IMPACT OF METER READING CYCLES AND CONSUMPTION ALLOCATION PROCEDURES ON THE UNACCOUNTED-FOR GAS

Authors

Name: José Francisco Quinta Catela Pequeno
Country: Portugal
Company: GalpEnergia S.A.
Address: Rua Tomás de Fonseca
Torre C
1600-209 LISBOA

Name: Lilian Berterreche de Menditte
Country: France
Company: GrDF
Address: 6 rue Condorcet
75009 Paris

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1. Background

The unbundling of distribution and retail activities has turned the business of natural gas distribution into one that demands more in terms of timely information and data processing.
Distribution System Operators (DSO) are required to accurately allocate gas quantities delivered to each end user on a daily basis and inform the Transport System Operators (TSO) and suppliers of those daily gas flows in greater detail.

Information required to be provided can affect supply, transport and distribution contracts, and cause significant economical impacts on a business.

As data on daily consumption is available only for customers with telemetered equipment – usually large industrial consumers, or connections between neighbour networks– no real data is available for most end-users, forcing DSOs to use consumption estimate methods.

Consumption estimations will always have a degree of error that is dependent on several management practices, and ultimately leads to an increase of Unaccounted-for Gas (UFG) that depends on the allocation and reconciliation mechanisms enforced by the regulator.

2. Aims

This paper aims to:

- Describe and distinguish this source of UFG amongst other more widely-recognised ones;
- Discuss the influence of meter reading and management practices, consumption estimate method sand allocation procedures on a business; and
- Establish the impact of the regulatory framework where appropriate.

The regulatory framework, figures and examples underlying the discussion are based on Portuguese and French cases, but the general conclusions that can be derived apply worldwide.

3. Definition of UFG

UFG can be defined as the:

> *Difference between the gas entering a distribution system at the point of custody transfer and that which can be measured and billed at all delivery points over a defined period of time.*

This definition – a simple volume or energy balance across the network – is widely accepted in the industry and has three fundamental issues:

1. Measurement at the inlet of the network – few points with accurate meters;
2. Measurement at the outlet of the network – usually at the consumption points (CP), which can be many and with lower accuracy; and
3. Period of time under evaluation.

Implicitly, pressure in a network is supposed to remain unchanged over the period, which is usually the case in distribution networks.
Also, the length of the network is supposed to remain unchanged during the period of evaluation.

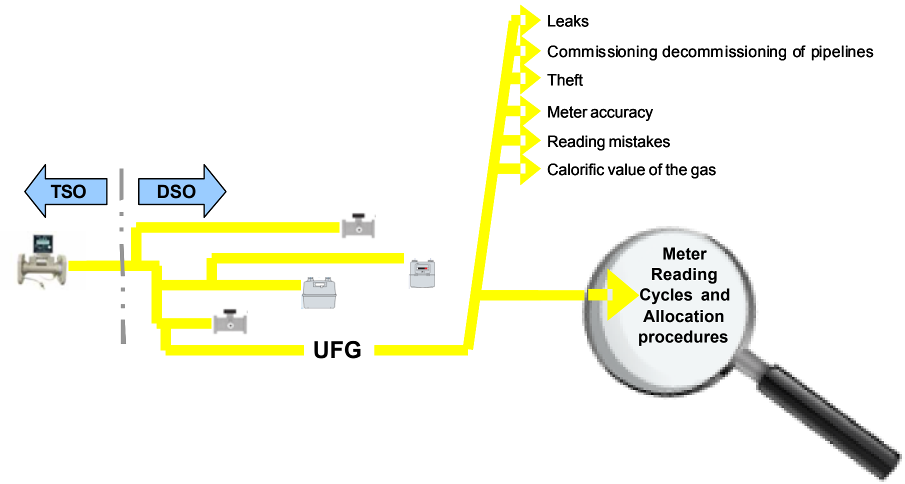
4. UFG causes

UFG results from several different causes, not all equally under the control of the DSO. These causes can be split into the following categories:

1. Physical causes – gas is in fact lost;

2. Accuracy of consumption determination – no gas is in fact lost, but the DSO is not able to measure it; and
3. Estimate causes – due to the need to allocate gas quantities without having definitive information on most consumption points.

The first two categories, of which a brief description is provided below, are commonly recognised. The third category is the main focus of this paper.



4.1 Physical loss of gas

Physical loss of gas includes loss from leaks, commissioning and decommissioning of pipelines and theft. The two first factors' importance will depend on the age of the network, its construction materials, work methods used by the DSO and mains replacement policies adopted.

Older networks tend to have a higher number of leaks, in particular if they are built in cast iron or ductile iron.
Commissioning, decommissioning and connection of new service lines were, in the past, activities that implicated venting of gas. These losses can be greatly reduced by:

- The use of polyethylene or PVC piping;
- Modern hot-tapping techniques and equipment;
- Methods to lower the pipeline pressure, as part of the decommissioning procedures; and
- Consuming the gas instead of venting or combustion.

Theft is a physical loss of gas and is a component of UFG. Gas theft varies between countries and depends on the country's economic and social environment; for example in South America it is known to be a very serious problem. One way to alleviate theft is to be able to detect it faster - this is dependant on the length of the reading cycle adopted. More frequent readings imply more frequent supervision of meter condition and tends to allow the company to detect the theft and deal with it quicker.

4.2 Accuracy

Accuracy of consumption determination entails not only the intrinsic accuracy of measuring devices, but also methods, equipment and management practices put in place to obtain meter readings and calculated consumptions.

In most cases the gas that enters the network is accurately measured by the TSO with appropriate meters equipped with continuous pressure and temperature[1] correction. Meter readings are taken on a daily, hourly, or even smaller period basis and immediately communicated to the supervision and billing systems.

The gas that leaves the network is measured by the DSO. Connections to neighbouring networks are usually equipped with meters of the same type of those used by the TSO and display the same degree of accuracy.

Connections to the residential consumption points, however, are equipped with smaller meters with lower accuracy and generally no pressure or temperature correction[2]. Readings from these meters will not be automatically communicated to the billing system[3]. To obtain readings the DSO have to dispatch personnel to visit the each CP and read the meter. Being a manual, operator-dependent method, this is inherently less reliable when compared to automated methods, such as telemetering; mistakes can be made that range from taking a reading from the wrong meter, to misreading the index of the meter. The use of handheld computers or data loggers with bar code reading capabilities to identify the meters can greatly reduce this type of mistake.

Accuracy will also be affected by meter malfunction, resulting from continuous work over its life span or sudden breakdown.

The continuous nature of gas meter operations usually results in higher metererrors. Eventually meters fall out of specification affecting the commercial relationship between the DSO, supplier and end customer. Being a slow process, this can be difficult to identify and manage.

For this reason most companies implement meter replacement programs, which are often regulated. In most European countries residential meters must be replaced after 20 years of use and industrial meters have to be checked at smaller intervals, depending on the and type size of the meter.

Sudden breakdown of a meter, however, may occur at any moment, with consequences that range from misreading of gas quantities to the complete absence of reading and in some cases blocking the gas flow.

[1] The more important delivery points, or those that operate at higher pressures, may also be equipped with compressibility factor correction and dedicated gas quality analysers.
[2] In these cases average pressure and temperature correction factors are applied to the consumption quantities in the billing system.
[3] Communication of the readings will be immediate and, or, with greater detail if smart meters, or some sort of data loggers are used.

In the case of large industrial or custody transfer meters close supervision will promptly spot any hint of failure, giving the owner the possibility to immediately correct the situation.
Small CP meters, however, given their very large number and less stringent inspection program are more prone to fail without being immediately detected.
The less frequently the meters are read, the more important this problem gets, as the reading is the only opportunity the DSO has to physically check the meter.
It would not be wrong to state that in every distribution system there will always be a percentage of defective meters affecting the measurement of the gas being delivered. This problem is worst in companies with long meter reading cycles.

Finally, if gas is traded in energy terms rather than volume the measurement or calculation of the heating value (HV) will introduce further sources of uncertainty.

HV can be directly measured or calculated from the chemical composition. Whatever the method the accuracy of the equipment used will always affect the determination of energy quantities.

HV can be very stable all over the network. This is the case when it comes from one only controlled source.
However, if gas is received from various sources or from sources with variable characteristics[4] HV can be very difficult to calculate and attribute to each CP.

As a summary of accuracy issues it can be stated that DSOs know well how much gas they receive but have more difficulty in knowing how much gas they deliver to each CP. These difficulties depend on the type of metering equipment installed in each CP which, in turn, depends on the type of utilisation and management policies.

4.3 Estimate causes

DSOs are obliged to provide information on consumption attributed to each supplier on a tight schedule – usually during the day following the one under reporting. The communication of this set of data is of the greatest importance for the management of the natural gas system.

The fact is DSOs do not have real measurements for most of the CPs with the required detail. Daily information will be available only for those CPs equipped with telemetered systems, which correspond to the largest customers and the larger volume of gas distributed.

The others are subject of estimate with the inherent errors.
The impact of this effect on UFG is not so widely and immediately recognised.
It depends on the regulatory framework, meter type and meter reading management policies.

Overall it will also depend on the distribution of consumptions between telemetered and non telemetered CP that can vary a lot from region to region – more urbane areas, with more

[4] This is the case, for instance, when biogas production plants are connected to the network.

residential CPs will exhibit a greater problem than industrial areas where all CPs are telemetered.

This cause of UFG is the main subject of this paper and will be discussed in the following sections

5. The Nomination and Allocation procedures

The unbundling of distribution and retail activities that led to the separation of the previously vertically integrated gas companies in network operators and suppliers brought a lot of complexity to the industry.

Before, each company had full control of its own network and on the flow of information from the distributor/supplier to the transport operator, required to keep the balance of the complete system, was almost limited to forecasts of total demand per connection point.
Moreover, the gas inside each network belonged to the network operator and was paid for according to the straight forward quantities measured at each connection point.

Today the gas is owned by the suppliers that contract with the TSO and DSO its transport and distribution from the source to each and every final CP.
Toll fees apply, depending on the quantity of gas transported or distributed, and on the maximum flow observed.
Because gas quantities belonging to each supplier are not segregated from one another – the gas in the tube is indistinguishable –, the operation of these contracts rely on the ability of each operator to measure and give information on the gas received or delivered under each contract. Information flow requires efficient circuits, for each day the correct amounts of gas should be imputed to the proper supplier across the system.

The industry developed a three phase process to solve this problem of which a simplified description follows:

Phase 1 – The nomination phase (day D-1)

In the nomination phase suppliers inform the TSO on the amount of gas to be injected in the transport network, on their behalf during day D, to cater for the consumption of their consumers. Amounts should be calculated with the best information available and take into account the weather conditions, if day D is a working day or a weekend, and many other factors that may influence consumption.
The nomination process determines the amount of gas that enters the transport network, provided no major unexpected event turns this determination physically impossible[5].

5 An example of such event could be a major rupture of the distribution network, leading to the interruption of the flow. If the injection of gas in the transport network is not interrupted the pressure would necessarily increase and eventually reach the maximum operating limit.

Phase 2 – Period of gas flow (day D)

During day D the TSO will monitor and control the flow of gas in its network according to the effective consumption, measured at the connection points with distribution networks, in order to maintain pressure[6] within defined limits.
Because there will always be a difference, even if small, between the input and output of the transport network, pressure will change, producing effects on gas stock and, since gas belongs to the suppliers, to each one's individual stock.
These changes are measured during day D and communicated to the several entities concerned on day D+1.

Phase 3 – The allocation phase (day D+1)

Early on day D+1 the TSO inform DSOs on the total amount of gas delivered at each connection point. DSOs allocate than quantities to each supplier.
Depending on the method used, which is regulated, a variable percentage of losses can be used to close the gas balance.
In any case, the sum of allocated quantities and losses must match the delivered quantity.
Allocated quantities are communicated to the TSO and used to calculate individual stock in the transport network.

The whole three day process can be summarised as follows:

Day =>		D-1	D	D+1
Process =>		Nomination (Kwh,m3)	Measurement of the gas at the outlet of transport grid (Kwh,m3)	Allocation (Kwh,m3)
Supplier	#1	x1	Y	y1
	#2	x2		y2
	…	…	(Y≠∑x)	…
	#n	xn		yn
		Sum(x1,x2,…xn) =X		Sum(y1,y2,…yn) =Y

With this information TSOs are able to calculate the new stock for each supplier.

		Initial stock	∆ stock	Final stock
Overall balance		Si	D	Sf
Supplier	#1	s1i	δ1=x1-y1	s1f
	#2	s2i	δ2=x2-y2	s2f
	…	…	…	…
	#n	sni	δn=xn-yn	snf
		Sum(s1i,s2i,…sni)=Si	∆=sum(x)-sum(y)	Sum(s1f,s2f,…snf)=Sf
		Sf=Si+∆		

Stocks must be kept within defined limits, outside of which heavy penalties may apply.

[6] The pressure in transport networks, also known as "line pack", is subject to change within defined limits, as part of normal .operation procedures.

For this reason great effort is made to use accurate information in the calculations and consumption forecasts.

DSOs are responsible for supplying the more difficult data to obtain.

6. Allocation shortcomings

Theoretically, allocation of consumptions is a simple process of adding the consumption of all consumers, each day, organized by supplier

$$\text{Allocation to Supplier } x = \sum_{\text{Consumer 1}}^{\text{Consumer n}} \text{Consumption of Consumer } ix$$

$$\text{Total Gas delivered} = \sum_{\text{Supplier 1}}^{\text{Supplier n}} \text{Allocation to Supplier } x$$

The problem is that DSOs do not know the consumption of all CP on a daily basis.

6.1 The simplest case – A network branch with industrial consumers

If all the gas in one branch of a network is used only by industrial customers, whose meters are telemetered and equipped with pressure and temperature correction systems, it is easy to obtain daily consumption data, aligned with the TSO readings[7].
In this simple case allocation process is simple and its accuracy will only depend on the accuracy of the meters and correctors involved.

Some mechanism must be accepted to distribute the difference between the TSO meter and the sum of CP meters. This difference should be small and its average, on the long run, approach zero.

Equations given above need therefore to be reviewed in order to accommodate this difference

$$\text{Allocation to Supplier } x = \sum_{\text{Consumer 1}}^{\text{Consumer n}} \text{Consumption of Consumer } ix$$

$$\text{Total Gas delivered} = \sum_{\text{Supplier 1}}^{\text{Supplier n}} \text{Allocation to Supplier } x + \text{Loss}$$

[7] Telemetered meters usually take readings at 12 pm, each day. The same happens with TSO readings. Readings should all be aligned. That is to say that, ideally they should all be taken at the same moment.

Losses can be supported by DSOs, or distributed by suppliers up to a maximum percentage defined by the regulator, depending on the process accepted by the regulation framework.

6.2 The general case – A network that supplies also residential customers

Residential customers and small business meters[8]are routinely read every month, every two months, or with some other periodicity.

For these CP no daily consumption can be calculated. The closest figure DSOs might get is an average between two readings and this will not do for allocation purpose and will not, in any case, be available in day D+1.

DSOs are thus forced to estimate the consumption of each CP without telemetered systems.

As required for the simplest case, the sum of estimated consumption and loss will have to match the total amount of gas reported by the TSO for each point. In this case, however, the match between estimated consumption and reported amounts will be less perfect than in the simple case described in previous section.
As a result losses will have a higher percentage impact.

7. Estimate methods

Estimate models can be rather complex. Some try to simulate the behaviour of individual customers, others the behaviour of sets of customers. For instance those belonging to a certain town or region, or connected to the same network branch.

Some of the variables widely used in such models, regardless the focus being individual customers or the collective behaviours, are:

- The temperature – Often, a base consumption is established for an average temperature for each month and correction for the actual measured temperature is applied as a factor;
- The day of the week – behaviour in a working day, or a weekend day is different;
- The month of the year – Residential customer consumption is strongly dependent on the season; cold seasons will have greater consumptions; Greater Summer/Winter temperature amplitude will enhance this effect;
- The occurrence of special events that may modify consumption patterns – a holiday next to a weekend, for instance.

To derive the impact of each of these variables in consumption, careful statistical work has to be carried out on the data selected to integrate the model. Furthermore, data must be carefully collected over several years, in order to pick up trends of slow behaviour changes[9].

[8] If smart meters are not in use, which is the most common case.

The larger the reading cycle, the more difficult it is to gather data with the necessary detail to be able to modulate seasonal consumption or other consumption habits, in which cases it is more efficient to install data loggers in selected customers premises.

Models are thus difficult to establish, result from long term tasks that require continuous improvement and up-dating and constitute valuable know-how of distribution companies.

7.1 Estimating the behaviour of the individual customer

Gas consumption behaviour modelling for each individual customer requires a lot of personal information that will have to be acquired thru the supplier.
Among other and in addition to the basic information mentioned above, the following pieces of information are usually useful:

- Customer type – residential, small industry, café or restaurant;
- Type and number of appliances – important in the case of non residential CP;
- Size of the family;
- Use of gas for heating purposes, or only to cook and heat up water.

All this information is difficult to get and to keep up to date.

An alternative to these very complex models is the development of simple estimate routines based on the homologue consumption. In this case daily consumption is calculated from daily average consumption of the same period, last year. The advantage is that the information needed – consumption figures – are obtained directly by the DSO and are already available in the commercial system.

Individual consumption models can be very accurate, but also heavy consumers of computer calculation resources.

Their use in daily nomination and allocation process can easily lead to a situation where DSOs are not capable of meeting the dead lines to publish information.

On the other hand individual consumption models can be very accurate and suitable for billing purposes, in the absence of real data.

7.2 Estimating the collective consumption behaviour

Estimate of collective consumption requires customers to be classified and included in tiers of homogeneous behaviour. Consumption of one tier will be estimated by multiplying the

[9] As an example of such a slow change in consumption habits we can mention the slow trend, observed in Portugal, to substitute gas stoves and ovens for electric ones, or the quite recent law that obliges new buildings to have solar heat recovery systems. Consumption drops quite remarkably, when compared with other households of similar size and social standard.

number of customers in the tier by its average consumption. The method is simple to use and saves computation time.
The set of tiers must be carefully designed to be representative of the distinct type of customers on the network.
The following set, in use in Portugal, was agreed between the Regulator and the several DSOs.

Tier	Designation	Consumption m^3/year
1	P1	0 to 220
2	P2	221 to 500
3	P3	501 to 1000
4	P4	1001 to 10,000
5	P5	10,001 to 50,000
6	P6	50,001 to 100,000
7	P7	Above 100,001

For each tier a profile of daily average consumption per CP along the year was determined. Although these profiles are not temperature dependent, they change with the part of the country, forecasting higher consumptions to the colder northern regions, and lower consumption to the south.
Above 100,000 m^3/year the installation of telemetering is mandatory, thus requiring no profile.

In France nine profiles are used according to the frequency with which the meter is read and on the type of customer:

Reading cycle	Profile
Every 6 month	Flat profile, for customers without heating usage of gas
	Seasonal profile for the other customers
Monthly	7 profiles reflecting various seasonal behaviour and consumption level

Collective consumption models can be more accurate than individual models when the aim is to estimate the overall demand of gas. The reason for this is that the development of correlations between gas throughput and the several independent variables chosen to explain consumption already take into account the simultaneity of consumption and cancel individual unpredictable behaviours.
On the other hand these models tend to under estimate consumption of individual customers, and cannot be used for billing purposes.

8. The allocation process

The allocation process depends on how complex a network is and has to cope with:

- Imbalance of measured and forecasted gas quantities reported by DSO and TSO; and
- Uncertainty of the information available on day D+1.

8.1 Balancing the daily reported gas quantities

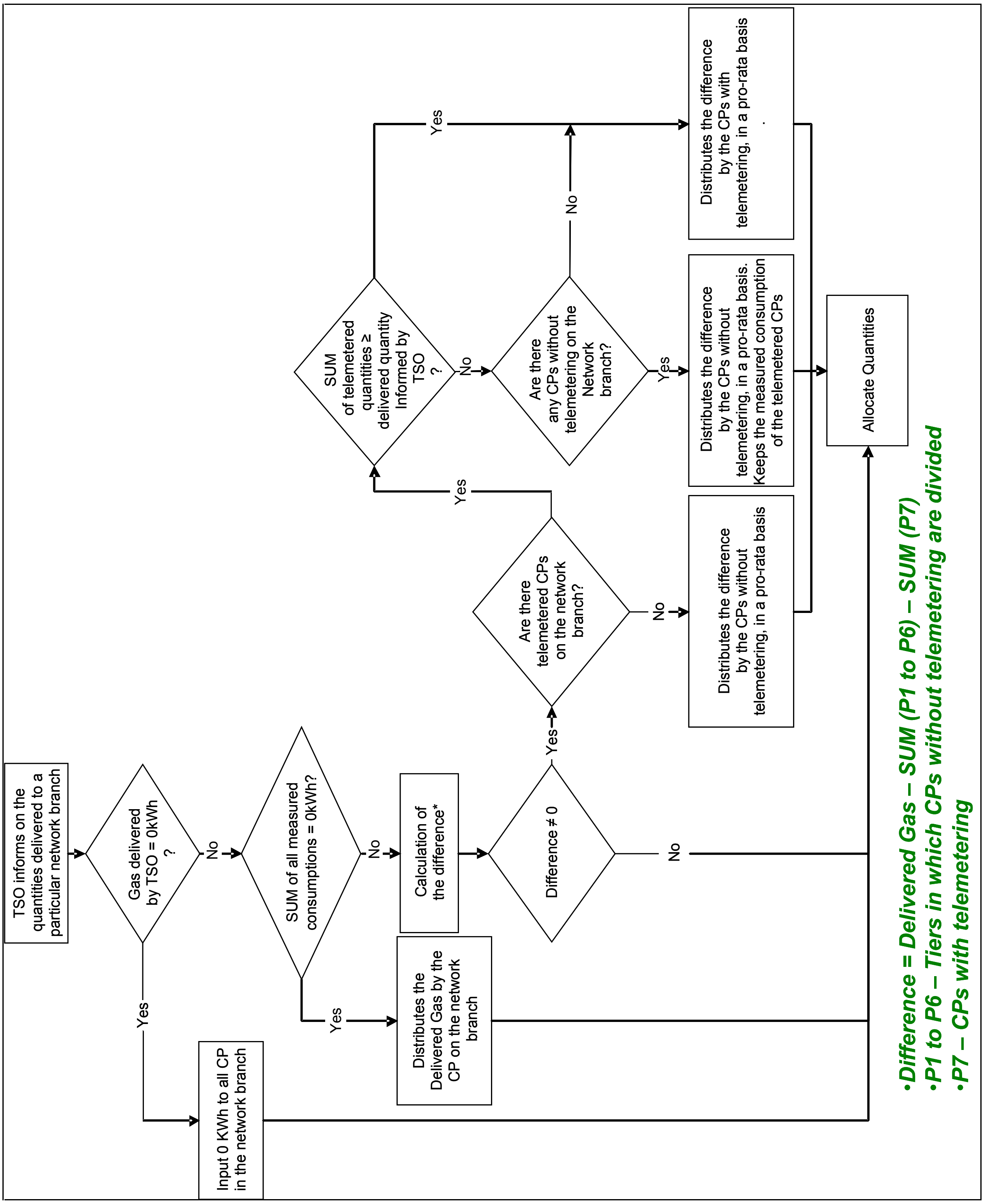
As explained above, in despite of any corrections that may occur, the gas quantities reported by the TSO, for each delivery point to the distribution network, is the most reliable figure available on day D+1 on the real quantities distributed. Therefore allocation procedures aim to close the gas balance, each day, against TSO figures. The way this goal is accomplished is object of regulatory provisions that have a wide impact on several players of the gas market.
The process is not the same everywhere. Rather it reflects the specifics of each market and its maturity.

In Portugal, where the unbundling process is quite recent, DSOs allocate measured and estimated quantities of gas and calculates the difference to the delivered quantity, as reported by the TSO. Allocated quantities are calculated with the estimated or measured consumption, on top of which a small percentage of losses may be added. This percentage is defined by the Regulator and cannot be objected by the suppliers.

The difference is then distributed according to an algorithm developed by the DSOs that is depicted in the following drawing.

The method tests several possible situations and uses different distribution options accordingly. The aim is to preserve the most reliable information available, which usually are the telemetered quantities, and distribute the imbalance by the estimated CPs.

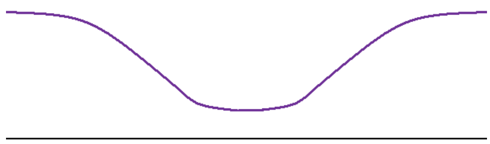
The overall method guarantees that the gas balance closes in the distribution network, by requiring that the total allocated amount matches delivered quantity, as reported by the TSO. Further, the DSO is not required to acquire gas. Suppliers support directly a fixed amount to compensate expected losses and imbalance resulting from the lack of real information.



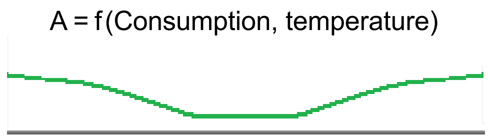
- *Difference = Delivered Gas – SUM (P1 to P6) – SUM (P7)*
- *P1 to P6 – Tiers in which CPs without telemetering are divided*
- *P7 – CPs with telemetering*

In France, allocation requires two steps. A preliminary allocation is published with a forecast of consumptions for each CP.
The result is then corrected to match the quantity communicated by the TSO and include an amount for estimated losses. This amount is determined with a “losses” model.
The model is based on historical data and has constant and consumption proportional loss as in the following example:

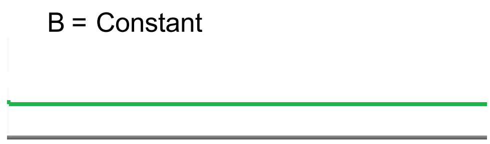
Consumption modulation along the year



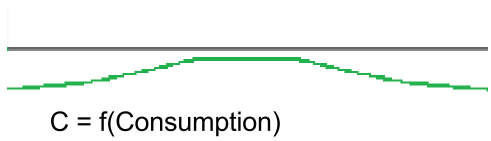
A. Consumption and temperature proportional loss
   - Fraud
   - Leakage
   - Measurement errors



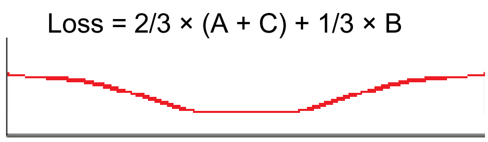
B. Constant losses
   - Accuracy of meter equipment
   - Reading mistakes



C. Consumption and temperature cons-modulated loss
   - Construction related losses like venting and purging (because construction activity decrease during Winter)



Resultant loss modulation
   - An example with 2/3 of proportional loss and 1/3 of constant loss; it will depend on the particular network to be modulated



Percentages of proportional and constant components, as well as the curve for each component are adapted for each particular network case.

The overall allocation process is easier to explain with a simple example:

TSO	Supplier	CP	Allocation		Total per Supplier
			Preliminary	Definitive	
25	A	A1	2	3	12
		A2	6	9	
	B	B1	2	3	12
		B2	6	9	
25	Estimated	1	16	24	

× F

F = (25-1)/16
F is calculated taking into consideration loss estimated with the “losses” model.

Definitive allocated quantities plus estimated loss must match delivered quantities, as communicated by the TSO, closing the gas balance in the distribution network daily.

Loss will be covered by the DSO with gas purchase.

Both French and Portuguese models establish and apply loss and distribute imbalance by the suppliers according to the consumption of their consumers.

However, the two models have different impact on the several players in the business:

- In the French model lost quantity is established by a statistical model, instead of being a fixed figure;
- French DSO bares the cost of such loss, while the Portuguese DSO passes the cost immediately to suppliers
- Imbalance is equally dealt with by distributing the difference by the CPs, but the distribution algorithm used is completely different

8.2 Long term review of provisional quantities

Because of the uncertainty that affects the daily allocation process, the information published on day D+1 may be taken as provisional and some sort of revision mechanism has to be contemplated to allow the substitution for definitive figures.

This mechanism is known as reconciliation. It has financial implications on the several players in the business and depends on meter reading cycles.

It consists basically in substituting the estimated consumption figures by those that result from the reading difference observed for each CP, and deriving resulting consequences:

- Recalculate the supplier's stock in the high pressure network;
- Apply toll fees to users of the distribution network (in the Portuguese case);
- Review the toll fees applied to the users of the distribution network (in the French case).

The way this is done depends on the regulatory framework.

In Portugal, the allocation data must be confirmed (or rather corrected) until three days after the end of each month, but can be further reviewed at any moment within the next four month.
This mechanism allows the correction of several types of errors, or shortcomings of the initial process:

- Lack of information for some CP – because of telemetering system failure, and subsequent need to estimate consumption;
- Correction of daily delivered quantities communicated by the TSO – volume or heating value;

- Substitution of estimated consumption by more accurate data – residential customers, whose meters are read every two month, will already have new readings, allowing the real average consumption of the period to be calculated instead of estimated.

Revision of the information affects only on the supply contracts, because the distribution fees are charged only on the real consumption figures.

In fact, in Portugal, DSOs charge suppliers after having read the meter and calculated exact consumed quantities for each CP. Invoiced values are always final[10], but DSOs will receive the fees with a delay that depends on the reading cycle.

Reading cycles, in turn, depend on the type of customer:

Type of customer	Reading cycle	Toll fee invoicing cycle
Residential Customers	2 month	2 month
Industrial or services customer up to 100,000 m3/year	1 month	1 month
Industrial or services customer above 100,000 m3/year	daily (telemetered)	1 month

Since the industrial and services segments are accountable for about 85% of total of consumption, the system guarantees that most of the invoicing occur within one month of the date on which the gas was distributed.

It is up to the supplier to verify that the quantities reported in DSOs invoice do match those reported to the TSO. To be completely correct they should be a little smaller, since they do not include allowed loss on the distribution network.

In France there is no possibility to review the allocation data published on day D+1 and invoicing from DSOs to suppliers follow a monthly cycle.

DSOs keep an account for each CP with all allocated quantities that will be settled when the meter is read. Invoiced fees are then reviewed to meet the corrected quantities.
Theoretically all accounts will zero every time the meter is read, but since reading cycles are rather long – 6 month – and CP consumptions are estimated on a daily basis, it becomes obvious how important it is to have a good estimate algorithm to avoid a large financial impacts.

This mechanism leaves on the DSO side not only the final imbalance between total gas input and output of the network, but also the financial impact of any tendencies of the “losses” model: If the model over estimates losses, DSOs will under charge suppliers until the settling reading is taken; If the model under estimates losses, than suppliers will be over charged.

[10] In fact for daily tariffs only, the monthly invoice may include some estimated days to be corrected with the next invoice

Affecting all the players in the business, this model is subject of great attention from all parties, and cannot be freely modified by the DSO.

9 The reading cycles and the period of time under evaluation

The impact of the reading cycles was mentioned, all along this paper, as one of the most important issues affecting overall UFG performance of the DSOs.
Recalling what is written above, long reading cycles can contribute to UFG:

- By forcing the need to estimate consumptions;
- By making it more difficult to promptly spot malfunctions or thefts;
- By making it more difficult to close gas balances in the network;
- By making it more difficult to establish consumption models;

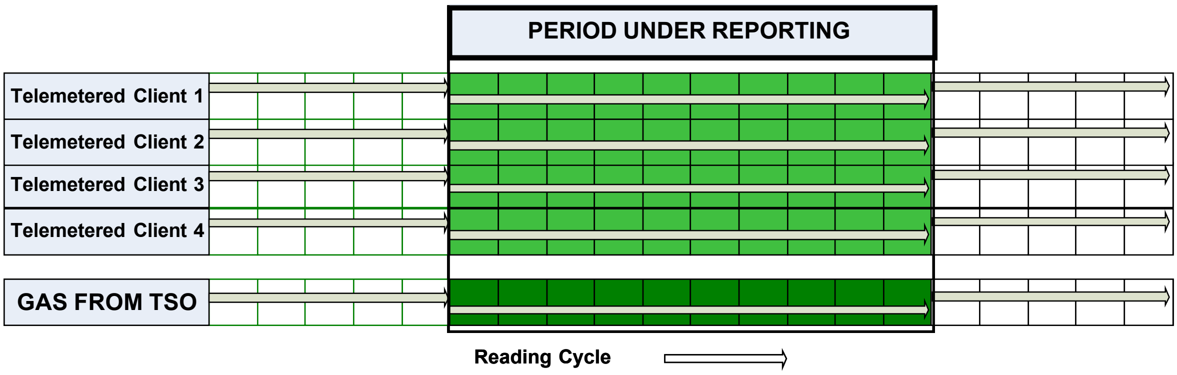
But reading cycles have yet another impact which was not clearly mentioned up to now, although mentioned in the UFG definition – the matching with the period of time within which the gas was consumed.

In Portugal the information used to allocate consumptions during each month is consolidated immediately after the end of the month and must match exactly the gas quantities measured between 0 am of first day and 12 pm of the last day of the month by the TSO.

This implies that suppliers that operate on the small customers market will have more estimated consumptions than a supplier focused on the large industrial customers.

The reason for this is the length and alignment of the reading cycle, when compared with the information consolidation cycle.

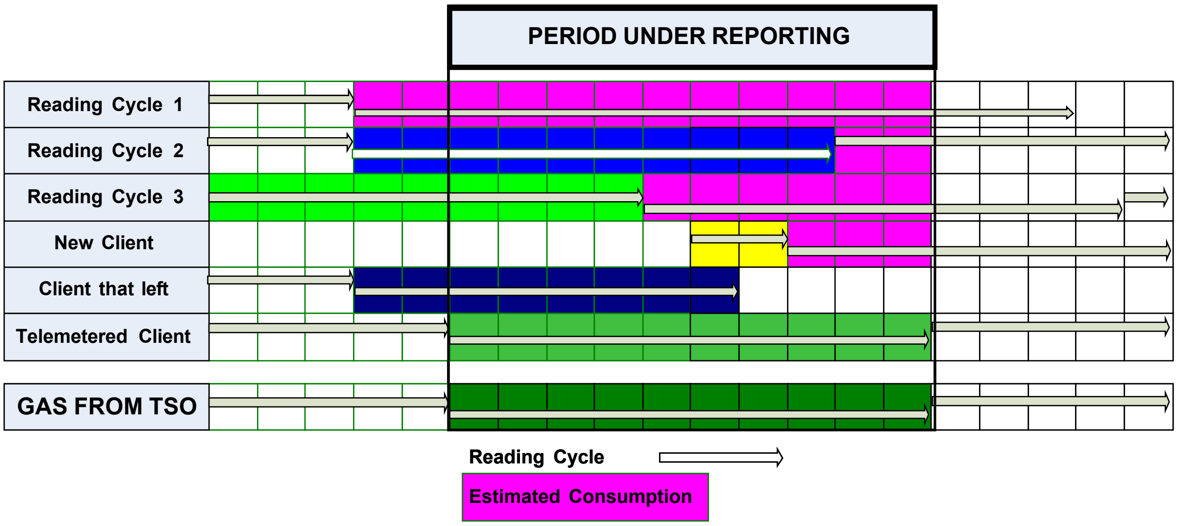
Consumption of points with telemeter equipment is fully aligned with the information cycle. Consumptions figures are real, fall in the month under reporting, and readings are taken automatically at 12 pm each day;



Monthly read consumptions will be slightly misaligned with the information cycle. This happens because of the large number of CPs in this cycle, making it impossible to read them all at 12 pm of the last day of the month; These CPs are read during the last 2 or 3 working days each month, not matching exactly the TSO reading moments.

Consumption of small residential customers, which are read with two month intervals, can be not read at all during the month under reporting. In fact, due to the very large number of these small customers, DSOs operate several simultaneous reading cycles, starting at different days along the month in order to even the number of meters to be read every day. Suppliers that focus their attention on this market segment will have almost only estimated information reported to the TSO.

In the following example those customers included in cycle 1 will not have a reading during the period under reporting, and all the consumption information will have to be estimated.



With these examples it becomes clear how difficult it is to check the match between:

- The consumption figures reported to the TSO, that will affect the supplier's stock in the transport network and ultimately the withdrawing of gas from the gas supplier; and
- The quantities underlying the distribution toll fees invoiced to the supplier, on which all the invoices from the supplier to the end customer will be based.

The problem resides on the different periods of reporting and will not be completely solved while the reading cycles continue to be longer than the reporting and accounting cycles.

10. Conclusions

With the unbundling of the activity, the information circuits on the natural gas business are quite complex and demanding on accurate data.

It is the role of DSOs to publish the most difficult data to acquire on a very tight schedule, minimising its intrinsic uncertainty.

To tackle the problem, DSOs developed sophisticated gas loss and consumption estimate models and information circuits, compliant with each country applicable regulatory framework.

By establishing the master rules, the regulatory system will in practice chose how this uncertainty affects the several players in the business and who ultimately bears the greater financial impact.

Recently the natural gas business has been discussing the possibility and convenience of substituting existing meters for smart meters. Until now this discussion was mainly focused on:

- The advantage to the end-user;
- The possibility to get information on consumption instantaneously;
- How easily a customer will change gas supplier;
- How well a customer will be able to manage its consumption; or
- The possibility of having profiled tariffs with different prices for different periods of the day.

For the DSO, smart meters are expected to simplify fraud detection and closing or opening gas supply to a customer.

Perhaps also UFG will be reduced through the effect of shortening reading cycles and solving what seems today to be an unsolvable problem that DSOs have to live with.

The question that remains is at what cost.