‘Waste not, want not’:

A vision for a distributed energy system

Part I: Our vision

A. Introduction

1. One of the key tests of the UK Government over the next decade will be its progress in cutting carbon dioxide (CO_2) emissions whilst ensuring that energy supplies remain secure and affordable for all. Policies implemented since 1997 have resulted in progress towards these goals. However, the scale of the challenges that are still ahead has been highlighted by a number of recent controversies, including the opposition to the Kingsnorth redevelopment and new nuclear-build, rising fuel poverty and escalating energy prices.

2. It is clear then that the UK is in need of urgent new approaches to the energy challenge. During the past six months, SERA has worked with a range of industry stakeholders (see listed in Appendix 1) to create a vision of an energy system that would enable the UK to tackle our major energy policy issues. The results of that work are set out in this paper, which principally argues for the major role which distributed energy generation and supply (DE) will have to play if the UK is to meet its 2020 and 2050 energy targets.

3. A properly planned and managed course of investments in DE can help to cut emissions of CO_2. DE is associated with smaller network transmission losses than the current centralised generation and transmission system, as electricity does not have to travel so far. A network designed for distributed energy also makes connecting renewable and low-CO_2 technologies easier because many renewables are inherently smaller in scale and need to be integrated within the built environment.

4. DE can also improve security of supply by promoting a more diverse energy generating mix, and less reliance on fossil fuels. Where DE is supported by heat supply networks, the thermal energy that is largely wasted in centralised generation can be used, providing further opportunity to lower the CO_2 emissions created per unit of energy used.

5. At the smaller scale DE also offers integration with the built environment and significantly lowers the threshold to sector entry, creating competition for the existing centralised energy sector and greater demand for investment. It engages the waste, construction, retail and farming industries, as well as local authorities, the public sector, social enterprises and individuals.

6. Finally, because DE is more efficient and diversifies the energy mix it will contribute in the longer term, as it achieves roll out on a commercial scale, to making energy affordable for all.

7. Indeed, the Government’s most recent Energy Review (2006) identified the need for a fully diversified energy mix. What it failed to highlight, however, was the big

challenges facing the development of DE, principally the physical and regulatory arrangements for the current energy market that constrain investment in the DE sector.

8. The current UK energy system is based around an extensive electricity and gas transmission network. This system was a natural repercussion of the historic abundance of fossil fuels available to the UK from North Sea oil and gas and the desire to remove noxious coal emissions from our communities. However, the system has promoted investment in the large-scale and centralised energy generation, which is most easily suited to plugging into these networks. In addition, the electricity trading arrangements that underpin this system discourage small-scale and/or local generation because of the licensing costs and procedures associated with it.

9. Government, in particular the Department for Business Enterprise and Regulatory Reform (BERR) should, therefore, work with Ofgem (the energy sector's economic regulator) to develop a better regulatory framework for DE. The new arrangements would allow the market to invest in generating technologies such as CHP and the infrastructure that is needed to support and encourage them, such as heat networks. This will reduce the waste of heat and electricity in the energy system, reduce CO_2 emissions and ensure a more sustainable security of energy supply.

10. BERR must also work with HM Treasury (the Treasury) and the Department for Environment Food and Rural Affairs (DEFRA) to devise a much clearer and more accessible package of financial instruments that will stimulate investment in DE. This will ensure that the UK economy benefits from the enormous potential that exists for economic growth through green jobs and innovation in the DE sector.

11. Most importantly of all, there must be a more coordinated approach to the use of DE as a method to help eradicate fuel poverty by 2016. Local, community driven energy projects have demonstrated that they offer real potential for sustained provision of affordable energy for vulnerable households. This is implicitly recognised by the Communities and Local Government (CLG) department's new Planning Policy Statement on Climate Change (Climate Change PPS), which was issued in December.

12. However, BERR should support the steps taken by CLG in this direction and allow Ofgem to work with social enterprises and local authorities to devise 'light-touch' contractual and/or license provisions. This would allow communities to engage more easily with the energy market and act as suppliers, distributors and generators so as to leverage the benefits of supply side competition and choice for all in the community.

13. It is important to note that in arguing for the measures outlined above we do not reject a competitive model for the UK energy sector. Instead, we suggest that by opening up the market arrangements to DE we will create the sort of dynamic industry that can provide greater competition and choice. Delivering DE, therefore, will require the active participation of the organisations that have to date pushed the current market arrangements to their competitive limit. These include BERR, DEFRA, and crucially the industry regulator Ofgem, although none of the officers within these departments can be expected to push forward the DE agenda without strong political leadership.

14. The Prime Minister set out a clear and powerful vision recently in a speech to WWF (November 2007). However, in the last year the machinery of Government have all

too often perhaps tried to pass too much responsibility for meeting the environmental challenge to other organisations, for example Ofgem.

15. This has naturally led to some focus on the role and the remit of Ofgem's statutory duties. However, given the myriad of opportunities presented by DE this is clearly a mistake and would appear to run counter to our democratic principles. Government must lead and send a clear message to its departments, regulator and to local and regional government and agencies on the future path for the development of DE.

16. The remainder of Part I of this paper sets out in greater detail the issues and policy suggestions raised above. Section B sets out the existing policy context and section C the benefits that arise out of DE as against the current energy generation and supply system. Sections D-F set out how the Government could work with Ofgem as a matter of urgency to alter the market arrangements such that they allow investment in DE.

17. In section G we put forward fiscal interventions that we believe could drive investment and innovation in DE. Section H explores why and how DE can make a real impact on the fuel poverty crisis. Section I, provides a summary of the policy measures that we propose.

18. Part II sets out a more detailed discussion of some of the key assumptions that we have relied upon in Part I.

B. The policy context

19. Over the past ten years the Government has delivered, through a prudent but progressive regulatory and social policy framework, a centralised energy market that has removed 3 million households from fuel poverty[1] and sought to reduce CO_2 emissions in the UK. The development of DE, by contrast, has been less successful.

20. Through the mechanism of the Energy Efficiency Commitment (EEC), the Decent Homes Strategy and the Warm Front programme the Government has provided substantial funding for energy efficiency improvements in the most vulnerable households. The Renewables Obligation (RO) has offered a fiscal incentive leading to increased interest by the market in installing large-scale renewable and other low-CO_2 emitting energy generating technologies. Measures in the Energy Bill and Planning Bill will help address barriers to the more effective deployment of large-scale technologies. CLG's Code for Sustainable Homes, which sets out a roadmap for zero carbon developments by 2016, clearly facilitates the future integration of buildings and energy infrastructure.

21. However, since 2003, domestic gas and electricity prices have increased by 90% and 60% respectively with the result that some 4 million households in the UK are in fuel poverty[2]. At the same time the percentage of energy delivered from renewable sources has risen to just 2% *[BERR (2007a)]*. This is substantially behind major European competitors, such as Germany, France and Spain, and less than a third of the European average *[EU Commission (2007)]*, meaning that already many of the opportunities offered by the UK's prominence in developing renewables and low-CO_2 technologies have been lost to China and to continental Europe.

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1 Figures supplied by NEA

2 Figures supplied by NEA. Fuel poverty is defined as the need to spend more than 10% of household income in order to achieve a warm and healthy living environment.

22. Mindful of this, and of the ongoing need to tackle environmental as well as social justice, the Government has carried out a number of thorough reviews of the energy sector and committed the UK to meaningful European and national targets for the reduction of CO_2 emissions and increase of low-CO_2 energy technologies by 2020[3]. It has also introduced a statutory duty to eradicate fuel poverty as far as reasonably practicable for vulnerable households by 2010 and for all households by 2016.[4] .

23. The measures that look likely to be put in place to set us on the road to these targets, include principally a new generation of nuclear power stations and a number of large-scale wind energy projects which could together account for up to 25% of the UK's electricity by 2020 (nearly 50% by 2030). The EEC will be replaced by a similar market mechanism, the Carbon Emissions Reduction Target, which will require certain gas and electricity suppliers to deliver carbon reduction targets, rather than energy efficiency targets.

24. Yet none of these measures are designed to deliver the DE generation market that the Government has identified, in the 2003 and 2006 Energy Reviews, as being essential to delivering much of the remaining capacity needed whilst also meeting its own social and environmental targets.

C. Why Distributed Energy

25. DE has been adopted widely throughout the rest of Europe because it minimises wasted heat and electricity transmission losses and allows greater diversity in the energy sector by attracting small to medium enterprises and the third sector into energy services. Aside from offering efficiency gains, DE can also contribute to diversifying the UK's energy mix *[Ofgem/DTI (2007) & Ofgem (2007d)]*.

26. Technologies include a range of on-site or community-based generating facilities (combined heat and power, waste to energy and small-scale or on-site renewables). Heat produced in generating electricity is captured and distributed to buildings as part of a thermal services network. Electricity is largely used onsite. However, DE can also be used to contribute to the security of the transmission grid thus helping to reduce the risk of power shortages and to ensure secure back-up capacity in the event that long-range transmission networks are compromised.

27. The environmental and social benefits of DE are discussed further below in Part II, sections 3-6. However, it is important to recall here that both BERR (see *[BERR (2006)]* and Ofgem[5] have already acknowledged the importance of DE as part of the full energy mix needed to meet the UK's energy challenge).

28. Whilst the benefits of DE are clear, there is a noticeable concern within Government that these technologies are expensive and so would place too great a financial burden on the UK energy sector. This analysis, however, is based on a number of incomplete assumptions and poor investment approaches. Such approaches have already contributed to the current energy market failures that we are experiencing and must now be reconsidered.

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3 Targets to be achieved by 2020: a 20% reduction in greenhouse gas emissions, a 20% overall binding target of renewable energy sources in the energy mix (expected to equate to 15% in the UK); a 10% minimum for biofuels; and a 20% energy efficiency improvement.

4 The Warm Homes and Energy Conservation Act 2000 applies to England and Wales. The devolved administrations have broadly similar objectives relating to fuel poverty but with different timescales.

5 The benefits of removing regulatory barriers to DE are discussed in paragraph 2.19 et seq Ofgem (2007d)

29. Therefore, whilst nothing in this paper is intended to deny the inescapable reality that avoiding dangerous climate change and ensuring long-term affordability and security of our energy services will necessitate considerable capital investment[6], the economics would appear to be significantly more nuanced than is often suggested.

30. It is important to realise the inaccuracy of the figures that focus on direct comparison between the KWh cost of large-scale as opposed to small-scale generation. First, it is necessary to factor in the cost savings from DE electricity because of reduced network infrastructure costs, which according to the IEA will account for around 50% of total investment in the electricity sector to 2030. Secondly smaller scale technologies work to a different economic equation because volume of demand rather than generation size will stimulate cost reductions.

31. A holistic assessment is also needed of the long-term cost benefits of investment in DE heat[7]. This equation has already been accepted for energy efficiency infrastructure (i.e., insulation measures). Similar recognition must be given to the efficiencies of a system of district heating and cogeneration over the current individual boiler installations and centralised electricity generation (see Part II, sections 3-5 for more details). This is particularly important because of the anticipated increases in fossil fuels prices as supplies diminish and global demand increases (the German Federal Environment Agency for example anticipates net savings of 5 billion Euros by 2020 as a result of reducing coal, oil and gas imports).

32. Finally, it is important to recall that smaller scale technologies leverage a much wider range of investment sources for the energy sector (for example retailers or building developers).

D. Creating a better regulatory system for DE

33. In order to achieve the objective of a balanced energy mix, the Government must provide the industry, investors and communities with greater direction towards DE. There can be no substitute for government leadership on this issue and as the House of Lord Select Committee on Regulators recently found, “Government must be explicit in the political decisions it makes and in the consequent guidance it issues to regulators” *[House of Lords (2007)]*.

34. Given, the environmental, national security and social justice imperative for energy market intervention, government must take a strategic overview of the market and network conditions and ensure that they are fit for purpose in ensuring that the UK benefits from the CO_2 reductions associated with renewables and the whole system CO_2 efficiencies associated with CHP and district heating.

35. Government must intervene now on DE, if it wants to prevent the current type of market failure that has led to a very low increase in low-CO_2 DE generation in the UK since 2001 and which, in the long run, will mean high energy prices that will leave even more households exposed to the price volatility of diminishing fossil fuels.

36. We must also move beyond debates around what constitutes the ‘best’ energy generating technologies (*e.g*. nuclear versus renewables or cherry-picking renewables projects) and instead look to address the underlying barriers to

[6] "Achieving this outcome (450ppm stabilisation) would be possible only with very strong political will worldwide and at substantial economic costs ." IEA, WEO, 2007

[7] See for example, Shoreditch Trust (2008) and Energy 4 All (2008)

investment in energy infrastructure. Citizens must be made to feel more engaged with the issues and understand the nature and advantages of the technological and organisational change that will be needed. A coherent framework for DE will tackle all of these issues.

37. Essential to that task is the introduction of a better regulatory framework for the energy sector that supports technological advancement. This will assist the market in bringing forward solutions systematically and at all levels of the market. It will also encourage smaller businesses to enter into the energy sector enhancing innovation and competition.

38. The natural vehicle for economic regulatory reform is the industry regulator Ofgem. However, Ofgem needs a clear steer from Government. In taking this position we agree with the House of Lords Committee's finding that Ofgem has been effective in carrying out its duties under the existing mandate from the Government and importantly that government should not hide behind regulators where strategic policy decisions are concerned *[House of Lords (2007)]*[8].

39. BERR should, therefore, outline to Ofgem that it wants to see a change. Principally it would require that Ofgem achieves a new balance between the immediate political pressure to ensure affordable prices and the need to ensure affordable, secure energy in the future and the longer-term social and environmental imperative. Essentially this would mean that Ofgem uses its secondary environmental and social duties to reorganise the electricity market so that it can accommodate distributed generation and create a regulatory framework for heat.

40. We recognise that there have been calls by many of our stakeholders for a statutory change in Ofgem's remit, such that its secondary duties are given equal importance to the need to maintain competition and consumer protection. Current interpretations of Ofgem's statutory duty are discussed in greater detail in Part II, section 1 below. We are not, however, proposing that Ofgem need necessarily have its statutory duties rewritten. Instead, we would leave it up to Government to decide whether it is necessary or more effective to change Ofgem's statutory remit or merely to issue guidance.

41. Either way it is of the utmost important that Government focuses its attention on understanding the measures, as set out in the following three sections, which are urgently needed to create the market arrangements capable of promoting DE.

E. A recognised heat market and in places a regulated heat network

42. We highly commend the Government on its work through the Office for Climate Change (OCC) on heat *[OCC (2008)]*. The consultation report prepared by the OCC clearly identifies the CO_2 savings, fuel poverty and energy security benefits associated with combined heat and power generation and with renewable heat (biomass/waste to heat/solar thermal and heat source ground pumps).

43. The target identified in the OCC report was for around 50% of heat from low-CO_2 or renewable sources by 2020. Given that it is estimated that only around 6% of this will come from biogas and that it is extremely difficult to install newer technologies such as ground source heat pumps or solar heating to existing building stock, then

[8] House of Lords (2007) paragraph 1.25

clearly district heating with CHP will be the key to meeting these targets[9]. We would, therefore, pick out the following recommendations for urgent action.

44. BERR should start by using the Section 36 license[10] process to ensure that there is a coordinated response to our 2020 targets. Permission should only be granted for new power station development where CHP technology is embedded and in locations where there is capacity to use the heat either for domestic or industrial purposes (a similar requirement may also need to be reflected in Pollution Prevention and Control permits).

45. It is unfortunate that of the 5 GW of gas and coal generation now consented for development in the UK, only around 1GW will be CHP enabled *[BERR 2007c]*. However, there are an estimated 9GW (*[BERR 2007c]*) of new fossil fuel powered stations that are still in the pre-consent process. As such, the proposed policy would provide an unequivocal and a timely signal to investors that there is a market for heat as well as electricity and gas.

46. We would note that although we have not discussed Carbon Capture and Storage technology in any detail in this paper the science and technology around CCS is still highly unlikely to be able to be safely deployed and in any case not before 2020.

47. We recognise also the challenges associated with using the heat output from power stations and the political concern to ensure that tightening up S36 licenses does not act as a barrier to developers coming forward to invest in new power stations. However, we feel that BERR can keep the lights on across the UK whilst also ensuring that we do not continue to waste the heat, which accounts over half of the energy potential from gas or coal firing in this country.

48. In order to achieve this they must ensure that there is sufficient capital available for investment in the network infrastructure needed to supply heating, cooling and hot water ("thermal services") to customers. They must also work with National Grid ("NGET") to ensure timely installation of the gas pipelines that are needed to fire the CHP engines.

49. BERR should start by mandating Ofgem to include heat, as well as electricity and gas within their remit. Ofgem could then work on devising a regulatory framework that enables investors willing to own and/or build heat networks to be recognised as a new natural monopoly and earn a fair rate of return on their capital in the same way as gas, water or electricity transmission networks.

50. As with any natural monopoly the role of the regulator would need to include powers to ensure that the monopoly owner charges fair usage price (i.e. an RPI - X equation) and that they are performing their duties in terms of maintenance and connection to new users. After a reasonable period (around 20 years has been suggested), the network could also be opened up to tender, especially if the operator had a poor performance record.

51. Equally because parts of the monopoly asset base would at least temporarily become stranded (unused) then the owner must be given some assurances that competitive installations (in this instance gas) will not be allowed by local authorities. This would fit in any event with the requirements of the Climate Change PPS. The

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9 See SDC (2007a) for potential residential CHP use and OCC (2008), for potential for industrial use of CHP heat

10 See the Electricity Act 1989

network operator would also need to be able to recoup connection fees. As to who would own or operate the network, the major water utilities may be best placed to raise the capital and install the network, although a range of enterprises, including various energy services social enterprises may be interested in operating various parts of it.

52. As with recent similar initiatives in the telecommunications sector, the process of scoping and tendering the networks should be centrally managed by BERR, although they would need to work with regional and local authorities on planning issues. We would note that considerable work has already been done by the Sustainable Development Commission (SDC) to identifying areas with the greatest potential for these 'heat zones' (SDC (2007a).

53. The alternative solution for investment in heat networks is on an incremental basis, through the development of a series of smaller scale new-build and retrofit developments. However, the urgency to reduce our CO_2 levels by 2020 means that we need to capitalise on the speed of implementation and efficiencies that are gained through a centrally managed system. In addition to the financing issues already discussed, we would also note that there are significant difficulties in local authorities coordinating cross boundary projects.

54. However, for smaller heat zone areas the incremental model of organic community engagement may be the preferable one. Our discussions with local energy services social enterprises demonstrate that this would generally work through using the value of land to unlock capital for investment in the network. Importantly these groups are able to remove the issues around planning because of their ability to carry out effective engagement with local communities.

55. We also agree with the findings of the OCC in terms of ensuring that the UK benefits from the 6% of heat that could readily be supplied by renewable heat. At present biogas is mainly used in the inefficient process of producing electricity. This is because biogas is not given equivalent recognition to other renewables or to natural gas.

56. In particular, we feel that heat created from biomass and waste (biogas/gasification) should be given incentives for its production and distribution in the same way as other renewable forms of energy. We see the greatest benefit being derived where these input fuels (in particular upgraded bio-methane) are used in larger-scale CHP schemes. This removes the risks associated with pollution. Bio-methane injection into the national gas grid must, therefore, be recognised (see *[REA (2008)]* report) because it offers an immediate commercial outlet for producers. Indeed, even where it is principally used for CHP, a technical and commercial outlet is needed to make commercial use of the excess bio-methane.

F. Removing the barriers to DE electricity generation and supply

57. It is clear that the current electricity market arrangements favour centralised, large-scale electricity generation (a wider discussion of the current arrangements is set out below in Part II, Section 1).

58. The incumbent market participants, the so-called 'Big-Six'[11] are not under the current arrangements given any incentive at all to invest in DE in order to diversify the market. Indeed, it would be quite illogical for them to act in this way because it

[11] British Gas, EDF E.on, Npower, Scottish Power and Scottish & Southern Energy

would inevitably risk the erosion of their existing and profitable position in the market. This would have to be seen as a breach of the fiduciary duties of their Directors. Similarly DE electricity generators and suppliers do not have the resources to engage with the lengthy and costly process involved with incremental review of the industry codes that underpin the market arrangements.

59. We would commend the Government on the work, which has already been done to remove the barriers to large-scale renewables, in particular wind. Having recognised the policy imperative caused by our 2020 and wider energy goals, Government has already put substantial political will into making substantial fiscal, regulatory and planning interventions. The recent announcement of a feasibility study into tidal energy on the Severn Estuary has also received huge support and, therefore, considerable interest from investors.

60. However, it is important to note that of the estimated 8,000 MW of renewable wind projects that are held up by planning or grid access issues, only around 300MW comes from large-scale wind[12]. This is supported by BERR's estimate that only 3% of renewables planning applications will receive expedited consent through the Infrastructure Planning Commission, as proposed by the Planning Bill [2008].

61. Therefore, an effective electricity regime will need to recognise that because renewable and low-CO_2 technologies operate effectively and are economic at smaller scales (typically 50KW-50MW) they can only fit into a DE system.

62. As such, we welcome BERR and Ofgem's acknowledgement of the barriers, which the current electricity market arrangements, create to a sustainable DE market. In particular, we commend Ofgem on its recent initial consultation on DE *[Ofgem (2007d)]*.

63. However, political support must now be given to Ofgem so that it can work in a coordinated manner with the DE sector in expediting the rapid implementation of a set of integrated and effective reforms of the current market arrangements. In addition, therefore, to the matters that were covered in its consultation, Ofgem must also examine the current issues around transmission network access and distribution network costs. It is important to note that in making these recommendations, we have been very mindful of the need to ensure that certainty is guaranteed to both existing and new energy sector investors.

64. From the 16 measures that were recently proposed by Ofgem, we would support the review and early implementation of the following *[Ofgem (2007d)]*.

65. First, the trading of DE electricity through virtual private networks (VPNs) would appear the most appealing method of allowing DE generators and suppliers to escape the costly processes involved with electricity market trading. This would mean that local generators could trade according to their local customer exposure and generating capacity during any given hourly time period. It would essentially mimic the wholesale electricity market using meters along the distribution network to monitor the flow of electricity on the distribution network between different local generators.

66. DE generators would, therefore, trade below the main wholesale market. Unlike more radical proposals, however, such as a dedicated wholesale DE market, DE would still be part of the overall electricity trading arrangements.

[12] Figures supplied by the REA

67. We acknowledge Ofgem's concern that the private wire exemption does not fit within the principles that underpin competitive markets in EU and competition law. VPNs would mean that, as suggested by Ofgem, the exemptions for DE electricity generation, in particular private wires do not need to be extended.

68. We are also concerned that the generating and supply exemption should not be extended as this would merely acknowledge the continuation of an electricity trading framework that is incompatible with DE generators and suppliers: Indeed, the current 50MW exemption for generation and 2.5MW exemption for supply has only presented a perverse incentive to generators not to increase capacity on sites where it would be technically more efficient to do so.

69. We note here that although we are supporting the creation of a sub-section of the market that can allow DE electricity generators to exert competitive pressure from below, we would very much welcome the full review of the New Electricity Trading Arrangements (NETA) rules, which has been proposed by Ofgem.

70. In order to ensure the success of VPNs, Ofgem will need to give further consideration to the current Cash-Out Arrangements operated in the electricity system.

71. Cash out prices penalise generators and suppliers who are unable to balance their contractual and physical positions (essentially this is to ensure that any given party is always good for the same volume of electricity supply onto the system). DE is inherently less predictable in its electricity generating output: much of its electricity is embedded (i.e., used onsite); CHP is set up for thermal services output and so only produces electricity when there is the thermal load demand; and renewables are intermittent. Smaller generators are also unable to match the liquidity of the larger market players and so cannot contract for the additional balancing supply that they need from the market ahead of time.

72. Investment in DE is, therefore, heavily discouraged through the Cash-Out arrangements and Ofgem will need to find a method to reduce the costs of imbalance penalties on smaller suppliers. These issues could, we suggest, be most easily off set, at least for an initial period, by offering DE electricity generators an electricity price incentive that would off-set that imbalance cost (this is discussed in greater detail, in section G below).

73. Similarly Ofgem must also work with NGET to ensure that DE generators are not effectively priced out of access to the electricity distribution network. Currently Distribution Network Operators ("DNOs") are required to levy standard charges on all electricity generators. This does not reflect the benefit that arises from the embedded (i.e. near to generation use) of DE. This means that DE suppliers only use a very small part of the electricity distribution network, which in turn saves on infrastructure maintenance costs for the DNO. We would, therefore, propose that Ofgem introduces mandatory "Short-haul tariffs" which would allow DNOs to share the embedded benefit cost savings with DE generators.

74. We note that similar proposals were put forward in 2007 by a group of industry experts through the Transmission Arrangements for Distributed Generation Working Group ("TADG") .The TADG's views were recently rejected in a letter from Ofgem largely due, we understand, to pressure from NGET. NGET is naturally concerned to continue to drive its profitability through charging the highest possible price for any network usage. However, the Government should recall that the electricity distribution network is a 'public good', which has been supported by considerable

public investment. It is important, therefore, that it is opened up to a range of generators and not restricted to the 'Big-Six' and NGET.

75. Similarly BERR should take a more active interest in the ongoing Transmission Arrangements Review. It should consider the need to give access to those DE providers who need to feed into the transmission system. We would propose that it considers implementing the 'connect and manage' model (as outlined in *[SDC (2007b)]*). This model has been widely supported by our stakeholders and has been used successfully in the EU to open the electricity market to larger renewables and DE projects.

76. We are less convinced by the proposals that would rely on incremental movement by the current market players, whose business models are predicated on the centralised market arrangements. These include intervention by way of a Specialist Energy Trader to negotiate connection for DE generators or a Licensed Supplier Agency to aggregate business for licensed DE suppliers and reform of BSC and BSC panel.

77. We welcome, of course, any proposal that is intended to open up the existing market to greater competition for low-CO_2 solutions. However, because the 'Big-Six' have already vertically integrated the coordination of entry to the electricity supply market (except for on-site or private wire networks) agents would need to be heavily regulated to guarantee an affordable route to market for DE generators. Past experience has shown that such interventions (for example the incentive for DNOs to connect DE and Registered Power Zones) are largely ineffective.

78. Finally, although there is little to recommend the general extension of the exemption regime, it will be important given the current approach to integrating energy generation into the built environment for Ofgem to review whether there are class exemptions that could be offered to local authorities and/or social enterprises.

G. Driving the economy and innovation through investment in DE

79. As discussed previously, DE infrastructure demands considerable capital investment although in the long-term there are considerable gains in terms of CO_2 efficiency and cost.

80. Most of the investment that will be needed for DE will have to come from existing and new private sector energy investors. The Treasury should work, therefore, with BERR, DEFRA and CLG to devise and implement a coordinated and simplified approach to financial incentives that will grant investor certainty and so continue to encourage investment in low-CO_2 and energy efficient technologies (see statement of the International Energy Agency, *[WEO (2007)]*).

81. It is also important to remember, the potential for *green collar jobs* and economic growth from investment in DE industries in the UK. Environmental services are an expanding market, and the UK is emerging as a world leader in related financial and business services, particularly in carbon markets.

82. Indeed, the report produced by the Government's Commission on Environmental Markets and Economic Performance (CEMEP) concludes that these impressive figures underestimate the impact of the future investment and employment opportunities on the whole economy. There is also evidence that investment in low-CO_2 technologies has already created jobs In the UK, with the environmental goods

and services sector estimated to already have a turnover of £25 billion and to employ 400,000 people *[CEMEP (2007)]*.

83. Government must not, therefore, ignore the role that DE will have in driving the low-CO_2 revolution. The opportunities for incredible economic growth through short-term capital investment in DE have already been proven in Germany, where according to Reuters the DG industry could be worth as much as 45bn Euros per annum by 2010.

84. As recently suggested by the SDC, it is essential that BERR should start by implementing the Treasury Green Book Guidance on the shadow price of CO_2 into Ofgem's wider policy practice *[Treasury (2007)]*. This would ensure that all government procurement decisions favour local and renewable energy sources, in particular by meeting the target for 15% of electricity to be sourced from CHP by 2010 *[DEFRA (2003)]*.

85. DEFRA should be commended for their current review of the raft of grant schemes provided for DE technologies, many of which will in any event some to an end during 2008. It is important that this time they ensure that, unlike the RO or EEC, they are adequate to boost the DE market.

86. Mechanisms such as the RO have proved successful for larger renewables projects and changes to the banding are to be welcomed, particularly because for the first time they have recognised the need to give financial incentives for heat.

87. However, the RO is limited to biomass fuelled heat networks. This promotes only a small fraction of the total CHP potential outlined elsewhere in this paper much of which would be gas or even coal fired. The RO is also unattractive for smaller or third sector providers where high transaction costs and the significant 'hassle' factor make it a less attractive incentive. The uplifts provided under the recently published Carbon Emissions Reduction Target (CERT) are also not sufficient to encourage DE.

88. There are possible benefits to be derived from the Carbon Reduction Commitment, however, the scheme is overly complex and is again likely to involve high transaction costs. In addition, we understand that a range of major commercial companies have expressed concerns about the current proposals because they do little to encourage investment in onsite renewables. This is clearly a perverse outcome for a sector with substantial resources and a clear and growing sense of community responsibility.

89. We would highlight here the need to separate the issues of heat network and generation investment. The network should we suggest be viewed as a 'public good' and as set out above should be afforded the financial treatment of a natural monopoly. With respect to heat generation we acknowledge the difficulties set out by the OCC report around some form of heat obligation to encourage the market to invest in CHP. We also see the creation of network infrastructure as providing some of the incentive for generators to want to enter the heat market.

90. However, we would suggest that given the pressing need to create a heat supply market, the Government will need to provide some form of investment tool. At present the sole financial support available for heat generation has come through the certificates available through the Climate Change Levy and from Enhanced Capital Allowance schemes.

91. Our suggestion is that it adopts some form of CHP supply obligation on suppliers. This is in keeping with the fiscal incentives used for renewable electricity and would reflect the Government's previously stated aspirations for CHP electricity (10MW of CHP electricity for the UK overall and 15% from the Government Estate by 2010). Given that CHP engines are designed to maximise on their heat as opposed to their electricity output then we would suggest that this incentive is better than the RO incentive on the renewable electricity output. The obligation should, therefore, also include additional reward for renewable CHP heat generation, effectively granting extra rewards to those who feed biogas heat into the system.

92. Simple alternatives, such as Feed in Tariffs (FITs) could be considered as an alternative initial spur for investment for both DE electricity and heat generation.

93. The proposal to introduce FITs for DE electricity generators is fundamentally a mechanism to address the exclusion and incompatibility of smaller scale technologies with a market place wholly geared towards large-scale centralised generation. FITs, therefore, offer an important interim measure to open up the market place to smaller scale technologies, whilst the regulatory reforms discussed above gradually increase the market options. In Germany FITs were structured over 20 years, with rewards reducing every year, with a view to pump-priming the renewables industry and then reducing technology costs.

94. In addition to offering incentives to investors, there is also a need to promote consumer confidence in DE.

95. BERR should work with DEFRA and CLG to establish a single official and industry endorsed accreditation scheme and register of low-CO_2 technologies. Currently there is a multiplicity of emerging technologies, particularly in the area of micro-generation, which have left consumers confused and investors uncertain as to where to invest [CEMEP (2007)]. The accreditation scheme and register would quantify and compare the potential CO_2 savings from a variety of different conversion processes and technologies to the point of delivery of the final product to the customers.

96. It would offer consumers certainty. However, it need not be unduly restrictive on competition or choice and should be developed in conjunction with relevant industry associations and leading research centres. It must also be compatible with current UK and EU[13] regulations and avoid duplication of costs and resources. Additional registration and accreditation should not make low-CO_2 technologies uncompetitive with established CO_2 technologies[14].

97. Finally, there is also the need to ensure that the UK is able to offer an adequate level of training *[CEMEP (2007)]* so that we are able to exploit the employment and economic potential for economic growth that will come from the emergence of this new market.

[13] We understand from our stakeholders that the industry wide certification scheme with the Building Research Establishment (BRE), the Microgeneration Certification Scheme (MCS), has been badly managed since it started, in Autumn 2006. The MCS is not integrated with a number of important UK and European Schemes, namely CLG's own Competent Persons Scheme. This makes the MCS a significant added cost to a market that is already struggling for finance.

[14] NOTE: this work stream could sit within a wider cross-cutting group, which would include the Energy Saving Trust, Carbon Trust and the Fuel Poverty Advisory Group (discussed below), to provide some form of green community energy 'services' along the lines of the Green Homes Service.

98. We are aware of a range of schemes that are being developed by Local Authorities, Regional Development Agencies ("RDAs") and social enterprises. The recent opening of the Energy Technologies Institute and the work of the Academy for Sustainable Community Skills are also highly encouraging. However, we would suggest that DBERR and the Department for Innovation, Universities and Skills should liaise more closely to ensure that a full range of adequate programmes are accredited and given support from the centre.

99. Taken together these policies would signal an intention on the part of the government, that as the country responsible for the first industrial revolution, the UK is determined to put in place concrete measures to ensure that we are at the forefront of the 'Low-CO_2 revolution'.

H. Energy for Communities: *an enhanced energy poverty strategy*

100. Implicit in an energy framework which supports and finances renewables and DE, will be added costs per unit of energy for consumers. However, given the challenges posed to the UK by globalisation, fuel scarcity and the rise in wholesale price of oil and gas and climate change it is in any event now inevitable that there will be a rise in energy prices.

101. Energy efficiency is the only rational and sustainable approach to fuel poverty (this is a view supported by National Energy Action (NEA) and the Fuel Poverty Advisory Group (FPAG)). Rather than subsidising inefficient energy consumption, through the welfare benefits system, the optimum option is to ensure that fuel-poor individuals and communities are equipped with generating and insulating technology that means they need to use and pay for less fuel.

102. Government has acknowledged the role of energy efficiency measures, principally the insulation of buildings, but to date has not been clear in articulating the fact that greater investment in renewables and efficient energy infrastructure will also afford greater protection from inevitable fuel price rises.

103. It is essential, therefore, that the UK takes action on DE now so that we can use the efficiencies offered to stabilise energy prices in our domestic and business market. Investment in renewables and DE should be viewed as a means to ensure that all domestic and business customers in the UK, including the 4 million households that are currently unable to afford basic energy services, are guaranteed low-CO_2 and affordable energy in the years to come.

104. It is important to note that we are not advocating that the UK abandons demand side efficiency measures and we support the FPAG's suggestion that the quality of measures such as cavity wall insulation, roof insulation and double-glazing are improved and rolled out more widely.

105. The Government's fuel poverty strategy has gone some way, through the Warm Front Program, EEC and the Decent Homes Strategy, to achieving this. However, it has failed to reach its suggested energy efficiency rating of SAP 65, which can effectively fuel poverty proof a dwelling. The overall efficiency of the technologies used in the Government's various programmes, for example condensing boilers, is also not sufficient to reduce the reliance of the fuel poor on high-carbon domestic fuel.

106. Government must, therefore, make a radical move both to improve demand-side efficiency measures and also to ensure that the most vulnerable communities and

households are given priority access to generating (supply side) technologies that will provide affordable energy in the long-term.

107. In parts of the UK, community based social enterprises have already demonstrated the ability to leverage greater purchasing power and reduce planning issues to ensure the most efficient blend of fuel input, energy generating and efficiency technologies.

108. These groups have the purchasing power to negotiate better customer service for their homes, businesses and public spaces[15] and can realise additional benefits in terms of local employment, training and regeneration *[CEMEP (2007)]*. Most importantly they are able to use the capital returns to fund local fuel poverty action schemes, making investment decisions that are needed to ensure the implementation and development of sustainable and affordable long-term energy solutions [for example the Baywind Project in Cumbria, which has returns of nearly 9% *[Energy4All (2008)]*.

109. The Climate Change PPS is expected to go a long way towards allowing local councils and developers to ensure integration of DE into new developments and the Guidance to the Climate Change PPS will set out the Government's clear intention for local planning officials to try to push through applications for DE projects.

110. However, Government must also work with Ofgem to establish a separate regulatory regime for local authorities and other democratic and/or accountable community based social enterprises or cooperatives. This regime could sit within Ofgem's Social Action Strategy whose new mandate from the Government around its secondary duties, as discussed above, should enable it to play a much more active part.

111. The regime would effectively recognise the distinction between the commercial market and social enterprises by simplifying the licensing requirements for the generation and supply of electricity and heat. These groups are in any event governed by legal duties to act in the best interests of their communities and so there is little reason why they should not be exempted from much of the consumer protection licensing[16]. Our discussions have also shown that even where these groups return sizeable profits these are redirected towards tackling the social issues related to energy policy, namely the eradication of fuel poverty.

112. However, we acknowledge the concerns expressed by Ofgem *[Ofgem (2007)]* regarding the legal status of community based energy services social enterprises. There have been examples of community owned CHP systems being bought by commercial energy suppliers in Europe. This indicates their potential importance in enhancing the UK's energy market. It also emphasises the need for accountability at all levels in the ownership and operation of these entities.

113. CLG will need to play a critical role in the development of any such regime. It should invite Ofgem and BERR to sit with the FPAG on a Fuel Poverty Action Group. The Group would liaise with all other relevant Government departments, in particular the Department for Work and Pensions and DEFRA, with local and regional government and with social enterprise.

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15 The Shoreditch Trust's CHP scheme on the Cranston Estate offers an example of an inner city fuel poverty scheme

16 The Secretary of State has powers under the Electricity (Class Exemptions from the Requirement for a License) Order 2000

114. The Group will need to urgently consider how 'community' groups could be legally exempted altogether from the licensing and other regulatory issues that act as barriers to entry into the DE market. In particular, where these groups are looking to access licensed networks then we would agree with Ofgem's suggestion that an exempt supplier obligation is added into the supply license[17].

115. The Group should also look at the types of legal entities (e.g., social enterprises, cooperatives and Local authority ESCOs) that could be allowed to apply for exempt status. Indeed, there is already a great deal of evidence as to how these structures can provide sound vehicles for raising investment and consumer protection.

116. Finally, the group should also devise methods of 'risk' funding for local councils and community energy services groups so that they can manage the start-up costs (planning, feasibility studies and distribution grid charges) associated with developing community energy projects and/or providing affordable energy services for vulnerable households in more remote areas.

117. Of particular interest may be the various proposals around leveraging land values to inject capital, for example the ReCharge scheme recently adopted by Kirklees Council. Under the scheme a second charge is taken out against the mortgage of any homeowner who agrees to have renewable generation installed on their home under the scheme. This means the householder (or business) encounters no upfront capital costs. When the property is sold the charge is recovered for a recycling fund.

118. We would be happy to assist Ofgem in collecting together relevant stakeholders for any of the above discussions.

119. The Treasury could make available funding for the Group by discontinuing Winter Fuel Payments for higher rate taxpayer. Alternatively, as Ofgem and the FPAG have proposed, the proceeds of a windfall levy on the gains being made by some electricity generators as a result of the EU Emissions Trading Scheme could be funnelled into fuel poverty measures.

120. Finally, it is important to touch upon the issues of metering and charging of customers.

121. We welcome the proposals made around the introduction of smart meters and displays for electricity and gas supply (for all households and businesses). Although there is no consistent evidence that all consumers respond to the better information that they are given, experience has shown that it is not easy to manage energy use or plan investment without detailed knowledge of consumer use and demand. The experience of other European countries has also shown that accurate data can lead to savings of up to 10-15% in high-income households and businesses[18].

122. The cost of smart metering makes it an unattractive choice for customers and energy companies are unwilling to invest because the technology becomes a stranded asset if the customer switches supplier. Our suggested solution is to bring metering into the regulated part of the mandate given to DNOs. Suppliers would also be required to advise customers on how to obtain the best results from their meters. Competition concerns would also be eradicated because meters would be owned and maintained by DNOs and not suppliers. An additional competitive

[17] Ofgem (2007d) paragraph 5.12 et seq

[18] Figures supplied by NEA

element could be introduced if community energy services groups (in particular Local Authorities) were also allowed to install and manage smart meters.

123. The technology would still incur a cost for the customer. However, with staggered payments and the efficiencies achieved through use of the metering, the cost to each household could we suggest be broadly revenue neutral. It is important that smart metering is also made available to vulnerable households and the Fuel Poverty Action Group should be tasked with bringing this within its financing strategy, as discussed above.

124. Ofgem should encourage the introduction of smart meters by making immediate reforms around the way in which suppliers are expected to charge their customers.

125. It should remove the ability of suppliers to charge customers more for using prepayment meters for gas and electricity than those who pay on direct debit (see the recent FPAG press release for details *[Fuel Poverty Advisory Group (2008)]*). It should also consider requiring energy suppliers to provide a greater range of tariffs for consumers, in particular mandatory time of use charges, which match peak cost to peak demand.

I. Conclusion[19]

126. One of the key successes of the Government in the 1980s was to put an end to a generation of energy crises. This used a competitive and quasi-liberal energy market to quickly extract the benefits of abundant and cheap North Sea oil and gas.

127. It is important to recall, however, that the policy makers of the day paid little regard to the long-term environmental or social impacts of their reforms.

128. The revisions made to the regulatory and market framework since 1997 have introduced far greater social and environmental checks and balances. However, the climate and fuel poverty challenge is increasing rapidly, such that there is now a need to complete those reforms *[MOD 1998]*.

129. Removing the barriers to the wide range of DE options will ensure that we comply with our duties to the environment. It will stimulate investment and technological innovation, create new jobs and increase the competitive options available to even the most vulnerable in our society.

130. A summary of our suggested policy interventions is as follows:

(a) Better regulation:

(i) Heat:

- BERR to amend Section 36 of the Electricity Act 1989 to require all new power stations not only to be CHP enabled but on sites where there is demand for the thermal energy output from industrial, commercial or residential customer;

- BERR to mandate Ofgem to establish a regulatory framework which will recognise the natural monopoly status of heat networks in high density heat zones;

[19] Please note that all definitions for technical terns, references and acknowledgments can be found in the section below.

- BERR to introduce measures that recognise the equivalence of biogas in the gas supply market, in particular as a technical and commercial buffer for use in heat networks.

(ii) Electricity:

- BERR to add political support to Ofgem's review of the barriers caused by the supply, distribution and imbalance costs for DE and ensure industry codes are aligned to support new technologies;

- Ofgem to implement the concept of Virtual Private Networks for DE electricity generators and suppliers, to allow smaller generators to escape unfair and costly network licence applications;

- BERR to recognise the embedded benefit of DE by reviewing the 'Cash Out Arrangements' so that imbalance and settlement costs are reduced for DE;

- Ofgem to require DNOs to reflect the embedded benefit of DE by devising 'Short-Haul Tariffs' for DE generators;

- Ofgem to consider whether a 'connect and manage' approach should be employed to allow preferential access for DE generators who need to feed into the transmission networks.

(b) Driving innovation and investment:

- BERR to implement Treasury Green Book Guidance on the shadow price of CO_2;

- BERR to introduce a FIT to reward small-scale CHP heat and set a CHP obligation based on heat targets for 2020 to reward larger network CHP generators;

- BERR to promote consumer confidence by coordinating the establishment of a system of accreditation for renewable and low-CO_2 energy generating and energy saving technologies;

- BERR and the Department for Innovation, Universities and Skills to ensure adequate training capacity for the skilled workers who will be needed in emerging sectors.

(c) Help communities to tackle fuel poverty:

- CLG, BERR and Ofgem to designate a separate regulatory framework for community energy groups in particular the GLA, Local Councils and other local energy services social enterprises/co-operatives;

- CLG, BERR, Ofgem, DWP and fuel poverty groups to establish a single programme, part financed by a levy on CO_2 windfalls from the energy sector, to:

    - Target building efficiency and low-CO_2 generating technologies at assisting the fuel poor;

    - work with local community energy projects, including providing guidance on legal establishment and best practice;

- Ofgem to devise charging structures that encourage energy saving but do not unfairly disadvantage vulnerable households, including:
    - mandating DNOs to supply smart metering services to every consumer;
    - requiring Suppliers to stop over charging pre-payment customers;
    - introducing time of use charges that charge a premium for peak period use.

Part II: Key background assumptions:

1. The current market and regulatory context?

1.1. The current regulatory system seeks to supply electricity, gas and heat through an efficient centralised energy configuration, which delivers cheap, reliable and balanced end-user electricity to UK businesses, homes and public spaces as well as gas to homes and businesses. The regulator, Ofgem, primary role as ensuring that consumers have a choice of suppliers and that prices for the end user (residential and business) remain affordable.

1.2. Ofgem also has a secondary duty to protect the wider interests of the market and the UK public, as set out in the guidance issued to Ofgem by BERR in 2004 *[BERR (2004)]*. In summary the guidance requests that Ofgem deliver on its primary duties, whilst also giving consideration to the Government's four goals for the energy sector, namely:

- cutting the UK's carbon dioxide emissions by some 60% by about 2050, with real progress by 2020;
- maintaining the reliability of energy supplies;
- promoting competitive markets in the UK and beyond, helping to raise the rate of sustainable economic growth and to improve productivity; and
- ensuring that every home is adequately and affordably heated a sustainable.

1.3 Ofgem has set out its approach and performance to date in responding to these goals in its recent report on Sustainable Development *[Ofgem (2007b)]* and in its response to the Sustainable Development Commission's 'Lost in Transmission' report *[SDC (2007b)]*.

1.4 Ofgem rightly has focussed on the delivery of these four goals within the remit of the energy structure that it has inherited. It acknowledges that the increasing price of input fossil fuels and future CO_2 increases mean that it already fails to deliver affordable energy to 4million households and that this number will grow. Ofgem's sole available response is to continue to maximise on the efficiencies in the market to reduce energy poverty, in particular through continued pressure on suppliers to assist vulnerable households through mechanisms such as EEC/CERT, competitive pricing and demand side management through the use of smart meters.

1.5 Ofgem acknowledges the choice and affordability benefits to consumers that would come from a diversified, innovative and competitive mix of centralised and distributed generation *[Ofgem (2007d)]*. Implicitly, therefore, Ofgem recognises that the cost and efficiency gains associated with DE would be more efficiently passed on to consumers if competition were to exit at the supply level between generators and distributors.

1.6 However, its current directive from Government is to focus on price based competition around a centralised structure of generation and supply. In this market, consumer 'switching' from one supplier to another exerts competitive pressure. As such, demand side pressure is expected to drive innovation and change *[Ofgem (2006)]*. It also continues to work to reduce the impact of the energy network on the environment by minimising loss from electricity and gas networks. This is all within the centralised configuration of the current energy framework. Concerns over

inefficiency and waste from this structure are recognised by Ofgem *[Ofgem (2007d)]* but it is for government to direct it towards a fundamental change to the most efficient energy system. As identified by the House of Lords during its recent review of the regulator, strategic decisions lie with Government.

1.7 In recognition of the barriers that Ofgem is in the process of reviewing the transmission and access issues related to small-scale and renewable electricity generation. It remains to be seen, however, to what extent the concerns of the renewables and small-scale market entrants are reflected in the current transmission access reviews[20]. This is necessarily a protracted process and the results released, as is to be expected, have favoured the views of market incumbents and network providers who dominate the process. Ofgem has also been unable to engage DNOs with the issue of reviewing the codes for their licenses. It, however, acknowledges the failure of the distributed generation incentive mechanisms to significantly increase connection since 1 April 2005 *[Ofgem (2007a)]*.

1.9 Ofgem is still in the process of reviewing proposals by the renewables sector and NGET to reduce the licensing requirements and access charges for small-scale generators. However, it continues to face resistance from the NGET to calls for restructuring the basis of access charging (i.e., moving from gross to nett charging and/or recognising embedded benefits in the cost). It has accepted that the current practice of expecting small-scale industry participants to make incremental changes to licensing provisions (i.e. through coding reviews) is unacceptable. However, in the absence of government intervention, strategic changes, such as the adoption of some form of agency distribution model and the exemption of small-scale generators from NGET Codes will be a slow and arduous process, which continues to stifle the DE market.

1.10 Similarly, under current practice the market expects even small-scale generators to go through the processes set out by the licensing and coding provisions to connect to a distribution network and contract with a supplier. This is clearly unrealistic[21]. However, again Ofgem has repeatedly stated that a more strategic approach to low-CO_2 generation, including the removal of some licensing and coding requirements[22] (i.e., exemptions beyond the current 100MW level for generation and 5MW level for supply and distribution) even for community and local authority groups would necessitate Government intervention.

1.11 Equally in terms of limiting heat waste, Ofgem will continue to perform its function in distributing funds from the Climate Change levy and Enhanced Capital Allowance schemes to support CHP and other DE systems. It recognises that none of these measures are achieving the growth needed to meet the Government's targets for CHP *[CHPA (2007)]* or renewable heat. However, it believes that a strategic approach to low-CO_2 generation in order to achieve the Government's 10GWE of CHP by 2010 (including reform of NETA and a regulatory framework for heat) would necessitate Government intervention.

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20 Ofgem published a report and call for comments by the Short Term Access Group in October 2007. The more specific Transmission Access Review consultation closed in September 2007 and published a series of proposals (emanating form its work with the TADG WG) for the industry to consider bringing into the relevant codes in July 2007.

21 This is a view supported by a number of industry representatives including the CHPA and REA

22 UK legislation sets out that companies involved in the generation, distribution, transmission, supply or provision through interconnectors of electricity or gas require licences, unless specifically excluded from doing so by the Secretary of State

2. Current energy efficiency policy/end-user efficiency

2.1 The Government's current energy efficiency package is aimed at capitalising on supply side energy efficiencies, principally the Energy Efficiency Commitment and the Decent Homes Standard.

2.2 The former places an obligation on suppliers to subsidise measures at the point of delivery of the final product to the customers (end-user efficiencies) that will reduce their heat and electricity consumption, for example insulation and efficient technologies such as Compact Florescent Lighting (CFL) and A-rated white goods. The latter is the primary mechanism in place to improve cold, energy inefficient homes in the social housing sector. Other policy instruments aimed at reducing energy consumption include:

- the EU Emissions Trading Scheme and the UK Climate Change Levy which encourage energy efficiency by commercial and public sector organisations;
- the UK Building Regulations, Energy Performance Certificates, Home Energy Conservation Act and 'Warm Front' Home Energy Efficiency Scheme which mandate and subsidise more energy efficient commercial and residential properties;
- regulation, improved labelling and voluntary industry agreements regarding more energy efficient lighting and appliances;
- reduced VAT rates on energy efficient materials and technology;
- funding of an Energy Saving Trust and a Carbon Trust to advise and assist on end user energy efficiency projects.

2.3 The Energy Efficiency Commitment and other more recent measures (for example, the Low Carbon Building Programme) have realised significant end-user energy savings. CO_2 savings of a little under 0.4 MtC per year were made under EEC1 (2002-5) and are expected to be around 0.5 MtC per year under EEC2 (2005-8). *[DEFRA (?)].* However, the Government has recognised that the present approach, based on specifying that suppliers must invest in certified end-user efficiencies, does not provide an incentive to suppliers to innovate in developing more efficient energy services for consumers.

2.4 New proposals, have therefore been made, including: a new round of the Supplier Obligation; the Carbon Reduction Commitment for large non-energy intensive industries and the incorporation of the energy/carbon standards in the Code for Sustainable Homes into future building regulations; regulation to reduce the emissions of fluorinated greenhouse gases, and the improvement of the energy efficiency of consumer electronics, with consultation papers on other product sectors to follow.

2.5 These measures would enable the UK to fall into line with its obligations under European Union law including the Directive on energy end-use efficiency and energy services, the European Energy Performance of Buildings Directive (EPBD), and directives on the efficiency of design of energy using appliances, the emission of fluorinated gases, and the labelling of household appliances and office equipment. The proposals for the new round of the supplier obligation (CERT), in particular should also give suppliers both the incentives, and the freedom over the measures they use, to realise CO_2 efficiencies.

2.6 However, the majority of these policies and the finances that support them (for example the recent grant by DEFRA to the Energy Savings Trust) are still aimed at offering strong incentives to suppliers to continue to provide products that will reduce end-user energy consumption.

3. The advantages of DE/ full cycle or demand side efficiencies

3.1 The government's proposals, as outlined in the above section, will mean existing energy suppliers paying a fraction of their substantial profits for improvements in the efficiency of end-user products. They do not promote, as was suggested in the 2006 energy review, the development in the UK of a liberalised energy sector and diversified energy mix, in which a range of providers could step in and compete for customers by exploiting CO_2 savings throughout the energy supply chain.

3.2 Implicit in that diversified model would be a move away from focusing solely on centralised energy supply and end-user efficiencies. Instead the new energy vision would see enterprising businesses and communities competing to realise the benefits to be accrued by exploiting other efficiencies in the energy supply chain, primarily by reducing the distance between fuel conversion and the end-users, the distributed heat and power supply model.

3.3 In a number of parts of the UK commercial small-scale/distributed renewables (mainly wind and biomass projects) have been operating successfully for a number of years (for example, Good Energy or Energy4All). Furthermore, according to the Combined Heat and Power Association there are now almost 1400 CHP plants in the UK. CHP plants come in various sizes. Although they all provide impressive efficiencies, the largest plants provide the greatest range of options for input fuels (waste etc) and CO_2 efficiencies.

3.4 The above examples constitute serious commercial attempts to enter the market and exploit CO_2 and energy savings at all levels of the generation and supply chain. However, these are piecemeal examples of what many experts and organisations have suggested should make up a sizeable part of a truly competitive and efficient energy market in which efficiencies are exploited at every stage of the production cycle to reduce energy consumption, CO_2 emissions and cost.

3.5 Currently the energy market does not properly account for or capture the CO_2 savings that could be derived from distributed energy. As can be seen from the diagram below the current market is divided into two main supply chains: Power and lighting (electricity) which is predominantly supplied by centralised coal, oil and gas-fired power stations which are inevitably inefficient as they have to reject heat to operate; and heat which although it is mainly produced by 75% to 86% efficient home based gas boilers is fed by a complex and outdated gas piping network (this is delineated by the vertical broken line). The remainder of the energy mix, nuclear, some renewables and CHP supplies only around 22% of power and lighting and a negligible amount of heat. Overall, only around 10% of UK energy needs are currently supplied by nuclear and renewables.

3.6 In the current market, energy is wasted throughout the processes of generation, distribution and use. The present inefficiency of the power industry is staggering and it has been suggested that the combination of fuel conversion inefficiency, transport losses through the grid, and inefficiencies in the use of the final power load means that only 10% of the fuel that produces the electricity in a light bulb actually ends up lighting it *[BERR (2004b)].*

3.7 The most obvious output sign of this is the cooling towers that are used to disperse heat from fossil fuel power stations when that heat could be used to provide thermal services in homes, offices and other buildings. Energy is also lost through keeping base load generation going, even when generated output exceeds demand. This is a particular problem with nuclear generation, which does not possess the flexibility of rapid control. There is further resistance loss as electricity is transmitted around the grid.

3.8 Even greater loss is created because the system is geared to provide limitless and cheap electricity leading to end user inefficiency: The most visible end use loss is light waste, electrical lighting used when ambient lighting is easily sufficient and building lighting fully left on when buildings are not being used; and the most extreme example of end use loss is in the form of electrical building heating where fossil fuels are converted to electricity and heat (with the heat lost in cooling towers, rivers or the sea) and then converted back into heating. Once the loss from long distance transmission is incorporated into the equation then one can see that only a fraction of the energy released by burning the fossil fuel provides effective heating.

4. Mapping a diversified energy structure

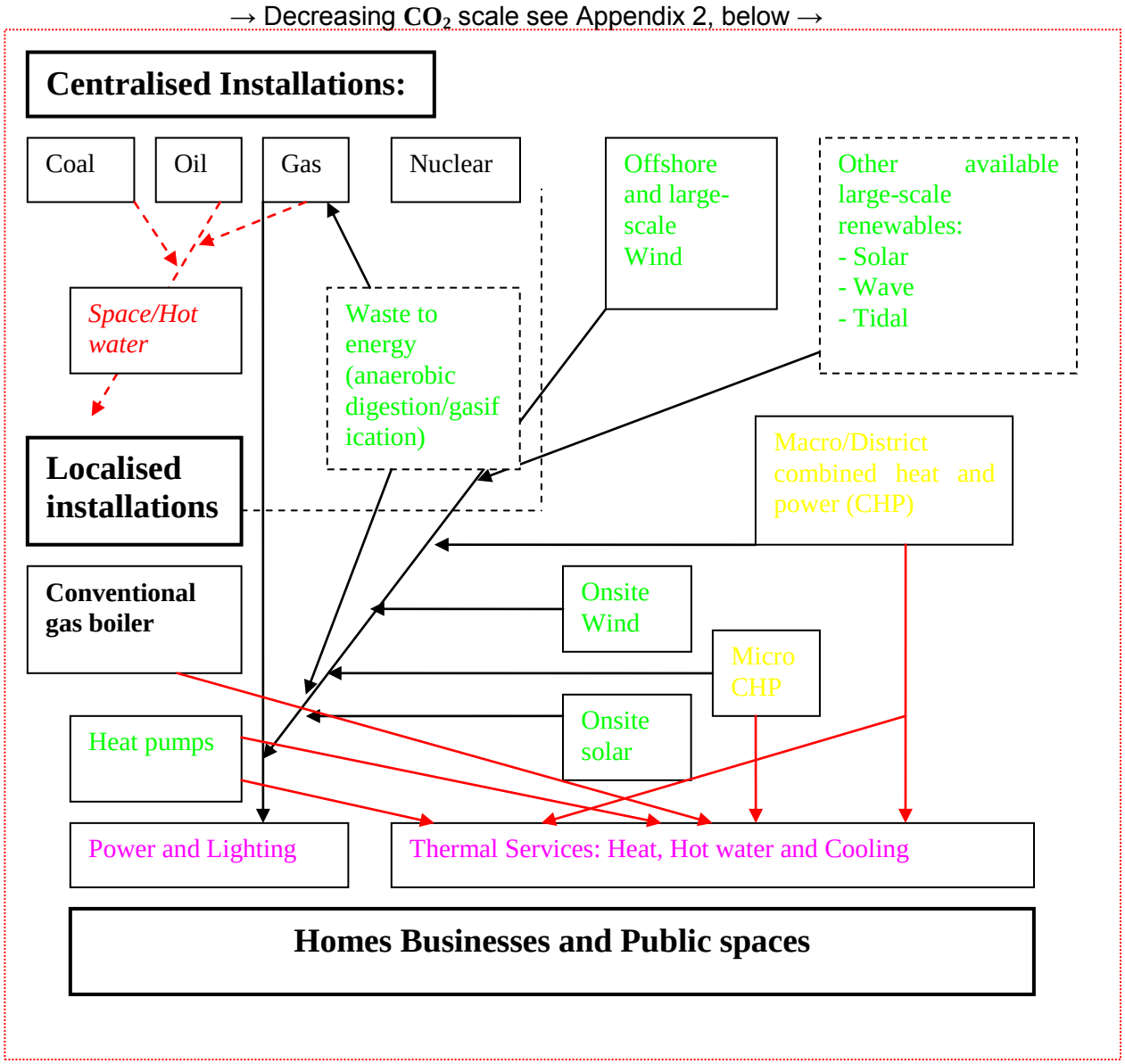
4.1 The diagram below outlines what a diversified energy model, including distributed generation, would look like. As can be seen it adds three times as many options (those outside the vertical broken line). It is apparent that this creates a lot more space in the market for new entrants and for entrepreneurship. The emergence of a new market for technologies such as, anaerobic digestion and gasification of waste, Solar PV, CHP and tidal lagoons, has already and would continue to provide high quality jobs and stimulate economic growth.

4.2 Importantly it can also be seen that instead of focusing on supply of energy a diversified mix focuses on the three core services that the end customer really desires, namely power and lighting and thermal services (heat, hot water and cooling). This highlights the CO_2 inefficiencies that are caused by centralised power stations that waste the majority of heat that is given off in the conversion process. The diagram and attached table at Appendix 2 highlight the benefits of local generation: The table sets out the Energy and the CO_2 footprint for different forms of generation. It also illustrates that saving energy is not the same as saving CO_2. Large-scale, centralised generation is a more efficient means by which to produce energy. However, it is more CO_2 intensive overall due to electricity transmission losses and heat losses. This emphasises the importance of effective support for energy and CO_2 efficient technologies at all scales if we are to meet all of our 2020 targets.

4.3 Because the full energy mix also provides a greater range of options that place generation nearer to the customer (this is delineated by the horizontal broken line) this means that there are fewer critical points, leading to greater security of supply. In addition, as described above in relation to the CO_2 conversion, as gas, oil and/or uranium become in shorter supply then the market could quickly adjust by bringing online more of the DE options.

4.4 There are weaknesses in this model. The most obvious of which is the need to balance the electricity so as to ensure that there is sufficient capacity for peak use. However, it is possible that an energy mix would allow this to be carried out more rather than less efficiently provided that demand management, through smart meters, is carried out more effectively.

Diagram: A diversified Energy Mix



**** Text boxes inside dotted line indicates the current dominant energy market offering, whilst boxes outside indicate the proposed expansion of the energy market.***
***** Broken lines on text boxes indicate technologies not yet a commercial part of the energy mix***

5. Explaining distributed renewables and cogeneration/CHP

5.1 Combined heat, cooling and power (sometimes known as co-generation or tri-generation and here referred to as CHP) remains, however, a technology, which, if integrated into the power supply generally, would be able to make enormous inroads into the overall CO_2 emissions balance sheet of the UK power industry. In cold weather the output heat can be used to heat buildings, and in hot weather it can drive cooling systems. Both of these technologies are well established and in widespread use around the world *[Euro Heat and Power (2007)]*. Generally speaking CHP engines run on fossil fuels, however, increasingly it is possible to use renewable fuels, in particular waste biomass or bio-gas making it a completely CO_2 neutral process.

5.2 The conversion of fuel even in the most efficient centralised gas power station is a maximum of 60% of fuel used with the rest simply disappearing up chimneys as heat loss during the process of making the electricity from the fuel supplied *[DEFRA (2004)]*. Combined Cycle Gas Generation or CCGT has been used as the comparator because it is the most efficient large plant technology. It is also the technology that will be used in the 5GW of generating development that has been recently consented by BERR. However, it should be noted that nearly half of the 9GW of generation that is now in the consent system would be fuelled by coal, which has an even less efficient energy and CO_2 emissions conversion rate.

5.3 CHP increases the overall capture of fuel to energy (heat and power) to up to 90%. This is a huge leap in efficiency and has been acknowledged by the Government through its target for 10GWE to be provided by CHP by 2010. To date the UK has only around 4-5GW, which means that it will not reach the 2010 target. This is largely due to the lack of financial incentives provided for CHP development. The Government have sought to enhance that policy by requiring, through Section 36 permissions, that gas-fired power stations are CHP enabled *[BERR (2007b)].* However, the SDC, which monitors the sustainability performance of the Government's own estate, notes that during the reporting period 2005-06, only seven departments sourced good quality combined heat and power (CHP) and that a total of just 2.2 % of electricity came from good quality CHP (as against a target of 15% by 2010).

5.4 The problem here is that in order for CHP to provide a meaningful commercial option it requires some take-off facilities for the heat. Currently, there are no national or even regional heat distribution networks in the UK and only a handful of fledgling city networks, supplied by smaller generators, for example in Sheffield, Southampton, and Nottingham.

5.5 Sheffield's district energy network is one of the largest and most successful. Established in 1988, it is still expanding, showing that it is possible to make this change in existing city centres. There are 43 km of pipe, delivering heat to more than 2800 homes, public buildings, and commercial properties in Sheffield. For every 100,000 MWh of energy supplied by this system it is estimated that 31,000 tonnes of carbon dioxide emissions are avoided. The Nottingham system heats 4800 homes, as well as Trent University and many other buildings, and much of it is fuelled by incineration of waste.

5.6 In Southampton the CHP system also provides cooling, in a network that was developed in 1994. The cooling network supplies air conditioning to hotels, retailers and a leisure centre. A notable example of an ambitious new CHP project is in Dunfermline where Fife Council is installing up to 3MW of CHP generating capacity to use gas from a landfill waste site. The generator will also supply heat, transported via a 3 km district heating main into the town, to 2 sheltered housing complexes, a number of high rise blocks, the Carnegie leisure centre and a newly built high school.

5.7 The main use currently of CHP heat in the UK, however, is in the industrial sector, where there is, as it were, a single customer (e.g. Conoco Phillips CHP at Immingham) who can guarantee a return on their investment within their own commercial network. The Cornerways (British Sugar) tomatoes greenhouse in Norfolk provides an excellent example of CHP utility. The facility, located next to the Wissington sugar factory, is the UK's largest producer of classic round tomatoes and is able to use waste heat and carbon dioxide produced as part of the sugar

manufacturing process. Importantly Conoco Phillips also has access to the gas networks needed to fuel the plant.

5.8 The potential for Gas Fired Power Stations to contribute to our heating and cooling demand in the UK is, however, enormous. Roughly speaking, taking heat derived from 50 megawatts power generation provides substitute central heating for about 4,000 homes; that is either alone or in combination of a smaller domestic supply plus substantial commercial supply. It has been estimated that up to 25% of the UK's heating and cooling needs could be provided by CHP *[SDC (2007a)]*.

5.9 The success of CHP depends on a long-term demand being engineered at commercial rates for the heat output. On a more basic level, the plant needs to be sited near commercial, industrial and/or domestic properties that are linked into the CHP derived heat. This is the measure of the real meaning of making a reasonably sized gas fired power station CHP enabled. It costs about £20 million to install the heat mains, the substation and the boiler replacement insulation for a 4,000 home domestic system, but this investment can be recovered through supply charges that facilitate very cheap heat (60% of previous costs of gas heating) over a 20 year period.

5.10 It will not, however, always be possible to site large power stations near to the ideal points of district heat supply and it is suggested that in these situations local authorities and housing groups, use their inherent local knowledge, credibility and engagement with communities, to develop smaller CHP heat and cooling networks. Where these organisations are able to gain local market power then the return of profits into providing cheaper and sustainable energy to the community would provide considerable social justice benefits and reduce energy poverty *[Shoreditch Trust (2008)]*.

5.11 Whilst CHP is the most mainstream form of distributed energy production, electricity can also be generated from a range of other small-scale and low-CO_2 processes including, wind, hydro, biomass, and micro-generation in the form of ground and air sourced heat pumps.

5.12 In Manchester, the CIS tower generates 183,000 kWh p.a. of electricity from its solar panels and one of its football clubs is about to install a wind turbine to power the stadium and surrounding community. Other notable examples are the Westmill Wind farm in Oxfordshire, which will produce nearly 100MW of energy and the twin wind turbines at the Dagenham Ford factory. These schemes provide a practical demonstration of the major benefits that DE can provide as well as the greater level of choice and service that is provided where not-for-profit community partnerships are established.

5.13 Whilst these projects all vary in size and depend on location specific factors for their success, they still provide an indication of the potential for a range of smaller providers, including third sector, businesses and the public sector to provide competition to the centralised energy market.

6. What is the relationship between distributed energy and fuel poverty?

6.1 The efforts of community groups, businesses, local and regional government and non-governmental organisations, to engage with and encourage communities to use less energy are well documented. These programmes encourage individual behavioural change the so-called low hanging fruit of energy efficiency. These

include end-user efficiencies from switching off machines on standby to purchasing A-rated appliances, installing CFL and insulating buildings properly.

6.2 It is widely recognised that improving insulation in existing housing is a very cost-efficient way to reduce both fuel poverty and the UK's domestic carbon emissions. 10% of households in England currently live in properties with a SAP rating of less than 30, a level that CLG equates to a Category I Health Hazard under the Housing Health and Safety Rating System. Installing insulation measures can result in average annual savings on fuel bills of £250 compared to current UK estimates for smart meters of at least £13 for electricity and £17 for gas.

6.3 The UK Government has promoted these sorts of improvements via the Decent Homes Standard in social housing (housing partnerships and publicly-owned stock) and in the private sector through Warm Front. EEC/CERT schemes have also been used to improve housing across all tenure types.

6.4 However, increasingly there is an awareness in the energy sector, from the large energy generators and suppliers to community and third sector organisations, that whilst less energy use is relatively easy to achieve, the real issue given the rising cost of CO_2 emissions to our communities is to look at how the UK can ensure the most CO_2 efficient modes of producing thermal services and electricity*.*

6.5 The London Borough of Merton has used its power of well being to stipulate on-site renewable energy installations for all new private developments. This has become known as the 'Merton Rule' and has been successfully copied by a number of other local planning authorities. Similar requirements are set out in the Mayor of London's plans. Good examples of distributed networks of combined heat and power (CHP) and renewables, which are commonplace in Denmark, Germany and Canada, can be found in Southampton, Aberdeen and Woking where not-for-profit partnerships brokered by the local authority have succeeded in reducing CO_2 emissions from their buildings by up to 80% and reducing annual energy bills by several million pounds. Several community groups in East London are also currently working on similar projects *[London Energy Partnerships (2007)]*.

6.6 The right mix of new technologies can also provide a solution to fuel poverty. Since 2003 the number of households in the UK that need to spend more than 10% of their income on energy in the home has risen to around 4 million[23].

6.7 As set out above, end user efficiencies are often not the most appropriate means by which to provide heat and power more cheaply because they do not exploit the greater CO_2 efficiencies of alternative technologies. The position of the most vulnerable households in our society will, therefore, steadily deteriorate as the market price of CO_2 rises to reflect the real cost to our society of climate change.

6.8 In addition, about 9.8% of dwellings (2,130,000 households) are currently in off-gas areas and 3.9% of dwellings (around 846,000 households) have solid walls and no mains gas. These are very hard to treat with conventional energy efficiency measures and end-user efficiencies[24].

6.9 In renewing infrastructure, therefore, the State (government and local government) needs to be more radical and look to supply side as well as end-user (demand side) efficiencies. It must think about the infrastructure for heat, gas and electricity

[23] Figures supplied by NEA
[24] Figures supplied by NEA

together because a whole system view is likely to suggest different answers to a straight replacement or substitution for our existing generating and distribution infrastructure.

6.10 The most recent report of the Fuel Poverty Advisory Group, the Government's adviser on implementation of its fuel poverty strategy, recommended that the Government invest in the full range of technologies, including DE generation. In particular they identified the potential for huge reduction in fuel poverty if thermal services could be provided in the most efficient manner. The role of micro-generation technologies, such as Ground Source Heat Pumps and Solar Thermal, in providing efficient and low-CO_2, thermal and hot water services to domestic properties was also recognised.

6.11 The charity National Energy Action (NEA) which also works to reduce fuel poverty, states that in many cases conventional energy efficiency improvements are inadequate or impracticable and is therefore encouraging on-site generation.

6.12 NEA has also demonstrated that community energy solutions, which use technologies such as large-scale CHP and/or on-site renewables have a role to play, but recognises that the structure of existing grant programmes has inevitably meant a concentration on stand-alone (*i.e.* micro-generation) technologies in individual properties.

7. Planning, local government and DE?

7.1 SERA research indicates that a majority of applications by distributed generator are currently refused planning consent *[SERA (2007a)]*. It is to be hoped that the planning reforms that are to be introduced in 2008 through the new Planning Bill 2008 and the Climate Change PPS will reverse this trend.

7.2 Concerns have been raised, however, that the electricity threshold for strategic planning projects has been set too low to ensure the speedy clearance of the majority of projects. The current draft covers only those that are over 50MW in England and Wales. Given that most wind installations fall within the DE category, this represents only 300 MW out of the current backlog of wind farm applications.

7.3 As such, it is to be hoped that the Bill will be revised to enable the Secretary of State to refer wind farm applications below the 50MW threshold to the new Infrastructure Planning Commission (IPC) and remove the 100MW threshold for offshore renewables projects to be considered by the IPC, so that all offshore renewable energy projects are considered by the IPC.

7.4 Equally, evidence received from stakeholders suggests that local authorities and RDAs will largely ignore the guidance issued to them by the Government through the Climate Change PPS. The guidance suggests a minimum quota of distributed generation as part of the planning gain for new developments. It is to be hoped that government will supply the capacity and vision needed to assist local government in making reasonable decisions.

8. EU ETS and DE:

8.1 Government and Ofgem view a robust CO_2 price as the most efficient driver towards a low-CO_2 and distributed energy market. The UK Government has sought to promote a robust CO_2 price, which would help the move to a low-CO_2 energy sector. The EU Emissions Trading Scheme is the main vehicle for trading by high intensity

CO_2 market sectors. However, the current scheme has not sent an effective price signal to the market because EU member states were given overgenerous emissions allocations and because member states provided energy companies with permits to pollute rather than a mechanism that rewards lower emissions. Perversely this has led to windfall profits for the big energy generators, estimated to be as much as £1 billion.

8.2 The UK Government has been a leader in supporting the EU Commission's 'improvement' of the next round of the EUETS (2012-2016) and it is hoped will continue to push for further improvements, in particular by bringing the aviation sector into the scheme and requiring companies to enter into a full auctioning process. This would be a unitary and efficient means by which to 'tax' CO_2 intensive industry and would provide investment for low-CO_2 sectors such as the emerging renewable and DE sectors. However, given the time delay, the inevitable volatility of any eventual trading system and the security and social justice issues associated with this sector, the Government will still require regulatory intervention in the domestic market.

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Appendix 1: Project Stakeholders:

Aberdeen Heat & Power Co Ltd

BIFFA

The British Wind energy Association

The Carbon Neutral Company

The Centre for Alternative Technology

Chris Cook (Community Energy Partnerships)

The Claverton Group

Climate Change Capital

Compass Environment and Sustainability Group

The Combined Heat and Power Association

The Country Land & Business Association

Cornwall Energy

Ecotricity

Energy4All

The Energy Savings Trust

The Energy Networks Association

Greenpeace

Kirklees Council

The London Development Agency

The Micropower Council

National Energy Action

Off-Grid.net

Orchard Partners

Peter Lehmann (Chair of the Fuel Poverty Action Group)

The Renewable Energy Association

Sheffield City Council

The Shoreditch Trust

The Sustainable Development Commission

Tesco PLC

Appendix 2 (Figures supplied by members of the Claverton Group[25])

Heat supply options for housing stock						CO2 savings compared to current installations			
Heat supply options	**kg/CO2/kWh per unit of Energy gross CV**	**Energy Average loss %**	**CO2 Average loss**	**kg/CO2/kWh per unit of Energy delivered gross CV**		**CO2 saving gas boiler 86%**	**CO2 saving gas boiler existing 75%**	**CO2 saving electric heating CCGT 48%**	**CO2 saving electric heating coal 36%**
Piped Urban Hot Water Heating from Biomass fired CHP or Biomass boilers	**0.000**	**20.000**	**0.000**	**0.000**		**0.222**	**0.255**	**0.437**	**0.920**
Electricity by Wire from Renewables Wind/solar Coal fired plant displaced	**0.000**	**10.000**	**0.000**	**0.000**		**0.222**	**0.255**	**0.437**	**0.920**
Electricity by Wire from Biomass coal fired plant displaced.	**0.000**	**10.000**	**0.000**	**0.000**		**0.222**	**0.255**	**0.437**	**0.920**
Piped Urban Hot Water Heating from Biomass fired CHP	**0.000**	**20.000**	**0.000**	**0.000**		**0.222**	**0.255**	**0.437**	**0.920**
Piped Urban Hot Water Heating from Nuclear fired CHP	**0.005**	**20.000**	**0.001**	**0.006**		**0.216**	**0.249**	**0.431**	**0.914**
Piped Urban Hot Water heating from Gas fired CCGT CHP	**0.033**	**20.000**	**0.007**	**0.040**		**0.182**	**0.215**	**0.397**	**0.881**
Piped Urban Hot Water Heating from Coal fired CHP	**0.066**	**20.000**	**0.013**	**0.079**		**0.143**	**0.175**	**0.358**	**0.841**
Piped Heat, CHP 500kWel 34.7 % efficiency electrical overall Electricity and heat efficiency 86% gross	**0.103**	**10.000**	**0.010**	**0.113**		**0.109**	**0.141**	**0.324**	**0.807**

[25] The Claverton Group is an alliance of academics, engineers, scientists and consultants who are recognised as the UK's leading specialists in the energy sector. The Group was formed in 2007 to lobby for greater Government support for the most sustainable and efficient energy technologies. The group derives its name from the venue, near Bath Spa, where its two initial conferences were held in 2007. There are around 180 subscribers to the Claverton Group.

Heat supply options for housing stock						CO2 savings compared to current installations			
Heat supply options	**kg/CO2/kWh per unit of Energy gross CV**	**Energy Average loss %**	**CO2 Average loss**	**kg/CO2/kWh per unit of Energy delivered gross CV**		**CO2 saving gas boiler 86%**	**CO2 saving gas boiler existing 75%**	**CO2 saving electric heating CCGT 48%**	**CO2 saving electric heating coal 36%**
Heat pump electric COP 3.2 Ground source electricity from gas				**0.137**		**0.086**	**0.118**	**0.300**	**0.784**
Heat pump electric COP 2.75 air electricity from gas				**0.159**		**0.063**	**0.096**	**0.278**	**0.762**
Heat from gas Micro CHP 1kWel 20% efficiency electrical overall Electricity and Heat efficiency 86% delivered gas				**0.171**		**0.051**	**0.230**	**0.266**	**0.749**
Heat from gas Micro CHP 1kWel 14% efficiency electrical, overall Electricity and Heat efficiency 86% gross delivered gas				**0.191**		**0.031**	**0.210**	**0.246**	**0.730**
Gas as fuel no extraction overhead	**0.191**	**2.000**	**0.004**	**0.195**					
Heat pump electric COP 3.2 Ground source 10 metres electricity from coal				**0.288**		**-0.066**	**-0.033**	**0.149**	**0.633**
Coal as fuel no extraction overhead	**0.301**			**0.301**					
Heat pump electric COP 2.75 air electricity from coal				**0.335**		**-0.113**	**-0.080**	**0.102**	**0.586**
Electricity by wire from Gas Electrical efficiency 48% Gross	**0.397**	**10.000**	**0.040**	**0.437**					
Electricity by wire from Coal Electrical efficiency 36% gross	**0.837**	**10.000**	**0.084**	**0.920**					

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