



Department
of Energy &
Climate Change

Factors affecting the uptake of gas CHP

Results of qualitative research

December 2014

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Contents

Executive summary	6
Decision Making	6
Factors affecting decision making in organisations.....	6
Internal vs. external assessment	7
Alternatives to gas CHP	7
Procurement and installation	7
Operational Experience	7
Technical	7
Financial	8
The impact of electricity and heat sales.....	8
Future plans for gas CHP	8
1. Aims and Objectives	10
Commercial optimum vs. realisable gas CHP projects.....	10
2. Methodology	10
Grouping to reflect experience of technology.....	11
Multiple sector coverage	11
Methods.....	11
Sample selection	13
Semi-structured interviewing	15
Follow-up survey.....	16
Qualitative Data Analysis.....	16
Quantitative Data Analysis	17
3. Results.....	18
The size of energy users.....	18
Composition of Group A.....	19
Decision making	20
Structure of decision making in organisations.....	20
The role of government incentives in decision making	25
Alternatives to gas CHP	25
Awareness and understanding of Gas CHP	26

Procurement and installation	27
Operational Experience	28
Technical performance	28
Financial performance	30
The impact of electricity and heat sales.....	32
Future plans for gas CHP	33
Market drivers and inertia	35
The role of government in the future development of gas CHP	35
Role of Trade Associations.....	37
Anomalies in the barriers to uptake of gas CHP	37
4. Conclusions	38
Competing access to capital.....	38
Energy generation is a non-core activity.....	39
Lack of technical support.....	39
Fear of the unknown.....	40
Lack of opportunity	40
CHP specific issues.....	40
Appendix 1 – Results from the initial online questionnaire	42
Sector breakdown	42
Split of responses by of size of energy use.....	42
Breakdown by use of gas CHP	43
Group A Responses	44
Group B Responses	48
Group C Responses	51
Group D Responses	53
Appendix 2 – Qualitative results matrices	54
Appendix 3 – Results from the quantitative post interview questionnaire	57
Financial assessment methodology.....	57
Assessment periods.....	57
Hurdle rates	57
Energy markets	57
Appendix 4 – Interview protocols for groups A-E	59
Appendix 5 – Quantitative post interview questionnaires	70
Appendix 6. The initial web based questionnaire	86
Initial Questions:.....	86
Section 2 (Group A only)	87

Section 2 (Group B only)	89
Section 2 (group C only)	90
Section 2 (group D only)	91
Section 3 – all groups	92

Executive summary

This project analyses barriers to the uptake of gas CHP through qualitative research, carried out by Ricardo-AEA, UCL and BRE on behalf of DECC. The overall purpose of the research is to develop a better evidence base and understanding of the investment decision-making concerning gas CHP, across a range of sectors.

The research covers 9 different sectors and comprises of an initial on-line survey followed by semi-structured interviews with parties who have gas CHP, have had gas CHP in the past, have considered but decided against gas CHP and who have never considered gas CHP. In addition, consultants, Energy Service Companies (ESCOs) and utilities that have dealing with gas CHP have also been included. A total of 49 face-to-face and telephone based interviews have been undertaken.

The results draw attention to the range of context and sector specific factors that have shaped assessments of gas CHP across private and public sector organisations. These are discussed in the following sections.

Decision Making

The results from the initial survey and subsequent interviews suggest that the financial performance of gas CHP is always important. Other factors including the capacity of gas CHP to deliver social and environmental benefits and energy supply resilience can also influence decisions to invest in gas CHP in some sectors.

One manifestation of this confluence of factors is that the location of the investment decision making process appears to be an important factor influencing the outcome. Remote decision making relative to the site of the gas CHP appears less likely to lead to investment in gas CHP, whereas those with local profit and loss accountability appear more willing to invest in gas CHP.

Factors affecting decision making in organisations

A problem highlighted by many interviewees is the availability of capital for investment in gas CHP. Organisations with energy intensive processes have clear commercial drivers to consider gas CHP. Of those interviewed in this category most are part of large multinationals in foreign ownership. They report that all equity investment decisions in their organisation are considered globally, leading to a feeling that the UK is missing out as investment in other locations is reported to give higher returns. While there are instances of debt capital being potentially available at a more local level, again competition from other investment opportunities are reported to be a barrier to accessing these debt facilities.

Less energy intensive industries have correspondingly less commercial pressure to invest in gas CHP. Those interviewed who fall into this category report that in their organisations (which are mostly UK based) competition for capital is from investment in energy efficiency or in increasing production or manufacturing efficiency.

Outside of the manufacturing sectors, different factors are reported to be dominant. In the local authority and higher education sectors, interviewees confirm the importance of meeting carbon emission targets, especially where government funding is linked to carbon performance (e.g. in

higher education). Growing concern around fuel poverty also appears to be leading some local authorities to consider investing in gas CHP.

Internal vs. external assessment

Interviewees report two general approaches to gas CHP opportunity assessment. The first is where an ESCO or similar makes a specific proposal to install gas CHP. The assessment of this proposal is then handled in a similar way to any other, usually at a senior level and usually led by a Finance Director or similar. While operational staff are consulted, they typically do not lead the assessment process.

The second reported approach is where a process has been instigated and led by an internal 'champion'. The role of the champion here is to identify the opportunity and then to progress it within the organisation. This usually leads to the production of a business plan that is then reviewed by senior management. This approach has been used by most of those who currently have gas CHP.

In all cases the use of external consultants or advisors is found to be commonplace. Where these are expert in gas CHP the result is generally reported as good but where consultants are not gas CHP specialists the outcome is sometimes seen as less satisfactory.

In the specific case of the local authority sector, contracting out of engineering and other functions in recent years is identified as leaving many interviewees without the capability to either undertake proper engineering or financial assessment of gas CHP opportunities, or to have the confidence to select a consultant to undertake this work.

Alternatives to gas CHP

For those organisations interviewed that do not have gas CHP, grid supplied electricity and gas fired boilers for heat and/or steam is the most common mix of energy supply. This option is seen by these organisations as low risk and appropriate to their business.

Organisations who have considered but rejected gas CHP report a range of alternative outcomes including investment in upgraded heat only systems and energy efficiency. Those organisations seeking to reduce their carbon emissions also report additional investment into renewable energy technology such as photovoltaic cells and biomass heating.

Procurement and installation

Interviewees from organisations with gas CHP all describe the need for good design and installations and how failings can lead to significant impacts on the technical and financial performance of the system. Some interviewees describe past situations where in-house teams underestimated the complexity of gas CHP leading to costly, failed schemes. Others describe how trying to cut costs at the procurement stage has led to poor reliability and higher long term costs as a result.

Those with more modern systems have demonstrated how the use of specialist designers, suppliers and installers has led to successful schemes. Those interviewed from the consultant/supplier sector also report that poor design and installation is now largely a thing of the past.

Operational Experience

Technical

Based on the evidence obtained in this study from the initial questionnaire and interviews, in the majority of cases gas CHP performs technically as or better than expected. Where this is not

the case the problems are reported as being down to wrongly sized or specified units or the expected heat load changing during the period of operation.

Those with gas CHP also report the need to have good maintenance contracts. These are usually with the supplier of the equipment and are negotiated at the same time as the contract to supply the gas CHP plant. Interviews identify examples of where poor maintenance support has had a negative impact on the host organisation. On the other hand one interviewee stated that in his view it is worth paying for the highest level of maintenance cover being offered as this will be recouped from operational benefits.

Financial

While evidence from the initial survey indicates that, in general people find gas CHP gives acceptable financial returns, the results from the interviews are more mixed. While recently installed schemes tend to perform as predicted, systems that are 10y or more old do not always do so. Interviewees indicate that this is because market conditions are different to when these systems were designed and that recent changes to energy prices and government policy have impacted adversely on their incomes.

The impact of electricity and heat sales

Based upon the results from interviews, there is little evidence of successful heat sales from gas CHP. One example of successful heat trading is where a gas CHP provides the heat for residential district heating. Another example is associated with either interdepartmental trading within the same organisation and the last is where heat from a gas CHP supplies retail units within a single complex where the heat sale is included in the rent.

Less successful examples reported are from older (10y or more) systems where heat is being sold at lower than market price to a long-term customer and where all local heat users have closed, reducing heat incomes to zero.

Those interviewed who are considering gas CHP confirm that they have no interest in selling heat outside of their organisation and none of the interviewees identified income from heat sales as a potential opportunity. Instead they consider that heat sale has the potential to reduce their operational flexibility as a result of their contractual obligation to provide heat.

There are no such issues with electricity sales. The greater potential flexibility of electricity supply presents no reported issues. This was the same for those who currently have gas CHP or are considering it. As a result, most of those interviewed who have gas CHP are exporting electricity to the grid, some on an ad-hoc basis and others as part of a long term supply contract. Here, the low value of electricity at night is identified as a common concern.

Almost all of those interviewed that have gas CHP mentioned that energy generation is not their core business and that in many cases they lack the skills or specialist knowledge to maximise the financial benefits of energy export.

Future plans for gas CHP

Among those interviewed and surveyed most express enthusiasm for gas CHP. The interviews confirmed that many who have recently installed systems were actively looking for opportunities to install more.

Those operating older (10 years or more) systems associated with energy intensive manufacture of commodity goods report poorer economic performance than expected when interviewed, with many issues down to units being sized against different market conditions. These operators are almost all caught up in the issue of competing for capital investment with

other projects elsewhere in their company in other locations in the world. These interviewees indicate that they are considering decommissioning their gas CHP.

Gas CHP often provides the heat for new building developments or refurbishments. Interviewees report that gas CHP is now the technology of choice for this application, with gas CHP considered as part of the building mechanical and electrical infrastructure rather than as a separate entity and therefore not requiring a separate financial justification. While retrofit to existing buildings is technically possible, interviewees consider that the cost and inconvenience of having to change a range of other building control and other systems act as a barrier to uptake.

Many of those interviewed who do not have gas CHP admit to some inertia around considering energy generation options which is preventing them from taking forward gas CHP projects. This inertia mainly comes from their focus on core business leading to a lack of effort on their part to look for energy opportunities. These interviewees see market or legislative pressures as potential drivers to action, citing the spate of investment in gas CHP in the food & drink sector as a result of the sector Climate Change Agreement (CCA).

The local authority sector reports enthusiasm for installing gas CHP, but only if the current technical capability based barriers within their own organisations can be overcome.

The role of Government in the future development of gas CHP

The response to questions in interview about the role of government in the development of gas CHP elicited a number of responses, but little real consensus around specific actions. For instance, CRC and CCA's were not singled out, but this may be a function of the size of the sample being interviewed.

Those sectors with a long tradition of operating gas CHP appear to be calling for the government to indicate continued support for gas CHP and to make policy decisions on which long-term investment decisions can be made.

Emerging sectors in terms of interest in gas CHP uptake such as local authorities see the need for government to provide more 'outreach' services to educate decision makers and then to support the process of gas CHP implementation. In these sectors, there is also a call for grant and other financial support activity to overcome inertia and to bring forward projects.

1. Aims and Objectives

The overall purpose of the research reported here is to develop a better evidence base and understanding of gas CHP investment decision-making across a range of sectors, the factors influencing investment decisions, why organisations do and do not consider gas CHP and why projects do and do not proceed.

The objective of the research is to inform decision making about the need for financial and non-financial policy intervention options and the rationale for these. The research looks at different market sectors and across the public and private sectors. It considers both:

- Where CHP is already expected to be cost-effective, but not implemented.
- Where CHP is not expected to be cost-effective under current policy and projected energy prices within an organisation's investment timeframe.

At the same time, the opportunity has been taken to gather information on the operational experiences of a range of organisations that are operating gas CHP systems.

Commercial optimum vs. realisable gas CHP projects

The commercial optimum for gas CHP schemes is where the units operate constantly at maximum output. All heat energy is used productively and all electrical energy used to displace grid supply with any excess relative to onsite demand earning revenue through sales of exported energy.

These opportunities are ideally suited to energy-intense manufacturing operations, although other high base load situations such as hospitals also meet these criteria. The opportunities to run gas CHP plant at its commercial optimum can be extended to sectors with different load profiles where local networks or grid connections offer load balancing and revenue generating possibilities.

This study is designed to uncover and analyse the barriers to realising the potential of gas CHP especially where the above optimum arrangement is possible.

2. Methodology

Key to this project is the identification of context specific factors affecting gas CHP uptake that are harder to ascertain through purely quantitative methods. This requires an iterative research design that draws on qualitative and quantitative methods and is scoped for a wide range of factors. The process is designed to incorporate experiences and evaluation criteria for technology applications that cross different sectors.

Grouping to reflect experience of technology

In order to achieve the objectives of this research, it is important to include those organisations that do and do not have gas CHP and of the latter those that have and have not considered gas CHP. As a result, the following target groups have been identified:

- **Group A** – Those who currently have gas CHP
- **Group B** – Those who had gas CHP in the past but no longer have gas CHP
- **Group C** – Those who considered but rejected gas CHP as an option
- **Group D** – Those who have never considered gas CHP

An additional group (**Group E**) is included to reflect the expert community that provides technical advice influencing an organisation's technology investment choices. This includes Energy Service Companies (ESCOs), utility companies and consultancies.

Multiple sector coverage

In order to achieve a spread of information from across a wide cross section of potential gas CHP applications, the research addresses the following sectors:

- Food & Drink
- Paper
- Retail & Warehousing
- Local Authority
- Higher Education
- Health
- Oil & Gas
- Chemicals
- Other

Methods

A mixed methods approach was adopted to generate results from targeted groups. Quantitative methods allow organisations to be targeted according to their relationship to gas CHP technology. Qualitative methods were used to probe for the set of reasons behind these relationships. Post interview questionnaires were designed to link qualitative experiences to the financial criteria used by the targeted organisations and provide an additional dataset to analyse the extent that these experiences were reflected within and across the sectors surveyed. These methods were designed to identify key factors in decision making processes rather than provide representative data on any single sector or group.

Therefore the following a three stage approach was used:

- **A web-based scoping survey.** The initial phase of the research involved the roll out of a short online survey (launched in the middle of March 2014), which has two key aims. Firstly, it provided a pool of potential interviewees for the subsequent phases of the project; and secondly it gives a snapshot of level of awareness and

experience with gas CHP. Appendix 6 reproduces the questions asked in the online survey. These are Group specific around central themes designed to explore the decision making process associated with gas CHP and where relevant operational experience, routes taken to finance, views on technical and financial performance and future plans.

The survey was sent out via Ricardo- AEA's and BRE's existing confidential databases. These databases contain over 5900 contacts and networks in local authorities, health, higher education, commercial and industrial sectors. This includes trade associations (Food & Drink Federation, Chemical Industry Association, and the Confederation of Paper Industries with a combined membership of over 1100 sites). These associations also contacted their members with a request to participate in the online questionnaire as did the Local Government Association.

In addition, for contacts across a range of sectors (including Oil & Gas) who have CHP or are considering/have considered it, the CHP Quality Assurance (CHPQA) and CHP Focus helpline and 'outreach' workshop contacts data (about 600 contacts in all) were used.

This yielded a total of 258 responses to the online survey. Of these 72 respondents indicated that they were willing to be interviewed (see Appendix 1). A breakdown of these responses by Sector is shown in Table 1.

Table 1 – Breakdown by sector of responses to initial pre-interview online scoping survey

Sector	Number of Responses
Chemicals	32
Paper	11
Food and drink manufacture	120
Oil & Gas	2
Retail & warehousing	3
Health	6
Higher Education	19
Local Authority	40
Other	25
TOTAL	258

Semi-structured interviews (2nd April-6th May 2014). The second phase of the research involved semi-structured interviews with organisations across a range of sectors. Interviewees were selected from those survey respondents who indicated their willingness to take part in further research, with organisations grouped

according to their experience with gas CHP. The sampling method used is described below. 49 interviews were undertaken (see Table 2). The number of interviews was dictated by the timeframe and the size of the pool of potential interviewees. Therefore the results give only a broad indication of the factors affecting the uptake of gas CHP and not precise measurements.

The interviews followed a basic interview protocol, tailored to make it appropriate to the group that the organisation is in. Where possible the interviews were face-to-face, but in 4 cases telephone interviews were used.

7 interviews were also carried out with companies involved in the CHP market, including 2 utilities, 3 ESCOs and 2 consultancies offering gas CHP advice in the market. 5 of these interviews were conducted over the telephone and 2 were face to face.

- **A follow-up survey** (May 2014). The final phase of the research was a post-interview survey, which focuses on financial factors (see Appendix 3). The survey requested detailed information on the financial factors that underlie decisions around investment in gas CHP and how this differs compared with other investment opportunities.

This approach was taken rather than to extend the interview process to include these financial factors for a number of reasons. There is real concern that mixing qualitative and quantitative research in the same interview has the potential to compromise the outcome from both. As discussed later, the detailed questions set by DECC require response from a finance specialist. This has the potential to influence who is interviewed and thus to skew the outcomes from the qualitative research. On an entirely practical point, many interviewees may also have been put off by the longer interview reducing our interview sample size.

A total of 19 responses were received to the follow up survey, 4 of which simply indicate through written comments that the organisation is unable to answer the questions. These all confirm that in these organisations investment decisions are made in a way which does not correspond to the questions being asked.

Sample selection

Of the 258 organisations which responded to the survey, 72 indicated that they were willing to participate in a follow-up interview. Of these, a total of 42 organisations were selected for interview. A further 7 interviews were held with those in Group E (the expert community).

In order to select organisations to interview, a purposive sampling strategy was used. This enabled the identification of organisations that best fit the requirements of the project. Wherever respondent numbers allowed, at least 5 interviews per sector were held, ideally with no more than 2 in Group A (have gas CHP). In most instances, the pool of available interviewees is just large enough to allow this breakdown. A total of 49 interviews were held, which enabled a cross-section of both Groups (i.e. experience with gas CHP) and sectors to be interviewed (see Table 2).

As the organisations in Group E (the expert group) are well known to DECC and Ricardo-AEA, a small number of participants were suggested by Ricardo-AEA and approved by DECC. The selection was then simply based on which of these were available for interview within the time slots available to introduce some degree of random selection.

As the interviews progressed, it became clear that some interviewees had allocated themselves to the wrong group or that they belong to multiple groups. For instance, one organisation had placed itself in Group A because they use heat and power from a gas CHP, however this organisation does not have its own gas CHP system. Another put itself in Group B because their gas CHP has transferred to a different ownership with the sale of a building, leaving the organisation looking for new gas CHP opportunities, making them a Group B and a Group C organisation. In the latter case, the interviewee was able to provide information relative to both of these Groups for use in the final analysis.

Table 2 – Breakdown of interviews undertaken

Final Interview matrix					
Sector	Group				TOTAL
	A	B	C	D	
Food and Drink	2	0	2	5	9
Paper	2	0	3	0	5
Retail & Warehousing	2	0	1	1	4
Local Authority	2	2	2	2	8
Higher Education	4	0	0	1	5
Health	3	0	0	0	3
Oil and Gas	0	0	1	0	1
Chemicals	3	1	1	0	5
Other*	2	0	0	0	2
Advisors/ESCOs/Utilities					7
TOTALS	20	3	10	9	49

* Other comprised one from the leisure sector and one from the minerals extraction sector

Key:

Group A – Have gas CHP

Group B – Had gas CHP

Group C – Considered but rejected gas CHP

Group D – Never considered gas CHP

Limitations of this approach to sampling have been identified. Firstly, due to time restrictions, not all sectors where gas CHP is common are covered. For instance, the leisure sector is not specifically targeted for interview, although this is overcome to some extent in some interviews as some representatives of local authorities have experience of running municipal leisure facilities and one leisure operator was interviewed within the 'other' category.

Secondly, and again owing to the short-time frame, the initial survey was sent out via existing contacts and networks. This potentially limits participation to those who are already known to Ricardo-AEA, BRE and DECC. While the sampling selection achieved as wide a coverage as possible and targeted a number of interviews, longer timescales would allow other mechanisms for dissemination of the initial survey to be explored. This would likely lead to engagement with a wider range of organisations and sectors.

However, the method used whereby interviewees effectively selected themselves goes as far as practically possible to ensure that this issue is mitigated and that those running the research had as little impact as possible on sample selection.

As can be seen from Appendix 1, only 12 organisations responding to the online questionnaire were in Group B. Of these, only the 3 identified in Table 2 put themselves forward for interview.

Semi-structured interviewing

An interview guide was developed through an iterative process that involved all of the project team and DECC. A key element of the design of the interview protocol is the creation of a process in which interviewees can feel confident and thus comfortable to share information about their experiences and opinions on gas CHP. The guide is based on a common framework, with modifications to make it relevant to each of Groups A-D. Separate guides were produced for the consultants and the utility/ESCOs comprising Group E (see Appendix 4 for group specific guides). Themes covered in the interviews are all specific to gas CHP and include:

- Organisational background
- The decision-making process
- Procurement and installation
- Organisational experience
- Specific financial issues
- Experience with contracts
- Future plans

The interview guides reproduced in Appendix 4 give more context and background to these themes and include the range of questioning that was undertaken within each theme.

All of the 49 interviews were undertaken within a 5 week period from the 2nd April to 6th May 2014. In order to achieve this outcome, 7 interviewers were used, sourced from experienced Ricardo-AEA and BRE staff. To ensure familiarity with the interview protocol and to achieve consistency of approach, a one-day workshop was held with the interviewers on the use of the interview guides and on the approach to use when interviewing. This workshop also provided an additional opportunity to get feedback on the draft interview guides from the project team and to make final improvements.

Individual interviewers undertook at least 5 interviews and as far as possible, interviewers were allocated to a single sector or to a small number of sectors. Only in 4 cases were face to face interviews not possible and here telephone interviews were used instead. Telephone interviews were used extensively for Group E. This is because this Group is experienced in providing detailed information and advice over the telephone.

The interviews were not recorded, but instead detailed written notes were taken. All interviewees were assured that their responses would remain confidential and anonymous, unless they indicated that they were willing to share their comments with DECC. Individual interviews lasted between half an hour and two hours. Team members from UCL attended interviews with different interviewers to assess consistency of approach.

This approach was taken to draw out the insights into gas CHP gained through sector and context specific experiences with the technology. Qualitative research was used in order to capture these details and uncover results that can be missed by quantitative methods.

Follow-up survey

During each interview, interviewees were also asked whether they would be willing to provide detailed, quantitative information about the financial aspects of gas CHP within a follow-up survey (see Appendix 3). Questions for this survey were designed in consultation with DECC and included:

- Financial assessment methodology
- Exporting revenues
- If the approach to gas CHP differs compared to other investment decisions.

It was felt that sending out this questionnaire prior to interview could have influenced who participated in the interview by implying that only quantitative financial data was required. This could also have prevented some organisations from participating. The questionnaire was therefore sent after the interview had been conducted. This approach saw a response rate of just under 40%. The results are analysed in Appendix 3 and provided in more detail in a confidential spreadsheet based report to DECC.

The post interview questionnaire also contained some elements of qualitative questioning. Where these questions were answered, they confirm the findings from the interview held with the responding organisation. This includes the central issue of whether financial investment criteria for CHP are common with other investment opportunities. None of the responses to the post interview questions stated that a higher return would definitely be required for CHP projects as a matter of company policy. However 2 considered that risks around market/regulation relative to their core activities might lead to a higher rate of return being required when specific business cases are considered. On the other hand, 1 said that a lower rate might be negotiated for projects delivering environmental benefit. 2 responses from Group C (considered but rejected gas CHP) stated that the rate of return projected from a gas CHP were lower than from other investments in process improvements.

Qualitative Data Analysis

In order to maximise the value of the interview process, a workshop approach was taken as part of the research to analyse the results from the interviews. This brought together all interviewers and other key project team members, as well as representatives from DECC.

The workshop provided two opportunities. First, it gave an opportunity to review the interview process, to confirm the quality of the material collected and to further standardise the correlation of responses. This was achieved by using the capacity of the workshop to look at the collected information as a whole and to gain the input of the interviewers, who could apply their additional insights from the interviews. These often go beyond what can be written in an interview report.

Second, the workshop enabled large amounts of qualitative data to be initially analysed and for key themes to be identified as they emerged during discussion. This collective questioning and analysis of the outcomes from the interviews therefore led to issues not previously considered as significant being drawn out. The outcome of this process therefore also shaped and extended the analytical categories that were used to identify the factors influencing the uptake of gas CHP and thus why projects do and do not proceed. This went beyond those factors that were expected at the start of the project.

The interview data was considered firstly by Group and then by sector. Starting with Group A, interviewers discussed the experiences that had been described to them of assessing, installing and operating gas CHP plant. By undertaking the assessment against this logical progression of development processes it enables differences to more easily be identified between sectors and individual organisations. In addition this approach greatly assists with the identification of other key factors and where in the process these had the biggest impact. These key factors include the historical context of investment decisions, the impact of changes in personnel, the varying availability of expertise within companies, and changes in the broader policy landscapes at the organisational and national level.

This process of analysing responses against the logical progression of decision making activities relevant to each Group was repeated across the groups. This provided specific information about the process of assessing gas CHP opportunities and (where relevant) information on operational experience.

The workshop then considered responses by sector, to identify any sector specific dynamics. For example public sector outsourcing has changed where the technical expertise for public service provision is located. In this way, the process of analysing and comparing specific experiences enables common themes to emerge across groups and sectors, albeit within a small sample size. Extensive notes were taken during the workshop and these were used within the analysis process alongside the interview reports.

The workshop identified a list of factors which appear to be affecting the uptake of Gas CHP from the interviewees' perspectives. After the workshop the interviewers used this list of factors to analyse their qualitative data in order to generate a matrix of results (see Appendix 2). This matrix provides the structure for the discussion of results presented in this report (see Section 3).

During the workshop the interviewers confirmed that interviewees assign different degrees of importance to these factors. These often vary according to sector. Almost every interviewee was thought to have taken the opportunity of the interview to stress or repeat what they feel is a crucial insight gained from their experience of gas CHP or the dynamics of their sector or specific organisation relative to the potential use of gas CHP. To reflect this in the matrix of results, the interviewers were asked to assign relative weightings. These are represented in in the matrix of results shown in Appendix 2 by one tick (a factor which was mentioned) and two ticks (a factor which was emphasised).

This approach generates high level messages. It has been taken to enable a broad scoping of different experiences and perspectives in order to bring out key factors and messages and to analyse them relative to a number of factors.

Quantitative Data Analysis

The post interview quantitative questionnaires yielded 19 responses. The results from this questionnaire were analysed separately and reported in Appendix 3. 5 respondents provided data on investment hurdle rates and 4 merely confirmed that the organisation was unable to answer the questions posed by DECC.

This inability to answer the questions almost all relates to the way in which the organisation concerned approaches investment appraisal, making the questions not relevant to them. For instance, many local authorities do not set formal investment hurdle rates or payback periods and the nature of the business case that is developed is specific to the nature of the project. In

this way projects delivering social benefit to meet policy objectives may merely have to demonstrate cost neutrality over their lifetime, which can be as long as 40 years.

3. Results

The results presented here are discussed by following the processes undertaken as organisations consider, install and operate gas CHP, with any decisions to decommission or increase gas CHP plant included.

In Group A this approach identifies the reality of ‘life with gas CHP’ and in other Groups highlights the location and nature of the barriers to uptake within the totality of the decision making process. Both of these types of experiences are important when seeking to accurately identify barriers to uptake and how these might differ from sector to sector.

Discussing the results in this structure allows for the survey results to be integrated with the more nuanced explanations elicited through interview. The discussion draws attention to the differences between groups, as well as indicative patterns within and between sectors where the data have allowed these comparisons to be made.

In addition the results from the post interview questionnaire are being analysed separately using quantitative methods and will be shared with DECC in a separate spreadsheet. Because of the sensitive nature of this information it will remain confidential to DECC.

The size of energy users

Of the 42 interviews undertaken across Groups A to D, the size of energy users breaks down as below.

- 30 large energy users (spending more than £2.5m/y on energy)
- 7 Medium energy users (spending between £0.3 and £2.5m/y on energy)
- 5 Small energy users (spending less than £0.3m/y on energy)

Table 3 shows how the size of energy use splits across the Groups interviewed.

Table 3 - The split of energy use across the Groups interviewed

Energy use	Group A	Group B	Group C	Group D
Large	18	3	7	2
Medium	2	0	3	2
Small	0	0	1	4

Key:

Group A – Have gas CHP

Group B – Had gas CHP

Group C – Considered but rejected gas CHP

Group D – Never considered gas CHP

Table 3 shows that 18 of the 20 Group A organisations interviewed are large energy users and none are small energy users. Conversely, smaller energy users make up the majority of Group D. This is unsurprising in that energy cost drivers are likely to be higher in large energy users, making them more likely to invest in technologies like gas CHP. Smaller energy users have fewer energy cost drivers making it less likely that they will have energy as a priority leading to investment in gas CHP.

This is confirmed by the results of the interviews. For all interviewees in Group A, energy management is a significant concern and plays a more strategic role in these organisations. For all those interviewed from Group D, energy management is an important but less critical concern relative to other priorities within their organisation such as making process improvements. Within this Group, for 3 out of the 8 organisations interviewed, gas CHP is not technically feasible to meet their heat load (see results matrix 2 in Appendix 2).

Composition of Group A

An important part of the analysis is to understand the impact of exporting and not exporting heat and power from gas CHP on the uptake of gas CHP. Of the 20 interviews with those who have gas CHP (Group A), 10 export power and of these 10, 6 also export heat. The interviews did not collect quantitative data on the scale of energy export. However, it was clear that in the view of all of those people questioned on this subject from Groups A to C, heat sales have to be at a scale which they consider makes heat distribution cost effective against a supply contract. This in turn will link to local conditions. Electricity sales on the other hand were found to be undertaken by almost all of those in Group A. This varies between sporadic and constant export activities.

Of those interviewees selling heat, 4 do so to supply internal clients or 3rd parties located on their own estate via local internal trading arrangements. These are not subject to the same commercial pressures of an open market.

One example of this situation is a hospital energy centre which provides heat and electricity to onsite retail units as part of the rental agreement. Another is a university where separate departments buy metered heat from the university central gas CHP system. While in both of these examples self-generation of heat is a technical option, in reality the size and internal location of the retail units within the hospital is a significant barrier to boiler installation and in the case of the university there is no mechanism for individual departments to 'go it alone' with heat supply.

Decision making

Financial performance is thought to be important by all.

There is some evidence that where decision making is close to the site of the proposed project that more projects proceed. This may indicate that human factors are contributing to local decision making and that these are influencing outcomes in some way.

In the experience of the majority of those interviewed, competing demands for investment can see gas CHP lose out to other priorities. Some report that this is a particular issue where decision making is part of an international or national process

Non-financial benefits from gas CHP appear to have different importance across the sectors studied.

'Champions' within an organisation are thought to be important in promoting gas CHP by almost all of those interviewed.

The main alternatives to gas CHP are considered by all of those interviewed in Groups C & D to be heat only systems, purchasing grid electricity and investment in energy efficiency

Where carbon is a driver, technologies such as PV and biomass are reported by a small number of interviewees to be used to specifically reduce carbon emissions.

The impact of how and where decisions were made about investments in gas CHP is a key theme that was indicated in the responses to the online questionnaire and came up in a vast majority of cases through interview discussions.

The online survey showed that 58 of the 88 Group A respondents (those with gas CHP), ticked the main reason for choosing to install gas CHP as 'it offered good financial performance relative to other investments' (see Appendix 1, Group A responses). This question allowed one main option, plus an 'other' reason to be given. By far the most common 'other' reason for installation was to improve carbon performance.

The interviews gave a more complex picture of how decision making processes shape the decision of whether or not to invest in gas CHP. All interviewees identify themselves as decision makers about energy related investments within their organisation, and unless indicated their responses relate to their own organisation, rather than the wider sector. The analysis draws out a number of themes which are discussed in the following subsections.

While the decision making process varies widely across the interviewees, within this sample in general there are two broad approaches. These are based on where the driver for gas CHP originates. Where an external provider makes an approach proposing the installation of a gas CHP system, the appraisal of this proposal invariably involves operational level staff, but the decision to install mainly resides with the organisation's finance team.

Where the proposal to consider gas CHP is internally generated within the organisation, the interview sample reports that, in a majority of cases, these are based on a bottom up driven process with operational staff, energy managers and sustainability managers providing a champion role. These same staff members are then involved in the development of the relevant business case which is appraised by a senior management team.

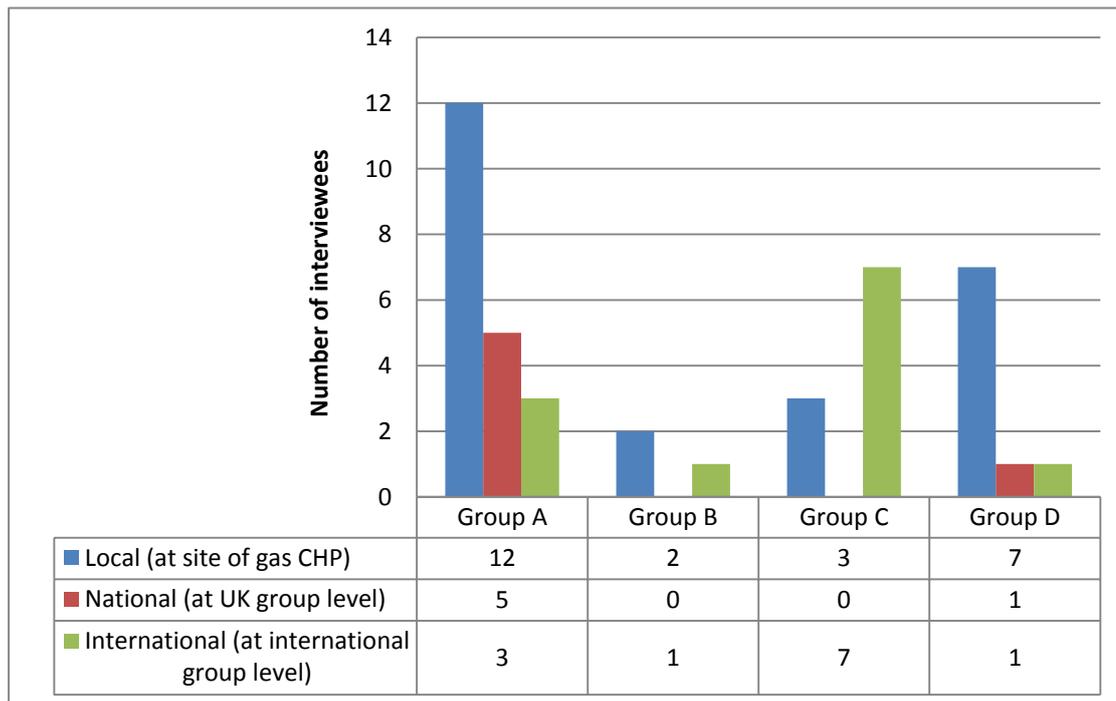
Structure of decision making in organisations

All interviewees discussed the organisational dynamics that characterise how decisions about investments in technology and energy efficiency are taken. A common factor across all of these interviews is the location of the decision makers relative to the physical site of CHP plant

operations. However, when considering the findings presented below it must be stressed that they are based on a relatively small sample size.

Figure 1 shows the different structures by group. It shows that a large majority of Group A organisations (those with gas CHP) have (or had) the investment decision making authority local to the management and operating authority of the gas CHP plant. This is not the case for Group C organisations (those who have considered but rejected gas CHP). The majority of these organisations have decisions about gas CHP investment made remotely, most usually at the international group level.

Figure 1 Site of decision making within interviewed organisations by group



The interviews held with respondents from Group C organisations that are in this situation highlight the impact of having investment decisions taken at group level. Within this sample, investment in gas CHP was not pursued. This is reportedly because of competing calls on capital across an international business to invest in core manufacturing facilities, or for investment in energy projects (including gas CHP) in other countries. No evidence was found that organisations require a higher rate of return from gas CHP relative to other investments. However, interviewees report that the rate of return that can be achieved in the international market is seen as being more favourable than in the UK by their owners.

This view is reinforced by a small number of Group A members with gas CHP systems installed before foreign acquisition. This has led to difficulties in being able to attract investment for new systems or even for system modification under current management.

The effect of decision making structures also comes through in the sector analysis of the interview data. Almost all of those interviewed from the local authority, higher education and health sectors stated that for their organisation’s decision making is all local to the site of the gas CHP or potential gas CHP project. Only one of the 15 interviewees from this sector stated the decision making was taken at a UK group level (see Appendix 2, results matrix 1).

However, it is important to note that factors other than location are at play in the decision making process. For instance while almost all interviewees in the local authority, higher education and health sectors all have decision processes that are local to the site of the gas

CHP, these sectors also all report high levels of non-commercial influences impacting on the decision making process.

Looking beyond these sectors the following pattern is observed among the interviewees.

- All interviewees in the retail & warehousing sector operate within a UK decision making framework.
- In the more 'industrial' sectors (e.g. chemicals, oil & gas, paper), almost all are now in foreign ownership and the decision making process is based overseas.
- There are differences within the food & drink sector. Of the 9 interviewed, larger organisations tended to be more like the 'industrial' sector, i.e. with some international ownership and decision making, while all of the smaller members operate with national and local decision making processes.

Most of the interviewees from organisations in foreign ownership consider that when it comes to competing for money to invest in energy projects, the UK is at a disadvantage compared with operations located in other geographies. The reasons they cited include:

- The UK is considered as having high energy prices relative to other locations in which their organisation operates. This is interesting as high energy costs might reasonably be considered as a driver for investment in technologies such as gas CHP in the UK. As this is not the case then the more likely issue is the relative cost of gas and electricity and not energy prices *per se*.
- UK 'Green taxes' are not perceived to benefit international owners of the manufacturing facility who are based outside of the EU. This may reflect differing international attitudes and responses to environmental issues in general rather than being specific to gas CHP.
- UK energy policy is seen by their foreign owners as inconsistent and risks undermining long term investment decisions. These inconsistencies relate to a view that government is seen as sending mixed messages and has shown itself liable to change policy, especially in the area of low carbon energy supply. Foreign investors require more long term certainty.

Within this specific group of interviewees the message from all of them implies that it is the increased profitability to the organisation as a whole from investing in gas CHP in the UK is seen by the owner as being lower than returns from other investments elsewhere. Almost all of these same organisations also perceive policy risk in the UK to be higher than in other locations, with lack of past consistency leading to future uncertainty.

However, this situation appears to be found only in certain commodity manufacturing situations in particular chemicals. In other specific cases, international groups familiar with gas CHP have installed this technology in their UK sites, with the paper sector providing examples of this.

This again indicates that there are a range of factors at play, not least the market dynamics associated with the various sectors interviewed.

Where decision making local to the site of the gas CHP is in place, more direct links to local benefits are possible. Similarly, where there is local profit and loss (P&L) accountability even within multinational businesses the wider benefits of gas CHP can be considered and can affect the financial assessment. Examples are the capacity to gain income from local energy sales, or to consider more collaborative energy use with others sharing the same general location.

This tends to indicate that human factors are a factor in local decision making in a way that is not seen in the more remote decision making processes.

But this scenario does not always guarantee a good outcome. One interviewee from the chemicals sector confirms that all UK sites in the organisation are separate P&L centres with investment decisions residing with local management. Feasibility studies have shown the potential attractiveness of gas CHP, but none of the P&L centre managers are investing. This is because the cost of failing to meet P&L performance targets are 'career limiting' and the market uncertainty around gas and electricity prices is a risk that they are not willing to take.

Across all sectors interviewees confirm that in many cases the required rate of return from a gas CHP might be reduced, or the acceptable payback timeframe lengthened if environmental or social benefits are recognised. The most pronounced example of this is in the local authority sector where all interviewees state that their social mandate means the benefits of a local energy supply favours gas CHP even where it is marginally cost effective. Over half of interviewees state that environmental/carbon/CSR issues are important to their organisation. In other sectors, operational benefits such as security of supply were cited as influencing factors in the decision making process by around a quarter of interviewees.

Internal vs. external opportunity assessment

The online questionnaire gives further insight into the dynamics of the decision making process. Table 4 shows the results to the question "How did you make your decision? (please tick all that apply)" which was asked to those with gas CHP (Group A). Of the 85 people responding to this question, 61 indicated that the decision was in response to an internally led process that identified the benefits of gas CHP and 19 indicated that it was taken in response to a consultant or other recommendation to install gas CHP.

The qualitative data helps interpret the results from Table 4, albeit from a far smaller sample size.

A key theme from the interviews is the importance of champions who could present the benefits of gas CHP to an organisation's decision makers. Figure 2 shows the number of interviewees who discussed the presence or absence of champions driving the decision to invest in gas CHP.

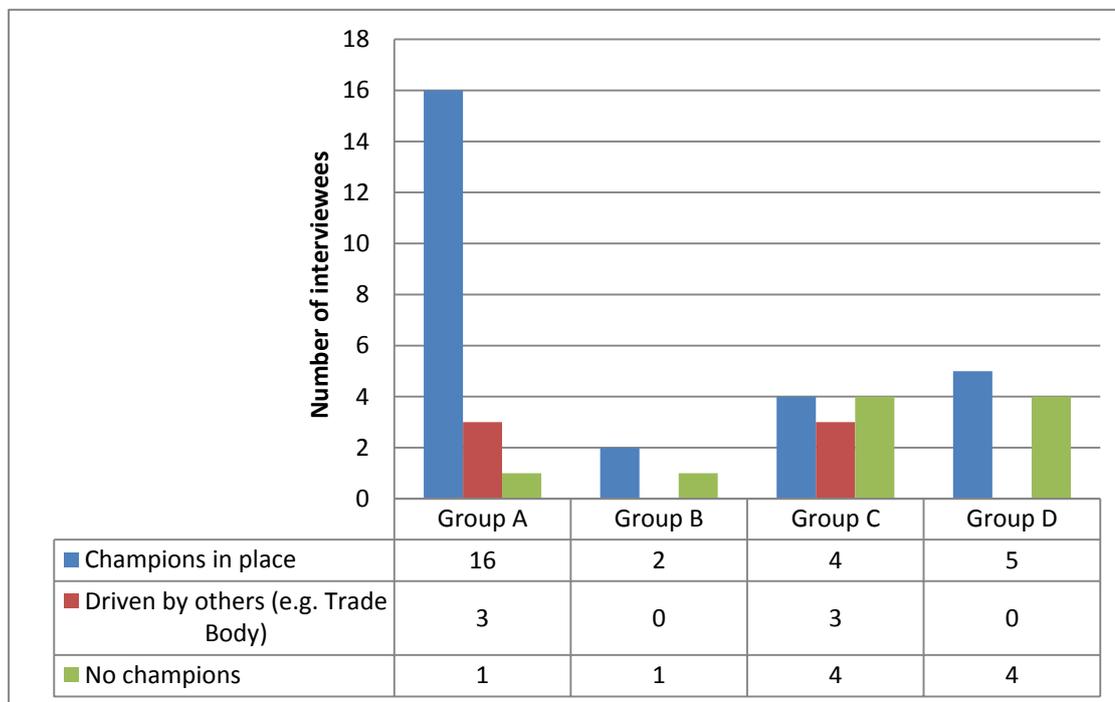
Table 4: Responses to the multiple choice question on decision making processes leading to gas CHP installation

Question: How did you make your decision? (please tick all that apply)

Answer Options	Response Count
As a result of an internally led process that identified the benefits of gas CHP	61
In response to a consultant or other recommendation to install gas CHP	19
In response to a government initiative or incentive scheme that made it attractive to install gas CHP	13
Don't know	9
Number answering this question	85

Almost all of the Group A interviewees describe a process where an individual or small team have driven the decision making process. Most of those spoken to placed emphasis on the ability of a champion to drive the process forward.

Figure 2 Presence of enablers within interviewed organisations, by group



Interestingly, these champions come from a number of different functional locations within the organisation. Some have a finance focused role, some are operational staff and others have an environmental or sustainability management role. In other words the champion does not have to come from a technical background; they just need a clear driver to fuel their enthusiasm. This might come from the desire to deliver financial or technical benefits through to improving environmental or carbon performance.

In Group C (organisations that have decided against gas CHP), 4 of the 10 interviewees feel that their organisation have a champion for gas CHP in place and 3 feel that they do not. Of these 4, 3 are owned by an international group and decisions are taken at the group level (See Appendix 2, results matrix 1).

Many interviewees identify the lack of a champion within the decision making structure of an organisation as a barrier to gas CHP being considered. Some call for better education of senior figures within organisations, such as through a targeted outreach campaign. This is especially so in the local authority sector where the lack of understanding about the benefits of gas CHP among elected Members and senior officials is seen as a significant barrier to future uptake of gas CHP by the sample of those interviewed.

In the vast majority of cases across all groups the initial drive for gas CHP is reported to come from middle ranking 'operations' focused individuals rather than being a 'top down' activity. However, there are a couple of notable exceptions. In 2 examples from industry, European parent companies with experience of gas CHP have pushed for installation in their UK sites, a direct contrast from the Group C experience discussed above. The small sample size in this study makes it impossible to draw any firm conclusions from this however.

For Group D (never considered gas CHP) there appears to be a lack of specific champions for gas CHP and where these are present they are at relatively low managerial levels within the organisation. For example the two Group D interviewees working for local authorities have local champions in place, but a lack of support from more senior managers means that even modest investments to assess the feasibility of gas CHP are not forthcoming.

The perspective of those interviewed from Group E (consultancy/ ESCO /utility group) who are on the outside looking in to organisations considering gas CHP, is that the final decision is almost always a financial one. There needs to be “operational fit” and balancing the operational and financial requirements for customers can be difficult. But in the end, CHP needs to make financial sense and get sign-off from the Finance Director.

The four local authority interviewees in these groups have social, environmental and carbon drivers in place. The decision making takes place at a local level and in three of the four cases, the organisations have internal champions. The main stumbling block for this group of interviewees is the lack of internal capacity and the lack of money to support detailed feasibility appraisal. The lack of internal capacity was reported to cover all aspects of gas CHP including engineering and financial assessments as well as the practical considerations associated with project development.

The role of government incentives in decision making

There is no evidence among those interviewed of specific government incentives influencing the decision to invest in gas CHP. The only possible exception to this is in those in Group A (currently have gas CHP) who are part of a Climate Change Agreement (CCA), where the availability of levy reduction for high quality gas CHP was reported to influence investment decisions.

Alternatives to gas CHP

An important element of this work is to identify those who have considered gas CHP and decided against it (Group C) as well as those who have not considered gas CHP for their organisation (Group D). For these cases, a key question is how these groups supply their heat and electricity demand and how decisions are made about the technologies used to provide these services.

Most interview respondents use a thermal only system and buy electricity from the grid. Although gas CHP is an established technology, for these interviewees the simplicity, ease and efficiency of gas boilers (including steam boilers) ensures that the organisations continue to use heat only systems. These technologies are often reported to be supported through consultants who help organisations to secure relatively low cost gas and electricity supplies.

For Group C and Group D organisations whose key focus is on the viability of their core business activities, retaining this technical set up is considered to be low risk and appropriate. In this small sample, energy is not enough of an issue to drive them to self-generation.

However, Group C and Group D also contains a subset of organisations for whom carbon is a key driver, and who have invested in smaller scale technologies such as photovoltaic systems or biomass heat specifically to address this concern. Some of those interviewed in Group C report an interest in biomass CHP. In all cases, the ability for gas CHP to provide a carbon benefit across a range of scales and operating situations is understood, although one interviewee did recognise that this differential will fall with increasing decarbonisation of grid electricity.

Awareness and understanding of Gas CHP

For Group D, the reported focus on core activities by those interviewed indicates a limited ability to invest in energy specific technologies, even where they might be technically and financially viable for their organisation. It is unclear how representative this finding is.

Figure 3 shows results from the online survey from Group D respondents about the reason they had not considered gas CHP. 78 people answered this question and they could pick as many options that described their reasons. The most prevalent response was ‘Just never considered it’, with 31 selecting this option. The next most prevalent option relates to concerns over capital costs followed by a lack of awareness of the technology and its benefits. These responses indicate the role to be played by improving the information available about the actual costs and benefits of this technology.

Figure 3 Group D responses to the question: ‘Why has your organisation never considered gas CHP in the past? (please select all that apply)’



Group E noted that many of their customers are now asking specifically for gas CHP and have already done an internal assessment of other options. In some cases (such as building developers) some customers of those interviewed had gone as far as to request a specific CHP unit. However, other cases reportedly show a lack of awareness. Analysis of Group E interviews show that client knowledge often correlates with the size of the unit being installed. With big systems there is more in-house understanding of gas CHP, but clients interested in smaller units need more ‘hand-holding’. While this appears to be logical, the small sample size makes it impossible to state if this is a representative outcome.

If correct, this finding has implications for the ambition to widen uptake of gas CHP and the level of 3rd party support this will require for smaller and more diverse organisations to adopt this technology. However, the ESCO interviewees viewed this as a market opportunity and discussed their knowledge and experience as a key service they could provide to clients.

Procurement and installation

Procuring gas CHP is considered by those interviewed as being a specialist process

Well-designed systems and trouble-free installations require experience and skill

Inexperienced in-house or advisor resources have led to operational problems in some cases.

The lack of in-house resources is a potential barrier to progressing viable gas CHP projects.

Sectors lacking appropriate engineering skills may face particular challenges

The responses to the online survey showed the range of options that respondents in Group A used to finance their gas CHP units (See Appendix 1, Group A responses). This survey question allowed multiple options to be selected, for instance where organisations have multiple gas CHP units which are financed in different ways.

The results showed that organisations combine financing options to procure their gas CHP units. 85 answered this question. Of these, 54 used internal funding and third party or loan finance was used in 21 cases. 11 respondents selected the 'other' option and 4 said they did not know how their system had been financed.

The survey responses from Group C (organisations that have considered and rejected gas CHP) show that financing was the main reason not to proceed with procurement (See Appendix 1, Group C responses). 34 respondents answered the question 'Why did you reject gas CHP as an option?' and 21 selected the response 'Not financially viable within your organisations investment criteria'.

The next main reason was selected by 14 respondents and relates to 'insufficient heat loads and/or lack of access to local heat markets'. Again respondents could select all reasons that were relevant.

There are three general procurement models used by those in Group A and B and that have been considered by those in Group C. These are:

- i. Purchase and ownership by the organisation. In this case the gas CHP unit may either be operated by the organisation or this can be contracted out.
- ii. Full ESCO/utility provision. In this case the gas CHP unit is bought, designed, installed and operated by an ESCO and the organisation buys power and or heat from the ESCO at agreed rates. The ESCO owns the unit.
- iii. Initial ESCO service with eventual asset transfer. In this case an ESCO designs, purchases and installs the gas CHP unit and the organisation subcontracts the unit's operation and maintenance from an ESCO under a capital purchase arrangement. The organisation then buys heat and power from the ESCO at agreed rates.

The experience of the procurement and installation process was different across all sectors.

Without exception all interviewees in Groups A to C have either employed a consultant to help with the procurement process, or have responded directly to a 'sales' offer by a provider.

Where responding to an offer, the process is essentially 'passive' with the decision being around whether to buy the offer or not. In all other cases, some more in-depth technical intervention is made by the host.

In general, the process is reported to have gone well by those interviewed, especially where the host has previous experience of gas CHP. In the small number of cases where the process has reportedly been less successful this is where the host or their advisor has underestimated the complexity of gas CHP systems and has used inexperienced in-house resources. One example is where a mechanical and electrical (M&E) contractor led the gas CHP installation. Another is from a Group A (gas CHP unit currently installed) organisation where a previous in-house design had failed, losing much money a decade or more ago. This was a major barrier to gaining approval for the current (successful) project which was designed and installed by a specialist.

While small in number, most respondents in Group B (had gas CHP, but was decommissioned) identify issues with their unit which could be traced back to some aspect of poor design. Of the 3 interviewees in Group B, 2 cite poor technical performance as the main reason for decommissioning and in the third case the plant had reached the end of its operational life. Also, a small number of Group A installations report operational issues relating specifically to a design or installation related problem.

There is only one instance of an interviewee raising concerns over an installation that had been managed by a specialist, with the interviewee considering that the units have been sized for electricity rather than for heat load. This has resulted in heat over capacity. However, all other interviewees describe more positive experiences with specialists successfully managing all aspects of the installation including compliance, infrastructure and contracts. Those in Group E also paint a positive picture and feel that the procurement and installation process is now largely trouble free.

A common theme in Group C (gas CHP considered but rejected) is the potential lack of in-house skills in order to progress a gas CHP opportunity into an operating project. This is especially so in the local authority sector, where it was raised by almost all interviewees. Many in this sector identify the loss of in-house engineering skills over recent years as a contributory factor.

Irrespective of sector, many of those interviewed from Group C identify that they also have concerns about their capacity to make a judgement on ESCO or other service based offerings.

Another common theme specific just to interviewees in the local authority sector is a view that they are also not well placed to identify which advisors/consultants to use to progress gas CHP opportunities. This issue was identified by almost all of those interviewed. Around half call for a pre-selection or vetting process to be put in place, such as the establishment of a 'buying solutions' type pool of potential contractors.

Looking specifically at the installation of gas CHP, the perspective from the small number of organisations from Group E is that this generally proceeds smoothly and this view is largely supported by the interviewees. However, some do cite delays in the process leading to potential operational issues. This is likely to be due to a lack of understanding on the host's part of the complexity of gas CHP and a resulting desire to press the installer for a quick process.

Operational Experience

Technical performance

Based on the findings from the online survey and interviews:

- Gas CHP performs technically as or better than expected in most cases
- Good system design is a requisite for good technical performance
- Good maintenance contracts are important for good operational experience

Table 5 shows the results from the online questionnaire to the question relating to the operational experiences of those with gas CHP (Group A). For the majority of respondents (59 out of 85) the gas CHP unit has performed technically as well as expected or better. 18 respondents identified that the unit is underperforming in comparison to expectations. 8 of the respondents are not sure how their unit is performing. This may be because the respondent does not hold a technical role within an organisation, or because the operation of the CHP unit is outsourced.

These findings are backed up by the outcomes of the interviews. Almost all of those in Group A report a good experience with the operation of their gas CHP, with the few exceptions being those mentioned previously where poor design or installation has led to some issues. One example here is the use of poor quality gas engines leading to frequent breakdowns and premature failure.

In Group B (had but decommissioned gas CHP), 2 of the 3 interviewees cite poor technical performance as the reason why they decommissioned their gas CHP. Poor initial design and installation are implicated as the cause of the problems encountered in both cases. The third unit in Group B simply reached the end of its operational life.

The initial on-line questionnaire supports this finding, with technical failure or poor performance dominating as reasons why gas CHP installations were decommissioned.

Table 5 – Group A operational experience with gas CHP

Has your gas CHP performed technically?	
Answer Options	Response Count
Better than expected	11
As expected	48
Worse than expected	18
Don't know	8
Number answering this question	85

A common theme among most interviewees is the need for high levels of maintenance when compared with gas boilers. One interviewee went as far as to say that it is important to buy the highest level of maintenance possible as, in his experience, this usually turns out to be the cheapest option in the long run. It is certainly the case that a few interviewees identify that in their experience low cost maintenance options lead to longer down time and that this in turn impacts on the financial performance of the system.

Another interviewee in Group A expresses concern with how ESCO operators appear not to have their best interests in mind, citing instances where a gas CHP installation was taken off line during a costly distribution use of system (DUoS) charge period for routine checks just because the engineer was passing. The same interviewee reports problems with the control system being set to have their gas boiler and not the CHP taking the lead on heat supply, leading to reduced operating hours and lower utilisation of the gas CHP unit. However, in general this seems to be an isolated example and not one shared across Group A. One interviewee from an ESCO commented on 'unrealistic expectations' on the part of their customers about the speed of service that they can provide.

The results from these interviews therefore tend to indicate that there are few operational technical barriers to the adoption of gas CHP providing that the correct steps are taken to design the system correctly using high quality components and that a good maintenance regime is put in place.

Financial performance

The financial performance of gas CHP is mixed.

Recently installed schemes tend to perform as predicted, but older systems may not.

Financial expectations vary across the sectors, especially between manufacturing and other sectors

Organisations with international ownership compete for investment on the world stage, with indications that they often require higher returns on investment

Local authority and other public sector organisations appear to have lower expectations of financial return and can include social and environmental benefits in their investment appraisal decisions

Table 6 shows the response to the pre-interview online survey question on the financial performance of gas CHP in Group A (have gas CHP). 53 of the 85 respondents report that the CHP unit has met or exceeded the expected financial performance, however 23 report the financial performance as being worse than expected.

Table 6 – Group A financial experience with gas CHP

Has your gas CHP performed financially?	
Answer Options	Response Count
Better than expected	9
As expected	44
Worse than expected	23
Don't know	9
Number answering this question	85

This is different to the findings from the interviews. Here, around half of interviewees in Group A report disappointment with the financial performance of their gas CHP. This may be down the nature of interviews that encourage more open discussion, or that more disgruntled people are likely to seek an interview to explain their concerns compared with those enjoying good financial performance from their gas CHP.

As stated in the previous section, in Group B the reasons for decommissioning gas CHP are dominated by technical issues. The interviews and initial on-line questionnaire indicated broadly similar levels of dissatisfaction with financial performance between Groups A and B. Based on this small sample, this tends to indicate that poor financial performance is not the cause of gas CHP decommissioning among those sampled.

From the interviews it appears that in all but one case, newer schemes (those installed in the last 5 years) deliver the predicted financial performance. It is the older schemes (those installed

10y or more ago) where financial performance appears to be an issue. These reportedly relate to either poor design (e.g. sizing against electrical not heat load) or where a larger differential between electricity and gas prices (the so called 'spark spread') in the past favoured larger scale electricity generation capacity.

Across the sectors, financial performance is viewed differently by those organisations interviewed. Sectors which are producing commodity products traded on the world market report that high energy prices in the UK relative to other manufacturing locations are problematic.

In addition, the Group A interviewees also consider that there has been a past lack of consistency in UK energy policy. 17 of the 30 interviewees organisations that currently have gas CHP (Group A) or have in the past considered installing gas CHP (Group C) identify policy shifts as a concern, as they create uncertainties in the market. These include all the interviewees from the chemicals sector, three of the five interviewees from the paper sector and one of the two interviewees from the food & drink sector. The most commonly cited issue was the removal of Levy Exemption Certificate (LEC) payments.

Combined, these factors are considered by interviewees to act as a barrier to inward investment in manufacturing in the UK. Some speculate that this may yet lead to some closure of manufacturing capacity in this country with major loss of jobs as a result, but no specific evidence to support this was offered.

In the manufacturing organisations interviewed, the required internal rate of return (IRR) from a gas CHP project is higher than in non-industrial sectors. For instance, two chemical sector interviewees who were prepared to discuss hurdle rates said that their organisations expected returns in the order of 25%, with the investment considered over a range anywhere from 5 to 15 years. This hurdle rate is reported to be relative to the returns that can be obtained by foreign owners from other investments across their portfolio and is not driven by gas CHP specific factors. One interviewee from a large, internationally owned food & drink company also raises the same issue about competition for investment driving up hurdle rates.

Those currently exporting heat to third parties outside of their organisation do not suggest that higher hurdle rates had been sought in the past to mitigate against potential loss of heat sales. However, one interviewee who has lost his heat market suggests that either this would have to be taken into consideration in association with any future investment into gas CHP, or a decision would be made to size the gas CHP to avoid the need for heat export.

In sectors such as local authorities and higher education, different approaches to financial investments are taken. For instance, one higher education organisation has a requirement for a 6% IRR. Others in this sector consider projects on a case by case basis, often as part of the development of a new building where the gas CHP system is included in the M&E costs rather than as a separate item. In this situation it appears to be usual for no separate investment appraisal to be undertaken for the gas CHP element. This means that, in practice, the organisation raises a lump sum as part of an infrastructure development programme to fund that development against a requirement to attract more students and/or research funds. This might comprise a mixture of loans, investment of available funds or sponsorship investment.

The local authorities interviewed also take a much wider view on the benefits of gas CHP. Of the 8 interviewees from this sector (2 each from groups A-D), 7 identify fuel poverty as a driver, with 5 emphasising this point as key (see Appendix 2, results matrix 2). The respondents recognise the value of gas CHP and district heating as a potential way to address the growing issues of fuel poverty. For instance, one interviewee who has a gas CHP explained that revenues from electricity sales are used to subsidise the heat provided in their social housing through their heat network. This means that, in many cases, the business case simply needs to

demonstrate a whole life benefit (rather than a cost) and this is not predicated on achieving a particular rate of return.

For these reasons almost all of the local authority sector interviewees feel that it is not possible for them to answer the financial questions posed by DECC in its quantitative questionnaire and many of the higher education organisations did not offer a return for the same reason.

Another, non-financial factor that was identified by interviewees as affecting investment decision making is the carbon benefits that can come from gas CHP. All of the local authority interviewees across Groups A-D identify carbon regimes and the need to reduce their carbon emissions as a key driver in decision making, with half of them emphasizing this point.

5 of the 6 interviewees from the higher education sector also emphasize the importance of carbon regimes, with the carbon performance driver linked to targets associated with grant or investment income. The one exception belonged to Group D, organisations who had never considered gas CHP.

Beyond the public sector, other interviewees also note the need to deliver good carbon performance. In particular the representatives of the chemicals industry and paper sector discussed this in interview.

Other identified areas were where the reputational benefits of good carbon performance impact on market share and thus business performance. This view is most commonly expressed by those interviewed from the higher education sector. One interviewee from this sector explained that, in his view, students are increasingly taking into consideration environmental issues when selecting Universities and that a good sustainability reputation could be driving energy investment criteria. A small number of interviewees from the food & drink sector also mentioned that carbon performance is of increasing importance in their markets.

The impact of electricity and heat sales

ESCOs or Utility Companies appear more likely to manage 3rd party heat and electricity sales compared to other ownership models.

All groups who have or are considering gas CHP report reluctance to sell energy to third parties

Reported reasons include:

- Energy generation not a core activity for the organisation
- Energy supply obligations could reduce the operational flexibility of the organisation
- Technical barriers around grid connections
- Poor perceived value of exported electricity.

The results from the pre-interview online survey indicate that 16 of the 90 respondents with gas CHP sell heat to someone else via a heat network. In the case of electricity, 10 sell directly to another customer and 31 to the grid. As this question allowed multiple answers, those selling to the grid may include some or all of those who also sell direct to private customers.

This pattern is not repeated among those interviewed in Group A where there is a higher instance of energy export. Of the 20 interviews undertaken, 10 export power and 7 also export heat, although of those selling heat 4 do so to serve internal markets and so may not necessarily be subjected to wider commercial market pressures.

The Group A interviews indicate that a high proportion of those interviewed 'over spill' power to the grid on either a regular basis or as part of a more ad hoc approach, for instance when their own process is not operating.

A large number of interviewees who are not serviced by an ESCO or utility company identify that energy generation is not their core business and that as a result, they consider that they lack the skills required to be commercial energy generators. Therefore, even where servicing energy markets has the potential to offer enhanced incomes; few are equipped to access these opportunities especially where a level of understanding of and response to a fluid energy market is required. As a result, contracting to supply energy from a gas CHP to anyone other than a simple arrangement to sell electricity back to the grid is often seen as a problem and not an opportunity by many.

Some interviewees across Groups A to C went as far as to say that they would not consider heat sale or electricity on a private wire basis as this will require them to provide certain guarantees on availability. This will mean that in effect, how they operate their business will become dictated by the energy sale which is a non-core activity. Such a reduction in operational flexibility is therefore seen as a major barrier to heat sales.

Other barriers identified by interviewees are the cost of getting a suitable connection from the distribution network operator (DNO) to support electricity export and the cost of installing heat distribution pipework. In the circumstances of the interviewee's projects both of these were regarded as real financial barriers to export.

It is also noted by many that the value of electricity at night in the market is low, which impacts on the income potential.

Some of the older (10y or more), larger gas CHP schemes operated by large manufacturing organisations are sized specifically to service other local customers. In one instance the prices charged for steam and electricity have dropped below the market price, lowering the revenue level. Here, the interviewee expressed concern that raising the price to this customer might put them out of business. This would further reduce the income generated from the gas CHP plant, making it less viable to operate. In another case, all of the major heat users around the gas CHP plant in question have closed. This has severely impacted on the viability of the gas CHP scheme. These examples provide confirmation of the worries stated in other interviews about becoming dependant on energy (especially heat) sales. In the future this is likely to mean that gas CHP is sized only to meet local heat demand, even if that means increased use of grid supplied electricity as a result.

Members of Group E said, for the most part, that units are now sized to on-site need, usually for heat. Sales of heat and electricity were therefore limited. One utility said that they manage customers' electricity exports as part of the utility's overall electricity trading portfolio, but that in the main, external sales were limited or non-existent. Issues with getting DNO agreement for a connection to allow electricity export were mentioned by one interviewee in this group.

Future plans for gas CHP

The results from the interview process indicate that large, embedded, process driven gas CHP may have a less certain future compared with other embedded electricity generating technologies.

While gas CHP has become the technology of choice to embed into large building development or refurbishment, growth of this application of the technology is linked to the rate of new building development or major refurbishment activities.

Almost every interviewee who has or is considering gas CHP expressed enthusiasm for the technology. However, despite this, responses to questions about future plans for gas CHP are mixed. Of those currently using gas CHP the initial online questionnaire indicated that about a quarter (21 out of 83 respondents) are considering decommissioning their gas CHP (see Appendix 1, Group A responses). This topic was followed up in the interviews.

In Group A, 2 organisations interviewed are considering decommissioning their gas CHP. Both are large scale manufacturers of non-food commodity products with large gas CHP plant that have been installed for 10 years or more. Under these circumstances the gas CHP was an integral part of a manufacturing process and the economic performance of the gas CHP impacts on the overall viability of the plant. This is affecting the decision to replace old plant with new gas CHP units. In one situation the economic case to invest in CHP had been made 30 years previously, but the same decision would not be taken again, given the short (sub 2 year) payback requirements and current investment priorities of the company.

The viability of some sites is being threatened because the gas CHP is costing money (relative to using boilers for steam raising and buying electricity from the grid). Another interviewee explained that the viability of the gas CHP is the major determinant of the viability of the factory and at that moment they were making a loss. In situations like these where the gas CHP is core to the business it can be hard to determine the real reason why decommissioning is being considered. Is it that the world market price for the product being produced is too low to justify that site being maintained, or is it that it is the cost of energy which is making the cost of the product too high? Either way, one of the few options open to the owners of sites in these situations is to try and drive down energy costs if it is to remain open.

As a result, the future plans for sites in this situation revolve around increasing the economic viability of the existing gas CHP plant, for instance by reconfiguring the gas CHP around a smaller turbine in an attempt to increase the cost effectiveness of the system. One interviewee is seeking regional investment funds for this purpose on the basis of job retention in the area. Interestingly, in this situation other approaches such as investment in increased energy efficiency will have the effect of making the problem worse as it will result in more excess energy having to be exported, which is currently a loss-making exercise.

Outside of this specific set of organisations considering decommissioning, all other Group A interviewees are generally positive about their gas CHP and plan to retain and where possible to expand the number of systems in operation. These tend to be smaller systems that do not export heat or power outside of the organisation. Applications such as trigeneration are also seen as positive applications for gas CHP with some interviewees in the retail & warehouse sector predicting good uptake of this technology in the future.

In the health and higher education sectors, interviewees confirm that it is now common practice in their sector for any building expansion, rebuild or refurbishment activity to include consideration of gas CHP as an integral part of the new M&E systems in the building. While this is positive, interviewees confirm that this makes uptake of gas CHP for this application opportunistic as it is mainly linked to new building and refurbishment activities. Retrofit was discussed, but was seen as an unrealistic option without major refit of the entire building and its control systems. However, this does remain a potential area for development, especially at times when boiler replacement is being considered.

Local authority interviewees all look positively on gas CHP and many have planning policy guidance that encourages district heating and CHP. Gas CHP is the obvious candidate especially in areas where air quality is seen as an issue preventing alternative fuels such as biomass. Here the barrier to uptake most commonly reported is a lack of internal technical capability and resources to develop projects and a lack of visibility of who best to advise them. Almost all local authority interviewees describe low levels of technical and engineering knowledge as an area of concern. This capacity gap is reported to be wide and to include all of the required engineering and financial analysis skills required for a gas CHP project. Some also identify a lack of skills to support the procurement process and to oversee the ongoing operation of the scheme.

Those organisations that have decided against gas CHP (Group C) were asked about the factors that would lead them to reconsider this option (See Appendix 1, Group C responses). In the online survey 34 people answered the question 'What would cause you to reconsider gas CHP in the future?' and 22 selected the option 'Government policy incentive makes gas CHP an attractive commercial option'. 12 selected 'Market opportunity' (e.g., heat network developing locally). Company growth and increased internal technical capacity to support gas CHP projects both received 6 responses. As respondents were able to select all factors considered relevant, these results therefore demonstrate the relative interest in the range of factors that might influence uptake. These include incentive schemes specifically promoting gas CHP generating capacity, public or private sector development of heat markets and network infrastructure, or changes to an organisation's size and operations.

Those spoken to from Group E are generally positive about the future of gas CHP, as might be expected. They also identify the potential for policy to be a key driver and see regulatory uncertainty as a barrier.

Market drivers and inertia

There is an opportunity to use brand and market based pressures to overcome inertia and to bring forward investment in gas CHP or to use legislation to achieve the same effect

Achieving the uptake of gas CHP assumes that the potential host organisation has the opportunity, appetite, capacity and active processes in place to first identify the benefits of gas CHP and then take up this technology. The interviews have shown that even where these are in place there are instances where inertia is preventing the development process for gas CHP from even starting. It is unclear how representative this finding is.

Before the recession, market pressures to stimulate investment in low carbon technology were beginning to be seen across a number of supply chains (especially in the food & drink sector). Of the interviews undertaken, 3 members of this sector feel that these pressures to reduce carbon emissions have not returned while 1 stated that they were under pressure to look at reducing emissions and for this reason were considering gas CHP. One member of the retail & warehousing sector has also invested in gas CHP as a direct consequence of the perceived need for them to reduce carbon emissions.

In many Group C interviews (those who have considered and rejected Gas CHP) the interviewees explained that given the pressures of work, they are unlikely to raise consideration of gas CHP up their agenda until 'they had to'. This is echoed to some extent in Group D (never considered gas CHP). In other words, the priority is their core business giving little spare capacity for other activities. The clear indication is that an external pressure, such as legislation or client pressure is needed to bring gas CHP onto the agenda. This has already been the case in many parts of the food & drink sector, where Group A interviewees cited the Climate Change Agreement (CCA) as a driver for their decision to invest in gas CHP.

The role of government in the future development of gas CHP

Those sectors with a long tradition of operating gas CHP appear to need the government to indicate continued support for gas CHP and to make policy decisions on which long-term investment decisions could be made.

Emerging sectors need for government to provide more 'outreach' services to educate decision makers and then to support the process of gas CHP implementation. In these sectors, there is also a call for grant and other financial support activity to overcome inertia and to bring forward projects

Common themes shared across the sectors and groups are:

- The need for 'joined up' government. Interviewees discussed the complex range of legislation, regulations and incentive schemes that were associated with the installation and operation of gas CHP units. This included a mix of current (e.g. EU ETS, CCL) and old policies such as LEC's. Many cited the introduction of fiscal measures in one area which have unintended consequences requiring re-balance often through a separate scheme. The result being two separate processes that required servicing. A general view is that a lot of management time is spent chasing only modest tax and other benefits, but no specific instances were cited.
- More transparency in the energy market. The majority of interviewees have little in-depth understanding of the energy market, but those who have tried to understand it reported issues with transparency and a lack of real support from energy providers. One interviewee commented that commodity trading in gas keeps prices high and that they would welcome government regulations restricting the ability to buy gas to those who consume it.
- Better access to connections. Limitations in gas supply or electricity grid connections are seen by some as a barrier to gas CHP expansion, with connection costs seen as prohibitive in some instances. This mainly where application to put more generation onto the local network triggered the need for upgrade of local network infrastructure, the cost of which would have to be borne by the generator. Respondents described antagonistic relationships with DNO's and felt that connections were costly and slow to obtain.

Comments specifically from Group A were that:

- Older CHP systems have benefitted in the past from Levy Exemption Certificates (LEC's) and the financial impact of losing this income is significant.
- Questions were raised as to why carbon and other reporting had to be so onerous. For example, one interviewee cited the requirement for figures on returns to be quoted to multiple decimal places which is far beyond the accuracy with which meters work and emission factors are calculated.

While there was also a general disquiet with the complexity of Government support regimes, no one scheme was consistently singled out by interviewees. This may therefore indicate a general concern about the inherent complexity of Government support mechanisms rather than relating to gas CHP *per se*.

The only other comments were from the local authority sector, which crossed a number of areas:

- Education. Uptake of Gas CHP could be helped if senior management and Elected Members have a clearer understanding of its benefits. In particular the non-energy social benefits from energy supply against growing fuel poverty are not felt to be recognised at more senior levels.
- Direct funding support. Many interviewees identify that budgets for feasibility studies are not readily available, especially for complex studies such as those required for

gas CHP where a major focus is on delivering social and other people based benefits.

- Specialist support. With the demise of the old 'Council Engineer' role, many local authority interviewees expressed lack of confidence in selecting gas CHP consultants or suppliers. As a result, many interviewees feel that they are unable to make informed decisions about the capability of potential consultants and/or service providers and called for some pre-endorsement process leading to an identified pool of providers. An idea expressed by some interviewees is for some kind of pre-vetting process, possibly by establishing an (OJEU compliant) 'buying solution' type framework to procure services from
- Grant or similar funding. The availability of grants can provide a real stimulus for a project that is out of proportion to the size of the grant. Many interviewees cited the work of the Heat Networks Delivery Unit (HNDU) as evidence of the enthusiasm that can be generated.

Role of Trade Associations

In general, Trade Associations are considered as doing a good job in making representations to government about key issues with gas CHP. In some sectors, sharing of case studies and good practice is also occurring, but the coverage is not universal. For instance, larger local authorities and higher education establishments both are reported as having good networks, but smaller members of these sectors are not always included.

It was identified by some interviewees that, by their very sector-specific nature, Trade Associations may not be the best route to sharing of best practice and that there is still a role for government to drive this activity through workshops, case studies and an promotion/ outreach activities.

This is considered important as it helps with the internal education process. Being able to demonstrate where gas CHP is being successfully deployed and the approach used to achieve that outcome is seen as a means to reduce barriers to uptake.

Anomalies in the barriers to uptake of gas CHP

By reviewing the results obtained it is possible to look for any evidence of different barriers to the uptake of gas CHP where schemes might reasonably be expected to be cost effective (generally those supplying on-site energy demand) against other situations such as when gas CHP is sized to supply large industrial heat demands and are exporting a significant proportion of power to the grid.

The small sample size of those in each of these categories in Group A prevents any definitive results in this area. However, what is clear is that the evidence of those who have gas CHP and are servicing just their own energy demand is that these organisations report good financial and technical performance. Those that export large amounts of power report a less favourable picture. This finding must be viewed with caution as it is also the case that those in the latter group tend to be older units making it unclear if this is also a factor.

Any question about barriers to uptake must also be addressed to Group C (those that considered, but rejected, gas CHP). Here, none of those questioned has considered investment in gas CHP predicated on large energy exports. At the same time, the interview process could not confirm the nature and extent of the interviewees own energy demand and so it is not possible to identify if any of these might reasonably expect to be cost effective.

As a result, it is not possible to find evidence for different barriers to the uptake of gas CHP between situations where it might be expected to be cost effective, due to own use of all of the energy produced, and where it might be expected not to be cost effective due to a significant proportion of power generated being exported power.

4. Conclusions

The results above allow a number of conclusions about the type and relative significance of barriers and drivers influencing gas CHP uptake to be drawn. The key barriers are discussed in order of perceived importance according to the analysis of the interview material. The drivers that offer the potential to mitigate these barriers are also discussed.

Competing access to capital

The competition for investment capital appears to be a major barrier for gas CHP uptake amongst some organisations that could be running plant at its most optimum. Those reporting this problem fall into two main groups.

The first of these are organisations producing high-volume products traded internationally where the market value for their products is set by the producer with the lowest cost of production. In the UK, many of the organisations interviewed are now part of the large international businesses that have been formed in response to these market pressures.

Interviews indicate that in these organisations competition for capital happens for two main reasons:

- All major investment is commonly evaluated at the international scale
- As a result, investment in gas CHP in the UK must compete with other investment opportunities at the international scale, with the investment giving the best return winning the competition for capital.

This means that even for energy intensive sectors like manufacturing that find themselves in this situation, prioritising investment in gas CHP can be hard because of the reported attractiveness of investments abroad. For this reason, some companies currently using gas CHP may very well not replace their units at end of their life. It is important to recognise that this might not be as a result of poor economic performance of gas CHP in the UK context, but as a result of higher returns that can be obtained from investments elsewhere in the organisation. In these conditions, perceptions around UK energy policy are reported as another barrier to investment in the UK.

The second group where interviews suggest that competition for capital is an issue is in less energy intensive sectors such as retail & warehousing and some areas of the food & drink sector. Here, investment in gas CHP appears to compete with other operational or process related investment decisions including investment into energy efficiency. This competition is more usually at the national level and the issue is the relative attractiveness of a gas CHP opportunity to investment in another part of the operation or production process.

This creates a complex dynamic. While energy intensive manufacturing has clear incentives to invest in gas CHP to keep energy and thus production costs down, it is the relative economic performance of this investment relative to the return from other international investments which appear to be the barrier.

In situations where the organisation is less energy intensive, investment in gas CHP is not an imperative leading to competition for capital from other areas such as in production or core activities. This is because while energy costs are still important in this situation, they are not as critical as in the high energy demanding manufacturing processes making purchase of grid supplied energy still an attractive option.

Working against this barrier are corporate social responsibility (CSR) and environmental standards which have started to reappear in the retail and other sectors as a driver for less carbon intense production processes. These have the potential to raise the relative importance of gas CHP (especially in the less energy intensive sectors) and reduce the required hurdle rate where better carbon performance has the potential to increase brand strength and thus market share.

Energy generation is a non-core activity

A second major barrier which appears to be strong in the less energy intensive sectors is the concern that energy generation is not a core activity. While this can be overcome by contracting out the operation, nevertheless it is seen as a diversion away from the fundamental business activity and as a result a risk. This is because the energy market and the potential benefits it can offer may not generally be well understood.

This problem appears particularly acute if off-site energy (especially heat) sales are involved to balance demand. Here the risk of taking on energy generating obligations was seen as one which reduced operational flexibility in the core business and introduced commercial risk. The need to identify and approach potential customers for heat is similarly not seen to be an activity that many wish to engage in, especially when it is linked to the contractual concerns associated with heat supply identified above.

Low prices for the electricity from gas CHP adds to this barrier and in some cases, the lack of an adequate grid connection is also reported as being an issue for electricity export.

Lack of technical support

A perceived need for greater technical capacity and support is a barrier that particularly affects local authorities. This sector has strong social, environmental and carbon drivers which create significant opportunities for the adoption of gas CHP. It also appears to have the lowest expectations in terms of financial returns and (based on the interview feedback) a large potential for uptake either in association with district heating or with large buildings in their ownership. The local authority sector also appears to be taking the lead in activities to involve other large heat users to collaborate to extend the heat network to a city/town centre scale and increase the size of gas CHP installations as a result.

All interviewees from the local authority sector expressed high levels of interest in and support for gas CHP. Given the strong drivers in this sector, the lack of technical support is thought to have become a disproportionately large barrier to uptake. Here, the need appears to be either for access to funding in order to procure suitable (preferably pre-vetted) technical support, or for this support to be made available on a no-cost basis.

Fear of the unknown

Low levels of understanding about gas CHP technology appear to be inhibiting the uptake of the technology and this is particularly significant for Groups C and D. Interviewees expressed concern about their organisations' ability to make decisions about gas CHP which included undertaking proper due diligence on ESCO or utility offerings.

The majority of interviewees in Groups A, B and C had used consultants to overcome this barrier and most were satisfied with the services they had commissioned, however some report less positive experiences. As a result scepticism towards this community still exists among some interviewees.

The view of the consultant/ESCO/utility community is that in general potential customers are better informed and that barriers around lack of client engagement may be reducing as a result.

Overall there are a number of factors working to reduce this 'fear of the unknown' barrier, including through the work of sector specific trade associations and knowledge sharing communities.

Lack of opportunity

In some sectors interviews suggest that gas CHP is the application of choice to provide the heat to a large building or small complex. Here, gas CHP is not considered in isolation but is designed and costed as part of the overall design and build package. However, these situations occur sporadically and the future development of gas CHP for this application is more likely to be opportunistic than strategic. While retrofit is a technical option, often it requires major reconfiguration of heating and control systems making it financially and technically unattractive unless part of a major refurbishment activity.

Interviews with Group C raise a similar theme; that investment decisions are most often tied to boiler plant replacement cycles and early replacement will require significant incentives. There are two factors here. The first is that including the avoided cost of boiler replacement in the business case for investment into gas CHP appears to be important to make the gas CHP opportunity financially attractive. The second is that in most organisations in Groups C and D, there are few triggers that will lead to the consideration of gas CHP until boiler replacement is due.

There would need to be another reason brought into play in order to stimulate consideration of early boiler replacement with gas CHP. The same argument is likely to apply to stimulate retrofit into building specific applications.

CHP specific issues

Those interviewees considering gas CHP have identified that gas CHP has to become a core element of the process or location that it is serving. It must become embedded within the process that it feeds. As a result, it places the highest technical and commercial demands on the technology owner of any decentralised power generating scheme, with possibly only biomass or waste based schemes requiring more input and resources.

This makes gas CHP different from almost any other energy generating technology

Even where the technology is third party supplied and operated, the process or heat load that it serves must be properly managed in order to maximise the benefits of the technology. This requires the expenditure of more operational management time and also can reduce the flexibility of the operation. As noted previously, this is perceived to make gas CHP the dominant factor over and above the core business, which is often unacceptable to the potential host. However, those currently exporting heat to third parties outside of their organisation do not

suggest that higher hurdle rates had been sought in the past to mitigate against potential loss of heat sales.

This range of factors represents a barrier to uptake of gas CHP compared with the operation of gas boilers and the purchase of grid electricity. However, there is evidence of areas of high potential uptake such as by local authorities, or as retrofit in major buildings, but these may be outside of the traditional gas CHP market. As a result, they may require new approaches to bring them forward that are tailored around specific need.

Appendix 1 – Results from the initial online questionnaire

The full questions comprising the initial online questionnaire are reproduced in Appendix 6.

Sector breakdown

Which sector are you in? (tick one)	
Answer Options	Response Count
Chemicals	32
Paper	11
Food and drink manufacture	120
Oil & Gas	2
Retail & warehousing	3
Health	6
Higher Education	19
Local Authority	40
Other	25
<i>answered question</i>	258

Split of responses by of size of energy use

Is your company a (tick one):	
Answer Options	Response Count
Large energy user (spending more than £2.5m/y on energy)	112
Medium energy user (spending between £0.3 and £2.5m/y on energy)	95
Small energy user (spending less than £0.3m/y on energy)	38
<i>answered question</i>	245

Breakdown by use of gas CHP

Is your company currently using or installing gas CHP?	
Answer Options	Response Count
Yes	98
No	143
<i>answered question</i>	241

Group A Responses

How many gas CHP systems do you have installed?	
Answer Options	Response Count
One	43
2 to 10	41
More than 10	7
Don't know	5
<i>answered question</i>	96

When did you install your gas CHP? (please tick one)	
Answer Options	Response Count
Currently being installed	4
Within the last 12 months	7
In last 1 to 5 years	30
Over 5 but less than 10 years ago	12
Over 10 years ago	32
Don't know	6
<i>answered question</i>	91

What size is your CHP? (please tick one)	
Answer Options	Response Count
Large (over 25 MWe)	13
Medium (over 2 MWe and up to 25 MWe)	39
Small (2 MWe or less)	32
Don't know	7
<i>answered question</i>	91

How do you currently use heat from your gas CHP? (please tick all that apply)	
Answer Options	Response Count
For own use (process, hot water or space heating)	85
Sell to another customer	6
Sell via heat network to more than one customer	10
Don't know	1
<i>answered question</i>	90

How do you currently use electricity from your gas CHP? (please tick all that apply)

Answer Options	Response Count
For own use (displacing grid electricity, or for isolated operation)	83
Sell to another customer (e.g. via a private wire network)	10
Sell to the grid	31
Don't know	1
<i>answered question</i>	90

What is the main reason that you chose to install gas CHP? (please select one main reason)

Answer Options	Response Count
It offered good financial performance relative to other investment options	58
It offered technical improvements in operations	9
Other	15
Don't know	6
<i>answered question</i>	88

How did you make your decision? (please tick all that apply)

Answer Options	Response Count
As a result of an internally led process that identified the benefits of gas CHP	61
In response to a consultant or other recommendation to install gas CHP	19
In response to a government initiative or incentive scheme that made it attractive to install gas CHP	13
Don't know	9
<i>answered question</i>	85

How did you finance the CHP? (please select all that apply)

Answer Options	Response Count
Own internal funding	54
Own Debt finance	6
Third party finance	15
Other, please specify	11
Don't know	4
<i>answered question</i>	85

Has your gas CHP performed technically? (please select one main reason)

Answer Options	Response Count
Better than expected	11
As expected	48
Worse than expected	18
Don't know	8
<i>answered question</i>	85

Has your gas CHP performed financially? (please select one main reason)

Answer Options	Response Count
Better than expected	9
As expected	44
Worse than expected	23
Don't know	9
<i>answered question</i>	85

Are you considering decommissioning your gas CHP?

Answer Options	Response Count
Yes	21
No	56
Don't know	6
<i>answered question</i>	83

Are you looking for more gas CHP opportunities in your organisation?

Answer Options	Response Count
Yes	63
No	13
Don't know	7
<i>answered question</i>	83

Group B Responses

Have you had gas CHP in the past but it is no longer operational?

Answer Options	Response Count
Yes	12
No	131
<i>answered question</i>	143

What is the main reason why you originally chose to install gas CHP? (please select one main reason)

Answer Options	Response Count
It offered good financial performance relative to other investment options	5
It offered technical improvements in operations	2
Other	1
Don't know	2
<i>answered question</i>	10

How did you make your original decision? (please select all that apply)

Answer Options	Response Count
As a result of an internally led process that identified the benefits of gas CHP	5
In response to a consultant or other recommendation to install gas CHP	2
In response to a government initiative or incentive scheme that made it attractive to install gas CHP	0
Don't know	4
<i>answered question</i>	10

What size was your CHP? (please select one option)

Answer Options	Response Count
Large (over 25 MWe)	1
Medium (over 2 MWe and up to 25 MWe)	1
Small (2 MWe or less)	3
Don't know	5
<i>answered question</i>	10

How did you use heat from your gas CHP? (please tick all that apply)

Answer Options	Response Count
For own use (process, hot water or space heating)	9
Sell to another customer	1
Sell via heat network to more than one customer	1
Don't know	1
<i>answered question</i>	10

How did you use electricity from your gas CHP? (please tick all that apply)

Answer Options	Response Count
For own use (displacing grid electricity, or for isolated operation)	8
Sell to another customer (e.g. via a private wire network)	1
Sell to the grid	1
Don't know	2
<i>answered question</i>	10

Did your gas CHP perform technically? (please select one main reason)

Answer Options	Response Count
Better than expected	0
As expected	2
Worse than expected	4
Don't know	4
<i>answered question</i>	10

Did your gas CHP perform financially? (please select one main reason)

Answer Options	Response Count
Better than expected	0
As expected	3
Worse than expected	3
Don't know	4
<i>answered question</i>	10

What made you decide to decommission it (select all that apply)

Answer Options	Response Count
Worse financial performance than expected	2
Worse technical performance than expected or other technical problem	3
Lack of internal resources to operate the plant	1
Equipment failure	3
Contractual issues (e.g. with heat sales, leasing issues, etc.)	0
Reached end of operating life and not replaced	3
Other	3
Don't know	2
<i>answered question</i>	10

Would you consider using gas CHP again?

Answer Options	Response Count
Yes	9
No	1
Don't know	0
<i>answered question</i>	10

Group C Responses

Has your organisation considered gas CHP, but decided against it?	
Answer Options	Response Count
Yes	39
No	89
<i>answered question</i>	128

When did you last appraise the option of gas CHP for your organisation?	
Answer Options	Response Count
Within the last 12 months	13
In last 1 to 5 years	18
Over 5 but less than 10 years ago	3
Over 10 years ago	3
Don't know	2
<i>answered question</i>	39

Why did you reject gas CHP as an option? (please select all that apply)	
Answer Options	Response Count
Not on the gas grid	2
Lack of space/other locational or site issues including noise, visual impact, etc.	7
Insufficient technical capability to operate the plant	2
Insufficient heat load/no access to local heat markets	14
Electricity grid/other connection issues	2
Short lease/facility ownership/business continuity issues	4
Not financially viable within your organisations investment criteria	21
Financially viable but other investment priorities	2
Other	9
Don't know	0
<i>answered question</i>	34

**What would cause you to you reconsider gas CHP in the future?
(please select all that apply)**

Answer Options	Response Count
Company growth	6
Increased internal technical capacity to support a gas CHP project	6
Capacity to invest improves	4
Government policy incentive makes gas CHP an attractive commercial option	22
Market opportunity (e.g., heat network developing locally)	12
Other	6
Don't know	3
<i>answered question</i>	34

Group D Responses

Why has your organisation never considered gas CHP in the past? (please select all that apply)	
Answer Options	Response Count
Just never considered gas CHP as an option	31
Gas not available	9
Lack of understanding of gas CHP technology/no information on the benefits of gas CHP	17
Lack of internal technical capacity required to consider gas CHP as an option	8
Poor heat demand/no local heat market.	15
Lack of confidence in gas CHP	1
Lack of local gas CHP system suppliers/advisors	0
Worries over high capital costs	19
Worries over high operating cost	7
Worries over reliability/operational issues	5
Long term concerns over continued economic viability	7
Lack of money to invest	11
Other investment priorities	12
No space/short tenancy/other site limitations	8
Other environmental concerns (e.g. noise, visual intrusion, etc.)	3
Other	4
Don't know	6
<i>answered question</i>	78

Appendix 2 – Qualitative results matrices

Matrix 1: Descriptive characteristics of organisations interviewed

	CHP Group	Sector									Energy demand profile			Energy Export		Technical feasibility of CHP		Structure of organisation			Decision making process			Capacity of organisation		Presence of enablers			Age of gas CHP				
		Food & Drink	Paper	Retail & Warehousing	Local Authority	Higher Education	Health	Oil & Gas	Chemicals	Other	low	medium	high	Heat	Power	Feasible	Not feasible	single site	multiple site	Multinational	Local (at site of gas CHP)	National (at a UK Group level)	International (international Group level)	Internally drives consideration of options like gas CHP	Can only respond to external offers	Champions in place	Driven by others (eg. trade association)	No champions	Installed (yr)	Decommissioned (yr)			
1	A	1									1		1	1	1			1	1				1							89,07			
2	A	1									1				1			1		1			1								10		
3	A		1								1		1	1	1			1			1		1								95		
4	A		1								1				1			1		1			1								10		
5	A			1							1				1			1		1			1								08		
6	A			1							1			1	1			1		1			1								09		
7	A				1						1		1	1	1			1		1			1								06		
8	A				1						1		1	1				1		1			1								90s		
9	A				1						1							1		1			1								08		
10	A				1						1		1	1				1		1			1								80s		
11	A				1						1							1		1			1								12		
12	A				1						1		1	1				1		1			1								00		
13	A					1					1							1		1			1								12		
14	A					1					1		1	1				1		1			1								90		
15	A					1					1							1		1			1								96		
16	A						1				1		1	1				1			1		1								90s		
17	A						1				1							1			1		1								80s		
18	A						1				1		1	1				1		1			1								11		
19	A							1			1							1		1			1									00	
20	A							1			1							1		1			1									00	
Total		20	2	2	2	2	4	3	0	3	2	1	2	17	6	10	14	0	8	8	4	12	5	3	17	2	16	3	1				
21	B				1													1				1									90s		
22	B				1													1				1									80s	09	
23	B										1							1		1			1								80s	14	
Total		3	0	0	0	2	0	0	0	1	0	0	0	1	0	0	3	0	1	1	1	2	0	1	3	0	2	0	1				
24	C	1									1							1				1									1		
25	C	1									1							1				1									1		
26	C		1								1							1		1			1								1		
27	C		1								1							1				1									1		
28	C		1								1							1				1									1		
29	C			1							1							1				1									1		
30	C				1						1							1				1									1		
31	C				1						1		1	1				1				1									90s		
32	C					1					1							1				1									1		
33	C										1							1				1									1		
Total		10	2	3	1	2	0	0	0	1	0	1	2	7	1	1	6	2	1	2	6	3	0	7	9	1	3	3	4				
											10				10				8			9			10			10			10		
34	D	1									1							1				1									1		
35	D	1									1							1				1									1		
36	D	1									1							1				1									1		
37	D	1									1							1				1									1		
38	D	1									1							1				1									1		
39	D			1							1							1				1									1		
40	D				1						1							1				1									1		
41	D				1						1							1				1									1		
42	D					1					1							1				1									1		
Total		9	5	0	1	2	1	0	0	0	0	4	2	3	0	0	6	3	4	5	0	7	1	1	6	3	5	0	4				
											9				9						9			9			9				9		
Totals		9	5	4	8	5	3	1	5	2	6	6	28	7	11	29	5	14	16	11	24	6	12	35	6	26	6	10					
											42				40						41			42			41			42			

Matrix 2: Relative weighting of drivers and concerns expressed by interviewees

		Sector										Importance of financial performance		Drivers							Key concerns raised									
		CHP Group	Food & Drink	Paper	Retail & Warehousing	Local Authority	Higher Education	Health	Oil & Gas	Chemicals	Other	Dominant (no other consideration)	Reduced by other considerations	Environmental	Carbon regimes	Commercial/ financial	CSR landscape	Energy security/ resilience	Social/ fuel poverty	Energy costs impacts on price on service/ product	DNO (Process / bureaucracy)	policy shifts	Intermediaries (expert advice/ suppliers / contractors)	Grid connections (eg gas su2ly)	Competing demands on capital investment	Lack of suitable heat sink	Perverse incentives from legislation/ complexity and number of regulatory issues	Spark spread	Lack of internal capacity	
1	A		✓									✓							✓		✓									
2	A		✓								✓			✓								✓								
3	A			✓							✓		✓	✓					✓		✓				✓		✓			
4	A		✓								✓			✓			✓		✓						✓		✓			
5	A			✓							✓			✓	✓								✓							
6	A			✓							✓			✓			✓		✓			✓								
7	A				✓						✓		✓	✓				✓		✓		✓								
8	A				✓						✓		✓	✓			✓	✓			✓					✓			✓	
9	A					✓					✓		✓	✓		✓			✓		✓									
10	A					✓					✓		✓	✓		✓			✓		✓					✓		✓		
11	A					✓					✓		✓	✓		✓			✓		✓					✓		✓		
12	A					✓					✓		✓	✓		✓			✓			✓				✓		✓		
13	A					✓					✓			✓											✓					
14	A					✓					✓			✓			✓		✓						✓					
15	A					✓					✓			✓			✓		✓		✓		✓							
16	A						✓				✓			✓			✓		✓		✓				✓		✓		✓	
17	A						✓				✓			✓			✓		✓		✓				✓		✓		✓	
18	A						✓				✓			✓			✓		✓		✓				✓		✓		✓	
19	A						✓				✓			✓			✓		✓		✓				✓		✓		✓	
20	A						✓				✓		✓	✓		✓		✓		✓		✓		✓						
21	B				✓						✓		✓	✓						✓					✓					
22	B				✓						✓		✓	✓		✓		✓			✓				✓		✓			
23	B						✓				✓		✓	✓		✓		✓		✓		✓			✓			✓	✓	
24	C	✓									✓			✓					✓		✓				✓					
25	C	✓									✓		✓	✓	✓				✓		✓		✓		✓					
26	C		✓								✓			✓					✓						✓					
27	C		✓								✓		✓	✓		✓			✓		✓				✓		✓			
28	C		✓								✓			✓					✓		✓				✓					
29	C			✓							✓			✓					✓						✓					
30	C				✓						✓		✓	✓				✓										✓	✓	
31	C				✓						✓		✓	✓				✓		✓								✓	✓	
32	C					✓					✓			✓				✓		✓										
33	C						✓				✓			✓				✓		✓					✓		✓		✓	
34	D	✓									✓			✓					✓			✓			✓					
35	D	✓									✓			✓					✓			✓			✓					
36	D	✓									✓			✓					✓			✓			✓					
37	D	✓									✓			✓					✓			✓			✓					
38	D	✓									✓			✓					✓			✓			✓				✓	
39	D			✓							✓														✓					
40	D				✓						✓		✓	✓					✓									✓	✓	
41	D				✓						✓		✓	✓					✓									✓	✓	
42	D				✓						✓			✓					✓		✓			✓		✓		✓	✓	

Appendix 3 – Results from the quantitative post interview questionnaire

The Table below shows the results of the post interview quantitative questionnaire. The questionnaires were different for each group and are shown in Appendix 5.

Just less than 40% of interviewees responded, but of these 4 responses declined to provide information. These were all because the questionnaire was thought to bear no resemblance to how the organisation undertook financial appraisals and so the respondent felt unable to complete it.

For example, the approach to financial appraisal in the Local Authority sector is often based on the overall merits of the scheme relative to local need and council policy. Under these circumstances it is common for no particular hurdle rate or investment period to be considered.

Financial assessment methodology

Of those who responded, there is a spread of financial assessment techniques used, with these spread across groups and sectors.

Assessment periods

6 respondents provided data on the length of assessment period used. The longest of these was 15y (quoted by 2 respondents) with one respondent quoting 10y, 2 quoting 5y and one quoting less than 2y.

Hurdle rates

7 respondents provided information on hurdle rates or required payback periods. 3 of these were from Group A, 3 from Group C and 1 from Group D.

Interestingly, the 3 responses from Group A were all the highest rates quoted at 6, 15 and 25%. The lowest of these was not from a manufacturing sector, the next was from the retail & Warehouse sector. The highest (25%) manufactured commodity products using an energy intensive process.

The 3 responses from Group C quoted a 4.5% hurdle rate (the local authority sector), 8% (anonymous) and a payback of 3.5y (paper sector).

The one Group D response quoted a hurdle rate of 4.5% and this came from the food & drink sector.

One of the respondents said that they applied a lower hurdle rate to low carbon projects, but no details were provided. One said that they used a 3% higher hurdle rate for gas CHP relative to investment in 'core' activities. This is because they have more confidence in their core market than in the energy market.

Energy markets

Of the 8 respondents across Groups A and B, only one currently sells heat, although one used to sell heat until its market collapsed. 3 of these respondents sell electricity, 2 on the half-hourly market. 2 respondents reported difficulty in gaining the required connection at an affordable price to enable them to export power.

Table 1 – Responses to the post interview quantitative questionnaire

Responses received by cut-off date		19 (39%)
Group A		7
Group B		1
Group C		6
Group D		1
Of these, those declining to provide information		4
Financial Assessment Methodology used		
	NPV	2
	IRR	3
	Simple payback	5
	Combination	5
Range of hurdle rates quoted		
		4.5 to 25%
Interviewees providing information on financial assessment periods		
		7
Range of financial assessment periods used (y)		
		2 to 15
Interviewees providing data on export tariffs		
		0

Appendix 4 – Interview protocols for groups A-E

Group A – Interview Guide and Questions

(Have gas CHP)

1. Background	
Question	(Guidance)
Can you tell me a little about the organisation and your role within it?	<i>The ice breaker question. How senior? How connected? (for older schemes) how informed?</i>
Could you tell me about how [organisation] uses energy?	<i>Useful context for the subsequent questions</i>
2. The decision-making process	
Question	Required information
Turning specifically to gas CHP, could you tell me about the why [organisation] installed the plant?	<ul style="list-style-type: none"> • To what extent was it part of a broader company strategy? Who originally raised it as an option? Was it driven by recommendations from a consultant/ advisor? • What outcomes did they seek (did these include environmental or Corporate Responsibility drivers)? • Did they look for opportunities to install gas CHP or to install gas CHP against a specific process need or market opportunity? • How important was financial performance in the decision-making process? • How important was technical performance in the decision-making process? • How important were other factors in the process (e.g. wider environmental issues) • Was the system new or a replacement?
3. Procurement and installation	
Question	Required information
What was your experience with the procurement and installation process?	<ul style="list-style-type: none"> • Who managed the procurement process? • Who set the specification? What criteria did [organisation] look for when considering gas CHP? • What did [organisation] find easiest/ hardest about the procurement and installation process? (Include aspects like accessing finance)

4. Organisational experience with gas CHP	
Question	Required information
How has the CHP system worked in practice? Has it met your expectations?	<ul style="list-style-type: none"> • What benefits has [organisation] experienced from the gas CHP (if any?) • Have they experienced any problems with the gas CHP? [If yes] Why do you think these were? How were these problems addressed? • Is the gas CHP performing as they expected?
5. Specific financial issues	
Question	Required information
How has the gas CHP performed financially?	<ul style="list-style-type: none"> • What were the original financial expectations (if possible, fill in the post interview questionnaire, or if not use the questions in it to identify the information required) • What is the reality against this expectation? (might be good or bad) • How does this compare than the return from other investments that the organisation has made or considered
6. Experience with contracts	
Question	Required information
Does [organisation] sell the heat and/or electrical output?	<ul style="list-style-type: none"> • Does [organisation] have any contractual arrangements based on the gas CHP? If yes, how long are they? If no, have you looked into opportunities for heat sales/different operating models, etc.? • How easy was it to negotiate any third party energy sales? Have they mitigated against this market failing in any way? • If possible – get information on the value of energy exports (heat and power) and the process of contract negotiation and the price of gas relative to these.
7. The Future	
Question	Required information
Will gas CHP continue to have a role in the future of your organisation? Why?	<ul style="list-style-type: none"> • Would [organisation] consider expanding the use of gas CHP? Why? • What recommendations would they make for others considering installing gas CHP? • Do they see a role for government support for gas CHP? • Is there also a role for industry and if so – what?

Group B – Interview Guide and Questions

(Had but decommissioned gas CHP)

1. Background	
Question	(Guidance)
Can you tell me a little about the organisation and your role within it?	<i>The ice breaker question. How senior? How connected? (for older schemes) how informed?</i>
Could you tell me about how [organisation] uses energy?	<i>Useful context for the subsequent questions</i>
2. The decision-making process	
Question	Required information
Turning specifically to gas CHP, could you tell me about the why [organisation] installed the plant?	<ul style="list-style-type: none"> • To what extent was it part of a broader company strategy? Who originally raised it as an option? Was it driven by recommendations from a consultant/ advisor? • What outcomes did they seek (did these include environmental or Corporate Responsibility drivers)? • Did they look for opportunities to install gas CHP or to install gas CHP against a specific process need or market opportunity? • How important was financial performance in the decision-making process? • How important was technical performance in the decision-making process? • How important were other factors in the process (e.g. wider environmental issues)
3. Procurement and installation	
Question	Required information
What was your experience with the procurement and installation process?	<ul style="list-style-type: none"> • Who managed the procurement process? • Who set the specification? What criteria did [organisation] look for when considering gas CHP? • What did [organisation] find easiest/ hardest about the procurement and installation process? (Include aspects like accessing finance)
4. Organisational experience with gas CHP	
Question	Required information
How did the gas CHP work in practice?	<ul style="list-style-type: none"> • Did the gas CHP perform as expected? • Did the gas CHP meet the organisations expectations? • What was good/ bad about the gas CHP i.e. what worked and what didn't work? Why?

5. Specific financial information	
Question	Required information
How did the gas CHP perform financially?	<ul style="list-style-type: none"> • What were the original financial expectations (if possible, fill in the post interview questionnaire, or if not use the questions in it to identify the information required) • What is the reality against this expectation? (might be good or bad) • How does this compare than the return from other investments that the organisation has made or considered
6. Experience with contracts	
Question	Required information
Did [organisation] sell the heat and/ or electrical output?	<ul style="list-style-type: none"> • Did [organisation] have any contractual arrangements based on the gas CHP? If yes, how long were they for? How were these managed? Did they look at opportunities for heat sales/different operating models, etc.? • How easy was it to negotiate any third party energy sales? Did they mitigate against this market failing in any way? • If possible – get information on the value of energy exports (heat and power) and the process of contract negotiation and the price of gas relative to these.
7. Decommissioning	
Question	Required information
When was the gas CHP plant decommissioned? Why was it decommissioned?	<ul style="list-style-type: none"> • Who decided to decommission the plant? • Could the decommissioning have been avoided? For instance, was it down to bad system design? • [If end of life] why did [organisation] decide to use a different system? • What were the consequences of decommissioning your gas CHP?
8. The future	
Question	Required information
Is there a future role for gas CHP have in your organisation? Why?	<ul style="list-style-type: none"> • What would need to change for [organisation] to consider (re)commissioning gas CHP? • Do they see a role for government support for gas CHP? • Is there also a role for industry – if so, what?

Group C – Interview Guide and Questions

(Group C – Considered but not installed gas CHP)

1. Background	
Question	(Guidance)
Can you tell me a little about the organisation and your role within it?	<i>The ice breaker question. How senior? How connected? (for older schemes) how informed?</i>
Could you tell me about how [organisation] uses energy?	<i>Useful context for the subsequent questions</i>
2. The decision making process	
Question	Required information
Could you talk me through the decision-making process that led to [organisation] initially considering the installation of gas CHP?	<ul style="list-style-type: none"> • To what extent was it part of a broader company strategy driven by an individual or team? Or was it driven by recommendations from a consultant/ advisor? • What outcomes did they seek (did these include environmental or CR drivers)? • Was support available and was the spark spread favourable at the time? • Did they look for opportunities to install gas CHP or to install gas CHP against a specific process need? • How important was financial performance in the original decision-making process? • How important was technical performance in the original decision-making process?
3. Assessing gas CHP	
Question	Required information
I understand that [organisation] eventually decided against commissioning gas CHP, could you talk me through that decision-making process?	<ul style="list-style-type: none"> • Who managed the assessment process i.e. was it done internally or did [organisation] hire a consultant? • Where there any factors that could have swayed the decision the other way? • Did they consider that a market failure was to blame and if so what? (Include technical such as heat markets) • Did they know that government support was available? • Did [organisation] have access to the information you needed to make this assessment? Were they satisfied with the advice they received? • Did they reconsider other size options for gas CHP or other technology options?

Group D – Interview Guide and Questions

(Group D – Never considered gas CHP)

1. Background	
Question	(Guidance)
Can you tell me a little about the organisation and your role within it?	<i>The ice breaker question. How senior? How connected? (for older schemes) how informed?</i>
2. Context	
Question	Required information:
Can you tell me how your organisation uses energy and the sources of energy that you use?	<ul style="list-style-type: none"> Do they just 'connect to the grid' or do they use other energy sources as well?
3. Importance of energy	
Question	Required information:
Is energy an issue for [organisation]? Why? And in what ways?	<ul style="list-style-type: none"> How important is energy in their organisation and why – is it changing? Do they have any external energy-related pressures on them (cost/environment/brand etc?) Where in the organisation does any 'pain' fall? And who is dealing with it?
4. Decision-making processes	
Question	Required information:
How does [organisation] currently manage energy use?	<ul style="list-style-type: none"> How important is energy management to their organisation and why Do they take active steps to manage energy? Who is responsible and how is energy management delivered?
5. Investment decisions	
Question	Required information:
We're interested in decision-making, what are your current investment priorities? Is energy one of them	<ul style="list-style-type: none"> Do they invest in their business Do they invest in energy in any form (energy efficiency/control/generation) Are they currently looking to invest in energy technology of any kind?
6. Specific financial issues	
Question	Required information:
If you were to consider gas CHP how would it need to perform financially?	<ul style="list-style-type: none"> What are your required financial returns (if possible, fill in the post interview questionnaire, or if not use the questions in it to identify the information required) Is this better or worse than the return from other investments that the organisation has made

7. Resources and skills	
Question	Required information:
What resources are they drawing on or in need of?	<ul style="list-style-type: none"> • Has the organisation got the skills it needs in order to assess a technology like gas CHP (including financial, technical, knowledge, skills, access to information) • Does it use external consultants?
	<ul style="list-style-type: none"> • Has it considered using (or does it use) consultants to look at energy opportunities?
8. Future	
Question	Required information:
As you know, this project is focusing specifically on gas CHP. The Department for Energy and Climate Change are interested in increasing the uptake of this technology, because it can deliver significant efficiency improvements. Would your organisation consider this technology? Why?	<ul style="list-style-type: none"> • Identify reasons why gas CHP either will or will not be considered
9. Role of government	
Question	Required information:
What would need to change for [organisation] to consider gas CHP?	<ul style="list-style-type: none"> • Is the required intervention just financial or are there other barriers to overcome? • Is there a role for industry to support gas CHP uptake by your sector?

Group E Advisors – Interview Guide and Questions

1. Background	
Question	(Guidance)
Tell me of your experience with gas CHP?	<i>The ice breaker question. How senior? How experienced?</i>
2. The decision-making process	
Question	Required information
What is your experience of how decisions around gas CHP are reached?	<ul style="list-style-type: none"> • To what extent was it part of a broader company strategy? Who originally raised it as an option? • How often are decisions driven by recommendations from you or from an internal driver? • What range of outcomes do clients seek (did these include environmental or Corporate Responsibility drivers)? • Did they look for opportunities to install gas CHP or to install gas CHP against a specific process need or market opportunity? • How important is financial performance in the decision-making process? • How important is technical performance in the decision-making process? • How important are other factors in the process (e.g. wider environmental issues)
3. Procurement and installation	
Question	Required information
What is your experience with the procurement and installation process?	<ul style="list-style-type: none"> • Who tends to manage the procurement process? • Who usually sets the specification? What range of criteria do organisations look for when considering gas CHP? • What do organisations tend to find easiest/hardest about the procurement and installation process? (Include aspects like accessing finance)

4. Organisational experience with gas CHP	
Question	Required information
What is your experience of gas CHP when it is in operation? Do you get involved in the operation of CHP?	<ul style="list-style-type: none"> • What range of benefits do organisations experience or expect from the gas CHP (if any?) • What are the common problems with gas CHP? How do these problems tend to be addressed? • In general, does gas CHP perform as expected (technically and financially)?
5. Specific financial issues	
Question	Required information
In your experience what financial performance do clients look for from gas CHP?	<ul style="list-style-type: none"> • What sort of criteria/indicators would they use (IRR, DR, NPV, Simple Payback etc.) • Switch to the attached questionnaire and get as much detailed information as possible
6. Experience with contracts	
Question	Required information
How common are energy sale contracts in gas CHP projects and in general how do they perform?	<ul style="list-style-type: none"> • What are the common contractual arrangements based on the gas CHP? • How easy is it to negotiate any third party energy sales? How common is it for organisations to mitigate against contracts failing in any way? • If possible – get information on their experience on the value of energy exports (heat and power) and the process of contract negotiation and the price of gas relative to these.
7. The Future	
Question	Required information
Will gas CHP continue to have a role in the future of your client's energy strategies?	<ul style="list-style-type: none"> • Do they see the uptake of gas CHP rising or falling. Why? • What recommendations would they make for others considering installing gas CHP? • Do they see a role for government support for gas CHP? • Is there also a role for industry and if so – what?

Group E Providers (ESCOs/Utilities) – Interview Guide and Questions

1. Background	
Question	(Guidance)
What gas CHP based services do you offer?	<i>The ice breaker question. It also allows an understanding of the range of services offered and if these are only based on gas CHP.</i>
2. The decision-making process	
Question	Required information
What is your experience of how decisions around installing gas CHP are reached by your clients?	<ul style="list-style-type: none"> • To what extent is this part of a broader company strategy? How often is it a client 'pull' relative to a sales pitch by your organisation? What are these 'pulls'? • Are non-energy benefits important to your clients and if so what are they? (e.g. Environmental or Corporate Responsibility drivers) • How important is financial performance in the decision-making process? • How important is technical performance in the decision-making process? • How important is the nature and extent of your offering important in the decision making process? • What specifically in your offer is valued most?
3. Procurement and installation	
Question	Required information
What is your experience with the procurement and installation of gas CHP process?	<ul style="list-style-type: none"> • In general, how informed/educated are your clients about gas CHP? • How does this impact on the procurement process? • Is Gas CHP the main driver for initiating the work, if not, what is?
4. Organisational experience with gas CHP	
Question	Required information
How successful is your system in meeting the needs of your client?	<ul style="list-style-type: none"> • Are the pre-installation expectations usually met? • What are the major issues/problems • Does this lead to friction?

5. Specific financial issues	
Question	Required information
In your experience what financial performance do you and your clients look for from gas CHP?	<ul style="list-style-type: none"> • Switch to the attached questionnaire and get as much detailed information as possible
6. Experience with contracts	
Question	Required information
How common are Gas CHP projects in ESCO contracts and in general how do they perform?	<ul style="list-style-type: none"> • What are the common contractual arrangements you are offering. How does Gas CHP feature in these contracts? • How easy is it to negotiate any third party energy sales? How common is it for organisations to mitigate against contracts failing in any way? • If possible – get information on their experience on the value of energy exports (heat and power) and the process of contract negotiation and the price of gas relative to these. • If possible – get information on contract duration (10, 15, 20 y?) • A general description of the overall package would be useful.
7. The Future	
Question	Required information
Do you see gas CHP as a growing market for you in the future?	<ul style="list-style-type: none"> • Do they see the uptake of gas CHP rising or falling. Why? • What is the basis of their sales pitch? • Do they see a role for government support for gas CHP? • Is there also a role for industry and if so – what?

Appendix 5 – Quantitative post interview questionnaires

The following questionnaires were drafted by DECC and distributed as appropriate by the interviewers via email after the interview process.

Group A – Currently have gas CHP

Post Interview Questions

Thank you for taking part in a face to face interview as part of our research for DECC into the factors influencing the uptake of gas CHP.

While the interview was based on gaining a wider understanding of the qualitative issues around gas CHP, in order to put your answers into context please can your organisation provide the additional data requested below.

As with all aspects of your involvement, your answers will be kept completely confidential and aggregated with the other answers that we receive unless you indicate that you are happy to share the information that you provide with DECC.

Thank you for your involvement.

Question	Answer
<p>What is your financial assessment methodology</p> <ul style="list-style-type: none"> • IRR vs. hurdle rate • NPV • Simple payback (of upfront capital costs within a specified period) • Other (please specify) 	
<p>[If IRR or NPV] What is your required project hurdle rate or discount rate for a gas CHP project and how does this break down into its constituent elements? In particular how much is your:</p> <ul style="list-style-type: none"> • weighted cost of capital, (and what is the debt:equity ratio?) • risk premium, (what is this risk premium for e.g. loss of third party heat customer or uncertainty on what price will be achieved for exported power?) • How much does the IRR reflect your organizational wide required rate of return on capital and opportunity cost e.g. the return you could have got from alternative investment opportunities? <p>What other contributory elements are there? (please specify)</p>	

<p>If you have invested in several CHP projects how have investment criteria varied from;</p> <ul style="list-style-type: none"> • Site to site • Business to business (if applicable) <p>And why?</p>	
<p>Did you evaluate ex-post how effective the financial assessment methodology used was at ensuring that the project delivered the projected/required rates of return?</p> <p>If so, how will this affect future investment decision making?</p>	
<p>What was the length of the financial assessment period that you used when you decided to invest in your gas CHP scheme? What factors led you to deciding upon the length of this period?</p>	
<p>If different from the financial assessment period, what assumptions did you make about the lifetime over which any debt raised to invest in the scheme would be repaid and financing costs incurred upon this debt e.g. the weighted average cost of capital?</p>	
<p>Did you have any difficulty accessing finance to pay for the CHP scheme?</p>	
<p>[If IRR or NPV] How do hurdle rates/discount rates you use for a CHP project compare to other potential investments that you might make? If they differ e.g. you require a higher rate of return on a CHP investment, why is this?</p>	
<p>Was major overhaul costs factored into the initial investment decision or are these considered as a separate decision when major overhaul is due?</p>	
<p>How did you take account of the role of government policy support and taxes in financial decision making?</p>	
<p>Was any boiler capacity displaced by the CHP project and was the avoided boiler cost factored into the investment decision?</p>	
<p>What electricity retail price structure do you have for power imported from the grid e.g. in what time blocks are different tariffs charged and how do these tariffs vary between blocks?</p>	

<p>Did the project involve third party heat customers? How was the price which third party customers paid for heat set e.g. with reference to the avoided cost of operating a gas boiler, the wholesale price of gas or some other method?</p> <p>Also how was revenue from heat sales treated in the investment decision e.g.</p> <ul style="list-style-type: none"> • was it discounted to account for risk of loss of heat contract, if so by how much? • was assumed revenue limited to the duration of the initial heat contract period, if so how long was this? 	
<p>Did the project involve exporting electricity? If so what were the arrangements for sale of this electricity and how was it accounted in the initial investment decision e.g.</p> <ul style="list-style-type: none"> • is it sold through a Power Purchase Agreement? What value was assumed in the investment decision relative to market value (wholesale or retail, please indicate)? How did the assumed value vary year on year? • do you trade your electricity in the half hourly market? What value was assumed in the investment decision? How does the assumed value vary year on year? 	
<p>Of all the risks you identified e.g. (potential loss of heat load, difficulty in accessing the full price for electricity) which were the most significant for the financial assessment and why?</p>	

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I am willing to share this data with DECC

I am willing to share this data with DECC and for them to use this data for other research

Signed

Dated

Group B – Had but decommissioned gas CHP

Post Interview Questions

Thank you for taking part in a face to face interview as part of our research for DECC into the factors influencing the uptake of gas CHP.

While the interview was based on gaining a wider understanding of the qualitative issues around gas CHP, in order to put your answers into context please can your organisation provide the additional data requested below.

As with all aspects of your involvement, your answers will be kept completely confidential and aggregated with the other answers that we receive unless you indicate that you are happy to share the information that you provide with DECC.

Thank you for your involvement.

Question	Answer
<p>What is your financial assessment methodology</p> <ul style="list-style-type: none"> • IRR vs. hurdle rate • NPV • Simple payback (of upfront capital costs within a specified period) • Other (please specify) 	
<p>[If IRR or NPV] What was the project hurdle rate or discount rate that you required for your gas CHP project and how did this break down into its constituent elements? In particular how much was your:</p> <ul style="list-style-type: none"> • weighted cost of capital, (and what is the debt:equity ratio?) • risk premium, (what is this risk premium for e.g. loss of third party heat customer or uncertainty on what price will be achieved for exported power?) • How much does the IRR reflect your organizational wide required rate of return on capital and opportunity cost e.g. the return you could have got from alternative investment opportunities? <p>What other contributory elements were there? (please specify)</p>	
<p>If you invested in several CHP projects how did the investment criteria varied from;</p> <ul style="list-style-type: none"> • Site to site • Business to business (if applicable) <p>And why?</p>	

<p>Did you evaluate ex-post how effective the financial assessment methodology used was at ensuring that the project delivered the projected/required rates of return?</p> <p>If so, how will this affect future investment decision making?</p>	
<p>What was the length of the financial assessment period that you used when you decided to invest in your gas CHP scheme? What factors led you to deciding upon the length of this period?</p>	
<p>If different from the financial assessment period, what assumptions did you make about the lifetime over which any debt raised to invest in the scheme would be repaid and financing costs incurred upon this debt e.g. the weighted average cost of capital?</p>	
<p>Did you have any difficulty accessing finance to pay for the CHP scheme?</p>	
<p>[If IRR or NPV] How do hurdle rates/discount rates you use for a CHP project compare to other potential investments that you might make? If they differ e.g. you require a higher rate of return on a CHP investment, why is this?</p>	
<p>Was major overhaul costs factored into the initial investment decision or are these considered as a separate decision when major overhaul is due?</p>	
<p>How did you take account of the role of government policy support and taxes in financial decision making?</p>	
<p>Was any boiler capacity displaced by the CHP project and was the avoided boiler cost factored into the investment decision?</p>	
<p>What electricity retail price structure do you have for power imported from the grid e.g. in what time blocks are different tariffs charged and how do these tariffs vary between blocks?</p>	

<p>Did the project involve third party heat customers? How was the price which third party customers paid for heat set e.g. with reference to the avoided cost of operating a gas boiler, the wholesale price of gas or some other method?</p> <p>Also how was revenue from heat sales treated in the investment decision e.g.</p> <ul style="list-style-type: none"> • was it discounted to account for risk of loss of heat contract, if so by how much? • was assumed revenue limited to the duration of the initial heat contract period, if so how long was this? 	
<p>Did the project involve exporting electricity? If so what were the arrangements for sale of this electricity and how was it accounted in the initial investment decision e.g.</p> <ul style="list-style-type: none"> • is it sold through a Power Purchase Agreement? What value was assumed in the investment decision relative to market value (wholesale or retail, please indicate)? How did the assumed value vary year on year? • do you trade your electricity in the half hourly market? What value was assumed in the investment decision? How does the assumed value vary year on year? 	
<p>Of all the risks you identified e.g. (potential loss of heat load, difficulty in accessing the full price for electricity) which were the most significant for the financial assessment and why?</p>	

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Signed

Dated

Group C – Have considered but not adopted gas CHP

Post Interview Questions

Thank you for taking part in a face to face interview as part of our research for DECC into the factors influencing the uptake of gas CHP.

While the interview was based on gaining a wider understanding of the qualitative issues around gas CHP, in order to put your answers into context please can your organisation provide the additional data requested below.

As with all aspects of your involvement, your answers will be kept completely confidential and aggregated with the other answers that we receive unless you indicate that you are happy to share the information that you provide with DECC.

Thank you for your involvement.

Question	Answer
<p>What is your financial assessment methodology</p> <ul style="list-style-type: none"> • IRR vs. hurdle rate • NPV • Simple payback (of upfront capital costs within a specified period) • Other (please specify) 	
<p>[If IRR or NPV] What was the project hurdle rate or discount rate that you required when considering a gas CHP project and how did this break down into its constituent elements? In particular how much was your:</p> <ul style="list-style-type: none"> • weighted cost of capital, (and what is the debt:equity ratio?) • risk premium, (what is this risk premium for e.g. loss of third party heat customer or uncertainty on what price will be achieved for exported power?) • How much does the IRR reflect your organizational wide required rate of return on capital and opportunity cost e.g. the return you could have got from alternative investment opportunities? <p>What other contributory elements were there? (please specify)</p>	
<p>If you considered several CHP projects how did the investment criteria vary from;</p> <ul style="list-style-type: none"> • Site to site • Business unit to business unit (if applicable) <p>And why?</p>	
<p>What was the length of the financial assessment period that you used when you considered a gas CHP scheme? What factors led you to deciding upon the length of this period?</p>	

<p>If different from the financial assessment period, what assumptions did you make about the lifetime over which any debt raised to invest in the scheme would be repaid and financing costs incurred upon this debt e.g. the weighted average cost of capital?</p>	
<p>Did you have any difficulty accessing finance to pay for a proposed gas CHP scheme?</p>	
<p>[If IRR or NPV] How did hurdle rates/discount rates considered for a gas CHP project compare to other potential investments that you might make? If they differ e.g. you require a higher rate of return on a CHP investment, why is this?</p>	
<p>Were major overhaul costs factored into the investment decision or would they have been considered as a separate decision when major overhaul came due?</p>	
<p>How did you take account of the role of government policy support and taxes in financial decision making?</p>	
<p>Would any boiler capacity have been displaced by the CHP project and was the avoided boiler cost factored into the investment decision?</p>	
<p>What electricity retail price structure do you have for power imported from the grid e.g. in what time blocks are different tariffs charged and how do these tariffs vary between blocks?</p>	
<p>Did the proposed project involve third party heat customers? How was the price which third party customers paid for heat going to be set e.g. with reference to the avoided cost of operating a gas boiler, the wholesale price of gas or some other method?</p> <p>Also how was revenue from heat sales treated in the investment decision e.g.</p> <ul style="list-style-type: none"> • was it discounted to account for risk of loss of heat contract, if so by how much? • was assumed revenue limited to the duration of the initial heat contract period, if so how long was this? 	

<p>Did the project involve exporting electricity? If so what were the proposed arrangements for sale of this electricity and how was it accounted in the initial investment decision e.g.</p> <ul style="list-style-type: none"> • Was it to be sold through a Power Purchase Agreement? What value was assumed in the investment decision relative to market value (wholesale or retail, please indicate)? How did the assumed value vary year on year? • do you trade your electricity in the half hourly market? What value was assumed in the investment decision? How does the assumed value vary year on year? 	
<p>Of all the risks you identified e.g. (potential loss of heat load, difficulty in accessing the full price for electricity) which were the most significant for the financial assessment and why?</p>	

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Signed

Dated

Group D – Have never considered gas CHP

Post Interview Questions

Thank you for taking part in a face to face interview as part of our research for DECC into the factors influencing the uptake of gas CHP.

While the interview was based on gaining a wider understanding of the qualitative issues around gas CHP, in order to put your answers into context please can your organisation provide the additional data requested below.

As with all aspects of your involvement, your answers will be kept completely confidential and aggregated with the other answers that we receive unless you indicate that you are happy to share the information that you provide with DECC.

Thank you for your involvement.

Question	Answer
<p>What is your financial assessment methodology</p> <ul style="list-style-type: none"> • IRR • NPV • Simple payback • Other (please specify) 	
<p>[If IRR] If you were to consider gas CHP what would be your required project hurdle rate? How does this break down? In particular how much would be your:</p> <ul style="list-style-type: none"> • Weighted cost of capital, (and what debt:equity ratio would you use?) • Risk premium, <p>What other contributory elements would you consider? (please specify)</p>	
<p>[If NPV] What discount rate would you use if you were to consider gas CHP and how does this break down? In particular how much would be the</p> <ul style="list-style-type: none"> • Weighted cost of capital, (and what debt:equity ratio would you use?) • Risk premium. <p>What other contributory elements would you include? (please specify)</p>	
<p>What would be the length of the financial assessment period that you would use if you were to consider investing in a gas CHP scheme?</p>	
<p>What assumptions would you make on the lifetime over which any debt raised to invest in a gas CHP scheme would have been repaid and financing costs incurred upon this debt e.g. the weighted average cost of capital</p>	

What rate of return will you require from a CHP project compared to other potential investments?	
--	--

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I am willing to share this data with DECC

I am willing to share this data with DECC and for them to use this data for other research

Signed

Dated

Advisors/Consultants/ESCO/Utility

Post Interview Questions

Thank you for taking part in an interview as part of our research for DECC into the factors influencing the uptake of gas CHP.

While the interview was based on gaining a wider understanding of the qualitative issues around gas CHP, in order to put your answers into context please can your organisation provide the additional data requested below.

As with all aspects of your involvement, your answers will be kept completely confidential and aggregated with the other answers that we receive unless you indicate that you are happy to share the information that you provide with DECC.

Thank you for your involvement.

Question	Answer
<p>In your experience, what is the financial assessment methodology most commonly used by your clients?</p> <ul style="list-style-type: none">• IRR vs. hurdle rate• NPV• Simple payback (of upfront capital costs within a specified period)• Other (please specify)	
<p>[If IRR or NPV] What is the range of required project hurdle rate or discount rate for a gas CHP project and how does this break down into its constituent elements? In particular how much is your clients:</p> <ul style="list-style-type: none">• weighted cost of capital, (and what is the debt:equity ratio?)• risk premium, (what is this risk premium for e.g. loss of third party heat customer or uncertainty on what price will be achieved for exported power?) <p>What other contributory elements are there? (please specify)</p>	
<p>In your experience do investment criteria vary from;</p> <ul style="list-style-type: none">• Site to site• Business to business (if applicable) <p>And why?</p>	

<p>Do you or your clients evaluate ex-post how effective the financial assessment methodology used was at ensuring that the project delivered the projected/required rates of return?</p> <p>If so, what is the typical outcome?</p>	
<p>What is the length of the financial assessment period that you or your clients typically use when deciding to invest in your gas CHP scheme? What factors tend to influence this decision?</p>	
<p>If different from the financial assessment period, what assumptions do you or your clients make about the lifetime over which any debt raised to invest in the scheme would be repaid and financing costs incurred upon this debt e.g. the weighted average cost of capital?</p>	
<p>Is it usual to encounter any difficulty accessing finance to pay for the CHP scheme?</p>	
<p>[If IRR or NPV] How do hurdle rates/discount rates that you or your clients use for a CHP project compare to other potential investments that you might make? If they differ e.g. require a higher rate of return on a CHP investment, why is this?</p>	
<p>Do you or your clients factor major overhaul costs into the initial investment decision or are these considered as a separate decision when major overhaul is due?</p>	
<p>How do you or your clients take account of the role of government policy support and taxes in financial decision making?</p>	
<p>In projects where boiler capacity is displaced by the CHP project, is it normal for the avoided boiler cost factored into the investment decision?</p>	

<p>Typically what electricity retail price structure does your client have for power imported from the grid e.g. in what time blocks are different tariffs charged and how do these tariffs vary between blocks?</p>	
<p>Where projects involve third party heat customers how is the price which third party customers are charged for heat set e.g. with reference to the avoided cost of operating a gas boiler, the wholesale price of gas or some other method?</p> <p>Also how is revenue from heat sales treated in the investment decision e.g.</p> <ul style="list-style-type: none"> • is it discounted to account for risk of loss of heat contract, if so by how much? • is assumed revenue limited to the duration of the initial heat contract period, if so typically how long is this? 	
<p>Where projects involve exporting electricity how is this accounted in the initial investment decision e.g.</p> <ul style="list-style-type: none"> • where it is sold through a Power Purchase Agreement what value is assumed in the investment decision relative to market value (wholesale or retail)? How is the value assumed to vary year on year? • Where electricity is traded in the half hourly market what value is assumed in the investment decision? How is the value assumed to vary year on year? 	
<p>Of all the risks you identify when assessing a project e.g. (potential loss of heat load, difficulty in accessing the full price for electricity) which was the most significant for the financial assessment and why?</p>	

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However please indicate below if you are willing to share this with DECC (leave blank if not).

I am willing to share this data with DECC

I am willing to share this data with DECC and for them to use this data for other research

Signed

Dated

Appendix 6. The initial web based questionnaire

The text below reproduces all of the questions included in the initial web-based questionnaire. This was set up as a 'branched' questionnaire with responses to specific questions dictating which question the respondent was next presented with. As a result, not every respondent responded to every one of the questions below.

Web-based questionnaire

This short questionnaire takes less than five minutes to complete. It has three sections with a maximum of 12 questions.

Questionnaire responses will provide important evidence to help the Department of Energy and Climate Change develop policies to encourage greater uptake of gas CHP. The results will be used to analyse gas CHP investment decision-making across a range of sectors.

The information you provide will be treated as confidential and will be stored **[Ricardo AEA data security protocols]**

Initial Questions:

Q1): Background to your organisation (tick one). You must complete all the questions in this section before moving on.

- Which sector are you in?
 - Chemicals
 - Paper
 - Food and drink manufacture
 - Oil & Gas
 - Retail & warehousing
 - Health
 - Higher Education
 - Local Authority
 - Other (text box)
- Is your company a (tick one):
 - Large energy user (spending more than £2.5m/y on energy)
 - Medium energy user (spending between £0.3 and £2.5m/y on energy)
 - Small energy user (spending less than £0.3m/y on energy)
- Is your company **currently** using or installing gas CHP?
 - Yes (Group A, filtered to next section)
 - No (follow to Q2)

Q2 Have you had gas CHP in the past but it is no longer operational?

- Yes (Group B, Decommissioned, filtered to relevant section)
- No (follow to Q3)

Q3 Has your organisation considered gas CHP, but decided against it?

- Yes (Group C – considered and rejected, filtered to relevant section)
- No (Group D- never considered, filtered to relevant section)

Section 2 (Group A only)

How many gas CHP systems do you have installed?

- One
- 2 to 10
- More than 10
- Don't know

If you have multiple installations please answer the following questions for your **latest installation only**.

When did you install your gas CHP? (please tick one)

- Currently being installed
- Within the last 12 months
- In last 1 to 5 years
- Over 5 but less than 10 years ago
- Over 10 years ago
- Don't know

What size is your CHP? (please tick one)

- Large (over 25 MWe)
- Medium (over 2 MWe and up to 25 MWe)
- Small (2 MWe or less)
- Don't know

How do you currently use heat from your gas CHP? (please tick all that apply)

- For own use (process, hot water or space heating)
- Sell to another customer
- Sell via heat network to more than one customer
- Don't know

How do you currently use electricity from your gas CHP? (please tick all that apply)

- For own use (displacing grid electricity, or for isolated operation)
- Sell to another customer (e.g. via a private wire network)
- Sell to the grid
- Don't know

What is the main reason that you chose to install gas CHP? (please select one main reason)

- It offered good financial performance relative to other investment options
- It offered technical improvements in operations
- Other (please state – text box)
- Don't know

How did you make your decision? (please tick all that apply)

- As a result of an internally led process that identified the benefits of gas CHP
- In response to a consultant or other recommendation to install gas CHP
- In response to a government initiative or incentive scheme that made it attractive to install gas CHP
- Don't know

How did you finance the CHP? (please select all that apply)

- Own internal funding
- Own Debt finance
- Third party finance
- Other, please specify (text box)
- Don't know

Operational Experience:

- Has your gas CHP performed technically
 - Better than expected
 - As expected
 - Worse than expected
 - Don't know
- Has your gas CHP performed financially
 - Better than expected
 - As expected
 - Worse than expected
 - Don't know
- Have you considered
 - Decommissioning your gas CHP
 - ◆ Yes
 - ◆ No
 - Looking for more gas CHP opportunities in your organisation
 - ◆ Yes
 - ◆ No
 - ◆ Don't know

Go to section 3 (interview request)

Section 2 (Group B only)

What is the main reason why you originally chose to install gas CHP? (please select one main reason)

- It offered good financial performance relative to other investment options
- It offered technical improvements in operations
- Other (please state – text box)
- Don't know

How did you make your original decision? (please select all that apply)

- As a result of an internally led process that identified the benefits of gas CHP
- In response to a consultant or other recommendation to install gas CHP
- In response to a government initiative or incentive scheme that made it attractive to install gas CHP
- Don't know

What size was your CHP?

- Large (over 25 MWe)
- Medium (over 2 MWe and up to 25 MWe)
- Small (2 MWe or less)
- Don't know

How did you use heat from your gas CHP? (please tick all that apply)

- For own use (process, hot water or space heating)
- Sell to another customer
- Sell via heat network to more than one customer
- Don't know

How did you use electricity from your gas CHP? (please tick all that apply)

- For own use (displacing grid electricity, or for island operation)
- Sell to another customer (e.g. via a private wire network)
- Sell to the grid
- Don't know

Experience:

- Did your gas CHP perform technically
 - Better than expected
 - As expected
 - Worse than expected
 - Don't know
- Did your gas CHP perform financially

- Better than expected
- As expected
- Worse than expected
- Don't know
- What made you decide to decommission it (select all that apply)
 - Worse financial performance than expected
 - Worse technical performance than expected or other technical problem
 - Lack of internal resources to operate the plant
 - Equipment failure
 - Contractual issues (e.g. with heat sales, leasing issues, etc.)
 - Reached end of operating life and not replaced
 - Other (text box)
 - Don't know
- Would you consider using gas CHP again (yes/no/don't know)
 - Yes
 - No
 - Don't know
- Does anything need to change before you consider installing gas CHP again?
 - Yes
 - No
 - Don't know
- If so what? (text box)

Go to section 3 (interview request)

Section 2 (group C only)

When did you last appraise the option of gas CHP for your organisation?

- Within the last 12 months
- In last 1 to 5 years
- Over 5 but less than 10 years ago
- Over 10 years ago
- Don't know

Why did you reject gas CHP as an option? (please select all that apply)

- Not technically feasible because:
 - Not on the gas grid
 - Lack of space/other locational or site issues including noise, visual impact, etc.
 - Insufficient technical capability to operate the plant
 - Insufficient heat load/no access to local heat markets
 - Electricity grid/other connection issues
 - Short lease/facility ownership/business continuity issues
- Not financially viable within your organisations investment criteria
- Financially viable but other investment priorities

- Others, please specify (text box)
- Don't know

What would cause you to you reconsider gas CHP in the future? (please select all that apply)

- Company growth
- Increased internal technical capacity to support a gas CHP project
- Capacity to invest improves
- Government policy incentive makes gas CHP an attractive commercial option
- Market opportunity (e.g. heat network developing locally)
- Other (text box)
- Don't know

Go to Section 3 (interview)

Section 2 (group D only)

Why has your organisation never considered gas CHP in the past? (please select all that apply)

- Just never considered gas CHP as an option
- Gas not available
- Lack of understanding of gas CHP technology/no information on the benefits of gas CHP
- Lack of internal technical capacity required to consider gas CHP as an option
- Poor heat demand/no local heat market.
- Lack of confidence in gas CHP
- Lack of local gas CHP system suppliers/advisors
- Worries over high capital costs
- Worries over high operating cost
- Worries over reliability/operational issues
- Long term concerns over continued economic viability
- Lack of money to invest
- Other investment priorities
- No space/short tenancy/other site limitations
- Other environmental concerns (e.g. noise, visual intrusion, etc.)
- Other (text box)
- Don't know

(Go to section 3)

Section 3 – all groups

Are you involved in decision making around energy supply and energy investment? If so, would you be willing to be interviewed to discuss your investment decision making process in more detail?

We are planning face-to-face interviews with a sample of companies/organisations within the next few weeks to understand how organisations consider investments in gas CHP and what the barriers are to the uptake of new gas CHP. These interviews will inform future government policy development and will cover all groups of people including those who:

- Currently have gas CHP
- Had gas CHP in the past but no longer operate gas CHP
- Have considered but decided against gas CHP
- Have never considered gas CHP

We would value your contribution. Would you be happy to participate in a face-to-face interview? If so, please provide your contact details below. If not would a colleague be willing to participate in a face to face interview? If so, please ask them to provide their details below

- Name:
- Position within Company/Organisation:
- Address
- Email:
- Phone number:

Is there someone else in your organisation who should attend also attend any interview or represent your organisation in your place?

- Yes
- No

(if yes) Please provide their contact details:

- Name:
- Position within Company/Organisation:
- Email:
- Phone number:

The results of this survey will be used to develop an evidence base for potential future policy on Gas CHP. The information you have provided in this questionnaire will be treated as confidential and anonymised in any reports produced. The data will stored in accordance with **[Riccardo AEA data protection protocols.]**

Please indicate below if you are happy for this information to be:

- Shared with DECC
- Used by DECC for future research and potentially shared with other consultants working on behalf of DECC

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