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A Business Approach For Delivering Energy Services Through Local Natural Gas Distribution Companies

FINAL REPORT

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The views expressed in this report are those of the authors and are not necessarily those of the United States Agency for International Development.

1.1 BACKGROUND

Egypt's abundant natural gas reserves provide the country with an opportunity to utilize its natural resources to facilitate sustainable economic development.[1] Natural gas-based energy systems can be a cost-effective and environmentally sound way to meet the increasing energy demands of local industry. However, in order to stimulate domestic markets for natural gas, innovative business approaches which remove technical and financial barriers are required.

This study summarizes work that was carried out by Nexant, Inc. under the Egyptian Environmental Policy Program (EEPP) which is funded by the United States Agency for International Development (USAID) mission in Cairo. As part of EEPP, Nexant is supporting the development of the National Energy Efficiency Strategy (NEES) as well as a range of market transformation initiatives that involve the delivery of energy services by the private sector. A key objective of the NEES is to foster the cost-effective utilization of domestic natural gas reserves. Local natural gas distribution companies (LDCs) can help achieve this objective by expanding their business operations through the linkage of natural gas delivery with the development of customized energy solutions. The adoption of this new business approach by LDCs will help achieve the following national objectives:

- Expanding domestic use of Egypt's natural gas resources as well as reducing local dependency on liquid fuel oil
- Increasing the efficiency of industrial energy consumption (thereby stimulating economic growth as well as the competitiveness of local industry)
- Developing environmentally sound energy solutions for local industry

To assess the viability of LDCs delivering energy services, Nexant conducted a case study analysis and business strategy assessment for Egypt-Kuwait Holding Company's (EK Holding) LDC subsidiary Natgas.[2] EK Holding requested that Nexant conduct a market assessment of Natgas' 6th of October city service territory in order to assess the market potential and to evaluate alternative approaches for delivering energy services to industrial customers.[3] Case study results indicate that LDCs can benefit from high-return investments that meet a growing demand for integrated energy services. Key case study results include:

- Economic Benefits: LE 30 million in net present value (NPV) for EK Holding and LE 16.5 million for customers[4]
- Natural Gas Utilization: 24% increase in natural gas sales in the 6th of October city due to energy services projects (compared to sales under the traditional LDC business)
- Environmental Protection: Annual emission reductions of 104,000 tons of carbon dioxide (CO_2), 5,000 tons of sulfur dioxide (SO_2), and 420 tons of nitrogen oxide (NO_x).

[1] Proven gas reserves total 45 trillion cubic feet (tcf). Seismic 3D surveys indicate reserves could reach 120 tcf.
[2] EK Holding is a member of the Egyptian Energy Service Business Association and contacted Nexant to request technical assistance (under NEES) to help evaluate the viability of entering the energy services business.
[3] In subsequent text, case study results that discuss economic benefits from investments in energy services will be attributed to EK Holding rather than its LDC subsidiary Natgas.
[4] The NPV is based on cash flows that are generated by LE 80 million in investments assuming a 16% discount rate over an initial five year period.

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1.2 ENERGY SERVICES CONCEPT

To tap into the energy services market, LDCs will have to provide industrial customers with services that extend beyond those typically offered by a natural gas utility. This will require that LDCs offer customers a menu of service options that can be used to move a project from inception to completion, including: feasibility studies, engineering services, project design, financing, equipment installation, and project start-up.

A key element under any scenario is that the cash flow that an LDC earns will be tied to the actual performance of a project. Specifically, an LDC will share the realized cost savings from a project with the customer for an agreed upon period of time in a manner that is commensurate with their level of risk. LDCs can package energy services to customers through the following delivery approaches:

- Performance Services in which the LDC implements a project and guarantees the customer an agreed upon level of technical and/or economic performance (the customer is responsible for arranging financing)
- Turn-key Services in which the LDC finances and develops a project as part of a comprehensive package of financial and technical services

To maximize potential business opportunities, LDCs must be able to combine elements from both the performance and turn-key services approach (e.g., utilizing a customized approach that allows customers to select from a menu of technical and financial services). Offering customized energy solutions to industrial customers will enable LDCs to not only cover a broader segment of the market but also to better manage their investment risks.

1.3 CASE STUDY RESULTS

The case study analysis of the 6th of October city indicates that LDCs and their industrial customers can achieve considerable economic and environmental benefits from the development of natural gas-based energy services projects.

1.3.1 Investment Opportunities

The 6th of October city contains numerous industries that can benefit from energy services, including the automotive, building materials, chemical, pharmaceutical, food & beverage, and paper sectors.[1] Based on case study results, the investment market for energy services is LE 80 million.[2] By providing customers with a flexible portfolio of energy services, EK Holding can capitalize on the following opportunities:

Cogeneration (LE 54 million): cogeneration projects are designed to simultaneously produce electricity and steam on-site at a customer's facility. Cogeneration systems are highly efficient since they capture and utilize waste heat that would otherwise be released into the

[1] The industrial sector is a key market for energy services since it accounts for over 46% of Egypt's total final energy consumption.

[2] The LE 80 million investment market reflects the cost of equipment and services that is required to develop and implement energy services projects in Natgas' current service territory in the 6th of October city.

environment. When coupled with the use of high-efficiency natural gas turbines and/or engines, cogeneration can be an attractive investment option.[1]

Fuel Switching (LE 22 million): fuel switching projects involve the conversion of oil-fired equipment (primarily boilers, ovens, and furnaces) to natural gas. Converting to natural gas can generate significant cost savings due to the favorable price differential between gas and alternative fuels.[2] Switching to natural gas can also result in additional benefits such as improved fuel combustion and product quality.

Self-generation (LE 4 million): self-generation projects are designed to meet the electricity demand for a single host company through the on-site production of power. Several industrial companies already rely on self-generation for back-up power. However, self-generation can also be used to continuously meet a company's baseload demand for power.

1.3.2 Economic Benefits From Investments in Energy Services

The economic benefits inherent in energy services investments are based on the use of low-cost natural gas and high-efficiency energy technologies. In the 6th of October city case study, economic benefits were calculated by taking the NPV of cash flows that would be generated from investments in energy services. NPV is used as a figure of merit because it eliminates the time dimension from investment decisions and allows for a direct comparison of the present value of cash inflows (project savings or revenues) against cash outflows (up-front equity investments, project operating expenses, and debt service).[3]

For the purpose of this analysis, the NPV from energy services investments was calculated over a five-year period taking into account potential customer acceptance and the probability of closing a deal.[4] A financial model was utilized to determine the potential economic benefits that result from the use of different energy services delivery approaches. The economic benefits earned by an LDC and its industrial customers varies according to the level of investment and/or performance risk.

Economic benefits are maximized when LDCs utilize a customized energy services delivery approach that offers customers both technical and financial services. The results of the 6th of October city case study indicate that the following economic benefits can be generated from investments in energy services:

- NPV of LE 30 million for EK Holding from energy services
- NPV of LE 16.5 million for customers over the initial five-year period.[5]

Adapting the results of this analysis to a timetable for actual capital expenditures will be an essential part of future business planning activities for an LDC.

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[1] Analysis of the local market for cogeneration reflects current regulatory conditions in the electric power sector.
[2] Fuel costs and characteristics are listed in Appendix C
[3] NPV serves as a measure of the economic value that is created from an investment.
[4] The maximum length of EK Holding's involvement in a project was assumed to range from three to five years.
[5] After year five, energy services projects will continue to earn economic benefits for customers that will significantly increase their NPV (potentially reaching LE 70 to 80 million after ten years).

1.3.3 Natural Gas Use and Environmental Protection

By entering into the energy services business, LDCs can develop projects that will increase natural gas sales. The 6th of October city case study results indicate that gas sales will increase by 24% from the development of energy services projects. Increased sales will result from both the identification of new markets for natural gas as well as the increased development of fuel switching projects (i.e., without offering energy services to industrial customers, some fuel switching investments will not be made).

The delivery of energy services will also create environmental benefits through the replacement of fuel oil with natural gas. Case study results indicate that investments in energy services will reduce the annual consumption of mazout (fuel oil #6) by approximately 7,200 tons and solar (fuel oil #2) by 29,000 tons. Substituting gas for oil will directly reduce local emissions of greenhouse gases (104,000 tons/year of CO_2) and atmospheric pollutants (5,000 tons/year of SO_2 and 420 tons/year of NO_x).

1.4 NEXT STEPS AND RECOMMENDATIONS

LDCs are in a unique position to capitalize on energy services investment opportunities due to their existing role as an energy provider to local industry. To successfully build an energy services business, LDCs will need to leverage the expertise of key industry stakeholders and outside investors. The development of a separate company (or LDC energy services business unit) is recommended in order to eliminate any potential conflicts between the obligations of traditional LDC activities and energy services business initiatives.

An essential step in forming a new energy services business unit or company will be the development of a detailed business plan and strategy that defines the following key elements:

- Energy services and products that will be offered to customers
- Marketing strategies that help introduce products and services to the local market
- Operating plans that define business functions and address human resource needs
- Financial requirements for start-up operations and initial investment opportunities.

The remainder of this study outlines a preliminary roadmap for assessing the creation of an LDC energy services business unit. The study is organized in the following sections:

- Section 2 outlines the study methodology
- Section 3 details a series of approaches commonly used to deliver energy services
- Section 4 contains the specific results from the 6th of October city case study, including the economic and environmental benefits from energy services investments
- Section 5 outlines an initial energy services business approach for LDCs as well as preliminary business planning recommendations

2.1 STUDY OBJECTIVES

The development of natural gas-based energy services will not only create attractive business opportunities for LDCs but will also support economic development and environmental initiatives on the national level. Specifically, the delivery of energy services by LDCs will increase the competitiveness of local industry, reduce emissions of greenhouse gases and atmospheric pollutants, and facilitate the efficient utilization of Egypt's natural resources.

As part of the USAID-funded NEES project, Nexant completed this study to assist LDCs as they start to enter into the emerging energy services business. The results of this study can be used by LDCs to evaluate the economic and technical viability of energy services projects as well as to help guide the creation of a separate energy services business unit or company.

2.2 STUDY METHODOLOGY

The work that was completed for this study was carried out as part of a collaborative effort between Nexant and representatives from EK Holding and its subsidiary Natgas.[1] The study was conducted in three phases that are illustrated below in Figure 2-1.

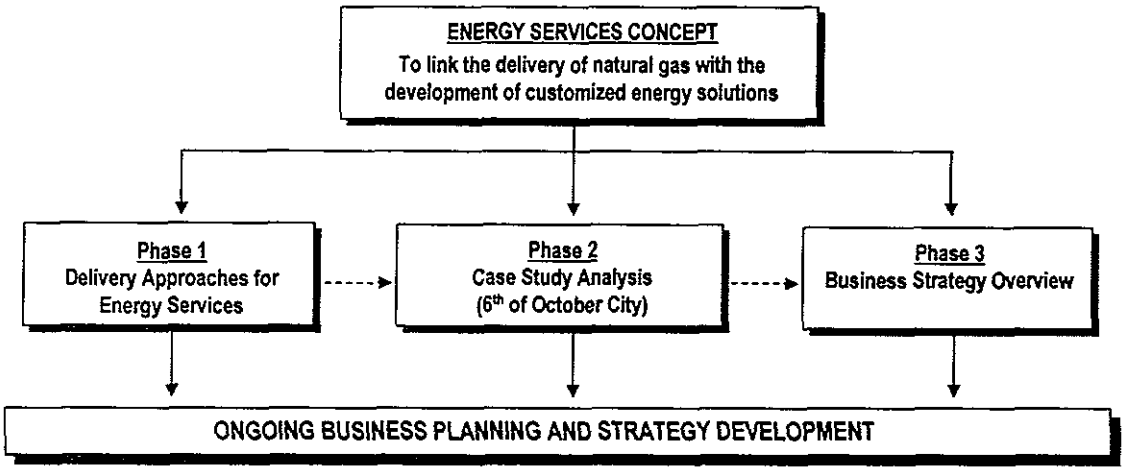

Figure 2-1 Business Strategy Methodology

Phase 1: Delivery Approaches for Energy Services. Nexant identified and evaluated a series of delivery approaches that could be used by EK Holding to develop natural gas-based energy services projects for local industry. Potential delivery approaches range from offering customers engineering and technical assistance (performance services) to providing a comprehensive package of technical and financial solutions (turn-key services). Based on discussions with EK Holding, Nexant selected three primary delivery approaches that were evaluated as part of Phases 2 and 3.

Phase 2: Case Study Analysis (6th of October city). A case study sample of 20 companies was selected following an analysis of Natgas' 6th of October city customer database. The sample

[1] EK Holding owns the National Gas Company (Natgas) which is one of several companies awarded a franchise by the Egyptian government to develop the local gas distribution network – see Appendix E for a LDC listing.

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population included a range of industries and was weighted according to the energy consumption of individual industry sectors (e.g. food & beverage, paper, etc.) A detailed survey was developed to determine the technical feasibility of potential energy services projects.[1] The survey was segmented into four main areas: business operations and energy consumption, equipment data and information, technical screening questions for energy services projects, and customer attitude towards energy services delivery approaches.[2]

Technical and financial analysis of data collected during the customer interviews was used to determine the following results for Natgas' 6th of October city service territory:

- Investment market (cost of equipment and services required to develop a range of energy services projects)
- Economic benefits to EK Holding and industrial customers from energy services investments (e.g. cogeneration, fuel switching, and self-generation projects)
- Natural gas use that would result from the development of energy services projects
- Reduced emissions of atmospheric pollutants and greenhouse gases that would result from investments in energy services.

Financial analysis was carried out using a financial model developed by Nexant that determines the feasibility of individual projects under different energy services delivery approaches. Based on thermal energy consumption data, the results for the 20 companies (sample population) were scaled to Natgas' entire 6th of October city service territory (a population of 112 companies).

Phase 3: Business Strategy Overview. Nexant evaluated a series of business strategy elements and planning issues that can be used by LDCs as they consider the formation of a separate energy services unit or company, including:

- Identification of an energy services business structure
- Evaluation of strategic alliances and partnerships
- Preparation of an energy services business plan.

The business strategy overview prepared in Phase 3, when coupled with the evaluation of service delivery approaches (Phase 1) and the case study analysis (Phase 2), provides LDCs with an integrated assessment of the local energy services business as well as outlines the initial steps in forming a new company.

[1] A copy of the survey is contained in Appendix A.

[2] See Appendix B for a description of the methodology used to determine the technical feasibility of energy services projects (including example calculations of project costs and savings).

Section 3 Delivery Approaches for Energy Services

To gain access to the energy services market, LDCs will need to offer customers a range of financial and technical services, including providing performance guarantees and project financing solutions. LDCs can package services to customers through the following delivery approaches:

- Performance Services in which the LDC develops a project and guarantees the customer an agreed upon level of technical and/or economic performance
- Turn-key Services in which the LDC finances and develops a project as part of a comprehensive package of financial and technical services

The viability of each energy services delivery approach depends in part on the market environment, the type of investment being considered, the project length, and the project specific risks. LDCs can also adopt a customized approach to developing projects that combines elements from both the performance and turn-key services options. Adopting a customized approach to delivering energy services can expand business opportunities for LDCs as well as mitigate investment risk by building a diversified portfolio of projects.[1]

3.1 Performance Services

In the performance services model, the LDC provides the customer with a guarantee that a project will achieve an agreed upon level of technical or economic performance. Under this model, the customer is responsible for financing the project which is typically arranged from a third-party source (e.g., commercial bank). The customer is responsible for making annual debt service payments that amortize the cost of the investment. Figure 3-1, shown below, outlines the responsibilities and risks assumed by key stakeholders.

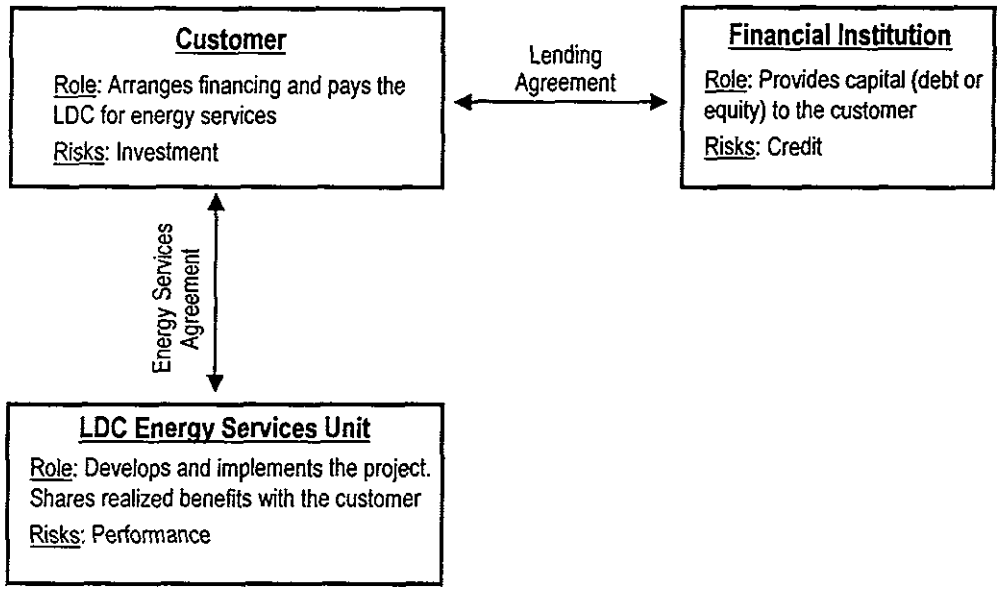

Figure 3-1 Performance Services

[1] The use of energy asset out-sourcing as an approach to delivering energy services was also evaluated as part of this study. A description of the out-sourcing approach is listed in Appendix D.

The LDC's guarantee to the customer states that the project will perform at a minimum level of technical or economic performance. The financing for the project is typically structured so that the actual savings from a project will equal or exceed the cost of the customer's annual debt service. If the savings do not cover the debt service due to the technical performance of a project, then the LDC will assume the financial responsibility for this shortfall. If, however, the project generates savings that exceed the annual debt service, then the customer and the LDC will share the excess amount for an agreed upon period of time.

Lenders often require that risks are mitigated through an energy services agreement (ESA). The ESA, which is standard in the development of energy services projects, outlines the roles and responsibilities of each party and assigns risks. The ESA addresses key terms and conditions, including: the methodology to allocate savings, the project term, operating requirements at the customer's facility, and procedures for monitoring and verifying savings.

The risks associated with developing a project under the performance services approach are spread amongst the stakeholders. The customer assumes the investment risk while the LDC assumes the performance risk which entails that the project be completed on schedule, within budget, and perform according technical specifications.

3.2 Turn-key Services

In the turn-key services delivery approach, the LDC offers a comprehensive package of services that can include project financing solutions. As illustrated below in Figure 3-2, the LDC assumes not only the performance risk but also the investment risk. Given their increased level of risk, the LDC earns a higher percentage of the savings generated by the project. The higher share of the savings will compensate the LDC for their services and allow them to earn a rate of return that is commensurate with their risk.

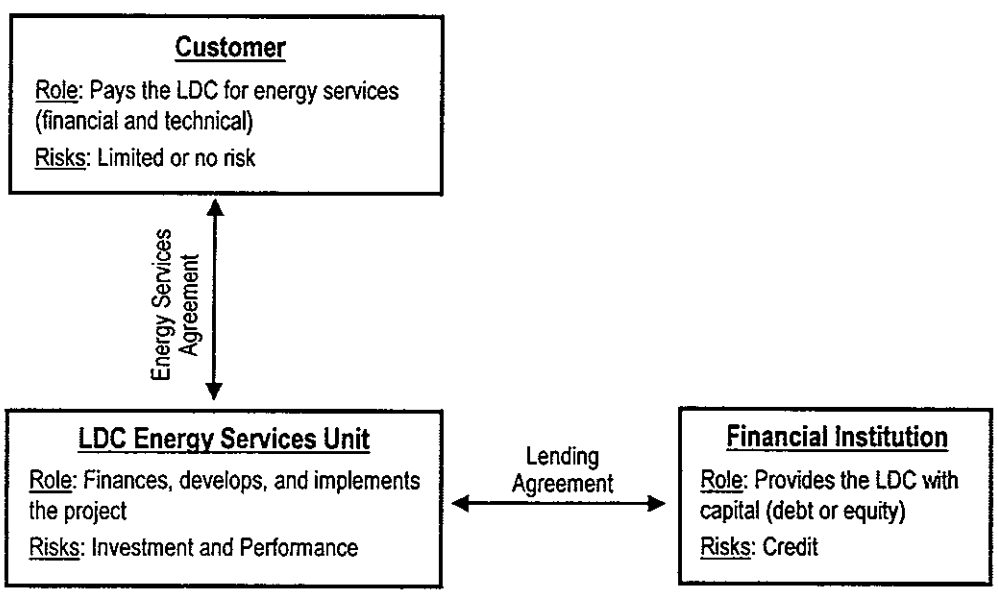

Figure 3-2 Turn-key Services

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The lending terms that an LDC receives under this approach will be based in part on the terms and conditions of the ESA. Lenders will look for an ESA that stipulates the minimum amount of savings that an LDC will receive over the project term. This is an essential element if the LDC is looking to finance the project on a non-recourse basis.

3.3 Customized Energy Services Approach

The performance and turn-key services approach represent two ends of the energy services delivery spectrum. However, to maximize potential business opportunities, an LDC must be prepared to allow customers to select from a menu of different service options. In order to provide customers with a more complete range of energy services, LDCs can utilize a customized approach to developing projects that combines elements from both the performance and turn-key services options (e.g., bundling a package of partial financing with engineering and project development services).

As illustrated below in Figure 3-3, offering customers a range of energy services will help LDCs not only cover a broader segment of the market but also better manage their investment risks (i.e., by sharing the overall investment risk with the customer).

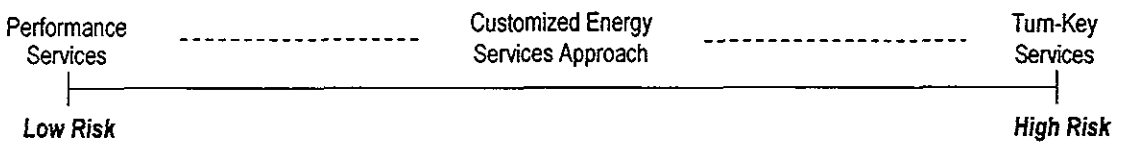

Figure 3-3 Energy Services Delivery Spectrum

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4.1 CASE STUDY OVERVIEW

A key input to the development of a business strategy for an LDC is the detailed assessment of the market for gas-based energy services within its service territory as well as other industrial areas nationwide. Market assessment results can be used as inputs to guide front-end business planning activities, including the evaluation of investment requirements, preparation of cash flow projections, analysis of capital budgeting issues, and forecasting of natural gas sales. Further, a detailed market assessment can provide valuable information on customer acceptance of different methods for delivering energy services.

This section summarizes the specific results of the case study analysis that Nexant conducted for EK Holding in Natgas' 6th of October city service territory.[1] Based on the results of technical and financial analysis that was completed for this case study, EK Holding can anticipate the following outcomes from providing natural-gas based energy services to industrial customers in the 6th of October city:

- Economic Benefits: LE 30 million in net present value (NPV) for EK Holding and LE 16.5 million for customers (from LE 80 million in energy services investments)
- Natural Gas Utilization: 24% increase in natural gas sales in the 6th of October city due to energy services projects (compared to sales under the traditional LDC business)
- Environmental Protection: Annual emission reductions of 104,000 tons of carbon dioxide (CO_2), 5,000 tons of sulfur dioxide (SO_2), and 420 tons of nitrogen oxide (NO_x).

4.2 ENERGY SERVICES INVESTMENT MARKET

The investment market includes the cost of equipment and services that would be required to develop cogeneration, fuel switching, and self-generation projects in the 6th of October city. It is assumed that all investments would be made using either the performance, turn-key, or customized energy services delivery approach.

Projects included in the investment market can be implemented under current market conditions and reflect an assessment of customer acceptance, technical and financial feasibility, and the probability of closing a deal.[2] For an energy services project to be considered financially feasible, it had to have a simple payback period of three years or less and pre-tax internal rate of return (IRR) > 25%.

Adapting the results of this analysis to a timetable for actual capital expenditures will be an essential part of future business planning activities for EK Holding. As noted in Section 5, an

[1] Case study results reflect the energy services market in Natgas' current service territory in the 6th of October city – the 112 company population.

[2] A "potential" market, that includes investments with longer payback periods and assumes an increased level of customer acceptance, was also determined in order to facilitate the development of long-term business planning scenarios. A summary of the potential investment market is included in Appendix F.

LDC will need to develop a pro-forma cash flow statement that illustrates the timing of investments and the resulting impact of the company's operations on its cash position.[1]

The market for investments in energy services is approximately LE 80 million. It is assumed that the investment market contains of a mix of projects that would be financed by EK Holding and its customers. Case study results indicate that EK Holding will need to finance approximately 75% (or LE 60 million) of energy services investments. Financing from EK Holding is required for projects that are outside of the customer's financial resources (e.g., cogeneration projects that have high up-front capital costs). Twenty-five percent of the investments (or LE 20 million) will be financed by the customer using the performance services approach. Customer-financed projects have shorter payback periods and modest capital investments. Figure 4-1 shows that cogeneration (67%) represents the majority of investment opportunities, followed by fuel switching (28%) and self-generation (5%).

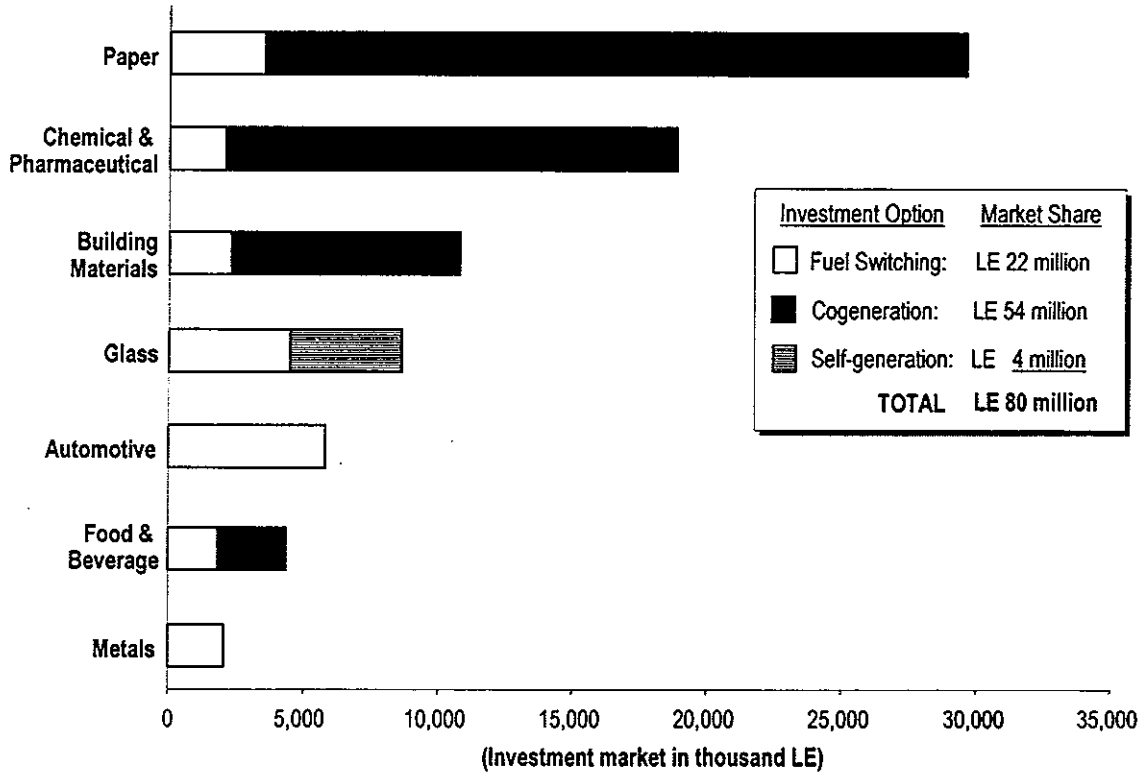

Figure 4-1 Energy Services Investment Market

Approximately 20 megawatts (MW) of cogeneration investment opportunities were identified in this case study. The majority of cogeneration projects are in industrial sectors that have a large demand for electric power and thermal energy on a continuous basis (including the paper, chemical & pharmaceutical, building materials, and food & beverage industry). The large share of energy services investments accounted for by cogeneration reflects both its widespread potential and high capital cost.

[1] This study makes no assumptions regarding the length of time it would take to achieve this level of investment. Achieving this investment level will be based in part on EK Holding's specific business strategy and timetable for starting up an energy services unit.

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Under current market conditions, the majority of attractive fuel switching investments are at facilities which use solar (fuel oil #2). Fuel switching investment opportunities are rather limited at companies that consume mazout (fuel oil #6).[1] A key driver of the viability of fuel switching projects is the price differential between liquid fuel oils and natural gas. Table 4-1 compares the current price of natural gas to alternative fuels (after converting each fuel to a common energy unit: million British Thermal unit - MBtu).

Table 4-1: Natural Gas and Liquid Fuel Oil Prices

Fuel Type	Price (in LE/MBtu)	Natural Gas Price Differential
Natural gas	4.02	0%
Mazout	4.54	13%
LPG	7.03	75%
Solar	10.20	154%

4.3 ECONOMIC BENEFITS FROM INVESTMENTS IN ENERGY SERVICES

Case study results demonstrate that investments in energy services will create considerable economic benefits for both EK Holding and industrial customers. In this study, economic benefits were calculated by taking the NPV of cash flows that would be generated from investments in energy services (i.e. the LE 80 million investment market). NPV is an attractive measure of economic benefits because it eliminates the time dimension from investment decisions and allows for a direct comparison of the present value of cash inflows (annual savings) against cash outflows (upfront investment costs and any ongoing expenses).

4.3.1 Project Development Assumptions

The NPV for EK Holding and the customer is driven by the terms of the energy services agreement. Table 4-2 lists the assumptions used to calculate the cash flow associated with the development of projects using the performance and turn-key services delivery approach.

Table 4-2: Energy Services Delivery Assumptions

Delivery Approach	Key Contractual Elements - Savings Share and Term
Performance Services	• All Energy Services Projects: EK Holding receives 30% of the savings for an initial three-year period
Turn-key Services	• Fuel Switching: EK Holding receives 50% of the savings from a project for a three-year period • Cogeneration and Self-generation: EK Holding receives 80% of the savings for a five-year period

The higher share of savings awarded to EK Holding under the turn-key services approach is commensurate with their increased level of risk (i.e., taking on both performance and

[1] The textile firms that were evaluated in this study are consumers of mazout and therefore have limited potential for fuel switching given the current price differential between natural gas and mazout.

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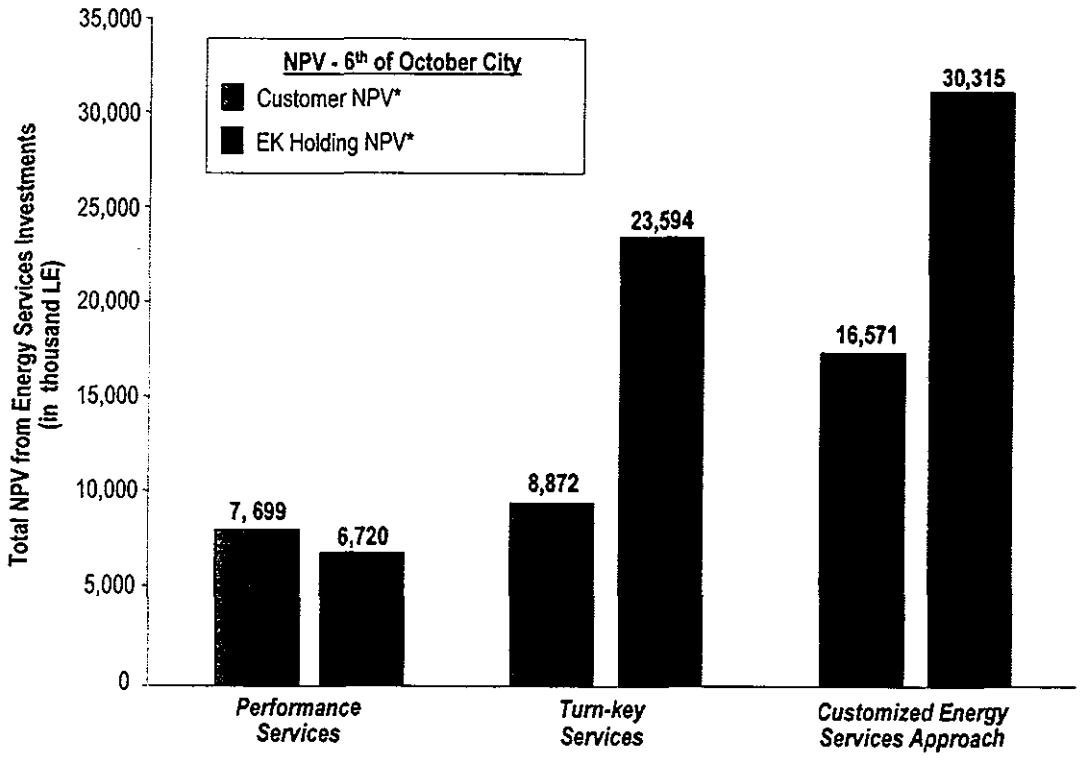
investment risks). It was also assumed that all projects were developed using a capital structure of 80% debt and 20% equity.[1]

4.3.2 Net Present Value from Investments in Energy Services

The case study results demonstrate that to maximize the NPV from investment opportunities, EK Holding needs to offer customers a flexible portfolio of services that draws on elements from both the performance and turn-key services delivery approach. Figure 4-2, shown below, illustrates the NPV that could be generated from investments in energy services under each of the different delivery approaches.



* NPV @ 16% discount rate over a 5 year period.

Figure 4-2 NPV from Investments in Energy Services

The adoption of a customized delivery approach will enable EK Holding to capture a greater share of the market than would otherwise be possible from offering customers a narrower range of energy services. Specifically, by allowing customers to select from a broad-based menu of services, EK Holding can successfully meet the demands of customers that are only interested in receiving and paying for a set of customized energy services.

From a sales and marketing perspective, it is important to note that the NPV listed in Figure 4-2 is calculated over a five-year period.[2] However, the actual life of equipment used in

[1] Loan terms were assumed to range from three to five years with an interest rate of 15%.

[2] A five-year period was selected because it reflects the maximum length of time that EK Holding is assumed to be involved in a project. See project development assumptions in Section 4.3.1.

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energy services projects has an approximate life that can range from 10 to 20 years. Therefore, the customer will accrue significant additional NPV over subsequent years – perhaps 3 to 4 times the level shown above in Figure 4-2.

4.4 INCREASED NATURAL GAS SALES

EK Holding can develop energy services projects that will increase natural gas sales in the 6th of October city by 24%. Increased sales will result from the identification of new markets for natural gas (cogeneration) and the increased implementation of fuel switching projects (i.e., some customers will not switch fuels without receiving energy services). Figure 4-3 illustrates that compared to a "business as usual" scenario, providing energy services will increase natural gas sales by 24% (assuming that all of the LE 80 million in energy services investments in the 6th of October city service territory are made).

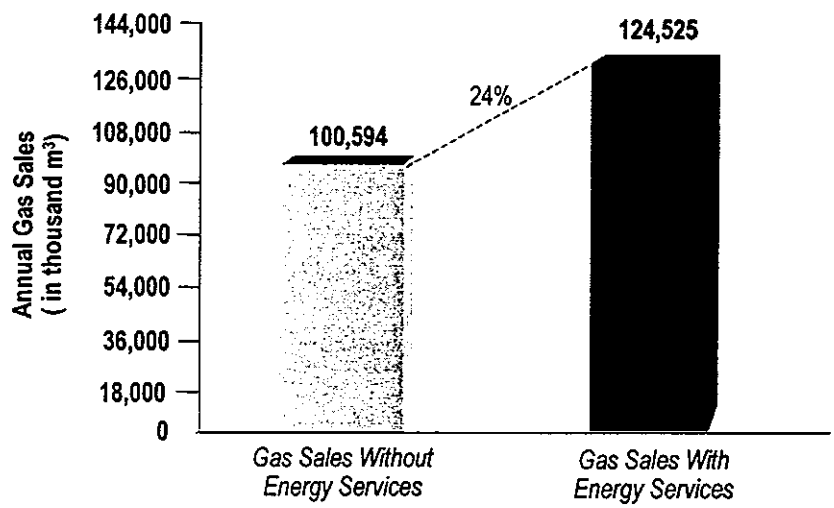

Figure 4-3 Increased Sales of Natural Gas from Energy Services

From a business planning perspective, EK Holding can utilize data on projected natural gas use to assess both the technical and financial impact on its LDC subsidiary from energy services activities. Specifically, EK Holding can determine the increase in Natgas' revenues as well as help its subsidiary plan for any added constraints that result from the increased volume of natural gas that will travel through its network.

4.5 ENVIRONMENTAL BENEFITS

The delivery of natural gas-based energy services will reduce local consumption of fuel oil. In Natgas' 6th of October city service territory, investments in energy services will result in the direct reduction of approximately 7,200 tons of mazout and 29,000 tons of solar. This substitution of fuel oil for natural gas will reduce emissions of greenhouse gases and atmospheric pollutants. Based on the case study results, the environmental benefits from investments in energy services in the 6th of October city include:

- Carbon dioxide (CO_2): 104,000 tons per year
- Sulfur dioxide (SO_2): 5,000 tons per year

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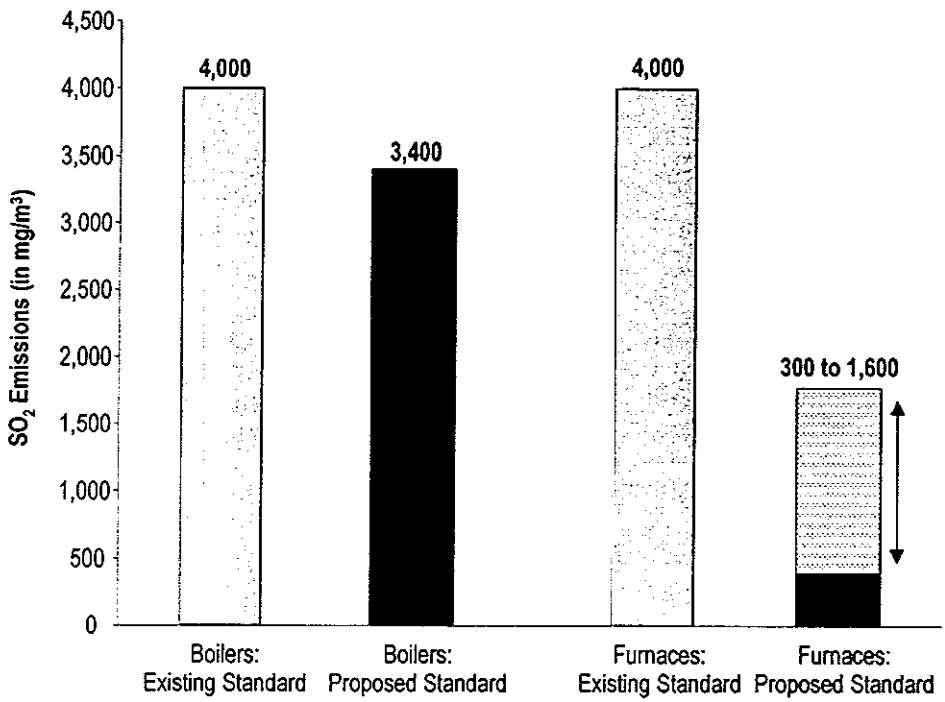
- Nitrogen oxide (NO_x): 420 tons per year

The tightening of environmental regulations for industry will help expand local business opportunities for EK Holding. As illustrated in Figure 4-4, increasingly stringent guidelines governing the emissions of SO_2 will be applied on industrial boilers and furnaces.



Source: Egyptian Environmental Affairs Agency (EEAA)

Figure 4-4 SO_2 Guidelines for Key Energy-Consuming Equipment

Incorporating environmental elements into the sales process can help EK Holding convince industrial customers of the long-term benefits from pursuing investments that allow for local industry to develop in economically and environmentally sustainable manner. From the perspective of an equity investor, EK Holding should evaluate the potential value from developing projects that have the potential to earn emission credits (in particular, CO_2 emission credits). In the future, it is possible that these credits could be traded as part of international emission trading schemes that were envisioned in the Kyoto protocol.

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5.1 BUSINESS STRATEGY OVERVIEW

LDCs are in a unique position to develop energy services projects given their relationships with major industrial energy consumers. However, entering into the energy services business presents LDCs with a new set of strategic issues and planning requirements. To assist LDCs with the potential formation of an energy services unit, Nexant evaluated the following business strategy and planning issues:

- Identification of a potential energy services business structure
- Evaluation of strategic alliances and partnerships
- Preparation of an energy services business plan

This section provides a summary of business planning issues and reviews the development of an organizational structure that could be used by LDCs to create a new energy services unit. For the purpose of this study, the potential formation of a separate energy services unit or company by EK Holding's was used as an example.

5.2 ENERGY SERVICES BUSINESS STRUCTURE

The development of energy services projects provides LDCs with an opportunity to participate in attractive investments opportunities with high rates of return. However, it is essential that energy services activities do not interfere with an LDC's main line of business: the distribution of natural gas. To avoid any potential conflicts with the LDC's obligation to serve, it is recommended that LDCs form a separate business unit to conduct energy services. Figure 5-1, illustrates an example of a structure for an energy services business unit that could be formed by EK Holding (referred to in this example as EK Energy Services).

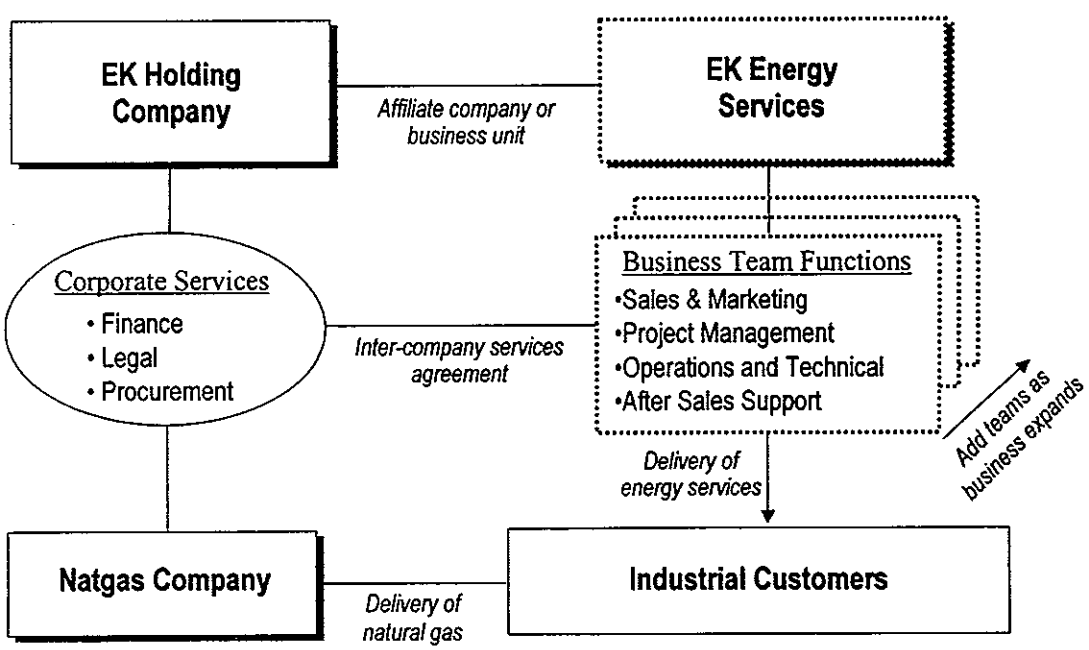

Figure 5-1 Energy Services Business Structure

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5.2.1 Corporate Services

By utilizing some of the existing corporate services at EK Holding, EK Energy Services can reduce some of the up-front costs associated with establishing a new business unit or company. Specifically, EK Holding could provide EK Energy Services with financing, legal, and procurement support. The arrangement between EK Energy Services and its parent company could be formalized through inter-company service agreements. Over time, however, it may become more cost effective for EK Energy Services to internalize some of these corporate functions.

5.2.2 Business Team Functions

Energy services can be delivered to customers through multi-disciplinary business teams that contain all of the key functions required to take a project from inception to completion. The number and size of business teams can be increased as projects are identified. By growing the business in-step with the identification of new projects, the energy services unit of an LDC can avoid the pitfall of adding overhead too quickly before a pipeline of projects is established. The autonomous structure of business teams also allows for them to operate on a separate profit and loss basis. This level of accountability provides team members with direct incentives to deliver projects on-time and within budget. Each energy services team should be led by a project manager and will contain the following business functions:

Sales & Marketing: includes project identification, initial sales, advertising, and marketing activities required to promote energy services to potential customers. Sales and marketing activities are coordinated by a project manager who provides customers with a consistent point of contact.

Project Management: encompasses front-end project development and ongoing management of customer relationships. This includes the development of customized energy solutions and the management of client relationships throughout all project phases.

Operations & Technical Services: includes project design, preparation of cost and saving estimates, equipment procurement, project installation, and project start-up.

After Sales Support: covers on-going services to a customer after the start-up of a project, including: monitoring and verification of project savings, operations and maintenance, and training for customers on the operation and maintenance of energy services equipment.

5.3 STRATEGIC ALLIANCES AND PARTNERSHIPS

LDCs can form a range partnerships and strategic alliances in order to accelerate the initial growth of their energy services business. The formation of alliances and partnerships, particularly in the early stages of a company's development, can be used to both support business development activities and to serve as potential sources for contracting out services. As part business planning efforts, LDCs should evaluate the short- and long-term benefits of entering into alliances with the following organizations:

- Equipment suppliers: agreements with suppliers of equipment that is frequently used in the development of energy services projects (e.g., gas turbines for cogeneration projects). LDCs can utilize alliances to secure discounts through bulk supply purchases as well as arrange for service-related contracts on equipment.
- Energy service companies (ESCOs): alliances that facilitate sales, marketing, and project development efforts. LDCs can develop preferred relationships with a set of ESCOs who can identify a pipeline of projects and also perform project development and implementation services as needed (i.e., contracting out of functions).
- Public sector organizations: partnerships with public sector entities that support both energy services business development activities and ongoing policy initiatives (primarily economic development and environmental protection). This could include partnerships that encourage industrial customers to convert to natural gas in order to increase the efficiency in which Egypt's energy resources are utilized (substituting oil for natural gas).

5.4 BUSINESS PLAN ELEMENTS

An essential step in forming an energy services business unit is the development of a detailed business plan. The preparation of a business plan can not only help refine operational elements for a start-up company but can also serve as a marketing document to sell the business concept to outside investors and/or partners. The following elements should be viewed as an outline of topics that LDCs can use to develop an energy services business plan:

Energy Services Offerings. Define the products and services that will be offered to customers, including: engineering/technical, environmental, feasibility studies, financing, construction, training, and operation and maintenance.

Marketing Strategy. Develop a plan to introduce energy services and products to the local market. This includes designing pricing strategies and targeting energy services markets (i.e. segmenting business opportunities by project type, industrial sector, and geographical region). Test marketing of products and services with selected customers can be used to assess marketing strategy elements (i.e. through the development of pilot projects).

Operating Plan. Establish procedures that outline the activities required to manage and coordinate key energy services business functions (e.g., sales and marketing, project management, engineering and technical services, and after-sales support). This includes defining the specific steps that must be completed in order to ensure the successful development and implementation of projects. The operating plan must also establish a clear definition of the roles and responsibilities for each business function including the sequencing of project development activities.

Financial Plan. Develop a detailed plan that outlines the short- and long-term financial requirements associated with the establishment and operation of an energy services company. This includes the identification of start-up costs, investment needs, and operating expenses. A key driver of the company's financial requirements will be the expected timing and value of projects that it will develop. The company's investment needs will also be a factor of the capital structure that is used to develop projects. The preparation of a pro-forma cash flow

statement can help focus financial planning by illustrating how the company's operations will be affected by its cash position.

LDCs will also need an operating budget that allocates resources between different business functions. The operating budget will help link the future expansion of staff to projected revenues from business operations and will be adjusted at various stages of the company's development.

Going forward, LDCs will need to develop a detailed business plan that addresses key financial, operational, management, and marketing issues associated with the start-up of an energy services company. In this manner, front-end business planning can be used to lay the foundation for establishing a profitable new business that offers high rates of return and provides industrial customers with natural gas-based solutions to meeting their energy needs.

Energy Services Survey – 6th of October City

A detailed survey was developed in order to determine the technical feasibility of a wide range of energy services projects. The survey was divided into the following sections:

- Business operations and energy consumption data
- Equipment data and information (for key energy-consuming equipment)
- Screening questions for energy services projects (e.g., cogeneration, etc.)
- Customer attitude towards energy services delivery approaches.

The survey was administered at the rate of one to two companies per day with each interview lasting approximately four hours. The survey was administered to a range of personnel, including: plant general manager, maintenance manager, production manager, and various technical staff. The interviews were followed by a walk-through of the factory, during which the status of existing equipment, operating practices, and the factory lay out were observed. The visits were arranged in advance by EK Holding.

A example (blank copy) of the survey is shown on the following pages.

COMPANY IDENTIFICATION

NAME _____

ADDRESS _____

_____

_____

Location on 6th Of October City Map: _____

_____

Phone Number: _____

Fax Number: _____

e-mail: _____

CONTACTS:

	1)	2)	3)
Name			
Title			
Ph. #			
Fax #			
e-mail			

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PRODUCTION

PRODUCTS	1) _____				2) _____				3) _____				4) _____			
Annual Production	_____				_____				_____				_____			
Average Daily Production	_____				_____				_____				_____			
Seasonality	winter (%)	spring (%)	summer (%)	fall (%)	winter (%)	spring (%)	summer (%)	fall (%)	winter (%)	spring (%)	summer (%)	fall (%)	winter (%)	spring (%)	summer (%)	fall (%)

OPERATION

Shifts per day _____

Working days per week _____

Working days per year _____

Seasonal variations _____

_____

_____

Summer Vacation Closure? _____

Do you program down time for maintenance? When and for how long?

_____

_____

_____

_____

ENERGY USE

Source	Annual Consumption	Daily Max Consumption	Daily Min Consumption	Price
Mazout				
Solar				
Natural Gas				
LPG				
Electricity				

How many meters for electricity consumption are there ? _____

Are there separate power meters for different sections of the plant? _____

Is "power" metered separately from "light" ? Y ____ N ____

Steam Requirement

average _____ tons/hr @ _____ psi

max _____ tons/hr @ _____ psi

min _____ tons/hr @ _____ psi

ENERGY USE (cont'd)

What percentage of your total production cost is represented by energy cost? _____ %

Does the Plant have an Energy Manager? Y ____ N ____

Does the Plant have an Energy Management System ? Y ____ N ____

If yes, give a brief technical description:

_____

_____

_____

_____

_____

List the main energy consuming equipment and systems, in order of magnitude:

	Equipment/System	Demand (as % of Plant total demand)
1)	_____	_____
2)	_____	_____
3)	_____	_____
4)	_____	_____
5)	_____	_____

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PRODUCTION EQUIPMENT DATA SHEET (major equipment)

Equipment Type: _____

Describe role in the production process: _____

_____

_____

_____

_____

_____

Production Rate (or Rating): Average _____ Max _____ Min _____

Energy source: _____ Consumption Rate: Average _____ Max _____ Min _____

Maker: _____ Age: _____ Number: _____

Type of operation: Continuous _____ Batch _____ Stand-by _____

Other caracteristics:

- Number of Burners _____ Type _____ (N/A _____)
- Production Temperature _____ Centigrades (N/A _____)
- Automatic Combustion Control system Y ____ N ____ (N/A _____)
- Variable speed drive Y ____ N ____ (N/A _____)
- Replacement being considered Y ____ N ____ (N/A _____)

Additional Information: _____

_____

_____

_____

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HVAC SYSTEM

Is HVAC necessary for the production process? Y ____ N ____ (If NO, skip entire page)

If Yes, describe how: _____

Describe areas, sizes and conditioning requirements: _____

Describe the system type (CAV, VAV) _____

Describe time of operation and seasonal dependence _____

Chillers:	Number	Size	Seasonal Operation
	_____	_____ Tons	_____
	_____	_____ Tons	_____
	_____	_____ Tons	_____

Fans:			Pumps:		
Nunber: _____	Size: _____ HP		Nunber: _____	Size: _____ HP	
Nunber: _____	Size: _____ HP		Nunber: _____	Size: _____ HP	
Nunber: _____	Size: _____ HP		Nunber: _____	Size: _____ HP	

LIGHTING SYSTEM

Does the production process require special lighting? Y ____ N ____

If Yes, describe:

Lamps Type	Number	Watts per Lamp

Ballast Type	Number	Tubes per Ballast

Comments:

Descrbe Fixtures and their age and maintenance status status:

FUEL SWITCHING POTENTIAL

What improvement, if any, would switching to a cleaner fuel generate in terms of production?

_____

_____

_____

_____

What, if any, potential problems does the Plant's Management perceive in switching to NG ?

_____

_____

_____

_____

_____

_____

COGENERATION POTENTIAL

What percent of steam demand does the Plant generate internally? ____ %

What price does the Plant pay for "outside" steam? _____ LE/ton (N/A ___)

What percent of electricity demand does the Plant generate internally? ____ %

WASTE HEAT RECOVERY POTENTIAL

Is there a source of waste heat in the Plant? Y ____ N ____

Describe and quantify: _____

Is waste heat being recovered presently ? Y ____ N ____

Is condensate being recirculated? Y ____ N ____

Would there be use for (additional) recovered waste heat? Y ____ N ____

Describe and quantify: _____

POWER FACTOR CORRECTION POTENTIAL

What is the overall PF of the Plant? _____

Does the Plant pay a PF penalty?

Is there a PF corretion system in the Plant?

ENERGY EFFICIENT ELECTRIC MOTORS AND VARIABLE SPEED DRIVES POTENTIAL

(consider only motors >10HP)

What is the Company's Policy for replacing electrical motors?

Does the production process require variations in motor speed ?

Does the Pant use Variable Speed Drives ? How many ? On which motors?

ENERGY EFFICIENCY BUSINESS SERVICE ISSUES

- Do you believe that the monetary savings resulting from installing energy efficient equipment justify the cost of investment? Y ____ N ____

  If No, why? _____

  If Yes, what energy efficiency investments has the company completed or considered? _____

- Would environmental compliance be a major driver for your Company to invest in an energy efficiency project?

- Please indicate what you perceive as the major obstacles to implementing energy efficiency measures (operational, technical, financial, etc.)

- How is your company most likely to finance an investment in energy efficiency?

ENERGY EFFICIENCY BUSINESS SERVICE ISSUES (cont'd)

- Would your company consider purchasing electricity and/or steam from a private supplier of energy services?

- Would your company be more likely to invest in an energy efficiency project if a private energy services company provided you with a performance guarantee?

- Would your company be more likely to invest in a project if an energy services company provided you with a performance guarantee and financing?

Methodology for Assessing the Technical Feasibility of Energy Services Projects

The company interviews and walk-through visits allowed for a preliminary assessment of the technical feasibility of a wide range of energy services projects. A set of criteria for selecting feasible projects was developed based on engineering and technical analysis. For each company, the following items were evaluated:

- Assessment of technical requirements associated with replacing liquid fuels with gas (requirements for new equipment and/or adjustments to existing equipment)
- Analysis of the monetary savings from converting from fuel oil to natural gas
- Feasibility of implementing an energy services project at a given facility (i.e. an assessment of the operational feasibility of installing new equipment – potential impact on a company's production process, etc.)
- Assessment of the avoided electricity consumption from the national grid that would result from the implementation of cogeneration and self-generation (determination of technical requirements)
- Analysis of the simple payback period for all potential energy services investments

The survey covered a wide range of energy services (both natural gas and electricity-based measures). However, based on the initial analysis of the survey results, it became clear that the largest market potential was in the following areas: fuel switching, cogeneration, and self-generation. The remainder of this appendix provides a summary of the procedures used to estimate the savings and costs associated with the development of energy services projects.

Fuel Switch - Savings and Cost Analysis Methodology

Savings

Savings from fuel switching investments are based on the cost differential between natural gas and liquid fuels (solar, mazout, and LPG). As discussed in Section 4.2, the cost of alternative fuels, expressed in LE/MBtu, vary considerably. For the purposes of this analysis, savings and costs for fuel switching projects are calculated as follows:

- Step 1: Determine the thermal energy required for production (i.e., based on original fuel consumption and fuel cost – prior to fuel switching)
- Step 2: Calculate the amount of natural gas needed to generate the thermal energy calculated in Step 1
- Step 3: Obtain the cost savings from fuel switching (the difference between the cost of the original fuel and the cost of natural gas after fuel switching)

Costs

The costs incurred for switching fuel include the following elements:

- Pressure reducing stations are used to lower natural gas pressure once it is delivered to a company from an LDC (typically gas is delivered to a company at a pressure of 7 bar). The pressure reducing station lowers the gas pressure within the factory in order to meet the requirements of energy-consuming equipment (to a level as low as 200 millibars). The cost of the station varies with a company's natural gas capacity requirements.
- Piping and valves that bring natural gas from the pressure reducing station to the point(s) of use within the factory. The cost of piping and valves is also proportional to the capacity of the system.
- Burners for equipment that need to be modified in order to switch fuels (i.e., gas cannot be burned effectively using burners that were originally designed for liquid fuel). The cost of burners is a function of their size (i.e., the rate at which they release thermal energy by combusting fuel).

Cogeneration - Savings and Cost Analysis Methodology

For the purposes of this analysis, it was assumed that a cogeneration plant would be installed in order to meet the entire electricity demand for an industrial facility as well as a portion (or all) of the facility's thermal energy demand (by utilizing waste heat). If it is not feasible for a company to utilize the waste heat (or if the company has no thermal demand), then a gas turbine would simply be used to generate electricity (self-generation project).

Savings

By generating electricity on-site (using a cogeneration plant), the company will avoid the monthly payments to the Egyptian Electricity Holding Company (EEHC). EEHC charges its industrial customers on the basis of the electric energy (kWh) used, and the actual demand (kW). The price structure is as follows:

- Energy Charge: 0.1535 LE/kWh
- Demand Charge: 7.30 LE/kW per month

In this analysis, it was assumed that a company installing a cogeneration unit will (a) self-generate all the electrical energy needed (covering peak demand period), and (b) disconnect from the national grid (and therefore will no longer be subject to a demand charge).

The waste heat released by a cogeneration unit can be captured and used to meet the thermal energy requirements of a company's production process. This increases the efficiency of energy utilization and can result in significant fuel savings. The conversion of thermal energy into electrical energy is achieved with an efficiency of approximately 30%. This means that 70% of the thermal energy released by the combustion inside the gas engine generator is then released into the atmosphere as waste heat. Practical engineering considerations limit the amount of waste heat that can be captured: for this analysis, we assumed the capture of 50%.

Costs

The costs associated with the implementation of a cogeneration unit include the following components (system requirements can vary depending on the specific application):

- Gas engine-generator or turbine
- Waste heat boiler
- Boost burners
- Flue gas duct
- Pressure reducing station (for the natural gas)
- Piping & valves to distribute the natural gas

The operation of a cogeneration unit will include the following elements:

- Natural gas for the gas engine(s) or turbine(s)
- Labor to operate & maintain the unit (estimated at 20% of annual fuel cost)

Technical Analysis: Example Calculations

This section contains a series of examples that illustrate the methodology used to calculate the costs and savings generated from fuel switching and cogeneration projects. The data and information contained in this section is representative of investment options at industrial companies located in the 6th of October city. Equipment and fuel cost data are based on discussions with local stakeholders (including industrial end-users and equipment suppliers).

The calculations are based on an example factory that is assumed to be operating on the following schedule: two shifts per day (8 hours for each shift), 25 days per month, 12 months per year. It is also assumed that the factory requires 10 tons/hour of steam at 10 Bar. It is assumed that the factory is producing steam with a boiler fired with solar fuel (fuel oil # 2), and operates with an efficiency of 85%. The factory's monthly electricity bill is assumed to be LE 75,000. It is also assumed that the factory's demand both for electric and thermal energy fluctuates within narrow margins throughout the year.

Fuel Switching Example

Savings

As a first step, we calculate how much solar fuel the factory consumes. From steam tables, we know that the production of 1 ton of steam at 10 Bar requires 2.625 MBtu. Taking into consideration boiler efficiency, the thermal power needed to produce 10 tons/h is:

(2.625 x 10) : 0.85 = 31 MBTU/h

which corresponds to:

31 MBTU/h : 46.1 MBTU/ton = 0.67 ton/h of solar fuel

equivalent to: 0.67 x (2 x 8 x 25 x 12) = 3,228 ton/y

at a cost of: 3,228 ton/y x 463 LE/ton = 1,494,500 LE/y

Switching from diesel to natural gas, the cost of fuel would be reduced as follows:

31 MBTU/h : 43.9 MBTU/ton = 0.71 ton/h = 795 m^3/h of NG

equivalent to: 795 m^3/h x (2 x 8 x 25 x 12) = 3,816,170 m^3/y

at a cost of: 3,816,170 m^3/y x 0.14 LE/m^3 = 534,265 LE/y

The saving obtainable by switching to natural gas is then:

1,494,500 - 534,265 = 960,236 LE/y

Costs

As seen above, the factory has a demand of 795 m^3/h. Assuming they install a system with a capacity of 1,000 m^3/h, then the corresponding equipment cost can be estimated as follows:

- Pressure reducing station: 300 x 1,000 = 300,000 LE
- Piping and valves: 80 x 1,000 = 80,000 LE
- Three medium burners: 3 x 33,000 = 99,000 LE
- Installation @ 10% of equipment cost: 50,000 LE
- Contingency @10% of equipment cost: 50,000 LE

TOTAL 579,000 LE

Note: The cost of installation and the amount of contingency included in the cost estimate, (both expressed as a percent of the equipment cost) are based on engineering assumptions. These costs can vary from project to project. In this example, a flat 10% is assumed for both.

Cogeneration

Savings

The annual cost for electric energy for the example factory is assumed to equal:

75,000 x 12 = 900,000 LE

This cost will be avoided by installing a cogeneration unit. The average electricity demand for the factory can be calculated as follows:

{[(kW x 2 x 8 x 25) x 0.1535] + (kW x 7.30)} = 75,000 LE

Where kW is the unknown; solving the equation, we find that the average demand is 1,092 kW, and the energy consumption is:

(1,092 x 2 x 8 x 25) = 437,000 kWh/month (equivalent to 5,241,600 kWh/year)
To produce this amount of electric energy with the gas engine (considering the efficiency of the gas engine), we need to use:

[(5,241,600 kWh/year x 3,413 Btu/kWh) x 10^{-6}] : 0.3 = 59,633 MBTU/year

70% of this value is released to the atmosphere as waste heat. Assuming that 50% of this value is recovered and used to produce steam in a waste heat boiler (with an efficiency of 85%), then the amount of steam produced would equal:

{[(59,633 x 0.7 x 0.5) MBTU/year] x 0.85} : (2.625 MBTU/ton) = 6,758 ton/year of steam

equivalent to:

6,758 ton/y : (2 x 8 x 25 x 12) = 1.41 ton/h of steam

This equals approximately 14% of the total demand. Therefore, the corresponding savings in diesel fuel would equal:

(3,228 ton/y x 0.14) x 463 LE/ton = 209,000 LE/y

Based on the calculations shown above, the total savings achievable from the installation of a cogeneration unit is:

900,000 + 209,000 = 1,109,000 LE/year

An alternate approach worth considering is the production of all the required steam using the waste heat boiler (which is equipped with additional booster burners). By following this approach, the system configuration would allow for both fuel switching and cogeneration. The diesel-fired boiler would no longer be needed and the factory would save the entire diesel fuel consumption. The additional savings (the savings in excess of simple waste heat recovery), would be:

1,494,500 LE/y x (1- 0.14) = 1,285,270 LE/y

It is important to note that this additional saving would be reduced by the cost of the additional natural gas needed for the booster burners (see below).

Cost of the Cogeneration System

In this example, it is assumed that the factory decides to install a cogeneration system that has a substantial capacity margin over the average demand of 1,092 kW. To meet this requirement, it is assumed that the factory installs two gas engine generator sets, respectively of 1,250 kW and 525 kW capacities. Therefore, the total installed capacity is 1,775 kW (which provides a 63% margin over average demand).

The cost for the gas engine generator set includes the following items:

• 525 kW gas engine	1,049,220 LE
• 1,250 kW gas engine	2,035,800 LE
• Switch gear	included in engine cost
• Controls	included in engine cost
• Installation	included in engine cost
• Contingency (@ 5%)	150,000 LE
TOTAL	3,085,020 LE

As shown above, the waste heat recuperation would allow the production of 1.5 ton/h of steam. A waste heat boiler of that size would cost approximately:

130,000 LE/ton x 1,5 = 195,000 LE.

Alternatively, we could install a waste heat boiler with booster burners, and produce the entire demand of 10 ton/h. In this case the cost would be:

• Boiler (84,000 x 10) =	840,000 LE
• One booster burner	65,000 LE
TOTAL	905,000 LE

Cost of the Natural Gas System

In the event that factory does not yet have a natural gas system in place, it would incur the following costs:

The natural gas system (for cogeneration) must have the capacity of delivering 1,529,000 m3/y (see calculation below in the operating cost section). This corresponds to 319 m3/h. Assuming the factory installs a system with a 500 m3/h capacity, the cost would be:

• Pressure Reducing Station: 200 x 500 =	100,000 LE
• Piping & Valves: 80 x 500 =	40,000 LE
• Installation	14,000 LE
• Contingency	14,000 LE
TOTAL	168,000 LE

The natural gas system required to satisfy cogeneration and booster burners for production of total steam demand the system must have the capacity to deliver:

(1,529,000 + 3,269,000)m3/y (see calculation below in the operating cost section)

This corresponds to 1000 m3/h. Assuming a system with a 1,500 m3/h capacity is installed, the cost would equal:

- Pressure Reducing Station: 300 x 1,500 = 450,000 LE
- Piping & Valves: 80 x 1,500 = 120,000 LE
- Installation 57,000 LE
- Contingency 57,000 LE

TOTAL 684,000 LE

Operating Costs (for simple cogeneration)

As shown above, the production of 5,241,600 kWh per year requires 59,633 MBTU/y. This corresponds to:

59,633 MBTU/y : 0.039 MBTU/m^3 = 1,529,000 m^3/y of NG

the associated cost would be:

1,529,000 m3/y x 0.14 LE/m3 = 214,000 LE/y

Natural gas for cogeneration and additional steam production:

The production of the additional 8.6 ton/h of steam, that cannot be produced by waste heat, will require an additional:

{[8.6 ton/h x (2 x 8 x 25 x 12)] x (2.625 MBTU/ton)} : 0.85 =
= 127,500 MBTU/y

which corresponds to:

127,500 MBTU/y : 0.039 MBTU/m^3 = 3,269,000 m^3/y of NG

and the additional cost would be:

(3,269,000 m^3/y x 0.14 LE/m^3) = 458,000 LE/y

Therefore, the cost for cogeneration and additional steam production would be:

214,000 LE/y + 458,000 LE/y = 672,000 LE/y

Labor and maintenance costs are assumed to equal 20% of the fuel cost for simple cogeneration and 10% of the fuel cost for steam production (see below).

Simple cogeneration: 214,000 x 0.2 = 42,800 LE/y

Cogeneration and additional steam production:

(214,000 x 0.2) + (458,000 x 0.1) = 88,600 LE/y

Note: in this analysis, we have assumed that labor & maintenance for the cogeneration system is approximately 20% of the fuel cost. For the natural gas system, it was assumed to equal approximately 10% of the fuel cost.

Summary of Investments Under Various Cogeneration Scenarios

As noted above, cogeneration projects can involve several different configurations:

Simple cogeneration (when natural gas is already available)

- Savings 1,109,000 LE/y
- Operating Cost (Natural gas and labor) 256,800 LE/y
- Capital Investment 3,280,020 LE

Simple cogeneration (when natural gas system must be installed)

- Savings 1,109,000 LE/y
- Operating Cost (Natural gas and labor) 256,800 LE/y
- Capital Investment 3,448,020 LE

Cogeneration and additional steam production (when natural gas is already available)

- Savings 2,394,270 LE/y
- Operating Cost (Natural gas and labor) 760,600 LE/y
- Capital Investment 3,990,020 LE

Cogeneration and additional steam production (when natural gas system must be installed)

- Savings 2,394,270 LE/y
- Operating Cost (Natural gas and labor) 760,600 LE/y
- Capital Investment 4,674,020 LE

Appendix C Equipment and Fuel Costs

A series of interviews were conducted with local equipment suppliers in order to develop cost estimates for cogeneration, fuel switching, and self-generation projects. Additional data was collected on local fuel cost and characteristics. The following pages summarize information and data that was collected as part of this analysis.

TABLE C-1: FUEL COSTS AND CHARACTERISTICS

FUEL	LE/Liter	LE/m^3	LE/Ton	LE/MBTU		Density (Kg/m^3)	Kjoules/Kg	MBTU/Kg	MBTU/m3	m3/MBTU
SOLAR	0.400		463.000	10.240		864.0000	43,700.00	0.0461		
MAZOUT	0.175		185.000	4.540		943.5000	44,700.00	0.0472		
LPG	0.001	0.690	320.000	7.030		2.1690	48,000.00	0.0506		
NG		0.141	158.750	4.020		0.8882	37,000.00	0.0439	0.0390	25.6180

TABLE C-2: EQUIPMENT COSTS IN EGYPT

EQUIPMENT	SIZE	ESTIMATED COST (in LE)
Diesel Generator Sets (Egyptian made - fuel:NG) (including switchgears, instrum, installat.)	15 kW 50 kW 300 kW 500 kW 1000 kW	33,000 77,000 270,000 450,000 930,000
Diesel Generator Sets (USA made - fuel:NG) (including switchgears, instrum, installat.)	300 kW 500 kW 1000 kW	330,000 670,000 1,230,000
Switch Gears	500 kW 1000 kW	130,000 250,000
Gas Turbine Generator Sets (including switchgears, instrum, installat.)	548 kW 1050 kW < 5,000 kW > 10,000 kW	3,400 LE/kW 5,400 LE/kW 3,400 LE/kW 1,270 LE/kW
Waste Heat Boilers	capacity < 5 ton/h 5t/h< capacity <30 t/h capacity > 30 ton/h	130,000 LE/ton 84,000 LE/ton 45,000 LE/ton
Steam Condensers	low capacity high capacity	11,000 LE/ton 7,500 LE/ton
Steam Separators	low capacity high capacity	4,000 LE/ton 3,000 LE/ton
Heat Exchangers	Gas-to-gas, <25°C, 18,000 Btu/h Gas-to-gas, < 200°C, 200,000 Btu/h Gas-to-gas, >1200°C, 2,500,000 Btu/h Liquid-to-liquid,<120oC, 750,000 Btu/h	1,300 52,000 500,000 19,500
Natural Gas Burners	2.5 MBTU/h 11.5 MBTU/h 26.5 MBTU/h	10,000 33,000 65,000
Dual Fuel Burners	2.5 MBTU/h 11.5 MBTU/h 26.5 MBTU/h	13,500 44,550 87,750
NG Pressure Reduction Stations	Capacity < 800 m^3/h Capacity > 800 m^3/h	200 LE/m^3 300 LE/m^3
Piping and Valves for NG Systems		80 LE/m3

TABLE C-3: GAS ENGINE GENERATOR COSTS

WAUKESHA Gas-Engine Generator Sets (1000 RPM)

SIZE (kW)	Price (LE) (3.48 LE = 1 $)	Competitive Price Reduction	Gas Conversion Kit (25%)	Switchgear (12%)	Controls & Instrum. (14%)	Custom Duty (30%)	Sales Tax (10%)	Installation (10%)	TOTAL COST OF THE SET (LE)	Unit Cost (LE/kW)
525	1,165,800	(116,580)	0	0	0	0	0	0	1,049,220	1,999
900	1,653,000	(165,300)	0	0	0	0	0	0	1,487,700	1,653
1,250	2,262,000	(226,200)	0	0	0	0	0	0	2,035,800	1,629

CATERPILLAR Gas-Engine Generator Sets (1500 RPM)

SIZE (kW)	Price (LE) (3.48 LE = 1 $)	Competitive Price Reduction	Gas Conversion Kit (25%)	Switchgear (12%)	Controls & Instrum. (14%)	Custom Duty (30%)	Sales Tax (10%)	Installation (10%)	TOTAL COST OF THE SET (LE)	Unit Cost (LE/kW)
500	852,600	(85,260)	0	0	0	255,780	85,260	85,260	1,193,640	2,387
1000	1,600,800	(160,080)	0	0	0	480,240	160,080	160,080	2,241,120	2,241

VOLVO Diesel-Engine Generator Sets (Egyptian made - 1500 RPM)

SIZE (kW)	Price (LE) (3.48 LE = 1 $)	Competitive Price Reduction	Gas Conversion Kit (25%)	Switchgear (12%)	Controls & Instrum. (14%)	Custom Duty (30%)	Sales Tax (10%)	Installation (10%)	TOTAL COST OF THE SET (LE)	Unit Cost (LE/kW)
300	158,790	0	39,698	19,055	22,231	0	23,977	23,977	287,727	959
500	260,300	0	65,075	31,236	36,442	0	39,305	39,305	471,664	943
1,000	545,250	0	136,313	65,430	76,335	0	82,333	82,333	987,993	988

In the outsourcing model, the LDC's energy services business unit extends its involvement in projects by taking-on an ownership role of the customer's energy-assets. Specifically, the LDC acquires (owns), operates, and maintains the customer's energy operations in order to achieve a designated level of savings. At the end of the project term, ownership of the energy assets are often transferred back to the industrial customer. In this manner, the outsourcing approach is similar to the build-operate-transfer (BOT) concept that has been used to develop private power plants in Sidi Krier and Port Suez.

Under this model, the LDC has increased autonomy to make targeted capital investments that improve the overall efficiency of an industrial end-user's energy consumption. By outsourcing its energy operations, the customer is able to focus their resources on their core business areas. The customer also receives a performance guarantee from the LDC that ensures that they will continue to receive a reliable supply of energy.

The LDC is compensated for its services through a series of payments that the customer makes to buy-back the output of their energy-assets (e.g., electricity and steam) The payment terms are structured so that the customer receives a discount over their current energy cost and that the LDC earns an acceptable rate of return on their investment. The long-term purchase agreement in the ESA provides lenders with a guarantee that the LDC will generate a stable cash flow over the life of the project. The roles and risks of the LDC, customer, and financial institution are illustrated below in Figure D-1.

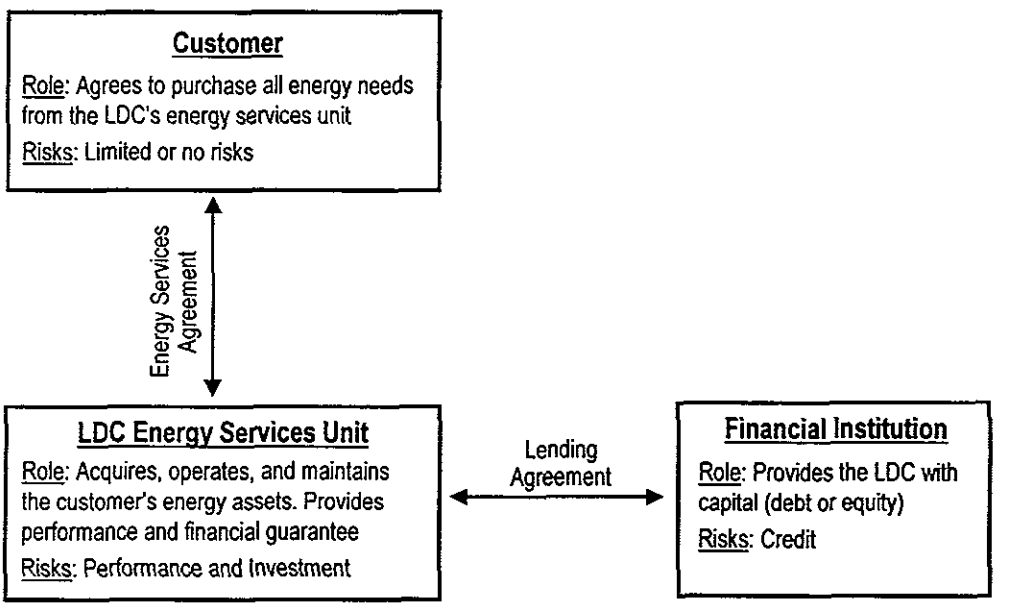
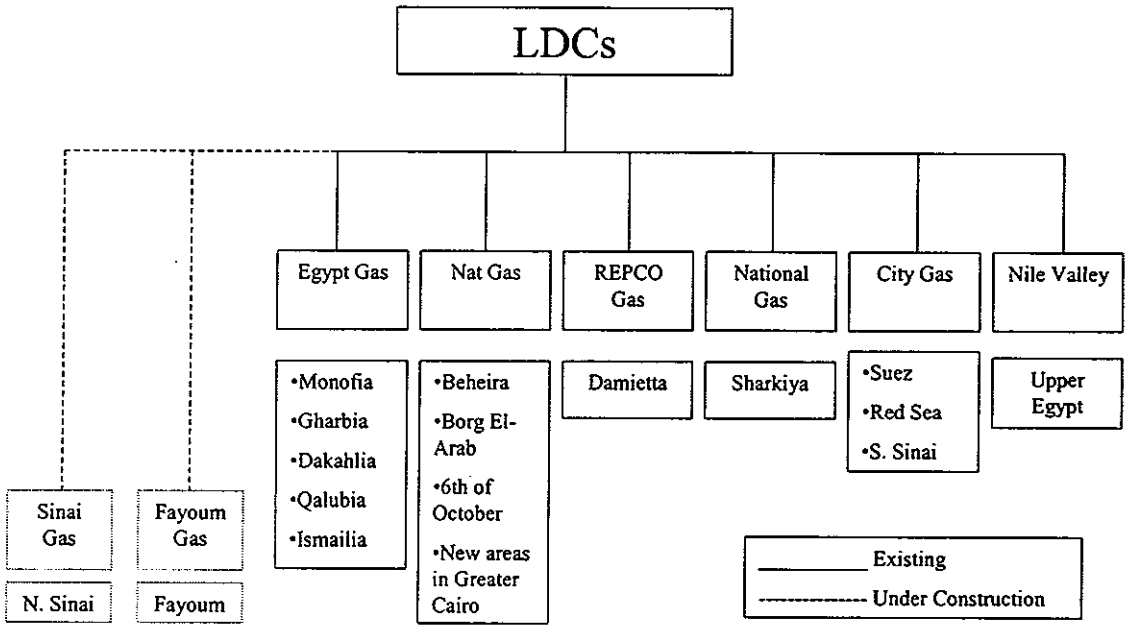


Figure D-1 Outsourcing of Energy Assets

Similar to the turn-key services delivery approach, the maximum potential loss for the LDC in the outsourcing approach is equal to their total investment in the customer's facility. Under the outsourcing model, however, the LDC is also taking-on an ownership role that carries an added element of risk associated with the operation of the customer's energy assets. This added level of risk entitles the LDC to earn a higher percentage of the project's savings.

The figure shown below outlines the existing and future LDCs that will be responsible for transporting and distributing natural gas in Egypt.



Source: American Chamber of Commerce. *The Egyptian Petroleum Industry*. August 2000.

Figure E-1 Private Sector Natural Gas LDCs

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As part of this study, a "potential" market for energy services was also determined in order to facilitate the development of long-term business planning scenarios (i.e. preparation of long-term cash flow projections and investment requirements). Similar to the investment market detailed in Section 4, the potential market includes the cost of equipment and services required to develop energy services projects in the 6th of October city. However, the "potential" market has less conservative assumptions regarding customer acceptance and the probability of closing a deal.[1] Further, projects included in the potential market were screened using a less restrictive financial criteria: acceptable investments have a payback period of 5 years or less and a pre-tax IRR > 15%. Table F-1, shown below, provides a breakout of the potential market results by industry sector.

Table F-1: Potential Investment Market Results

Industry Sector	Total Investment (in LE)
Automotive	6,435,795
Building Materials	13,621,521
Chemical and Pharmaceutical	26,979,774
Food & Beverage	5,570,536
Glass	11,761,070
Metals	2,571,168
Paper	42,755,235
Textiles	508,865
TOTAL	**110,203,964**

Additional financial and technical analysis results of the potential market include:

- Economic Benefits: LE 40.5 million in net present value (NPV) for EK Holding and LE 21.5 million for customers (from LE 110 million in energy services investments)[2]
- Natural Gas Utilization: 60% increase in natural gas sales in the 6th of October city due to energy services projects (compared to sales under the traditional LDC business)
- Environmental Protection: Annual emission reductions of 142,150 tons of carbon dioxide (CO_2), 7,000 tons of sulfur dioxide (SO_2), and 570 tons of nitrogen oxide (NO_x).

[1] Given that the energy services concept is relatively new in Egypt, some of the investments included in the "potential" market represent long-term investment opportunities. For the purpose of this case study analysis, an emphasis was placed on determining an achievable market (detailed in Section 4) that only includes projects that represent near-term investment opportunities.

[2] The analysis of the "potential" market was conducted using the same economic and project development assumptions listed in Section 4.3.1.