Upstream Issues in Colombian Gas Supply*

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Abstract

Market Analysis Ltd has been commissioned by the Comisión de Regulación de Energía y Gas (the CREG) to conduct an economic study examining the market conditions in the natural gas supply industry in Colombia, and to make recommendations for reform where desirable. The analysis takes into account the current issues in natural gas supply, industry perspectives and the views of government agencies, including the CREG. We have also considered the preliminary analysis of Frontier Economics in their study for the Ministerio de Minas y Energía, and the proposals made by Pöyry Energy Consulting on behalf of the National Hydrocarbon Agency (ANH). In our consultations for our previous study, a number of industry representatives suggested that gas producers in Colombia may be withholding firm gas supply contracts from the market, in order to exploit their market power in upstream gas supply. As a consequence, gas shippers and consumers are unable, or less willing, to contract for firm capacity in the gas transportation network. A major purpose of the current study has been to investigate this issue, and to make suggestions for reform where necessary. We recommend that a"gas release" programme be introduced in Colombia, building upon regulations already in place.

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1 Introduction

Market Analysis Ltd has been commissioned by the Comisión de Regulación de Energía y Gas (the CREG) to conduct an economic study examining the market conditions in the natural gas supply industry in Colombia, and to make recommendations for reform where desirable. The analysis takes into account the current issues in natural gas supply, industry perspectives and the views of government agencies, including the CREG. We have also considered the preliminary analysis of Frontier Economics in their study for the Ministerio de Minas y Energía, and the proposals made by Pöyry Energy Consulting on behalf of the National Hydrocarbon Agency (ANH).

Our previous study for the CREG[1] concluded that no major overhaul of the existing regulatory framework for gas transport in Colombia was either necessary or desirable. Although Colombia has adopted a more "decentralized" or "market-based" approach to gas transport regulation than that currently found in many European and North American markets, it is nevertheless within the mainstream of international best practice, where market mechanisms and private (or "merchant") investments are increasingly relied upon to provide for new gas transport infrastructure. Any abrupt change in the regulatory framework at a time when very significant new investments in pipeline capacity are being made would risk creating even more uncertainty and delay, as well as upsetting existing long-term contractual commitments between market participants.

A number of detailed proposals for improvements in the existing regulatory regime were recommended, however, including:

- the split between commodity versus capacity charges in contracts for firm pipeline capacity;
- the calculation of the utilization factor;
- the need to provide better price signals for pipeline usage and location decisions, via the introduction of auctions for transport contracts (similar to those in the UK and other European countries); and
- some minor relaxations in the rules on vertical integration

We also observed in that report that the recent stresses in the Colombian gas transportation network, created by the El Nino event, were caused, in part, by a failure of market participants to signal the need for system expansion via a demand for long-term, firm capacity contracts. In particular, some consumers and distributors purchased interruptible transport contracts, and were duly interrupted. This meant that the transport system operator, the TGI, did not see a demand to expand capacity on its pipeline network until the demand for long-term contracts increased in 2009.

[1] David Harbord and Nils-Henrik von der Fehr, "Regulation and Incentives for Investment in the Colombian Gas Transport Network," 8 February 2010.

While this situation now appears to have largely resolved itself, a number of industry representatives suggested that gas producers in Colombia have been withholding firm gas supply contracts from the market, in order to exploit their market power in upstream gas supply. As a consequence, gas shippers and consumers are unable, or unwilling, to contract for firm capacity in the gas transportation network. A major purpose of the current study has been to investigate this issue, and to make suggestions for reform where necessary. Our recommendation is to introduce a country-wide "gas release" programme in Colombia, which builds upon regulatory measures already in place and the Cramton (2008) report.

Section 2 provides an overview of the Colombian gas market. Section 3 briefly describes the current regulatory framework and current problems. Section 4 describes gas release programmes and virtual capacity auctions in Europe. Section 5 proposes a "gas release programme" for Colombia and discusses a number of issues to be resolved prior to implementation. Section 6 discusses the "single buyer" proposal of Pöyry Energy Consulting. Section 7 concludes.

2 Overview of the Colombian Gas Market

This section provides a brief overview of the gas supply and transport market in Colombia.

2.1 Supply

All natural gas sold in Colombia is domestically produced with roughly 90% coming from two main fields: The Guajira fields on the Caribbean coast and the Cusiana fields in the interior. Several minor fields account for the remaining 10%.

Guajira has about one-half of Colombia's reserves (but this is declining over time), and currently provides 65% of production. The field is jointly operated by Ecopetrol, the state-owned oil company, and Chevron Texaco. In 2009, average production of the Guajira fields was approximately 703 GBTU per day. Gas from these fields is delivered to the entry point of Ballena, and is shipped to the inland part of the country, the Atlantic/Caribbean coast, and to Venezuela.

Cusiana has about 50% of total Colombian gas reserves and currently provides approximately 25% of production. The field is operated jointly by Ecopetrol, BP, and Total and produces approximately 250 GBTU per day.

Other minor fields produce around 80 GBTU per day: La Creciente, 40 GBTU; Payoa, 20 GBTU; other, 20 BGTU. There is also a new field in Gibraltar, expected to produce 30 GBTU per day by the end of 2010.[2]

Upstream gas production in Colombia is therefore highly concentrated. Table 1 shows average daily production by company in 2009, and Table 2 shows average daily gas production by field and company.[3] The Herfindahl-Hirschman Index (HHI) for gas supply is 4529, and the

[2] In addition, a mining company that operates close to the Ballena – Barrancabermeja pipeline has recently announced the existence of coal-bed methane reserves that could be developed in the near future. There is also offshore exploration activity in the Caribbean that appears to have significant potential for future gas production.

[3] Source: Company declarations made under Ministerial Decree 2687 (July 2008).

degree of concentration is set to increase when Ecopetrol acquires complete control over the Cusiana fields by 2019.

Table 1. Gas supply by company in 2009

Company	GBTUD	Share
Ecopetrol	670	63%
Chevron	236	22%
BP	62	6%
Tepma/Total	28	3%
Pacific Rubiales	42	4%
Others	25	2%
TOTAL	1,063	100%

Table 2. Gas supply by company and field in 2009

Field	Company	GBTUD	Share
La Guajira	Ecopetrol	467	66%
	Chevron	236	34%
Cusiana	Ecopetrol	161	64%
	BP	62	25%
	Total	28	11%
La Creciente	Pacific Rubiales	42	100%
Isolated fields	Ecopetrol	42	63%
	Others	25	37%

Gas supply contracts from the Guajira field are sold at a regulated price, currently $3.88 per MBTU (US), using a value estimated in the 1970s and indexed twice a year with the New York fuel oil price. Gas supplied from other fields is unregulated. Auctions for 32,821 MBTUD of long-term, firm gas contracts were held for production from the Cusiana field in December 2009, resulting in a price of $6.14 (US) per MBTU.

Association contracts: The Guajira fields are jointly operated by Ecopetrol and Chevron Texaco under an association contract which was extended in 2003 to continue for the life of the field. Ecopetrol's share of production under this contract is 65.6%, and Chevron's is 34.4%. The "Cusiana" fields are operated by Ecopetrol, BP, and Tepma/Total under five association contracts. Ecopetrol's share is currently 60%, BP's 24.8% and Tepma's 15.2%. From 2010 – 2019 these contracts expire and Ecopetrol will acquire control of the fields.

Under association contracts, production and investment decisions are made jointly by the companies. Hence the producers are not really independent competitors in supply, even if required to market gas independently. The concentration measures described above consequently significantly underestimate the degree of market power exercised by Ecopetrol in upstream gas supply.

2.2 Demand

Demand for gas in Colombia falls into four main categories: residential and commercial (19%); industrial (45%); electricity generation (24%); and vehicles (11%), located on the Atlantic/Caribbean coast (34%) and in the interior (52%). Exports to Venezuela currently account for 14% of demand. Approximately 49% of demand on the north coast comes from thermal electricity generators. The interior also has significant gas-fired generation capacity, but these units generate little or no electricity in a typical year, since hydro resources are less expensive when there are sufficient water resources.

The main consumption points are located in the major urban centres (e.g. Bogotá, Cali, Barranquilla, and Medellín among others), and where gas-fired power plants and refineries are located. These plants are located in the southern part of the country, near to Barranquilla, and in the central interior region near to Barrancabermeja.

The market is unconcentrated on the demand side. Table 3 below shows the annual average contract positions of consumers and shippers from 2008 to 2010 in MBTUDs.[4] The market HHI's for these years are 793, 931 and 914, respectively. The vast majority of Colombia's gas is sold via firm contracts with durations from three to five years, although some contracts are longer. Current gas contracts are mostly take-or-pay with a high minimum percentage of "take" over the month or year.

2.3 Transportation

Colombia has two large Transportation System Operators (TSOs): Promigas on the Atlantic/Caribbean coast, and TGI in the inland part of the country. The Promigas system's Ballena – Barranquilla – Cartagena – Jobo network is 590 kilometers long with a capacity of 540 GBTUD. The TGI has two interconnected pipelines systems: the Ballena – Barrancabermeja pipeline which runs for 580 kilometers and has a capacity of 190 GBTUD, and the Cusiana – Bogotá – Vasconia – Cali – Neiva pipeline (1700 kilometers long) with a capacity of 220 GBTUD. Other minor TSOs deliver gas from the TGI system to local markets such as Medellín and Bucaramanga (see Figure 1).

The TGI purchased its pipeline network from the state-owned EcoGas in an auction in 2006 for a price of $1.4 billion (US). The other pipeline networks have been developed under private ownership. The regulatory framework for the gas transportation network is described in detail in our previous report (Harbord and von der Fehr, 2010).

3 The Regulatory Framework

Numerous regulatory measures relating to gas production and supply have been introduced since the mid 1990s concerning:

[4] The contract total in Table 3 is less than the total production figure in Table 1, probably because exports are not included.

Table 3. Annual average contract positions of purchasers, 2008-2010						
	Average 2008	Market share	Average 2009	Market share	Average 2010	Market share
E2	125,000	14.04%	140,000	15.09%	134,583	14.89%
GECELCA	109,200	12.26%	100,700	10.86%	57,260	6.34%
GAS NATURAL	105,200	11.81%	95,192	10.26%	96,715	10.70%
EPM	84,300	9.47%	83,787	9.03%	84,553	9.36%
ISAGEN	59,000	6.63%	59,000	6.36%	59,000	6.53%
ECOPETROL REFINERIA	55,000	6.18%	55,377	5.97%	74,019	8.19%
TERMOFLORES	52,874	5.94%	34,126	3.68%	34,126	3.78%
PDVSA	50,000	5.61%	150,000	16.17%	150,000	16.60%
CEMENTOS ARGOS	36,000	4.04%	5,727	0.62%	0	0.00%
EPSA	36,000	4.04%	36,000	3.88%	36,000	3.98%
MERIELECTRICA	32,800	3.68%	32,800	3.54%	32,800	3.63%
ABONOS COLOMBIANOS	20,500	2.30%	20,500	2.21%	20,500	2.27%
CERROMATOSO	16,000	1.80%	16,000	1.73%	16,000	1.77%
TERMOEMCALI	16,000	1.80%	16,000	1.73%	16,000	1.77%
REFICAR	14,940	1.68%	14,940	1.61%	14,940	1.65%
TERMOFLORES III	10,526	1.18%	10,526	1.13%	10,526	1.16%
CHEC	9,624	1.08%	9,624	1.04%	9,624	1.06%
ECOPETROL	9,102	1.02%	9,102	0.98%	6,254	0.69%
DINAGAS	9,100	1.02%	6,563	0.71%	7,768	0.86%
ALCANOS DE COLOMBIA	8,100	0.91%	8,100	0.87%	13,696	1.52%
TERMOFLORES II	7,369	0.83%	7,369	0.79%	7,369	0.82%
MANSAROVAR	4,500	0.51%	3,620	0.39%	3,841	0.43%
DRUMMOND	3,988	0.45%	0	0.00%	0	0.00%
GASES DEL LLANO	3,221	0.36%	2,924	0.32%	3,170	0.35%
PETROBRAS	2,400	0.27%	2,250	0.24%	2,049	0.23%
CEMEX	2,100	0.24%	2,111	0.23%	1,793	0.20%
FAVIDRIO	1,270	0.14%	0	0.00%	0	0.00%
PRODUCTOS F SANCELA	1,177	0.13%	1,177	0.13%	0	0.00%
GAS N DEL CESAR	880	0.10%	550	0.06%	1,200	0.13%
SIDENAL	706	0.08%	706	0.08%	0	0.00%
GASES DEL CARIBE	678	0.08%	57	0.01%	0	0.00%
ESTACION BOMBEO	550	0.06%	550	0.06%	550	0.06%
MANS SILICEAS	471	0.05%	471	0.05%	0	0.00%
TOPTEX S.A.	471	0.05%	471	0.05%	0	0.00%
MADIGAS	406	0.05%	0	0.00%	0	0.00%
TERMOOCOA	403	0.05%	403	0.04%	403	0.04%
GASES DEL CUSIANA	400	0.04%	727	0.08%	362	0.04%
SURTIGAS	260	0.03%	22	0.00%	0	0.00%
ENERCA	25	0.00%	60	0.01%	0	0.00%
GASES DEL CARIBE	0	0.00%	0	0.00%	3,158	0.35%
SURTIGAS	0	0.00%	0	0.00%	2,107	0.23%
GASES DE OCCIDENTE	0	0.00%	0	0.00%	1,413	0.16%
GAS DEL RISARALDA	0	0.00%	0	0.00%	1,141	0.13%
GASES DEL QUINDIO	0	0.00%	0	0.00%	624	0.07%
OTHER	0	0.00%	0	0.00%	206	0.02%
TOTAL	**890,540.08**	**100%**	**927,530.67**	**100%**	**903,748.50**	**100%**

- regulation of prices for Guajira and de-regulation of Cusiana. Guajira regulation to be reviewed in September 2010 to decide whether to de-regulate prices (CREG Resolution 057, 1996; CREG Resolution 023, 2000; CREG Resolution 118, 2005, CREG Resolution 070, 2006)
- rules for, or prohibiting, the joint marketing of gas (CREG Resolution 057, 1996; CREG Resolution 093, 2006)
- the definition of "take-or-pay" and firm contracts, including penalties for breach (CREG Resolution 023, 2000; Ministerial Decree 880; CREG Resolution 70, 2005; CREG Resolution 188, 2009)
- auction procedures to allocate firm gas when demand exceeds supply (CREG 070, 2006; CREG 095, 2008)
- Ministerial Decrees 2687 (July 2008) and 4670 (10 December 2008) on declarations of firm and interruptible gas supplies

Ministerial Decree 2687 and CREG Resolution 095 of 2008 were designed to elicit larger quantities of firm gas supplies from producers, and are considered in more detail below. There are also restrictions on the degree of vertical integration between gas transporters, producers and distributors established in the 1990s (described in Harbord and von der Fehr, 2010).

3.1 Declarations and Auctions

Ministerial Decree 2687 (July 2008) obliged Colombia's gas producers to submit annual declarations to the Ministry of Mines and Energy specifying:

- the potential production available from each field for a ten-year period
- the amount of committed (i.e. contracted) production for each company in each field for a ten-year period
- the amount of the total potential gas production the company offers as interruptible gas supplies for a ten-year period
- the amount of the total potential gas production gas the company offers as firm gas supplies for a ten-year period[5]

CREG Resolution 95 of 2008 established the procedures for the sale of firm gas supplies declared under Ministerial Decree 2687. According to the resolution, firm gas declared available from unregulated fields must be sold via an ascending, simultaneous auction within 45 days of the declaration, whenever purchase requests from shippers and distributors exceed available

[5] This should in principle be calculated as the difference between potential production less committed production and the amount declared available as interruptible supplies.

supply. Otherwise, the gas can be sold via bilateral negotiations and contracts. Firm gas from the Guajira field must be sold at a regulated price according an allocation procedure specified in Article 8, Decree 2687. Any firm gas remaining after the allocation procedure can then be sold according to a procedure defined in Article 7 of Resolution 95 of the CREG. Gas supplies declared as "interruptible" are not subject to any regulations with respect to the means of sale.

Ministerial Decree 4670 (December 2008) modified Decree 2687 in two ways: (i) a regulatory "holiday" was created for the month of January 2009 allowing producers to sell firm gas contracts via bilateral negotiations with shippers; and (ii) the price of gas from Guajira sold in the secondary market was restricted to not exceed the regulated Guajira price.

Annex A shows the declarations made by producers from the three main gas fields La Guajira, Cusiana and La Creciente. Although there are numerous anomalies and inconsistencies in the numbers declared, a clear pattern emerges in the Guajira and Cusiana fields. This is an unwillingness to offer significant quantities of firm gas contracts to the market, especially after 2012/13. There is also a tendency, particularly on the part of Ecopetrol, to offer less than the total gas production available as either firm or interruptible gas contracts.

In the three declarations since September 2008:

Guarija

- Chevron offered firm gas from 2009-13 in first declaration
- No firm gas has been offered since February 2009
- From 2012 large quantities offered as interruptible contracts

Cusiana:

- No firm gas offered in first two declarations
- Large quantities of interruptible gas offered from 2012/2013
- Ecopetrol offered small quantities of firm gas in October 2009
- Auctioned 32,821 MBTUDs in five-year contracts from August 2010

La Creciente:

- Offered firm gas in first two declarations, but no auction was held due to lack of demand
- Currently offering mostly interruptible from 2012/13

In our consultations with the companies (Ecopetrol, Chevron, Pacific Rubiales, and BP), a number of reasons were offered for this, including:

- geological uncertainties (or contractual complexity) surrounding future gas supplies available in particular fields;

- uncertainty about future market conditions;
- regulatory uncertainty concerning future regulation of prices and contracts; and
- a preference for selling via bilateral negotiations and contracts as opposed to auctions (Chevron and Ecopetrol)

Gas purchasers, on the other hand (GasNatural, Isagen, Alcogen, and others), have complained about the increasing lack of availability of firm gas contracts from producers. Gas-fired power plants are required by regulation to obtain firm gas and transport contracts in order to participate in the reliability charge scheme in the electricity market. Until recently, distribution companies were subject to a similar requirement in order to serve the regulated market (approximately 19% of the total Colombian gas market). This requirement was relaxed by CREG Resolution 75 of 2008 because of the difficulty distributors faced in obtaining firm gas supply contracts.

Most of the gas purchasing companies have also expressed a clear preference for transparent auctions over bilateral contracting procedures, especially if sufficient quantities of firm gas are offered in the auctions, making them more likely to result in competitive prices. Indeed, subject to this qualification, there appears to considerable support for the deregulation of prices at Guajira in favour of competitive, country-wide auctions.

Although Ministerial Decree 2687 and CREG Resolution 95 were designed to ensure that larger quantities of firm gas were offered by producers to the market, their effect appears to have been the opposite of what was intended. For a combination of reasons, producers have offered less and less firm gas in their declarations, exploiting the opportunity offered in the regulations to declare all, or most, future supplies as interruptible. Reform of these regulations therefore seems to be desirable, and Section 5 describes our proposals for doing so. The following section first describes the experience of related schemes in Europe, in both gas and electricity markets.

4 Gas Release and Virtual Capacity Auctions in Europe

Both gas release programmes and virtual capacity auctions have been used to promote competition and liberalization in gas and electricity markets in Europe. We briefly describe this experience in this section.

4.1 Gas Release Programmes

Gas release programmes have been implemented in several European countries.[6] These programmes have been imposed on incumbent gas monopolies to open up gas wholesale markets to competition in the UK, Spain and Italy, and as undertakings in merger or antitrust proceedings in France, Denmark, Germany, Austria and Hungary. A number of these programmes are described briefly below. Auctions have typically been the means by which the released gas has been allocated, although bilateral contracting has also been used in some circumstances.

[6] See Chaton *et al.* (2008), Bartok *et al.* (2006) and EFET (2003) for more details.

Britain: In 1988, the UK's Monopolies and Merger Commission (MMC) decided that the monopsony position of British Gas in the upstream gas market constituted a barrier to entry, which allowed British Gas to maintain a monopoly position in the supply of gas to downstream customers. Initially, a voluntary commitment to comply with a "90/10 rule", under which British Gas could contract for no more than 90% of new fields, was obtained, but was less effective than hoped. largely because the remaining 10% was snapped up by gas-fired power generators.

Following a review by the Office of Fair Trading (OFT), in March 1992 British Gas gave an undertaking to release gas from its long-term contracts to speed access to gas supplies by independent traders.[7] The gas release programme was administered by the regulator Ofgas, and British Gas agreed to make available for release 500 million therms annually from 1992 - 1995. Gas traders bid for a share of each tranche of gas, priced at BG's weighted average cost of gas, plus a wholesale fee of 0.25 pence per therm. New entrants were active bidders, and in 1992/93, 32 companies successfully applied for gas, and an additional 70 companies in 1993/94. By the time of the 1994/95 release, a spot gas market had begun to develop, and commercial gas prices fell as the incumbent's market share dropped.

Spain: The Spanish government introduced a release gas programme for 25% of the gas that Spain receives from Algeria through the Maghreb pipeline from October 2001 to January 2004. Contracts were for 3 years and totaled 1.4 bcm per year, or 11% of total supplies to the Spanish market (and 15%-19% of the regulated market). Participation was conditional on submission of sales forecast and plans for securing diversified gas supplies once the release programme had ended. Bidders were limited to a maximum of 25% of the total volume offered. The average price paid was equal to Gas Natural's purchasing cost plus a fixed management fee. Fourteen gas traders submitted bids, of which six were allocated volumes in return for a total payment of $273 million: BP 25%, Iberdrola 25%, Union Fenosa 20%, Endesa 18%, Hidrocantabrico 10% and Shell 2%.

Denmark: The merger between DONG, Elsam, Energi E2, Nesa, Copenhagen Energy (electricity division) and Frederiksberg Forsyning (electricity division) - creating the new energy company DONG Energy - was approved by the European Commission in March 2006 subject to a six-year gas release programme beginning in 2006. This specified auctions of 400 million m3 each year, with DONG Energy receiving similar gas volumes at one or more of the gas trading hubs in Northern Europe.[8] The 400 million m3 is divided into ten lots to be supplied over two years with a daily contract quantity of approximately 20 million m3 per year, and with flexible delivery terms. The contracts specify 90% take-or-pay provisions. The total quantity to be released over the entire gas release programme from 2006 to 2011 is up to 2,400 million m3, corresponding to 10% of the Danish gas market.

[7] This program was coupled with a prohibition for BG to sign contracts with the North Sea producers for new sources of gas.

[8] Under the programme, DONG Energy will deliver natural gas in Denmark and will receive swaps of corresponding volumes in the UK, Belgium, Germany and the Netherlands.

Austria: As a condition for the approval of the merger between OMV and Energie Allianz which created EconGas, the Austrian competition authority created a gas release programme in 2002. In July 2003, Econ Gas auctioned 250 million cubic meters (MMcm) of natural gas. EconGas held its second online auction for the same volume of gas in July 2004 and its third for a volume of 270 MMcm in July 2005. Although EconGas has to release 20% of its long-term import contracts until 2008, the price of released gas is determined by the auctions, and EconGas has no obligation to sell if the auction price is below cost.

France: The Commission de Régulation de l'Energie (CRE) made the approval of the restructuring of Total and Gaz de France conditional on a three-year gas release programme beginning in January 2005. Under the programme, Gaz de France has to auction 1.42 bcm of gas each year. Although the released volume represents only 3.5% of domestic sales in the Southern market, the CRE maintains that the temporary supplies should allow new marketers to enter, and expects the Fos-2 Liquefied Natural Gas (LNG) terminal, and more pipeline interconnections to the Spanish transport network, should enable new entrants to secure their own longer-term supplies from 2008.

Germany: In 2002, the Federal Minister of Economics and Labour approved the acquisition by E.ON of the share capital in Ruhrgas, subject to Ruhrgas fulfilling a number of obligations. These obligations included a Gas Release Programme under which E.ON Ruhrgas is required to conduct six annual auctions and to release a total volume of 200 billion kWh of gas. E.ON Ruhrgas offered in each of the six annual auctions a tranche of 33.33 billion kWh of high calorific gas, which were made available in three annual quantities of 11.11 billion kWh. The deliveries under contracts won in the annual auction commenced on 1st October of each year.

Hungary: On 21 December 2005, the European Commission approved the acquisition of MOL WMT and MOL Storage, two subsidiaries of MOL, the incumbent oil and gas company in Hungary, by E.ON Ruhrgas ('E.ON'), a large integrated German energy supplier, subject to certain conditions and obligations.[9] The package of remedies included a gas release programme, whereby E.ON will sell 1 billion cubic meters ('bcm') in 8 yearly auctions. Moreover, E.ON will divest half of its 10-year gas supply contract with MOL Exploration and Production (E&P), covering Hungarian domestic production, through a contract release. These two measures will release 16 bcm until 2015, up to 2 bcm per year, equivalent to 14% of Hungarian consumption.[10]

[9] Prior to the merger, MOL already had almost exclusive control over the access to gas resources and infrastructure in Hungary. MOL owned the gas transmission network, all Hungarian gas storage facilities, and held a quasi-monopoly position in the gas wholesale markets. E.ON, unlike MOL, had strong market positions in the retail supply of gas and electricity in Hungary, via control of two out of six gas regional distribution companies (RDCs) and 3 out of six electricity RDCs.

[10] The total quantities of gas released over the gas years 2007/2008 to 2013/2014 represent approximately 60% of the size of the market for the supply of gas to power plants and 55% of the size of the market for the supply of gas to large industrial customers.

This is the most significant gas 'release' ever implemented in Europe, both in terms of volumes and duration.

4.1.1 EC Competition Policy Objectives

The European Commission (see Bartok *et al.*, 2006) has noted a number of critical features of gas release programmes.

Volumes: The quantities of gas to be released depend on the objectives of the gas release programme and of the regulatory framework. In a merger case, the volumes should be sufficient to remove the competition concerns. Only if the volumes released are sufficient to allow eligible customers in all affected markets to benefit from the programme (as direct purchasers or indirectly as customers of traders buying gas through the gas release programme) can a gas release programme offset the incumbent's ability and incentives to engage in anticompetitive behavior. A gas release programme should, in addition,specify that quantities offered for sale but unsold in a given year should be added to the quantities to be released the following years.

Duration of the programme: A gas release programme generally aims at increasing the liquidity on gas wholesale markets and facilitating new entry. In a merger case, a gas release programme may seek to reduce or eliminate the merging parties' ability and incentives to engage in behavior that would significantly impede effective competition. To achieve these objectives, the gas release programme should remain in place for a sufficiently long period, to ensure that the market structure and the competitive conditions have changed significantly, and that the level of competition achieved via the programme is sustainable.

Price and costs: The price at which gas is available through the gas release programme should enable wholesalers to compete with the dominant supplier of gas on wholesale and retail markets. An auction mechanism is a way of efficiently allocating the gas quantities to be released, in which the price results from competitive bids given prevailing market conditions. The Weighted Average Cost of Gas (WACOG) is recognized in the EFET paper as a benchmark.

Gas supply duration and lot size: The duration of the gas supply contract and the size of the lots in a gas release programme should be designed so as to meet the needs of the various categories of bidders in the relevant markets.

Flexibility: The daily, monthly, quarterly and yearly flexibility provisions for the gas supplied through the gas release programme are essential. Wholesalers and industrial customers should have the ability to structure the gas quantities they purchase according to their own or their customers' consumption profiles. Depending on the conditions of access to storage, the requirements for the flexibility of the gas supplied through a gas release programme differ. The annual

flexibility (swing and take-or-pay levels) should reflect the incumbent's average annual flexibility. Experiences in European countries, particularly Germany, show that the attractiveness of a gas release programme for small wholesalers and industrial customers depends strongly on the flexibility provisions of the gas supply.

Security of supply: The gas supply conditions should include standard provisions on security of supply issues (maintenance, force majeure, off-spec, interruptibility, etc.) following the common practices in the relevant markets. The rights and obligations of the purchasers and the seller should be balanced.

Auction design and guarantees: The 'ascending clock auction' has been used in several countries as a procedure to allocate gas release quantities. The organization of the auction should ensure that the seller does not obtain information on its competitors. The amount of the deposits and guarantees should not be disproportionate, and should not constitute a disincentive for potential bidders. Payment terms should reflect standard market practices, and should not be less favorable than those of the seller's upstream supply contracts.

Access to transmission: Access to sufficient gas transmission capacities is necessary to ensure that wholesalers and end users purchasing gas through the gas release programme can transport gas to the place where the programme is intended to solve competition concerns. Thus, access to transmission capacity is essential to a gas release programme. If transmission capacity is contracted for by the companies selling gas in the gas release programme, it should be released to the transmission system operator in proportion to the gas quantities released.

4.2 Virtual Capacity Auctions

Virtual capacity auctions have been introduced in a number of recent European merger cases.[11] The most common motivation has been to promote competition in electricity markets with one or more dominant firms. Virtual power plant auctions are sales of electricity capacity which, rather than "physical" divestitures, are "virtual" divestitures by one or more dominant firms in a market. Instead of selling the physical power plant, the firm retains management and control of the plant, but offers contracts that are intended to replicate the output of the plant. Typically, these contracts are sold as divisible goods of varying durations, offered in periodic open and transparent auctions.

France: In relation to Electicite de France's (EDF) purchase of 34,5% of the shares in the German utility EnBW, EDF agreed to make 6,000 MW of virtual capacity available in France by November 2003 in order to increase competition in the market. EDF was at the time selling to around 90% of customers in the French market. The virtual capacity is auctioned to companies which then sell the electricity in the French market. The VPP contracts offered in the EDF

[11] See Schultz (2009) and Ausubel and Cramton (2009) for further details.

auctions are divided into two groups: base-load products and peak-load products. Each VPP product is an option contract for energy whose strike price approximates the variable cost of the respective energy. For example, in the December 2009 auction, the strike prices of the base-load and peak-load VPP products were 10 €/MWh and 53 €/MWh, respectively. The contracts for virtual capacity have durations of 3, 6, 12, 24 and 36 months. The first auction for 1,200 MW took place in September 2001, and there have been 34 quarterly auctions as of December 2009, organized as ascending clock auctions. The initial agreement with the European Commission specified that EDF should provide virtual capacity for a period of five years, but in 2005 EdF agreed to continue to offer VPP's on a voluntary basis until new arrangements were agreed.

Ireland: Due to the Electricity Supply Board's (ESB) dominance in the Irish power market, the Irish government initiated the Virtual Independent Power Producer Auction (VIPP), a form of virtual capacity auction similar to that in France. The auctions - where independent suppliers can bid for 600 MW out of a total of 4,500 MW - are intended to reduce ESB's market power until more independent suppliers enter the market.

Belgium: In 2003, the Belgian Competition Council approved that a subsidiary of Electrabel became the default supplier for the customers of several inter-municipal distribution companies. As Electrabel has a very large market share in Belgium it was agreed that Electrabel should offer, via auctions, up to a maximum of 1,200 MW of virtual power plant (VPP) capacity in Belgium. The terms are to a large extent similar to the French, in particular capacity shall be offered for a period of five years.

Holland: The Dutch electricity producer Nuon agreed with competition authorities that it would auction 900 MW virtual capacity in order to be allowed to buy Reliant and its 3500 MW capacity. Again there is a five year limit on the requirement. The Dutch market size is around 20.000 MW.

Denmark: In March 2004 the large Danish producer Elsam agreed to auction 600 MW virtual capacity in order to be allowed to make an indirect purchase of 36% of the shares in the other big Danish producer E2, see Konkurrences-tyrelsen (2004). The total Danish market size is about 7000 MW. As in the other countries auctions are to be held regularly, and for varying durations all below three years. The Danish rules specify that a single buyer at most must acquire 300 MW. The agreement with the competition authorities stipulates that the virtual producer can buy electricity at the lowest marginal cost obtainable in the different plants owned by Elsam. Contrary to the previously mentioned cases, the Danish competition authorities required that the virtual capacity should be provided indefinitely.

Virtual capacity auctions have also been introduced in Spain and Portugal in 2007, and EON Energy in Germany decided to hold virtual capacity auctions from September 2007 although not required to do so by the competition authorities.

5 A Gas Release Programme for Colombia

Colombia faces issues similar to those which led to the introduction of gas release programmes, and virtual capacity auctions, in a number of European countries. That is, a highly concentrated upstream market with a single dominant producer (Ecopetrol). This has led to an apparent under-supply of long-term, firm gas contracts with consequent repercussions on the transport market. Although intended in part to address this issue, Ministerial Decree 2687 (July 2008) and CREG Resolution 095 (2008) failed to specify minimum quantities of firm gas to be offered for sale in auctions by the companies. They also allow for auctions to be held separately by each company for each field, rather than impose the simultaneous auctions suggested in Cramton (2008).

In addition, currently more than 60% of Colombia's gas supplies (from Guajira) are sold at a regulated price, while gas prices in other fields are unregulated. This clearly creates some distortion in the market since, independently of their location, buyers prefer to obtain the relatively low-priced gas from Guajira. It also implies that the Guajira suppliers will, other things being equal, prefer to offer interruptible contracts over firm contracts, since the prices for each are capped at the same level.

Our proposals address these issues by describing a "gas release" programme for Colombia. In particular, we propose to deregulate the gas price in Guajira so long as sufficiently competitive auctions can be introduced which cover gas sold from all fields simultaneously. In this way, the resulting auction prices should better reflect the balance of demand and supply for natural gas in the entire Colombian market, creating more meaningful price signals for short-term consumption and production, and for longer-term expansion of supply.

Cramton (2008) proposed an simultaneous ascending clock auction design for long-term firm gas contracts in Colombia, with the following features:

1. A mandatory auction for producers in which suppliers must sell all of their firm gas contracts in the auction (whereas a voluntary auction would allow producers to also sell long-term gas contracts bilaterally).[12]

2. A single auction including all unregulated fields and producers, to allow buyers to see all the options for long-term gas contracts, and to arbitrage across the substitute products, enhancing price formation and reducing transaction costs.

3. Standardized contracts or products specifying::

   - the delivery points, for example Cusiana
   - minimum percentages of take or pay on a monthly or yearly basis, and the cap on the rate of take
   - start dates and durations

[12] Cramton's proposal allowed producers to participate in the day-ahead spot market, but not in the secondary market for longer-term contracts.

- whether and how the contract prices are indexed
- lot sizes
- the contractual guarantees and penalties

4. Seller commitment to supply schedules before the auction starts, to prevent them from adjusting their offers in response to revealed demand during the auction. Supply schedules specify the quantity offered of each product, and reserve prices. Each seller decides before the auction how to split its quantity between contract durations, with no requirement that quantity be offered for all products, or in any particular proportion. There is no requirement that different producers have the same reserve price, but a cap on the reserve prices may be introduced to prevent market power abuse.

Ideally, both firm gas and transport would be purchased at the same time, to resolve buyers' coordination problems. This would lead to a more complex auction, however, one that Cramton viewed as too ambitious to develop in the near term.

Cramton (2008) did not envisage the Guajira producers participating in the auction, although there appears to be no barrier to extending the auction in this way, once the Guajira price is deregulated. The essential element missing in this auction design, as in the Ministerial decrees, is a means of forcing producers to supply competitive quantities of gas to the market. Mandatory participation in a simultaneous auction would still permit producers to declare most, or even all, of their available production capacity as "interruptible" under current regulations, and hence avoid the requirement to participate in the auction. In addition, it seems evident that a cap on reserve prices will need to be set by the regulatory authorities. Otherwise, producers will remain able to withhold supply from the market, by simply specifying very high reserve prices.

Our recommendation is that Cramton's mandatory auction scheme be adopted, but modified in the following ways:

Mandatory auction for all major fields The price of Guajira gas should be liberalized, and all producers in the existing major fields, including Guajira, Cusiana and La Creciente, be required to sell all of their **firm and interruptible** gas contracts in mandatory annual or semi-annual auctions. Smaller new fields, and suppliers developing new sources of gas in Colombia, should be able to participate in the auctions on a voluntary basis.[13]

Mandated quantities In each annual or semiannual auction, the quantity of gas offered by each producer for each field should be equal to the potential production declared for the field or fields in question for each year ("Potencial de Producción"), multiplied by the producer's share of that production in that year, less the producer's committed sales in that year ("Demanda Nacional" and "Exportaciones").

[13] In Section 5.2 below we recommend that Ecopetrol be excluded from developing and owning new sources of gas in Colombia.

Standard contracts Gas should be sold in standardized firm and interruptible contracts with the same start date,[14] for periods of one to five (or one to ten) years.

No bilateral contracts Firm or interruptible gas contracts which remain unsold in a given auction cannot subsequently be offered to consumers in bilateral negotiations, or in the secondary market. Rather, any unsold gas should be offered for sale in subsequent auctions.

Reserve prices Sellers may set reserve prices for both firm and interruptible gas contracts, so long as the prices in any year do not exceed the reserve price set by the regulator.

Our proposal adapts Ministerial Decree 2687, CREG Resolution 095 of 2008, and the Cramton (2008) auction design to address market power issues and the withholding of supply. The aim is to:

- close the loopholes in existing regulations to ensure that "competitive" quantities of gas will be offered to the auctions;
- make the upstream market more open and transparent, so all long-term contracts are sold on the same terms to all purchasers (including sales for export);[15]
- provide a mechanism for establishing competitive, country-wide prices for both firm and interruptible gas contracts; and
- allow buyers to arbitrage over contract duration, location, and firm versus interruptible contracts in a single auction.

These modifications of the Cramton (2008) proposal should ensure that much larger quantities are offered at reasonable prices in an open and transparent market, with reasonable prospects for setting competitive prices for natural gas in Colombia. They also allow buyers to arbitrage across a larger range of substitute products, including contract durations and firm versus interruptible contracts. So long as the market power of producers can be controlled by forcing the "release" of gas, deregulating the price at Guajira will also reduce the current distortions in the market.

As such, they may be sufficient to resolve the recent problems with gas supplies described in Section 3 above. An important caveat, however, is that we are assuming that producers' declarations concerning potential production ("Potencial de Producción") and committed demand are not subject to significant potential for manipulation. Otherwise, producers will be capable of frustrating the intent of the new regulations, by reducing the amount of potential production they announce in their annual or semi-annual declarations.

There are a number of reasons for believing that this may not be a crucial issue. First, producers' declarations can be monitored by the relevant authorities (e.g. the CREG, the Ministry

[14] See Cramton (2008, Section 5.2) on this.

[15] Cramton (2008, Section 5.8) described a method for giving priority to internal demand in the auctions. It is not clear that this would be desirable.

and the ANH) who hold some independent information on the relevant quantities. Secondly, since under our proposals producers will only be able to sell gas in the auctions, their incentives to manipulate the declarations will be reduced, if not removed altogether. Nevertheless, producers with market power will still have an incentive to reduce their quantities in order to increase auction prices, so verifiability of company declarations remains highly desirable in our view.[16]

Given the requirement in our proposals to offer all gas for sale in competitive auctions, it is also unclear whether or not producers will have an incentive to offer large quantities of interruptible contracts, and few or no firm contracts, as they do currently. In particular, producers' incentives to declare only interruptible gas available have been created, in large measure, by Ministerial Decree 2687 and Guajira price regulation. Hence, it may not be necessary to impose any additional obligations on producers to supply firm contracts. We are undecided on this issue, but suggest some rules for doing so should this be deemed desirable. The general idea is that of the available production capacity declared by producers, a minimum percentage must be offered in the form of firm contracts of one to five (or ten) year durations, with higher proportions required in the earlier years for shorter contract durations. For example:

Proportion of firm contract offers For an auction in Year 1 for contracts of one to five year durations, each producer in each field shall offer at least: 75% of Year 1 available production in firm contracts; 65% of Year 2 available production in firm contracts; 50% of Year 3 available production in firm contracts;... etc. up to Year 5.

The precise percentages to be applied need to be determined, possibly in consultation with the industry. The basic idea is that since producers' uncertainty increases over time, it is less risky to impose higher proportions of firm offers in early years, or for shorter time periods. While this may still lead to relatively little firm gas being offered in longer-term contracts, so long as a high proportion of firm gas is available for the first three to four years in any auction, this may be sufficient to resolve the problems of the buyers, especially since new auctions will be held every six to twelve months.

5.1 Issues

A number of further issues remain to be worked out in implementing the proposed gas release programme.

Setting reserve prices: Without regulated reserve prices, sellers could still withhold quantity by choosing high reserve prices. There are no obviously correct reserve prices available, but producers have used Guajira prices in past auctions (e.g. Pacific Rubiales, Ecopetrol), hence the biannually updated Guajira price formula may be a suitable candidate, especially for gas

[16] I have been informed that for technical geological and engineering reasons, it may be difficult or impossible for gas producers to manipulate their declarations in this way. If this is true, then the manipulability issue described here becomes much less worrisome.

sold from the Guarija fields. In Cusiana, the opportunity cost of gas is determined by price of oil, so Cusiana reserve prices should possibly be set on that basis to reflect the true opportunity cost.

Number of products and contract types: In order to keep the proposed auctions as simple, transparent and liquid as possible, standardized contracts are essential Cramton (2008) recommended that the producers work with gas demanders and the CREG to establish a standard contract for long-term firm gas supplies. There have been some developments since then, in particular Ministerial Decree 880 which defined firm contracts, and proposed CREG Resolution 188 of 2009. However, further work remains to be done in the design of standardized contracts for both firm and interruptible contracts.

Alternative auction designs: Cramton's (2008) auction design is a traditional, clock auction format which is already familiar in Colombia, and has good properties. As such, its adoption may be relatively uncontroversial. Certain details of the auction design, such as the proposed activity rules and bidders' ability to switch demand between products, may deserve reconsideration however.

An alternative might be to use a recently-proposed, sealed-bid mechanism to auction substitute products. This auction format is described in Klemperer (2010) for the case of two products, and has some desirable properties. Namely that it is extremely fast to implement, less vulnerable to collusion, and is easy to describe to bidders. Its drawback compared to an open, dynamic auction is that it does not allow for "price discovery".

Another possibility would be to adapt the Cramton auction design so as to allow the proportion of firm versus interruptible contracts to be determined by the auction itself, depending on demand and the price differential between the two types of contract. Annex B sketches one possible way of doing so.

More consideration will need to be given to the detailed design of the mandatory gas auctions.

Simultaneous gas and transport auctions: Ideally, gas and transport contracts would be purchased at the same time, to resolve buyers' coordination problems. In our previous study, we recommended that auctions for transport contracts be introduced, to improve congestion and location price signals. Holding simultaneous auctions for gas supply and transport contracts would potentially be complex, however, and Cramton (2008, Section 6) viewed this as too ambitious to develop in the near term. Nevertheless, some coordination between gas and transport auctions should kept under consideration for further development.

5.2 Duration of the Gas Release Programme

Gas release programmes, and virtual capacity auctions, are designed to alleviate, or mitigate, market power problems, and need to remain in place until the relevant markets become sufficiently competitive. For example, the UK programme lasted from 1992- 1995, at which point

British Gas had reduced its market share sufficiently to alleviate most concerns. The Hungarian programme is for 10 years to 2015, and the EDF auctions in France are now set to continue indefinitely.

The Colombian gas release programme will in principle need to continue until sufficient competition has developed in upstream gas supply. At present there is little prospect of this occurring, especially following the decision to return the entire Cusiana field to Ecopetrol by 2019. Competitive conditions may be improved in smaller ways by a number of measures or developments, however:

1. Gas royalties which accrue to the government are currently marketed by Ecopetrol on behalf of the ANH. Since these royalties amount to approximately 15% of all gas sold in Colombia, independent marketing of these royalties should be introduced. The simplest approach would be for this gas to be placed in the annual or biannual auctions at a low, or zero, reserve price, on behalf of the ANH.

2. The development of new gas fields by producers other than Ecopetrol. Given the current and future levels of concentration in upstream gas supply, Ecopetrol should probably be excluded from developing and owning new sources of gas in Colombia.

3. The introduction of LNG and other sources of supply in Colombia.

Assuming that such measures or developments eventually result in a significant lessening of Ecopetrol's market power in the upstream market, some relaxation in the rules described above could be considered. A better alternative, however, would be to reduce the size of Ecopetrol directly by introducing more diversified control of the gas resources in the existing Guajira and Cusiana fields. Since the only long-term solution is to reduce concentration of upstream market power, this requires reversing decision to give more control over Cusiana production to Ecopetrol. A possible alternative would be to divide Cusiana into independently controlled fields, perhaps by auctioning off production and exploitation rights to different companies, as existing contracts expire. In doing so, it will be important that "association-type" contracts, which allow for joint decision making over production and investments, are not used in the future. Ideally, the same would be done at Guajira, although current contracts may prevent this. Absent significant improvements in upstream market structure, Colombia will need to maintain a gas release programme for the indefinite future.

5.3 Vertical Integration Issues

Ecopetrol is the dominant firm in Colombia's upstream gas market and, as noted above, its dominance is set to increase when Ecopetrol acquires complete control over the Cusiana field by 2019. It is also involved in various downstream activities, including ownership of a refinery in Barrancabermeja (which demands up to 90 GBTUDs), and other downstream operations which purchase gas. Ecopetrol's activities as both an upstream seller and downstream purchaser of gas

has led to a number of concerns being expressed by its downstream customers and competitors, specifically that:

- Ecopetrol competes with resellers in secondary market and offers better terms to its own downstream operations than it does to other purchasers; and
- Ecopetrol requires gas resellers to provide information on their secondary market transactions, placing Ecopetrol at a competitive advantage

Cramton (2008, Section 5.7)) suggested one approach to dealing with the first issue:

> "*It is straightforward to handle the situation where a seller is also a buyer, for example, as in the case of Ecopetrol buying gas for use in its refinery operations. The simplest approach is for the seller to announce its supply schedule, just like any other seller, and in addition announce its demand schedule. Both announcements are made before the auction starts. The seller is a price taker for the quantity it wins, paying the clearing price. This is equivalent to the seller removing the quantity it buys from its supply schedule.*"

This appears to be workable proposal for dealing with Ecopetrol's direct purchases for its own refinery, although it may also be necessary to ensure that Ecopetrol, acting as a purchaser, is prevented from reselling any gas it purchases in the secondary market. It will also be necessary to restrict the amount of gas Ecopetrol can purchase in the auctions, to prevent it from using this mechanism as an alternative means of restricting supply.

Ecopetrol's alleged favouring of its own downstream partners is dealt with by our auction proposal: all buyers will purchase gas on exactly the same terms in these auctions. Finally, the ban on Ecopetrol selling gas in bilateral contracts or in the secondary market should prevent any abuse of information acquired in secondary market transactions.

6 Gas Release versus the "Single Buyer" and Other Proposals

Pöyry Energy Consulting, on behalf of the ANH, have proposed an alternative solution to the market power issues in the Colombian upstream gas market. This is to establish a "single buyer agency" to act as "counterweight" to the limited number of producers in the market. Specifically:

- gas producers must offer all gas in Colombia to the single buyer, and any production not purchased by the single buyer may be offered by the producer for export
- the single buyer should buy gas from producers at the lowest possible price, but taking account of the costs of production and the need to provide incentives for new gas production
- after purchase, the single buyer would calculate the weighted average cost of gas (WACOG), and give first option to distributors supplying the residential market, with the remaining gas offered in a mixture of daily, monthly, annual and longer term contracts via auctions

- any profit made by the single buyer could be made available to support expansion of the gas industry or subsidize tariffs to the poorest residential consumers[17]

The single buyer model obviously imposes a great degree of centralized control on the market, and as such is unlikely to result in efficient purchase and allocation decisions. Ofgem (2010) has recently considered a similar "central" energy buyer proposal, and notes that:

> "*The Central Energy Buyer would represent a significant departure from usual competitive electricity and gas markets that rely on market participants to respond to price incentives.*"

Consequently,

> "*there is a significant risk ... that the Central Energy Buyer makes the wrong choices and over-contracts, with consumers bearing the costs.*" [18]

The single buyer proposal also requires that the regulator have access to detailed information concerning, for example, gas exploration and production costs, which are almost impossible to obtain or estimate.

The main problem with the single buyer proposal, however, is that it fails to address the key issue in upstream gas supply in Colombia. This is the incentive of upstream producers with market power to reduce supply in order to increase prices.[19] Our proposals deal with this issue by forcing producers to offer their available production to the market. Once this issue is resolved, it is difficult to see what added value the single buyer option provides. Instead of the single buyer purchasing gas from producers (at potentially the wrong price), and selling it on in auctions to consumers, it makes more sense for shippers and consumers to purchase gas directly from producers in competitive auctions.

7 Conclusions

Our auction proposal builds on previous ministerial decrees, CREG resolutions and the 2008 Cramton report, and resolves the problems with the current regulations, i.e. Decree 2687, CREG 095, 2008 and Guajira price controls. The aim is to create an open, transparent and competitive country-wide market for long-term gas contracts in Colombia, which provides price signals for gas consumption and investment in new fields, or for the development of alternatives, such as LNG. Numerous elements of the proposal still need refinement and development, for example the standardization contracts and a possible requirement on producers to sell firm gas contracts. This should be done in consultation with the industry and consumers.

[17] Pöyry (2009) also allow for adjustments to be made to the single buyer model over time "as upstream competition develops", although their report contains no suggestions for how this could be brought about.

[18] Ofgem also believes that a central energy buyer may dampen innovation.

[19] In other words, why would producers offer larger quantities of gas to the single buyer than they currently offer to the market in their annual declarations?

Our proposal is entirely consistent with the development of a more organized and transparent daily spot market for short-term gas transactions as has been proposed elsewhere (Frontier Economics 2010). But a gas release programme will be required indefinitely in Colombia unless the upstream market structure is addressed in medium or longer term.

References

[1] Ausubel L. and Cramton P. (2009) "Virtual Power Plant Auctions," mimeo, University of Maryland, December.

[2] Bartok, C., Moonen, S., Lahbabi, P., Paolicchi, A., and de la Mano, M. (2006), "A Combination of Gas Release Programmes and Ownership Unbundling as a Remedy to a Problematic Energy Merger: E.ON / MOL," EC *Competition Policy Newsletter,* Number 1, Spring 2006.

[3] Brattle Group (2010) "International Examples of Gas Infrastructure Regulation," a report commissioned by the Colombian Comisión de Regulación de Energía y Gas (CREG), Bogota.

[4] Chaton, C., Gasmi,F., Guillerminet, M., and Oviedo J. (2008) "Gas release and transport capacity investment as instruments to foster competition in gas markets," mimeo, IDEI.

[5] Cramton, P. (2008) "Auctioning Long-term Gas Contracts in Colombia," a paper commissioned by the Colombian Comisión de Regulación de Energía y Gas (CREG), Bogota.

[6] EFET (2003) *Implementation of Gas Release Programmes for European Gas Market Development*, European Federation of Energy Traders, June.

[7] Frontier Economics (2010) "Diagnostic of Natural Gas Market Failures in Colombia," March.

[8] Harbord, D. and von der Fehr, N-H. (2010) "Regulation and Incentives for Investment in the Colombian Gas Transport Network," a report commissioned by the Colombian Comisión de Regulación de Energía y Gas (CREG), Bogota.

[9] Klemperer, P. (2010) "The Product-Mix Auction: a New Auction Design for Differentiated Goods," forthcoming in the *Journal of the European Economic Association.*

[10] Ofgem (2010) *Project Discovery: Options for Delivering Secure and Sustainable Energy Supplies*, 3 February, London.

[11] Poyry Energy Consulting (2010) "Recommendations for Further Development of the Colombian Gas Market," a report commissioned by the National Hydrocarbon Agency (ANH), Bogota.

[12] Schultz, C. (2009) "Virtual Capacity and Competition," mimeo, University of Copenhagen, July.

Annex A: Declarations from Main Gas Fields

La Guajira

La Guajira Declaration No. 1 September 2008

Company	MBTUD	2008	2009	2010	2011	2012	2013
ECOPETROL	PDOF	0	0	0	0	0	0
	PDOI	0	0	0	0	92,660	112,881
	Available[20]	2,694	-8,828	34,315	90,209	229,016	237,538
CHEVRON	PDOF	0	62,248	61,213	163,176	196,137	193,627
	PDOI	9,234	0	0	0	0	0
	Available	9,234	62,249	61,214	163,176	196,137	193,627

La Guajira Declaration No. 1 September 2008

Company	MBTUD	2014	2015	2016	2017	2018
ECOPETROL	PDOF	0	0	0	0	0
	PDOI	98,562	82,845	51,076	22,290	0
	Available	211,122	180,579	135,994	95,570	60,091
CHEVRON	PDOF	0	0	0	0	0
	PDOI	173,103	147,600	146,060	126,041	108,456
	Available	173,103	147,600	146,060	126,041	108,456

La Guajira Declaration No. 2 February 2009

Company	MBTUD	2009	2010	2011	2012	2013	2014
ECOPETROL	PDOF	0	0	0	0	0	0
	PDOI	3,066	5,549	11,420	189,058	178,032	159,340
	Available	120,544	142,820	148,614	325,413	302,690	271,900
CHEVRON	PDOF	0	0	0	3458	0	0
	PDOI	0	0	0	0	0	173,103
	Available	0	0	0	3458	0	173,103

La Guajira Declaration No. 2 February 2009

Company	MBTUD	2015	2016	2017	2018	2019
ECOPETROL	PDOF	0	0	0	0	0
	PDOI	137,848	106,631	78,340	53,510	28,436
	Available	235,581	191,549	151,619	116,567	175,447
CHEVRON	PDOF	0	0	0	0	0
	PDOI	147,600	146,060	126,041	108,456	92,003
	Available	147,600	146,060	126,041	108,456	92,003

[20] "Available" supply is the difference between the total declared potential production, multiplied by the company's share of the field's production, less contractually committed production for that company in that year.

La Guajira Declaration No. 3 October 2009

Company	MBTUD	2009	2010	2011	2012	2013	2014
ECOPETROL	PDOF	0	0	0	0	0	0
	PDOI	3,066	9,200	11,420	189,058	178,032	159,340
	Available	-16,728	9,199	11,420	226,821	239,203	213,301
CHEVRON	PDOF	0	0	0	3458	0	0
	PDOI	0	0	0	0	0	173,103
	Available	0	0	0	3458	0	173,103

La Guajira Declaration No. 3 October 2009

Company	MBTUD	2015	2016	2017	2018	2019
ECOPETROL	PDOF	0	0	0	0	0
	PDOI	137,848	106,631	78,340	53,510	28,436
	Available	183,581	139,549	99,619	64,566	29,926
CHEVRON	PDOF	0	0	0	0	0
	PDOI	147,600	146,060	126,041	108,456	92,003
	Available	147,600	146,060	126,041	108,456	92,003

Cusiana

The Cusiana declarations do not specify individual companies, since the proportion of gas production controlled by each company varies over time, and we do not have precise information on this at present. Currently, Ecopetrol controls at least 60% of the gas produced in these fields, and this proportion will increase to 100% from 2016 -2019.

Cusiana Declaration No. 1 September 2008

Company	MBTUD	2008	2009	2010	2011	2012	2013
	PDOF	0	0	0	0	0	0
	PDOI	1,040	14,040	7,800	14,430	174,592	184,264
	Available	5,448	44,939	44,585	53,360	224,710	234,330

Cusiana Declaration No. 1 September 2008

Company	MBTUD	2014	2015	2016	2017	2018
	PDOF	0	0	0	0	0
	PDOI	184,264	187,464	184,224	181,241	181,241
	Available	234,330	234,330	230,280	226,551	226,551

Cusiana Declaration No. 2 February 2009

Company	MBTUD	2009	2010	2011	2012	2013	2014
	PDOF	0	0	0	0	0	0
	PDOI	14,838	13,458	19,728	150,945	159,445	159,445
	Available	60,098	63,878	75,307	206,824	215,224	215,224

Cusiana Declaration No. 2 February 2009

Company	MBTUD	2015	2016	2017	2018	2019
	PDOF	0	0	0	0	0
	PDOI	170,221	162,356	154,871	154,871	155,134
	Available	226,000	226,000	226,000	226,000	

Cusiana Declaration No. 3 October 2009

Company	MBTUD	2009	2010	2011	2012	2013	2014
	PDOF	2,027	17,313	39,980	43,003	45,259	46,639
	PDOI	26,494	36,681	32,043	162,301	168,544	167,165
	Available	31,971	80,156	107,215	293,921	302,321	302,321

Cusiana Declaration No. 3 October 2009

Company	MBTUD	2015	2016	2017	2018	2019
	PDOF	31,400	15,851	17,444	18,726	19,131
	PDOI	186,196	186,727	183,278	184,699	184,842
	Available	318,321	318,321	318,321	318,321	318,321

All of the firm gas offered in the October 2009 declarations came from Ecopetrol. In December 2009, Ecopetrol auctioned 32,821 MBTUDs in five-year contracts beginning in August 2010, at an auction price of $6.14 (US) per MBTU.

La Creciente

La Creciente Declaration No. 1 September 2008

Company	MBTUD	2008	2009	2010	2011	2012	2013
Pacific Rubiales	PDOF	5,893	3,260	48,000	0	0	0
	PDOI	0	0	48,000	45,333	18,667	48,000
	Available	16,943	15,260	60,000	60,000	57,333	30,667

La Creciente Declaration No. 1 September 2008

Company	MBTUD	2014	2015	2016	2017	2018
Pacific Rubiales	PDOF	0	0	0	0	0
	PDOI	48,000	48,000	48,000	48,000	48,000
	Available	60,000	60,000	60,000	60,000	60,000

La Creciente Declaration No. 2 February 2009

Company	MBTUD	2009	2010	2011	2012	2013	2014
Pacific Rubiales	PDOF	9,679	865	12,524	12,524	37,571	37,571
	PDOI	0	0	14,194	14,194	0	26,717
	Available	17,795	8,981	39,429	39,429	50,283	77,000

La Creciente Declaration No. 2 February 2009

Company	MBTUD	2015	2016	2017	2018	2019
Pacific Rubiales	PDOF	37,571	37,571	37,571	37,571	37,571
	PDOI	26,717	26,717	26,717	26,717	26,717
	Available	77,000	77,000	77,000	77,000	77,000

La Creciente Declaration No. 3 October 2009

Company	MBTUD	2009	2010	2011	2012	2013	2014
Pacific Rubiales	PDOF	9,679	865	12,524	12,524	0	0
	PDOI	0	0	14,194	14,194	37,571	64,288
	Available	17,795	8,981	39,429	39,429	50,283	77,000

La Creciente Declaration No. 3 October 2009

Company	MBTUD	2015	2016	2017	2018	2019
Pacific Rubiales	PDOF	0	0	0	0	0
	PDOI	64,288	64,288	64,288	64,288	64,288
	Available	77,000	77,000	77,000	77,000	77,000

After the February declaration, Pacific Rubiales firm gas offered exceeded demand, hence no auctions were held.

Annex B: An Example of a Possible Clock Auction Design[21]

The aim is to allow the clock auction to determine the overall quantities of firm versus interruptible gas contracts, depending on demand and the price differential between the two types of contract. Total supply of gas is determined before the auction, based on suppliers' capacities.

For example, suppose total supply is 100, of which at least 25 has to be sold as interruptible gas. This reflects the constraint that producers cannot supply more than 75% of their potential production as firm gas. In each round of the clock auction, the auctioneer names two prices, one for firm and one for interruptible gas contracts.[22] Each bidder declares the quantities of firm and interruptible gas they are willing to acquire at the current prices. If the total quantity demanded – i.e. the sum of all bidders' demand for firm and interruptible contracts – is less than or equal to total supply, then the auction terminates. Otherwise, it proceeds to the next round.

Between rounds (i.e. when total demand is greater than supply), the price of at least one type of contract is increased. The price of firm gas is increased (according to a predetermined rule) if and only if the demand for firm gas is positive, otherwise it is kept fixed. The price of interruptible contracts is increased (according to a predetermined rule) if and only if the demand for interruptible gas is greater than 25, otherwise it is kept fixed. Therefore, if at the end of one round there is total excess supply but the demand for interruptible gas is equal to (or less than) 25, only the price of firm contracts is increased.

Between rounds, bidders cannot increase their total demand, but can switch between the two types of contract. This allows bidders to allocate their demand between firm or interruptible contracts depending on relative prices, and to change this allocation as the prices change. Prices increase until total demand is equal to total supply. An appropriate closing rule needs to be designed, so that, for example, there is no excess supply at the end of the auction.

When the auction terminates, bidders' demands at the final prices determine the quantity of firm and interruptible contracts actually sold. Suppliers have to sell the corresponding quantities of firm and interruptible contracts in proportion to their total capacity. More precisely, if at the final prices demand for firm contracts is 60, and demand for interruptible contracts is 40, then each supplier sells 60% of its capacity as firm contracts and 40% as interruptible contracts.

At the beginning of the auction, the prices for firm and interruptible contracts could be set equal, or the price of firm contracts could be set higher to reflect the lower value of interruptible contracts.

[21] This example was prepared by Marco Pagnozzi.

[22] The actual auction will include a larger number of contracts of different durations. We consider only two contracts here for simplicity.