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Connecting Residential Households to Natural Gas: An Economic & Financial Analysis

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Egypt is a country rich in natural gas. But because of the high subsidies on LPG and the relatively high connection charges for natural gas, most urban and semiurban households continue to use liquefied petroleum gas (LPG) for cooking and for heating water. That's a big problem for the government, which provides substantial subsidies for LPG. This paper shows that converting households, including low-income ones, to natural gas can be economically viable: the savings from avoiding subsidies on LPG can finance most of the costs of switching the residential load from LPG to natural gas. The remaining share can be borne by households through their savings from switching.

The system for connecting users to the gas network involves an output-based aid approach. The costs of connections are recovered through contributions by users and through a subsidy provided by the government and channeled through the gas distribution companies. The gas distributors prefinance the costs of connections through debt or equity. Once connections are verified, the distributors are allowed to recover these costs through rates over a four-year period

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Arab Republic of Egypt

Connecting Residential Households to Natural Gas: An Economic & Financial Analysis

FINAL REPORT

April 2006

GPOBA

The Global Partnership on Output-Based Aid

The World Bank

CURRENCY AND EQUIVALENT UNITS

Currency Equivalent

Currency Unit = Egyptian Pound (LE or EGP)
Exchange Rate = Egyptian Pounds (LE) 5.8 per US$ 1.00 (as per January 1, 2006)
$ = US Dollar (USD)

Natural Gas Equivalent

1 kg of LPG equals 1.31 m^3 of natural gas
1 mmBtu of natural gas equals 27.8 m^3 of natural gas

ABBREVIATIONS AND ACRONYMS

bbl	Barrel
Bcm	Billion Cubic Meters
CAPEX	Capital Expenditures
EGAS	Egyptian Natural Gas Holding Company, owned by GoE
EGPC	Egyptian General Petroleum Company, owned by GoE
ELNG	Egyptian LNG, sponsored by British Gas, Petronas, EGAS, and EGPC
GASCO	Egyptian Natural Gas Company, owned by GoE
GoE	Government of the Arab Republic of Egypt
GPOBA	Global Partnership on Output-Based Aid
IEOC	International Egyptian Oil Company, a subsidiary of Eni S.p.A
IRR	Internal Rate of Return
JVP	Joint Venture Partner
LDC	Local Distribution Company
LE	Egyptian Pound (EGP)
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas, a mixture of propane and butane
mmBtu	Million British Thermal Units
MoF	Ministry of Finance
MoP	Ministry of Petroleum
OPEX	Operating Expenses
Petronas	Malaysian National Oil Company
PSA	Production Sharing Agreement
SEGAS	Spanish Egyptian Gas Company, sponsored by Eni, Union Fenosa, EGAS, and EGPC
ton	Metric Ton
WTP	Willingness to Pay

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ACKNOWLEDGEMENTS

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1. EXECUTIVE SUMMARY

Egypt is a gas-rich country and in 2004 had the 15th largest proven gas reserves in the world. Domestic gas consumption was dominated by the power sector (65%), followed by the fertilizer (9%), petrochemicals (9%), other industrial sectors (9%), and the commercial and residential sectors (8%). Egypt started to export piped gas to Jordan on the Arab Gas Pipeline in 2003 and in 2005 liquefied natural gas (LNG) exports through the SEGAS LNG and ELNG terminals commenced. In 2006, Egypt became the world's sixth-largest LNG exporter with output of 17.5 billion cubic meters (Bcm) per year.

The natural gas market has changed considerably in Egypt – the country has evolved as a major international gas exporter. Industrial customers in the domestic market are increasingly relying on natural gas to meet their energy needs. Natural gas is already used as a major source of energy and feedstock in the power, fertilizer, and petrochemicals sectors. The country now has a well-developed high-pressure transmission network in Nile Delta to supply industrial load.

The Government of Egypt (GoE) aims to connect 6 million residential customers over the next 6 years in the Nile Delta and Upper Egypt at total investment costs of about LE 15 billion (US$ 2.6 billion). There are currently millions of residential customers living near existing transmission infrastructure in urban and semi-urban areas such as Cairo, Suez, and Alexandria that use relatively more expensive liquefied petroleum gas (LPG) for cooking and water heating. To connect urban residential load in Upper Egypt major new transmission pipeline development will be required. EGAS/EGPC continues to make losses for every cubic meter of gas or kilogram of LPG sold into the domestic market under current subsidized prices and this poses a major challenge to the company which faces large financing requirements to convert the residential sector to natural gas throughout Egypt.

This paper aims to analyze the overall macro- and micro-economic costs and benefits of switching residential households to natural gas, to quantify the willingness to pay (WTP) of the GoE and households towards the financing of gas connections based on their potential savings, and investigate alternative financing options to increase natural gas connections. This study does not analyze whether other conversion programs (*e.g.*, industrial or commercial load) or other fuels would have higher net benefits to the GoE.

Key Economic and Financial Assumptions

A key assumption is that, in the short- to medium-term, the GoE is unlikely to reach 'economic' pricing for natural gas and LPG, mostly due to social considerations. With the assistance of the World Bank, the GoE has embarked on an ambitious program of economic and social transformation, including wide-ranging reforms in the areas of social safety nets and subsidies.[1] In particular, the LPG subsidy is socially sensitive as it is a

[1] A recently published report by the World Bank on "Egypt: Toward a More Effective Social Policy: Subsidies and Social Safety Net" from December 2005 highlights that energy subsidies are substantial with economic costs of 8.1 percent of GDP in 2004.

'fuel of the poor' and any phasing out should only be done after an expanded social safety net has been put in place. Also, some price increases are planned at the residential level; the timing and scope of those adjustments remain uncertain.

For the purpose of this paper, it was assumed that LPG and natural gas prices will continue to be subsidized in the short- to medium-term, which will require the contribution of the GoE towards the financing of gas connections from its savings on avoided LPG subsidies. However, the analysis also demonstrates that if 'economic' prices are charged for LPG and natural gas, middle- and higher volume households would be willing to pay for all gas connection costs due to the relatively high prices of LPG.

In this context, the authors have not analyzed in detail the LPG consumption levels of various household income groups (poor, low-income, middle-income, and high-income households); the low-, middle-, and higher-volumes used for the analysis are indicative only.

In addition, this paper focuses on the direct 'savings' benefits to the GoE and households when converting to natural gas. Due to the lack of available data, this paper does not aim to quantify indirect benefits to households, including health, environmental, social benefits, which if calculated would further strengthen the overall economics of converting households and increase their willingness to pay for connection. Hence, the economic and financial analysis and the associated findings in this report may be overly conservative. The key economic assumptions made in this paper are set out below.

Table 1: Key Economic Assumptions

Natural Gas	
Average price paid by EGAS/EGPC to upstream producers	US$ 2.50/mmBtu
Average economic retail price	US$ 3.50/mmBtu
Average total costs of connecting a household	LE 2500 (US$ 431)
Household connection fee payment	LE 1500 (US$ 259)
Government contribution to total connection fee	LE 1000 (US$ 172)
LPG	
Regulated price per 12.5-kg cylinder at official LPG distribution outlets	LE 2.5 (US$ 0.43)
Average purchase price per 12.5-kg cylinder from private distributors	LE 7.0 (US$ 1.21)
Average monthly LPG consumption	
Low-volume household	1 cylinder (12.5 kg)
Middle-volume household	2 cylinders (25 kg)
Higher-volume household	3.3 cylinders (42 kg)
LPG Price	
Economic price of LPG	Import Parity Price
Economic price indexing	See Table 3
Discount Rate	
Annual rate based on Egyptian LE sovereign rates	10%
Indirect Benefits of Switching to Natural Gas	
Social, health, environmental and safety benefits	Not quantified

Major Findings on Conversion Economics for Residential Households

The economic and financial analysis in this paper demonstrates that despite (a) the absence of a heating load in Egypt and (b) the high investment costs for gas distribution development, it is economically viable to finance network development and connect households that currently use 1.25 or more 12.5-kg LPG cylinders (equivalent to $20m^3$ of natural gas) monthly. This volume break-even point and the analytical findings are based on an average 2005 LPG market price, delivered to Egypt, of US$ 440/ton (plus a 15-percent margin to reflect the costs of transporting, filling, and distributing the cylinders within Egypt). This delivered economic price for LPG is indexed over a 20-year period using the World Bank Oil Forecast, February 1, 2006 (see Table 3).

The authors also calculated the LPG break-even prices for low-, middle-, and higher-volume households. At an average LPG price above US$ 399/ton over a 20-year investment period, it would be economically viable to connect low-volume households. For medium- and higher-volume households, an average LPG price above US$ 241/ton and US$ 165/ton, respectively, would justify conversion.

At current 'subsidized' LPG and natural gas prices, the combined savings of switching to natural gas (the aggregate savings of GoE and a middle- or higher-volume household, as the case may be) exceed the total investment requirement for a new gas connection. However, middle-volume households do not convert to natural gas because their share of the potential savings is less than their required contribution of LE 1500 (US$ 259) to the connection fee.

At 'economic' prices for gas and LPG, middle- and higher-volume households would have an economic incentive to finance the total gas connection fee of LE 2500 (US$ 431) by themselves. At economic prices, the GoE does not have any net savings from households switching and hence would be unwilling to contribute towards gas connection financing.

There are two impediments to connecting lower-volume households to the natural gas network, at both 'economic' and 'subsidized' prices, (assuming that those households are low income and poor households). The first is the inability of lower-volume households to bear the LE 1500 (US$ 259) costs of connection, even when payments are spread over time. Although a household makes an annual saving by converting from LPG to natural gas, it is not enough to fund a new connection. The second impediment relates to the timing of the GoE's LPG subsidy savings and the government's connection payments, which causes a negative cash-flow problem for the EGAS/EGPC.

The economic and financial analysis in this paper is based solely on direct 'savings' benefits to households and the GoE. The environmental, social, health, and safety benefits of households converting to natural gas have not been quantified. Indeed, there are indications from other jurisdictions around the world that customers are willing to pay a significant 'convenience premium' for having access to natural gas. A typical

distribution network development also comprises commercial customers (*e.g.*, restaurants, shops, etc.) who tend to be imbedded in residential areas.

Mixing of household groups, incorporating indirect benefits to households and including commercial load into the analysis may substantially improve the economics of connections and it is likely that this will make it economic viable to connect all households, including low volume households, to natural gas.

In conclusion, this paper argues that the sooner residential households are switched from using LPG to natural gas the higher the net benefits for Egypt and provides analytical support to the GoE to embark on its ambitious gas conversion program. It is important to note, however, that changes in the international LPG market price forecast would alter the economics of conversion.

The analysis further highlights that while households have net benefits to switching to natural gas and should be contributing towards the financing of new gas connections, the GoE has the largest net benefits due to the savings on LPG subsidies.

2. LIQUEFIED PETROLEUM GAS (LPG) OVERVIEW

2.1 THE LPG STORY IN EGYPT

To meet their domestic energy needs for cooking and water heating, most residential customers in Egypt who are not connected to the natural gas network use LPG. There is no heating load in Egypt. The poor use LPG for cooking. Higher-income groups also use LPG for water heating, and gas consumption per household increases significantly once those heaters are installed. Higher-income households also tend to use more energy per capita for cooking than lower-income households.

The market for LPG in Egypt is large. In 2004, Egypt consumed about 3.1 million tons of LPG at a market value of about LE 9.1 billion (US$ 1.6 billion), all of which is handled by EGAS/EGPC. EGAS/EGPC bought about 2 million tons of LPG from its joint venture partners (JVPs) in Egypt and the remaining 1.1 million tons were bought in international markets. EGAS/EGPC pays JVPs market prices for LPG.

In 2005, the international market price, delivered to Egypt, for Mediterranean LPG, averaged approximately US$ 440/ton (LE 2551/ton) at an annual average crude oil price of about US$ 53/bbl. Adding a 15-percent margin to reflect the costs of transporting, filling, and distributing the LPG cylinders within Egypt gave an estimated delivered economic cost of LE 2934/ton (US$ 506/ton).

However, in Egypt, the domestic LPG price is fixed at LE 200/ton (US$ 35/ton), which accounted for only 7 percent of its economic costs in 2005. Consequently, the total economic subsidy the GoE paid for LPG in the domestic market was around LE 8.5 billion (US$ 1.5 billion) or 1.5 percent of GDP.

A combination of increasing international energy prices, a depreciating Egyptian Pound (LE) against the US Dollar,[2] and high subsidies on the domestic LPG price has created major negative budgetary implications for the GoE.[3] Table 2 provides indicators of the impact of LPG subsidies on the macroeconomic position of Egypt in 2005.

The GoE regulates and administers the price per 12.5-kg cylinder at LE 2.5 (US$ 0.43) at official LPG distribution outlets. However, those outlets are limited and often not located in or near residential areas. A network of unregulated private distributors has emerged who sell LPG cylinders to end-users for about LE 7 (US$ 1.21) each. Hence, for every cylinder sold, the private LPG distributors have revenues of about LE 4.5 (US$ 0.78); their distribution costs offsetting these revenues are not known. The LPG value chain is shown in Table 2.

[2] The Egyptian Pound has depreciated by almost 50 percent over the last five years against the US Dollar.

[3] Irrespective of whether the LPG is bought from JVPs or in international markets, the appropriate benchmark price for calculating the economic subsidy for LPG is the import parity price.

Table 2: LPG Value Chain, 2005

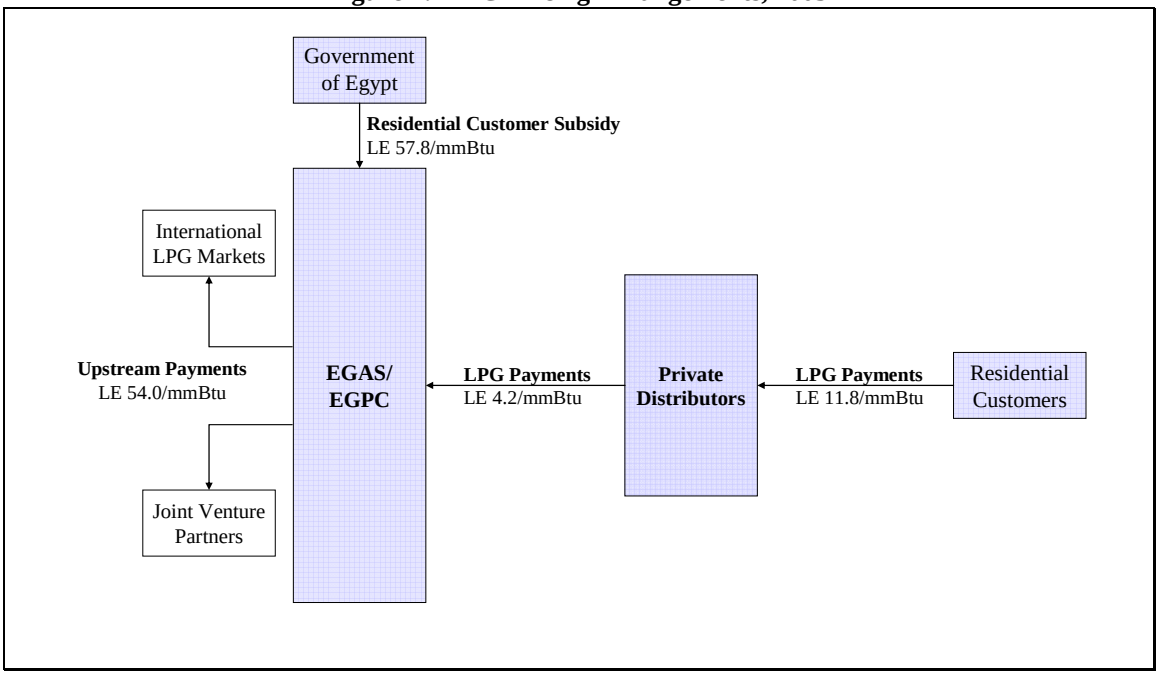
	Aggregate Market* (LE billions)	**Wholesale Market** (LE/ton)	**12.5-kg Cylinder** (LE/cylinder)	**Heating Value** (LE/mmBtu)
International market price (US$ 440/ton)	7.911	2552	31.9	54.0
Plus 15% transportation/filling/distribution	+1.187	+383	+4.8	+8.1
Economic cost, delivered	9.098	2935	36.7	62.1
GoE Subsidy	**-8.478**	**-2735**	**-34.2**	**-57.8**
Selling price at official EGAS distribution outlet	0.620	200	2.5	4.2
Plus private distributors' mark-up	+1.116	+360	+4.5	+7.6
Selling price by private distributors	1.736	560	7.0	11.8

Source: World Bank calculations; *based on 3.1 million tons of LPG consumption.

In 2005, after the mark-up by the private LPG distribution network, residential customers, regardless of volume, paid about 19 percent of the economic value of LPG.

Figure 1 illustrates the financial flows among the GoE, EGAS/EGPC, the LPG market, the private distribution market, and residential customers and sets out the current LPG pricing arrangements. As can be seen, the GoE subsidy is LE 57.8/mmBtu, as compared with LE 14.3 - 18.5/mmBtu for natural gas (see Table 16). It is understood that the subsidy is currently borne by EGAS/EGPC and that there is no financial transfer between GoE and the company.

Figure 1: LPG Pricing Arrangements, 2005



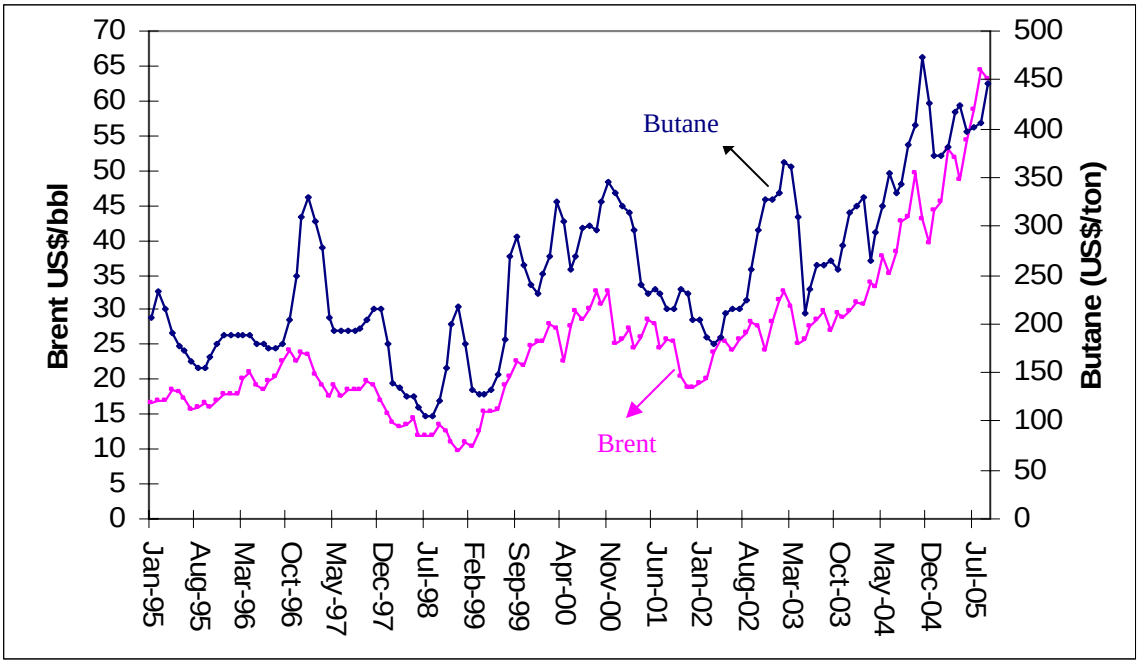
Source: World Bank.

2.2 FORECASTING MARKET PRICES FOR LPG

A strong relationship exists between crude oil and butane prices. (LPG is a mixture of butane and propane. Butane and propane are closely correlated and similarly priced.)

Figure 2 demonstrates this relationship. For the period 1995 to 2005, the correlation coefficient for Brent Crude and Saudi Aramco Butane was 0.87.[4]

Figure 2: Brent Crude and Saudi Aramco Butane Price Developments, 1995-2005



Source: World Bank calculations based on Platts data.

Based on this correlation of oil and butane prices, this paper, for analytic purposes, will use the World Bank Oil Forecast, February 1, 2006, shown in Table 3, to index LPG prices in the future.

Table 3: World Bank Oil Forecast (US$/bbl)
Base Case

	Crude Oil, Average, Real (1990 dollars)
2005	49.89
2006	53.83
2007	49.80
2008	46.76
2009	43.81
2010	40.93
2015	29.58

Source: World Bank, February 1, 2006.

For the purposes of sensitivity analysis, this paper will also compare results indexed with the oil forecast in Table 4, which is from the Annual Energy Outlook 2006, published by the Energy Information Administration of the US Government.

[4] The correlation coefficient is a numerical value which identifies the strength of relationship between two variables. Maximum Value=1.0; Minimum Value=-1.0. A correlation of +1.0 means that two variables are perfectly correlated.

Table 4: Alternate Oil Forecast (US$/bbl)
Alternate Case

	Crude Oil, Average, Real (2004 dollars)
2005	49.70
2006	53.95
2007	51.46
2008	48.98
2009	46.49
2010	43.99
2015	43.00

Source: Energy Information Administration, Annual Energy Outlook 2006.

2.3 ECONOMICS OF LPG

Table 5 shows the subsidized and economic costs of the LPG purchased by low-volume, middle-volume, and higher-volume households, using the World Bank Oil Forecast for forecasting economic costs. Low-volume households consume an estimated 12.5 kg (1.0 cylinder) of LPG per month or 150 kg per year (7.10 mmBtu/yr); middle-volume households consume 25 kg (2.0 cylinders) of LPG per month or 300 kg per year (14.19 mmBtu/yr); and higher-volume households consume an estimated 41.7 kg (3.3 cylinders) of LPG per month or 500 kg per year (23.65 mmBtu/yr).

Table 2 shows that, over the long-term, households are projected to pay about 27 percent of the 'economic' cost of LPG if they continued to be subsidized at current levels.

Table 5: LPG Cost to Households (LE)

Year	**Low-Volume** (150 kg/yr)		**Middle-Volume** (300 kg/yr)		**Higher-Volume** (500 kg/yr)	
	Subsidized	**Economic**	**Subsidized**	**Economic**	**Subsidized**	**Economic**
1	84	475	168	950	280	1583
2	84	439	168	879	280	1465
3	84	413	168	825	280	1375
4	84	387	168	773	280	1289
5	84	361	168	722	280	1204
6	84	336	168	672	280	1120
7	84	311	168	623	280	1038
8	84	294	168	589	280	981
9	84	278	168	555	280	925
10	84	261	168	522	280	870
11	84	261	168	522	280	870
12	84	261	168	522	280	870
13	84	261	168	522	280	870
14	84	261	168	522	280	870
15	84	261	168	522	280	870
16	84	261	168	522	280	870
17	84	261	168	522	280	870
18	84	261	168	522	280	870
19	84	261	168	522	280	870
20	84	261	168	522	280	870
Total	**1680**	**6165**	**3360**	**12330**	**5600**	**20551**
Present Value (10% discount rate)	**715**	**2917**	**1430**	**5833**	**2384**	**9722**

Source: World Bank calculations, using World Bank Oil Forecast, February 1, 2006.

Table 6 shows the cost to the GoE of subsidizing LPG sales to low-volume, middle-volume, and higher-volume households. The inflows represent the receipts of EGAS/EGPC at the official LPG distribution centers (at LE 2.5/cylinder). The outflows represent the price at which EGAS/EGPC purchases LPG in the international markets plus 15 percent for transportation and handling.

Table 6: EGAS/EGPC Cost for Supplying LPG to Average Households (LE) – Base Case

Year	**Low-Volume** (150 kg/yr)			**Middle-Volume** (300 kg/yr)			**Higher-Volume** (500 kg/yr)		
	Inflows	**Outflows**	**Cost to EGAS/ EGPC**	**Inflows**	**Outflows**	**Cost to EGAS/ EGPC**	**Inflows**	**Outflows**	**Cost to EGAS/ EGPC**
1	30	-475	-445	60	-950	-890	100	-1583	-1483
2	30	-439	-409	60	-879	-819	100	-1465	-1365
3	30	-413	-383	60	-825	-765	100	-1375	-1275
4	30	-387	-357	60	-773	-713	100	-1289	-1189
5	30	-361	-331	60	-722	-662	100	-1204	-1104
6	30	-336	-306	60	-672	-612	100	-1120	-1020
7	30	-311	-281	60	-623	-563	100	-1038	-938
8	30	-294	-264	60	-589	-529	100	-981	-881
9	30	-278	-248	60	-555	-495	100	-925	-825
10	30	-261	-231	60	-522	-462	100	-870	-770
11	30	-261	-231	60	-522	-462	100	-870	-770
12	30	-261	-231	60	-522	-462	100	-870	-770
13	30	-261	-231	60	-522	-462	100	-870	-770
14	30	-261	-231	60	-522	-462	100	-870	-770
15	30	-261	-231	60	-522	-462	100	-870	-770
16	30	-261	-231	60	-522	-462	100	-870	-770
17	30	-261	-231	60	-522	-462	100	-870	-770
18	30	-261	-231	60	-522	-462	100	-870	-770
19	30	-261	-231	60	-522	-462	100	-870	-770
20	30	-261	-231	60	-522	-462	100	-870	-770
Total			**-5565**			**-11130**			**-18551**
Present Value (10% discount rate)			**-2661**			**-5323**			**-8871**

Source: World Bank calculations, using World Bank Oil Forecast, February 1, 2006.

Table 7 shows the same information as Table 6 but using the Alternate Oil Forecast.

Table 7: EGAS/EGPC Cost for Supplying LPG to Average Households (LE) – Alternate Case

Year	**Low-Volume** (150 kg/yr)			**Middle-Volume** (300 kg/yr)			**Higher-Volume** (500 kg/yr)		
	Inflows	**Outflows**	**Cost to EGAS/ EGPC**	**Inflows**	**Outflows**	**Cost to EGAS/ EGPC**	**Inflows**	**Outflows**	**Cost to EGAS/ EGPC**
1	30	-478	-448	60	-956	-896	100	-1593	-1493
2	30	-456	-426	60	-912	-852	100	-1519	-1419
3	30	-434	-404	60	-868	-808	100	-1446	-1346
4	30	-412	-382	60	-824	-764	100	-1373	-1273
5	30	-390	-360	60	-779	-719	100	-1299	-1199
6	30	-388	-358	60	-776	-716	100	-1293	-1193
7	30	-386	-356	60	-772	-712	100	-1287	-1187
8	30	-384	-354	60	-769	-709	100	-1281	-1181
9	30	-383	-353	60	-765	-705	100	-1275	-1175
10	30	-381	-351	60	-762	-702	100	-1270	-1170
11	30	-384	-354	60	-769	-709	100	-1281	-1181
12	30	-388	-358	60	-776	-716	100	-1293	-1193
13	30	-391	-361	60	-783	-723	100	-1305	-1205
14	30	-395	-365	60	-790	-730	100	-1317	-1217
15	30	-399	-369	60	-797	-737	100	-1328	-1228
16	30	-404	-374	60	-808	-748	100	-1346	-1246
17	30	-409	-379	60	-818	-758	100	-1364	-1264
18	30	-415	-385	60	-829	-769	100	-1382	-1282
19	30	-420	-390	60	-840	-780	100	-1399	-1299
20	30	-425	-395	60	-850	-790	100	-1417	-1317
Total			**-7520**			**-15040**			**-25066**
Present Value (10% discount rate)			**-3257**			**-6513**			**-10855**

Source: World Bank calculations, using Alternate Oil Forecast.

For every cylinder of LPG sold into the domestic residential sector, EGAS/EGPC suffers a substantial loss.

3. NATURAL GAS OVERVIEW

3.1 THE NATURAL GAS STORY IN EGYPT

By the end of 2004, Egypt had, with 1870 Bcm, the 15th largest proven gas reserves in the world. In 2005, the Ministry of Petroleum (MoP), based on studies conducted by international companies, estimated an additional 3400 Bcm as probable and possible reserves. Most of this increase has come about as a result of new natural gas discoveries offshore in the Mediterranean and some finds in the Western Desert.[5]

Privately and publicly owned companies operate in all segments of Egypt's natural gas chain. Upstream, international oil & gas majors including IEOC (a subsidiary of Eni S.p.A.), Shell Egypt NV, BG Egypt S.A., and BP Egypt Gas Co., operate on- and offshore natural gas fields in the Western Desert and in the Nile Delta and Mediterranean. There are also smaller international oil companies operating in natural gas exploration and production activities in Egypt, including Apache Egypt Companies. Egypt has two operational LNG terminals, ELNG, located at Idku, and SEGAS LNG, located at Damietta. Egypt expects to be the world's sixth largest LNG exporter by 2006, with output of 17.5 Bcm/year (7.5 Bcm/year from SEGAS and 10 Bcm/year from ELNG).

Egypt started to export piped natural gas to Jordan from the Arab Gas Pipeline in mid-2003. The first leg of the Arab Gas Pipeline, 265 km from El-Arish in Sinai (Egypt) to Aqaba (Jordan), supplies 1.1 Bcm/year of natural gas to Aqaba Power Station. (The pipeline has a total annual capacity of 10 Bcm.) A 395 km extension of the pipeline across Jordan has been completed and it is anticipated that Jordan will consume 3.4 Bcm/year of Egyptian natural gas in the near future. In addition, Egypt plans to add natural gas exports to Syria and Lebanon (and potentially to Turkey and to Europe) when the pipeline is extended beyond Jordan and has already signed some initial agreements.

The downstream sector is dominated by the Egyptian Natural Gas Holding Company (EGAS) and Egyptian General Petroleum Corporation (EGPC), both state-owned companies, which are the only suppliers of natural gas into the domestic market (and the only importer of LPG); Egyptian Natural Gas Company (GASCO), the state-owned gas transmission company; and nine Local Distribution Companies (LDCs).[6]

All natural gas networks in Egypt are owned by EGAS/EGPC. Nine LDCs operate the system on behalf of EGAS/EGPC to supply gas to approximately 2 million commercial and residential customers.

The GoE allocated the distribution concessions to private and publicly owned companies based on criteria such as number of residential households connected per annum,

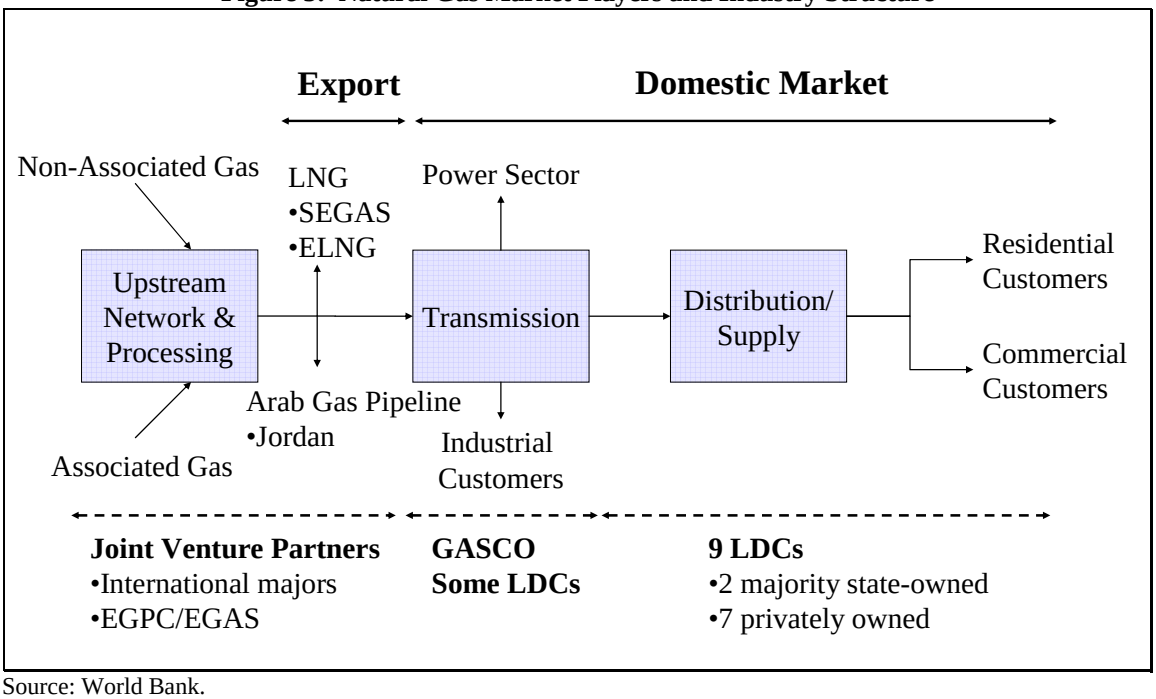
[5] BP Statistical Review of World Energy June 2005 and Egypt Country Analysis Brief, Energy Information Administration, US Department of Energy, May 2005.

[6] In Egypt, pipeline pressure is measured in bar. One bar can be approximated to one atmosphere (more precisely, 1 bar equals 0.9869 atmospheres). The transmission network operates at 70 bar and above, and the distribution network at 7 bar and below.

technical qualification, reasonable rate of return, and others. Of the nine LDCs, one is fully state-owned (Egyptian Town Gas), one is majority state-owned (Egypt Gas), and seven are majority privately owned (Fayum Gas Company, Nile Valley Gas Company, National Gas Company (NatGas), Transgas Company, Repco Gas, National Gas S.A.E., and City Gas). Some LDCs, including NatGas, Nile Valley Gas Company, Fayum Gas, and City Gas, also operate transmission networks.

Figure 3 illustrates the industry structure of the Egyptian natural gas sector.

Figure 3: Natural Gas Market Players and Industry Structure



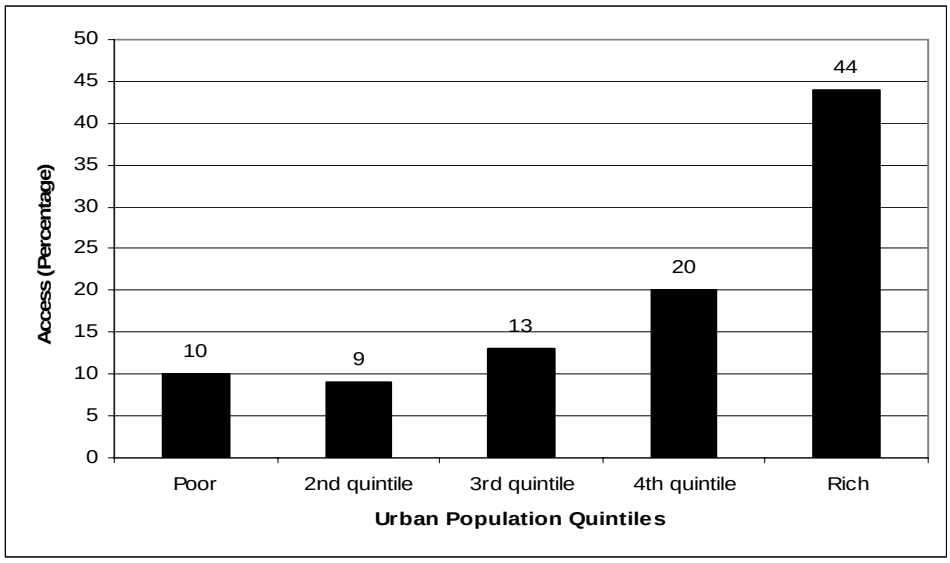
Source: World Bank.

3.2 ACCESS TO NATURAL GAS

The Nile Delta has an extensive coverage of high pressure transmission network to supply commercial and industrial customers, mostly power generators and urban areas including Cairo, Suez, and Alexandria. There are some distribution networks in urban and semi-urban areas in the Delta but the vast majority of residential households continue to use LPG to meet their domestic energy needs. Upper Egypt is currently not connected to natural gas network.

Figure 4 shows that 44 percent of the richest household groups living in urban areas in Lower Egypt have access to natural gas, while only one tenth of the urban poor and 9 percent of low-income households are connected to natural gas distribution network.

Figure 4: Access of Households to Natural Gas in Urban Areas in Lower Egypt in 2004



Source: Egypt-Toward a More Effective Social Policy: Subsidies and Social Safety Net, World Bank, draft, September 2005.

There are millions of residential households that live near existing transmission gas infrastructure in urban and semi-urban areas in Lower Egypt that are not connected and continue to use more heavily subsidized and expensive LPG.

3.3 NATURAL GAS PRICING

The buying and selling of natural gas in the domestic market is dominated by EGAS/EGPC, GASCO, and the LDCs. In the Egyptian context, the term 'tariff' refers to the payment by EGAS/EGPC to transmission and distribution companies for the operation of the gas connection network owned by EGAS/EGPC. 'Price' reflects the total payment by customers for natural gas delivered to their premises. Gas retail prices are regulated by the Ministry of Petroleum (MoP) in consultation with the Cabinet of Ministers.

EGAS/EGPC sources the natural gas to supply the domestic market from either the 'equity gas' it receives under its Production Sharing Agreements (PSAs), for which no cash payment is required, or 'joint venture gas' it purchases from its JVPs.[7] EGAS/EGPC pays for joint venture gas at prices that are linked to international crude oil prices.[8] There is a contractual 'ceiling' price for the joint venture gas EGAS/EGPC buys from the JVPs, ranging from US$ 2.50-2.65/mmBtu. There are also a few 'older' PSAs

[7] However, EGAS/EGPC is paying tax & royalty on the equity and joint venture gas to the GoE.

[8] Despite 'equity gas' being 'free' for EGAS/EGPC, in economic terms the value for that gas is its opportunity costs (eg export value).

in place where no price ceiling is incorporated in the contract.[9] In 2005, equity and joint venture gas each accounted for about 50 percent of domestic natural gas consumption.

Under the current pricing scheme, customers pay less than the full economic price for natural gas. EGAS/EGPC sells natural gas to power plants and industrial customers at a fixed price of US$ 1.00/mmBtu. Residential and commercial customers pay a volume-based block price that is collected by the LDCs and passed through to EGAS/EGPC. The current annualized retail and commercial price schedule is set out in Table 8.

Table 8: Retail & Commercial Price Schedule

Annual Consumption	Retail & Commercial Price		
	LE/m^3	LE/mmBtu	US$/mmBtu
0-360 m^3/yr	0.10	2.78	0.48
360-720 m^3/yr	0.20	5.56	0.96
above 720 m^3/yr	0.30	8.34	1.44

Source: EGAS.

A residential customer is defined as a customer who uses up to 720 m^3/yr of natural gas. Commercial customers use above 720 m^3/yr. Residential and commercial customers are both served from the distribution network.

For bulk transmission services, EGAS/EGPC pays GASCO (and some LDCs) a volume-based fee of LE 0.007/m^3. This is equivalent to a postage-stamp transmission rate of LE 0.19/mmBtu (US$ 0.03/mmBtu).

Each LDC has entered into one or more contracts with EGAS/EGPC pursuant to which the LDC seeks to convert LPG users to natural gas. Current and potential arrangements for financing the costs of connection are described in section 3.4 below and subsequent chapters of this paper. For distribution services, each LDC receives from EGAS/EGPC a Commission. Under the new arrangements, the Commission is based on quantities of natural gas sold, as set forth in Table 9 below.

[9] For the purposes of this paper, natural gas is assumed to be purchased by EGAS/EGPC at an average price of US$ 2.50/mmBtu. This price is based on information provided by the MoP and based on average contract prices in existing PSAs.

Table 9: Commission Rate for Natural Gas Distribution (LE/m^3)

Year	Fee Rate	OPEX rate	Commission Rate
1	0.10	0.15	0.25
2	0.10	0.15	0.25
3	0.10	0.15	0.25
4	0.10	0.15	0.25
5	0.10	0.18	0.28
6	0.10	0.20	0.30
7	0.10	0.23	0.33
8	0.10	0.27	0.37
9	0.10	0.30	0.40
10	0.10	0.34	0.44
11	0.10	0.39	0.49
12	0.10	0.41	0.51
13	0.10	0.44	0.55
14	0.10	0.46	0.56
15	0.10	0.49	0.59
16	0.10	0.52	0.62
17	0.10	0.55	0.65
18	0.10	0.59	0.69
19	0.10	0.62	0.72
20	0.10	0.66	0.76

Source: NatGas, September 2005.

The Commission payable to an LDC is subject to a cap, however. The cap is a ceiling on the aggregate Commission payable to the LDC, calculated based on a maximum Commission per customer (LE 100 for the first ten years and LE 125 for the following ten years). Table 10 below shows marginal Commissions by LDCs for adding low-volume, middle-volume, and higher-volume households at a natural gas consumption rate equivalent to LPG consumption.

Table 10: Commission Payments (LE)

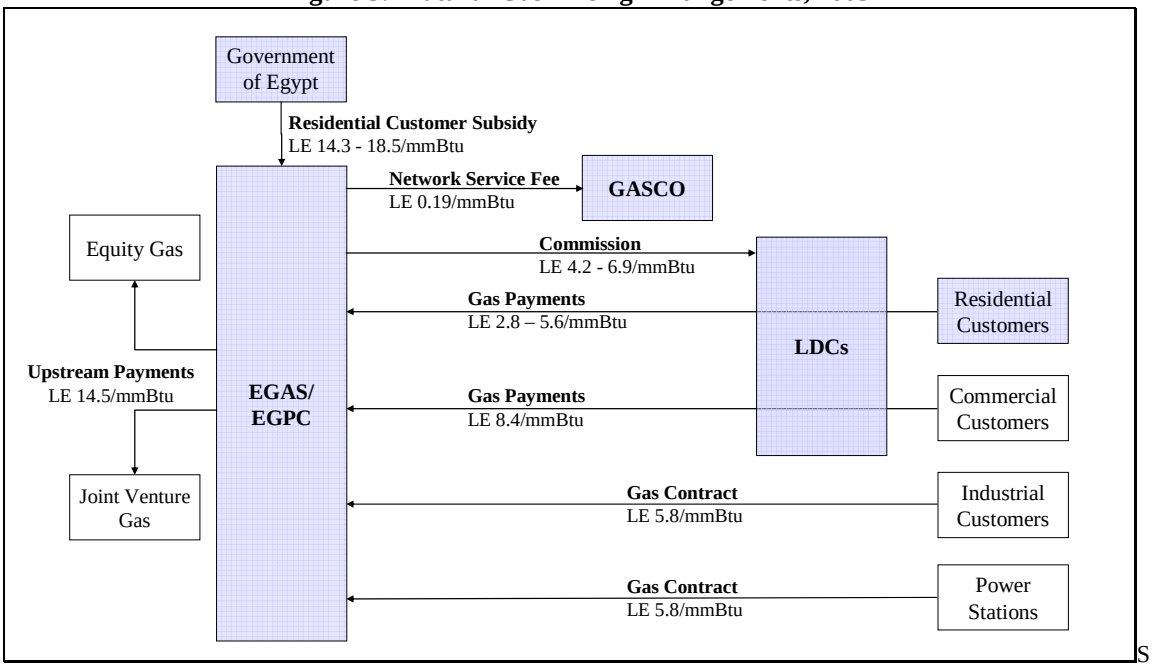
Year	Low-Volume (197 m^3/yr)	Middle-Volume (394 m^3/yr)	Higher-Volume (657 m^3/yr)
1	49.3	98.6	100.0
2	49.3	98.6	100.0
3	49.3	98.6	100.0
4	49.3	98.6	100.0
5	55.2	100.0	100.0
6	59.2	100.0	100.0
7	65.1	100.0	100.0
8	73.0	100.0	100.0
9	78.9	100.0	100.0
10	86.8	100.0	100.0
11	96.6	125.0	125.0
12	100.6	125.0	125.0
13	108.5	125.0	125.0
14	110.5	125.0	125.0
15	116.4	125.0	125.0
16	122.3	125.0	125.0
17	125.0	125.0	125.0
18	125.0	125.0	125.0
19	125.0	125.0	125.0
20	125.0	125.0	125.0

Source: World Bank calculations.

This paper has not explored the cost structures of the LDCs. For service providers like the LDCs, it is likely that the costs of servicing customers are largely fixed costs and do not vary much, if any, with the consumption level of the customer. The MoP has set these Commission rates and caps (and the GASCO fees as well) in its capacity as sector regulator. This paper assumes that the Commission payment scheme is reviewed periodically by the GoE and adjusted as necessary to allow operators to recover its prudently incurred operating costs.

Figure 5 illustrates the financial flows among the GoE, EGAS/EGPC, the upstream producers, GASCO, the LDCs, and customers and sets out the current natural gas pricing arrangements. As can be seen, the GoE subsidy is LE 14.3 - 18.5/mmBtu, as compared with LE 57.8/mmBtu for LPG (see Table 16).

Figure 5: Natural Gas Pricing Arrangements, 2005



Source: World Bank.

3.4 CONNECTING TO NATURAL GAS

The MoP, in consultation with the Cabinet of Ministers, is the price regulator for the natural gas sector in Egypt. All transmission and distribution network development must be approved by EGAS/EGPC. GASCO and the LDCs prepare annual network expansion plans, and pre-finance transmission and distribution network development which they eventually recover through connection fee payments from households and EGAS/EGPC.

On July 1, 2005, the MoP set the Connection Fee for a new connection to the network at LE 2500 (US$ 431) nationwide. The Connection Fee is split into two parts: (a) an authorized Household Connection Fee of LE 1500 (US$ 259) that is paid by the

household and (b) an authorized LDC Connection Fee of LE 1000 (US$ 172) that is paid by EGAS/EGPC.

All households contribute the Household Connection Fee, up-front prior to connection, except that, in some cases, the National Bank of Egypt offers customer financing of Household Connection Fees. This financing is for up to seven years. In these cases, the relevant LDC facilitates the financing through coordinated billing and collection.

LDCs pre-finance the LDC Connection Fee through debt or equity, as each LDC chooses. LDCs are allowed to recover the LDC Connection Fee from EGAS/EGPC through rates over four years, without interest,[10] upon verification of connections. (See Table 11.) The LDC Connection Fee is 'output-based aid' ('OBA') in the terminology of the World Bank and the Global Partnership on Output-Based Aid (GPOBA). In simplified terms, there are two key elements to an OBA approach: (a) performance-based, and (b) explicit subsidies. The performance-based element means that service providers are for the most part paid *after* the delivery of an agreed output – in this case household connections to the natural gas network. Therefore, the service provider takes on pre-financing risk, and is only compensated after it has proven service delivery. The explicit subsidy element means that an identified group of consumers (in this case, everybody being connecting to the gas network) is not paying the full cost of receiving the service. The two elements come together under OBA, whereby some of the cost of providing the service to the user is covered by a donor or the government, but the related payment is paid to the service provider only after it delivers the service.

Table 11: Rate Recovery by LDCs of the LDC Connection Fee

Year	LDC Connection Fee (LE)
1	400
2	200
3	200
4	200
Total	**1000**
Present Value (10% discount rate)	**816**

Source: MoP.

On behalf of EGAS, the owner of all natural gas distribution networks in Egypt, the LDCs procure the new connections for which they have been authorized by EGAS/EGPC, most likely using the contracting services of one of three active contractors: HouseGas (an affiliate of City Gas and Repco Gas), Egypt Gas (owned by the GoE), or Orascom Construction Industries Company (not known to be an affiliate of any LDC). Table 12 shows estimated component costs of a new connection.

[10] Under the previous scheme, which is still applicable to pre-existing gas connections, LDCs are allowed to recover capital expenditures over five years, with an authorized rate of return of 18 percent.

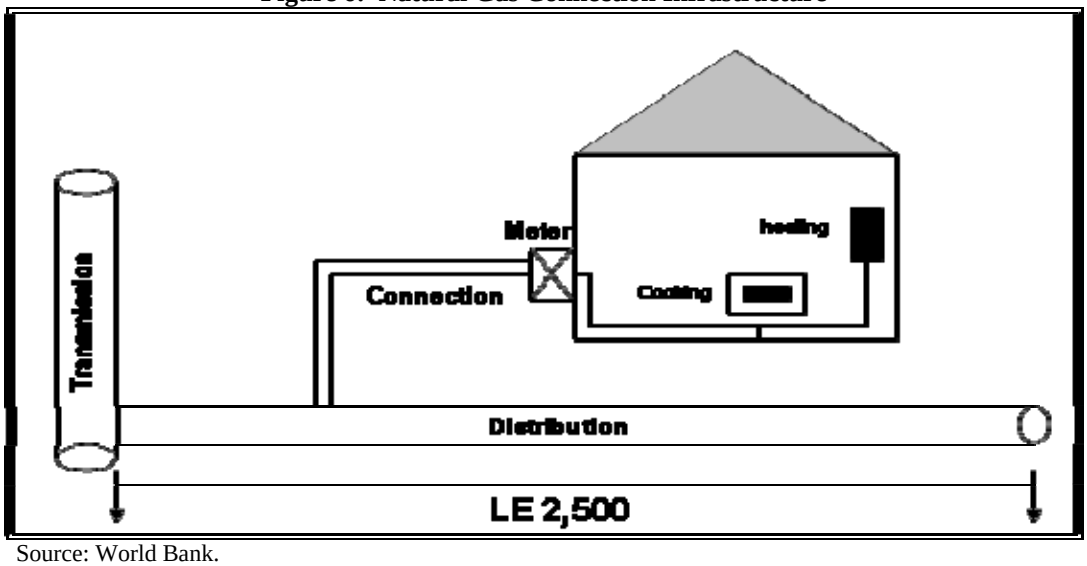
Table 12: Breakdown of the Authorized Connection Fee

	LE
• **Networks** (material, regulators, excavation, laying, backfilling, permits, reinstatement)	760
• **External Installations** (material, scaffolding, finishing –sleeves for holes, repainting, etc.)	750
• **Internal Installations** (material, meter kits, finishing)	760
• **Conversion of Appliances** (material, appliances conversion, flues & vents installations)	230
Total Connection Fee	**2500**

Source: Information provided by NatGas, September 2005.

The Connection Fee includes the costs of constructing the distribution pipeline, connecting the household to the distribution main, and installing all necessary internal and external equipment, including the meter and the conversion of existing appliances. Figure 6 below illustrates the infrastructure that is covered by the natural gas Connection Fee.

Figure 6: Natural Gas Connection Infrastructure



Source: World Bank.

In addition, for each new connection, EGAS/EGPC pays the relevant LDC a one-time Administrative Fee of LE 30 (US$ 5) to defray the costs of setting up the new account.

3.5 ECONOMICS OF NATURAL GAS

Under the current pricing scheme, customers pay natural gas commodity prices subsidized by the GoE while delivery costs (*i.e.*, Commission and GASCO charges) are absorbed by EGAS/EGPC. This results in costs to the GoE as shown in the following tables. The inflows represent the receipts of EGAS/EGPC through the gas commodity price charges to residential customers. The outflows represent the price EGAS/EGPC pays for the gas to upstream producers and the commission and GASCO tariff and LDC connection and administrative fees.

Table 13: EGAS/EGPC Cost for Supplying an Average Low-Volume Household (LE)

Year	INFLOWS	OUTFLOWS			
	Commodity (197 m^3/yr @ $ 0.48/mmBtu)	**Upstream Producers** ($ 2.50/mmBtu)	**Commission + GASCO**	**LDC Connection Fee + Administrative Fee**	**Cost to EGAS/EGPC**
1	20	-103	-51	-430	-564
2	20	-103	-51	-200	-334
3	20	-103	-51	-200	-334
4	20	-103	-51	-200	-334
5	20	-103	-57	-	-140
6	20	-103	-61	-	-144
7	20	-103	-66	-	-150
8	20	-103	-74	-	-158
9	20	-103	-80	-	-163
10	20	-103	-88	-	-171
11	20	-103	-98	-	-181
12	20	-103	-102	-	-185
13	20	-103	-110	-	-193
14	20	-103	-112	-	-195
15	20	-103	-118	-	-201
16	20	-103	-124	-	-207
17	20	-103	-126	-	-210
18	20	-103	-126	-	-210
19	20	-103	-126	-	-210
20	20	-103	-126	-	-210
Total	**394**	**-2058**	**-1798**	**-1030**	**-4491**
Present Value (10% discount rate)	**168**	**-876**	**-637**	**-843**	**-2188**

Source: World Bank calculations.

Table 14: EGAS/EGPC Cost for Supplying an Average Middle-Volume Household (LE)

Year	INFLOWS	OUTFLOWS			
	Commodity (394 m^3/yr @ $ 0.52/ mmBtu)	**Upstream Producers** ($ 2.50/mmBtu)	**Commission + GASCO**	**LDC Connection Fee + Administrative Fee**	**Cost to EGAS/EGPC**
1	43	-206	-101	-430	-694
2	43	-206	-101	-200	-464
3	43	-206	-101	-200	-464
4	43	-206	-101	-200	-464
5	43	-206	-103	-	-266
6	43	-206	-103	-	-266
7	43	-206	-103	-	-266
8	43	-206	-103	-	-266
9	43	-206	-103	-	-266
10	43	-206	-103	-	-266
11	43	-206	-128	-	-291
12	43	-206	-128	-	-291
13	43	-206	-128	-	-291
14	43	-206	-128	-	-291
15	43	-206	-128	-	-291
16	43	-206	-128	-	-291
17	43	-206	-128	-	-291

Year	INFLOWS	OUTFLOWS			Cost to EGAS/EGPC
	Commodity (394 m^3/yr @ $ 0.52/ mmBtu)	**Upstream Producers** ($ 2.50/mmBtu)	**Commission + GASCO**	**LDC Connection Fee + Administrative Fee**	
18	43	-206	-128	-	-291
19	43	-206	-128	-	-291
20	43	-206	-128	-	-291
Total	**858**	**-4115**	**-2300**	**-1030**	**-6587**
Present Value (10% discount rate)	**365**	**-1752**	**-930**	**-843**	**-3159**

Source: World Bank calculations.

Table 15: EGAS/EGPC Cost for Supplying an Average Higher-Volume Household (LE)

Year	INFLOWS	OUTFLOWS			Cost to EGAS/EGPC
	Commodity (657 m^3/yr @ $ 0.70/ mmBtu)	**Upstream Producers** ($ 2.50/mmBtu)	**Commission + GASCO**	**LDC Connection Fee + Administrative Fee**	
1	95	-343	-105	-430	-782
2	95	-343	-105	-200	-552
3	95	-343	-105	-200	-552
4	95	-343	-105	-200	-552
5	95	-343	-105	-	-352
6	95	-343	-105	-	-352
7	95	-343	-105	-	-352
8	95	-343	-105	-	-352
9	95	-343	-105	-	-352
10	95	-343	-105	-	-352
11	95	-343	-130	-	-377
12	95	-343	-130	-	-377
13	95	-343	-130	-	-377
14	95	-343	-130	-	-377
15	95	-343	-130	-	-377
16	95	-343	-130	-	-377
17	95	-343	-130	-	-377
18	95	-343	-130	-	-377
19	95	-343	-130	-	-377
20	95	-343	-130	-	-377
Total	**1910**	**-6859**	**-2342**	**-1030**	**-8321**
Present Value (10% discount rate)	**813**	**-2920**	**-950**	**-843**	**-3899**

Source: World Bank calculations.

For every cubic meter of natural gas sold into the domestic residential sector, EGAS/EGPC suffers a loss. This reduces EGAS/EGPC's financial capability to approve and finance new distribution network development.

4. COMPARISON OF LPG AND NATURAL GAS SUBSIDIES

Natural gas sales prices in Egypt are subsidized by the GoE, but, on an mmBtu-equivalent basis, the subsidies for natural gas are modest in comparison with those for LPG. Table 16 illustrates the 2005 subsidy rates in Egypt for natural gas for recently connected consumers (the costs of a natural gas connection are not included), and compares these with LPG pricing. As explained above, the LDC handling fees and the retail commodity charges vary for different consumption levels. The table shows the subsidy levels for the average low-volume, middle-volume, and higher-volume household.

Table 16: Comparison of Subsidies for LPG and Natural Gas, 2005

LPG Value Chain (LE/mmBtu)		**Natural Gas Value Chain** (LE/mmBtu)			
		Low-Volume (7.1 mmBtu/yr)	**Middle-Volume** (14.2 mmBtu/yr)	**Higher-Volume** (23.7 mmBtu/yr)	
Cost of LPG at port of entry into Egypt (US$440/ton)	54.0	14.5	14.5	14.5	Cost of natural gas at wellhead (US$ 2.50/mmBtu)
Value of LPG at EGAS official distribution center (includes 15% transportation costs)	62.1	14.7	14.7	14.7	Value of natural gas with GASCO transportation costs (LE 0.007/m^3)
		21.3	21.3	18.3	Value of natural gas with LDC distribution costs (*i.e.*, Commission)
GoE Subsidy	**-57.8**	**-18.5**	**-18.2**	**-14.3**	**GoE Subsidy**
Selling price of LPG to private distributors (LE 2.5/cylinder)	4.2				
Cost to household of LPG (includes transport costs from distribution center) (LE 7.0/cylinder)	11.8	2.8	3.0	4.0	Cost to household of natural gas (block pricing based on average consumption as outlined in Table 8)

Source: World Bank calculations.

As Table 16 illustrates, households using natural gas today pay about 24-34 percent of the cost of the equivalent heat content of subsidized LPG. If natural gas transportation costs (*i.e.*, Commission and GASCO fees) were also borne by households, then households using natural gas would pay about 66-83 percent of the cost of the equivalent heat content of subsidized LPG.

5. ECONOMICS OF CONNECTING HOUSEHOLDS TO NATURAL GAS

5.1 WILLINGNESS-TO-PAY (WTP)

The GoE proposes to connect an additional 6 million households to the natural gas network over the six years.

This section analyzes the saving potentials of the households (low-volume, middle-volume, and higher-volume), the GoE, and LDCs by switching to natural gas and the 'willingness' of each to contribute to the capital costs of new natural gas connections under current 'subsidized' and 'economic' prices for natural gas and LPG.

Willingness to pay (WTP) can be defined as the *maximum* amount (or breakeven amount) households, the GoE, and LDCs are prepared to pay for connecting households, although in practice any new allocation of connection costs will be more acceptable if benefits and/or burdens are shared. As mentioned above, the official Connection Fee is currently LE 2500 (US$ 431) plus a one-time Administrative Fee of LE 30 (US$ 5).

5.2 HOUSEHOLD WTP

One conservative method for estimating the WTP of households for converting to natural gas is to compare post-conversion energy costs to costs being paid for alternative energy sources (*e.g.*, LPG) to meet domestic energy needs. In Egypt, natural gas transportation costs (*i.e.*, Commission and GASCO) are being absorbed by EGAS/EGPC, so, for comparability, the WTP can be calculated as the difference between the subsidized and/or economic costs currently paid for *delivered* LPG and the subsidized and/or economic costs paid for *delivered* natural gas. Households should be willing to pay the same as before conversion, and, considering the other benefits of natural gas (*e.g.*, convenience), may be willing to pay even more. This analysis does not quantify such indirect benefits.

Table 17 shows the annual savings for an average low-volume household that converts to natural gas use, based on consumption of 7.10 mmBtu/yr and current subsidized LPG and gas prices.

Table 17: Estimated WTP for Connection – Average Low-Volume Household (LE)

Year	LPG (150 kg/yr)	Natural Gas (197 m^3/yr)		Annual Savings to Household (WTP) after Conversion	
	Commodity (LE 7/cylinder)	Commodity ($ 0.48/mmBtu)	Commission + GASCO	EGAS pays Commission + GASCO	Household pays Commission + GASCO
1	84	20	51	64	14
2	84	20	51	64	14
3	84	20	51	64	14
4	84	20	51	64	14
5	84	20	57	64	8
6	84	20	61	64	4
7	84	20	66	64	-2
8	84	20	74	64	-10

Year	LPG (150 kg/yr)	Natural Gas (197 m^3/yr)		Annual Savings to Household (WTP) after Conversion	
	Commodity (LE 7/cylinder)	**Commodity** ($ 0.48/mmBtu)	**Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**
9	84	20	80	64	-16
10	84	20	88	64	-24
11	84	20	98	64	-34
12	84	20	102	64	-38
13	84	20	110	64	-46
14	84	20	112	64	-48
15	84	20	118	64	-53
16	84	20	124	64	-59
17	84	20	126	64	-62
18	84	20	126	64	-62
19	84	20	126	64	-62
20	84	20	126	64	-62
Total WTP				**1286**	**-512**
Present Value WTP (10% discount rate)				**547**	**-90**
Internal Rate of Return on Household Connection Fee (LE 1530 investment)				**NA**	**NA**

Source: World Bank estimates.

The table above indicates that under current subsidized natural gas prices, a low-volume household that converts to natural gas should be able to pay about LE 547 towards the cost of connection or the service fees for natural gas (*i.e.*, Commission and GASCO), with a modest increase in out-of-pocket costs after six years in the latter case.

Table 18 shows the annual savings for an average middle-volume household that converts to natural gas use, based on consumption of 14.19 mmBtu/yr.

Table 18: Estimated WTP for Connection – Average Middle-Volume Household (LE)

Year	LPG (300 kg/yr)	Natural Gas (394 m^3/yr)		Annual Savings to Household (WTP) after Conversion	
	Commodity (LE 7/cylinder)	**Commodity** ($ 0.52/mmBtu)	**Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**
1	168	43	101	125	24
2	168	43	101	125	24
3	168	43	101	125	24
4	168	43	101	125	24
5	168	43	103	125	22
6	168	43	103	125	22
7	168	43	103	125	22
8	168	43	103	125	22
9	168	43	103	125	22
10	168	43	103	125	22
11	168	43	128	125	-3
12	168	43	128	125	-3
13	168	43	128	125	-3
14	168	43	128	125	-3
15	168	43	128	125	-3
16	168	43	128	125	-3
17	168	43	128	125	-3
18	168	43	128	125	-3
19	168	43	128	125	-3

Year	LPG (300 kg/yr)	Natural Gas (394 m^3/yr)		Annual Savings to Household (WTP) after Conversion	
	Commodity (LE 7/cylinder)	**Commodity** ($ 0.52/mmBtu)	**Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**
20	168	43	128	125	-3
Total WTP				**2502**	**202**
Present Value WTP (10% discount rate)				**1065**	**135**
Internal Rate of Return on Household Connection Fee (LE 1530 investment)				**5.5%**	**NA**

Source: World Bank estimates.

The above table illustrates that under current subsidized natural gas prices, a middle-volume household that converts to natural gas should be able to pay about LE 1065 towards the cost of connection or the service fees for natural gas (*i.e.*, Commission and GASCO), with a very small increase in out-of-pocket costs after ten years in the latter case. Even if the middle-volume household pays the service fees for natural gas (*i.e.*, Commission and GASCO), it should be willing to make a small contribution to the connection costs (by this analysis, LE 135).

Table 19 shows the annual savings for an average higher-volume household that converts to natural gas use, based on consumption of 23.65 mmBtu/yr.

Table 19: Estimated WTP for Connection – Average Higher-Volume Household (LE)

Year	LPG (500 kg/yr)	Natural Gas (657 m^3/yr)		Annual Savings to Household (WTP) after Conversion	
	Commodity (LE 7/cylinder)	**Commodity** ($ 0.70/mmBtu)	**Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**
1	280	95	105	185	80
2	280	95	105	185	80
3	280	95	105	185	80
4	280	95	105	185	80
5	280	95	105	185	80
6	280	95	105	185	80
7	280	95	105	185	80
8	280	95	105	185	80
9	280	95	105	185	80
10	280	95	105	185	80
11	280	95	130	185	55
12	280	95	130	185	55
13	280	95	130	185	55
14	280	95	130	185	55
15	280	95	130	185	55
16	280	95	130	185	55
17	280	95	130	185	55
18	280	95	130	185	55
19	280	95	130	185	55
20	280	95	130	185	55
Total WTP				**3690**	**1348**
Present Value WTP (10% discount rate)				**1571**	**621**
Internal Rate of Return on Household Connection Fee (LE 1530 investment)				**10.7%**	**NA**

Source: World Bank estimates.

The table above indicates that under the current subsidized natural gas prices, a higher-volume household that converts to natural gas should be able to pay about LE 1571 towards the cost of connection or the service fees for natural gas (*i.e.*, Commission and GASCO). Even if the higher-volume household pays the service fees for natural gas (*i.e.*, Commission and GASCO), it should be willing to make a 41 percent contribution to the Household Connection Fee (by this analysis, LE 621).

All household groups have an economic incentive to provide some contribution towards financing of gas connections. However, except in the case of a higher-volume household that does not have to pay the Commission and GASCO tariffs, households are unwilling to pay the total Household Connection Fee of LE 1500 based on their potential savings from switching.

5.3 GOVERNMENT WTP

The WTP of the GoE to pay for natural gas connections to households is presumed to be the net savings that the GoE will realize from avoided subsidies on LPG consumption less subsidies on natural gas. The current rates of subsidy are shown in Table 16.

Table 20 shows the annual subsidies (WTP) of the GoE, using the World Bank Oil Forecast to index LPG prices. The LPG subsidies are taken from Table 6 and the natural gas subsidies are taken from Tables 13, 14, and 15.

Table 20: Estimated GoE Subsidies (LE) – Base Case

	Low-Volume		Middle-Volume		Higher-Volume	
	EGAS pays Commission + GASCO	**Household pays Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**
Present Value LPG	2661		5323		8871	
Less Present Value natural gas	2188	1551	3159	2230	3899	2950
Present Value GoE WTP	**473**	**1110**	**2163**	**3093**	**4972**	**5921**
Internal Rate of Return (LE 1530 investment)	**NA**	**6.5%**	**17.0%**	**24.9%**	**46.9%**	**54.4%**

Source: World Bank calculations, using World Bank Oil Forecast, February 1, 2006.

Table 21 shows the same information but using the Alternate Oil Forecast for indexing future LPG prices.

Table 21: Estimated GoE Subsidies (LE) – Alternate Case

	Low-Volume		Middle-Volume		Higher-Volume	
	EGAS pays Commission + GASCO	**Household pays Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**
Present Value LPG	3257		6513		10855	
Less Present Value natural gas	2188	1551	3159	2230	3899	2950
Present Value GoE WTP	**1068**	**1706**	**3354**	**4283**	**6956**	**7905**
Internal Rate of Return (LE 1530 investment)	**6.4%**	**11.5%**	**23.7%**	**30.0%**	**52.2%**	**59.0%**

Source: World Bank calculations, using Alternate Oil Forecast.

The tables above shows the significant incentives for the GoE to contribute substantially to the costs of Household Conversion Fees. The WTP calculations demonstrate that it is economically viable to finance gas connections to middle- and higher-volume households and to contribute to the connection financing to low-volume households.

5.4 WTP OF LOCAL DISTRIBUTION COMPANIES

As mentioned above, each LDC receives from EGAS/EGPC LE 1000 for each new gas connection and LE 1500 from the household. The LDC pre-finances its LDC Connection Fee of LE 1000. Under the current arrangements, the first EGAS/EGPC installment of 40 percent is recovered through rates after three months of natural gas supply to the connected household, and the balance is recovered through rates in installments of 20 percent a year for three years, without interest, as shown in Table 11.

This arrangement for pre-financing the LDC Connection Fee has a present value savings to the GoE of LE 184 (US$ 32), using a 10% discount rate.

LDCs should be allowed to recover reasonable CAPEX and OPEX costs for supplying households and make a reasonable rate of return on their investments. As these costs are periodically reviewed by the MoP in their capacity as sector regulators, this paper will assume these costs are currently reasonable and through periodic adjustments will remain so. Therefore, the LDCs are assumed to have no further WTP for Household Connection Fees.

5.5 SAVINGS POTENTIAL OF SWITCHING HOUSEHOLDS

The above analysis demonstrates the macro- and micro-economic benefits of switching households from LPG to natural gas under current LPG and natural gas prices. Table 22 recaps the present value savings to households (from section 5.2 above).

Table 22: Present Value Savings to a Household Switching to Natural Gas

	Low-Volume (7.10 mmBtu/yr)		Middle-Volume (14.19 mmBtu/yr)		Higher-Volume (23.65 mmBtu/yr)	
	EGAS pays Commission + GASCO	**Household pays Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**
LPG consumption						
quantity (kg/yr)	150 kg/yr		300 kg/yr		500 kg/yr	
present value (10% discount rate) (LE)	715	715	1430	1430	2384	2384
Equivalent natural gas consumption						
quantity (m^3/yr)	197 m^3/yr		394 m^3/yr		657 m^3/yr	
present value (10% discount rate) (LE)	168	805	365	1295	813	1763
Present Value WTP (10% discount rate) (LE)	**547**	**-90**	**1065**	**135**	**1571**	**621**

Source: World Bank calculations.

The analysis shows the savings/loss of each household group when switching to natural gas from LPG. As described in section 3.3 above, current subsidized retail natural gas prices for residential customers vary depending on the volume consumed.

Table 20 estimates the GoE net subsidy savings from switching a marginal customer in each household group to natural gas. Table 23 aggregates the WTP from the previous sections.

Table 23: Economics of a Conversion (LE) – 'Subsidized' Prices – Base Case

	Low-Volume		Middle-Volume		Higher-Volume	
	EGAS pays Commission + GASCO	**Household pays Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**
Present Value household WTP	547	-90	1065	135	1571	621
Present Value GoE WTP	473	1110	2163	3093	4972	5921
Present Value LDC WTP	NA		NA		NA	
Present Value total WTP	**1020**	**1020**	**3228**	**3228**	**6543**	**6543**
Internal Rate of Return (LE 1530 investment)	**5.0%**	**5.0%**	**26.4%**	**26.4%**	**60.0%**	**60.0%**

Source: World Bank calculations, using World Bank Oil Forecast, February 1, 2006, 10% discount rate.

Table 24 shows the same information using the Alternate Oil Forecast.

Table 24: Economics of a Conversion (LE) – 'Subsidized' Prices – Alternate Case

	Low-Volume		Middle-Volume		Higher-Volume	
	EGAS pays Commission + GASCO	**Household pays Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**	**EGAS pays Commission + GASCO**	**Household pays Commission + GASCO**
Present Value household WTP	547	-90	1065	135	1571	621
Present Value GoE WTP	1068	1706	3354	4283	6956	7905
Present Value LDC WTP	NA		NA		NA	
Present Value total WTP	**1615**	**1615**	**4419**	**4419**	**8527**	**8527**
Internal Rate of Return (LE 1530 investment)	**10.9%**	**10.9%**	**31.3%**	**31.3%**	**64.2%**	**64.2%**

Source: World Bank calculations, using Alternate Oil Forecast, 10% discount rate.

As shown in Table 23, at *subsidized* prices for LPG and natural gas, the combined present value WTP of the GoE and households of switching to natural gas is calculated at LE 1020 (US$ 176) for the low-volume households, LE 3228 (US$ 557) for middle-volume households, and LE 6543 (US$ 1128) for higher-volume households.

Table 25 shows the present value WTP of households at 'economic' prices for LPG and natural gas. Middle- and higher-volume households have financial incentives to pay the total connection fee of LE 2500 and will switch to natural gas. Low-volume households would only be willing to pay up to LE 1500 towards financing of gas connections. At 'economic' prices the GoE is unwilling to contribute towards gas connection financing due to the lack of subsidy savings.

Table 25: Economics of a Conversion (LE) – 'Economic' Prices – Base Case

Economic	Low-Volume	Middle-Volume	Higher-Volume
Present Value household WTP	1691	3381	5635
Present Value GoE WTP	NA	NA	NA
Present Value LDC WTP	NA	NA	NA
Present Value total WTP	**1691**	**3381**	**5635**
Internal Rate of Return (LE 2530 investment)	**3.4%**	**16.5%**	**33.5%**

Source: World Bank calculations, using World Bank Oil Forecast, February 1, 2006, 10% discount rate.

Table 26 shows the same information using the Alternate Oil Forecast.

Table 26: Economics of a Conversion (LE) – 'Economic' Prices – Alternate Case

Economic	Low-Volume	Middle-Volume	Higher-Volume
Present Value household WTP	2286	4571	7619
Present Value GoE WTP	NA	NA	NA
Present Value LDC WTP	NA	NA	NA
Present Value total WTP	**2286**	**4571**	**7619**
Internal Rate of Return (LE 2530 investment)	**8.5%**	**21.6%**	**38.4%**

Source: World Bank calculations, using Alternate Oil Forecast, 10% discount rate.

This analysis demonstrates that it is economic to convert from LPG to natural gas for middle- and higher-volume households both under current 'subsidized' and 'economic' prices for LPG and natural gas. Although the low-volume households are not attractive by themselves to convert, by targeting areas with a combination of income groups and possibly commercial customers, it should be possible to convert all income groups economically.

5.6 HEALTH, ENVIRONMENTAL, SOCIAL AND SAFETY BENEFITS

In addition to the economic savings from switching to natural gas, there are social, health, environmental and safety benefits to the households. Currently, poor households collect LPG cylinders from distribution outlets, an activity that is time-consuming, requires substantial efforts, and has gender implications.

Poor households often do not have transportation facilities and have to carry the relatively heavy LPG cylinder between the household and the cylinder shop. This task is performed mostly by women. A 12.5-kg LPG cylinder has a total weight of about 18 kg (12.5 kg is the weight of the LPG and the 5.5 kg is the weight of the metal cylinder). The weight of the cylinders often causes rough handling and can result in explosion and injury to persons (*e.g.*, burns).

Switching households from LPG to natural gas also has additional health and environmental benefits as it significantly reduces CO_2 emissions. (1 ton of natural gas causes 2.6 tons of CO_2 emissions compared with 1 ton of LPG that causes 2.95 tons of CO_2 emissions.)

There is also the 'convenience' factor of natural gas. Experiences from other jurisdictions show that households are willing to pay a premium for access to natural gas. Anecdotal evidence in Egypt shows that households are willing to pay finance charges for conversion to natural gas that are multiples higher than the cost of LPG would otherwise have been under today's subsidized prices.

This analysis does not quantify any of those indirect benefits to households. To quantify those benefits a comprehensive socio-economic survey would have to be carried out and hence this analysis and the associated WTP calculations may be overly conservative.

6. OPTIONS TO INCREASE GAS CONNECTIONS

The previous chapters establish the economic basis for converting domestic LPG users to natural gas under the existing regime. This chapter sets out the scope of financing requirements for gas connections and sets out various options for improving the economics and for financing the cost of new natural gas connections.

6.1 SCOPE OF FINANCING REQUIREMENTS

The GoE plans to build 6 million natural gas connections over the next six years at a total investment cost of LE 15 billion (US$ 2.6 billion). Under the current arrangements, LE 6 billion (US$ 1.1 billion) will have to be raised by LDCs and LE 9 billion (US$ 1.6 million) by consumers.

On an annual basis, the total investment is LE 2.5 billion (US$ 430 million) per year on average. Of this, under the current arrangements, LDCs will have to raise LE 1 billion (US$ 170 million) and consumers will have to raise LE 1.5 million (US$ 260 million) annually. Table 27 sets out the CAPEX requirements for natural gas connections in the next fifteen years.

Table 27: CAPEX Requirements for Natural Gas Connections until 2012

	LE (billion)
6-Year Investment Requirement	**15.0**
• Total LDC Connection Fees	6.0
• Total Household Connection Fees	9.0
Annual Investment Requirement	**2.5**
• Total LDC Connection Fees	1.0
• Total Household Connection Fees	1.5

Source: World Bank calculations.

6.2 CHANGING CURRENT ARRANGEMENTS TO FACILITATE NEW CONNECTIONS

This section will investigate options for improving the economics of natural gas connection and delivery by altering the existing pricing and other arrangements, to facilitate new connections.

- **Should natural gas prices increase to include Commission and GASCO charges?**

To maximize economic efficiencies and create the appropriate price signals, customers should pay the total costs of being supplied with energy, including the gas commodity price and transportation and service fees.

In Egypt, the natural gas commodity charges are substantially below equivalent LPG charges, both of which are subsidized by the GoE. Rather than create a windfall for customers converting to natural gas (ignoring connection costs), it would appear reasonable for natural gas prices to include the costs of delivery. The analysis in section 5.2 above shows that including the Commission and GASCO charges in the current price of natural gas results in savings for consumers for the first six years for low-volume households, and for the first ten years for middle-volume households, and in all years for higher-volume households.

The analysis suggests that charging natural gas customers for the Commission and GASCO amounts is feasible. The financing analysis in section 6.3 below assumes this change. These amounts may be fashioned as service fees or increases in commodity charges.

- **Can the natural gas price be increased even more?**

The analysis in section 5.2 above shows a small reduction in fuel costs for low-volume and middle-volume households in the early years after conversion. Higher-volume households show savings of about 25 percent (present value) after connection.

Changes in gas prices for high-volume consumers, the upper steps of retail block pricing (see Table 8), may be warranted. Consideration could be given to the following:

Table 28: Pro Forma Retail Price Schedule

Current Arrangement		**Pro Forma***	
Annual Consumption	**Retail Price** (LE/m^3)	**Annual Consumption**	**Retail Price** (LE/m^3)
0-360 m^3	0.10	0-360 m^3	0.10
360-720 m^3	0.20	360-500 m^3	0.30
above 720 m^3	0.30	above 500 m^3	0.50

* N.B. For illustrative purposes only.

Although a conclusion cannot be reached without further study, such a lowering of the consumption thresholds in the retail pricing scheme would appear to have no effect on low-volume or middle-volume households, and would reduce the subsidy for higher-volume households by about LE 400 (present value). Raising the retail prices as indicated in Table 28 (at the current thresholds) would appear to have no effect on low-volume households, but would reduce the subsidy for middle-volume and higher-volume households by about LE 30 and LE 250 (present value), respectively. It would appear that combining the reduction in thresholds with the pricing increases for those upper levels has a compounding effect only on the higher-volume households, reducing their subsidy by LE 925. Given the need for further study, the financing analysis in section 6.3 below assumes no change in the current pricing arrangements.

- **Can there be a decrease in Commission and/or GASCO rates? Or a decrease in the 'ceiling' commission?**

The LDCs and GASCO should be entitled to reimbursement of reasonable costs of operating the gas networks. As sector regulator, the GoE should periodically review the Commission and GASCO rates. An analysis of adjusting these rates is beyond the scope of this paper.

However, for illustrative purposes, one could assume further efficiency gains of LDCs in the operation of distribution network and a decrease in the 'ceiling' commission to, say, LE 90 for the first ten years and LE 112.5 for the second ten years, a 10 percent reduction from today's rates. If implemented, this change would slightly increase the attractiveness of natural gas to all households from about LE 10 to LE 90 present value.

The financing analysis in section 6.3 below assumes no change in Commission and/or GASCO rates.

- **Can the Connection Fee be reduced?**

In recent years, the GoE has adjusted the Connection Fee periodically. Under the current arrangement, LDCs are providing an economic subsidy of LE 184 (see section 5.4 above) to the connection cost of LE 2500 (7.4 percent). As sector regulator, the GoE should periodically review the Connection Fee for reasonableness. An analysis of adjusting this fee is beyond the scope of this paper.

However, for illustrative purposes, one could assume the Household Connection Fee is reduced to LE 1300. Obviously, the present value effect of such a reduction is an improvement of LE 200.

The financing analysis in section 6.3 below assumes no change in the Connection Fee.

- **Can upstream payments be reduced?**

The upstream producers are receiving on average about US$ 2.50/mmBtu for natural gas. Given today's oil prices, and the existence of two LNG facilities and a pipeline for export, the analysis in the next bullet and section 6.3 below assumes no scope for reduction of the payments to upstream producers.

- **Pro Forma Analysis**

For illustrative purposes only, the following Table 29 shows the effect on the economics of new gas connections of implementing the possible changes described above (*i.e.*, increasing gas prices, decreasing the Commission cap, and reducing the Connection Fee). In comparing with Table 23, one can see that although the subsidy for the higher-volume bracket would be decreased (primarily due to the adjustments in the block-pricing) as a result of the pro forma changes, the overall economics are little affected.

Table 29: Present Value Economics – Pro Forma

	Low-Volume		Middle-Volume		Higher-Volume	
	Household pays Commission + GASCO (Table 23)	**Pro Forma**	**Household pays Commission + GASCO** (Table 23)	**Pro Forma**	**Household pays Commission + GASCO** (Table 23)	**Pro Forma**
Present Value household WTP	-90	-78	135	193	621	-211
Present Value GoE WTP	1110	1110	3093	3122	5921	6845
Present Value LDC WTP	NA		NA		NA	
Present Value total WTP	**1020**	**1032**	**3228**	**3315**	**6543**	**6634**
Internal Rate of Return (LE 1530/1330 investment)	**5.0%**	**6.9%**	**26.4%**	**31.5%**	**60.0%**	**70.4%**

- **What is the break-even average LPG price below which the avoided LPG subsidies no longer pay for the connection fees?**

An alternate approach to this economic analysis is to calculate the levelized LPG price below which the net savings generated by avoided LPG subsidies no longer pay for the costs of new connection. As previously mentioned, the above analysis uses the World Bank Oil Forecast, February 1, 2006, to index international LPG market prices. This forecast starts with the recent international LPG market price of US$ 440/ton for 2005, steps up in 2006, and declines in 'real' terms thereafter (see Table 3). Table 30 below calculates instead the fixed 'real' international LPG market price below which investing in a new connection is uneconomic. The table shows the break-even prices using the savings available to GoE plus the savings of a household after conversion to natural gas.

Table 30: Break-Even Average LPG Prices (US$/ton)

	Low-Volume	Middle-Volume	Higher-Volume
Break-Even using Total WTP	399	241	165

Source: World Bank calculations.

This analysis shows that so long as the GoE forecast of 'real' international LPG market prices averages above US$ 399/ton, it will be economic for the GoE to finance the conversion of consumers as low as one cylinder of LPG per month.

6.3 FINANCING OF NEW CONNECTIONS

In looking at financing options, this paper will assume Commission and GASCO charges are included in natural gas prices, but other options discussed in the previous section are not immediately implemented given the difficult policy implications and their limited impacts.

- **Should the LDC Connection Fee be increased?**

Under the current scheme, LDCs are pre-financing the LDC Connection Fee of LE 1000, and recovering it from EGAS/EGPC over four years, without interest. There is no known problem with this part of the current scheme. In fact, the terms are attractive to the GoE and should not be reduced unless part of a regulatory adjustment of rates.

Of course, if LDCs are willing to pre-finance more than LE 1000, with below-market return on investment, this would improve the economics of conversion. However, this paper will assume the MoP and MoF, as regulators of the sector, have set the LDC Connection Fee and terms at a reasonable level.

- **Should households finance the Household Connection Fee?**

Financing of the Household Connection Fee of LE 1500 presents significant challenges. As shown in Table 23, even with EGAS/EGPC absorbing the Commission and GASCO payments, all but the higher-volume households should be expected to decline the offer to convert under the current pricing arrangements.[11] With households paying the Commission and GASCO charges, as this section 6.3 assumes, no households should be inclined to pay the Household Connection Fee.

If households were offered financing of LE 1500 from the National Bank of Egypt, for seven years and at an interest rate of 12 percent (including insurance), as some are, the household would incur costs of about LE 330 per year. This alone is more that the LPG costs of a higher-volume household.

As shown in Tables 17, 18, and 19, the capacity for households to pay for the Household Connection Fee is very limited, from nil to LE 185 per year in the best case (higher-volume household with EGAS/EGPC subsidy of Commission and GASCO). One would assume that households should bear a part of the cost of connection for policy reasons, and the GoE should consider the appropriate level of household contribution to a new connection. For purposes of this analysis, it is assumed that the Household Connection Fee is paid by others, as discussed below.

As noted above, this paper's approach to Household WTP is conservative and considers only the relative costs of service. Consideration should be given to conducting some field research to determine the approximate value to consumers of the 'convenience' of using natural gas. A high 'convenience' factor could significantly increase Household WTP and thereby decrease the need for the GoE to pay for connections.

- **Should LDCs pre-finance the Household Connection Fee?**

Utility companies customarily pre-finance assets for recovery over time through rates. In simplistic terms, the investment is levelized over the recovery period using an authorized return on ratebase (*i.e.*, an interest rate). The rate of return would represent the weighted cost of capital of the utility, and the recovery period would typically be related to the life of the asset. Reviewing these calculations is a common function of regulators.

In Egypt, the financial capacity for LDC pre-financing of new connections is limited to the amount that can be recovered from the GoE through rates (*i.e.*, the GoE WTP as

[11] The economic analysis used a discount rate of 10%. Households would likely have a higher discount rate, which would serve to make payment of the Household Connection Fee even less attractive.

shown in Table 31). Presumably, the GoE would be willing to increase fees paid to LDCs by an amount equal to its net reduction in subsidies. With front-end loading of the LDC Connection Fee under current arrangements, the GoE WTP is uneven in the early years, and some financial engineering may be necessary for LDC pre-financing of new connections to be attractive to financial intermediaries.

Table 31: GoE WTP by Volume (LE)

Year	Low-Volume			Middle-Volume			Higher-Volume		
	LPG Subsidy (Table 6)	**Natural Gas Subsidy** (Table 13*)	**GoE WTP**	**LPG Subsidy** (Table 6)	**Natural Gas Subsidy** (Table 14*)	**GoE WTP**	**LPG Subsidy** (Table 6)	**Natural Gas Subsidy** (Table 15*)	**GoE WTP**
1	445	513	-68	890	593	297	1483	677	806
2	409	283	126	819	363	456	1365	447	917
3	383	283	99	765	363	402	1275	447	828
4	357	283	73	713	363	350	1189	447	741
5	331	83	248	662	163	499	1104	247	856
6	306	83	223	612	163	449	1020	247	773
7	281	83	198	563	163	400	938	247	690
8	264	83	181	529	163	366	881	247	634
9	248	83	164	495	163	332	825	247	578
10	231	83	148	462	163	299	770	247	523
11	231	83	148	462	163	299	770	247	523
12	231	83	148	462	163	299	770	247	523
13	231	83	148	462	163	299	770	247	523
14	231	83	148	462	163	299	770	247	523
15	231	83	148	462	163	299	770	247	523
16	231	83	148	462	163	299	770	247	523
17	231	83	148	462	163	299	770	247	523
18	231	83	148	462	163	299	770	247	523
19	231	83	148	462	163	299	770	247	523
20	231	83	148	462	163	299	770	247	523

Source: World Bank calculations; *as mentioned in section 6.2, Tables 13, 14, and 15 have been adjusted so households pay Commission + GASCO.

The following table shows the cost of financing the Household Connection Fee (LE 1500, annual principal and interest payments, levelized) over a range of terms and interest rates.

Table 32: Cost of Financing (LE)

Interest Rate	Term (years)								
	4	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**
10%	473	344	281	244	220	204	192	183	176
12%	494	365	302	265	242	226	215	207	201
14%	515	386	323	288	265	250	239	232	226
16%	536	407	345	310	289	274	265	258	253
18%	558	429	368	334	313	300	291	284	280
20%	579	451	391	358	338	325	317	312	308

Source: World Bank calculations.

Without any special credit enhancement, LDCs may be presumed to borrow in the range of 6-8 years and 14-16 percent interest, although specialized lenders like the International Finance Corporation (IFC) may be able to lend to the LDCs for longer tenors. At these terms, LDC pre-financing of the Household Connection Fee would be attractive to the

GoE, based on the GoE WTP, only for higher-volume consumers. Better financing terms might be available with a regulatory order approving the inclusion of the financing cost in rates, although probably not fully reflecting EGAS/EGPC credit due to regulatory risks. If EGAS/EGPC were to guarantee payment of the investment recovery amounts in a legally assignable form, lenders should be able to finance at EGAS/EGPC terms, which might be 10-12 years and 12-14 percent interest.

The GoE may wish to investigate supplemental external credit enhancement from institutions like the World Bank. A partial credit guarantee from the World Bank would create a blended credit, partly GoE and partly World Bank. Such an arrangement might induce lenders to reach up to 18 years at 12 percent interest and fees, although this would need to be tested in the banking community. If these types of terms are available, with cross-subsidization between income groups, a program might be designed to cover the broader market for conversion to natural gas, even more so if households contribute a nominal co-payment. Financial tailoring, particularly during the lumpy early years, could make a significant improvement, if lenders have that flexibility.

- **Should EGAS/EGPC finance the Household Connection Fee?**

As mentioned above, EGAS/EGPC is the owner of all natural gas transmission and distribution assets in Egypt, and will be the owner of the new connections being installed. One option is for EGAS/EGPC to finance the Household Connection Fee (LE 1500 less any nominal co-payment by households) directly.

Again, the GoE's appetite for financing of connections is the GoE WTP as shown in Table 31. As mentioned above, the unevenness of the GoE WTP in the early years may require some year-to-year tailoring of financing for a closer match of the GoE's savings and financing.

Within the Egyptian financial markets, EGAS/EGPC should be well positioned to borrow at rates more attractive than the LDCs. If financing for a term of 10-12 years and at a 12-14 percent interest rate is available to EGAS/EGPC, financing new connections of higher-volume consumers would be an attractive option.

The GoE may wish to investigate external financing such as a World Bank loan. On an LE equivalent basis, a World Bank loan, which can be as long as 20 years, should be attractive for conversions of households of all but the lowest gas consumers (unless there is an aggregation between lower- and higher-volume gas consumers).

- **Are there other factors to consider between LDC and EGAS/EGPC financing of the Household Connection Fee?**

Financing of connections by the LDCs in the Egyptian commercial banking market would depend in large part on the expectation that the LDC would recover its capital costs through rates paid by EGAS/EGPC, and, consequently, on the creditworthiness of EGAS/EGPC. The obligation of EGAS/EGPC to make these payments constitutes a

direct liability of EGAS/EGPC, and would need to be recorded as such. If EGAS/EGPC were to document its obligation with an assignable guarantee of its liability, it would greatly facilitate LDC financing.

It is debatable whether the addition of a GoE guarantee of EGAS/EGPC's payment obligations to the LDCs would increase the liabilities of the sovereign, given the close relationship between GoE and EGAS/EGPC, although such a guarantee certainly would facilitate LDC financing if it were assignable to lenders.

Whether financing of new connections is arranged as direct borrowing by GoE or of a borrowing by LDC enhanced by a GoE guarantee, such financing would constitute a direct liability of the sovereign.

The GoE should explore with potential lenders the possibility of only a partial guarantee of the LDCs' repayment obligations to the lenders, rather than a full guarantee of EGAS/EGPC's capital recovery payments. Such a partial credit guarantee might, for example, guarantee only later principal repayments so as to motivate lenders to lend for a longer term. This might reduce the sovereign liability to half or less (present value) of the loan amount.

A guarantee by the GoE may provide benefits that are less obvious, as well. The involvement of private financiers, particularly private Egyptian commercial banks, will necessarily impose commercial behavior on the LDCs. Putting the LDCs at risk for cost overruns and construction delays will encourage efficiency in the procurement of new connections of potential natural gas customers.

Six million new connections represent a very large amount of financing. Another potential advantage of LDC financing supported by a GoE guarantee is the opportunity to reduce GoE involvement in the financing over time. If, in fact, the involvement of private financiers and the provision of only a partial guarantee by the GoE has the effect of imposing commercial discipline on the LDCs, presumably the LDCs should, over time, become able to support financing of new connections on the basis of their own credit, reducing or eliminating the need for GoE guarantees.

Based on the above assumptions, it was demonstrated that it is economically viable to develop the natural gas distribution network for middle- and higher-volume households in Egypt. Although low-volume households are not attractive by themselves to convert due to their limited volume uptake, by targeting areas with a combination of income groups and possibly commercial customers, it should be possible to convert all income groups economically.

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