ASSESSING THE FUTURE CHALLENGES OF THE GLOBAL GAS MARKET

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ABSTRACT

Introduction
Natural gas is increasing its share of the global energy mix, and is projected to continue to do so over the period to 2020. The key drivers for this demand growth will be continued penetration of gas in the power generation sector in the majority of gas markets, as well as the development of less mature gas markets such as China.

This presents a huge opportunity, but also significant challenges, since the principal gas markets of North America and Europe are facing a dramatic increase in import dependency at the same time as Asian economies step up their gas demand. This will translate into increased demand for long-distance pipelined gas and particularly for LNG. The growth in LNG trade flows will itself lead to a change in the dynamics of gas trade, from independent local or national markets, into an increasingly interconnected global gas market.

Aim of the study
This paper assesses the outlook for gas demand and supply by principal regional gas market around the world, to assess the scale and direction of likely future trade flows of both pipeline and LNG to import-dependent markets, and the resulting impact on global gas trade and regional pricing dynamics. Given the extent of change anticipated in future market dynamics, the paper goes on to assess the challenges facing various market participants in bringing future gas supplies to market.

Results
The aggregate import requirement for gas trade (i.e. excluding supply developed for indigenous markets) will broadly treble between 2005 and 2020, in the form of both LNG and new pipeline projects. LNG demand alone is projected to attain a level of 450 MTA by 2020, with imports growing most dramatically into the deregulated North American gas market, reaching 100 MTA by 2020 – more than five times the 2005 level. New import dependent markets, such as the UK, New Zealand and Chile, will further add to the complexity of the global gas trade. And CNG may also open additional, smaller markets (e.g. Indonesia, Mediterranean and Caribbean).

Supply to meet global LNG demand will come from both brownfield LNG expansion trains complemented by new projects from the likes of Yemen, Angola, Russia, Venezuela and Iran. Pipeline export projects will be dominated by new flows from Russia and the Former Soviet Union, Alaska and Canada.

Conclusions and Implications
The results portray a future global market of rapidly increasing complexity, with new and growing import dependent markets competing for pipeline and LNG volumes. Accordingly there are a number of challenges for producers that arise from the significant shift in the fundamentals of the global gas market, including access to gas reserves and access to markets. In addition, the scale of investment required to meet this growth in gas trade is enormous. New LNG capital investments alone will exceed an average $10 bn pa, with pipeline capex requirements not far behind. Project financiers, keen to participate in this growth sector, will therefore also need to understand the risks involved in both LNG and pipeline projects.

For policy makers there is also recognition over this forecast period that the majority of gas markets around the world are becoming more import dependent over the period to 2020, and in some cases markedly so. With security of supply therefore coming back into the energy policy agenda, and likely to remain there, there appears growing consensus regarding the wisdom of diversification – both of gas supply and, ultimately, in limiting reliance upon natural gas.
TABLE OF CONTENTS

1. Abstract
2. Body of Paper
3. References
4. List of Tables
5. List of Figures
2. ASSESSING THE FUTURE CHALLENGES OF THE GLOBAL GAS MARKET

INTRODUCTION

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This presents a huge opportunity, but also significant challenges, since the principal gas markets of North America and Europe are facing a dramatic increase in import dependency at the same time as Asian economies step up their gas demand. This will translate into increased demand for long-distance pipelined gas and particularly for LNG. The growth in LNG trade flows will itself lead to a change in the dynamics of gas trade, from independent local or national markets, into an increasingly interconnected global gas market.

AIM OF THE STUDY

This paper assesses the outlook for gas demand and supply by principal regional gas market around the world to 2020, to assess the scale and direction of likely future trade flows of both pipeline and LNG to import-dependent markets, and the resulting impact on global gas trade and regional pricing dynamics. Given the extent of change anticipated in future market dynamics, the paper goes on to assess the challenges facing various market participants in bringing future gas supplies to market.

METHODS EMPLOYED

Wood Mackenzie generates forecasts for gas demand for regional markets around the world, using a variety of energy models. These take into account the drivers of gas demand in each sector (power generation, industrial, residential and commercial) and the dynamics of competing fuels. Where appropriate, other factors such as energy policy and infrastructural constraints on gas supply are also factored in.

Gas demand forecasts are presented and reconciled with contracted and future gas supply, using Wood Mackenzie’s global upstream gas reserve and production coverage at a field-by-field level for over 90 countries. From this analysis it is possible to determine the future incremental supply requirement, as well as the need for future infrastructure development. In reconciling future (i.e. as yet undeveloped or uncontracted) gas supply with the gas demand forecasts, Wood Mackenzie considers the most likely allocation of supply to markets, taking into account the relative cost of competing sources of supply (on the grounds that lower cost supplies have a competitive advantage) but also the likely strategies of the producers and preferences of the buyers concerned.

As the market becomes increasingly complex and dynamic, it is increasingly difficult to undertake this analysis on a manual basis. For this reason, Wood Mackenzie has developed a number of global gas flow optimisation models to inform this allocation of gas supply to markets over the last four years. These models incorporate all of the variables into a single optimisation model comprising gas demand curves for regional markets, contracted supply and future gas supply curves, as well as infrastructural capacities, costs and constraints. The models optimize supply and demand for the global gas market to deduce future gas trade flows and the resulting impact on gas market prices.
In 2006 Wood Mackenzie will produce a licensed version of these models - the Global Gas Model. The Global Gas Model will be a powerful analytical tool for companies wishing to better understand the increasingly global nature of gas market dynamics, while testing out different scenarios of market development and the impact on their own and competitors’ positions and portfolios. In addition, the Global Gas Model will allow the seasonal nature of gas flows to be modelled.

STUDY RESULTS

A Gas Demand to 2020

Global gas demand is forecast to show steady growth over the forecast period to 2020. Gas demand has and will be driven by a broad range of factors, with those listed below being of particular importance:

1. Economic growth: The demand for gas, and by extension LNG, is closely linked to economic growth. There is a correlation between economic growth and direct gas consumption but a stronger correlation exists with gas demand from the power generation sector (see next bullet). Continued economic growth in the Asia-Pacific region in particular, is forecast to have a significant impact on gas demand, as new transmission and distribution infrastructure is put in place.

2. Increased use of gas in power generation: Economic growth and electricity demand are closely correlated and in recent years a significant proportion of the new power generation capacity required to meet rising electricity demand has been gas-fired. Gas-fired generation has been favoured by developers primarily because of the shorter lead times required to develop the facilities compared to coal and nuclear. However environmental legislation has also been a key influence as gas-fired generation produces less carbon dioxide than either coal or oil-fired facilities and carbon dioxide emissions are becoming increasingly regulated, in some markets via explicit taxation or pricing mechanisms which impact project economics. As well as driving the development of new-build capacity, environmental legislation has also forced or incentivised generators to convert oil-fired plant to gas, further increasing gas demand.

However there are also two factors that may act to curtail gas demand forecasts relative to previous expectations. These are:

1. The impact of high gas prices on gas demand, especially in the power generation sector, as well as in the industrial (including feedstock) sector. The former is discussed in greater detail below.

2. The increasing concern amongst policy makers in those markets that are projected to become significantly more import dependent than currently, from the perspective of security of gas supply. This is particularly prevalent in Europe in early 2006, following concerns over the disruption to some Russian gas imports during winter months. This is discussed further in Implications at the end of this paper.

Gas Demand for Power Generation

Increased development of gas-fired power generation capacity is a major driver of gas demand over the forecast period. In deriving our gas demand forecasts we have taken into account expected competition from other power generation fuels including coal and nuclear. At the current time there is considerable interest in the development of new nuclear and clean coal-fired generation capacity, particularly in Europe and North America. This interest is driven by high gas prices, security of supply concerns about imported gas and increasing environmental legislation on carbon emissions.
Together these factors could potentially lead to the development of significant additional amounts of new nuclear and coal capacity in certain regions, which could lower demand. However, given the significant lead times required to permit and then construct such facilities, particularly nuclear ones, any adverse impact on gas/LNG demand is unlikely to feed through until the end of the forecast period. The relative economics of gas, coal and nuclear power generation will be key in determining to what extent new clean coal and nuclear capacity is built.

Our analysis of coal technology economics is based on pulverized coal generation technology fitted with FGD (flue gas desulphurisation). For coal the key sensitivity considered is the fuel cost – the switching cost has been calculated at US$1.70 (base long-term view of global coal prices) and at US$2.10/mmbtu (high global coal price). For nuclear generation, capital costs of new plant is estimated in the range of US$1,750 and US$2,000 per installed kW of capacity, reflecting the consensus range of estimated capex.

In the European Union, the relative economics of competing fuels in power generation are also impacted by environmental legislation on carbon emissions, and specifically the value of carbon that may prevail. The following table summarises the impact on switching levels for power generation in the EU at different values of carbon emissions:

<table>
<thead>
<tr>
<th>Carbon trading value (US$/tCO₂)</th>
<th>0</th>
<th>25</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal @ $1.70/GJ</td>
<td>5.20</td>
<td>7.00</td>
<td>8.80</td>
</tr>
<tr>
<td>Coal @ $2.10/GJ</td>
<td>5.70</td>
<td>7.50</td>
<td>9.30</td>
</tr>
<tr>
<td>Nuclear capex $1750/kW</td>
<td>6.80</td>
<td>5.40</td>
<td>4.10</td>
</tr>
<tr>
<td>Nuclear capex $2000/kW</td>
<td>7.70</td>
<td>6.40</td>
<td>5.00</td>
</tr>
</tbody>
</table>

While a comparison of the relative economics would suggest that nuclear becomes a viable alternative to gas for new build capacity at US$5-6/mmbtu (depending on carbon value), there remain certain barriers to the development of nuclear, in particular the widespread public opposition to nuclear in some markets.

Regional Gas Demand Forecasts to 2020

Taking into account the above factors, Wood Mackenzie has generated gas demand forecasts for each principal region of North America (1), Europe (2), Asia (3) and, as well as the Former Soviet Union. These are summarised in the following graph, quoted in bcm (Billion Cubic Metres) pa.

Figure 1 Regional Gas Demand Forecasts to 2020
The demand forecasts reflect the relative maturity of the gas market in North America and to a lesser extent Europe, compared to the Asian markets where the greatest gas demand growth is anticipated.

B Future Gas Supply likely to meet Demand to 2020

Wood Mackenzie's proprietary data on existing contracted and incremental future gas supply is reconciled with demand forecasts, taking into account the costs of competing gas supplies into individual markets, as well as the likely strategies of the producers and preferences of the buyers concerned. In the majority of markets, pipeline sources of natural gas may be competing with LNG. One of the key outputs of this exercise is to assess the likely future level of LNG and pipeline projects that may supply each individual gas market over the period to 2020. The results are outlined below, divided between LNG and pipeline.

Future LNG supply

LNG demand (4) is projected to attain a level of more than 450 MTA (Million Tonnes per Annum) by 2020, with imports growing most dramatically into the deregulated North American gas market, reaching 100 MTA by 2020 – more than five times the 2005 level. New import dependent markets, such as the UK, will further add to the complexity of the global gas trade. Whereas historically the Pacific Basin has dominated the LNG business, the Atlantic Basin will develop rapidly over the course of the next decade, resulting in a much more balanced split in demand across the two basins.

Figure 2 LNG Demand Forecast by Basin 2005-2020

The supply response to the forecast growth in LNG requirements has already been significant, with a great number of new projects in varying stages of development, ranging from the early stages of commissioning through to feasibility studies. The potential LNG volume from proposed projects, estimated at least 525 MTA in 2020, exceeds our forecast for LNG demand – it is therefore clear that not all projects will meet their proposed timetables, with many being delayed, deferred or abandoned.
Incremental supply will come from both brownfield LNG expansion trains and new greenfield projects from the likes of Yemen, Angola, Russia, Venezuela and Iran. The projected increase in LNG demand in the Atlantic Basin will be complemented by a potential four-fold increase in supply from Atlantic Basin projects compared to 2005, with Nigeria, Egypt and Russia in particular playing an increasingly important role. In the Pacific Basin, new Australian LNG projects abound, with the potential to contribute in excess of an additional 60 MTA if all proposed projects were to proceed.

An important factor behind LNG’s dramatic growth is the fact that as the technology has matured, costs have been reduced dramatically, to the extent that LNG is competitive with pipeline alternatives.

**Pipeline Gas Supply**

Wood Mackenzie’s forecast for each country is derived on the basis of expectations regarding gas supplies via existing and proposed pipelines and the relative market share of LNG. For example, our North American LNG forecast factors in significant Alaskan imports from circa 2015 and our European LNG demand forecasts are developed on the basis of certain assumptions about Russian imports. Pipeline exports originating in eastern Russia are, at some point in time, expected to compete with LNG deliveries to China, Japan and South Korea.

Hence in all the principal markets of Europe, North America and Asia, large pipeline projects are competing with LNG. While the exact size, route and/or timing of many of these pipelines is highly uncertain, future such projects will be centered around the regions of Russia and the Former Soviet Union, Alaska, Canada and via Turkey into Europe. A summary of the principal new, international, pipeline projects that are anticipated in the forecast time horizon is provided below:
### Table 2  Future Major International Gas Pipeline Projects (5) 2008-2020*

<table>
<thead>
<tr>
<th>Name (Route)</th>
<th>Approximate (initial) capacity (bcm pa)</th>
<th>Indicative capital cost ($ 2005)</th>
<th>Possible Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Europe</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medgaz (Algeria to Spain)</td>
<td>8</td>
<td>$0.8 bn</td>
<td>2009</td>
</tr>
<tr>
<td>NEGP (Russia to Germany)</td>
<td>27.5</td>
<td>$5.0 bn</td>
<td>2012</td>
</tr>
<tr>
<td>IGI (Greece to Italy)</td>
<td>8</td>
<td>$1.0 bn</td>
<td>2010</td>
</tr>
<tr>
<td>Nabucco (Turkey to Austria)</td>
<td>25</td>
<td>$4.5 bn</td>
<td>2011</td>
</tr>
<tr>
<td>GALSI (Algeria to Italy via Sardinia)</td>
<td>10</td>
<td>$2.0 bn</td>
<td>&gt;2012</td>
</tr>
<tr>
<td><strong>North America</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mackenzie Delta (Canada to US)</td>
<td>12</td>
<td>$4.5 bn</td>
<td>2010</td>
</tr>
<tr>
<td>Alaska to US Lower 48</td>
<td>45</td>
<td>$15.0 bn</td>
<td>2014</td>
</tr>
<tr>
<td><strong>Asia</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PNG Gas (PNG to Australia)</td>
<td>4</td>
<td>$1.5 bn</td>
<td>2011-12</td>
</tr>
<tr>
<td>Kovytyka (Russia) to China</td>
<td>~30</td>
<td>$6.0 bn</td>
<td>&gt;2010</td>
</tr>
<tr>
<td>Iran to Pakistan and India</td>
<td>30-40</td>
<td>$7.5 bn</td>
<td>&gt;2010</td>
</tr>
<tr>
<td>Sakhalin I (Russia) to China</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* excludes looping of existing routes, and projects not currently deemed likely in this time horizon

C  Principal Future Trade Flows

Gas demand and incremental supply is reconciled to provide a possible solution of future gas trade flows to meet gas demand. The overall global solution for 2020 can be summarized in the following stylized graphic:

**Figure 4  Principal Future Gas Trade Flows (LNG and Pipeline)**
A key observation from the results indicate that LNG exports from the Middle East is emerging as a principal supplier. Projects in this region have the undeniable advantage of geographic location, with the ability to supply markets in both the Atlantic and Pacific basins. Indeed growth in liquefaction capacity in Qatar is projected to be stronger than in any other country, reaching capacity of 77 MTA in 2010/11 to become the largest single producer.

The ability of Qatari LNG to deliver cost effectively any importing gas market around the world is impressive, as demonstrated by comparing the long-run marginal costs of supply (including upstream, liquefaction, shipping and regasification) to both the equivalent cost of supply from competing pipeline sources of supply, and the gas price achieved in 2005. So, for example in the UK, Qatari LNG is broadly comparable with competing pipeline gas supplies from Norway.

Figure 5 Qatar LNG Costs of Supply vs Competing Pipeline Supply costs

Notwithstanding the strong competitive position of Middle Eastern LNG, there remains some uncertainty regarding the actual potential to be achieved by Middle East as a supply source given the moratorium on future gas developments in Qatar and the current political issues surrounding Iran in the international arena.

From a pipeline perspective, Russian gas flows to Europe, and ultimately to China too, dominate. Accordingly Russia will continue to extend its significant influence on the European gas market, as well as a growing influence on the broader global gas markets with potential exports to both Asia and North America.

Russia’s influence on Europe is projected to extend volumetrically (with exports of Russian/CIS gas to Europe of ca. 300 bcm pa projected by 2020), geographically (playing an increasingly significant role in “new” markets such as the UK) and commercially (perhaps dictating the evolution pricing and contract structures, particularly as costs of new supply rise). Moreover the security of supply dimension is increasingly at the top of the agenda for governments and customers in Europe – and has recently been elevated further by the disruption in supplies in early 2006.
Going forward, the proportion of Europe’s supply met by Russia is set to increase, which means reliance on a country whose political and commercial relationships with neighbouring countries on which it is dependent for supplies (i.e. CIS countries) or for transit (i.e. Ukraine) are often far from stable. As a result, European players and governments are pursuing alternatives, such as in the form of different sources of gas (e.g. LNG or Iranian/Caspian gas via Nabucco), in order to improve the level of diversity.

**CNG – An alternative method of gas transportation**

In addition to future pipeline and LNG trade flows, Wood Mackenzie believes CNG ships can be a cost effective means of connecting gas markets and supplies up to distances approaching 4,000 kms. Remote coastal markets (with large single points of consumption such as industrial plants, power generation or city gas networks) will be ideal for gas delivery by CNG ship. Although no CNG ships are in operation today, the high level of activity in marketing, technological and regulatory approvals around this technology lead Wood Mackenzie to believe CNG ships and barges will be in operation by the end of this decade.

*CNG can fill an economic niche that exists between the more established technologies where:

1. Stranded or associated gas supplies which are within 4,000 kilometres of premium priced energy markets - for example high priced gas markets or markets burning petroleum fuels (diesel or LPG’s in particular).
2. Traditional gas markets are experiencing indigenous gas production decline. For example the US and New Zealand.
3. New gas markets can be developed. For example where gas imports have not been economic before due to lack of critical mass to underpin a gas pipeline or LNG project. Such regions could include Caribbean, Indonesia, Mediterranean markets.*
CONCLUSIONS

The results portray a future global market of rapidly increasing complexity, with new and growing import dependent markets competing for pipeline and LNG volumes. The increasing proportion of natural gas production that is internationally traded, whether by pipeline or LNG ship, is the most striking feature of the forecast period to 2020. This necessarily means that individual national or regional gas markets will become physically interconnected, and as a result many will exhibit quite different gas market dynamics.

This raises the issue of whether US, Asian and European Gas prices will be linked in the future. This is part of the wider hypothesis that a ‘global gas price’ may emerge, with prices in different regional markets reflecting a market set price after adjusting for transportation differentials. This debate has been driven by the increased use of LNG in both the European and North American markets and the roles of portfolio players such as Exxon, Shell and BG who have supply and market positions over the globe.

Companies have and will continue to divert individual cargoes between markets to take advantage of price differentials. The global spot market for LNG is increasing both in absolute size and its proportion of the LNG market, although it still currently accounts for only just over 10% of global LNG trade. While this share is unlikely to increase significantly over the next 10 years due to both physical and contractual constraints, a global price for short-term LNG supplies does appear to have emerged, at least for periods of time. Asian buyers have been forced to pay prices for spot cargoes that reflect a premium to US Henry Hub or Spanish prices, rather than long-term Asian contract prices.

This study indicates that for price linkages between markets to materialise a certain level of liquidity needs to develop in global markets, which presently only exists in the US and to a smaller degree in the UK, with a defined pricing point and a large number of buyers and sellers. Portfolio players must have the ability and will to move LNG volumes between markets in response to price differentials. This would imply that the markets have the ability to accept LNG from a variety of sources, i.e. to be able to accept various ship sizes and LNG of varying qualities.

One of the main barriers to a ‘global gas price’ involve the high investments costs associated with the LNG supply chain. The vast majority of LNG supply tends to be underwritten by supply contracts, which may have a defined rather than market price. The high capital costs and contractual nature of this business leaves little excess capacity that could be used to respond to price signals. Even when excess capacity does exist, access to the capacity may not be available to those that could take advantage of these arbitrage opportunities. In addition the long lead times that supply takes to respond to price differentials, relative to the short-time span of volatile natural gas markets, make it difficult to act on a given price signal.

Wood Mackenzie’s long term expectation is that LNG will create a global market with linked regional pricing. However opportunities for spot trades will continue, particularly in managing seasonal gas balances. In the medium term barriers to significant expansion in the spot LNG market will continue to exist. By 2010 the global LNG market is likely still to be predominantly contract driven, with a lack of speculative capacity and liquidity issues in both Asia and Europe. Only by 2020 may the majority of these barriers have been resolved.
IMPLICATIONS

The study indicates that while the growth prospects for the sector are compelling, and present real opportunities for gas producers, there are a number of challenges that arise from the significant shift in the fundamentals of the global gas market. They can be summarized under three categories:

i. Access to Reserves
ii. Access to Market
iii. Access to Capital

Access to Reserves

The majority of the gas reserves that will need to be developed over the next decade are in countries dominated by National Oil Companies (NOCs), such as Russia and the Middle East. The challenges for IOCs wishing to participate in this growth opportunity will therefore be access to reserves, and the terms on which such access is granted.

Access to Markets

In many regional markets, access to market is not straightforward and requires the development of a competitive position to place the gas. In addition, price risk is something that has to be managed in North America, with the traditional oil-price determinant of gas prices also under threat in Europe. Add to that increasing linkages and price arbitrage between these two markets via Atlantic Basin LNG trade, and the trading environment appears far more complex. As a result, market participants are faced with a rapidly changing business environment that producers (as well as buyers, and policy makers alike) need to understand and manage in order to succeed. For producers this may mean developing a position further “down” the gas supply chain, whether to actively place volumes at trading hubs or otherwise secure an offtake for gas supplies, such as supplying customers directly, and/or participation in gas-fired power generation capacity.

Access to Capital

The sheer scale of investment required to meet this growth in gas trade is enormous. New LNG capital investments alone will exceed an average $10 bn pa, with pipeline capex requirements not far behind. Recent evidence suggests that the huge surge in LNG projects is also feeding into higher EPC costs as a result of a scarcity of resource. Project financiers, keen to participate in this growth sector, will therefore also need to understand the risks involved in both LNG and pipeline projects.

From a financier’s perspective, the gradual emergence of a global spot price for LNG means that the way in which spot and optional volumes are priced by a project should now be given far greater consideration. Project financiers will therefore increasingly require access to detailed European and North American gas price forecasts in order to assess the outlook for spot LNG prices.

Implications for Policy Makers

This paper demonstrates that the majority of gas markets around the world are becoming more import dependent over the period to 2020, and in some cases markedly so. But this comes at a time when gas has been successfully increasing its penetration of the overall energy mix through its economic and environmental advantages over many competing fuels.
The knowledge that gas is very expensive to store, with many markets physically constrained from constructing such capacity, has led to increasing disquiet amongst some consumer bodies and governments regarding the implications of becoming increasingly dependent, and the potential impact of a supply disruption. So, while the focus for most of the last decade has been on liberalization and the environment, security of supply is coming back into the energy policy agenda and looks likely to remain there.

There is growing consensus regarding the wisdom of diversification. For some countries unable to sufficiently diversify their gas supply portfolio, the policy of diversification may lead to a policy of limiting their reliance upon natural gas within the energy mix. However, for the majority, diversity is about avoiding becoming too dependent on a single source of supply. Such a desire is, in many markets, going to lead to further demand (if possible) on LNG supplies. In this regard, the globalization of gas markets, and the formation of a more mobile and responsive supply to meet demand should and can be regarded as a positive development. Coupled with the increased level of pipeline interconnection (e.g. around Europe), and the roll out of liberalization allowing open access to infrastructure, security of supply can accordingly be enhanced.
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4. LIST OF TABLES
1. European gas price switching levels in power generation
2. Future Major International Pipeline Projects 2008-2020

5. LIST OF FIGURES
1. Regional Gas Demand Forecasts to 2020
2. LNG Demand Forecast by Basin to 2020
3. LNG Supply Forecast by Basin to 2020
4. Principal Future Trade Flows (LNG and Pipeline)
5. Comparative Costs of LNG and Pipeline Supply
6. CNG vs Pipeline vs LNG Economics