliance Market Survey

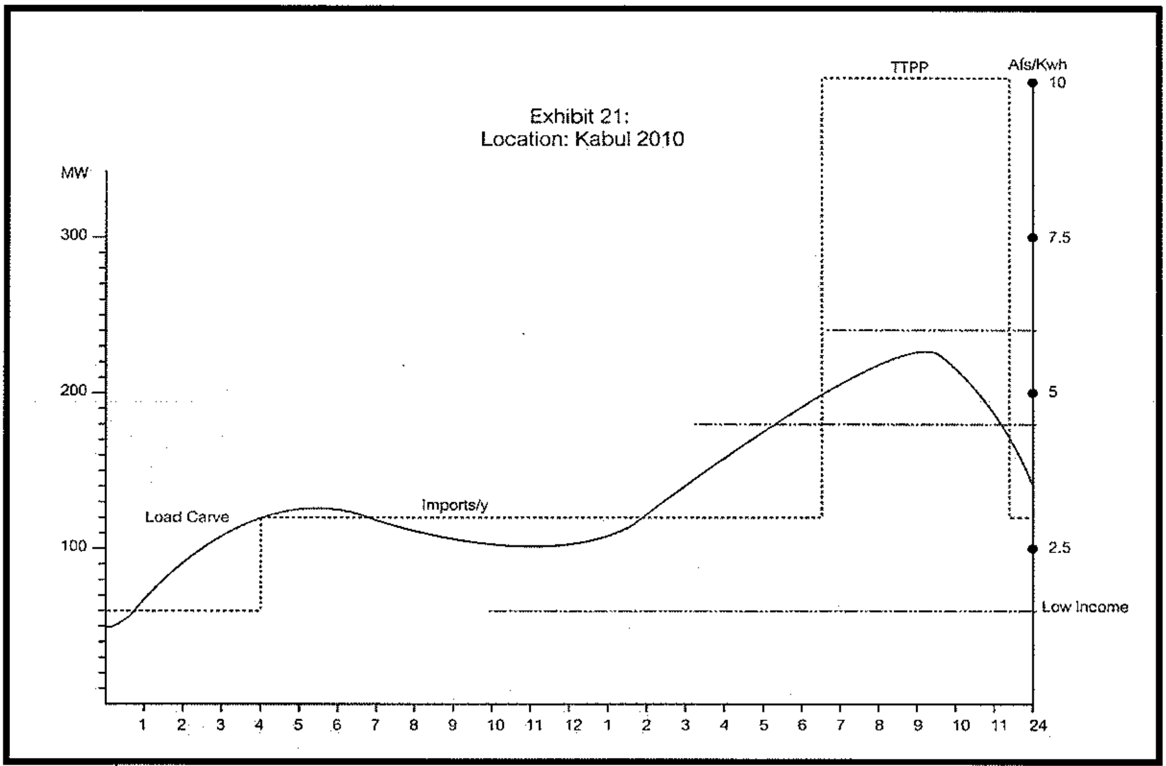
9. Total installed cost (with management, indirect costs): MEW Survey and ACEP database
10. Total savings per year, by load period (MHz/y): derived from above
11. Total savings to the customers (financial): based on (6) and (2)
12. Total savings to the country (socio-economic) based on (6) and shadow prices (marginal costs of supply. Exhibit 18)
13. Total program costs (computed from above)
14. Financial payback (computed from above)
15. Economic payback (computed from above)
16. Key barriers (from research and interviews.)
17. Difficulty of implementation (ACEP experience and interviews)
18. Time to 100 percent market penetration (ACEP experience and interviews)

Exhibit 18 below contains: the load curve for Kabul, the supply cost curve over time (can be related to the load curve), and the various DABS tariffs. From this exhibit, it can be seen that the tariff is always higher than the average cost of supply except for the lowest income tariff group (US 3 cents vs. 6 cents). The major positive implication of this is that when demand is reduced in this consumer bracket through bulb replacement, DABS bottom line will benefit from both lower and eliminated use of high-cost diesel thermal power because demand can be satisfied from hydro supply and DABS' cost for subsidies is lower. In fact, benefits accrue to customers, DABS/KED, GIRoA, and the overall economy.

C.2.5 Kabul Demand Curve

Exhibit 18: Kabul Load Curve, Demand in MW, Tariffs and Marginal Cost of Supply

(Right Y axis is US cents/KWh marginal supply cost and numbers need correcting to US cents)



Sources of Data

Past surveys and reports

The most useful reports for our analysis have been:

- The 2006 SARI Kabul Energy Survey (Bibliography)
- The 2007 Energy strategy prepared for the Afghanistan National Strategy (finalized in 2008)
- The World Bank SASDE report "Energy Efficient Lighting Options for Afghanistan, 2009
- The India BEE-ECO-3 Energy Conservation Building Code (2010)
- The MOUD's numerous city surveys and publications.

Other data sources are listed in the bibliography.

ACEP's data collection initiatives

In order to obtain original and up-to-date data for our analysis, we have undertaken a number of new surveys and data collection activities, namely:

- The Kabul ACEP Energy End Use Survey (final survey analysis still underway)

- A number of instrumented load data measurements at several industrial and commercial sites in the Kabul area
- The Kabul Energy Appliance Supply Survey
- An end-use survey of Bamiyan (in design phase)
- A brief review of energy demand data for the city of Kandahar

In the next paragraphs we summarize the findings of each initiative when available.

Kabul End-Use Energy Survey

The main objective of the ACEP-implemented Kabul Energy End-Use Survey was to obtain actual quantitative data of households' energy consumption in residential buildings in terms of major electrical appliances used. Other aims were to determine household lighting details, level of energy awareness, current use of other forms of energy, etc. This information was collected through questionnaires and face-to-face interviews with 3,000 respondents throughout greater Kabul.

The following steps have been taken under this scope of work:

1. Establishment of methodology
2. Sector focus and resource allocation
3. Designing the sample
4. Designing the questionnaire
5. Selection of interviewers
6. Training of supervisors and interviewers
7. Conducting pre-test survey and survey
8. Minimizing nonresponsive
9. Processing the data
10. Conclusion

See Annex V for Survey Methodology and details.

This report is based on preliminary use of raw data extracted from the various surveys and studies mentioned in Section I. In addition to the household appliance survey, we carried out data metering and logging activities to obtain some indications of load curves and power factors in two non-household sectors in Kabul. The findings from these sites are presented below:

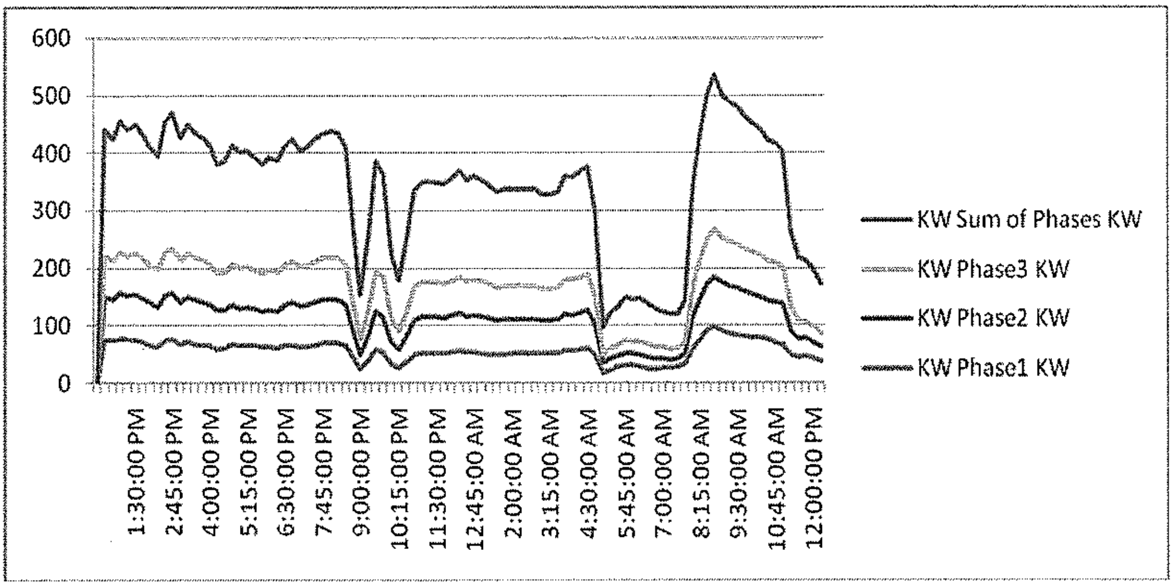
Data Collection at Two Large Customer Sites

ACEP staff identified two replicable installations – the Kabul Grain Silo (a light industry case) and the Intercontinental Hotel – using EE measuring instruments borrowed from the Afghanistan Electrical Power Corporation. In addition to gathering needed data, we trained electrical engineers and team personnel in the use of standard energy audit instruments.

Kabul Silo

The Silo in Kabul City is a government-owned factory that was built by the Russians some 30 years ago. As it is Government-owned, we may assume that the management has little incentive to improve efficiencies. The factory's electrical equipment is in poor condition from an operational and safety point of view, and there is a total lack of energy-efficient motors and capacitors, as demonstrated by the following curves.

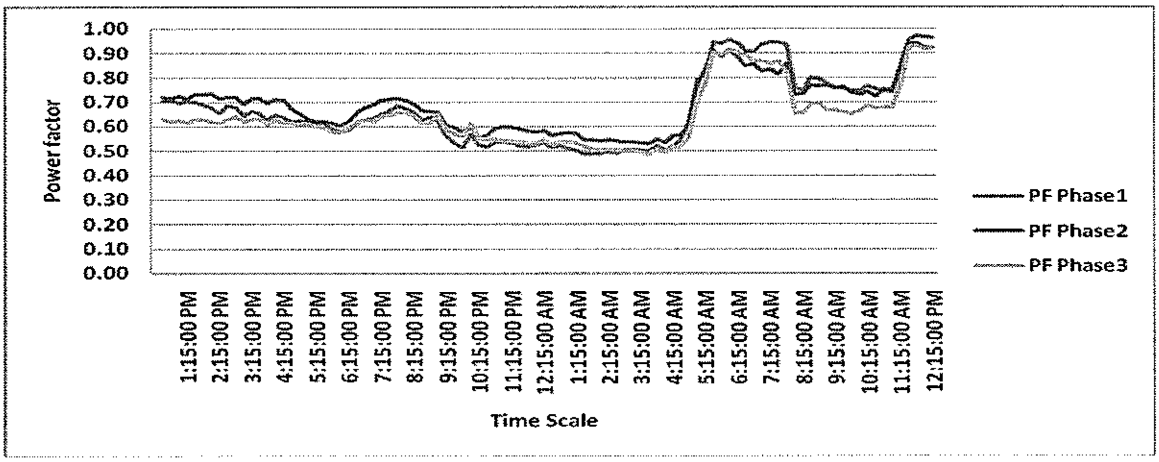
Exhibit 19: Power Recorded at Silo Factory



Source: Data recorded by ACEP team on May, 25 2010

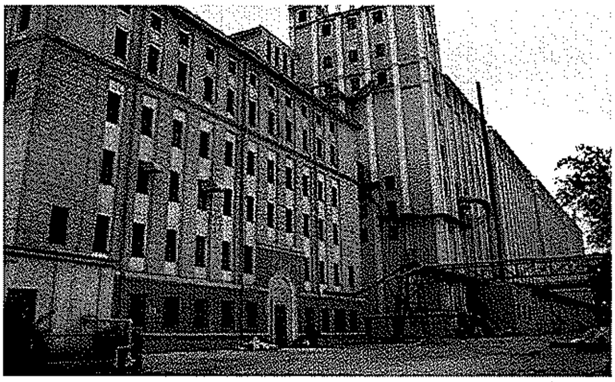
As seen above, the three phases of the plant are not balanced. Moreover, the plant uses only 480 kW, which is also under-loaded. To save demand and energy all the phases should be balanced. Obviously the situation at this one installation cannot be extrapolated to other light industries, but it does point to one problem likely to exist at older installations in the public sector.

Exhibit 20: Power Factor Recorded at Silo Heater

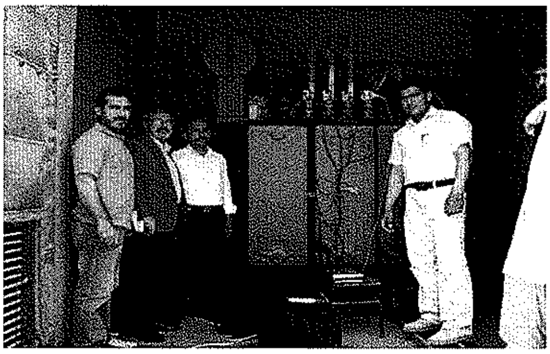


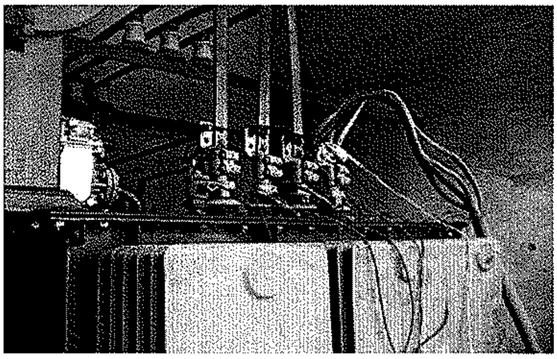
Source: Data recorded by ACEP EE team on May. 25 2010

The power factor[2] was recorded while the factory was operating at between 0.50 and 0.72, which is very poor. This means that the plant consumes more power than is actually required. We recommended installing a capacitor bank, which should bring this power factor to ~~0.98~~. 0.95



Silo Factory in Kabul





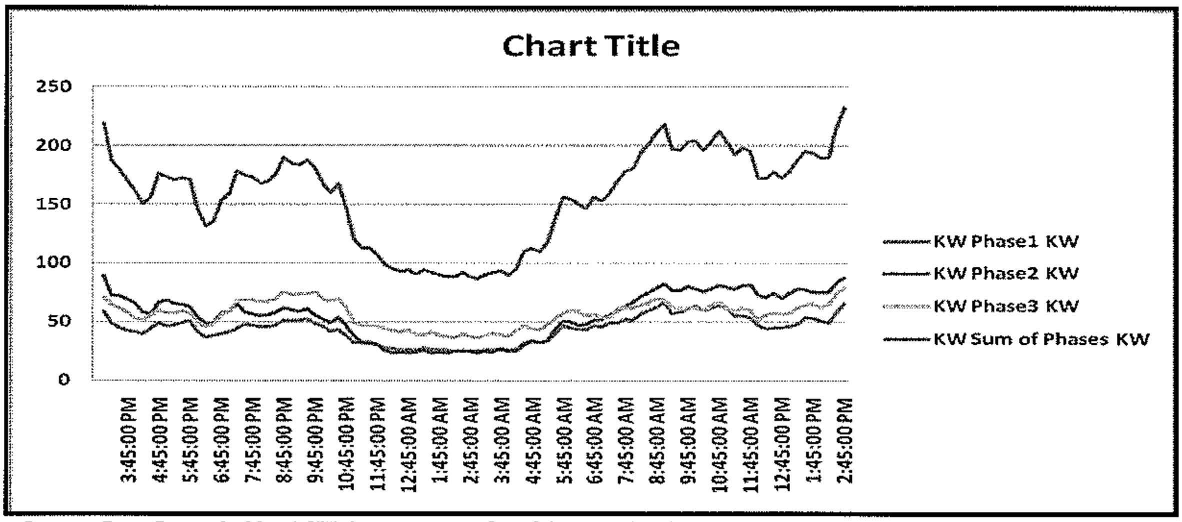
Measuring Equipment installed on Silo Factory transformer

Intercontinental Hotel

The Intercontinental Hotel, owned by the government of Afghanistan, is almost 40 years old and has not seen any energy equipment upgrades. Most of the existing equipment, including boilers, compressors, water heaters, pumps, etc. is old.

[2] The power factor of an AC electric power system is defined as the ratio of the real power flowing to the load to the apparent power. In systems with low power factors more generating capacity is needed to supply the same amount of useful power, hence this is a major financial drain on the utility.

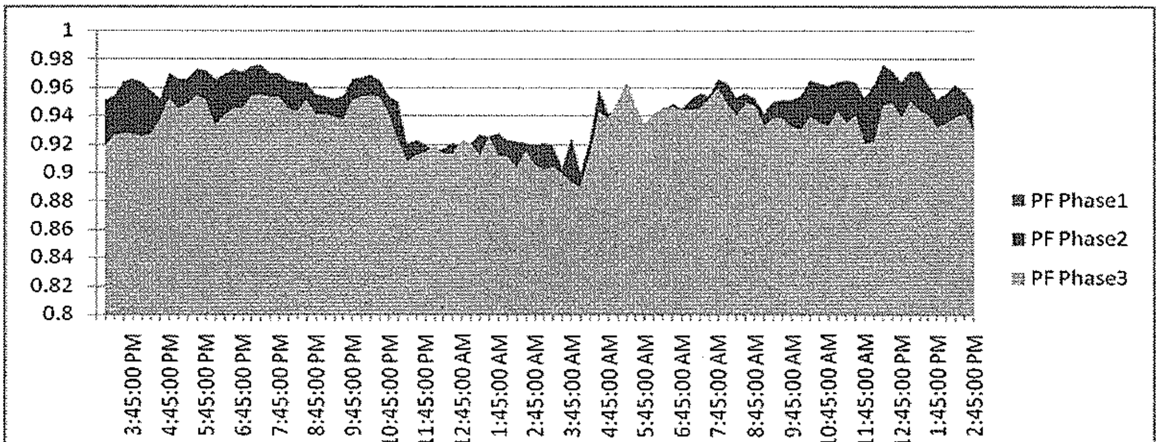
Exhibit 21: Power Recorded at Intercontinental Hotel



Source: Data Recorded by ACEP Team on site dated 26 may 2010

The above curve shows that the hotel's maximum power consumption is only 225 kW against an installed transformer capacity of 615 kVA. Due to this overcapacity of transformer, the hotel has avoidable energy losses. The hotel has two kinds of losses in its transformer: load loss and no-load loss. However, in this case, all the three phases are balanced.

Exhibit 22: Power Factor Recorded at Intercontinental Hotel



Source: Data Recorded by ACEP Team on site dated 26 May 2010

In terms of power factor, the hotel is doing well with a power factor that varies from 0.90 to 0.97, but installation of capacitor banks to improve and stabilize its power factor is still required.

No. Do not install PF correction past 0.90!

Intercontinental Hotel in Kabul

ACEP C2 team installing EE measuring instruments at the Intercontinental Hotel in Kabul

Kabul ACEP Appliance Survey

DSM cannot proceed unless there is a thorough understanding of installed energy-using technologies. Under ACEP supervision, a Kabul-wide electric appliance survey was conducted by MEW and Bakhatar University engineers. The survey shows that Chinese and Malaysian-made electrical/electronic products dominate the Kabul market. The table below provides an overview of the major products in use, their origin, size and electric consumption (watts).

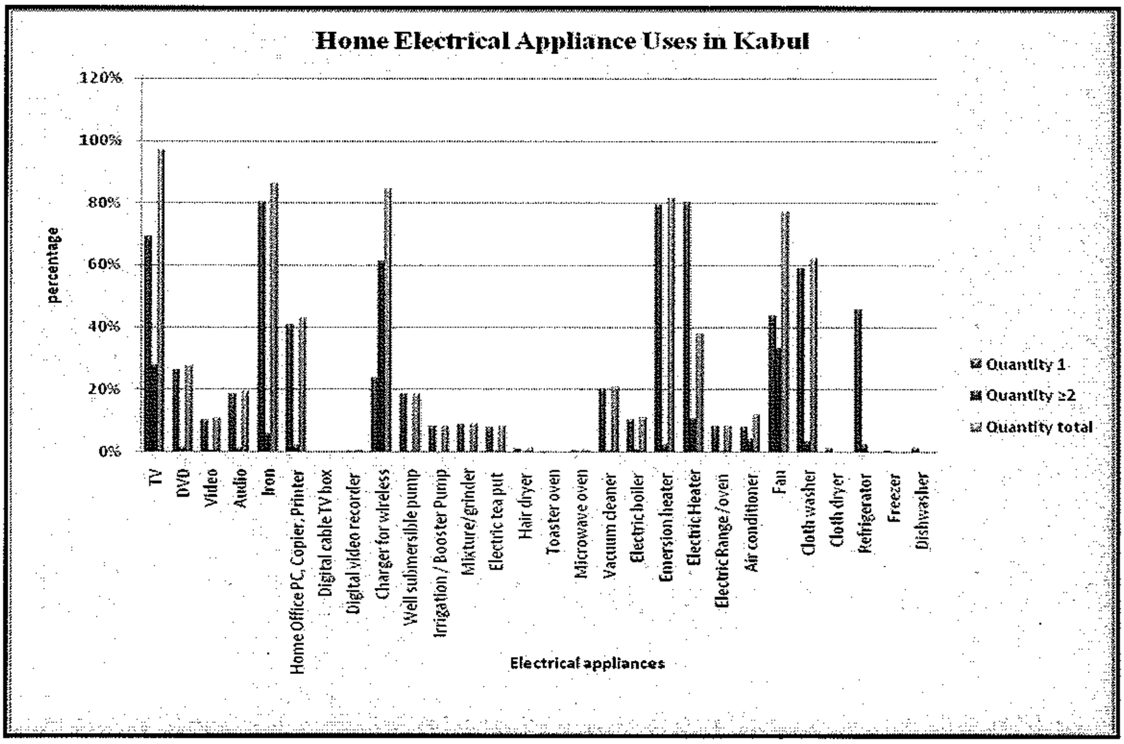
The survey also showed that CFLs are used more than incandescent lighting (about 70 percent, see discussion in previous chapters). Fans and lights (CFL, IB, FTLs) are the most common appliances, followed by TVs. Rice cookers are less common than TVs, possibly because people still use LPG and wood as their main sources of energy for cooking. Among middle income households, refrigerators, computers, and water heaters are increasingly common. Air conditioners were mostly found among the higher income households.

As for domestic appliances, Chinese products are prevalent in the market followed by Malaysia and then Japan and Pakistan. Due to the absence of import quality standards and consumer education (no national standards and labeling), low-cost, low quality products continue to be popular in the market.

Exhibit 23: Major List of Home Appliances Imported

No.	Products	Country of Origin	Size/Capacity	Electricity consumption
1	TV	China, Malaysia, Japan	21 – 42 inches	96-230 watts
2	Washing Machine	Malaysia, Japan, Pakistan	5-12 kg	315-2200 watts
3	Computers	Malaysia	15-19 inches	90-350 watts
4	Photo Copier	Japan		1200-1500 watts
5	Water Heater	China, Italy	30-50	1650-5000 watts
6	CFL	China, Malaysia		3-100 watts
7	FTL	China, Pakistan	2-4 ft	20-40 watts
8	IB	China, Pakistan		15-200 watts
9	Refrigerator	Japan	38-65 ltr	180-230 watts
10	Air-conditioning units	Pakistan, Korea, Japan	12000-24000 BTU	1900-2650 watts
11	Electric Tea Kettle	China, Malaysia	1.7-7.0 ltr	1800-2200 watts
12	Vacuum Cleaner	China, Japan		1200-3000 watts
13	Electric/Microwave Oven	Malaysia		1400-1600 watts
14	Iron	China, Malaysia, Pakistan, Japan		1000-1800 watts
15	Fan	Pakistan, Malaysia	14-18 inches	50-60 watts
16	Rice Cookers	Malaysia	1.5-5 ltr	500-1250 watts

Exhibit 24: Home Electrical Appliances used in Kabul



C.2.9

Bamyan Household Energy Use Survey

ACEP is working on implementing an integrated micro hydro project for Bamyan, from generation, distribution, and end use. To understand existing electricity and likely future demand, a Bamyan household energy use survey will be undertaken to obtain the detailed information to support the design of the distribution network. The survey will also obtain information on the use of appliances.

See Annex VI for details methodology and designed output.

C.2.10

Kandahar Energy Use

Although we were not able to travel to Kandahar, we relied on existing data from AEIC and DABS to develop a preliminary picture of power demand and efficiency potential for the city. Current electricity use varies widely from 100 to 800 MWh/day because of extreme unreliability of supply. It averages 20,000 MWh/month (source: AEIC), with an estimated average daily demand varying from less than 10 MW to up to 54 MW (when all available diesel units and the two Kajaki units operate at the same time). Average load in "normal operations" should be 30-40 MW. Power is supplied from Kajaki hydro plants (31 MW capacity, two units operational, but with sporadic line cuts) and the Kandahar diesel generators (23 MW total capacity). The latest official figures estimate the population at 700,000-800,000 vs. 465,000. Although thousands are estimated to be leaving Kandahar these days because of insecurity, the city population is expected to reach one million before 2015, which could mean a need for 100 MW peak load, or a doubling the current capacity. Based on our knowledge of Kabul, Bamiyan, and northern cities, we believe that significant savings through DSM can be achieved (CFLs, SHW and prepaid meters (see Annex II). Given the reliance on diesel generation, DSM is critically important.

C.2.11

Economic and Financial Data

Electricity, fuel and equipment prices, interest and discount rates, taxes, growth rates (sources: DABS, KED, MEW, MOE, BOS, MOF, USAID, WB and ABD and vendors).

Technology Diffusion Assumptions

ACEP database and on-going discussions with manufacturers, vendors and end users.

C.2.12

Approach Limitations

In the economic, financial and institutional analysis of the key EE measures carried out above, we were cognizant of a number of limitations and uncertainties:

- **Load curves uncertainty and variability, including peak hour distribution by class of customers (AM, mid-day, and PM peak).** Although KED and AEIC have good data on connected customers, they do not have detailed load information (e.g. hourly load curves) by category of customers. This critical information for our analysis is available from only two sources:
    - Direct load data logging using recording equipment in households, buildings and industries
    - Bottom up estimates from Kabul survey data (using the inventory of equipment and daily utilization schedules)
- Survey limitations (high, uncontrolled growth environment)
- There are limitations with respect to the household survey, including the following:
    - Poor awareness and technical know-how among customers
    - Lack of utility participation

- Lack of availability and access to accurate data
- Lack of proper documents (utility cards/bills)
- Unavailability of the head of the family
- Social limitations (male surveyors cannot enter house)
- Lack of trust in utilities and outcome implementations
- Lack of data on environmental degradation/hazards

- High level and variance in cost of transactions, management and operation and maintenance costs.

  Transaction costs in Afghanistan are high because of cultural issues, security concerns, corruption, and lack of experience with new technologies and systems, e.g., installation of new, high efficiency variable speed electric motors.

- **Overall data unreliability (population, income, growth rate, equipment stocks, new construction, etc.).** A chronic problem in Afghanistan is the lack of reliable data (for example, on population, income, formal vs. informal housing characteristics, rate of electrification, losses evaluation), which was a major constraint in carrying out a quality analysis of the EE/DSM measures that follow. Consequently, this study team abandoned earlier plans to use sophisticated DSM modeling tools such as those used by the US Department of Energy (IRP and DSM), as well as others that are more tailored for developing countries e.g., the Danish model SAVE-X. We decided instead to rely on simple and transparent screening tools and assumptions.

C.3

D.3. RESULTS

Using the economic and financial assumptions presented above (and in the footnotes of the DSM Summary below) we have carried out an economic and financial analysis of the most promising selected priority options. These are: awareness and outreach campaigns; urban re-lamping; solar water heaters, large electric customers, and new efficient buildings. Detailed computations and related algorithms are provided in Annex VII.

We have postponed a more detailed analysis for the longer term options which includepre-paid meters (for demo project), LED (for demo project), standard and labeling of efficient appliances (policy initiative), and Building Codes (EE) (policy initiative) because they are not immediate priorities and do not lend themselves to reliable cost/benefit analyses given the low quality of the market data available.

Detailed Results

As shown in the Summary of DSM Measures below, The Awareness and Outreach Campaign was budgeted at $1million for the first 12 months (average amount spent in similar countries of the region e.g., Sri Lanka, Nepal, Bangladesh) and is expected to generate about $4 million in economic savings for a simple payback period of three months. However, the CFL replacement program could save $30 million during the same period at a cost of $3 million for an economic payback period (at NEPS marginal costs) of just over one month. The other measures: SWH and ESCO services for large customers would save a total of $7.4 million at a cost of the same order of magnitude, that is, a payback period of one year. Finally, the EE initiative in new buildings (last line in the table) is expected to save $1.2 million and cost around $3 million, that is, a payback period of 2.5 years (35 percent Internal Rate of Return [IRR]), but the data reliability for this last measure is still very low and not on par with the others.

Exhibit 25: DSM Summary

Summary of DSM Measures

Main DSM Assumptions (Inputs)

DSM Technology	Target in Units	Tariffs in US$/MWh	Savings in %	Hours of Operation	Peak Hours AM	Peak Hours PM	Off Peak Hours	KWh saved/DSM unit/yr	Unit Cost DSM unit ($)	Total Unit Cost per Installation
Awareness and Outreach Campaign (No. of People)	30,000,000	60	2	NA	NA	NA	NA	NA	NA	NA
Urban Re-Lamping Programs										
CFLs for Res. Outdoor	50,000	120	75	3650	1217	2433		277.4	1.5	3
CFLs for Road & Street Lighting	10,000	200	75	4380	0	1825	2555	832	6	12
CFLs in Govt. Buildings	500,000	200	75	3432	0	0	3432	161.3	1.5	3
CFLs in Low Income Housing	1,000,000	30	75	5840	730	1825	3285	274.5	1.5	3
SWH for Large Customers	10,000	200	90	1460	122	304	1034	2920	900	1200
Large Electric Power Consumers										
TOD/Load Management	1,257	200	10	4380	0	1825	2555		500	750
Power Factor/High Eff. Motors/Muni. Pumping	5,000	200	25	7300	730	1825	4745	18250	500	600
ESCO/Energy audits at large customers	125	200	20	4380	0	1825	2555	87600	55000	55000
New Buildings Initiative (Sq. Meters)	100,000	200	40	7300	730	1825	4745	60	80	100
TOTALS										

Cost & Benefits

DSM Technology	Total Saving MWh/y	Morning Peak	Evening Peak	Off Peak	Total Customer saving US$ million	Total National Saving US $ million	Total Cost US $ million	of which private sector	Net Prog. Cost to Public Sources	Customer Pay Back Period (yr)	National Pay Back Period (yr)	Penetration Time
Awareness and Outreach Campaign (No. of People)	70,000	NA	NA	NA	4.2	4.2	1	0.0	1	0.24	0.24	1 yr
Urban Re-Lamping Programs												
CFLs for Res. Outdoor	13,870	0	9,293	4,577	1.66	2.2	0.15	0.05	0.1	0.08	0.07	1 yr
CFLs for Road & Street Lighting	8,322	0	5,576	2,746	1.66	1.3	0.12	0.0	0.1	0.07	0.09	1 yr
CFLs in Govt. Buildings	80,652	0	0	80,652	16.1	4.8	1.5	0.0	1.5	0.09	0.31	1 yr
CFLs in Low Income Housing	274,480	34,310	85,775	154,395	8.2	30.7	3.0	0.0	3.0	0.36	0.98	1 yr
SWH for Large Customers	29,200	2,433	6,083	20,683	0.9	2.8	12.0	9.0	3.0	13.70	4.35	3 yr
Large Electric Power Consumers												
TOD/Load Management			11	11	0.5	0.5	0.94	0.0	0.9	2.06	2.06	2 yr
Power Factor/High Eff. Motors/Muni. Pumping	9,125				2.0	2.0	0.3	0.0	0.3	0.16	0.16	3-5 yr
ESCO/Energy audits at large customers	11				2.2	2.2	6.88	3.5	3.4	3.14	3.14	2 yr
New Buildings Initiative (Sq. Meters)	6		0.15	0.39	1.2	1.2	10.0	7.0	3.0	8.33	8.33	5 yr
TOTALS					38.6	51.8	35.9	19.6	16.4	0.93	0.69	

1. Source: KURD note
2. Interview with Mr. Rosooli, Dy. Mayor on June 6, 2010
3. ACEP estimation based on discussion with DABS/KED and government representatives 10% of total number of units in Kabul
4. Estimates based on ACEP survey and KED/MOUD consumers data indicate the number of remaining IB is about 40 % of total of 5 Million for purpose of this we have consider 1 M in first phase
5. Official tariff structure for Kabul as of June 2010: See chapter 1 for details
6. Generally accepted target based on Eco Asia study. This target is consistent with Kabul data where the change is primarily from 60 w IB to 13 w CFL
7. Marginal cost/avoided cost per kWh has been assumed as follows: Morning peak 0.06 (hydro); evening 0.21 (Tarakil TPP); off peak 0.03 (Imports)
8. Outdoor lights have been assumed to operate 12 hours a day of which 5 in evening peak, similar assumptions for road lights,
9. Government building lighting assumptions are as follows: lights on 12 hours a day (7 am to 7 Pm), 5.5 days a week all off peak hours
10. Low income housing lighting assumptions are as follows: 2 hours morning leak plus 5 hours evening plus 9 hours off peak, a total of 16 hours a day (source Kabul survey)
11. Solar water heater (10,000 units in 2011; 20,000 units in 2012 and 30,000 units in 2013)
12. Target population equal 10% of commercial (1165), 100 others for industrial, pumping, military of a total of 1257 (Source DABS
13. Average load 50 KW, saving 10% or 5 kW, 5 hours a day equal 25 kW per day per site. New tariff assume to be 30 cents (15 Agh) and 6 cents (3 Agh off peak)
14. Saving resulting from ppm assumed at 10% of total consumption
15. Assuming 1,000,000 sq m new construction every year in Kabul of which 600,000 in residential and 250 in commercial, plus 20% informal
16. Based on data from India for new building we assume base line consumption at 150 Kwh per sq m per year period, 40% saving means 60 Kwh/sq m/yr
17. Assuming cost of high quality construction with international EE building code at 200 $/sq m vs. 120 $/traditional construction i,e sources of 80 $/sq mll
18. A review of campaign in 50 countries as resulted into 1-5 % saving in the first year for the sake of Afghanistan we choose 2% because of excellent establishment of TV everywhere.
19. By 2011 Afghanistan will consume 3.5 Twh @ 2% will be 70 Gwh.

Results Limitations

As mentioned earlier, the quality and limited coverage of the data poses a challenge to determining the size of programs for each DSM measure; estimating their market penetration and their total installed costs, inclusive of "transaction costs."

Extrapolation to Other Cities and Multiyear Projections

Although most of the analysis has been made for Kabul, we believe that the results of the economic and financial analysis are valid in other urban locations of Afghanistan because:

- The power tariffs are the same . The cost of energy varies, SHPs is more expensive than NHPS.
- The equipment prices and performance are the same
- The availability of CFLs and other major energy efficiency equipment is about the same

Implications (Building the "Pyramid")

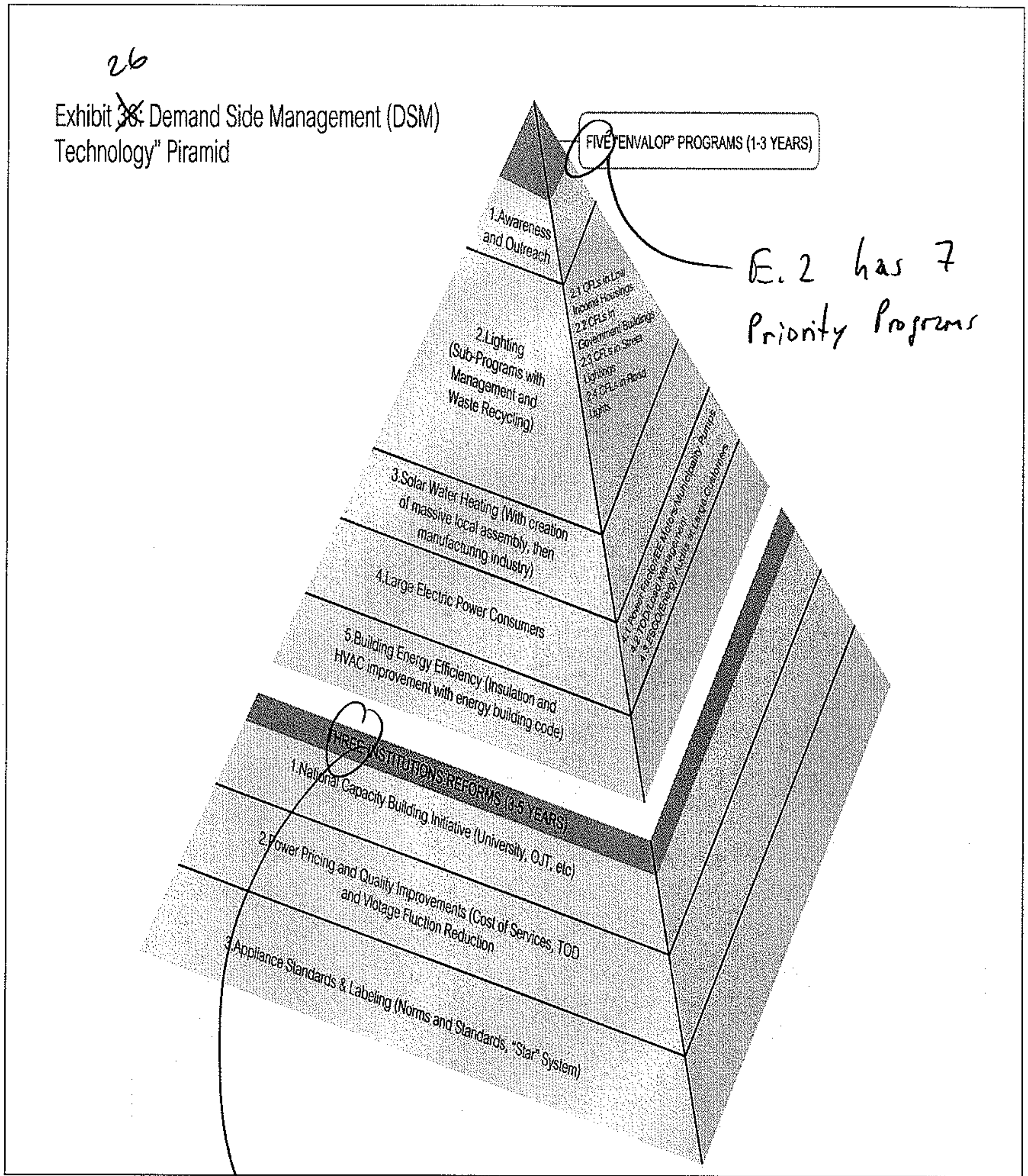
A thorough study of these barriers and discussions with experts of the MEW EE Advisory Committee has led us to consider *"bundling"* measures that actually can be rolled out in all major cities of Afghanistan, (e.g., Kabul, Kandahar, Jalalabad, Mazer-i-Sherif, Herat and others).

- **An information, awareness and outreach initiative**
- **An urban efficient lighting Initiative,** consisting of CFL replacement in low income households and government buildings
- **An SHW Initiative** to provide support through a first-time but limited subsidy for the first 10,000 users
- **A large user Initiative, including "Captive Non-Payers"**: large motors and pumps, with new energy efficiency motors, capacity factor improvement and energy audits with future ESCO financing, in tandem with an attempt to introduce time of the day tariffs (esp. for water pumping)
- An energy efficiency new building initiative, with ECBC, EE envelope, and appliance components, with a focus on HVAC.

To be successful, these implementation programs will need to be supported by a number of longer term reforms and demonstration projects.

In the next chapter we will analyze the various barriers that are likely, if not addressed, to impede the rapid and massive roll out of these initiatives.

Exhibit 26: Demand Side Management Technology "Pyramid"



E.2 has 8 long term reforms

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D Em AND MANAGEMENT

D. CONSTRAINTS/ BARRIERS FOR IMPLEMENTING ~~ENERGY EFFICIENCY~~ OPTIONS IN AFGHANISTAN (PRICE AND NON-PRICE)

The paucity of meaningful ~~EE~~ DSM activities in Afghanistan is attributed to a challenging combination of economic, financial, technical, historical, socio-cultural, and institutional barriers, as summarized below:

Exhibit 27: Measure Barriers

Economic and financial barriers:

1. Many users of electricity are not required to pay directly for the power they use, especially among government entities (many bills are not paid by the agencies themselves, but from a general fund)
2. There is a lack of financial incentives for efficiency investments
3. Import duties do not reflect efficiency or quality features
4. Existing tariffs provide inefficient electricity pricing for some customers and do not reflect the high cost of generation during peak hours (5-11 PM) and differential rates (No difference in the tariffs for commercial and industrial consumers vs. high income residential)
5. Shortage of dedicated sources of capital for implementing ~~EE~~ DSM options and absence of low interest credit for ~~EE~~ DSM

Technical barriers:

1. Lack of metering that could promote efficiencies (Time of the day tariffs, power factor) for large users
2. Lack of availability of ~~EE~~ DSM equipment
3. Most existing distribution infrastructure is antiquated, inefficient and subject to breakdown and "loss-prone"
4. Low efficiency of durable end use electrical equipment at household, manufacturing and commercial levels
5. Lack of agreed norms and industry standards for ~~EE~~ DSM equipment
6. Low quality, low efficiency imported technologies (lighting, motors, duty cycles, etc.)
7. Poor power quality (voltage reductions and fluctuations) that damages equipment, unreliable and lack of continuity of supply

Historical/ Institutional/Socio-cultural:

1. Thirty years of war have left the country's power sector infrastructure, which was never robust or national in scope, in complete need of major capital investments and repairs
2. The extended period of conflict has robbed the country of cadres of people with technical skills, and those that remain are near retirement age
3. A "tradition" of not paying bills in some sectors combined with wholesale theft of energy
4. "Split incentives" factor in large buildings: the developer/owner's interest is in low first cost (inefficient systems and low EE) whereas the tenant's interest is in paying lowest bills (efficient systems and high EE)
5. Lack of education and knowledge of energy systems
6. Lack of public trust in electric utility
7. Lack of a public energy efficiency policy
8. Lack of institutions to initiate and implement ~~EE~~ DSM activities
9. No Operation and Maintenance culture; extreme shortage of trained and motivated technicians
10. Rapid growth of Kabul, which is expected to continue
11. Lack of demonstration projects to reduce perceive risk in new EE technologies
12. Absence of effective, enforceable regulation
13. Ineffective-legal system, but functioning systems of tribal law and customs
14. No effective private sector EE businesses (little reason for entrepreneurs to enter market)
15. Lack of sufficient reliable data
16. Pervasive and systemic corruption

<u>General lack of reliable data.</u>
<u>For example:</u>
Population of Kabul: 3.65M-5.1M (4.6m)!
Total population of Afghanistan 25-31M (30M)!
Number of households: 520,000-700,000 (680,000)!
Informal customers: 100,000-200,000+ (160,000)!
Total generation in NEPS: 300-500MW (290mw + IMPORTS)
National electrification rate: 16%-36% (20%)!

Growth rate of the economy: 8 - 22 %

In comparison to other post-conflict economies Afghanistan still needs to overcome many structural and policy barriers in order to integrate the basic concepts as practiced elsewhere in the world in terms of ~~energy efficiency~~. ~~Energy conservation~~ as a standard accepted practice is not recognized in Afghanistan, which is often attributed to its largely rural and fragmented economic system and shortage of qualified human resources to support such practices. The very concepts of EE and DSM are entirely new for many. Currently, there are only a few recently trained specialists who are familiar with them, and even fewer understand how to actually apply efficient standards in a concerted and acceptable fashion. More importantly, the population at large is not aware of the existence of many kinds of EE equipment or practices and of their possible benefits.

Nevertheless, the recent increased availability in the overall supply of energy in the NEPS system (with fewer outages and continuity of supply), and in tandem with the availability of improved technologies (CFLs), consumer habits have been impacted in recent years, especially in the most affluent segments of the Afghan urban population and in the commercial sector (see results of the 2010 Kabul survey). In spite of such positive tendencies, changes in consumer behavior are still slow, not being seen across the board all regions of the country. In addition, they have been mostly limited to lighting. In our investigations, we have found very few – if any – working water solar heaters, building insulation, building and industry building control systems, and efficient electric motors .

Positive developments are limited to a steady displacement of incandescent lighting by CFLs and a significant increase in market share of more efficient split-type air conditioners in place of package-type window units for new multi storied buildings.

The impacts of various price-driven improvements in energy use in Afghanistan have often been quickly offset, which is attributed to an overall increase in total energy consumption driven by increasing incomes, population growth, and more ready access to reliable imported energy supplies.

While energy intensity in Afghanistan remains high in certain segments of the economy, e.g., industry and large buildings relative to comparable low-income economies (180-200 kWh/m2 vs. 150 or below in new buildings) as a result of system losses, lack of insulation and poor equipment efficiencies, average consumption per capita remains one of the lowest in the world due to very limited access to electricity outside urban centers (see introduction).

The essential need is to **find ways of increasing the ~~efficiency of energy~~ use in order to increase the overall availability of electric power, despite obviously higher perceived priorities by both the government and the customers,** by means of innovative measures adapted to the changing realities of the situation and new opportunities that may arise. This means:

- **Enhancing the commercial and economic drivers for energy efficiency implementation** by facilitating and promoting the local EE market and removing impediments and disincentives for corporate and end-user EE investments, and

- **Reducing the institutional obstacles** for increased use of energy efficient technologies and practices, and the fostering of an EE industry and consumer culture

This section will briefly outline the main barriers to implementing such a strategy, and one that is based on discussions held over the past nine months at MEW EE Advisory Committee meetings. As part of this initiative, reviews of past studies as well as over 100 interviews have been carefully considered (see bibliography and list of interviews). First, we will identify and analyze the so called "market" barriers which can be addressed by technical and financial measures and then the "non-market" or "institutional" barriers.

D.1 MARKET BARRIERS

As indicated above Exhibit 27, major examples of barriers to the commercial viability of EE investments in the Afghan marketplace include:

- **Lack of information, knowledge, and experience** amongst residential, commercial, industrial, low-income and small business energy consumers on the costs, benefits, and effective approaches – "best practices" – for securing energy efficiency

- **Current utility (DABS) incentive structure** that associates financial performance with energy sales, not energy service

- **Customer tariffs and prices** that do not reflect the full costs of supply, thereby "undervaluing" energy use, especially during the evening peak hours

Lack of Information, Awareness and Technical Know-How

At the market level, EE in Afghanistan has been almost exclusively promoted by equipment suppliers claiming to offer more efficient equipment for sale in comparison to their competitors. This has meant that only a limited range of energy users could be reached by such technologies. In the meantime, poor efficiency, lower quality electricity equipment has also been spreading in a growing and competitive market. Professionals providing services to industry and building managers are not compensating for this lack of proper EE promotion.

Architects and electrical engineers interviewed for this study clearly mentioned that they were almost never asked to explore energy efficient solutions in their designs, both commercial and residential, and that they generally comply with their clients' requirements rather than proposing long-term energy saving solutions at higher up-front construction costs. Moreover, most were unaware of MOUD's Building Energy Code and therefore not even involved in its development.

Availability and access to relevant data is yet another impediment to EE implementation. EE suffers from a lack of detailed demand-side, end-user data that would provide a detailed view at the national level and would enable policy makers or market actors to make informed decisions in choosing a more energy efficient path. This dimension requires efforts on data collection by disaggregated consuming sector and end-users, an understanding of consumer behavior and technology in a given energy service (i.e., realistic EE penetration potential), and the consequent development of EE indicators and targets.[3] Energy efficiency cannot be promoted successfully in the industrial sector, for instance, without energy audits of existing installations and assessment of upgrade options available to each type of facility. The ACEP Kabul Energy survey was a first step in that direction.

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[3] In the following paragraphs, we have drawn on several papers dealing with the same issues in neighboring countries. In particular, we have used a document by Hagler Bailly, Pakistan, (Vincent David and Jamil Masud) "Implementing Energy Efficiency in Pakistan" ADB, Manila, August 2007 (See detailed bibliography).

Energy-efficient behavior of consumers requires broad-based and continued education and information dissemination. Several European countries are experimenting with so-called "social marketing" approaches to enhance energy efficient consumer behavior and support demand-side management concepts. A specific approach to enhancing customer information and awareness will have to be developed for the special needs of Afghanistan.

Financial, Pricing, and Fiscal Incentives

Higher quality EE equipment is generally more expensive than low efficiency equipment. To overcome this additional cost barrier, EE policies and programs may contain some financial and/or fiscal strategies to facilitate the introduction of the more expensive technology into the market and initiate a gradual transformation in the long-term as the benefits of such higher up-front investments in the form of lifecycle energy savings become apparent and more widely and commonly used in the market.

Afghanistan has no experience with such price-driven EE initiatives. In the National Afghanistan Strategy, however, the GIRoA had promoted market mechanisms for economic efficiency, but there is no EE-relevant monitoring and coordination capability within the GIRoA at present to implement – and monitor – the effectiveness of any such measure.

Regulatory and Legislative Support

As noted earlier, the new draft Electricity Law allows sound and consistent decisions that must be made in terms of designing programs, interventions, pricing decisions, legislation, regulations, and other tools necessary to bring about permanent improvement in national energy efficiency indicators and best practices.

In addition, regulatory and legislative support to energy efficiency and energy conservation is almost absent from the legal framework in Afghanistan. This is a major deficiency for EE promotion in the country, and one that must be redressed urgently in line with a comprehensive policy development initiative. It is expected that the soon-to-be established Afghanistan Energy Regulatory Agency will deal with these issues in a concerted and timely fashion.

D.2 INSTITUTIONAL BOTTLENECKS

Discussed below are specific institutional barriers and identified shortcomings:

Government Commitment

In the power sector, the GIRoA and donors have understandably focused their attention and resources on overcoming the severe supply crisis that has crippled economic development since 2001. Some successes are noted, as with the completion of NEPS, and a potential energy supply crisis for Kabul has been mitigated for now. For the rest of country, with the exception of Kandahar or Herat, little has been achieved.

It has been recognized that the GIRoA needs to do more to demonstrate that it is implementing policies that benefit people, and this is beyond the overriding issues of maintaining energy security. Cost and reliability of electricity are the main concerns of consumers. Many small and medium enterprises have been forced until now to rely on costly diesel generation to supply their electricity needs.

If energy efficiency is prominently integrated with national economic planning and development, it can and should be perceived as one of the most cost-efficient ways to bring about improvements in living standards and competitiveness, thus also reducing Afghanistan's overdependence on outside energy sources. Reasonable prices for durable equipment for consumers are center-stage to a concerted effort to bring about EE, but they will not happen without government leadership.

It goes without saying that the Government and other stakeholders must also show continued commitment and resolve to fight pervasive corruption that exists in the energy distribution and payment system.

Some conceptual changes in the GIRoA planning process are necessary to achieve such an objective, such as:

- Embedding EE into the national energy policy and security strategy (MEW), and as a targeted "supply" option, whereby realizable energy utilization improvements among key consumption and production sectors of the economy are identified.

- Evaluating all available options, and the actions and means required; the achievement of a range of EE improvements would be based on a time phased and sequential action plan, which includes performance benchmarking, institutional monitoring, and verifiable program milestones.

- Devising effective institutional, policy, legal, and regulatory frameworks, as necessary components in facilitating the implementation of a coherent and long-term national EE action plan; such frameworks will address public and private sectors and include provisions for the proper allocation of financial, human, and technical resources in meeting such objectives.

- Re-orienting government planning and spending is needed in all sectors so that EE considerations and requirements are addressed across the board by all agencies as part of their routine operational procedures, and included in planning, investments, service provision, and infrastructure development activities.

- Including provincial governments in the process in a meaningful and participatory way, and outside of Kabul, stakeholders have not only critical local knowledge but they are likely to seize on initiatives that can benefit their constituents and ensure sustainability.

- Coordinating government and donor actions, policies, and planning for sustainability is essential, as it is necessary to build on each successive EE gain over the long term to help redirect national economic growth on a more energy efficient footing. Unlike most neighboring countries, the investments required for Afghanistan's long-term growth provide an opportunity to make wise choices in terms of rational energy use.

- The importance of these measures cannot be understated and the degree and manner in which they are implemented will largely determine the longevity and extent to which national energy policy can be put into place. The various implications of each of these components and policies must be examined in detail and fully understood in determining efficiencies over time. Otherwise, albeit good intentions and adequate financial resources, without proper design and buy in from the start, a future EE strategy may suffer the fate of previous such efforts.

Most of these elements have been incorporated in the current draft of the MEW EE Policy and Strategy.

Planning and Coordination

It is essential to involve thoughtful planning of a national EE initiative in order to avoid making the same mistakes that were made in neighboring countries. Local conditions, especially in terms of various implementation and other identified constraints, must be considered at all stages and buttressed with emerging market considerations, especially in four key aspects:

1) Market and economic evaluation of significant, cost-effective EE opportunities in key sectors, prioritization and sequencing of action areas, and definition of realistic national EE targets

2) A review of the strategic approach to EE implementation, with well-defined stakeholder and institutional roles (including leadership responsibilities), focus areas, tasks, outputs, organizational setup, coordination and networking arrangements and reporting requirements

3) An evaluation of the technical, material, financial, human, and other resources required, and their respective sources for meeting the investment and recurring costs of a sustained, long-term EE strategy, and necessary allocation and procurement of commitments from the respective stakeholder entities, led by the GIRoA

4) Establishment of effective institutional and national EE performance data collection and monitoring mechanisms in the form of measurable milestones, information sharing, institutional and program evaluation, end-user and market feedback, etc., which allow for corrective actions and mid-course refinement to be undertaken promptly.

Again, most of these considerations have been taken into account in ACEP work with the MEW EE sub-department over the last few months.

Organizational Roles

There are two aspects of the organizational setup relevant to the establishment of a national EE initiative:

1. The larger context of the energy sector supplier, consumer, and management structure, as well as the state of the domestic energy market
2. The specific institutions tasked with or otherwise directly engaged in EE promotion, facilitation, and implementation.

As far as the first category is concerned, the ongoing deregulation, privatization, and corporatization of the previously state-run energy supply and distribution system in Afghanistan offers new opportunities and challenges for implementing effective EE practices.

While on the one hand – by introducing market competitiveness, removing price subsidies, and penalizing inefficient operations – it raises the economic and financial imperatives amongst market stakeholders for adopting improved EE measures, on the other hand – by unbundling vertically integrated energy utilities into separate production, transmission, and distribution entities – it complicates the situation for external programmatic interventions that are also simultaneously required in a "push-pull" EE strategy, such as those necessary for implementing DSM measures.

This is because, in a disaggregated and decentralized organizational scheme, the investor and beneficiary of EE implementation are often separate and distinct entities – e.g., savings or changes at the consumer level would not automatically impact on energy supply as they would under an integrated energy supply scheme (the so-called "split incentive" barrier). Thus, a differentiated strategy might be required: DSM as a tool to displace peak demand to lower demand periods would make sense for DISCOs, while energy savings at a lower-than-production marginal cost would appeal to integrated power companies and society in general, as it would contribute to least-cost power supply. Nonetheless, overall market liberalization, tariff rationalization, and increased consumer choice is universally accepted to provide, along with other benefits, improved prospects for higher energy efficiency, despite the correspondingly more sophisticated, market-sensitive EE approaches required in such instances.

In addition to evaluating ways of strengthening its institutional capacity to play an important role in a revised national EE agenda, the rationale of ascribing an all-encompassing mandate to a central organization, no matter how well endowed, is also questionable.

In other words, an effective role for effective national EE management involving a host of disparate energy sector stakeholders, interests, and consumer groups may well require a broader-based, more dispersed institutional structure and agency involvement, instead of compartmentalizing it into an isolated federal agency as per past practice. Certain functions, such as information collation and dissemination, donor coordination, service and product certification, technical training, and interagency liaison, among others, would best be centrally coordinated and administered. However, wider institutional involvement in actual EE dissemination, implementation, financing, and servicing may well require greater direct localized government, utility, industry, trade, and consumer group involvement.

This approach would not only enable distinct institutional strengths and relevant commercial interests to be better leveraged for specific EE purposes (utility-led DSM programs, industry-led audit programs, municipal building energy, and street lighting standards, etc.), but would also greatly reduce the strain and dilution of functions amongst central agencies that could instead better focus on their primary coordination and facilitative roles. In addition to a horizontal broadening of the EE institutional setup, the development and expansion of individual organizational mandates should initially focus on priority functions only, gradually expanding over time as both institutional and market capacities develop and mature and in line with a phased EE implementation plan.

Staffing and Resource Allocation

Lack of sufficient political commitment or clear long-term government initiatives results not only in vaguely defined and over-ambitious mandates being ascribed to nascent institutions at the time of their inception, but also results in inadequate funding and resource allocation.

Apart from a reassessment of the required institutional setup, with more realistic and workable mandates for dedicated EE institutions (MEW EE, NEPA), a future government EE initiative must clearly strive to empower these agencies with the necessary political and functional powers, adequate minimum upfront and recurring budgetary support guarantees, and administrative independence to be able to recruit and retain the best available expertise over the long term. Funding, staff, compensation policies, and material resources must be properly assessed as part of the institutional reorganization activity at the outset in line with the development of the national EE policy and action plan. There should also be provisions provided for continued professional education and in-service training.

Management and Monitoring

Weak organizational management and institutional monitoring can derail various GIRoA attempts at creating new agencies. New institutions in particular require a great deal of additional effort in defining and organizing their internal affairs and operations properly, developing new management systems, and building capacity, while at the same time frequently also having to "learn" their main tasks and functions. That the latter is frequently overstated at the outset – instead of being expanded gradually from a modest, initial mandate as the institution learns to stand on its feet – often completely overwhelms and derails the effort, with the agency invariably resorting to surviving "on paper" rather than in terms of actual capacity to deliver. This situation usually remains, especially given the lack of established agency performance monitoring mechanisms within the GIRoA administrative framework, and assumes the shape of an entrenched institutional characteristic that becomes extremely difficult to change in the longer run. At the same time, dedicating a complex task to a single purpose-made agency conveniently compartmentalizes the issue and absolves decision makers of further responsibility; additional efforts in this respect are either not taken or redirected to the agency that has little capacity to implement them, thus wasting good money after bad as well as losing time-constrained opportunities for affecting meaningful change.

This situation could be rectified if line agencies, such as NEPA or any other organizations created with a specific mandate on EE, were given, along with the necessary resources and technical assistance, clearly defined organizational roles, annual plans, and targets with mandatory reporting requirements that can be reviewed periodically at the appropriate executive levels, and can provide the basis for both corrective action as well as subsequent institutional enhancement and expansion. Such monitoring must extend to key personnel, outputs, activities, financial management, and external stakeholder feedback, and can be utilized as an evaluation and motivational tool for staff and management. Such a system alone, if reasonably designed, could bring about a sea of change in organizations that otherwise find it impossible to bootstrap from the ad hoc and isolated circumstances in which they usually find themselves.

In addition to institutional and organizational monitoring mechanisms, an effective EE program must be based on measurable national targets and intermediate milestones. The success of program design, the need for mid-term modifications, the allocation of additional resources, and the expansion of the program's ambit all depend critically on a proper evaluation of the results achieved against a scale of benchmarks derived from local and international experience. This, in turn, requires a strengthening of relevant energy-related data collection and analysis capabilities, which need to be institutionalized within new EE organizational arrangements.

Institutional Summary: At this time, we believe that most of our recommended programs can be carried out by DABS and private sector companies (engineering and construction). This is true for the lighting and SWH initiative, and with some capacity building, for the large user initiative. The Awareness and Outreach campaign will need the leadership of MEW; the efficient building initiative will be more complex and take more time to organize.

In the next few years, the MEW EE sub department should be tasked to be the focal point of the programs. More specifically:

The mission of MEW EE sub department's mission should be to lead, develop, coordinate, oversee, monitor, and evaluate all aspects of energy efficiency in the power sector.

Specifically, the sub-department should:

- Recommend policies that will reduce the electricity intensity of the economy while supporting its development
- Develop a reliable data base of key electricity end use information, especially for large customers and the government sector, in cooperation with AERA
- Identify with other stakeholders, including the private sector, priority energy efficiency programs
- Determine the appropriate legal, regulatory, and institutional framework to best implement such programs
- Coordinate efforts of all stakeholders at the national and regional levels
- Monitor progress of such activities and verify energy efficiency results in specific sectors and at the macro level
- Adopt a proven methodology, i.e., the International Project Monitoring and Valuation Protocol (IPMVP) and train MEW professional to its practice.
- Demonstrate new, high potential but unproven EE technologies in Afghanistan
- Leverage donor and private sector resources
- Implement all components of the law that relate to EE

Page Break

In the next chapter, we will bring together all the technical, economic, financial, and institutional aspects of a proposed EE agenda for Afghanistan that will deal effectively with the perceived barriers and funding constraints.

E. IMPLEMENTATION

International experience has demonstrated that identifying the most promising programs and barriers to address is not sufficient to ensure program success. In addition to sound technical, economic, financial, social, and institutional analysis, a number of prerequisites are needed. These include the following **Five Imperatives:**

1. Government commitment and leadership at all levels from central to village
2. Appropriate policy, regulations, and incentives
3. Dedicated budgets
4. Clear implementation responsibilities
5. Strong and independent monitoring and verification of energy savings

We will first review how the key barriers affect our recommended priority programs and then present our approach to dealing with the Five Imperatives.

E.1 DEALING WITH BARRIERS

In this chapter we describe our approach to dealing with the key barriers to implementing the most attractive EE/DSM options identified earlier. Based on our previous analysis, we have reorganized the list of barriers into three groups: Customers (small and large), Utility (DABS, distribution companies), and Government (MEW and other concerned ministries).

Exhibit 28: Taxonomy of barriers, by Category of Stakeholders

Small customers:	
o	**Lack of information, understanding and awareness**
o	**Lack of culture of energy savings and bill payment tradition**
o	**Lack of trust in government and national/parastatal organizations e.g., DABS**
o	***Low power quality (reducing willingness to pay and damaging equipment)***
Large customers:	
o	**Lack of capital**
o	**No incentive pricing (TOU tariffs)**
o	**Split incentives in commercial sector**
o	**Lack of private sector specialized and competent services (ESCOs, suppliers)**
DABS	
o	**See EE/DSM as money losing activities**
o	**Lack of understanding of long-term benefits**
o	**No incentives, no (regulatory) mandate- quite the opposite**
o	**Lack of financial resources to fund EE/DSM programs**
o	**Old and obsolete infrastructure**
o	**Lack of load and loss data**
o	**Lack of motivated and qualified personnel; salaries inadequate to recruit best people**
MEW and the GIROA	
o	**No awareness and understanding of benefits**
o	**No institutional capability and clear responsibilities over EE/DSM and no accountability**
o	**No budget**
o	**"GENERATION IS KING." MORE IS BETTER."** ***"REAL AFGHANS DO NOT CONSERVE."***

Most of these barriers have been selected and aggregated into three main categories, as shown in the following exhibit.

Exhibit 29: Barriers

	ECO./FIN.				TECHNICAL				INSTITUTION									
INITIATIVE	Lack of Funding	Lack of Payment	Pricing	Credit/Capital Avability	Lack of Proper Meters	Lack of EE Equipments	Old Infrustructure	Low Quality of Equipments	Power Quality	Lack of Awareness\Knowledge	Split Incentives	Lack of Trust	Lack of Policy	No Culture O&M	Explosive Growth	Legal/Regulation	Data Quality and Availability	High Cost of Transaction
1 OUTREACH AND AWARENESS	●									○		●	●				○	○
2 EFFICIENT LIGHTING			○			○		●	●				○					○
3 SOLAR WATER HEATER	●		○	●		○	○	●		○	●		○					○
4 LARGE ELECTRIC POWER CUSTOMER	○	○	●	○	○	●	○	●	○	○			○	●				
5 BUILDINGS EFFICIENT AND APPLIENCE	●			●		○	○	●		○	●		●		●	●	○	○

Legend
● Major Barrier
○ Barrier

Priority Programs

E.2 APPROACH

To deal with these barriers, the following three-pronged approach is recommended:

1. **Develop a series of short-term (1-3 years) high impact, highly replicable, and high-return activities.** Such activities have a high potential of being successful in Afghanistan based on past experience here and other similar countries.

2. **Start a process of longer term reforms** that will be essential to the success of these activities.

3. **Carry out a number of high impact, highly replicable demonstration projects** that will tackle the perceived risks and barriers.

E.2.1. Priority programs, short term, high impact, highly replicable, high return

Earlier in this Section, we identified the following seven priority programs and/or initiatives:

(1) National Awareness and Outreach Campaign

(2) Urban re-lamping programs (from IBs to CFLs):

- Low income households
- Government buildings
- Outdoor lights
- Road and street lights – CFL in Roads? Really?

(3) Solar water heaters dissemination initiative

(4) Load management incentives to large customers (20 KVA and above)

(5) Large electric motor (5 kW) performance improvement program

(6) A New building initiative – Building "Envelope" and HVAC

(7) Development of a private Afghan energy services industry (AESCO)

E.2.2. Longer term reforms

In the previous chapters, we identified the following needed reforms:

(1) Capacity building

(2) Pricing and tariffs

(3) Data collection

(4) Power quality improvements

(5) Home appliances norms and standards (CFLs, SWH, ACs, TVs, geysers, motors, building codes)

(6) Incentives, legislation and regulations (carrot and stick); rewards for doing the right things

(7) Financing

(8) M&V

Demonstration programs

In order to facilitate the adoption and reduce the perceived risk of new technologies beyond those recommended above, we have identified four priorities for demonstration programs:

(1) Low cost, low maintenance, and high efficiency local SWH

(2) LEDs for rural applications

(3) Pre-paid meters for non-paying customers

(4) DSM cell at KED

Program Summary or the "Pyramid"

Our recommended program consists of three intertwined blocks of initiatives. The first two are best illustrated as the top (programs) and form the basis (reforms) of the pyramid. The last one (demos) is a separate piece aiming at addressing risks and preparing the market for new activities (see Exhibit 26).

E.3 FULFILLING THE FIVE IMPERATIVES

In order to fulfill the Five Imperatives, we recommend the following actions and approach:

Securing Top Government Commitment

The establishment of the MEW EE Committee and its transformation into an ICE official subcommittee has been the MEW's main initiative to elevate the visibility of EE at the highest level of government (several ministries are represented, as well as DABS and most multilateral and bi-lateral donors). The National EE Conference, which was opened by the Minister of Energy and Water with participation of several other ministers and representatives from the President's Office and the Parliament with an associated high level media campaign was a major step in order to achieve this GIRoA initiative.

Developing and Implementing Supporting Policies and Incentives

Based on the cost/benefit analysis presented earlier in this Section, we will recommend the following policy and financial incentives to be proposed by the MEW to the government before the end of 2010:

- Revise the draft Electricity Law and the TOR of the future AERA to provide national support to EE and DSM activities as well as implementation roles and monitoring and evaluation responsibilities
- Propose to the Interministerial Energy Commission and the Ministry of Finance a provision for $150 million of grants and soft loans for EE and DSM investments in the private sector e.g., rebates on EE equipment, tax holidays and grants for the establishment of an Afghan Solar Water heater industry and an Afghan Energy Services (ESCOs) industry

Appropriating necessary budgets

Based on ACEP's analysis presented earlier, it is estimated that the overall EE program would cost $53 million and save $36 million per year at market prices (financial analysis) or $52 million at shadow prices (economic analysis) over $250 million NPV (12 percent discount rate) plus 30 MW of avoided new generation worth a minimum of $150 million, for a total of $400 million in total national benefit, which is an exceptional benefit/cost ratio of 7.5:1.

Assigning Clear Responsibilities

Exhibit 30: National Afghanistan EE Program cost by suggested funding source (US dollars, million)

	Role	Initiate	Implement	Fund	M&V
Organization					
Ministry of Energy and Water		x		x	xx
Ministry of Economy				xx	xx
Ministry of Urban development			x	x	xx
Ministry of Information and Culture		x	x		xx
Ministry of Woman 's affairs		x	x		xx
DABS		x	xx	xx	xx
ANSA			xx	x	
NEPA		x		x	xx
KU,KPU		x	xx		
NGOs		x	xx	xx	
Private Sector		x	xx	xx	
Donors		x	xx	xx	xx

Establishing strong and credible monitoring and verification mechanisms for reporting actual energy savings.

Based on international experience, we recommend that the MEW adopt the International Project Monitoring and Valuation Protocol (IPMVP) adopted by more than 40 countries in order to establish the rules for this critical activity. The proper agency can then be selection e.g. the MEW EE sub-department to implement the protocol.

Conclusion: Afghanistan's per capita current energy consumption is very low by international standards; an aggressive EE strategy is needed to capture most of the current and future potential identified in this report. Reducing the evening peak load by 30 MW in 2010 and 50 MW in 2013 will indeed have the unmatchable following benefits:

1. It will reduce the need for future generation and transmission by $150 and 250 million respectively at a cost of only about 10 percent of these.
2. It will reduce the cost of the marginal fuel (diesel) consumption by up to $6.2 million/year, for a net present value of over $60 million.
3. It will reduce emissions to the environment proportionately.
4. It will free capital for other national priorities.

5. The EE activities will generate new private sector businesses and jobs.
6. The EE activities will act as a catalyst for the Afghan economy to move into more advanced technology and develop advanced skills for its manpower.

This report has identified five "bundled" programs to be implemented in five Afghan cities in the next five years to achieve these results. It has also identified and analyzed the major barriers to successful implementation of these programs and recommended a number of fundamental market and institutional reforms, as well as defined specific roles for each key shareholder to ensure overall program success.

In the ACEP companion report "Energy Efficiency Strategy Report," we will present a detailed strategic approach to such an implementation.

ANNEX I: STUDY SCOPE, SCHEDULE, DATA SOURCES, AND METHOLOGY

Objective of this Report:

USAID and the GIRoA have decided to devote a substantial component of the ACEP program to EE and DSM both for on-grid (mostly urban) and off-grid (mostly rural) end-uses. Under this component, International Resources Group (IRG), as the prime contractor, has prepared this Assessment Report on the potential of, barriers to, and specific opportunities for increasing the efficiency of electricity use at all levels and in all sectors (see box). The methodology and the scope of the study are presented in more detail below.

Based on the terms of reference and discussions with stakeholders at the MEW EEAC meetings, we have defined a scope for this project that covers over 90 percent of the commercial electricity used in Afghanistan. The scope and the project limitations are summarized in the table below:

Scope:

- Time horizon 2010-2015 (more than five years is considered unrealistic for efficiency programs as they are designed primarily for short term results)
- All of Afghanistan on-grid, but with a focus on the Kandahar-Kabul corridor where over 40 percent of the customer reside – sample measures for off-grid (rural, renewable and transitional)
- Existing, retrofit, and new applications
- All technologies that can reduce electricity demand will be considered, from efficient lighting to advanced motor controls
- Generation and T&D options will only be described briefly as they are covered by other Technical Assistance programs (SMEC, KESIP)
- Focus on end-use
- Residential, commercial, government, and industry (not military)

Assumptions:

- Diesel oil price: $1/liter. Source: AIRP
- Tariffs: From table Exhibit 3 Source: AEIC
- Tarakhil thermal (diesel) Power Plant marginal cost: 23 cents/kWh (efficiency: 40 percent +). Source AIRP.
- Efficiency of Transmission: 95 percent: Source: ICE

- Efficiency of Distribution: 49 percent. Source: KESIP
- Discount rate: 12 percent
- Exchange rate: 48 AFg/one USD

Limitations

- No reliable population data (from 25-31 million)
- No reliable data on number of households with power in Kabul (from 260,000-700,000)
- Limited knowledge of small cities/large villages (10,000 people) across the country
- Limited knowledge of the pace of traditional fuel growth or abandonment
- Limited knowledge of informal sectors

Schedule:

The study was carried out over a period of nine months, from October 1, 2009 to June 30, 2010.

SOURCES OF DATA:

- Over 210 individuals representing 26 organizations were interviewed during the course of the study, including 33 donor representatives and foreign consultants (see Annex XI).
- Additionally, over 100 sources and publications were reviewed and considered by our research team as part of the desk research.

Counterparts and Working Arrangements

ACEP is primarily focused on off-grid renewable applications working with PRTs. ACEP's EE Component did not have a defined counterpart from program inception, although the MEW was viewed as the most logical starting point. However, EE involves a multitude of players (see Exhibit 5) and it can hardly be the purview of a single agency. Moreover, this program will lead to the introduction of many new technologies and programs e.g. efficient lighting, solar water heating (SWH), new building codes and legislative initiatives, all of which will require different implementing partners. As a result, ACEP decided in November 2009 to create an independent EE Working Group (EEWG) sponsored by the MEW with the twin function of acting as (1) a counterpart to ACEP for guidance and advice and (2) an advisory group to the MEW itself in its efforts to create a new EE sub department within the newly created Department of Policy. As the group matured and became more relevant and productive, it was then decided with senior MEW management to make this group an official MEW EE Advisory Committee, chaired by Engineer Malalai, head of the MEW's Policy Department. It is expected that this group will also operate as a subcommittee of the Inter Ministerial Committee on Energy in a way similar to that of its sister subcommittee on Renewable Energy. Meetings of the EE committee have been held on a monthly basis since November 2009 and have provided continuous guidance in the preparation of this report.

Methodology

In completing this study, and bearing in mind the scarcity of existing and reliable data, ACEP has used a proven methodology previously used by IRG in similar countries (Pakistan, Ukraine, India, China, South East Asia, Nepal and Bangladesh) over the past 20 years.

The methodology consists of 8 steps

Step 1: Gather relevant data, identify key stakeholders, develop a preliminary blue print for the report and discuss extensively with key stakeholders and industry experts (see Annex VII) for list of consulted experts).

Step 2: Identify major data gaps (e.g. tariffs, loads and customer taxonomy) to validate a blue print.

Step3: Design and conduct surveys to fill data gaps (e.g., end use surveys, instrumented data logging, appliance performance and availability), interviews and technical data gathering efforts to generate needed data.

Step 4: Select the quantitative approach: traditional static analysis (cost/benefit by measure) vs. a dynamic model.

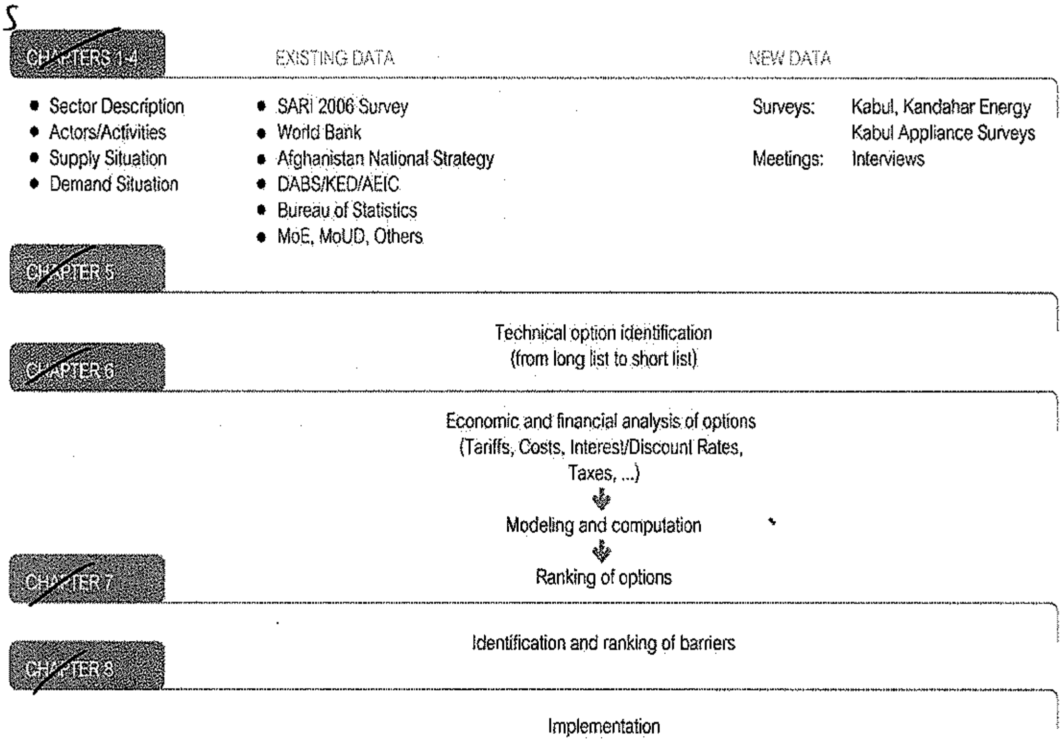
Step 5: Carry out quantitative analysis using the tool(s) selected above.

Step 6: Identify appropriate DSM measures and develop a short list based on simple payback analysis and input from Afghan counterparts.

Step 7: Undertake detailed analyses of social acceptability (barriers), economic, financial, environmental and institutional for the most promising measures.

Step 8: Summarize findings and conclusions and make recommendations for the implementation strategy.

Study Flow Chart



ANNEX II. DEMAND SIDE MANAGEMENT

1. Demand Response – Different from "Demand Side Management"

"Demand Response" is a subset of DSM or a potential DSM program solution. It helps to make the electric grid much more efficient and balanced by assisting the grid's commercial and industrial customers in reducing their electric demand, and/or by shifting the time period when they use their electricity, and/or by prioritizing the way they use electricity. Such measures reduce their overall energy costs. A DSM program will include measures that promote the following:

- Reduced customer peak and overall energy demand
- Improves the electric grid's reliability
- Balances the electric grid through increased efficiency
- EE
- Manages electricity costs
- Conservation through both behavioral and operational changes
- Load management
- Fuel switching
- Distributed energy
- Provides systems that encourage load shifting or load shedding during times when the electric grid is near its capacity, or when electric power prices are high.

Demand Response has also been defined as a DSM subset that is a set of time-dependent activities that reduces or shifts the electricity usage of selected customers.

2. Background on Demand Side Management

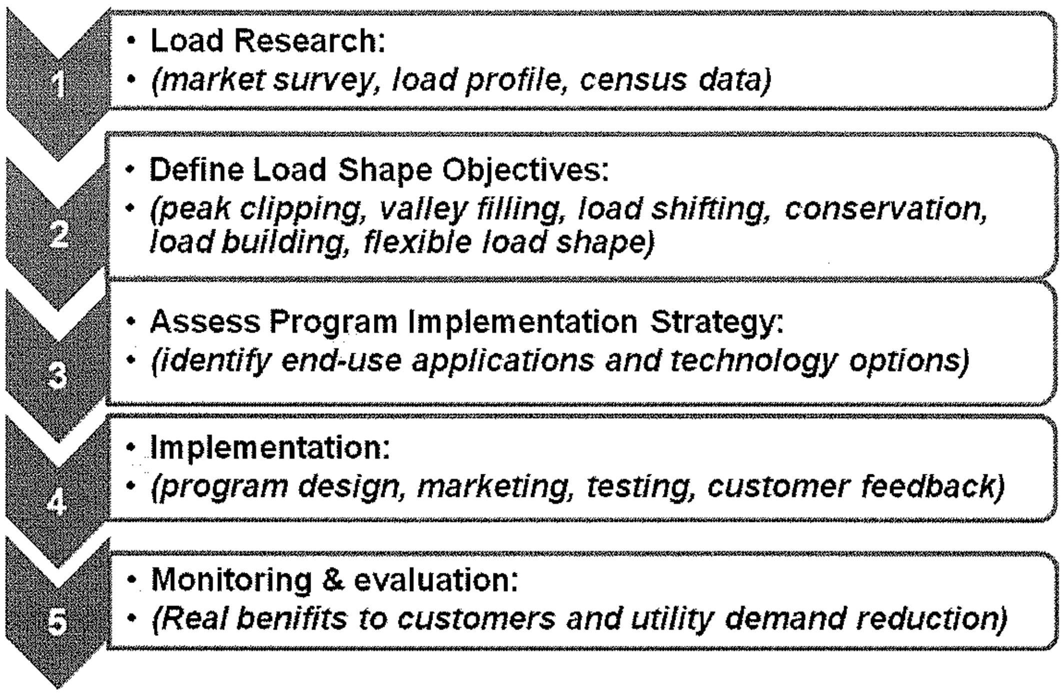
DSM programs consist of the planning, implementing, and monitoring activities of electric utilities that are designed to encourage consumers to modify their level and pattern of electricity usage.

In the past, the primary objective of most DSM programs was to provide cost-effective energy and capacity resources to help defer the need for new sources of power, including generating facilities, power purchases, and transmission and distribution capacity additions. However, electric utilities are also using DSM to enhance customer service. DSM refers only to energy and load-shape modifying activities undertaken in response to utility-administered programs. It does not refer to energy and load-shape changes arising from the normal operation of the marketplace or from government-mandated energy-efficiency standards.

3. DSM Implementation Model

DSM programs are utility and customer specific. The figure below describes various steps involved in implementation of a DSM initiative.

DSM Implementation Model



Step 1: Load Research

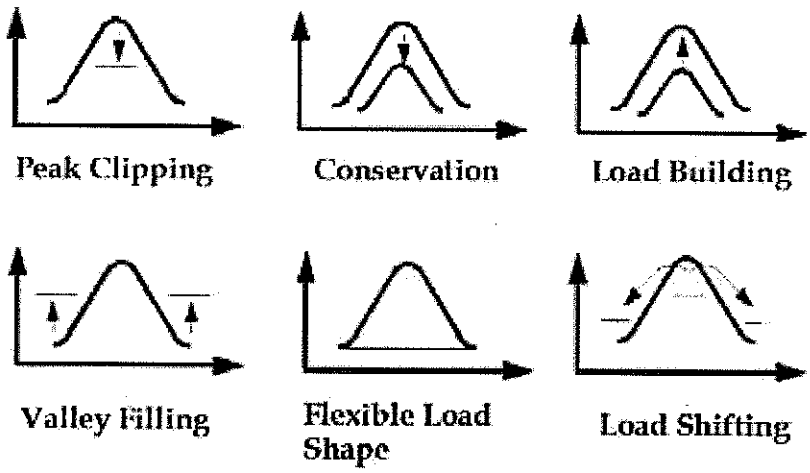
This stage in the DSM implementation will typically assess the customer base, tariff, load profile on an hourly basis, and will identify the sectors contributing to the load shape. This step will also identify the peak load contributors.

Step 2: Define Load Shape Objectives

Based on the results of the load research in the utility, DSM engineers will define the load shape objectives for the current situation. Various load-shape objectives – Peak Clipping (reduction in the peak demand), Valley Filling (increased demand at off-peak), Load Shifting (demand shifting to non-peak period), and Load Building (increased demand) are possible. These are represented in the figure below:

Load Shape Objectives

Specific descriptions of load shape objectives are shown in the box below



Meaning of Load Shape Objectives

- **Peak Clipping** – Reduction of utility load primarily during periods of peak demand
- **Valley-Filling** – Improvement of system load factor by building load in off-peak Periods
- **Load Shifting** – Reduction of utility loads during periods of peak demand, while at the same time building load in off-peak periods. Load shifting typically does not substantially alter total electricity sales
- **Conservation** – Reduction of utility loads, more or less equally, during all or most hours of the day
- **Load Building** – Increase of utility loads, more or less equally, during all or most hours of the day
- Provision of a more **Flexible Utility Load Shape** – Refers to programs that set up utility options to alter customer energy consumption on an as-needed basis, as in interruptible/curtailable agreements

Step 3: Assess Program Implementation Strategies

This step will identify the end-use applications, which can be potentially targeted to reduce peak demand, specifically in sectors with higher subsidies. This step will also carry out a detailed benefit analysis for the end-users and the utilities, including analysis on societal as well as environmental benefits.

Step 4: Implementation

The implementation stage will design the program for specific end-use applications. It will promote the program to the target audience through marketing approaches such as advertising and focus group meetings as in the case of the commercial and industrial sectors.

Step 5: Monitoring & Evaluation

This step will track the program design and implementation and will compare the same with the proposed DSM, which have been set by the utility. A detailed benefit-cost analysis in this case will include identifying the avoided supply cost for the utility vis-à-vis the total program cost for the utilities and benefits to the participants, including reduced bill sizes or other incentives to the end-users.

ANNEX III : MEW RESPONSIBILITIES

as defined where?

The responsibilities of the MEW include:

31B.1.1) to provide a draft annual national development strategy for presentation to the Cabinet in the areas of rural electrification with policy specific requirements and recommendations necessary to implement the strategy.

31B.1.2) every second year, following the Administrative Procedures of Article 32, propose an indicative hydropower and renewable energy Resources Development Plan

31B.1.3) Following the Administrative Procedures of Article 32, the MEW shall prepare and publish by December 31 of each year, an Annual Energy Assessment of the condition of energy generation, consumption, distribution, transmission and supply in Afghanistan

31B.1.5)

31B.1.7) Conduct and publish an annual assessment of the adequacy of generation supply to the distribution and supply companies in Afghanistan, including the final customers and industries within Afghanistan, who require electricity.

31B.1.8) Maintain and annually publish an assessment of all publicly, privately, and donor funded activity related to electricity generation, transmission, distribution of electricity in Afghanistan.

31B.1.9) every second year, propose an indicative national strategic plan for electricity supply of Afghanistan.

31B.1.10) The Revised Indicative Strategic Plan may contain Indicative Capacity Development Targets (ICDT), for various forms of energy capacity that are believed to be required in meeting the market requirement for electricity consumption within Afghanistan, and to a reliability standard that is to be established by MEW in accordance with the procedures of Article 32 for the issuance of a rule.

31B.1.12) Following the Administrative Procedures of Article 32, the MEW shall annually review the levels of retail tariffs for electricity.

31B.1.13) on an annual basis to propose how the Electricity Development Fund will be utilized. Upon completion of the required administrative procedures of Article 32, the Ministry shall then publicly publish the Annual Revised Uses of the Electricity Development Fund on its web site. The AERA shall apply the Electricity Development Funds as directed by the Annual Revised Uses.

31B.1.15.1 The MEW shall Prepare and deliver to the public a program of education on issues of electricity development, generation, operations of the industry, problems of supply, matters of energy efficiency, and related topics.

31B.1.15.2 MEW shall collect data and information of activities and actions of and related to the energy sector of Afghanistan, shall maintain a Database for the Energy Sector of Afghanistan, and make that Database available to the public, including on an accessible website.

31B.1.15.3 The MEW and shall regularly conduct analysis of problems, potential and actual policies, regional, implications of regional activities in energy, and carry out other studies and analyses, useful to inform the MEW, the Government and the public on the options of and basis for choices of energy policy. Such studies shall be placed on the Ministry web site, and may be published in other forms at option of the MEW.

31B.1.15.4

31B.2 Policy on Defining Licensed Territories

31.2.4.1. Where renewable resources are believed to exist in economic quantities, the MEW definition of a territory may require that a Licensee is required to seek to employ economically viable renewable resources existing on the defined territory.

31B.2.4.2. If MEW has identified natural resource use in definition of a territory, then the AERA shall grant a Supply or Distribution Licensee, if they so request, a Generation License that allows the Licensee to develop and employ such resource.

31B.2.4.3. If a Distribution or Supply Licensee is selling under a tariff regulated by the AERA, if the tariff does not allow recovery of the full cost of development and use of such resource, such Licensee shall not be considered in violation of a License that seeks use of renewable resources if it has not used the specified resource. The AERA in setting tariffs, or the MEW is proposing tariffs, may consider impact of the tariff on consumers from including such costs, when defining tariff methods.

In particular and more relevant to this report, in its article 38, the new law stipulates that MEW shall encourage energy efficiency;

ANNEX IV. KANDAHAR PRELIMINARY EE LOAD REDUCTION

(EE/DSM) opportunities.
(Preliminary, not based on site visit and analysis)

1. Current electricity use varies from **100 to 800 MWh/day** and an average of 20,000 MWH/month (Source: AEIC) , with an estimated average daily demand varying from less than **10 MW to up to 54 MW** (when all available diesel units and the 2 Kajaki units operate at the same time). Average load in "normal operations" should be in the range of 30-40 MW.
2. Power is supplied from the Kajaki hydro plant (31 MW capacity with two turbines operational (the transmission link was cut five times last year)) and the Kandahar diesel generators (23 MW total capacity)
3. The population is currently estimated at 700,000-800,000 vs. an official figure of 465,000. Despite a large exodus because of insecurity, the city population is expected to reach 1 million by 2015, which would mean a minimum need for 100MW peak Load, or a near doubling of the current capacity.
4. Based on our findings in in Kabul , , we believe that following three actions could be taken in Kandahar from an EE/DSM standpoint to ease the situation:
    - Based on type of ~~bulb~~ lamp usage, free bulb exchange of CFLs for incandescent bulbs via utility or ESCO . For example, 200,000 units (13 W CFL vs. 60 W Incandescent each, would mean about 9 MW peak reduction and/or power for an additional 90,000 customers (15,000 households). Implementation period 3-6 months. Cost: $500,000 with management and distribution costs included
    - Widespread installation of Solar Water Heaters (1,000 units would mean another possible 1-2 additional MW reduction). Timing 12-18 months. Depending on level of rebate or subsidy, and including program management cost, total program costs should be $500,000 to $1M. A constraint could be lack of trained installation technicians.
    - Pre-paid meters. Savings of up to 5% of current load (because of better customer understanding of costs) or up to 2 MW. Implementation period 18-24 months. Costs, including management, should be between $100 and $200 per customer, or about $1 million for with a first group of 10,000 customers.
5. **Summary**: total short term (24 months or less) peak (7 -1`1 PM) load saving potential may be up to 12 MW (22%) and average load saving up to 5 MW (14-15%). Total cost should not exceed $3M (less than $600/average kW saved, plus fuel savings)

NOTE: Costs exclude security and are estimated at ± 10 percent and would need verification through on site surveys and local contractors experience.

ANNEX V: KABUL ENERGY END USE SURVEY

1. Methodology

There is no single methodology available for a household energy use survey; the methodology adopted here in this survey was proven to be suitable for a city like Kabul, where accessing and collecting reliable data is no simply task.

The Household Survey collects information about the housing unit through questionnaires and interviews. To determine household energy use, consumption levels were researched from household billing records maintained by the city's energy suppliers (KED).

2. Sector focus and resource allocation

On average, 75 percent of the resources for this survey have been allocated to households, 10 percent to government/ public buildings, 10 percent commercial/ private buildings and 5 percent to industry.

As per the survey plan, a residential, commercial and industrial survey has been completed based on the target of 3,000 households, 100 commercial/government buildings and ten industrial sites to be visited and information has been collected through questionnaires.

3. Sample Design

A Stratified Two–stage Sampling was adopted for the survey. Kabul City has been divided into 22 districts; each of which was further divided into two areas by the local administration, namely formal areas and informal areas.

1) Selection of Primary Sampling Units: The sample selection of block/street has been performed separately and independently in each part proportional to the total number of households in that block or district (regarding to the District Passport/Recommendation).
2) Selection of Secondary Sampling Units: In this case, private households were the ultimate sampling units. Households in every sample block and districts have been listed to serve as the sampling frame then the set of households were rearranged by size of household (classified by number of household members) and type of economic household (determined on the basis of the occupation type which produces the highest income in the household). Finally private sampled households were selected by using a systematic method in each type of local administration with the following sample sizes:
    - Households from each of sample blocks in formal areas courtyard type
    - Households from each of sample in informal on plain
    - Household from each of sample in informal on slope
    - Household from each of sample in formal area apartment type

The total number of sampled households for the whole city is 3,000 households.

4. Questioners

- The questionnaires were finalized after a pre-test was conducted to ensure that it would conform to data collection requirements. The pre-test includes cultural sensitivities of the people, confidentiality issues, length of the interviews and etc.
- The final questionnaires were translated into the local language of Dari .

5. Data-collection procedures

Data collection encompassed several phases, including:

1. Designing the questionnaire,
2. Surveyors selection
3. Training supervisors and interviewers/ surveyors,
4. Pretesting the questionnaire,
5. Interviews techniques,

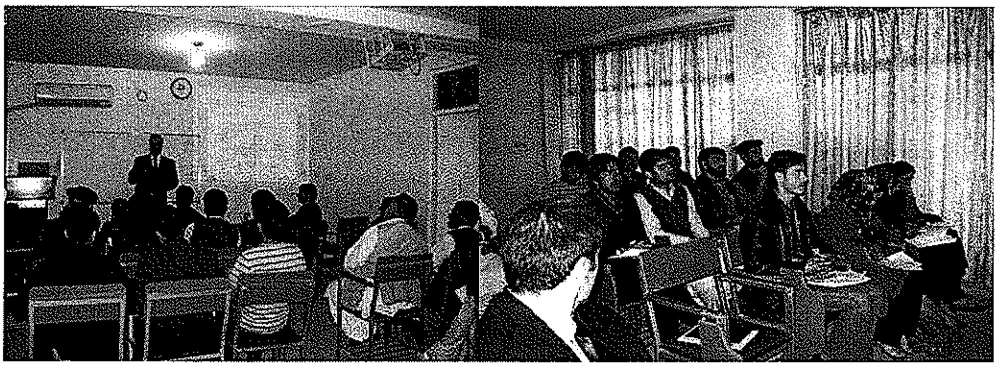
6. Surveyors Selection

- Twenty-two surveyors were selected among the students of Bakhatar University. The following criteria used in the selection process:
  - i. Students in their final year of study
  - ii. High performing students with
  - iii. Personal activity of the students

It was decided to conduct the survey during students' academic vacation period so that the survey would not interfere with their studies and so they could devote their full attention to the survey.

7. Train selected surveyors

- As part of the trainings provided to the selected surveyors and team leaders, the following topics were covered:
  - i. Theoretical materials - theoretical issues related to the project
  - ii. Statistical survey – advantages and disadvantages of the survey, as well as the survey methodology
  - iii. Questionnaires - questionnaire construction, type of questions, method used to increase response rates, and sequence of questions)
  - iv. Refreshment information on electrical appliances, capacity of them, power quality, etc.
  - v. Students were trained to carefully consider national and cultural traditions and
  - vi. sensitivities in order to best obtain the required information during survey



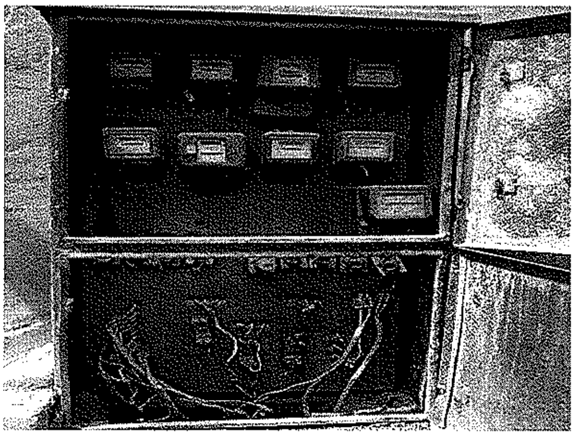
Above: training of the surveyors in progress

- After the survey teams were successfully formed, each team member was trained on the technical aspects of the information and data required
- The surveyors were then trained on how to collect data of the various electrical appliances used by households, especially the appliances' capacities (in watt), quantity and make

8. **Survey**

- In accordance with the sampling methodology and the secondary data collected from the 22 district offices, the number of households and other public and commercial buildings were defined
- The survey started with the collection of secondary data found directly at district offices. The survey was then launched based on the number of households and other targeted buildings, and in line with the developed sampling methodology.

Survey in progress



Condition of metering

9. **Using Software and Database**

- System Introductions:

The application of entering survey data for energy and appliance used as Back-end Database SQL Server 2005 and front-end application ASP Net 2005.

- Secure and manageable:

Through this application the data has been kept in the correct format and save time during data entering and reporting by using specific User ID. The data would be confidential and secure with no chance to duplicate or enter wrong data into the system.

- Advantages:

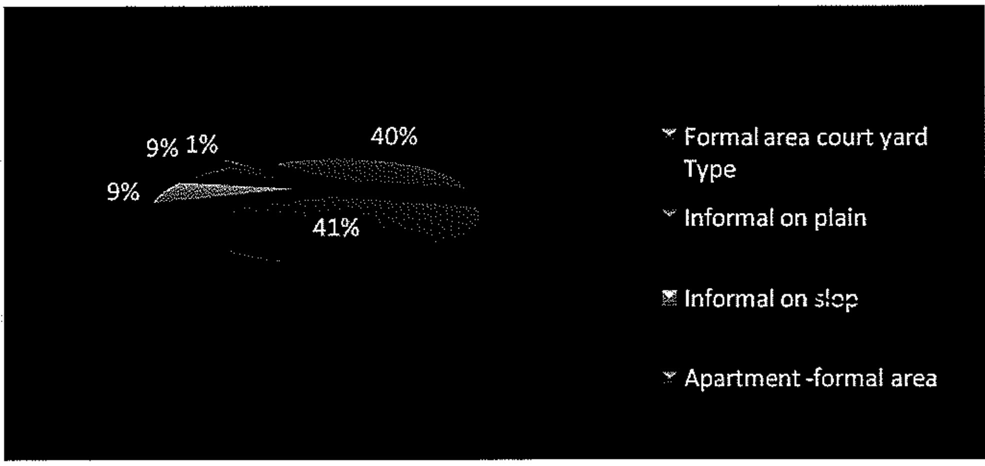
The advantages of this application are its user friendly characteristics: more than ten users can enter data into the database at the same time and more than ten users can view its reports simultaneously.

10. Survey Results

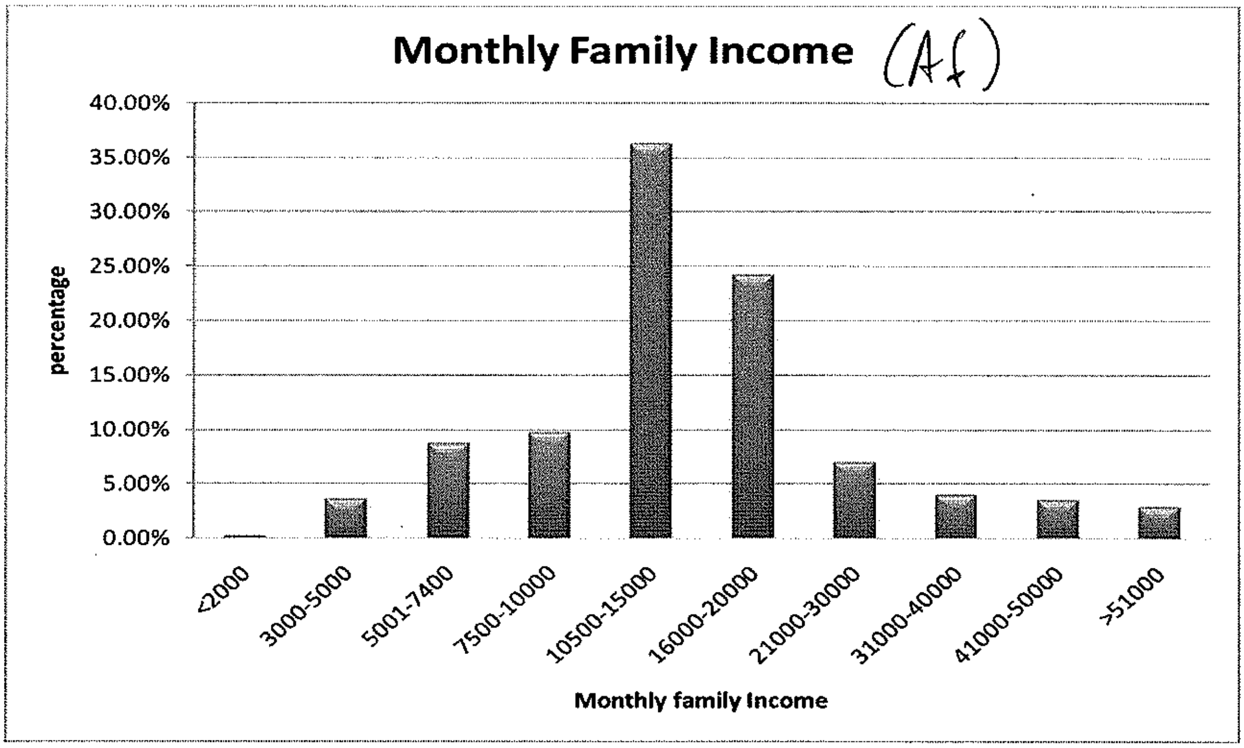
1) Household characteristic:

Throughout greater Kabul, residential households have been divided into five categories; the number of surveyed households in each category is presented below. In addition this table represents monthly family income in Kabul; more than 36 percent of families' income ranges from $200-300 per month, which is the monthly average in this metropolitan city.

House type	Formal area court yard Type	Informal on plain	Informal on slope	Apartment - formal area	Apartment - informal area	Total
Number	1211	1212	271	287	19	3,000
Percentage	40.36	40.4	9.03	9.3	0.63	100



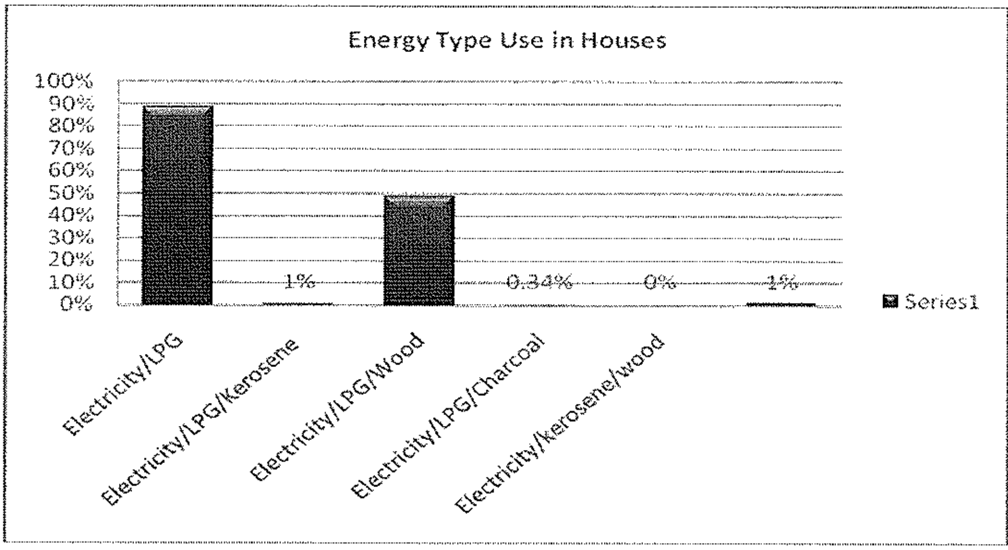
Surveyed households in greater Kabul



(2) Energy Sources

The conducted survey is the first of its kind in Kabul. The main objective of this survey was to collect information on household energy consumption to determine the use of different sources of energy, such as electricity, petroleum products, liquid petroleum gas (LPG), charcoal and wood, etc.

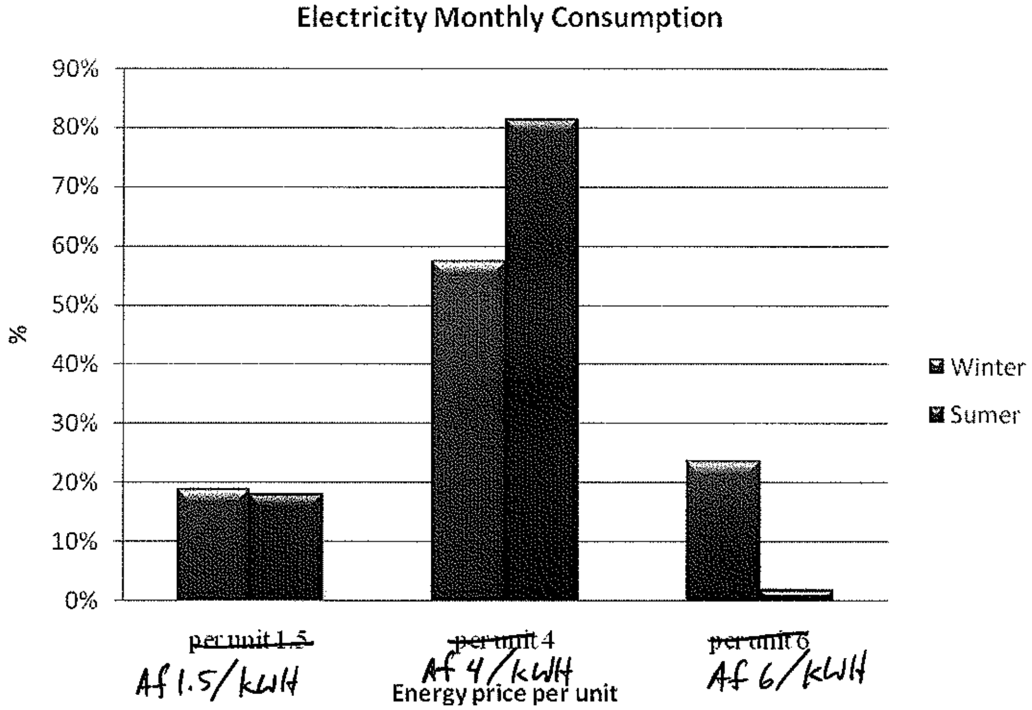
Survey findings are as follows:



As seen in the above table, electricity and LPG comprises 89 percent of the total energy used in households. This fuel source is followed by wood as the second most common fuel option. Use of others fuel sources and combinations showed are used by very negligible segments of society (one percent or lower).

(3) Monthly Electricity Consumption

Determine	Receive elec. bill		Cost of per Unit kWh/Afghani			Monthly Consumption Afghani						Generator
						Winter			Summer			
	yes	No	1.5	4	6	Up to 225	226-1400	>1400	Up to 225	226-1400	>1400	
Number	2692	232	698	1279	728	508	199	639	559	2193	50	66



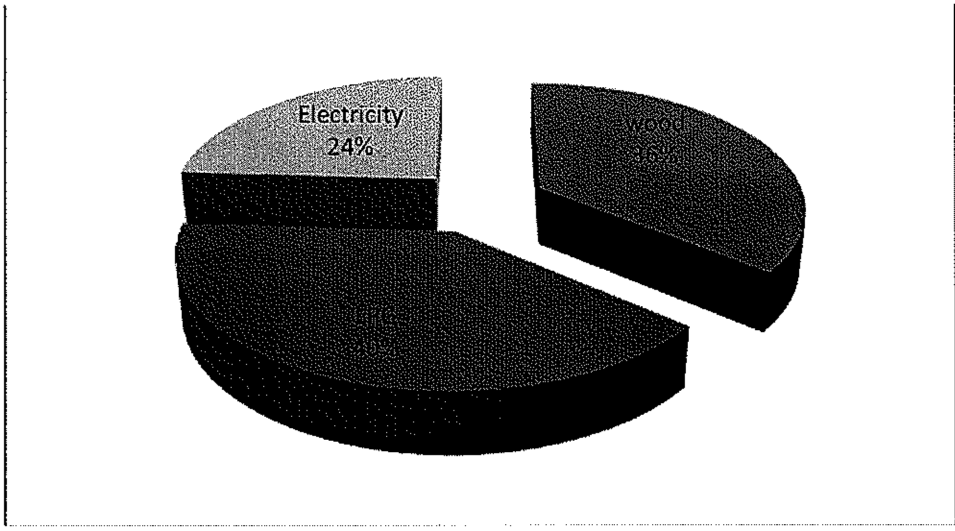
Energy Price per Unit

1. Electricity consumption has been estimated on the assumption that the following electrical appliances are used in Kabul City households: Lighting (IBs, CFLs FTLs), refrigerators, air conditioners, washing machines, electric cookers, emersion water heaters, irons, television sets (TVs), personal computers, etc.
2. It should be noted that actual electricity consumption may vary due to a number of factors other than household size. These factors include stock and usage patterns of appliances, size, location and orientation of premises, weather, etc.
3. Monthly electricity consumption levels during the summer were higher than during the winter period (above figure).This means that within the winter period people use other energy sources (wood, fuel oil, LPG, etc.) for their heating needs.

(4) Water Heating

Water heating and lighting are the most important areas of household electricity consumption. It is in these areas where substantial energy efficiency work could be carried out., saving households upwards of 35 percent of energy use. Hot water is needed in households for a wide array of purposes (clothes washing, bathing, dishwasher, food preparation etc.) and different forms of energy sources such as electricity, LPG, wood, fuel oil, etc. are used. Sources of energy depend on an energy source's availability and cost. During the winter, when for household heating uses other type of energy, so for food preparation and water heating uses electricity as prime energy. For this reason, electricity consumption in winter is less than during summer, as shown in below table:

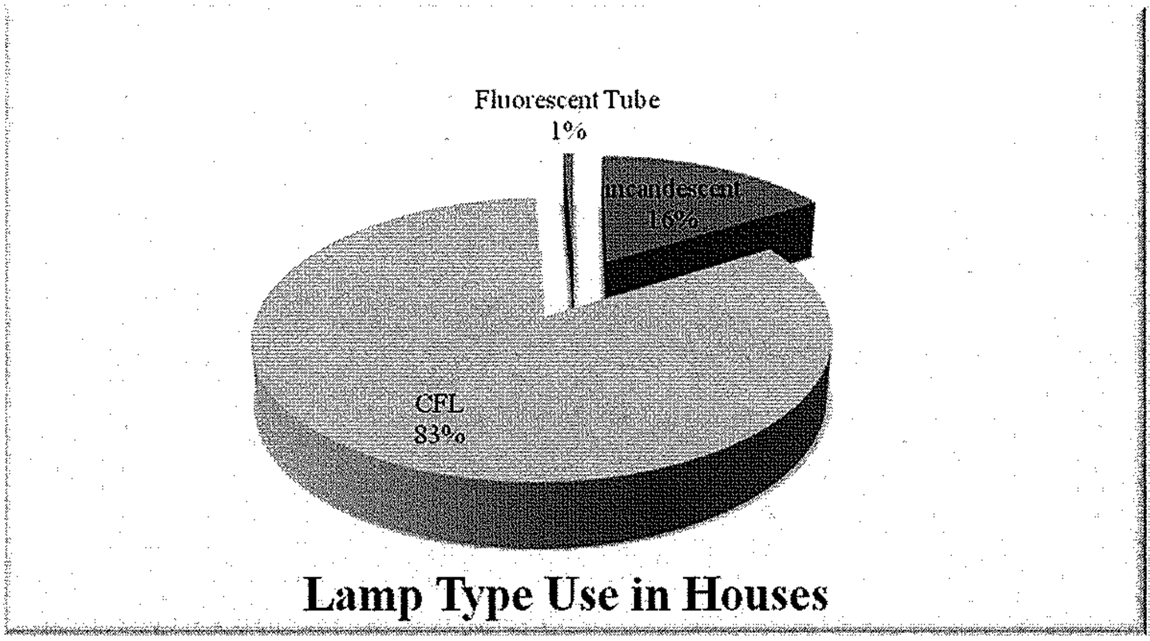
Electrical					LPG kg						Wood kg				Other	
quantity	Capacity kW		Use h/day kWh		quantity			Average expenditure /day kg			Wood stove quantity		Average expenditure /day kg		quantity	Average expenditure /day kg/lit
	1-2	≥3	Up to 3	More than 3	1-2	2.1-4	More than 4	01-1	1.1-2	More than3	1-2	3and more	1-2	More	0	0
1151	1089	30	686	474	1912	55	1	1866	76	50	1661	137	298	1490	0	0

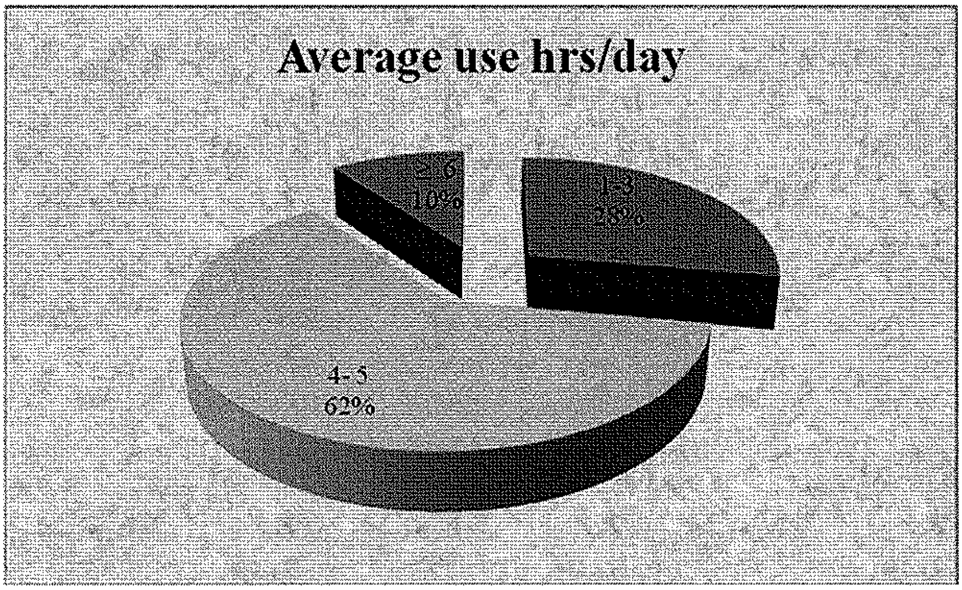


Energy type using for water heating

(5) Lighting System:

Another important sector is lighting; making improvements in various types of lighting technologies has proven to be one of the fastest and most effective ways of cutting energy costs. By using new lighting technologies, home owners can reduce the amount of energy needed for lighting by about 35 percent. Moreover, advances in lighting controls offer further energy savings by reducing the amount of time that lights remain on.





As shown in the survey results, most of Afghan households use CFLs but the qualities of many CFLs available in the market are very low. This situation has forced some people to go back to using IBs. Much work needs to be done in improving the quality of CFLs and preventing low quality products from entering into the market.

Qualify lighting:

- Reduces energy costs — uses at least 35 percent less energy than incandescent lighting, saving on operating expenses
- Reduces maintenance costs — lasts five times longer than incandescent lighting and about two to five times longer than fluorescent lighting.

- Reduces cooling costs, as it produces very little heat

Lighting products must first pass a variety of tests before they can be qualified as being energy efficient; they must demonstrate the ability to display the following characteristics:

i. Brightness equal to or greater than existing lighting technologies (incandescent or fluorescent), with light well distributed over the area lighted by the fixture

ii. Light output remains constant over time, only decreasing towards the end of the rated lifetime (at least 35,000 hours or 12 years based on eight hours of use per day)

iii. Excellent color quality. The shade of white light appears clear and consistent over time

iv. Efficiency is as good as or better than fluorescent lighting

v. Light comes on instantly when turned on

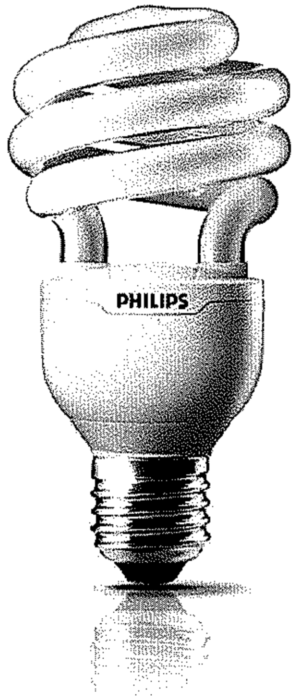
vi. No flickering occurs when dimmed

Developing safe and responsible disposal methods will become an important task as CFLs, as energy-efficient lighting products, become more popular,

The amount of mercury in a single CFL is extremely small, but risks of contaminating the environment still exist, especially if large numbers of bulbs are not properly disposed. This risk is particularly daunting considering the lack of any waste management system in Afghanistan.

This is very long. An average screw base replacement CFL has a lamp life of about 10,000-hrs.

2010, November 3
data subject to change



Product Description

TORNADO ESaver Dimmable

An energy-saving lamp in twister shape, with adjustable light output, for use with standard wall dimmers

Benefits

- Extra ambiance creation in dimmable mode
- Highest energy efficiency, resulting in one eighth of the energy consumption of an incandescent lamp for the same rated light output
- Additional energy-saving effect in dimming mode
- Highest reliability throughout lifetime, which is especially beneficial where lighting is required for longer periods of time and/or where lamp replacement is difficult

Features

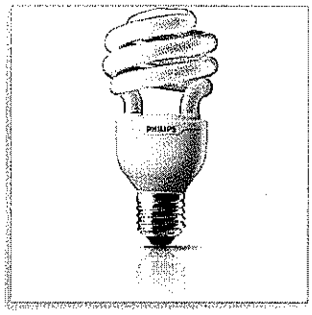
- Long-life alternative to incandescent lamps
- Dimmable down to 5% of nominal light output
- The perfect choice for end-users who demand the best performance and reliability
- Average lifetime eight times longer than an incandescent lamp
- European energy-efficiency label A

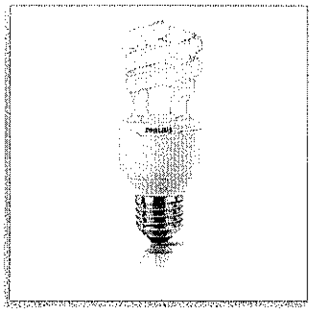
Application

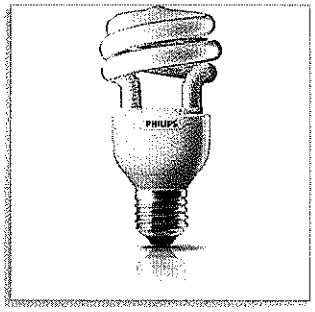
- Designed to replace incandescent lamps, especially those equipped with dimmers
- Mainly indoor

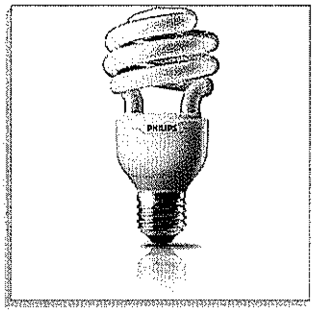
PHILIPS
sense and simplicity

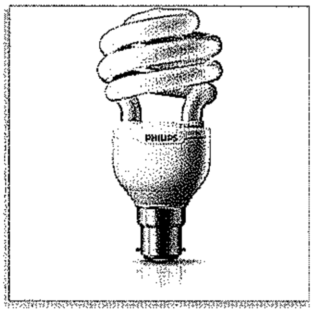
Related products



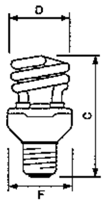




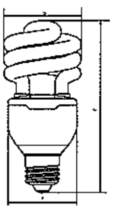




Dimensional drawing

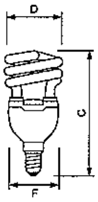


Product	C (Max)	D (Max)	F (Max)
TORNADO Dimmable 13W/827 E27 220-240V -	124.0	47.0	45.4
TORNADO Dimmable 13W/827 E27 220-240V -	124.0	47.0	45.4

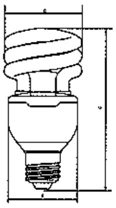


Product	C (Max)	D (Max)	F (Max)
TORNADO Dimmable 20W/827 E27 220-240V	127.0	61.0	52.4
TORNADO Dimmable 20W/827 E27 220-240V	127.0	61.0	52.4

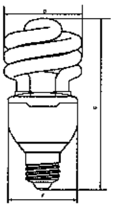
Dimensional drawing



Product	C (Max)	D (Max)	F (Max)
TORNADO Dimmable 13W/827 E14 220-240V -	129.5	47.0	45.4
TORNADO Dimmable 13W/827 E14 220-240V -	129.5	47.0	45.4



Product	C (Max)	D (Max)	F (Max)
TORN DIM 15W/827 E27 220-240V 50/60Hz	120.0	61.0	52.4



Product	C (Max)	D (Max)	F (Max)
TORN DIM 20W/827 E27 220-240V 50/60Hz	127.0	61.0	52.4

Compare table

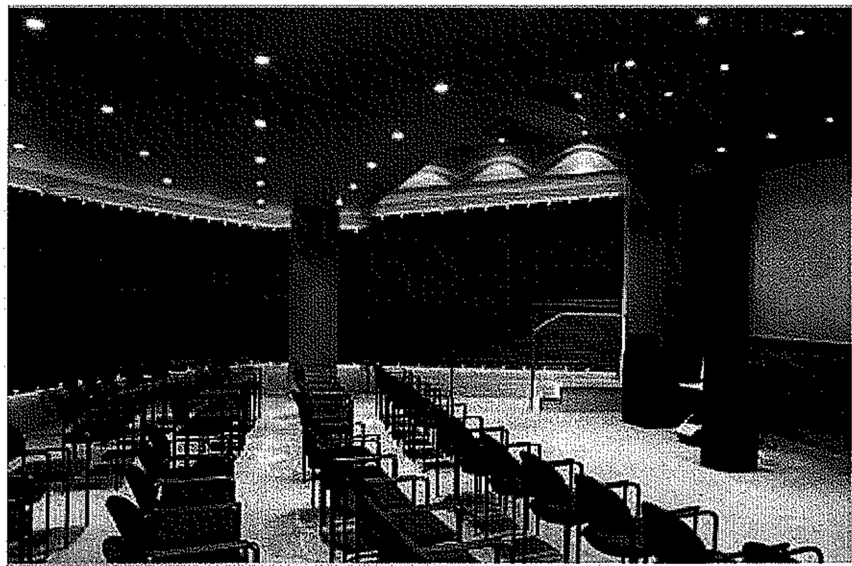
Order code	Full product name	Cap-Base	Color Code	Color Designation (text)	Voltage	Line Frequency	Lamp Wattage	Luminous flux lamp	Dimmable	Energy Efficiency Label (EEL)	Chromaticity Coordinate X
826494 00	TORNADO ESaver Dimmable 20W WW E27 1BC	E27	827	Warm White	220-240	50/60	20	1200	Yes	A	463
837506 00	TORNADO ESaver Dim 20W WW E27 220-240V 1BC	E27	827	Warm White	220-240	50/60	20	1200	Yes	A	463
828269 00	TORNADO ESaver Dimmable 13W/827 E14 1PF	E14	827	Warm White	220-240	50/60	13	700	Yes	A	463
904833 00	TORNADO ESaver Dimmable 13W WW E14 1BC	E14	827	Warm White	220-240	50/60	13	700	Yes	A	463
828122 00	TORNADO ESaver Dimmable 13W/827 E27 1PF	E27	827	Warm White	220-240	50/60	13	700	Yes	A	463
904857 00	TORNADO ESaver Dimmable 13W WW E27 1BC	E27	827	Warm White	220-240	50/60	13	700	Yes	A	463
924046 00	TORNADO ESaver 15W WW E27 220-240V 1PF	E27	827	Warm White	220-240	50/60	15	900	-	-	463
394701 10	TORNADO ESaver Dimmable 20W/827 E27 1PF	E27	827	Warm White	220-240	50/60	20	1200	-	-	463
394718 10	TORNADO ESaver Dimmable 20W/827 B22 1PF	B22	827	Warm White	220-240	50/60	20	1200	-	-	463

Compare table

Order code	Full product name	Chromaticity Coordinate Y	Color Rendering Index	Life to 50% failures	Lumen Maintenance 2000h	Lumen Maintenance 5000h	Luminous Efficacy Lamp	Color Temperature	Mercury (Hg) Content	LLMF - end nominal lifetime	Starting Time	Warm-up Time to 60% Light Outp
826494 00	TORNADO ESaver Dimmable 20W WW E27 1BC	420	82	8000	85	75	60	2700	-	65	1	60
837506 00	TORNADO ESaver Dim 20W WW E27 220-240V 1BC	420	82	8000	85	75	60	2700	-	65	1	60
828269 00	TORNADO ESaver Dimmable 13W/827 E14 1PF	420	82	8000	85	75	53.8	2700	-	65	1	60
904833 00	TORNADO ESaver Dimmable 13W WW E14 1BC	420	82	8000	85	75	53.8	2700	-	65	1	60
828122 00	TORNADO ESaver Dimmable 13W/827 E27 1PF	420	82	8000	85	75	53.8	2700	-	65	1	60
904857 00	TORNADO ESaver Dimmable 13W WW E27 1BC	420	82	8000	85	75	53.8	2700	-	65	1	60
924046 00	TORNADO ESaver 15W WW E27 220-240V 1PF	420	80	10000	85	75	60	2700	2	-	-	-
394701 10	TORNADO ESaver Dimmable 20W/827 E27 1PF	420	80	10000	85	75	60	2700	2	-	-	-
394718 10	TORNADO ESaver Dimmable 20W/827 B22 1PF	420	80	10000	85	75	60	2700	2	-	-	-

Philips PL-T 57W 4-Pin Compact Fluorescent Lamps

Superior energy and thermal efficiency for high performance in downlights

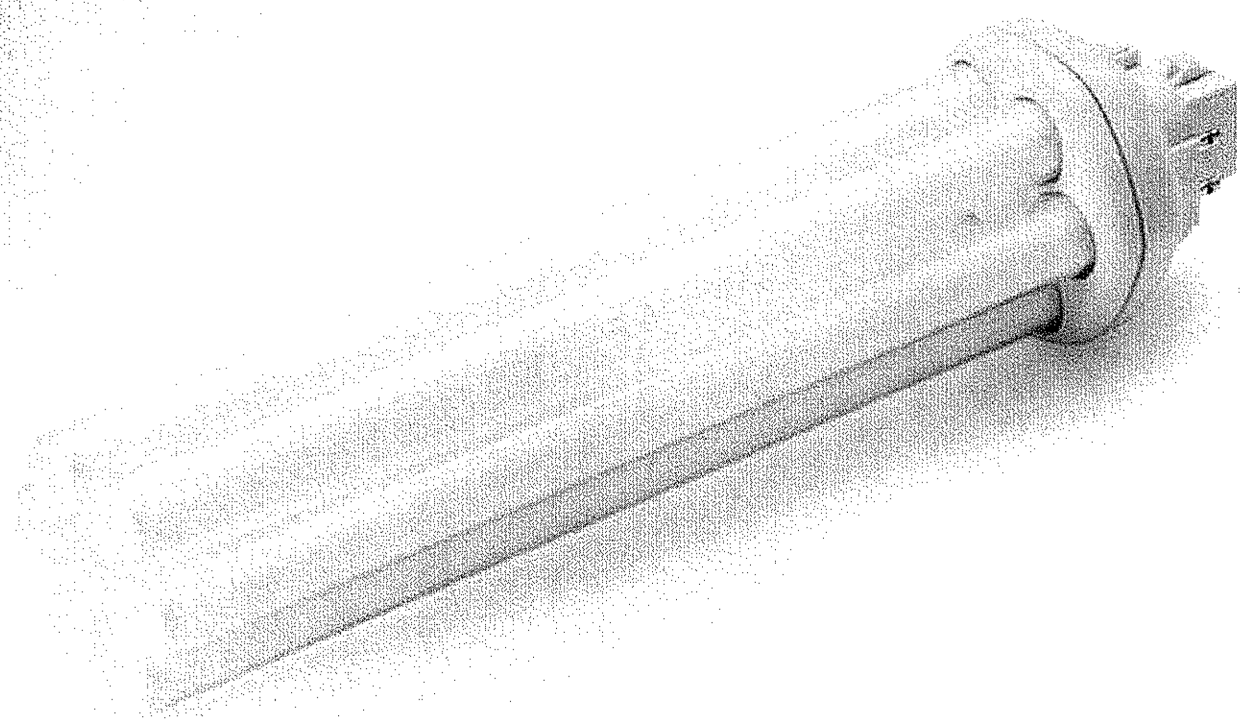


Photography © Z. Jedrus

Ideal for downlights in offices, hotels and retail as well as in multi-lamp fixtures in medium to high-bay applications

- **Amalgam Technology**
  Philips 57W PL-T Lamps provide >90% of rated lumens in ambient temperatures from 15°F to 130°F
- **High Efficacy**
  75 lumens/watt
- **Dimmable for Added Flexibility**
  Philips 57W PL-T Lamps may be used with electronic dimming ballasts
- **Broad Range of Color Temperature**
  3000K, 3500K, and 4100K
- **High Performance**
  4300 lumens
- **Quality of Light**
  Excellent CRI of 82
- **12,000 Hour Rated Average Life**[1]

1) Average life under specified test conditions with lamps turned off and restarted no more frequently than once every 3 operating hours. Lamp life is appreciably longer if lamps are started less frequently.



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Philips PL-T 57W 4-Pin Compact Fluorescent Lamps

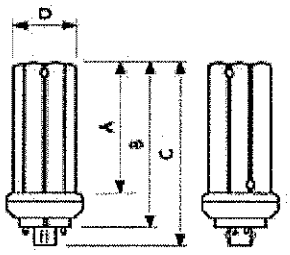
Electrical, Technical and Ordering Data (Subject to change without notice)

Product Number	Ordering Code	Watts	Bulb Type	Base	Generic Description	Pkg. Qty.	Color Temp. (Kelvin)	MOL (In.)	Rated Avg. Life (Hrs.)[1]	Approx. Initial Lumens[2]	Design Lumens[3]	CRI
14631-6	PL-T 57W/830/4P/A	57	PL-T	GX24q	CFTR57W/GX24q/30	10	3000	7.79	12,000	4300	3741	82
14632-4	PL-T 57W/835/4P/A	57	PL-T	GX24q	CFTR57W/GX24q/35	10	3500	7.79	12,000	4300	3741	82
14633-2	PL-T 57W/841/4P/A	57	PL-T	GX24q	CFTR57W/GX24q/41	10	4100	7.79	12,000	4300	3741	82

1) Average life under specified test conditions with lamps turned off and restarted no more frequently than once every 3 operating hours. Lamp life is appreciably longer if lamps are started less frequently.
2) Approximate initial lumens. The lamp lumen output is based upon lamp performance after 100 hours of operating life, when the output is measured during operation on a reference ballast under standard laboratory conditions.
3) Design lumens are the approximate lamp lumen output at 40% of the lamp's rated average life. This output is based upon measurements obtained during lamp operation on a reference ballast under standard laboratory conditions.

Dimensions (In.)

A max.	B max.	C max.	D max.
6.21	7.17	7.79	1.62



PHILIPS

ANNEX VI: BAMYAN HOUSEHOLD ENERGY USE SURVEY

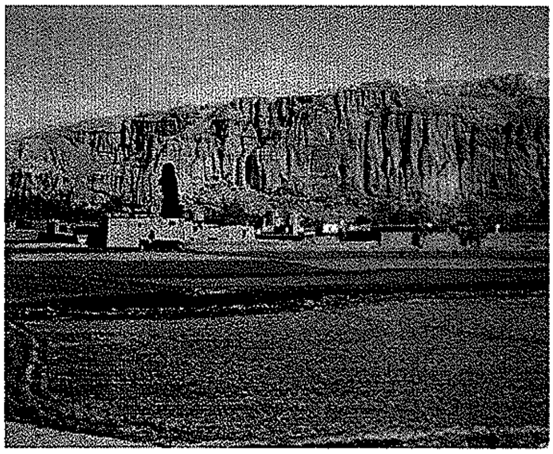
Introduction

The importance of energy as an essential ingredient in economic growth as well as in any strategy for improving the quality of human life is well established. Residential energy consumption depends mainly on the available amounts of local resources, which are closely connected with the present rural economy and living standards.

Bamyan does not have any electricity supply in an organized way by the electricity authority or private procedure, so upon the request ACEP decided to install a micro hydro power generation and distribution network to lightening Bamyan and a foundation stone was laid down by the Governor. Design work for the power plant and distribution network are on the way and a concrete present consumption and future load forecast is essential for support the design works.

Thus, a household energy use survey has been designed to access energy consumption information, especially among the villages, commercial units, government and non-government offices, and others in Bamyan province. Thus effort will be focus on especially residential and commercial building including hospitals, university energy consumption in Bamyan City. The survey is also needed to provide reliable basic data for load forecast in the years to come.

Meeting with the Bamyan Governor on May 1, 2010



Bamyan Valley with Buddha in Background

Objective

The main objective of this assignment is to provide a sound basis to estimate Household Energy Usage of the existing consumption and future estimation which required analysis of existing situation and in use appliances, market analysis and consumer interests etc.

The activity as follow:

- To collect a reliable assessment on how electrical power is currently being used in the Residential, Commercial and business units in the 24 villages and Bamyan city, including in relation to expenditures on other energy source, such as petroleum products, L.P.G. – cooking, electricity, charcoal, wood, and other sources, to provide a solid basis to estimate consumption and future forecast.

Scope of Work

The SOW derives are as follows:

Sector focus and resource allocation

The primary focus is on households over 24 villages. The secondary foci are on Government and Commercial buildings and business units, in that order 70% of the resources allocated to this survey should be allocated to households and 30% to Government, Commercial and other business. A "paper" survey where all data will be obtained from answers to standardized questionnaires. The scope of the work includes a detail study for energy uses of various forms of energy sources like Electricity and Fuel oil in the Residential , Commercial buildings and business units.

The broad scope of the study will be as per the following:

A) Residential Sector

Collecting data from sample of no less than 1188 Bamyan's households. Sample must be provide a statistically representative picture of the different types of objects (building location, type, size, number and use characteristics of occupants ,income, nature and others, type of energy used, metering configurations and others)

B) Commercial Sector

Collecting data through 570 questionnaires from Government/ Public and Commercial/Private buildings. Sample shall provide a statistically representative picture of the different types of buildings (type, size, nature and age of building, type of energy used, electrical appliances and others).

C) Approach

The following sequential approach has been adopted during the survey:

1) Designing the questionnaire,
2) Training supervisors and interviewers,
3) Conducting pretesting,
4) Minimizing nonresponsive,
5) Processing & analyzing the data, and
6) Preparation of report

A) Time Schedule

The Bamyan household energy survey may be completed by the end of November 2010.

B) Outputs

The outputs of the survey shall provide the following information's:

A. Residential Energy Usage Survey (REUS)
   - Analysis of the approximately 1188 target electricity end use as follow:
     - Monthly energy cost, if any
     - Inventory of appliances, by type ,age and rated power data;
     - Approximately hours of use, or each major appliance
     - Domestic lighting uses detail information as per the questionnaire
     - Breakdown of electricity use such as lighting, water, heating, ventilation, cooling, TV, ironing and others.

B. Commercial Building Energy Usage Survey (CBEUS):
   - Analysis of the approximately 570 target electricity end use as follow:
     - Monthly energy costs (if any);
     - Inventory of appliances, by type, age and rated power data; hours of use, or each major appliance.
     - Commercial lighting uses detail information as per the questionnaire
     - Breakdown of electricity use such as lighting, water, heating, ventilation, cooling, TV, ironing and others.

The above information shall be used to compute existing demand load and future load forecast to design the distribution network.

ANNEX VII: KED LOAD ANALYSIS

A load curve is a graphical representation of the temporal evolution of electrical energy demand in a fixed point throughout the electrical grid. Normal, the values are shown in a daily horizon and 15 minute time buckets. The transformer load curve consolidates the demand for all consumers served by it, as well as possible losses due to the energy distribution,

By monitoring the curves it is possible to establish forecast models for load curve growth and, consequently, optimized policies for expanding the electrical distribution grid. However, this requires the use of sophisticated and expensive measuring equipment. In practical terms, this level of monitoring is economically prohibitive, given the large number of distribution transformers throughout the electrical grid.

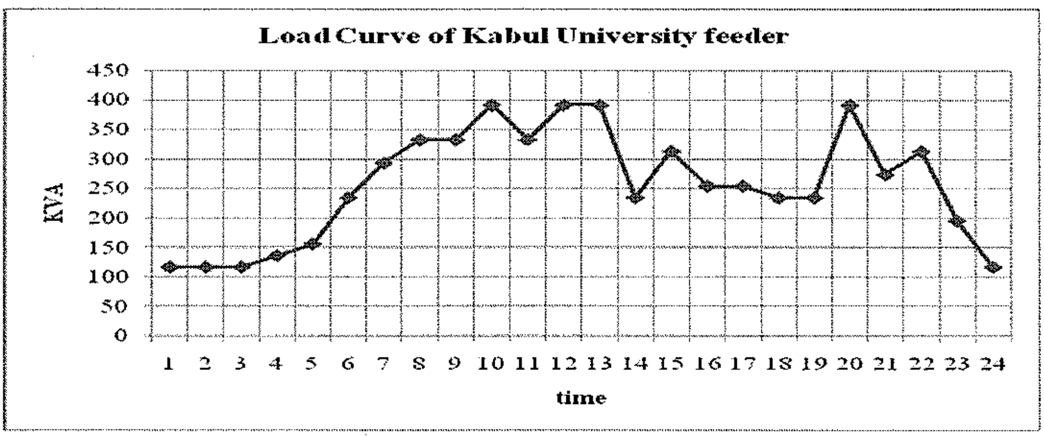
The load curve is also called a plot of load (or load per end-user) variation as a function of time for a defined group of end-users.

The end-user grouping may be by electrical proximity, e.g., by feeder, substation, region, or system level. Alternatively, it may be by end-user class.

End-user class (also called customer class) characterization is more appropriate when assessing usage behavior. Such behavior is normally assessed at the feeder, substation, region, or system level, and at this level, end-users of a given class tend to use electrical energy in much the same manner. This is the orientation we will take in this module.

Daily, weekly, monthly, and yearly load curves are commonly developed and used in order to gain insight into the usage behavior of a group of end-users.

Bellow shows a daily load curve for transformer and tree 3 deferent kind of load feeders. Figure -1 show commercial buildings daily load curve (education- administrative). As show graphic the peak load for this kind of buildings morning from 8:30 to 11:00 mid day (noon) from 12:00 to 13:00 and evening from 19:30 to 20:30. The morning peak can be consider like work load, the mid day load is shows that in commercial building the electricity uses also for food preparation including water heating (from 12:00 to 13:00 break in Kabul). The evening load (19:00 to 20:30) show the electricity usage for lighting.



Source: KED Junction-4.

FIGURE 1

(FIGURE 2)

The Hospital feeder daily load Curve same like as above graphic. There is electricity consumption within work time (work starting at 8:00 to 16:00/17:00), but the graphic show the electricity usage for food preparation (12:00 to 13:00 break for lunch) and lighting (end of the work time in night).

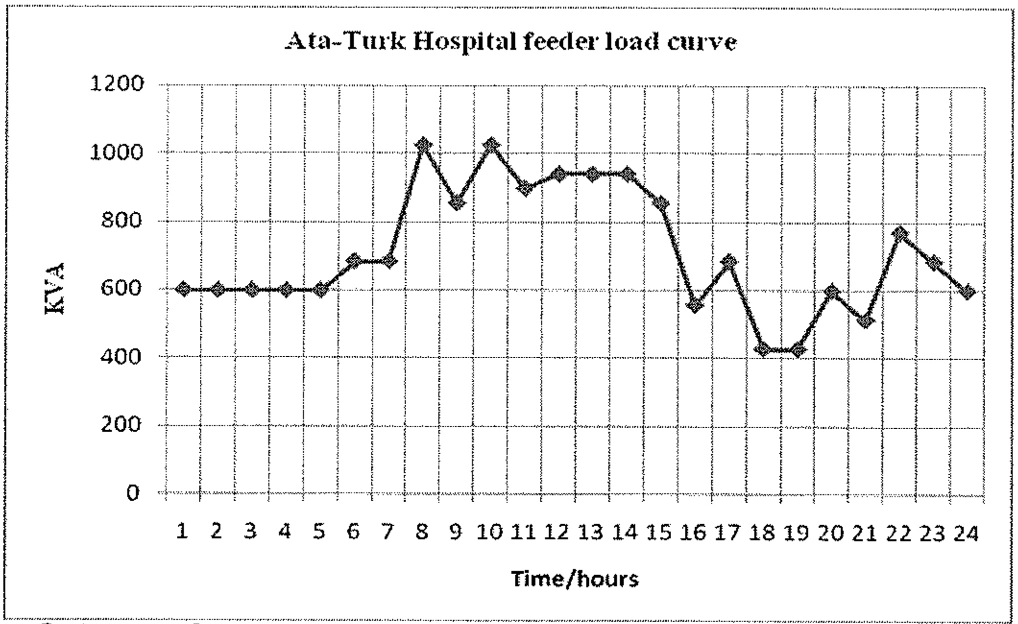


FIGURE -2

Source: KED

As show the graphic bellow shows residential end-users. The multiplicity of high peaks is due to the intermittent operation of large appliances such as refrigerators, air conditioners/fans, water heater and stoves, where the highest peaks are a result of simultaneous operation of such devices and lighting.

We observe the smoothing effect on the curves. We also observe the peak load per end-user decreases as the number of end-users in the group increases. This is because at any given moment, some end-users will incur a peak while others do not, so that the average load at any given moment will always be less than the highest individual peaks for that moment.

(FIGURE 3A and 3B)

Bagcha-e-atfal transformer load curve

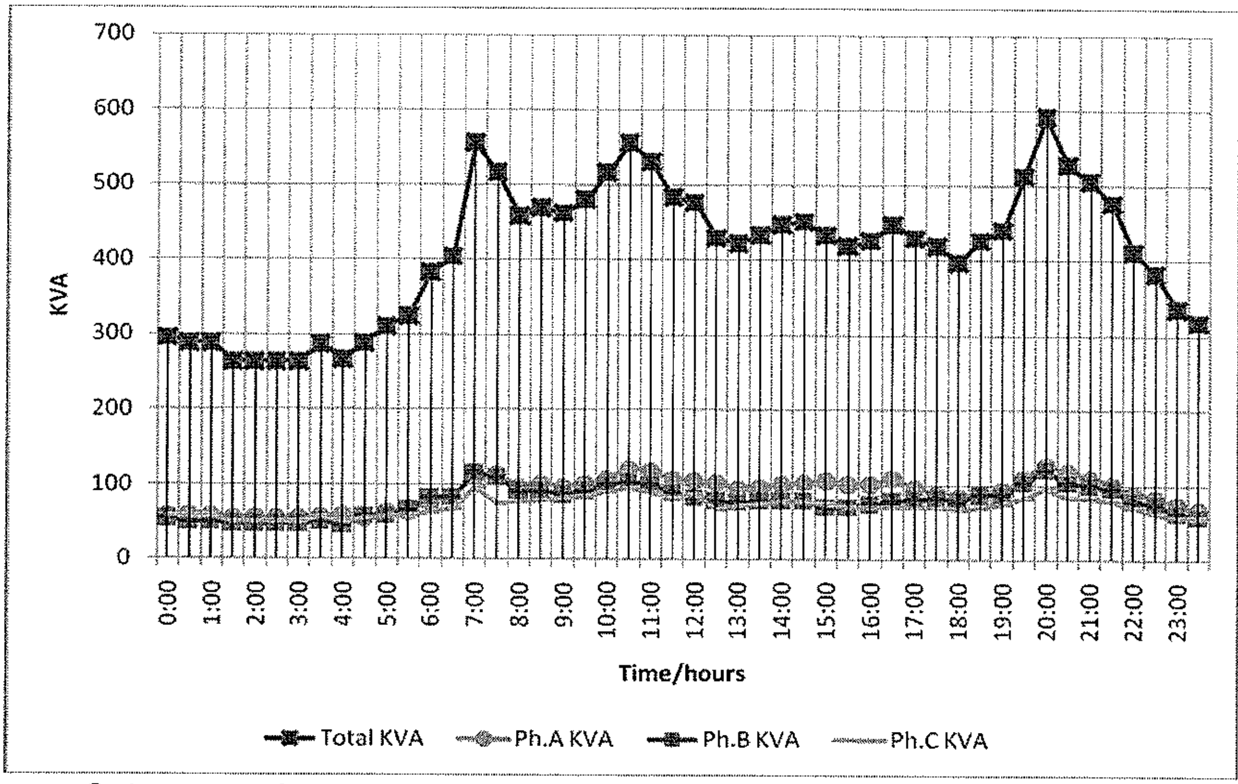
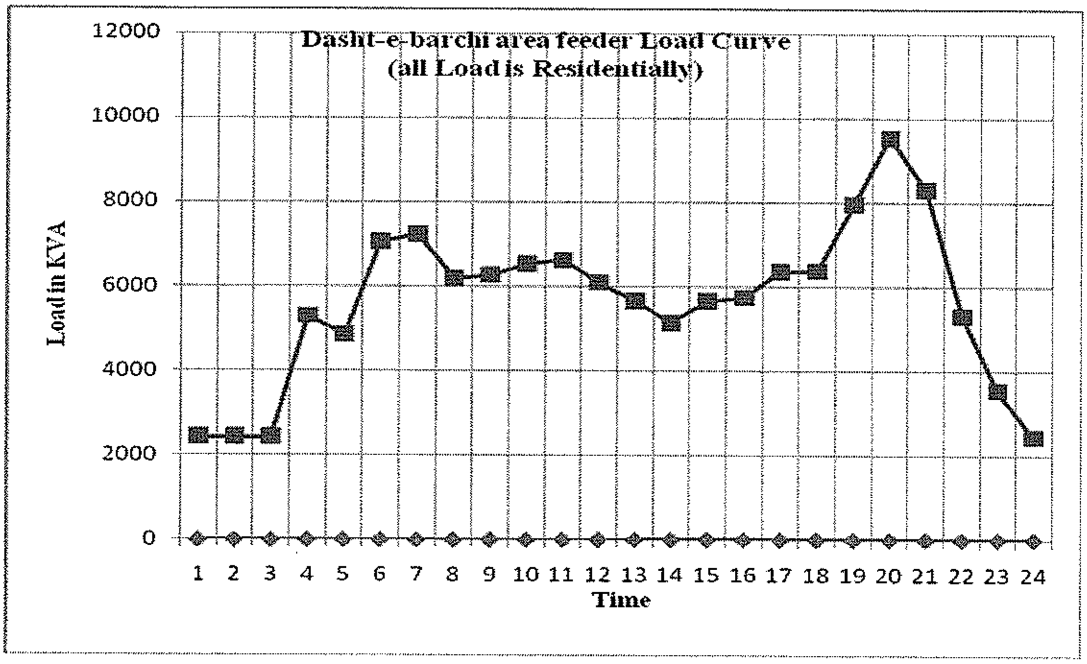


FIGURE 3-A

Residential feeder load Curve.

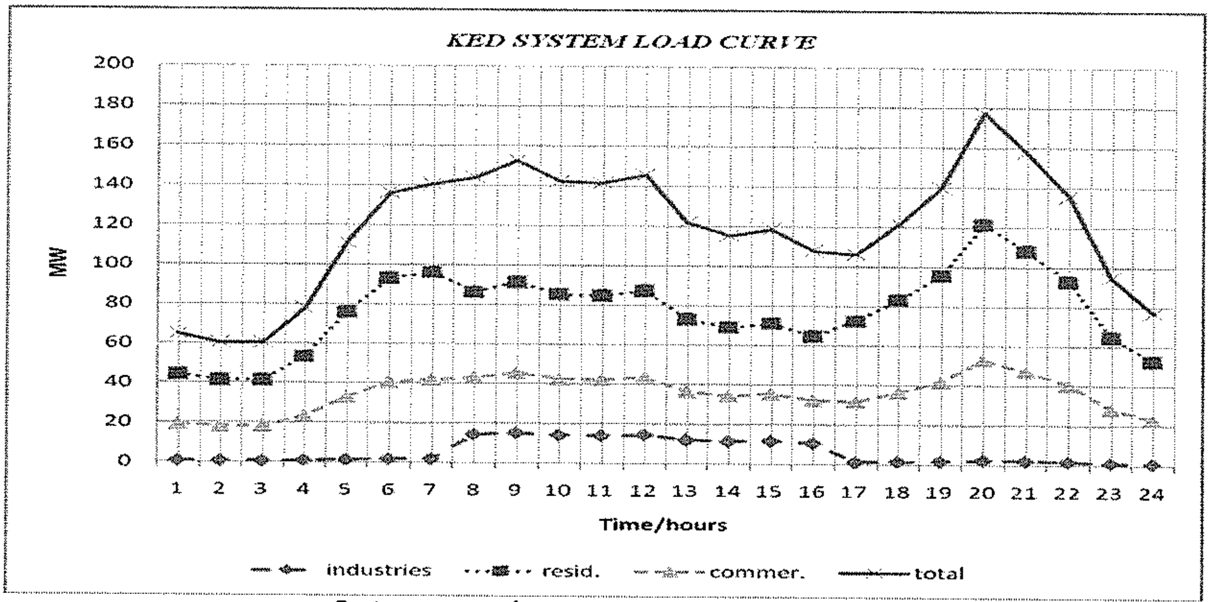


Source: KED Junction-4. FIGURE 3-B

The aggregation of load curves across multiple end-users is done for each of the different end-user classes, except the load curves are given in terms of percent of peak rather than load per end-user.

The charts illustrates such load curves for the various end-user classes, including a "miscellaneous" class (mainly sales to other utilities) and also the aggregation of these class-specific load curves into a system load curve.

Illustrate system load curve (10 jul-2010)



Source: KED FIGURE 4

Some observations from the graph charts are follow:

1. Residential loads
   - Have three peaks: once at 7 am, once at noon (11:00 am), and once at 8 pm(in summer) and 6pm (in winter),
   - Have tree valleys, once at 7 am , once at 10:30 and once at 8 pm,
   - Differ in that the system load does not fall off so steeply after 8 pm.
2. Commercial loads peak at about 9 am, dip slightly at noon, and then are rise slightly until about 6 pm after which they drop sharply.
3. The industrial load curves are similar to the commercial except that. This is the case since many industrial end-users operate just from 8amto 4/5pm a day.

The final aggregate curve (solid line) has the same form as the residential curves but the peaks and valleys are less pronounced due to the smoothing effect of the other load class curves.

Definition: A *conforming* load, relative to a group of loads, has a load curve that looks similar to the group's load curve. A *non-conforming* curve does not.

Residential loads are typically conforming relative to the system load, as we saw in the above.

City street light load is non-conforming relative to the system load as these loads tend to peak at the system off-peak times.

The current system peak is in the morning, mid-day (noon) and evening; the morning peak is started approximately 6:00 am and prolonging tree hours up to 9:30 am. The mid-day peak not so long it is from 11:30am to 12:30 pm. The evening peak started approximately 17 pm (in summer and 16:30 pm in winter). The largest share of the peak is from residential sector, especially evening peak. The analysis in this survey shows that lighting, cooking, water heaters, TV, electric fans (in summer) and electric heater (in winter) the main contributors to peak residential demand.

Mid-day peak is expected to be as important as the present evening peak. It will be necessary for KED to also focus on reducing the consumption in the commercial sector in order to reduce the noon peak. The industrial and to a much extent the commercial sector represent about xx% of the noon time demand, and this share is rising.

Regarding to the information given from KED the energy consumption in Kabul as follow;

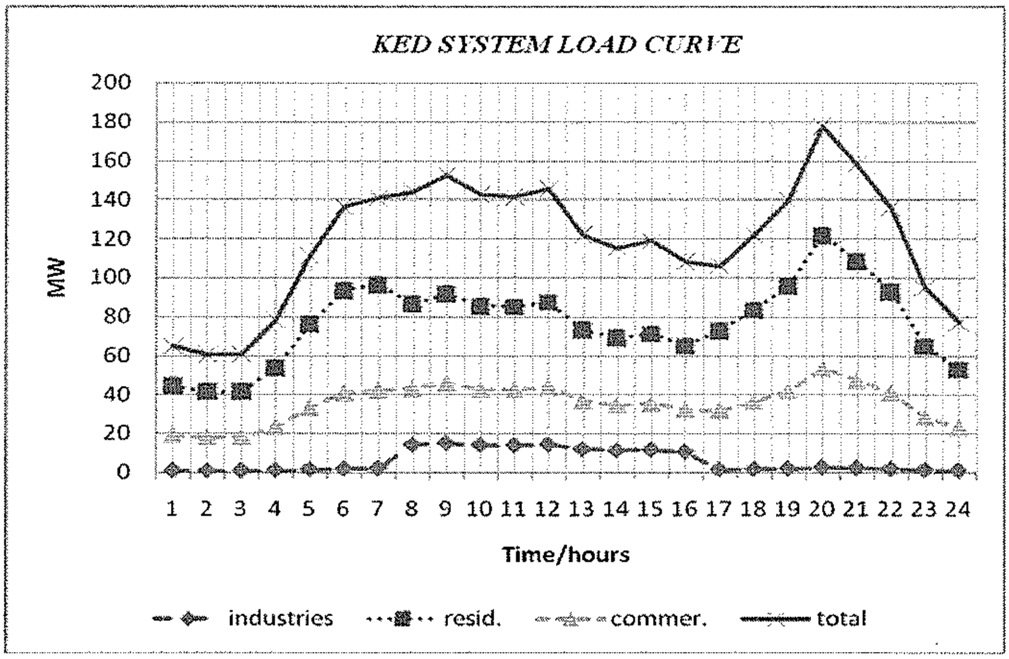
1. Industries total consumption: 16-17 MW/hour, 10% of total grid loads. (Working only from 8 am to 4/5pm.)
2. Lighting: 12-14 MW/hour, 70% CFL, 30% Incandescent (not match to the survey result. From survey we find 83% CFL and 16% incandescent and 1% fluorescent tube light), duration depends on the seasons.
3. In summer from 7:00/7:20 - 8:30/9:00 pm.
4. In Winter: 4:30/5:00 - 6:30/8:00pm.
5. Peak Load- 10-jul-2010. (19-04-1389): Evening peak: 7:30 to 9:30 pm~ 176, 7 MW; mid day (noon): 10:30 am to 1:00 pm~145.5MW; Morning: 7 am - 9:20 am ~152 MW.
6. The majored household appliances: Cooking, water heater, lighting, fans, iron, washing machine, cooling and heating equipment. (Cooling in summer ~ 15-16 MW, heating in winter more than 16 MW).

Load duration curve:

A load duration curve is also a graph between load and time in which the ordinates representing the load are plotted in the order of descending, magnitude, that is, with the greatest load at the left lesser loads towards the right and the lowest load at the time extreme right. The load duration curve is derived from the load curve and therefore represents the same data as that of the load curve. The load duration curve is constructed by selecting the maximum peak points and connecting them by acurve.

It is often of interest to know the percent of time that the load in a system, flowing through a substation, or flowing on a feeder exceeds some particular level.

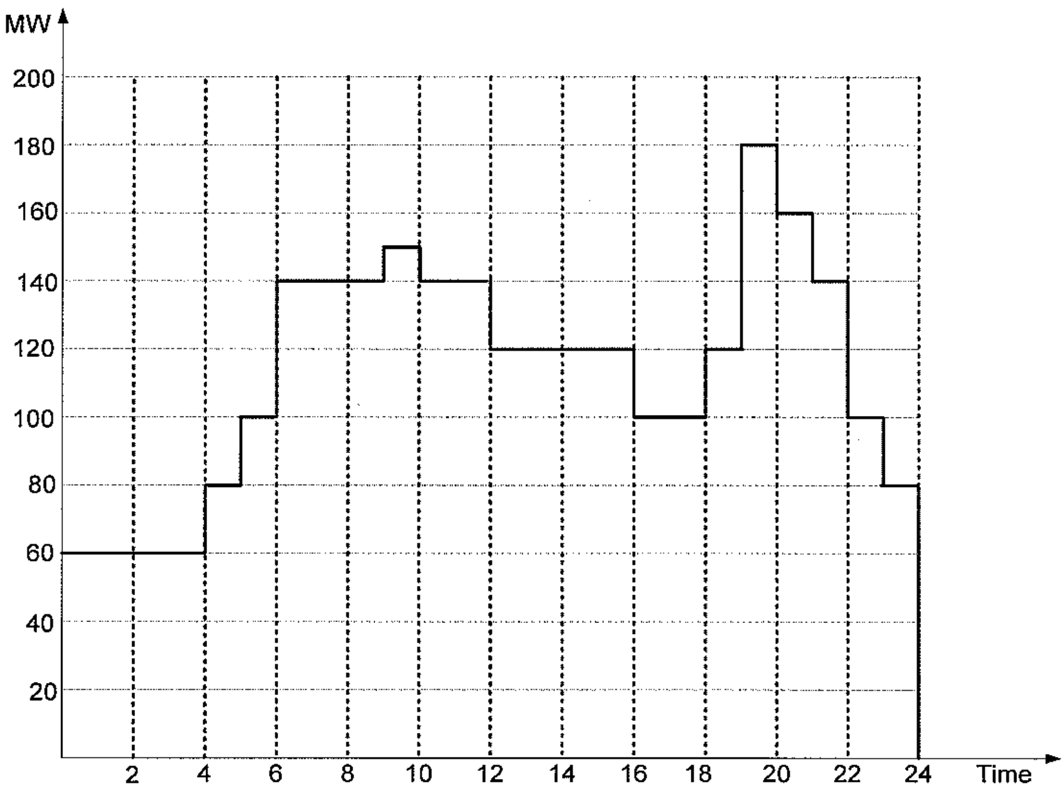
Consider that we have obtained, either through historical data or through forecasting, a plot of the load time for a period T, as shown in Fig. below. (FIGURE 5)

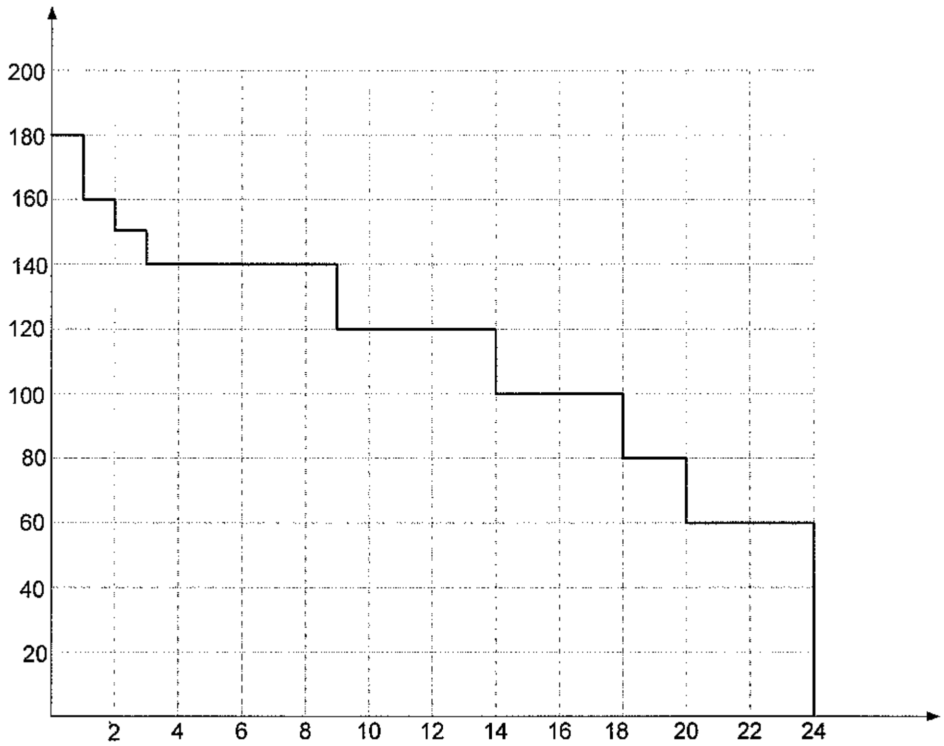


KED system load curve FIGURE 5

Of course, the data characterizing Figure will be discrete, as illustrated in figure.

Discredited load curve and Load range divided into intervals





Load in MW	Hours in day	Time in percentage
180	1	1 / 24 = 0.42 = 42 %
160	1 + 1 = 2	2 / 24 = 0.83 = 83%
150	1 + 1 + 1 = 3	3/24=0.125=12.5%
140	1 + 1 + 1 + 6 = 9	9/24 = 0.375 = 37.5%
120	1 + 1 + 1 + 6 + 5 = 14	14/24=0.58=58%
100	1 + 1 + 1 + 6 + 5 + 4 = 18	18/24 = 0.75 = 75%
80	1 + 1 + 1 + 6 + 5 + 4 + 2 = 20	20/24=0.83=83%
60	1 + 1 + 1 + 6 + 5 + 4 + 2 + 4 = 24	24 / 24 = 1 = 100 %

Load duration Curve

Load duration curves are useful in that they provide guidance for judging different alternatives.

Information's available from load duration curve

i. It gives the minimum load present throughout the given period.

ii. It enables the selection of base load and peak load power plants.

iii. Any point on the load duration curve gives the total duration in hours for the corresponding load and all loads of greater value.

iv. The area under curve and corresponding load duration curve are equal. Both these areas represent the same associated energy during the period under consideration.

v. The average demand during some specified time period such as a day, or month, or year can be obtained from the load duration curve as follows:

$$Average\ demand = \frac{kWh(or\ MWh) consumed\ in\ a\ given\ time\ period}{hours\ in\ the\ time\ period}$$
$$= \frac{area\ under\ the\ load\ duration\ curve}{base\ of\ the\ load\ duration\ curve}$$

$$energy\ consumption$$
$$= 180 \times 1 + 160 \times 1 + 150 \times 1 + 140 \times 6 + 120 \times 5 + 100 \times 4 + 80 \times 2 + 60 \times 4 = 2730 MWh$$

$$Average\ load = \frac{2730}{24} = 113.75\ MW$$

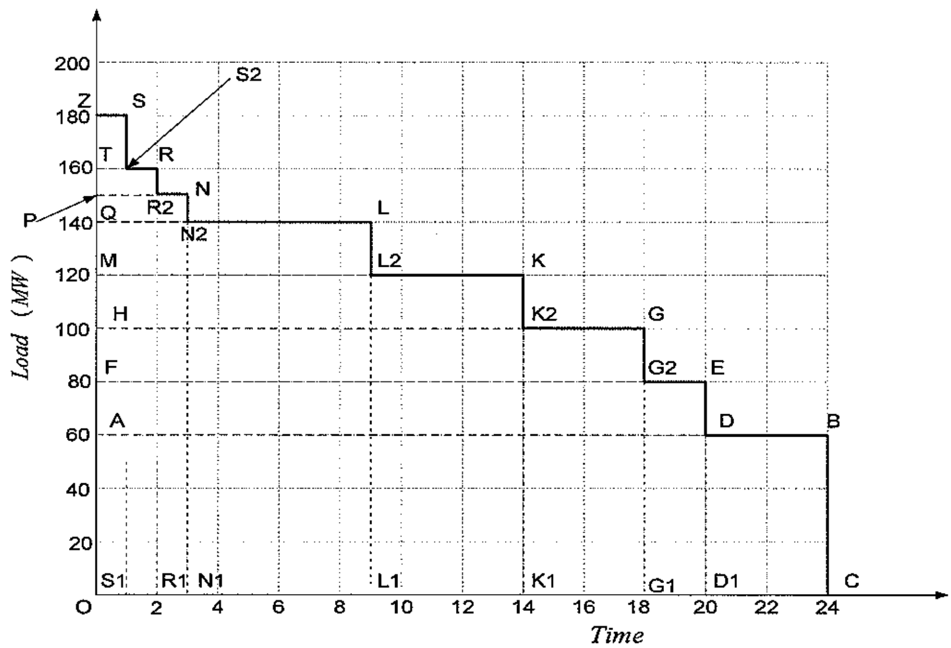
$$Maximum\ demane = 180\ MW$$

$$Load\ factor = \frac{average\ load}{maximum\ demand} = \frac{113.75}{180} = 0.632$$

Plotting of load energy curve

The load energy curve is the plot of the cumulative integration of the load curve starting from zero loads versus the particular load. The load energy curve is derived easily from the load-duration curve. The table is prepared by the area of the curve under taken load as figure:

Load duration curve use for energy curve



Load in MW	Area (energy at different load level) (MWh)	Corresponding point on the graph
0	0	O
60	OABC=1440	P_1
80	OFED1+A1=1840	P_2
100	OHGG1+A1+A2=2200	P_3
120	OMKK1+A1+A2+A3=2480	P_4
140	OQLL1+A1+A2+A3+A4=2660	P_5
150	OPNN1+A1+A2+A3+A4+A5=2690	P_6
160	OTRR1+A1+A2+A3+A4+A5+A6=2710	P_7
180	OZSS1+A1+A2+A3+A4+A5+A6+A7=2730	P_8

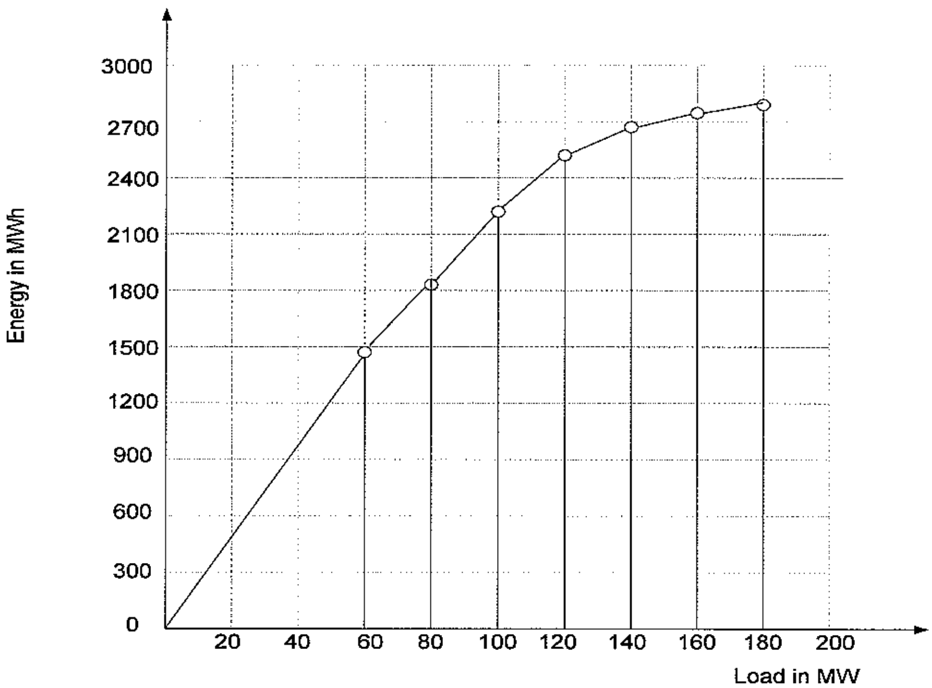


Fig.9 Load energy curve

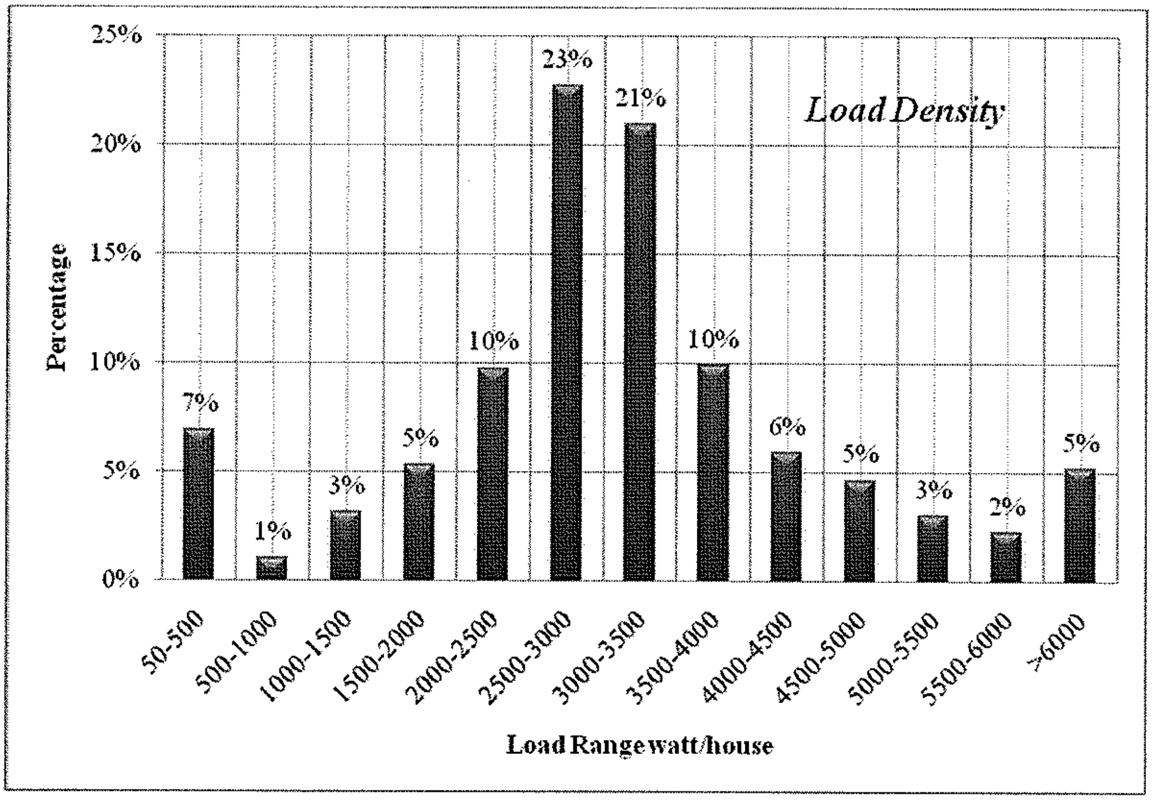
Load Density:

The load of consumers is the basis for designing electrical networks and systems. Not considering the verified loads in the development of the power sources and transmission networks might not be economical. For calculation of the load the below factors shall be considered:

- House area
- Number of families (people living in the same houses),

The must necessary factor is the determination of the capacity (wattage), and the number and type of the consumers. For the load determination of the electrical consumers, specific units such as houses, industrial site, and commercial, public, administrative and others similar institution are taken under study and after evaluation the results are used for calculation. In Kabul City such kind of studies haven't done yet.

The figure below shows installed load density.



- The installed load density of the houses (uses appliance load in houses) is varying in board rang (up to 50watt to 40 kW). The smallest number of the loads almost belongs to low families income households are areas not covered by the KED. The average load density for houses 4.5 kW/house, (approximately).

- Even for the under KED cover areas still the uses level of powerful appliances like appliances for air conditioning, heating, water heating and cooking is low electrical appliances). The reasons might be the economic low level of the people's life and not have reliable power supply.

- Use of the survey data on all-electric homes is valuable in understanding the overall estimated energy use in homes. Though highly dependent on averages, the data does indicate that for all-electric homes, the average load ranges from about 3.0 to almost 6.5 kW per houses (approximately 25- 55 watt/m^2). The consumption levels probably depend on the economic level of the family and, to some extent in uses of new electrical appliances.

ANNEX VIII: DSM FINANCIAL ANALYSIS AND ALLOCATED FORMULAS

DSM SUMMARY

DSM Technology	Target #	Tariff[5] US $/MWh	Main DSM Assumptions: Savings %	Hrs of Operation	Peak hrs Am	Peak hrs PM	off peak hours	KWh saved/ DSM unit/y	Unit Cost DSM unit($)	Total Install Unit Cost	Technical savings potential: MWh/y	Morning Peak	Evening Peak	Off Peak	Total Customer saving US$ mill	Total National saving US$ mill	Total Cost US$ Mill	Economic Benefits: Customer Pay Back(yr)	National Pay Back (yr)	Key Barriers to implement	Difficulty to implement	Penetration
1 Awareness & Outreach Campaign(# of people)	30000000	60	2 (18)	NA	NA	NA	NA	NA (19)	NA	NA	70,000	NA	NA	NA	4.2	4.2	1	0.238	0.238	Receptivity	Low	1 year
2 Urban Re-lamping Programs																						
CFLs for Res outdoor light (100-24 w CFL)[1]	50000	120	75	3650	1217	2433		277.4	1.5	3	13,870	0	9293	4577	1.66	2.2	0.15	0.090	0.067	none	very low	1 year
CFLs in Road and Street lights (250-60w CFL)[2]	10000	200	75[6]	4380	0	1825	2555	832.2	6	12	8,322	0	5576	2746	1.66	1.3	0.12	0.072	0.090	reforms	medium	1year
CFLS in Government buildings (60 - 13 w CFL)[3]	500000	200	75[6]	3432	0	0	3432	161.30	1.5	3	80,652	0	0	80652	16.13	4.8	1.5	0.093	0.310	reforms	medium high	1year
CFLS in Low Income housing (60 to 13 w CFL)[4]	1000000	30	75[6]	5840	730	1825	3285	274.48	1.5	3	274,480	34310	85775	154395	8.2344	30.71	3	0.364	0.098	difficult WD	difficult WD	1 year
3 SWH for Large Customers (2 kW and1460hr/y)	10000 (11)	200	90	1460	122	304	1034	2920	900	1200	29,200	2433	6083	20683	0.876	2.76	12	13.699	4.345	private sec	medium	3 years
4 Large Electric Power Consumers																						
TOD/Load Management	1257 (12)	200	10 (14)	4380	0	1825	2555		500	750			11.47	11.47	0.46	0.46	0.94	2.055	2.055	new tariff	high	2years
Power Factor/EE motor/Municipality Pump	5000	200	25	7300	730	1825	4745	18250	500	600	91,250				18.25	18.25	3	0.164	0.164	difficult	high	3-5 yrs
ESCO/Energy Audits at large customers	125	200	20	4380	0	1825	2555	87600	55000	55000	11				2.19	2.19	6.875	3.139	3.139	new tariff	high	2years
5 New Building Initiative(# of square meters)	100000 (15)	200	40	7300	730	1825	4745	60 (16)	80 (17)	100	6	0.06	0.15	0.39	1.20	1.20	10	8.333	8.333	culture	high	5 yrs

Note:

1. Source: KURD note
2. Interview with Mr. Rosooli, Dy. Mayor on June 6, 2010
3. ACEP estimation based on disclussion with DABS/KED and government representatives 10% of total number of units in Kabul
4. Estimates based on ACEP survey and KED/MOUD consumers data indicate the number of remaining IB is about 40 % of total of 5 Million for purpose of this we have consider 1 M in first pohase
5. Official tariff structure for Kabul as of June 2010 : See chapter 1 for details
6. Generalelly acepted target based on Eco Asia study. This target is consistent with Kabul data where the change is primarially from 60 w IB to 13 w CFL
7. Margional cost/avoided cost per Kwh have been assumed as follows: Morning peak 0.06 (hydro); evening 0.21 (Tarakil TPP); off peak 0.03 (Imports)
8. Outdoor lights have been assumed to operate 12 hours a day of which 5 in evening peak, similar assumpsions for road lights,
9. Government building lighting asssumptions are as folows: lights on 12 hours a day (7 am to 7 Pm), 5.5 days a week all off peak hours
10. Low income housing lighting assumptions are as follows: 2 hours morning leak plus 5 hours evening plus 9 hours off peak , a total of 16 hours a day (source Kabul survey)
11. Solar water heater (10,000 units in 2011; 20,000 units in 2012 and 30,000 units in 2013)
12. Target population equal 10% of commercial (1165), 100 others for industrial, pumping, military of a total of 1257 (Source DABS)
13. Average load 50 KW, saving 10% or 5 Kw, 5 hours a day equal 25 Kw per day per site. New tariff assume to be 30 cents (15 Agh) and 6 cents (3 Agh off peak)
14. Saving resulting from ppm assumed at 10% of total consumption
15. Assuming 1,000,000 sq m new construction every year in kabul of which 600,000 in residential and 250 in commercial, plus 20% informal
16. Based on data from India for new building we assume base line consumption at 150 Kwh per sq m per year period, 40% saving means 60 Kwh/sq m/yr
17. Assuming cost of high quality construction with international EE building code at 200 $/sq m vs 120 $/traditional construction i,e sur cost of 80 $/sq m
18. A review of campaign in 50 countries as resulted into 1-5 % saving in the first year for the sake of Afghanistan we choose 2% because of excellent establishment of TV every where.
19. By 2011 Afghanistan will consume 3.5 Twh @ 2% will be 70 Gwh.

ANNEX IX : PERSONS CONTACTED

	Name	Organization	Address
1	[redacted] (PMU Project Manager)	Ministry of Urban Development	Macroryan 4 Banayee Compound, Kabul
2	[redacted] (Energy Project manager)	USAID, Energy Project	Great Masoud road Kabul, Afghanistan
3	[redacted] (Advisor)	Bakhatar University	South Gate of Kabul University Kabul Afghanistan
4	[redacted] (Head Of planning Controlling)	Da Afghanistan Berishna Sherkat	Chaman Houzuri Kabul Afghanistan
5	[redacted] (Chancellor Bakhatar University)	Bakhatar University	South Gate of Kabul University Kabul Afghanistan
6	[redacted] (Mechanical engineer)	Afghan Electrical Power Corporation AEPC	Street 15, Wazir Akbar Khan Kabul Afghanistan
7	[redacted] (Energy Planning & Policy Analysis Director)	Afghan Energy Information Center	Ministry of Energy & Water Durul Aman Road Kabul Afghanistan
8	[redacted] (General manager, Operations)	Sustainable Energy Services Afghanistan	Deh bori square Street #2 Kabul Afghanistan
9	[redacted] (lead Energy Specialist)	The World Bank	Washington DC 20433, USA
10	[redacted] (senior Advisor) [redacted]	Afghanistan Energy Capacity Development Program	House # 178 ghori Watt Kabul Afghanistan
11	[redacted] (chief of Party)	Consulting group USAID contractor	Nil
12	[redacted] (Executive Management Advisor)	Consulting group USAID contractor	Nil
13	[redacted] (Director for New & Renewable Energy)	Ministry of Energy & Water	Dural Aman Road Kabul Afghanistan
14	[redacted] (head of Construction Department)	Geres Afghanistan	House#2, street# 2 , Deh bori Sarai Ghazni Kabul Afghanistan
15	[redacted] (chancellor bamyan University)	Bamyan University	Bamyan Afghanistan
16	[redacted] (Renewable energy expert)	Ministry of Rehabilitation & development	MRRD compound Nila Bagh Street Darul Aman road Kabul Afghanistan
17	[redacted] (energy efficiency & cell Assistant)	Energy efficiency in Public Buildings	National Environmntal protection agency street# 2, shahs darak Kabul Afghanistan
18	[redacted] (economist)	The world Bank	1818 H street NW Washington DC 20433
19	[redacted] (head of Department)	MVV decon Gmbh Economics & Policy	Salzufar 8, 10587 Berlin, Germany
20	[redacted] (electricity Delivery Advisor)	Consulting group USAID contractor	Nil
21	[redacted] (head engineer department)	Ministry Of Rural Rehabilitation & development	Ministry Of Rural Rehabilitation & development Kabul Afghanistan
22	[redacted] (advisor)	Board member Deh sabaz City Development Authority	Sawakada Palaza Next to micro finance bank Ansari Square Kabul Afghanistan

23	[redacted] (technical Deputy Director General)	Afghan National Standards Authority	Industrial Park Area Kabul jalal Abad road Kabul Afghanistan
24	[redacted] (general Technical cooperation)	GTZ	Ministry of Energy and Water Darull Aman road
25	[redacted] (deputy for Ministry of interior)	Ministry of interior	Ministry of interior
26	[redacted] (senior energy Specialist)	The world bank	Wazir akbar Khan Kabul Afghanistan
27	[redacted] (program coordinator)	KFW (German Development Cooperation)	German house#33/2, Charah e sedarat Kabul Afghanistan
28	[redacted] (local governance management specialist)	Ministry of Rural & rehabilitation	MRRD compound Nila Bagh street Darul Amn road Kabul Afghanistan
29	[redacted] (commercial Director)	Afghan Electric Power Corporation	Street # 15, Wazir Mohammad Akbar khan Kabul Afghanistan
30	[redacted] (head of transmission)	Da Afghanistan Bershna Shirkat	Chaman e Hozori Islamic republic Of Afghanistan
31	[redacted] (Commercial And Revenue Advisor)	Consulting group USAID contractor	Nil
32	[redacted] (Project Manager)	Ministry of Urban & Development	Ministry of Urban & development
33	[redacted] (Country Director)	Geres Afghanistan	H#2, Street#2, dehbori Sara e Ghazni
34	[redacted] (deputy Division Chief, water & energy)	USAID	Great Masoud road Kabul Afghanistan
35	[redacted] (AEIC Director)	LBG/B&V	Wazir Akbar Khan Kabul Afghanistan
36	[redacted] (Technical Director)	Khan engineering Co. Ltd	Parak e Sanati Kabul Afghanistan
37	[redacted] (Bamyan Governor)	Bamyan Province	Bamyan province
38	[redacted] (Management Analyst)	Afghanistan Support Project	House# 1055 street 15 wazir Akbar khan
39	[redacted] (Country Director)	Flag International LLC	Kolola Poshta Road near Burj e Barq Bus Stop
40	[redacted] (Regional Program Manager)	AGA KHAN FOUNDITION Afghanistan	Sar e Asyab Bamyan Afghanistan
41	[redacted] (Director of Planning)	Ministry of Public Health	Great Masoud avenue Kabul Afghanistan
42	[redacted] (field Program Officer Bamyan)	USAID Afghanistan	Great Masoud Road Kabul Afghanistan
43	[redacted] (executive Director)	AIMS Afghanistan information	House # 1070 street 15 wazir Mohammad kabar khan Kabul Afghanistan
44	[redacted] (engineering Director)	NRECA International management system Ltd.	4301 Wilson Boulevard Arlington Virginia 22203
45	[redacted] (Chief Of Bamyan Provincial council)	Independent directorate of local governance	Bamyan

46	[redacted] (Vice president Operations)	NRECA International Ltd.	4301 Wilson Boulevard Arlington Virginia 22203
47	[redacted] (Chief Of Party)	Sheberghan Gas field Project USAID contractor	House # 178 Ghori watt karte Chahar Kabul Afghanistan
48	[redacted] (Development Advisor) listed twice	Us Agency for international Development	Mazar e sharif
49	[redacted] (Chief Excutive Officer)	Berishna Sherkat	Chaman hozori Kabul Afghanistan
50	[redacted] (Sec to MEW minister)	MEW	Darullaman Road Kabul Afghanistan
51	[redacted] (Chief of Party)	Advanced Engineering Associates	House # 1104 dtreet # 4 Qala e farhullah Kabul
52	[redacted] (Principle)	Global Energy	USA
53	[redacted] (infrastructure & development services)	PA Consulting Group	USA
54	[redacted] (Senior Advisor to Minister)	President Office	Presidential Place Arg Kabul Afghanistan
55	[redacted] (Long Term Observer)	European Commission	Kabul Afghanistan
56	[redacted] (Operating Officer)	Bershna Sherkat	Chaman Hozori Kabul Afghanistan
57	[redacted] (Minister urban development)	MoUD	Makroryan 3 Kabul
58	[redacted]	Remote Hydro light	Kabul Afghanistan
59	[redacted] (Gender Advidsor)	IFES	Shash Darak Kabul Afghanistan
60	[redacted] (deputy chief of mission)	Indian Embassy	Malalai Watt Kabul
61	[redacted] (Chief of party)	Republic of France France embassy	Sher pur Kabul
62	[redacted] (General manager)	Afghan Urban Water supply	Kabul Afghanistan
63	[redacted] (President)	Sun Ovens International	USA
64	[redacted] (Special advisor)	US Embassy	US Embassy Great Masoud Road Kabul
65	[redacted]	WB	Wazir Akbar Khan Kabul
66	[redacted]	NEPA	Shash Darak AKbul Afghanistan
67	[redacted] (DABS advisory)	LBG B&V	Wazir Akbar Khan Kabul
68	[redacted] (Energy Specialist)	ADB	Haji Yaqub roundabout Kabul Afghanistan
69	[redacted] (Program expert)	ARD	Shash Darak Kabul
70	[redacted] (Chief of party)	ARD	Shash Darak Kabul
71	[redacted] (Economic Officer)	US Embassy	Great masood road Kabul Afghanistan
72	[redacted] (project implementation officer)	ADB	Haji Yaqub roundabout Kabul Afghanistan

73	[redacted] (president)	National coalition for dialogue with Tribes of Afghanistan	Kabul
74	[redacted] (Deputy chief of party)	ARD	Shash Darak Kabul
75	[redacted] (Mayor)	Kabul Municipality	Kabul Afghanistan
76	[redacted] (Vice President)	USAID	USA
77	[redacted] (General Manager)	Sustainable energy services Afghanistan	Dehbori Squar Kabul Afghanistan
78	[redacted] (technical Support Specialist)	LBG B&V	Wazir akbar khan
79	[redacted] (Chief of party)	Advanced Engineering association	Ghori watt KArte 3 Kabul Afghanistan
80	[redacted] (Economist)	WB	Waizr akbar khan

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