Formal Report 328/07

Greenfield Gas Distribution: Cross-country Experience

ESMAP

Energy Sector Management Assistance Program

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Units of Measure

bcm	billion cubic meters
CO_2	carbon dioxide
F	fahrenheit
km	kilometer
km^2	square kilometer
m^3	cubic meters
mn	million

Acronyms and Abbreviations

APEC	Asia-Pacific Economic Cooperation
APERC	Asia-Pacific Energy Research Center
APM	administered price mechanism
BGC	British Gas Corporation
BOTAS	Boru Hatlari ve Petrol Tasima AS (Turkey's petroleum pipeline corporation)
CHP	combined heat and power
DDHA	Danish District Heating Association
DH	district heating
DNNs	Distributeurs Non-nationalisés
EU	European Union
FRG	Federal Republic of Germany
GAIL	Gas Authority of India Limited
GdF	Gaz de France
GdP	Gas de Portugal
GNI	gross national income
HDDs	heating degree days
IEA	International Energy Agency
INH	Instituto Nacional de Hidrocarburos
Kogas	Korean Gas Corporation
LACGEC	Latin American and Caribbean Gas and Electricity Congress
LNG	liquefied natural gas
LPG	liquefied petroleum gas
NELP	new exploration licensing policy
OECD	Organisation for Economic Co-operation and Development
OIL	Oil India Limited

ONGC	Oil and Natural Gas Corporation
RoR	rate of return
TPA	third party access
TPES	total primary energy supply
T&D	transmission and distribution
ToP	take-or-pay
UN	United Nations
WB	World Bank

Executive Summary

Purpose of the Study

Once confined to a few countries, gas distribution systems have spread widely around the world in the past few decades. The discovery of new gas deposits, technological advances cutting the cost of gas transportation and environmental concerns have prompted a growing number of countries to embark on projects that introduce natural gas to a wider base of consumers.

Despite its growing importance, however, comparative studies on gas distribution across countries are significantly lacking, especially pertaining to areas outside the Organisation for Economic Cooperation and Development (OECD). The major purpose of this study is partly to fill this gap, and partly to contribute to the understanding of several issues essential to gas distribution worldwide. These include the following:

- What explains the uneven level of gas distribution development across countries worldwide? Why did some countries develop their gas distribution infrastructure notably earlier than others?

- Why have some countries failed to achieve any significant progress in establishing gas distribution networks despite proclaimed initiatives to do so? Also, what contributed to delays in the accomplishment of such greenfield projects?

- What are the new challenges and opportunities for countries which embarked more recently on greenfield gas distribution?

The study aims to present information about specific countries which have initiated gas distribution projects rather than suggestions. However, by drawing on the experience of a large number of countries, it also aims to provide practical lessons about issues which could potentially foster or impede gas distribution projects.

Methodology

The study emphasizes how countries vary in terms of the level of development of gas distribution networks. Chapter 3 outlines the major factors contributing to such a diversity. These factors fall into three categories which form the basis for analyzing gas distribution in the countries selected in the study: supply-side factors, demand-side factors and policy choices of governments.

The report is based primarily on a desk study of a sample of 28 countries from five continents. Each country has undertaken greenfield gas distribution projects at some stage. In selecting the countries, the priority has been to achieve the greatest possible variety in terms of the factors driving gas distribution. Principal factors include the level of economic development, geographic size and location of the country, climatic conditions, availability of

indigenous or foreign gas supply, population density, gas market structure and predominant government policies with implications for the gas sector.

Each country included in the sample has a unique story about developing gas distribution networks, and could provide valuable lessons. However, illustrating these lessons through a separate case study for each of the 28 countries would make any practical conclusions cumbersome. Thus, this study takes an alternative approach and brings together these countries for the purpose of examining the presence of certain *patterns* about the experience of these countries, as well as addressing the questions noted above.

The 28 countries are categorized into two groups: Group I ("pioneers") and Group II ("newcomers"). The distinction is based on one major criterion: countries in Group I started significant greenfield gas distribution projects at least three decades ago. Countries in Group II started more recently, some as late as toward the end of the 90s. This distinction helps to emphasize that gas distribution today faces significantly different circumstances than in the past. Thus, to some extent, by examining the experience of Group I, this study provides insights primarily about how gas distribution was done in the past, while the experience of Group II highlights the more recent challenges and opportunities in this sector. This categorization of the 28 countries also highlights the fact that reaching high levels of household gasification is usually a very time-consuming process. Thus, some countries have significantly lower rates of residential gas penetration simply because they started the process of greenfield gas distribution relatively later. Finally, an analysis based on this categorization helps to address one of the major questions in this study: why some countries started greenfield gas distribution projects much earlier than others?

Main Conclusions

There has been a highly *uneven level of gas distribution development worldwide*. Some countries managed to develop an extensive gas distribution infrastructure several decades ago, while others are just starting to invest in this area. Based on the experience of the 28 countries analyzed in this study, this diversity is an outcome primarily of the following:

- On the supply-side, possessing a distribution infrastructure based on manufactured gas has created cost-cutting opportunities in gas distribution investments and provided a major headstart for several countries. As another supply-related issue, acquiring an early access to natural gas (indigenous or imported) has also helped some countries achieve a relatively faster progress in greenfield gas distribution projects than others. Finally, the economic level of development of a country has largely determined when it acquired access to natural gas, especially if coming from foreign sources;

- On the demand-side, the presence of a relatively colder climate which requires space heating has appeared central for greenfield gas distribution. It is rare that countries with low heat load develop extensive gas distribution networks. The economic level of development of a country appears as a crucial demand-side factor as well, as it has significantly affected the ability of households to switch to natural gas from other fuels; and

- While there is no "one-size-fits-all" policy model which explains successful progress in greenfield gas distribution, the study reveals that policy choices have been highly significant. Accordingly, several countries have managed to develop extensive gas distribution infrastructure despite facing major disincentives (such as a warm climate or lack of indigenous gas supplies) for

greenfield projects. Similarly, some countries have failed to benefit from major assets, such as the presence of sizable indigenous gas supplies, largely due to policies adopted by their governments.

Group I

The *success of countries in Group I* ("pioneers") in developing extensive gas distribution networks has been an outcome mainly of the following:

- Most of them benefited from a legacy of large scale distribution networks operating on manufactured gas. Once natural gas was available, there was a major cost incentive to convert this to more efficient fuel;

- Most of these countries, at least during the initial stages of greenfield gas distribution, possessed significant indigenous gas reserves. Meanwhile, their pioneering role in upstream investments allowed them to tap these resources, contributing to an early development of a national gas market;

- Owing to their relatively higher level of economic development (measured in terms of national income per capita), Group I countries were the first to be able to afford large-scale investments in major cross-border pipelines or liquefied natural gas (LNG) import terminals. Similarly, they were the first to develop extensive transmission networks. Both of these developments assured gas supplies for a growing number of consumers, especially those served by distribution grids;

- Gas distribution in most countries in the Group benefited from the presence of high heat load associated with their relatively cold climate. However, in the case of a few of these countries, heat load remained a less significant factor, as the residential sector largely abstained from using natural gas for space heating purposes;

- Switching to natural gas is a costly process, especially for residential consumers – the primary object of gas distribution networks. In the case of Group I countries, the relatively high level of per capita income facilitated the displacement of existing fuels; and

- The study reveals that countries in this Group have achieved high levels of gas distribution development despite opting for quite different policies. The differences are major in terms of the level of government involvement (such as ownership and regulation of gas tariffs) in distribution; the concentration of ownership in this segment of the gas market; the level of vertical integration in the gas market overall, and the timing and scope of reform. Therefore, the experience of Group I countries illustrates that there are different paths to success in greenfield gas distribution.

Group II

A small subset of Group II countries has also managed to achieve rapid progress in greenfield gas distribution projects. Success in these countries appears to be associated primarily with various policy choices adopted by their governments. For instance, legislative changes encouraging the involvement of private entrepreneurs have been highly consequential in fostering investment in gas distribution. Also, measures aimed at gas market liberalization in these countries have coincided with acceleration in gas distribution projects. However, there is no single explanation for the *success of all of this subset of Group II countries*. Interestingly, the countries most advanced in terms of greenfield gas distribution are those with no significant indigenous gas reserves (Colombia being the only exception).

Meanwhile, most countries in Group II have achieved progress in greenfield gas distribution to a lower extent. Examining the experience of these countries reveals the following:

- Many Group II countries possess sizable indigenous gas reserves. However, due to shortcomings in the legal environment or other problems, nearly all of them failed to mobilize investments in their upstream, and production of natural gas remained constrained until the 80s or even the 90s. This has been a major source of delay for gas market development, overall, and investment in gas distribution infrastructure, in particular;

- Partly due to financial constraints, but also as an outcome of lower priority on the part of the governments, many of these countries failed to establish an extensive transmission network which could have sparked development in gas distribution;

- Due to the relatively milder climate in most Group II countries, developing gas distribution networks for residential consumers has long remained a low priority for governments. Similarly, switching to gas has usually been a lower priority for households. This is due to the relatively high costs associated with this process as well as the availability of relatively cheap (or free) access to combustible renewables (usually wood) as an alternative source of energy for a significant share of the population; and

- The study provides multiple examples for policies adopted by Group II countries which have impeded progress in greenfield gas distribution. Some of these policy choices include: lower national priority on natural gas; the presence of a national oil and gas company with traditional emphasis on oil; specific regulations of distribution tariffs which reduce the incentives for investment; the presence of subsidies for fuels competing with natural gas; weak enforcement of clean air regulations; and delays in privatization of distributors amidst the financial problems of incumbent gas companies.

Challenges and Opportunities for Development of Greenfield Gas Distribution

Unlike the case of Group I countries, in which distribution networks had reached an advanced stage before the introduction of major reforms (such as privatization of the national transmission owner and reduction in the level of vertical integration in the market), such reforms have coincided largely with the early stage of greenfield gas distribution in Group II countries. These countries thus provide valuable examples of progress in gas distribution amidst major shifts in the gas market toward higher levels of competition and limited government involvement.

Another distinctive feature for the "newcomers" is the large role of power generation in the development of a national gas market. Unlike most countries in Group I, power plants have emerged as major consumers in the early stages of gas market development for most countries in Group II. This is mainly due to the late start-up of gas market development, which coincided with the new global emphasis on gas-fired power generation. As a result of this relatively late start-up, infrastructure development in this group of countries appears blessed with the presence of power plants as anchor consumers. Power plants located in different parts of these countries have been a major driver in the construction of transmission pipelines, following which cities have initiated greenfield gas distribution projects.

Group II countries also, on the whole, have not benefited from the inexpensive natural gas that was normal when many of the Group I countries installed their gas distribution systems. In the early days of gas distribution, natural gas was very cheap at the well head since it was a by-product of oil production and often flared. This is no longer the case and the Group II countries are usually installing systems to deliver relatively more expensive natural gas.

Finally, the Group II countries are dealing with gas distribution in a period of heightened environmental awareness. Some Group I countries (such as the United Kingdom) were very much aware of the reduction in air pollution associated with the introduction of natural gas. (Gas distribution in London was the main reason for the elimination of the infamous London fogs.) However, all Group II countries are aware of the reduction in air pollution associated with natural gas distribution, as well as the reduction in carbon emissions, as natural gas replaces generally more polluting and carbon-intensive fuels.

1. Introduction

Natural gas has become an increasingly important fuel for household, commercial and service consumers. This has required extensive investment in the construction of gas distribution networks serving these consumers.

Historically, gas distribution networks developed first in countries which were marked by a comparatively higher level of economic development, significant indigenous supplies and a relatively cold climate. In the early 20s, the United States was the leader in establishing natural gas distribution networks. This was the result of significant discoveries of natural gas, substantial heating demand as well as technological progress, namely the invention of all-welded steel pipelines in the mid-20s. These enabled gas producers to connect their fields with major consumption centers through long-distance transmission pipelines. The United States was followed, after World War II, by Western European countries which benefited from indigenous gas supplies (especially in the United Kingdom and the Netherlands), cross-border pipelines and liquefied natural gas (LNG) import facilities constructed to allow a growing number of consumers access to this new fuel.

Today, a growing number of countries have made significant progress in establishing extensive distribution networks which provide their households with access to gas. These countries vary in almost all aspects considered to be important for initiating large-scale investments in gas distribution. Thus, many countries with significant progress in developing gas distribution would be classified as "low income" or "lower middle income" countries. Others possess a relatively warm climate which does not require space heating, resulting in significantly lower gas consumption per household than in the countries which pioneered in gas distribution. Moreover, a growing number of countries with no indigenous gas reserves are embarking on developing distribution networks for gas.

Several major factors have contributed to such "globalization" of gas distribution. First, discoveries of natural gas reserves in an increasing number of locations have provided the impetus for investing in infrastructure for transporting this fuel to meet growing demand. Second, technological progress has resulted in the invention of stronger steels, high-pressure pipelines, deepwater pipe-laying, larger LNG trains, and more efficient compressor stations. These have contributed to significant cost-cutting in both pipeline and LNG projects. Also, the growing role of power plants, fired by gas, has helped anchor development of the national transmission infrastructure, which, in turn, has prompted development of gas distribution networks. Meanwhile, increasing environmental concerns have also fostered the introduction of natural gas to households in an increasing number of cities worldwide.

This study addresses several major questions:

- What explains the uneven level of gas distribution development across countries worldwide? Why did some countries develop their gas distribution infrastructure notably earlier than others?
- Why have some countries failed to achieve any significant progress in establishing gas distribution networks despite proclaimed initiatives to do so? What contributed to delays in the accomplishment of such greenfield projects?
- What are the new challenges and opportunities for countries which embarked more recently on greenfield gas distribution?

2. Definitions, Methodology and the Importance of Gas Distribution

Definitions

Gas distribution is defined as the activity of transporting and marketing gas from the city gate to a consumer's meter. Often, the borderline between distribution and transmission is blurred, and countries adopt different definitions for each. In general, however, distribution takes place in low-pressure pipelines serving the residential and commercial-public services sectors. Occasionally, distribution networks may serve smaller- and medium-size industrial users. Rarely, in some countries, have distributors been allowed to sell gas to larger industrial users and power plants. These types of consumers traditionally fall within the domain of high-pressure transmission network operators.

Greenfield gas distribution is an activity involving large-scale construction of distribution lines. Besides construction in areas with no distribution grid whatever, the report's definition encompasses growth of investment in new networks. It also includes cases of converting existing distribution grids, based on manufactured gas, into grids based on natural gas, if this involves large-scale investment and expansion in terms of reaching new consumers. Expanding an existing distribution network is not included as part of greenfield distribution, if it is limited mainly to connecting consumers who are already in an area served by the existing distribution pipelines.

The Importance of Gas Distribution

The study acknowledges that gas distribution is not always the optimal choice for providing energy to residential and commercial-public services consumers. However, it calls attention to the variety of ways that countries have benefited from developing greenfield gas distribution projects. These include the following:

- Natural gas is one of the cleanest burning fossil fuels. Its introduction among households helps to reduce emissions and improve the quality of air, especially in areas marked by significant levels of pollution;
- Many attributes associated with natural gas can provide additional convenience to households. Thus, gas is a versatile fuel with the possibility for numerous applications, such as space heating, water heating, cooking, airconditioning, pool heating and clothes drying. It provides a continuous and reliable supply, with possible interruption being of little concern. Also, unlike many other types of fuel (such as fuel oil), it does not require local storage;
- If gas is priced below alternative fuels, it can significantly reduce the energy bill of households;
- In countries where combustible renewables (such as wood) are a major source of energy for households, natural gas can help reduce deforestation; and

- Use of natural gas can improve a country's energy security by reducing dependence on petroleum products consumed by households and the commercial-public services sector.

Methodology

There is great variation in the prevalence of distribution grids worldwide. Countries range from those that have achieved nearly universal gas penetration in households and commercial-public services to those with an absolute lack of any gas distribution infrastructure.

Chapter 3 aims to illustrate the major reasons behind this variety. Its primary point is that multiplicity of factors may potentially affect a country's decision to develop gas distribution networks and its success in implementing such a decision. These factors are grouped into three categories: supply-side factors; demand-side factors; and government policies with major implications for gas distribution.

In theory, each factor could directly or indirectly determine the extent of gas penetration in households and commercial-public services – the primary driver for building distribution networks. Meanwhile, the study emphasizes that no single factor appears as a necessary prerequisite for having an advanced gas distribution network. By the same token, countries may respond differently to circumstances which pose major disadvantages for greenfield gas distribution.

Chapter 4 provides a cross-country analysis of progress in gas distribution. Countries (rather than individual companies), and their efforts related to greenfield distribution projects, constitute the core of the analysis. The section draws on a large sample from all parts of the world – 28 countries from five continents.

Each country examined in the study has embarked on greenfield gas distribution. Many exhibit similar features in relation to the three types of drivers examined here. However, despite major similarities, they have ended up with significantly different levels of success in gas distribution. By contrast, some countries have reached nearly identical levels of gas penetration (in the residential sector, in particular), despite differences in the supply, demand and policy sides of greenfield gas distribution.

In selecting the countries, priority has been given to achieving the greatest possible variation in the level of economic development, geographic size and location of the country, climatic conditions, availability of indigenous or foreign gas supply, population density, gas market structure and predominant government policies with implications for the gas sector.

Many countries have been excluded from the study for one of the following reasons. First, some countries exhibit similar features to those included in the sample, and do not contribute significantly to understanding greenfield gas distribution. Second, the study excludes countries in which there have been no initiatives for gas distribution whatever (such as Bahrain, Brunei, Darussalam, Trinidad and Tobago, Nigeria and so on, and so forth). A separate explanation is provided for countries emphasizing district heating (DH) instead of greenfield gas distribution (Box 3.1: The District Heating Alternative), as a result of which they are also excluded from the sampled countries. Third, the former Communist bloc is represented by three countries only (Russia, Bulgaria and the Czech Republic), as distribution in a centrally planned economy does not pose a practical example under current circumstances. Fourth, some countries with substantial progress in greenfield gas distribution are absent because of the lack of sufficient historical data on the evolution of their gas distribution networks (for example, Bangladesh, Pakistan, the Arab Republic of Egypt and the Islamic Republic of Iran).

Each country in the sample, in fact, has its own story about gas distribution and could provide

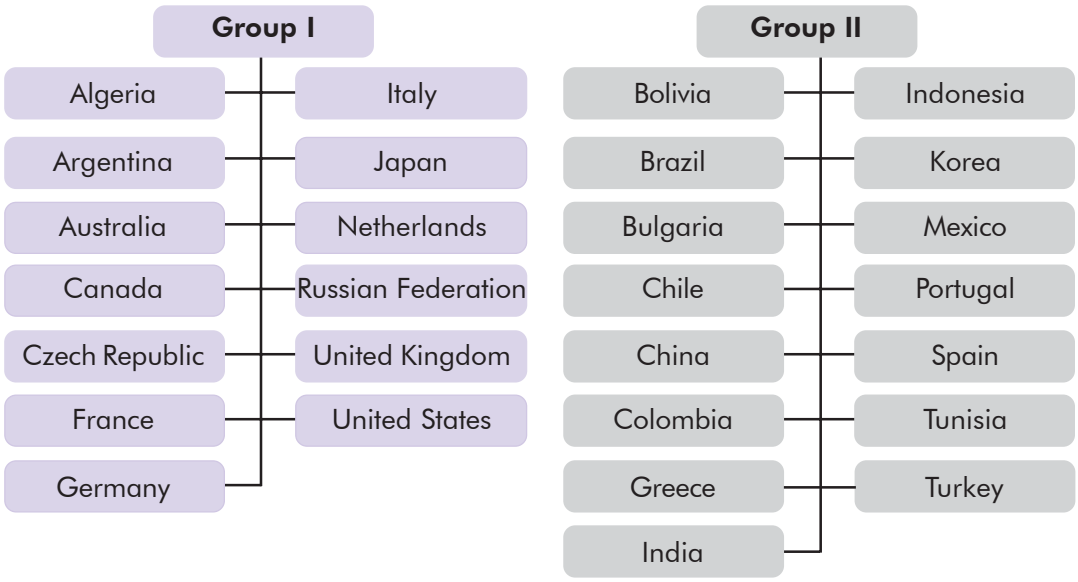
valuable lessons. A separate case study on each of these countries could provide worthy insights about their experience with gas distribution. However, illustrating these lessons through separate case studies on each of the 28 countries would make any practical conclusions cumbersome. Thus, this study takes an alternative approach and brings together a large number of countries for the purpose of examining the presence of certain *patterns* and addressing the questions noted above.

The countries are examined in two separate groups: Group I (the "pioneers" in gas distribution), and Group II (the "newcomers" in gas distribution Figure 2.1).

distribution relatively later. Reaching high levels in household gasification is usually a very time-consuming process, and, even for the most successful countries, the introduction of gas to most households has taken many decades. Second, such a distinction helps to address one of the major questions in this study: why did some countries have a much earlier start-up in greenfield gas distribution projects than others?

Group I includes countries which have reached a significant level of residential gas penetration (at least 30 percent). While set arbitrarily, this figure allows the inclusion of a large number of countries (13) which had a "pioneering" role in gas distribution, and achieved some degree

Figure 2.1: Selected Countries with Gas Distribution



The distinction is based on one major criterion: countries in Group I started significant greenfield gas distribution projects at least three decades ago. Countries in Group II started more recently, some as late as toward the end of the 90s. This distinction is important for two reasons. First, it takes into account the fact that some countries have significantly lower rates of residential gas penetration simply because they started the process of greenfield gas

of success in spreading gas to their households. Group II includes countries which did take at least some initiative in greenfield gas distribution projects in the past three decades. Their success, measured in terms of the share of households with access to natural gas, is highly variable. For some countries, household penetration is higher than in several countries in Group I, while for others it is as low as nearly "0" percent. This variation allows for the

analysis of the different level of success in greenfield distribution projects across countries, and provides possible explanations for the reasons behind this.

The study is based primarily on desk research relying on extensive analysis of greenfield gas distribution initiatives in each of the 28 countries. In terms of data, it relies primarily on statistics available from the International Energy Agency (IEA), Eurogas, International Gas Union, the United Nations (UN), Asia-Pacific Economic Cooperation (APEC), as well as the World Bank's own sources.

3. Factors Driving Greenfield Gas Distribution

Supply-side Factors

Supply, in this analysis, encompasses two aspects of natural gas. First, embarking on greenfield gas distribution projects requires some assurances as to the availability of natural gas. Whether from indigenous reserves or from fields located abroad, the presence of natural gas (or the mere prospect of it) is a significant factor which influences decision-making in building gas distribution networks. It can also be a major factor explaining why some countries had an earlier start-up in terms of developing their national gas industry overall, and gas distribution, in particular. Second, supply also encompasses the potential costs associated with shipping natural gas from the well head to retail consumers. This aspect is important, as almost any country, in theory, could have access to natural gas; however, for some countries, it will occur only at prohibitive cost.

Several issues with potential implications on greenfield gas distribution could be grouped under each of these aspects of the supply side of natural gas:

- **Issues related to the availability of gas:** Not surprisingly, the first countries to establish natural gas industries, as well as gas distribution networks, were those that possessed significant volumes of natural gas. Building a national gas industry based on imported gas is the outcome of major technological improvements[1] and appears as a more recent phenomenon. Meanwhile, some countries simply benefit from their geographic location and emerge as major transit hubs, which can provide assurances for gas supply as well as facilitate the construction of a national transmission network. Yet, possessing indigenous gas provides several advantages. It frees a country from the need to negotiate at length on supply deals with foreign countries (or their companies). It eliminates the need to build cross-border pipelines, where construction can proceed only after negotiations which may often become burdensome. In addition, larger indigenous gas reserves in proportion to the country's potential demand usually help reduce concerns for supply security. Finally, the presence of significant gas reserves poses a constant reminder of the opportunity cost of not using those resources. This could potentially spark development of gas distribution networks, along with a national gas industry; and
- **Issues related to the costs of supplying gas to final consumers:** Building gas

[1] *Some major technological improvements include the invention of stronger steels, high-pressure pipelines, deepwater pipe-laying, larger LNG trains and more efficient compressor stations.*

distribution pipelines is a costly process. Some countries have been able to benefit from the presence of infrastructure for distributing manufactured gas, which was converted to natural gas at comparatively low cost. Also, final consumers in gas distribution (such as households, commercial and service consumers) bear additional costs, namely those associated with transporting gas over longer distances. One factor which could affect such costs is the proximity of gas reserves to consumption centers. Another factor is whether the country imports gas through a pipeline or LNG tankers, with the latter usually being associated with higher costs. Similarly, terrain for building long-distance pipelines can also affect shipping costs significantly. Finally, quite often, construction of long-distance (especially cross-country) gas pipelines has necessitated some government funding. As a result, the financial capability of the respective government has also been significant in launching such major infrastructure projects.

Demand-side Factors

A rough comparison across countries reveals that potential demand for natural gas by retail consumers is one of the chief determinants for the development of gas distribution grids. Also, from the perspective of distribution companies, the expected size of gas demand is the principal variable determining their profits. In most countries, including those in which utility providers are not driven by profit, elaborate studies estimating natural gas demand are necessary to determine the capacity and investment requirements of the distribution grid.

The following section looks into the principal drivers of gas demand in the residential sector – the chief source of demand for gas transported through the distribution grid. Also, the analysis applies to the commercial and services sectors, which generally appear as a major supplementary source of gas demand.[2] The overall gas demand structure within a country (that is, the share of power generation, industry, residential, commercial and services sectors in total gas demand) is also considered with respect to its implications in developing greenfield gas distribution networks, and in the provision of gas to retail consumers.

Energy Consumption Patterns of Households

Traditionally, there have been three major areas of gas consumption by households: space heating, water heating and cooking. Recently, new areas of application, such as air conditioning, clothes drying and pool heating, have emerged, expanding the demand for gas in many households.

Space heating has a prominent place among the various areas of residential gas application. Where significant space heating requirements exist, households usually consume the bulk of natural gas for meeting their space heating needs, with the rest of gas delivered to them used for cooking, water heating, and (if any) other purposes.[3] Countries in which space heating is widespread usually consume larger volumes of natural gas (or any other energy) per household than those where space heating is limited.

The potential for using gas in space heating has at least two implications. Distribution

[2] *It is possible to build distribution networks based primarily on the commercial and service sectors and, to a lesser degree, on the residential sector. In practice, however, this has remained more as an exception, as examined in Chapter 4.*
[3] *Some exceptions exist, such as Japan (as examined in Chapter 4).*

companies serving consumers using gas for space heating are likely to sell relatively higher volumes of gas per consumer, which will potentially affect their profits. Consumers, on the other hand, faced with the option of using gas for heating, are more likely to be sensitive to the relative cost of competing fuels. This is because larger volumes of energy consumption will imply larger shares of energy expenditures in their overall monthly (or annual) budgets.

The potential volume of gas consumption by households is determined largely by the following factors:

- **Climate:** This determines the need for space heating, as well as the average residential heat load. A measure of climate is the number of heating degree days (HDDs). A HDD is considered to be equal to zero, if the temperature exceeds a certain base value, usually 65°F.[4] In countries (or regions) with relatively warm climates, the need for space heating is minimal. Under these circumstances, the viability of building a distribution network is not as clear and this can discourage investment. This is especially the case if residential customers (who consume gas for needs other than space heating) are the only consumers allowed to be served by a distribution company working for profit.

  Nevertheless, whereas colder climates lead to high residential heat loads on an average, they also contribute to a higher level of seasonality in residential gas demand. This requires designing distribution pipelines based on peak load capacity, which is associated with additional costs. A partial remedy for this comes from the growing use of air conditioning fired by natural gas. It contributes to a higher volume of gas consumption during warmer seasons, which are traditionally marked by lower residential consumption;

- **Competing fuels and their relative prices:** Estimating how consumers react to relative fuel prices requires studies on the elasticity of demand for various income groups. However, consumers in general are expected to prefer fuels that are delivered to them at consistently lower costs than others. Thus, in countries (or regions) where natural gas is priced below competing fuels, consumers are more likely to switch to gas once it is available. Similarly, availability of relatively inexpensive electricity (possibly because of abundant hydro resources or a priority on nuclear energy), biomass, or petroleum products pose significant challenges to the penetration of gas in households;

- **Average per capita income:** When households switch to natural gas their choice is determined mainly by three types of costs: the price of gas; the connection fees which are usually required for access to gas; and the cost of appliances which use gas. In countries with higher per capita (such as most industrial countries), none of these usually constitutes an excessive cost for an average household. Moreover, consideration of the superior convenience of gas (versus that of many other fuels) and its environmental impacts could often be strong enough to prompt households to switch to gas.[5] In low-

[4] *If the temperature is below the base value, HDD is calculated as the difference between the base value and the average of the high and low temperatures of the day. The sum of daily values provides the annual HDD value. Herbert, John.* Clean Cheap Heat, The Development of Residential Markets for Natural Gas in the United States *(New York: Praeger, 1992), 141.*

[5] *With regard to the lack of a significant price advantage for competing fuels, households in higher income countries have tended to prefer natural gas because of its inherent higher level of convenience: there is no need to store the fuel (in contrast to coal and fuel oil in particular), and supply interruptions (in comparison with electricity) are less likely.*

income countries, on the other hand, the cost of switching to natural gas is often prohibitive, which impedes progress of the overall penetration level. Nevertheless, unless households have access to relatively cheaper energy (especially biomass, which is often free), there is a strong incentive to switch to gas to lower burdensome monthly energy bills; and

- **Household formation patterns:** The average size of a country's household[6] also has implications for developing gas distribution projects. Smaller household size, in general, relates to higher average consumption of gas (and other fuels) per person, but may potentially imply lower levels of consumption per consumer (household). Meanwhile, decreasing household size implies growth in the potential number of consumers, even if the overall population growth rate is stagnating.[7]

Settlement Density

Building gas distribution networks involves substantial economies of scale. A principal measure for benefiting from economies of scale is *the average volume of gas demand per kilometer (km) of the distribution grid*. This, in turn, depends greatly on a country's (or region's) settlement density.

There are several aspects of settlement density, none of which, in themselves, is a precondition for getting involved in greenfield gas distribution. However, each of them may appear as a significant cause of success or failure in the penetration of natural gas in the residential, commercial and service sectors of a country (or its particular regions):

- **Population density and its distribution:** Higher density of population usually means lower investment costs per consumer. This may be the case for both country and regional levels of gas distribution. Thus, distribution companies operating in countries with sparse population density may experience fewer opportunities for benefiting from economies of scale. However, this problem may be largely disregarded in the case of significant concentrations of population in large cities and agglomerations. For this reason, greenfield gas distribution projects are often initiated in the largest cities of a country, subsequently spreading to other regions;

- **Level of urbanization:** Urbanization level is significant due to its implications for population density. Generally, higher levels of urbanization provide more favorable conditions for benefiting from economies of scale. In a predominantly rural country, spreading gas distribution beyond a few large cities is highly challenging, as it implies building mains over longer distances to serve fewer consumers (compared with countries with higher urbanization levels); and

- **Type of dwelling:** The type of dwelling is another aspect of settlement density with potential implications for the scope and speed of residential gasification. The predominance of multifamily dwellings (apartments) versus detached houses significantly enhances the economies of scale of a distribution project. It also lowers the average cost of accessing gas for households.

[6] *Household is defined as a person or a group of persons who occupy a common dwelling.*
[7] *The average size of households, in turn, is determined mainly by the fertility rate, changes in the age structure of the population and marriage behavior.*

Presence of Anchor Consumers

Industrial users and power plants could potentially have a large impact on total gas volumes supplied within a country. Therefore, their contribution to the development of gas distribution networks is likely to occur in one of two ways. First, adding either of these types of consumers to the distribution system ensures significant economies of scale for local distribution companies. Even the provisional right to act as the exclusive provider of gas services to a power plant or larger industrial consumer could affect the fortunes of a distribution company to a significant extent. Whether a distribution company is allowed to benefit from this depends on the regulatory framework for gas distribution projects.

Second, large consumers can indirectly contribute to greenfield gas distribution. Industrial users and power plants may serve as anchors for the development of a country's transmission infrastructure, which is often the sine qua non element in initiating any distribution projects. Overall, their large concentrated demand, especially if associated with long-term supply contracts, provides predictable stream of revenues. This is essential for financing investments in transmission infrastructure, which can then reach cities waiting for distribution projects.

Government Policies on Gas Distribution

There are several policy choices through which governments can foster or impede development of gas distribution networks. A policy recommendation for a specific country needs to be based on studies of its energy market and the potential and desired role for gas in this market. For this reason the following discussion of policies is not meant to provide a rigid guideline for government involvement in the gas distribution business. Rather it is a discussion of how different policies may affect gas distribution.

This section evaluates two sets of policies. The first set includes several policies whose positive role in fostering gas distribution projects has been generally proven worldwide. These include policies aimed at:

- Reducing risks involved in securing gas supplies for final consumers;
- Creating larger economies of scale for distribution companies;
- Expanding gas demand by residential consumers; and
- Coordinating gas demand and supply in the market.

The second set includes the policy choices which governments are often required to make in the process of developing a national gas market. These pertain primarily to issues involving ownership of the gas chain, and the level of vertical and horizontal integration in the market structure. Since worldwide experience indicates that countries have succeeded in establishing comprehensive distribution networks despite pursuing significantly diverse policy choices on these matters, the emphasis is on major pros and cons of these potential choices.

Policies Fostering Greenfield Gas Distribution

The following policies, although not part of an exhaustive list, may significantly promote greenfield gas distribution:

- **Comprehensive energy strategy with priority on gas:** Usually, as an outcome of energy security and environmental concerns, many countries have elaborated comprehensive energy strategies with priority on expanding the share of gas in their overall energy mix. Such a strategy facilitates a government's ability to bring natural gas consumption to a projected level. In addition,

Box 3.1: The District Heating Alternative

DH has emerged as a viable alternative to gas distribution in a number of countries. DH systems distribute steam or hot water to multiple buildings. The heat can be provided from a variety of sources, including geothermal, natural gas, coal or even wood. At present, Europe has more than 100 million DH consumers, nearly half of which are in Russia.[8] Eastern European and Nordic countries also use DH extensively.

As the decision to introduce DH in former Communist countries occurred in an economic environment based on central planning, a brief review of two Nordic countries provides more useful insights about DH.

Denmark provides probably the best example of a developed DH system as an alternative to natural gas distribution. As of 2004, there were only 331,000 consumers who consumed natural gas directly from a distribution network.[9] By contrast, half of the population (1.2 million dwellings) is served by DH.[10] The share of DH has expanded in the past three decades and continues to grow, although there have been no plans to expand the existing gas distribution grid.[11] Similarly, in Finland, the share of DH in space heating was 49 percent in 2004,[12] whereas only 34,300 consumers were directly connected to the gas distribution network. Gas distributed to households through local distribution companies accounted for less than 5 percent of the gas consumption in Finland. In fact, DH consumed nearly 36 percent of the nation's gas.[13]

The penetration of DH is a process which has taken decades in most countries. Almost always, local governments with interests in electricity supply have had the leading role in DH projects. Larger DH networks have similar features to the electricity market. There are no examples of full-fledged Third Party Access (TPA) on the transmission grid of a DH project, although unbundling between competing heat producers has been common. Usually, there are a great number of heat producers, a transmission monopoly and several local distribution companies.

A greenfield DH project is subject to substantial risks and is no less complicated than a greenfield gas distribution project. Its viability usually requires even greater population density (as well as a greater predominance of multifamily dwellings) than does a gas distribution pipeline.[14]

Yet, two inherent advantages of DH have helped it appear as an attractive alternative to gas distribution:

- **Increased use of cogeneration for DH:** combined heat and power (CHP) production has become increasingly common in DH projects. This has not only improved the competitiveness of DH, but has also secured a higher overall efficiency in fuel consumption. It is estimated that CHP increases the efficiency of primary fuels' use by 35-40 percent in comparison to heat-only boilers and condensing power production;[15] and
- **Wider fuel choice:** DH companies are able to use a large range of fuel-types in their plants – natural gas, coal, oil, refuse-driven fuels, geothermal energy, peat and biomass. This raises the possibility for market entry of independent heat producers, enhancing competition in the DH market.

[8] *Gochenour, Carolyn. 2001.* District Energy Trends, Issues and Opportunities – The Role of the World Bank*, (2001), World Bank Technical Paper 493: 43.*
[9] *Eurogas, 2003–04 report: 35.*
[10] *www.dff.dk (Danish District Heating Association).*
[11] *Griffin, op. cit., 19.*
[12] *www.energia.fi.*
[13] *Ibid.*
[14] *Grohnheit, Poul and Bent Mortensen. 2003. "Competition in the market for space heating: district heating as the infrastructure for competition among fuels and technologies."* Energy Policy*: 818.*
[15] *Gochenour, op. cit., p. x -xvi*

it is an effective means for assuring investors about a country's long-term objectives regarding natural gas penetration;

- **Legislation on gas.** This may establish clear rules for operation in the gas market, and codify the roles, rights and responsibilities of different players so that they can operate on a level playing field. Overall, legislation is often essential in establishing a stable investment environment and reducing uncertainty and investment risks. This, in turn, helps lower the cost of capital along the gas chain, including greenfield gas distribution projects;

- **Policies promoting supply and infrastructure development:** As development of gas distribution projects often requires clear assurances about sufficient gas supply, some government intervention may be helpful (and, sometimes, necessary) in the upper segments of the gas chain. Thus, if a country has significant gas reserves, enacting legislation favorable to upstream development may appear instrumental in attracting investors. In case of insufficient domestic reserves, it might be necessary for a government to get actively involved in negotiations with foreign governments (or companies operating abroad) for imports of gas. Although not always required, the use of government guarantees in the form of Take-or-pay (ToP) agreements has been an effective means for securing gas imports to countries with a developing gas market. Government involvement may also be substantial at the level of transmission, as government may play an active role (through equity or guarantee provisions) in the construction of cross-border pipelines and national transmission infrastructure;

- **Policies regarding the price of competing fuels for consumers:** Countries vary in terms of government involvement in setting the price of competing fuels for final consumers. The level of involvement may range from a government directly setting the price of most types of competing fuels to a situation where government retains only tax measures as a means of control. In all cases, governments do have the ability to get involved in a way which will provide natural gas some competitive advantage over the other fuels. Yet, any involvement confronts two major challenges. First, it may cause distortions in fuel consumption in the longer run. Second, if government intervention takes the form of capping the price of gas for final consumers, the effect may be to discourage investment in greenfield distribution projects. Overall, it is quite rare that government interventions aimed at promoting gas against other fuels will proceed without any unintended implications. An effective approach, as a possible alternative to directly promoting gas, is eliminating obstacles for its penetration. This may involve, for instance, removal of any existing subsidies related to the consumption of fuels competing with gas (such as underpriced electricity, DH, or coal);

- **Targeted subsidies for households:** An alternative policy aimed at promoting penetration of gas in households is subsidizing the cost of gas or the connection charges for potential consumers, or both. Subsidies may be provided either directly by the government or through cross-subsidization. Cross-subsidization may involve larger consumers such as industrial users and power plants. However, a possible means for cross-subsidization without leading to significant distortions is the establishment of consumer "blocks," whereby high-income groups partly subsidize low-income households. An inherent advantage of natural gas as a fuel is the enhanced possibility for establishing

targeted subsidies; this stems from the fact that it is transported through pipelines reaching designated consumers;

- **Public campaigns addressing misperceptions on natural gas:** In many developing countries where gas is being introduced to residential consumers, there has been a widespread misperception concerning its safety. It has often been considered by households as a potentially explosive and dangerous fuel. Government entities, as well as private companies involved in gas distribution, can address this problem to a large extent through public campaigns which can also emphasize the environmental (as well as other) benefits of natural gas;

- **Environmental policies and emission standards:** The competitiveness of gas could also be improved through legislating and enforcing stricter emission standards. Some countries have established limits on or fully banned the use of "dirty" fuels (such as coal) in residential space heating in larger cities. Others have imposed limits on the use of competing fuels with higher emissions in power generation or industry. This has had implications on the whole gas chain, promoting the spread of natural gas among various types of consumers;

- **Requirements on new dwellings:** A number of countries have issued nationwide regulations requiring new multifamily dwellings to incorporate piping for natural gas. While this leaves households with an open choice for consuming gas, it is another means for encouraging gas penetration in the residential sector; and

- **Design of the electricity market:** Design of the electricity market can affect development of the gas market, as well as gas distribution projects. First, a national priority on gas-fired power plants can often ensure the financial viability of the whole gas chain. It promotes the construction of transmission pipelines and, potentially, the distribution grid as well. Conversely, a national priority on nuclear or hydropower generation may slow the penetration of natural gas among all types of consumers. Second, whether the electricity market is controlled by a vertically integrated monopoly, or is open to competition, also has implications. Competitive electricity markets are more likely to foster development of gas-fired power plants, which may indirectly contribute to the development of gas distribution.

Other Major Policy Choices Affecting Gas Distribution

The following set of policies is also significant in terms of its implications for greenfield gas distribution. As distinct from the policies described above, however, the application of most of these policies depends much more on the level of maturity of a country's gas market. Some policies, in fact, originated in mature markets, and their applicability to countries newly developing their gas markets is hardly proven yet. A few countries with recent experience in gas distribution (as examined below in Chapter 5) have adopted some of the policies originating in mature countries, and have had significant success in gasification. But, for many others, it is still too early to judge. For some other policy choices (as in the case of ownership of distribution), the policies do not seem to be correlated with a successful development of gas distribution. Thus, for instance, various countries have achieved similar levels of gas penetration in the household, commercial and services sectors despite opting for different policy choices. Hence, their overall impact on a country's success in greenfield gas distribution projects is subject to debate, and should be analyzed merely through focusing on their advantages and disadvantages:

- **Private versus public ownership of distribution:** Public and private companies act with largely different incentives which can affect the cost and efficiency of the project, as well as the price of gas delivered to consumers. Public distribution companies have been usually more inclined to lower the price of gas for end users, which can foster the speed and the level of gas penetration. However, a major concern about public companies, especially if they are part of a vertically integrated structure, is their tendency to use profits for cross-subsidizing other public services they provide. Employing excessively large numbers of personnel and the lack of incentives to reduce labor costs have been other issues prevalent among public gas distributors.

  Private companies, on the other hand, are guided primarily by the goal of maximizing their profits. As this is achieved through minimizing costs while keeping gas prices high, penetration of gas could be slowed if this results in prices uncompetitive with other fuels. Thus, the allocation of rents appears as a major concern for countries with predominantly private ownership of distribution, and requires elaborate regulation;

- **The level of vertical integration in the gas market:** Governments or regulatory entities may have significant impact on the level of vertical integration[16] in the gas market. The implications of this choice, however, largely depend on the context of each country's gas market. Overall, a high level of vertical integration, such as the presence of a company uniting upstream, transmission and distribution, has several impacts. It raises the possibility of cross-subsidization between the various segments of the gas market. On the positive side, however, vertical integration helps to synchronize investment along the gas chain, create more predictable revenue streams and minimizes transaction costs. While not required, some level of integration could be highly valuable in countries newly developing their transmission and distribution (T&D) infrastructure, as it may facilitate access to capital. Meanwhile, in countries with problems about enforcement of contracts, vertical integration may help companies minimize risks. Finally, establishing limits on vertical integration in a new market could slow down its development and curb incentives for investment;

- **Introduction of TPA in transmission:** Establishing third party access (TPA)[17] to the transmission pipelines is highly beneficial for distribution companies, as they are provided with potential access to gas suppliers different from their traditional transmission company (such as producers and trading companies). This results in transferring cost reductions achieved in other parts of the gas chain (upstream and transmission) to the distribution companies, although not necessarily to their consumers. However, in countries with a significant lack of transmission infrastructure and a weak regulatory framework, introducing TPA may often discourage investment in transmission pipelines. This is particularly the case if transmission is undertaken by private companies, and a weak regulatory

[16] Vertical integration can be defined as the ownership links between four different functions performed within a gas chain: production, transport through a high-pressure network (transmission), transport through a low-pressure network (distribution) and trading of gas.

[17] TPA is defined as the obligation for pipeline owners (or operators) to provide open access to third parties wanting to use their transport services for a given charge.

framework has resulted in excessively low transmission fees;

- **Introduction of TPA in distribution:** A TPA regime on the distribution network is a further step toward in market liberalization, which extends to allowing any type of consumer direct access to producers and traders. This ensures that gas distributors will, in large part, transfer the cost reductions they achieve over time to their consumers. Moreover, they will be prompted to seek out the lowest price gas supplier, which will help to intensify wholesale competition as well. Several countries (such as the United States and the United Kingdom) that have experimented with this type of TPA have achieved significant reduction in end user prices, including the price of gas in the residential, commercial and public services sectors.

  Nevertheless, the suitability of TPA for greenfield gas distribution projects is debatable. For a distribution company, it implies the possibility of losing some of the larger consumers, and even the smallest clients (households). This raises investment risks and could drive away potential investors from a distribution project. The problem could be partly alleviated by adopting a phased approach regarding the "eligibility" of consumers for TPA to the distribution network. Thus, while the ultimate goal is to provide every consumer with the right of TPA, a clear guideline regarding the gradual expansion of "eligibility" could help to reduce investment risks. In addition, it is possible to establish separate transport and retail tariffs on the distribution network, ensuring a certain rate of return (RoR) for the investor;

- **The choice of unbundling:** The major benefit of unbundling[18] is that it ensures effective implementation of TPA. This occurs because, if a transport (transmission) company has stakes in production and gas sales, it has the incentive to restrict competition in both market segments by discriminating against other companies willing to use its transmission grid; by raising the price of its service; or by lowering the quality of service for "third" companies. Thus, separating the merchant function of a transmission company from its transport operations largely removes this problem. The same remedy could be applied to the transport and merchant functions of distribution companies, already subject to a TPA regime on their own networks. Another major benefit of unbundling includes increased efficiency in allocating costs among various functions of a company, which limits the possibility for cross-subsidization. This, in fact, facilitates the tasks of regulating T&D overall. Unbundling enhances regulators' access to information about underlying costs, including the assets which appear as a part of the "rate base." In addition, unbundling could help in addressing the problems of transfer pricing and insider transactions occurring between different segments of a vertically integrated company.

  A major problem with unbundling the transport and merchant functions of a transmission or distribution company is that it may discourage investors willing to undertake both functions. This could particularly pose a problem in greenfield projects in which the rate of return for transportation is perceived as low by potential investors. Similarly, countries with

[18] *Unbundling is closely linked to the concepts of vertical integration and TPA. It is about breaking a vertically integrated company into its components or separating the merchant and transport functions of a transmission or distribution company.*

smaller potential gas markets may be deterred from opting for unbundling as a means to attract large investors;

- **The level of horizontal integration:** A common practice among distribution companies is providing services in areas other than natural gas. This mostly involves the provision of electricity as well as water. A government may opt for this type of horizontal integration and, thereby, secure several benefits. It will create some economies of scale in reading meters, billing and collection, and can also assist a government in executing its energy policy. However, the policy has several drawbacks. It may potentially lead to cross-subsidization between energy sources, create bureaucratic barriers to optimal resource allocation and result in unclear performance evaluation of the distribution company; and
- **Concentration of ownership in distribution:** The number of companies involved in a country's distribution business may range from a single company to thousands. The choice of ownership concentration[19] in this segment of the gas market not only depends largely on the size of the market itself, but also on policy makers. Governments and regulators have various means by which to affect the level of concentration. They can decide on the individual size (in terms of potential demand) of the country's regions designated for greenfield gas distribution. Also, they can establish limits on the number of designated distribution areas for which a single distribution company is eligible. Opting for a higher degree of ownership concentration allows for larger economies of scale. It also alleviates the need for involvement in tendering arrangements for a great number of distribution regions, which could be cumbersome and could lead to delays in gasification. However, such a choice is likely to deter smaller investors willing to become involved in smaller distribution projects.

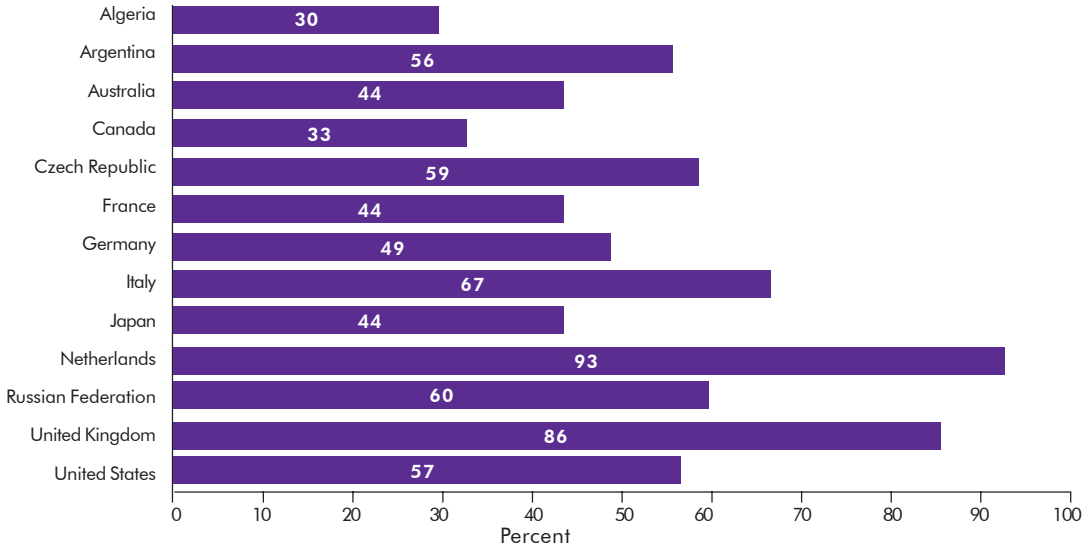
[19] *Ownership concentration in distribution is defined as the percentage market share of the major distribution company in terms of a country's natural gas demand (met by distribution companies). In this report, it is considered to be "high" if a single company is in charge of distribution in the whole country, or if the major company holds a share higher than 80 percent of the market; "medium" if a single company holds higher than a 20 percent of the distribution market but below 80 percent; and "low" if no company has a share higher than 20 percent.*

4. Experience with Greenfield Gas Distribution: The Pioneers

Based on the methodology described in Chapter 2, 13 countries from five continents have been included in Group I. All these countries started significant investment in greenfield gas distribution projects more than three decades ago (Annex – Table A1). The United States and Canada are included since this is where natural gas distribution began on a large scale. However, more than half of the countries in this Group are from Europe. Several other European countries (such as Austria, Belgium, Hungary, Poland, the Slovak Republic and several former Soviet republics) could have been included in this Group as they also managed to achieve high residential gas penetration after a relatively early start-up in greenfield gas distribution projects. There is only one country from South America (Argentina), one from Asia (Japan) and one from Africa (Algeria), although there are other countries in these continents which have experience in gas distribution.[20]

Possibly, the best indicator of the rate of gas penetration in a country's residential sector is the percentage of households with a connection to the natural gas grid. According to this indicator, the Netherlands is the world's leader in gas distribution, having the highest percentage of gasified households. It achieved nearly universal access to gas as early as the beginning of the 70s. The United Kingdom is another country where gas has reached a very high penetration rate, with nearly 86 percent of households connected (as of the end of 2004). All other countries have impressive, but significantly lower share of households benefiting from access to natural gas (Figure 4.1).

Figure 4.1: Penetration of Natural Gas in Households



Note: Data for 2000-04; details related to the Figure are in Annex – Table A1.

[20] *Several countries, such as Egypt, Iran, Bangladesh and Pakistan, have also had significant achievements in spreading natural gas in the residential sector. However, due to the lack of sufficient information about the historical evolution of their gas distribution networks, they are excluded from the study.*

Additional measures may provide useful insight about the significance of natural gas in a country's residential sector or in its overall economy. Such measures include the share of gas consumption in the total energy consumption of the residential sector, as well as the overall share of natural gas in a country's Total Primary Energy Supply (TPES). A comparison between these measures is provided in Annex – Table A1. The disparity among the three indicators highlights the presence of different patterns of gas consumption across countries in the residential sector, as well as overall in their economies.

Accordingly, the ranking of the 13 countries in Group I looks slightly different when based on each of the three indicators. Thus, in terms of the share of gas in the total energy consumption of the residential sector, the Netherlands is still the world leader, and Argentina appears on a par with the United Kingdom, with natural gas constituting 66.1 percent of the residential energy demand. This is despite the fact that a much lower percent of Argentina's households (56 percent) are connected to natural gas in comparison to the United Kingdom (86 percent). This highlights the relatively high share of gas in the total energy consumption of households in Argentina. Meanwhile, Russia, the Netherlands, and Argentina are the countries in the Group with the highest share of gas in their respective TPES. This, in turn, reflects the relatively strong presence of natural gas in these countries' overall energy consumption.

Supply-side Aspects

There is striking similarity of supply-side drivers for greenfield gas distribution in Group I countries. These may explain, to a large extent, the reason for the relatively early start-up of this group of countries in developing their gas distribution infrastructure. Such factors include the presence of distribution networks based on manufactured gas in most countries in Group I prior to the spread of natural gas, as well as the presence of substantial indigenous gas reserves in most of these countries.

Manufactured Gas Networks

In most countries in Group I, greenfield gas distribution benefited from the presence of distribution networks based on manufactured gas. In many of them, residential users had already been acquainted with manufactured gas in the 19th century. While it still required quite significant investment, mainly in the conversion of distribution networks, there was a clear tendency in favor of switching to this more efficient fuel.

In the United Kingdom, manufactured gas (from coal) had reached one of the highest levels of penetration, with the consumer base standing at 11.3 million in 1949.[21] By the early 60s, when vast natural gas deposits were discovered in the British section of the North Sea, the price of coal was rising, creating pressure to seek alternative fuels which could be used to manufacture gas. The discovery of natural gas resulted in a massive campaign to convert to natural gas which was initiated in 1967. The campaign was successfully completed within 10 years, while, in the meantime, new distribution pipelines were built with the aim of enhancing the level of gas penetration among British households.

In the Netherlands, the use of manufactured gas had also reached significant levels before inauguration of the Groningen natural gas field. In 1962, the year before vast volumes of gas started to flow from the Groningen field, total distribution of all types of gas (only a quarter of which was natural gas) stood at about 1 billion cubic meters (bcm) of natural gas equivalent. The total number of consumers having gas connections had reached 2.5=million (mn), of which only 400,000 had converted to natural gas.[22] With the development

[21] *Davis, Jerome.* Blue Gold: The Political Economy of Natural Gas *(London: George Allen & Unwin, Publishers, 1984), 97.*
[22] *Peebles, Malcolm.* Evolution of the Gas Industry *(New York: New York University Press, 1980), 119.*

of the Groningen natural gas reserves, massive conversion of existing manufactured grids was initiated, along with investment in greenfield gas distribution pipelines. Conversion to natural gas was completed by the early 70s, when, with the addition of new distribution grids, natural gas achieved nearly near-universal penetration in the household market.

In the United States, when natural gas began to massively displace manufactured gas by the late 40s, the number of manufactured gas consumers had increased to 8.7 mn.[23] Yet, unlike Europe, natural gas and manufactured gas had already penetrated commercial buildings and households simultaneously, along separate lines, for several decades. Especially after the 20s, natural gas began to gain the upper hand in its competition with manufactured gas. This was largely the result of significant natural gas discoveries, as well as the invention of all-welded steel pipelines in the mid-20s, which made it possible to connect gas-producing regions with areas of significant potential demand through transmission pipelines.[24]

In Japan, another country with extensive manufactured gas networks, there were already 8.2 mn consumers consuming gas manufactured from more than a dozen types of sources (such as coal, crude oil, kerosene and naphtha) in 1968 – right before LNG imports began. The gradual displacement of manufactured gas by LNG followed. Other countries, such as France, Germany, Italy and Argentina, also experienced significant development of distribution grids based on manufactured gas. However, such development remained largely below the levels of the United Kingdom, the Netherlands, the United States and Japan.

Indigenous Gas Reserves

Another major area of similarity is the presence of substantial indigenous gas reserves in most of the countries in Group I. For many countries in this Group, this made a significant contribution to their relatively early start of greenfield gas distribution. Natural gas, combined with the financial capability of these countries in investing in gas-related infrastructure (such as long-distance pipelines in particular), helped to spread natural gas to residential and other consumers earlier than in the case of most other countries in the world (such as those examined in Group II).

The United States provides one of the clearest examples of early discovery and exploitation of natural gas resources, which eventually led to substantial development of a national gas industry as well as sizable gas distribution networks. Starting in the mid-20s, natural gas had begun to emerge as a common source of energy for households and the commercial and services sectors, accompanied by large-scale investments in distribution pipelines. Until as late as the mid-50s, natural gas production and consumption were overwhelmingly concentrated in this country alone.

Similarly, before large-scale natural gas discoveries elsewhere in the European continent, Italy, France and Germany benefited from some domestic sources, which fostered the early but limited spread of gas consumption in the 40s and 50s. However, the rapid spread of natural gas consumption outside the United States was mainly the outcome of large-scale discoveries after the late 50s. Thus, the discovery of the Groningen field in the Netherlands in 1959 and major gas deposits in the British section of the North Sea in the 60s paved the way for these two countries to emerge as leaders in gas distribution. Algeria, Russia, Canada, Australia and Argentina also benefited from discoveries of gas deposits sufficient to meet their needs for several decades.

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[23] *Ibid., 55.*

[24] *Davis, Jerome.* Blue Gold: The Political Economy of Natural Gas *(London: George Allen & Unwin Publishers, 1984), 6.3.*

Imports and Transit

Yet, Japan and the Czech Republic (and the former Czechoslovakia overall) also had an early start-up in gas distribution based on imports. As a result, their success in greenfield gas distribution indicates that other factors may offset the lack of indigenous resources. While Japan's success may be explained primarily through particular choices made by its successive governments and some demand-side factors (examined in the next Section), the case with the Czech Republic highlights the potential contribution of a country's geographic location.

Czechoslovakia was fortunate to have access to abundant natural gas resources owing to its transit status. It was the main route for Soviet (and subsequently Russian) gas exports to western Europe. Several other countries in this Group also benefited from a similar status. In the case of Germany, the need to construct major transit pipelines (mainly for Russian gas) contributed to the emergence of sizable transmission companies. France benefited from transiting Norwegian gas to Spain and Italy, while Italy transited limited volumes to Slovakia. In both of the latter cases, however, the contribution of their transit role to the construction of transmission pipelines reaching domestic consumers was minimal.

While indigenous gas reserves did provide the initial spark for the development of a national gas industry for many countries in Group I, several of them were soon faced with a significant problem due to the lack of sufficient gas resources to meet their growing demand. These countries managed to successfully address this challenge by building long-distance cross-country pipelines, as a result of which their own supplies were supplemented through imported gas. Establishing groundbreaking LNG chains was an additional alternative tested by these countries.

The Federal Republic of Germany (FRG), and, subsequently, France, benefited from the discovery of the Dutch Groningen field by constructing major pipelines connecting to the Netherlands as early as 1963. By the 70s, two new gas sources (USSR and Norway) became available for West European consumers, whereas Czechoslovakia gained access to Soviet gas in 1967. Algerian gas, initially exported in the form of LNG, reached Italy in 1983 through the Transmed pipeline. In North America, the United States benefited from increasing volumes of imports through multiple pipelines from Canada supplementing its indigenous supply. In South America, Argentina was the first country in the continent to inaugurate a cross-border pipeline, allowing imports from neighboring Bolivia after 1972. Imported volumes, however, served mainly as a supplementary source to Argentina's expanding domestic gas output.

LNG imports served as an alternative to constructing pipelines. However, none of the countries in Group I, except Japan, favored LNG over pipelines mainly because of its comparatively higher costs. Japan, on the other hand, largely because of its geographic location, found LNG imports its only realistic option. LNG imports commenced in 1968, and very soon Japan emerged as the undisputed leader in LNG imports in the world.

Proximity to Gas Fields

Several countries in Group I benefited from the proximity of major consumption centers to natural gas fields. Countries with substantial indigenous supplies and relatively smaller size have been the most advantaged in terms of the relative costs of constructing their transmission grids.[25] This includes mainly the Netherlands and the United Kingdom, which gained access to their indigenous supplies through relatively shorter (less than 1,000 km)

[25] *Greater length of transmission pipelines is assumed to increase natural gas prices for residential and commercial-public consumers. This study has not delved into a cross-country comparison of natural gas prices based on the length of transmission pipelines. However, an overview of gas prices to final consumers reveals an enormous variety, part of which stems from taxation and price regulation rather than distances in transmission.*

transmission pipelines. Italy, Germany and France also benefited from their relatively smaller size, which accorded a degree of proximity to major consumption centers to their limited indigenous supply sources. They also benefited from proximity to Dutch and Norwegian gas. Algerian gas reaching Italy also passed through a relatively short (1,070 km from the source to Sicily) pipeline.

Soviet gas, on the other hand, emerged as the most remote supply source for European consumers. However, a pipeline connection between Soviet gas fields and West European markets was successfully accomplished, largely as a result of the political and economic interests of the USSR, as well as the financial capability of the relatively higher income countries of Western Europe. In the case of Czechoslovakia, its access to Soviet gas was mainly an outcome of its membership in Comecon and the Warsaw Pact. Meanwhile, the large size of USSR and the growing concentration of its natural gas reserves in western Siberia precluded its major cities (located west of the Urals mountains) from benefiting from short-distance pipelines. However, this did not appear as an obstacle to gasification of its major consumption centers.

In North America, both the United States and Canada have faced a major disadvantage because of their relatively large territories. In the United States, most of the gas fields are located in Texas, Louisiana and Oklahoma, far from major consumption centers such as New York, Pennsylvania and Ohio. In Canada, significant levels of gas consumption in its most populated provinces, Ontario and Quebec, could not begin until inauguration of the TransCanada pipeline in 1957. This major long-distance pipeline provided access to the rich natural gas fields in Alberta. In both countries, a comprehensive transmission network was successfully completed despite the challenges of building pipelines across relatively long distances. In both cases, the size of the potential market (see the demand-side analysis following) provided powerful incentives for large-scale investments.

In South America, Argentina faced the same drawback, as a large part of its natural gas resources were located in the far south. One outcome was a major transmission pipeline stretching 3,420 km from southern Argentina to Buenos Aires. In Australia, a fragmented transmission infrastructure emerged, originally built to transport gas from centrally located fields to coastal urban areas. In Japan, numerous LNG terminals were constructed in proximity to major consumption centers. The highest concentration of terminals occurred in the highly populated, industrial Tokyo, Osaka and Nagoya regions. This, however, resulted in the emergence of several isolated transmission networks, which led to significant price differences between regional markets. This has been a significant obstacle to further penetration of gas in regions where it is quite expensive.

Terrain

It is worth noting that the nature of the terrain for transmission pipelines has had only a minor impact on the development of greenfield gas distribution projects in Group I countries. However, there is some evidence that this factor was influential in determining shipping costs. For instance, Japan faced severely unfavorable terrain for building transmission pipelines. They had to be constructed in very mountainous and seismically active areas, which raised the cost of construction substantially and contributed to Japan's having the highest natural gas prices for all types of consumers among the Organisation for Economic Co-operation and Development (OECD) countries.[26]

Price and Cost

In several Group I countries, gas was initially priced at very low levels because it was often a by-product of oil production with a limited market. This was the case when the U.S. natural gas industry was developed

[26] *Japan's natural gas prices have been significantly higher than Korea's, which also relies on LNG.*

and, to some extent, though less so, when the U.K. gas industry was developed in the 60s. This pricing of natural gas made it very inexpensive – which is no longer the case in most countries.

Demand-side Aspects

Countries in Group I share several features on the demand-side of gas distribution. First is the presence of a climate which requires space heating. Also, nearly all countries in the Group possess comparatively high levels of per capita income. A less significant feature shared among "pioneers" is the relatively small size of households resulting in higher gas consumption per person. However, countries also vary markedly with respect to major fuels competing with gas and their relative prices, the way they benefited from settlement density and the role of anchor consumers in the development of the national gas market and distribution (Annex – Table A3).

Space Heating

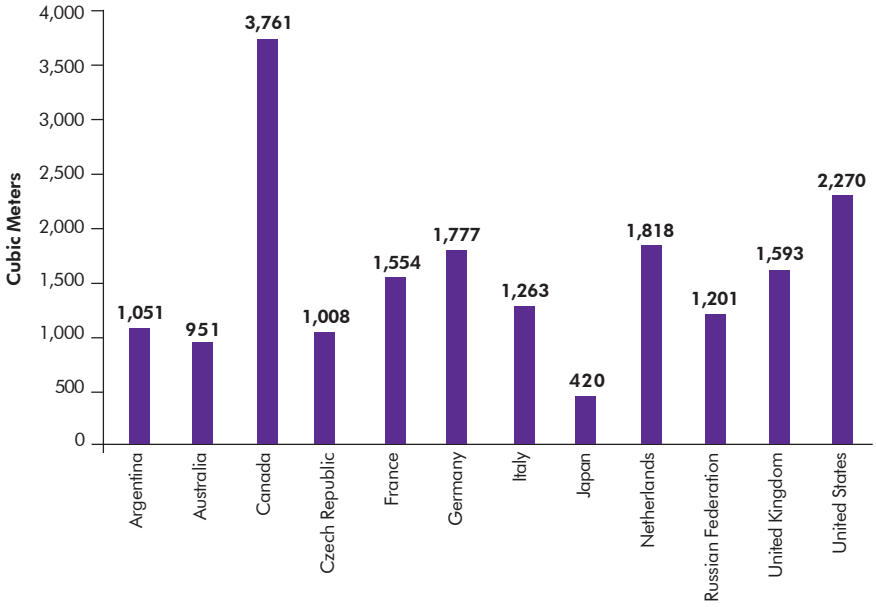
A striking similarity among countries in Group I is the presence of a *climate requiring significant space heating*. The only exception is Algeria, where this requirement is quite limited. Algeria is a major example of a country with a successful experience in gas distribution despite the general lack of cold climatic conditions. Its experience provides evidence that an extensive gas distribution infrastructure can be completed in warmer climates as well. However, under such circumstances, success is associated with other drivers, among which government's choice to finance distribution infrastructure appears highly significant. It is also worth noting that there are some regional climatic differences within the United States, Argentina and Australia, as a result of which some regions do not require space heating. But, overall, space heating is a significant source of residential demand for natural gas in these countries.

As recent surveys on the consumption patterns of households in each country in Group I are absent, estimating the precise role of natural gas in meeting their space heating demand is challenging. However, there is evidence that substantial space heating is prevalent in all countries, except Algeria. Also, natural gas is widely used for meeting space heating requirements in most of the Group I countries.[27] Yet, it is worth noting that households in several of the countries with a cold climate have met their space heating requirements with alternative fuels. Thus, for different reasons, the residential sector in Japan, the Czech Republic and Russia has opted in favor of fuels other than natural gas for their space heating purposes. In effect, in these countries and in Algeria, the availability of substantial heat load has not been as instrumental for building a distribution network as in the case of the remaining countries of Group I.

Climatic conditions, moreover, appear as the central element in explaining the diversity of gas consumption per household in Group I (Figure 4.2). Annual volumes of gas consumed on average by households appears to be highest in Canada (3,761 cubic meter [m^3]), largely reflecting its colder climate. In Europe, Germany, the Netherlands, and the United Kingdom have higher volumes of gas consumption per household than France and Italy, which have relatively milder climates. By the same token, households in Argentina and Australia consume nearly three times less gas than a Canadian household on average. The United States, on the other hand, is marked by a significantly higher level of gas consumption per household than European countries, primarily as a reflection of the larger size of living space, as well as climatic differences.

[27] *The evidence derives mostly from the annual reports of International Energy Agency (IEA) on individual countries, which specify that space heating is a significant source of gas demand. An additional source, with surveys on residential energy (and gas) consumption in European Union (EU) countries for the late 90s, may be found on the Website of the University of Oxford Environmental Change Institute: http://www.eci.ox.ac.uk: Fawcett, T., K. Lane and B. Boardman,* Lower Carbon Futures *(University of Oxford: Environmental Change Institute, 2000).*

Figure 4.2: Estimated Average Gas Consumption per Household



Again, Russia, the Czech Republic and Japan appear more as the exceptions. They have relatively low gas consumption levels per household, ranking even below Italy, despite having colder climates. The explanation in the case of Russia and the Czech Republic is the prevalence of DH. Many households connected to natural gas use this fuel mainly for cooking and water heating. Similarly, households in Japan, even if connected to gas, rarely use it for space heating (mainly because of its inability to compete with petroleum products).

Per Capita Income

Another common feature among Group I countries, with implications for their energy consumption patterns, is the level of per capita income. Based on the World Bank classification, nine of the countries belong to the high-income category. The rest, Argentina, Russia and the Czech Republic, are upper middle-income countries, only Algeria falls into the lower middle-income category.[28] There is no country in this Group that falls into the low-income category (Annex – Table A3).

In this respect, it is possible to conclude that nearly all Group I countries benefited from relatively high levels of per capita income, which facilitated penetration of gas in households. The relatively high level of gas penetration in Russia and Algeria could possibly be explained, mainly by their endowment of indigenous gas supplies, as well as government policies promoting the spread of gas. Such drivers have been particularly important, given that Algeria lacks climatic conditions leading to significant heat load, while Russian households have been largely served by DH for their space heating requirements.

Household Size

Countries in Group I have also exhibited considerable similarity in terms of household size.

[28] According to the World Bank classification (Atlas method), countries are divided based on 2005 Gross National Income (GNI) per capita as follows: US$875 or less – low-income; US$876-3,465 – lower middle-income; US$3,466-10,725 – upper middle-income; US$10,726 or more – high-income.

The decline in the size of households, and the parallel rise in single person households, has been a worldwide trend. In this context, the high-income countries have been marked by their significantly smaller size of households (with Algeria being a partial exception) (Annex – Table A5).

The declining size of households has increased the potential number of residential gas consumers, as it has been associated with the rise in housing stock. In Europe's context, this has been particularly significant, given the considerably low rates of population growth. This, in fact, has been a principal reason for the continuous addition of new consumers in the Netherlands, where a near-universal penetration of gas had already been achieved in the early 70s.

Yet the overall impact of household formation patterns on gas distribution requires detailed analysis in a number of areas, such as trends in average consumption per household, and the size of living space per inhabitant. It is probable that although a decline in household size may help expand the number of potential residential consumers, this may occur at the expense of volumes of gas consumed per household (although the reverse may be true regarding per capita consumption).

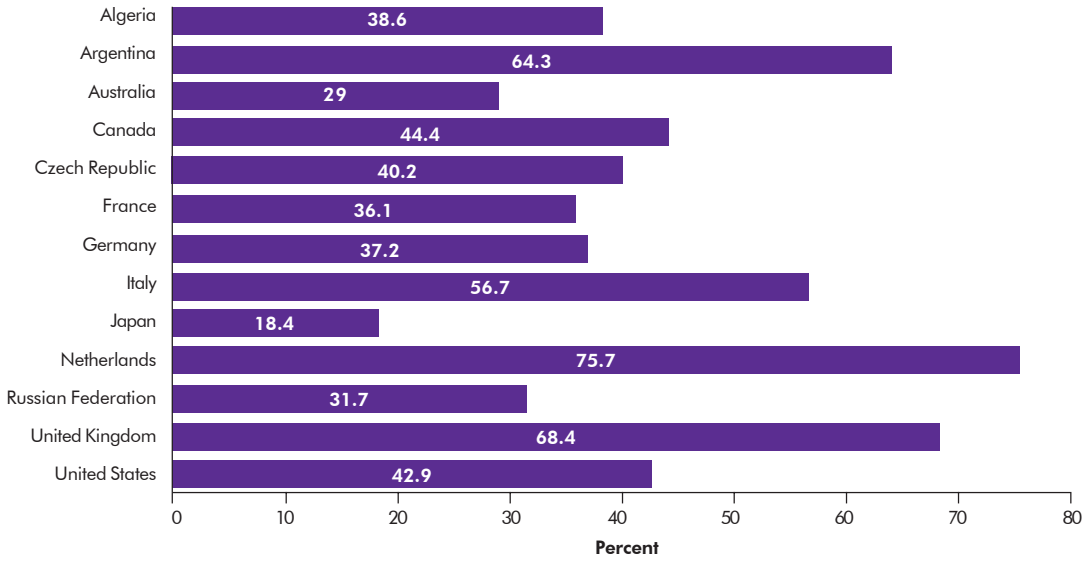
Competing Fuels

There is considerable variety among countries in Group I in terms of the role of fuels competing with natural gas. Gas distribution projects proceeded by replacing distinct types of fuels used in the households in each of these countries.

Annex – Table A6 indicates the recent (2004) status of the various types of fuels used in the residential sector in Group I countries. Apparently, natural gas has emerged as the preferred fuel of households in all countries, except Japan, Russia and Australia. Furthermore, gas has a significant share of the total residential energy consumption in these three countries (Figure 4.3).

The price of competing fuels, along with perceptions as to their convenience and safety, are the principal determinant of household consumption patterns. Whereas there has been great variety in terms of competing fuel prices across countries as well as across the time span of several decades, a few conclusions are possible:

Figure 4.3: Share of Natural Gas in Total Residential Energy Consumption



Note: Data for 2004. In the case of France and Algeria, figures refer to consumption in both residential and commercial-public services sectors. Details related to the Figure are in Annex – Table A6.

- Petroleum products and coal have been the major fuels replaced by natural gas among residential consumers in the past three decades. Despite periodic fluctuations, the price of petroleum products (mainly light fuel oil) has commonly been higher than the price for natural gas, prompting households to switch to the latter fuel. It has preserved its significant role in several countries, but nowhere (within Group I) does it appear as the preferred fuel of households (excluding the area of transport). (In the earliest days of gas penetration, the difference between light fuel oil prices [home heating oil] and gas was greater than during the most recent decades);

- The trend toward shifting away from coal has been augmented by environmental policies, even though its price has not always been higher than the price of natural gas. All countries in Group I have made massive strides in eliminating coal from (direct) residential consumption. As a result, in none of the 13 countries does coal appear among the three most preferred fuels of households. This progress has been particularly notable in the case of the United Kingdom, France and the Czech Republic, where in 1973 coal occupied the first place in residential energy consumption;[29]

- Electricity has remained the primary competitor to natural gas in all countries in Group I. Its consumption by households has increased throughout the ongoing process of residential gas penetration. Meanwhile, in several cases, it has posed significant challenges for gas penetration. The most notable examples are France and Canada, where the abundance of relatively cheap electricity has periodically slowed the process of gas penetration. In the case of France, this has occurred largely as the result of the priority given to nuclear power generation, whereas in Canada natural gas has competed with electricity in regions with abundant hydro resources;[30] and

- DH appears as an important competitor to natural gas in Russia and the Czech Republic. In both cases, however, gas penetration started during the period when a centrally planned economy prevailed. Within that context, DH did not significantly impede the increase in the number of households connected to gas. However, it did result in comparatively lower volumes of natural gas consumed per household.

Settlement Density

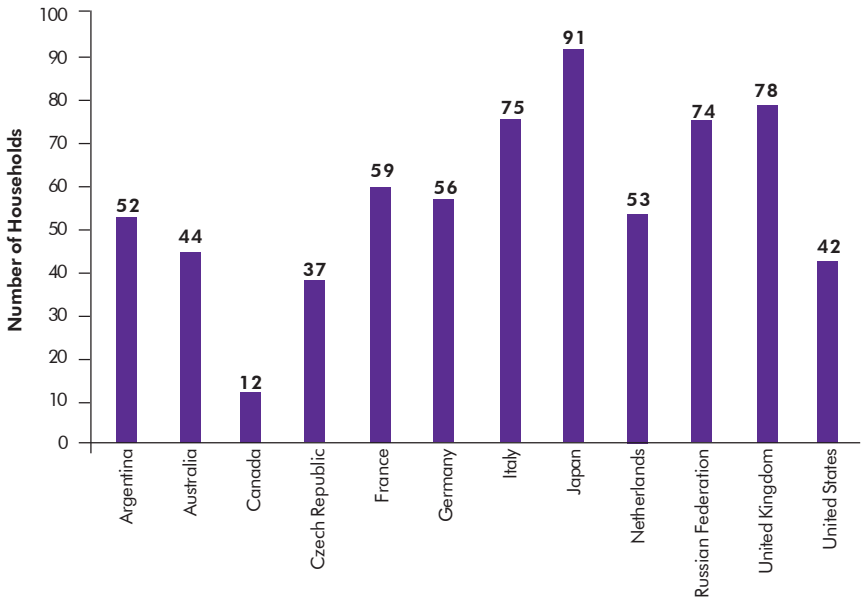
Another area where countries in Group I differ significantly is their settlement density. This has had major implications for the number of residential consumers per km of the distribution grid, and consequently for the ability of distribution companies to benefit from economies of scale.

Figure 4.4 indicates the significant differences across countries in terms of the number of households per km of the distribution network. Japan and the United Kingdom have the highest number of residential consumers per km of the national distribution grid, implying higher opportunities for economies of scale for their distribution companies. On the other hand, Canada and the Czech Republic have the lowest number of residential consumers per given length of their distribution networks.

The variation stems from differences in the settlement density of countries in Group I. Moreover, there are considerable differences in all of the three major

[29] IEA Statistics – Natural Gas Information 2004, *International Energy Agency: 249, 279, 479.*
[30] *Finon, Dominique. "French Gas Industry in Transition: Breach in the Public Service Model" (Institute D'economie et Politique De L'energie, 2001).*

Figure 4.4: Estimated Number of Households per Km of Gas Distribution Grid



Note: Data for 2001-04; details related to the Figure are in Annex – Table A7. Data for Algeria not available.

aspects of settlement density: population density and its distribution; level of urbanization; and the predominant type of dwelling. However, distribution companies in each country have been able to benefit from economies of scale owing to different aspects of settlement density:

- In Japan, economies of scale have derived mainly from high population density (persons per square kilometer [km^2]), and the presence of several large cities (with Tokyo being the largest city in the world), where most distribution investment has concentrated;
- The United Kingdom has benefited from all three aspects of settlement density, as it has one of the highest population densities in Europe, with a significant concentration in large cities, a high level of urbanization and widespread occupancy of multifamily dwellings;
- Surprisingly, in the Netherlands, which has one of the highest population densities in Europe, the number of residential consumers per km of the distribution network is comparatively low (53). This is largely due to the relative lack of large cities and the low urbanization rate. In the case of Germany, the absence of large cities is also a significant element in explaining the relatively low number of residential consumers per km of distribution pipeline;
- Australia, despite having the lowest population density in Group I, exhibits a slightly higher (than a few others in Group I) number of households per km of the distribution grid, owing mainly to its high level of urbanization and the concentration of population in only a few large cities. Argentina offers another example of a low population density but a high level of urbanization, and concentration of the population in a few large cities;
- Distribution in Italy and France has benefited from high levels of urbanization and the predominance of multifamily dwellings, whereas the major drawbacks in the case of the United States are its low population density and the major share of households residing in detached houses in city suburbs;

- The concentration of population in large cities has also been a major advantage for gas distribution in Russia, while it has posed a significant drawback in the Czech Republic. In both countries, the prevalence of apartment buildings dating back to the period of central planning has also enhanced opportunities for economies of scale; and

- In Canada, the bulk of distribution activity has been concentrated in Ontario and Quebec, where the population is concentrated in a few large cities. Canada's overall low population density, however, has been a major obstacle to penetration of gas in the other parts of the country (with the partial exception of Alberta, which supplies most of the gas).

Other Retail Consumers

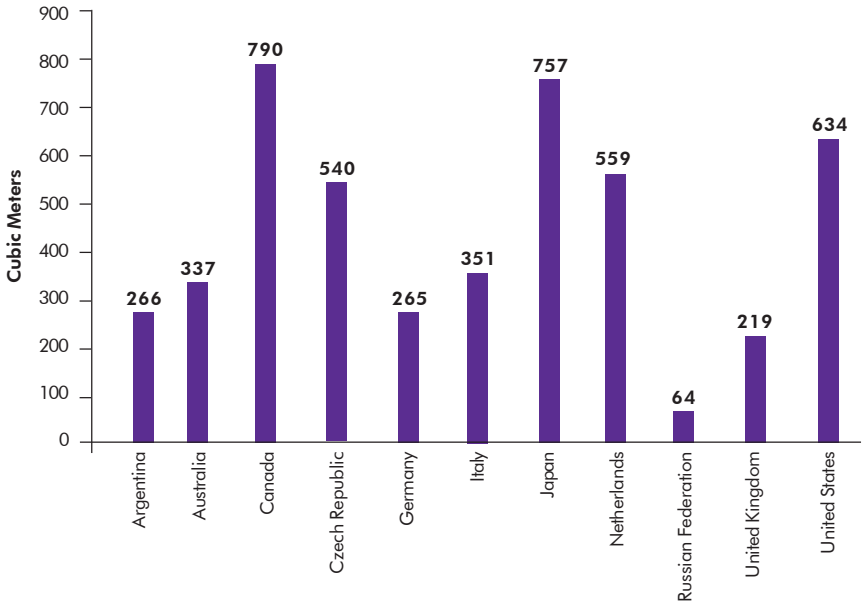
Nevertheless, households are not the only consumers served by the distribution network. Commercial and public services consumers provide additional demand on the same distribution grid. As gas consumption per consumer in the commercial and public services sector is generally higher than in an average household, this augments the potential for economies of scale.

Countries in Group I have benefited differently from connecting commercial and public services consumers to the distribution network. Thus, in Canada and the United States, this sector has consumed 634 and 790 m^3 of gas respectively (in 2004) for every 1,000 m^3 of gas consumed by households. This figure appears as low as 64 m^3 in Russia, and only 219 m^3 in the United Kingdom, implying comparatively lower opportunities for economies of scale (Figure 4.5).

Anchor Consumers

Industrial users and power plants may also significantly enhance the opportunities for economies of scale in a country's gas distribution business. They may serve as anchor consumers for development of both distribution and transmission networks. However, unlike the commercial and public services sector, they are predominantly

Figure 4.5: Commercial-public Services Consumption of Gas per Every 1,000 Cubic Meters Consumed by Households



Note: Data for 2004. Disaggregated data for France and Algeria is not available. Details related to the Figure are in Annex – Table A8.

served through high-pressure pipelines which are part of the transmission grid rather than the distribution network.

The direct contribution of power generation and the industrial sector to development of distribution networks varies across countries. It depends on national legislation to determine the division of consumers between T&D companies. Specifically, this is determined by an eligibility criterion according to which consumers above a particular annual level of demand are allowed direct access to transmission companies. The precise division of industrial users (as well as some power plants) between T&D companies is not clear because of the lack of historical data on the evolution of the eligibility criterion in each country. However, a study conducted by the IEA in six European countries (the Netherlands, the United Kingdom, Italy, Germany, France and Belgium) indicates the presence of substantial diversity across countries. Judging by 1995 figures, distribution companies in the Netherlands benefited most from serving larger consumers. Whereas Dutch distributors had the lowest number of households per km of the total distribution network (56 in 1995), they had the highest volumes of total sales per km of the grid. This was partly the result of relatively higher volumes of gas consumed per household. However, the contribution of large consumers had a major role. France, on the other hand, had the lowest volumes of gas consumption per km of its distribution grid, precisely because of the relatively peripheral role for large consumers in the development of the distribution grid.[31]

The indirect contribution of industrial users and power plants to greenfield gas distribution occurs mainly through their anchor role in the construction of extensive transmission networks within and across countries – networks which are eventually necessary to reach the city gates of distribution areas. In this regard, there are considerable differences across countries in terms of their anchor consumers. Thus, industrial users have been a major factor in driving the development of gas markets around the world for more than half a century. Annex – Table A3 indicates industry's substantial role in the evolution of the gas market of Group I countries, in which Japan and Algeria appear as partial exceptions.

The major impact, however, has come from the role of power plants in the development of national gas markets. For many countries – Italy and the United Kingdom, in particular – power plants fired by natural gas have gained a prominent role only since the late 80s.[32] For others, such as Algeria and Japan, the power sector has been the principal driver in the development of their gas markets and infrastructure since the early entry of natural gas. Finally, for another group of countries – France and, to some extent, Canada – utilization of gas in the power sector has been a low priority. However, the large-scale use of gas in industry in these countries has helped to compensate for the minimal role of power plants in gas market and infrastructure development.

Major Policies with Implications for Gas Distribution

Governments of Group I countries have adopted a variety of strategies to foster development of their gas markets and gas distribution, in particular. The United States was the first country to develop a large-scale gas industry, and the State was primarily absent in terms of owning major stakes in the sector. However, the United States government created a highly regulated environment for every segment of the gas chain. Thus, through the Natural Gas Act of 1938, the RoR for transmission companies came under government control; this was subsequently extended to well head gas prices after 1956. When gas market liberalization was initiated with the Natural Gas Policy Act of 1978, the country

[31] *Natural Gas Distribution – Focus on Western Europe (Paris: IEA, 1998), 33.*
[32] *Hierl, Jochen. Regulatory Reform: European Gas (Paris: OECD, 2000).*

had already completed an extensive gas distribution network.

Strong government involvement also became the dominant policy once natural gas started to spread in Europe. However, unlike in the United States, this participation involved a direct government role in establishing national gas companies. Thus, in Italy, which in the late 40s became one of the first European countries to embark on substantial domestic production of natural gas, the government established ENI as a company which would oversee the country's whole hydrocarbon sector, controlling both AGIP, the national oil and gas producer, and SNAM, the national transmission company.[33]

Government involvement through State-owned bodies, with a dominant role in the gas market, prevailed in the United Kingdom and France as well, where British Gas Corporation (BGC) and Gas de France (Gaz de France – GdF) were created as principal instruments of the State for developing the national gas market and its infrastructure. Meanwhile, in the Netherlands, the State preferred a partnership with companies representing its interests in the upstream and transmission rather than a dominant role. In Germany, on the other hand, the government abstained from a major role in the upper segments of the gas chain, and retained mainly financial interests in upstream and transmission companies.

Strategies to promote gas sector development through State ownership differed in the other parts of the world. Thus, Japan was another country in which the State abstained from significant involvement in the ownership of major infrastructure, such as LNG terminals and transmission pipelines. In Argentina and Algeria, however, State companies dominated the gas market in the initial stages of development and, in fact, in Algeria's case, this role has been retained to date. Australia and Canada were marked by significant government involvement in the development of national transmission networks. The gas sector in the USSR and Czechoslovakia, in the meantime, was always a part of a centrally planned energy strategy and economic development plan.

Natural gas became especially prominent in the national energy strategies of several countries in Group I after the oil crisis of 1973. Enhancing energy security became a priority, with natural gas perceived as a major means of reducing national dependence on oil imports. A primary example was Italy, where with government encouragement, natural gas spread massively into the residential, industrial and power generation sectors.

The response to energy security concerns, however, has not always helped the spread of natural gas. French governments, for instance, chose to promote nuclear power as a major source of energy and as an alternative to imported oil. The spread of nuclear power not only inhibited the potential growth of gas-fired power generation, but turned electricity into a tough competitor for natural gas in the residential sector.

An additional reason for assigning a growing priority to natural gas in national energy strategies were rising environmental concerns after the 70s, and especially in the 80s, 90s and today. Growing concerns about pollution created by coal and heavy petroleum products, prompted governments to elaborate policies which helped promote the spread of natural gas as an alternative. Also, over the past decade, growing concern about global warming has prompted an increased emphasis on natural gas which produces less carbon which coal or petroleum products per unit of heat produce when burned.

The following policies, some of them adopted as part of a national energy strategy, could be cited as particular examples which helped spread residential gas consumption and, consequently, the development of gas distribution networks:

[33] *http://www.snamretegas.it/english/chi_siamo/storia.html.*

- In all western European countries in Group I (except Germany), the government took responsibility for determining and approving gas tariffs for residential consumers for several decades in the process of gas market development. Besides the goal of promoting residential gas consumption, tariff policies were applied as a means of countering inflation and reducing costs for industries to foster their international competitiveness. German governments, on the other hand, abstained from any control over prices throughout the gas chain from the well head to sales to final consumers;[34]

- Government control over tariffs has not always been effective in spreading the use of natural gas, as the policies of French governments in the 70s and 80s showed. Governments in France subsidized residential consumers by preserving relatively low tariffs. However, a concurrent policy of controlling electricity tariffs contributed largely to the slow penetration of natural gas in the residential and commercial-public services sectors. This was one of the principal reasons for France's lagging behind Italy in terms of household penetration and gas consumption during this period. Accordingly, in 1973, France and Italy's gas consumption in the residential and commercial-public services sectors was 6.1 bcm and 4.4 bcm, respectively. By 1990, Italy was consuming far more natural gas than France in these sectors, as well as other sectors. Italy's consumption in the residential and commercial, and services sectors reached 18.9 bcm, whereas France's consumption reached only 14.7 bcm;[35]

- As another example of a policy promoting gas distribution, Canada (until 1985) and Australia (until 1994) resorted to cross-subsidization of residential consumers by industrial consumers. Such a measure was aimed at helping natural gas compete against other fuels used by households;

- In the Netherlands, uniform residential tariffs were established which served as an effective means for reaching near-universal gas penetration among households. Partly aided by their country's relatively smaller geographic size, the Dutch authorities were successful in spreading natural gas to all parts of the country;

- Experiences in five countries in Group I illustrate that lifting State control over tariffs, as well as instituting additional measures for market liberalization, can improve the relative price of natural gas. This occurred in the United States after the Natural Gas Policy Act of 1978, and, particularly after the introduction of regulated TPA on the transmission network in 1985. Similar trends occurred in Canada, which largely phased out cross-subsidization and introducing regulated TPA on the transmission grid in the mid-80s. In the United Kingdom, following liberalization measures initiated in the early 80s, residential gas prices dropped 24 percent from 1986 to 1995.[36] This trend was repeated in Argentina after the decision to privatize Gas del Estado and liberalize the gas market in 1992. Finally, Australia joined the pioneers of gas market liberalization through the Council of Australian Governments Agreement in 1994. The agreement introduced negotiated TPA to

[34] *Natural Gas Prospects (Paris: International Energy Agency, 1986), 26.*
[35] *Data from* IEA Statistics – Natural Gas Information 2004 *(International Energy Agency), p. 280, and p. 330.*
[36] *Andrej, Juris. March 1998. "Market Development in the U.K. Natural Gas Market," Policy Research Working Paper 1890, The World Bank, Washington, DC.*

both T&D networks, and required functional unbundling of transportation and merchant functions of T&D companies. Significant drops in gas prices for all types of users were recorded in the years following these measures;[37]

- Government tax policies have provided another effective measure in spreading consumption of natural gas. Although complete annual data for taxes on natural gas and its competing fuels is missing, for most countries in Group I gas has been taxed at lower rates than has electricity, and at much lower rates than light fuel oil (gas oil). Italy, for instance, has been notorious for having some of the highest taxes on gas oil, which contributed to the rapid expansion of its natural gas market;[38]

- Direct subsidies covering part of the connection costs, and sometimes the cost of gas-compatible appliances, have also helped to promote gas effectively. Primary examples are the Netherlands and the United Kingdom, following discoveries of major gas deposits in the early 60s. In the Netherlands, public distribution companies bore much of the cost of households' conversion from manufactured gas to natural gas in the 60s and 70s. In addition, they provided new natural gas-compatible appliances to households at significant discounts.[39] In the United Kingdom, a massive campaign for spreading natural gas was initiated in 1967. This involved converting existing manufactured gas networks to natural gas and connecting new households to the distribution network. As a monopsony buyer, the United Kingdom's Gas Council was able to acquire gas at prices considerably lower than in other parts of the western world. Part of this implicit subsidy was used to finance conversion projects and construction of new distribution pipelines. The rest went to consumers in the form of lower prices and direct subsidies;[40]

- In Algeria, direct subsidies to households to cover part of their connection costs, largely explain the spread of natural gas distribution in this lower middle-income country. Such subsidies have been particularly important as households usually do not need space heating, and use gas solely for cooking or heating water. This particular policy choice has been instrumental in Algeria's success with greenfield gas distribution despite its lack of a climate requiring a larger heat load; and

- The Czech Republic is a major example of how a country's gas distribution can benefit from its transit status. Its experience after the end of central planning is particularly notable. In the 90s, the Czech national transmission company, Transgas, used part of its transit fees to maintain the price of gas delivered to residential consumers at comparatively low levels against competing fuels. Thus, the country witnessed a rapid expansion in the number of new households connected to gas in the past decade.[41]

Ownership and Gas Market Structure

The structure of the gas market, including issues about ownership in its distribution segment, is an area where governments in Group I followed highly diverse policies. This diversity is a major indicator that there is no "one-size-fits-all" policy which would

[37] *Natural Gas Reform in the Asia Pacific Economic Cooperation (APEC) Region Asia Pacific Energy Research Center (APERC, 2003), 57.*
[38] *Based on Eurogas annual reports in the 90s and 2000.*
[39] *Peebles, Malcolm.* Evolution of the Gas Industry *(New York: New York University Press, 1980), 132.*
[40] *Ibid., 38.*
[41] *There were 1,421,000 households connected to natural gas in 1990. By the end of 2004, the number reached 2,592,400.*

secure success in greenfield gas distribution. This Section highlights this diversity, while examining the approach used in the 13 countries included in the Group on the following policies:

- Private versus State ownership in gas distribution;
- Concentration of ownership in gas distribution;
- Gas market structure – presence of vertical integration during the period of major investment in a country's greenfield gas distribution; and
- Major liberalization efforts affecting the gas market structure since the 80s.

Ownership of gas distribution is one area where countries in Group I adopted diverse policies. Yet, at least in the early stages of greenfield gas distribution, a certain pattern was observable in most countries in the Group. This involved a predominant role undertaken by the State in gas distribution. This was particularly the case in Europe. Thus, in all European countries (in Group I) until the 80s, when the United Kingdom initiated privatization of its gas sector, distribution was largely a task performed through State-owned companies. In the Netherlands and Germany, these were mainly companies in which majority ownership belonged to municipalities. In the United Kingdom, distribution was conducted by a single State-owned company, (BGC). In France, State-owned GdF held a dominant role in the country's distribution business after nationalization of the gas sector in 1946. The only exception was the presence of about a dozen "nonnationalized" distribution companies (*Distributeurs Non nationalisés* – DNNs). These were municipal companies with the status of a mixed company with a public shareholding majority. In the USSR and Czechoslovakia, distribution was naturally a business conducted by the State. Italy provided a partial exception in Europe, where privately- owned distribution companies were able to secure the largest market share overall, although public involvement remained significant.

Private ownership in gas distribution has been much more common in other parts of the world. In the United States, gas distribution was historically undertaken by private companies, with cities gasified by municipally-owned companies being largely exceptions. Gasification of households in Canada was also driven primarily by private companies. However, some major exceptions exist. For instance, gas distribution in the province of Saskatchewan was developed mainly by SaskEnergy, owned by the provincial government. Several utilities in Alberta were also owned by the state (municipalities); however, they had minor market shares. In Japan, greenfield gas distribution also remained mainly in private company hands. In Australia, on the other hand, there were major variations across States. Publicly-owned utilities conducted distribution in major gas-consuming States, such as Victoria and West Australia. However, in New South Wales and the Australian capital territory (States with significant residential gas consumption), distribution was conducted by private companies. Distribution was driven primarily by private companies in the remaining parts of Australia as well.

Concentration of ownership in gas distribution is an area in which countries in Group I exhibit the largest differences. It varies from countries where distribution is in the control of a single company in charge of gas distribution nationwide, to those where the number of utilities distributing gas to private companies is in the range of several hundreds and even more than a thousand, with a significantly small market share for its largest participant. The level of ownership concentration is significant, as it enhances the ability of distribution companies to benefit from economies of scale.

This diversity is largely an outcome of the initial approach taken by governments with existing distribution infrastructure based on manufactured gas. Thus, in Europe, the major contrast is between France and the United Kingdom on the one hand, and Germany, the Netherlands and Italy, on the other. The governments of both France and the United Kingdom chose to nationalize their

manufactured, gas-based distribution networks in the aftermath of World War II. In France, this occurred in 1946, when the fragmented industry based on manufactured gas was nationalized and put under the control of a single State-owned company – GdF. The nonnationalized distributors played only peripheral roles in total gas sales to residential and commercial-public consumers. Nearly all greenfield gas distribution projects were undertaken by GdF, as a result of which even in the early 2000s, when gas liberalization trends reached France, more than 90 percent of the distributed gas passed through GdF's network. Moreover, GdF obtained stakes in some of these nonnationalized distribution companies.

In a similar fashion, in 1949, the Government of the United Kingdom decided to eliminate the fragmented structure in the country's gas distribution business. In that period, more than a thousand local companies were involved in the production and marketing of manufactured gas. The Gas Bill of 1949 established 12 autonomous area boards, each responsible for its own gas supplies. They replaced the previously fragmented gas structure based on private and municipal companies. To facilitate coordination between them and the establishment of a larger strategy for the market, the 12 boards were united under a Gas Council.[42] The discoveries of major gas deposits in the 60s, and the subsequent growing volumes of natural gas flowing into the mainland, led to another reorganization within the gas industry. Thus, in 1972, the structure based on a Gas Council and the 12 area boards was replaced by a single company – the BGC. It was given the task of further developing the nation's T&D networks, having a monopoly role in both.

Unlike France and the United Kingdom, other western European governments (in Group I) abstained from nationalizing their distribution networks. The outcome was a highly fragmented ownership structure. The number of distribution companies remained in the range of several hundreds in the other three countries from Western Europe (Germany, the Netherlands and Italy). Italy had the highest number of distributors (more than 700), while the Netherlands had the lowest – nearly 200. In all of them, however, a degree of concentration of ownership developed over time. Thus, in the Netherlands, the number of distribution companies gradually dropped (reaching about 30 by 2002). The major changes in Italy and Germany were in terms of the emergence of companies with a sizable market share. Italy's ENI held a sizable market share through its major subsidiary Italgas, whereas Germany's Ruhrgas acquired controlling stakes in multiple distribution companies around the country.

Single entities monopolized gas distribution in Czechoslovakia and the USSR. They experienced a reverse trend in the 90s and 2000s when their utilities were privatized. In Russia a large number of distributors emerged following privatization in the late 90s. However, its major gas company, Gazprom, managed to acquire control over part of these utilities because of the financial difficulties they experienced as a result of a government-imposed limits on tariffs. In the Czech Republic, eight distribution companies (and one transmission company) emerged after reorganization involving the national monopolist Czech Gas Company in 1994. In 2002, a single strategic investor (RWE) acquired majority control over six of the distribution companies, leading to a high level of ownership concentration in the country's distribution business.

The gas distribution sector in the United States emerged highly fragmented. This was partly due to the fact that natural gas had been spreading massively, along with manufactured gas, since the 20s. As a result, thousands of companies were

[42] *Peebles, op. cit., 27.*

involved in producing both types of gas, their transportation, and marketing. This fragmentation was reinforced in the late 40s, as the United States government, unlike the governments of France and the United Kingdom, abstained from nationalizing the gas industry. Yet, some consolidation occurred as most companies distributing manufactured gas converted to natural gas, went out of business, or were taken over by natural gas distributors. By the early 50s, the gas distribution sector consolidated to around a thousand natural gas distribution companies, most of which were originally manufactured gas distributors. The overall level of ownership concentration remained low on the national level.

In Canada, the level of ownership concentration has also remained low on the national level, although distribution companies have been able to acquire dominant market shares at the provincial level. In Australia, significant cross-ownership between distribution companies has allowed some companies (such as Envestra) to have a leading market share in multiple locations (across states). In Japan, the prevalence of manufactured gas left a legacy of more than 100 companies involved in gas production and distribution. With the advent of LNG in 1969, the fragmented nature of the gas distribution sector remained. However, the sector consolidated around four major companies with dominant shares in the gas distribution market.

In Argentina, gas distribution was under the control of a single company (Gas del Estado) until 1992. Following its privatization, eight distribution companies were created (and another one joined subsequently). Metrogas, the largest company serving Buenos Aires, serves nearly a third of the consumers in the country. Also, several companies serve more than one distribution region, leading to significant ownership concentration in the distribution segment of the market. On the other hand, in Algeria, a single company, Sonelgaz, has remained in charge of distribution.

Concentration of ownership in a country's gas distribution business tends to create larger distribution companies which can benefit from economies of scale. However, in practice, this has not automatically translated into lower distribution costs (per m^3) and higher efficiency. A statistical study conducted by IEA[43] has emerged with instructive findings. Focusing on company size in Germany, the Netherlands and Italy, the study found no support for the assumption that larger companies should be able to benefit from economies of scale and, consequently, enjoy lower distribution unit costs. In fact, in the case of the Netherlands, larger distribution companies tended to have higher unit costs than smaller ones.

This anomaly, however, does not indicate that economies of scale are irrelevant in distribution. In fact, their presence is significant, but most countries have simply failed to fully benefit from them. This has partly stemmed from governments' risk-averse policies about cutting costs in distribution, as that has often been perceived as detrimental to local employment. However, the major explanation is that in an environment lacking competitive measures, the stakeholders (municipalities or private company managers) have little incentive to cut costs. This was largely the case in the European countries in the IEA study before initiation of gas market reforms.[44]

The level of vertical integration is another area in which countries in Group I made different choices. The variation was particularly striking before most countries started initiating measures aimed at reducing the overall level of vertical integration in the market.

The countries in Group I differ both in terms of the level of vertical integration and the way in which it

[43] Natural Gas Distribution – Focus on Western Europe *(Paris: International Energy Agency, 1998), 61.*
[44] *Ibid., 62.*

was achieved. Annex – Table A9 summarizes the status of vertical integration in 13 countries before major liberalization measures were undertaken. In some countries (such as Italy and Japan), one or more companies operated as fully integrated entities with major roles in all segments of the gas chain (upstream, imports, transmission, distribution). In others (such as the Netherlands, Argentina and most others in Group I), vertical integration remained limited to about two segments of the gas chain, as a rule. Overall, some type of vertical integration has existed in all countries in Group I. However, its level or the method by which it was achieved do not appear significant in explaining the rate of residential gas penetration across countries.

Finally, countries in Group I have differed significantly in terms of the *measures aimed at liberalizing their gas markets*. The variation has been in terms of the type of measures introduced, as well as their timing (Annex – Table A9). The United States, Canada and the United Kingdom have played a pioneering role in introducing TPA (initially on the transmission grid and, subsequently, to the distribution grid), as well as the unbundling of the transport and merchant functions of the companies involved in T&D. The difference in their starting points (in terms of the preexisting level of vertical integration, for instance) has contributed to the variety of liberalization measures introduced in these countries.

Whereas gas market reform in each country could be the subject matter for an elaborate study in itself, Group I countries indicate that it did not have a significant impact on the development of greenfield gas distribution. Nearly all the countries in Group I had already established extensive gas distribution networks and had reached a substantial level of gas penetration in their residential and services sectors before the introduction of major reform measures began. Most gasification activity following the introduction of reforms has pertained to the refurbishment of existing networks and/or their expansion with the goal of reaching new consumers. It has rarely involved greenfield projects.

Judging by the increasing number of households connected to natural gas in Group I countries in the 90s and beyond, it is possible to conclude that gasification has continued to progress following market reforms. However, for the implications of gas market reforms on greenfield gas distribution, countries other than those in Group I need to be examined. The next Chapter focuses on countries with relatively recent experience in greenfield gas distribution.

5. Experience with Greenfield Gas Distribution: The Newcomers

The 15 countries selected for Group II vary significantly in geographical location as well as level of economic development. What is common to all of them is that they can be considered as relative "newcomers" in gas distribution. In all of these countries, significant investment in greenfield gas distribution projects began less than three decades ago. Isolated distribution networks serving a few towns did exist in some of them (such as in Spain, Chile and Mexico) before the 70s, but no large-scale attempts at residential gasification existed until the 70s or the 80s. In fact, in many of these countries (such as Portugal, Chile, Brazil and Greece), gasification of households in major consumption centers did not start until as late as the end of the 90s.

The countries in this Group have been deliberately selected to vary considerably in terms of the rates of gas penetration in households. Based on this diversity, the study examines the various reasons for success for those that achieved comparatively higher penetration rates, and focuses on the major challenges which explain the lower penetration rates in the others. Meanwhile, the study acknowledges that some countries started gas distribution projects much more recently than others. As a result, low gas penetration rates for households are not always an indication of slow progress in greenfield gas distribution.

It is noteworthy that some of the "newcomers" have been able to accomplish greenfield gas distribution projects which generated residential penetration rates exceeding those found in several "pioneer" countries. For example, despite starting investment in gas distribution projects significantly later, Korea (with household penetration of 49 percent) is significantly ahead of several countries in Group I – namely France, Australia, Japan, Canada and Algeria. Also, Spain and Colombia (with a penetration rate of 41 percent and 35 percent, respectively) are ahead of Canada and Algeria from Group I. On the other hand, in nearly half of the selected countries in Group II, largely because gas was introduced very recently, the rate of penetration is less than 3 percent.

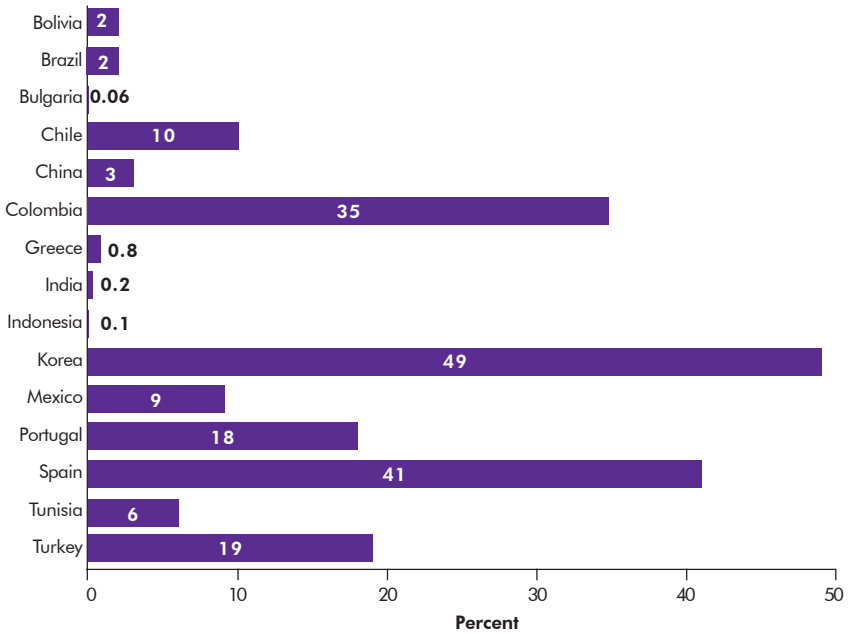
The focus of this Chapter is on the variety of factors which have affected the level of gas penetration in the residential, commercial and services sectors in this group of countries. It explores the major similarities and differences across countries in Group II, and compares them to Group I countries, where applicable. It also examines the challenges and opportunities they have faced as the result of having a later start-up (compared to Group I countries) in gas distribution.

Supply-side Aspects

Based on a comparison between the countries in Group I and Group II, as well as cross-country comparisons within Group II, it is possible to draw the following conclusions:

- The legacy of distribution networks based on manufactured gas has been very small among "newcomers," as opposed to most "pioneer" countries;

Figure 5.1: Penetration of Natural Gas in Households



Note: Data for 2001-04; details related to the Figure are in Annex – Table A10.

- For various reasons, gas usage in most of the Group II countries (as measured by its share of TPES) is much lower than in Group I countries. In the case of countries with abundant gas, this was mainly due to late start-up in major upstream investments. In the case of countries lacking indigenous gas supplies, this was largely as a result of the comparatively late completion of infrastructure for gas imports (such as cross-border pipelines and/or LNG terminals);

- There is a paradoxical situation in terms of the availability of indigenous gas supplies. Many countries in Group II possess significant indigenous reserves of natural gas, but it is these countries which have achieved the smallest progress in greenfield gas distribution so far;

- Many countries in this Group were challenged significantly by their comparatively lower level of economic development, which resulted in slower progress in major infrastructure investment (such as transmission networks reaching multiple regions of the country) required for initiating greenfield gas distribution; and

- Finally, in Group II countries, the main centers of gas demand tended to be further from the gas supplies than was the case with a number of the Group I countries, especially the European Group I countries.

Lack of Manufactured Gas Networks

Unlike most countries in Group I, very few "newcomers" were able to benefit from an extensive gas distribution network based on manufactured gas. In case they benefited from such a legacy, it was limited only to one or a few major cities. Chile, for example, possessed a distribution network dating back to the mid-19th century. This network has been undergoing conversion to natural gas since the commencement of imports from Argentina in 1997. In Portugal, a distribution network existed in Lisbon, serving around 230,000 consumers, before the introduction of gas in 1997. In Korea, manufactured gas was introduced in 1972 and spread to several major cities. Its network has also been undergoing conversion since the first LNG terminal was launched

in 1986. In the case of the other countries in the Group, the extent of networks based on manufactured gas was even more limited. In several countries (such as Mexico, Tunisia, China, Indonesia, Brazil and Greece), some cities have had a gas distribution infrastructure based on coal or naphtha. However, their contribution to spreading natural gas among households has been small. In the case of China and Brazil, conversion of existing distribution networks to natural gas has been going on, even though in China the number of households using manufactured gas has also been growing.[45]

Low Overall Usage of Natural Gas

A comparison between the two groups of countries in terms of the share of natural gas in total primary energy supply (TPES) highlights the relatively late entry of natural gas in meeting the energy needs of Group II countries. The share of natural gas in TPES stood at 10.7 percent and 1.4 percent on an average for Group I and Group II countries in 1973, respectively. Quite notably, in all countries in Group II (except Mexico), the share of gas was less than 1.5 percent. By 1990, gas' share increased in the TPES of both groups of countries. Yet, the sizable gap between the two groups remained: gas' share in TPES went up to 16.3 percent in Group I and only 4 percent in Group II (Annex – Table A11).

Indigenous Supplies of Natural Gas

A major paradox is apparent with respect to the availability of indigenous supplies of natural gas in Group II countries. The countries most advanced in terms of greenfield gas distribution are those with no significant indigenous gas reserves. Thus, on the one hand, Korea, Spain, Turkey, Portugal and Chile lacked any significant indigenous supplies, but were able to achieve residential gas penetration above 10 percent.[46] Colombia appears the only exception, as gas distribution projects proceeded rapidly in the past decade amidst abundant domestic supplies. On the other hand, all the remaining countries, with the exception of Bulgaria and Greece, have benefited from sizable indigenous gas reserves (Annex – Table A12). However, their residential gas penetration rates have remained markedly lower.

The slow rate of upstream development in the gas-abundant countries of this Group lies at the core of this paradox. This is in contrast with most countries in Group I, which were involved in large-scale upstream investments as early as the 60s and 70s (some even before that), which helped to expand their reserve base as well as the volumes of indigenous supply. Most countries in Group II failed to mobilize investments in their upstream, and production of natural gas remained at considerably lower volumes until as late as the 80s and even the 90s. Mexico, where significant gas production already occurred in the 70s, is a partial exception, but the large growth in output experienced in the 90s illustrates the unexploited potential in previous periods.

Another common cause for the slow rate of upstream development has been the lack of incentives for producing natural gas. Thus, operators of fields usually lacked the necessary incentives to sell associated or nonassociated gas to the domestic market. As a result, they quite often opted in favor of leaving the gas in the ground, focusing on export markets, and flaring or venting the gas (in the case of associated gas).

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[45] *In 2000, 25,809,000* persons *residing in urban areas had access to natural gas, and 39,444,000 persons in urban areas had access to manufactured gas. In 2003, 43,200,000 persons residing in urban areas had access to natural gas and, in addition, 47,921,000 persons in urban areas had access to manufactured gas.* China Statistical Yearbook 2003 – *National Bureau of Statistics of China.*

[46] *The major discovery in Spain was the Gaviota field near the Basque region in the 80s. However, it was depleted by 1994. At present, there is active production only in a small offshore field in the Gulf of Cadiz – 30 km from Huelva. Chile's major discovery occurred in the Magellan basin in the far south of the country, thereby satisfying only regional demand. In Korea and Portugal, natural gas production has never occurred at a commercial level, whereas in Turkey it has remained very limited.*

Gas Supply Infrastructure

The countries facing shortage of indigenous supplies were able to compensate for this through constructing cross-border pipelines or LNG terminals. Nevertheless, such projects were completed significantly later than in the case of Group I countries, which partly explains their later start-up in gas distribution as well. The earliest examples of such infrastructure in Group II appear to be from the 70s and are limited to only two countries – Spain and Bulgaria. In the case of Spain, the first step was taken in the 70s with the inauguration of the country's first LNG terminal. Its foreign supplies, however, remained limited for quite a long time. Thus, in 1980, its total imports were still only 1.7 bcm. By 1990, LNG imports reached 4.5 bcm, but residential consumption remained below 0.5 bcm. The main impetus for gas market growth came after the completion of two cross-border pipelines. The first, which provided Norwegian gas through France, was launched in 1993, whereas the country gained its greatest access to foreign supplies in 1996, following the inauguration of the Maghreb-Europe gas pipeline linking Algeria's giant Hassi R'Mel field with Cordoba in Spain. In the case of Bulgaria, a pipeline securing Soviet gas was completed in the 70s, but natural gas was designated for areas other than households.

While several of the other countries in the Group also eventually acquired access to imported gas, for some of them it occurred significantly later. Tunisia benefited from the ability to import Algerian gas following completion of the Transmed pipeline linking Algeria with Italy in 1983. The next country in the Group gaining access to imported gas was Korea. Its first LNG imports began in 1986, paving the way for speedy gas market development. Turkey followed in 1987 through inauguration of a pipeline for Soviet gas built through Romania and Bulgaria. The country recorded its first residences connected to natural gas in 1988. Expansion of this pipeline's capacity, as well as the construction of additional pipelines – one for Russian gas under the Black Sea another for Iranian gas and most recently one for Azeri Gas – provided Turkey with the necessary supply for developing its gas market overall and expanding the number of cities with distribution systems.

After prolonged negotiations, several private companies embarked simultaneously on the construction of multiple pipelines linking Chile with Argentina. The first one commenced in 1997 and the others followed, linking several gas basins (La Mora, Neuquen and Noroeste) in Argentina with consumption centers scattered around Chile. In the meantime, Portugal was linked to the Maghreb-Europe pipeline through two separate connections in Spain. As a result, both countries have experienced fast growth in gas market development and, in particular, fast residential penetration, since the late 90s.

Mexico benefited from multiple connections with the United States for both imports and exports. Growing demand in the country in the 90s has transformed it into a major importer of United States gas. Similar trends have occurred in India and China, which, until recently, were self-sufficient. However, in both countries, the growth in demand has surpassed the growth in indigenous supplies, thereby requiring the commencement of import projects. India received its first LNG imports in 2004 and China is expected to complete several LNG terminals consecutively. In both India and China, distribution projects have commenced in multiple locations but their viability depends largely on their ability to secure gas supplies. Brazil is another country benefited from imports following the construction of pipelines connecting it with Argentina and Bolivia. Finally, Greece, owning a small LNG terminal for Algerian gas, finalized a major pipeline for importing Russian gas through Bulgaria in the late 90s, and has imported gas in increasing volumes ever since.

Proximity of Consumption Centers to Natural Gas Fields

Several countries in this Group have been significantly affected by issues related to the proximity of major consumption centers to natural

gas fields. Largely due to the lower level of economic development in these countries (in comparison to those in Group I), the need to construct long-distance transport infrastructure (either for indigenous or foreign supplies) has emerged as a major challenge. This has been particularly the case in the geographically larger countries of this Group, such as India, China, Indonesia, Brazil and Mexico.

A pronounced feature in these countries is that development of transmission pipelines nationwide has remained largely incomplete (with Mexico being a partial exception, although it has an ongoing need for investment in new transmission networks). As a result, isolated transmission networks serving only certain localities close to the gas field have been common. For example, until recently, China's fast-growing cities, located on or near its east coast, were not able to benefit from natural gas supplies owing to their remote location. Thus, reserves in the Sichuan province served mainly regional demand and made no contribution to supplying gas in cities such as Beijing and Shanghai. Largely with the objective of allowing other regions to benefit from gas, China undertook massive investment in the 4,200 km-long West-East pipeline, which commenced in 2004.

Indonesia's case illustrates further how problems related to lack of a transmission network could slow the penetration of natural gas in different regions. Most of the country's transmission infrastructure has been developed to connect gas fields with several bulk users (such as power plants) found in relative proximity. Meanwhile, its major consumption centers in Java have been largely lacking in terms of access to gas supplies, most of which are found in the remote locations of Kalimantan and Sumatra islands. This has hindered further penetration of natural gas.

However, the ability to build a well-established transmission network alone also does not assure development of a gas distribution infrastructure. A major example is Bulgaria, which, following the inauguration of Soviet gas imports in the mid-70s, established a transmission network stretching to nearly all industrial regions and major cities of the country. This network supplied industries and DH systems. However, it was not accompanied by development of gas distribution networks in the cities, and the process still remains in a highly preliminary stage. As examined in the following discussion, major policy choices by successive governments have resulted in very limited residential gas penetration despite the presence of this national transmission network.

Demand-side Aspects

A comparison between the "pioneers" and "newcomers" in gas distribution leads to the following conclusions:

- Most countries in Group II have a climate for which space heating requirements are minimal. This results in potentially lower gas consumption per residential consumer. Countries with relatively colder climates in Group II appear to be those with the biggest progress in greenfield gas distribution;

- Most countries in Group II are characterized by a comparatively lower level of economic development in terms of their national per capita income. This affects residential consumption patterns and the ability of households to afford the cost of gas connections. It puts "newcomers" in stark contrast to "pioneers," which have some of the highest Gross National Income (GNI)/ capita levels in the world;

- In terms of fuels competing with natural gas, combustible renewables (wood and other biomass) and wastes[47] play a larger role in the residential consumption of Group II

[47] *Combustible renewables and wastes, as defined by IEA, include wood, charcoal, biogas and wastes.*

countries, whereas their role in Group I countries has been largely peripheral. This is probably the result of the lower income levels of Group II countries, where many households tend to have access to combustible renewables at low cost or for free;

- As gas became increasingly important in power generation in the past two decades, the latter has appeared as a significant "anchor consumer" for developing a national gas industry and, consequently, greenfield gas distribution projects. Due to the relatively later start-up in gas distribution, the countries in Group II have been able to benefit from this trend better than in the case of Group I;

- Many countries in Group II exhibit considerably low urbanization rates, which appears as another reason for why greenfield projects in some of these countries have remained limited to a few larger cities; and

- Group II countries are developing gas distribution systems during a period of heightened environmental awareness with governments well aware of the low air pollution associated with burning gas and reduced carbon dioxide (CO_2) emissions.

Requirement for Space Heating

Many countries in Group II have climates requiring minimal space heating. This includes particularly Colombia, Tunisia, India, Indonesia, Bolivia, Brazil, and many parts of most of the remaining countries. This is in stark contrast with the countries in Group I, where households in all countries, except Algeria, required significant energy for space heating. As examined in the case of Group I countries, the presence of a relatively cold climate does not always translate into the usage of natural gas for space heating purposes. However, the use of natural gas for space heating considerably raises the average gas consumption per households. Accordingly, for most countries in Group II, the average gas consumption per household is usually low, which is a factor that may often raise doubts about the viability of a greenfield gas distribution project.

An accurate estimate of average residential gas consumption is difficult to make for each country in Group II[48] because of the very low numbers of households connected to natural gas. As a result, Figure 5.2 outlines the approximate gas consumption of households only in the six countries with residential gas penetration rates above 10 percent. Turkey appears to have the highest consumption per household, followed by Chile and Korea. Meanwhile, Portugal and Colombia appear to have the lowest. The countries with highest penetration of gas in households appear to be those with relatively colder climates than the rest of the countries in Group II.

Nevertheless, Colombia's relative success in spreading gas distribution networks illustrates that climatic conditions do not necessarily prohibit greenfield gas distribution. The country's climate requires no space heating. Reportedly, nearly all households use gas only for cooking – even water heating is not a major area of residential gas application. As a result, gas consumption per household is low.[49]

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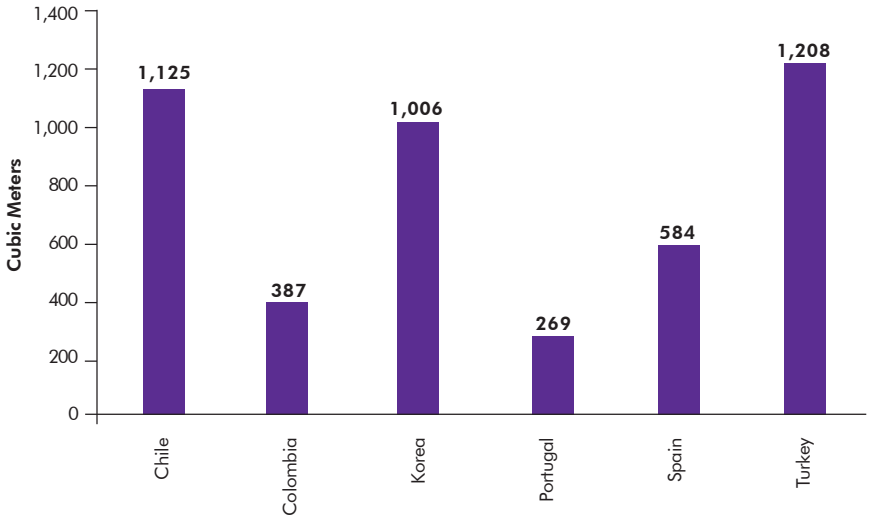
[48] As the number of households connected to gas grows, the average gas consumption per household has changed rapidly across the years for most of the countries in the group. This is caused partly by the lack of simultaneous data on residential connections and residential gas consumption. However, it is also because average consumption in the first localities connected to natural gas does not necessarily represent the households connected subsequently.

[49] According to one source, the average monthly consumption per households varies between 22 and 28 m^3. This is small compared with Canada, where the average monthly consumption is around 300 m^3. See Guillermo Diaz, "Experiences with the Development of New Residential Markets for Natural Gas – A Colombian Case Study," Technical Paper presented in the sessions and published in the proceedings of the Third LACGEC (Latin American and Caribbean Gas and Electricity Congress) in Santa Cruz de La Sierra, Bolivia, on April 23, 2002, http://www.technogas.ca/lacgec3.html.

Figure 5.2: Estimated Average Gas Consumption per Household



Note: Data for 2001-04; details related to the Figure are in Annex – Table A14.

Yet, distribution companies in Colombia have managed to spread gas among households as the result of various strategies. These included optimization of investment costs in distribution through employing pipelines, service regulators and metering equipment of reduced capacity. Another strategy commonly employed has involved reducing the connection charges for households and providing gas-compatible equipment at a discount.[50]

Income per Capita

All countries in Group II rank significantly below those in Group I in terms of the level of income per capita. Seven countries in the Group belong to the lower middle-income category and one to low-income category. Spain has the highest per capita income in the Group; however, it ranks below nine of 13 countries in Group I.

This could partly explain the relatively late start-up of gasification of Group II countries. Low per capita income acts as a potential impediment for households switching to natural gas because of costs that often appear unaffordable. Governments of such countries have experienced major challenges in meeting sizable investment requirements which has contributed to delays in establishing a national gas infrastructure, including import facilities, transmission pipelines and distribution grids. Several governments have managed to successfully address this challenge by handing over greenfield gas distribution projects to private companies.

It is probably not a coincidence that in the case of Group II countries, which have already achieved relatively higher residential gas penetration rates, gasification began after a distinct period of rapid economic growth. Gas market development, and, particularly, greenfield gas distribution, therefore accelerated significantly after Spain's accession to the European Union (EU) Community in 1986. Portugal also benefited from joining the Community before the introduction of gas in 1997. In fact, EU funds have been significant in Portugal's gasification projects. Korea and Chile have the distinction of being two of the fastest growing countries in their respective continents. In Turkey, the 80s was marked by market reforms and rapid growth before the introduction of gas in 1987. Similarly, in China, greenfield gas distribution projects have accompanied rapid economic growth.

[50] *Ibid.*

However, the selected examples in the report indicate that high national income per capita does not appear to be a precondition for gas distribution. This is illustrated by the slow pace of residential gasification in countries with relatively advanced economies (such as Greece, a high-income country), as well as the successful development of greenfield gas projects achieved in countries with significantly low income (Colombia, Turkey and Algeria).

Household Size

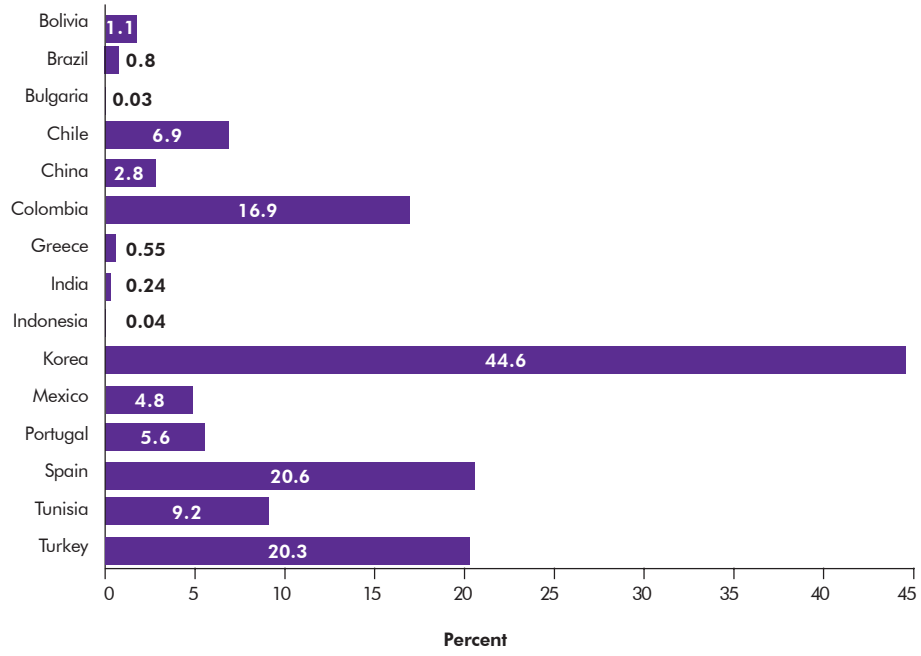
In terms of the average size of households, most countries in Group II rank higher than those in Group I (Annex – Table A15). This implies potentially lower per capita gas consumption. However, it also implies higher consumption per household. In the context of low-income countries, this may contribute to households' switching to natural gas as energy consumption tends to grow in larger families, thereby increasing their annual expenditures. Switching to gas is particularly attractive if gas is subsidized or appears as the cheapest competing fuel. However, no study is available on the connection between size of household and propensity to switch to natural gas.

Regarding the type of dwellings in which households reside and their implications for gas consumption, Spain and Turkey provide a useful example. In both countries, there is a large role for multifamily dwellings, which usually have a common boiler. This has created the potential for distributors to benefit from economies of scale.

Competing Fuels

As of 2004, the status of natural gas versus competing fuels in Group II countries appears different from countries in Group I. Natural gas has reached the status of being the preferred residential fuel in only one country in Group II so far (Korea). In all other countries in the Group, gas ranks behind at least two alternative fuels. For many of them (seven out of 15), gas is still the least preferred fuel in the households. This outcome is largely due to the comparatively lower rate of households connected to natural gas in these countries (Annex – Table A16 and Figure 5.3).

Figure 5.3: Share of Natural Gas in Total Residential Energy Consumption



Note: Data for 2004; details related to the Figure are in Annex – Table A16.

A common pattern in Group II countries, observed in Group I countries as well, is that coal has been the principal fuel supplanted by natural gas. This reflects the environmental policies of governments, particularly those aimed at improving air quality in large cities. Major examples are Turkey, Korea, Spain and Chile. Meanwhile, some other countries, namely India and Bulgaria, have also witnessed an overall decline in residential consumption of coal, but this is hardly associated with gasification of households as its rate has remained very low.

The substitution of petroleum products has been much less pronounced in Group II than in Group I. In only two countries (Turkey and Bulgaria) has the overall residential consumption of petroleum products declined in both absolute and relative terms. In several countries, namely Bolivia, Mexico and Indonesia, the presence of significant oil production has resulted in a large share of petroleum products in residential energy consumption. This has created significant challenges for natural gas penetration, especially because of subsidized petroleum product prices for end users.

Among petroleum products, liquefied petroleum gas (LPG) has been widely used by households in Group II. This fuel has served as a significant alternative to natural gas and has usually been introduced earlier. LPG has particularly inhibited the penetration of natural gas in countries where governments have chosen to subsidize its price for households. However, where subsidies have been absent or negligible, following the entry of natural gas in a city or a region, LPG traders have often been obliged to reduce their prices, implying competitiveness with natural gas. This was the case, for instance, in Chile's capital of Santiago following the introduction of natural gas in 1997.[51] Under such circumstances, the two fuels have continued penetrating households simultaneously but with an increasing number of households preferring natural gas. In this process, the major advantage for LPG as a fuel has been the lower cost of an LPG bottle compared with the connection fees for natural gas.

Occasionally, natural gas has appeared competitively priced against electricity. A partial contribution to this has come from market reforms in the power sector, resulting in the abolition or reduction of price subsidies for electricity consumption by households. In other cases, regional disparities in electricity prices (caused mainly by regional electricity supply disparities) have inhibited gas penetration. This has largely been the case in northern Portugal, where residential users have had access to relatively cheap electricity.

However, the most distinctive feature of Group II countries is most likely the prevalence of combustible renewables and waste as alternative fuel-types among residential consumers. As Annex – Table A16 illustrates, this category appears to be the preferred fuel in households' energy consumption in nine of the 15 Group II countries. This is partly because of the lower income per capita in these countries which decreased the rate of fuel switching. Also, for several of them, it reflects comparatively lower urbanization rates, as rural inhabitants are most likely to have access to fuels such as firewood for free or at comparatively low costs.

Settlement Density

As one of the most common means for benefiting from scale economies, gas distribution activities in nearly all Group II countries have been concentrated on one or few of the largest cities of the country. Such cities have been the first, and often the only ones to be connected to natural gas. This has been particularly the case in countries with low urbanization rates, such as China, India and Indonesia, where most of the population resides in rural areas and opportunities for economies of scale nationwide have been limited.

[51] *Asia Pacific Energy Research Center (*Natural Gas Reform in the APEC Region*, APERC, 2003), 78.*

A major example is China, where both natural gas and manufactured gas have been spreading rapidly in several major urban areas over the past decade. The result, based on China's national statistics for 2003, is that 76.7 percent of the urban population has been identified as having access to "tap gas" (up from 17.8 percent in 1989). This is in stark contrast to China's rural regions, as nearly all gasification has taken place in its cities.

Other major examples are Brazil and Greece. Thus, nearly all gasification activity in Brazil has remained limited to its two largest cities – Sao Paula and Rio de Janeiro. Similarly, in Greece, since the late 90s the households connected to natural gas have been mainly in Athens, with ongoing greenfield distribution projects focused on other large cities. In India, as well, most activity has focused on a few larger cities (New Delhi and Mumbai, in particular).

Turkey, in the meantime, provides an example of a country with more advanced experience in greenfield gas distribution. As elsewhere in Group II, the initial focus of gas distribution was on the country's two largest cities, Ankara and Istanbul. They were the first to access natural gas in 1988 and 1992, respectively. After nearly a decade of slow progress in terms of spreading gas to other cities, there was a major boost in terms of greenfield gas distribution following the enactment of a new legislation on the natural gas market in 2001. This legislation established a regulator for natural gas as well as an accelerated process whereby distribution licenses would be awarded to private firms. As a result, by the end of 2005, households in 24 distribution regions (several of them including more than one city) were acquiring access to natural gas. This, as examined next, illustrates the need to focus on policies adopted by the government, which can provide further explanations about what drives success in greenfield projects.

Commercial and Service Consumers

The role of commercial and service consumers in creating opportunities for scale economies has differed substantially across countries in Group II. This reflects different choices by governments or distribution companies. Thus, in 2004, while commercial-public consumers in Spain consumed 105 m^3 of gas per every 1,000 m^3 of gas consumed in the households, in Indonesia, they consumed 1,609 m^3 per 1,000 m^3 in households.[52]

In several countries in this Group (Indonesia, Bulgaria, Greece, Bolivia and Brazil), natural gas consumption in the commercial and services sectors has significantly outweighed residential consumption (Annex – Table A17). It has been a common strategy for many distribution companies to have the commercial and services sectors as their first consumers. This is a means of reducing the risks associated with building distribution networks. Indonesia provides a unique example of developing a distribution infrastructure based almost solely on serving consumers such as hotels, hospitals and public buildings, as well as other consumers from the commercial and services sectors

Anchor Consumers

A distinctive feature of Group II is the large role of power generation in development of a national gas market. Unlike most countries in Group I, power plants emerged as major consumers in the early stages of gas market development for most countries in Group II. This is mainly due to the later start-up of gas market development, which coincided with the new global emphasis on gas-fired power generation in these countries. As a result of this relatively late start-up, infrastructure development in this group of countries appears blessed with the presence of power plants as anchor consumers. Power plants located in different parts

[52] *Part of the difference in the ratio of gas consumption in the commercial and services sectors versus households across Group II countries is associated with the differing ratios for overall energy consumption in the two sectors.*

of these countries have been a major driver in the construction of transmission pipelines, following which cities have initiated greenfield gas distribution projects.

Power plants appeared as anchor consumers for the introduction of LNG in Korea in 1986. Similarly, gas-fired power plants were the principal purchasers of natural gas once cross-border pipelines were completed, and provided access to imported gas to Turkey, Portugal and Chile. In Colombia, which has been producing gas for several decades, power generation was an integral part of gas market development. In Spain, which started limited gas consumption in the 70s, gas-fired power plants have gained importance only in the last decade. An agreement signed in 1994 between the country's State-owned gas company, Enagas, and Unidad Electrica, an association of the electricity enterprises, was instrumental in proceeding with a major cross-border pipeline project for importing gas from Algeria. Rapid expansion of greenfield gas distribution projects followed.

In several Group II countries, the penetration of gas in power generation has been delayed because of the presence of alternative fuels. Thus, for example, abundant coal reserves in China, India and Indonesia have helped postpone the penetration of gas in power generation.[53] Brazil offers a similar example with its abundant hydro resources, which also helped delay gas penetration in the power sector. In all four countries, the relatively underdeveloped transmission infrastructure, and the presence of a large number of cities with no access to natural gas, are partly the result of historically lower priority given to gas in power generation.

In a number of Group II countries, it has been the industrial users who have served as the primary anchor consumers for gas market development. In Spain, for instance, industry has been the main driver in gas market development since the early introduction of gas in the 70s. In a similar fashion, Chile's indigenous supplies in the late 80s and 90s were mainly consumed by large industrial plants. In other countries as well (such as Mexico, China, India, Indonesia, Brazil and Greece), the shift toward natural gas in power plants has occurred after a significant expansion of gas consumption in industry. Thus, there have been different paths in terms of the "sequencing" of anchor consumers in the process of developing a national gas industry.

Environment

The environmental advantages of natural gas are well known and are a significant factor in encouraging countries to introduce gas distribution. For example, in Turkey, the main alternative to natural gas for home heating was, for a long time, lignite. This resulted in severe air pollution in the winter in the larger cities, especially the colder ones such as Ankara. With the introduction of natural gas, air pollution declined rapidly. As a result, air pollution is now much lower in cities where gas distribution systems have been in place for some time such as Ankara, Istanbul, Eskisehir, Bursa and Izmit. Now, with the commencement of development of gas distribution systems in nearly 50 other cities, air pollution is likely to decline there also, once gas usage increases.

The Group II countries may also benefit in the longer run by using natural gas instead of more carbon-intensive fuels for heating. This would reduce their carbon emissions and it is possible that if the projects are designed correctly carbon credits might be available which could be sold. However, not all gas distribution projects will reduce carbon emissions since they may replace LPG or hydropower and also some Group II countries, such as Turkey, have not signed the Kyoto Protocol and are, therefore, not eligible to sell carbon credits.

[53] *India and Indonesia have attached a higher priority to gas-fired power generation since the 90s.*

Policy Framework and Market Structure for Gas Distribution

As illustrated in the case of Group I countries, there is no "one-size-fits-all" policy which could secure success in gas distribution projects. Neither have countries so far developed their gas distribution networks on the basis of identical gas market structures. As a result, while aiming to identify certain patterns encompassing all or most of the countries in Group II, this Section provides multiple examples from these countries which emphasize the diversity of policy across the countries. For this purpose, it examines the following:

- The role of State vs. private ownership in gas distribution;
- Concentration of ownership in gas distribution;
- The degree of vertical integration in the initial period for greenfield gas distribution networks;
- Implications of gas market liberalization efforts on gas distribution;
- Examples of specific strategies adopted by governments that have successfully promoted gas distribution; and
- Major policy choices creating obstacles for greenfield gas distribution projects and delays in their implementation.

Private vs. State-led Development of the Gas Market and Gas Distribution

The following are examples of the leading role of State-owned companies in the initial years of gas market development in several Group II countries which have achieved the highest level of residential gas penetration:

- In Korea, in 1982, legislation created the state-owned Korean Gas Corporation (Kogas), with a monopoly role in LNG imports, operation of LNG facilities, transmission and sales to large consumers;
- In Spain, a State-owned company (Enagas) was created in the early 70s to take charge of imports, LNG facilities, development of the national transmission network, sales to large consumers and a role of some kind in gas distribution;
- In Turkey, State-owned Boru Hatlari ve Petrol Tasima AS (Turkey's Petroleum Pipeline Corporation – BOTAS) was given a monopoly role in imports, wholesale, transmission and a role in distribution development following the introduction of gas in 1987;
- In Portugal, the government established Gas de Portugal (GdP) to develop gas distribution grids and establish a major stake in another major player, Transgas – the national monopoly in imports and transmission;
- In Colombia, State-owned Ecopetrol was accorded a leading role in the country's upstream development as well as in transmission projects; and
- In Chile, State-owned ENAP was also accorded a dominant role in upstream development and transmission.[54]

The dominant role of the public sector was observable during the initial stage of greenfield gas distribution projects as well. In this respect, most countries in Group II are quite similar to those in Group I. Thus, only in a very few countries (such as Korea and Bulgaria) did private entrepreneurs take the leading role in establishing gas distribution networks.

[54] *The dominant role for the State was applicable for most of the remaining countries in Group II as well.*

Yet, there has been a major shift toward private participation in gas distribution in the past decade. In all countries, except in Tunisia, privately-owned companies have played increasingly important roles in greenfield gas distribution projects in contrast to countries in Group I, most of which had advanced significantly in terms of gas distribution networks before allowing a dominant role for private actors. For instance, legislative changes encouraging private involvement in utilities in the mid-90s largely accounted for Colombia's rapid rate of household gasification. The cash-strapped government of Colombia has had limited funds for distribution projects, which accounted for the delay in their realization. Similarly, in Spain, privatization of its major gas distributor (Gas Natural) has contributed to the fast pace of residential gasification since the late 90s. In Portugal, the rise of privately-owned distribution companies contributed to its reaching household penetration rates which appeared far ahead of the initial optimistic scenarios of the government. In Chile, when gas started flowing from Argentina, private companies had already been allowed to occupy a growing role in distribution based on manufactured gas. Once growing amounts of gas began to flow from Argentina, these private companies took the opportunity to invest in natural gas distribution projects and rapidly expand the number of gasified households. In Turkey, large investments in greenfield gas distribution projects are occurring simultaneously in multiple distribution areas of the country, coinciding with gas market reforms which provided a larger place for private players. In part, this is owing to the presence of a newly expanded transmission grid reaching regions that formerly had no access to natural gas. However, it also reflects the presence of a number of private companies willing to invest in the gas distribution business of the country.

Similarly, in Mexico, private company participation has coincided with acceleration of investment in greenfield gas distribution projects. Thus, the number of residential (and commercial-public services) consumers increased nearly fourfold from 1997 to 2002, reaching 2,300,000 (up from 604,000 in 1997).

In Brazil, private distributors have gained an increasingly important role after a constitutional amendment which allows private participation. Thus, since the mid-90s, private companies have been involved in large-scale conversion of distribution networks based on manufactured gas to natural gas. However, natural gas has still failed to spread to localities beyond a few of Brazil's major metropolitan centers, despite the availability of gas in multiple locations. Likewise, in China, investment in gas distribution has also accelerated since the mid-90s, when a growing number of private companies joined greenfield projects as minority partners.

Nevertheless, there are also some examples for countries where growing private participation has not sparked significant progress in gas distribution networks. For instance, in Bolivia, India, Indonesia and Greece, the increase in the number of households with access to natural gas has remained very slow even after legislative changes allowed for a growing role for private entrepreneurs. In the case of Bulgaria, private companies have been active from the early start of distribution concessions at the beginning of the 90s. However, after more than a decade of involvement, the total number of residential consumers with access to natural gas has remained extremely low (reaching only 2,000 residential consumers in 2004).

Yet, the slow progress in gas distribution projects in these particular countries can hardly be attributed to the growing role for private entrepreneurs. Instead, other policy choices have obstructed private companies from fully realizing their potential. It is noteworthy that in all these countries (except Bulgaria), the incumbent State-owned distributor has retained its dominant role in gas distribution. The involvement of private companies has remained limited to minority ownership in some distribution companies, or to leadership in relatively smaller distribution projects.

Concentration of Ownership in Gas Distribution

Concentration of ownership in distribution has remained relatively high in most countries in

Group II. Tunisia provides an example of the most extreme case in which a single State-owned company (STEG) has been charged with conducting natural gas distribution. In several other countries, a single company has maintained a dominant (though not exclusive) role in gas distribution. This has principally been the case in Spain (through the dominant market share of Gas Natural); Portugal (through GdP's major stakes in the country's distribution companies, as well as its dominant role in the country's largest distributor serving Lisbon); Chile (with a single company, Gasco, owning major stakes in most of the country's distributors).

The high level of concentration has been adopted largely as a strategy to secure economies of scale for the major participants, as well as a means of attracting large (especially international) investors. Thus, for instance, numerous distribution companies emerged in Colombia in the 90s with the goal of serving various regions of the country. However, the Colombian government specified that market concentration in distribution will be permitted by 2015, when gasification of households is expected to be nearly completed. Thus, current distribution companies have significant cross-ownership, resulting in a higher level of market concentration.

In several other countries (Bolivia, India and Greece), the incumbent national gas distributor still undertakes most of the distribution activity directly, or owns major stakes in local distribution companies, resulting in a high degree of market concentration. In other Group II countries (Turkey, Mexico, Brazil, China and Bulgaria), market concentration has been impacted by allowing (private) distribution companies to conduct distribution projects in multiple locations and gain significant market share (Annex – Table A18). Korea, on the other hand, has maintained a significantly low degree of market concentration in gas distribution.

The Degree of Vertical Integration

Typically, for many countries with a newly developing gas market, countries in Group II have had a high degree of vertical integration before the introduction of gas market reforms. As summarized in Annex – Table A18, in several of the countries, a single company dominated all imports, the construction of the national transmission grid and sales to large consumers. This was the case in Korea, Spain, Turkey and Portugal, except in Korea, these companies had a significant role in gas distribution as well. In Colombia, the national gas and oil company, Ecopetrol, dominated both gas production and transmission. In Chile, the gas market was largely underdeveloped until imports began in 1997. Following the inauguration of gas import pipelines in 1997, a major characteristic of the Chilean gas market has been the significant degree of integration between T&D companies.

At varying degrees, vertical integration was prevalent in the remaining countries of Group II as well. In Mexico, India, Indonesia, Brazil, Bolivia and Greece, a single company dominated all segments of the gas chain before reforms. In the remaining countries, distribution was undertaken by separate entities (Bulgaria and China), or was integrated only with transmission (as has been the case in Tunisia, where STEG's role in upstream has been minimal).

Greenfield Distribution Amidst a Liberalized Gas Market

In most countries in Group I, development of gas distribution networks had reached an advanced stage before the introduction of major reforms, such as privatization of national transmission owners, TPA in the transmission grid and reducing the existing level of vertical integration in the market. In Group II, however, such major reforms have coincided largely with the early stage of greenfield gas distribution. Many Group II countries began to liberalize their gas markets, following the example established by "pioneers" – the United States and the United Kingdom, in particular.

While the principal reform measures in the market structure of each country are outlined in Annex – Table A18, three measures have appeared central for most countries in Group II: encouragement of

private participation in gas infrastructure development, establishment of certain limits on vertical integration and introduction of TPA in the transmission networks.

As the degree of residential gas penetration is comparatively low in some countries in the Group, the implication of market reforms is hard to estimate at this point. However, based on data for the countries with the biggest progress in gas distribution, it is possible to conclude gas market reforms have coincided with fast progress in greenfield projects:

- **Spain:** Major reform measures were introduced in the mid-90s. Residential gas consumers experienced a rapid increase after this period, with their number rising from 2,720,000 in 1995 to 5,203,000 in 2003;
- **Colombia:** Major gas reforms were also introduced in the mid-90s. Residential gas customers increased sharply from 931,000 in 1995 to 3,300,000 in 2004;
- **Chile:** In 1995, the country had only 37,175 residential gas consumers. By 2004, the number of residential consumers reached 397,000. This rapid growth has occurred in an environment marked by minimal government intervention. Thus, multiple import pipelines (from Argentina) were completed with the involvement of government limited to negotiation of international treaties establishing a clear framework for investors. Following the flow of imported gas in 1997, gas distribution developed rapidly without any particular financial incentives on the part of the government. The government's involvement in this period concentrated on monitoring anticompetitive behavior in the market;
- **Portugal:** When gas imports were introduced in 1997, State companies retained a dominant role for the first several years. By 2003, Portugal had undertaken major initiatives for meeting the requirements in the EU Gas Directive. Meanwhile, private companies obtained a large role in distribution by the late 90s, proceeding rapidly with gas distribution. As a result, the number of residential gas connections reached 683,000 by 2003 (up from 74,000 in 1998);
- **Turkey:** Major reforms were undertaken with the Natural Gas Law in 2001. In the span of two years (from June 2003 until June 2005) the energy regulatory authority finalized tenders for distribution licenses for 24 new regions, attracting considerable attention among private companies. Following this, there has been a massive increase in the number of cities undergoing construction of greenfield gas distribution networks;[55] and
- **Korea:** The principal measure aimed at reducing government involvement was adopted in 1999, when 39 percent of the national gas company, Kogas, was privatized. However, by 1999, Korea had progressed far ahead of the other countries in Group II in gas distribution projects under its original State-led gas market structure.

Some Strategies Promoting Greenfield Gas Distribution

Countries in Group II have adopted various strategies for promoting gas distribution development. Without going into detail about each country's strategies, the examples below offer some insight into major policy choices:

- Governments in this group of countries have generally set tax rates for residential natural gas consumption below the rates for electricity, and occasionally below petroleum products, such as gas oil. As major examples, Spain and Turkey have adopted this

[55] *Source: www.epdk.org.tr.*

type of tax policy which contributed significantly to the penetration of natural gas;[56]

- At least in the first years of gas penetration, governments have exercised control over residential gas tariffs, taking into account the price of competing fuels. Thus, for example, the tariff policy of the Korean government has reflected its objective of spreading natural gas among households. Similarly, Turkey's residential gas tariffs in the 90s remained among the lowest in Europe, with gas priced not only below electricity, but also lower than light fuel oil;[57]

- Establishing standards for new dwellings has also contributed to residential gas penetration. Thus, in Portugal, the government ruled that all new dwellings constructed after 1989 should have internal piping infrastructure suitable for natural gas. However, many city councils have failed to enforce this legislation;[58]

- Cross-subsidization between households has been another measure aimed at promoting development of gas distribution networks. Thus, in Colombia, legislation in 1994 (Law 142) required local authorities to establish six categories of residential consumers, each to be charged a different rate for gas consumption. Consumers in the highest two Categories (5 and 6) faced rates higher than long-term marginal costs of distribution, whereas those in Categories 1 through 3 faced rates lower than the long-term marginal cost. A consumer category was defined based on its neighborhood, rather than its precise level of income. However, neighborhoods were assumed to reflect income. This policy has proven effective in terms of the fast spread of residential gas penetration since the mid-90s;

- Cross-subsidization of households by industrial consumers has been another policy adopted with the objective of promoting gas penetration. This policy was widely used in Colombia in the 90s, when residential tariffs were generally kept below industrial gas tariffs;

- Cross-subsidization between regions has been another strategy aimed at helping development of greenfield gas distribution. For instance, Spain adopted the same tariff rate for all consumers in the same consumer category (households, industry and power generation), irrespective of location. This was pursued as a means to spread natural gas to remote regions; and

- Direct subsidies partly or fully covering the cost of household connections, and occasionally the cost of conversion to new appliances, has been an effective measure. Thus, for example, several public distribution companies in Portugal (such as Portgas) adopted this policy following natural gas imports in 1997. However, rather than a policy established by governments, this has been mainly a strategy of individual publicly- or privately-owned distribution companies.

Policy Choices Creating Obstacles for Progress in Greenfield Gas Distribution

The focus in this section is on some policy choices adopted in those Group II countries which have achieved the lowest penetration rates of natural gas

[56] *Annual reports of Eurogas; IEA Statistics.*
[57] *IEA Statistics – Natural Gas Information 2004, International Energy Agency: 131-133.*
[58] *http://www.eci.ox.ac.uk: Fawcett, T., K. Lane, B. Boardman,* Country Pictures *(Oxford: University of Oxford, Environmental Change Institute, 2000). Supporting material for Fawcett, T., K. Lane, B. Boardman,* Lower Carbon Futures *(Oxford: University of Oxford, Environmental Change Institute, 2000).*

in households. The section provides examples of several major policies that have had negative implications on developing greenfield gas distribution networks. Each policy choice needs to be considered in the context of the country examined, and should not be construed as constituting an obstacle to distribution in other countries. Also, the examples do not form part of an exhaustive list of the problems experienced in each country.

In Mexico:

- Until the mid-90s, natural gas development was a low priority for the Mexican government, as well as the national oil and gas company, Pemex. (In fact, historically, the natural gas industry developed largely as the result of a need to solve the problem of associated gas in oil production.) This significantly weakened the role of gas in meeting Mexico's energy needs, as well as incentives for building T&D infrastructure; and

- Before the reforms of the mid-90s, Pemex was given the responsibility for setting end user tariffs and, to a large extent, the profit margins of distribution companies. As a rule, the tariffs were set too low to secure profits sufficient for progress in investment in distribution networks. Moreover, until 1992, residential gas prices were set to be equal to or below industrial prices, which in most instances barely covered the cost of gas provided by distribution companies.[59]

In Tunisia:

- The structure and organization of the national gas distributor (STEG) impeded development of gas distribution networks: STEG was assigned responsibility for distributing not only gas, but also electricity. Such horizontal integration has been common in many countries around the world, including many of the Group I countries (Germany, the Netherlands, United States, Japan and Australia being major examples). However, horizontal integration in the context of Tunisia has had negative implications on gas – STEG emerged largely as an "electricity utility with a gas activity."[60] The strong electricity culture within the company prevented a balanced approach toward gas versus electricity. The major implication was that STEG focused mainly on consumers from the power generation and industrial sectors, whereas residential gas penetration remained a low priority.

In China:

- Until the early 90s, natural gas traditionally received a lower priority. The presence of abundant coal reserves and emphasis on their development, along with the priority on coal-fired power generation, inhibited development of the national gas market and transmission infrastructure, which remained concentrated in the gas-producing regions. Consequently, throughout the 90s, companies involved in gas distribution were frequently confronted by concerns about sufficient supplies of gas if they wanted to proceed with gas distribution investments. Given the fast growth in industrial consumption, these concerns have existed in the 2000s too;

- In addition, government regulation, resulting in artificially low well head and transport prices for gas, has obstructed growth in gas supply and investment in transport infrastructure; and

[59] *Regulatory Reform in Mexico's Natural Gas Sector (International Energy Agency, Paris, 1996), 55.*
[60] *Increasing the Efficiency of Gas Distribution – Phase 1: Case Studies and Thematic Data Sheets (ESMAP Report 218/99, July 1999), 19.*

- A major study of China, conducted by IEA in 2002, concluded that lack of a comprehensive energy strategy in the Chinese leadership is hindering development of the gas market, including gas distribution. The national policy on developing China's gas market was based on a project-by-project approach, which created concerns among investors regarding imbalances between the country's supply and demand.[61] By contrast, in many countries with advanced distribution networks, the early penetration of gas was accompanied by a comprehensive strategy covering gas upstream, imports, transmission infrastructure, distribution, pricing and marketing.

In India:

- Various policy choices have inhibited gas supply and the growth of a potential gas market. This includes the limited role allowed to independent companies in gas development until the introduction of the new exploration licensing policy (NELP) in 1997. Also, the government has fixed well head tariffs for State-owned companies Oil and Natural Gas Corporation (ONGC) and Oil India Limited (OIL) at low levels, which has limited their ability to supply increasing volumes of gas to the market;

- The price of petroleum products remained within the scope of the "administered price mechanism" (APM) until 2002. This included heavy subsidies for LPG and kerosene – the dominant fuels in the residential sector. Furthermore, when APM was dismantled in 2002, LPG and kerosene were excluded in the short term to protect the interest of consumer. This has been a continuous obstacle to residential gas penetration; and

- Delays in pipeline construction caused by administrative procedures have been a common obstacle in several greenfield gas distribution projects, including the largest ones in Mumbai, New Delhi and Gujarat. Slow growth in the consumers base reduced cash flows, weakening the distributors financially and eventually their ability to invest.

In Indonesia:

- For nearly two decades until the early 90s, the priority of successive governments was on exporting natural gas rather than expansion of its use in the domestic market. This was particularly the case in the power sector, which was designed to work on coal and petroleum products. Reflecting this priority, Indonesia's major investments in gas infrastructure focused on LNG export terminals, rather than T&D pipelines within the country;

- Kerosene and LPG have remained the principal fuels consumed by households, largely as a result of substantial subsidies. Major attempts to phase out the subsidies did not occur until as late as 2001. This has also inhibited the growth of natural gas as a residential fuel. Fuel subsidies provided to other sectors had similar implications;[62]

- Until new legislation on the oil and gas sector in 2001, distribution was in the domain of a single State-owned company – PGN. The company was allowed to sell to medium-size and smaller-size industrial consumers,

[61] Developing China's Natural Gas Market – The Energy Policy Challenges (International Energy Agency, Paris, 2002).
[62] According to data from Indonesia's Department of Finance, fuel subsidies constituted 9.1 percent of domestic revenues in the fiscal year 1998. This share increased to 17.3 percent, 19.1 percent and 23.8 percent in 1999, 2000 and 2001, respectively. In 2002, it dropped to 10 percent.

which emerged as its primary consumers. Sales to the commercial and services sector were also significant. However, the company largely neglected the residential sector, widely preferring to sell LPG instead of natural gas to households; and

- Clean air rules, prevalent in most industrial countries, have been either nonexistent or weakly enforced in Indonesia. This has reduced incentives to shift to natural gas except for a price advantage.

In Bolivia:

- Private participation in distribution was allowed after the late 80s; however, private companies functioned mainly as agents of YPFB and received a commission in exchange. Their role remained limited mainly to the construction of distribution pipelines, which weakened their incentive for full-scale involvement in distribution;

- The distribution companies in the late 80s and part of the 90s were created in an ad hoc manner, without proper tendering procedures or prequalification. As a result, most of them lacked sufficient technical and financial capabilities to be involved in greenfield distribution networks;

- The delay in privatization of YPFB's distribution network has also impeded the growth of gas distribution. Reducing YPFB's role in distribution has been on the agenda for many years, but has not been realized. In the meantime, governments have consecutively given YPFB the responsibility to implement major programs for spreading gas distribution networks to a large number of localities in Bolivia. However, its limited financial capabilities have reduced its level of investment. Furthermore, its policy of waiving the connection charges for most residential consumers has helped to attract residential consumers, but weakened it financially in its investments in gas distribution. Meanwhile, YPFB has complained about the lack of specialized labor for realizing its distribution investment programs;[63] and

- A policy favoring continuous subsidies to residential consumers for LPG, a common fuel among households, has reduced the attractiveness of shifting to natural gas.[64]

In Brazil:

- Heavy involvement of state governments in distribution has also contributed to slower growth in greenfield investment. As of 2005, state governments control 18 of the 24 distribution companies. Because of lack of financial resources and limitations on borrowing imposed by Brazil's Central Bank, most of them have postponed investment in distribution projects;[65]

- The national company, Petrobras, has been active in gas sales in several states. Although potentially a large investor in distribution, its strategy has been based on selling gas mainly to large consumers (such as power plants and industrial users), instead of developing distribution networks for serving residential consumers;[66] and

- The focus on larger consumers has not been limited to Petrobras. As a major example, Comgas, one of the main distribution

[63] *"YPFB Delays Natural Gas Connections,"* South American Business Information, *May 7, 2003.*
[64] *"Bolivia Energy Provision,"* EIU Business – Industry Overview, *July 6, 2004.*
[65] *"Brazil: BNDES to Finance Natural Gas Distribution Expansion,"* South American Business Information, *April 12, 2005.*
[66] *"Rio Regulator Wants to Break Petrobras Natgas Monopoly,"* Business News Americas, *May 28, 2004.*

companies of Brazil serving Sao Paulo, has concentrated its marketing activities in the industrial sector rather than the residential and commercial and services sectors. Thus, it has benefited from legislation allowing distribution companies to sell gas to larger consumers, but it has chosen to neglect the residential and commercial and services consumers.[67]

In Greece:

- Governmental priority on natural gas was not present until as late as the 90s. The limited volumes imported as LNG were allocated to several large industrial consumers and power plants. Pipeline imports were initiated in 1997, but the country lacked the transmission infrastructure to supply most of its consumption centers;
- The legal framework for gas distribution was established in 1995 when DEPA, the national gas company, was given the responsibility to establish three distribution companies in Greece's three major consumption centers (Athens, Thessaloniki and Thessaly). However, the company progressed slowly in the creation of these companies. Moreover, it retained a majority stake in all three companies, with the rest assigned to strategic investors. Putting the latter in charge of most of the financial obligations for investment, while not providing them commensurate management control in the distribution companies, has also contributed to delays in residential gas penetration; and
- Delays in DEPA's privatization have also negatively affected gas distribution. The company has been unwilling to sink large amounts of money into projects which would be taken over by private companies.[68]

In Bulgaria:

- The government did not approve differentiated prices for residential and industrial consumers until 2002. As a result, residential gas tariffs remained substantially low, which deterred large-scale investment in distribution networks;
- Some major residential energy sources, such as electricity and DH (where available), remained subsidized throughout the 90s. Such energy sources were able to maintain their competitiveness against natural gas;
- Bulgargaz, the owner of the transmission network in Bulgaria, has often declined to invest in pipelines connecting its network with the distribution grids established by private distributors. This is the result of the financial difficulties it experienced during the sharp decline in Bulgaria's overall gas sector in the 90s. Occasionally, private distribution companies have been able to negotiate to invest in such connections in exchange for gas priced below its market value. However, this has been a relatively slow process, contributing to delays in gas distribution development as well; and
- In the early 90s, Bulgaria was divided into a large number of concession regions for gas distribution. This deterred large investors because of the potentially small volumes of sales expected in many of these regions. This policy has recently been reversed, with the country being divided into large (nine) concession regions.

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[67] *Based on Comgas' figures for 2003, only 10 percent of its revenues came from the residential sector, whereas the share of commercial sector was 5 percent. Meanwhile, industrial clients accounted for 73 percent of Comgas' revenues, power plants and (CHP) – 6 percent and vehicles – 6 percent. Source: www.comgas.com.br*

[68] *Fawcett, T., et al.* Country Pictures, *op. cit., 42.*

Annex

Table A1: Indicators of Overall and Residential Gas Penetration in Group I Countries

Country	Share of Total Gas Consumption in TPES in 2004 (%)	Share of Gas in Residential Energy Consumption in 2004 (%)	Number of Residential Consumers Connected to Natural Gas (year)	Approximate Percentage of Households Connected to Natural Gas (%)**
Africa				
Algeria	64.3	38.7*	1,392,200 (2001)	30
Asia				
Japan	13.2	18.4	21,151,000 (2000)	44
Australia	19.6	29.0	3,223,000 (2001)	44
Europe				
Czech Republic	17.1	40.2	2,592,400 (2004)	59
France	14.6	36.1*	10,731,000 (2004)	44
Germany	22.6	37.2	17,730,000 (2004)	49
Italy	35.8	56.7	15,050,000 (2004)	67
Netherlands	44.7	75.7	6,357,000 (2001)	93
Russia Federation	54.0	31.7	39,812,800 (2001)	60
United Kingdom	37.4	68.4	21,378,000 (2004)	86
North America				
Canada	29.0	44.4	4,195,300 (2001)	33
United States	22.1	42.9	61,100,000 (2003)	57
South America				
Argentina	50.9	64.3	5,939,000 (2003)	56

Sources: IEA, Eurogas, EIA, American Gas Association (for United States), Sonelgaz (for Algeria), APEC (for Japan, Australia), http://www.unchs.org/programmes/guo/guo_hsdb4.asp (for number of households).
** Share of gas in residential and commercial-public services consumption.*
*** Calculation based on dividing the total number of households by the number of residential consumers connected to natural gas for the given year.*

Table A2: Supply-side Issues for Group I

	Reserves in bcm (2005)	Primary Gas Supply (bcm)				The Role of Indigenous Supply and Historical Level of Self-sufficiency in Gas (% of Indigenous Supply in Primary Gas Supply in 1973 and 2004)	Benefiting from Transit Role
		1973	1990	2000	2004		
Algeria	4,494	1.9	15.0	20.5	23.5	• Self-sufficient; major role as a net exporter • 235% in 1973; 369.7% in 2004	No
Argentina	528	8.3	22.5	36.5	39.3	• Self-sufficient; some role as a net exporter • 80% in 1973; 120.5% in 2004	No
Australia	774	3.8	17.7	22.6	26.4	• Self-sufficient; growing role as net exporter • 105.4% in 1973; 140.4% in 2004	No
Canada	1,584	43.4	67.0	90.3	89.9	• Self-sufficient; major role as a net exporter • 173.6% in 1973; 203.0% in 2004	No
Czech Republic	4	1.3	6.6	9.2	9.6	• Initially benefiting from limited indigenous supply dominant role for imports • 37% in 1973; 2.3% in 2004	Yes
France	11	17.1	28.2	39.7	45.6	• Initially benefiting from significant indigenous supplies gradually dominant role for imports • 47% in 1973; 3.0% in 2004	Yes
Germany	254	41.3	69.7	87.7	101.2	• Initially benefiting from significant indigenous supplies gradually dominant role for imports • 56% in 1973; 20.3% in 2004	Yes
Italy	224	17.1	47.4	70.7	80.6	• Initially highly self-sufficient; gradually dominant role for imports • 90.1% in 1973; 16.1% in 2004	Yes
Japan	39	6.8	53.9	80.4	83.5	• Initially benefiting from limited indigenous supplies dominant role for imports • 38.8% in 1973; 3.5% in 2004	No
Netherlands	1,736	40.4	43.5	48.9	51.3	• Self-sufficient; major role as a net exporter • 185% in 1973; 167.6% in 2004	Yes
Russia Federation	47,040	255.7*	714.3*	391.2	421.8	• Self-sufficient; major role as a net exporter • 99.6% in 1973**; 146.9% in 2004	Yes
United Kingdom	525	30	58.3	101.8	102.5	• Self-sufficient • 97.3% in 1973; 98.7% in 2004	No
United States	5,390	624.1	530.2	661.3	631.0	• Largely self-sufficient; growing role as a net importer • 98.6% in 1973; 84.3% in 2004	No

Source: Oil and Gas Journal (for proven gas reserves as of the end of 2005), IEA (for the rest of data).
* Figures for USSR.

Table A3: Major Demand-side Issues for Group I

	Main Determinants of Household Gas Consumption Patterns		Settlement Density			Anchor Consumers for Gas Market Development: Power Generation a) Gas Consumption in bcm b) % in Total Gas Consumption c) Electricity Generated from Gas (% of Total)				Anchor Consumers for Gas Market Development: Industry d) Gas Consumption in bcm e) % in Total Gas Consumption f) % of Gas in Total Energy Consumption in Industry			
Countries	*Climate Requiring Substantial Space Heating*	*Gross National Income per capita based on (WB Atlas Method) (US$ in 2005)*	*Population Density (persons per km²) (2004)*	*Presence of Large Cities in 2000 (A – number of cities above 5 m people; B – 1 to 5 m; C –250,000 to 1 m; D –100,000 to 250,000)*	*Urbanization level (2003) (%)*	*1973*	*1990*	*2000*	*2004*	*1973*	*1990*	*2000*	*2004*
Algeria	No	2,730	13	A – 0, B – 1, C – 4, D – 29	58.8	a) 0.38 b) 19.8 c) 54.9	a) 4.9 b) 32.7 c) 93.7	a) 7.9 b) 38.5 c) 96.7	a) 10.1 b) 42.8 c) 97.0	d) 0.23 e) 12.2 f) 31.3	d) 2.5 e) 16.6 f) 66.3	d) 3.2 e) 15.7 f) 76.2	d) 2.0 e) 8.4 f) 50.0
Argentina	Yes	4,470	14	A – 0, B – 3, C – 27, D – 28	90.1	a) 2.0 b) 24.2 c) 24.5	a) 6.2 b) 27.5 c) 39.0	a) 12.8 b) 35.1 c) 55.0	a) 13.1 b) 33.3 d) 54.7	d) 2.6 e) 30.9 f) 34.2	d) 4.8 e) 21.2 f) 48.9	d) 7.3 e) 20.1 f) 52.0	d) 6.5 e) 16.6 f) 49.5
Australia	Yes**	32,220	2	A – 0, B – 5, C – 5, D – 5	92	a) 0.94 b) 24.6 c) 4.3	a) 4.1 b) 27.5 c) 10.6	a) 4.7 b) 20.8 c) 12.6	a) 9.2 b) 34.3 c) 12.3	d) 1.8 e) 47.0 f) 9.9	d) 7.2 e) 40.5 f) 26.5	d) 8.7 e) 38.6 f) 26.7	d) 7.4 e) 28.1 f) 28.5
Canada	Yes	32,600	3	A – 0, B -4, C -12, D -20	80.4	a) 5.2 b) 12.1 c) 6.0	a) 2.3 b) 4.1 c) 2.0	a) 9.0 b) 10.0 c) 5.5	a) 8.9 b) 9.7 c) 5.4	d) 14.6 e) 33.5 f) 22.2	d) 22.7 e) 34.0 f) 33.3	d) 28.6 e) 31.7 f) 32.0	d) 24.0 e) 26.7 f) 30.5
Czech Republic	Yes	10,710	129	A – 0, B – 1, C – 2, D – 3	74.3	a) 0.16 b) 12.6 c) 0.9	a) 0.82 b) 12.5 c) 0.6	a) 1.5 b) 16.2 c) 4.9	a) 1.7 b) 17.7 c) 4.6	d) 0.57 e) 44.2 f) 2.5	d) 2.2 e) 34.1 f) 15.2	d) 3.2 e) 34.8 f) 23.7	d) 3.1 e) 31.9 f) 21.6
France	Yes	34,810	110	A – 1, B – 3, C – 20, D – 29	76.3	a) 2.5 b) 14.6 c) 5.5	a) 0.5 b) 1.8 c) 0.7	a) 2.7 b) 6.8 c) 2.1	a) 6.2 b) 13.6 c) 3.2	d) 7.4 e) 43.5 f) 10.3	d) 12.7 e) 45.0 f) 22.8	d) 15.9 e) 40.2 f) 28.7	d) 16.3 e) 35.7 f) 31.4

(continued...)

(...Table A3 continued)

	Main Determinants of Household Gas Consumption Patterns			Settlement Density		Anchor Consumers for Gas Market Development: Power Generation a) Gas Consumption in bcm b) % in Total Gas Consumption c) Electricity Generated from Gas (% of Total)				Anchor Consumers for Gas Market Development: Industry d) Gas Consumption in bcm e) % in Total Gas Consumption f) % of Gas in Total Energy Consumption in Industry			
Countries	*Climate Requiring Substantial Space Heating*	*Gross National Income per capita based on (WB Atlas Method) (US$ in 2005)*	*Population Density (persons per km²) (2004)*	*Presence of Large Cities in 2000 (A – number of cities above 5 m people; B – 1 to 5 m; C –250,000 to 1 m; D –100,000 to 250,000)*	*Urbanization level (2003) (%)*	*1973*	*1990*	*2000*	*2004*	*1973*	*1990*	*2000*	*2004*
Germany	Yes	34,580	230	A – 0, B – 9, C -17, D – 18	88.1	a) 12.9 b) 31.2 c) 10.9	a) 13.8 b) 19.8 c) 7.4	a) 15.6 b) 17.8 c) 9.3	a) 21.1 b) 20.8 c) 10.1	d) 17.4 e) 42.2 f) 12.6	d) 25.1 e) 36.0 f) 22.1	d) 27.2 e) 31.0 f) 27.4	d) 24.0 e) 23.7 f) 26.9
Italy	Yes	30,010	192	A – 0, B – 4, C – 13, D – 28	67.4	a) 1.2 b) 7.0 c) 3.1	a) 9.8 b) 20.7 c) 18.7	a) 22.8 b) 32.2 c) 37.6	a) 28.8 b) 35.7 c) 44.3	d) 10.5 e) 61.7 f) 18.1	d) 17.8 e) 37.5 f) 33.1	d) 21.5 e) 30.4 f) 38.2	d) 20.7 e) 25.7 f) 37.0
Japan	Yes	38,980	337	A – 2, B – 4, C – 25, D – 51	65.4	a) 2.3 b) 34.4 c) 2.3	a) 39.7 b) 67.7 c) 19.8	a) 56.1 b) 69.7 c) 23.1	a) 55.8 b) 62.9 c) 22.8	d) 1.9 e) 28.2 f) 1.5	d) 4.7 e) 8.7 f) 3.3	d) 9.5 e) 11.8 f) 6.1	d) 12.9 e) 15.4 f) 7.7
Netherlands	Yes	36,620	395	A – 0, B – 2, C -8, D – 17	65.8	a) 13.1 b) 32.4 c) 79.5	a) 9.9 b) 22.8 c) 50.9	a) 14.6 b) 29.9 c) 58.8	a) 16.9 b) 32.9 c) 60.6	d) 11.4 e) 28.2 f) 38.5	d) 12.3 e) 28.2 f) 41.7	d) 11.5 e) 23.5 f) 36.2	d) 8.4 e) 16.3 f) 32.5
Russian Federation*	Yes	4,460	8	A – 2, B -11, C -63, D – 96	73.3	a) 87.2 b) 34.1 c) 18.4	a) 282.4 b) 39.5 c) 33.8	a) 226.8 b) 58.0 c) 42.3	a) 243.9 b) 57.8 c) 45.2	d) 98.6 e) 38.5 f) 31.8	d) 198.9 e) 27.8 f) 44.6	d) 47.5 e) 12.1 f) 20.1	d) 30.7 e) 7.3 f) 21.8
United Kingdom	Yes	37,600	243	A – 1, B – 3, C- 24, D – 33	89.1	a) 1.1 b) 3.6 c) 1.0	a) 1.4 b) 2.4 c) 1.6	a) 31.6 b) 31.1 c) 40.2	a) 33.5 b) 32.8 c) 40.6	d) 11.2 e) 37.4 f) 15.7	d) 14.7 e) 25.3 f) 28.1	d) 17.8 e) 17.5 f) 34.9	d) 13.1 e) 12.8 f) 27.4
United States	Yes**	43,740	30	A – 4, B – 33, C – 87, D -126	80.1	a) 102.0 b) 16.3 c) 18.6	a) 108.8 b) 20.5 c) 11.9	a) 166.8 b) 25.2 c) 15.8	a) 179.0 b) 28.1 c) 17.6	d) 216.8 e) 34.7 f) 37.0	d) 150 e) 28.3 f) 31.2	d) 189.2 e) 28.6 f) 32.5	d) 146.4 e) 23.2 f) 29.2

Sources: UN – Department of Economic and Social Affairs, Population Division (for settlement density); The World Bank (for income per capita); IEA (for anchor consumers).
** Data for 1973-1990 refers to USSR. For this period, data for gas consumption in power and heat generation includes energy sector's own use.*
*** Regional exceptions exist. Space heating is not the principal source of gas demand in households in several localities, but on the country level, space heating is widespread.*

Table A4: Gas Consumption in Households in Group I

Country	Total Residential Gas Consumption in bcm (year)	Approximate Gas Consumption per Household in Cubic Meters (same year)
Algeria*	NA	NA
Argentina	6,245 (2001)	1,051
Australia	3,065 (2001)	951
Canada	15,778 (2001)	3,761
Czech Republic	2,611 (2004)	1,008
France	16,110 (2001)	1,554
Germany	31,519 (2004)	1,777
Italy	19,020 (2004)	1,263
Japan	8,883 (2000)	420
Netherlands	11,558 (2001)	1,818
Russian Federation	47,820 (2001)	1,201
United Kingdom	34,074 (2004)	1,593
United States	138,730 (2002)	2,270

Sources: Eurogas, IEA.
Note: NA=Not applicable.
** Algeria provides figures for the aggregate consumption of residential and commercial public services sectors, which lead to significant bias in estimating gas consumption per household. Therefore, in 2001, 1,800 Cubic Meters (m^3) were consumed by residential and commercial public services on – average.*

Table A5: Average Size of Households in Group I

Country	Average Size of Households in 1985	Average Size of Households in 2000
Algeria	7.1	6.3
Argentina	3.8	3.5
Australia	3.0	2.6
Canada	2.8	2.5
Czech Republic	2.6	2.3
France	2.7	2.4
Germany	2.4	2.3
Italy	3.0	2.5
Japan	3.2	2.6
Netherlands	2.7	2.3
Russian Federation	2.9	2.2
United Kingdom	3.6	3.2
United States	2.8	2.6

Source: UN Habitat (www.unchs.org).

Table A6: Role of Gas vs. Competing Fuels in Households of Group I Countries

Country	Ranking of Competing Fuels for Residential Use in 2004	Major Fuels Displaced by Gas in Households Since 1973*	Share of Gas in Total Residential Energy Consumption in 2004 (%)
Algeria	1) **Petroleum Products** 2) Gas 3) Electricity 4) Combust Renewables and Waste	NA	38.6**
Argentina	1) **Gas** 2) Electricity 3) Petroleum Products 4) Combust Renewables and Waste	Petroleum Products	64.3
Australia	1) Electricity 2) **Gas** 3) Combust Renew & Waste 4) Petroleum Products 5) Geothermal-solar 6) Coal	Petroleum Products, Coal	29.0
Canada	1) **Gas** 2) Electricity 3) Petroleum Products 4) Combust Renewables and Waste 5) Coal	Petroleum Products, Coal	44.4
Czech Republic	1) **Gas** 2) Electricity 3) Heat 4) Coal 5) Combust Renewables and Waste 6) Petroleum Products	Coal	40.2
France	1) **Gas** 2) Electricity 3) Petroleum Products 4) Combust Renewables and Waste 5) Coal 6) Geothermal-solar	Coal	36.1**
Germany	1) **Gas** 2) Petroleum Products 3) Heat 4) Electricity 5) Combust Renewables and Waste 6) Coal 7) Geothermal-solar	Petroleum Products, Coal	37.2
Italy	1) **Gas** 2) Electricity 3) Petroleum Products 4) Combust Renewables and Waste 5) Coal 6) Geothermal-solar	Petroleum Products, Coal	56.7
Japan	1) Electricity 2) Petroleum Products 3) **Gas** 4) Geothermal-solar 5) Combust Renewables and Waste 6) Heat	Coal	18.4
Netherlands	1) **Gas** 2) Electricity 3) Combust Renewables and Waste 4) Heat 5) Petroleum Products 6) Geothermal-solar 7) Coal	Petroleum Products, Coal	75.7
Russian Federation	1) Heat 2) **Gas** 3) Electricity 4) Coal 5) Petroleum Products 6) Combust Renewables and Waste	NA	31.7
United Kingdom	1) **Gas** 2) Electricity 3) Petroleum Products 4) Coal 5) Combust Renewables and Waste 6) Heat	Coal	68.4
United States	1) **Gas** 2) Electricity 3) Petroleum Products 4) Combust Renewables and Waste 5) Geothermal-solar	Petroleum Products, Coal	42.9

Source: IEA.
Note: NA= Not applicable.
** Owing to the lack of detailed surveys on residential consumption patterns, fuel displacement is evaluated on a countrywide basis rather than individual households before and after gas connection. Fuels have been considered displaced by natural gas if their residential consumption has exhibited a consistent drop in terms of both physical volumes and share in total residential energy consumption from 1973 to 2002.*
*** Includes commercial and public services sector.*

Table A7: Number of Households per km of Distribution Grid in Group I Countries

Country	Length of Distribution Grid (km-year)	Total Number of Households Connected to the Grid (same year)	Number of Households per km of Distribution Grid*
Algeria	NA	NA	NA
Argentina	109,500 (2001)	5,742,600	52
Australia	73,300 (2001)	3,223,000	44
Canada	345,000 (2001)	4,195,300	12
Czech Republic	69,201 (2004)	2,592,400	37
France	182,022 (2004)	10,731,000	59
Germany	314,000 (2003)	17,590,000	56
Italy	200,000 (2004)	15,050,000	75
Japan	233,244 (2001)	21,151,000	91
Netherlands	119,000 (2001)	6,357,000	53
Russia Federation	540,000 (2001)	39,812,800	74
United Kingdom	274,600 (2004)	21,378,000	78
United States	1,458,000 (2001)	60,800,000	42

*Sources: Eurogas Annual Report 2001, Eurogas Annual Report 2003, Eurogas Annual Report 2004, Asia-Pacific Energy Research Center (*Natural Gas Reform in the APEC Region*, APERC, 2003).*
Note: NA= Not applicable.
** The number of households per km of distribution grid is derived by dividing the total number of households connected to natural gas by the length of the distribution grid in the same year. As the two numbers may not correspond to the same date (or month) of the year, the derived statistics are an approximation for the given year.*

Table A8: Consumption in the Commercial and Public Services Sector in Group I Countries

Country	Residential Consumption in 2004 (bcm)	Commercial and Services Consumption in 2004 (bcm)	Total Households and Commercial and Services Consumption in 2004 (bcm)	Commercial-public Services Consumption per every 1,000 Cubic Meters Consumed in Households (Cubic Meters)
Algeria	NA	NA	NA	NA
Argentina	6,564	1,749	8,312	266
Australia	3,133	1,055	4,188	337
Canada	15,543	12,277	27,819	790
Czech Republic	2,611	1,411	4,022	540
France	NA	NA	19,442	NA
Germany	31,519	8,355	39,874	265
Italy	19,020	6,677	25,697	351
Japan	9,832	7,443	17,276	757
Netherlands	8,776	4,911	13,687	559
Russian Federation	47,449	3,024	50,473	64
United Kingdom	34,074	7,466	41,540	219
United States	126,365	80,092	206,457	634

Sources: IEA, Eurogas (for France and Italy).
Note: NA= Not applicable.

Table A9: Ownership and Market Structure in Group I Countries

Country	Private versus Public Ownership in Gas Distribution	Concentration of Ownership in Distribution	Market Structure: Presence of Vertical Integration in the Period of Major Growth in Distribution Projects*	Market Structure: Major Liberalization Reforms since 80s
Algeria	– Public ownership	– High – Monopoly role for Sonelgaz	– High degree of vertical integration – Sonatrach monopoly in upstream, wholesale, exports and export infrastructure (pipelines and LNG) Also dominant role in transmission. – Limited vertical integration between Transmission and Distribution (Sonelgaz dominates sales to large, medium and small consumers, and controls several high-pressure pipelines)	– NA
Argentina	– Public ownership until 1992 (Gas del Estado); mainly private ownership after 1992	– Medium – Nine Discos with some companies owning more than one	– Transmission and distribution controlled by vertically integrated Gas del Estado until 1992	– 1992 Natural Gas Law: Privately-owned two transmission and nine distribution companies; Stringent limits on vertical integration; TPA on the transmission grid; TPA on the distribution network for eligible consumers.
Australia	– Ownership varying across States	– Medium – Eighteen Discos in 2003, some of them involved in multiple States	– Vertical integration between Transmission and Distribution in some States	– 1994 Council of Australian Governments Agreement resulting in negotiated TPA on Transmission and Distribution; unbundling of transport and trading functions of Transmission and Distribution companies (in effect since 1997); since 2002, residential users free to choose suppliers in New South Wales, Australian Capital Territory and Victoria
Canada	– Mainly private ownership; limited provincial or municipal government role	– Low – Multiple players on the national level, but high concentration on the provincial level	– Vertical integration between Transmission and Distribution in some provinces; initial dominant role for TransCanada transmission company, but, subsequently multiple players in all segments of the gas chain	– After 1985: regulated TPA on the transmission grid; transmission companies required to functionally unbundle transport and marketing activities. Subsequently, distribution and marketing functions of Discos unbundled in multiple provinces

(continued...)

(...Table A9 continued)

Country	Private versus Public Ownership in Gas Distribution	Concentration of Ownership in Distribution	Market Structure: Presence of Vertical Integration in the Period of Major Growth in Distribution Projects*	Market Structure: Major Liberalization Reforms since 80s
Czech Republic	– Public ownership with partial private ownership after 1994; – Dominant private role after 2002	– High – Single company (RWE) holding majority shares in six (out of eight) Discos since 2002	– Vertical integration under Czech Gas Company in charge of upstream, transmission, distribution until 1994	– Czech Gas Company split into eight and a transmission company in 1994; Discos – 2000 Energy Act: monopoly of Transgas in imports lifted; account separation for transmission and storage; TPA introduced on the transmission grid; unbundling of transmission and sales as of 2006; six out of eight Discos integrated back with Transgas; supplier choice for households as of 2007
France	– Mainly public ownership (GdF and municipalities) after 1946	– High – Dominant role for GdF	– Dominant role of a vertically integrated company (GdF) in charge of transmission, distribution and monopoly rights in imports (till 2003)	– GdF monopoly of imports removed in 2003 2003 Requirement for unbundling of transportation, supply, production and storage after 2003; all large consumers free to choose suppliers as of 2004 (to be extended to all consumers in 2007)
Germany	– Mainly public (municipalities) with growing role for private Discos	– Medium – Several hundred Discos, but significant cross-ownership	– High degree of vertical integration between production and transmission, but multiple players in all segments of the gas chain; some integration between transmission and distribution	– Energy Industry Act in 1998: all gas consumers allowed to choose their suppliers with no gradual thresholds; negotiated TPA introduced
Italy	– Private, municipally owned and mixed Discos; dominant share for private Discos	– Medium – Several hundred Discos, but a quarter of the market controlled by Italgas	– Dominant role of a fully integrated company (ENI) in upstream and transmission, and significant role in distribution since 40s	– 2000 decree: legal unbundling of production, Transmission and Distribution; regulated TPA introduced on the Transmission and Distribute grid for eligible Discos required consumers; to unbundled their supply and distribution activities as of January 2003.
Japan	– Mainly private ownership; limited municipal involvement	– High – More than 200 Discos, but dominant share for four vertically integrated companies	– Dominant role for four companies fully vertically integrated after commencement of LNG in 1969	– After 1995: consumers (with demand above 2 mcm/year) free to choose suppliers; after 1999, four major vertically integrated companies obliged to provide mandatory TPA for consumers with demand above 2 mcm/year

(continued...)

(...Table A9 continued)

Country	Private versus Public Ownership in Gas Distribution	Concentration of Ownership in Distribution	Market Structure: Presence of Vertical Integration in the Period of Major Growth in Distribution Projects*	Market Structure: Major Liberalization Reforms since 80s
Netherlands	– Mainly public; continuing dominant role of municipalities	– Low – Initially more than 200 Discos, dropping to 30 in 2002. Municipalities holding major shares	- High degree of vertical integration between production and transmission (under Gasunie)	– Gas market liberalized after Gas Act in 2000: all consumers free to choose suppliers as of July 2004; negotiated TPA; accounts separation of Gasunie's transport, storage and trading; legal unbundling of transport and sales functions of Discos
Russia	– Public ownership until privatization of most Discos in late 90s	– Medium – Several hundred Discos, but a major role for Discos controlled by Gazprom	– Fully integrated structure under the Ministry of Gas Industry (in USSR) Dominant role of fully integrated Gazprom retained in 90s and 2000s	- Partial privatization of Gazprom in 1993; limited involvement of companies other than Gazprom in upstream allowed in 90s; negotiated TPA on the transmission grid since 1997
United Kingdom	– Public ownership after 1949 Private after 1986 privatization of BGC	– High – Monopoly role for British Gas until 90s; continuing dominant role for Centrica	– Fully integrated Transmission and Distribution monopoly under BGC; multiple players in upstream	– BGC privatized in 1986; British Gas unbundling in 1997; TPA introduced in 1996 for large consumers, with all consumers being eligible to choose suppliers since 1998
United States	– Mainly private ownership; limited municipal involvement	– Low – More than 1,000 Discos, with few of them holding market share above 5%	– Limited vertical integration between upstream and transmission (and a few Discos owning transmission assets); multiple players in all segments of the gas chain	– Regulated TPA on the transmission grid in 1985 Functional unbundling of transport and trading activities of transmission companies in 1992, subsequently applied in distribution in multiple States

** The period of major growth in gas distribution varies but is mainly the 60s to mid-80s for most countries.*

Table A10: Indicators of Overall and Residential Gas Penetration in Group II Countries

Country	Share of Total Gas Consumption in TPES in 2004 (%)	Share of Gas in Residential Energy Consumption in 2004 (%)	Numbers of Residential Consumers Connected to Natural Gas (year)	Approximate Percentage of Households Connected to Natural Gas (%)	Period when Significant Household Gasification Started**
Asia					
China	2.6	2.8	43,200,000 (2003) (total persons with natural gas)	3	Early 90s
India	4.1	0.24	428,000 (2004)	0.2	Late 60s, but major activity since early 90s
Indonesia	19.4	0.04	64,900 (2003)	0.1	Early 80s
Korea	11.9	44.6	7,055,000 (2001)	49	Mid 80s
Europe					
Bulgaria	13.2	0	2,000 (2004)	0.06	Early 90s
Greece	7.3	1	30,800 (2004)	0.8	Late 90s
Portugal	12.4	5.6	744,000 (2004)	18	Late 90s
Spain	17.7	20.6	5,203,000 (2003)	41	Mid-70s but major activity since 80s
Turkey	22.8	20.3	3,345,000 (2004)	19	Late 80s
North Africa					
Tunisia	39.1	9.2	120,700 (2001)	6	Mid-80s
North America					
Mexico	26.4	4.8	2,300,000 (2002)*	9	20s, but major activity since late 90s
South America					
Bolivia	28.3	1.1	38,000 (2003)	2	Late 80s
Brazil	7.7	0.8	995,000 (2003) (total clients)	2	Late 90s
Chile 90s	24.2	6.9	397,000 (2004)	10	Major activity since late

Sources: IEA, Eurogas, EIA, APEC (for Korea and Mexico).
** Includes the number of consumers from the public-commercial services sector.*
*** Gasification refers to natural gas. Many countries in the group (Korea, Chile and Portugal) had a significant legacy of manufactured gas-based networks before the introduction of natural gas. Others (Mexico, Tunisia, China, Indonesia, and Greece) also benefited from a legacy of manufactured gas-based networks, but at a more limited extent.*

Table A11: Share of Gas in TPES in Group I and Group II Countries (percent)

	1973	1990
Group I		
Algeria	5.8	15.6
Argentina	10.3	20.7
Australia	4.1	10.1
Canada	14.8	20.7
Czech Republic	4.0	8.8
France	6.0	10.5
Germany	6.2	11.5
Italy	9.9	20.7
Japan	2.2	3.3
Netherlands	30.9	34.5
Russia Federation	13.4	20.5
United Kingdom	10.7	19.7
United States	21.1	15.7
Group Average	**10.7**	**16.3**
Group II		
Bolivia	0.0	6.1
Brazil	0.3	1.8
Chile	1.1	6.7
China	0.5	1.3
Colombia	1.4	3.6
Greece	0.0	0.5
India	0.2	1.5
Korea	0.0	0.7
Mexico	13.6	11.4
Portugal	0.7	0.3
Spain	1.3	5.1
Tunisia	0.4	5.8
Turkey	0.2	1.3
Group Average	**1.4**	**4.0**

Source: IEA.

Table A12: Supply-side Issues for Group II

	Reserves in bcm (2005)	Primary Gas Supply				The Role of Indigenous Supply and Historical Level of Self-sufficiency in Gas (% of indigenous supply in primary gas supply in 1973, 1990 and 2004)	Benefiting from Transit Role
		1973	1990	2000	2004		
Bolivia	672	0.1	0.78	1.4	1.7	• Self-sufficient with a major role as an exporter • 1877.8% in 1973; 438% in 1990; 594.0% in 2004	No
Brazil	322	0.2	3.8	9.3	18.9	• Initially benefiting from significant indigenous supplies; growing dependence on imports • 100% in 1973; 100% in 1990; 57.2% in 2004	No
Bulgaria	6	0.2	6.8	3.7	3.1	• Initially benefiting from very limited indigenous supplies; subsequently nearly fully dependent on imports • 100% in 1973; 0.1% in 1990; 10.7% in 2004	Yes
Chile	97	0.62	1.8	6.5	8.0	• Initially benefiting from limited indigenous supplies; gradually dominant role for imports • 100% in 1973; 100% in 1990; 23.3% in 2004	No
China	1,493	5.4	17.0	27.4	44.2	• Self-sufficient (but excess demand requiring imports in the near future) • 100% in 1973; 100% in 1990; 104.3% in 2004	No
Colombia	113	1.9	4.3	7.3	7.8	• Self-sufficient • 100% in 1973; 100% in 1990; 100% in 2004	No
Greece	1	0	0.12	2.1	2.7	• Initially benefiting from very limited indigenous supplies; subsequently nearly fully dependent on imports • 0% in 1973; 100% in 1990; 0.8% in 2004	No
India	1,089	0.72	11.9	25.3	28.4	• Self-sufficient (but excess demand requiring imports in the near future) • 100% in 1973; 100% in 1990; 100% in 2004	No

(continued...)

(...Table A12 continued)

	Reserves in bcm (2005)	Primary Gas Supply				The Role of Indigenous Supply and Historical Level of Self-sufficiency in Gas (% of indigenous supply in primary gas supply in 1973, 1990 and 2004)	Benefiting from Transit Role
		1973	1990	2000	2004		
Indonesia	2,738	0.23	22.2	36.3	38.7	• Self-sufficient with major role as an exporter • 100% in 1973; 230.5% in 1990; 198.3% in 2004	No
Korea	7	0	3	18.9	27.8	• Fully dependent on imports • None in 1973; 0% in 1990; 0% in 2004	No
Mexico	448	12.4	26.0	39.6	50.4	• Initially self-sufficient; increasing role for imports • 100% in 1973; 98.4% in 1990; 82.2% in 2004	No
Portugal	0	0	0	2.3	3.7	• Fully dependent on imports • None in 1973; 0% in 1990; 0% in 2004	No
Spain	3	1	5.4	16.7	27.0	• Nearly fully dependent on imports • 0% in 1973; 25.6% in 1990; 1.2% in 2004	Yes
Tunisia	77	0.12	1.3	3.0	3.7	• Benefiting from limited indigenous supplies • 100% in 1973; 26.8% in 1990; 64.8% in 2004	Yes
Turkey	8	0	3.5	14.8	22.4	• Nearly fully dependent on imports • None in 1973; 6.1% in 1990; 3.1% in 2004	Not Yet

Source: Oil and Gas Journal *(for proven gas reserves as of the end of 2005), IEA (for the rest).*

Table A13: Demand-side Issues for Group II

	Main Determinants of Household Gas Consumption Patterns			Settlement Density		Anchor Consumers for Gas Market Development: Power Generation a) Gas Consumption in bcm b) % in Total Gas Consumption c) Electricity Generated from Gas (% of total)				Anchor Consumers for Gas Market Development: Industry d) Gas Consumption in bcm e) % in Total Gas Consumption f) % of Gas in Total Energy Consumption in Industry			
Countries	*Climate Requiring Substantial Space Heating*	*Gross National Income per capita Based on (WB Atlas Method) (US$ in 2005)*	*Population Density (persons per km²) (2004)*	*Presence of Large Cities in 2000 (A – number of Cities above 5 m people; B – 1 to 5 m; C – 250,000 to 1 m; D – 100,000 to 250,000)*	*Urbanization Level (2003) (%)*	*1973*	*1990*	*2000*	*2004*	*1973*	*1990*	*2000*	*2004*
Bolivia	No	1,010	8	A – 0, B – 2, C – 2, D – 4	63.4	a) 0.02 b) 19.4 c) 2.7	a) 0.3 b) 38.5 c) 37.7	a) 0.5 b) 34.7 c) 46.0	a) 0.6 b) 35.5 c) 29.2	d) 0 e) 0 f) 0	d) 0.18 e) 24.2 f) 56.7	d) 0.35 e) 25.4 f) 71.1	d) 0.43 e) 25.4 f) 40.3
Brazil	No	3,460	21	A – 2, B – 13, C – 37, D – 70	83.1	a) 0 b) 0 c) 0	a) 0.1 b) 2.6 c) 0.01	a) 1.0 b) 10.7 c) 1.1	a) 4.7 b) 24.9 c) 5.0	d) 0.1 e) 50.0 f) 0.7	d) 2.5 e) 64.9 f) 7.6	d) 4.8 e) 51.5 f) 9.6	d) 7.0 e) 37.1 f) 9.3
Bulgaria	Yes	3,450	67	A – 0, B – 1, C – 2, D – 5	69.8	a) 0 b) 0 c) 0	a) 3.4 b) 50.0 c) 20.7	a) 1.4 b) 38.0 c) 4.7	a) 1.1 b) 35.3 c) 3.6	d) 0 e) 0 f) 0	d) 2.9 e) 42.1 f) 24.7	d) 1.7 e) 45.6 f) 33.8	d) 0.8 e) 26.1 f) 20.6
Chile	Yes	5,870	21	A – 1, B – 0, C – 5, D – 16	87	a) 0.03 b) 4.8 c) 1.1	a) 0.07 b) 3.9 c) 1.3	a) 2.0 b) 31.0 c) 21.9	a) 3.4 b) 42.3 c) 34.0	d) 0 e) 0 f) 0	d) 0 e) 0 f) 0	d) 0.7 e) 11.4 f) 11.8	d) 3.5 e) 43.3 f) 30.8
China	Yes*	1,740	136	A – 4, B – 85, C – 231, D – 29	38.6	a) 0 b) 0 c) 0	a) 1.1 b) 6.5 c) 0.5	a) 3.3 b) 12.0 c) 0.5	a) 4.4 b) 9.9 c) 0.4	d) 2.4 e) 43.1 f) 1.9	d) 10.6 e) 60.2 f) 3.5	d) 13.1 e) 47.7 f) 3.8	d) 13.4 e) 30.4 f) 2.8
Colombia	No	2,290	37	A – 1, B – 3, C – 19, D – 15	76.5	a) 0.38 b) 20.0 c) 8.0	a) 1.7 b) 39.3 c) 12.4	a) 2.5 b) 34.1 c) 18.8	a) 2.0 b) 25.5 c) 12.9	d) 0.23 e) 12.3 f) 7.6	d) 0.88 e) 20.4 f) 18.2	d) 1.1 e) 14.9 f) 18.7	d) 1.7 e) 21.9 f) 23.8
Greece	Yes	19,670	80	A – 0, B – 1, C – 1, D – 7	60.8	a) 0 b) 0 c) 0	a) 0.02 b) 13.0 c) 0.2	a) 1.5 b) 73.1 c) 11.1	a) 1.9 b) 70.8 c) 15.3	d) 0 e) 0 f) 0	d) 0.09 e) 69.9 f) 2.1	d) 0.44 e) 20.9 f) 7.0	d) 0.45 e) 16.6 f) 10.2

(continued...)

(...Table A13 continued)

	Main Determinants of Household Gas Consumption Patterns			Settlement Density		Anchor Consumers for Gas Market Development: Power Generation a) Gas Consumption in bcm b) % in Total Gas Consumption c) Electricity Generated from Gas (% of total)				Anchor Consumers for Gas Market Development: Industry d) Gas Consumption in bcm e) % in Total Gas Consumption f) % of Gas in Total Energy Consumption in Industry			
Countries	*Climate Requiring Substantial Space Heating*	*Gross National Income per capita Based on (WB Atlas Method) (US$ in 2005)*	*Population Density (persons per km²) (2004)*	*Presence of Large Cities in 2000 (A – number of Cities above 5 m people; B – 1 to 5 m; C – 250,000 to 1 m; D – 100,000 to 250,000)*	*Urbanization Level (2003) (%)*	*1973*	*1990*	*2000*	*2004*	*1973*	*1990*	*2000*	*2004*
India	No	720	328	A – 6, B – 26, C –107, D – 102	28.3	a) 0.33 b) 45.8 c) 0.5	a) 4.2 b) 35.3 c) 3.4	a) 11.1 b) 43.9 c) 10.0	a) 15.5 b) 54.6 c) 9.5	d) 0.3 e) 43.2 f) 1.4	d) 6.1 e) 51.5 f) 10.2	d) 10.4 e) 41.0 f) 12.1	d) 7.7 e) 27.0 f) 7.2
Indonesia	No	1,280	126	A – 1, B – 7, C – 20, D – 20	45.6	a) 0 b) 0 c) 0	a) 0.37 b) 1.7 c) 2.3	a) 6.3 b) 17.3 c) 28.3	a) 4.8 b) 12.4 c) 16.1	d) 0.13 e) 58.0 f) 6.3	d) 5.8 e) 26.2 f) 42.7	d) 11.4 e) 31.4 f) 36.8	d) 5.9 e) 15.4 f) 20.5
Korea	Yes	15,830	491	A – 1, B – 6, C – 26, D – 8	80.3	a) 0 b) 0 c) 0	a) 2.3 b) 75.6 c) 9.1	a) 6.4 b) 33.9 c) 10.7	a) 11.8 b) 41.1 c) 16.2	d) 0 e) 0 f) 0	d) 0.08 e) 2.7 f) 0.2	d) 3.2 e) 17.0 f) 5.0	d) 4.4 e) 15.8 f) 5.7
Mexico	No	7,310	53	A – 1, B – 10 , C – 54, D – 48	75.5	a) 1.9 b) 15.3 c) 14.2	a) 3.9 b) 14.8 c) 11.6	a) 10.7 b) 27.0 c) 19.5	a) 21.6 b) 44.5 c) 38.8	d) 8.1 e) 65.5 f) 41.7	d) 15.0 e) 57.7 f) 36.1	d) 11.9 e) 30.0 f) 35.3	d) 11.9 e) 23.7 f) 34.6
Portugal	Yes	16,170	114	A – 0, B – 0, C – 2, D – 6	54.6	a) 0 b) 0 c) 0	a) 0 b) 0 c) 0	a) 1.3 b) 57.0 c) 16.5	a) 2.3 b) 61.2 c) 26.1	d) 0 e) 0 f) 0	d) 0 e) 0 f) 0	d) 0.7 e) 32.3 f) 7.8	d) 1.1 e) 29.1 f) 11.7
Spain	Yes	25,360	85	A – 1, B – 1, C – 12, D – 30	76.5	a) 0.14 b) 14 c) 1.0	a) 0.3 b) 5.5 c) 1.0	a) 2.9 b) 17.4 c) 9.1	a) 8.4 b) 31.1 c) 20.0	d) 0.42 e) 41.6 f) 2.0	d) 4.1 e) 76.5 f) 15.1	d) 10.5 e) 63.1 f) 28.4	d) 13.5 e) 50.1 f) 33.6
Tunisia	No	2,890	61	A – 0, B – 1, C – 1, D – 5	63.7	a) 0.12 b) 96.0 c) 32.7	a) 0.98 b) 73.7 c) 34.7	a) 2.3 b) 76.9 c) 63.7	a) 2.8 b) 76.7 c) 90.2	d) 0.01 e) 9.1 f) 2.8	d) 0.29 e) 22.2 f) 19.7	d) 0.5 e) 16.7 f) 28.1	d) 0.66 e) 17.8 f) 33.6
Turkey	Yes	4,710	89	A – 1, B – 4, C – 18, D – 36	66.3	a) 0 b) 0 c) 0	a) 2.6 b) 74.5 c) 17.8	a) 9.3 b) 62.8 c) 37.0	a) 13.2 b) 58.9 c) 41.3	d) 0 e) 0 f) 0	d) 0.8 e) 23.5 f) 4.9	d) 2.1 e) 14.2 f) 8.0	d) 2.6 e) 11.7 f) 10.9

Sources: UN – Department of Economic and Social Affairs, Population Division (for settlement density); The World Bank (for income per capita); IEA (for anchor consumers).
** Some regional exceptions exist. Some localities, especially those in southern China, do not require space heating.*

Table A14: Gas Consumption in Households for Selected Countries in Group II

Country	Number of Households Connected to Natural Gas (year)	Total Residential Gas Consumption in bcm (same year)	Approximate Annual Gas Consumption per Household in Cubic Meters (same year)
Chile	318,300 (2002)	0.358	1,125
Colombia	2,175,000 (2001)	1	387
Korea	7,055,000 (2001)	7.097	1,006
Portugal	744,000 (2004)	0	269
Spain	5,203,000 (2003)	3.037	584
Turkey	3,345,000 (2004)	4.044	1,208

Sources: IEA (for residential gas consumption), International Gas Union (for number of household connections), www.dosider.org (for number of household connections in Turkey).

Table A15: Average Size of Households in Group II

Country	Average Size of Households in 1985	Average Size of Households in 2000
Bolivia	5	5.2
Brazil	4.5	4
Bulgaria	2.9	3
Chile	4.4	4
China	4.5	4
Colombia	5.8	4.8
Greece	3.2	2.7
India	5.8	5.5
Indonesia	4.8	4
Korea	4.2	3.3
Mexico	5.3	4.3
Portugal	3.3	2.7
Spain	3.7	3.1
Tunisia	5.5	4.7
Turkey	5.3	4.2

Sources: UN Habitat (www.unchs.org).

Table A16: Role of Gas vs. Competing Fuels in Households in Group II Countries

Country	Ranking of Competing Fuels for Residential Use in 2004	Major Fuels Displaced by Gas in Households Since 1990*	Share of Gas in Total Residential Energy Consumption in 2004 (%)
Bolivia	1) Petroleum Products 2) Combust Renewables and Waste 3) Electricity 4) **Gas**	None	1.1
Brazil	1) Combust Renewables and Waste 2) Electric 3) Petroleum Products 4) **Gas**	None	0.8
Bulgaria	1) Electricity 2) Combust Renewables and Waste 3) Heat 4) Coal 5) Petroleum Products 6) **Gas**	Petroleum Products, Coal	0.03
Chile	1) Combust Renewables and Waste 2) Petroleum Products 3) Electricity 4) **Gas** 5) Coal	Coal	6.9
China	1) Combust Renewables and Waste 2) Coal 3) Electricity 4) Petroleum Products 5) Heat 6) **Gas**	Coal	2.8
Colombia	1) Combust Renewables and Waste 2) Electricity 3) **Gas** 4) Petroleum Products 5) Coal	Coal	16.9
Greece	1) Petroleum Products 2) Electricity 3) Combust Renewables and Waste 4) Geothermal-solar 5) Heat 6) **Gas** 7) Coal	Coal	0.55
India	1) Combust Renewables and Waste 2) Petroleum Products 3) Electricity 4) Coal 5) **Gas**	Coal	0.24
Indonesia	1) Combust Renewables and Waste 2) Petroleum Products 3) Electricity 4) **Gas** 5) Coal	None	0.04
Korea	1) **Gas** 2) Electricity 3) Petroleum Products 4) Heat 5) Coal 6) Combust Renewables and Waste 7) Geothermal-solar	Coal	44.6
Mexico	1) Petroleum Products 2) Combust Renewables and Waste 3) Electricity 4) **Gas**	None	4.8
Portugal	1) Combust Renewables and Waste 2) Electricity 3) Petroleum Products 4) **Gas** 5) Geothermal-solar 6) Heat	Petroleum Products**	5.6
Spain	1) Electricity 2) Petroleum Products 3) **Gas** 4) Combust Renewables and Waste 5) Coal 6) Geothermal-solar	Coal	20.6
Tunisia	1) Combust Renewables and Waste 2) Petroleum Products 3) Electricity 4) **Gas**	None	9.2
Turkey	1) Combust Renewables and Waste 2) **Gas** 3) Petroleum Products 4) Coal 5) Electricity 6) Geothermal-solar	Petroleum Products, Coal	20.3

Source: IEA.

** Owing to lack of detailed surveys on residential consumption patterns, fuel displacement is evaluated on a countrywide basis rather than by individual households before and after obtaining a gas connection. Fuels have been considered displaced by natural gas if their residential consumption has exhibited a consistent drop in terms of both physical volumes and share in total residential energy consumption from 1990 to 2004.*

*** Refers to fuels displaced by natural gas only in terms of their overall share in total residential energy consumption although no drop has been recorded in terms of physical volumes.*

Table A17: Consumption in the Commercial and Services Sectors in Group II Countries

Country	Residential Consumption in 2004 (bcm)	Commercial and Services Consumption in 2004 (bcm)	Total Households Commercial and Services Consumption in 2004 (bcm)	Commercial and Services Consumption per every 1,000 Cubic Meters Consumed in Households (cubic meters)
Bolivia	0.009	0.012	0.021	1,375
Brazil	0.191	0.277	0.468	1,448
Bulgaria	0.007	0	0.024	5,000
Chile	0.354	0.106	0.46	298
China	10.13	3	13.494	332
Colombia	0.783	0.138	0.921	176
Greece	0.033	0.044	0.077	1.333
India	NA	NA	1	NA
Indonesia	0.025	4	4.206	163,609
Korea	8.588	2.877	11	335
Mexico	0.955	0.222	1.178	232
Portugal	0.2	0.156	0.356	778
Spain	3.366	0	3.722	105
Tunisia	0.185	0.054	0.24	293
Turkey	4.044	1.378	5	340

Source: IEA.
Note: NA = not applicable.

Table A18: Ownership and Market Structure in Group II Countries

Country	Private versus Public Ownership in Gas Distribution	Concentration of Ownership in Distribution	Market Structure before Reforms: Presence of Vertical Integration	Market Structure after Reforms: Major Liberalization Reforms
Bolivia	– Mainly public ownership (under YPFB) – Private participation allowed since 1986, but still have limited role	– High – Single company (YPFB) dominating distribution.	– Initially vertically integrated structure under State-owned YPFB	– Partial privatization and unbundling of YPFB after 1994 Capitalization Law – 1996 Hydrocarbon Law forbids transmission companies from involving directly in distribution and in trading gas; TPA on the transmission grid
Brazil	– Mainly public ownership until 1995 – Growing role for private Discos after 1995 constitutional amendment	– Medium – Several companies distributing gas in more than one region (for example, Gas Natural and Petrobas)	– Initially vertical integration under State-owned Petrobras – monopoly in upstream, imports and wholesale	– After 1995 constitutional amendment, private participation allowed in upstream, imports and transmission, but Petrobras' dominant role retained in practice – Unbundling for upstream and transmission required (into separate legal entities) after 1997 Petroleum Law. But no restrictions on cross-ownership across these activities. Transmission companies cannot buy or sell gas – TPA on the transmission grid
Bulgaria	– Mainly private ownership; significant involvement of municipalities	– Medium – Single private company (Overgas) with controlling stakes in multiple Discos	– Vertical integration under State-owned Bulgargaz – monopoly in imports, transmission and transit, and limited role in distribution	– TPA on the transmission grid
Chile	– Initially, mainly public ownership – Mainly private ownership after 1997	– Medium – Single company (Gasco) owning major shares in most Discos	– Some vertical integration between upstream and transmission (upstream company ENAP holding shares in several transmission pipelines), and between transmission and distribution (several companies, such as Gasco, holding shares in several transmission pipelines and distribution)	– TPA on the transmission grid – After 1997, multiple players in transmission (nine in 2003). Transmission companies involved in direct gas sales to large consumers
China	– Initially public ownership, but growing role for private Discos municipal participation remaining significant	– Medium – Several companies distributing gas in more than one region (for example, Hong Kong and China Gas; Xinao Gas; Panva Gas)	– Initially vertically integrated structure under State-owned CNPC	– In addition to CNPC, two new vertically integrated companies created – Sinopec and CNOOC. Three companies dominating upstream, transmission and sales to large consumers

(continued...)

(...Table A18 continued)

Country	Private versus Public Ownership in Gas Distribution	Concentration of Ownership in Distribution	Market Structure before Reforms: Presence of Vertical Integration	Market Structure after Reforms: Major Liberalization Reforms
Colombia	– Initial public ownership – Main growth in distribution after privatization in mid-90s	– Medium – More than 20 Discos in 2004 but significant cross-ownership	– Initially, high level of vertical integration in production and transmission (under Ecopetrol)	– Unbundling of regulated and competitive activities since 1996 – Stringent limits on vertical integration: transmission companies barred from direct involvement in gas production, distribution and retail – Transmission companies subject to TPA – Rise of independent transmission and distribution companies since late 90s
Greece	– Mainly public ownership (under DEPA) with minority role for private companies	– High – Single company (DEPA) holds controlling stake in all three Discos	– Initially vertical integration under State-owned Depa – monopoly for imports, wholesale, Transmission and distribution	– Limited competition in imports introduced in 1991 (through Prometheus Gas) – Account unbundling of DEPA since 2001 – DEPA's monopoly in transmission ending in 2006
India	– Initially public ownership (Discos owned by State governments); after 1984 dominant role for State-owned GAIL; growing role for private Discos	– Medium – Single company (GAIL) with stakes in nearly all Discos; Another company (BG) a partner in multiple Discos	– Initially gas sector dominated by two vertically integrated State-owned companies (ONGC, OIL)	– In 1984, GAIL, another vertically integrated company, created to take over nearly all interstate and regional transmission and distribution networks, and build new ones; GAIL involved in upstream and sales too – Rising wholesale competition, especially after late 90s with the expansion of private participation in upstream
Indonesia	– Public ownership till 2001 (under PGN) – PGN partially privatized in 2001, and growing role for private Discos	– High – Single company (PGN) dominating distribution	– Initial vertical integration under State-owned oil and gas company Pertamina – in charge of upstream, transmission, distribution and exports.	– Since 1994, distribution company PGN in charge of a part of the transmission grid – Oil and Gas Law in 2001 allows TPA on the transmission grid, prohibits upstream companies from involvement in transmission and trading, and requires Pertamina's and PGN's unbundling

(continued...)

(...Table A18 continued)

Country	Private versus Public Ownership in Gas Distribution	Concentration of Ownership in Distribution	Market Structure before Reforms: Presence of Vertical Integration	Market Structure after Reforms: Major Liberalization Reforms
Korea	– Mainly private	– Low – 28 Discos in 2003, six of them serving Seoul only	– High degree of vertical integration under State-owned Kogas in charge of LNG imports, transmission and sale to large consumers	– Partial privatization of Kogas in 1999 (39% of shares sold to public). Since 2001, entities other than Kogas allowed to import LNG, provided they own LNG facilities
Mexico	– Public ownership until 1995 (under Pemex and CFE) – Dominant role for private Discos since 1995	– Medium – Several companies distributing gas in more than one region (for example, Gas Natural)	– Initially vertically integrated structure under State-owned Pemex	– 1995 Natural Gas Law allowing growing private company role in transmission and Distribution – TPA on the transmission grid – weakened by Pemex domination of wholesale; TPA on the distribution network for eligible consumers – Some vertical integration allowed, based on separation of accounts
Portugal	– Mainly public ownership until late 90s (under GdP) – Dominant role for private Discos since late 90s but some stakes in Discos retained for GdP	– High – Single company (GdP) owning major shares in all six regional Discos with controlling stake in the largest Disco (for Lisbon)	– Initially, vertically integrated structure under State-owned GdP with role in distribution, major stakes in Transgas – The monopoly in transmission and imports. – In 2000, further vertical integration uniting GdP and Petrogal under GALP Energia (GALP-Transgas monopoly in imports, transmission and sales to large consumers, and GALP Gas with stakes in Discos)	– Privatization of GALP Energia with minority shares left to the state – GDP monopoly in imports preserved (EU derogation until 2008) – Decisions in line with EU Gas Directive in 2003: Power sector free to choose suppliers as of July 2004; creation of an independent transmission operator after ownership unbundling (separating Transgas from GALP Energia and integrating it with the electricity transmission operator REN); Discos subject to legal unbundling of transportation and trading; regulated TPA on the gas networks and LNG terminals

(continued...)

(...Table A18 continued)

Country	Private versus Public Ownership in Gas Distribution	Concentration of Ownership in Distribution	Market Structure before Reforms: Presence of Vertical Integration	Market Structure after Reforms: Major Liberalization Reforms
Spain	– Initially, municipally owned Discos, integrated under Gas Natural in 1991 – Subsequent privatization of Gas Natural and dominant private role	– High – Dominant role for Gas Natural since 1991	– Initially high level of vertical integration: state-owned Enagas de facto monopoly in imports, LNG facilities, transmission, storage, sales to large consumers, and shares in Discos (since 1972) – Enagas functioning under INH (Instituto Nacional de Hidrocarburos – a vertically integrated body in upstream and downstream oil and gas)	– Reorganization of the gas sector, allowing further vertical integration – main gas distributor Gas Natural Group acquired Enagas in 1994 – TPA on the transmission grid since 1996 – 1998 Hydrocarbon Law leading to major reorganization: Enagas nominated as the transmission system operator (with limits imposed on maximum shares to be owned by a single company – 35%); unbundling of Enagas and Gas Natural; unbundling of transport and retail functions of Discos (with all consumers eligible for choosing their suppliers since 2003)
Tunisia	– Public ownership (under STEG)	– High – Single State-owned company (STEG) in charge of distribution	– High degree of vertical integration: Upstream and wholesale dominated by State-owned ETAP (ETAP monopoly in imports); vertical integration between transmission and distribution (performed by State-owned STEG); limited involvement of STEG in upstream	– NA
Turkey	– Mainly public ownership until 2001 – Growing role for private Discos since 2001 and privatization of some existing public Discos	– Medium – Several companies with licenses for distribution in more than one region	– Initially, vertically integrated structure under State-owned Botas – a monopoly in imports, wholesale and transmission, and role in distribution	– 2001 Natural Gas Law: unbundling of Botas and introduction of competition in wholesale – TPA on the transmission grid (controlled by Botas) – TPA on the distribution grid for eligible consumers

List of Formal Reports

Region/Country	Activity/Report Title	Date	Number
	SUB-SAHARAN AFRICA (AFR)		
Africa Regional	Anglophone Africa Household Energy Workshop (English)	07/88	085/88
	Regional Power Seminar on Reducing Electric Power System Losses in Africa (English)	08/88	087/88
	Institutional Evaluation of EGL (English)	02/89	098/89
	Biomass Mapping Regional Workshops (English)	05/89	–
	Francophone Household Energy Workshop (French)	08/89	–
	Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development (English)	03/90	112/90
	Biomass Assessment and Mapping (English)	03/90	–
	Symposium on Power Sector Reform and Efficiency Improvement in Sub-Saharan Africa (English)	06/96	182/96
	Commercialization of Marginal Gas Fields (English)	12/97	201/97
	Commercializing Natural Gas: Lessons from the Seminar in Nairobi for Sub-Saharan Africa and Beyond	01/00	225/00
	Africa Gas Initiative — Main Report: Volume I	02/01	240/01
	First World Bank Workshop on the Petroleum Products Sector in Sub-Saharan Africa	09/01	245/01
	Ministerial Workshop on Women in Energy	10/01	250/01
	and Poverty Reduction: Proceedings from a Multi-Sector	03/03	266/03
	and Multi-Stakeholder Workshop Addis Ababa, Ethiopia, October 23-25, 2002		
	Opportunities for Power Trade in the Nile Basin: Final Scoping Study	01/04	277/04
	Energies modernes et réduction de la pauvreté: Un atelier multi-sectoriel. Actes de l'atelier régional. Dakar, Sénégal, du 4 au 6 février 2003 (French Only)	01/04	278/04
	Énergies modernes et réduction de la pauvreté: Un atelier multi-sectoriel. Actes de l'atelier régional. Douala, Cameroun du 16-18 juillet 2003. (French Only)	09/04	286/04
	Energy and Poverty Reduction: Proceedings from the Global Village Energy Partnership (GVEP) Workshops held in Africa	01/05	298/05
	Power Sector Reform in Africa: Assessing the Impact on Poor People	08/05	306/05
	The Vulnerability of African Countries to Oil Price Shocks: Major Factors and Policy Options. The Case of Oil Importing Countries	08/05	308/05
Angola	Energy Assessment (English and Portuguese)	05/89	4708-ANG
	Power Rehabilitation and Technical Assistance (English)	10/91	142/91
	Africa Gas Initiative - Angola: Volume II	02/01	240/01

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Benin	Energy Assessment (English and French)	06/85	5222-BEN
Botswana	Energy Assessment (English)	09/84	4998-BT
	Pump Electrification Prefeasibility Study (English)	01/86	047/86
	Review of Electricity Service Connection Policy (English)	07/87	071/87
	Tuli Block Farms Electrification Study (English)	07/87	072/87
	Household Energy Issues Study (English)	02/88	–
	Urban Household Energy Strategy Study (English)	05/91	132/91
Burkina Faso	Energy Assessment (English and French)	01/86	5730-BUR
	Technical Assistance Program (English)	03/86	052/86
	Urban Household Energy Strategy Study (English and French)	06/91	134/91
Burundi	Energy Assessment (English)	06/82	3778-BU
	Petroleum Supply Management (English)	01/84	012/84
Burundi	Status Report (English and French)	02/84	011/84
	Presentation of Energy Projects for the Fourth Five Year Plan (1983-1987) (English and French)	05/85	036/85
	Improved Charcoal Cookstove Strategy (English and French)	09/85	042/85
	Peat Utilization Project (English)	11/85	046/85
	Energy Assessment (English and French)	01/92	9215-BU
Cameroon	Africa Gas Initiative – Cameroon: Volume III	02/01	240/01
Cape Verde	Energy Assessment (English and Portuguese)	08/84	5073-CV
	Household Energy Strategy Study (English)	02/90	110/90
Central African Republic	Energy Assessment (French)	08/92	9898-CAR
Chad	Elements of Strategy for Urban Household Energy The Case of N'djamena (French)	12/93	160/94
Comoros	Energy Assessment (English and French)	01/88	7104-COM
	In Search of Better Ways to Develop Solar Markets: The Case of Comoros	05/00	230/00
Congo	Energy Assessment (English)	01/88	6420-COB
	Power Development Plan (English and French)	03/90	106/90
	Africa Gas Initiative – Congo: Volume IV	02/01	240/01
Côte d'Ivoire	Energy Assessment (English and French)	04/85	5250-IVC
	Improved Biomass Utilization (English and French)	04/87	069/87
	Power System Efficiency Study (English)	12/87	
	Power Sector Efficiency Study (French)	02/92	140/91
	Project of Energy Efficiency in Buildings (English)	09/95	175/95
	Africa Gas Initiative – Côte d'Ivoire: Volume V	02/01	240/01
Ethiopia	Energy Assessment (English)	07/84	4741-ET
	Power System Efficiency Study (English)	10/85	045/85
	Agricultural Residue Briquetting Pilot Project (English)	12/86	062/86
	Bagasse Study (English)	12/86	063/86
	Cooking Efficiency Project (English)	12/87	
	Energy Assessment (English)	02/96	179/96
Gabon	Energy Assessment (English)	07/88	6915-GA
	Africa Gas Initiative – Gabon: Volume VI	02/01	240/01
The Gambia	Energy Assessment (English)	11/83	4743-GM
	Solar Water Heating Retrofit Project (English)	02/85	030/85
	Solar Photovoltaic Applications (English)	03/85	032/85
	Petroleum Supply Management Assistance (English)	04/85	035/85

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Ghana	Energy Assessment (English)	11/86	6234-GH
	Energy Rationalization in the Industrial Sector (English)	06/88	084/88
	Sawmill Residues Utilization Study (English)	11/88	074/87
	Industrial Energy Efficiency (English)	11/92	148/92
	Corporatization of Distribution Concessions through Capitalization	12/03	272/03
Guinea	Energy Assessment (English)	11/86	6137-GUI
	Household Energy Strategy (English and French)	01/94	163/94
Guinea Bissau	Energy Assessment (English and Portuguese)	08/84	5083-GUB
	Recommended Technical Assistance Projects (English & Portuguese)	04/85	033/85
	Management Options for the Electric Power and Water Supply Subsectors (English)	02/90	100/90
	Power and Water Institutional Restructuring (French)	04/91	118/91
Kenya	Energy Assessment (English)	05/82	3800 KE
	Power System Efficiency Study (English)	03/84	014/84
	Status Report (English)	05/84	016/84
	Coal Conversion Action Plan (English)	02/87	–
Kenya	Solar Water Heating Study (English)	02/87	066/87
	Peri-Urban Woodfuel Development (English)	10/87	076/87
	Power Master Plan (English)	11/87	–
	Power Loss Reduction Study (English)	09/96	186/96
	Implementation Manual: Financing Mechanisms for Solar Electric Equipment	07/00	231/00
Lesotho	Energy Assessment (English)	01/84	4676-LSO
Liberia	Energy Assessment (English)	12/84	5279-LBR
	Recommended Technical Assistance Projects (English)	06/85	038/85
	Power System Efficiency Study (English)	12/87	081/87
Madagascar	Energy Assessment (English)	01/87	5700-MAG
	Power System Efficiency Study (English and French)	12/87	075/87
	Environmental Impact of Woodfuels (French)	10/95	176/95
Malawi	Energy Assessment (English)	08/82	3903-MAL
	Technical Assistance to Improve the Efficiency of Fuelwood Use in the Tobacco Industry (English)	11/83	009/83
	Status Report (English)	01/84	013/84
Mali	Energy Assessment (English and French)	11/91	8423-MLI
	Household Energy Strategy (English and French)	03/92	147/92
Islamic Republic of Mauritania	Energy Assessment (English and French)	04/85	5224-MAU
	Household Energy Strategy Study (English and French)	07/90	123/90
Mauritius	Energy Assessment (English)	12/81	3510-MAS
	Status Report (English)	10/83	008/83
	Power System Efficiency Audit (English)	05/87	070/87
	Bagasse Power Potential (English)	10/87	077/87
	Energy Sector Review (English)	12/94	3643-MAS
Mozambique	Energy Assessment (English)	01/87	6128-MOZ
	Household Electricity Utilization Study (English)	03/90	113/90
	Electricity Tariffs Study (English)	06/96	181/96
	Sample Survey of Low Voltage Electricity Customers	06/97	195/97
Namibia	Energy Assessment (English)	03/93	11320-NAM

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Niger	Energy Assessment (French)	05/84	4642-NIR
	Status Report (English and French)	02/86	051/86
	Improved Stoves Project (English and French)	12/87	080/87
	Household Energy Conservation and Substitution (English and French)	01/88	082/88
Nigeria	Energy Assessment (English)	08/83	4440-UNI
	Energy Assessment (English)	07/93	11672-UNI
	Strategic Gas Plan	02/04	279/04
Rwanda	Energy Assessment (English)	06/82	3779-RW
	Status Report (English and French)	05/84	017/84
	Improved Charcoal Cookstove Strategy (English and French)	08/86	059/86
	Improved Charcoal Production Techniques (English and French)	02/87	065/87
	Energy Assessment (English and French)	07/91	8017-RW
	Commercialization of Improved Charcoal Stoves and Carbonization Techniques Mid-Term Progress Report (English and French)	12/91	141/91
SADC	SADC Regional Power Interconnection Study, Vols. I-IV (English)	12/93	-
SADCC	SADCC Regional Sector: Regional Capacity-Building Program for Energy Surveys and Policy Analysis (English)	11/91	-
Sao Tome and Principe	Energy Assessment (English)	10/85	5803-STP
Senegal	Energy Assessment (English)	07/83	4182-SE
	Status Report (English and French)	10/84	025/84
Senegal	Industrial Energy Conservation Study (English)	05/85	037/85
	Preparatory Assistance for Donor Meeting (English and French)	04/86	056/86
	Urban Household Energy Strategy (English)	02/89	096/89
	Industrial Energy Conservation Program (English)	05/94	165/94
Seychelles	Energy Assessment (English)	01/84	4693-SEY
	Electric Power System Efficiency Study (English)	08/84	021/84
Sierra Leone	Energy Assessment (English)	10/87	6597-SL
Somalia	Energy Assessment (English)	12/85	5796-SO
Republic of South Africa	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95
Sudan	Management Assistance to the Ministry of Energy and Mining	05/83	003/83
	Energy Assessment (English)	07/83	4511-SU
	Power System Efficiency Study (English)	06/84	018/84
	Status Report (English)	11/84	026/84
	Wood Energy/Forestry Feasibility (English)	07/87	073/87
Swaziland	Energy Assessment (English)	02/87	6262-SW
	Household Energy Strategy Study	10/97	198/97
Tanzania	Energy Assessment (English)	11/84	4969-TA
	Peri-Urban Woodfuels Feasibility Study (English)	08/88	086/88
	Tobacco Curing Efficiency Study (English)	05/89	102/89
	Remote Sensing and Mapping of Woodlands (English)	06/90	–
	Industrial Energy Efficiency Technical Assistance (English)	08/90	122/90
	Power Loss Reduction Volume 1: Transmission and Distribution System Technical Loss Reduction and Network Development (English)	06/98	204A/98
	Power Loss Reduction Volume 2: Reduction of Non-Technical Losses (English)	06/98	204B/98

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Togo	Energy Assessment (English)	06/85	5221-TO
	Wood Recovery in the Nangbeto Lake (English and French)	04/86	055/86
	Power Efficiency Improvement (English and French)	12/87	078/87
Uganda	Energy Assessment (English)	07/83	4453-UG
	Status Report (English)	08/84	020/84
	Institutional Review of the Energy Sector (English)	01/85	029/85
	Energy Efficiency in Tobacco Curing Industry (English)	02/86	049/86
	Fuelwood/Forestry Feasibility Study (English)	03/86	053/86
	Power System Efficiency Study (English)	12/88	092/88
	Energy Efficiency Improvement in the Brick and Tile Industry (English)	02/89	097/89
	Tobacco Curing Pilot Project (English)	03/89	UNDP Terminal Report
	Energy Assessment (English)	12/96	193/96
	Rural Electrification Strategy Study	09/99	221/99
Zaire	Energy Assessment (English)	05/86	5837-ZR
Zambia	Energy Assessment (English)	01/83	4110-ZA
	Status Report (English)	08/85	039/85
	Energy Sector Institutional Review (English)	11/86	060/86
	Power Subsector Efficiency Study (English)	02/89	093/88
	Energy Strategy Study (English)	02/89	094/88
	Urban Household Energy Strategy Study (English)	08/90	121/90
Zimbabwe	Energy Assessment (English)	06/82	3765-ZIM
	Power System Efficiency Study (English)	06/83	005/83
	Status Report (English)	08/84	019/84
	Power Sector Management Assistance Project (English)	04/85	034/85
Zimbabwe	Power Sector Management Institution Building (English)	09/89	–
	Petroleum Management Assistance (English)	12/89	109/89
	Charcoal Utilization Pre-feasibility Study (English)	06/90	119/90
	Integrated Energy Strategy Evaluation (English)	01/92	8768-ZIM
	Energy Efficiency Technical Assistance Project: Strategic Framework for a National Energy Efficiency Improvement Program (English)	04/94	–
	Capacity Building for the National Energy Efficiency Improvement Programme (NEEIP) (English)	12/94	–
	Rural Electrification Study	03/00	228/00
	Les réformes du secteur de l'électricite en Afrique: Evaluation de leurs conséquences pour les populations pauvres	11/06	306/06
	EAST ASIA AND PACIFIC (EAP)		
Asia Regional	Pacific Household and Rural Energy Seminar (English)	11/90	–
China	County-Level Rural Energy Assessments (English)	05/89	101/89
	Fuelwood Forestry Preinvestment Study (English)	12/89	105/89
	Strategic Options for Power Sector Reform in China (English)	07/93	156/93
	Energy Efficiency and Pollution Control in Township and Village Enterprises (TVE) Industry (English)	11/94	168/94
	Energy for Rural Development in China: An Assessment Based on a Joint Chinese/ESMAP Study in Six Counties (English)	06/96	183/96
	Improving the Technical Efficiency of Decentralized Power Companies	09/99	222/99

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	Air Pollution and Acid Rain Control: The Case of Shijiazhuang City and the Changsha Triangle Area	10/03	267/03
	Toward a Sustainable Coal Sector In China	07/04	287/04
	Demand Side Management in a Restructured Industry: How Regulation and Policy Can Deliver Demand-Side Management Benefits to a Growing Economy and a Changing Power System	12/05	314/05
	A Strategy for CBM and CMM Development and Utilization in China	07/07	326/07
Fiji	Energy Assessment (English)	06/83	4462-FIJ
Indonesia	Energy Assessment (English)	11/81	3543-IND
	Status Report (English)	09/84	022/84
	Power Generation Efficiency Study (English)	02/86	050/86
	Energy Efficiency in the Brick, Tile and Lime Industries (English)	04/87	067/87
	Diesel Generating Plant Efficiency Study (English)	12/88	095/88
	Urban Household Energy Strategy Study (English)	02/90	107/90
	Biomass Gasifier Preinvestment Study Vols. I & II (English)	12/90	124/90
	Prospects for Biomass Power Generation with Emphasis on Palm Oil, Sugar, Rubberwood and Plywood Residues (English)	11/94	167/94
Lao PDR	Urban Electricity Demand Assessment Study (English)	03/93	154/93
	Institutional Development for Off-Grid Electrification	06/99	215/99
Malaysia	Sabah Power System Efficiency Study (English)	03/87	068/87
	Gas Utilization Study (English)	09/91	9645-MA
Mongolia	Energy Efficiency in the Electricity and District Heating Sectors	10/01	247/01
	Improved Space Heating Stoves for Ulaanbaatar	03/02	254/02
	Impact of Improved Stoves on Indoor Air Quality in Ulaanbaatar, Mongolia	11/05	313/05
Myanmar	Energy Assessment (English)	06/85	5416-BA
Papua New Guinea	Energy Assessment (English)	06/82	3882-PNG
Papua New Guinea	Status Report (English)	07/83	006/83
	Institutional Review in the Energy Sector (English)	10/84	023/84
	Power Tariff Study (English)	10/84	024/84
Philippines	Commercial Potential for Power Production from Agricultural Residues (English)	12/93	157/93
	Energy Conservation Study (English)	08/94	–
	Strengthening the Non-Conventional and Rural Energy Development Program in the Philippines: A Policy Framework and Action Plan	08/01	243/01
	Rural Electrification and Development in the Philippines: Measuring the Social and Economic Benefits	05/02	255/02
Solomon Islands	Energy Assessment (English)	06/83	4404-SOL
	Energy Assessment (English)	01/92	979-SOL
South Pacific	Petroleum Transport in the South Pacific (English)	05/86	–
Thailand	Energy Assessment (English)	09/85	5793-TH
	Rural Energy Issues and Options (English)	09/85	044/85
	Accelerated Dissemination of Improved Stoves and Charcoal Kilns (English)	09/87	079/87
	Northeast Region Village Forestry and Woodfuels Preinvestment Study (English)	02/88	083/88

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	Impact of Lower Oil Prices (English)	08/88	–
	Coal Development and Utilization Study (English)	10/89	–
	Why Liberalization May Stall in a Mature Power Market: A Review of the Technical and Political Economy Factors that Constrained the Electricity Sector Reform in Thailand 1998-2002	12/03	270/03
	Reducing Emissions from Motorcycles in Bangkok	10/03	275/03
Tonga	Energy Assessment (English)	06/85	5498-TON
Vanuatu	Energy Assessment (English)	06/85	5577-VA
Vietnam	Rural and Household Energy-Issues and Options (English)	01/94	161/94
	Power Sector Reform and Restructuring in Vietnam: Final Report to the Steering Committee (English and Vietnamese)	09/95	174/95
	Household Energy Technical Assistance: Improved Coal Briquetting and Commercialized Dissemination of Higher Efficiency Biomass and Coal Stoves (English)	01/96	178/96
	Petroleum Fiscal Issues and Policies for Fluctuating Oil Prices In Vietnam	02/01	236/01
	An Overnight Success: Vietnam's Switch to Unleaded Gasoline	08/02	257/02
	The Electricity Law for Vietnam — Status and Policy Issues — The Socialist Republic of Vietnam	08/02	259/02
	Petroleum Sector Technical Assistance for the Revision of the Existing Legal and Regulatory Framework	12/03	269/03
Western Samoa	Energy Assessment (English)	06/85	5497-WSO
	SOUTH ASIA (SAS)		
Bangladesh	Energy Assessment (English)	10/82	3873-BD
	Priority Investment Program (English)	05/83	002/83
	Status Report (English)	04/84	015/84
	Power System Efficiency Study (English)	02/85	031/85
	Small Scale Uses of Gas Pre-feasibility Study (English)	12/88	–
	Reducing Emissions from Baby-Taxis in Dhaka	01/02	253/02
India	Opportunities for Commercialization of Non-conventional Energy Systems (English)	11/88	091/88
	Maharashtra Bagasse Energy Efficiency Project (English)	07/90	120/90
	Mini-Hydro Development on Irrigation Dams and Canal Drops Vols. I, II and III (English)	07/91	139/91
	WindFarm Pre-Investment Study (English)	12/92	150/92
	Power Sector Reform Seminar (English)	04/94	166/94
	Environmental Issues in the Power Sector (English)	06/98	205/98
	Environmental Issues in the Power Sector: Manual for Environmental Decision Making (English)	06/99	213/99
	Household Energy Strategies for Urban India: The Case of Hyderabad	06/99	214/99
	Greenhouse Gas Mitigation In the Power Sector: Case Studies From India	02/01	237/01
	Energy Strategies for Rural India: Evidence from Six States	08/02	258/02
	Household Energy, Indoor Air Pollution, and Health	11/02	261/02
	Access of the Poor to Clean Household Fuels	07/03	263/03
	The Impact of Energy on Women's Lives in Rural India	01/04	276/04
	Environmental Issues in the Power Sector: Long-Term Impacts And Policy Options for Rajasthan	10/04	292/04

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	Environmental Issues in the Power Sector: Long-Term Impacts And Policy Options for Karnataka	10/04	293/04
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	Status Report (English)	01/85	028/84
	Energy Efficiency & Fuel Substitution in Industries (English)	06/93	158/93
Pakistan	Household Energy Assessment (English)	05/88	–
	Assessment of Photovoltaic Programs, Applications, and Markets (English)	10/89	103/89
	National Household Energy Survey and Strategy Formulation Study: Project Terminal Report (English)	03/94	–
	Managing the Energy Transition (English)	10/94	–
	Lighting Efficiency Improvement Program Phase 1: Commercial Buildings Five Year Plan (English)	10/94	–
	Clean Fuels	10/01	246/01
	Household Use of Commercial Energy	05/06	320/06
Regional	Toward Cleaner Urban Air in South Asia: Tackling Transport Pollution, Understanding Sources.	03/04	281/04
Sri Lanka	Energy Assessment (English)	05/82	3792-CE
	Power System Loss Reduction Study (English)	07/83	007/83
	Status Report (English)	01/84	010/84
	Industrial Energy Conservation Study (English)	03/86	054/86
	Sustainable Transport Options for Sri Lanka: Vol. I	02/03	262/03
	Greenhouse Gas Mitigation Options in the Sri Lanka Power Sector: Vol. II	02/03	262/03
	Sri Lanka Electric Power Technology Assessment (SLEPTA): Vol. III	02/03	262/03
	Energy and Poverty Reduction: Proceedings from South Asia Practitioners Workshop How Can Modern Energy Services Contribute to Poverty Reduction? Colombo, Sri Lanka, June 2-4, 2003	11/03	268/03
	EUROPE AND CENTRAL ASIA (ECA)		
Armenia	Development of Heat Strategies for Urban Areas of Low-income Transition Economies. Urban Heating Strategy for the Republic Of Armenia. *Including a Summary of a Heating Strategy for the Kyrgyz Republic*	04/04	282/04
Bulgaria	Natural Gas Policies and Issues (English)	10/96	188/96
	Energy Environment Review	10/02	260/02
Central Asia and The Caucasus	Cleaner Transport Fuels in Central Asia and the Caucasus	08/01	242/01
Central and Eastern Europe	Power Sector Reform in Selected Countries	07/97	196/97
	Increasing the Efficiency of Heating Systems in Central and Eastern Europe and the Former Soviet Union (English and Russian)	08/00	234/00
	The Future of Natural Gas in Eastern Europe (English)	08/92	149/92
Kazakhstan	Natural Gas Investment Study, Volumes 1, 2 & 3	12/97	199/97
Kazakhstan & Kyrgyzstan	Opportunities for Renewable Energy Development	11/97	16855-KAZ
Poland	Energy Sector Restructuring Program Vols. I-V (English)	01/93	153/93
	Natural Gas Upstream Policy (English and Polish)	08/98	206/98
	Energy Sector Restructuring Program: Establishing the Energy		

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	Regulation Authority	10/98	208/98
Portugal	Energy Assessment (English)	04/84	4824-PO
Romania	Natural Gas Development Strategy (English)	12/96	192/96
	Private Sector Participation in Market-Based Energy-Efficiency Financing Schemes: Lessons Learned from Romania and International Experiences.	11/03	274/03
Slovenia	Workshop on Private Participation in the Power Sector (English)	02/99	211/99
Turkey	Energy Assessment (English)	03/83	3877-TU
	Energy and the Environment: Issues and Options Paper	04/00	229/00
	Energy and Environment Review: Synthesis Report	12/03	273/03
	Turkey's Experience with Greenfield Gas Distribution since 2003	03/07	325/05
	MIDDLE EAST AND NORTH AFRICA (MENA)		
Turkey	Turkey's Experience with Greenfield Gas Distribution since 2003	05/07	325/07
	Greenfield Gas Distribution: Cross-country Experience	12/07	328/07
Arab Republic of Egypt	Energy Assessment (English)	10/96	189/96
	Energy Assessment (English and French)	03/84	4157-MOR
	Status Report (English and French)	01/86	048/86
Morocco	Energy Sector Institutional Development Study (English and French)	07/95	173/95
	Natural Gas Pricing Study (French)	10/98	209/98
	Gas Development Plan Phase II (French)	02/99	210/99
Syria	Energy Assessment (English)	05/86	5822-SYR
	Electric Power Efficiency Study (English)	09/88	089/88
	Energy Efficiency Improvement in the Cement Sector (English)	04/89	099/89
	Energy Efficiency Improvement in the Fertilizer Sector (English)	06/90	115/90
Tunisia	Fuel Substitution (English and French)	03/90	–
	Power Efficiency Study (English and French)	02/92	136/91
	Energy Management Strategy in the Residential and Tertiary Sectors (English)	04/92	146/92
	Renewable Energy Strategy Study, Volume I (French)	11/96	190A/96
	Renewable Energy Strategy Study, Volume II (French)	11/96	190B/96
	Rural Electrification in Tunisia: National Commitment, Efficient Implementation and Sound Finances	08/05	307/05
Yemen	Energy Assessment (English)	12/84	4892-YAR
	Energy Investment Priorities (English)	02/87	6376-YAR
	Household Energy Strategy Study Phase I (English)	03/91	126/91
	Household Energy Supply and Use in Yemen. Volume I: Main Report and Volume II: Annexes	12/05	315/05
	LATIN AMERICA AND THE CARIBBEAN REGION (LCR)		
LCR Regional	Regional Seminar on Electric Power System Loss Reduction in the Caribbean (English)	07/89	–
	Elimination of Lead in Gasoline in Latin America and the Caribbean (English and Spanish)	04/97	194/97
	Elimination of Lead in Gasoline in Latin America and the Caribbean - Status Report (English and Spanish)	12/97	200/97
	Harmonization of Fuels Specifications in Latin America and the Caribbean (English and Spanish)	06/98	203/98
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	Energy Partnership (GVEP) Workshop held in Bolivia	06/05	202/05
	Power Sector Reform and the Rural Poor in Central America	12/04	297/04
	Estudio Comparativo Sobre la Distribución de la Renta Petrolera en Bolivia, Colombia, Ecuador y Perú	08/05	304/05
	OECS Energy Sector Reform and Renewable Energy/Energy Efficiency Options	02/06	317/06
	The Landfill Gas-to-Energy Initiative for Latin America and the Caribbean	02/06	318/06
Bolivia	Energy Assessment (English)	04/83	4213-BO
	National Energy Plan (English)	12/87	–
	La Paz Private Power Technical Assistance (English)	11/90	111/90
	Pre-feasibility Evaluation Rural Electrification and Demand Assessment (English and Spanish)	04/91	129/91
	National Energy Plan (Spanish)	08/91	131/91
	Private Power Generation and Transmission (English)	01/92	137/91
	Natural Gas Distribution: Economics and Regulation (English)	03/92	125/92
	Natural Gas Sector Policies and Issues (English and Spanish)	12/93	164/93
	Household Rural Energy Strategy (English and Spanish)	01/94	162/94
	Preparation of Capitalization of the Hydrocarbon Sector	12/96	191/96
	Introducing Competition into the Electricity Supply Industry in Developing Countries: Lessons from Bolivia	08/00	233/00
	Final Report on Operational Activities Rural Energy and Energy Efficiency	08/00	235/00
	Oil Industry Training for Indigenous People: The Bolivian Experience (English and Spanish)	09/01	244/01
	Capacitación de Pueblos Indígenas en la Actividad Petrolera. Fase II	07/04	290/04
Boliva-Brazil	Best Practices in Mainstreaming Environmental & Social Safeguards Into Gas Pipeline Projects	07/06	322/06
	Estudio Sobre Aplicaciones en Pequeña Escala de Gas Natural	07/04	291/04
Brazil	Energy Efficiency & Conservation: Strategic Partnership for Energy Efficiency in Brazil (English)	01/95	170/95
	Hydro and Thermal Power Sector Study	09/97	197/97
	Rural Electrification with Renewable Energy Systems in the Northeast: A Preinvestment Study	07/00	232/00
	Reducing Energy Costs in Municipal Water Supply Operations	07/03	265/03
	"Learning-while-doing" Energy M&T on the Brazilian Frontlines		
Chile	Energy Sector Review (English)	08/88	7129-CH
Colombia	Energy Strategy Paper (English)	12/86	–
	Power Sector Restructuring (English)	11/94	169/94
	Energy Efficiency Report for the Commercial and Public Sector (English)	06/96	184/96
Costa Rica	Energy Assessment (English and Spanish)	01/84	4655-CR
	Recommended Technical Assistance Projects (English)	11/84	027/84
	Forest Residues Utilization Study (English and Spanish)	02/90	108/90
Dominican Republic	Energy Assessment (English)	05/91	8234-DO
Ecuador	Energy Assessment (Spanish)	12/85	5865-EC
	Energy Strategy Phase I (Spanish)	07/88	–
	Energy Strategy (English)	04/91	–
	Private Mini-hydropower Development Study (English)	11/92	–

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	Energy Pricing Subsidies and Interfuel Substitution (English)	08/94	11798-EC
	Energy Pricing, Poverty and Social Mitigation (English)	08/94	12831-EC
Guatemala	Issues and Options in the Energy Sector (English)	09/93	12160-GU
	Health Impacts of Traditional Fuel Use	08/04	284/04
Haiti	Energy Assessment (English and French)	06/82	3672-HA
	Status Report (English and French)	08/85	041/85
	Household Energy Strategy (English and French)	12/91	143/91
Honduras	Energy Assessment (English)	08/87	6476-HO
	Petroleum Supply Management (English)	03/91	128/91
Jamaica	Energy Assessment (English)	04/85	5466-JM
	Petroleum Procurement, Refining, and Distribution Study (English)	11/86	061/86
	Energy Efficiency Building Code Phase I (English)	03/88	–
	Energy Efficiency Standards and Labels Phase I (English)	03/88	–
	Management Information System Phase I (English)	03/88	–
	Charcoal Production Project (English)	09/88	090/88
	FIDCO Sawmill Residues Utilization Study (English)	09/88	088/88
	Energy Sector Strategy and Investment Planning Study (English)	07/92	135/92
Mexico	Improved Charcoal Production Within Forest Management for the State of Veracruz (English and Spanish)	08/91	138/91
	Energy Efficiency Management Technical Assistance to the Comisión Nacional para el Ahorro de Energía (CONAE) (English)	04/96	180/96
	Energy Environment Review	05/01	241/01
	Proceedings of the International Grid-Connected Renewable Energy Policy Forum (with CD)	08/06	324/06
Nicaragua	Modernizing the Fuelwood Sector in Managua and León	12/01	252/01
	Policy & Strategy for the Promotion of RE Policies in Nicaragua. (Contains CD with 3 complementary reports)	01/06	316/06
Panama	Power System Efficiency Study (English)	06/83	004/83
Paraguay	Energy Assessment (English)	10/84	5145-PA
	Recommended Technical Assistance Projects (English)	09/85	
	Status Report (English and Spanish)	09/85	043/85
	Reforma del Sector Hidrocarburos (Spanish Only)	03/06	319/06
Peru	Energy Assessment (English)	01/84	4677-PE
	Status Report (English)	08/85	040/85
	Proposal for a Stove Dissemination Program in the Sierra (English and Spanish)	02/87	064/87
	Energy Strategy (English and Spanish)	12/90	–
Peru	Study of Energy Taxation and Liberalization of the Hydrocarbons Sector (English and Spanish)	120/93	159/93
	Reform and Privatization in the Hydrocarbon Sector (English and Spanish)	07/99	216/99
	Rural Electrification	02/01	238/01
Saint Lucia	Energy Assessment (English)	09/84	5111-SLU
St. Vincent and the Grenadines	Energy Assessment (English)	09/84	5103-STV
Sub Andean	Environmental and Social Regulation of Oil and Gas		

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	Operations in Sensitive Areas of the Sub-Andean Basin (English and Spanish)	07/99	217/99
Trinidad and Tobago	Energy Assessment (English)	12/85	5930-TR
	GLOBAL		
	Energy End Use Efficiency: Research and Strategy (English)	11/89	–
	Women and Energy -A Resource Guide		
	The International Network: Policies and Experience (English)	04/90	–
	Guidelines for Utility Customer Management and Metering (English and Spanish)	07/91	–
	Assessment of Personal Computer Models for Energy Planning in Developing Countries (English)	10/91	–
	Long-Term Gas Contracts Principles and Applications (English)	02/93	152/93
	Comparative Behavior of Firms Under Public and Private Ownership (English)	05/93	155/93
	Development of Regional Electric Power Networks (English)	10/94	–
	Round-table on Energy Efficiency (English)	02/95	171/95
	Assessing Pollution Abatement Policies with a Case Study of Ankara (English)	11/95	177/95
	A Synopsis of the Third Annual Round-table on Independent Power Projects: Rhetoric and Reality (English)	08/96	187/96
	Rural Energy and Development Round-table (English)	05/98	202/98
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	Reducing the Cost of Grid Extension for Rural Electrification	02/00	227/00
	Undeveloped Oil and Gas Fields in the Industrializing World	02/01	239/01
	Best Practice Manual: Promoting Decentralized Electrification Investment	10/01	248/01
	Peri-Urban Electricity Consumers — A Forgotten but Important Group: What Can We Do to Electrify Them?	10/01	249/01

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	Village Power 2000: Empowering People and Transforming Markets	10/01	251/01
	Private Financing for Community Infrastructure	05/02	256/02
	Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook	07/03	264/03
	A Review of ESMAP's Energy Efficiency Portfolio	11/03	271/03
	A Review of ESMAP's Rural Energy and Renewable Energy Portfolio	04/04	280/04
	ESMAP Renewable Energy and Energy Efficiency Reports 1998-2004 (CD Only)	05/04	283/04
	Regulation of Associated Gas Flaring and Venting: A Global Overview and Lessons Learned from International Experience	08/04	285/04
	ESMAP Gender in Energy Reports and Other related Information (CD Only)	11/04	288/04
	ESMAP Indoor Air Pollution Reports and Other related Information (CD Only)	11/04	289/04
	Energy and Poverty Reduction: Proceedings from the Global Village Energy Partnership (GVEP) Workshop on the Pre-Investment Funding. Berlin, Germany, April 23-24, 2003.	11/04	294/04
	Global Village Energy Partnership (GVEP) Annual Report 2003	12/04	295/04
	Energy and Poverty Reduction: Proceedings from the Global Village Energy Partnership (GVEP) Workshop on Consumer Lending and Microfinance to Expand Access to Energy Services, Manila, Philippines, May 19-21, 2004	12/04	296/04
	The Impact of Higher Oil Prices on Low Income Countries And on the Poor	03/05	299/05
	Advancing Bioenergy for Sustainable Development: Guideline For Policymakers and Investors	04/05	300/05
	ESMAP Rural Energy Reports 1999-2005	03/05	301/05
	Renewable Energy and Energy Efficiency Financing and Policy Network: Options Study and Proceedings of the International Forum	07/05	303/05
	Implementing Power Rationing in a Sensible Way: Lessons Learned and International Best Practices	08/05	305/05
	The Urban Household Energy Transition. Joint Report with RFF Press/ESMAP. ISBN 1-933115-07-6	08/05	309/05
	Pioneering New Approaches in Support of Sustainable Development In the Extractive Sector: Community Development Toolkit, also Includes a CD containing Supporting Reports	10/05	310/05
	Analysis of Power Projects with Private Participation Under Stress	10/05	311/05
	Potential for Biofuels for Transport in Developing Countries	10/05	312/05
	Experiences with Oil Funds: Institutional and Financial Aspects	06/06	321/06
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