Unlocking the Value of Flared Natural Gas

By Bent Svensson and Mauricio O. Ríos

As the international community is examining ways to reduce greenhouse gas emissions and mitigate the impact of global warming on climate change, the World Bank Group is supporting important initiatives that make concrete contributions toward reducing CO_2 emissions and improving energy efficiency.

One of these initiatives is the World Bank-led Global Gas Flaring Reduction partnership (GGFR). Through this public-private partnership, the World Bank is working with oil-producing countries and companies to reduce the amount of natural gas that is being burned or flared (about 150 bcm per year) by bringing down the barriers that prevent a higher rate of associated gas utilisation.

In brief, the goal is to unlock the value of natural gas that is currently wasted to improve energy efficiency, expand access to energy and contribute to climate change mitigation, thus promoting sustainable development.

As part of these efforts, the World Bank's GGFR partnership, in collaboration with other major international partners like the Methane to Markets partnership, organised a high-level Global Forum on Flaring Reduction and Gas Utilisation in Amsterdam in December 2008.

About 200 representatives from governments and both international and state oil companies came together for two days to share best practices, learn about new technologies and identify opportunities for further gas commercialisation and market development that will allow them to reduce the burning or flaring of natural gas associated with oil production.

The estimated 150 bcm of natural gas flared and vented annually is equivalent to 25% of annual gas consumption in the United States or 30% in the European Union. And the annual 35 bcm of gas flared in sub-Saharan Africa alone could generate half of that continent's power consumption.

"Gas flaring wastes resources and harms the environment, and that's why it is important to step up the efforts in reducing flaring and increasing gas utilisation," said Somit Varma in his keynote address at the event in Amsterdam. "Gas flaring also deprives developing countries of an energy source that is cleaner and often cheaper than others available, and reduces potential tax revenue and trade opportunities." Varma is Director of the Oil, Gas, Mining and Chemicals Department at the World Bank Group and Chairman of the GGFR's Steering Committee.

Gas flaring also has a global impact on climate change by adding some 400 million tonnes of CO_2 in annual emissions. Furthermore, the Methane to Markets partnership estimates that some 100 bcm of methane is vented or lost through fugitive[1] emissions in the oil and gas industry each year.

1 Emissions from all non-combustion sources as well as from waste gas disposal activities.

WHY IS GAS FLARED?

"Hard" Causes

- Distance from significant gas markets
- Reliability of supply from associated gas
- Gas infrastructure constraints (lack of, or access to it)
- Risks of gas re-injection in oil reservoir

"Soft" Causes

- Limited institutional, legal and regulatory framework for gas, including associated gas
- Ineffective fiscal terms (gas price, equity share, tax structure, etc.)
- Underdeveloped domestic market for gas/products (LPG, CNG, methanol, power, etc.)
- Funding constraints and need for coordinated actions by multiple stakeholders

As methane is a more potent greenhouse gas than CO_2, this adds the equivalent of over 1 billion tonnes of CO_2 a year. Altogether, annual emissions from flaring and venting (1.4 billion tonnes) are equivalent to more than twice the potential yearly emission reductions from projects currently submitted under the Kyoto Protocol's clean development mechanisms.

Thus, both upstream gas flaring and downstream methane leakage reductions are very relevant in today's debate on energy issues. In this debate, everyone is looking for win-win solutions that mitigate climate change, increase access to energy and foster economic growth. And this is precisely what gas flaring and venting reduction can achieve: lowering CO_2 emissions and methane leakages opens new economic opportunities through gas utilisation; it improves energy efficiency and it enhances energy security by increasing available supplies.

Countries and companies, however, often face significant barriers to reduce gas flaring and venting, including: limited access to international gas markets as well as incipient local markets to commercialise the gas; lack of funding to put in place the necessary infrastructure to use the associated gas that comes with oil production; and an ineffective regulatory framework for using the associated gas.

Launched at the World Summit on Sustainable Development in August 2002 in Johannesburg, the World Bank's GGFR partnership brings around the table representatives of governments of oil-producing countries, state-owned companies and major international oil companies so that together they can overcome the barriers to reducing gas flaring by sharing global best practices and implementing country-specific programmes.

Today, most GGFR partners have endorsed the Global Standard for gas flaring reduction. This Global Standard provides a framework for governments, companies and other key stakeholders to consult with each other, take collaborative actions, expand project boundaries, and reduce barriers to associated gas utilisation. GGFR partners that have endorsed the Global Standard are committed to no flaring in new projects, and to eliminate continuous production flaring by 2010, unless there are no feasible alternatives.

Flaring wastes about 150 bcm of natural gas a year.

Results on the ground

In just over six years since its creation, the GGFR partnership has already achieved some significant results on the ground, including:

Seventeen major oil companies, the OPEC Secretariat and 15 countries that contribute a significant share of the world's total flaring (about 50%) have already joined GGFR.

- The majority of partners have endorsed the Global Standard for gas flaring reduction.
- GGFR has implemented demonstration projects for associated gas utilisation in eight countries.
- GGFR is assisting Algeria, Cameroon, Equatorial Guinea, Kazakhstan, Nigeria and Qatar to meet identified dates for minimum flaring, through

increased collaboration between operators, the national oil company and the regulator.

- The GGFR partnership is also making steady progress in the two major flaring countries in the world, Russia and Nigeria.

As part of the flaring reduction process in Nigeria, for instance, GGFR is facilitating dialogue between government and industry representatives through the Nigeria Flare Reduction Committee, which has met every three weeks for the past 12 months.

The committee's terms of reference include: to review each operator's existing flare reduction programme; to integrate these individual company plans into a "Nigeria Associated Gas Utilisation Plan" and into Nigeria's Gas Master Plan; and to look for opportunities for cooperation between operators that could accelerate the collection of the gas. In this context, several options to meet the government's targets have been presented to the respective authorities.

In Russia, where three years ago the gas flaring issue was not high on the government's list of priorities, authorities have now sent unequivocal signals of its willingness to reduce gas flaring and improve associated gas utilisation in the next few years. Former President Putin in 2007, in his annual address to the nation, said that gas flaring was "unacceptable" and that it needed to be reduced to minimum levels. A study entitled "Using Associated Gas in Russia", sponsored by the GGFR partnership, contains some key recommendations from which concrete policy decisions and plans could be designed and implemented in the near future.

Satellite imagery

Through satellite imagery, the GGFR partnership is also shedding more light on gas flaring pollution, pinpointing the extent of this major environmental and wastage problem.

The satellite study, commissioned by the World Bank and carried out by the US National Oceanic and Atmospheric Administration (NOAA), is showing that some countries are burning off more gas than was initially reported.

RIGHT
Table 1.

GGFR PARTNERS AROUND THE WORLD

Countries
Algeria
Angola
Azerbaijan
Cameroon
Chad
Ecuador
Equatorial Guinea
Gabon
Indonesia
Iraq
Kazakhstan
Nigeria
Qatar
Uzbekistan
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Table 2.

The data from satellite observations has reshuffled who are the top 20 gas-flaring nations, compared to official figures from previous years. Russia has moved to No.1, replacing Nigeria, and new on the list, based on what satellite sensors have detected, are China, Oman, Uzbekistan, Malaysia, Egypt and Saudi Arabia.

ESTIMATED FLARED VOLUMES FROM SATELLITE DATA

Volumes in bcm	*2005*	*2006*	*2007*	*Change from 2006 to 2007*
Russia	55.2	48.8	50.0	1.2
Nigeria	21.3	19.3	16.8	(2.5)
Iran	11.3	12.1	10.6	(1.5)
Iraq	7.1	7.4	7.0	(0.4)
Kazakhstan	5.8	6.0	5.3	(0.7)
Algeria	5.2	6.2	5.2	(1.0)
Libya	4.4	4.3	3.7	(0.6)
Angola	4.6	4.0	3.5	(0.5)
Saudi Arabia	3.0	3.3	3.4	0
Qatar	2.7	2.8	2.9	0.1
China	2.8	2.8	2.5	(0.3)
Indonesia	2.7	3.0	2.4	(0.6)
Kuwait	2.5	2.5	2.1	(0.4)
Venezuela	2.1	2.0	2.1	0.1
Uzbekistan	2.5	2.8	2.0	(0.8)
USA	2.0	1.9	1.9	0
Oman	2.5	2.2	1.9	(0.3)
Mexico	0.9	1.2	1.7	0.5
Malaysia	1.7	1.8	1.7	(0.1)
Gabon	2.2	1.9	1.6	(0.3)
Total top 20	**142**	**136**	**128**	**(8)**
Rest of the world	**20**	**21**	**19**	**(2)**
Global flaring level	**162**	**157**	**147**	**(10)**

Notes: Totals rounded, Red = Partner countries

To better comprehend which countries were reducing their flaring, and where flaring was increasing, NOAA scientists looked at satellite imagery extending from 1992 to 2007, and created colour-coded, time-phased composite images that produced a new list of the top 20 flarers.

Because most gas flaring occurs outside urban areas, NOAA scientists were able to pinpoint burn-offs and convert their light intensity to measurable quantities of pollution, primarily from CO_2. To ensure precise correlations, only night-time photos under cloud-free conditions were analysed.

Gas flaring estimates, which were produced for 60 countries or areas around the world, show that global gas flaring has remained largely stable over the period 1992-2006, in the range of 150 to 170 bcm. However, the latest satellite estimates from 2006 and 2007 show a decline from 157 bcm in 2006 to 147 bcm in 2007.

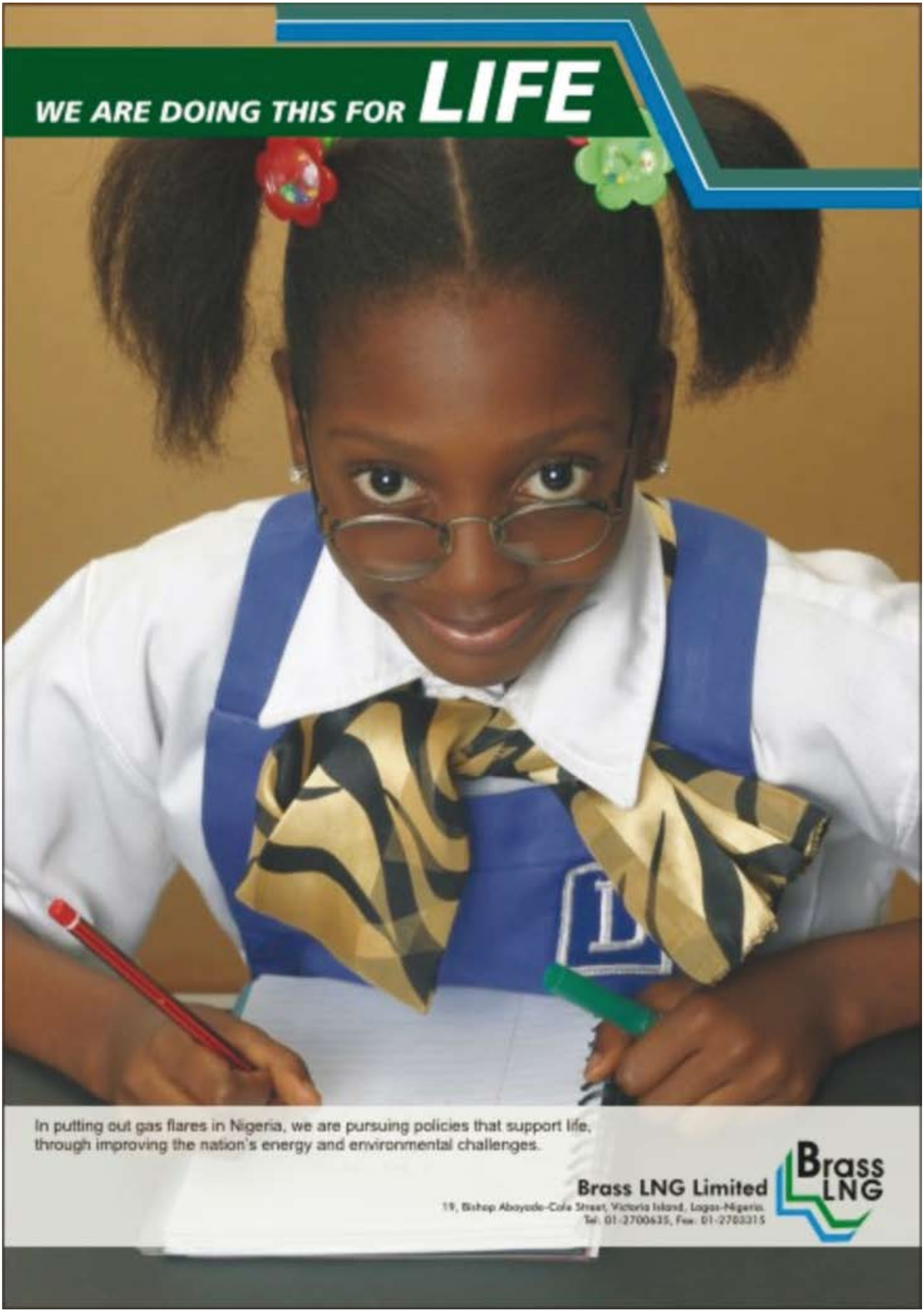
According to the satellite data, the major flaring region in the world is Russia and the Caspian Sea (about 60 bcm); followed by the Middle East and North Africa (about 45 bcm). Sub-Saharan Africa (about 35 bcm) is the third-biggest flaring region, followed by Latin America with some 12 bcm of gas flared annually. (*See Table 2 for country data.*)

The study's estimates are a good additional source of information but satellite imagery has its limitations and uncertainties that GGFR is working to reduce in a joint effort with the NOAA scientists. These sources of error and uncertainty include variations in flare efficiency, mis-identification of flares, non-continuous sampling and some environmental effects.

Challenges ahead

While GGFR has already achieved some great milestones, a significant reduction of global gas flaring still needs to be achieved in order to complete the mission with the desired impact.

Initial achievements already demonstrate that gas flaring and venting reduction efforts are not only relevant in today's energy context but also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viable as demonstrated by several countries and companies, and desirable for its obvious environmental and economic benefits.

Thus a major challenge for the third phase of the GGFR partnership (2010-2012) is to bring other key players on board. Although more than 80% of global venting and flaring occurs in fewer than 20 countries (and GGFR has worked with most of them in one way or another) some important flaring countries and oil companies still are to join the GGFR partnership, including Kuwait, Libya, China, Brazil and Mexico.

Iraq, Azerbaijan and Uzbekistan are some of the newest partners who have joined the GGFR partnership in 2008, and more are expected to do so in 2009.

Another challenge is the need for faster implementation of gas flaring reduction projects so that countries and companies can deliver concrete results and global gas flaring continues to decline in greater volumes.

For this to occur, all relevant stakeholders need to do their part to unlock the value of this wasted gas. And what does it mean to unlock the value of wasted gas?

Through satellite imagery, the GGFR partnership is shedding more light on gas flaring pollution.

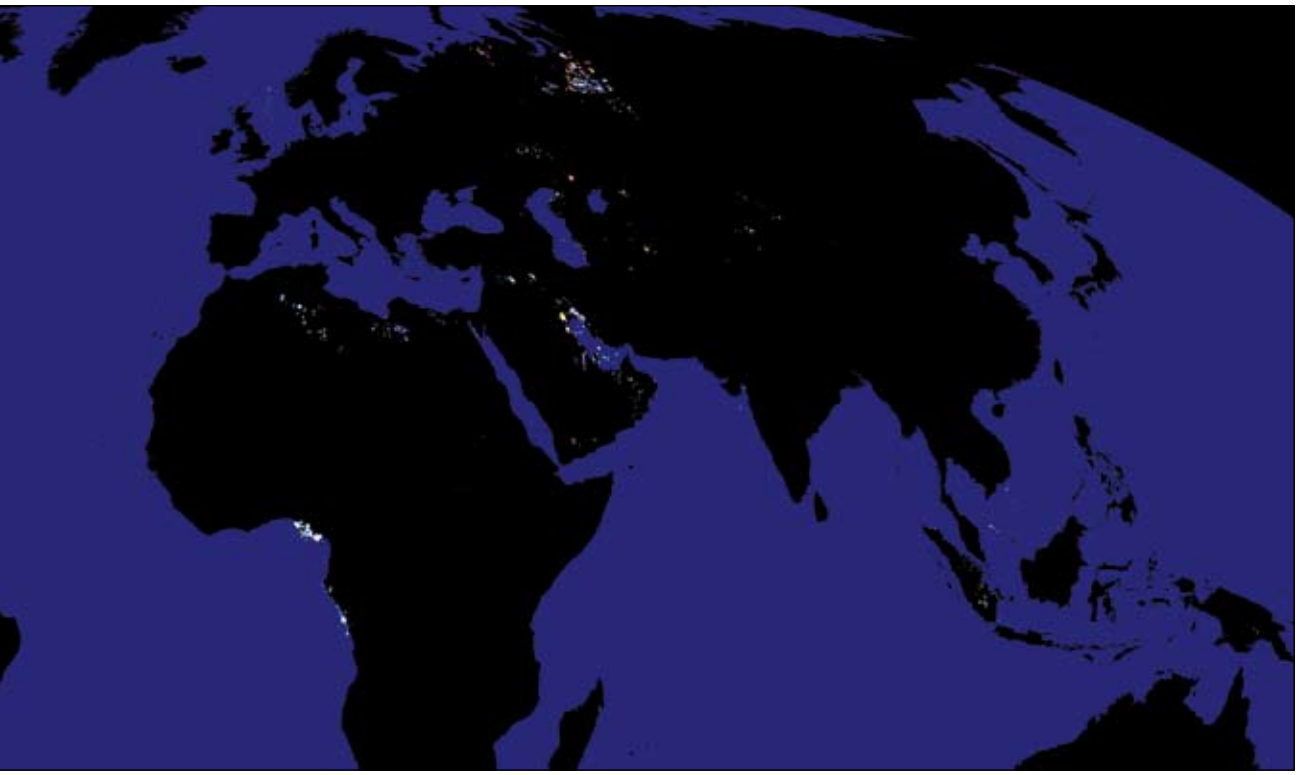
Unlocking the value of wasted gas

Over the past six years GGFR partners have accumulated a wealth of experience, lessons and best practices about gas flaring reduction, so they now better understand the barriers they need to overcome, including:

- Better data to gauge the magnitude of the practice at the country and company levels.
- Governments need to have not only effective regulations in place but also clear policies with the right incentives for operating companies, so that the necessary infrastructure is put in place and markets for gas utilisation are developed.
- Country buy-in, high-level support and an effective local partnership between government and industry are key ingredients to ensure success in gas flaring reduction. There should no longer be any doubt that government and the private sector need to work as real partners if tangible results are to be achieved.
- Leadership and commitment play a critical role in both the public and private sectors in order to sustain progress over the long term.
- And new and small-scale gas utilisation technologies need to be nurtured to commercialisation, to provide additional economic options to flaring.

Thus, "unlocking" the value of wasted gas requires a concerted effort by governments and industry, as well as other stakeholders including multilateral financial institutions and technology developers.

This is why the World Bank-led GGFR partnership was created in the first place. GGFR's main role is that of a catalyst that brings key stakeholders around the table, facilitates the establish-



ment of a common ground with clear targets and does not allow them to give up or get distracted from the ultimate objective.

Conclusion

In today's climate change debate, it is important to see the gas flaring and venting issue not only in its technical and economic dimensions. But rather, all stakeholders should look at the gas flaring reduction challenge as an opportunity for making a concrete contribution to climate change mitigation, by improving energy efficiency and expanding access to a cleaner source of energy for the people who most need it.

Thus, it is necessary that each relevant stakeholder – government, industry, technology developer and financial institution – does whatever it takes to unlock the value of wasted gas because actions will always speak louder than words.

The World Bank Group, through the GGFR partnership and other initiatives, will do its part. We trust that all other relevant stakeholders will do theirs so that sooner, rather than later, we will see significant reduction in gas flaring and venting around the world.

Bent Svensson is a leading energy economist and Programme Manager of the World Bank-led Global Gas Flaring Reduction partnership. Mauricio O. Ríos is a Communications Officer with the World Bank Group.

FOR MORE INFORMATION

GGFR Partnership: www.worldbank.org/ggfr

Global Forum site:
www.flaringreductionforum.org

World Bank's Oil, Gas, Mining and Chemicals Department:
www.worldbank.org/ogmc

Natural Gas in Kuwait

The importance of natural gas to the State of Kuwait was evident in the years spent on exploring for a local source. Kuwait was traditionally known as "Black Oil" country and it was only with the recent major find of free natural gas in North Kuwait, in 2000, that the country became a player in the gas area. The find, due primarily to the results of seismic surveys, emphasized the importance of state-of-the-art technology.

Natural gas was subsequently produced at a Production Facility in 2008. Currently producing 175 mcfpd, plans are underway to increase production at the facility to 600 mcfpd by 2011 and 1 bcfpd by 2015.

Again, the use of innovative technologies, which optimize recovery while at the same time are economically feasible, is key to the success of the project. Also important are the various models, including probabilistic economic modeling, dynamic compositional modeling with tubing model development for forecast scenarios, geo-static modeling of all structures, and joint reservoir studies using analogues, fracture modeling, fluid, and rock properties data. Affiliated surface and subsurface infrastructure to accommodate the gas and the associated products is also in the planning and construction phases; proper integration of the value chain is critical as gas, unlike oil, cannot be stored or exported if the LPG capacity is not adequate.

The Kuwait Oil Company has a goal of a maximum of 1% gas flaring by the year 2012, and networks are being put in place that are flexible enough to maintain this target at all times. The aim is to have production of more than 2 bcfpd of total gas, both free and associated, by the year 2015, with all gas being fed to the LPG if possible. By-products will include 6000 tons/day of ethane, propane, and butane and 760 tons/day of sulfur. The total capital investment planned for the next 7 years for gathering, processing and upgrading facilities and wells is estimated at around $8-9 billion.

Currently, six fields in North Kuwait are being developed for gas production, with most of the gas scheduled for the power plants within the State. Found in the Najmah/Sargelu and Marrat formations, the reservoirs are below 14,000 ft, overpressured, naturally fractured carbonates, with critical fluids. Plans are in place to drill 90 wells, and six rigs have been leased to accomplish this goal.

Using the newest technology to maximize well recovery rates, incorporate HSE issues, and find solutions for sour gas will be part of the reservoir development activities. An aggressive, capital intensive gas exploration program will be undertaken during the next five to ten years and will include deeper horizons in the new and existing fields. This aggressive approach, combined with a well integrated and managed gas value chain and the use of new technology will help the Kuwait Oil Company achieve its ambitious goals, thereby ensuring a solid energy future for the State.

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Oil for Development

By Petter Nore

Petter Nore, Director of Oil for Development.

The Norwegian Oil for Development (OfD) initiative aims at assisting developing countries, upon their request, in their efforts to manage petroleum resources in a way that generates economic growth and promotes the welfare of the population in an environmentally sustainable way. OfD is now planning to cooperate with IGU to create a joint educational module that will cover the whole gas chain.

Petroleum plays an important role in an increasing number of developing countries. Oil and gas hold the promise of becoming vital resources for economic and social development. Unfortunately, in many cases it is proving difficult to translate petroleum resources into welfare for the people. As a result, many developing countries, rich in natural resources, still score low on international development performance indices and are caught in the "resource curse".

Decades of experience in the oil and gas sector have given Norway valuable expertise on how to manage petroleum resources in a sustainable way, ranging from technical/geological expertise, fiscal management and environmental challenges, to overall policy development, government accountability, the question of state ownership and interaction with national and international industry.

This expertise could be useful for developing countries that already hold petroleum resources, or countries that are still in the exploration phase. Hence, the Norwegian Oil for Development initiative aims at assisting partner countries in their efforts to make oil a blessing, and not a curse.

The Norwegian experience

Norway has to a large extent succeeded in transforming oil resources into advanced welfare for its people. The sharing of these experiences constitutes a key component of the OfD initiative. Still, what has been accomplished in Norway will not necessarily be a success elsewhere, and the policies chosen in a given country will always have to be tailored to the particular challenges those countries are facing. Local ownership is crucial for a country's capability to succeed. Therefore, OfD does not seek to export a Norwegian "model" for governance in the petroleum sector. The chosen solutions and policies must be anchored in relevant governmental bodies within OfD's partner countries.

The steady increase in demand for Norwegian assistance within petroleum sector management, along with a growing global focus on these issues, inspired the launching of the Oil for Development initiative in 2005. However, Norway through the Norwegian Petroleum Directorate (NPD) has assisted developing countries with petroleum resources for more than 25 years. Some of the first countries to receive such assistance from the 1980s were Angola, Tanzania, Mozambique, Vietnam and South Africa.

Vietnam is an example where the Norwegian petroleum assistance has made a difference over time. The Norwegian Petroleum Directorate started cooperation with PetroVietnam, the state-owned oil company, more than 15 years ago. Back then Vietnam had no record of the country's oil resources. However, as a result of long-term institutional cooperation with NPD, PetroVietnam has now established a data and reporting system, which indicates how much oil Vietnam holds and how much the oil companies are producing. Such systems improve to a large extent the transparency of the oil sector in the country and allow government and civil society organisations to control the sector.

"Where we can make a difference"

All support provided within the OfD programme is demand driven. Assistance will not be efficient unless the challenges that are raised and the solutions found are truly accepted and understood in the receiving country. Imposing external solutions on partner countries will simply not work.

However, there are some recurrent themes that tend to emerge in all OfD's partner countries. The aspiration for national capacity building is strong. Both governments and local businesses in petroleum-rich countries are keen on developing educational and training programmes to strengthen the local work force and educate members of the government. This can be achieved by a variety of educational initiatives and by providing on-the-job training.

Cooperation ranges from offering limited assistance in specific thematic areas to long-term institution building. The aim is to concentrate the efforts in countries where OfD "can make a difference". Experience shows that progress is most likely to develop in cases where OfD gets involved at an early stage of a country's oil activities, where the programme that is agreed on is comprehensive and long term, and where there is good cooperation between the government of the partner country and Norway.

Today, OfD cooperates with 25 developing countries. Ten of these are core countries with long-term programmes, whereas the other 15 are countries with more limited assistance.

Holistic assistance

OfD adopts a holistic approach in its assistance to partner countries, meaning that resource, environmental and revenue management are regarded as an entity. Good governance and anti-corruption are both vital components in all the petroleum-related assistance OfD offers. The Norwegian experiences are based on a joint consideration of all these components and they are integrated elements of petroleum management.

OfD's assistance covers areas such as legal frameworks, administration and supervision mechanisms, licensing and tendering processes, organisation of public/private interfaces of petroleum governance, local content and industrial develop-

OfD aims to assist Madagascar in using its petroleum resources to generate economic growth.

Ghana became one of Ofd's core countries of operation in March 2008.

ment. In the environmental management area, impact assessment studies, which will uncover the effects that petroleum activities may have on environmental and social conditions, are important. Moreover, the reduction of gas flaring is another crucial factor. Revenue management covers the establishment of government take systems, taxation, anti-corruption and petroleum funds.

A number of recent studies illustrate that good governance is crucial to ensure that the potential wealth from oil, gas and other resources become beneficial to the general population of the country. Good governance in particular implies clear divisions of roles, transparent policies, non-corrupt authorities with expertise that can monitor and report on oil companies, as well as a strong civil society that can hold the government accountable for its actions.

Although it is important to see petroleum management in close relation with the environment and fiscal aspects, resource management is the core constituent, and counts for most of OfD's activities. However, the relative share of revenue management and environmental management in the programme is increasing due to a rising demand among OfD's partner countries. In November 2008, OfD held the first anti-corruption course tailor-made for petroleum-rich countries, in Madagascar.

Demand driven

OfD builds to a large extent on existing activities, and expands support to countries requesting assistance on petroleum governance. Support is mainly provided to governments and governmental agencies, as well as civil society in countries of cooperation through a wide range of Norwegian expert bodies and regional and international organisations. To be eligible for assistance from OfD, the country must be on the OECD's Development Assistance Committee (DAC) list, petroleum resources or potential resources must be present, Norwegian experience and expertise must be relevant and last, but not least, the government in the respective country must request assistance.

Some of the countries in OfD's portfolio are there as part of a wider political process. In Sudan, for example, the overall Norwegian goal is to support a long-lasting peace through the Comprehensive Peace Agreement, and OfD has a role to play as the petroleum resources located in the region of Abyei pose a particular challenge to the Peace Agreement. This is partly due to disagreement over whether Abyei is part of the North or the South and partly because of disputes over where to

draw the border in Abyei. In 2008, North and South agreed on a temporary arrangement to split the petroleum revenues from the region. Since 2006, OfD has encouraged interaction between North and South through joint education and training within the oil sector.

Capacity constraint is always a subject of consideration for any development institution. Hence, only a limited number of new countries are likely to qualify for cooperation on petroleum governance and requests for such support will be subject to close scrutiny. The focus will be on the identification of areas for cooperation where Norwegian expertise is highly relevant and can make a difference. Issues concerning governance, the commitment to transparency and anti-corruption, the overall situation on human rights and the rule of law will be assessed.

Who we are

OfD unites the efforts of a range of different public and private institutions representing separate skills and expertise. A ministerial steering committee has been established to formulate strategic directions, guidelines and priorities for OfD. The steering committee consists of representatives of the Ministry of Foreign Affairs (Chair), the Ministry of Petroleum and Energy, the Ministry of Finance and the Ministry of the Environment. The OfD secretariat is part of the Norwegian Agency for Development Cooperation (Norad), and is responsible for coordination and implementation of the initiative.

Support is provided government to government. The idea is to connect equivalent governmental bodies and agencies in Norway with those in the partner countries. Key implementing agencies on the Norwegian side include NPD, Petrad (International programme for petroleum management and administration), the Pollution Control Authority (SFT), the Directorate for Nature Management (DN) and the Petroleum Safety Authority (PSA).
A range of consultancies, research institutions and NGOs such as the Revenue Watch Institute are also involved.

Angola and OfD have entered the second phase of an institutional cooperation programme which will run until 2011.

Moreover, Norway gives priority to the Extractive Industries Transparency Initiative (EITI), and engagement with EITI will be seen as a clear advantage. OfD works closely with the World Bank, while the Norwegian oil and gas industry is also drawn upon in transferring expertise and knowledge.

Oil for Development may draw upon the expertise of Norwegian and international oil and service companies in areas such as education/vocational training, community development and the enhancement of local content, technology transfer and industrial/economic spin-offs from oil sector activities. In addition, the companies have valuable environmental experience that could be made available – also in the form of multi-stakeholder partnerships. Importantly, OfD's key objective is to strengthen capacity and competence in government institutions and provide advice on petroleum governance and revenue management. Cooperation with industry will be based on careful analysis of roles and responsibilities of different stakeholders, and efforts are made to ensure that OfD is contributing to a level playing field among competing oil industry players, and not the opposite.

Cooperation with IGU

An increasing number of countries, such as Bolivia, Ghana, Mozambique, Nigeria and Timor-Leste, are requesting assistance on gas management. Hence, in 2008, IGU and OfD agreed to develop a special educational course on gas that can be used in countries with gas resources. The course will be created and carried out in close relation with Petrad, which has already developed similar courses on resource management, environmental management, revenue management, local content, good governance and corruption prevention. It is, however, the first time such a module has been developed in cooperation with an international organisation like IGU.

Petter Nore is the Director of Oil for Development (www.norad.no/ofd).

OIL FOR DEVELOPMENT

- A Norwegian programme seeking to assist developing countries with petroleum recourses to avoid the "resource curse".
- The programme was initiated in 2005, and is currently led by Petter Nore.
- Core objective: OfD aims at assisting developing countries, upon their request, in their efforts to manage petroleum resources in a way that generates economic growth and promotes welfare of the population in an environmentally sustainable way.
- To be eligible for any form of assistance from OfD the following criteria must be met:
  - Cooperation must be demand driven;
  - The country must be OECD/DAC-eligible (or other financing must be supplied);
  - Significant petroleum resources or potential resources must be present;
  - Norwegian experience and expertise must be relevant;
  - Demand for capacity and competence building in public institutions must be identified.
- Core countries: Angola, Bolivia, Ghana, Madagascar, Mozambique, Nigeria, Sudan, Timor-Leste, Uganda and Vietnam.
- Countries with limited cooperation: Afghanistan, Bangladesh, Cambodia, Ecuador, Ivory Coast, Iraq, Kenya, Lebanon, Mauritania (assistance currently frozen), Nicaragua, Palestinian Territory, São Tomé e Principe, South Africa, Tanzania and Zambia.
- Budget in 2009: NOK 264 million ($38 million).
- Website: **www.norad.no/ofd**

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Gas Market Integration in the Southern Cone

By Ariel A. Casarin and Luciana A. Nicollier

Gas market integration is the focus of Strategic Guideline 3 of the current Triennium and work in this area is being coordinated by a special Task Force. Past issues of the IGU Magazine have included papers on the energy relationship between Russia and Germany, and cooperation between Qatar Petroleum and ExxonMobil. In this issue we have two more case studies and the first looks at South America's Southern Cone.

In several regions of the world, neighbouring countries have been feeling the pressure to take steps towards interconnecting their gas networks. However, not all countries follow the same steps towards, or achieve the same degree of, natural gas sector integration, as several factors condition the extent of interregional gas development. The evolution of proven reserves is just one factor affecting gas development. The presence of large economies of scale in transportation and distribution together with the relative inflexibility of investments and the lack of a world standard for gas pricing imply that the development of natural gas is mainly driven by demand – more precisely, by a demand that can justify financing the investments required all along the gas chain.[1] Therefore, overall economic and political conditions, regulatory frameworks and pricing policies are as important to integration as reserves. This case study examines the steps that the countries in the Southern Cone have taken towards the integration of their natural gas markets.[2]

Argentina is the major gas producer in the Southern Cone.

The integration of natural gas markets offers advantages to both producing and importing countries. For producing countries, the main advantage of integration is the possibility to attract investment that would otherwise not be justified by a reduced local market. As soon as investors take into account the attractiveness of potential neighbouring markets, integration can help producer countries in using their natural resources to finance their development. For importer countries, market integration provides a source of energy to support their economic growth. Additional advantages of integration are related to higher reliability of supply and more stable rules. Moreover, integration tends to increase the utilisation of common energy resources, makes gas/electricity integration possible and increases the scale of energy markets. Altogether, these factors imply that gas market integration might be helpful in increasing the competitiveness of the countries involved.[3]

However, some observers consider that gas market integration has some disadvantages, which are mainly related to each country's

1 In fact, 85% of gas consumed in the world is produced locally (OECD; 2003).

2 The Southern Cone is the region formed by Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay. Hereafter, Paraguay will be excluded in the analysis as this country is unlikely to take part in a regional gas market in the medium term because of its current lack of reserves and demand for natural gas.

3 World Bank (2007).

freedom to develop its public policies. Examples may include a smaller margin for discretional regulatory policies or the restriction of domestic options for energy supply. This would especially be the case when economic and political environments differ considerably between neighbouring countries. Integration may also weaken the negotiating power of countries that have a strong position when dealing on a bilateral basis.

Natural gas markets in the Southern Cone

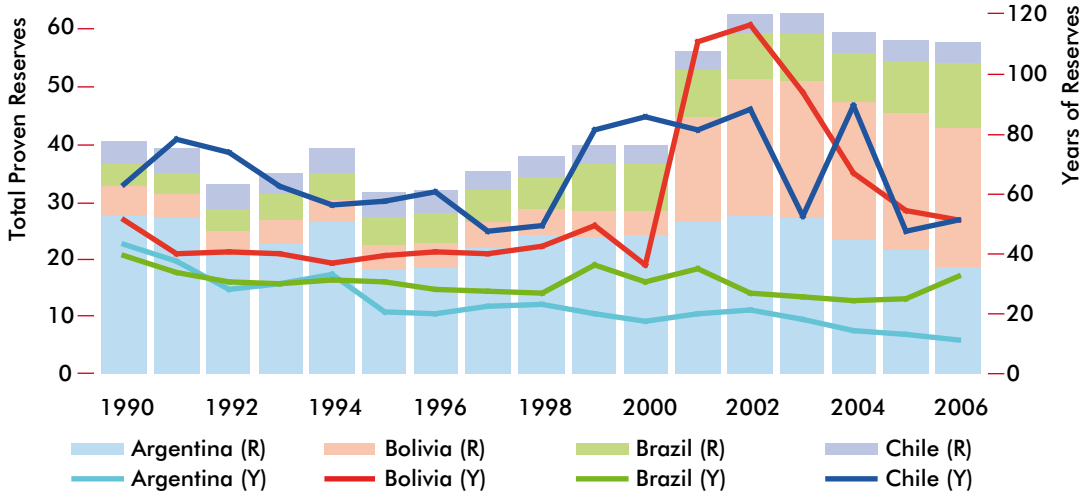
With the exception of Argentina, natural gas markets in the Southern Cone started to develop relatively recently based on important discoveries of this hydrocarbon in the late 1980s and early 1990s. Indeed, between 1990 and 2006, total reserves in the region increased more than 40%, mainly as a result of an expansion in exploration activities that responded to a more stable economic and political environment, privatisation and liberalisation of gas markets, as well as to a shift in demand more favourable to natural gas.[4,5] By 2006, proved natural gas reserves in the Southern Cone reached 57,841 billon cubic feet (bcf), or about 1% of the world's total. However, the dynamics of natural gas reserves differ considerably across countries. *Figure 1* shows that proven reserves increased sharply in Bolivia and Brazil while they decreased in Argentina and Chile.

4 The increase in gas consumption is not exclusive to Latin America. World natural gas consumption is projected to more than double over the next decades, rising from 23% to 28% of world total primary energy demand by 2030, and surpassing coal as the world's second energy source (Mares, D.; 2004).

5 Natural gas demand increased due to a combination of economic and environmental conditions. During most of the 1990s, natural gas was a less expensive source of energy than the oil products that it primarily competed against. Low gas prices (and the expectation that they would remain low), its clean-burning qualities and increasing environmental regulations contributed to large investment in facilities, particularly electric generation, that use natural gas (American Petroleum Institute, 2008).

LEFT
Figure 1.

PROVEN NATURAL GAS RESERVES IN THE SOUTHERN CONE, 1990-2006 (BCF)



Notes:

(1) Uruguay is not included because it lacks reserves.

(2) Years of reserves are defined as total proven reserves divided by total production.

(3) R= total proven reserves, Y= years of reserves.

Source: Energy Information Administration.

BELOW
Table 1.

Figure 1 also presents each country's reserves in years, at prevailing production levels. It shows that by 2006 the region had natural gas for 147 years, a stock considerable smaller than the 255 years of proven reserves that the region had in 2002 when reserves in Argentina and Bolivia where at their highest. The data also shows that Argentine reserves decreased steadily from 1990 while Bolivia's started their downward movement in 2003, due to a combination of higher production and less exploration activities. Brazil's reserves, on the other hand, started an upward trend in 2005, mainly as a result of the development of the Santos Basin.

PRODUCTION AND CONSUMPTION OF NATURAL GAS IN THE SOUTHERN CONE, 1990-2006 (BCF)

	Argentina				Bolivia				Brazil				Chile				Uruguay				Region
	P	*C*	*P-C*	*GDP*	*P*	*C*	*P-C*	*GDP*	*P*	*C*	*P-C*	*GDP*	*P*	*C*	*P-C*	*GDP*	*P*	*C*	*P-C*	*GDP*	*P = C*
1990	630	717	-87	1.00	107	30	77	1.00	97	97		1.00	66	66		1.00				1.00	900
1991	704	781	-77	1.13	104	26	78	1.07	119	119		1.03	52	52		1.10				1.07	979
1992	709	787	-78	1.26	110	32	78	1.09	130	130		1.03	55	54	1	1.24				1.17	1005
1993	760	833	-73	1.35	103	30	73	1.13	146	146		1.09	62	62		1.34				1.22	1071
1994	786	856	-70	1.44	105	35	70	1.17	152	152		1.16	69	69		1.42				1.33	1112
1995	883	953	-70	1.41	113	43	70	1.22	159	159		1.21	67	67		1.58				1.32	1223
1996	938	1010	-72	1.49	109	37	72	1.26	178	178		1.24	64	64		1.70				1.42	1290
1997	967	1008	-41	1.62	112	47	65	1.30	195	195		1.29	75	99	-24	1.82				1.50	1349
1998	1045	1077	-32	1.69	107	31	76	1.35	205	205		1.28	70	114	-44	1.88				1.57	1427
1999	1221	1143	78	1.63	87	32	55	1.34	218	231	-13	1.28	42	162	-120	1.87	1	-1		1.54	1568
2000	1321	1173	148	1.64	117	44	73	1.37	257	333	-76	1.35	40	184	-144	1.97	1	-1		1.54	1736
2001	1312	1103	209	1.59	165	29	136	1.40	234	396	-162	1.38	42	224	-182	2.06	1	-1		1.51	1753
2002	1275	1069	206	1.43	205	36	169	1.42	287	473	-186	1.42	39	227	-189	2.12	1	-1		1.36	1806
2003	1449	1221	228	1.57	255	79	176	1.46	311	499	-188	1.44	65	279	-214	2.23	2	-2		1.41	2081
2004	1585	1339	246	1.74	355	76	279	1.53	341	608	-267	1.54	38	293	-254	2.39	4	-4		1.61	2319
2005	1611	1428	183	1.94	436	75	362	1.60	345	657	-312	1.61	72	302	-230	2.57	3	-3		1.88	2465
2006	1628	1475	153	2.15	466	85	381	1.69	349	683	-334	1.70	67	263	-196	2.72	4	-4		2.07	2510
% Change 1990-2006	6.45	4.22		3.28	9.51	6.23	10.56	2.92	8.11	13.50		3.14	-1.17	13.60		5.84				3.27	6.78
% Change 1990-1995	6.5	5.14		7.39	0.68	7.80	-2.45	3.8	9.95	9.95		3.99	3.03	3.08		9.34				6.19	5.82
% Change 1996-2000	9.61	4.34		1.94	-1.10	-0.38	-1.38	2.01	8.83	15.28		1.63	-14.10	29.75		3.26				1.90	7.73
% Change 2001-2006	5.49	7.14		7.52	24.91	24.04	25.31	3.96	7.84	11.82		4.42	10.95	5.00		5.96	36.62			7.96	8.44

Notes:

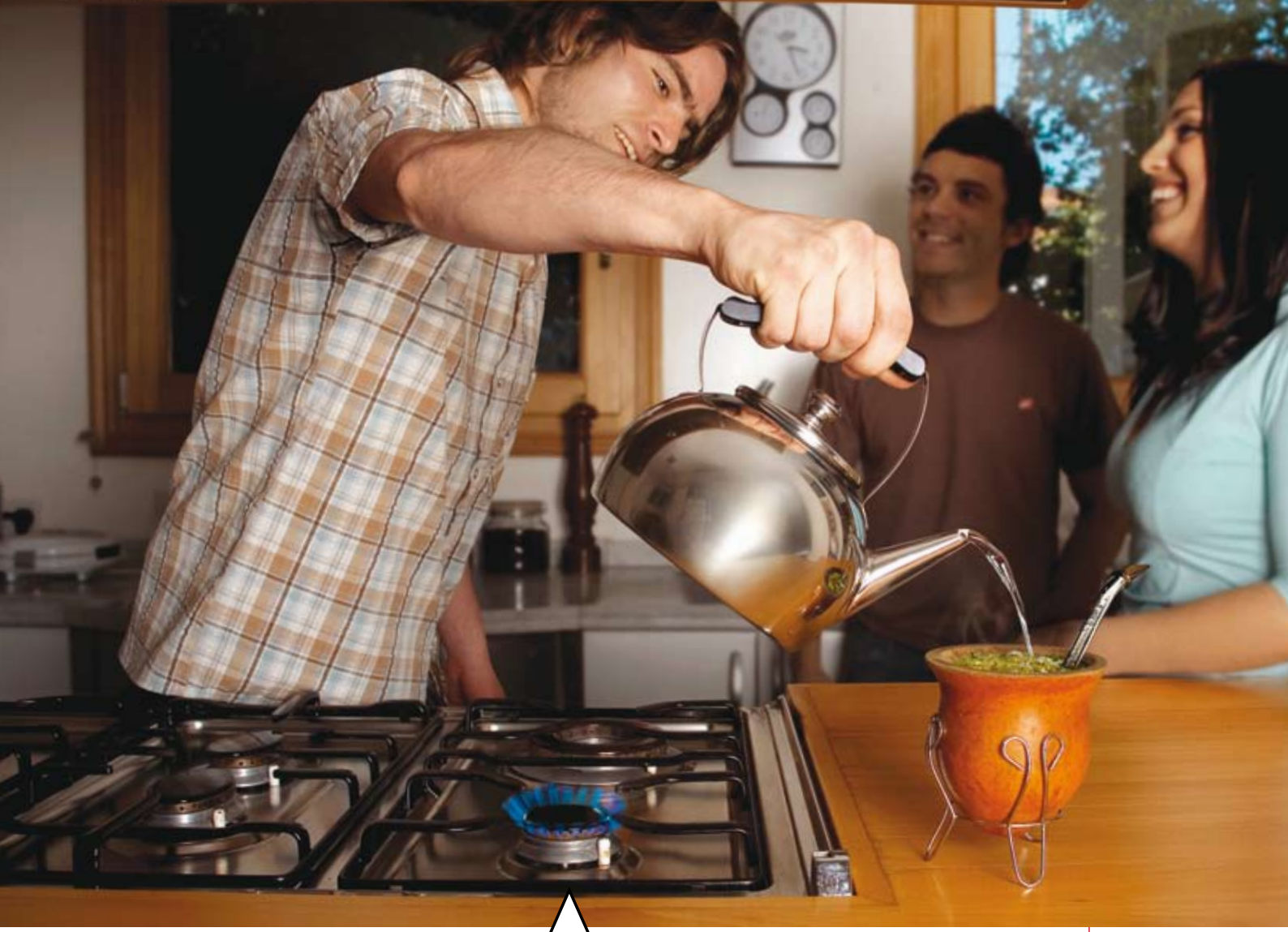
(1) P = Production, C = Consumption, GDP = Gross Domestic Product based on purchasing-power-parity, per capita. Index 1990 = 1.

(2) Total consumption for the whole region equals total production, because during this period there were no imports or exports to countries outside the Southern Cone.

(3) Natural gas production and consumption in billion cubic feet.

(4) Equivalent annual change expressed as percentage.

Source: Energy Information Administration and International Monetary Fund.



WE GET TO YOU.

We are the company that operates the longest pipeline system in our country. Our 8,000 kilometers of pipeline transport the gas that over ten million Argentinians use every day.

We are also there, behind that appetizing mate, driving the energy for life, driving towards the future.

CERTIFICACIÓN ISO 9001 - ISO 14001 - OSHAS 18001

TGS Transportadora de Gas del Sur S.A.

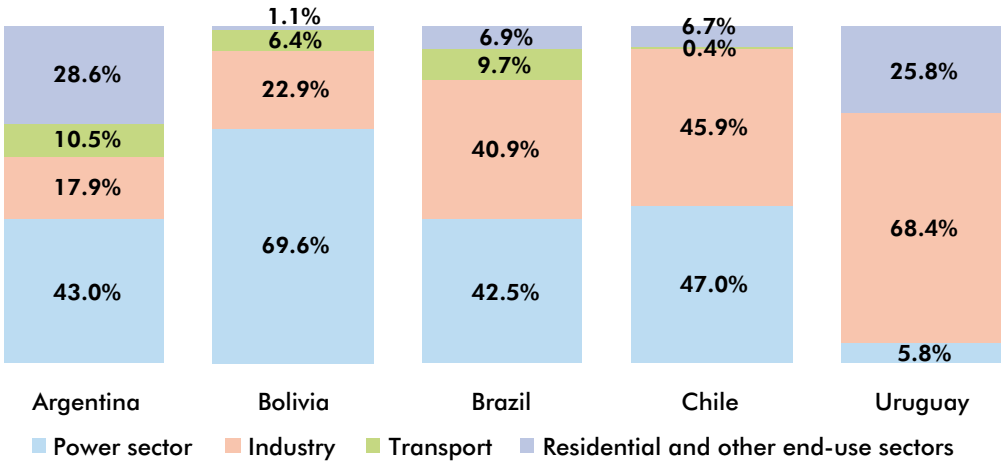
Widespread structural reforms and efforts towards macroeconomic stabilisation helped South American countries to recover sustained levels of economic growth. Hand-in-hand with rapid economic growth, there was also a rapid increase in regional energy demand, and natural gas was no exception. *Table 1* presents natural gas production and consumption series and compares them with the evolution of GDP. The series show that consumption and production are not equally distributed across countries. Natural gas production and demand is highly concentrated in Argentina, which in 2006 accounted for 65% of the region's gas production and almost 60% of total consumption. Bolivia's production was almost 20% of the region's total, while its consumption of natural gas was only 3.4%. In total, these two countries produce 85% of the natural gas in the region, and their gas exports to other countries represent more than 20% of the gas consumed in the Southern Cone. Put differently, the difference between production and consumption – the net trade balance – together with reserves data in *Figure 1* suggest that there exists a natural market for gas in which Bolivia and Argentina provide a surplus fuel source to Brazil, Chile and Uruguay.

The series in the table also show that between 1990 and 2006 natural gas demand in the region increased steadily, continuing its upward trend even in years of economic recession. Moreover, gas consumption increased much faster than GDP in all countries, though at a different pace: it increased about 30% per year more rapidly than GDP in Argentina, two times faster in Bolivia, Brazil and Chile and even more quickly in Uruguay.[6] The series also suggest that the increase in gas consumption is inversely correlated with its initial level; while Argentina was the largest gas consumer in 1990, its growth in demand was the smallest. The series also indicate that the increase in production was due to higher production levels

6 The increase of demand in Uruguay is due to the rapid expansion of gas grids in the residential sector.

RIGHT
Figure 2.

SHARE OF NATURAL GAS CONSUMPTION IN THE SOUTHERN CONE, 2005



Notes:

(1) Power sector refers to energy uses in electricity plants, but it also includes distribution losses which are almost negligible in all the countries except Bolivia (11.9% and 6% of total gas consumption, respectively) and in Chile (11.9% and 6% of total gas consumption, respectively).

(2) Other end-use sectors include the residential, commercial and public sectors, as well as agriculture and forestry and other non-energy uses.

Source: International Energy Agency.

in Argentina, Bolivia and Brazil. However, the increase in production differs both across countries and periods; while gas production increased the fastest in Argentina and Brazil during the second half of the 1990s, it did so in Bolivia from 2000, transforming this country into the largest gas exporter in the region.

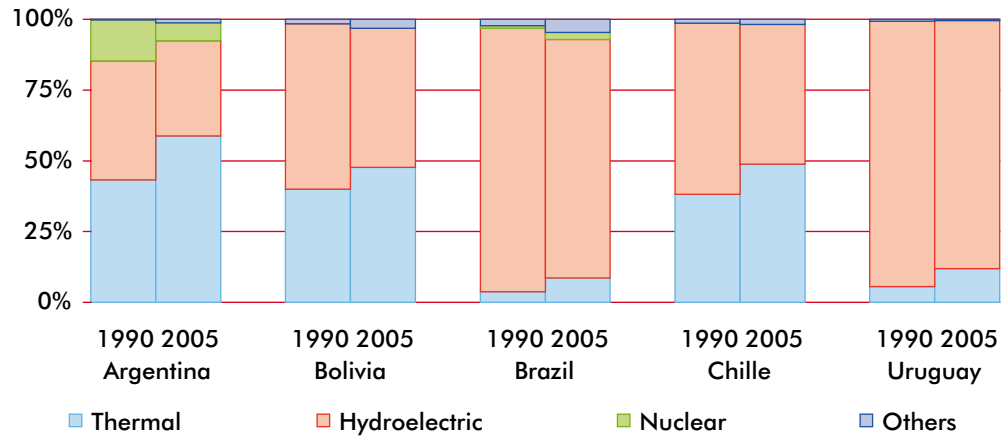
These trends in natural gas demand and supply respond to a combination of geographic, economic and regulatory conditions that affected the evolution and maturity of gas markets in each country. It is generally considered that maturity of gas markets is reached when gas penetration in the commercial and household sectors is high and can only be marginally improved.[7] *Figure 2* shows that Argentina has the most mature gas sector in the region, with 28.6% of gas being consumed mainly by the residential and commercial sectors. This high level of penetration is due to the existence of an extensive pipeline network connecting main production regions to all major urban centres. Nonetheless, more than 40% of natural gas consumption comes from the power sector. Uruguay also seems to have developed quickly into a mature market. The picture is different in Bolivia, Brazil and Chile, where only a small fraction of total gas is consumed by end-use sectors, a fact that can be explained not only by a lack of network infrastructure but also by climatic conditions that translate into little or no need for space heating – like in most parts of Brazil, for example. On the contrary, in these countries gas consumption in the power and industry sectors results from differences in hydropower resources and the price of gas relative to other fuels.

Figure 3 complements *Figure 2* by presenting the sources of electric power generation in the Southern Cone. It shows that between 1990 and 2005, the share of thermal generation (and thus

7 This is because commercial and household sectors entail the highest costs in terms of infrastructure and supply flexibility. Note that maturity does not mean saturation, as it there exists considerable scope for growth even in mature markets (OECD; 2003).

ELECTRICITY GENERATION IN THE SOUTHERN CONE BY GENERATION TECHNOLOGY, 1990 AND 2005

LEFT
Figure 3.



Notes:
(1) Percentages correspond to net electric power generation.
(2) Others include geothermal, solar, wind, and wood and waste electric power generation.
Source: International Energy Agency.

the use of natural gas in the power sector) increased in all countries. However, the implications of that increase in gas usage within each country's energy matrix differ across countries. In Argentina and Bolivia, more use of gas implies a less diversified energy matrix, while in the other countries thermal generation was encouraged as a way of reducing the dependence on hydroelectric power generation, and thus of increasing the diversification of the energy matrix.

● Integration of gas markets in the Southern Cone

Gas trade in the Southern Cone has increased considerably in the last decade, but the region is still far away from regional integration. Indeed, regional trade and integration can be characterised as steps taken on a continuum towards full regional integration (El-Agraa, 1989). Following Pineau et. al (2004), it is possible to categorise the three key dimensions of integration of network energy markets into infrastructure interconnection, commercial integration and progression towards regional regulations. *Table 2* summarises the integration continuum, in which each dimension is further sub-divided into four stages. The table shows that the degree of physical infrastructure integration moves from isolated national systems to operation of a fully integrated regional system. Similarly, regulatory integration is at its maximum when a regional regulatory agency is established, and commercial integration occurs when efficient regional secondary and future markets are in place.

The evidence seems to suggest that the level of natural gas integration in the Southern Cone differs across dimensions. In the first place, infrastructure integration can be examined by means of the extent of cross-border transmission capabilities and the share they represent of total demand. *Table 3* displays key data for the cross-border pipelines in the Southern Cone.
The table shows that the Yabog pipeline was the first cross-border gas project in South America; it links Bolivia to the northern regions of Argentina, which are not well supplied by the domestic gas transmission network. The table also shows that the longest and largest pipeline in the region is the Gasbol pipeline, which connects the production fields in Bolivia to the main consumption centres in Brazil. The capacity of this pipeline represents about 53% of total gas consumption in Brazil.

Over the last decade, however, another 11 cross-border pipelines connecting Argentine and Bolivian production fields with consumption

BELOW
Table 2.

INTEGRATION CONTINUUM FOR REGIONAL MARKETS

Degree of Integration	Infrastructure Integration	Regulatory Integration	Commercial Integration
No regional integration	Isolated national systems	Independent national regulation	National markets with local ownership
↓	Cross-border pipelines	Compatible regulation	Cross-border trade and ownership
↓	Coordinated efforts in transport investment	Coordination of regulatory agencies	Unique regional price reference
Full regional integration	Fully integrated regional system operation	Regional regulatory agency	Regional secondary/future markets

Source: Adapted from Pineau et al. (2004).

HIGH TECHNOLOGY TO SUPPORT DEVELOPMENT

PRA-1 – Autonomous Re-pumping Platform
Brazil

Second bridge spanning the Orinoco River
Venezuela

Capanda Hydroelectric Plant
Angola

Miami International Airport South Terminal
U.S.A.

Lisbon Metro
Portugal

Project for the Expansion of Overland Gas Transportation Capacity - Argentina

For over 60 years, Construtora Norberto Odebrecht has been carrying out infrastructure work that greatly contributes to the development of the countries where the company operates, in such diverse fields as: power generation, transportation, real estate undertakings, industrial plants, sanitation, oil & gas, among other.

The decentralized operating methods allow the company to meet even the most specific needs of its clients, working in full synergy with the different cultures – which makes Odebrecht a truly local company wherever it operates.

Odebrecht currently develops in Argentina two large gas pipeline projects which will ensure the gas supply for the whole country. These two projects comprise the North and South Pipelines – jointly totaling 65 loops and 15 compressor plants, increasing the daily gas transportation and supply capacity from the current 120 million cubic meters to over 145 million.

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www.odebrecht.com

RIGHT
Table 3.

CROSS-BORDER PIPELINES IN THE SOUTHERN CONE

Pipeline	Countries		Began Operations	Length	Capacity	Capacity Utilisation
	Exporter	*Importer*	*Year*	*Km*	*MMcf/day*	*%*
Yabog-Yacimientos	Bolivia	Argentina	1972	435	230	17
Gasbol	Bolivia	Brazil	1999	3219	1000	2
Paraná-Uruguayana	Argentina	Brazil	2000	451	100	20
Gasoducto del Litoral	Argentina	Uruguay	1998	19	4.9	2
Cruz del Sur	Argentina	Uruguay	2002	402	180	1
Tierra del Fuego	Argentina	Chile	1996	84	71	10
Gas Andes	Argentina	Chile	1997	467	310	2
Gas Atacama	Argentina	Chile	1999	933	300	2
NorAndino	Argentina	Chile	1999	781	250	3
Gasoducto del Pacifico	Argentina	Chile	1999	531	340	2
El Cóndor-Posesión	Argentina	Chile	1999	10	71	10
Patagónico	Argentina	Chile	1999	32	99	7

Sources: Energy Information Administration, "South American Gas. Daring to Tap the Bounty" (OECD, 2003) and website of Gasoducto Cruz del Sur.

regions in Argentina, Brazil, Chile and Uruguay were built. *Table 3* shows that seven pipelines were built between 1996 and 1999 connecting Argentina to Chile: three small pipelines (Tierra del Fuego, El Cóndor-Posesión and Patagónico) were built to meet the increased gas demand resulting from the expansion of a methanol plant in the extreme south of Chile, and the other four pipelines, which are bigger and longer, were built to supply Argentine gas to end-users and power plants.[8] The quick expansion of cross-border pipelines connecting Argentina and Chile is due to the fact that gas reserves in Chile – which are modest – are distant from consumption centres, so consumers can be supplied more economically from Argentina's basins. All in all, the total capacity of these pipelines doubled the current consumption levels in Chile.

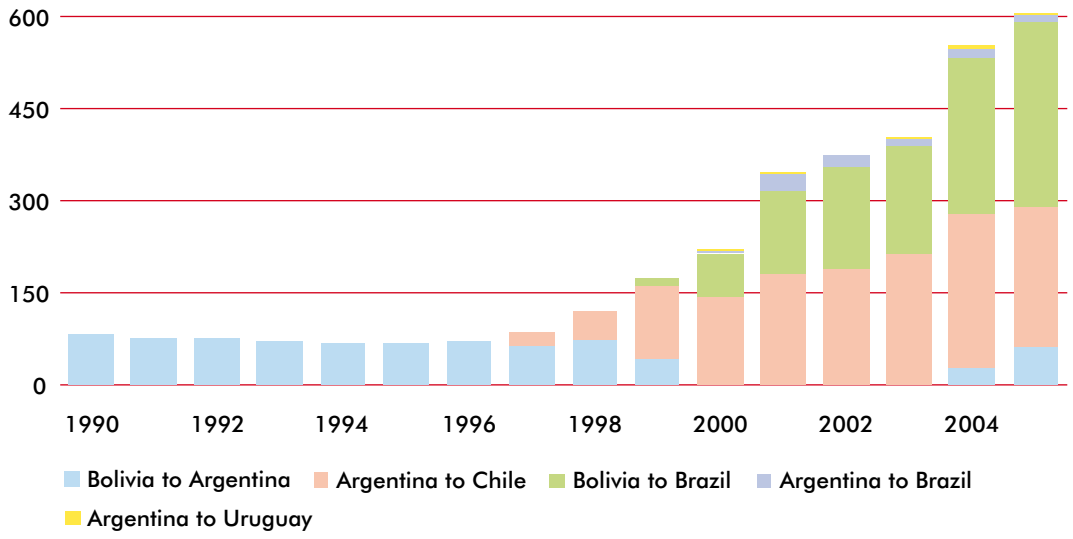
The capacity of the pipelines that permit natural gas exports from Argentina to Brazil is smaller than those heading to Chile. The Paraná-Uruguayaná pipeline provides natural gas to a power plant in the south of Brazil, though this pipe is part of a more ambitious project that would allow Argentine gas to compete with the gas that Brazil imports from Bolivia. The Cruz del Sur and Gasoducto del Litoral pipelines, on the other hand, supply both end-users and power plants in Uruguay.

From a commercial perspective, gas systems in the Southern Cone are partially integrated. By 2006, more than 600 bcf of natural gas was traded between Argentina, Bolivia, Brazil, Chile and Uruguay. However, cross-border gas trade

8 Gasoducto del Pacifico and Gas Andes supply natural gas to residential and consumer users, while Norandino and Gas Atacama transport gas for industrial users and power plants.

RIGHT
Figure 4.

CROSS-BORDER GAS TRADE IN THE SOUTHERN CONE, 1990-2005 (BCF)



Source: Energy Information Administration and Secretaría de Energía de la República Argentina (Argentine Energy Bureau).

does not have a long history in the region. *Figure 4* shows that by the mid-1990s, international gas trade in the region consisted of a small quantity of exports from Bolivia to Argentina only.[9] The figure also shows that cross-border gas trade grew quickly from 1997, when Argentina began exporting to Chile. Most of the increase in the inter-regional gas trade was accounted for by Bolivia's exports to Brazil and Argentina's exports to Chile.[10] Exports accounted for more than 80% of total natural gas production in Bolivia and of 15% of total production in Argentina.

Commercial integration of energy markets usually results in the evolution of a unique regional price reference. Theory predicts that in an integrated market, prices of homogeneous products from different suppliers should move in the same direction, and price differentials should only be present if there are differences in transportation costs or quality. However, as shown by Ashe et al. (2002), the explanation behind price discrepancies may be somewhat more complicated in natural gas markets. Natural gas is overwhelmingly sold on complex long-term contracts that have a number of features that may influence the contract price, and hence lead to price variations across contracts. The authors show that when natural gas from different suppliers competes closely in the same market, prices move proportionally over time but there may be systematic differences in the price levels.

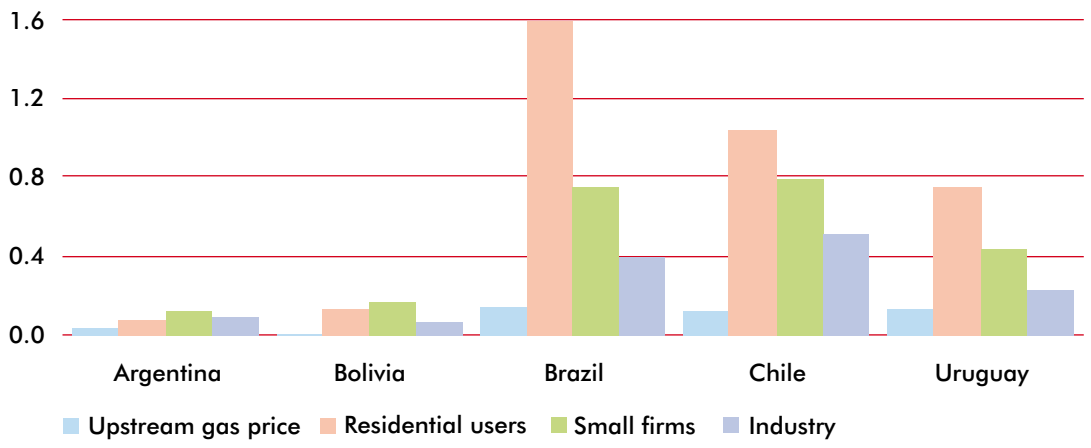
Figure 5 illustrates the magnitude of the price distortion by comparing the level of residential and industrial prices of gas in the region, and shows that natural gas in producing countries is cheaper than in importing countries. Natural gas in Brazil's domestic market is 176 times more expensive than in the Bolivian market and five times more

9 In fact, this was the case for more than 30 years, as gas exports from Bolivia to Argentina started in the 1960s, when the Argentine gas market was expanding rapidly.

10 Note also that Bolivian exports to Argentina never exceeded 100 bcf per year. Actually, they were zero between 2000 and 2003, when shortages in Argentina made it necessary to import Bolivian gas again.

LEFT
Figure 5.

PRICE OF NATURAL GAS IN THE SOUTHERN CONE BY USER TYPE, 2007



Notes:

(1) Prices expressed in US dollars per cubic metre.

(2) Residential tariffs include value added tax.

(3) Small firms and industry tariffs do not include taxes.

(4) Price of natural gas for Uruguay and Chile was determined as the average price of gas imports from the corresponding Argentine basins; for Brazil, it was determined as the price of imports of Bolivian natural gas. Argentine and Bolivian prices of natural gas were computed as the average of the residential and industrial prices allowed by the national gas regulatory agency.

Sources: Metrogas (2007), ENARGAS (Argentine Natural Gas Regulatory Agency), Secretaría de Energía de la República Argentina, Superintendencia de Hidrocarburos de Bolivia (Bolivian Hydrocarbons Bureau) and Bolivian newspaper El Deber.

expensive than in the Argentine market, and residential users in Brazil pay as much as 23 times the price paid by those in Argentina. Moreover, the figure shows that the relationship between the cost of gas for the various types of users is different in producing and importing countries: in Argentina and Bolivia, natural gas for residential users is cheaper than for firms, but in Brazil, Chile and Uruguay residential users pay the highest natural gas tariff.[11]

Indeed, probably the most restrictive dimension to integration consists of the regulatory asymmetries between markets, which to some extent might be related to the political and economic development differences among the countries in the region than to the specific characteristics of natural gas markets. In particular, the two largest producing countries in the region – Argentina and Bolivia – have both undergone intense macroeconomic and political crises that have had a strong impact on the energy industry. The severity of the impact led governments to restructure regulations – away from market forces – which ultimately brought about distortions in the prices of local energy baskets.

The artificially low prices of natural gas in Argentina resulting from the government's regulatory intervention led to both a rapid increase in demand and brought to a standstill exploration for new fields. As a result, consumers faced supply shortages when the economy recovered (unsatisfied demand in winter totalled about one-third of total demand) and natural gas exports were halted.[12] On the other hand, Bolivia's liberal energy regime

11 It is reasonable to expect that residential users pay a higher tariff than industrial ones, as the former are more expensive to serve than the latter.

12 Among other things, the government froze prices of natural gas to consumers at a devaluated peso rate, limiting incentives for exploration and production. (World Bank, 2007)

Promigas: Experience and Effectiveness in Energy Market Development

Promigas is a corporation deeply rooted in Colombia's energy and gas sector. With investments in natural gas transmission and distribution services, fuels, lubricants and compressed natural gas, it has proven its competitiveness by establishing itself a place in Latin American energy markets with successful penetration in Panama, Peru, Ecuador, Chile and Mexico.

For more than 40 years Promigas has brought progress to Colombia by promoting the massive use of natural gas. As both a transporter and distributor, it has been part of this process since the 1960s working with the different actors involved in the natural gas sector, and creating teamwork with the government and the private sector to consolidate its development by actively contributing with the building of an appropriate regulatory framework.

Promigas has established programs with considerable social impact. The regional gas pipeline project is one example. It has also undertaken national and international projects to obtain funds from developed countries in order to subsidize natural gas connections for low-income families.

As a result, more than 1.6 million Colombians in nearly 160 towns enjoy the benefits of natural gas. The majority of them are residential users and 85% belong to the lower income brackets. Penetrating these markets has been one of our most outstanding achievements.

The scheme to promote the massive use of natural gas was created and implemented by Promigas together with the Colombian government and has been internationally evaluated as worthy of replication.

Promigas has also been a pioneer in the development of the NGV market in Colombia since 1986. Today, more companies have become involved in this unregulated business, which has considerable macroeconomic and environmental impact and which has expanded far beyond expectations to become one of the fastest growing segments in Colombia.

Promigas also plays an important role in several Latin American countries as a direct investor and through the companies in which it has a controlling position.

As part of an effort to replicate the successful natural gas distribution model it has applied in Colombia, Promigas acquired 40% of Gas Natural de Lima y Callao S.A. (Cálidda), a natural gas distribution company in the city of Lima, Peru. The corporation also continues with its expansion in regional markets through its portfolio of investments. Organización Terpel's entry in Panama and Chile, and the consolidation of Gazel's operations in Peru, Mexico and Chile are two examples.

Our customers – gas distribution companies, thermoelectric power plants and petrochemical companies, among others – perceive us as a reliable and responsible company and as a reference in the natural gas sector: 97% satisfaction rating is a good measure of our good customer relations.

FOCUSED
DYNAMIC
UNITED

Three words that explain how we move more industries, homes and vehicles every day, thanks to natural gas. Through our companies integral corporate management we contribute to improve the quality of life of more people in Latin America.

Promigas

was overturned by means of a highly nationalistic hydrocarbons law approved in 2005, which resulted in the nationalisation of gas firms. As a result, both Argentina and Bolivia changed the private-sector orientation of their gas markets, which has had a strong impact on their neighbours, particularly Brazil and Chile.

The direct government intervention in gas markets has made both Argentina and Bolivia unreliable suppliers of natural gas in the region. Consequently, Brazil and Chile have changed their energy plans to focus on self-sufficiency and diversification of energy suppliers, based not only on higher exploration investments but also on the introduction of LNG and the conversion of thermoelectric plants from natural gas to diesel. Diversification of energy suppliers in Brazil and Chile changed a number of factors. The introduction of LNG, even though more expensive than neighbours' gas, provides importer countries with both flexibility and security of supply. This change also implies that Brazil and Chile are becoming more attractive to investors in natural gas sectors than Argentina and Bolivia, and thus that regional energy integration becomes less attractive and likely.

Conclusions

Natural gas markets in the Southern Cone present complementarities that can be better exploited under regional integration. The region has both large reserves and the correspondingly large potential domestic markets necessary to justify the major costs involved in developing those reserves and in building the network infrastructure. Complementarities derive from the fact that the combination of reserves and domestic market potential differs across countries; Argentina has both, Bolivia's reserves are the largest, but the country lacks domestic market potential, and Brazil and Chile do not have important exploited reserves, but they do have significant gas market potential.

The analysis indicates that the natural complementarities in the gas markets of Argentina, Bolivia, Brazil, Chile and Uruguay would be better exploited under an integrated system. Still, the evidence also seems to suggest that the region is far from a complete integration of its natural gas markets. Gas integration in the Southern Cone seems to differ across the integration continuum. The data indicates that a good percentage of the cross-border infrastructure required to make integration possible is already in place. Indeed, the rapid increase in natural gas trade in the Southern Cone was a consequence of the construction of new cross-border interconnections – that is to say, it was a response to higher infrastructure integration.

Nonetheless, one of the main limitations to the integration of natural gas markets in the region is the lack of an infrastructure network that allows gas from different suppliers to be considered as competitive to each other. As Argentine and Bolivian gas do not compete with each other in either of the importer countries, they cannot be aggregated into a single commodity with a single price. In Chile, for example, there are three independent gas network systems (north, central and south) and so there is no possibility for the natural gas feeding one of the systems to compete against gas feeding any of the other two systems. The situation is no different in Brazil, where in spite of the country's capability to import gas from Argentina and Bolivia, the domestic infrastructure is not developed enough.

Cross-border pipeline projects involve more than one sovereign state and, therefore, there is a need for the states to share the risks and rents. Some degree of coordination is required regarding energy taxation, technical standards and access regulation. Probably the main limitation to the integration of gas markets in the Southern Cone has been the high level of isolation of regulatory systems. Indeed, the economic and political evolution of the countries in the region has limited the integration process. Changes in the economic environment of exporter countries

and shortages of supply have changed market conditions; and importer countries have been faced with a trade off between security of supply and a higher cost of energy inputs. The analysis suggests that, in the future, Argentine natural gas will be largely destined for domestic use and that the country will have to continue importing natural gas, while Chile and Brazil will slowly move to different (more secure) suppliers of natural gas outside the region, reducing their dependency on Argentina and Bolivia.

Nevertheless, while there is no regional integration from a regulatory perspective, as the region operates on the basis of independent national regulation, from commercial and infra-structure perspectives, the integration process is a bit more advanced and is characterised by the existence of cross-border trade and ownership. It appears evident that further development of gas markets in the region is dependent on the harmonisation and improvement of regulatory standards. The challenge is to develop the institutional capabilities to achieve that goal.

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The Silent Success of Axial Excellence

Integrated valve systems for critical control and safety applications

Mokveld was founded in 1922 in Gouda in the Netherlands. In the mid-fifties the company started making valves, a development which accelerated when the Nederlandse Aardolie Maatschappij B.V. (joint venture between Shell and ExxonMobil) discovered the Groningen gas field in 1959. Mokveld started delivering valves for the production of the billions of cubic meters of gas and over the years was challenged to respond to constant changes with respect to safety, noise and emissions.

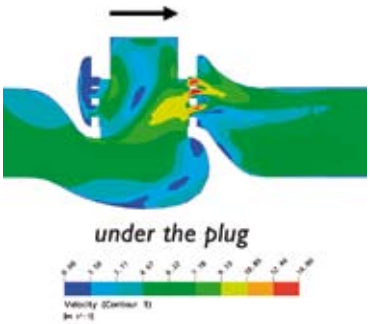
Now, 50 years later, the company has gained an excellent reputation as an international supplier of quality valve products. Not just a valve manufacturer, however, a niche player committed to contribute to safe, reliable and sustainable development of the world's energy resources. Two important products in this perspective are the High Integrity Pressure Protection System (HIPPS) and the axial control valve.

High Integrity Pressure Protection System (HIPPS)

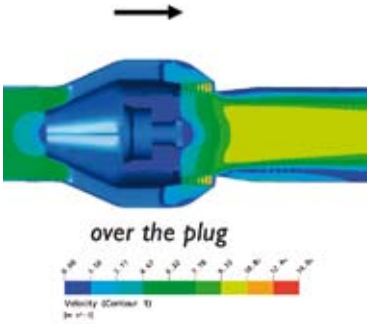
A HIPPS is a type of safety instrumented system designed to prevent over-pressurisation of a plant or pipeline. The HIPPS will shut-off the source of the high pressure before the design pressure of the system is exceeded, thus preventing loss of containment through rupture (explosion).

In conventional systems overpressure is dealt with through relief systems. Disadvantages are release of process fluids or their combustion products into the environment and a large footprint of the installation. Conventional relief systems are no longer acceptable and HIPPS provides a popular solution in cases where:

- high-pressures and/or flow rates are processed
- the environment is to be protected
- the economic viability of a development needs improvement
- the risk profile of the plant must be reduced



Conventional Globe Valve
Preferential flow deteriorates trim performance and leads to unbalanced trim forces.



Axial Control Valve
Axial flow and source treatment by Total Velocity Management is key to reliability

In the early 1970s Mokveld supplied the first HIPPS to (EON-) Ruhrgas for protection of the German Gas Grid. As market leader Mokveld has developed and promoted this technology for almost 40 years now. Final element in Mokveld HIPPS is the axial on-off valve and actuator with thoroughly documented reliability data

Axial Control Valve

Control valves are critical elements in a process loop. Malfunction or failure of a control valve can seriously affect safe plant operation and the environment. Selecting a valve with proven reliable performance will help to reduce costly maintenance and lost production time.

Conventional globe style control valves are still used extensively. However, the "S" shaped body results in preferential flow with localised high fluid velocities being the prime source of noise, erosion, vibration and malfunction resulting from unbalanced forces. Prevention is better than cure. Mokveld Total Velocity Management® concept is an intelligent axial valve design that carefully manages fluid velocity in all areas of the valve (trim and body). Source treatment by Total Velocity Management® is the key to reliability and safety.

In the axial flow design the streamlined annular flow path – and the evenly distributed flow through the cage – reduce high local velocities, turbulence and impacts of flow jets and particles. This is fundamental for reliable valve performance because vibration, erosion and unbalanced flow and forces are avoided. With a minimum of turbulence and change of the fluid velocity, there is no energy conversion in the valve body itself. Pressure drop is taken over the trim only, which has been specifically designed for this task. As a result unplanned process downtime is avoided and maintenance cost (total cost of ownership) are reduced.

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