Microgeneration & Billing

1 Introduction

In the context of an imminent energy crisis, the end of cheap and readily available oil, and the potentially catastrophic impact of climate change on western civilisation, some might wonder why so much attention should be paid to an item so apparently trivial as metering and why smart metering in particular is seen by some as such a significant measure. Whilst no-one would argue that even the smartest of smart meters alone is going to solve the energy crisis, it is the cumulative effect of measures such as this which will impact on the economic viability of technologies such as microgeneration which can themselves make a major contribution to our future sustainable energy system.

This paper will therefore focus on the way in which metering and billing of microgeneration can effect the economic viability of certain microgeneration technologies and identify the challenges which must be overcome if we are to capture the true benefits of microgeneration, fairly reward those who invest their resources in it and thus support the uptake of this valuable technology.

2 The Energy Challenge

The UK, along with the rest of Europe faces a number of unprecedented challenges to the continued survival of our way of life; economies founded upon abundant, cheap fossil fuels are now confronted by the double-edged sword of rapidly depleting oil and gas resources, combined with increasing energy needs from emerging, developing nations with substantial populations and ultimate energy demands far in excess of those of the present industrialised world. If that were not enough, the mere use of these resources is contributing to anthropogenic climate change with unknown, but almost certainly undesirable impacts on the habitability of our world.

Europe has committed to meeting these challenges and has proposed a range of goals aimed at moving towards a more sustainable energy system[1], with an initial target by 2020 of achieving 20% reduction in carbon emissions, 20% improvement in energy efficiency and of meeting 20% of our energy consumption from renewable sources. The 20% renewables target for energy is particularly significant as this applies across the economy, not just the electricity sector. As it is almost inevitable that a significant proportion of, for example, the transport sector's energy needs will be met from electricity, then the electricity industry will have to deliver substantially more than 20% of current capacity from renewables.

Unfortunately, the current competitive energy market in the UK in particular does not lend itself to strategic infrastructure development and there has been a decision making vacuum for several years which, combined with the already scheduled plant closures to meet the LCPD, means that by 2013, the UK will face a shortfall in electricity generation of around 45%[2], even if there is no increase in demand from other sectors.

It is within this context that any contribution from low carbon generation is to be valued and we simply cannot afford to ignore any particular technology solution because it is deemed too trivial or too difficult to capture.

3 The Potential Contribution of Microgeneration

3.1 The scope for Microgeneration

Numerous studies commissioned by Government agencies have all concluded that Microgeneration can make a significant contribution to the long term UK energy mix. Depending on the relative costs of gas and electricity, specific microgeneration technologies offer immediate environmental and economic benefits and can be delivered in significant volumes through existing delivery chains. Foremost amongst these are micro CHP (most beneficial where gas is relatively cheap compared to electricity), and heat pumps which are more appropriate in the opposite scenario and which will almost certainly become the heating system of choice within the next couple of decades .

However, it must be conceded that not all forms of microgeneration necessarily represent the most cost effective means either of mitigating carbon emissions or providing security of supply, although even the more expensive measures empower and engage individual members of society who can choose to invest their own resources in an incremental and low risk way, without the need for high level bureaucratic intervention.

A recent study by Element Energy for BERR[3] demonstrated the potential for 1 – 3 million microgeneration installations together with CO2 savings of 1 and 3 million tonnes by 2020 and 2030 respectively, the leading technologies being identified as micro CHP and heat pumps. Significant subsidies would, however, be required to achieve any significant penetration of other Microgeneration technologies.

3.2 Benefits of Microgeneration

Microgeneration can, in its own right, deliver carbon savings, contribute to long term security of supply and help tackle fuel poverty. It will help avoid single fuel dependency and add diversity to complement large scale intermittent sources, acting as an enabler for high penetration levels of, for example, large scale wind. It will also help to minimise system losses, although that is of less relevance if Microgeneration is significantly less efficient than large scale RE.

So, although Microgeneration is no silver bullet, it does have a significant role to play as part of a mix of heat and power producing solutions. A number of studies, with a particular focus on micro CHP, have shown how Microgeneration can help deliver all four of the key policy objectives in UK Energy Policy. The results are surprising, in that the benefits identified generally exceed the earlier claims made by manufacturers. Three studies in particular show that micro CHP makes a substantial contribution to fuel poverty, carbon mitigation and diversity of supply targets.

A Policy Studies Institute paper[4] shows that micro CHP contributes almost as much to fuel poverty as all other measures put together including micro CHP. This paradox is explained by the fact that, if homes are well insulated, the reduction in thermal load leads to a reduction in electricity production and hence makes it unlikely that micro CHP would be installed in as many homes: "Micro CHP can do almost as much for fuel poverty as making all possible energy efficiency improvements, including micro CHP."

A report by the consultancy Ilex[5], shows that appropriate emission factors to be used for calculating CO2 displacement for the next 10 years are actually higher than both that of the average generation mix and of current marginal generation emissions. Current government policy is based on 0.43kg/kWh which is the average mix, a somewhat arbitrary and in this case, inappropriate measure. Micro CHP is shown to displace marginal plant and the study, which matches actual generation profiles for installed WhisperGen units against marginal plant, shows a displacement of 0.54 rising to 0.67kg/kWh by 2010. This counter-intuitive result is the consequence of the increasing cost of coal-fired generation which, although it reduces the total amount of coal generation in the overall mix, shifts all coal generation into the margin.

Further indirect benefits accrue to micro CHP as it has a profile which supports intermittent wind resources and, by nature of its diversity, reduces the need for back-up capacity. The ECI study[6] based on 20 years of wind and consumption data, concludes that only 400MWe back-up capacity would be required if micro CHP were to support 10GWe of wind generation.

The SIAM (System Integration of Additional Microgeneration) study[7] was expected to identify adverse impacts of large-scale implementation of micro CHP on Distribution Networks, potentially requiring significant investment in network upgrades. In fact, the study showed that in only a few extreme cases would micro CHP incur additional short term costs, that in the majority of cases it would have beneficial impacts and the overall benefit to the UK distribution network was substantial; savings in deferred network upgrades and improved operational efficiency were estimated at up to £1.2 billion by 2020 assuming a high penetration level of Microgeneration.

A fundamental attribute of Microgeneration is that it will, by definition, be introduced incrementally, avoiding catastrophic financial and technical risks and delivering real carbon and financial savings from day one. Other potential carbon mitigating solutions, such as nuclear, involve step changes in capacity and will not deliver any benefits for as much as a decade; it is a substantial risk to attempt to anticipate what market conditions might pertain in 10 years when it comes on line, still less over the subsequent 40 years or so life of such plant.

It is, therefore, inappropriate to consider Microgeneration as just another generation option in the same way as central plant alternatives. If we invest in a CCGT plant to replace an existing obsolete plant, that is not the same as incrementally eroding the demand for marginal plant. The former may (as in the case of nuclear) demand to be run as baseload and will thus displace baseload or “must run” plant such as renewable wind; in this context nuclear is displacing zero carbon generation. Microgeneration by contrast (specifically micro CHP which is largely peak-following) will displace marginal plant, with consequently high financial and carbon benefits.

Some advocates of Microgeneration cite the benefits of public engagement, and it is clear that householders who invest in Microgeneration do become more conscious of their overall carbon footprint and tend to modify their lifestyles to further reduce their environmental impact. However, there is a limit to how much value should be attributed to this, particularly if the technologies in which they invest are subsequently shown to be significantly less effective than larger scale alternatives. An example of this is the current fad for micro wind which, even at the optimistic cost of £1500 for a 1kWe unit is far less effective than investing a similar amount in a large scale, say 2MWe, product which will have a yield of an order of magnitude higher, even accounting for transmission & distribution losses.

One particular attraction of this feature to Government, is that it is individual consumers who make the investment decision and invest their own money, so whilst there is still a cost to the UK economy it is a cost which does not have to be met from taxation, indeed it is an investment made from taxed income, in contrast to central plant investment which is tax deductible.

This may go some way to explaining the UK Government's enthusiasm for Microgeneration, as well as their indiscriminate embracing of all microgeneration as a panacea to our energy problems.

4 The UK Government's proposals for export reward

The development of a Microgeneration Strategy by the UK Government in 2005 led to the establishment of a number of working groups and various studies which aimed to identify obstacles to the implementation of microgeneration and propose solutions which would accelerate uptake in the competitive market. The lack of suitable export reward mechanisms was identified as an obstacle to microgeneration as it meant that a significant proportion of the value of microgeneration was unable to be captured by the generator, the supplier or the UK economy.

However, none of the studies at that time recognised the relative impact of support measures on different technologies and it was assumed that a fair export reward would incentivise all microgeneration technologies equally. The subsequent, somewhat perverse fiscal incentives[8], grant programmes[9] and policy measures[10] have distorted the market to such an extent that, whilst some technologies remain dependent on achieving a fair reward, others are already so heavily subsidised that the additional benefit of a fair market hardly impacts their economic viability, or lack thereof.

In 2006, the Climate Change & Sustainable Energy Act was passed, incorporating *inter alia*, the "discretionary power, exercisable by the Secretary of State, if necessary, for the purpose of…increasing the amount of the electricity consumed in Great Britain that is generated by Microgeneration…modifications (to Supply Licence conditions) …to require the licence holder to offer to acquire electricity generated by microgeneration by the licenceholder's customers."

This rather woolly clause has been interpreted as meaning that the suppliers must offer fair export terms to their customers on pain of the SoS imposing actual terms in the absence of voluntary action. This sadly reflects the limited understanding by Government of the complexity of the electricity trading and settlement system; it is simply not possible to mandate relevant "fair terms" under the current industry structure. So far attempts by industry have been frustrated by the competing demands of OFGEM (advocating competition per se) and the practical need to establish cost-effective energy trading infrastructure for the relatively small amounts of exported power under consideration. The initial OFGEM proposal, for example, would have imposed costs per customer well in excess of the value of the exported energy, and still would have failed to recognise anything beyond the energy component, that is ignoring any value in terms of network support, carbon mitigation or contribution to a diversified UK generation portfolio.

5 The Energy Suppliers' Response

To their credit, the energy suppliers have tried, albeit so far without success, to develop an agreed process for attributing value of export fairly. This has involved extensive work to understand the value of exported power (and the impact of modified import patterns) as well as to agree standards and infrastructure requirements for metering, trading and settling exported electricity.

Somewhat perversely, attempts by the energy suppliers to agree common standards for smart metering and related infrastructure in order to facilitate the competitive market for microgeneration demanded by OFGEM, have been frustrated by the regulatory constraints also imposed by OFGEM which are intended to prevent collusion by the companies in establishing a cartel!

In the meantime there is little agreement about the value of exported power and, in the absence of any means of capturing value, suppliers have resorted to offering "give-away" schemes which simply reward microgeneration customers for their generation, even though this in itself incurs transaction costs. In other words, not only are suppliers paying their customers for exported power for which they are not recompensed, they are incurring additional costs for the pleasure of doing so!

In order to mitigate this "double whammy", suppliers have tended to offer rewards either by allowing customers to provide their own meter readings (i.e. they do not pass through the settlements process) or by deemed value based on the installed capacity of the microgeneration. That is, for a given installed capacity in a given location, it is assumed you will export a certain amount of kWh over a year, regardless of whether or not you actually export anything at all. For customers on the E.ON Solanet tariff, for example, the export reward for PV varies from less than £10 to almost £120 for a 2kWe system located in the SW of England, depending on the size and therefore assumed consumption of the household.

Other suppliers, such as Good Energy offer a reward for the entire generation of 9p/kWh (on which they reclaim the value of ROCs), but this is against a relatively high tariff for imported electricity.

Some might argue that as long as suppliers are offering some reward for export and, particularly if the reward is unduly generous, then this will encourage the uptake of microgeneration and generally raise the perception of microgeneration as a beneficial technology solution to our energy needs.

Unfortunately, this disjoint between "value" and "reward" illustrates the unsustainability of the approach and it is clear that such short term solutions are unhelpful if significant penetrations of microgeneration are ever to be achieved. The point at which such offerings cause unacceptable distortions in the settlements process is determined by the amount of unaccounted for electricity in the system; the point at which it becomes commercially unacceptable is also determined by the eventual impact on suppliers' profit margins.

At some point, there are almost certain to be undesirable side effects for microgenerators, particularly if suppliers eventually withdraw their subsidised offerings as the cost becomes too onerous, destroying confidence in the market. It is also questionable whether we wish to confuse the public between the fair value of microgeneration and over-inflated subsidies, which will inevitably feed back to other customers, raising energy prices disproportionately and unnecessarily. Already the over-generous treatment of costly PV systems is being challenged by some as a subsidy for the rich by the poor.

The question thus remains, as to how suppliers can provide fair reward for export in a sustainable, cost-effective and ultimately market stimulating manner.

6 Issues remaining

The key challenges remaining fall into two main areas, namely the establishment of what the true value of microgeneration actually is, and secondly the metering and other infrastructure issues related to recording and billing the appropriate amounts at a transaction cost which does not significantly erode this value.

6.1 Establishing the value of microgeneration

The value of microgeneration is perceived differently by utilities and microgeneration customers. Indeed, different parts of utilities also perceive different impacts, with suppliers, network operators and generators all having particular opportunities to capture specific elements of the value chain, respond to their own unique challenges and identify and exploit new business opportunities.

Even amongst suppliers, there are clear differences of opinion of the value of microgeneration generally and export in particular. One supplier, in response to a Government consultation on the issue, stated:

"There is considerable debate as to the true value of electricity exported from distributed generation schemes. The prices that suppliers are able to offer will be based on their expectation of wholesale electricity prices rather than retail prices. A price that is in excess of this wholesale price is not economically justifiable."

One might question then, why that same supplier is currently offering a net metering tariff!

More enlightened suppliers have attempted to balance the complex components of the value chain to gain an understanding of microgeneration and, more importantly, to establish how they can capture this value and share it fairly with their customers.

6.1.1 Value to the customer

The value which the customer is already able to capture lies in that of the electricity generated and used to avoid import of grid electricity. In addition, some suppliers offer terms for export of both renewable (such as PV) and non-renewable generation (such as micro CHP). Customers are also able to apply for ROC (Renewable Obligation Certificates) which have a minimum value of 3p/kWh, although their tradable value is currently around 5p/kWh. Microgeneration is eligible for double ROC, that is, the ROC which would normally be associated with 1Mwh is applied to each 500kWh. Against this, the economics of micro CHP are reduced by the cost of additional gas which must be purchased in order to make up for the heat which is no longer available; in general it may be assumed that for every unit of micro CHP electricity generated, a corresponding additional unit of heat is lost.

It can be seen from table 1 below that different technologies are affected to greater or lesser extent by both their operational characteristics and the financial support measures applied to them, so that PV payback is virtually unaffected by the export tariff (or lack thereof); it remains economically unattractive regardless and requires absurdly costly subsidies such as those offered in Germany to overcome its inherent inapplicability to UK climatic conditions.

On the other hand, where technologies such as current micro CHP technologies are installed, their payback in the absence of export reward is around six years, reducing to four years if a fair export value (based on the profiled wholesale export value) is applied. Other value elements which accrue to suppliers (outlined below) may eventually be shared with micro CHP operators which will further enhance the attractiveness of this technology. Indeed, in the absence of viable export tariffs, it may be preferable to capture value from, for example, ancillary services such as reserve capacity (on an aggregated basis) which would avoid the prohibitive transaction costs and deliver as much value as the total export kWh. This, combined with short term electrical storage (within half hour periods) would improve utilisation and might virtually eliminate export so that every kWh generated would be worth the cost of imported power. However, this would be a sub-optimal solution as far as the supplier is concerned and is an unnecessary distraction where technology has to be developed to resolve failures in the market.[11]

The situation facing fuel cells and other micro CHP units with higher electrical output is exacerbated by the fact that, as generation increases, so generally does export. Higher efficiency generators are thus more dependent on export than lower efficiency technologies. Thus fuel cells, despite being "supported" by UK Government, are actually disadvantaged by the current system which subsidises non-viable technologies such as PV, but discourages the development of higher efficiency, more environmentally beneficial technologies.

	PV kWhe	**PV Value (£)**	**1kWe mCHP kWhe**	**1kWe mCHP value**	**1kWe FC kWhe**	**1kWe FC value**
Capital cost		**10,000**		**750**		**1500**
Generation	**1600**	**-**	**3000**	**-**	**6000**	**-**
Avoided import	**1000**	**100**	**2000**	**200**	**3000**	**300**
Export	**600**	**30**	**1000**	**50**	**3000**	**150**
ROC	**1600**	**160**	**-**	**-**	**-**	**-**
Additional gas	**-**	**-**	**3000**	**75**	**6000**	**150**
Net value (no export)	**-**	**290 (260)**	**-**	**175 (125)**	**-**	**300 (150)**
Payback (no export)		**35 (38)**		**4 (6)**		**5 (10)**

Table 1 Relative importance of export tariff on different microgeneration technologies

6.1.2 Value to utilities

From the energy suppliers' perspective, it was initially assumed by utilities that micro CHP and other forms of microgeneration would inevitably result in a loss of business, based on the simplistic notion that supplier and network operator profits were predicated on the number of kWh which they sold or transported respectively. It has become apparent that not only can supplier profits be maintained, but even enhanced. Table 2 below shows how, if the modified cost to supply is taken into account, although the number of kWh reduces, the margin on each kWh doubles, so that the customer can save up to £200 per year, whilst the supplier margin increases by around 10%. All this assumes that there is a mechanism in place for the supplier to capture export value and modified import value; in the absence of these, the value of a micro CHP customer to the supplier, for example is virtually destroyed, falling from £60 to £5 per year. However, even in this situation, the profit which may be gained by the supplier if they were to supply the micro CHP system could compensate for this annual loss, effectively capitalising the lost annual income in year 1.

	Boiler/grid	Micro CHP 2008	Micro CHP 2010?
Import tariff (cost) p/kWh	**9.5 (9.0)**	**9.5 (9.0)**	**9.5 (8.5)**
Annual import kWh	**6000**	**3360**	**3360**
Electricity bill (profit) £	**570 (30)**	**319 (17)**	**319 (34)**
Export tariff (value) p/kWh		**4 (0)**	**4 (4)**
Export total kWh	**0**	**1130**	**1130**
Export profit (loss) p/kWh	**0**	**(45)**	**0**
Export payment to customer £	**0**	**45**	**45**
Total energy bill (profit) £	**1184 (58)**	**960 (3)**	**960 (65)**

Table 2 Profitability of micro CHP from energy supplier's perspective

Other value components which may be considered by utilities include ancillary services, both for balancing generation capacity shortfalls (particularly valuable in support of intermittent generation), carbon trading, and the ability to optimise the cost to supply all customers by means of advanced DSM (Demands Side Management) technology. At its ultimate level, this is represented by the VPP (Virtual Power Plant), which can manage both domestic loads and generation to optimise system efficiency and maximise profitability.

6.2 Infrastructure development

As early as 2002, the introduction of the P81 standard removed the requirement for microgenerators to meter exports using HH metering. It was believed that this would simplify the process to the extent that export reward could be approached in much the same way as import is currently handled for domestic customers, that is, by means of assumed consumption profiles based on diversified demand seen on the network for all domestic customers.

This proposal was intended to overcome the problem originating from the introduction of the competitive electricity market in the UK. The HH (Half Hourly) market was introduced when the UK electricity industry was privatised and it became necessary to recognise the cost of producing electricity at different time periods as demand fluctuated. Competition was first introduced to the large energy users for whom the cost of half hourly metering (around £600 per year) was insignificant, before being extended to smaller customers. Simplistically, this annual fee was determined by dividing the cost of operating the HH trading system, by the relatively low number (around 50,000) of HH customers who were using it. Against this historical precedent there would be significant challenges to including the additional 23 million or so domestic customers at a more appropriate cost. Thus it was decided from the outset that the mass domestic market would be assumed to have a range of predetermined HH demand profiles and billed accordingly. This demand profile could be relatively easily established both by consideration of the national profile after removing the HH metered customers and by undertaking fairly extensive household sample consumption monitoring.

Unfortunately this would have meant that, in order to recognise microgeneration export, a separate profile class would have to be developed, based on a statistically relevant sample of microgeneration customers.

To this end, a project was established in 2003 by the DTi and operated by BEAMA to monitor the consumption, generation and export profiles of over 200 microgeneration installations. It quickly became apparent that the profiles for each technology (micro CHP, PV and micro wind) were entirely different and that it would be impossible to apply this methodology, particularly for customers operating more than one type of microgeneration technology.

In the meantime, P81 provided for a "chunked" profile, based on notional micro CHP operation in line with heating patterns of two hours in the morning and five hours in the evening. During those two chunked periods, it would be assumed that the export profile was the same as the import profile for unrestricted domestic supply customers and value attributed accordingly. It also assumed that the import profile would be modified by the inverse of this profile. This resulted in the favourable scenario that generation was assumed to all occur during those two high value chunks and that it would be both added to the export profile and subtracted from the import profile. However, for relatively low numbers of microgeneration installations, it was considered that this would not unduly distort the settlements systems. A study by Ilex[12] concluded that up to 33,000 micro CHP installations would be an acceptable limit. If microgeneration develops at anything like the anticipated rates, this will occur within the next few years.

However, even this relatively crude approach has failed to offer sufficient value to the microgeneration operator to be widely adopted and there are almost no customers making use of the P81 process; the only exceptions being a few customers[13] with relatively large microgeneration technologies, towards the 50kWe upper limit of the definition of microgeneration.

A subsequent process (P218) has been debated for several years with the goal of establishing a short and long term solution to the metering and settlement of export from microgeneration. The first option, promoted by OFGEM, would have required that import and export were not only metered separately, but that a different MPAN (registration number) was to have been allocated to each component, this on the basis that it would have encouraged competition between suppliers who could offer import and export tariffs independently. Unfortunately it would have created significant confusion in the registration system, particularly on change of supplier, and the costs of operating two MPANs would have doubled the transaction costs (an additional £40 annually). This would have entirely eroded the value of exports from a typical domestic microgeneration customer. It was also considered very unlikely that any supplier would choose to offer "export only" terms.

A second option, proposed by a number of suppliers, was to provide for only one MPAN, but associated with two registers, such as is already practiced for off-peak customers who have separate registers for daytime and night-time consumption. In this situation, a supplier wishing to offer "export only" would still have been able to do so, albeit with the cost of an additional meter. This option was blocked by a small number of energy suppliers who believed that, although this offered a workable solution, it would be too costly to implement for the small number of microgeneration customers currently in the market!

A third option, again proposed by a number of suppliers, was to assume that any generator of a given capacity would export a certain amount, and simply attribute this to the supplier who rewarded that customer, effectively a mirror of the solution offered by E.ON to its Solanet customers. On closer examination, it became apparent that there were significant complications to this solution and that it would not overcome transaction costs and might actually require more system changes than the earlier options.

A longer term solution being proposed by E.ON is to allow suppliers to install their own HH sub-metering for export which they would be free to manage outside the settlement system, aggregating all their microgeneration HH customers into one "super customer" which would then be settled as one account, dramatically reducing the transaction cost within the settlement system, but passing the cost to the supplier's own internal IT systems. However, this would offer the opportunity for the supplier to develop an IT system suitable for the large numbers of domestic customers and might even eventually be exploited to manage DSM solutions for their entire customer base. This will clearly take some considerable time to implement, and an interim solution is urgently required.

7 Conclusions

The UK Government has recognised the potential contribution that microgeneration can make to the nation's urgent energy needs as well as in mitigating our contribution to anthropogenic climate change. They have also identified one of the key obstacles to microgeneration operators in achieving a fair economic payback for their investment and thus in stimulating the market for microgeneration in support of their energy goals. However, there is a gulf between the well-intentioned, if somewhat misguided policies, and the absence of robust and balanced delivery mechanisms.

Government needs to establish a coherent energy policy in which the impact of one policy measure in support of a given technology does not directly nor indirectly discriminate against other equally valuable technologies. Thus there is a need to establish fair reward based on values attributable equally to all microgeneration operators, not just the currently fashionable ones and Government should resist calls by interest groups, including the microgeneration industry as a whole for special treatment. If the true value of microgeneration including indirect benefits such as carbon trading, network support and facilitation of widespread intermittent generation as well as DSM and ancillary services such as reserve capacity are factored into the value, then subsidies should not be necessary for relevant microgeneration technologies.

It is regrettable that the majority of energy suppliers, whilst meeting their licence obligations to provide some form of export reward by offering apparently generous export tariffs, are doing little to move the agenda forward to a resolution of infrastructure and other issues which require industry consensus.

There is an urgent need for Government and industry to work together to establish appropriate trading mechanisms for the short term as early as possible. This needs to resolve a number of specific technical issues in a detailed, pragmatic way, not simply by wishfully mandating solutions.

Beyond this, we need to consider more complex, but potentially more profitable solutions which capture value in an optimal way, thus encouraging the most cost effective solutions for the provision of a sustainable energy future.

Specifically, longer term opportunities for VPP and real time DSM both to optimise microgeneration and to support intermittency need to be explored. Indeed microgeneration should be considered not in isolation, but as part of an integrated energy system; on its own microgeneration can make a valuable contribution, but when considered as an integral part of a diversified mix of generation and DSM, it provides significant synergy to the whole.

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1 *Directive on the promotion of energy from renewable sources*, January 2008

2 EON UK estimate

3 *The growth potential for Microgeneration in England, Wales and Scotland*, Element Energy 2008

4 *Climate Change and Fuel Poverty*, Simon Dresner & Paul Ekins, Policy Studies Institute, 2004

5 Carbon *displacement by micro CHP generation*, Ilex Energy Consulting, December 2004

6 *The practicalities of Developing Renewable Energy Standby Capacity and Intermittency*, Graham Sinden, Environmental Change Institute, March 2004

7 *System Integration of Additional Microgeneration*, Mott MacDonald, DTI, 2005

8 Qualification of all renewable MG technologies for double ROCs

9 Clear Skies Programme and subsequent Low Carbon Buildings Programme

10 Merton Rule requiring developers to incorporate a certain percentage of specified MG technologies in their developments regardless of appropriateness of technology, discriminating against non-renewable low carbon technologies

11 An even more perverse, sub-optimal development of technology is current in Japan, where the unwillingness of utilities to accept any exported power has led to the specification of complex control systems which in many cases constrain generation even to the extent of limiting overall system efficiency, simply to avoid export. Indeed, many MG developers are reducing the electrical output of their products to this end.

12 *Metering, settlement and export reward options for microgeneration*, DTI, 2005

13 A total of 30 customers according to OFGEM, *Review of the market for exported electricity from microgenerators*, March 2008