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Combined Heat & Power
Sustainable Energy Services
District Heating & Cooling

2050 Pathways Call for Evidence Co-ordinator
Department of Energy and Climate Change
3 Whitehall Place
London
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8th October 2010

Dear 2050 Team,

The Combined Heat and Power Association welcomes the opportunity to respond to the 2050 Pathways call for evidence. It is important for Government to explore future options as major medium and long term investments are considered which will have a profound influence on how the UK's energy system evolves out to 2050.

Developing a thriving low carbon economy requires a far more integrated approach to thinking than has traditionally occurred. The linkages envisaged between heat, power, transport, agriculture and waste are far more interconnected and complex than currently. The opportunities and limitations that these linkages bring will require a far more long term and integrated form of regulation and incentivisation.

A greater focus on integration will enable previously unseen efficiencies to be exploited. At the very heart of greater integration lie combined heat and power (CHP), heat networks and energy services. The traditional approach to energy supply, by which electricity generation and fuels for heating are considered independently, has driven a sub-optimal system which does not maximise efficiency, security of energy supply or, therefore, affordability. Similarly, a focus on individual heat solutions at domestic, commercial and industrial scales has limited efficiency and compromised industrial competitiveness. To address the wholesale change required to attain the greenhouse gas emissions targets of 2050 a fundamental shift in how energy is considered and delivered needs to take place. The 2050 pathways analysis is an important step and this response seeks to help Government develop an effective tool which best drives affordability, emissions reductions and security of supply.

This letter sets out 6 key areas where the pathways analysis could be developed to ensure that the optimal and most cost efficient use of energy sits at the heart of our evolving energy system. These are:

- **Optimising resource use within any given sector should be a fundamental tenet of the pathways model** – for heat and power this means that CHP should be the default option for any fuel type (e.g. both renewable and low carbon)
- **Heat networks must be a key part of supplying industrial and urban heat loads** to achieve cost effective decarbonisation
- **The role of heat networks and CHP in providing decentralised grid balancing services in a cost effective manner must be better recognised** and exploited in the model
- **The potential for high efficiency CHP in providing valuable flexible reserve capacity must be included in the model**, particularly to combat the effects of intermittency in certain renewable generation,.
- **The current 2050 analysis has a very limited assessment of industrial energy use, particularly, industrial grade heat.** A refinement of the model in

which industrial heat is specifically addressed is vital to ensure that policy supports decarbonised industry

- **The upgraded 2050 model must account for locational opportunities** (e.g. linking CCS infrastructure with electricity transmission networks and industrial centres could reveal opportunities for substantial efficiencies not yet evidenced in the model).

The remainder of this submission considers each of these elements in turn.

Optimising Resource Use

Optimising resource use within any given sector should be a fundamental tenet of the pathways model – for heat and power this means that CHP should be the default option for any fuel type (e.g. both renewable and low carbon)

As analysis has sought to develop thinking on 2050 pathways there has been a growing focus on the role of electricity. Decarbonisation of the electricity grid provides a low or zero carbon energy source that can be put to a vast array of different uses from lighting to transport.

Whatever scenario is modelled in the pathways attaining the 2050 GHG reductions, these still require a major contribution from thermal electricity generation. What appears to be lacking from the model, however, are mechanisms to drive the optimal operation of those thermal generating stations. Whatever the technology, there are drivers of resource use, cost optimisation and affordability. This should lead to CHP as the default option. Under the EU Cogeneration directive, high efficiency CHP must save at least 10 per cent primary (input) energy above separate power and heat generation. In addition, the high grades of heat used in electricity generation can also be used to provide heat vital for industrial processes which other forms of heating (e.g. heat pumps) cannot provide. The current signals for large generation plant development results in plant being located **away** from heat loads. In many cases legacy factors predominate, including location of existing grid infrastructure and historic fuel sources. There must, therefore, be a change in the locational signals to ensure that proximity to heat demand or heat network infrastructure becomes the dominant locational factor for such plant.

Applying engineering principles would lead to maximising **system** efficiency and CHP would, therefore, be at the heart of a rational low carbon economy. The traditional consideration of power and heating fuels in separate silos has led to market and regulatory signals that lead to a less optimal system of independent heat and power generation model. **The CHPA recommends, therefore, that the 2050 pathways analysis and tool be refined to enable maximum system energy efficiency (particularly in the generation sector) to be considered along side demand side efficiency measures.**

Use of Heat Networks to Facilitate Heat Decarbonisation

Heat networks must be a key part of supplying industrial and urban heat loads to achieve cost effective decarbonisation
Heat networks, as with other networks (gas, water, electricity) are 'input agnostic'. Provided that the input attains the required standard, such as electrical frequency or calorific value, the network will transport irrespective of source. One key difference is that heat can be at a wide range of temperatures from below ambient (for district cooling) to thousands of degrees. There are different heat network types to deliver industrial grade heat, space and water heating and cooling. Heat networks provide flexible infrastructure enabling heat delivery technologies to evolve on a network over time. Initially, connections may come from gas fired CHP which may later be supplemented and replaced by renewable CHP or CCS technologies. In addition, other technologies, such as heat pumps and solar thermal can integrate well with district heating networks.

The flexibility offered by heat networks enables heat to be supplied from an evolving set of generators and prevents 'technology lock-in' or a commitment to achieving a given level of attainment with any one fuel source. In urban areas, heat networks offer a highly effective mechanism for delivering heat to homes, businesses and the public sector.

The 2050 pathways analysis presents only limited options for heat networks to be used to supply heat from power stations. Whilst this presents a valuable and highly cost effective option in some locations, there are also significant opportunities for small scale networks with localised low carbon and renewable generation, and these appear not to have been explored in the 2050 work. As a valuable infrastructure with long investment timescales, it is vital that the 2050 scenarios examine the potential for heat networks as the UK needs to start constructing these now if we are to successfully decarbonise urban heat loads.

Delivering Grid Balancing through Flexible CHP and Heat Networks

The role of heat networks and CHP in providing decentralised grid balancing services in a cost effective manner must be better recognised and exploited in the model

The anticipated greater levels of electrification of heating and transport in 2050 combined with higher penetration of variable renewable generation will lead to 'peakier' electricity demand and less predictable generation. The need for grid balancing services will inevitably grow, with the risk that maximum peak electricity demand could far exceed the average demand. Addressing this pattern of demand growth will potentially require highly intensive and costly reinforcement of the electricity grid and significant amounts of backup generation and storage. Whist this is technically possible, it is unlikely to be the most cost effective or sustainable mechanism for addressing such demand.

Heat storage presents an alternative approach to managing these system stresses, utilising proven technologies and maintaining system operability at potentially far lower costs. Operating CHP generation in tandem with relatively small amounts of heat storage can mitigate against such grid peakiness:

- during periods of excess electricity production electrical energy can be converted to heat for immediate consumption or storage for later use
- during periods of shortfall in system electricity production CHP plant can operate to produce both electricity and heat at maximum efficiency, with any surplus heat being stored for later use.

These localised balancing services can be offered cost effectively to distribution network operators with no impact on the availability of heat to network users. In Denmark, where there is a high penetration of heat networks, such practices are commonplace. As the 2050 model is developed further to explore costs, then the value of CHP and heat networks for grid balancing should be present in the model. The lack of inclusion of such services in the current model limits the available options when considering the cost implications of balancing a variable grid. These options exist today from large scale right down to the smallest scale where highly flexible domestic microCHP units providing balancing services to the lowest voltage parts of the grid.

The CHPA recommends that the 2050 pathways analysis provides the option of localised balancing services through heat networks, heat storage at all scales and CHP as a way of addressing the challenges of a decarbonised electricity grid and greater electricity demand.

The contribution of CHP in Capacity Markets

The potential for high efficiency CHP in providing valuable flexible reserve capacity, particularly to combat the effects of intermittency in certain renewable generation, must be included in the model.
The current review of electricity markets will include examining how electricity capacity can be guaranteed. A growth in unpredictable generation will lead to a greater need for predicable generation capacity. The challenge created, however, is that much of the new generation anticipated is either very challenging to modulate (nuclear), designed to operate as base-load to cover costs (CCS) or not dispatchable on demand (wind). Biomass remains as a possible option to deliver capacity but questions remain to be addressed over the most appropriate use of this resource. One possibility, which the model does not appear to address, is the value of CHP in delivering capacity. Large scale CHP (with steam turbines) can effectively modulate how much power they generate very rapidly and the heat can still be delivered for its intended purpose. Similarly, smaller scale CHP can modulate power output very effectively, particularly when combined with heat storage. The 2050 pathways analysis does not appear to present the opportunity for capacity services from CHP plant but it is one key way to ensure that any capacity system does not drive high emissions and delivers resource use efficiency. **The CHPA recommends that the potential for CHP to offer capacity services should be included within the modelling work.**

Decarbonising Industrial Heat

The current 2050 analysis has a very limited assessment of industrial energy use, particularly, industrial grade heat. A refinement of the model in which industrial heat is specifically addressed is vital to ensure that policy supports decarbonised industry
An in-depth examination of the Excel model that runs the 2050 pathways tool reveals that in all scenario choices, only 2% of industrial heat can be delivered through heat networks from CHP. This lack of flexibility appears to run contrary to the Government's own commissioned work into the potential for CHP which highlights that there is significant opportunity in the industrial sector with potential for an additional 6 GW_e installed capacity[1]. In addition, the Committee on Climate Change has identified that reducing industrial emissions from heat is one of the most challenging areas. Research by Poyry Energy Consulting for Greenpeace identified 9 industrial clusters in the UK with a potential for between11 and 16 GW_e of CHP capacity[2]. By utilising low and zero carbon CHP at these sites, the electricity grid can be decarbonised at the same time as decarbonising industrial processes addressing one of the most significant problems for developing a low carbon economy – industrial heat.

The upgraded 2050 model must account for locational opportunities (e.g. linking CCS infrastructure with electricity transmission networks and industrial centres could reveal opportunities for substantial efficiencies not yet evidenced in the model).
As noted above the 2050 pathways work would benefit from a greater focus on the possibility of collocating new power generation and industrial heat demands as a mechanism for driving a more efficient energy system and decarbonising industrial emissions. To ensure an internationally competitive decarbonised industrial sector in 2050, industrial heat supply will need to be decarbonised. Utilising heat offtake from low carbon and renewable generation stations will enable both a low carbon electricity grid and decarbonised industrial heat supply. In addition, the increased efficiency of cogeneration will improve the security of supply by reducing primary energy demand. As industrial grade heat can not be transported over long distances, the location of

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[1] Department for Environment Food and Rural Affairs: Analysis of the UK potential for Combined Heat and Power, (October 2007)
[2] Securing Power: Potential for CCGT CHP generation at industrial sites in the UK, A report to Greenpeace, Pöyry Energy Consulting (2008)

new thermal generation plant near to centres of industrial heat demand is a vital component to deliver decarbonised industry. These locational factors will become increasingly significant as CCS becomes an important technology for the decarbonisation of industrial heat. Under these circumstances, the importance of co-locating power generation with heat demand becomes that much greater with the opportunity to exploit economies of scale in utilising CCS infrastructure for both heat and power supply. The 2050 work should, therefore, go further by examining the locational opportunities for port usage and biomass imports, the opportunities for CCS infrastructure and industrial heat demand.

Closing Remarks

The 2050 analysis presents an opportunity to take a broader view of the energy system as a whole to ensure that the future system is robust, cost effective and delivers the 2050 goals. The current model would benefit from a greater focus on locational drivers and opportunities for energy delivery to ensure that the current mechanisms do not stand in the way of an optimised future system. It is also important that there is information sharing with other related modeling work such as that of the Committee on Climate Change to ensure that the benefits from other work can be incorporated into the evolving model

The CHPA would welcome the opportunity to discuss these proposals, and the evidence that supports them with the 2050 team.

Yours sincerely,

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Policy Manager