Appendix 1

Project:	**Croydon Decentralised Energy Study**	Job No:	**60103445**
Subject:	**Draft Note about Initial CHP and District Heating Network sizing for Croydon Energy Clusters**		
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Checked by:	**Peter Concannon**	Date:	**11th December 2009**
Approved by:		Date:	

Development of monthly Energy demand Profiles

Assumptions
Residential developments are assumed to be new flats

Table 1 shows the assumed split of the annual heating demand and DHW based on our past experience and building models.

Table 1 – Assumed split of annual heating demand between space heating and DHW

55%	% of new office annual heat demand attributable to Space heating
45%	% of new office annual heat demand attributable to DHW
54%	% of new residential annual heat demand attributable to Space heating
46%	% of new residential annual heat demand attributable to DHW
95%	% of Space heating demand for existing & other buildings
5%	% of DHW demand for existing & other buildings

Profile Generation
In order to carry out CHP modelling, it was necessary to create a monthly profile describing the energy demands in terms of space heating, DHW, cooling and electricity for each energy cluster. A brief explanation of how these profiles are derived is given below.

New office – monthly profile of space heating and DHW use is based on previous IES model of a proposed office building. The monthly space heating and DHW demands falling in each month were calculated as a percentage of the annual demand from this model and these percentages were then used to apportion the monthly space heating and DHW demand for the current office models for the Croydon DES study
Existing office – Monthly space heating profile based on monthly London degree day profiles. DHW demand is split according to the number of days in the month
Residential – based on monthly output from cSAP software for a flat built to be PartL2010 compliant. The monthly space heating and DHW demands falling in each month were calculated as a percentage of the annual demand from the cSAP model and these percentages were then used to apportion the monthly space heating and DHW demand for the proposed residential developments for the Croydon DES study. It is also assumed that there is no space heating demand between June and September.
All other buildings - Monthly space heating profile based on monthly London degree day profiles. DHW demand is split according to the number of days in the month

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Table 2 - Annual energy demand breakdown by Energy Cluster

	Heating MWh p.a	Cooling MWh p.a	Electricity MWh p.a
Energy centre 1	54,286	22,394	36,207
Energy centre 2	29,372	14,935	23,933
Energy centre 3	45,479	24,369	32,332
All clusters	**129,137**	**61,698**	**92,472**

Figure 1 - Monthly Energy demands for Energy Cluster 1

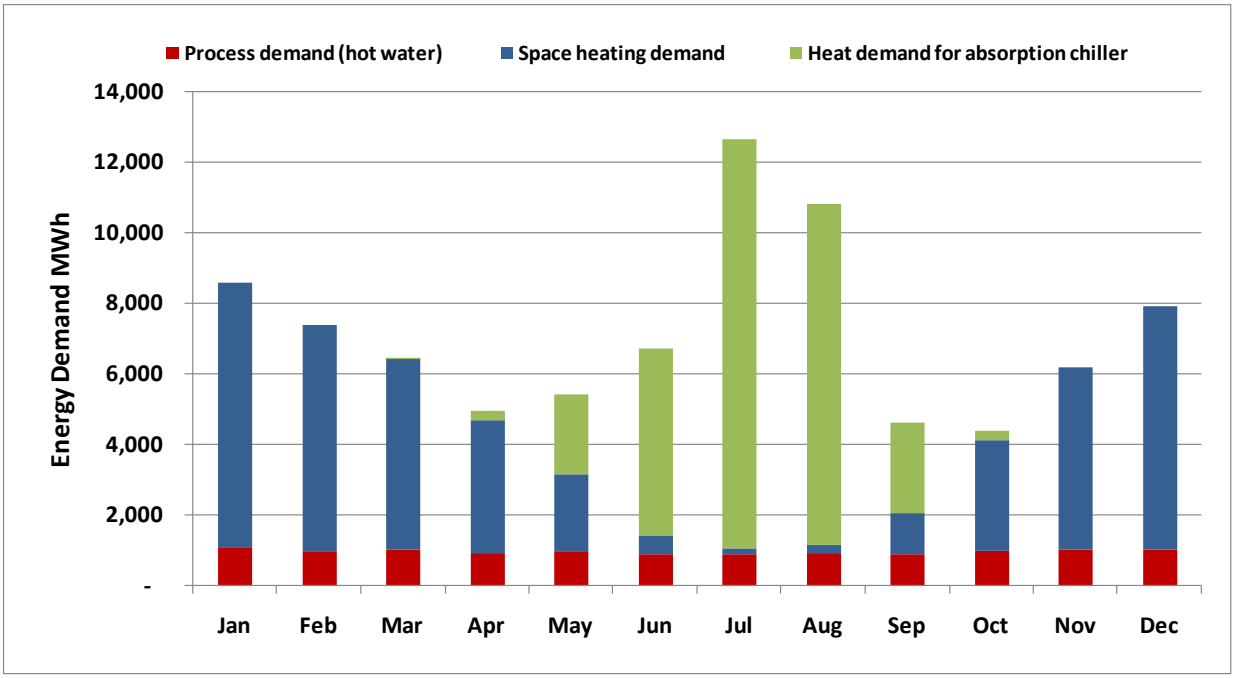

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Figure 2 - Monthly Energy demands for Energy Cluster 2

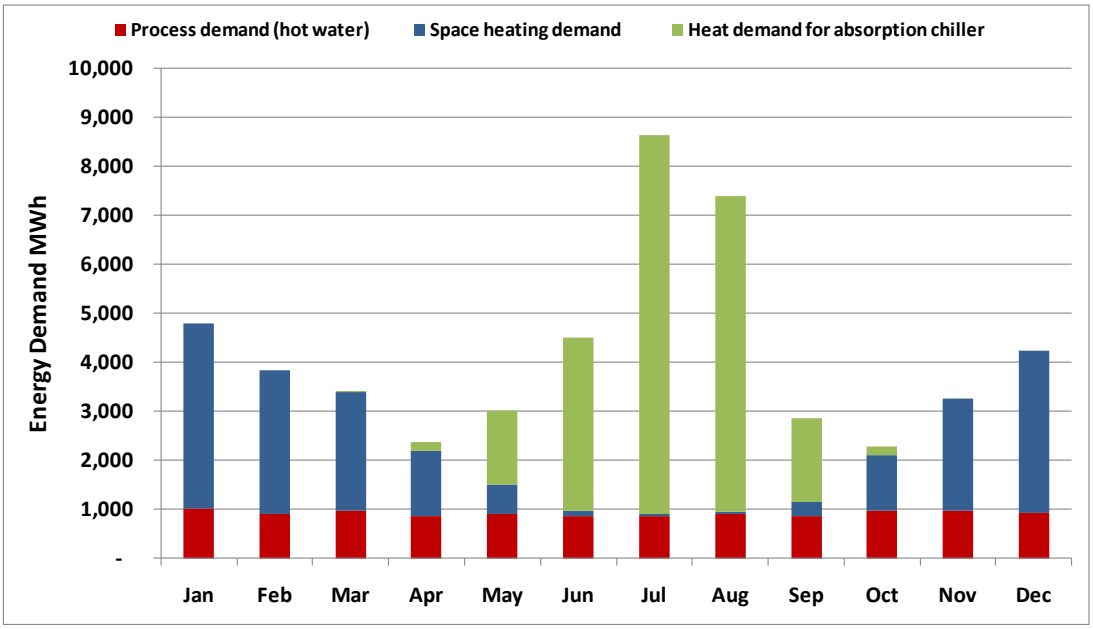
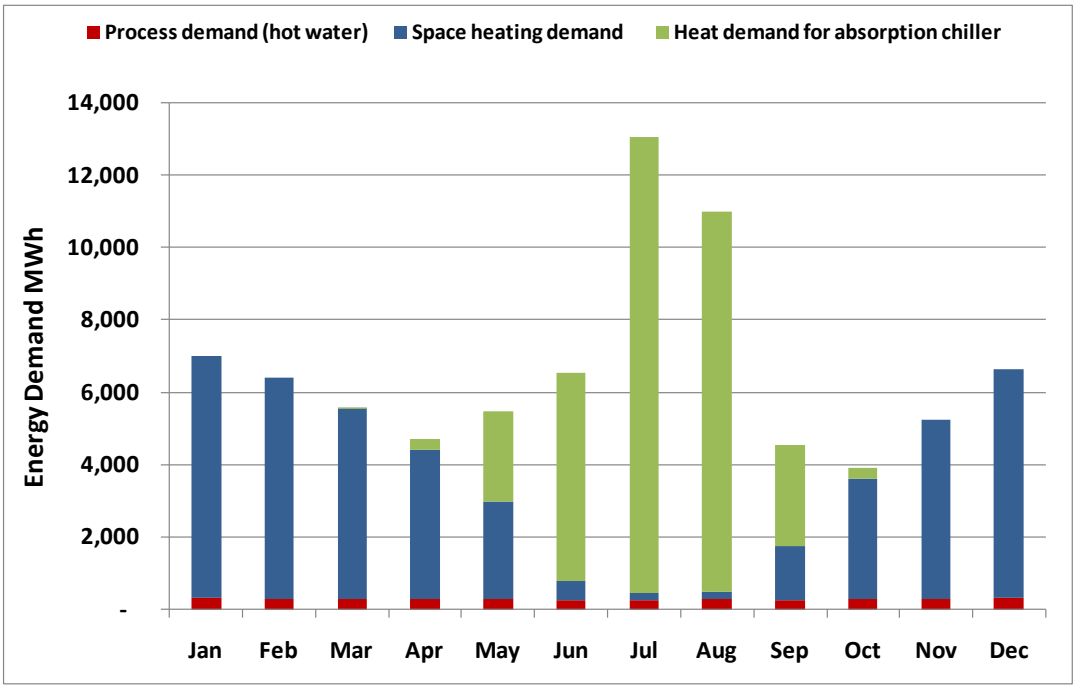


Figure 3 - Monthly Energy demands for Energy Cluster 3



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CHP Sizing

Assumptions

CHP runs for 17 hours per day
CHP provides heat for space heating and DHW demand first, then absorption chiller second if there is a cooling demand to be met.
Remaining cooling demand not met by absorption chiller is met by conventional chiller
CHP sized to meet 70% of each energy cluster heating demand (excluding absorption chiller heat demand)
Conventional chiller CoP: 4
Absorption chiller CoP: 0.7
CHP annual availability: 90%
Base case boiler efficiency: 88%
CHP analysis based on Jenbacher CHP units
DHN distribution losses are 5% of total heating demand

Figure 4 - Monthly Energy outputs and demands for Energy Cluster 1

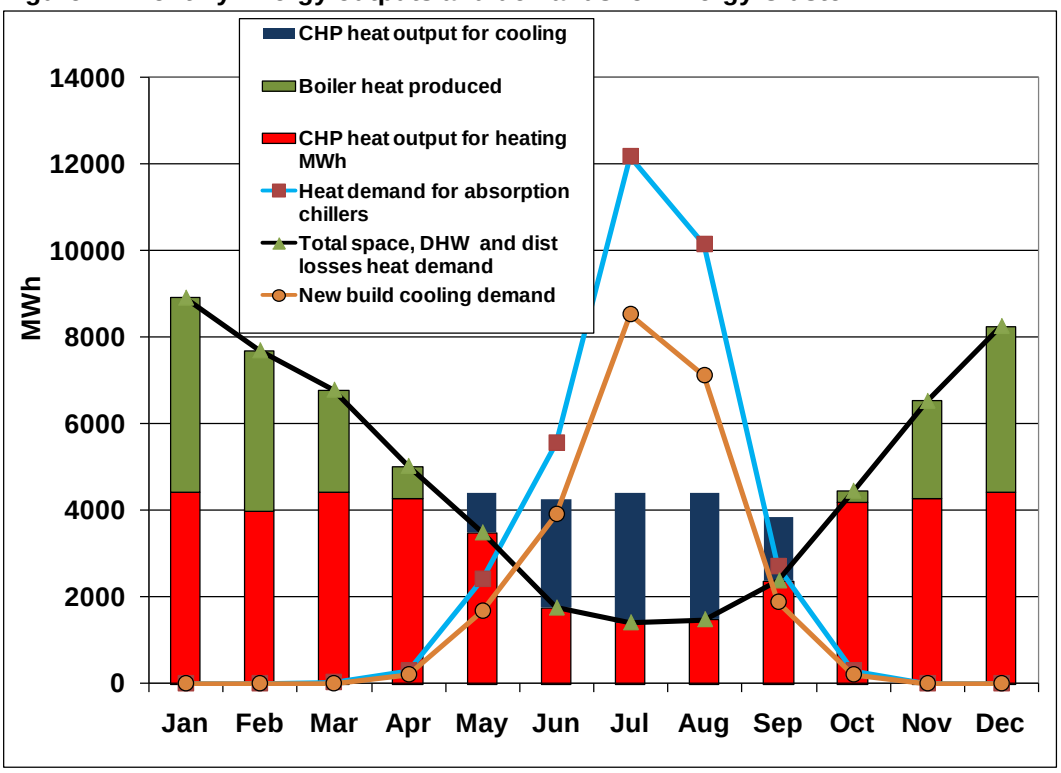

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Figure 5 - Monthly Energy outputs and demands for Energy Cluster 2

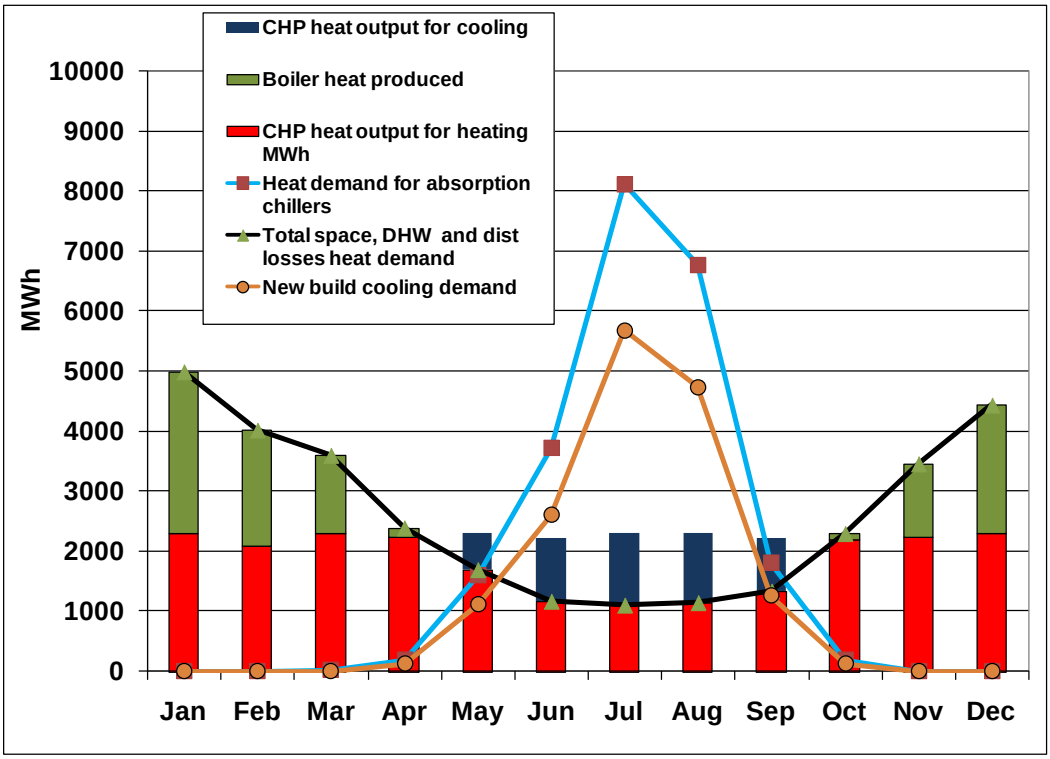

Figure 6 - Monthly Energy outputs and demands for Energy Cluster 3

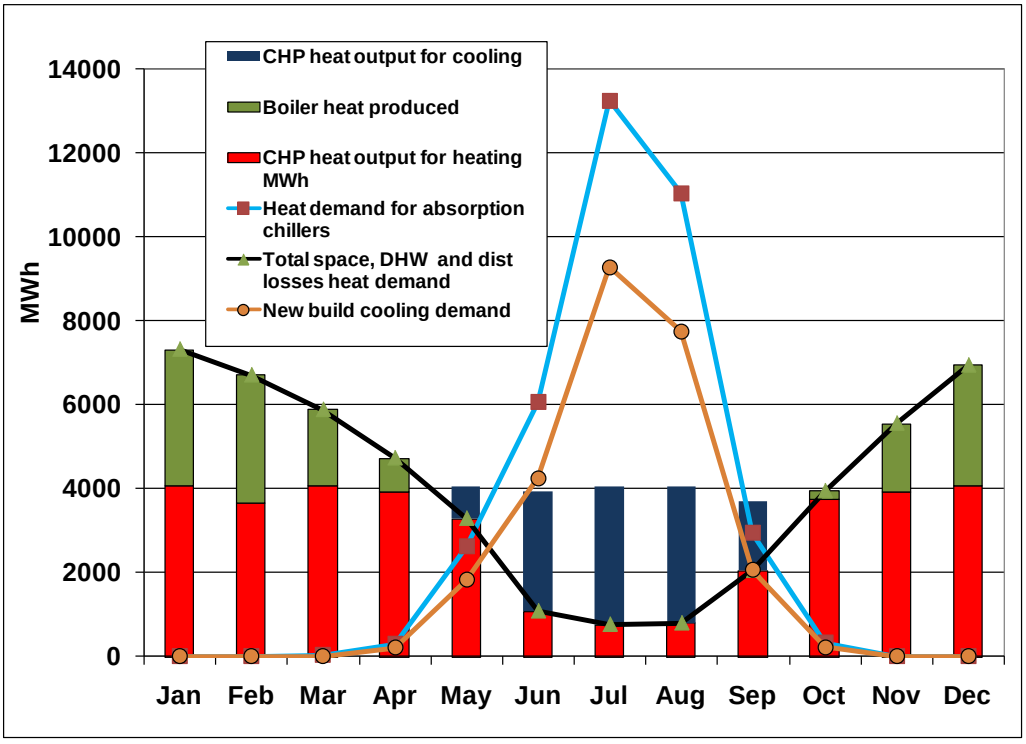

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Table 3 shows the assumed proportion of energy produced in the energy centres by building type. This is based on the proportion that each building type makes up of the relevant annual energy demand.

Table 3 - Proportion of energy produced attributed to building type

	Energy Centre Cluster 1	**Energy Centre Cluster 2**	**Energy Centre Cluster 3**
% of heat demand for existing commercial	9%	7%	83%
% of heat demand for new commercial	50%	55%	2%
%heat demand for existing public buildings	6%	5%	0%
% heat demand for new public buildings	11%	0%	0%
% of heat demand for new residential	24%	33%	15%
% of cooling demand for existing commercial	18%	11%	99%
% of cooling demand for new commercial	72%	89%	1%
% cooling demand for existing public buildings	0%	0%	0%
% cooling demand for new public buildings	11%	0%	0%
% electricity demand for existing commercial	12%	8%	88%
% of electricity demand for new commercial	55%	65%	1%
Electricity demand for existing public buildings	3%	2%	0%
Electricity demand for new public buildings	7%	0%	0%
Electricity demand for new residential	22%	25%	11%
CO_2 saving tonnes	14,963	7,684	14,346
CO_2 saving %	33%	27%	34%

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Table 4 - CHP Sizing summary table for issue to Davis Langdon

	Units	Zone 1	Zone 2	Zone 3
CHP Electrical capacity	kWe	**10,056**	**5,097**	**9,473**
Total heat demand excluding distribution losses	MWh p.a.	54,286	29,372	45,479
% heat provided by CHP for heating	%	70%	70%	72%
CHP heat produced for heating	MWh p.a.	40,481	22,107	35,420
Gas boiler heat produced for heating	MWh p.a.	17,696	9,517	13,613
Heat sold to customers	MWh p.a.	54,286	29,372	45,479
DH Network heat losses	MWh p.a.	3,890	2,253	3,553
Heat demand for existing commercial	MWh p.a.	5,015	1,910	37,615
Heat demand for new commercial	MWh p.a.	26,946	16,076	858
Heat demand for existing public buildings	MWh p.a.	3,483	1,337	-
Heat demand for new public buildings	MWh p.a.	5,946	109	-
Heat demand for new residential	MWh p.a.	12,896	9,799	7,006
Total heat consumed	MWh p.a.	54,286	29,372	45,479
Total cooling demand	MWh p.a.	23514	15682	25587
Cooling from absorption chillers	MWh p.a.	7,594	3,452	8,286
Cooling from conventional chillers	MWh p.a.	15,920	12,229	17,302
CHP heat for absorption chillers	MWh p.a.	10,849	4,932	11,837
Cooling sold to customers	MWh p.a.	23,514	15,682	25,587
Cooling demand for existing commercial	MWh p.a.	4,160	2,637	23,266
Cooling demand for new commercial	MWh p.a.	16,868	20,822	248
Cooling demand for existing public buildings	MWh p.a.	-	-	-
Cooling demand for new public buildings	MWh p.a.	2,486	-	-
Total cooling produced at Energy Centres	MWh p.a.	23514	15682	25587
Fuel/heat purchase				
Total CHP heat produced for heating and cooling	MWh p.a.	51,329	27,039	47,256
CHP fuel use	MWh p.a.	142,201	72,210	130,917
Gas boiler fuel use	MWh p.a.	20,109	10,815	15,469
Heat from Rolls Royce Power	MWh p.a.			
Total electricity demand	MWh p.a.	36,207	23,933	32,331
Electricity generated by CHP	MWh p.a.	56,151	28,657	51,696
Electricity sold to customers	MWh p.a.	35,672	21,802	32,331
Electricity sold to licensed supplier (export to grid)	MWh p.a.	20,480	6,855	18,825
Electricity demand for existing commercial	MWh p.a.	4,239	1,795	28,552
Electricity demand for new commercial	MWh p.a.	19,744	14,149	372
Electricity demand for existing public buildings	MWh p.a.	1,029	425	-
Electricity demand for new public buildings	MWh p.a.	2,663	29	-
Electricity demand for new residential	MWh p.a.	7,997	5,369	3,407
Carbon dioxide savings				
CO_2 saving tonnes	tonnes	14,963	7,684	14,346
CO_2 saving %	%	33%	27%	34%

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District Heating Network

There are 5 options explored:
DHN serving Energy Centre 1 cluster only
DHN serving Energy Centre 2 cluster only
DHN serving Energy Centre 3 cluster only
DHN serving Energy Centre clusters 1,2 &3
DHN served by Rolls Royce plant via heat interface unit in Croydon Town Centre energy centre

Assumptions
Flow velocity for energy clusters: 2m/s
Flow velocity for pipes connecting Rolls Royce plant to energy cluster 1: 3m/s
Flow and return temperatures for energy clusters: 95/65
Flow and return temperatures for Rolls Royce to energy cluster connection pipe: 125/65
Pipe sizes for each energy cluster based on largest required pipe diameter

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