To:

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Response to the consultation document: "The regulatory implications of domestic-scale micro-generation"

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1 Introduction

Dear Arthur

Having read the consultation document ("The regulatory implications of domestic-scale micro-generation"), we would like to make some comments.

We are:-

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Our main comments are that we would like to see some consideration or discussion of real-time pricing in conjunction with the implementation of micro-generation and meter upgrades. It is our belief that allowing domestic customers to (optionally) participate in real-time pricing is one of the most sensible ways that the electricity industry can progress. We envisage that separate real-time prices would be established for buying and selling from the grid. This links closely with the issues of electricity meters running in 'reverse' but clearly requires new metering arrangements at domestic premises. The advantages for the industry include more stable wholesale buy/sell prices, reduced peak demands, reduced reserve capacity requirements and increased load factor for existing generation capacity.

The advantages for the consumers include savings on import electricity bills and the option to export micro-generated (or stored) electricity at times of peak demand (and therefore higher prices).

There are 5 points which we have focused on below:-

- The impact of domestic CHP boilers
- Real-time pricing and half-hourly metering
- Islanding
- Monitoring and control of VAR import/export
- Metering Communications Requirements

We hope these comments are useful to you!

Many regards,

Andrew Roscoe
Graham Ault
Bob Currie
Stuart Galloway

1.1 The impact of domestic CHP boilers

As part of a thesis investigating energy use and real-time pricing in the UK[1], we "disaggregated" domestic electricity and gas load profiles into their component parts against time-of-day and day-of-year timeframes, and cross-correlated these with overall DTI energy use figures. One useful conclusion about domestic CHP boiler micro-generation was this:-

Currently about 70% of UK households have gas central heating of some sort. If 50% of these households (35% in total) were to convert to CHP boilers, and our electricity consumption patterns were to stay otherwise unchanged, then our (UK) winter peak demand for electricity in the early weekday evenings (currently about 53GW) would drop to about 42GW, while our summer peak demand would remain similar to it's current level at about 42GW also. This is because the time of peak CHP usage (for heat) coincides at (roughly) the same times of day as the peak domestic electricity usage.

This is a very interesting result. The implication is that if MORE than 50% of households convert to CHP boilers, then the UK peak demand will no longer be in the winter but in the summer. Persuading up to 50% of households to convert to CHP boilers could be seen as a very desirable thing, but once the figure of 50% is surpassed, the continued addition of micro-generated power becomes less of a benefit to the network performance. The effect may begin to become detrimental since the generated power may not coincide exactly with the peak electrical demand. If all 70% of households converted to CHP boilers, an approximately 20GW spike might occur in generation in the early morning and evening, and this might cause network stability problems unless mitigated by some kind of signal such as real-time pricing.

1.2 Real-time pricing and half-hourly metering

The electricity industry in the UK seems to shun real-time and time-of-use pricing at present, despite the fact that it could offer financial savings to many customers, could help to prevent blackouts, could minimise capital outlay on generation capacity, and could enable higher proportions of climate-dependent renewable generation to operate effectively on the network.

If electricity meters are going to be replaced as part of a micro-generation installation programme, then our recommendation would be to make the new meters of the "advanced" variety such that they can be billed (for import and export) on half-hourly timeframes by remote control. The additional cost of this feature in urban areas is small since a small wireless transmit/receive module is all that is required, along with a simple CPU. No extra connections to phone lines need to be made in most domestic installations, so the new meters can be a direct replacement for a standard meter. Off-the-shelf solutions can be purchased today. Once a customer has such a meter, then the "supplier" should offer the customer an optional electricity purchase plan which allows them to pay real-time wholesale prices plus the TUos, DuOS and Electricity Retailer fees. Similarly, if the customer wishes to export power, then they should be offered an "export plan" which pays the real-time wholesale price MINUS the TuoS & DuOS fees and presumably also the Retailer fee.

This type of cost and revenue plan, if offered by suppliers, will encourage customers to minimise consumption during periods of peak demands, and will encourage them to export from micro-generation when demand is high. It will minimise the incentive to export power if demand is low, since the revenue from selling will be correspondingly low, and possibly zero if the wholesale price drops below the value of the DuOS+TuOS+Retailer fees.

To be socially acceptable, the available pricing "plans" from suppliers would probably need to be available in a range, from fixed price price-per-kWh (the current situation), through to half-hourly pricing. Intermediate options include summer/winter day/night pricing, weekday/weekend prices, 4-48 hour guaranteed forecast prices, and critical peak price override at short notice for those not already subscribed to half-hourly pricing.

[1] ftp://ftp.strath.ac.uk/Esru_public/documents/MSc_2004/roscoe.pdf

1.3 Islanding

We were surprised to see so little discussion about islanded operation. We understand that the current regulatory situation is that when LOM (Loss of Mains) occurs, then the micro-generation should trip off. However, there are two main reasons why this regulation should be clarified and/or adjusted:-

1. There is significant research being carried out at several establishments (including our own department at the University of Strathclyde), which is aimed at providing security of supply in the event of network outages and network capacity shortfall through managed power islanding. To date, most of this is targeted at industrial scale generation, but the principles being investigated are equally applicable to micro-generation.

2. Within the domestic environment, many people who install micro-generation and think ahead to possible winter blackouts will probably form some DIY plan for powering certain parts of their own house from their own micro-generation if the need arises. How does regulation deal with this? Do the domestic connection regulations allow you to do this if you remove at least the main fuse to the house and/or open the main isolating switch? Or is it illegal in all scenarios? A common plan for such a DIY scheme is to use a local micro-generator or portable petrol generator to power enough of the household circuits such that the gas central heating water pump runs, together with a few key electric lights. I think any related regulation should be realistic in its expectations that people WILL implement such DIY schemes if the standard micro-generation installation does not provide an islanded mode as a built-in feature. I would propose that domestic micro-generation installations should therefore be installed with an islanded mode of operation setting, which interlocks with breaker(s) at the main domestic connection point, to provide a safe way of operating as a power island under extended LOM conditions. This is more a technical issue than a regulation issue but should be kept on the table from the very outset of the micro-generation era.

1.4 Monitoring and control of VAR import/export

There is no mention of VAR monitoring in the consultation document. If domestic micro-generation is to be installed, there will presumably be at least a minimum requirement in engineering standards and agreements with DNOs that the equipment operates at or near unity power factor. If new meters are to be installed, based upon solid-state measuring devices, then a simple software enhancement will enable them to measure not only real but also reactive power flows. This reading could be used periodically by the DNO or supplier to verify correct operation of the micro-generation unit (or more specifically the micro-generation unit plus the customer's load). Ideally this monitoring would be remote, piggy-backed within a wireless real-time pricing data infrastructure; but as a fall back the monitoring could be by physical meter reading at the customer’s premises.

Looking further into the future, we see an increasing dialogue in "the value of VARs" and in local power management. There is currently a significant deficit in understanding in this area, coupled with increasing interest from the potential distributed generators (VARs could be a source of revenue and might define the type of generator hardware installed). Within a future "actively managed" network with widely distributed generation, holding voltage within allowed limits and providing the appropriate voltage support will be a key technical challenge. Currently, voltage support is provided by the DNO hardware and is tailored heavily to specific local network topology, loads, and known DG. With less predictable domestic micro-generation added to the network, it becomes increasingly likely (but not certain) that these micro-generators may have to become part of the voltage support and power management system themselves. Small micro-generators with power-electric interfaces will be ideally positioned for such a task, as will larger industrial DG with synchronous generators, DFIGs or power-electronic interfaces. Significant research is still required in this area.

1.5 Metering Communications Requirements

Within an infrastructure of new electricity meters, there would be value in providing for the following features inside any new communications protocol:-

- Communication of real-time and forecasted buy and sell real power prices to the customer meter
- Communication of measured import/export real power to the DNO/supplier/buyer
- Communication of real-time and forecasted buy and sell reactive power prices to the customer meter
- Communication of measured import/export reactive power to DNO or a "support service provider"
- -Communication of forced commands from the DNO to the micro-generation unit or local loads (overriding pricing signals). These commands could force micro-generation unit shutdown, startup, power output, VAR import/export, or load shedding, and are a less attractive solution than pricing, but may be necessary if pricing signals do not succeed.

The real-time and forecasted prices would not be a provided as a result of a nationwide market, but would be determined via a predictable algorithm (regulated by OFGEM) from supply and demand within a specific network area. The price might need to take account of local power flow constraints (excessive generation on-line, excessive demand, thermal limits of lines and equipment etc.) and also voltage control limits.

Even more uncertain are future requirements for frequency control. With a high penetration of DG on the network, the traditional methods of controlling frequency will not necessarily be enough. Technical solutions can almost certainly be found which will allow frequency control with large amounts of micro-generation, but it is quite likely that these solutions will involve the micro-generation and industrial DG taking an active role in frequency management. To make this possible, we would also need to add a frequency control signal within the communications channel to/from the customer's micro-generation. The nature of this signal and it's interaction with the micro-generation are as yet uncertain.