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Smart meters in Great Britain: the next steps?

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Sustainability First

Sustainability First aims to mainstream sustainability into public policy by developing new ideas on major environmental issues, such as climate change, waste and transport.

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1. Introduction

Since Sustainability First's March 2006 report the debate about smart metering has moved on in a number of ways. The general consensus is that smart metering will and should happen in the UK but the areas of remaining debate are about:

- What policy or regulatory changes could or should be made to facilitate this?
- The timescale – for households and businesses.
- Whether smart metering delivery should be left to decisions by individual market actors or whether some form of geographic co-ordination is required.
- The extent of the potential energy market players' and public benefits (affordability, security of supply, environmental).

Given this context this report aims to make a contribution to the current areas of debate by covering the following issues:

- Gas meter market and technical issues for gas smart meters (the 2006 report focused on electricity smart meters).
- Communications options for electricity and gas smart meters.
- Costs of smarting gas and electricity meters.
- Social and prepayment meter issues – electricity and gas.
- Smart meter contribution to UK goals for energy saving and carbon reduction.

This is the main report and it is being published in hard copy and on the Sustainability First web site. This report summarises detailed papers on the above five topics. The full papers are available via the web site (www.sustainabilityfirst.org.uk), along with case studies on recent experience with smart meters in California, the Netherlands and Northern Ireland.

2. Executive summary

Since Sustainability First's March 2006 report the debate about smart metering has moved on, due to work by Ofgem, the Energy Retail Association and the Energy White Paper that sets out the Government's "expectation that, within the next 10 years, all domestic energy customers will have smart meters with visual displays of real-time information that allow communication between the meter, the energy supplier and the customer." The consensus is that smart metering should happen in the UK but debate continues about what policy or regulatory changes might be needed to facilitate this.

The Energy White Paper's vision is welcome. However, to achieve smart meters for all in a ten year timescale will require major investment in new meters and associated communications and at least a doubling of the current meter replacement rate. The lack of clear supplier incentives for mass smart meter installation means that at least some government and/or regulatory intervention will be required if the vision is to become a reality.

Potential impact on energy demand and emissions

The ability to influence consumer behaviour is central to the public policy rationale for smart meters. A visual display linked to the smart meter could provide immediate feedback. However, displays without a smart meter will not facilitate a link to price signals through innovative tariffs. Low-cost stand alone visual displays are not available for conventional gas meters and yet households use around four times more gas than electricity. The Energy White Paper proposes that suppliers provide visual displays on demand to households from 2008-10, but potential energy savings may fall short of the 2010 carbon reduction goal for domestic metering and billing. If the EWP proposal results in displays being delivered without smart meters, it runs the risk of limited benefit for potentially significant cost and diverting supplier effort from the greater prize of full smart meters. In-home displays should be delivered along with smart meters and not as a separate initiative.

In our 2006 report we estimated that smart meters, as part of a package of energy saving initiatives, might produce a 1-3% energy saving in the domestic sector. We feel it is right to stick to this until more empirical GB evidence is available. Although a 1% saving sounds small, it would be very worthwhile – potentially around 8% of the UK's domestic sector carbon target to 2010. The potential energy and carbon saving benefits of smart meters are most likely to be realised where they are linked with advice, information and financial incentives (e.g. EEC/CERT), and sustained media activity.

Smart meters can be used to give price signals to save energy and shift demand. For gas, a one-degree centigrade thermostat turn-down might reduce domestic gas use by 10%. For electricity, there is a potential discretionary load for domestic electrical appliances of around 20-25% (around 16TWh pa or 2MtC) – mainly wet appliances including tumble-driers, and, electric showers, chargers, stand-by power, and some lighting. However, it is hard to anticipate how much discretionary load would shift in practice, and, much domestic electricity load will not respond to time-of-use tariffs.

Trials with electricity time-of-use tariffs in Northern Ireland, California and Australia have achieved demand shifting from peak periods, but limited if any overall energy saving. Electricity demand shifting by households may offer some modest operational security of supply benefits and some emissions reductions, but overall demand reduction for both electricity and gas will produce greater emissions reductions.

Social issues

A broader range of tariffs and pricing options could provide new services of value to consumers, but time-of-use tariffs would need to be accompanied by clear information to enable consumers to make informed choices.

Two particular social issues that need consideration are whether low income/vulnerable households would be able to benefit from new tariff options and whether more information would cause such households to cut back on essential use. These social factors need to be borne in mind by suppliers, the Government and Ofgem in the deployment of smart meters. Furthermore, smart meters need to form part of a broader strategy to improve energy efficiency for low income households.

Smarter prepayment meters offer the potential to reduce some of the costs associated with PPMs and also may attract more customers to "pay as you go", producing supplier and customer benefits. However, whilst improvements in technology may tackle some of the causes of higher charges, there are also other factors causing the differentials between prepayment and direct debit.

Technical and cost issues

There is currently more experience with electricity smart meters and better commercial availability of the technology than for gas. Smarting electricity meters is cheaper than smarting gas meters and less complicated. Linking the gas and electricity meters to share communications offers some cost savings and is the approach being used elsewhere (Netherlands, California), but would necessitate solutions to the complexities that would arise in the GB market, due to many customers not having a dual fuel contract and having a choice to switch supplier.

For electricity all smart meters should support prepayment as this adds little to costs and will result in savings in replacing meters when customers change payment method. For gas, the extra cost of prepayment functionality is currently more significant, and so a fuller appraisal of the costs and benefits of widespread installation of smart meters with this functionality would be required.

Communications choices relate to the investment strategy (targeted versus geographic roll-out) and location (meter density). At present it is assumed that dedicated network options such as Power Line Carrier or Radio will be cheaper than GSM and so the latter may be best used only in less dense areas or for a targeted as opposed to geographic approach. However, the costs, technicalities, governance and regulatory arrangements of dedicated network options need to be better understood. GSM, plus options such as home broadband (around 50% of UK homes have broadband) could become more attractive. Future flexibility and adaptability remain important principles in an environment that is extremely dynamic in technical and cost terms.

We have estimated cost ranges for smart meters for the domestic sector, but would stress that we have not been able to clarify all costs. Estimated capital costs (smart meter and communications) at 300,000 volumes (prices would be lower at significantly higher volumes) are:

- Gas credit meters – £55-100, depending upon whether retrofit or new.
- Gas prepayment meters – £100-140.
- Electricity meters (credit and prepayment functionality) – £40-75, depending upon communications options.
- Gas and electricity meters together (credit and prepay functionality for electricity, credit for gas) – £80-140, depending upon communications options and whether new or retrofit gas meter.
- Gas and electricity meters together (credit and prepay functionality for electricity and gas) – £110-180, depending upon communications options.

To these costs need to be added installation – £25-30 for one meter or £40-55 for two meters. A separate radio-linked visual display would add £20-30. There are also stranding costs, data infrastructure costs and recurring costs, to take into account.

The cost estimates for electricity smart meters have fallen since our last report and it is likely that this trend will continue, particularly with increases in volume, and also apply to gas smart meters and communications options. Policy and regulatory approaches thus need to be flexible enough to secure the benefits of future cost reductions.

Policy options for smart meter investment

Agreement by suppliers to the Energy Retail Association's (ERA) interoperability specification will be a fundamental step in averting potential stranding of new domestic smart-meters, but it does not guarantee that any smart meters will be installed – it sets out agreed standards if suppliers choose to install them.

Although recent regulatory changes address some barriers to smart meter installation there are only clear incentives for targeted installation of smart meters (up to perhaps 30% of customers) for suppliers. Furthermore, the uncertainty around what, if anything, the government will mandate, is likely to further inhibit investment. Government intervention is thus required if its ambition of smart meters for all within 10 years is to be met – the question remains what forms of intervention will deliver most benefit at least cost. We have developed thinking from our first report to set out three broad delivery options that can be summarised as follows:

- **Option 1: Evolution of supplier-led approach –** for metering provision and services, within a mandated timescale and framework. This would require four key policy changes. Firstly, the Government to clarify a minimum agreed smart meter specification for electricity and gas – to ensure interoperability. The ERA's work would form the basis for such a specification. Secondly, the Government to require all new and replacement meters installed from a specified date to meet the approved smart meter specification. Thirdly, the Government to place an obligation on all suppliers to ensure that all their customers have a smart meter, for electricity and gas, within 10 years of a specified start date. Finally , the Government/Ofgem to devise a regulatory settlement for legacy meters that will be replaced before the end of their assumed 20 year accounting life, because of the above policy changes. This option would be likely to lead to an evolution of the present supplier-led competitive approach to metering. It involves limited government intervention and should promote innovation and competition between suppliers in metering, although there would be risks of non-delivery or late delivery of the targets if issues were difficult to resolve.

- **Option 2: Systematic roll-out – meter and communications network –** over a fixed period (e.g. 10 years) for electricity and gas meters, likely to be geographic and based upon some form of meter company franchise, possibly regional. This would require the four Option 1 policy and regulatory interventions, plus: the Government/Ofgem creating a new Meter Licence and running a competitive tender for franchises for procurement and installation of smart meters in each region. To protect consumers, and ensure non-discriminatory access, some form of regulatory oversight would be likely, but may not necessarily require price control. Alternatives could be some form of light-touch ex-ante regulation, or, ex-post regulation to prevent excess returns. DNOs may also need to be required to make networks available for Power Line Carrier. This approach would involve more intervention than Option 1 and potential competition policy concerns would need to be addressed. Whilst there would clearly be competition for the franchise, providing an incentive for efficiency and innovation among those tendering, it would not promote competition between suppliers in metering provision (though it may benefit retail competition by making switching easier) and may be less effective than Option 1 in promoting innovation. Potentially, it would transfer the cost and risk of investment – in part or in full – to customers but the risks of non-delivery or late delivery of the government's 10-year vision should be lower than for Option 1.

- **Option 3: Systematic roll-out – communications network only** – Hybrid of Options 1 & 2. Set-up, roll-out and operation of a dedicated meter communications network remunerated via a franchise, possibly regional – while continuing to leave smart meter procurement and installation to suppliers within a mandated timescale and framework. This would require the changes detailed under Option 1 plus broadly the same changes detailed under Option 2, except that the licence and franchise would be for meter communications only. Suppliers would be required to use the meter communications network or pay charges for a minimum period, to reduce risk for the communications franchise holder(s). As with Option 2, potential competition policy concerns would need to be addressed. Option 3 would allow for innovation in metering procurement (although it could limit innovation in meter communications and entail some complex interfaces) and a continued supplier-led competitive approach to meter investment. This approach involves more government and regulatory intervention than Option 1, but less than Option 2.

The next steps

Some policy and/or regulatory intervention will be required if the Energy White Paper (EWP) aspiration, of smart meters in all homes within 10 years, is to be realised. The debate to be had now therefore is about how much and in what ways the Government and Ofgem needs to intervene.

We have set out three possible options for delivery of smart meters in Great Britain. We do not favour one option over another, but set out the policy and regulatory changes that each could require, their pros and cons and some of the key questions that would need to form part of a detailed options analysis. Clearly to pursue any of these options will require a number of legislative and regulatory changes and a very major implementation effort. An important next step will be to carry out a fully-costed analysis, with sensitivities, of the likely present and future costs of a limited number of delivery options. This is clearly a task where the Government and Ofgem need to provide leadership, working in collaboration with the industry.

The UK Government anticipates that some of their EWP metering and billing proposals will implement the ESCO Directive. It is however not clear whether the Directive will be implemented solely through the displays and billing proposals or also through measures to realise the expectation for domestic customers to have smart electricity and gas meters within 10 years. Uncertainty about what, if anything, the government may or may not mandate, is presently inhibiting even modest smart meter investment. There is therefore a need for Government to act quickly to set out how its smart meter vision will become a reality.

3. Current policy and market context

Within the past year, a number of factors have come together to significantly change the context of the UK smart meter debate:

- Significant concern voiced about high fuel bills and recent high prices.
- High public profile of climate and carbon issues – yet UK CO_2 emissions have been rising. Practical ways actively sought by policy-makers to achieve individual engagement with energy and carbon saving – not least in an attempt to mitigate the impact of higher fuel prices likely to arise from interventions to achieve carbon reductions.
- Smart meters are increasingly viewed as a pre-condition to delivery of wider domestic demand-side measures. The Climate Change Programme Review, the 2006 Budget, the 2006 Energy Review, the 2007 Energy White Paper and active consideration of a new Supplier Obligation post-2011, each reflect a common desire to capture the potential public policy, informational and demand-side benefits of smart meters. In June 2006 Ofgem published its cost benefit assessment and concluded that "Smarter forms of domestic gas and electricity meters could have a significant role to play in improving customer service, tackling climate change by improving energy efficiency, maintaining security of supply, and reducing fuel poverty."
- The Energy Demand Research Project will assess the extent to which some of the potential benefits to customers, suppliers and the environment will be realised in practice.
- The Energy White Paper makes four new proposals on metering and billing[1]:
    1. That suppliers should extend to larger GB businesses advanced and smart metering services within the next five years.
    2. Graphical historic information on domestic customers' bills
    3. From May 2008, where technically feasible, every household having an electricity meter replaced and every new home will be given a real-time electricity display, free-of-charge. Additionally, 'from as soon-as-possible in 2008 to March 2010, any household requesting a real-time display for their electricity meter should be given one free of charge by their energy supplier'.
    4. An expectation that 'within the next 10 years, all domestic energy customers will have smart meters with visual displays of real-time information that allow communication between the meter, the energy supplier and the customer' .. and that suppliers will 'roll-out smart meters when it is cost-effective to do so and within the timescales we have set'.

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[1] Meeting the Energy Challenge: A White Paper on Energy. DTI, May 2007. Paragraphs 2.64 – 2.74

- ESCO[2] Directive – the initial focus is likely to be on larger users to achieve most energy savings – and this supports the priority accorded to an I&C roll-out in GB in the first instance. Implementation by May 2008, preceded by Government consultation and adoption in UK law, possibly via secondary legislation under the European Communities Act. For the domestic sector, it is not presently clear how the UK Government intends to implement the Directive – whether via the EWP proposal for non-smart in-home electricity displays, and / or through additional measures to realise the expectation for domestic customers to have smart electricity and gas meters within 10 years.
- Firm roll-out or firm plans for electricity smart meters in an increasing number of countries, including in Europe.
- Manufacturers are demonstrating a great appetite to adapt and develop smart meter models for the GB domestic market. With the prospect of volume, meter-costs appear materially lower than a year ago.
- Suppliers are now universally keen to take transformational steps to domestic smart metering. The Energy Retail Association (ERA) has since late 2006 been working on its Supplier Requirements for Smart Metering (SRSM) project to develop agreed smart meter specifications and interoperability frameworks. The potential business benefits of improved data-accuracy, improved cash-flow, scope for market differentiation, and post-2011 supplier obligation developments are increasingly better-understood and more actively factored into business planning.
- Meter market – for electricity, removal of price controls for new meters, and requirement for competitive meter procurement by suppliers. For gas, increasing awareness that meter market development is unlikely to make progress until the present competition investigation is resolved. The Supply Licence Review has addressed some potential barriers to new-asset stranding (28-day rule), meter procurement arrangements, and, the universal requirement for bi-annual gas-meter inspections. A major question remains as to whether the government's EWP expectation for smart meters for all domestic customers within ten-years can be achieved without additional interventions in the meter market.

[2] Energy End-Use Efficiency and Energy Services Directive. Dir 2006/32/EC. April 2006.

Conclusion on policy and market context

Smart meters are therefore no longer the neglected policy area of only a year ago. The focus of debate has shifted materially from whether the UK should invest in smart meters, as to how that investment should come about.

Notwithstanding this new consensus around the merits and potential role of smart metering, a number of significant elements have not materially changed or moved forward in the past year. Importantly, there are still major gaps in understanding – in particular, in respect of the full costs and benefits of different policy and delivery options, the commercial availability of residential smart meters (especially gas), possible logistics and communications technologies.

4. Gas smart meters – gas meter market, gas smart meter technology and battery life

4.1 Gas meter market

Suppliers are responsible for making metering arrangements on behalf of their domestic customers. Data processes and data flows are subject to common governance arrangements to enable smooth customer switching.

The main actors in the gas metering market include the six large energy suppliers (and a number of smaller ones), National Grid, four independent gas distribution networks and a number of stand-alone meter operators. There are also major players specialising in meter-reading, meter-data processing, billing, credit and risk management, and back-office systems. Some existing electricity and gas licensees are developing non-licensed meter businesses, whilst others have curtailed their metering activities. At least one supplier has fully outsourced meter related activities. By contrast, a number of suppliers have recently moved some meter services in-house.

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 the UK meter market is attracting new interests, including communications specialists and financial institutions. There is also a new focus on developing new meter-related consumer-products.

Most GB residential gas meters (c. 90%) remain in ownership of National Grid. Nevertheless, since 2003, three new players have entered the market following appointment by British Gas of alternative meter asset managers on a regional basis (both gas and electricity). Of the one million new and replacement gas meters installed each year, over half are covered by these contracts. Ofgem's expectation is that this number will increase as other gas suppliers seek cost-advantages through tendering for new metering provision.

4.2 Gas meter technology

There are some 21.4 million domestic gas meters in Great Britain[3] of which 2.3 million (12%) are pre-payment[4]. Over 90% of gas meters in residential, SME and smaller commercial premises in GB are mechanical diaphragm meters. Around 8% of installed residential gas meters in GB are ultrasonic (E6). For both diaphragm and ultrasonic meters, the supplier is presently reliant on a pedestrian meter-read for billing purposes. Around 1 million gas meters (c. 5% of stock) are replaced each year. Additionally, over 200,000 new gas-meters are installed per annum for new connections.

Of the 2.3 million pre-payment gas meters, most are the Quantum model, which generally use a smart-card, allowing transfer of information such as tariff-changes and meter-reading at the payment service point. 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 topped up.

There are over 400,000 industrial and larger SME gas meters of which 2,000 are Daily Metered customers and already 'smart'. Most of the 400,000 I&C non-daily metered customers presently do not have access to automated or smart meter services, but this looks set to change over the next five years following the EWP proposal[5].

4.3 Domestic gas smart meters

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

However, gas smart meters are not widely available for the domestic sector – as at June 2007 very few gas smart meters are actually installed in homes. The ERA is developing a detailed technical specification for a new gas smart meter. Nor are domestic sector stand-alone smart gas-meters being widely deployed elsewhere in the world. Elsewhere, gas meters have mostly been made smart through the retrofit option (see below). Oxxio in the Netherlands is the main example that we have found of the installation of new gas smart meters and these are linked via in-home Radio to the electricity smart meter. We did not identify examples of domestic gas smart meters with direct GSM communications to a supplier, although there are examples of this in the industrial and commercial sectors, including in the UK.

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

[4] Ofgem. Domestic Metering Innovation – Next Steps. June 2006. p 15; Ofgem 2007.

[5] Advanced Metering for SMEs. Carbon and Cost Savings. Carbon Trust. May 2007.

Metrology in a gas smart-meter may be mechanical (i.e. diaphragm), ultrasonic, or, potentially, newer flow-sensing technology. Some conventional gas meters may be 'smarted' by adding an electronic module to the existing meter box. Where a prepayment function is required, smart-meters will require a pre-pay safety valve. If remote switching between credit and pre-pay functions then this will also need to be highly robust and safe. The ERA specification addresses this.

Unlike for electricity, a separate 'non-smart' in-home consumer display cannot be wirelessly linked to a mechanical gas meter. For gas, a meter pulse output would first need to be activated, transmitted to and captured by a data-logger. With a new stand-alone gas smart meter it will be feasible to have a wireless link to an in-home display, including to a shared display with the electricity meter.

4.4 Retrofit options for smarting existing gas meters

Existing non-smart meters could be made smart by some form of retrofit option as an alternative to installing a new smart meter. Certain gas credit 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 data-logger, totalled, stored, and / or onward transmitted. A pulse mechanism could be activated on an existing meter and coupled with retrofit of an electronic AMR capability (e.g. Low Power Radio). Use of the meter pulse output has been the basis for much AMR development in the US.

Retrofit devices for meters with an in-built pulse capability are lower-cost than for those meters with no such capability. Around 55% of domestic gas credit meters in Great Britain are 'pulse enabled' or 'pulse-ready'. A further 10% (approx) of gas credit meters are ultrasonic (E6) and can also be retro-fitted. Domestic gas credit meters installed prior to 1992 (about 35% of the stock) have no inbuilt pulse capability. This proportion is reducing as older meters are displaced.

Although there are costs and practicality issues to consider, retrofit may be useful for dual-fuel and may help to mitigate stranding costs for legacy gas meter assets. However, it would only currently be suitable for credit (not prepayment) meters. The data logger retrofit solution for existing gas meters, with radio link to a smart electricity meter, is the option being pursued in California (see case study).

4.5 Conclusions on options for smarting gas meters

The main options for smarting gas meters are thus as follows:

- Independent retrofit: retaining the existing gas non-smart pulse credit meter and adding a communications facility to enable it to send and receive messages from the energy retailer – i.e. it does not have to operate via the electricity meter.
- Independent new smart credit: installing a gas smart credit meter with its own communications facility to enable it to send and receive messages from the energy retailer – i.e. it does not have to operate via the electricity meter.
- Independent new smart prepay: installing a gas smart meter that can be switched remotely between credit and prepay with its own communications facility to enable it to send and receive messages from the energy retailer – i.e. it does not have to operate via the electricity meter.
- Linked retrofit (credit only): retaining the existing gas non-smart pulse credit meter and adding a module to enable it to send and receive messages to and from an electricity smart meter via low power radio (the electricity smart meter then communicates – on behalf of both gas and electricity with the energy retailer).
- Linked new smart credit or credit/prepay: installing a gas smart credit meter and adding a module to enable it to send and receive messages to and from an electricity smart meter via low power radio (the electricity smart meter then communicates – on behalf of both gas and electricity with the energy retailer).

The linked options would probably only be feasible either for a dual fuel offering or if meters were installed on a geographic regional monopoly basis.

4.6 Battery life

Smart meters are electronic and thus need access to a power source. Electricity smart meters can utilise mains power so they need a battery just to maintain the clock and other data in the event of a power failure. As the battery would be used infrequently if would last for the useful life of the meter. Gas meters cannot be connected to a power source for safety reasons therefore battery life is potentially a more significant issue for gas smart meters. Battery requirements for gas smart meter functions are:

- Measurement of gas volume –in electronic or ultrasonic gas meters.
- Data store / memory function – battery required in all cases.
- Tamper sensors etc – battery required in all cases.

- Battery required for all communications whether within the house (e.g. between the meter and a visual display and/or data store) or to the supplier.
- For prepayment batteries are also required (as in Quantum meters) to operate the valve that disconnects and reconnects as credit runs out and is topped up.
- Retrofit alternatives generally need a battery to enable them to collect, store transmit, receive data
- Although many add-on displays are battery powered, in future they will mostly plug into a 13-amp socket. A battery may be provided for back up.

The key factor affecting battery life is how frequently the meter sends and receives data such as meter readings, tariff changes, credit top-up for prepayment. Power consumption also depends on 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: once a day send and receive information – 5+ years; once a week send and receive information – 12+ years; once a month send and receive information – 15+ years. GSM takes much more power than Radio for the same time length of communications. However, it may be possible to manage the number of communications and their duration to give a similar battery life for Radio or GSM.

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 Radio communications to the electricity smart meter, which in turn sends messages to Oxxio via GPRS.

4.7 Conclusions on battery life

- 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, and need not be a determinant of communications choice.
- 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.

5. Communications options for gas and electricity smart meters

5.1 Key communications considerations

A smart meter system communicates meter-data to a data-collection point. AMM (automated meter management) enables two-way communication from meter-to-supplier and supplier-to-customer[6], which is necessary for pay-as-you-go and remote tariff-changes. A capability to store data by timed-intervals is needed to offer time-of-use or real-time tariffs.

A variety of communications technologies can transmit meter-data, each with potential pros and cons. These include dedicated network options – such as power line carrier or wireless radio – and cellular mobile communications. Communications can be narrow-band or broadband, but narrow-band (i.e. slow speed) is sufficient for meter-data.

Accuracy, consistency and reliability in transmission of meter-data are fundamental whatever the communications technology. A choice which may be fit-for-purpose and cost-effective in one environment (e.g. urban/remote; high/low-meter density; indoor/outdoor; dual-fuel etc) may prove less appropriate in another. The potential for obsolescence is also a factor as next-generation options and combinations emerge.

There is also considerable international experience in meter-related communications. Historically, communications have not been a core business activity for energy suppliers or for meter manufacturers. New partnerships with communications specialists are likely to develop new thinking and expertise.

Meter communications can be considered in three broad tiers:

- In-home communications – between meter (or meters or smart-box), home-display, and possibly other appliances. Most likely using very low-power short-range radio transceivers, in the form of an in-built battery-powered microchip.
- Local area-network connectivity (LAN) – from the meter (or smart-box) within the home to a concentrator, hub or router which communicates beyond the home. (LAN connection is not needed where a GPRS/GPS modem is inbuilt into a meter and which communicates directly to the Wide Area Network).

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[6] Much meter-communication to date has been one-way (from the meter-to-supplier) offering the means for pedestrian and drive-by AMR (Automated Meter Reading), notably in the United States.

- Connectivity from LAN to Wide Area Network (WAN) – Onward transmission from LAN by a variety of fixed or cellular communications.

5.2 Power line carrier (PLC)

PLC involves transmission of a radio-frequency signal from the electricity meter via the existing lower-voltage electricity distribution wires, to convey meter-data to the WAN. There is a long history of low-speed one-way PLC for electricity network control, telemetry and demand-side management. Increasingly, there is also two-way PLC experience[7]. PLC for smart meters has successfully been rolled out in Italy, and also in some parts of Scandinavia and Guernsey.

Power line carrier for domestic metering would involve installation (or adaptation) of electricity meters to transmit and receive a radio signal. The signal would travel along the existing electricity distribution wires to data-concentrators sited, perhaps, on neighbourhood electricity transformers. A data-concentrator would aggregate data from groups of, say, 20-150 meters and onward transmit it. This could be by PLC (or medium-range radio) until the meter data reaches a communication gateway to the WAN. Additional equipment on the distribution network, such as repeaters and controllers would also be required.

For the UK, Power Line Carrier raises a number of commercial and regulatory issues arising from the physical development and operation of a new, probably independent, communications network on an electricity distribution network.

5.3 Radio frequency (RF) networks

Short-Range Radio systems – operate within a 100 metre range, using standard communications protocols, enabling interoperable 'open-architecture'[8]. Some narrow-band examples are Zigbee, Bluetooth and Z-Wave. These systems are potentially low-cost[9], and can incorporate a radio (one- or two-way), memory, and a micro-controller on a small microchip. These can be installed when a meter is manufactured (or, possibly, retrofitted), and are battery-operated. The chips work at a low-data rate and low-power, offering potential long battery-life and secure networking. Short-range radio systems can be arranged in a simple 'star' configuration, suitable for 'walk-by' or 'drive-by' data-

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7 In France, EdF has used two-way PLC to transmit tariff signals to meters for over 20 years.

8 For example, standard Internet protocols could permit use of either PLC or RF in the same meter, depending on which route is available to the meter.

9 Zigbee micro-chip end-device at below US $3. Texas Instruments. Graham Martin. Vice-Chair, Zigbee Alliance. Slides. Metering Europe Conf. Copenhagen. 2006.

collection[10] – or in more complex mesh network arrangements. In a mesh network, the microprocessor can act as a repeater, transmitting data securely along a line of microchips in adjacent meters – including through walls – until the signal reaches a main collector. Mesh radio therefore potentially offers similar networked characteristics and a cost-competitive alternative to power line carrier.

Medium-Range Radio – say up to 8 kms range. Commonly termed Low Power Radio (LPR), and potentially able to provide a networked communications option via base stations. For the UK, LPR would require new electricity meters with transceiver capability and (to achieve UK-wide coverage) might need around 20,000 base stations. Base-stations would connect wirelessly to a WAN gateway, and from there to suppliers. LPR is widely deployed in the USA and also in Sweden and Denmark. Medium-range radio could work in combination with Power Line Carrier or short-range radio.

Long-Range Radio – over 8 kms. One example is the one-way Teleswitch system operated from Droitwich, for remote switching of some Economy 7 meters.

5.4 Cellular mobile communications

The main option is GPRS / GSM – with SMS – General Packet Radio / Global System for Mobile Communications with SMS messages (Short Messaging Service), currently using the ubiquitous 2-G (second generation) cellular network with 90% coverage in the UK. However, as SMS uses the underlying communications infrastructure it is not 2G or 3G dependent – and accordingly does not risk becoming outdated[11]. To use this system requires installing either a smart-box with modem – or a new meter with a modem (most probably the electricity meter) – to become the in-home hub. A modem can communicate directly from the home to the WAN.

Cellular mobile communications would potentially allow suppliers considerable flexibility in targeting particular customer groups, including commercial and larger SME customers, pre-payment customers or remote residential customers.

5.5 Other communications options

In the future, it may become feasible to make use of household landline connections (particularly broadband), to send meter data to a supplier and also to send back meter-related information from the supplier to the customer. An estimated 60% of UK households have a home computer Internet connection of which nearly 50% are

[10] Widely used in the United States.
[11] Some concerns expressed that 2G may not be maintained by network providers into the long term, and that it could be problematic to embed 2-G sim cards into a meter expecting a 15 year life.

broadband. Some suppliers already provide information to customers over the Internet. Various landline links are currently used to provide the communications function for some large industrial and commercial meters.

5.6 Cost and interoperability considerations

Both PLC and Radio have supporters and detractors, in particular reliability in data transmission and arrangements with respect to network downtime. PLC and Radio are assumed to offer comparable costs and lower costs than mobile communications. However, relatively little detailed cost information is available for either PLC or Radio in a UK-specific context. Comparisons need to take full account of capital and development costs plus ongoing costs of running and maintaining a fixed network. Over time, the costs of mobile communications, and in particular the cost of a modem, look set to decline. The 2002 British Gas radiometer pilot and the forthcoming Energy Demand Research Project may be helpful in improving knowledge of costs. For Radio, other recent UK RF network roll-outs may also offer some possible cost comparisons. For PLC, overseas examples may offer an initial source of cost-data.

Some specific factors that affect cost estimates for mobile solutions are:

- Over time, the costs of mobile communications, and in particular the cost of a modem, look set to decline. The capital cost of a modem is presently around £20-30. It is suggested this could reduce to £10 within a few years, but this may prove optimistic.
- At 3-8p per text, the costs are judged expensive against costs assumed for PLC and Radio. Communications operators presently show limited interest because meter-data traffic looks extremely low. Around one billion texts are sent in the UK each day. By contrast, texts from energy meters may number around 25 million per week (i.e. one text per household per week).
- The modem will have a SIM-card. A number of uncertainties exist where a customer switches supplier (i.e. whether the SIM card is left in place and data can be re-routed – the most likely solution – or whether the card has to be changed).

In today's non-smart meter world, industry-wide agreements and governance arrangements determine the handling of meter-data flows when a domestic customer switches supplier[12]. Opting to build on present agreements, and to continue to communicate via present arrangements for existing data-flows, could obviate the need for early or expensive replacement of existing billing systems.

[12] Meter Registration Agreement (electricity) and Supply Point Administration Agreement (gas).

5.7 Conclusion on communications

Better understanding and more detailed full lifetime cost comparisons are needed of the main communications options – PLC, Radio and Mobile. This needs some insight into how communications costs could change and into the respective governance arrangements. Evolving options mean that lock-in to a single uniform approach to meter communications for all of the UK could prove inappropriate. Future flexibility and adaptability remain important principles in an environment which is extremely dynamic in both technical and cost terms.

6. Costs of smart meters and benefits to suppliers

6.1 Costs of smart meters

This section looks at the likely capital and installation costs of smart meters. As with the 2006 report, the focus is on the domestic sector, although similar costs are likely to apply to the smaller end of the commercial sector. The main focus has been options and costs for smarting gas meters, as this was not covered by the 2006 SF report, nor indeed in any detail in other studies, including that by Ofgem. The other focus has been to update and expand the cost information on communications options for gas and electricity smart meters.

Cost estimates can vary considerably depending upon volume and technology assumptions. For commercial reasons, much cost information provided to this study was generic. The costs below reflect a synthesis of two main sources of information: known costs where smart metering has been introduced overseas; likely costs in the UK, based on certain volume and technology assumptions. However, the figures come with a significant health warning – there are some very different views about the reasonableness of some costs amongst different parties (meter manufacturers, energy suppliers etc).

This chapter presents the tables showing the overall costs for three different options. The detailed information on the cost elements and specifications is in the full paper.

Costs of non-smart meters – for comparison

Non-smart gas credit meter	£18-20
Gas Quantum prepayment meter	£75-100
Non-smart electricity meter	£7-8
Electricity key prepayment meter	£45-50

6.2 Tables: Smart meter and communications costs

The figures in the tables are based on a number of different sources in the UK and international experience and assume a reasonable volume purchase (at least 300,000). Clearly prices would come down for significantly larger volumes (e.g. 2 million) Tables 1, 2 and 3 examine the costs of smarting gas meters independently; smarting electricity meters independently and smarting gas and electricity meters together.

Table 1: Options for smarting gas meters independently (meter and communications)

Gas smart option	Meter costs	Communications to supplier	Running costs of communications	Total cost
Retrofit (add data logger to existing gas credit meter)	£25-35	GPRS/GSM £30-40	SIM rental £5-10 p.a. 3-8p per text	£55-75 plus running costs
Independent new smart credit	£40-60	GSM/GPRS £30-40	SIM rental £5-10 p.a. 3-8p per text	£70-100 plus running costs
Independent new smart prepay/credit	£70-100	GSM/GPRS £30-40	SIM rental £5-10 p.a. 3-8p per text	£100-140 plus running costs

Table 2: Options for smarting electricity meters independently (meter and communications)

New electricity smart meter costs	Communications to Supplier (direct) GSM/GPRS	Total cost with GSM/GPRS (columns 1,2)	Communications with PLC or Radio	Total cost with PLC or Radio (columns 1,4)
£25-35	£30-40 for modem plus: SIM rental £5-10 p.a. 3-8p per text	£55-75 plus running costs	PLC to data concentrator £10; +GSM onwards £5; Radio to data concentrator £10-20; + GSM onwards £5 Running costs for PLC and Radio?	PLC £40-50; Radio £40-60 Both plus running costs

Table 3: Options for smarting gas and electricity meters together (meters and communications)

Gas smart credit option costs	New electricity smart meter costs	Gas to electricity meter commun-ications	Commun-ications to Supplier(direct) GPRS/GSM	Total cost with GSM/GPRS (columns 1,2,3,4)	Commun-ications PLC or Radio	Total cost with PLC or Radio (columns 1,2,3,5)
Retrofit data logger £30-35	£25-35	In-home radio £5-10	£30-40 for modem plus: SIM rental £5-10 p.a. 3-8p per text	£90-120 plus running costs	PLC to data concentrator £10; + GSM onwards £5; Radio to data concentrator £10-20; + GSM onwards £5 Running costs for PLC and Radio?	PLC £80-95; Radio £85-105 Both plus running costs
New £40-60	£25-35	In-home radio £5-10	£30-40 for modem plus: SIM rental £5-10 p.a. 3-8p per text	£100-140 plus running costs	PLC to data concentrator £10 +GSM onwards £5; Radio to data concentrator £10-20 + GSM onwards £5 Running costs for PLC and Radio?	PLC £85-120 Radio £85-130 Plus running costs for both

Note to table 3: for gas credit/prepayment meter option, the costs of the meter would be £70-100 (£30-40 higher than for gas credit only)

Notes to all the tables

- Separate radio-linked customer display if required would add £20-30 to costs (for linked options this cost would be shared between the gas and electricity meter).
- Add installation costs of £25-30 for one meter or £40-55 for two meters.
- Other costs to be added to all options. One-off costs: data systems; stranding costs. Ongoing costs – data management; maintenance/faults rectification.
- Electricity smart meter costs are assumed to include credit/prepay remote switch functionality which adds only £3-5 to the base costs.
- Running costs for PLC and Radio are currently still being clarified.

6.3 Conclusions on costs

Smarting electricity meters is cheaper than smarting gas meters and less complicated because electricity meters can be directly connected to a mains power supply, whereas gas meters cannot. For electricity it makes sense in cost terms to fit a whole new smart meter to replace the old meter. For gas, a smart credit meter can be achieved either via retrofit or by installing a new smart meter, although the retrofit option does not appear to be feasible for prepayment gas meters. A new gas smart meter could be linked either directly to the supplier, or via the electricity meter or smart box. The linked approach is being used elsewhere, where gas meters are being smarted. However, there is presently no retail competition in California and limited switching in the Netherlands (the two case studies). The linked approach offers some cost savings, but would necessitate solutions to the complexities that would arise in the GB market.

Electricity prepayment adds little to the base costs and will result in savings in replacing meters when customers change payment method. For gas, the incremental cost of adding prepayment functionality is more significant (though costs should come down if volumes increase significantly) and so a decision as to whether to include this in every meter would need to take account of the relative costs and benefits. For example, it could currently make sense to install gas meters with prepayment functionality in some areas (e.g. social housing estates or multiple occupation dwellings where a high proportion of households would be likely to use prepayment).

The costs presented are estimates and based on volumes of 300,000 plus. It is clear that since our 2006 report costs have been coming down and this trend is likely to continue. Significantly larger volumes would also produce cost reductions. Further work on costs, particularly related to potential delivery options (e.g. targeted or geographic) is clearly an important task that remains to be undertaken in coming to final decisions about costs and benefits.

6.4 Supplier benefits of smart metering

In our 2006 report we examined what benefits might accrue from the introduction of smart meters for: suppliers; customers; other energy market participants (e.g. network operators); public policy. In this report we have done some further work on the benefits to suppliers, and some of the public policy issues – i.e. likely impact on energy demand, carbon emissions, low income households and prepayment meter users. The public policy issues are dealt with in separate chapters. The supplier benefits are dealt with here.

Capgemini surveyed the experiences of 31 North American and European Utilities that have deployed Smart Metering pilot projects.[13] They point out that the average business case for smart metering starts with metering and billing but that this will not get past the internal hurdles in most companies Smart metering technology can support many facets of the distribution, generation and retail business – regulated and unregulated. Many of the benefits identified by Capgemini would not be realisable directly by suppliers, although clearly suppliers might be able to share the value through agreements with network operators. However, benefits split between different parts of the energy market will be easier to capture in the vertically integrated energy companies (the majority of those surveyed by Capgemini) than in the GB situation where most network ownership and operation is separate from retail and generation.

Based on the work by Capgemini and discussions with suppliers and others the following benefits for suppliers have been identified:

- Reduced meter reading.
- Reduced call centre activity – fewer billing queries, prepayment meter card and token problems.
- Better cash flow/use of working capital – gap between getting an accurate meter reading, billing and collecting money all shortens.
- Bad debt reduction – more use of pay as you go; elimination of estimated bills; better (automated) detection of fraud/theft/meter tampering.
- More efficient supplier switching – more accurate data processes and transfers; elimination of misdirected payments from prepayment meters.
- Prepayment meters with fewer problems leading to call outs.
- Switching between credit and prepayment remotely.
- Electricity only – better data potentially enables better management of power purchase agreements.

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[13] Capgemini, 2007. Getting all of the value from your smart metering investment by Doug Houseman,

- New retail packages – e.g. time of use tariffs; energy services, micro-generation, increased dual fuel offers.

Some suppliers now envisage that the sort of benefits outlined above would make a business case for targeted installation of smart meters for up to 30% of their customer base.

6.5 Conclusions on supplier benefits

It seems that suppliers now see a greater range and higher value for the benefits of smart meters than they did a year ago. We have not attempted to put actual figures on these values due to lack of clear data that would enable us to do so. However, a key message from suppliers is that whilst the benefits are greater than previously thought, this does still not add up to a business case for widespread (as opposed to targeted) smart meter installation.

7. Smart meter contribution to UK goals for energy saving and carbon reduction

7.1 UK carbon reduction goals

The UK domestic target is to reduce CO_2 emissions by 20% against a 1990 baseline by 2010[14]. Within this goal, the government seeks to reduce household carbon emissions by 4.8MtC pa by 2010[15]. The Energy White Paper[16] estimates that proposals for household billing and real-time displays will deliver annual savings of up to 0.4MtC by 2010, and up to 0.5MtC pa by 2020. This is almost equivalent to a 1% pa reduction in domestic energy demand (electricity and gas).[17] In-home visual electricity displays may help to deliver some electricity savings through increased price awareness, albeit not for gas. In addition, improved historical feedback on energy bills may make an additional contribution. However, a 0.4 MtC saving from these sources by 2010 seems unlikely, because there will be limited time to install the displays by 2010[18], they will be largely electricity only, and also unable to offer time-of-use price information. Moreover, timescales for investment are such that by 2010 smart meters could offer no material contribution.

The Energy White Paper makes no specific allowance for a contribution to carbon reduction from domestic smart meter investment. However, if smart meter investment on a substantial scale starts soon, we would expect the contribution from metering and billing of 0.5 MtC by 2020 to be readily achievable.

In-home visual displays should form an integral part of a smart-meter package where they could provide both gas and electricity feedback, and, for electricity, provide variable time-of-use price information, thereby being more likely to prompt an active consumer response.

[14] The draft Climate Change Bill subjects the UK to legally-binding five-year rolling carbon-reduction targets, seeking to reduce CO_2 emissions on 1990 levels 60% by 2050, with 'real progress' to 26% to 32% by 2020.
[15]UK Climate Change Programme. Cmnd 6764. 4.8MtC by 2010. March 06.

[16] Meeting the Energy Challenge. A White Paper on Energy. Cmnd. 7124. May 2007. para 2.73. p.65

[17] A 1% reduction in energy use was used by Ofgem as an illustrative assumption of a 0.36MtC pa saving – 8% of the 4.8MtC by 2010 goal. Ofgem. Domestic Metering Innovation. February 2006. p.18. para 4.14; DTI Metering & Billing Consultation. Nov. 2006. RIA p.38, para.5. Carbon emissions from domestic energy saving will vary, inter alia, with fuel-type (electricity or gas) and respective carbon-intensity. For electricity end-use, carbon-intensity will depend upon the generation-mix and marginal generating plant.

[18] For all new and replacement electricity meters from May 2008 (say, 2.5 million meters) and until March 2010 to households that request them (say, 5 million meters if 20% of customers).

7.2 EU goals

In March 2007, EU heads of state agreed to promote energy efficiency by reducing overall EU-growth in energy consumption by 20% by 2020. The ESCO Directive[19] will be one of the delivery mechanisms, and includes a non-binding provision for member states to achieve a 1% pa energy saving from 2008, with an expectation of a 9% energy saving by 2017. Within the Directive no assumption is made about the contribution from Article 13 on metering.[20] [21]

The UK Government anticipates that some of their EWP metering and billing proposals will implement the ESCO Directive. It is however not clear whether the Directive will be implemented solely through the displays and billing proposals or also through measures to realise the expectation for domestic customers to have smart electricity and gas meters within 10 years. A full evaluation of the costs and benefits (including the expected carbon savings) will be important, to show that the requirement to offer non-smart in-home displays in the period 2008 to 2010, is compatible with the Government EWP expectation for domestic smart meters in every home within the next 10 years.

7.3 Gas demand – potential for customer price response

In 2005, over one-third of primary UK energy consumption was gas, of which 35% was domestic. Gas provides 70% of household energy and represents around 55% of household carbon emissions. Around 80% of UK domestic heating load is met by gas. Four times more gas than electricity is used in the home (KWh equivalent). Domestic gas-use is seasonal – a winter summer ratio of 5:1 – and highly temperature dependant.

Domestic gas demand grew by 1-2% a year from 1990. In 2005 and 2006, demand (weather corrected) for domestic gas reduced by around 2% on the previous year[22]. This is believed to be due to higher prices, anticipation of further price rises, and considerable media coverage about price and gas security of supply. Notably, it was not in direct response to higher bills for winter 2006/07 – which consumers had still to receive.[23] A key question is how to deliver a sustained price response of this kind and, critically, how to avoid increased use when gas prices start to fall.

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[19] Energy End-Use Efficiency and Energy Services Directive. Dir 2006/32/EC. April 2006.

[20] Meetings w European Commission. February 2006.

[21] The Directive neither defines the term meter, nor expands on the phrase 'individual meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use'.

[22] National Grid. Winter 2006/07 Consultation Update. July 2006

[23] Domestic gas prices rose 45% real in the period 2004 to 2006. Energy White Paper. P.77 para 2.1.6.

Unlike for electricity, most price-response in domestic gas will result in an overall reduction in demand, rather than simple load shifting. This is because most domestic gas use is space heating and hot-water and any demand reduction will not transfer to a different time of day. A price response for domestic gas could therefore produce lower bills for consumers and reduced carbon emissions.

There are significant short- and long-run costs to the gas market associated with meeting both daily and seasonal peaks. In theory, improved peak management could reduce short-term operational and commodity related costs (e.g. spot-gas, system-balancing), and possibly, longer-term infrastructure investment (gas transmission and distribution pipeline capacity and/or storage – including LNG). However, the largely disaggregated GB gas industry structure fragments the incentives for market participants to capture some or all of the potential benefits.

Daily peak demand management is important in the industrial and commercial (I&C) sectors because many shippers, suppliers and large gas-users are directly exposed to short-term gas-prices, including on-the-day commodity prices. Many large gas users already have access to interruptible contracts. However, there is likely to be additional demand side response in the I&C gas sector, which more sophisticated tariffs could unlock. In this context, the Energy White Paper proposal to extend advanced and smart meter services to Non-Daily Metered I&C gas customers within the next five years is very welcome[24].

7.4 Domestic gas sector – variable tariffs

There appears little push among gas-market actors to capture any benefits of peak-demand reduction in the domestic gas sector. One reason may be that much gas procurement for domestic customers ties into long-term contracts. Another is that commercial arrangements and pricing for gas-market balancing are daily, rather than within-day half-hourly pricing as for electricity. This reflects the comparative flexibility of gas as a fuel in terms of short-term storage (e.g. line pack, gas monitors), in contrast to electricity, which cannot be stored. For gas therefore, with no marginal within-day pricing system, there is no obvious commercial driver for suppliers to offer domestic gas customers within-day time-of-use tariffs.

[24] Energy White Paper. P55. para 2.33. See also 'Advanced Meters for SMEs. Carbon and Cost-Savings'. The Carbon Trust. May 2007, which found demand reduction benefits from smart-meters coupled with advice for the larger SME sector, including for gas.

However, other variable retail-tariffs might assist suppliers to achieve improved peak demand management for the domestic gas-sector.

- Block or volume gas tariffs – average gas demand is around one third less than peak demand, and so block tariffs (charging more for higher usage) could offer a strong demand reduction incentive. However, they could prove controversial, especially in winter.
- Seasonal gas tariffs – could benefit shippers and suppliers in the spring and autumn, when gas demand is most unpredictable due to temperature variation. They may need to be extremely high to influence customer behaviour, and again this could prove controversial.
- Time-of-use tariffs for domestic electricity – almost one-third of total gas demand is for power generation. Time-of-use tariffs for domestic electricity consumers, where gas is the marginal generating plant, could deliver some gas peak demand reduction.

Although variable tariffs from gas smart meters could play a role in influencing gas demand, it is helpful to see this in context. In most homes, the domestic boiler is the major gas use appliance. Energy-savings 'foregone' as a result of mishandling of domestic boiler controls are estimated at 14TWh pa. Moreover, a one degree centigrade turn down of the central heating thermostat might reduce domestic gas use by as much as 10%. There are around 1.4 million domestic boiler replacements each year, of which half are estimated to entail upgrade of heating controls[25]. If a main public policy goal is domestic gas demand reduction, improved display panels for gas boiler controls could do much to encourage lower domestic gas use, regardless of gas smart meters or non-smart visual displays.

7.5 Potential price responsiveness of electricity-load[26]

UK domestic electricity consumption in 2005 (c. 116 TWh) represented around one-third of total UK electricity end-use. In 2005-06, GB domestic electricity demand fell by 0.2%[27] while domestic electricity prices rose 29% real in the period 2004 to 2006[28]. Given that

[25] Market Transformation Programme – Sustainable Products 2006: Policy Analysis and Projections p.54 and . Energy Saving Trust. Website. Defra draft paper ' Potential carbon savings from energy efficiency and micro-generation appliances installed in the domestic sector, 2011-2020'. p.3 June 2007.

[26] This section draws largely from Market Transformation Programme – Sustainable Products 2006: Policy Analysis and Projections. Numbers are broadly illustrative.

[27] National Grid

[28] Energy White Paper. P.77, para 2.1.6

domestic electricity demand continued to grow at around 1.5% pa on average during this period, this suggests a domestic electricity price response, albeit apparently modest.

70% of domestic electricity in 2005 was used in electrical appliances including lighting [29], and c. 30% by space-heating and cooking. Lights and appliances comprise over 20% of household carbon emissions. Some appliance-use is 'discretionary' – i.e. able to respond to time-of-use tariffs – and some 'non-discretionary' – i.e. unlikely to respond to such tariffs[30]. Unit-for-unit electricity is more expensive than gas albeit gas use is four times higher than electricity (KWh equivalent). Electricity represents c. 45% of household fuel spend and gas c. 55%. Electricity time-of-use tariffs may therefore offer a consumer cash saving, provided there are sufficient 'discretionary load' high-use appliances. Key areas of domestic electricity use in the UK are as follows (See Table 4 for more detail):

- Less than 10% for space and water heating[31], of which 90% is Economy 7 off-peak – therefore no additional price response will be achieved through ToU tariffs. Electric shower usage could be price responsive as could domestic air conditioning where used.
- Wet domestic appliances – estimated 17%. Significant discretionary load – washing machines, dishwashers and tumble-driers.
- Cold domestic appliances – estimated around 21%. Presently non-discretionary load, though potential for load-control.
- Lighting – estimated c. 22% . Some lighting may respond to ToU tariffs at the margin, but new low energy light bulbs from 2011 will have more impact on reducing demand.
- Electronic / digital / brown appliances and chargers – estimated c. 22%. Mostly non-discretionary load. New product standards may start to improve efficiency.
- Home computing – estimated 10%. Mostly non-discretionary.
- Standby estimated 6-10%. Some discretionary element.

As the above shows, much domestic electricity use will be non-responsive to time of use tariffs. Discretionary load is mainly via wet appliances including tumble-driers, as well as electric showers, chargers, stand-by power, and some lighting – amounting to a potential discretionary load of around 20-25% of all domestic electrical appliance use. This would equate roughly to around 16TWh pa or 2MtC. Of this, it is hard to anticipate how much load would shift in practice in response to time of use tariffs.

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[29] 80 TWh in 2005

[30] The terms time-of-use and time-of-day seem to be used interchangeably in the UK. However, time-of-use is the more frequent and generic term encompassing different forms of peak and off-peak pricing (including banded time-of-use). Time-of-use is therefore preferred in this report, except in case studies where 'Time-of-day' has been used by the relevant company. cf Survey of T0U Pricing for US EPA by Energy & Environmental Economics Inc. July 2006.

[31] 1.9million homes have electric heating.

Load-shifting, not demand reduction, will be the response to ToU tariffs. The NIE Keypad 'Powershift' trial achieved some load-shifting, but no overall electricity demand reduction[32]. Powershift consumers saved money but not energy. Electricity demand reduction may be achieved through improved appliance product standards, but not ToU tariffs.

65% of total electricity consumption is in the I&C sector, which could therefore offer greater potential than the domestic sector for demand response[33]. The Energy White Paper proposal that suppliers should extend advanced metering in this sector is therefore welcome. This new measure, in tandem with the proposed Carbon Reduction Commitment and the requirement to display Energy Performance Certificates in larger public buildings should ensure widespread penetration of smart meters into the I&C sector over the next five years, providing scope for these customers to be offered time-of-use or variable tariffs.

Electricity peak demand reduction could in principle offer: short-run cost-savings through improved flexibility for system security and operation; and, possibly, long-run benefits in terms of avoided capacity investment (generation and transmission). However, these benefits are fragmented and relatively modest for individual market players. GB transmission and distribution networks are already incentivised through existing regulatory arrangements with respect to some of the benefits claimed for smart meter investment – such as improved loss management, network diagnostics and response times for lost supplies at remote locations. The extent of carbon saving from load-shifting will depend upon the carbon intensity of the electricity generated – i.e. the marginal generating plant.

7.6 Conclusions on energy saving and carbon reduction from smart meters

Smart meters can be used to give price signals to save energy and shift demand. Electricity demand shifting may offer some benefits but demand reduction is the more important goal to achieve emissions reductions. 50% of domestic customers pay their bills by monthly direct debit and probably have limited awareness of how much they are spending. By contrast, pre-payment customers have much better awareness of their energy use as they need to top-up their credit on a regular basis. Smart meters coupled with advice and effective media coverage could help to provide more customers with sustained feedback and hence change behaviour. However, most demand reduction will be achieved through

[32] NIE ToU trial in 2004 of 200 Keypad customers . See Appendix for full case study. Northern Ireland Electricity suggests that 15% of domestic electrical appliance load may be price responsive, with a possible further 15% offering the opportunity. NIE slides. Utilities Metering Forum. March 2007. The NIE Timeshift Trial suggests a 10% reduction at evening peak when a significant price-signal was applied, which would seem to suggest a very active response from available discretionary load.

[33] From 2003 to end-2006, 93% real wholesale electricity price increase. Ofgem.

appliance and product regulation, better controls and higher standards for building regulations.

In our 2006 report we estimated that, smart meters might produce a 1-3% energy saving in the domestic sector. We recognise that it is reasonable to assume higher (5%) savings for the commercial and industrial sector.[34] Nevertheless, we still feel it is right to stick to 1-3% for the domestic sector, until more empirical GB evidence is available. Although a 1% saving sounds small, it would be very worthwhile – it represents 8% of the UK's domestic sector carbon target to 2010.

[34] Advanced metering for SMEs: carbon and cost savings. Carbon Trust, May 2007

Table 4: Estimated UK domestic electrical appliance end-use 2005 (minus cooking and heating)

Domestic electrical appliance use (estimates from MTP Stock Model)	**TWh pa in 2005 (estimated)**	**Percentage of all domestic electrical appliance load (estimated)**	**Emissions MtC 2005 (estimated)**
Domestic wet appliances Dishwashers 2.3 TWh *30% ownership -* *Assumed average use – 248x pa* Washing Machines & Washer Driers 7.2 *78% ownership* *Assumed average use – 274x pa* Tumble Driers 4 *40% ownership* *Assumed average use – 148x pa*	13.5	17	1.4
Cold appliances Freezers / Refrigerators	16.2	21	2.00
Microwaves – *86% ownership*	2.3	3	0.25
Kettles – *97% ownership*	4.2	5	0.40
All consumer electronics TVs 9.6 Digital Adapters 2.2 Videos DVDs 2.1 Chargers (at no-load) 3.4	17.3	22	2.00
Lighting GLS (Tungsten filament) 14.6 CFLs (Low energy – compact fluorescent lamps) 1.0 Fluorescent 1.9 Halogen 0.29	17.9	22	2.00
PCs / Domestic ICT PCs 4.5 Laptops 0.1 Monitors 2.5 Printers 0.7	7.9	10	1.00
Total	**79.4**	**100**	**9.00**

Source – Sustainable Products 2006: Policy Analysis and Projections. Market Transformation Programme – www.mtprog.com

8. Social and prepayment meter issues

8.1 Social issues and implications

A broader range of tariffs and pricing options could provide new services of value to consumers. However, there is evidence[35], that between one fifth and one third of consumers actually lose money by switching supplier (although they may derive other benefits such as new services). A broader range of tariffs would therefore need to be marketed sensitively and be accompanied by clear information to enable consumers to make informed choices.

There are two other potential social impacts of smart meters and time-of-use tariffs that need to be considered:

- Whether low income/vulnerable households can benefit from new tariff options.
- Whether, as a result of greater information, low income/vulnerable households cut back on essential use in general and at high price periods in particular.

Both could be more important for gas than electricity given its use for heating.

8.2 Effects of time-of-use tariffs

Whilst most households (including those on low incomes) have gas central heating, more low income than better off households use electric heating. Since it is in electricity that time-of-use tariffs are most likely to be introduced, then low income households are more likely than better off ones to have essential use that may be difficult to time-shift. Clearly the actual impacts would depend upon the structure of the tariffs in terms of peak and off-peak periods. In Northern Ireland, trials of a time-of-use tariff for prepayment meter customers suggested that such customers actually had usage patterns which meant they would benefit from the tariffs introduced there. It is clear therefore that time-of-use tariffs can be constructed in ways that either benefit or disadvantage certain types of households.

[35] Do Consumers Switch to the Best Supplier? By Chris M. Wilson Department of Economics, University of Oxford & Catherine Waddams Price ESRC Centre for Competition Policy and Norwich Business School, University of East Anglia
CCP Working Paper 07-6

8.3 Effects of more information

In the absence of evidence on the impacts of information from smart meters on low income/vulnerable households the nearest proxy is the impact of energy advice in its various forms (leaflets, advice by phone or face-to-face etc). Another possible proxy is evidence on self disconnection and rationing by prepayment meter users.

A study undertaken in 1998[36] surveyed 100 social housing tenants, and found that energy advice did not lead directly to savings for the majority, who were already using their heating systems correctly and, due to financial constraints, used energy very efficiently. In contrast a control group (who received energy efficiency measures) used 20% less energy on average despite achieving 2°C higher internal temperatures. The researchers concluded that for low-income households in inefficient homes, energy advice aimed at changing behaviour is no substitute for improvements to the building fabric, for example, cavity wall insulation.

Research for the EST found that 55% of those who recalled receiving advice on use of heating and hot water followed some of this advice.[37] Those who seemed likely to save more were private tenants, quite low income households (£5,001 to £10,000 a year), C2/DE social grades and people aged 16 to 34 – savings for these groups were estimated at between £45-57 per year. AB social grades and those on the lowest incomes changed their behaviour less after advice (savings of £35-37 per year) – ABs because they can afford not to, and low income households because some may already do much to save energy and others may have no central heating to adjust. In terms of cooking and appliances, the groups which seemed likely to save more were council tenants (savings of £10.87 a year), DE social grades (£10.33) and low income households (£9.93). High income (£5.12) and professional (AB) households (£3.64) seem likely to save less as they follow fewer tips.

Prepayment meter (PPM) users are generally more aware of how much they are spending on energy than those who pay by other means, because they often know how much credit they need to put onto the meter each week. Thus PPM users already have some of the information that more consumers would get with a smart meter (albeit smart meters would provide more sophisticated information).

A 2001 survey aimed to establish the prevalence of self-disconnection and self-rationing amongst low income energy consumers.[38] [39] The survey found that about a quarter of

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[36] Energy advice to tenants: Does it work? by John Walker and Nigel Oseland, published by the Chartered Institute of Housing in association with the Joseph Rowntree Foundation

[37] New Perspectives/Energy Inform (2004) Savings from behavioural changes following energy advice: report on a survey. New Perspectives, Ipswich

[38] Affording Gas and Electricity: Self Disconnection and Rationing by Prepayment and Low Income Credit Consumers and Company Attitudes to Social Action Centre for Management under Regulation, University of Warwick Centre for Competition and Regulation, University of East Anglia, 2001

prepayment consumers had self disconnected in the previous year, and most had done so for periods of less than seven hours. However most who had self disconnected had done so more than once in the previous twelve months, and some more than twenty times. Most of those who had self disconnected attributed this to having forgotten to recharge the card, rather than to shortage of money. However self disconnection for money reasons clearly is a significant problem for a minority of prepayment users. Most tried to economise on their use of fuel; only 27% reported that they neither self disconnected nor self rationed. Pensioners were least likely to self disconnect or self ration. Households with both gas and electricity prepayment meters were most likely to both self disconnect and self ration.

8.4 Conclusions on social issues

Smart meters may raise a number of social issues, depending upon how they are deployed. Key factors will be the use of new tariffs and the extent to which smart meters form part of a broader strategy to improve energy efficiency for low income households. The Energy Demand Research Project should help to shed light on how different demographic groups respond to the information provided by smart meters and the different tariffs that they facilitate. Social factors need to be borne in mind by suppliers, the Government and Ofgem in the deployment of smart meters.

8.5 Prepayment meter issues

Prepayment meter usage has been growing in Great Britain since the early 1990s. There are currently around 5.9 million pre-payment meters in use in Great Britain (13% of domestic meters). There are 2.3 million gas PPMs – 12% of domestic gas customers. Almost all gas pre-payment meters are Quantum meters, which use smart-card technology[40]. There are 3.6 million electricity PPMs – 14% of domestic electricity customers, of which: 1.3 million are token meters; 1.5 million are key meters; 0.8 million are smart card meters.

Low income households are much more likely to have a PPM than households in general. PPM use is greatest amongst single parent households, the unemployed and those with long term illness or disability. PPM use is relatively low amongst elderly households, although higher amongst pensioners dependent upon state benefits than those with occupational pensions.[41]

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[39] Self-disconnection is interruption to supply because the card has not been charged. Self-rationing occurs when the respondent reports not being able to afford sufficient fuel to heat the home.

[40] Under their meter price control, National Grid Gas charges Suppliers £29.73 pa for a PPM, of which £7.86 pa is for meter provision. Gas pre-payment meter costs are currently quite substantially cross subsidised by charges made for domestic gas credit meters.

[41] Source: MORI research for Ofgem, 2005

Prepayment meter users tend to pay more than those who pay by different methods. The average gas prepayment bill is £615 per annum (20,500 kwh consumption) compared to £546 for the average direct debit customer (a difference of £69 or 12.6%). The average electricity prepayment bill is £385 compared to £349 for the average direct debit customer (a difference of £36 or 10.2%)[42] The differential appears to be increasing – in 2000 it was £47 for gas and £29 for electricity.[43]

It is generally accepted that prepayment meters are a higher cost payment method than direct debit. This is due both to higher costs of the meters themselves and higher servicing costs, although these costs are offset to some extent by the cash flow advantages to suppliers of cash in advance of energy use and the elimination of debt. However, whether differentials on the current scale are fully cost reflective is a matter of some debate – they may also reflect less active competition for PPM customers.

Suppliers are likely to be less keen to recruit PPM customers for three main reasons. Firstly, the higher costs of serving them. Secondly, PPM customers tend to be on low incomes and hence are less good propositions for selling other services. Thirdly, customers with debt over £100 can be prevented from switching – even though only about 15% of PPM customers are in debt at any one time (and only 5% have more than £100 of debt) , two-thirds initially have a PPM fitted because they are in debt – suppliers will have to check this before the customer can switch which represents another cost.

8.6 Prepayment meter technology

Token meters have a greater susceptibility to fraud and mis-directed payments and high maintenance costs due to the need for site-visits to re-set tariffs and obtain meter readings. Suppliers are removing token meters – switching customers to key meters or onto another payment method. Numbers fell from 1.5 million in early 2006 to 1.3 million by the end of 2006. Current estimates are that by the end of 2009 all token meters will have been removed – some suppliers will achieve this by the end of 2007.

In Northern Ireland 190,000 keypad electricity prepayment meters have been installed, (25% of residential customers). These have led to costs savings and lower prices for prepayment customers. However, the scope for similar benefits in Great Britain is lower because most of the prepayment meter stock is key or smart card. 'Key' meters and smart card meters allow transfer of information such as tariff-changes and meter reading data to and from the key or card at the payment service-point. In this sense, key and smart card meters are 'semi-smart'[44].

[42] As at 26 April 2007 – Energywatch
[43] DTI – FPAG paper, May 2007 meeting
[44] Ofgem. Pre-payment Meters. Consultation on New Powers under the Energy Act 2004 and Update on Recent Developments. February 2005. 32/05.

The main potential for new PPM technology could reduce PPM costs would seem to lie in the following areas.

- Eliminating the need to insert a card or key into the meter. Breakages and loss of cards or keys lead to costs of replacement, risks of fraudulent use and may necessitate a visit (Transco undertake 1 million visits a year due to problems at a cost of £50 a visit).
- Eliminating misdirected payments. Another problem with cards and power-keys is that some customers continue to use the old supplier's key or card when they switch so a supplier can receive payment for energy it has not actually delivered. Although there is an agreed industry process for power-key users, which ensures misdirected payments are correctly re-allocated, this still causes costs to reconcile the payments. Estimates put the value of payments sent to the wrong supplier at £150 million a year.[45]
- Eliminating the need to visit the property to change the meter from prepayment to credit and vice versa. About 10% (600,000) of the prepayment meter population changes each year, at £50 per visit.
- Having a greater range of options to make credit top up as flexible and simple as for prepay mobile phones, where customers can use Paypoint; phone or Internet; supermarket checkouts; cash point machines. This offers the potential to make prepayment more attractive and thus for more customers who have payment problems to move onto it.

Logica CMG estimate suppliers could save up to 30% of the cost of managing prepayment through smart technology.[46] However, if prepayment meter customers still buy credit frequently costs might not fall as much as expected. It is not clear whether payment infrastructure expansion would reduce or increase costs – this would depend upon the relative costs of new methods compared to existing ones.

Prepayment customers will not necessarily see savings, even if new smart prepayment meters reduce suppliers' costs. Many suppliers have already equalised their PPM tariffs with credit meter tariffs. In these cases, suppliers may keep the benefit or reduce prices to other customers.

There may be concerns that remote switching capability could lead to customers being switched from credit to prepay without the safeguards and processes that currently apply. This may mean some review of supply licence obligations is required.

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[45] Logica CMG newsletter, Vision Online, Issue 6, 2005
[46] Logica CMG op cit

8.7 Conclusions on prepayment meters

Smarter prepayment meters offer the potential to reduce some of the suppliers' costs associated with PPMs, which could benefit PPM customers (many of whom are on low incomes) if cost savings are passed on. The main scope for cost reductions could come from remote switching between credit and prepayment and eliminating cards and keys. However, whilst improvements in technology may tackle some of the causes of higher charges for prepayment meter customers, there are also other factors causing the differentials between prepayment and direct debit.

9. Policy options for delivery of smart meters

9.1 The need for intervention by Government and Ofgem

Agreement by suppliers to the ERA interoperability specification will be a fundamental step in averting potential stranding of new domestic smart-meters, but it does not guarantee that any smart meters will be installed – it sets out agreed standards to be followed if suppliers choose to install them. Recent regulatory changes address some barriers to smart meter installation[47], but if the Government's Energy White Paper ambition of electricity and gas smart meters in every home within ten-years is to be realised, more intervention beyond the present arrangements for meter provision will be needed by Government and Ofgem. Present uncertainty about what, if anything, the government may or may not mandate, is presently inhibiting even modest smart meter investment, for fear of stranding new meter assets.

The initial debate therefore is about how much and in what ways intervention is needed. There is a view that simply requiring new and replacement meters to meet a Government/Ofgem endorsed smart meter specification would be sufficient to secure a level of investment that could, over a number of years, lead to a tipping point such that all meters would be smart within a period close to ten years. This could well happen but there are a number of risks with limiting intervention in this way. Most notably, some or all suppliers might simply (within technical and feasibility constraints) extend asset life of existing meters to avoid the costs of smart meter investment. This could result in smart meter installation taking closer to 20 than 10 years. It is our view that rather more intervention than simply requiring new and replacement meters to be 'smart' will be required to achieve a ten year transformation timescale.

Below, we develop thinking from our first report to set out three policy options for delivery of domestic and smaller SME smart meters. Each option has different characteristics, likely benefits and shortcomings. Two basic differences lie in the approach to communications and in the regulatory treatment of the risks and costs of investment. The options are summarised below (see Annex for more detail).

[47] Supply Licence Review – July 2007 – repeal of 28 day rule; likely to be new risk-led approach to bi-annual visual meter inspection for gas.

9.2 Option 1 – Evolution of supplier led approach

Evolution of present supplier-led competitive approach for metering provision and services, but within a mandated timescale and framework.

Policy and regulatory changes required:

- The Government to clarify a minimum agreed smart meter specification for electricity and gas – to ensure interoperability and to facilitate expenditure on behalf of customers. The ERA work would form the basis for such a specification that the Government/Ofgem would have to endorse.
- The Government to require all new and replacement meters installed from a specified date to meet the approved smart meter specification. This may require legislation. This would bring an end to installation of conventional meters and avert wasteful stranding of new assets.
- The Government to place an obligation (or require Ofgem to do so) on all suppliers to ensure that all their customers have a smart meter (that meets the endorsed specification), for electricity and gas, within 10 years of a specified start date. Interim targets could be set (e.g. within 2 years; within 5 years etc) This would accelerate the rate of meter replacement from the current 5% per annum (replacing around 4 million meters per annum, instead of c. 2 million now). Assuming market participants agreed, this could be achieved through a licence condition. Otherwise legislation might be required – which could be done through the European Communities Act if needed to implement Article 13 of the Directive.
- The Government to require Ofgem to devise and implement a regulatory settlement for legacy meters that will be replaced before the end of their assumed 20 year accounting life, because of the above policy changes.

These four policy changes would be likely to lead to an evolution of the present supplier-led competitive approach for metering provision and services. Suppliers would be free to choose how to meet their targets either through geographic or more selective targeted approaches. Suppliers could do the work themselves or contract out and would have an incentive to collaborate (subject to any competition implications). The key considerations are mainly for the industry to resolve rather than for Government, although there could clearly be a role for DTI and/or Ofgem in industry leadership and dispute resolution on specific issues.

This approach thus involves limited government intervention and should promote innovation and competition between suppliers in metering procurement, although there would be risks of non-delivery or late delivery of the targets if issues were difficult to resolve.

9.3 Option 2: Systematic roll-out – meter and communications network

Systematic roll-out over a fixed period of both electricity and gas meters, and associated communications network likely to be based on some form of franchise, possibly regional.

Policy and regulatory changes required:

- The four changes detailed under Option 1 plus:
- The Government to require Ofgem to create a new Meter Licence. Any company that satisfied the required conditions could apply. Ofgem would award licences as it does at present for other licences.
- The Government (or Ofgem or some new body) to determine metering region(s) (e.g. the former PES or LDZ boundaries). It would run a competitive tender in which licensed meter companies can bid for a franchise (say for five years) for procurement and installation of smart-meters in each region. These regional franchised meter companies would become the exclusive providers of smart meters and communications for each region.
- The Government/Ofgem to amend the supply licence to require suppliers to arrange for smart meter and communications provision and installation in a geographic area via the appointed regional franchised meter company.
- The meter licence holder to be required to offer non-discriminatory and transparent terms for access to and use of the meters and communications. To protect consumers, some form of regulatory oversight would be likely, but would not necessarily involve formal price control. Alternatives could be some form of light-touch ex-ante regulation, or, ex-post regulation to prevent excess returns.
- DNOs may need to be required to make networks available for Power Line Carrier. Strict business-separation would be needed for DNO meter-related activity, to ensure transparency and non-discrimination.

The above changes would result in a systematic roll-out of both electricity and gas meters, for domestic and small business customers and associated communications (likely to be a mixture of PLC or Radio for most areas, plus GSM in remote areas) over a 10 year period. They would transfer long-term responsibility for the meter asset and its communications away from the supplier to the franchised meter company, irrespective of whether a customer switches supplier. The financial risk of potential stranding of new smart meter assets, where a customer switches supplier, would be removed from the supplier. Some meter companies may perform better than others – and some could fail. The regulatory arrangements would need to take account of this.

This approach would involve more government and regulatory intervention than Option 1 and potential competition policy concerns would need to be addressed. Whilst there would clearly be competition for the franchise, ensuring some incentive for efficiency and innovation, Option 2 does not promote competition between suppliers in meter provision (though it may benefit broader retail competition by making switching easier) and may be less effective than Option 1 in promoting meter innovation. Potentially, it transfers the cost and risk of investment – in part or in full – to customers but the risks of non-delivery or late delivery of the government's 10-year vision should be lower.

9.4 Option 3 – systematic roll-out – communications network only

Hybrid of Options 1 & 2. Set-up, roll-out and operation of a fixed meter communications network remunerated via a franchise, probably regional. Smart meter installation left to suppliers within a mandated timescale and framework.

Policy and regulatory changes required:

- The four changes detailed under Option 1 plus:
- Broadly the same changes detailed under Option 2 (including possible regulatory oversight of the terms and charges offered by franchised meter communications companies), except that the licence and franchises would be for meter communications only.
- Suppliers would have to be required to use these regional meter communications networks or to pay their charges for a minimum period, to reduce risk for the communications franchise holders.

The above changes would help to de-risk meter-communications by designating this as local monopoly infrastructure resulting in perhaps regional meter communications networks being established – primarily PLC and/or Radio. As with Option 2, potential competition policy concerns would need to be addressed. Option 3 would allow for innovation in metering (although could limit innovation in meter communications and entail some complex interfaces) and a continued supplier-led competitive approach to meter investment (in the context of the obligation on suppliers to secure a smart meter for all customers within 10 years).

This approach involves more government and regulatory intervention than Option 1, but less than Option 2.

Both for industrial and commercial and domestic smart-meters, the underlying question remains which approach could deliver most benefit at least cost:

- For consumers and public policy – in terms of lower bills and delivery of any energy and carbon-saving.
- For suppliers – in terms of reduced cost-to-serve, scope for product innovation and differentiation, and competitive retail edge.

9.5 Key considerations for policy and regulatory intervention

In considering the next steps, some main issues relate to:

- Smart meter specification. The ERA work clearly provides the basis for determining a smart meter specification, which the Government / Ofgem would need to endorse. The ERA work relates to meter functionality (i.e. the meter box), interoperability and also to the basic protocol requirements to enable data transfer in common formats[48]. The ERA is also evaluating communications options.
- Costs. Considerable uncertainty attaches to present costs – especially communications related – and how costs might evolve in the future. On the face of it, Option 1 looks more expensive (at today's costs) per meter installed than either of the dedicated local network options, with their possible logistical and procurement benefits. However, this needs to be off-set against a realistic assessment of the likely life-time costs of the set-up, roll-out, governance, operation and maintenance of a dedicated communications network, be it PLC or Radio. The potential for mobile communications costs to reduce in the future also needs to be factored into any comparison. Moreover, the potential for maximising the scope for competition and innovation to reduce costs is also an important consideration. Of the three options, Option 1 offers most scope for this.
- Back-fill costs. Options other than a systematic street-by-street roll-out will create a need, possibly ten years hence, for back-fill of homes without smart meters with consequent logistical issues and potential costs.
- Balance of risk. Under Option 1 the risk for new smart-meter investment would continue to sit, as now, with suppliers, albeit potentially mitigated by compliance with the ERA specification. Under Option 2, investment cost and risk would transfer to a licensed meter company with the potential for direct cost pass-through (in part at least) to customers. Under Option 3 the communications risk – where most uncertainty attaches – would be removed from suppliers, while leaving the lesser, meter-related, risk with suppliers.

[48] Energy Retail Association – SRSM Project – Smart Meter Functional Specification.

- Other demand-side measures. These need to be delivered in tandem in order to achieve the energy demand reduction potential of smart meters.

An important next step will therefore be to carry out a fully costed analysis, with sensitivities, of the likely present and future costs of a limited number of delivery options. This exercise needs to be led by the Government and Ofgem in full collaboration with the industry.

Under any option, domestic smart meter delivery within a decade represents a very significant and complex investment programme, and with potential long lead-times. Early decisions are therefore needed, first to clarify ESCO directive compliance; secondly to ensure an effective linkage with any post-2011 supplier obligation; and, thirdly, to have a realistic chance of achieving the 0.5MtC pa contribution attributed in the Energy White Paper to metering and billing by 2020.

9.6 Issues for the industry to consider

Technical and commercial considerations are mainly for the industry to resolve rather than for Government or Ofgem, although there could be a leadership role for DTI and Ofgem in possible dispute resolution. Some issues, which will require detailed industry consideration, include the following.

- Communications is not a core activity for suppliers or for many meter manufacturers. A fuller understanding is needed in respect of:
- Technical capabilities – and full life-time costs – of PLC, radio and mobile communications.
- Likely administrative and commercial frameworks needed to enable cross-industry use of communications networks.
- Meter reading and billing arrangements. How these will adapt to smart meter investment, especially transition arrangements, how to realise operating efficiencies and whether major new IT investment might be needed and over what time-scale.
- Governance frameworks for meter-data flows. MRA (electricity) and SPAA (gas) – what adaptation of existing frameworks will be required? In particular, there will need to be confidence in smooth customer switching, especially the mechanics of single fuel switching where electricity and gas meters are in-home radio-linked. This will be necessary both for fixed and mobile approaches to communications.
- Data privacy. Safeguards over third-party access to fully electronic meter data.
- Meter choice. How decisions will be made and by whom (e.g. suppliers, meter franchise operators etc) about what kind of meter(s) are installed in each home, including with

respect to single and dual-fuel, especially in Option 2. Similar questions would arise with respect to in-home visual displays.

- Flexibility requirements. Suppliers will need some flexibility to prioritise particular customer groups for meter replacement, For example, I&C and larger SME customers; public buildings requiring Energy Performance Certificates; enterprises subject to the new Carbon Reduction Commitment. Similarly, on the domestic side, the fuel-poor, or hard-to-access customers, social landlords, new housing developments, including proposed new eco-towns, or other targeted ‘green’, or location-specific initiatives.
- Fuel-specific and dual-fuel considerations. These include under what circumstances electricity and gas meters would – or would not – be smarted together. In particular, a question arises in a systematic roll-out about how gas smart-meters with both credit and pre-pay capability are likely to be installed and charged for because these meters are presently higher cost than gas credit smart meters or conventional gas pre-payment meters.
- Customer feedback. Options include an in-home display, other visual mechanisms (e.g. via home computer) or non-visual (e.g. time-of-use tariffs). Under all delivery options, it seems likely that in-home displays and / or other approaches to customer feedback linked to smart meters would be delivered competitively – not least to enable supplier differentiation – albeit possibly in the context of a mandated framework.
- Customer relations. All Options, but especially Options 2 and 3, would entail major new, potentially high-profile, industry activity in terms of home visits and interaction with customers. Efficient handling and good customer-relations will be a major reputational matter, both during smart meter installation and in promoting new retail opportunities that smart meters may unlock.

Key characteristics, technical and communications issues, some likely cost considerations, fuel-specific issues and the policy and regulatory requirements for each of the three options are discussed in the Annex.

10. Conclusion

It seems that suppliers now see a greater range and higher value for the benefits of smart meters than they did a year ago. However, this does still not add up to a business case for widespread (as opposed to targeted) smart meter installation. The carbon reduction potential therefore continues to be a central part of the overall cost benefit case for smart meters.

Smart meters could provide a platform in every home for feedback and messaging to support other demand-side measures and to help increase the uptake of micro-generation. The potential energy and carbon saving benefits of smart meters are most likely to be realised where they are linked with advice, information and financial incentives (e.g. EEC/CERT), and supported by sustained media activity.

A visual display linked to a smart meter could provide immediate feedback on consumption and influence consumer behaviour. Other methods of providing information – e.g. Internet, on bills etc – may also be effective, although they lack the immediacy of a prominent visual display. However, displays on their own (without a smart meter) will not facilitate a link to price signals – e.g. time-of-use or rising block tariffs. Stand alone visual displays are not available for gas and yet households use around four times more gas than electricity. Displays also cannot deliver the other benefits that smart meters can provide of accurate bills and savings in supplier costs. The Energy White Paper proposes that suppliers provide visual displays on demand to households from 2008-10. However, if this results in displays being delivered without smart meters, it runs the risk of limited benefit for potentially significant cost and diverting supplier effort from the greater prize of full smart meters. In-home displays should be delivered along with smart meters and not as a separate initiative.

The Energy White Paper set out a vision for all consumers to have a smart meter within 10 years. Clearly, another factor is the need to comply with the requirements of the Energy End Use Efficiency and Energy Services Directive. The debate to be had now therefore is about how much and in what ways the Government and Ofgem needs to intervene. We have set out three alternative options for delivery of smart meters in Great Britain and the policy and regulatory changes that each could require. An important next-step will be to carry out a fully-costed analysis, with sensitivities, of the likely present and future costs of the main delivery options. This is clearly a task where the Government and Ofgem need to provide leadership, working in collaboration with the industry.

The White Paper vision is welcome, but to achieve this in a ten year timescale will require a doubling of the current meter replacement rate. Uncertainty about what, if anything, the government may or may not mandate, is presently inhibiting even modest smart meter investment. There is therefore a need for Government to act quickly to set out how its smart meter vision will now become a reality.

Annex

Three policy options for domestic smart meter investment

Investment option 1: Evolution of supplier-led approach
Key characteristics

• Evolution of the present supplier-led competitive approach for metering provision and services with the additional aim of I&C coverage within five years and full domestic smart-meter coverage within a decade. Targeted approach initially likely to be focused on particular customer-groups. Likely to be largely non-geographic, using mobile communications.
• Likely to require cellular mobile communications direct from the home to the meter-data aggregator – i.e. GPRS / GSM with SMS. Mobile options are more expensive today, chiefly due to high modem costs – but costs could reduce in time.
• Coverage inherently piecemeal in terms of geography, but potentially most effective in terms of early-deployment to those likely to derive most benefit. Potential greater all-round efficiency in terms of customer-targeting and product differentiation.
• Likely to prove least-cost option in terms of:
  • Needless stranding of legacy assets
  • Early lock-in to communications options.
• **Fragmentation** – likely to pose logistical issues in terms of back-fitting 5-10 years hence, for homes and premises still without smart meters. This may prove costly in the long-run.

Technical/communications
• Meters most likely to be installed with GPRS/GSM and SMS connection to WAN. • Where customer switches supplier, arrangements needed in respect of SIM-card (see Regulation below). • Difficult to envisage how a 'dedicated network' could be installed or operated for

Investment option 1: Evolution of supplier-led approach
even a very localised area under targeted approach (e.g. social-landlord, proposed eco-towns). Perhaps via intervention of a third-party (e.g. local authority), but mechanism for recovery of network costs not obvious. • WiFi to home Internet connection could become a long-term option – but secure meter-to-router connection not yet commercially established. Around 50% of UK homes have a broadband connection[49]. • With mobile communications, could have in-home linked – or independent – gas-meter arrangement.
Cost
• Significant logistical / procurement-related cost-benefits less likely to be achieved. • Mobile communications costs believed to be twice those of a dedicated network. Modem-cost could come down over next few years. Cost of one weekly text serving both meters – 3-8p per text.
Fuel-specific issues
• Stand-alone domestic electricity smart-meter models are presently commercially more available than stand-alone gas – and potentially lower-cost and cheaper to install. In a competitive approach, smart-meter retail-led offerings are more likely to be electricity-only, or, dual-fuel. Retail-led approaches seem less likely to be gas-only, except for pre-payment. • Gas meters with a dual credit / pre-pay capability and isolation valve, may be more likely to have a modem than an in-home wireless link, and may therefore be well-suited to targeted installation. • For dual-fuel customers, gas-retrofit pulsed-options may be attractive because dual-fuel customers are more likely to have both meters changed at the same time. • New cross-industry administrative and commercial agreements will be needed to handle meter data-flows. In particular, these will need to ensure correct electronic routing of meter data-flows where customers switch a single fuel, especially with a

[49] Ofcom. April 2007. 13 million UK homes.

Investment option 1: Evolution of supplier-led approach
hubbed gas-to-electricity smart-meter arrangement. • In a targeted approach to smart-meter investment, gas smart meters are likely to lag behind electricity, and costs come down more slowly. Both from a household fuel-bill and energy-saving point of view, a slower roll-out of gas meters than electricity could be disadvantageous for consumers. (The per unit cost of electricity is higher than gas, but, on average, domestic gas bills are higher than electricity – because in energy-terms, more gas is used in the home than electricity).
Policy and regulatory changes
• All suppliers to agree ERA smart-meter specification for electricity and gas meters. • The Government to require all meters installed from a specified date to meet an interoperable smart-meter specification (say from May 2008 – ESCO Directive implementation). This has additional expenditure implications and may therefore require legislation. Clearly before this can be done the Government (and Ofgem) would need to clarify whether it endorses the ERA (or some other) specification. • Ofgem to amend the supply licence to place an obligation on all suppliers to ensure that all their customers have a smart meter (which meets the agreed interoperability specification) within 10 years of a specified start date. Interim targets could be set (e.g. within 2 years; within 5 years etc). Failure to meet such a condition could constitute a licence breach. • Suppliers would be free to choose how to meet their targets – i.e. either through geographic or more selective targeted approaches. Suppliers could do the work themselves or contract out and would have an incentive to collaborate (subject to any competition implications). • The Government to require Ofgem to devise and implement a regulatory settlement for legacy meters that will be replaced before the end of their assumed 20 years accounting life, because of the above policy changes. • **Smart meter coverage –** Consideration is needed *now* of what eventual steps, if any, might be needed to address possible piecemeal nature of smart-meter coverage and need for 'back-fill', say five-to-ten years hence. Backfill communications would be mobile or, perhaps eventually, home-broadband. These may both become lower-cost options than now. Either way, backfill could be a logistical challenge – and may or may not be costly. The uncertainties of eventual back-fill in a targeted approach

Investment option 1: Evolution of supplier-led approach
need factoring into any detailed analysis of roll-out options. • **Mobile communications and SIM-card – arrangements for transfer of meter data** – with mobile communications, where customer switches supplier, administrative and commercial arrangements will be needed to enable fully electronic transfer of meter-data to avoid SIM-card change, which potentially involves the cost of a home-visit.
Option 1 – Overall conclusion
These policy and regulatory changes would be an evolution of the present supplier-led competitive approach for metering provision and services. It reflects the most basic level of intervention likely to be needed to deliver smart meters to all homes within ten years. It entails relatively limited government intervention although there could be risks of non-delivery or late delivery.

Investment Option 2: Systematic roll-out – meter and communications

Key characteristics

- Systematic roll-out of both electricity and gas meters, and associated communications over, say, a 10 year period.
- Roll-out likely to be geographic for domestic meters – perhaps based upon franchise arrangements that mirror former electricity Public Electricity Supply regions and / or gas Local Distribution Zones. Franchises likely to be regional.
- Likely to entail set-up and operation of dedicated-communications network – probably some combination of Power Line Carrier and Radio.
- Medium and small SMEs to be treated as domestic customers.
- Any priority roll-out for I&C meters may be non-geographic and may therefore use GPRS/GSM rather than a dedicated network (see Options 1 & 3).
- Supplier agreement on ERA meter-specification and for communications a pre-condition.
- Suppliers would be responsible for making meter arrangements for their customers[50]. Suppliers would be required to arrange for meters via a franchise arrangement in a geographic area, through a licensed meter company.
- Franchise for procurement and installation of both smart-meter and meter-communications to be awarded for a given area through competitive tender to a licensed meter company.
- Outcome would be to transfer long-term responsibility for the meter asset and its communications away from the supplier to the franchised meter company, irrespective of whether a customer switches supplier.
- Financial risk of potential stranding of new smart-meter assets, where customer switches supplier, would be removed from supplier. Potentially positive for new-entrant smaller suppliers.
- Meter charges made by the meter company to the supplier could pass-through – in part or in full – to consumers via the supply price.

[50] The new electricity and gas Supply Licences (July 2007) will no longer have an explicit obligation upon suppliers to provide domestic customers with a meter. Suppliers have obligations to offer terms for supply to domestic customers, and the Gas and Electricity Acts require that a supply is given through a meter. Supply Licence Review – Further Proposals. 217/06. December 2006 and Ofgem Open Letter on Gas Supply Licence Meter Work Obligations. 2 May 2007.

Investment Option 2: Systematic roll-out – meter and communications

- Franchise open to any licensed meter company. Franchise could be for a fixed-term (say five years). Tender to be run by a body independent of suppliers – probably Ofgem. Franchise competition would be incentive for efficiency and innovation. Present Ofgem / DTI contestability proposals for offshore transmission projects offer a potential model.

Technical / communications

- **Meter and communications –** Could lead to early lock-in to volume technology choices with attendant risk – especially on the communications side. Forgoes flexibility benefits of incremental or targeted approach of a competitive market model.
- **Meter communications –** Systematic roll-out likely to entail set-up and operation of a dedicated local network up to WAN gateway – could be PLC or Radio (Short or Medium Range), or in combination. Could be GSM for remote areas. For PLC and for Medium-Range Radio, network could be rolled-out as separate exercise from home-visit programme to install meters. For Short-Range Radio options (e.g. Zigbee), communications network and meter installation likely to be physically rolled out together.
- Communications choice, roll-out and operation would be for meter company – and be their risk. May not be a uniform communications-choice across a franchise area, depending on meter-locations and densities etc.
- Meter companies before being in a position – either to tender or to secure financing – would need full understanding of:
  - Potential costs, benefits, capabilities, installation and operational implications, and full life-time costs for PLC, Radio and Mobile Cellular Communications.
  - Electricity and gas meter densities and general characteristics of a franchise area – including information, at a fairly localised-level, on the scope to use electricity meters as the communications hub for gas-meters.
  - Characteristics of regulatory oversight and risk/reward basis under which the franchise arrangement will operate.

Investment Option 2: Systematic roll-out – meter and communications

Cost

- **Meter cost –** Clarity on meter volumes should offer procurement cost-benefits (volume may reduce meter-costs by one-third) –and potential for lower cost of capital.

  A dedicated-network offers the prospect of lower-cost electricity meters, because the modem-cost is removed from the meter. The cost-reduction benefit for gas-credit smart-meters is likely to be less. This is because under most scenarios gas-credit smart-meters will be radio-linked to the electricity meter or smart-box, and will not have a modem (including in Option 1).
- **Installation –** likely lower average installation cost; improved organisational logistics; and expertise.
- **Communications cost –** Infrastructure / network set-up and ongoing operational and maintenance costs need to be fully factored into any dedicated network option.
- **Supplier cost –** Reduced meter-reads, lower call-centre costs and improved cash-flow fully realised at volume.
- **Cost to customer –** could be spread over 10-15 years or more – i.e. appropriate to infrastructure asset with long-life. Potential benefit of better price competition realised through more dynamic market.

Fuel-specific issues

- In a systematic roll-out would gas and electricity meters be installed in a single visit?
- More likely:
  - If both meters being connected at same time to a 'dedicated network'.
  - If electrical skills only required – not CORGI. i.e. gas retrofit with data-logger – and linked by short-range radio to electricity.
  - If administrative and commercial arrangements for meter data-flows for both dual-fuel and for non-dual-fuel customers.

Investment Option 2: Systematic roll-out – meter and communications

- Less likely:
  - If independent new gas and electricity meters to be installed – and separate CORGI & electrical skills needed.
  - If non-dual fuel customers
- **Gas-smart meters with dual credit / Pre-pay capability –** There is a generally-held view that installation of these smart gas credit / pre-pay meters is likely to increase well beyond the present 10% for conventional gas pre-pay, because of the potential to reduce cost-to-serve. Under Option 2, there are a number of issues in respect of these meters:
  - On what basis existing conventional gas pre-pay meters (which are already semi-smart) would be replaced with these meters?
  - A supplier – or customer – could presumably request a more expensive dual-capability credit / pre-pay gas meter – and not a (lower-cost) smart gas-credit or a conventional pre-pay meter. Questions arise as to how individual suppliers should bear the costs of these meters – and the extent of smeared charges, if any.
  - Questions also arise (as for conventional gas pre-pay), in respect of *safe remote re-connection* of these maters. The ERA specification addresses this, by requiring a *customer-activated step at the meter*, to enable physical reconnection.

Policy and regulatory changes

- **Policy and regulatory changes would include the four changes under Option 1.**
- The substantial costs and risks involved in a mass programme mean that there is likely be considerable regulatory, consumer and supplier pressure for cost transparency and non-discrimination.
- Additional statutory or licence requirements would be needed – not least to ensure that the development phase is fully remunerated, to create a level playing field for all suppliers, and, to overcome possible competition considerations[51]. These additional requirements are as follows.

[51] In practice, many of the detailed steps identified could be achieved by modifying standard licence conditions, subject to majority agreement by current licence holders.

Investment Option 2: Systematic roll-out – meter and communications

- Creation of a new meter licence by Ofgem, endorsed by government[52]. Any company able to satisfy the required conditions could apply for a licence.
- Ofgem to amend supply licences to require suppliers to arrange for smart-meter and communications provision and installation in a geographic area via an appointed regional franchised meter company.
- Ofgem / DTI to determine metering region(s) (e.g. former PES or LDZ boundaries) and to organise a competition in which licensed meter companies can bid for a franchise (say for five years) for procurement and installation of smart-meters in each region. These regional franchised meter companies would become the exclusive providers of smart meters and communications for each region.
- The meter licence-holder to be required to offer non-discriminatory and transparent terms for access to and use of their meter assets and communications network.

  Meter Assets – Meter company to offer terms for providing assets; requirement for economical and efficient procurement of meter assets; and to replace, say, 10% of meter stock pa with ERA-compliant assets.

  Communications – Meter company to offer terms for a communications connection for every meter point within franchise area; requirement to provide, operate and maintain economical and efficient meter communications network for the full franchise area. Requirement to be a party to cross-industry governance frameworks for non-discriminatory access to communications networks.

  DNOs – Possible requirement on DNOs to make networks available for Power Line Carrier. Clear ring-fence between metering and distribution assets. Clear cost-separation for any use of DNO hardware / assets, including clarity on inter-business charging.

  Meter data – Strict business-separation and confidentiality with respect to meter data.
- **Meter companies – risk and reward –** Meter company charges would be shared on an equitable basis among all suppliers. It would be for suppliers to decide to what extent these charges would pass-through – in part or in full – via the supply

[52] Upon application by the Authority to make activities licensable, could be achieved by Order of the Secretary of State (Utilities Act 2000 sections 43 (electricity license) and 88 (gas licence)).
[53] Distribution Price Control Review. Final Proposals. Ofgem. Nov 2004
[54] 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).

Investment Option 2: Systematic roll-out – meter and communications

price. Some form of regulatory oversight will be likely, to ensure the consumer is safeguarded from excessive cost.

- Ultimately, any regulatory approach would need to reflect the likely investment risks in terms of meter-technology, communications and roll-out logistics – and the extent to which a meter company takes on some or all of that risk. Should meter companies seek high returns (to reflect high-tech asset-risk, potential early obsolescence and logistical challenges of a roll-out) they should also expect to face more exposure to those risks. For the full financial risk – especially the communications risk – to simply transfer to the customer via a full cost pass-through, would not necessarily best serve suppliers or customers in sustained pressure to drive down costs of providing smart meters. The strongest efficiency driver would be incentives for meter companies to take at least some of the risk.
- Needlessly burdensome regulatory arrangements could be unwelcome. Some form of light-touch regulation may be feasible – provided effective efficiency incentives were in place. Meter assets and communications may or may not be price-controlled. They could be subject to some form of light-touch ex-ante rate-of-return regulation, or, could earn non-regulated returns subject to ex-post regulation reflecting reasonable risk while preventing excess returns. Similar options are under debate with respect to new offshore transmission.
- Given the nature and scale of risks associated with a systematic roll-out, some meter companies may perform better than others – and some could fail. Regulatory arrangements would need to take account of this.
- **Stranding of legacy meters –** Option 2 could entail more early asset-stranding than Options 1 or 3. Suitable redress arrangements will be needed for early meter-replacement. Cost burdens will need addressing.

  For electricity legacy assets, with a combined RAV of around £230 million[53], the stranding burden potentially sits with DNOs.

  Gas legacy assets have a historical-cost net-book value in excess of a billion pounds[54]. Under the Meter Services Agreement, stranding cost sits with suppliers. For meters not covered by the MSA, stranding cost sits with National Grid.

  Existing third-party meter providers have entered the market in good-faith – around 2-3 million meters have been installed to date (electricity and gas). Satisfactory redress would also be needed for early replacement of those meters, and for termination of present contracts.

Investment Option 2: Systematic roll-out – meter and communications

Option 2: Overall conclusion

The above changes would result in a systematic roll-out of both electricity and gas meters, for domestic and small business customers and associated communications over a 10 year period. They would transfer long-term responsibility for the meter asset and its communications away from the supplier to a franchised meter company, irrespective of whether a customer switches supplier. The financial risk of potential stranding of new smart-meter assets, where a customer switches supplier, would be removed from the supplier.

This approach requires more government and regulatory intervention than Option 1. Potentially, it transfers the full cost and risk of investment direct to customers but the risks of non-delivery or late delivery of the government's 10-year smart meter vision should be less.

Investment option 3: Systematic roll-out – communications network only

Key characteristics

- A pared-down approach to Option 2 could be to install and remunerate a national meter communications network – PLC or Radio – but continue to leave smart-meter provision to commercial decisions by suppliers. This could help de-risk meter-communications by designating this as infrastructure – while potentially enabling a continued supplier-led competitive approach to meter investment.
- The ERA specification means that both the meter-box and within-home communications could continue to be competitively provided by suppliers or their agents. In principle, if meters are ERA-compliant, both interoperability and stranding-protection will be assured.
- The most probable element for designation as 'common communications infrastructure' would be the basic communications link transmitting meter-data from the home to the first WAN-interface.
- Communications technology would be Power Line Carrier or Medium-Range Radio (**but probably not Short Range Mesh Radio** – see Technical below).
- Would be based upon a regulated geographic franchise as in Option 2. Unlike Option 2 would retain supplier-led competitive approach to meter investment. Option 3 offers a hybrid of Options 1 and 2.
- This more limited step in terms of meter-communications might then provide a basic but flexible platform from which to facilitate a variety of approaches to smart-meter investment.
- With a communications network roll-out, initial steps to smart meter deployment may not necessarily be universal or fully geographic. Nevertheless, the fact of a communications network with eventual national coverage could offer capacity for 100% smart meter coverage within, say, a decade.
- A communications network could also offer the potential for accelerated roll-out, while leaving flexible meter delivery options for suppliers to decide. For example:
  - **Systematic Meter Roll-Out –** Could be by meter-life (as now) and minimise needless stranding of legacy assets – or could be largely geographic.
  - **Incremental Meter Roll-Out –** Suppliers would be free to target particular customer groups (e.g. I&C; public buildings requiring an Energy Performance Certificate; enterprises included in Carbon Reduction Commitment);

Investment option 3: Systematic roll-out – communications network only
or particular locations (e.g. cities, social landlords, new Eco-Towns etc). • **Targeted meter roll-out –** Suppliers able to target high-cost-to-serve, hard-to-access domestic customers – or customers they wish to attract or retain through innovative retailing. • Key characteristics of the communications-only approach would otherwise be broadly similar to Option 2.
Technical / Communications

• **See points on meter communications from Option 2.**
• From outset, network would need:
  • Prospect of a minimum accounting life, say 10 – 15 years
  • Sufficient capacity to transmit meter-data from all potential meters that might connect later.
• Network most likely to be PLC or Medium-Range Radio, or combination, depending on local conditions.
• **Short-range Mesh Radio –** appears unlikely to be suitable choice for communications-only network. This is because where meter-communications are dependent upon a short-range radio-signal 'hopping' from meter-to-meter (e.g. Zigbee), meters would need to be installed at the same time. Short-range mesh radio however is viewed as attractive in a variety of roll-out scenarios. Therefore, the need to combine communications and meter roll-out for short-range mesh radio, may in communications terms, serve to make Option 2 more flexible and attractive than Option 3.
• Would also need to consider franchise treatment of remote areas where GSM might be most economical, and costs of 'dedicated network' infrastructure possibly not warranted.
• A communications-only approach would only be likely to succeed if meters could be installed by suppliers (or their agents) on a straightforward 'plug and play' basis, once the communications-network is up and running. Basic simplicity is likely to entail:

Investment option 3: Systematic roll-out – communications network only
• No requirement for home-access during network roll-out phase. • Meters installed by supplier (or their agent) in each home would need to be interoperable with the communications technology serving those particular premises i.e. PLC, Medium-Range Radio or GSM. This would need to be administratively simple in terms of suppliers' arrangements for meter procurement and installation. Presume ERA-compliance should suffice. • Meter installation by a single, straight-forward, home-visit – even if 5-10 years hence. • **Fragmentation / Complexity:** Separation of responsibility for meters and communications could cause needless fragmentation and transactional complexity and could be a significant drawback for Option 3. Suppliers will anyway procure meters from meter providers – and this approach would add yet another supplier interface. **Benefits of communications-only focus –** Conversely, the narrower remit of a communications-only approach could prove beneficial in terms of communications focus, expertise and delivery. It could also reduce overall cost and risk by minimising the elements of smart-metering investment not exposed to competition.
Cost
• **Risk –** Responsibility for communications costs would sit with the licensed meter communications company. How much risk to be retained by them – and how much borne by customers would depend on the arrangements for regulatory oversight. See regulatory discussion for Option 2. • **Meter Cost –** Assuming same replacement rate as other Options (presume 10% pa), likely to offer similar volume-related cost-benefits. A dedicated-network offers the prospect of lower-cost electricity meters, because the modem-cost is removed from the meter. The cost-reduction benefit for gas-credit smart-meters is likely to be less. This is because under most scenarios gas-credit meters will be radio-linked to the electricity meter or smart-box and will not have a modem (including in Option 1 – targeted option). However, in a competitive environment for meter provision, the potential for lower meter costs afforded by Option 3 ought to be attractive to suppliers.

Investment option 3: Systematic roll-out – communications network only

- **Meter installation –** lower average meter-installation costs and improved organisational logistics are less likely to be achieved for Option 3 – unless meter roll-out is predominantly geographic in practice (which it could be).
- **Communications cost –** Infrastructure / network set-up, operational and maintenance costs need to be fully factored into any fixed network option.
- **Supplier cost –** Reduced meter-reads and lower call-centre costs may be realised.
- **Cost to customer of communications network –** could be spread over 10-15 years – i.e. appropriate to communications infrastructure asset. Potential benefit of better price competition realised through more dynamic market.

Fuel-specific issues

- With a communications network in place, suppliers would be free to target individual customers as they wished – including high-cost-to serve, hard-to-access, and dual-fuel.
- **Supplier differentiation –** roll-out of a communications network and leaving meter provision with individual suppliers, potentially allows considerable scope for supplier innovation and differentiation in terms of the meter box, home display unit and retail-led packages.
- **Impact on retail competition** – once a communications network is rolled-out in a particular locality or region, vigorous marketing by suppliers of smart-meter packages may follow – with potential benefit for domestic retail competition.
- Continued competitive meter provision would mean that where a dual-fuel customer switched one fuel, but not the other, then adequate administrative and commercial arrangements would need to be in place to handle meter data flows for non-dual-fuel customers, as for Option 1.
- **Water meters –** A communications-only network may also offer eventual scope to install smart water-meters in some areas too. Potentially, water meters could communicate over the dedicated network to the WAN, perhaps accessing this via an in-home wireless link to the electricity meter. Clearly, suitable governance and commercial frameworks would first need to be put in place.

Investment option 3: Systematic roll-out – communications network only

Policy and regulatory changes

- Policy and regulatory changes would include the four changes under Option 1.
- Additional requirements would be needed broadly as for Option 2, including legislation or other mandate (except that the licence created and franchises tendered would be for meter communications only), with possible regulatory oversight of the terms and charges offered by the franchised meter communications companies to suppliers. Main features would be:
  - Suppliers responsible for making meter arrangements for their customers.
  - Suppliers obliged to offer a new compliant smart meter (probably ERA) to every customer over, say, a 10-year period.
  - Suppliers obliged to arrange for meter communications via a franchise arrangement in a geographic area through a licensed meter communications provider.
  - Franchise to be awarded by competitive tender for a fixed term. Tender organised independently of suppliers.
  - Charges for meter communications would be shared on an equitable basis among all suppliers. It would be for suppliers to decide to what extent these charges could pass-through – in part or in full – to customers via the supply price. Likely to entail some kind of regulatory oversight as a customer safeguard.
  - Suppliers would be required to use the franchised regional meter communications network or to pay their charges for a minimum period, to reduce risk for the meter-communications provider. Suppliers would not be free to opt-out from the communications franchise or from payment of its charges. However, suppliers could opt to install meters with modems (for example if the costs and convenience were attractive), provided the meters were otherwise ERA-compliant. A wish to opt-out seems most likely if the costs of mobile communications falls significantly at some point later in the franchise period.
- Business separation could be needed between franchised meter communications company – contracted to all suppliers – and, a meter provider who may be contracted to an individual supplier. This suggests yet further fragmentation – especially if meter companies wish to offer suppliers a one-stop-shop for meter communications, provision, installation, and other meter services. This could be a further argument against Option 3 – and an argument in favour of keeping meter

Investment option 3: Systematic roll-out – communications network only
communications and meter provision together as for Option 2. • Stranding arrangements for legacy assets would be as for the other Options.
Overall conclusion on Option 3
• The above changes would help to de-risk meter-communications by designating this as local monopoly infrastructure resulting in meter communications networks, perhaps regional – either PLC and/or Radio – being established. It would allow a continued supplier-led competitive approach to meter investment (in the context of the obligation on suppliers to secure a smart meter for all customers within 10 years). • This approach involves more government and regulatory intervention than Option 1, but potentially less with respect to the meter than Option 2.