# Smart meters in Great Britain : the next steps ?

## Paper 1 : Gas meter market, regulation and technology

**Gill Owen and Judith Ward**

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# Gas Meter Market, Regulation and Technology

## Gas Meter Market Overview

Industry arrangements have evolved since 2000 to place energy suppliers at the hub of competitive metering services for residential and smaller energy customers.

Suppliers are responsible for making metering arrangements on behalf of their domestic customers, and for making arrangements for meter-reading. Suppliers contract with others who provide meter assets, operate meter services (installation, maintenance, repair, replacement etc) and read meters. Data retrieval and processing for billing, and aggregation for settlement may also be undertaken as separate services. Data processes and data flows are subject to common governance arrangements to enable smooth customer switching. Market frameworks for gas and electricity metering are similar, but not identical.

The UK meter sector today comprises active players, engaged across both gas and electricity. On the gas side, main actors include the six large energy suppliers (and a number of smaller ones), National Grid with major gas-meter interests and four independent gas distribution networks[1]. In addition, on the electricity side, distribution network operators retain metering interests. A number of stand-alone meter operators are also active. Some existing electricity and gas licensees are developing non-licensed meter businesses, and others in contrast have curtailed their former metering activities. At least one major supplier has fully outsourced its meter-related activities. By contrast, a number of suppliers have recently moved some meter services in-house.

There are also major players specialising in meter-data reading and retrieval, processing, billing, credit and risk management, and back-office systems.

There is an active UK meter manufacturing base, selling a range of predominantly non-smart gas meter models for use in the residential sector.

Increasingly, in anticipation of potential developments going forwards, the UK meter market is attracting new interests, including, for example, from communications specialists and financial institutions. There is also a new focus on the customer-interface in terms of developing new meter-related consumer-products.

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[1]The gas distribution networks are the former twelve Local Distribution Zones, now owned and managed as eight gas distribution networks as follows : **National Grid** - North-West ; London ; West Midlands and East of England ; **Scotia Gas Networks** – Scotland ; South of England; **Northern Gas Networks** operational activity contracted to United Utilities – North of England ; **Wales and West Utilities -** Wales; South-West.

## Development of Competition in Gas Metering

The journey to introduce competition in meter asset provision and in meter services dates back to the phased introduction of retail supply competition in the 1990's for both electricity and gas[2]. In the first instance, metering innovation was driven in the industrial and commercial sectors, particularly in response to the need for half-hourly metering in the 100 kW electricity retail market in 1994 and, later in 1996 for automated Daily Metering for very large consumers with gas-use over 58,600 MWh pa.

Subsequent full retail-market opening in electricity (1998) and in gas (1998/99), entailed separation of electricity distribution and gas transportation businesses from energy supply. This in turn was accompanied by a move to open to competition meter provision and meter operation for the residential and smaller business sectors[3]. For gas, Ofgas proposed that initially Transco's price control should be separated to identify the prices for transportation, metering and meter reading activities. Ofgas also proposed that these Transco activities should be separated physically, financially and in terms of information provision. This meant that new industry processes were required to allow others to compete with Transco in providing metering and meter-reading services. These standard industry-wide processes to support competition in gas metering services were adopted in July 2004[4]. Within the Transco transportation business (now National Grid), business separation of metering was given effect.

In terms of understanding the GB gas meter market today, it is helpful to see the significant shift, still in train today, from the fully bundled arrangements of the late 1990's, where all residential and smaller business gas-metering assets were owned by a single entity as a part of the network infrastructure, and where meter costs, subject to an efficiency factor, were a direct pass-through to suppliers.

Today's frameworks for competitive development of the GB metering sector remain in a state of transition. The regulatory intention is to move to fully competitive arrangements for provision of meter assets and meter services. To this end, the DNO / gas transporter role of 'last-resort' meter-provider is expected to lapse, in turn prompting suppliers to contract for other arrangements. For electricity, this next-step became effective for all new

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[2] Electricity – 1990 – 1 MW ; 1994 – 100kW ; 1998 – full retail competition. Gas – 1996 - Daily metered > 58,000 MWh pa; Monthly meter-read > 293 MWh pa ; 1998/99 – full retail competition.

[3] Ofgas. Initial proposals for securing effective competition in the provision of gas metering and meter reading activities. October 1998. Director General's Final Proposals – May 2000 ; Adopted – May 2001.

[4] RGMA – Review of Gas Metering Arrangements – July 2004. REMA – Review of Electricity Metering Arrangements – May 2003.

and replacement meters and for meter operation from April 2007 – albeit the existing price-controlled arrangements between suppliers and electricity distributors for existing 'legacy' assets are to continue until reviewed at the next DNO price-control in 2010. For gas, provision of default 'last-resort' meter services by the transporters will be considered at the next gas-meter price control review[5].

Three further factors contribute to the nature of the evolving GB gas meter market.

First, in May 2005, four of the eight gas distribution networks were divested by National Grid to three new owners[6]. These four independent gas networks hold no legacy gas meter assets, which were retained by National Grid. However, the independent gas transporters continue for the time-being to have a 'last-resort' role with respect to providing new and replacement gas meters within their geographic footprint - unless suppliers put in place alternative arrangements.

Second, in a further move towards effecting full business separation of transportation and metering, National Grid put forward proposals in late 2004 to restructure its regulated and non-regulated metering activities into a single meter operator organisation[7].

Third, the timing of the next gas-meter price-control review, including evolution of the 'last-resort' arrangements for gas-meters, and full separation and eventual re-structuring of National Grid's meter business, await the outcome of a Competition Act investigation announced by Ofgem in July 2005. This is a review of the Meter Services Agreement, the contract which defines the arrangements between National Grid and most (but not all) suppliers for provision, maintenance and installation of almost all residential and smaller business gas meters.

Accordingly, the present framework for competition in the GB gas-meter market is more uncertain than that for electricity, and regulatory developments lag a little behind. For the main actors, these interim issues give rise to an element of uncertainty in respect of longer-term strategy, including on gas smart meter investment.

Evolution of the competitive market in gas meter services continues however, and the overall expectation remains that third-party meter operators for both electricity and gas will become more established in the market and take business from incumbents - Distributors and National Grid - unless they prove competitive in a de-regulated environment.

[5] Date yet to be determined.

[6] See footnote 1.

[7] The Proposed Restructuring of National Grid Transco's Metering Business. Ofgem consultation. March 2005. 78/05.

## Gas Meter Asset Management and Ownership

For the historic reasons outlined, most GB residential gas meters (c.90%) remain in ownership of National Grid[8]. Nevertheless, since 2003, three additional asset managers have entered the market following appointment by British Gas of alternative meter asset managers on a regional basis for meter services in respect of new and replacement meters (both gas and electricity)[9]. In practice, of the one-million new and replacement gas meters being installed each year, over half are being replaced under these contracts. Following resolution of the present uncertainties, Ofgem's expectation is that this number will increase as other gas suppliers seek cost-advantages through tendering for new metering provision.

Regulatory and Governance Frameworks for the UK Domestic Gas Metering Market

Key features of the present regulatory and governance arrangements for residential gas meters are as follows :

- **Supplier Responsibility for Meter Arrangements** - Energy suppliers are responsible for making metering arrangements on behalf of their domestic customers[10 11].

- Gas suppliers are required to arrange for a **Meter Asset Manager** to provide assets and to operate meter services on their behalf [12].

[8] The twenty-million plus meters owned by National Grid were given a net book value of around £1 billion in 2002. (Historical cost less accumulated depreciation at 31 March 2002. Transco Regulatory Accounts 01/02).

[9] Meterfit – a joint-venture with United Utilities ; Onstream – a non-regulated National Grid subsidiary ; and Capital Meters – a Siemens and Macquarie Capital joint-venture.

[10] Gas Act 1986. Schedule 2 & Supply Licence Condition 34. Electricity Act 1989. Schedule 7 & Electricity Supply Licence Condition7. Suppliers are not required by their Licences to provide metering services to non-domestic consumers >73,200 KWh pa or >2,500 therms pa, where meter provision is subject to commercial arrangements.

[11] From July 2007, the new Supply Licences remove the formal obligation on suppliers to provide a meter at domestic premises. Instead, suppliers will continue to have obligations to offer terms for supply to domestic customers – implicitly through a meter. Suppliers will continue to be obliged to use an Authority-approved Meter Asset Manager for meter-related services. For work involving a meter connection to a service pipe, suppliers will be obliged to use (or arrange inspection by) an Ofgem / CORGI Approved Meter Installer (OAMI). Longer term, Ofgem plan to consider whether arrangements for managing safety of gas meter installation and provision are best handled outside the Supply Licence, including the option of industry self-governance. (Ofgem letter on Gas Supply Licence Meter Work Obligations. 2 May 2007).

[12] Supply Licence Condition 34 (2A). A MAM provides meter-related services. From July 2007 these will be defined as meter provision, installation, commissioning, inspection, repair, alteration, repositioning, removal, renewal and meter maintenance of the Gas Meter and associated installation. (New Standard Supply Licence Condition 12 from July 2007).

- **Transporters as 'Last Resort' Meter Provider** - Suppliers can discharge their meter provision obligation by requiring the relevant gas transporter to provide meters to domestic consumers under price-controlled arrangements[13].

- **Commercial Arrangements** - Alternatively, suppliers can procure meter services through commercial arrangements with a third-party [14].

- **Meter Asset Managers** - Key players in delivery of gas meter activities are Meter Asset Managers (MAM). The MAM holds all metering information for individual meters[15], and commonly manages and coordinates meter replacement programmes, and purchase of new meters. MAMs may own meter assets, but not necessarily. Meter Asset Management is not a licensed activity but MAMs must be on an Authority-approved register. MAMs are subject to the industry-wide Meter Asset Management Code[16].

- **Safety -** Gas meters are subject to stringent safety regulations[17], including in respect of installation and any subsequent work on the meter. Suppliers are presently required to ensure that at least every two years every domestic gas meter is read and visually inspected for tampering and for leaks[18]. This universal two-year requirement is presently subject to review, and, subject to final HSE views, the present bi-annual inspection arrangements may be adapted for the future to a more targeted and risk-led inspection approach.

- **Billing -** Meter Reading Agents collect meter data (Data Collectors) and aggregate it (Data Aggregators). Meter reading is not a licensed activity, albeit arrangements are subject to an Ofgem Code of Practice.

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[13] Gas Transporter Standard Special Licence Condition A10 requires a transporter to comply with any reasonable request by a supplier to provide a gas meter to a domestic customer through a meter asset manager. Gas Transporter Standard Special Licence Condition A43 requires the transporter to publish a statement of charges for meter services. These two conditions effectively combine to make gas transporters 'meter providers of last resort'.

[14] Supply Licence Condition 34.2. The supplier remains the Gas Act Owner where a meter is hired, rented or leased by them from a third party. A transporter can also be a Gas Act Owner.

[15] Meter Asset Management is defined in Std Condition 34 (2A) of the Gas Supplier Licence (From July 2007, Std Condn 12). Information held by MAMs includes meter address, location in premises, meter-type, model, manufacturer, serial number, age, payment-type etc

[16] MAMCoP - Code of Practice for Gas Meter Asset Managers. Sept 2005. Inter alia, specifies required competencies for work on different activities in respect of gas meters.

[17] Gas Safety (Management) Regulations 1996 & Gas Safety (Installation and Use) Regulations 1998. Gas Supply Licence – Std Licence Condition 17(1) and (2) (to become Condition 12 of new Gas Supply Licence in summer 2007).

[18] Std Licence Condition 17 (1) and (2) Gas Supply Licence. (To become Condition 12 of new Gas Supply Licence in July 2007).

- **Governance** - Common industry rules and governance arrangements in the competitive gas market are brought together in the Uniform Network Code[19]. In parallel, rules and governance arrangements have been developed to facilitate competition in the retail gas market, and, more recently, to facilitate competition in meter services.

- **The Supply Point Administration Agreement (SPAA)** adopted in 2005, is a domestic-supplier agreement, designed to ensure coordinated and efficient processes for customer-switching. It details supplier-to-supplier and supplier-to-transporter procedures, not otherwise covered by existing contracts or agreements, but central to effective customer switching[20]. Metering data flows, defined in the predecessor RGMA, are included as a schedule to the SPAA[21].

- Gas Shippers do not actively participate in meter provision, but do have licence obligations to communicate requirements and data between suppliers and transporters. Since May 2005, Xoserve has taken on responsibility for managing the commercial interfaces between gas transporters and shippers.

- **Xoserve** is jointly owned by the five Gas Transporters and the NTS[22] . It manages industry-wide information systems and serves the data-needs of both the wholesale and retail gas markets, facilitating exchange of customer switching data through the UK Link Computer System. UK Link manages a 'Sites and Meters' data-base and Xoserve's Supply Point Administration data-base holds data about every gas meter in Great Britain, including data on supplier-change and meter-readings, identified for each gas supply point by a unique Meter Point Reference Number. Meter data held by Xoserve is put to two main uses : facilitating automated administration of supplier-change ; and, in support of reconciliation, settlement and invoicing of transportation and energy charges for shippers.

19 Formerly the Network Code, until industry restructuring following National Grid divestment in May 2005 of four gas distribution networks. Shippers do not actively participate in meter provision, but they do have licence obligations to communicate requirements and data between suppliers and transporters.

20 All domestic suppliers (Supply Licence Condition 34A) and gas transporters (Gas Transporter Licence Condition 14) are required to comply with the SPAA. In the future, Meter Owners or Asset Managers may also become parties to the SPAA. Non-domestic gas suppliers are not required to become parties to the SPAA, but can do so voluntarily. The UNC does not address direct relations between transporters and suppliers in respect of gas transport (unless a supplier also happens to be a licensed shipper).

21 The SPAA Metering Schedule incorporates earlier obligations developed under the RGMA (Review of the Gas Meter Arrangements). The RGMA designed and base-lined standard industry-wide processes and data flows to support a competitive gas metering market in 2004.

22 National Grid Distribution, Northern Gas Networks, Scotland Gas Networks, Southern Gas Networks and Wales and West Utilities, and the National Grid National Transmission System (NTS). For historic reasons, Xoserve still resides within National Grid.

**Gas Meter Price-Control**

Domestic metering represents a small part of a customer's final energy bill – perhaps around 1-2% - and a small proportion of a suppliers' total cost-base[23]. Nevertheless, the metering price-control regime has helped to expose the costs of metering-related activity to greater scrutiny, and, together with the gradual move to metering competition, seeks to maintain a downward cost-pressure on what was (and for gas to some large extent remains) a monopoly activity in the hands of relatively few providers.

For gas, separate metering price controls were first established in 2000, with the aim of improving transparency in overall cost-allocation between Transco's then gas transporter and metering activities, prior to full business separation. The initial gas meter price control was reviewed in 2002 and again in 2006[24].

The price control takes the form of a price cap on 'basic' meters as at 2002, (ie not 'non-basic' meters or 'smart' meters) and caps the prices at which gas transporters may charge suppliers in respect of installation, maintenance and provision of a domestic meter – either credit or prepayment.[25] The domestic gas-meter price-control takes the form of three tariff-caps. From 1 April 2007 these are [26] :

- **Domestic credit meters** : £ 13.53
- **Pre-payment meters** : £31.61
- **Domestic credit to pre-payment exchange** : £55.43

[23] Ofgem. Decision on the Future of the Gas and Eletricity Metering Price Controls. 187/06. October 2006. p1. Ofgem estimates that for an electricity credit customer on average around 1-2 % of the final bill is for meter provision and meter maintenance (p. 15). It seems reasonable to make a similar assumption for gas credit customers too. For prepayment electricity customers, the equivalent figure for meter provision and meter maintenance as a proportion of a customer final energy bill is estimated on average to be around 6%. It would therefore seem fair to assume a higher proportion attributable to metering for gas prepayment customers, given the considerably higher maintenance costs associated with gas pre-payment meters.

[24] The initial gas-meter price control in 2000 took the form of an allowed revenue cap. In 2002 this was changed to a price cap arrangement. In October 2006, Ofgem indicated (187/06) that the present gas meter price controls will remain until conclusion of their Competition Act investigation into the Metering Service Agreements (MSA) for provision, maintenance and installation of domestic gas meters between National Grid and most energy suppliers. On 27 April 2007 Ofgem issued a supplementary statement (R/18) and at the time of writing, the timetable for conclusion of Ofgem's investigation is not known.

[25] For non-domestic metering services, there is also a Daily Meter Reading tariff-cap of £409.65 pa (07 prices). Uncapped metering services are subject to non-discrimination provisions. The caps do not cover the industrial and commercial meter market, nor meter reading services for non-daily metered (NDM) (ie domestic) meters.

[26] Indexed from 2000 prices.

The gas meter price controls apply to gas transporters – in effect National Grid and the four independent gas transporters[27]. Gas transporter licences include an ongoing Last Resort provision, requiring a gas transporter to provide metering services where requested by a supplier at the price-controlled rate[28].

**Pre-payment price control -** The gas meter price control arrangements reflect a maximum differential between gas credit and gas pre-pay tariffs[29]. Price-controlled meter providers are concerned that allowable charges for gas pre-payment meters remain considerably below actual cost-to-serve[30] and wish to see these charges become more cost-reflective. In the meantime, shortfalls in revenues from pre-payment meter activity tend to be recovered from credit meter charges. The pre-payment meter shortfall is therefore likely to be a particular issue for the new independent gas transporters without legacy meter assets but nevertheless with licence responsibilities for Last Resort meter provision within their geographic gas-distribution areas. Arguably, allowing charges for pre-payment meters to become properly cost-reflective could in time improve the overall cost-benefit of installing fully-smart pre-payment meters for certain customer categories.

**Meter Services Agreements** - The regulatory drive from 2000 onwards to unbundle Transco's gas network and metering activities, led to the need for a new industry-wide contractual framework for metering. In 2004, National Grid concluded negotiation of, and entered into, Metering Services Agreements (MSAs) for the provision, maintenance and installation of domestic gas meters with most suppliers[31]. These contracts provide credit meter prices below the price cap, in return for a supplier agreement to replace meters at a rate related to meter-life, specified in the contract. In effect, MSA credit meter charges are somewhat lower than the allowable tariff-capped credit-meter annual charges (but not for pre-payment), and in return the MSA includes a provision enabling suppliers to be

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[27] National Grid ; Scotia Gas Networks ; Northern Networks ; Wales and West Utilities. For example, from 1 April 2007, National Grid calculates its meter charges within the tariff caps as follows :

- **Domestic credit meters** : £ 13.53 (of which £7.75 is allowed for meter provision, £5.23 for meter installation and £0.56 for meter maintenance.)
- **Pre-payment meters** : £31.61 (of which £8.47 is allowed for meter provision, £5.23 for meter installation, and £17.91 for meter maintenance).
- **Domestic credit to pre-payment** exchange (£55.43)

[28] Gas Transporter Licence. Standard Special Licence Conditions A10 and A43. 'Last Resort' arrangements for gas meter provision will be revisited when gas-meter price-control is next reviewed. For electricity, the equivalent 'last resort' provision under price-controlled arrangements in respect of provision of new and replacement meters, and for meter operation, was removed from DNO Licences from 1 April 2007 (but retained with respect to provision of in-situ (legacy - pre-March 07) meters. Ofgem 187/06.

[29] Ofgem. Metering Price Control Review Consultation. 108/06. June 06. £15 at 2000 prices.

[30] National Grid estimate £17 per pre-payment meter. Ofgem. 108/06. p.15.

[31] Not EDF Energy and some smaller suppliers. Suppliers not party to the Meter Service Agreements are served via the cross-supplier negotiated PMA (Provision and Maintenance Agreements). Under the PMA, price-controlled tariffs apply and there is no provision for term or exit payments. The PMA also covers arrangements for Industrial and Commercial gas meters.

charged for premature meter replacement. There is currently a Competition Act investigation by Ofgem into the MSA contracts [32].

## Gas Meters – Facts and Figures

**Residential gas meters** - There are some 21.4 million domestic gas meters in Great Britain[33] of which 2.1 million (10 %) are pre-payment[34]. Almost all gas pre-payment meters are the Quantum model, which uses a smart-card technology.

**Gas customer payment methods** – 10 million (48%) gas customers pay by direct debit arrangement ; 7.5 million (35%) pay quarterly in arrears by cheque or cash ; 2.1 million (10%) are pre-payment ; 1.4 million (c.7%) pay by flexible schemes (weekly, fortnightly, or fuel direct)[35].

**Gas meter stock turnover** - Gas meters do not have a 'certified' life, unlike electricity. Around 1 million gas meters (c 5% of stock) are replaced each year, termed 'policy' exchanges. Replacement rates are implicit in depreciation treatment in the gas-meter price control[36]and in the Meter Services Agreement between National Grid and suppliers. Additionally, perhaps 200-400,000 new meters are installed per annum for new connections [37].

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[32] National Grid Meter Services Agreement – Charges Statement from 1 April 2007. MSA charges are calculated on the basis that the useful life of a credit meter is 20 years from installation and 10 years for a pre-payment meter.

The gas-meter price controls currently apply to meters covered by the MSAs, but provisions in the MSA allow them to be novated to other non-regulated businesses within National Grid Group. Should this arise, the regulated price controls would no longer apply to meters covered by the MSAs.

[33] Ofgem. Domestic Retail Market Report – March 06 (published July 06) and Ofgem. January 2007. Non-infringement decision. EDFE.

Equivalent numbers for GB electricity meters – 26.7 million total. 24 million non-half-hourly domestic meters (91%). Of these Elexon estimate c. 16 million are single-rate credit, c. 4.5 million are multi-rate (including Econ 7) and 3.5 million (c.14 %) are pre-payment ; 2.5m (8.5%) non-HH non-domestic in Profiles Classes 3 to 8 ; and half-hourly meters 110,000 (0.4%).

[34] Ofgem. Domestic Metering Innovation – Next Steps. June 2006. p 15

[35] DTI website – www.dti.gov.uk/energy/policy-strategy/consumer-policy/domestic-comp. Equivalent numbers for electricity are : Total customers – 24.8 m of which Direct debit – 11m (44%) ; Quarterly – 9 m (36%) ; Pre-Pay – 3.5 m (14%) ; Flexible – 1.3 m (5%)

[36] Straight-line depreciated over 20 years.

[37] In 2007, construction of new homes in England is running at c.150,000 pa. Also, estimate from DTI Smart Meter Working Group, 2001.

**I&C and larger SME customers** - There are over 400,000 industrial, commercial and larger SME gas meters of which 2,000 are Daily Metered customers. Most non-daily metered customers do not have automated meters, and are divided into four bands[38]. *See Chart overleaf.*

**Metering as a proportion of final bills -** Electricity meter provision and maintenance is estimated by Ofgem to represent around 1-2% of the final bill to domestic customers – and prepayment perhaps around 6%. For gas, similar figures may be assumed (but slightly higher for pre-pay).

**Gas theft** - the figure traditionally attributed to unidentified theft of gas has been very low at 0.3% of total LDZ consumption[39].

[38] Advanced Metering for SMEs. Carbon and Cost Savings. Carbon Trust. May 2007. Also, SBGI web-site.

[39] Ofgem Review of Reconciliation by Difference, p 17. 31 March 06 states that some estimates for the value of gas and electricity stolen are as much as £100m pa – but most of this is understood to be electricity. ENA Report of the Theft of Energy Working Groups. April 2006 suggests a range of £10-60million for electricity (2003 prices) and below £1million for gas (2004 prices).

**Chart – UK Gas-Customer Meter Bands by Gas Consumption Levels.**

| Meter Band | Consumption MWhpa/therms pa | Meter-Read / Billing Type | Number of Meters | Average Annual Gas Consumption |
|---|---|---|---|---|
| **Daily Read (DM) automated** | >58,600 MWh<br><br>(UNC DM requirement) | Automated | 2,000 | |
| **Non-Daily Meter Read<br>Bands 1-4<br>(Monthly NDM)** | | | | |
| **Non-Daily 4** | >5,860 MWh | Monthly Read<br>(not all automated) | 3,100 | 14,240 MWh |
| **Non-Daily 3** | <5,860 MWh –<br>>2,196 MWh | Monthly Estimated | 7,700 | 3,320 MWh |
| **Non-Daily 2** | <2,196 MWh –<br>>732 MWh | Monthly Estimated | 26,600 | 1,160 MWh |
| **Non-Daily 1** | <732 MWh –<br>>73 MWh /<br><br><25,000 therms -<br>>2500 therms | Monthly Estimated | 381,000 | 170 MWh |
| **NDM Domestic and Most SMEs**<br><br>**Six-monthly meter-reads - or less** | <73,200 KWh /<br><2,500 therms | Quarterly estimated. On average, two-reads pa | 19 million plus 2 million PPM | c. 20,000 KWh pa |

**Source – Carbon Trust. Advanced Metering for SMEs. May 07**

# Gas Meter Technology

**Gas meter design -** Gas meters vary in design according to their energy off-take. Capacity of a gas meter is the main determinant of cost, depending on size, materials and complexity of metrology.

## Domestic Gas Meters

Gas meters in residential, SME and smaller commercial premises in GB operate at low pressure, below 7 barg. Over 90 % of these low-capacity meters are mechanical diaphragm meters operating at standard low pressure [40]. The most common domestic meter-type is known as U-6, entailing a gas flow of less than 11 standard cubic metres per hour (scmh). U-6 meters measure gas-usage from very low volumes (eg from pilot-light) to substantial central heating loads[41].

While the materials used in meter-manufacture have evolved over the years, diaphragm metrology has changed little in over a century. It is robust, economic, accurate at small volumes, does not require an external power source, is virtually maintenance-free and a thirty-year meter life is not unusual although accuracy may diminish over time[42].

Around 8% of installed residential gas meters in GB are ultrasonic (E6). In these meters, gas flow is inferred by measuring the velocity of the gas as it passes through the meter and a computation is then carried out to determine the volume that has passed. Ultrasonic meters are presently higher-cost than diaphragm meters, are high-accuracy, and commonly used for pre-payment[43]. For both diaphragm and ultrasonic meters, the supplier is presently reliant on a pedestrian meter-read for billing purposes, and thereafter calculates

[40] 25 millibars

[41] Other meters in common domestic use in the UK are R5 and G4. U16 meters measure larger SME / commercial gas-loads below 21 standard cubic metres per hour.

[42] See Kromschroeder website (www.kromshcroeder.de) for animation of how a diaphragm meter works. Domestic diaphragm meters measure gas on a 'positive displacement' basis. Within the meter, this involves use of twin chambers of known volume as measuring units. The chambers are fitted with a gas-tight diaphragm, driven by the differential pressure between the inlet and outlet of the meter. The gas enters the diaphragm chamber via a radial valve, designed to continually slide to and fro. Gas enters one side of the diaphragm while at the same time the other side is emptying through a separate opening on the valve. Once one side of the chamber is full, the valve moves across, allowing the gas to fill the side which has now emptied. The radial valves are in continuous motion, linked to a fixed arm which physically transfers the motion of the valve to move a numeric register, or dial, enabling a display on an index of the total volume of gas used. Actaris web-material. Also, for detailed explanation see – 'Diaphragm Meters, Applications, Installations and Maintenance. Paul G Honchar. Sensus Metering Systems. Dubois PA. 43rd Canadian Gas Association Gas Measurement School. June 2004.

[43] Eg E6V

the energy provided. This is done by taking the gas volume recorded by the meter[44]and multiplying this by the calorific value and a temperature and pressure correction factor[45].

**Conventional Gas Pre-Payment Meters** – Of the 2.1 million conventional pre-pay residential gas meters installed in UK homes, most are the Quantum model. Depending on the model, these use an electronic token or smart card. Key technology could also be available. The smart-card technology allows transfer of information such as tariff-changes and meter-reading data at the payment service point and is therefore 'semi-smart'. Pre-pay meters have a battery-powered isolation valve to enable safe cut-out and cut-in of the gas supply when credit runs out and is later topped up.

**Non-Domestic Meters**

Higher-capacity meters have a higher capital cost and more costly and complex installation requirements, including larger regulators, valves and pipework. They may also require pressure protection systems and filters.

There are presently three main types of meter in use in the Industrial and Commercial sector – diaphragm, rotary and turbine. Diaphragm meters do not need regular maintenance, unlike rotary and turbine meters. Installations connected to high-pressure systems operating above 7 barg are considerably more complex, and may include a flow computer and perhaps equipment to reduce pressure and pre-heating.

Daily Metered industrial meters, and a limited proportion of other high-end Band-4 (monthly-read) and Band-3 commercial gas-use meters increasingly have some form of AMR.

In the wake of new requirements to display Energy Performance Certificates in certain large public buildings and the intended Carbon Reduction Commitment scheme for private and public enterprises with large-scale energy use, suppliers will increasingly make new arrangements for metering and billing with many of these larger Band 3 and 2 customers too. The recent Carbon Trust report highlighted the need for the bulk of the

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[44] Many installed gas meters in GB (around 70%), still measure gas-consumption in cubic feet – ie in imperial units. Formally, under the Weights and Measures Act 1985, imperial measurement is prohibited for all equipment which post-dates 1980. This has not been judged a reason to replace gas meters.

[45] The calorific value (CV) is a measure of the heat energy contained in a certain volume of the gas when it is burnt. The CV is measured on a daily basis for areas of the gas network and the relevant values are then used for energy billing for meters connected in that area. The CV is defined at standard test conditions of temperature and pressure so in order to account for local variations from this standard, a correction factor is applied representing more 'normal' conditions.

remaining 380,000 gas meters in smaller industrial and commercial concerns (Band1) to have access to smart meters as a priority.[46] Importantly therefore, the May 2007 Energy White Paper proposals for the I&C sector now mean that conventional metering for I&C gas customers in non-daily bands 4 to 1 will be replaced over the next five years by advanced or smart metering services. This is welcome.

Nevertheless, for most of the UKs smaller SME gas-customers, gas-consumption sits below the 73,200 KWh pa threshold (<2,500 therms pa). Therefore in metering and consumption terms, these customers are not readily distinguishable from domestic gas customers. Any measures adopted with respect to smart meters for domestic customers will therefore be very important in reaching these smaller SME customers.

**Domestic Gas Smart Meters**

Electricity smart meters are commercially available in the UK and internationally, both for the I&C and residential sectors.

For gas, a wide range of AMR (Automated Meter Reading) and AMM (Automated Meter Management ) products are commercially available for installation in the non-domestic sector, both in the UK and internationally.

For the domestic sector however, models of stand-alone automated gas-meters are presently neither widely available commercially, nor mass-produced. To date, from the point of view of manufacturers, demand for gas smart-meters has not been there and, without volume, costs have looked high. In this sense, at the time of writing, gas smart meters are not readily available for off-the-shelf purchase for installation across the UK's stock of 21-million domestic gas meters points. Nor are domestic stand-alone smart gas-meters being widely manufactured or deployed elsewhere in the world[47].

For the UK, domestic gas smart meter models are now being developed in connection with a number of new supplier-led projects, including (but not only) the DTI Energy Demand Research Project (to be managed by Ofgem), and shortly to get underway. At the time of writing only a very few gas smart meters are actually installed in homes. The ERA is concluding its development of a detailed technical specification for a new gas smart meter, which is likely to prove central to GB gas smart meter development going forwards.

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[46] Carbon Trust. Advanced Metering for SMEs. May 2007.

[47] Most AMR in US, incl California, understood to be retrofit of existing meter – not stand-alone new meters. Netherlands – a few thousand stand-alone.

A number of basic technical considerations relating to gas smart meters, and which differ from electricity, are worth high-lighting here.

- **Power Source -** For safety reasons, and unlike electricity meters, gas meters are not directly mains connected. Any electronic function associated with a gas meter therefore requires a battery.

- **AMR / AMM** – Communication is often characterised as one-way (meter-to-supplier), or two-way (meter-to-supplier and supplier-to-meter). This is because to date much AMR experience around the world has been one-way. In practice, there is no particular technical- or cost- constraint on two-way communication for gas meters, even where remote meter reading remains the main objective. Two-way communication is necessary for some functions : remote changes to retail-tariffs and to enable switch between pre-payment and credit functions. (For semi-smart pre-payment / pay-as-you-go by card or key, limited two-way communication is effected via the card).

- **Metrology** – Metrology in a gas smart-meter may be mechanical (ie diaphragm), ultrasonic, or, potentially, newer flow-sensing technology.

  If the metrology is mechanical some additional means will be needed to electronically capture a numeric value for the conventionally-measured gas-volume – and then a means to transmit it. In this way, some existing models of conventional gas meter may be fairly readily 'smarted' by adding an electronic module to the existing meter box. This option is understood to be in active development.

  More recent developments in gas-flow sensing technology beginning to be deployed in larger industrial and commercial electronic gas-meters. At volume, new electronic domestic-sized gas meters incorporating newer sensing technologies may begin to offer a cost-competitive alternative to conventional gas-metrology. Also, potentially by function of taking up less space in the meter box may to some extent offset some materials-related costs in the meter[48].

- **Communications -** For safety reasons, communications from a gas meter will almost certainly be wireless and therefore battery-powered. Subject to this constraint, all wireless forms of in-home and wider communication are possible – GPRS / GSM modem, and Radio – regardless of whether 'smarting' of the meter is achieved with a new electronic meter, or, via retrofit of the existing meter.

- **Pre-Payment Safety Valve** – Electronic smart-meters which may in future have a dual credit and pre-pay function will continue to require a pre-pay safety valve and a

[48] Sentec

highly robust and safe means of switching between the credit and pre-pay functions. The ERA specification addresses this.

- **In-Home Visual Displays for Non-Smart Mechanical Gas Meters -** Unlike for electricity, a separate 'non-smart' in-home consumer display for gas **cannot be wirelessly linked to a mechanical gas meter**. To do this for gas, a meter pulse output would first need to be activated and transmitted to and captured by a data-logger. **In other words, a separate display from a conventional gas meter can only be achieved with some form of data-logger arrangement which is not a low-cost option.**

  With a new stand-alone gas smart meter it will of course be feasible to have a wireless link to an in-home display, including to a shared display with the electricity meter.

  Notably, around 1.4 million domestic boilers are replaced each year, and of these, half also involve boiler-control upgrades. One alternative might therefore be development of more sophisticated in-home electronic displays for gas-boiler or central heating controls. For many households, the gas-boiler may prove a very good proxy for the gas-meter in terms of overall gas consumption[49]. It should be feasible to develop a variety of simple consumer products attaching to a boiler control panel, able to offer user-friendly messaging about approximate gas-use over a day, week etc, external and internal temperature, thermostat turndown etc. Controls of this kind would need to be installed by a qualified electrician, and are not likely to be 'self-install'.

## Smarting Existing Meters by Activating a Meter Pulse Output

A pulse mechanism activated on an existing meter – either gas or electricity – and coupled with retrofit of an electronic AMR capability - potentially offers an alternative to a new smart meter.

The pulse output from a meter can either be already in-built - or externally synthesised – and subject to the chosen arrangements for data-logging and consumer electronics, can offer scope for a variety of smart consumer functionality, without replacement of the existing meter. Use of the meter pulse output has been the basis for much AMR development in the US. The ERA specification presently does not include the possibility of meter-retrofit, but the potential costs, benefits and practicality of retro-fit of some existing domestic gas credit meters in GB, as against installing new smart gas meters, is

[49] At least for space-heating and much hot-water. Not for cooking, individual gas fires etc.

nevertheless an option to consider. Not least, it may offer a means of simple dual-fuel arrangements and may also help to mitigate stranding costs for legacy gas meter assets.

**How a Pulse Offers the Potential for Smart Retrofit of Domestic Gas Meters**

In addition to the basic numeric or dial register, certain gas meters have an inbuilt capability to create a 'pulse' every time a given volume of gas has passed. These pulses can be 'counted' by a datalogger [50]. This pulse-generated data can be totalled, stored, and / or onward transmitted. Communication of the pulse information away from the meter is likely to be a data-signal (rather than by pulse) and can (uncommonly) be by wire e.g. like a telephone wire, or, can be wireless e.g. Low Power Radio.

If a meter reading is taken at the outset, and the value of each pulse is known (for example, one pulse per cubic foot), then at any time it is possible to calculate the meter reading remotely by adding the volume-equivalent of the number of pulses counted, to the initial meter-read. This forms the basis of most AMR technology.

Around 55% of domestic gas credit meters in Great Britain may be either **'pulse enabled' (R5 meters)** or **'pulse-ready' (U6/G4** meters - which have the rotating magnet fitted but require retro-fit of the switch). In practice, this covers almost all domestic credit meters installed by National Grid since 1992. (Not known whether the roughly 2 million new gas meters installed since 2003 by other meter operators have a pulse capability). In addition, a further 10% (approx) of gas credit meters are ultrasonic (E6). These meters have an 'optical port', which can also be retro-fitted with a (different) technology to read the meter.

Domestic gas credit meters installed prior to1992 have no inbuilt pulse capability. This represents roughly 35 % of the meter stock. This proportion is reducing as older meters are displaced.

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[50] **How a Pulse is Created -** The pulse is commonly generated using a magnet connected to the rotating index, which as it passes, causes switch-contacts to open and close. If an electrical detector is connected to these contacts then each closure and opening of the switch can be used to create an electrical pulse. On a gas meter, the electricity supply must be at extremely low voltage to avoid the possibility of creating a spark. The connection to the meter is normally made via an electrical isolation device, sometimes known as a 'barrier' or 'chatterbox'.

For meters without any inbuilt pulse capability, (or those where the internal contactor mechanism has failed) it is feasible to create a pulse by clipping-on an external sensor. These sensors are usually optical devices which use a photo cell to detect movement of the index and use this to synthesise a pulse output. More sophisticated devices actually 'read' the numerical characters on the index and are known as Optical Character Recognition (OCR).

**Available Add-On Devices**

A variety of potential 'add-on' pulse devices are available – both for gas meters which are pulse capable, and for those which are not. Our understanding of the main type of add-on device is as follows.

- **For Pulse-Enabled R5 Meters** – simple connection of a datalogger / AMR device to the contacts on the meter. Some dataloggers / AMR devices (such as that used by National Grid in commercial installations) contain an integral electrical isolation barrier so that wires from the unit can be connected directly to the meter ports. The AMR unit is battery powered.

- **For Pulse-Ready U6/G4 Meters** – simple retro-fit of switch unit to provide pulse capability. Cost approximately £5 (may be less at volume). Installation – few minutes additional time when AMR / communications unit anyway being installed. Comments regarding fitting of AMR unit as above.

- **For Meters with Dials** – External Clip-On attached to the outside of the index which can sense / count rotations of a dial and synthesise a pulse – requires power source e.g. battery. Relatively simple device and no meter modification required. Some manufacturers offer this in a single unit with a datalogger / AMR communications device. Otherwise can be wired - or wireless - connection to a datalogger/AMR unit. Some issues with location (incl, for example, exposure to sunlight) and secure attachment of the device to the meter to maintain ability to visually inspect the index whilst avoiding possibility that it is easily displaced. Thus, requires careful fitting. Low power consumption for the sensor device, so expected long battery life[51].

- **For Meters with Numeric Index** – External Clip-On which 'looks at' / reads meter index and either synthesises a pulse or uses electronic Optical Character Recognition (OCR). Varies from relatively cheap (simple photo cell detector) to expensive (OCR). Other comments as above for dial meter devices.

- **Ultrasonic E6 Meters - Optical Read** – Retrofit of electronic device which can connect to the optical port of the meter. Understood to be higher-cost than other add-ons, but potentially could be combined with datalogger / AMR device.

Add-on devices for meters which have an in-built pulse capability are lower-cost than add-ons for meters which have no built-in pulse or optical capability. However, gas meters without pulse-capability are among the 35% of pre-1992 meters, and may therefore be candidates for replacement under the policy of accuracy-driven meter exchange programmes.

[51] >10years – National Grid. Metering Europe Conf. Copenhagen. Oct 06.

**Possible Constraints of 'Add-On' Devices**

- Possible need for industry-wide safety agreement if mounted onto meter
- Physical space needed to fit device onto meter index.
- Electrical isolation required (eg 'chatterbox' or barrier) if connecting to integral pulsar unit.
- Where device dependent on optical technology, high security of attachment needed.
- Many gas meters are located outside home – could pose security issues - and strength of LPR signal if sending pulse signal by radio to separate datalogger / AMR unit.
- Regulatory – consumer must continue to have access to primary register on meter to verify their bill – i.e. any add-on device must not obscure meter index.

**Possible Benefits of Add-On Devices**

- Low cost for some options – especially for 'pulse ready' U6/G4 meters
- Potential flexibility ie one of several options for supplier
- Potential to offer AMR benefits.
- Two-way communication also feasible, enabling some consumer functionality via AMR/smart box (eg pulse-count could be stored by interval – enabling block or seasonal tariffing; connection to separate visual display, or internet access to consumption data).
- Does not strand existing meter asset and could be rapidly deployed
- Dual-fuel retrofit could be carried out by single person at same time. Can retrofit with electrician – rather than requiring a CORGI engineer – (unless intrude into meter or interrupt gas path). Will nevertheless require certain competence level – eg ability to decide suitability of meter for retrofit, ability to handle commissioning etc
- Meter Pulse Utilisation Code – New Industry Code of Practice – including for residential meters.

**Possible Shortcomings of Add-On Devices**

- Comparative economics of retrofit to fitting new smart meter - eg still need site-visit ; risk of poor pulse condition in pulse enabled (R5) meters ; on-site verification that pulse working correctly etc.
- Accuracy of pulses for billing - if datalogger 'miscounts' the pulses then inferred reading will be incorrect.
- Need to calibrate pulses - and correctly synchronise with initial meter reading.
- Fraud – consumers could interfere and interrupt pulse output.
- Two boxes needed (meter + datalogger/AMR).
- Device needs to store / process data and then transmit. Power consumption depends on frequency of transmission – transmission frequency of pulse output may therefore be a constraint if battery powered, although no evidence of this from US experience for example.

## Battery Life

For a meter to be truly smart it needs to be electronic in operation to provide smart information and thus it needs access to a power source. Batteries will generally be required in all smart meters, whether gas or electricity. Electricity smart meters can utilise mains power so the battery's main function is to maintain the clock and other fixed data in the event of a power failure. As the battery would be used infrequently if would therefore last for the useful life of the meter.

The general consensus is that gas meters cannot be connected to mains power for safety reasons, although there are some suggestions that it might be possible to provide a low voltage/low current supply within safety requirements and this could potentially reduce the battery demand. However, the current assumption is that a battery is required in a gas smart meter to power all the electronic functions – including gas measurement, the two way communications modem and prepayment functionality (where required).. Therefore battery life is potentially a more significant issue for gas smart meters.

### Current Gas Pre-payment Meters

The current range of non-smart gas prepayment meters already require a battery for at least some functions. In general the meter would have one battery (or set of batteries) for all functions.

- For all types of gas prepayment meter – a battery is required to operate the solenoid which controls the valve that disconnects and re-connects the gas supply when credit runs out and is later topped-up.
- The older Quantum electronic token meter (ETM) is a mechanical meter with an electronic module permanently fixed to the front. There is no requirement for a battery to operate this type of meter, only the electronics of the prepayment function and the valve.
- In electronic meters, such as the E6, or ultrasonic Libra the battery is required to operate both measurement and valve actuation
- In electro-mechanical meters (pulse enabled or pulse ready) the battery will operate the valve (as with the E6) and the pulse generator.

Battery life has typically been increasing with improvements in technology. Typical life for (old technology) Quantum meters is approx 2-4 years. Average life of batteries for the newer prepayment meters is 10 years (design criteria) but the possibility is increasing of significantly longer life, maybe up to 20 years. However, the life of the battery is crucially dependent on the frequency of valve actuation and can at present be anything between 2 and 10 years. Average life thus depends on customer account usage. On newer designs one disconnect per fortnight should support 10 years (some say 12 years and increasing).

**Gas Smart Credit Meters**

Battery requirements for credit smart meter functions :

- Measurement of gas volume – Battery not required in a diaphragm meter but is required in an electronic or ultrasonic gas meter. Data store / memory function – battery required in all cases.
- Tamper sensors etc - battery required in all cases.
- Communications (i.e. to transmit and receive message). Battery power will be required for all communications whether they are within the house (e.g. between the meter and a separate visual display and/or a data store in an electricity smart meter) or outside the house to the supplier.

It is the communications functions that make the heaviest use of the battery and thus are the main variable affecting battery life in gas smart credit meters. Power consumption depends on frequency of communication and whether the meter is 'listening' for incoming communications or just switches on when required (e.g. once a day) Some manufacturers suggest that the range is as follows : once a week send and receive information – 12+ years; once a month send and receive information – 15+ years; once a day send and receive information – 5+ years.

There are also important differences between low power radio(LPR) and GSM/GPRS. In terms of battery power GSM takes much more power for the same time length of communications. GSM typically uses 1-2 watts to transmit, whereas LPR requires typically 10-100 milliwatts. Some manufacturers suggest that for LPR communications from a gas smart meter to a local (i.e. within the same property) electricity meter – 48 times per day gives 10+ years.

However, understanding the overall difference in power consumption is rather more complicated due to the different ways in which GSM and LPR will operate. To reduce power consumption GSM will have a defined transmit/receive schedule, although it will still drain some power in stand-by mode. LPR will either need to transmit continuously or listen continuously for a wake up signal – either way it will be using power all the time. The general assumption is that GSM will use more power, but it may be possible to manage the communications to give a similar battery life irrespective of the choice of LPR or GSM. Designing the meter to accommodate two large (D cell) batteries is also an option for extending battery life with GSM.

Another factor to take into account is that communication distances are much shorter with LPR than GSM. LPR gives only a short hop capability but might be better for local hub solutions. An option therefore is for the gas meter to communicate with the electricity meter using LPR , and for onward communication to the supplier to take place from the electricity meter using GSM.

GSM is generally higher power and could give more secure communications.
GSM is more expensive but does not need an infrastructure. Low power radio units are less expensive but there is a need for an infrastructure. The cost of the infrastructure must be amortised over the volume of units. At present, LPR is around £10-15 cheaper than GSM.

**Add on Pulse Alternatives**

Add on pulse alternatives generally need a battery to enable them to collect and store data and to transmit / receive data to / from another smart device connected to a power source. Some optical probes connected (hard-wired) to an AMR device do not need their own battery as they can be 'powered' from the datalogger/AMR.

**Separate Visual Displays**

Separate visual displays (i.e. a display unit for customer use in a convenient location, that is linked to the smart meter via some form of wireless connection) could either be battery or mains powered. If mains powered this could be wired in or, more likely, plugged into a 13-amp socket to allow movement flexibility around the house. A battery may be provided for back up.

Although a number of add on displays on the market at present are battery powered, mains power is the more likely option as this will not suffer battery life limitations – this will be important if customers want to interrogate their display often to check on consumption.

**Factors affecting battery life**

Battery life depends on several factors, e.g. battery technology, operating environment (temperature/humidity), number of valve operations, any other high-current operations such as smart card insertion etc. Quiescent current (i.e. how much power is drained even when functions that use current are not being performed) is a key factor.

**Some key factors that can affect battery life are:**

- The number of functions the meter is required to perform – e.g. storage of interval data , pre-payment / credit switch, ability to detect fraud, battery deterioration, etc. However, some functions use virtually nothing whereas, others use lots. As a rough guide, disconnect and data transfer uses the most, so if you disconnect everyday and send data every hour, the battery will deplete quicker.

- How frequently the meter sends and receives data such as meter readings and tariff changes (and credit top-up for prepayment) The effects may vary according to communications (LPR or GSM – see above)

- How frequently the customer interacts with a visual display, to check their consumption or other data . This could affect battery life within the meter as well as the life of any battery in the display itself. Heavy use of a large graphic display that is backlit might have a particularly large impact on battery life. However, it depends upon how the interaction takes place. If each interrogation requires the meter to 'wake-up' and then broadcast the latest (real-time) information then battery consumption will be greater. If the display shows only the totals at the last 'routine' download then the battery life will not be affected. Minimising the communications duration when updating the display will help to reduce power consumption. "Excessive" use of the display could be controlled by a configurable software parameter. For example, information flow to the remote visual display can be sent to a pre-prepared programme that optimizes the data packet size for communications between gas meter and remote visual display to save battery power.

For the gas smart meters being installed by Oxxio in the Netherlands, battery lifetime is expected to be 12-15 years, assuming daily usage of RF communications. These gas smart meters send a daily message by RF (LPR) to the electricity smart meter, which in turn sends messages to OXXIO via GPRS. Oxxio's business case assumes a battery replacement by the meter operator after 12 years.

**Battery Deterioration Detection**

Accurate empirical measurements of remaining battery capacity are not not easy to do, but there are various ways to monitor and deal with deterioration.

- Battery deterioration can be detected by measuring voltage
- Another option is a simple pre-set calendar that counts down against predicted life.
- Currently deterioration is often picked up through a flag which is displayed on the meter, and reported to the Meter Owner by the meter reading agent. For Smart meters it is likely that this will be a message which the meter will automatically generate. For example, a register can count the number of user operations (valve cycles, button presses, card insertions) – each operation has an associated energy consumption figure. Each time an operation is performed, the counter is decremented by this figure, to record power usage. When the counter reaches a calculated threshold (e.g. 6 months remaining life) a low battery warning can be shown on the display and a message sent to the data manager/supplier. "Low battery" could be a standard alarm message with any communication s technology.

**Who can change batteries?**

Who can change a battery could be an important issue as it can have an impact on costs. Clearly the lowest cost option would be for the customer to change the battery on the meter, datalogger or visual display. The most expensive option is if the battery has to be changed by someone who is CORGI registered. In between these would be for someone with a lower qualification to change it.

Currently batteries in prepayment gas meters are changed by a representative of the meter owner who has the appropriate training and CORGI registration. However, the battery box is sealed and while some batteries are replaced on-site, a proportion of meters are actually removed and batteries replaced in the factory. Many consider that CORGI registration is not really required and that a lesser qualified person (e.g. meter reader) could exchange batteries. It requires the permission of the meter owner and appropriate equipment to reset the meter / reset any tamper alarms.

It is possible that a meter could be designed which would allow the customer to change the battery, but a battery accessible to the customer would provide the means for a customer to interfere with the operation of a Smart meter, simply by removing the battery. A battery compartment in the meter would therefore need to be sealed and accessible only with special tools. It is unlikely that any battery associated with the base metrology could be changed by consumer as the MAM has a Gas Act duty to maintain the meter in proper order for registering gas supplied.

It is likely that the preference will be to make meter batteries last as long as possible and for them to be replaced (as is presently often the case) in the factory only as part of refurbishment.

**Separate Visual Display** – If these have batteries then they would be able to be replaced by the customer. However, as noted above, it is more likely that they would be mains operated.

## Conclusions on battery life

To sum up therefore :

- Battery life for gas smart meters (credit or prepayment) is likely to be 10-15 years under most communications options and usage scenarios. This should therefore equate to the expected asset life.

- On the basis of a 10-15 year life, batteries would not need to be replaced on-site. Where replacement is undertaken this would be at the factory as at present with gas prepayment meters, where the meter would be tested and re-certified with a new battery.

- In practice, the approach to battery life will be to specify what power demands are required(e.g. frequency of communications  and then design a battery to meet this demand. The question is then about cost.