NAP IMPLICATIONS AND OPTIONS FOR CHP

A series of reports and notes to DEFRA

November 2003

Copyright statement

Disclaimer

INTRODUCTION

This report presents a compilation of the various studies and associated notes that ILEX has undertaken for DEFRA on the issues and options relating to the allocation of allowances to CHP plant under the NAP.

The reports and notes are presented in chronological order.

TABLE OF CONTENTS

REPORT 1: NAP IMPLICATIONS AND OPTIONS FOR CHP – AUGUST 2003

1. INTRODUCTION AND BACKGROUND

1.1 Combined Heat and Power (CHP) is an important element in the Government's strategy for reducing greenhouse gas emissions. It is a cross-cutting technology that makes use of the heat produced as a by-product of the electricity generation process, which would normally be wasted to the environment. CHP can increase the overall efficiency of fuel use to as much as 70-90%, compared with 35-52% from conventional electricity generation. Furthermore, because it often supplies its heat and electricity locally, CHP can also avoid efficiency losses due to electricity transmission and distribution.

1.2 In recognition of the important role that CHP can play in the achievement of an environmentally sustainable energy system, the Government has set a target of at least 10 GW of installed Good Quality CHP capacity by 2010. However, current market difficulties have placed the achievement of this target in severe doubt. In the recent Energy White Paper, the Government reaffirmed its commitment to the target, and stated that future additional measures, including the EU Emissions Trading Scheme (EU ETS), would help to provide further support for CHP.

1.3 The EU ETS is due to start in 2005. Under the terms of the scheme, large industrial emitters of CO_2 (including all combustion plant with a capacity of over 20MW thermal input[1]) will be given emissions caps on an installation specific basis. They will then be allocated tradable allowances equal to this cap. In order to comply with the scheme, participants must hold sufficient quantities of allowances at the end of each year to at least cover their emissions during the course of that year. The key principle of the scheme is the ability of companies to trade their allowances in order that emissions reductions are achieved at least cost to the EU as a whole.

1.4 The scheme is likely to have fundamental implications for heat and power generation, including:

- widespread switching to more carbon-efficient forms of generation due to generators facing an opportunity cost of carbon;

[1] The 20MW thermal capacity threshold is based on the aggregate thermal capacity from one site. This means that some combustion plant below 20MW will also be covered by the scheme, if there are several combustion plant on one site that, when combined, have a larger capacity than the 20MW threshold.

- higher wholesale electricity prices due to generators incorporating the cost of carbon into their pricing decisions;
- new cost or revenue streams from buying or selling carbon allowances, depending on the allocation methodology used for the National Allocation Plan (NAP);
- changes in underlying fuel prices caused by relative changes in demand for fuels (e.g. an increase in the price of gas);
- higher administrative costs, due to monitoring, verification and trading requirements; and
- potential leakage through switching of heat or power generation to installations of less than 20MW in order to fall outside the scope of the scheme.

1.5 Since CHP is more carbon efficient than most "conventional" electricity generation, this is exactly the type of technology that one would naturally expected to be incentivised by the EU ETS. However, this might not necessarily be the case in practice, since the extent to which CHP is likely to be promoted, or inhibited, by the scheme will depend on the overall combination of the impacts listed above.

1.6 In addition, the structure of the scheme is such that the risks and opportunities will be very different for the different types of CHP plant, based on factors such as fuel type, efficiency, size, heat to power ratio, level of fixed costs and whether the plant is an existing plant or a new-entrant. Some CHP generators will undoubtedly benefit from the scheme, whereas others may be driven out of business or never make it off the drawing board.

1.7 DEFRA has asked ILEX to undertake some high-level analysis in order to ascertain the existence, and magnitude, of any potential problems with the EU ETS in terms of disincentivising some types of CHP. Further, to establish whether there is likely to be sufficient justification for using the NAP to rectify any disincentives and/or actively incentivise CHP, thereby helping to meet the government's 10 GW target. And finally to suggest ways in which this might be done.

1.8 This report summarises the findings of our analysis:

- Section 2 uses some high-level calculations, based on the key impacts, to assess the implications of the EU ETS for different types of CHP plant;
- Section 3 examines whether there is justification for attempting to rectify the concerns identified in Section 2 through the NAP and estimates the potential scale of the problem; and
- Section 4 sets out ideas for how these issues might be addressed through the NAP.

2. ASSESSING THE IMPACT OF THE EU ETS ON CHP

The key impacts

2.1 A large proportion of the impact of the scheme will stem from the price of CO_2 that will emerge from the scheme. As soon as CO_2 has a price it should be treated as a resource cost, just like any other factor input, such as fuel. This will alter the pricing and production decisions of manufacturers based on their relative carbon intensities. Importantly, it should be recognised that the price that emerges from the scheme should, in theory, be independent of the allocation methodology used by governments to award allowances.

2.2 The second main impact of the scheme will be due to the methodology adopted by governments to allocate CO_2 allowances. There are a wide variety of methodologies available to governments that, because there is great diversity in the carbon-characteristics of the installations covered, can lead to wildly differing allocation outcomes in terms of quantities of allowances awarded. The different methodologies will determine the extent to which companies need to purchase extra allowances, or will indeed be in the position of being able to sell surplus allowances.

2.3 In many cases the impact of different allocation methodologies will 'only' be distributional in nature – i.e. they will result in transfers of wealth between and within industry sectors, but they will not alter the resource allocation decision. Because the allocation process is a 'zero sum game', and the potential sums of money at stake are very large, this is clearly a very politically sensitive issue. However, because the impacts are 'only' distributional, they should not have any detrimental impact on the performance of the economy as a whole.

2.4 In some cases, however, there is the potential for different allocation methodologies to have impacts on resource allocations and the efficiency of the scheme as a whole. This will particularly be the case in situations of marginal profitability, where the allocation methodology used could tip the balance when it comes to making new entry or closure decisions, or when deciding between different technologies, such as CHP plant versus heat-only boilers. These efficiency implications are likely to be of far greater concern to governments when deciding on allocation methodologies, than situations where the impact is only distributional.

Analytical approach

2.5 ILEX has developed a simple spreadsheet model to examine the net impact on the operating revenue of CHP plant, which considers the cost of purchasing any required CO_2 allowances and the net increase in electricity revenue due to wholesale electricity prices increasing in response to a cost of CO_2. The underlying assumptions made about CHP plant, heat-only boilers and

conventional electricity generation for the purposes of this high-level analysis are set out in Annex A. It should be noted that our analysis focuses on the absolute, rather than relative, impacts of the scheme on CHP plant. We therefore do not assess whether CHP plant would be equitably treated compared to other participants, simply whether they would be better or worse off under the EU ETS than in the case where the EU ETS did not exist.

2.6 In order to assess, and present, the implications of the scheme on future CHP development, which is likely to be very heterogeneous, we identified the variables that were most likely to drive differences in impacts across different types of CHP. The four key variables that we considered to have the most impact on outcome were:

- **the size of plant** – distinguishing between cases where:
  - both the heat-only boiler and the equivalent heat-load CHP plant would be below the 20MW thermal input threshold ("small");
  - the heat-only boiler would be below the 20MW threshold while the equivalent heat-load CHP plant would be above it ("medium"); and
  - both the heat-only boiler and the equivalent heat-load CHP plant would be above the 20MW threshold ("large");
- **the fuel used** – distinguishing between coal-fired plant ("coal") and gas-fired plant ("gas")[2];
- **the heat to power ratio of the technology used** - distinguishing between:
  - those technology types with a low heat to power ratio i.e. Combined-Cycle Gas Turbine (CCGT), Gas Turbine (GT), Internal Combustion Engine (ICE) and MicroGen ("low"); and
  - those technology types with a high heat to power ratio i.e. Back Pressure Steam Turbines (BPST) and Pass-Out Condensing Steam Turbines (POCO) ("high"); and
- **the current status of the plant** – distinguishing between cases where:
  - the CHP plant is already in existence ("existing CHP");
  - a heat-only boiler is currently in existence ("existing heat"); and
  - neither a CHP nor a heat-only boiler currently exists ("new heat load").

2.7 Table 1, overleaf, summarises the percentage of CHP capacity projected to make up the 10GW target in 2010 that is expected to fall within each of the different categories identified above. It should be noted that these figures are estimates, based on the Cambridge Econometrics projections[3], and supplemented by data

[2] While some CHP is powered by other fuels (e.g. oil), gas- and coal-fired plant make up by far the majority of both existing, and projected, CHP plant, and so we have focused on these in our analysis.

[3] Source: Table C3, "*Modelling Good Quality Combined Heat and Power Capacity in the UK to 2010*", Cambridge Econometrics, May 2002.

from AEAT and our own knowledge of the characteristics of the different plant technologies. It should further be noted that the split between small, medium and large plant is subject to the greatest uncertainty due to the lack of good source data.

Table 1: Estimated percentage of 2010 CHP plant capacity by plant-type

Current status	Fuel type	Heat:Power	"Small"	"Medium"	"Large"	Total
Existing CHP	Coal	High	0%	0%	1%	1%
Existing CHP	Coal	Low	0%	0%	3%	4%
Existing CHP	Gas	High	0%	1%	9%	10%
Existing CHP	Gas	Low	4%	2%	26%	32%
Existing Boiler	Coal	High	0%	0%	0%	0%
Existing Boiler	Coal	Low	0%	0%	0%	0%
Existing Boiler	Gas	High	0%	0%	0%	0%
Existing Boiler	Gas	Low	8%	6%	18%	32%
New heat load	Coal	High	0%	0%	0%	0%
New heat load	Coal	Low	0%	0%	0%	0%
New heat load	Gas	High	0%	0%	0%	0%
New heat load	Gas	Low	5%	4%	12%	21%
Total			**17%**	**13%**	**69%**	**100%**

2.8 Table 1, above, shows that the majority of CHP capacity estimated to make up the 10GW target in 2010 is "large" plant (i.e. of a sufficient size that both the CHP plant and the heat-only boiler of an equivalent heat-load would be above the 20MW threshold). The majority of plant is also expected to be gas-fired and to have a low heat to power ratio. Just under half of expected CHP capacity in 2010 is made up of existing CHP plant, with 32% coming from replacement of existing boilers and the final 21% coming from the emergence of new heat-load demand.

2.9 In addition to distinguishing between the different plant-types discussed above, we also identified three scenario factors, the variation of which could have significant implications for the overall impact on CHP. These were:

- **the proportion of emissions covered by free allocation** – distinguishing between scenarios where:
  - installations are allocated sufficient allowances to exactly cover their emissions ("100%");
  - installations are allocated sufficient allowances to cover half of their emissions ("50%"); and
  - installations have to buy all their allowances in the market-place ("0%");
- **whether free allowance allocations continue for the remainder of the phase in the event of plant closure** e.g. in the event that a participant switches from a heat-only boiler to a CHP plant during the course of the

scheme – distinguishing between scenarios where free allocations do continue when a plant closes ("yes") and where they do not ("no"); and

- **the extent to which the cost of carbon is passed through into electricity prices** – with scenarios distinguishing between:
  - the full pass through of carbon costs into electricity prices that would be theoretically expected, given the cost increase incurred by the marginal generating plant in the electricity market ("100%");
  - only half of the pass through of carbon costs into electricity prices that would be theoretically expected ("50%");
  - none of the pass through of carbon costs into electricity prices that would be theoretically expected ("0%").

2.10 Given the time constraints of the work, we have not attempted to include detailed quantitative analysis of the impact of additional administration costs of the scheme, or of the second order impacts that could occur through changes in underlying fuel prices due to changes in demand, though we have dealt with these issues qualitatively at the end of the section.

Results

2.11 Table 2, overleaf, summarises the results of our analysis in terms of the impact of the EU ETS on different types of CHP plant for different allowance allocation and cost-pass through scenarios. In order to quantify the scale of impact, the numbers given in the table show the net impact of the ETS on operating revenue as a percentage of expected fuel purchase costs. Where figures are negative, this indicates that the CHP plant in question would be disadvantaged by the scheme, and more likely to opt for a heat-only boiler rather than a CHP plant.

2.12 To present the results, we have graded the cells by colour, as follows:

- dark blue – strongly positive impact (this covers all plant types and scenarios where CHP is expected to experience a gain in net operating revenue from the ETS that is equivalent to over 20% of their underlying fuel costs);
- light blue – moderately positive impact (this covers all plant types and scenarios where CHP is expected to experience a gain in net operating revenue that is equivalent to between 4% and 20% of their underlying fuel costs);
- green – broadly neutral impact (this covers all plant types and scenarios where the impact on net operating revenue is expected to be between plus or minus 4% of their underlying fuel costs);
- yellow – moderately negative impact (this covers all plant types and scenarios where CHP is expected to experience a loss in net operating revenue that is equivalent to between 4% and 20% of their underlying fuel costs); and
- red – strongly negative impact (this covers all plant types and scenarios where CHP is expected to experience a loss in net operating revenue that is equivalent to over 20% of their underlying fuel costs).

2.13 The final column in Table 2 indicates the relative “importance” of each CHP type, based on the proportionate contribution that each is expected to make towards meeting the 2010 GW target (as presented in Table 1).

Table 2: Impact of EU ETS on different types of CHP plant (for key to table, please see paragraphs 2.11-2.13)

				Carbon cost pass-through into elec price	100%						50%						0%						% of total 2010 capacity
				% of emissions covered by free allocation	100%		50%		0%		100%		50%		0%		100%		50%		0%		
				Free allocations continue on closure?	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	
Existing CHP	Coal	Small	Low heat:power		46%	46%	46%	46%	46%	46%	23%	23%	23%	23%	23%	23%	0%	0%	0%	0%	0%	0%	0%
			High heat:power		17%	17%	17%	17%	17%	17%	8%	8%	8%	8%	8%	8%	0%	0%	0%	0%	0%	0%	0%
		Medium	Low heat:power		46%	46%	22%	22%	-2%	-2%	23%	23%	-1%	-1%	-25%	-25%	0%	0%	-24%	-24%	-48%	-48%	0%
			High heat:power		17%	17%	-8%	-8%	-32%	-32%	8%	8%	-16%	-16%	-40%	-40%	0%	0%	-24%	-24%	-48%	-48%	0%
		Large	Low heat:power		46%	46%	22%	22%	-2%	-2%	23%	23%	-1%	-1%	-25%	-25%	0%	0%	-24%	-24%	-48%	-48%	3%
			High heat:power		17%	17%	-8%	-8%	-32%	-32%	8%	8%	-16%	-16%	-40%	-40%	0%	0%	-24%	-24%	-48%	40%	1%
	Gas	Small	Low heat:power		32%	32%	32%	32%	32%	32%	16%	16%	16%	16%	16%	16%	0%	0%	0%	0%	0%	0%	4%
			High heat:power		11%	11%	11%	11%	11%	11%	6%	6%	6%	6%	6%	6%	0%	0%	0%	0%	0%	0%	0%
		Medium	Low heat:power		32%	32%	23%	23%	13%	13%	16%	16%	6%	16%	-3%	-3%	0%	0%	-10%	-10%	-19%	-19%	2%
			High heat:power		11%	11%	2%	2%	-8%	-8%	6%	6%	-4%	-4%	-13%	-13%	0%	0%	-10%	-10%	-19%	-19%	1%
		Large	Low heat:power		32%	32%	23%	23%	13%	13%	16%	16%	6%	6%	-3%	-3%	0%	0%	-10%	-10%	-19%	-19%	26%
			High heat:power		11%	11%	2%	2%	-8%	-8%	6%	6%	4%	14%	-13%	-13%	0%	0%	-10%	-10%	-19%	-19%	9%
Existing Boiler	Coal	Small	Low heat:power		46%	46%	46%	46%	46%	46%	23%	23%	23%	23%	23%	23%	0%	0%	0%	0%	0%	0%	0%
			High heat:power		17%	17%	17%	17%	17%	17%	8%	8%	8%	8%	8%	8%	0%	0%	0%	0%	0%	0%	0%
		Medium	Low heat:power		46%	46%	22%	22%	-2%	-2%	23%	23%	-1%	-1%	-25%	-25%	0%	0%	-24%	-24%	-48%	-48%	0%
			High heat:power		17%	17%	-8%	-8%	-32%	-32%	8%	8%	-16%	-16%	-40%	-40%	0%	0%	-24%	-24%	-48%	-48%	0%
		Large	Low heat:power		46%	46%	33%	22%	19%	-2%	23%	23%	10%	-1%	-4%	-25%	0%	0%	-14%	-24%	-27%	-48%	0%
			High heat:power		17%	17%	13%	-8%	9%	-32%	8%	8%	4%	-16%	0%	-40%	0%	0%	-4%	-24%	-8%	-48%	0%
	Gas	Small	Low heat:power		32%	32%	32%	32%	32%	32%	16%	16%	16%	16%	16%	16%	0%	0%	0%	0%	0%	0%	8%
			High heat:power		11%	11%	11%	11%	11%	11%	6%	6%	6%	6%	6%	6%	0%	0%	0%	0%	0%	0%	0%
		Medium	Low heat:power		32%	32%	23%	23%	13%	13%	16%	16%	6%	6%	-3%	-3%	0%	0%	-10%	-10%	-19%	-19%	6%
			High heat:power		11%	11%	2%	2%	-8%	-8%	6%	6%	-4%	-4%	-13%	-13%	0%	0%	-10%	-10%	-19%	-19%	0%
		Large	Low heat:power		32%	32%	27%	23%	21%	13%	16%	16%	11%	6%	5%	-3%	0%	0%	-5%	-10%	-11%	-19%	18%
			High heat:power		11%	11%	10%	2%	8%	-8%	6%	6%	4%	-4%	3%	-13%	0%	0%	-2%	-10%	-3%	-19%	0%
New heat load	Coal	Small	Low heat:power		46%	46%	46%	46%	46%	46%	23%	23%	23%	23%	23%	23%	0%	0%	0%	0%	0%	0%	0%
			High heat:power		17%	17%	17%	17%	17%	17%	8%	8%	8%	8%	8%	8%	0%	0%	0%	0%	0%	0%	0%
		Medium	Low heat:power		46%	46%	22%	22%	-2%	-2%	23%	23%	-1%	-1%	-25%	-25%	0%	0%	-24%	-24%	-48%	-48%	0%
			High heat:power		17%	17%	-8%	-8%	-32%	-32%	8%	8%	-16%	-16%	-40%	-40%	0%	0%	-24%	-24%	-48%	-48%	0%
		Large	Low heat:power		46%	46%	22%	22%	-2%	-2%	23%	23%	-1%	-1%	-25%	-25%	0%	0%	-24%	-24%	-48%	-48%	0%
			High heat:power		17%	17%	-8%	-8%	-32%	-32%	8%	8%	-16%	-16%	-40%	-40%	0%	0%	-24%	-24%	-48%	-48%	0%
	Gas	Small	Low heat:power		32%	32%	32%	32%	32%	32%	16%	16%	16%	16%	16%	16%	0%	0%	0%	0%	0%	0%	5%
			High heat:power		11%	11%	11%	11%	11%	11%	6%	6%	6%	6%	6%	6%	0%	0%	0%	0%	0%	0%	0%
		Medium	Low heat:power		32%	32%	23%	23%	13%	13%	16%	16%	6%	6%	-3%	-3%	0%	0%	-10%	-10%	-19%	-19%	4%
			High heat:power		11%	11%	2%	2%	-8%	-8%	6%	6%	-4%	-4%	-13%	-13%	0%	0%	-10%	-10%	-19%	-19%	0%
		Large	Low heat:power		32%	32%	23%	23%	13%	13%	16%	16%	6%	6%	-3%	-3%	0%	0%	-10%	-10%	-19%	-19%	12%
			High heat:power		11%	11%	2%	2%	-8%	-8%	6%	6%	-4%	-4%	-13%	-13%	0%	0%	-10%	-10%	-19%	-19%	0%

2.14 It can be seen from Table 2 that CHP plant are, on the whole, likely to be positively affected by the introduction of the EU ETS provided that the costs of carbon are passed through into electricity prices by conventional generating plant. This would make sense, given CHP's superior efficiency and hence low carbon intensity. However, the table also shows that there are quite a number of circumstances where the impact of the EU ETS on CHP is likely to be, at best, broadly neutral and, at worst, moderately or significantly harmful.

2.15 The table shows that "small" plant, where both the CHP plant and the equivalent heat-only boiler fall below the threshold of the scheme, are always likely to be neutrally or positively affected by the EU ETS[4]. This is because they are likely to reap any benefits occurring from an increase in electricity price, without having to incur any of the costs involved with taking part in the scheme.

2.16 Similarly, in all scenarios where all existing and new plant are allocated sufficient free allowances to cover at least 100% of their emissions then, as one would expect, they should all be at least neutral or better off under the scheme. This is because they are likely to reap any benefits occurring from an increase in electricity price, without having to incur any additional costs from purchasing allowances in the market.

2.17 The implications for existing or new CHP plant covered by the scheme, which do not receive sufficient allowances to cover their full emissions, are more complicated. These are discussed further below.

Impact on existing CHP

2.18 Table 3, overleaf, shows the impact of the EU ETS on existing CHP plant covered by the scheme that do not receive sufficient free allowances to cover their full emissions. The scenarios depicted would be likely to occur in cases where the allocation methodology used is very unfavourable to CHP or the overall reduction target imposed is extremely stringent.

[4] This is based on the assumption that no plant under the 20 MW threshold will be caught by the scheme. In reality, since the threshold is based on the aggregate thermal capacity from one site, then some of the implications highlighted in the case of "medium" CHP plant could also apply equally to some "small" plant where several combustion plant exist on one site.

Table 3: Impact of EU ETS on existing CHP plant (for table key, see pp 2.11-2.13)

Carbon cost pass-through into elec price			100%				50%				0%				% of total
% of emissions covered by free allocation			50%		0%		50%		0%		50%		0%		2010
Free allocations continue on closure?			Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	capacity
Coal	Medium	Low heat:power	22%	22%	-2%	-2%	-1%	-1%	-25%	-25%	-24%	-24%	-48%	-48%	0%
		High heat:power	-8%	-8%	-32%	-32%	-16%	-16%	-40%	-40%	-24%	-24%	-48%	-48%	0%
	Large	Low heat:power	22%	22%	-2%	-2%	-1%	-1%	-25%	-25%	-24%	-24%	-48%	-48%	3%
		High heat:power	-8%	-8%	-32%	-32%	-16%	-16%	-40%	-40%	-24%	-24%	-48%	40%	1%
Gas	Medium	Low heat:power	23%	23%	13%	13%	6%	16%	-3%	-3%	-10%	-10%	-19%	-19%	2%
		High heat:power	2%	2%	-8%	-8%	-4%	-4%	-13%	-13%	-10%	-10%	-19%	-19%	1%
	Large	Low heat:power	23%	23%	13%	13%	6%	6%	-3%	-3%	-10%	-10%	-19%	-19%	26%
		High heat:power	2%	2%	-8%	-8%	4%	14%	-13%	-13%	-10%	-10%	-19%	-19%	9%

2.19 Working on the assumption that existing plant are likely to be allocated at least some allowances for free under most NAPs, then the scenarios assuming that they would have to purchase all of their allowances are fairly unlikely. Focusing instead on the scenarios assuming that 50% of allowances are allocated for free, the table shows that all plant types would be worse off under the scheme if conventional generating plant do not pass the carbon cost through into electricity prices.

2.20 In cases where the carbon cost is only partially passed through into electricity prices, then most gas-fired plant benefit from the scheme (with the exception of those with a high heat to power ratio) while all coal-fired plant are still disadvantaged by the scheme. It is only in the case where the carbon cost is passed fully into electricity prices that coal-plant begin to benefit from the scheme, and even then, only if they have a high heat to power ratio. All gas-fired plant benefit from the scheme if the carbon cost is passed fully into electricity prices, though the extent of benefit again depends on the heat to power ratio.

Impact on potential new CHP arising from replacement of existing boilers

2.21 Table 4, overleaf, shows the impact of the EU ETS on potential new CHP development covered by the scheme arising from replacement of existing boilers, where the new plant do not receive sufficient free allowances to cover their full emissions. These scenarios would be likely to occur in cases where:

- an existing boiler is below the threshold of the scheme and the new CHP plant is above it and new entrants are not awarded free allocation to cover 100% of their emissions;
- replacement of a boiler originally covered by the scheme is considered to be a case of closure of one installation followed by new entry of another, and new entrants are not awarded free allocation to cover 100% of their emissions; or
- the definition of the installation does not change but the CHP plant does not receive additional free allowances to cover the new electricity generation component of its emissions.

Table 4: Impact of EU ETS on new CHP plant due to replacement of existing boilers
(for table key, see pp 2.11-2.13)

Carbon cost pass-through into elec price			100%				50%				0%				% of total
% of emissions covered by free allocation			50%		0%		50%		0%		50%		0%		2010
Free allocations continue on closure?			Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	capacity
Coal	Medium	Low heat:power	22%	22%	-2%	-2%	-1%	-1%	-25%	-25%	-24%	-24%	-48%	-48%	0%
		High heat:power	-8%	-8%	-32%	-32%	-16%	-16%	-40%	-40%	-24%	-24%	-48%	-48%	0%
	Large	Low heat:power	33%	22%	19%	-2%	10%	-1%	-4%	-25%	-14%	-24%	-27%	-48%	0%
		High heat:power	13%	-8%	9%	-32%	4%	-16%	0%	-40%	-4%	-24%	-8%	-48%	0%
Gas	Medium	Low heat:power	23%	23%	13%	13%	6%	6%	-3%	-3%	-10%	-10%	-19%	-19%	6%
		High heat:power	2%	2%	-8%	-8%	-4%	-4%	-13%	-13%	-10%	-10%	-19%	-19%	0%
	Large	Low heat:power	27%	23%	21%	13%	11%	6%	5%	-3%	-5%	-10%	-11%	-19%	18%
		High heat:power	10%	2%	8%	-8%	4%	-4%	3%	-13%	-2%	-10%	-3%	-19%	0%

2.22 Working on the basic assumption that new CHP plant would have to purchase all of their allowances from the market, and that any allowances from an existing boiler would be forfeited if the boiler were replaced with a CHP plant, then all plant types would be worse off under the scheme, unless conventional generating plant pass the cost of carbon fully through into electricity prices. If the cost of carbon is passed fully through into electricity prices, then gas-fired CHP with a low heat to power ratio (this makes up the majority of new CHP expected to switch from existing boilers) would benefit from the scheme, with all other plant types still being disadvantaged.

2.23 The situation is improved if new CHP plant are allocated some free allowances, or if they are allowed to keep their existing allowances if the existing boiler is replaced with a CHP plant. However, it should be noted that, even under these scenarios, all plant are still worse off if conventional plant do not pass any of the cost of carbon through into electricity prices.

Impact on potential new CHP arising from the emergence of new heat loads

2.24 Table 5, below, shows the impact of the EU ETS on potential new CHP development covered by the scheme arising from the emergence of new heat loads, where the new plant do not receive sufficient free allowances to cover their full emissions. These scenarios would be likely to occur in cases where new entrants are not awarded free allocation to cover 100% of their emissions. For the key to the table, please see paragraphs 2.11-2.13.

Table 5: Impact of EU ETS on new CHP plant arising from new heat loads

Carbon cost pass-through into elec price			100%				50%				0%				% of total
% of emissions covered by free allocation			50%		0%		50%		0%		50%		0%		2010
Free allocations continue on closure?			Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	capacity
Coal	Medium	Low heat:power	22%	22%	-2%	-2%	-1%	-1%	-25%	-25%	-24%	-24%	-48%	-48%	0%
		High heat:power	-8%	-8%	-32%	-32%	-16%	-16%	-40%	-40%	-24%	-24%	-48%	-48%	0%
	Large	Low heat:power	22%	22%	-2%	-2%	-1%	-1%	-25%	-25%	-24%	-24%	-48%	-48%	0%
		High heat:power	-8%	-8%	-32%	-32%	-16%	-16%	-40%	-40%	-24%	-24%	-48%	-48%	0%
Gas	Medium	Low heat:power	23%	23%	13%	13%	6%	6%	-3%	-3%	-10%	-10%	-19%	-19%	4%
		High heat:power	2%	2%	-8%	-8%	-4%	-4%	-13%	-13%	-10%	-10%	-19%	-19%	0%
	Large	Low heat:power	23%	23%	13%	13%	6%	6%	-3%	-3%	-10%	-10%	-19%	-19%	12%
		High heat:power	2%	2%	-8%	-8%	-4%	-4%	-13%	-13%	-10%	-10%	-19%	-19%	0%

2.25 Working on the basic assumption that new CHP plant arising from new heat loads would have to purchase all of their allowances from the market, then the situation

is similar to that discussed above for new CHP plant due to switching from existing boilers. The main difference is that new CHP plant arising from new heat loads do not have the option of retaining allowances from the existing boiler (because there isn't one), and hence the situation can only be improved by allocating free allowances directly to the new plant and/or ensuring that the cost of carbon is passed through into electricity prices.

Further considerations

2.26 The above analysis assumes that the methodology used when allocating allowances for free would be such that it could exactly cover the installation's level of emissions (or a specified proportion of them i.e. 100%, 50% or 0%). In reality, different types of allocation methodology (e.g. based on historic emissions or projected output etc) will lead to installations receiving different levels of allowances, and generally needing to buy or sell allowances in order to end up with the number that exactly cover their emissions. Quantitative analysis of the implications of specific different types of allocation methodology is outside the scope of this analysis, since it is understood that this has been covered elsewhere in the NAP methodology work for DEFRA. However, comparing the results set out above when installations are allocated allowances to cover 0%, 50% and 100% of their emissions levels respectively should at least illustrate the significance that variations in the level of allocation have on the desirability of investing in CHP.

2.27 The analysis undertaken segregates plant on the basis of the 20MW threshold. In reality, the fact that this rule is based on the aggregate thermal capacity from one site means that some combustion plant below 20MW will also be caught by the scheme. This means that some of the implications highlighted in the case of "medium" CHP plant could also apply equally to some "small" plant where several combustion plant exist on one site.

2.28 It is worth noting that, while the quantitative analysis set out above incorporates the factors that we think are likely to have the most significant impact on CHP plant, there are likely to be some additional impacts that are not covered by this analysis. These are discussed further below.

2.29 Firstly, there is likely to be an impact on underlying fuel prices (and hence further knock-on impacts on electricity prices) brought about by changes in demand for different fuels as a result of the scheme. In particular, one would expect that gas prices would increase slightly to reflect the higher level of demand brought about by the scheme. The magnitude of this impact is difficult to estimate, but the net effect of the increased gas price due to the EU ETS is likely to be small in comparison to the impacts which we have already identified.

2.30 Finally, the scheme will bring about increased administration costs, related to the monitoring, reporting and verification of emissions and transactions costs arising from participation in the trading markets. While these costs are likely to be relatively small for the majority of plant, their introduction could still have a significant impact on smaller CHP plant. This is particularly the case in situations

of marginal profitability, where a small change in fixed costs could affect whether it is more profitable to have a CHP plant within the scheme or a heat-only boiler outside the scheme.

[This page is intentionally blank]

3. IS THERE JUSTIFICATION FOR TAKING ACTION?

3.1 The analysis in the previous section shows that CHP would be positively affected by the scheme, provided that both existing and new plant are allocated sufficient free allowances to cover all of their emissions and that the cost of carbon is fully passed-through into electricity prices. However, if CHP plant are not freely allocated all of the allowances that they require, or the cost of carbon is not fully passed-through into electricity prices, then the analysis shows that a significant proportion of CHP plant covered by the scheme could well be negatively affected by its introduction, despite CHP's superior efficiency and low carbon intensity. The magnitude of the expected impact means that the consequences could be severe (Table 2 shows that estimated financial implication of the EU ETS on some CHP types can be up to +/-50% of underlying fuel costs).

3.2 However, many sectors are likely to claim to be adversely affected by the scheme and to argue that they should be compensated through additional allocation of allowances. By its very nature, the distribution of allowances under the NAP will be a zero sum game, with additional allocations for specific sectors having to be "paid for" through reducing the allowances available to others. Why should CHP be treated as a special case?

3.3 Before the UK government can decide whether to develop special rules for CHP, it must satisfy itself on two issues:

1. ***Will the outcome of special measures be more economically efficient?*** Rather than simply affecting the distribution of allowances, will any intervention actually result in an overall net benefit in terms of the economic efficiency of the scheme?
2. ***Is it a sufficiently large issue to be worried about?*** Even if it could be shown that special treatment for CHP would lead to a more economically efficient outcome, if the number of potentially affected schemes is relatively small, then it would probably not be worth the considerable time and effort required to develop such special rules.

3.4 This section examines whether there is sufficient justification for using the NAP to rectify the issues identified in Section 2. Firstly the extent to which there are theoretical reasons for intervention is explored. Then we use some high-level calculations to estimate the general magnitude of these issues.

Theoretical justification

3.5 The existence of the 20MW threshold for combustion plant allows "leakage" out of the scheme. If those on the margin of being affected by the scheme gain from making decisions that avoid them being captured by the scheme, then this is likely to result in perverse behaviour.

3.6 The EU ETS has a number of different size/output thresholds across the different sectors that it covers. In general, these could have a small efficiency impact on the scheme by providing perverse incentives for potential participants to change their main business operations in order to avoid being captured by the scheme. In the case of CHP, this would be the equivalent of deliberately decreasing the overall heat-demand needed by the business (e.g. by decreasing the organisation's product output) in order that a smaller CHP plant could be built, or deliberately building several smaller plant on adjacent sites so that the threshold is not breached. While there is a chance that this could occur in theory, the main business implications of doing so would generally far outweigh any benefits derived from avoiding being covered by the scheme, and hence it is unlikely to occur in practice, except in some very marginal cases.

3.7 Of much greater significance is the fact that a CHP plant requires a much larger capacity than a boiler providing an equivalent heat load. Since the CHP plant and the heat-only boiler (combined with purchase of electricity) are close substitutes that can be interchanged without impacting noticeably on main business activity, then this provides a classic opportunity for such leakage to occur.

3.8 Many potential CHP developments (all those labelled as being of "medium" size in the analysis in Section 2) will face an explicit choice between using a heat-only boiler that is below the threshold capacity for the scheme, or an equivalent heat-load CHP plant that is above the threshold[5]. Installations on the margin of being covered by the scheme will therefore effectively be able to opt-out of the scheme by using a standard boiler rather than a CHP plant. Where CHP is being disadvantaged by the EU ETS, this effectively means that CHP is facing unfair competition from heat-only boilers of less than 20MW. If the scheme is such that it influences a significant number of potential CHP developers to stick with boilers instead, then not only is this economically inefficient, but the existence of emissions leakage also increases total emissions levels.

3.9 Another potential issue relates to the fact that the administration costs arising from the scheme, in terms of monitoring, reporting and verification, are likely to result in a proportionately larger burden on CHP installations than they would on conventional plant, given the small scale of most CHP installations. Given the existence of the 20MW threshold, and the marginal profitability of most CHP plant, then these administration costs alone could potentially be sufficient to tip the balance in favour of a heat-only boiler that escapes coverage of the scheme.

3.10 Two further issues that could exacerbate the impact of the threshold effect discussed above relate to new entrants more generally. Firstly, new entrants are likely to face a higher proportion of fixed costs than incumbents, since a large proportion of an existing plant's costs associated with construction are sunk costs and hence should not influence their decision-making. Since organisations will

[5] This additionally relates to some "small" CHP developments (i.e. below the 20MW threshold) in cases where several combustion plant exist on one site and the introduction of a CHP plant would bring the aggregate capacity above the threshold.

need to be covering their fixed costs in order to stay in business, then anything impacting negatively on a potential installation's ability to cover their fixed costs (e.g. the need to buy emissions allowances) could tip the balance between the project going ahead or not.

3.11 Secondly, the decision time horizon is very different for existing and new-build plant. For existing plant, the decision to stay open or not is based on price expectations for one or two years out. Even if they decide to cease operations, the plant can be mothballed, retaining the option to open again if the price environment improves. For new-build, however, decisions need to be based on consideration of price expectations for up to 10-15 years out. If there is considerable uncertainty over allowances – both over their price and the extent to which they will receive a free allocation – then it is likely to have a much more negative impact than for existing plant.

3.12 Although these new entry issues are not specific to CHP, they do have particular significance for CHP, given the level of new entry involved. Since CHP is still very much a developing technology, the majority of CHP plant affected by the scheme from 2005 to 2012 are likely to be potential new entrants rather than existing plant. This is far higher than the potential rates of new entry that might be expected in other sectors.

3.13 The combination of these factors (i.e.:

- the 20 MW thermal input capacity threshold;
- the fact that CHP plant are larger than the equivalent heat-only boilers;
- the marginal profitability of most CHP plant at present;
- the additional administration costs involved; and
- the high proportion of new entrants expected in the sector)

signifies that the scale of CHP development is likely to be affected by allocation decisions. This means that different allocation decisions for CHP will not just result in distributional implications, as they would in many other sectors, but they will also have implications for economic efficiency and overall emissions levels.

3.14 We consider that the existence of these factors provides sufficient theoretical justification for using the NAP to ensure that the different types of CHP plant are not disincentivised by the introduction of the scheme.

3.15 Whether there is additional economic justification for going beyond this and using the NAP to actively further incentivise CHP will depend upon the extent to which the market price for carbon, and the extent to which the carbon cost is passed through into electricity prices, will completely encapsulate the true damage costs of CO_2 emissions. If it is thought that the true costs of carbon are likely to be above that reflected in the electricity market price then, given that our analysis shows that the scale of CHP development is likely to be influenced by the level of allowances allocated, there could be an additional argument for ensuring that CHP is further incentivised through the scheme. Consideration of the expected market

price of carbon, and the true social costs of carbon, are outside the scope of this project. However, some options for ensuring that the full market price of carbon is passed through into electricity prices are identified in Section 4.

Estimating the scale of the issue

3.16 In order to estimate the scale of the issue in terms of the potential impact on CHP capacity and the total expected CO_2 emissions from new plant, ILEX further developed its model using the Cambridge Econometrics data as a basis for the split between technology types and plant sizes.

3.17 The main implications for the economic efficiency of the scheme relate to the substitution away from CHP, to heat-only boilers, in order to avoid being covered by the scheme. It is therefore only really the "medium" plant (i.e. those where the CHP plant would be above the 20MW threshold while the equivalent heat-only boiler would be below it) that are likely to have the opportunity to do this[6]. Based on the breakdown of expected plant in Table 1, 13% of CHP are medium sized. Therefore, approximately 1.3GW of the 10GW of 2010 capacity (or 1.1GW of the 8.4GW expected capacity in 2007, using linear interpolation between 2000 and 2010 levels) would have the opportunity to avoid the scheme by switching to heat-only boilers.

3.18 While the calculation above provides an indication of the "opportunity" for leakage, we also need to establish the extent to which there is likely to be a "motive" for perverse behaviour. This will clearly vary under different scenarios. Under the most pessimistic scenario conditions (i.e. where there are no free allocations of allowances for either existing CHP or new entry, the cost of carbon is not reflected in the electricity price and those switching from existing boilers to CHP lose their allocations in the process), then 100% of medium sized plant would be disadvantaged by the scheme and hence could have a potential motive for perverse behaviour.

3.19 A more realistic base case scenario might be where existing plant are allocated 100% of their allowances for free, while new entry plant have to purchase all their allowances (including those switching from existing boilers who lose their allocations in the process) and the cost of carbon is partially reflected in the electricity price. Even using these assumptions, then our analysis shows that 78% of medium sized plant would still be disadvantaged by the scheme, and hence could have a potential motive for perverse behaviour. This roughly corresponds to 1.0GW of the 10.0GW target in 2010, or 0.8GW of the 8.4GW expected capacity in 2007.

---

6 As noted before, it is possible that there could be a similar substitution away from "small" CHP caught by the aggregation threshold due to there being several combustion plant on one site. It is also possible that there could be some additional substitution away from "large" CHP through developers deliberately building several smaller plant on adjacent sites so that the threshold is not breached. However, this is thought to be much less probable, since the costs involved with doing so are likely to be significant.

3.20 Whilst it is not possible to prove that those medium-sized plant disadvantaged by the scheme would definitely switch to heat-only boilers in order to avoid it, the general scale of impacts indicated by our analysis[7] suggests that the effect on operational decisions could be significant.

3.21 The incentive for switching away from CHP towards heat-only boilers as a result of the scheme could be mitigated by treating CHP more favourably in the allocation process. If both existing and new entry CHP were allocated sufficient allowances to cover all of their emissions, then none of the medium sized plant would be disadvantaged by the scheme and hence none of the plant would have an incentive for perverse behaviour.

3.22 Allocations to ensure that existing CHP plant receive sufficient allowances would be dealt with by the allocation methodology used in the NAP itself. However, if the UK government decided to allocate 100% of free allowances to new entry CHP, they would need to set-aside sufficient allowances in the NAP for this purpose, so that these could be allocated out later.

3.23 ILEX estimates of the approximate quantity of allowances that might be needed to be set aside for this purpose are set out in Table 6. These are based on a combination of the Cambridge Econometrics projections, supplementary data provided from AEAT and our own knowledge of the characteristics of the different plant technologies that are likely to develop over time. We have assumed that all CHP plant entering the market after 2003 will be treated as a new entrant in the scheme.

Table 6: CO_2 emissions arising from new entry CHP in the EU ETS

CO_2 emissions ($ktCO_2$)	**2005**	**2006**	**2007**	**Total**
Emissions from post-2003 CHP plant > 20MW th input	**1684**	**3242**	**4800**	**9725**
Less:				
Emissions from displaced heat-only boilers > 20 MW th input	614	1282	1949	3845
Emissions from displaced conventional electricity	2497	4916	7336	14749
Total emissions within the scheme displaced by new-entry CHP	3111	6198	9285	18594
Net reduction in scheme emissions due to new-entry CHP	***1428***	***2956***	***4485***	***8869***

3.24 Table 6 shows that a set-aside based solely on the level of emissions expected from the new-entry plant themselves would need to be in the region of $10MtCO_2$ (based on cumulative emissions for 2005, 2006 and 2007). However, given that the additional CHP plant would actually be displacing larger quantities of emissions from other sources already covered by the scheme (our analysis indicates that up to $19MtCO_2$ could be displaced from existing conventional

[7] For some types of plant, our analysis shows that the negative financial impact of the EU ETS could be the equivalent of up to a 48% increase in fuel costs. This would have a massive impact on plant viability.

electricity and heat-only boilers as a result of the additional CHP), then an alternative option would be to remove this larger quantity from the initial allocation in order to retain the overall stringency of the target.

4. RECOMMENDATIONS FOR HOW THESE ISSUES MIGHT BE ADDRESSED THROUGH THE EU ETS

4.1 The analysis set out in Sections 2 and 3 shows that there are three main factors affecting the impact of the EU ETS on CHP development, all of which could be influenced by the NAP to some extent:

- **The level of free allowances given to existing plant**
  - ensuring that existing plant are allocated sufficient allowances to completely cover their emissions would remove the incentive for substitution away from existing medium-sized CHP towards heat-only boilers;
- **The treatment of new entrants**
  - allocating free allowances to new CHP plant, rather than making them purchase allowances from the market, would remove the incentive for new entrants to substitute heat-only boilers for potential medium-sized CHP plant solely in order to avoid being captured by the scheme;
  - if it is not deemed appropriate to allocate free allowances to new entrants, there is a second-best option which would reduce, though not remove, the perverse incentive for existing boilers. This would be to ensure that existing boilers were able to retain their free allowance allocation when switching to CHP, rather than having to relinquish them and purchase 100% of their required allocation as a new-entrant;
- **The extent to which the carbon cost is reflected in the electricity price**
  - giving more stringent allocations to conventional power producers would increase the likelihood that they would incorporate the cost of carbon into their pricing decisions[8].

4.2 Analysis related to the implications of specific allocation methodologies is being undertaken as part of the main NAP study[9] and are hence outside the scope of this note. However, we would suggest that there are two main ways of ensuring that CHP plant are allocated a sufficient quantity of allowances to prevent perverse behaviour: these are the sectoral level approach and the plant level approach.

---

8 While economic theory dictates that the cost of carbon should be factored into product prices, regardless of allocation methodology, initial indications from the large integrated utilities are that they would not be expecting to pass this cost onto their customers. Relatively lax allocations to electricity generators could facilitate this inertia by allowing plant to continue operating and pricing as before (even if this is not profit-maximising behaviour). Reducing the quantity of allowances allocated to conventional generation, so that they have to purchase allowances if they want to continue operating at business as usual levels, may help to facilitate the change process and bring about an economically efficient allocation of resources.

9 "*Alternatives for implementing the UK's National Allocation Plan*" prepared by NERA, AEAT and SPRU, August 2003.

The sectoral level approach:

- first, the total allocation required for CHP plant as a whole could be identified, based on 100% of projected emissions for CHP during the course of the scheme;
- this amount could then be netted off the total sectoral allocation intended for electricity generation or combustion installations;
- CHP could then be treated as a sector in itself, with allocations being further split, based on projected emissions, between that needed for existing plant and that to be set aside for new entrants;
- the allocation methodology for existing plant could be based on e.g. historic emissions or historic output[10];
- for new plant, allocations could potentially be based on capacity, using a benchmark to estimate average / efficient emissions levels per MW; and
- an alternative option, if allowed under the terms of the directive, could be for allocations to new entrants to be given out retrospectively during the reconciliation period to exactly reflect actual emissions levels[11].

The plant level approach:

- using this approach, the total electricity sector emissions could be estimated on the basis of projected emissions for all generation plant, including CHP;
- the within sector allocation methodology for existing plant would then need to reflect the expected level of emissions for existing CHP plant:
  - this would probably need to be done through applying an emissions benchmark to historic output levels (with the emissions factor ideally taking account of the additional heat, as well as power, output of CHP if at all possible);
  - either a favourable base year could be used (probably pre-NETA), or CHP plant could potentially be given the choice of a number of recent years in order to avoid the situation where CHP plant are penalised by the recent dip in CHP use due to current market conditions; and
- a large set-aside would be needed in order to cater for all potential generation entrants (or potential entrants across the scheme as a whole). As demonstrated in paragraph 3.23 for CHP plant, new-entrant plant in general are likely to be more carbon-efficient than any existing plant being displaced, so they will actually reduce the need for existing plant to have allowances. This can be taken into account when allocating for existing plant.

---

[10] Since the total level allocated to CHP is determined at the sectoral level, the actual allocation methodology chosen for distribution between CHP is less significant than if the methodology was being used to allocate between CHP and conventional plant.

[11] This retrospective approach would not be allowed for allocations to existing plant, so it is probably likely that the Commission would not allow this to be used for new entrants either.

4.3 From the point of view of CHP, the first of the two approaches would be preferable. This is because it is easier to address the specific concerns of CHP, and to ensure that they receive a favourable allocation, if they are dealt with separately, rather than if a standard allocation methodology has to be applied across the generation/combustion sector as a whole.

4.4 In order to ensure that the cost of carbon is reflected in electricity prices, the allocation methodology used would need to bear heavily on conventional coal-fired electricity generators. This could be done through one, or all, of:

- allocating between sectors on the basis of projected rather than historic – this would decrease the level of allowances allocated to the electricity sector[12];
- allocating a proportion of electricity sector allowances to end-users on the basis of indirect emissions – since the end-user would also have to be a direct emitter in order to benefit from this, this could have an additional favourable impact on CHP[12]; and
- allocating within the electricity generation sector on the basis of output rather than emissions – this would mainly remove allocations from the price-setting coal-fired generators, instead favouring the more carbon-efficient generators, such as CHP and CCGT. It can be seen that allocating on the basis of electrical output alone would result in a significantly less favourable allocation to CHP than a methodology that acknowledged both heat and power outputs.

4.5 Table 7, below, shows average emissions per MWh of electrical output, and per MWh of electrical and heat output, for different plant type. This helps to illustrate the extent to which an output-based allocation would benefit CCGT, and to some extent CHP, at the expense of coal-fired generators. It can be seen that allocating on the basis of electrical output alone would result in a significantly less favourable allocation to CHP than a methodology that acknowledged both heat and power outputs.

Table 7: Average emissions per MWh of electrical output

Fuel	Plant type	tCO_2/MWh(e)	tCO_2/MWh(e+h)
Conventional electricity			
Gas	CCGT	0.36	0.36
Coal	Large coal	0.87	0.87
CHP			
Gas	Low heat:power	0.51	0.26
Gas	High heat:power	1.44	0.23
Coal	Low heat:power	0.89	0.45
Coal	High heat:power	2.50	0.39

[12] However, it should be recognised that if CHP is treated as part of the wider electricity sector (the second of the two approaches to CHP allocation set out overleaf), then any adjustments to reduce the number of allowances available to the sector as a whole would also be likely to result in underallocation to CHP; unless a particularly favourable allocation methodology were used to distribute allowances on a plant-by-plant basis.

4.6 If such allocation methodologies are not used, and conventional coal-fired generators are given relatively generous allocations of allowances, then it is more likely that carbon prices will not be passed through into electricity prices, and that CHP and other more carbon-efficient generators may actually be worse off under the scheme.

4.7 In conclusion, our analysis in Section 2 shows that the EU ETS could potentially have a significantly negative impact on certain types of CHP plant. Section 3 demonstrates both that there is sufficient theoretical justification to intervene through the NAP, and that the magnitude of potential impacts (both positive and negative) is high relative to underlying fuel costs and hence could have a significant impact on overall CHP levels. Section 4, above, suggests that there are a number of ways in which the NAP could be used to rectify the situation, including ensuring that both existing and new plant receive sufficient free allocation to cover all of their emissions and by allocating less to conventional generation plant in order to facilitate the cost-pass through of carbon into electricity prices.

4.8

ANNEX A: SUMMARY OF ASSUMPTIONS USED

Assumptions relating to average plant efficiencies	Average electricity efficiency	Average heat efficiency	Average total efficiency
Combined-Cycle Gas Turbine plant	50%	-	50%
Coal plant	36%	-	36%
Heat only boilers	-	75%	75%
Back Pressure Steam Turbine CHP	12%	69%	81%
Combined-Cycle Gas Turbine CHP	37%	36%	73%
Gas Turbine CHP	27%	40%	67%
Internal Combustion Engine CHP	34%	45%	79%
Pass-Out Condensing Steam Turbine CHP	13%	65%	78%
MicroGen CHP	25%	51%	76%

Other assumptions	
Market price of carbon	€10/tCO_2
Price of gas	2.6 €/GJ[13]
Price of coal	1.8 €/GJ[13]
Extent to which coal:gas on margin and hence setting electricity prices	90:10
Load factor (used for estimating the number of allowances that would need to be set-aside to cater for new entrants)	63%
Coal:gas ratio of fuel used for generation from existing CHP plant	10:90

[13] It should be noted that this is only the price of fuel to CHP generators. No fuel prices are used for conventional generators. This is because the calculation only looks at the *net* impact on conventional generators' costs due to the cost of carbon – i.e. it doesn't calculate conventional generators' full costs.

Coal:gas ratio of fuel used for generation from new CHP plant	0:100
Ratio of new CHP expected by 2010 relating to new heat loads as opposed to replacement of existing boilers	40:60
Low heat to power ratio	1:1
High heat to power ratio	5.4:1

NOTE 1: JUSTIFICATION FOR AWARDING NEW-ENTRANT CHP PLANT CO_2 ALLOWANCES FREE-OF-CHARGE – 23 SEPTEMBER 2003

1. INTRODUCTION

1.1 This note is the result of a telephone conversation between Simon Coates of ILEX and Nader Bahri of DEFRA.

1.2 It sets out a series of bullet points as to why new-entrant CHP plant should receive CO_2 allowances free-of-charge.

2. WHY SHOULD NEW-ENTRANT CHP PLANT RECEIVE CO_2 ALLOWANCES FREE-OF-CHARGE

- The decision whether to allocate CO_2 allowances to new-entrants free-of-charge will have economic efficiency impacts
  - Our analysis indicates that the decision whether to develop a CHP plant or not will be significantly influenced by the extent to which the plant is awarded CO_2 allowances free-of-charge. This is because CO_2 allowances represent a significant percentage of a CHP scheme's operating income, and because the economics of CHP plant are very marginal at the moment.
  - This clearly has resource allocation implications not just in terms of capital, but also in terms of fuel and emissions.
  - In addition, the fact that there is a 20MWth threshold for inclusion within the scheme means that there is the risk of 'leakage' out of the scheme. This is because the thermal capacity of a CHP plant can be significantly greater than the thermal capacity of a heat-only boiler serving the same heat load. Accordingly if new-entrants are faced with having to purchase their CO_2 allowances rather than having them awarded free-of-charge, developers may decide to develop a heat-only boiler which is less than 20MWth (and therefore be exempt from the need to purchase allowances) rather than a CHP plant and be faced with having to purchase allowances.
- It is a sufficiently large issue for government to be concerned about
  - Over 4GWe of new-entrant CHP capacity is required in order to meet the government's 10GW target by 2010.
  - This represents a significant proportion of the UK's energy requirements and, due to the significantly different carbon intensities between CHP

plant and the existing electricity generators they would be displacing, will have a major impact on the UK's CO_2 emissions.

- Awarding allowances to new-entrants free-of-charge will put them on a level playing field with existing plant
  - From an equity point-of-view, it can be argued that awarding allowances free-of-charge to new entrants in the same way as they are awarded to existing plant is only 'fair'. Once they are on a level playing field, they would then be able to compete on their own merits.
- By withholding CO_2 allowances from existing generators, there is a greater likelihood that price-setting generators will properly reflect cost of carbon in electricity prices.
  - If existing price-setting generators are given sufficient CO_2 allowances to cover their emissions there is a very real risk that they will not properly reflect the value of carbon in electricity prices.
  - This would result in the wrong price signals being given to generators and consumers, and consequentially a mis-allocation of resources.
  - Alternatively, if price-setting generators are forced to purchase a greater proportion of their required CO_2 allowances they will be much more likely to factor the cost of CO_2 into their production and pricing decisions.
  - Withholding allowances for new-entrants will automatically result in existing price-setting generators being awarded fewer allowances.
- Allowances would be withheld from existing generators which, because they would be displaced by the new-entrant CHP plant, wouldn't need them anyway.
  - As set out in Table 6 of our report[14], the allowances required by new-entrant CHP plant would be more than offset by the reduction in required allowances from the existing conventional generators that would be displaced by the CHP plant.

[14] *"NAP implications and options for CHP – A report to DEFRA"*, ILEX, August 2003

3. HOW MIGHT CO_2 ALLOWANCES BE AWARDED?

3.1 If it is accepted that withholding allowances for award to new-entrant CHP plant would be beneficial to the UK economy and consistent with the aims of the EU Emissions Trading Scheme, there remains the question of how this should be achieved. In this respect there are three questions that must be addressed:

- Should CHP be treated differently from other new-entrants?
  - Awarding allowances to CHP new-entrants but not to other new-entrants (e.g. a CCGT) could only realistically be achieved if CHP were treated as a completely different sector to the electricity sector. Even then the government would need to justify why CHP is sufficiently different to justify such special treatment. Possible arguments include:
    - It is a sector whose percentage of expected new-entrants compared to existing plant is sufficiently large to warrant special treatment for new-entrants.
    - It is much more affected by the 20MWth threshold level than other sectors, and hence there is much more scope for perverse behaviour if new-entrants aren't awarded a free allocation.
    - It is a sector whose high carbon-efficiency is consistent with the aims of the EU ETS.
    - It is a sector whose benefits to the UK economy coupled with the existence of significant barriers have justified a major UK government target for its development (namely 10GWe by 2010).
- How many CO_2 allowances should be withheld?
  - There is a danger that more new-entrants come forward than were estimated at the time when the decision regarding how many CO_2 allowances should be withheld. This would result in a situation whereby later new-entrants might not receive the allowances they were 'due'.
  - To prevent this happening, governments would need to err on the side of withholding more allowances than they expect would be needed. However, as previously stated, because CHP plant would be displacing less carbon-efficient generators, this should not be a problem. One option would be to withhold an amount equal to the projected displaced electricity and heat emissions as these should be greater than the amount required by new-entrants, and means that existing generators do not get more than they need.
- How should allowances be awarded to new-entrants?
  - In order to ensure that those technologies that are the most carbon-efficient (and hence consistent with the aims of the ETS) receive the greatest benefit, the award of allowances should be based on a methodology that takes account of an installation's carbon-intensity. A benchmarking methodology linked to an installations rated capacity would achieve this and be very simple to administer.

- Such a solution would also proportionately award CHP more than other new-entrants if it was decided that all new-entrants (including non-CHP plant) should be awarded allowances free-of-charge.

NOTE 2: PROJECTIONS OF NEW CHP CAPACITY AND ASSOCIATED CO_2 EMISSIONS – 1 OCTOBER 2003

1. INTRODUCTION

1.1 ILEX has been asked to develop further the analysis presented in our report *"NAP Implications and Options for CHP"*.

1.2 The intention of this further work is to help answer the following questions:

- *Will awarding CO_2 allowances free-of-charge to new-entrant plant have a significant impact on the amount of new CHP that is likely to be developed over the next ten years?*
- *What will be the implications of new CHP plant development in terms of CO_2 emissions?*

1.3 This note sets out the results of this follow-on analysis. Given the extremely short timescale for delivery of this work, ILEX must caveat the analysis by stating that these represent our best estimates given relatively poor data availability and relatively unsophisticated models.

2. HOW MUCH MORE NEW CHP MAY COME FORWARD AS A RESULT OF AWARDING ALLOWANCES TO NEW-ENTRANTS FOR FREE?

2.1 ILEX believes it is impossible to quantify such a figure without a major piece of analysis.

2.2 Instead, in this analysis we aim to demonstrate three things:

1. Awarding allowances to new-entrants free-of-charge will have a major positive impact on their economics;
2. Not allocating new-entrants permits free-of-charge could add significant risk to CHP economics, hence stifling new CHP capacity;
3. There exists a significant amount of potential new CHP capacity whose economics are marginal.

2.3 By demonstrating these three facts we believe it is reasonable to assume that a significant proportion of these potential schemes will have their economics *and risk profiles* sufficiently improved to warrant their development.

Financial impact of award of free allowances to new-entrant CHP plant

2.4 Using the model ILEX developed for the previous piece of work, ILEX has calculated the financial benefit to new CHP schemes of 100% free allocation of allowances expressed in £/kWe/yr.

2.5 Such avoided costs represent pure bottom line benefit to the scheme's net operating revenues compared with the outlook pre-NAP. In order to help quantify this benefit, ILEX then calculated the present value of 10 years worth of such avoided costs using a pre-tax, real discount rate of 12%. The resulting £/kWe number is then directly comparable with the £/kWe capital cost of developing a plant.

2.6 Table 8 below presents the results of this analysis.

Table 8 - PV benefit of 100% free allocation of CO_2 allowances

CO_2 cost (€/t)	5	10	20
PV of allowances (£/kWe)	55	111	221

2.7 The PV benefit is directly proportional to the amount of allowances awarded for free. Thus, the PV benefit of awarding 50% of required allowances for free would be half that of awarding 100% of allowances for free.

2.8 The capital cost of a 'typical' new CHP plant is 800 £/kWe ± 200[15]. Clearly, the PV benefit of free allowances represents a significant contribution to the plant's capital costs, and could thus be regarded as having a major positive impact on a scheme's economics.

Amount of CHP potential

2.9 The detrimental change in market conditions that has affected CHP over the last few years has resulted in a significant number of potential schemes being put on hold. ILEX's report "*Review of CHP Projections to 2010*"[16] identifies 24 specific schemes that have been put on hold or scrapped. The total capacity of such schemes was 3.4 GWe.

---

15 Source: Telephone conversation with Graham Meeks of CHPA and several CHP developers.

16 A report to Future Energy Solutions, May 2003.

2.10 Without knowing the specific details of each scheme it is impossible to say whether the awarding of free allowances in itself will be enough to make the projects viable again.

2.11 However, given that the CO_2-induced rise in electricity prices will itself significantly improve the economics of such schemes, it is reasonable to assume that the award of free allowances will 'make the difference' for a reasonable % of these schemes and others like them.

2.12 If it 'makes the difference' for just 17% of these schemes it would result in 600MWe of capacity being developed that would not otherwise have appeared.

2.13 It is worth making the point that it is not just the projected financial benefit to CHP schemes that will improve the chances of such projects being developed. Of key importance is the removal of a significant amount of risk given that the award of free allowances means that new CHP schemes are neutral to the cost of CO_2 that emerges.

3. QUANTITY OF CO_2 EMISSIONS ARISING FROM NEW CHP DEVELOPMENT

3.1 If new-entrant plant are to be given allowances for free, the UK government needs to know how many allowances to hold back to award such plant. ILEX has developed projections of CO_2 emissions arising *and avoided* as a result of the development of new CHP plant.

3.2 Such projections were developed for four different scenarios:

1. The Cambridge econometrics 10 GWe by 2010 projections;
2. An ILEX scenario resulting in 6.5 GWe by 2010;
3. An ILEX scenario resulting in 8 GWe by 2010; and
4. An ILEX scenario resulting in 10 GWe by 2010.

3.3 The numbers for the three ILEX scenarios are simply arrived at by applying crude factors to the Cambridge Econometrics data. All the ILEX scenarios assume that the rate of development is slower in the earlier years and faster for the later years. This is based on the assumption that there will be a significant lead time between the economics of CHP picking up, and new CHP capacity being developed.

3.4 We present data out to 2012 in order to cover the full extent of the second phase of the EU ETS. The projections for the years 2011 and 2012 assume a rate of development 50% of that between the years 2005 and 2010.

3.5 The data presented shows how many allowances will be required by new-entrant CHP plant[17]. However, a key aspect of CHP is that it will be avoiding emissions that would otherwise have occurred due to the separate provision of heat and power by heat-only boilers and conventional generation respectively.

3.6 Accordingly, we also present the emissions that would have otherwise occurred if the heat load were satisfied by heat-only boilers of greater than 20MWth capacity. Here we distinguish between existing boilers that will receive allowances in their own right, and new heat loads. In addition, we present the emissions that would have occurred if the electricity were generated by conventional generators.

3.7 The net impact is presented which shows that CHP plant lead to a significant reduction in overall emissions. This is an extremely powerful argument justifying the withholding of allowances from electricity generators to award to new-entrant CHP because such electricity generators *wouldn't have needed the allowances anyway*.

3.8 The tables below present the results.

Table 9 - Projected CO_2 emissions arising from, and avoided by, new CHP plant for different scenarios (kt)

									Total	
CE projections scenario	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2005-7**	**2008-12**
Post-2003 CHP plant emissions	1,912	3,486	5,063	6,655	8,251	9,847	10,645	11,443	10,461	46,842
Less displaced emissions from										
>20MWth Existing boilers	-488	-897	-1,307	-1,721	-2,134	-2,548	-2,755	-2,961	-2,692	-12,120
>20MWth New heat loads	-325	-598	-872	-1,147	-1,423	-1,699	-1,836	-1,974	-1,795	-8,080
Conventional generating plant	-2,696	-5,199	-7,704	-10,216	-12,730	-15,245	-16,502	-17,759	-15,599	-72,452
Overall impact	-1,598	-3,208	-4,820	-6,429	-8,037	-9,644	-10,448	-11,252	-9,625	-45,809

									Total	
ILEX 6.5 GW scenario	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2005-7**	**2008-12**
Post-2003 CHP plant emissions	246	1,003	1,763	2,529	3,295	4,060	4,443	4,826	3,013	19,152
Less displaced emissions from										
>20MWth Existing boilers	-70	-249	-429	-613	-796	-980	-1,071	-1,163	-748	-4,623
>20MWth New heat loads	-47	-166	-286	-409	-531	-653	-714	-775	-499	-3,082
Conventional generating plant	-238	-1,397	-2,557	-3,719	-4,882	-6,045	-6,626	-7,208	-4,192	-28,480
Overall impact	-109	-808	-1,509	-2,212	-2,915	-3,617	-3,969	-4,320	-2,426	-17,033

									Total	
ILEX 8 GW scenario	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2005-7**	**2008-12**
Post-2003 CHP plant emissions	416	1,816	3,219	4,628	6,037	7,446	8,151	8,855	5,451	35,119
Less displaced emissions from										
>20MWth Existing boilers	-102	-459	-817	-1,178	-1,539	-1,900	-2,081	-2,261	-1,378	-8,958
>20MWth New heat loads	-68	-306	-544	-785	-1,026	-1,267	-1,387	-1,507	-918	-5,972
Conventional generating plant	-440	-2,631	-4,824	-7,020	-9,216	-11,412	-12,510	-13,608	-7,895	-53,767
Overall impact	-194	-1,579	-2,966	-4,355	-5,743	-7,132	-7,827	-8,521	-4,740	-33,578

[17] We assume that plant will be classed as 'new entrant' if it is developed post 2003.

ILEX 10 GW scenario	2005	2006	2007	2008	2009	2010	2011	2012	Total 2005-7	Total 2008-12
Post-2003 CHP plant emissions	865	2,962	5,063	7,169	9,276	11,382	12,435	13,488	8,890	53,750
Less displaced emissions from										
>20MWth Existing boilers	-212	-759	-1,307	-1,859	-2,410	-2,962	-3,237	-3,513	-2,279	-13,981
>20MWth New heat loads	-142	-506	-872	-1,239	-1,607	-1,974	-2,158	-2,342	-1,519	-9,321
Conventional generating plant	-1,101	-4,402	-7,704	-11,009	-14,314	-17,619	-19,272	-20,924	-13,206	-83,138
Overall impact	-590	-2,704	-4,820	-6,938	-9,055	-11,173	-12,232	-13,291	-8,115	-52,689

NOTE 3: IMPACT OF EU ETS-INDUCED GAS PRICE INCREASES ON CHP – 15 OCTOBER 2003

1. INTRODUCTION

1.1 ILEX has been asked by DEFRA to develop further the analysis presented in our report *"NAP Implications and Options for CHP"*.

1.2 The purpose of this further work was to examine the extent to which gas price increases *caused by the EU ETS* may detrimentally impact upon the economics of CHP. The cause of these gas price increases are due to the Europe-wide increase in gas consumption arising from the EU ETS, *over and above the expected increase in gas consumption that is predicted to occur anyway.*

2. METHODOLOGY

2.1 To calculate the impact on CHP, ILEX adapted its existing model to introduce a new variable, gas price increase, expressed as a percentage.

2.2 The impact on the model's operation from this new variable is two-fold:

- Firstly, the net increase to the CHP scheme's fuel costs are added to the financial calculation *less the net increase to the alternative heat-only boiler's fuel costs*[18].
- Secondly, the (positive) impact on electricity prices was taken into account through the increased costs of gas-fired generators for the time when they were at the margin.

2.3 The model was run against ILEX's central gas scenario with four values for the percentage price increase due to the EU ETS (0%, 5%, 15%, 25%). Given that there may be some inconsistency between a scenario that has a high gas price increase and a low CO_2 price, ILEX also ran the model for different values of CO_2 price (5, 10 and 20 €/t).

[18] This subtraction of the net fuel cost increase incurred by the alternative heat-only boiler is to ensure consistency with the rest of the model calculations (which are aimed at calculating the change in the net cost/benefit of choosing a CHP scheme rather than a heat-only boiler arising from the EU ETS).

2.4 In order to aid clarity, ILEX only ran the model for new, gas-fired CHP which has a low heat:power ratio – the type of CHP which accounts for the vast majority of new build potential.

3. RESULTS

3.1 The results of the analysis are presented in the table below[19].

3.2

CO2 cost pass-through into electricity price		100%									50%								
% of emissions covered by free allocation		100%			50%			0%			100%			50%			0%		
CO2 cost (€/t)		20	10	5	20	10	5	20	10	5	20	10	5	20	10	5	20	10	5
Gas price increase	0%	66%	32%	15%	47%	23%	10%	28%	13%	5%	33%	16%	8%	14%	6%	3%	-5%	-3%	-2%
	5%	61%	28%	12%	42%	19%	8%	24%	10%	3%	29%	13%	5%	11%	4%	0%	-8%	-6%	-4%
	15%	51%	22%	8%	34%	13%	4%	17%	5%	-1%	22%	7%	0%	5%	-1%	-4%	-12%	-10%	-8%
	25%	43%	16%	4%	27%	8%	0%	12%	1%	-4%	16%	2%	-4%	0%	-5%	-8%	-15%	-13%	-11%

3.3 As one would expect, the results illustrate the fact that the higher the increase in gas price, the worse it is for new-entrant CHP.

3.4 A key message to extract from these tables is, if there is not full pass-through of CO_2 prices into electricity price and new-entrant CHP are not awarded any free allowances, then the economics of CHP plant get progressively worse as CO_2 prices increase. What is more, as CO_2 prices increase it is more likely that gas prices will increase by a greater amount, further exacerbating the problem for CHP. This is illustrated by the far-right box of cells in the above table.

3.5 If, however, new-entrant CHP are awarded some free allowances then, as CO_2 prices increase, their economics improve, although the rate of improvement is likely to be damped by the increase in gas prices caused by the CO_2 price increase.

19 It should be noted that the cells which are equivalent to the existing analysis presented in our previous reports are those which have a 0% gas price increase and a 10€/t cost of CO2 (our central CO2 projection).

NOTE 4: ESTIMATED SIZE OF CHP SET-ASIDE – 5 NOVEMBER 2003

1. INTRODUCTION

1.1 ILEX has been asked to develop further the analysis presented in our report *"NAP Implications and Options for CHP"*. The intention of this further work is to help establish the magnitude of allowances that would need to be set aside in order to provide Combined Heat and Power (CHP) new entrants to the EU Emissions Trading Scheme (ETS) with a free allocation as part of the UK National Allocation Plan (NAP). This note sets out the results of this follow-on analysis.

1.2 As stated previously, ILEX feels it is impossible to quantify this accurately without a major piece of analysis. Given the extremely short timescale for delivery of this work, we must therefore heavily caveat the analysis undertaken by stating that these represent our best estimates given relatively poor data availability and relatively unsophisticated models.

1.3 We have not developed our own fundamental projections for CHP capacity and emissions covered by the EU ETS for this work. Instead, the projections set out below are based on the Cambridge Econometrics (CE) work[20], with some high-level adjustments to take account of our view as to the likely rate of development of different CHP plant over the years in question. We understand that DEFRA is currently undertaking some longer term studies to develop more fundamental projections of CHP capacity over time, which should help to provide a more detailed understanding of these issues in due course.

2. PROJECTIONS OF CHP CAPACITY

2.1 The level of future CHP capacity will be dependent on a large number of factors, including the carbon price faced in the EU ETS and the extent to which new CHP plant are awarded free allowances or not. The ILEX projections set out below are based mainly on the suggested adjustments to the CE projections that we identified in a report to FES earlier this year[21]. This has been combined with the assumption that there will be a significant lead time between the economics of CHP picking up, and new CHP capacity being developed, so that the rate of

---

20 "*Modelling Good Quality Combined Heat and Power Capacity in the UK to 2010*", CE, 2002.

21 "*Review of CHP Projections to 2010: a report to Future Energy Solutions"* commissioned by Workstream 1 of the Distributed Generation Technical Steering Group, May 2003. This report is complete, but has yet to be released by FES for publication, pending the update of the CE projections.

development is slower than the CE projections in the early years and then speeds up later on.

2.2 We have made some further high-level adjustments to the CE projections to reflect the potential impact of different EU ETS carbon prices[22], and the free allocation of allowances[23], on future CHP capacity. We have also extended the projections until the end of 2012, in order to cover the full extent of the second phase of the EU ETS[24].

2.3 Figure 1, below, sets out total capacity projections based on the CE projection and four different ILEX-adjusted scenarios:

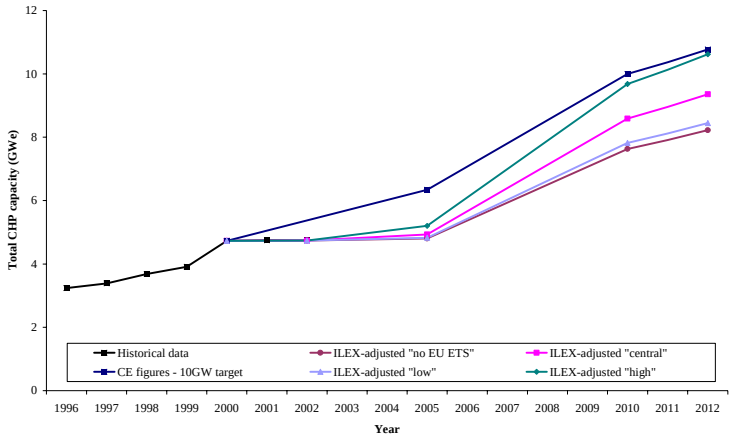
- a "*no EU ETS*" scenario - based entirely on the adjustments set out in our earlier FES report, mentioned above;
- a "*low*" scenario – as above, but with high-level adjustments to reflect a carbon price of €5/tCO_2 and no free allocation for new entrants;
- a "*central*" scenario – as above, but assuming a carbon price of €10/tCO_2 and free allocation for new entrants based on projected CHP emissions; and
- a "*high*" scenario – as above, but assuming a carbon price of €20/tCO_2 and free allocation for new entrants based on projected avoided emissions.

22 To adjust for the impact of different carbon prices, we have used the CE estimate that a £4/tCO_2 carbon price would incentivise an additional 219MWe of CHP capacity, and have assumed that this relationship holds constant across the range of carbon prices considered.

23 The impact of allocation on the development of different CHP types will clearly depend heavily on the allocation methodology adopted. Given the uncertainty surrounding this issue, and the difficulty of estimating this impact accurately without much more detailed analysis, we have simply made some very high-level adjustments to these projections to reflect the impact of allocation. For free allocation based on direct emissions and a carbon price of €10/tCO_2, we have assumed that an extra 0.58 GWe of capacity would be developed as a result of the free allocation. For free allocation based on avoided emissions and a carbon price of €20/tCO_2, we have assumed that an extra 2.05 GWe of capacity would be developed as a result of the free allocation. These estimates are arrived at by looking at the proportionate impact that the relevant allocation effect has compared to the carbon price effect on a typical new entrant CHP's finances, and assuming that this translates directly into the same proportionate impact on new capacity levels.

24 The projections for the years 2011 and 2012 assume a rate of development for new CHP plant over 20MW thermal input of half that experienced from 2005 to 2010.

Figure 1 – Estimates of total CHP capacity up to 2012 (GWe)

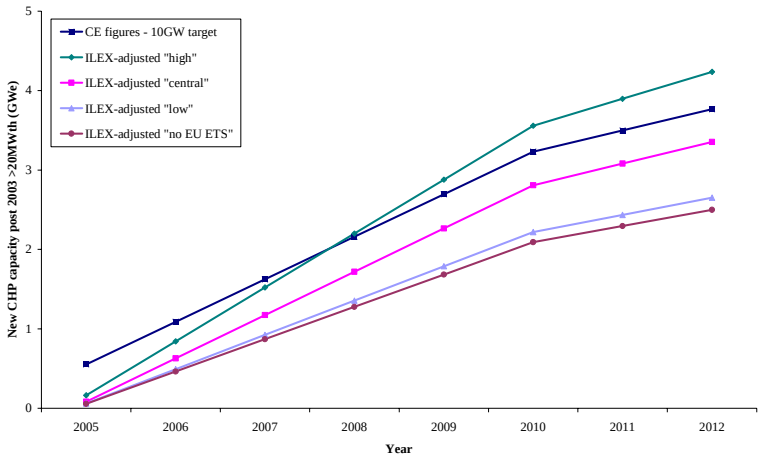


2.4 Figure 1 shows a central ILEX-adjusted projection (which assumes a €10/tCO_2 carbon price and a free allocation that covers 100% of direct emissions) of 8.6 GWe total estimated CHP capacity by 2010. The remaining scenarios presented range from 7.6 GWe (for the ILEX-adjusted projection given no EU ETS) to 9.9 GWe (for the original CE projections). It should be noted that the ILEX-adjusted scenarios simply reflect illustrative variations based on carbon price and allocation – they do not reflect the full uncertainty surrounding the projections, and hence CHP capacity could, in reality, be above or below these levels.

2.5 The projections set out above are for total CHP capacity up to 2012. In order to determine how much would need to be set-aside for new-entry CHP under the National Allocation Plan, then it is projections for CHP plant of over 20MW thermal input entering the market from 2004 onwards that are important. We have estimated this sub-set of CHP for each of the scenarios in Figure 2, below, based on the proportionate breakdown of different plant sizes used in our original report[25].

25 "*NAP implications and options for CHP: a report to DEFRA*", August 2003. Table 1 on page 5.

Figure 2 – Estimates of new entrant CHP capacity into EU ETS



2.6 Figure 2 shows a range between the scenarios presented of 2.1 GWe to 3.6 GWe, with a central ILEX-adjusted projection of 2.8 GWe of post-2003 CHP plant of over 20 MW thermal input entering the market by 2010.

3. PROJECTIONS OF CO_2 EMISSIONS

3.1 Table 10, below, sets out the estimated CO_2 emissions arising from, and avoided by, new CHP plant over 20MW thermal input for each of the scenarios outlined above. These estimates are based on the breakdown of the different plant type used in the CE projections, and supplemented by data from AEAT and our own knowledge of the characteristics of the different plant technologies.

Table 10 - Projected emissions arising from, and avoided by, new CHP plant over 20MW thermal input for different scenarios ($KtCO_2$)

									Total	
CE figures - 10GW target scenario	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2005-7**	**2008-12**
Post-2003 CHP plant emissions	1,912	3,486	5,063	6,655	8,251	9,847	10,645	11,443	10,461	46,842
Less displaced emissions from										
>20MWth Existing boilers	-488	-897	-1,307	-1,721	-2,134	-2,548	-2,755	-2,961	-2,692	-12,120
>20MWth New heat loads	-325	-598	-872	-1,147	-1,423	-1,699	-1,836	-1,974	-1,795	-8,080
Conventional generating plant	-2,696	-5,199	-7,704	-10,216	-12,730	-15,245	-16,502	-17,759	-15,599	-72,452
Total displaced emissions	*-3,509*	*-6,694*	*-9,883*	*-13,084*	*-16,288*	*-19,491*	*-21,093*	*-22,695*	*-20,086*	*-92,651*
Overall impact	-1,598	-3,208	-4,820	-6,429	-8,037	-9,644	-10,448	-11,252	-9,625	-45,809

									Total	
ILEX-adjusted "no EU ETS" scenario	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2005-7**	**2008-12**
Post-2003 CHP plant emissions	367	1,581	2,799	4,022	5,245	6,468	7,080	7,691	4,747	30,506
Less displaced emissions from										
>20MWth Existing boilers	-93	-398	-705	-1,015	-1,324	-1,634	-1,789	-1,944	-1,196	-7,706
>20MWth New heat loads	-62	-265	-470	-676	-883	-1,089	-1,193	-1,296	-797	-5,137
Conventional generating plant	-382	-2,274	-4,169	-6,067	-7,964	-9,862	-10,810	-11,759	-6,825	-46,462
Total displaced emissions	*-537*	*-2,938*	*-5,344*	*-7,758*	*-10,171*	*-12,585*	*-13,792*	*-14,999*	*-8,818*	*-59,305*
Overall impact	-170	-1,357	-2,545	-3,736	-4,926	-6,117	-6,712	-7,308	-4,071	-28,798

ILEX-adjusted "low" scenario	2005	2006	2007	2008	2009	2010	2011	2012	Total 2005-7	Total 2008-12
Post-2003 CHP plant emissions	388	1,680	2,977	4,279	5,580	6,882	7,533	8,184	5,045	32,458
Less displaced emissions from										
>20MWth Existing boilers	-97	-424	-752	-1,084	-1,415	-1,747	-1,912	-2,078	-1,273	-8,236
>20MWth New heat loads	-65	-282	-501	-722	-943	-1,164	-1,275	-1,385	-848	-5,490
Conventional generating plant	-406	-2,425	-4,446	-6,470	-8,494	-10,518	-11,529	-12,541	-7,278	-49,552
Total displaced emissions	*-568*	*-3,131*	*-5,700*	*-8,276*	*-10,852*	*-13,429*	*-14,717*	*-16,005*	*-9,399*	*-63,278*
Overall impact	-180	-1,451	-2,723	-3,998	-5,272	-6,546	-7,184	-7,821	-4,354	-30,821

ILEX-adjusted "central" scenario	2005	2006	2007	2008	2009	2010	2011	2012	Total 2005-7	Total 2008-12
Post-2003 CHP plant emissions	474	2,096	3,721	5,352	6,982	8,613	9,428	10,243	6,291	40,618
Less displaced emissions from										
>20MWth Existing boilers	-113	-531	-950	-1,372	-1,795	-2,217	-2,428	-2,639	-1,594	-10,451
>20MWth New heat loads	-76	-354	-633	-915	-1,196	-1,478	-1,619	-1,759	-1,063	-6,968
Conventional generating plant	-509	-3,056	-5,605	-8,157	-10,709	-13,261	-14,537	-15,813	-9,170	-62,477
Total displaced emissions	*-698*	*-3,941*	*-7,189*	*-10,445*	*-13,700*	*-16,956*	*-18,584*	*-20,212*	*-11,828*	*-79,896*
Overall impact	-224	-1,845	-3,468	-5,093	-6,718	-8,343	-9,156	-9,968	-5,536	-39,277

ILEX-adjusted "high" scenario	2005	2006	2007	2008	2009	2010	2011	2012	Total 2005-7	Total 2008-12
Post-2003 CHP plant emissions	727	2,741	4,758	6,780	8,803	10,826	11,837	12,848	8,225	51,095
Less displaced emissions from										
>20MWth Existing boilers	-175	-700	-1,227	-1,757	-2,286	-2,816	-3,081	-3,346	-2,102	-13,286
>20MWth New heat loads	-117	-467	-818	-1,171	-1,524	-1,877	-2,054	-2,231	-1,401	-8,857
Conventional generating plant	-888	-4,057	-7,229	-10,403	-13,577	-16,751	-18,338	-19,925	-12,174	-78,994
Total displaced emissions	*-1,180*	*-5,224*	*-9,273*	*-13,330*	*-17,387*	*-21,445*	*-23,473*	*-25,502*	*-15,677*	*-101,137*
Overall impact	-453	-2,483	-4,516	-6,550	-8,584	-10,619	-11,636	-12,653	-7,452	-50,042

3.2 Table 10 shows that the total estimated reduction in CO_2 emissions as a result of the additional CHP displacing the separate provision of heat and power by heat-only boilers and conventional generation respectively, ranges from 4.1 $MtCO_2$ to 9.6 $MtCO_2$, with a central ILEX-adjusted estimate of 5.5 $MtCO_2$.

3.3 The data for estimated post-2003 CHP plant emissions presented in Table 10, above, shows the level of set-aside that would be required under each scenario, if allocation to new-entrant CHP were to be based on the levels of CO_2 directly emitted by CHP. It can be seen that this ranges from 4.7 –10.5 $MtCO_2$ for Phase 1 as a whole, with a central ILEX-adjusted estimate of 6.3 $MtCO_2$.

3.4 The data for estimated displaced emissions presented in Table 10, above, shows the level of set-aside that would be required under each scenario, if allocation to new-entrant CHP were to be based on avoided, rather than direct, emissions. It can be seen that this ranges from 8.8 – 20.1 $MtCO_2$ for Phase 1 as a whole, with a central ILEX-adjusted estimate of 11.8 $MtCO_2$[26].

[26] It should be noted that the level of emissions would be influenced by the allocation methodology adopted. All the scenarios set out above that are based on a less generous allocation methodology, would therefore result in a higher level of avoided emissions, and a higher required set-aside than shown, were an allocation methodology based on total avoided emissions to be adopted.

4. ESTIMATING THE LEVEL OF ALLOWANCES TO BE SET ASIDE

4.1 Based on the above results, our central ILEX-adjusted scenario, which assumes that CHP receive a free allocation based on direct CHP emissions, would therefore indicate a set-aside of approximately 6 $MtCO_2$ to cover new-entry CHP plant during the first phase of the scheme. However, as cautioned above, this estimate is subject to a great deal of uncertainty and the actual level of set-aside required could clearly vary significantly from this estimate.

4.2 Given that a decision on set-aside levels will need to be taken before much of this uncertainty resolves itself, it is worth considering the implications of either under- or over- estimation of the amount of set-aside required for CHP new entrants.

Implications of under-estimation

4.3 If the size of the set-aside for CHP is under-estimated, then the set-aside allocation would run out part way through Phase 1 and there would be no allocation left to give to new CHP schemes coming along later in the phase. This could create chaos for CHP development, with new projects developed on the basis of receiving a free allocation, suddenly finding that this was no longer available to them. If potential CHP developers considered that there was a possibility that this situation might arise from the start, then this could bring about a lack of confidence and potential perverse impacts for CHP development.

4.4 Alternatively, the UK Government could, in theory, "buy" its way out of the problem by purchasing extra allowances in the ETS marketplace and giving these to new CHP schemes for free after the original set-aside has been used up. Whether this would be a real option in practice would depend on whether this behaviour was considered an infringement of state aids rules by the European Commission and/or whether it would be considered politically acceptable for the Government to spend tax-payers money on purchasing allowances in this way.

Implications of over-estimation

4.5 If the size of the set-aside for CHP is over-estimated, then some of the set-aside allocation would still be unused at the end of Phase 1 of the scheme. There are a number of options for what could be done with this excess allocation. For example, the Government could decide to retire it, or to bank it into the allocation pot for the next phase, if the market already looks to have sufficient levels of supply during Phase 1. Alternatively, if prices are looking high and supply is constrained, then the Government could auction the excess allowances into the market in order to raise revenue and increase supply levels at the end of Phase 1.

4.6 The main potential detrimental consequence of over-estimation depends on where the allocation used for the set-aside has been taken from in the first place. If the set-aside for CHP new entrants has been "funded" by decreasing the level of allocation to sectors that are subject to international competition, then over-

estimation of the set-aside could further endanger the competitiveness of installations in these sectors. On the other hand, if the set-aside for CHP new entrants has been "funded" by decreasing the level of allocation to sectors that are not subject to international competition, then the implications of over-estimation are likely to be small.

4.7 Given that the emissions displaced as a result of CHP growth come mainly from the power generation sector (plus some relating to heat-only boilers), then it would seem likely that any set-aside is mainly "funded" from this area. Since these sectors are not subject to high levels of international competition, then the competitiveness implications of any over-estimation of set-aside should be small.

4.8 Indeed, one of the major issues facing the application of the EU ETS to the power generation sector is the danger that the large vertically integrated generators will not fully pass the cost of carbon through into electricity prices, thereby reducing the carbon savings achieved in this sector and reducing the efficiency of the scheme as a whole. It is expected that generators will be more likely to pass the opportunity cost of carbon through into electricity prices if they receive a more stringent allocation and therefore have to purchase at least some of their allowances from the market, rather than receiving them all for free. Reducing the total allocation to conventional generators in order to fund a set-aside for new entry CHP could therefore result in the additional benefit of helping to prompt cost pass through and increasing the efficiency of the scheme.

What would this mean for set-aside decisions?

4.9 In general, it would appear that under-estimation of the set-aside required for new entry CHP could cause some administratively difficult, and politically embarrassing, complications, with potential perverse impacts for future CHP development. On the other hand, over-estimation of the set-aside could be relatively easily dealt with at the end of the phase, and could actually be beneficial in helping to prompt cost pass through into electricity prices.

4.10 Since the consequences of under-estimating the level of set-aside required would appear to be more damaging than the implications of over-estimation, we would recommend that any set-aside is based not on a "best guess" of allowances required, but instead allows for a more optimistic outcome of future CHP development. This would then provide a buffer of additional allowances that could be used as a safety-valve, if needed, thereby reducing the risk of under-allocation.

4.11 Assuming that any free allocation to new entry CHP would be based on covering direct emissions from CHP plant, then a set-aside level of approximately 12 $MtCO_2$, based on our central ILEX-adjusted estimate of emissions displaced as a result of expected CHP growth, could help to address the concerns of under-estimation set out above. This set-aside would be sufficient to cover direct emissions of new entry CHP under all the scenarios set out above, even those with a relatively optimistic view of CHP development. Any set-aside allocation remaining at the end of the phase could then be retired, banked, or auctioned off,

depending on Government intentions. While these scenarios do not cover the full range of uncertainty surrounding CHP projections, the risk of under-allocation when using a set-aside of 12 $MtCO_2$ should be relatively small.

4.12 At the same time, since the total set-aside is based on our "best guess" of displaced emissions, then the reduction in other sector emissions in order to "fund" this set-aside should reflect the fact that generators and heat-only boilers will need a lower level of allocation as a result of this CHP growth in any case. The removal of this 12 $MtCO_2$ from the allocation pot simply retains the expected overall stringency of the target on other sectors, compared to a situation where this CHP growth does not take place.

4.13 A larger set-aside could be established if one wanted to minimise the risk of under-allocation still further, or to base free allocation to new entry CHP on displaced emissions, or even to aid cost pass-through in the electricity sector. This could either be done in isolation, as above (e.g. with a straight 20 $MtCO_2$ set-aside), or could be combined with other allocation options.

4.14 For example, since the Government can choose to hold back up to 5% of the total allocation pot for auctioning during Phase 1, then one option could be to hold back this 5% as a set-aside for new-entry CHP and then to auction off any remaining allocation left at the end of the phase. At well over 20 $MtCO_2$, this should be more than sufficient to cover the needs of new entry CHP, even if allocating on the basis of avoided emissions.

4.15 Similarly, the Government could choose to set allocation targets on the basis of the more stringent 20% domestic targets, and could then draw on the balance between the 12.5% Kyoto target and the 20% target for free allocations to new entry CHP. Any remaining allocation left at the end of the phase could then be retired. This would ensure more than sufficient set-aside for new entry CHP, while confirming the political message of the more stringent 20% target and helping to ensure that cost-pass through takes place in the power generation sector.

5. CONCLUSION

5.1 Based on the above analysis, our central ILEX-adjusted scenario, which assumes that CHP receive a free allocation based on direct CHP emissions, represents our "best guess" of the set-aside required to cover new-entry CHP plant. This indicates a set-aside of approximately 6 $MtCO_2$ during the first phase of the scheme.

5.2 However, as cautioned above, this estimate is subject to a great deal of uncertainty and the actual level of set-aside required could clearly vary significantly from this estimate. Since the consequences of under-estimating the level of set-aside required would appear to be more damaging than the implications of over-estimation, we would recommend that any set-aside is based not on a "best guess" of allowances required, but instead allows for a more optimistic outcome of future

CHP development. This would then provide a buffer of additional allowances that could be used as a safety-valve, if needed, thereby reducing the risk of under-allocation.

5.3 This could be done through using a set-aside of approximately 12 $MtCO_2$, based on our central ILEX-adjusted estimate of emissions displaced as a result of expected CHP growth. This set-aside would be sufficient to cover the direct emissions of new entry CHP under all the scenarios set out above, even those with a relatively optimistic view of CHP development. Alternatively, larger set-aside levels could be used, based on either combining a new entry CHP set aside with holding back up to 5% of the total allocation pot for eventual auctioning, or with the leeway provided by imposing the more stringent 20% domestic target on existing installations and holding back the difference between this and the more generous 12.5% Kyoto target for any new entry allocations that are needed.

NOTE 5: ESTIMATED SIZE OF CHP SET-ASIDE PART 2 – 6 NOVEMBER 2003

1. INTRODUCTION

1.1 This note follows on from the note sent yesterday regarding estimations for the appropriate size of a set-aside for new entrant CHP during Phase 1 of the EU ETS. The analysis presented is based on the same approach as set out previously, but incorporates a number of additional scenarios to cover potential allocation methodologies based on differential treatment of CHP plant that serve a new heat load as opposed to those that replace existing boilers (hereafter referred to as new heat load CHP and existing heat load CHP respectively).

1.2 The scenarios used are as follows:

- **Scenario A.** Existing heat load CHP lose their existing allocation on replacement of their boiler and do not receive any free allocation. New heat load CHP do not receive any free allocation.
- **Scenario B.** Existing heat load CHP keep their existing boiler allocation but do not receive any additional free allocation. New heat load CHP do not receive any free allocation.
- **Scenario C**. Existing heat load CHP lose their existing boiler allocation but receive a free allocation equal to the expected difference between their existing boiler and new CHP emissions. New heat load CHP receive a free allocation equal to the expected difference in emissions between a new boiler and the new CHP plant.
- **Scenario D**. Existing heat load CHP lose their existing boiler allocation but receive a free allocation equal to their expected total emissions. New heat load CHP receive a free allocation equal to the expected difference in emissions between a new boiler and the new CHP plant.
- **Scenario E**. Existing heat load CHP keep their existing boiler allocation and receive an additional free allocation equal to the expected difference between their existing boiler and new CHP emissions. New heat load CHP receive a free allocation equal to their expected total emissions.
- **Scenario F**. Existing heat load CHP lose their existing allocation but receive a free allocation equal to their expected total emissions. New heat load CHP receive a free allocation equal to their expected total emissions. (**NB: It is worth noting that this is equivalent to the ILEX-adjusted central scenario portrayed in yesterday's note)**

1.3 All scenarios assume a carbon price of €10/tCO_2. All scenarios based on equivalent treatment of existing heat load and new heat load CHP assume a 60:40 ratio of existing heat load CHP as opposed to new heat load CHP. Where existing

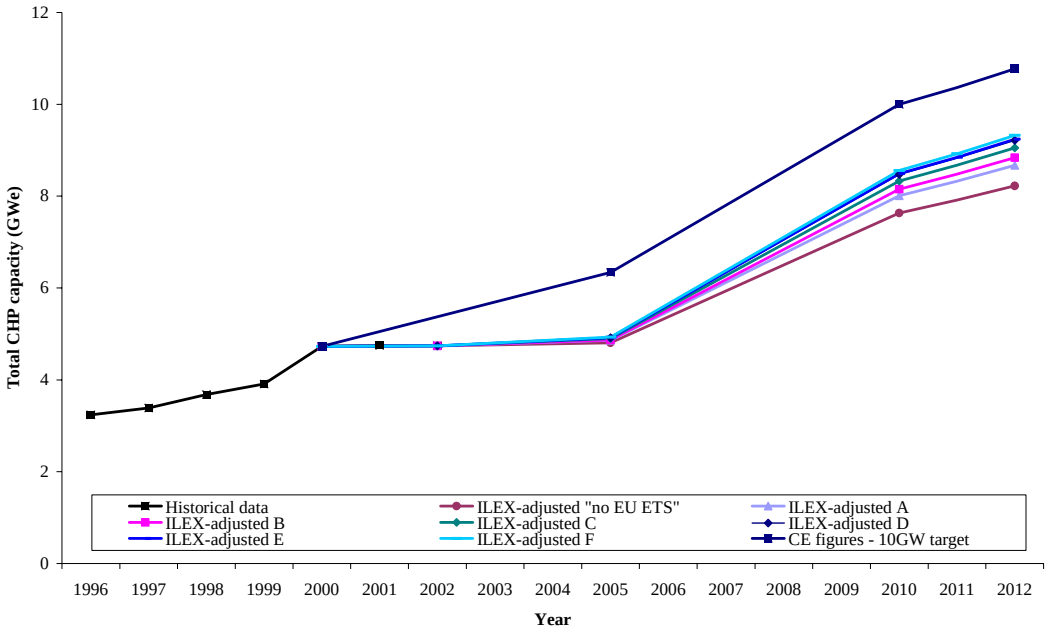
heat load CHP and new heat load CHP are treated differently, the ratio changes slightly to reflect this, though the difference is not significant.

1.4 The analysis is subject to the same caveats as before – namely that we feel it is impossible to quantify the size of an appropriate set-aside accurately without a major piece of analysis, and that the results presented below are our best estimates given relatively poor data availability and relatively unsophisticated models. We have not developed our own fundamental projections for CHP capacity and emissions covered by the EU ETS for this work. Instead, the projections set out below are based on the Cambridge Econometrics (CE) work[27], with some high-level adjustments to take account of our view as to the likely rate of development of different CHP plant over the years in question.

2. PROJECTIONS OF CHP CAPACITY

2.1 Figure 1, below, sets out total CHP capacity projections for Scenarios A-F, as described in paragraph 1.2. To provide context, the original CE projections and ILEX-adjusted "no EU ETS" projections from yesterday's note are also presented.

Figure 3 – Estimates of total CHP capacity up to 2012 (GWe)



2.2 Figure 1 shows that the new scenarios outlined in paragraph 1.2 result in an estimated range of total CHP capacity by 2010 of 8.01-8.56 GWe. It is worth stressing that this range simply reflects variations based on high-level adjustments to estimate the impacts of variations in allocation methodologies on CHP

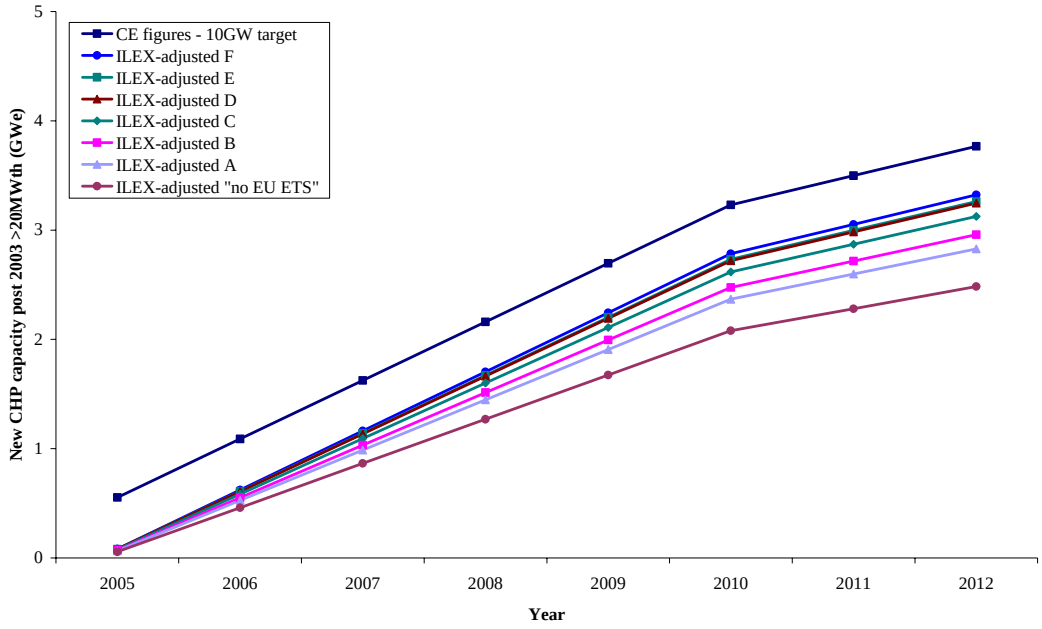
27 "*Modelling Good Quality Combined Heat and Power Capacity in the UK to 2010*", CE, 2002.

development. As such, the range shown is relatively small and only represents a very small proportion of the full uncertainty surrounding the projections.

2.3 As before, these adjustments are estimated by looking at the proportionate impact that the relevant allocation effect has compared to the carbon price effect on the finances of new entrant CHP plant, and assuming that this translates directly into the same proportionate impact on new capacity levels.

2.4 Figure 2, below, shows estimated projections for capacity of CHP plant of over 20MW thermal input entering the market from 2004 onwards, since it is these that would be eligible for any set-aside for new entry CHP. As before, we have estimated this sub-set of CHP for each of the scenarios in Figure 2, below, based on the proportionate breakdown of different plant sizes used in our original report[28].

Figure 4 – Estimates of new entrant CHP capacity into EU ETS



2.5 Figure 2 shows that the new scenarios outlined in paragraph 1.2 result in an estimated range of 2.1-2.8 GWe of post-2003 CHP plant of over 20 MW thermal input entering the market by 2010.

3. PROJECTIONS OF CO_2 EMISSIONS

3.1 Table 10, below, sets out the estimated CO_2 emissions arising from, and avoided by, new CHP plant over 20MW thermal input for each of the scenarios outlined in paragraph 1.2 above. As before, these estimates are based on the breakdown of

28 "*NAP implications and options for CHP: a report to DEFRA*", August 2003. Table 1 on page 5.

the different plant type used in the CE projections, and supplemented by data from AEAT and our own knowledge of the characteristics of the different plant technologies. The CE projections and ILEX-adjusted "no EU ETS" scenarios have been included to provide context.

Table 11 - Projected emissions arising from, and avoided by, new CHP plant over 20MW thermal input for different scenarios ($KtCO_2$)

CE figures - 10GW target scenario	2005	2006	2007	2008	2009	2010	2011	2012	Total 2005-7	Total 2008-12
Post-2003 CHP plant emissions	***1,912***	***3,486***	***5,063***	***6,655***	***8,251***	***9,847***	***10,645***	***11,443***	***10,461***	***46,842***
from replacement of existing boilers	1,147	2,091	3,038	3,993	4,951	5,908	6,387	6,866	6,276	28,105
from serving new heat loads	765	1,394	2,025	2,662	3,300	3,939	4,258	4,577	4,184	18,737
Less displaced emissions	***-3,184***	***-6,066***	***-8,953***	***-11,851***	***-14,751***	***-17,651***	***-19,101***	***-20,551***	***-18,203***	***-83,905***
from existing boilers	-488	-897	-1,307	-1,721	-2,134	-2,548	-2,755	-2,961	-2,692	-12,120
from new heat loads	-325	-598	-872	-1,147	-1,423	-1,699	-1,836	-1,974	-1,795	-8,080
from conventional generating plant	-2,370	-4,571	-6,774	-8,983	-11,194	-13,404	-14,510	-15,615	-13,716	-63,705
Overall impact on emissions	***-1,272***	***-2,580***	***-3,890***	***-5,196***	***-6,500***	***-7,804***	***-8,456***	***-9,108***	***-7,742***	***-37,063***

ILEX-adjusted "no EU ETS" scenario	2005	2006	2007	2008	2009	2010	2011	2012	Total 2005-7	Total 2008-12
Post-2003 CHP plant emissions	***367***	***1,581***	***2,799***	***4,022***	***5,245***	***6,468***	***7,080***	***7,691***	***4,747***	***30,506***
from replacement of existing boilers	220	949	1,679	2,413	3,147	3,881	4,248	4,615	2,848	18,304
from serving new heat loads	147	632	1,120	1,609	2,098	2,587	2,832	3,077	1,899	12,203
Less displaced emissions	***-491***	***-2,663***	***-4,840***	***-7,025***	***-9,210***	***-11,395***	***-12,487***	***-13,579***	***-7,994***	***-53,696***
from existing boilers	-93	-398	-705	-1,015	-1,324	-1,634	-1,789	-1,944	-1,196	-7,706
from new heat loads	-62	-265	-470	-676	-883	-1,089	-1,193	-1,296	-797	-5,137
from conventional generating plant	-335	-2,000	-3,666	-5,334	-7,003	-8,671	-9,505	-10,339	-6,001	-40,853
Overall impact on emissions	***-124***	***-1,082***	***-2,042***	***-3,003***	***-3,965***	***-4,926***	***-5,407***	***-5,888***	***-3,247***	***-23,189***

Scenario A	2005	2006	2007	2008	2009	2010	2011	2012	Total 2005-7	Total 2008-12
Post-2003 CHP plant emissions	***409***	***1,784***	***3,163***	***4,547***	***5,931***	***7,315***	***8,007***	***8,699***	***5,356***	***34,498***
from replacement of existing boilers	246	1,071	1,898	2,728	3,558	4,389	4,804	5,219	3,214	20,699
from serving new heat loads	164	714	1,265	1,819	2,372	2,926	3,203	3,480	2,143	13,799
Less displaced emissions	***-587***	***-3,256***	***-5,929***	***-8,610***	***-11,291***	***-13,972***	***-15,313***	***-16,653***	***-9,772***	***-65,840***
from existing boilers	-101	-450	-802	-1,156	-1,510	-1,864	-2,041	-2,218	-1,353	-8,790
from new heat loads	-67	-300	-534	-771	-1,007	-1,243	-1,361	-1,479	-902	-5,860
from conventional generating plant	-419	-2,505	-4,593	-6,684	-8,775	-10,865	-11,911	-12,956	-7,517	-51,190
Overall impact on emissions	***-178***	***-1,471***	***-2,766***	***-4,063***	***-5,360***	***-6,657***	***-7,306***	***-7,955***	***-4,416***	***-31,342***

Scenario B	2005	2006	2007	2008	2009	2010	2011	2012	Total 2005-7	Total 2008-12
Post-2003 CHP plant emissions	***425***	***1,861***	***3,300***	***4,745***	***6,190***	***7,635***	***8,357***	***9,079***	***5,587***	***36,006***
from replacement of existing boilers	255	1,117	1,980	2,847	3,714	4,581	5,014	5,448	3,352	21,604
from serving new heat loads	170	744	1,320	1,898	2,476	3,054	3,343	3,632	2,235	14,402
Less displaced emissions	***-611***	***-3,402***	***-6,198***	***-9,001***	***-11,805***	***-14,609***	***-16,011***	***-17,412***	***-10,210***	***-68,838***
from existing boilers	-104	-470	-838	-1,209	-1,580	-1,951	-2,137	-2,322	-1,412	-9,199
from new heat loads	-69	-313	-559	-806	-1,053	-1,301	-1,424	-1,548	-942	-6,133
from conventional generating plant	-437	-2,618	-4,801	-6,986	-9,172	-11,357	-12,450	-13,542	-7,856	-53,506
Overall impact on emissions	***-185***	***-1,541***	***-2,897***	***-4,256***	***-5,615***	***-6,974***	***-7,654***	***-8,333***	***-4,624***	***-32,832***

Scenario C	2005	2006	2007	2008	2009	2010	2011	2012	Total 2005-7	Total 2008-12
Post-2003 CHP plant emissions	***446***	***1,960***	***3,478***	***5,002***	***6,525***	***8,048***	***8,810***	***9,572***	***5,885***	***37,957***
from replacement of existing boilers	268	1,176	2,087	3,001	3,915	4,829	5,286	5,743	3,531	22,774
from serving new heat loads	178	784	1,391	2,001	2,610	3,219	3,524	3,829	2,354	15,183
Less displaced emissions	***-641***	***-3,591***	***-6,546***	***-9,508***	***-12,470***	***-15,432***	***-16,914***	***-18,395***	***-10,777***	***-72,719***
from existing boilers	-108	-496	-886	-1,278	-1,671	-2,064	-2,260	-2,456	-1,489	-9,729
from new heat loads	-72	-331	-590	-852	-1,114	-1,376	-1,507	-1,638	-993	-6,486
from conventional generating plant	-461	-2,764	-5,070	-7,377	-9,685	-11,993	-13,147	-14,301	-8,295	-56,504
Overall impact on emissions	***-195***	***-1,630***	***-3,067***	***-4,506***	***-5,945***	***-7,384***	***-8,103***	***-8,823***	***-4,893***	***-34,761***

Scenario D	2005	2006	2007	2008	2009	2010	2011	2012	Total 2005-7	Total 2008-12
Post-2003 CHP plant emissions	***461***	***2,033***	***3,608***	***5,188***	***6,769***	***8,349***	***9,140***	***9,930***	***6,102***	***39,377***
from replacement of existing boilers	277	1,220	2,165	3,113	4,061	5,010	5,484	5,958	3,661	23,626
from serving new heat loads	184	813	1,443	2,075	2,708	3,340	3,656	3,972	2,441	15,751
Less displaced emissions	***-663***	***-3,728***	***-6,798***	***-9,876***	***-12,954***	***-16,031***	***-17,570***	***-19,109***	***-11,190***	***-75,541***
from existing boilers	-111	-514	-920	-1,328	-1,737	-2,145	-2,350	-2,554	-1,545	-10,114
from new heat loads	-74	-343	-613	-886	-1,158	-1,430	-1,566	-1,703	-1,030	-6,743
from conventional generating plant	-478	-2,871	-5,265	-7,662	-10,059	-12,456	-13,654	-14,853	-8,614	-58,684
Overall impact on emissions	***-202***	***-1,696***	***-3,191***	***-4,688***	***-6,185***	***-7,682***	***-8,431***	***-9,179***	***-5,088***	***-36,164***

Scenario E	2005	2006	2007	2008	2009	2010	2011	2012	Total 2005-7	Total 2008-12
Post-2003 CHP plant emissions	***463***	***2,042***	***3,624***	***5,212***	***6,799***	***8,387***	***9,181***	***9,975***	***6,129***	***39,554***
from replacement of existing boilers	278	1,225	2,174	3,127	4,080	5,032	5,509	5,985	3,677	23,732
from serving new heat loads	185	817	1,450	2,085	2,720	3,355	3,672	3,990	2,451	15,822
Less displaced emissions	***-666***	***-3,745***	***-6,830***	***-9,922***	***-13,014***	***-16,106***	***-17,652***	***-19,198***	***-11,241***	***-75,894***
from existing boilers	-111	-517	-924	-1,335	-1,745	-2,156	-2,361	-2,566	-1,552	-10,162
from new heat loads	-74	-345	-616	-890	-1,163	-1,437	-1,574	-1,711	-1,035	-6,775
from conventional generating plant	-481	-2,884	-5,289	-7,698	-10,106	-12,514	-13,718	-14,922	-8,654	-58,956
Overall impact on emissions	***-203***	***-1,704***	***-3,206***	***-4,710***	***-6,215***	***-7,719***	***-8,471***	***-9,224***	***-5,113***	***-36,339***

Scenario F	2005	2006	2007	2008	2009	2010	2011	2012	Total 2005-7	Total 2008-12
Post-2003 CHP plant emissions	***474***	***2,096***	***3,721***	***5,352***	***6,982***	***8,613***	***9,428***	***10,243***	***6,291***	***40,618***
from replacement of existing boilers	285	1,258	2,233	3,211	4,189	5,168	5,657	6,146	3,775	24,371
from serving new heat loads	190	838	1,488	2,141	2,793	3,445	3,771	4,097	2,516	16,247
Less displaced emissions	***-683***	***-3,849***	***-7,020***	***-10,198***	***-13,377***	***-16,556***	***-18,145***	***-19,734***	***-11,551***	***-78,010***
from existing boilers	-113	-531	-950	-1,372	-1,795	-2,217	-2,428	-2,639	-1,594	-10,451
from new heat loads	-76	-354	-633	-915	-1,196	-1,478	-1,619	-1,759	-1,063	-6,968
from conventional generating plant	-494	-2,964	-5,436	-7,911	-10,386	-12,861	-14,098	-15,336	-8,894	-60,591
Overall impact on emissions	***-208***	***-1,753***	***-3,299***	***-4,847***	***-6,395***	***-7,943***	***-8,717***	***-9,491***	***-5,260***	***-37,392***

3.2 Table 10 shows that the new scenarios outlined in paragraph 1.2 result in an estimated range of 4.4 - 5.3[29] $MtCO_2$ total estimated reduction in Phase 1

[29] It should be noted that the estimated displaced emissions from conventional generating plant for the CE projections, ILEX-adjusted "no EU ETS" scenario and Scenario F are slightly lower than those presented in yesterday's note, due to a small previous error in the carbon-intensity of the marginal electricity displaced.

emissions as a result of the additional CHP displacing the separate provision of heat and power by heat-only boilers and conventional generation respectively.

3.3 The set-aside for each scenario is different, depending on the allocation methodology used. Table 12, below, brings together the estimated set-aside that would be required for each scenario, based on the allocation assumptions set out in paragraph 1.2.

Table 12 – Estimated size of set-aside required for Phase 1 under each scenario

3.4	Scenario	3.5	Estimated size of set-aside required for Phase 1($MtCO_2$)
3.6	A	3.7	None
3.8	B	3.9	None
3.10	C	3.11	3.4
3.12	D	3.13	5.1
3.14	E	3.15	4.6
3.16	F	3.17	6.3

3.18 Table 12 shows that estimated set-asides for the scenarios set out in paragraph 1.2, range from zero (for those scenarios where no free allocation is given) up to 6.3 $MtCO_2$ (for the scenario where the set-aside allocation covers 100% of expected emissions).

3.19 As before, we would caveat these results by saying that the estimates are subject to a great deal of uncertainty and that the risks of under-estimation of the set-aside would seem to outweigh the risks of over-estimation. Therefore, we would recommend that any set-aside is based on a more optimistic outcome of future CHP development than the "best guesses" outlined above might imply. For example, this could be achieved by basing the actual number of allowances set aside on estimated total emissions displaced as a result of expected CHP growth, or by basing expected CHP growth on the much more optimistic projections developed by Cambridge Econometrics. This would then provide a buffer of additional allowances that could be used as a safety-valve, if needed, thereby reducing the risk of under-allocation.

ILEX

Quality Control Check Sheet

NAP IMPLICATIONS AND OPTIONS FOR CHP

Report Unique Serial No: 2003/082

Director John Macadam	Date: 25 November 2003
Project Manager Simon Coates	Date: 25 Novebmer 2003
Authors Simon Coates Rhian Bisson	Date: 25 November 2003
Administrator	Date: 25 November 2003

ILEX
King Charles House
Park End Street
Oxford, OX1 1JD, England

Tel: +44 (0)1865 722660
Fax: +44 (0)1865 722988
E-mail: energy.consult@ilexenergy.com
www.ilexenergy.com