National Grid Property Ltd

Addendum to the West Southall Masterplan Energy Strategy

Illustrative Solutions and Detailed Appraisal of Low and Zero Carbon Technologies' Integration Options after Detailed Simulation and Modelling

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Executive Summary

1.1 This report seeks to respond to comments made by the GLA in their review of the planning application for West Southall (LB Ealing Ref: P/2008/3981-S; LB Hillingdon Ref: 54814/APP/2009/430; and GLA Ref: PDU/2310/EW04). The Energy Strategy (October 2008) submitted to the LB Ealing and LB Hillingdon on 8th October 2008 as part of the outline planning application proposed two illustrative potential energy strategies, of which only one would be finally integrated into the scheme:

Primary Strategy 1: On-Site CHP Energy Centre with Biomass

An Energy Centre to provide Heat and Power by a community heat and power distribution network by utilising modular small-CHP units (potentially comprising 2no 228kWe/358kWth CHP Units, 4no 135kWe/215kWth CHP Units and 1no 110kWe/181kWe CHP Unit) and biomass boilers technologies. A phased strategy is proposed, which would comprise a single energy centre located at Plot H16.

If Primary Strategy 1 is adopted a strategy requiring the demonstration of the implementation of a combined heat and power system to achieve the required capacity would need to be submitted to and approved by the local planning authority, prior to occupation of the first plot, and reviewed thereafter. This would be required by way of a condition attached to the granting of planning permission.

This system, if implemented, would serve all buildings thereafter.

Primary Strategy 2: Turbo Expanders/Combined Cycle System

The Blue NG Scheme, i.e. Combined Heat and intelligent Power (CHiP), to provide Heat and Power by a community heat and power distribution network. The West Southall development will draw energy from the turbo expander scheme (combined cycle scheme) which will draw on gas pressure differentials in equipment on the retained National Grid Gas east gasholder compound and serviced by biodiesel heat engine plant located at H16 Plot. The turbo expanders are installed into the gas distribution system to reduce the pressure from the high pressure transmission mains to the lower pressure distribution network. During the expansion process the gas is

made to do useful work in the form of electricity generation. However, during this process the gas cools and requires re-conditioning to allow distribution along the network. As a result of this heat is also required for the process at the turbo expander site. A gas infrastructure turbo-expander scheme, if implemented, would be operational at the time the early residential dwellings are occupied and would serve all buildings thereafter.

1.2 One of these illustrative strategies (or another that would integrate future technologies which can not be foreseen at this stage) will ultimately be incorporated within the development to provide heat and power to the development. The necessary infrastructure for either of the two options will be accommodated within Plot HS.16 of the West Southall Masterplan (Please refer to Parameter Plan Ref. 0317-P1002-00 entitled 'Predominant Ground Floor Uses' for details). This will be the only energy centre for the development.

1.3 It should be noted that the choice of strategy will be made at a later stage of the project and hence this addendum assesses only if illustrative Primary Strategy 2 can provide equal or better CO_2 improvements against illustrative Primary Strategy 1.

1.4 In their review of the Energy Strategy, the GLA concluded that: further information on the proposed demand reduction measures should be provided; further modelling work should be submitted for both strategies; a communal heat network should be committed to; the sizing of the CHP should be further assessed; cooling needs should be assessed; and further consideration should be given to the impact of and the supply chain for the delivery of bio fuel.

1.5 WYG, the Applicant's Energy Consultants, met with the GLA to discuss the proposals on 6th February 2009. It was agreed that information would be submitted to address the points set out above.

Energy: Compliance with building regulations and non-domestic baseline emissions

1.6 The modelling results for representative dwellings using SAP 2005, summarised in Table 1 below, demonstrate compliance with building regulations 2006. Please see page 37 of Appendix 1 for full details. Detailed information for non-residential buildings is available in Appendix 1.

1.7 Overall the 'Building Emissions Rate' and 'Dwellings Emission Rate' of the proposed development are improved on average by 24.87% by energy efficiency measures in relation to the 'Target Emission Rate' defined by 2006 Amendments of the Building Regulations Part L. This improvement does not include any low or zero carbon technologies.

Dwelling(s)	Floor area (m^2)	$kgCO_2/m^2$		% Improvement
		TER	DER	
Flat 1	48.64	30.36	20.46	32.00
Flat 2	46.61	26.81	19.16	28.00
Flats 3, 4	56.16	26.90	18.76	30.00
Flat 5	56.80	26.06	17.86	31.00
Flat 6	56.92	31.72	20.40	35.00
Flats 7, 12	56.80	26.79	18.66	30.00
Flats 8, 9, 10, 11	56.16	24.83	17.85	28.00
Flat 13	56.92	31.72	20.40	35.00
Flat 14	56.80	25.96	18.33	29.00
Flat 15	56.80	26.63	19.33	27.00
Flat 16	56.92	31.99	20.97	34.00
Flat 17	59.25	26.41	18.54	29.00
Flats 18, 19, 20, 21	46.61	26.81	18.88	29.00
Flats 22, 23	56.16	24.83	17.83	28.00
Flats 24, 48	48.64	26.15	18.24	30.00
Flat 25	46.61	23.18	17.41	24.00
Flat 26, 28	56.16	21.29	16.15	24.00
Flat 27	56.16	24.83	17.86	28.00
Flat 29	56.80	22.42	16.51	26.00
Flats 30, 54	56.92	27.79	18.83	32.00
Flats 31, 36, 55	56.80	23.08	16.74	27.00
Flats 32, 33, 34, 35	56.16	21.29	16.15	24.00
Flat 37, 61	56.92	27.79	18.16	34.00
Flats 38, 62	56.80	22.33	16.48	26.00
Flats 39, 63, 77	56.80	22.93	16.70	27.00
Flats 40, 64, 78	56.92	28.05	18.60	33.00
Flats 41, 65	59.25	22.60	16.59	26.00
Flats 43, 43, 44, 45	46.61	23.18	17.82	23.00
Flats 46, 47, 70, 71	56.16	21.29	16.14	24.00
Flat 49	46.61	25.87	19.16	25.00
Flats 50, 51, 52	56.16	23.91	17.86	25.00
Flat 53	56.80	23.69	17.75	25.00
Flats 56, 57, 58, 59	56.16	23.91	17.85	25.00
Flats 60, 74	56.80	25.83	18.66	27.00
Flats 66, 67, 68, 69	46.61	25.87	18.94	26.00
Flat 72	48.64	29.27	21.40	26.00
Flat 73	56.92	29.77	20.18	32.00
Flat 75	56.92	30.72	20.40	33.00
Flat 76	56.80	25.02	18.33	26.00
Flat 79	59.25	24.48	17.30	29.00
Flats 80, 81	56.16	23.91	17.83	25.00
Flat 82	56.80	27.69	19.55	29.00
Flat 83	56.92	30.99	20.97	32.00
Flat 84	59.25	27.42	19.46	29.00
House 1	72.70	23.16	16.67	27.00
House 2	72.70	23.16	16.66	28.00
House 3	89.12	21.66	15.51	28.00
House 4	53.99	29.75	20.25	31.00
House 5	80.46	21.63	15.86	26.00
House 6	82.90	24.06	16.66	30.00
House 7	87.70	20.94	15.27	27.00
House 8	72.70	23.16	16.87	27.00
House 9	72.70	23.16	16.69	27.00
House 10	87.63	22.94	16.38	28.00

Table 1 SAP Summary of Illustrative Solution for an Indicative Number of Dwellings

TER = Target Emissions Rate, according to the minimum requirements of Building Regulations 2006;
DER = Dwelling(s) Emission Rate, as design and after energy efficiency measures.

1.8 Domestic and non-domestic baseline emissions, including un-regulated energy usage (cooking, televisions and radios, office PCs, food retail refrigeration, multi-storey car park lighting, cinema projectors etc), have been calculated using SBEM / SAP and BRE Technical Guides / Databases and are summarised in Table 2 below.

Baseline (Minimum Requirement of Building Regulations)	Area, in m^2	$kgCO_2/m^2$ Emissions: Building Services	$kgCO_2/m^2$ Emissions: Other Appliances*	Increase of Emissions due to Appliances *	$kgCO_2/m^2$ Emissions: Total	$kgCO_2$ Emissions: Total
Residential	320,000	24.90	15.30	+ 61.45%	40.20	12,864,000
Non-Food Retail	14,200	93.70	56.00	+ 59.77%	149.70	2,125,798
Food Retail	5,850	118.20	250.98	+ 212.34%	369.18	2,159,728
Restaurants, Bars and Cafes	1,750	93.70	51.15	+ 54.59%	144.85	253,493
Hotel	9,650	54.30	30.87	+ 56.85%	85.17	821,903
Office / Studios, Conference	6,500	43.80	49.41	+ 112.81%	93.21	605,861
Cinema	4,700	50.50	39.35	+ 77.93%	89.85	422,307
Healthcare	2,550	44.50	19.43	+ 43.66%	63.93	163,024
Educational	3,450	29.00	15.92	+ 54.88%	44.92	154,961
Sports Pavilion	390	24.70	22.94	+ 92.89%	47.64	18,581
Multi-Storey Car Park	24,450	0.00	6.33	NA	6.33	154,768
TOTAL, in m^2	393,490				**SUM, in $kgCO_2$**	19,744,426
					COMBINED SUM, in $kgCO_2/m^2$	50.18

* Other Appliances Loads include unregulated loads such as lifts, computers, external lighting, televisions, cooking etc

Table 2 Summary of Baseline CO_2 Emissions

Full details of the SBEM assessments and SAP summaries that have been used to develop the 2006 baseline are available in Appendix 1.

1.9 **Energy Efficient Design - Domestic buildings**

The Energy Strategy (October 2008) sets out the Applicant's aspiration that dwellings will be insulated to a high level, similar to 'passive house' standards; with air leakage set at around $2m^3/(m^2*h)$@50Pa and 'whole house' ventilation systems fitted as standard. It should be noted that in this instance 'passive house' does not refer to a specific standard, rather a general approach to design and construction that incorporates high standards of insulation and air tightness. BSRIA (ref: BG 4-2006) identify that an Air Permeability Rate of $3m^3/(m^2*h)$ @50 Pa is the best practice in UK, and $5m^3/(m^2*h)$ @50 Pa is normal practice in UK. We propose an Air Permeability Rate of $4m^3/(m^2*h)$ @50 Pa for West Southall. With this in mind, the proposed thermal transmittances are as follows:

	Latest Building Regulations (2006) Maximum Average U-Values, in W/m^{2}K	Proposed Maximum U-Values: West Southall Development, in W/m^{2}K	% Improvement than the Latest Amendments of Building Regulations
External Walls	0.35	0.15	**57%**
Windows	2.2	1.1	**50%**
Roofs	0.25	0.15	**40%**
Floors	0.25	0.15	**40%**
Air Permeability	10m^3/m^{2}h @50Pa	4m^3/m^{2}h @50Pa	**60%**

Table 3 Proposed Building Fabric Thermal Characteristics

The final inclusion of the demand reduction and energy efficient design measures will be decided at the detailed design stage. These could include:

- Energy efficient appliances and lighting
- Building energy management systems
- Heat recovery
- Smart metering (following commercialisation of the technology)
- Fans with low 'Specific Fan Power'.

A condition will be attached to the planning permission requiring consideration of energy efficient design measures to be assessed at the detailed design stage for each plot.

The percentage improvement of the 'Dwellings Emissions Rate' on the 'Target Emissions Rate', excluding low or zero carbon technologies, is set out in Table 1. The minimum percentage improvement would be 23%.

1.10 **Energy Efficient Design - Non-domestic buildings**

Estimated carbon dioxide savings for the non-domestic elements of the development are summarised in Table 4 below. The following energy efficiency measures could be implemented:

- T5 lighting, compact fluorescent or better
- Building energy management systems
- Heat recovery
- Demand side management
- Power-correction factor measures
- Ventilation System with low 'Specific Fan Power'.

The average percentage improvement of the 'Building Emissions Rate' on the 'Target Emissions Rate', excluding Low or Zero Carbon Technologies, is calculated to be 16.72%. As the design of these buildings has not been finalised, the CO_2 improvement of 16.72% would be a site average for buildings other than dwellings.

1.11 Power, Heating and Cooling Infrastructure: Heat network and infrastructure requirements

A site wide heat and power distribution network would be provided under both strategies. This will be addressed by way of a planning condition attached to the planning permission. Full details and indicative plans are provided in Appendix 3. The site infrastructure will provide links to domestic and non-domestic buildings for space heating and domestic hot water.

The delivery model for West Southall has yet to be confirmed, but it is likely that an Energy Services Company (ESCo) will be established to deliver and manage the necessary infrastructure.

Details of the building and plant requirements for either Strategy are provided in Appendix 3. The required infrastructure, including storage of fuel, will capable of being accommodated within Plot HS.16, as identified on Parameter Plan 0317-P1002-OO.

1.12 Power, Heating and Cooling Infrastructure: Optimising CHP output

Further work has been undertaken to optimise the output of the CHP plant based on the heat profiles of the development; 54.51% of the total heat requirement would be provided by the CHP Units. This is an improvement on the level indicated in the Energy Strategy (October 2008) of 14% of the heating supplied by the CHP units.

The design optimisation of the CHP units accords with the 'Combined Heat & Power Association' and the GLA's recommendations. During the first stage of the development, one 110kWe/181kWth CHP unit would be installed and would supply the baseload heating needs. When the Masterplan is further developed, more units will be installed into the energy centre which would supply the new baseload heating needs. By the end of the construction programme, seven units will be installed and will supply heating as per Figures 1 and 2. The detail for the inclusion of these units will be addressed by way of a planning condition attached

to the planning permission which would require the submission of and approval of details by the local planning authority.

If Primary Strategy 2 were delivered, this would be operational at the time the early residential dwellings are occupied and it would provide at least the same percentage (%) of heat required on site as per Primary Strategy 1.

As a result, if Primary Strategy 1 were delivered, a 26.92% overall reduction in carbon emissions would be achieved, of which 7.23% will be achieved from natural gas CHP. Please see pages 29 - 31 of this report for fuller details.

Cooling is not intended to be provided through site infrastructure. The cooling needs of the site will be provided as per the following design recommendations: -

- Fresh air shall be brought into the dwellings and buildings by cross ventilation by opening windows. The solar gain shall be reduced by appropriately designed shading devices. Carefully designed overhangs shall shade sunlight in the summer but let the lower winter sun in for passive heating.
- Low-energy lighting along with energy efficient appliances shall be fitted, where provided. The applications of maximum energy efficiency measurements to appliances may therefore reduce summer overheating when at the same time have a significant impact on energy use in a residence.
- When cooling is required, cooling shall be provided by Air-Source-Heat-Pumps, Fan Coils, Chilled Ceilings and Active Chilled Beams (with the exception of cinemas where a Variable Air Volume (VAV) system would be more appropriate) or any other future low carbon technology.

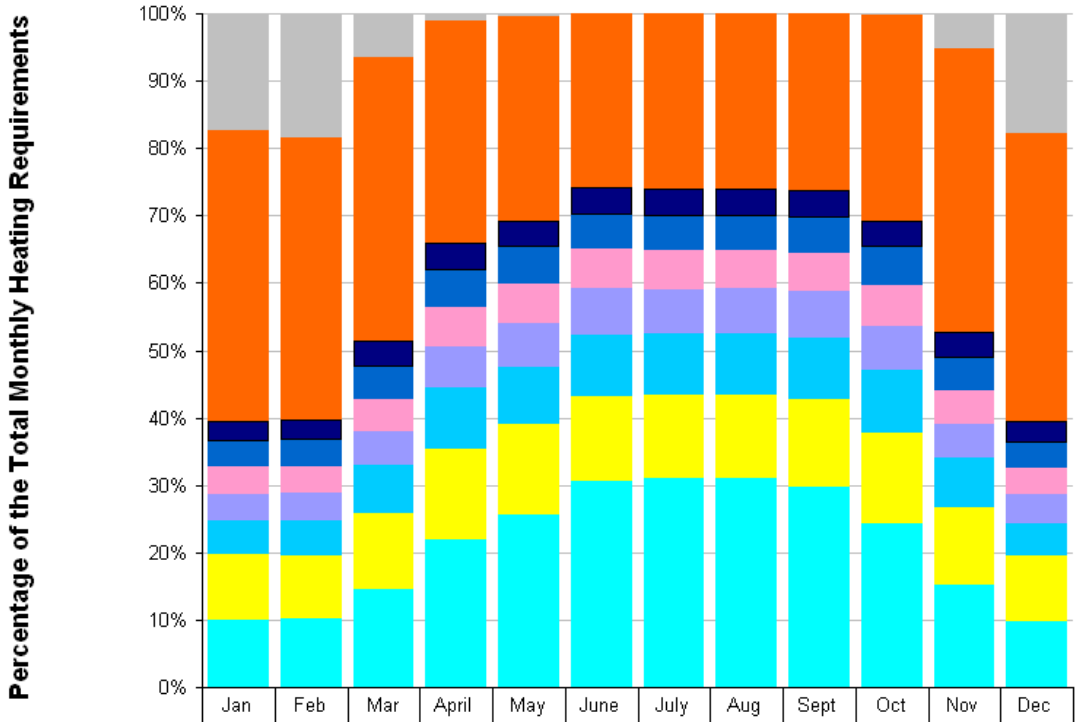
A condition will be attached to the planning permission requiring consideration of energy efficient design measures, to include cooling, to be assessed at the detailed design stage for each plot. This will have regard to the recommendations above.

1.13 **Renewable Energy (Policy A4.7)**

Monthly profiles have been plotted which include monthly profiles showing the percentage of the hot water requirements that would be provided by CHP, biomass and top-up gas boilers for Primary Strategy 1. The graph showing monthly profiles is available in Figure 1.

A condition will be attached to the planning permission requiring details of the phasing and capacity of the CHP, biomass and top-up gas boilers to be submitted to and approved by the local planning authority prior to the occupation of the first plot, and reviewed thereafter.

For more information about the operation of the heat generation systems, refer to the graph of Figure 2.



	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Natural Gas Boilers	17.5%	18.4%	6.4%	1.1%	0.5%	0.0%	0.0%	0.0%	0.0%	0.2%	5.1%	17.8%
Biomass Boilers	43.0%	41.9%	42.1%	33.1%	30.2%	25.7%	26.0%	26.0%	26.3%	30.5%	42.2%	42.8%
CHP 7: 110kWe/181kWth	3.1%	3.1%	3.9%	4.1%	4.0%	4.2%	4.2%	4.1%	4.1%	4.0%	4.0%	3.2%
CHP 6: 135kWe/215kWth	3.8%	3.8%	4.8%	5.4%	5.5%	5.1%	5.0%	4.9%	5.2%	5.7%	4.8%	3.8%
CHP 5: 135kWe/215kWth	3.9%	3.9%	4.8%	5.8%	5.9%	5.8%	5.8%	5.8%	5.7%	6.1%	4.9%	3.9%
CHP 4: 135kWe/215kWth	4.1%	4.1%	5.0%	6.1%	6.4%	6.9%	6.5%	6.6%	7.0%	6.3%	5.0%	4.2%
CHP 3: 135kWe/215kWth	5.0%	5.2%	7.2%	9.2%	8.5%	9.1%	9.1%	9.0%	9.1%	9.4%	7.4%	4.9%
CHP 2: 228kWe/358kWth	9.6%	9.4%	11.2%	13.4%	13.4%	12.7%	12.3%	12.5%	12.9%	13.5%	11.5%	9.6%
CHP 1: 228kWe/358kWth	10.0%	10.1%	14.6%	21.9%	25.6%	30.5%	31.1%	31.0%	29.7%	24.3%	15.1%	9.8%

Figure 1 Montly Percentage of CHP Units, Biomass Boilers and Natural Gas per Hot Water Demand

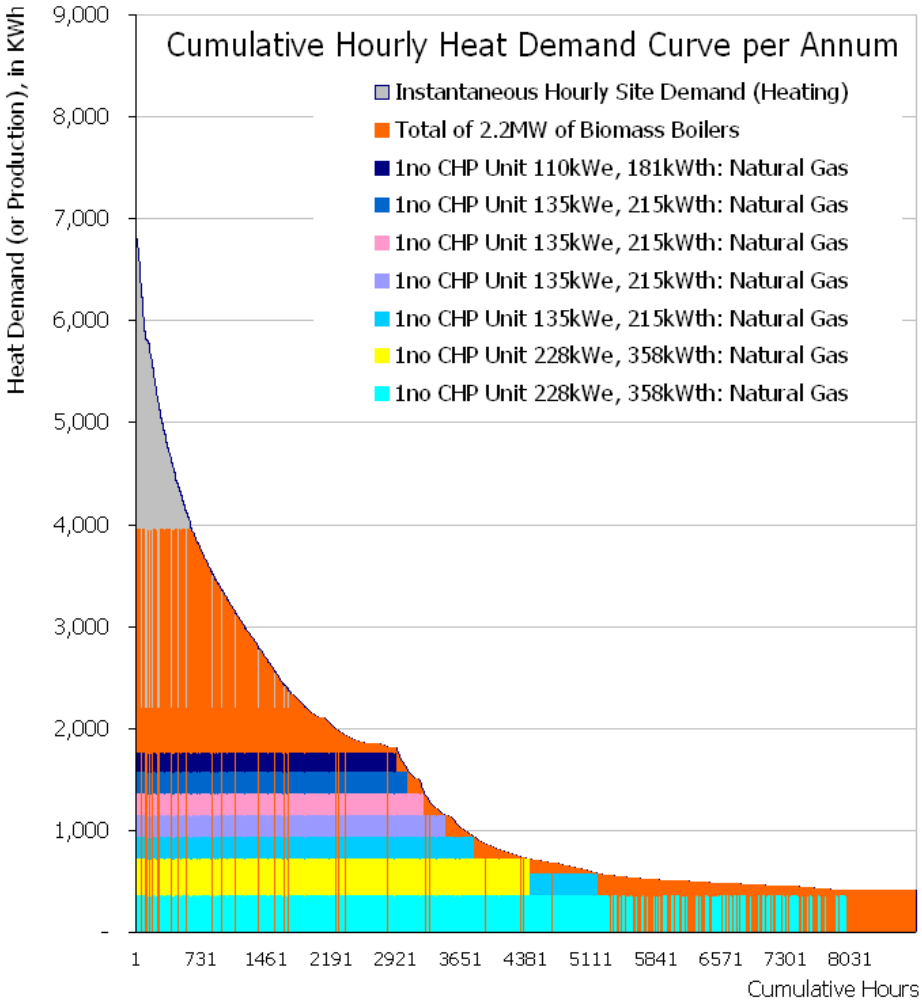


Figure 2 Cumulative Hourly Heat Demand Curve for All Heat Generation Systems.

1.14 **Delivery and supply**

The delivery of fuel for either of the two strategies would be via the road network proposed within the site, which in turn link into the existing road network. Detailed servicing arrangements to Plot HS.16 would be submitted to and approved by the local planning authority prior to commencement of development of Plot HS.16.

Potential suppliers of fuel for Primary Strategy 1 will be identified during detailed design for the energy centre. This will require details of the suppliers to be submitted and approved by the local planning authority prior to the commencement of development of the energy centre.

Information regarding potential suppliers of fuel for Primary Strategy 2 is given in a separate planning application by Blue NG.

1.15 Primary Strategy 1 - Air quality

The air quality impacts of the proposed development are detailed in the Environmental Statement, submitted as part of the outline planning application (principally Section 10: Air Quality). This assessment concludes that the operational effects of Primary Strategy 1 would not lead to a breach of the AQS objectives and effects range from negligible to minor adverse.

Under Primary Strategy 2 the increase in pollutant concentrations would lead to a slight breach of the AQS objectives at some isolated locations. The increase in pollutant concentrations is attributable to both emissions from the Blue NG scheme and increased vehicle emissions associated with changes in traffic flow characteristics. These operational effects generally range from slight to moderate adverse for No2 and negligible for PM10 emissions.

1.1 Primary Strategy 2 – Fuel Information

Details of the carbon intensity of the bio-diesel (pure rapeseed oil) that will be used under Primary Strategy 2 are summarised in the table below. The figures have been used to calculate the carbon savings for Primary Strategy 2.

Green House Gas Emissions Data		
Blue-NG typical Fuels	**$gmCO_2/MJ$**	**$kgCO_2/kWh$**
Pure Rapeseed Oil to be used by the Blue NG Scheme	*35*	*0.0097*
Note:The emission factor listed above includes estimates of CO_2 emissions from planting, harvesting, sawing up and other processing, and delivery to the point of use according to the Blue NG Operators		
Conversion Formulas		
g/MJ x	0.001	=kg/MJ
kg/MJ x	0.2778	=kg/KWh
Comparisons	$gmCO_2/MJ$	$kgCO_2/kWh$
Farmed Wood methanol	7	0.0019
Waste Wood Methanol	5	0.0014
Heating oil		0.2700
Mains gas		0.1940
House Coal		0.2910
Targets set in Part L2A: 2006		$kgCO_2/kWh$
• wood logs		0.025
• wood pellets in bags		0.025
• bulk wood pellets		0.025
• wood chips		0.025
• heat from boilers – biomass or biogas		0.025
• heat from boilers – waste combustion		0.043
• waste heat from power stations		0.018
Value that has been used for the Assessment of the Blue NG Scheme		**0.025**

Table 4 - Turbo Expander Scheme Fuel Information

Following discussions with the GLA it is considered that as the BlueNG proposals are the subject of a separate planning application it is not appropriate to provide the following information at this stage:

- Details of the impact of high fuel prices on the running costs and viability of the bio-diesel engines; and
- Details of the CHP engine to be used, the manufacturer and the manufacturer's warranty.

1.16 **Overall CO_2 Emissions after including all unregulated loads**

Table 5 summarises the potential CO_2 reductions of the illustrative Primary Strategy 1. It should be noted that the CO_2 emissions from the unregulated / appliances' loads are expected to make up 49% of the total projected emissions for the development. These are mainly electricity loads that can not be controlled by building and building services design, i.e. structures planning and design, but only by occupational and behavioural change. If the occupants would take the full advantage of smart metering, demand side management, high efficiency appliances and appliance controls, the CO_2 emissions from the unregulated / appliances' loads could be reduced by up to 30% with an extra 15% site CO_2 emissions reduction; the overall CO_2 reductions then would be 40% in relation to the baseline.

	Total Net Carbon Dioxide Emissions, in tonnes per annum	Total Carbon Dioxide Emissions Savings in relation to the baseline, in tonnes per annum	
Baseline Scenario	19,744	-	
After Energy Efficiency Measures Only	16,904	2,841	14.39%
After the integration of the Natural Gas CHP	15,476	4,268	21.62%
After the integration of 2.2MW Biomass Boilers	14,429	5,316	26.92%

Table 5 Summary of CO2 Emissions by Primary Strategy 1

1.17 **Complementary Renewable Energy Sources**

Under Primary Strategy 1, the CHP capacity has been optimised and the percentage CO_2 improvement of biomass boilers has been re-assessed in light of this. Under Primary Strategy 1 a 5.31% reduction in CO_2 would be achieved through the use of renewable energy (bio-mass boilers supplying the site wide heat network) in relation to the total emissions on site. (Note:

This is equal to 6.77% emissions reduction in relation to the emissions after the implementation of all energy efficiency measures and CHP)

It is noted that, though the renewable energy target is below the 20% required by the adopted London Plan (2008), the percentage of total heat provision by CHP Units is 54.51% and that this fits better within the London Plan hierarchy, as the CHP is fully optimised and is the primary heat source. GLA have indicated flexibility is available on the 20% target in this case as the scheme is giving precedence to other aspects of the GLA hierarchy. In that context the scheme includes provision of a district heating system throughout the site. It would be possible for the percentage of CO_2 emissions by biomass to be increased to 20% by reducing the standards of the thermal envelope and reducing the percentage of heat provision by CHP. However, whilst such a design approach could achieve a percentage compliance it would be against the main aim of the regulations to reduce the overall site emissions.

The overall CO_2 reduction, including energy efficiency measures, would, therefore, be 26.92% against the 2006 Baseline when all the unregulated loads are included.

1.18 It is not intended to include any complementary renewable energy system at this stage. The Energy Strategy will, however, be kept under review and the feasibility of the inclusion of additional technologies will be assessed for each plot at the relevant detailed design stage.

1.19 **Overall**

The scheme will provide:

- At least a 24% overall average improvement by energy efficiency measures, in Dwelling Emissions Rates (DER) over Target Emissions Rate (TER);
- A district heating system throughout the site;
- Energy reduction measures and provisions of Low and Zero Carbon Systems at or better than Level 4 of the Code for Sustainable Homes; and
- Excellent BREEAM for non-residential buildings.

By delivering an overall CO_2 reduction of 26.92% against 2006 Baseline, when including all the unregulated / appliances loads, the West Southall development can comply with the aims of

the London Plan. The reductions would be achieved by energy efficiency measures (14.39%), natural gas CHP (7.23%) and Biomass boilers (5.30%). Future technologies are likely to be commercialised in the timescale of this development and these may also contribute to achieving the above reductions too. The Energy Strategy will be kept under review as the West Southall development is progressed.

The CHP operation has been optimised, as it has been requested by the GLA, and the heat provision by the CHP systems can supply 54.51% of the total heat demand, space heating and domestic hot water, for the site. The above percentage will be reassessed when, as is likely, an Energy Services Company (ESCo) is established to deliver and manage the necessary infrastructure.

When the unregulated / appliances loads are not considered, illustrative solution Primary Strategy 1 has the potential to reduce the average site BER/DER by 46.52% against 2006 TER by energy efficiency measures (24.87%), natural gas CHP (12.49%) and Biomass boilers (9.16%).

This percentage is achievable by either the illustrative Primary Strategy 1 or Primary Strategy 2. Table 6 summarises the potential reduction of CO_2 emissions for the residential elements of the development, when all the carbon credits will be attached to the residential part of the Masterplan. These exceed the minimum requirements of Code Level 4.

The overall reduction of CO_2 emissions could be further increased at detailed design stage by reducing the percentage of the unregulated / appliances loads. These loads are related to occupational behaviour and any percentage (%) reduction of these can not be assessed at this planning stage. At the detail planning stage, the impact of smart metering, demand side management, high efficiency appliances and appliances controls will be evaluated for the final proposed design.

			Natural Gas CHP Only		Natural Gas CHP + Biomass	
Dwelling(s)	Floor area (m^2)	TER	BER	% Improvement	BER	% Improvement
Flat 1	48.64	30.36	16.40	45.00	9.38	69.00
Flat 2	46.61	26.81	15.96	40.00	9.56	64.00
Flats 3,4	56.16	26.90	14.97	44.00	8.86	67.00
Flat 5	56.8	26.06	14.51	44.00	8.75	66.00
Flats 7, 12	56.8	26.79	14.89	44.00	8.83	67.00
Flats 18-21	46.61	26.81	15.69	41.00	9.28	65.00
Flats 24, 48	48.64	26.15	15.29	41.00	9.16	64.00
Flat 27	56.16	24.83	14.54	41.00	8.78	64.00
Flats 30, 54	56.92	27.79	14.82	46.00	8.56	69.00
Flats 37, 61	56.92	27.79	14.50	47.00	8.49	69.00
Flats 32-35	56.16	21.29	13.72	35.00	8.61	59.00
Flats 40, 64, 78	56.92	28.05	14.70	47.00	8.53	69.00
Flats 41, 65	59.25	22.60	13.89	38.00	8.73	61.00
Flats 46, 47, 70,	56.16	21.29	13.72	35.00	8.62	59.00
Flats 56-59	56.16	23.91	14.53	39.00	8.77	63.00
Flats 60, 74	56.8	25.83	14.89	42.00	8.83	65.00
Flats 66-69	46.61	25.87	15.75	39.00	9.34	63.00
Flat 72	48.64	29.27	16.87	42.00	9.47	67.00
Flat 75	56.92	30.72	15.59	49.00	8.71	71.00
Flat 76	56.8	25.02	14.73	41.00	8.80	64.00
Flat 82	56.8	27.69	15.32	44.00	8.91	67.00
House type 1	72.7	23.16	12.91	44.00	7.54	67.00
House type 2	72.7	23.16	12.90	44.00	7.54	67.00
House type 3	89.12	21.66	11.92	44.00	7.08	67.00
House type 6	82.9	24.06	12.59	47.00	7.27	69.00
House type 9	72.7	23.16	12.93	44.00	7.57	67.00
CODE LEVEL			Level 3		Level 4	

Table 6 Evaluation of Potential Credits Related to the 'Code for Sustainable Homes'

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Tables

Assessor's Name: Dr Yianni Spanos
Certifications Scheme: CIBSE Certification Ltd
Certification No.: LCCD42016

Registered

2 Introduction

2.1 Primary Strategy 1: On-Site CHP Energy Centre with Biomass

Primary Strategy 1 provides an overall average 26.92% CO_2 reduction per square meter against 2006 baseline, of which 14.39% is achieved by Energy Efficiency Measures, 7.23% by the provision of 54.51% of heating by natural gas CHP and 5.31% by the use of biomass boilers to meet the remaining heat demand.

Energy efficiency measures will include:

- Increased building fabric insulation
- Reduced air-permeability
- Energy efficient lighting

2.2 A community heat and power distribution network will be connected to a Central Energy Centre that incorporates natural gas CHP units and Biomass boilers. These will provide heat for all the space heating and domestic hot water required as well as meeting some of the development's power requirements.

CO2 emissions for Primary Strategy 1 are summarised in Table 7: -

	Total Net Carbon Dioxide Emissions, in tonnes per annum	Total Carbon Dioxide Emissions Savings in relation to the baseline, in tonnes per annum	
Baseline Scenario	19,744	-	
After Energy Efficiency Measures Only	16,904	2,841	14.39%
After the integration of the Natural Gas CHP	15,476	4,268	21.62%
After the integration of 2.2MW Biomass Boilers	14,429	5,316	26.92%

Table 7 Emissions Summary: Primary Strategy 1 - Natural Gas CHP Units and Biomass Boilers

2.3 The development as designed is projected to have annual net CO_2 emissions of 14,429tonnes. An equivalent development built to current Building Regulations would have annual CO_2 emissions of 19,744 tonnes.

2.4 Therefore, the proposed scheme will provide annual CO_2 emissions savings of 5,316 tonnes. This equates to a 26.92% overall average improvement above Building Regulations for CO_2 emissions, when unregulated power, appliances and cooking related CO_2 emissions are included in the calculations.

2.5 It should be noted that even though 100% of the heating can be provided by Low or Zero Carbon Technologies, the total CO_2 reduction by these technologies cannot significantly higher than those presented in Table 7; as the ratio of "heat related CO_2 emissions" to the "electricity related CO_2 emissions", in such a development can not higher than 1:6.

2.6 PRIMARY STRATEGY 2: Turbo Expanders / Combined Cycle System, i.e. The Blue NG Scheme

2.7 The National Grid gas pressure reduction station ("PRS") requires heat to counter the Joule-Thomson effect and ensure that the bulk temperature of the gas remains within the operational range specified by National Grid. BlueNG propose to meet this heating requirement using heat recovered from the CHiP (Combined Heat and intelligent Power) power generation cycle.

2.8 Under these proposals, Primary Strategy 2 will provide at least the same CO_2 % reduction per square meter as Primary Strategy 1.

Energy efficiency measures will include:

- Increased building fabric insulation
- Reduced air-permeability
- Energy efficient lighting

2.9 A community heat and power distribution network will be connected to a Central Energy Centre that houses the Blue NG scheme. This would provide heat for all the space heating and domestic hot water required as well as meeting all of the development's power requirements, with excess electricity exported to the grid.

2.10 Based on the information submitted by Blue NG, the proposed development is projected to have annual net CO_2 emissions of -3,700tonnes. An equivalent development built to current Building Regulations would have annual CO2 emissions of 19,744 tonnes.

	Total Net Carbon Dioxide Emissions, in tonnes per annum	Total Carbon Dioxide Emissions Savings in relation to the baseline, in tonnes per annum
Baseline Scenario	19,744	
After Energy Efficiency Measures Only	16,904	2,841
After the integration of the Blue NG Scheme	-3,700	23,444

Table 8 Emissions Summary: Primary Strategy 2 - The Blue NG Scheme

Based on the information submitted by Blue NG, the proposed development is projected to have annual net CO_2 emissions of -3,700tonnes. An equivalent development built to current Building Regulations would have annual CO_2 emissions of 19,744 tonnes.

3 Methodology

3.1 The carbon dioxide emissions of all residential units have been calculated by the Standard Assessment Procedure (SAP: 2005) for the energy rating of dwellings, while the carbon dioxide emissions of non-dwellings have been calculated by a dynamic simulation model produced within IES<Virtual Environment> utilising available information on energy consumption profiles that are available within the NCM database. The energy consumption of the assessed options was computed by a Dynamic Simulation Modelling tool, i.e. IES<VE> and bespoke in-house developed tools. The assessed Masterplan is compared with equivalent buildings that could have just passed the "Part L: 2006 Target Emissions Rate" benchmark.

3.2 In order to comply with the Part L: 2006 of the Building Regulations, the actual Building Emissions Rate (BER – for non dwellings) or Dwellings Emissions Rate (DER – for dwellings)] must be less than or equal to the Target Emissions Rate (TER).

3.3 The SAP: 2005 methodology has been used to develop standard assessment profiles for the energy rating of dwellings. The energy consumption of appliances and cooking within dwellings has been calculated using the standard algorithms proposed by BRE within the Code for Sustainable Homes Technical Guide. For all other types of accommodation, the non-building services appliances and other unregulated energy profiles are based on the NCM:BRE Database and have been compared against the Good Practice Benchmarks of "CIBSE Guide F – Energy Efficiency in Buildings, 2nd Edition, 2004, Part C". All appliance consumption data is better than Guide F Benchmarks for each type of building.

3.4 Competent trained engineers undertook the SAP & SBEM-IES<VE> calculations to evaluate the emissions rating of all the proposed types of accommodations. By developing Virtual building models, the actual energy consumption of all proposed accommodation was projected using a typical year, i.e. CIBSE London Test Reference Year (TRY), and BRE's National Calculation Method (NCM) consumption profiles. The methodology is shown in Figure 3.

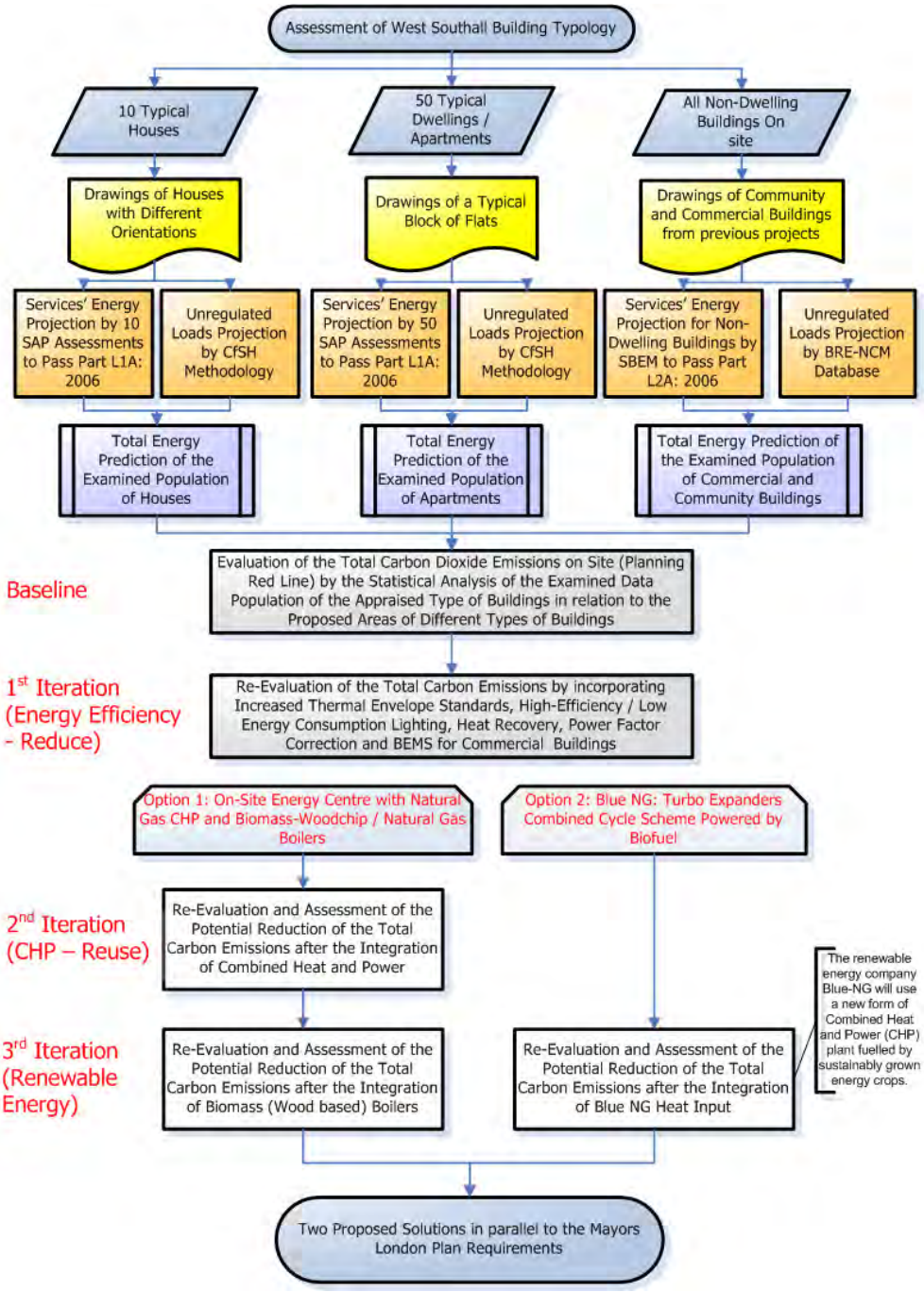

Figure 3 Detail Energy Appraisa's Methodology Flow Chart

4 Baseline and Emissions after Energy Efficiency Measures

4.1 The data, which have been derived by the DSM / SAP simulations is summarised in Table 8 below (please see Appendix 1 for full details of the indicative performance specifications used). Table 9 summarises the projected CO_2 emissions after the inclusion of energy efficiency measures.

Baseline (Minimum Requirement of Building Regulations)	Area, in m^2	$kgCO_2/m^2$ Emissions: Building Services	$kgCO_2/m^2$ Emissions: Other Appliances*	Increase of Emissions due to Appliances *	$kgCO_2/m^2$ Emissions: Total	$kgCO_2$ Emissions: Total
Residential	320,000	24.90	15.30	+ 61.45%	40.20	12,864,000
Non-Food Retail	14,200	93.70	56.00	+ 59.77%	149.70	2,125,798
Food Retail	5,850	118.20	250.98	+ 212.34%	369.18	2,159,728
Restaurants, Bars and Cafes	1,750	93.70	51.15	+ 54.59%	144.85	253,493
Hotel	9,650	54.30	30.87	+ 56.85%	85.17	821,903
Office / Studios, Conference	6,500	43.80	49.41	+ 112.81%	93.21	605,861
Cinema	4,700	50.50	39.35	+ 77.93%	89.85	422,307
Healthcare	2,550	44.50	19.43	+ 43.66%	63.93	163,024
Educational	3,450	29.00	15.92	+ 54.88%	44.92	154,961
Sports Pavilion	390	24.70	22.94	+ 92.89%	47.64	18,581
Multi-Storey Car Park	24,450	0.00	6.33	NA	6.33	154,768
TOTAL, in m^2	393,490				**SUM, in $kgCO_2$**	19,744,426
					COMBINED SUM, in $kgCO_2/m^2$	50.18

* Other Appliances Loads include unregulated loads such as lifts, computers, external lighting, televisions, cooking etc

Table 9 Baseline CO_2 Emissions

After Energy Efficiency Measures (Minimum Requirement of Building Regulations)	Area, in m^2	kgCO2/m2 Emissions: Building Services	$kgCO_2/m^2$ Emissions: Other Appliances	Increase of Emissions due to Appliances *	$kgCO_2/m^2$ Emissions: Total	$kgCO_2$ Emissions: Total
Residential	320,000	17.83	15.30	+ 85.81%	33.13	10,601,280
Non-Food Retail	14,200	71.90	56.00	+ 77.89%	127.90	1,816,238
Food Retail	5,850	112.80	250.98	+ 222.50%	363.78	2,128,138
Restaurants, Bars and Cafes	1,750	79.20	51.15	+ 64.59%	130.35	228,118
Hotel	9,650	46.40	30.87	+ 66.53%	77.27	745,668
Office / Studios, Conference	6,500	39.00	49.41	+ 126.69%	88.41	574,661
Cinema	4,700	47.10	39.35	+ 83.55%	86.45	406,327
Healthcare	2,550	32.40	19.43	+ 59.97%	51.83	132,169
Educational	3,450	13.60	15.92	+ 117.03%	29.52	101,831
Sports Pavilion	390	14.70	22.94	+ 156.09%	37.64	14,681
Multi-Storey Car Park	24,450	NA	6.33	NA	6.33	154,768
TOTAL, in m^2	**393,490**				**SUM, in $kgCO_2$**	16,903,881
					SUM, in $kgCO_2/m^2$	42.96
					Improvement than Baseline	14.39%

Table 10 CO_2 Emissions after Energy Efficiency Measures

4.2 The proposed energy efficiencies measures, based on good and best Practice design principles[i], are summarised in Tables 11 and 12 below.

	Energy Performance	Benchmark source and date
Boilers		
Condensing Boilers	92%	CIBSE F-2004
CHP		
CHP Power Efficiency	28%	CHP Club
CHP Quality Index	105	CHPQA-2003
Specific fan power		
Specific fan power (W/l/s) - local ventilation unit	0.2	Part L:UK -2006
Specific fan power (W/l/s) – Whole Build Vent Sys – H.R.	2	Part L:UK -2006
Specific fan power (W/l/s) – Whole Build Vent Sys – H.R.	1.8	CIBSE F, GPG192
Specific fan power (W/l/s) - all other central systems	1.8	CIBSE F, GPG192
Heat pump COP		
Heat pump COP if heating pump capacity < 20 kW (COP)	2.2	CIBSE F-2004
Heat pump COP if 61kW < 120 kW	2.5	CIBSE F-2004
Heat pump COP if > 120kW	2.6	CIBSE F-2004
Lighting		
Average lamp life (h)	8000	GPG199-1996
Average luminous efficacy (lumen/W)	45	Draft L:UK -2005
Lighting efficiency (W/m² x 100lux)	3	CIBSE F-2004
Lighting installed capacity (W/m²TFA)	12	CIBSE F, ECON19
Security lighting - maximum wattage (W)	150	ECOH-2005
Pumps		
Pumps > 150 m³/h (efficiency)	65%	BELOK-2005
Pumps < 150 m³/h (efficiency)	50%	BELOK-2005

Table 11 Summary of good and best practice systems specifications

	Latest Building Regulations (2006) Maximum Average U-Values, in W/m²K	Proposed Maximum U-Values: West Southall Development, in W/m²K	% Improvement than the Latest Amendments of Building Regulations
External Walls	0.35	0.15	**57%**
Windows	2.2	1.1	**50%**
Roofs	0.25	0.15	**40%**
Floors	0.25	0.15	**40%**
Air Permeability	10m³/m²h @50Pa	4m³/m²h @50Pa	**60%**

Table 12 Heat Transmittance Values (U-Values) for external building elements, in W/m²K, in comparison to current Building Regulations Requirements.

4.3 CO_2 emissions from the unregulated / appliances' loads are expected to make up 49% of the total projected emissions for the development. Most of this demand will be from non-domestic buildings, as a result only 63.1% of the total emissions would be produced by the residential elements, which make up 81% of the proposed floor area. A comparison is shown in Figure 5.

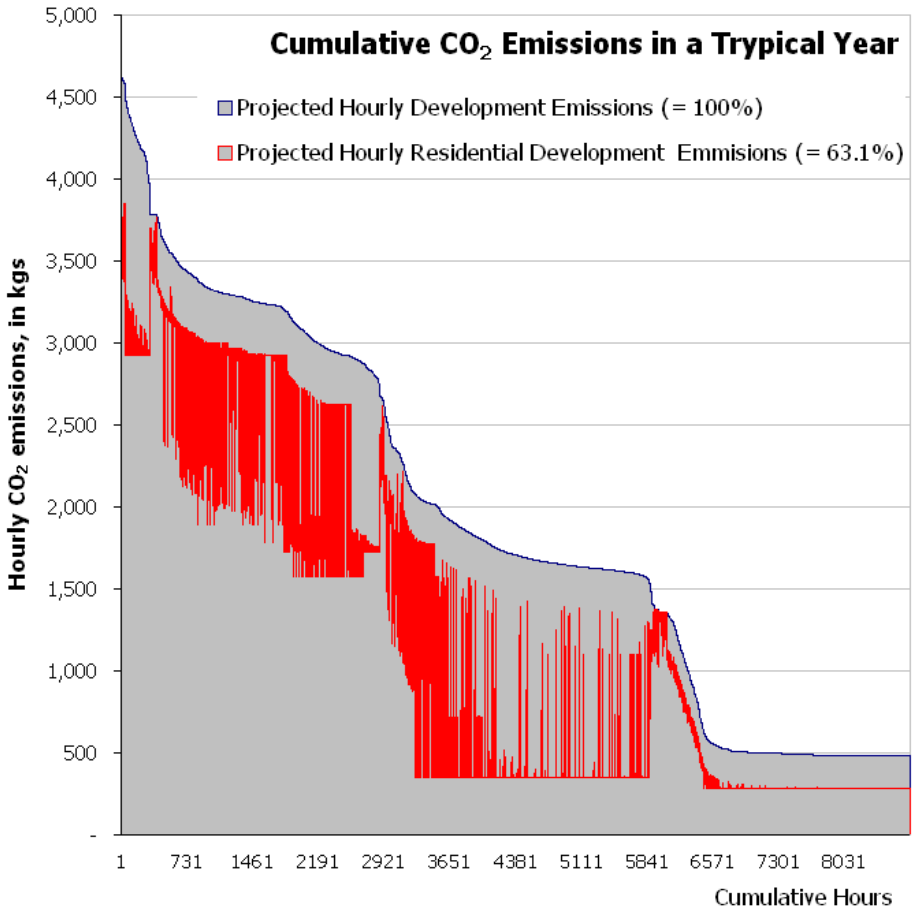

Figure 4 Comparison of Projected Emissions of West Southall Masterplan with the Residential Accommodation of the Site

4.4 83.96% of the total annual heating demand will come from residential elements of the development. More information and a comparison between the "total site" and "residential only" heating demands is shown in Figure 6. Please see Appendix 2 for further information on energy consumption.

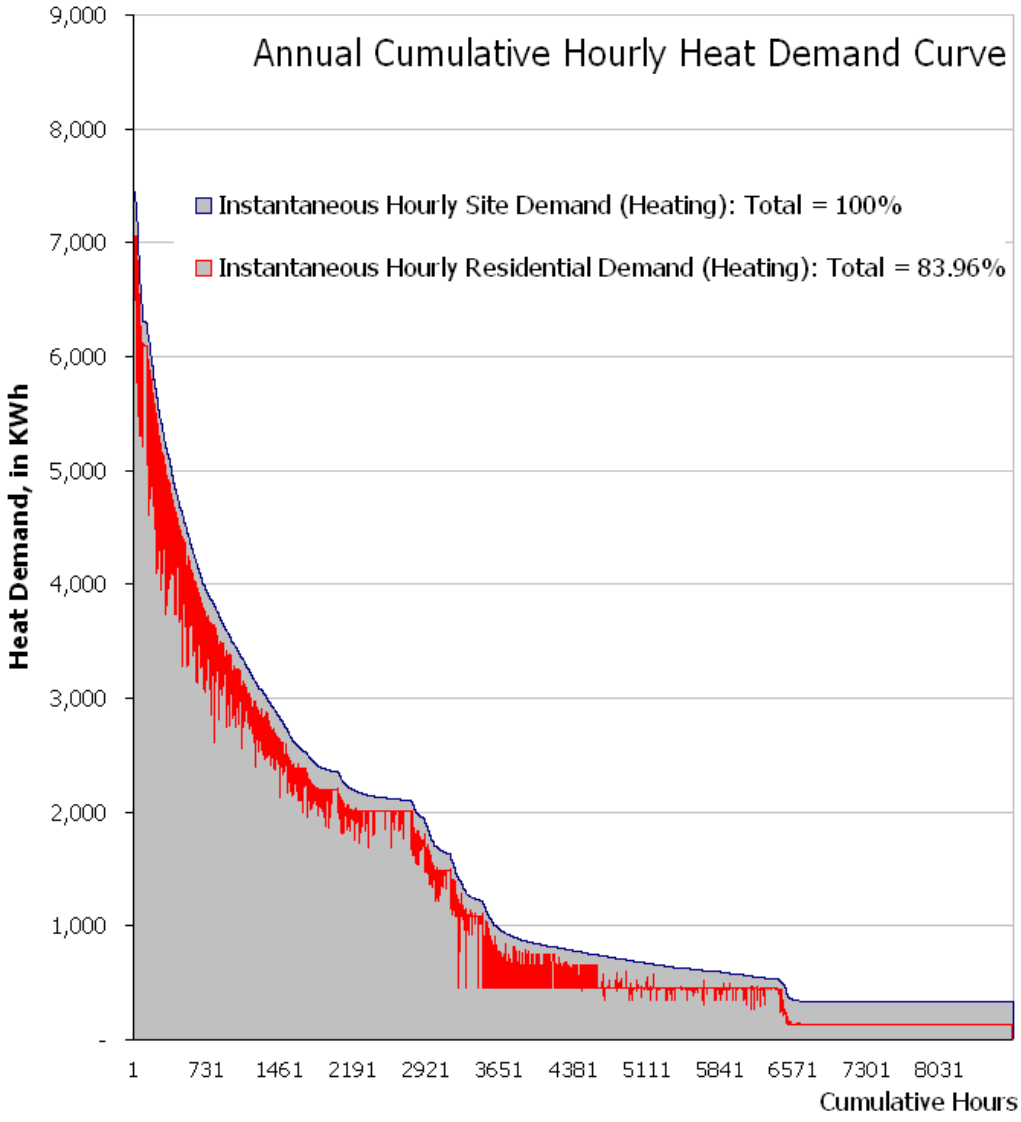

Figure 5 Comparison of the Projected Total Heat Demands of the West Southall Masterplan against the Residential Accommodation Only

5 Energy Statements

5.1 These are based on Appendix D of the 'Supplementary Planning Guidance, Sustainable Design and Construction (Mayor of London)'. The purpose of this information is to identify where a proposed project can make the most effective energy and carbon emissions savings in a scheme. It validates whether a scheme achieves the Mayor's percentage target for reduction in carbon emissions from renewable energy technologies.

5.2 Both the proposed Primary Strategies fully comply with Building Regulations and the Mayor's of London Planning requirements.

5.3 Both proposed strategies will provide district heat and power networks. Appendix 3 provides further information including:

- Indicative Power Distribution Network, incl. an Embedded High Voltage Rings' Network
- Indicative Heat Distribution Network, incl. potential location of thermal substations
- An Indicative Energy Centre Layout of Primary Strategy 1: On-Site CHP Energy Centre with Biomass boilers
- The Operational Energy Input and Output of Primary Strategy 2: Turbo Expanders / Combined Cycle System, i.e. Blue-NG Option

5.4 **Primary Strategy 1: On-Site CHP Energy Centre with Biomass**

5.5 A key method of enhancing the energy-efficiency of a development is to embrace economies of scale, where possible. A centralised heating plant is therefore preferable to individual heating systems, especially where there is a need for hot water throughout the year. Such a system is well-suited to residential units. Whenever a centralised system is considered suitable, the CO_2 saving which can be gained from employing Combined Heat and Power (CHP) should be considered.

5.6 CHP is usually a financially sustainable solution when it is used to provide heat and electricity for over 4,000 hours a year and is ideally suited to a demand profile which is predictable and relatively constant. In addition, financial and technical reasons, all three of the following conditions should be fulfilled during its operation:

i) The CHP should not operate during the night tariff; the CHP should operate between 7:00 and 24:00 hours, AND

ii) The Heat Output of the CHP should be less than the Instantaneous / Hourly Heat Demand on Site; AND

iii) The Electricity Output of the CHP should be less than the Instantaneous / Hourly Power Demand on Site.

5.7 To further optimise the operation of the CHP units, the thermal store design and optimisation modelling exercise has been based on the Domestic Hot Water demand for evening hours. Modelling and research has identified that the ratio of heating demand for Domestic Hot Water in residential developments between the hours of "07:00 – 9:00" and "18:00 – 24:00" is approximately 1:4.5.

5.8 The above suggest that a modular CHP system which consists of 7 units (2no 228kWe/358kWth CHP Units, 4no 135kWe/215kWth CHP Units and 1no 110kWe/181kWe CHP Unit) is the most suitable approach. These units have been sized to be installed at different development stages, i.e. only 1 unit will be operational during Stage 1 of the Development. Even though the average operation time of all units when fully operational will be 3,655hours per annum, the mean operational time of the bigger units will 5,100hours meaning that this will be a financially viable solution. 54.51% of the total heat demand can be supplied by the CHP units. For more information, please refer to Figure 6.

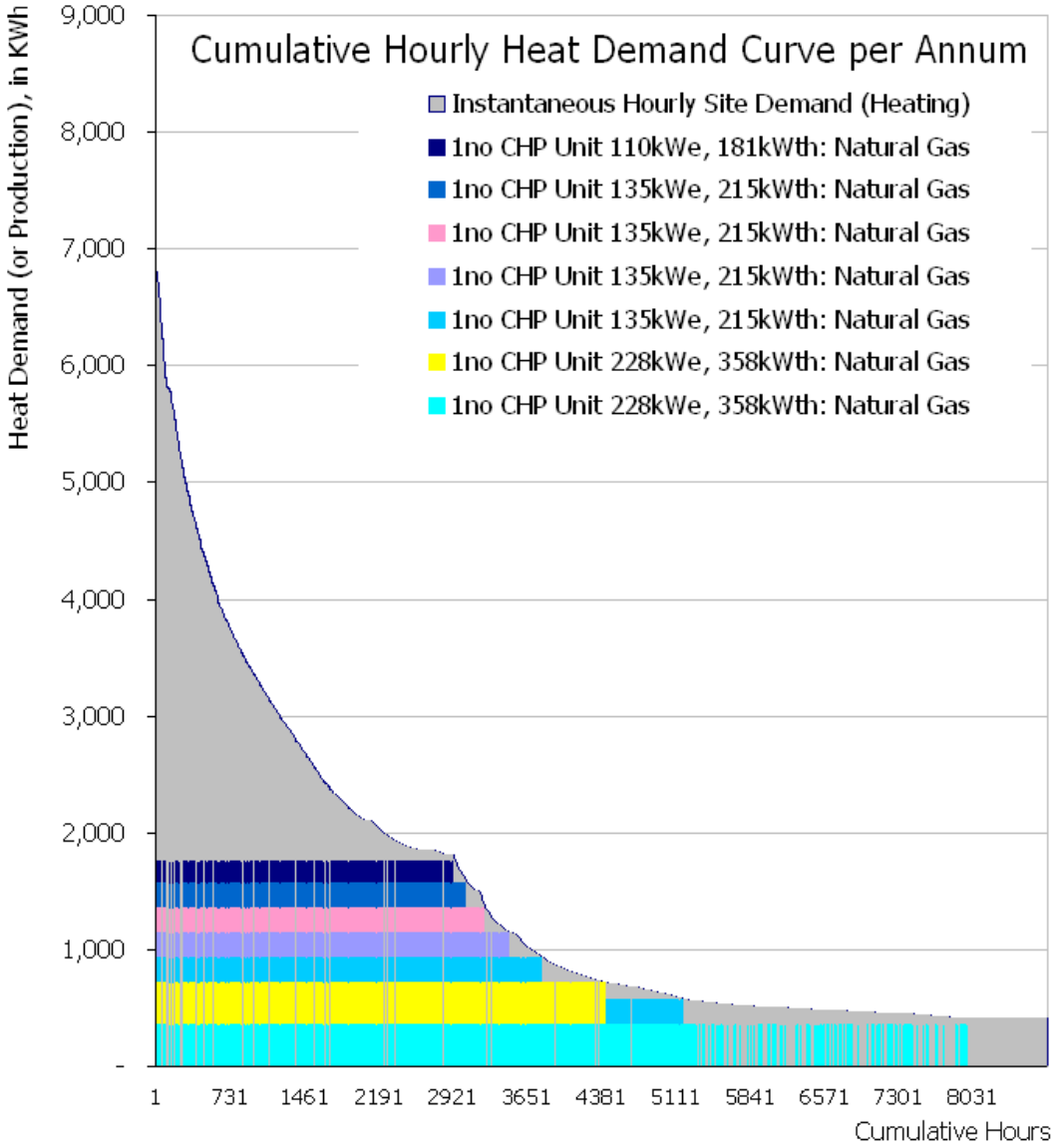

Figure 6 Provision of 54.51% of the Masterplan Heating Demand by the Integration of a Modular CHP System

5.9 The performance calculations of the 7 Natural Gas CHP Units are summarised in Table 13. 2.2MWth Biomass Boilers have also been proposed to provide top-up heating. The total CO_2 reductions of the development (including energy efficiency measures) are 26.92%, as summarised in Table 14.

Symbol	Value	Units	Description	Notes
Q_{htot}	14,509,848	kWh	Annual heating demand for space heating and hot water	
M	54.51%	%	Percentage of heating demand met by CHP	
Q_h	7,909,318	kWh	Annual heating supplied by CHP	$Q_{hot} \times M$
Rq	1541	kW	Rated heat output of CHP (maximum)	
h	5133	hours	Full hours run (equivalent)	$Q_h \times R_q$
R_e	1108	kW	Rated net electricity output of CHP (maximum)	
Q_e	5,676,642	kWh	Net electricity generated	$R_e \times h$
Cf_e	0.568	kgCO2/kWh	Carbon dioxide factor for grid-displaced electricity	0.568
C_e	3,224,333	kg	Carbon dioxide saved owing to electricity from CHP	$Qe \times Cf_e$
R_f	3536	kW	Rated fuel consumption of CHP	
Q_{fchp}	18,148,831	kWh	Annual fuel consumption of CHP	$R_f \times h$
Cf_{fchp}	0.194	kgCO2/kWh	Carbon dioxide factor for fuel supply to CHP	Natural Gas
C_{chp}	3,520,873	kg	Resulting carbon dioxide emissions due to fuel consumed by CHP	$Q_{fchp} \times Cf_{fchp}$
E_{con}	89	%	Seasonal efficiency of conventional boiler	Condensing
Q_{con}	8,886,874	kWh	Annual fuel consumption of conventional boiler	Q_h/E_{con}
Cf_{fcon}	0.194	kgCO2/kWh	Carbon dioxide factor for fuel supply to conventional boiler	Gas = 0.194
C_{con}	1,724,054	kg	Resulting carbon dioxide emissions due to gas for conventional boiler	$Q_{con} \times C_{fcon}$
Cs	1,427,513	kg	Carbon dioxide emissions saving resulting from the CHP system	$C_{con} - C_{chp} + C_e$

Performance calculation are made on an annual basis, with the assumption that the CHP system use is heat lead. The performance of the CHP is based on hours run. This is calculated by dividing the annual heat demand of the building (space heating, water heating, process heating) which will be supplied by the CHP system by the rated maximum heat output of the CHP machine itself, excluding any heat-only element contained in the installation. This calculation must, therefore, take into account any other heating system that will help to supply peak heat demand in order to give the actual heat supplied by the CHP installation (accounted for above by the factor 'M'). The carbon dioxide emissions saving resulting from a CHP system can be derived as follows: Cs=Ccon-Cchp+Ce

Table 13 CO_2 Reduction Performance Calculations for #7 Natural Gas CHP Units

Steps		$kgCO_2$	$kgCO_2/m^2$	Carbon Dioxide Reductions %
1	Baseline	19,744,426	50.18	
2	Energy Efficiency Savings Only, i.e. 'Be Lean'	16,903,881	42.96	Improvement than Step 1 = (50.18 - 45.96) / 50.18 = 14.38%
3	Savings from CHP Only, i.e. 'Be Clean': 2no 228kWe/358kWth, 4no 135kWe/215kWth & 1no 110kWe/181kWe	15,476,367	39.33	Improvement than Step 2 = (42.96 - 39.33) / 42.96 = 8.44%
4	Saving from Renewable Energy - 2.2MW Biomass Boilers Heating, i.e. 'Be Green'	14,428,617	36.67	Improvement than Step 3 = (39.33 - 36.67) / 39.33 = 6.77%
5	Overall Savings for Proposed Development	Improvement than Step 1, i.e. Baseline		OVERALL Improvement than Baseline, i.e. Energy Efficiency measures, low and zero carbon technologies = **26.92%**

Table 14 CO_2 Reduction Performance Calculations for #7 Natural Gas CHP Units and a 2.2MW Biomass Boiler

5.10 Primary Strategy 2: Turbo Expanders / Combined cycle system, i.e. The Blue NG Scheme

5.11 The operational characteristics of the Blue NG Scheme, which will be implemented as part of the Primary Strategy 2, are summarized in Table 15. The CO_2 Emissions of the fuel to be used in the Blue NG Scheme are shown in Table 16.

Parameter	The Blue NG, Heat and Power Data
Inputs	
Fuel Input (MWth)	28.00
Heat Utilisation	
Heat to Expander (MWth)	4.30
Pre-Heat Load	0.90
District Heat Load (MWth)	5.00
Fuel Preparation Input (MWth)	0.50
Total Heat Export	6.40
Electrical Export	
Engine Output (Mwe)	13.95
Expander Output (Peak) (MWe)	4.00
Total Electrical Export (MW)	17.95
System Efficiencies	
CHP Efficiency (%)	86.96
Electrical Efficiency (%)	64.11
System Efficiency (%)	86.96
Heat to Power Ratio	1 : 2.8

Table 15 Operation Characteristics of the Blue NG Scheme

Green House Gas Emissions Data		
Blue-NG typical Fuels	**$gmCO_2/MJ$**	**$kgCO_2/kWh$**
Pure Rapeseed Oil to be used by the Blue NG Scheme	*35*	*0.0097*
Note:The emission factor listed above includes estimates of CO_2 emissions from planting, harvesting, sawing up and other processing, and delivery to the point of use according to the Blue NG Operators		
Conversion Formulas		
g/MJ x	0.001	=kg/MJ
kg/MJ x	0.2778	=kg/KWh
Comparisons	$gmCO_2/MJ$	$kgCO_2/kWh$
Farmed Wood methanol	7	0.0019
Waste Wood Methanol	5	0.0014
Heating oil		0.2700
Mains gas		0.1940
House Coal		0.2910
Targets set in Part L2A: 2006		$kgCO_2/kWh$
• wood logs		0.025
• wood pellets in bags		0.025
• bulk wood pellets		0.025
• wood chips		0.025
• heat from boilers – biomass or biogas		0.025
• heat from boilers – waste combustion		0.043
• waste heat from power stations		0.018
Value that has been used for the Assessment of the Blue NG Scheme		**0.025**

Table 16 The Blue NG Scheme's Fuel CO_2 Emissions

5.12 Assessing the output of the Blue NG Scheme against the site's Instantaneous projected Power demand (as outlined in Appendix 2), shows that this Strategy can provide 100% of the power required. The Blue NG Scheme will also have a constant thermal output of $5MW_{th}$ (in addition to the heat required for the PRS), which will be sufficient to provide 96.37% of the total heat demand on site. For more information please refer to Figure 8.

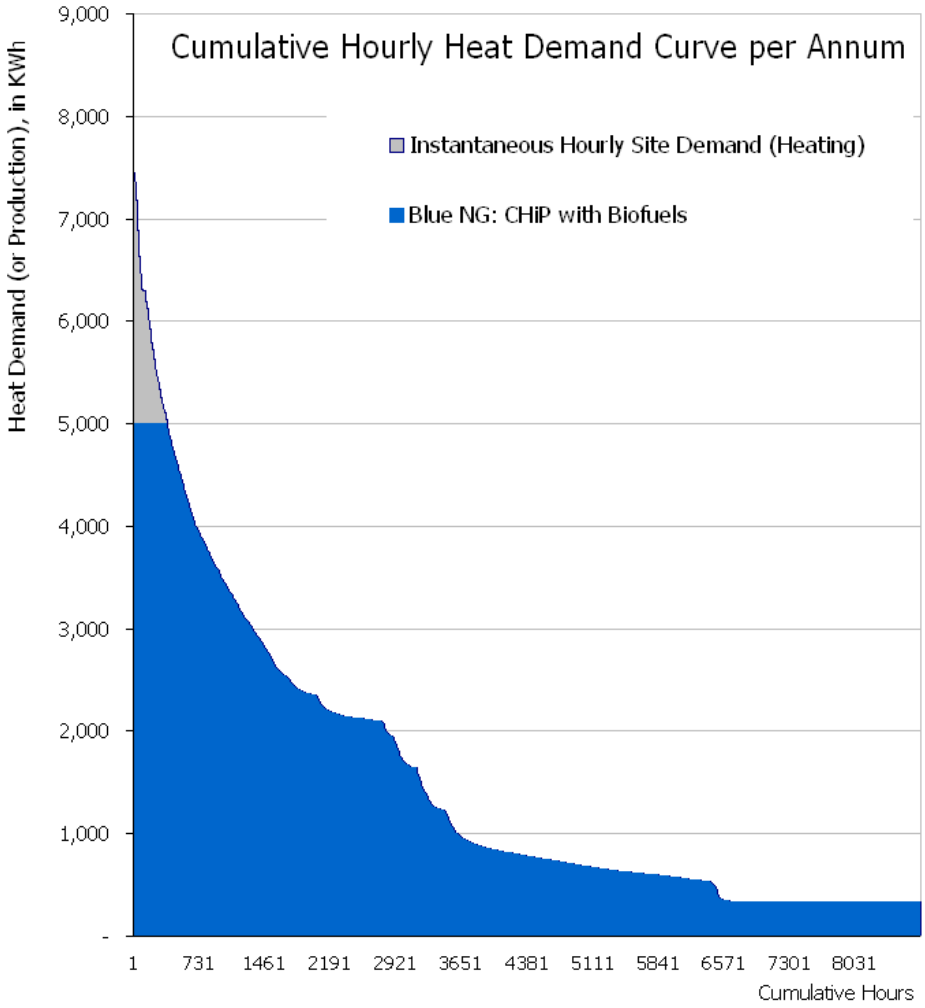

Figure 7 Projected Total Heat Demands of the West Southall Masterplan against the Provision of Heat by the Blue NG Scheme

5.13 Under the Turbo Expander / Combined Cycle System operational characteristics outlined in Table 6 and Figure 8, the potential reduction of CO_2 emissions can be calculated as shown in Table 17. The CO_2 reduction summary of the Blue NG Scheme is shown in Table 18.

Symbol	Value	Units	Description	Notes
Q_{htot}	14,509,848	kWh	Annual heating demand for space heating and hot water	
M	96.37%	%	Percentage of heating demand met by CHP	
Q_h	13,983,141	kWh	Annual heating supplied by CHP	Q_{hot} x M
Rq	5000	kW	Rated heat output of CHP (maximum)	
h	2,797	hours	Full hours run (equivalent)	Q_h x R_q
R_e	11,963	kW	Rated net electricity output of CHP (in proportion with the total output)	
Q_e	33,455,710	kWh	Net electricity generated	R_e x h
Cf_e	0.568	kgCO2/kWh	Carbon dioxide factor for grid-displaced electricity	0.568
C_e	19,002,844	kg	Carbon dioxide saved owing to electricity from CHP	Qe x Cf_e
R_f	20,696	kW	Rated fuel consumption of CHP (proportional to the total output)	
Q_{fchp}	57,877,667	kWh	Annual fuel consumption of CHP	R_f x h
Cf_{fchp}	0.025	kgCO2/kWh	Carbon dioxide factor for fuel supply to CHP	Conservative Figure
C_{chp}	1,446,942	kg	Resulting carbon dioxide emissions due to fuel consumed by CHP	Q_{fchp} x Cf_{fchp}
E_{con}	89	%	Seasonal efficiency of conventional boiler	Condensing
Q_{con}	15,711,394	kWh	Annual fuel consumption of conventional boiler	Q_h/E_{con}
Cf_{fcon}	0.194	kgCO2/kWh	Carbon dioxide factor for fuel supply to conventional boiler	Gas = 0.194
C_{con}	3,048,010	kg	Resulting carbon dioxide emissions due to gas for conventional boiler	Q_{con} x C_{fcon}
Cs	20,603,912	kg	Carbon dioxide emissions saving resulting from the CHP system	C_{con} - C_{chp} + C_e

Performance calculation are made on an annual basis, with the assumption that the CHP system use is heat lead. The performance of the CHP is based on hours run. This is calculated by dividing the annual heat demand of the building (space heating, water heating, process heating) which will be supplied by the CHP system by the rated maximum heat output of the CHP machine itself, excluding any heat-only element contained in the installation. This calculation must, therefore, take into account any other heating system that will help to supply peak heat demand in order to give the actual heat supplied by the CHP installation (accounted for above by the factors 'M'). The carbon dioxide emissions saving resulting from a CHP system can be derived as follows: Cs=Ccon-Cchp+Ce

Table 17 CO_2 Reduction Performance Calculations for the Blue NG Scheme

Steps		$kgCO_2$	$kgCO_2/m^2$	Carbon Dioxide Reductions %
1	Baseline	19,744,426	50.18	
2	Energy Efficiency Savings Only, i.e. 'Be Lean'	16,903,881	42.96	Improvement than Step 1 = (50.18 - 45.96) / 50.18 = 14.38%
3	Saving from Renewable Energy - Blue NG	-3,700,032	-9.40	Better than the improvement by the Low and Zero Carbon Technologies of **Primary Strategy 1**
4	Overall Savings for Proposed Development	Improvement than Step 1, i.e. Baseline		OVERALL Improvement than Baseline, i.e. Energy Efficiency measures, low and zero carbon technologies **better than** "the improvement from the Baseline" of **Primary Strategy 1**

Table 18 CO_2 Reduction Performance Calculations for the Blue NG Scheme

6 Conclusions & Discussion

6.1 This report presents two illustrative solutions which both can achieve an overall minimum CO_2 emissions improvement of 26.92% against 2006 Baseline when all the unregulated loads such as cooking, PCs, multi-parking lighting, food retail refrigeration, cinema screen projectors lighting etc are included in the comparison calculations. The two Primary Strategies are only two of the ways in which the CO_2 emissions improvement of 26.92% can be achieved. Technology will be advanced and other building envelope and low carbon energy systems will be able to provide an equivalent improvement. Primary Strategy 1 has the potential to reduce the total development's Carbon Dioxide by 26.92% against 2006 Baseline by energy efficiency measures (14.39%), natural gas CHP (7.23%) and Biomass boilers (5.31%). The electricity produced by Primary Strategy 1 will be distributed within the site. Primary strategy 2 could achieve at least the same percentage savings.

6.2 The percentages included in paragraph 6.1 are lower than the Energy Strategy report (October 2008), as the above percentages include all the un-regulated loads, which have been more assessed for this report. The overall improvement of the 'Building Emission Rate' (BER) / 'Dwelling Emissions Rate' (DER) than the 2006 'Target Emission Rate' (TER) is calculated when the unregulated loads are excluded from the calculations. Primary Strategy 1 has the potential to reduce the BER/DER by 46.52% against 2006 TER by energy efficiency measures (24.87%), natural gas CHP (12.49%) and Biomass boilers (9.16%). Therefore, all the Dwelling on site can fulfil the energy and renewable energy requirements of Code for Sustainable Homes (CfSH) Level 4. Buildings other than dwellings can achieve valuable credits towards a BREEM Excellent rating. A summary table of illustrative SAP outcomes which show that CfSH Level 4 is achievable are available in Table 19.

6.3 The CHP operation has been fully analysed and reassessed following the recommendation by the GLA. Illustrative energy consumption projections indicate that the proposed 7 CHP units can provide 54.51% of the total site heating (space heating and domestic hot water) requirements.

6.4 The site has extra CO_2 emissions reduction potential by changing the occupants' behaviour into more energy-saving conscious attitude as the results presented in this report have incorporated unregulated / appliances loads according to Good 'Business As Usual' Practices.

Such a reduction is not related to planning, building design or Buildings Regulations compliance calculations. A 30% potential reduction of the unregulated / appliances loads will reduce further the total CO_2 site emissions by 15%. This reduction can not be evaluated at this planning stage, as the final design of buildings and building services have not been developed. During the Detail Planning Application, a carbon dioxide emissions assessment could also consider the potential impact of smart metering, demand side management, high efficiency appliances and appliances controls.

			Natural Gas CHP Only		Natural Gas CHP + Biomass	
Dwelling(s)	Floor area (m^2)	TER	BER	% Improvement	BER	% Improvement
Flat 1	48.64	30.36	16.40	45.00	9.38	69.00
Flat 2	46.61	26.81	15.96	40.00	9.56	64.00
Flats 3,4	56.16	26.90	14.97	44.00	8.86	67.00
Flat 5	56.8	26.06	14.51	44.00	8.75	66.00
Flats 7, 12	56.8	26.79	14.89	44.00	8.83	67.00
Flats 18-21	46.61	26.81	15.69	41.00	9.28	65.00
Flats 24, 48	48.64	26.15	15.29	41.00	9.16	64.00
Flat 27	56.16	24.83	14.54	41.00	8.78	64.00
Flats 30, 54	56.92	27.79	14.82	46.00	8.56	69.00
Flats 37, 61	56.92	27.79	14.50	47.00	8.49	69.00
Flats 32-35	56.16	21.29	13.72	35.00	8.61	59.00
Flats 40, 64, 78	56.92	28.05	14.70	47.00	8.53	69.00
Flats 41, 65	59.25	22.60	13.89	38.00	8.73	61.00
Flats 46, 47, 70,	56.16	21.29	13.72	35.00	8.62	59.00
Flats 56-59	56.16	23.91	14.53	39.00	8.77	63.00
Flats 60, 74	56.8	25.83	14.89	42.00	8.83	65.00
Flats 66-69	46.61	25.87	15.75	39.00	9.34	63.00
Flat 72	48.64	29.27	16.87	42.00	9.47	67.00
Flat 75	56.92	30.72	15.59	49.00	8.71	71.00
Flat 76	56.8	25.02	14.73	41.00	8.80	64.00
Flat 82	56.8	27.69	15.32	44.00	8.91	67.00
House type 1	72.7	23.16	12.91	44.00	7.54	67.00
House type 2	72.7	23.16	12.90	44.00	7.54	67.00
House type 3	89.12	21.66	11.92	44.00	7.08	67.00
House type 6	82.9	24.06	12.59	47.00	7.27	69.00
House type 9	72.7	23.16	12.93	44.00	7.57	67.00
	CODE LEVEL		Level 3		Level 4	

Table 19 Evaluation of Potential Credits Related to the 'Code for Sustainable Homes'

7 References and Bibliography

[i] according to

- BRE (2008) Building Research Establishment (BRE) Environmental Assessment Methodology (BREEAM) for Offices: 2008, Assessors' Manual, BRE
- CHPQA Standard - http://www.chpqa.com
- CIBSE (2004), CIBSE Guide F: Energy efficiency in buildings, Second edition, CIBSE
- BRE (2008), Code for Sustainable Homes, 2008 Assessors' Manual, BRE
- DEFRA (2000), Energy Consumption Guide 19: Energy use in offices, DEFRA
- BRESCU (2002), Energy Efficiency Standards: For new and existing dwellings, General Information Leaflet 72, BRE
- BRESCU (2003), Designing Energy Efficient Multi-Residential Buildings, GPG 192, BRE
- DCLG (2006), UK Building Regulations 2000, Part L, 2006 Amendments, DCLG
- CIBSE (2000), Testing buildings for air leakage, CIBSE

National Grid Property Ltd

Appendix 1: Projected and Indicative Only Design Performance Specifications

Addendum to the West Southall Masterplan Energy Strategy

GENERAL INFORMATION

The purpose of this appendix is to present an indicative strategy to be implemented for the design of the West Southall Development.

West Southall Development is a complex site incorporating 320,000 sq.m of residential units, non-food retail and retail units, restaurants, bars and cafes, cinema, health care and educational facilities, office/studio units, sports pavilion and a multi-storey car park. For the modelling we have simulated the typical buildings using the APACHE thermal dynamic simulation platform on IES <VE> 5.9.0 on. The aim of this report is to illustrate energy consumption in relation to baseline and again extreme only thermal specification.

Restaurant/Bar/Café buildings

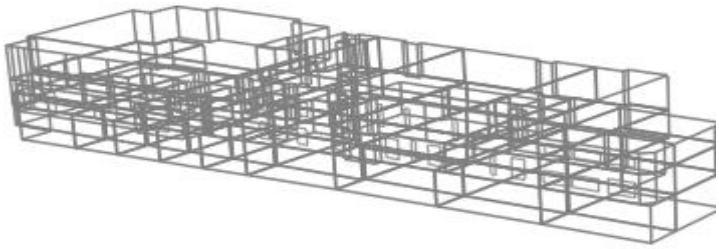

Figure 1 Structural representation of the thermal model regarding indicative designs of bars, cafe and restaurant buildings

Minimum system specification requirements

1. Modeled Performance Specifications for "Restaurants, Bars and Cafes": -

Heating:	LTHW Boiler
Fuel type:	Natural Gas
Generator Seasonal Efficiency:	0.8900
Cooling:	Air cooled
Nominal EER:	3.12500
SFP:	1.6 W/ (l/s)

Room Description	NCM Building activity Hours and Operational Profile
Bars	NCM RestPub: Eating/drinking area
Restaurant	NCM RestPub: Eating/drinking area
Cafe	NCM RestPub: Eating/drinking area

Table 1 NCM Building activity and Operational Profile

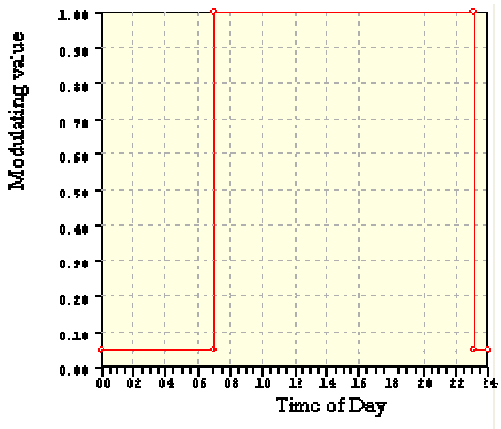

Figure 2 Modulating value for unregulated equipment operational profile

Peak Heat demand	53.18 W/m²
Peak Cooling demand	25.80 W/m²
Peak Power demand*	44.34 W/m²
Annual CO_2 emissions - Heat	172.52 kg CO_2/kWh
Annual CO_2 emissions – Cooling	15.76 kg CO_2/kWh
Annual CO_2 emissions – Power**	214.63 kg CO_2/kWh
Annual CO_2 emissions – Total**	130.35 kg CO_2/kWh
Annual CO_2 emissions – Unregulated loads only	51.15 kg CO_2/kWh

* Figure does not include cooling
** Includes unregulated loads

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L

Project name

Typical Restaurants

As built

Date: Sun Mar 01 13:56:06 2009

Administrative information

Building details

Address: West Southall , Ealing,

Certification tool

Calculation engine: Apache

Calculation engine version: "5.9.0"

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 5.9.0

BRUKL compliance check version: v3.1.a

Occupier details

Name: National Grid Property Limited

Telephone number:

Address: , ,

Certifier details

Name: Yianni Spanos - WYG

Telephone number: 020 86496600

Address: 9th Floor - Sunley House 4 Bedford Park, Croyd

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

1.1	Calculated CO2 emission rate from notional building	130.2 KgCO2/m2.annum
1.2	Improvement factor	0.2
1.3	LZC benchmark	0.1
1.4	Target CO2 Emission Rate (TER)	93.7 KgCO2/m2.annum
1.5	Building CO2 Emission Rate (BER)	79.2 KgCO2/m2.annum
1.6	Are emissions from building less than or equal to the target?	BER =< TER
1.7	Are as built details the same as used in BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services systems should be no worse than the design limits

2.1 Are the U-values better than the design limits? Better than design limits

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Limit}$	$U_{i\text{-}Calc}$	Surface where this maximum value occurs*
Wall**	0.35	0.14	0.7	0.14	GFCF0004:Surf[1]
Floor	0.25	0.13	0.7	0.13	GFCF0004:Surf[0]
Roof	0.25	0.13	0.35	0.13	FFCF0004:Surf[1]
Windows***, roof windows, and rooflights	2.2	0.76	3.3	0.76	GFCF0004:Surf[6]
Personnel doors	2.2	0.66	3	0.66	ZZZ_0006:Surf[5]
Vehicle access & similar large doors	1.5	0	4	0	No Vehicle access doors in building
High usage entrance doors	6	0	6	0	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m2K)] $U_{i\text{-}Limit}$ = Limiting individual element U-values [W/(m2K)]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m2K)] $U_{i\text{-}Calc}$ = Calculated individual element U-values [W/(m2K)]

* There might be more than one surface exceeding the limiting standards.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standards are similar to those for windows.

*** Display windows and similar glazing are not required to meet the standard given in this table.

2.2 Is air permeability no greater than the worst acceptable standard? No greater than worst acceptable standard

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.5

2.3 Are all building services standards acceptable?

2.3a-1 Standard Bar System HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system. For a multiple boiler system the limiting efficiency for any individual boiler is 0.80		
Efficiency check	**Limiting Cooling Nominal efficiency**	**This building**
Cooling efficiency	2.25	3.13
Efficiency check	**Limiting Specific Fan Power**	**This building**
SFP	2.5	1.6

2.3b- "No DHW systems in project"

2.4	Does fixed internal lighting comply with England and Wales Building Regulations Part L paragraphs 49 to 61?	Separate submission
2.5	Are energy meters installed in accordance with GIL65?	Separate submission

Criterion 3: The spaces in the building without air-conditioning have appropriate passive control measures to limit the effects of solar gains

3.1	Method of showing compliance with England and Wales Building Regulations Part L in paragraph 64?	Separate submission

Criterion 4: The performance of the building, as built, is consistent with the BER

4.1	Have the key features of the design been included (or bettered) in practice?	Separate submission
4.2	Is the level of thermal bridging acceptable?	Separate submission
4.3	Has satisfactory documentary evidence of site inspection checks been produced?	Separate submission

4.4 Design air permeability

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.5

4.5	Has evidence been provided that demonstrates that the design air permeability has been achieved satisfactorily?	Separate submission
4.6	Has commissioning been completed satisfactorily?	Separate submission
4.7	Has evidence been provided that demonstrates that the ductwork is sufficiently airtight?	Separate submission

Criterion 5: Providing information

5.1	Has a suitable building log-book been prepared?	Separate submission

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area (m2)	15727	15727
External area (m2)	21782	21782
Weather	LON	LON
Infiltration	2	2
W/K	3854.22	15766.2
W/m2K	0.18	0.72
Alpha	19.78	10

Building Use

% area	Building Type
	Office
	Primary school
	Secondary school
	Further education universities
	Primary health care buildings
	Nursing residential homes and hostels
	Hospital
	Hotel
100	**Restaurant/public house**
	Sports centre/leisure centre
	Sports ground arena
	Retail
	Warehouse and storage
	Theatres/cinemas/music halls and auditoria
	Social clubs
	Community/day centre
	Libraries/museums/galleries
	Prisons
	Emergency services
	Crown and county courts
	Airport terminals
	Bus station/train station/seaport terminal
	Workshops/maintenance depot
	Telephone exchanges
	Industrial process building
	Launderette
	Dwelling
	Retail warehouses
	Miscellaneous 24hr activities

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat kWh/m2	Cool kWh/m2	Aux kWh/m2	Heat SSEEF	Cool SSEER	Heat G SEFF	Cool G SEER
[ST] Fan coil systems, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	5	166.9	1.7	27.4	44.2	0.8	1.69	0.89	2.5
	Notional	327.8	198.2	109.7	33	49.6	0.83	1.67	----	----

Educational Facilities

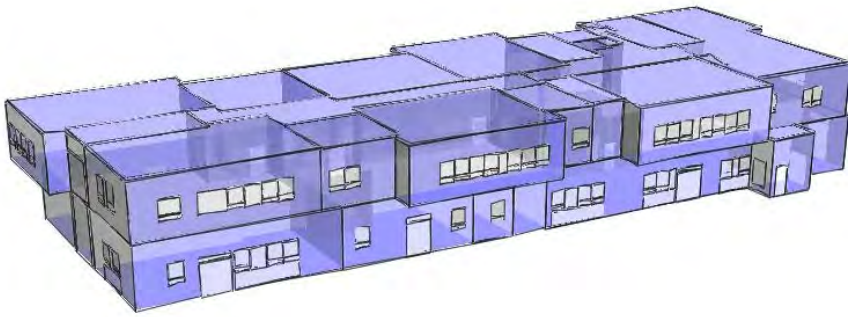

Figure 3 3D representation of the thermal model of an indicative educational building

Minimum system specification requirements

2. Modelled Performance Specifications for the main heating system: -

Heating:	LTHW Boiler
Fuel type:	Natural Gas
Generator Seasonal Efficiency:	0.8900
Cooling:	Natural Ventilation

Room Description	NCM Building activity Hours and Operational Profile, i.e. unregulated loads
Laboratories	NCM SecSchl: Workshop
Business units	NCM SecSchl: Classroom
Teaching rooms	NCM SecSchl: Workshop
Electronics	NCM SecSchl: High density IT work space
Material rooms	NCM SecSchl: Workshop - small scale

Table 2 NCM Building activity and Operational Profile

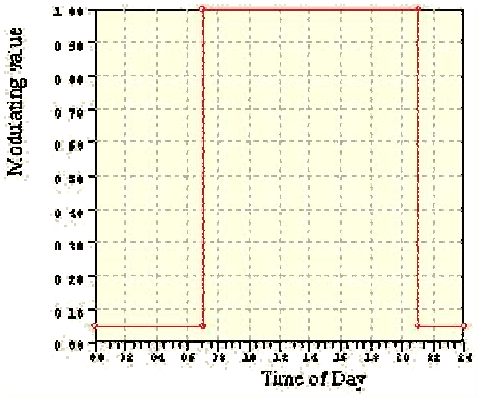

Figure 4 Modulating value for unregulated equipment operational profile

Peak Heat demand	71.73 W/m²
Peak Power demand*	23.86 W/m²
Annual CO_2 emissions - Heat	22.90 kg CO_2/kWh
Annual CO_2 emissions – Power**	59.52 kg CO_2/kWh
Annual CO_2 emissions – Total**	29.51 kg CO_2/kWh
Annual CO_2 emissions – Unregulated loads only	15.92 kg CO_2/kWh

* Figure does not include cooling

** Includes unregulated loads

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L

Project name

Typical Educational

As designed

Date: Sun Mar 01 14:23:23 2009

Administrative information

Building details

Address: West Southall, Ealing,

Certification tool

Calculation engine: Apache

Calculation engine version: "5.9.0"

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 5.9.0

BRUKL compliance check version: v3.1.a

Occupier details

Name: National Grid Property Limited

Telephone number:

Address: , ,

Certifier details

Name: Yianni Spanos - WYG

Telephone number: 02086496600

Address: 9th Floor - Sunley House 4 Bedford Park, Croyd

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

1.1	Calculated CO2 emission rate from notional building	40.2 KgCO2/m2.annum
1.2	Improvement factor	0.2
1.3	LZC benchmark	0.1
1.4	Target CO2 Emission Rate (TER)	29 KgCO2/m2.annum
1.5	Building CO2 Emission Rate (BER)	13.6 KgCO2/m2.annum
1.6	Are emissions from building less than or equal to the target?	BER =< TER
1.7	Are as built details the same as used in BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services systems should be no worse than the design limits

2.1 Are the U-values better than the design limits? Better than design limits

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Limit}$	$U_{i\text{-}Calc}$	Surface where this maximum value occurs*
Wall**	0.35	0.14	0.7	0.14	BSTR0011:Surf[7]
Floor	0.25	0.13	0.7	0.13	BSTR0010:Surf[0]
Roof	0.25	0.14	0.35	0.14	GRND0010:Surf[1]
Windows***, roof windows, and rooflights	2.2	0.77	3.3	0.77	BSTR0011:Surf[1]
Personnel doors	2.2	0.63	3	0.63	BSTR0011:Surf[3]
Vehicle access & similar large doors	1.5	0	4	0	No Vehicle access doors in building
High usage entrance doors	6	0	6	0	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m2K)] $U_{i\text{-}Limit}$ = Limiting individual element U-values [W/(m2K)]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m2K)] $U_{i\text{-}Calc}$ = Calculated individual element U-values [W/(m2K)]

* There might be more than one surface exceeding the limiting standards.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standards are similar to those for windows

*** Display windows and similar glazing are not required to meet the standard given in this table.

The format of this compliance document is in draft form as the final layout is still being checked by the Building Control Officers

2.2 Is air permeability no greater than the worst acceptable standard? No greater than worst acceptable standard

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

2.3 Are all building services standards acceptable?

2.3a-1 Main heating system for existing building (Biofuel) HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system For a multiple boiler system the limiting efficiency for any individual boiler is 0.80		

2.3a-2 VRF (Extended first floor) HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	Limiting heat source efficiency not specified	5.5
Efficiency check	**Limiting Cooling Nominal efficiency**	**This building**
Cooling efficiency	Limiting cooling efficiency not specified	3.9
Efficiency check	**Limiting Specific Fan Power**	**This building**
SFP	2.5	0.66

2.3b- "No DHW systems in project"

2.4	Does fixed internal lighting comply with England and Wales Building Regulations Part L paragraphs 49 to 61?	Separate submission
2.5	Are energy meters installed in accordance with GIL65?	Separate submission

Criterion 3: The spaces in the building without air-conditioning have appropriate passive control measures to limit the effects of solar gains

3.1	Method of showing compliance with England and Wales Building Regulations Part L in paragraph 64?	Separate submission

Criterion 4: The performance of the building, as built, is consistent with the BER

4.1	Have the key features of the design been included (or bettered) in practice?	Separate submission
4.2	Is the level of thermal bridging acceptable?	Separate submission
4.3	Has satisfactory documentary evidence of site inspection checks been produced?	Separate submission

4.4 Design air permeability

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

4.5	Has evidence been provided that demonstrates that the design air permeability has been achieved satisfactorily?	Separate submission
4.6	Has commissioning been completed satisfactorily?	Separate submission
4.7	Has evidence been provided that demonstrates that the ductwork is sufficiently airtight?	Separate submission

The format of this compliance document is in draft form as the final layout is still being checked by the Building Control Officers

Criterion 5: Providing information

5.1	Has a suitable building log-book been prepared?	Separate submission

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area (m2)	2095	2095
External area (m2)	3680	3680
Weather	LON	LON
Infiltration	1	1
W/K	703.15	2621.53
W/m2K	0.19	0.71
Alpha	18.32	10

Building Use

% area	Building Type
	Office
	Primary school
100	**Secondary school**
	Further education universities
	Primary health care buildings
	Nursing residential homes and hostels
	Hospital
	Hotel
	Restaurant/public house
	Sports centre/leisure centre
	Sports ground arena
	Retail
	Warehouse and storage
	Theatres/cinemas/music halls and auditoria
	Social clubs
	Community/day centre
	Libraries/museums/galleries
	Prisons
	Emergency services
	Crown and county courts
	Airport terminals
	Bus station/train station/seaport terminal
	Workshops/maintenance depot
	Telephone exchanges
	Industrial process building
	Launderette
	Dwelling
	Retail warehouses
	Miscellaneous 24hr activities

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat kWh/m2	Cool kWh/m2	Aux kWh/m2	Heat SSEEF	Cool SSEER	Heat G SEFF	Cool G SEER
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	50.9	0	16.9	0	2	0.84	0	0.89	0
	Notional	365.1	0	130	0	0	0.78	0	----	----
[ST] Fan coil systems, [HS] Heat pump: air source, [FT] Grid Supplied Electricity										
	Actual	50.3	32.9	3	2.3	8.4	4.65	3.98	5.5	5.5
	Notional	570.9	42.4	191.1	7	19.4	0.83	1.67	----	----

Office/Studio Units

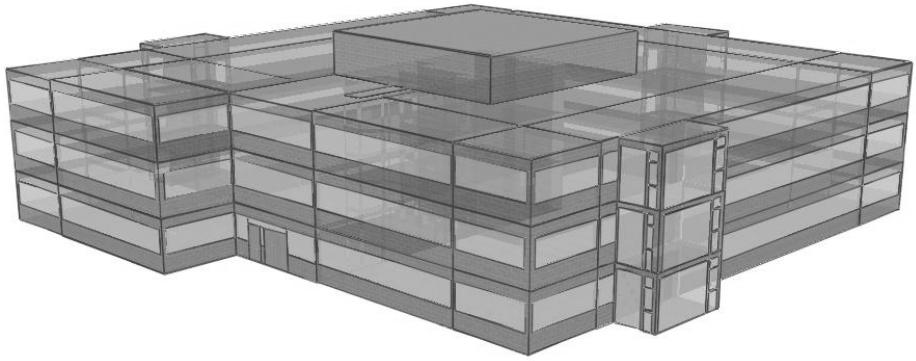

Figure 5 3D representation of the thermal model of an indicative office building

Minimum system specification requirements

3. Modeled Performance Specifications for the main system: -

Heating:	LTHW Boiler
Fuel type:	Natural Gas
Generator Seasonal Efficiency:	0.8900
Cooling:	Air cooled
Nominal EER:	3.12500
SFP:	1.8 W/ (l/s)

Room Description	NCM Building activity Hours and Operational Profile
Officies	NCM Office: Open plan office
Reception	NCM Office: Reception
Toilets	NCM Office: Toilet

Table 3 NCM Building activity and Operational Profile

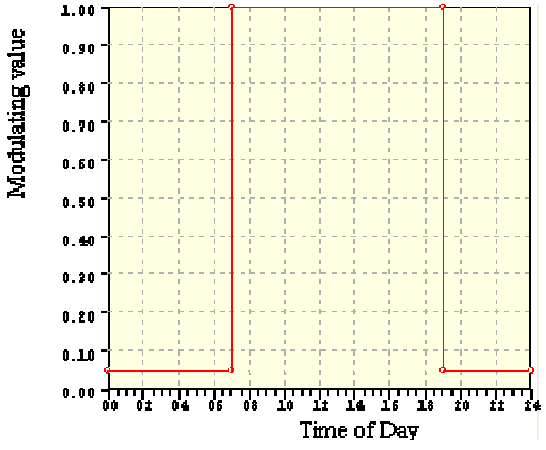

Figure 6 Modulating value for unregulated equipment operational profile

Peak Heat demand	11.67 W/m²
Peak Cooling demand	54.94 W/m²
Peak Power demand*	39.07 W/m²
Annual CO_2 emissions - Heat	15.45 kg CO_2/kWh
Annual CO_2 emissions – Cooling	93.20 kg CO_2/kWh
Annual CO_2 emissions – Power**	109.25 kg CO_2/kWh
Annual CO_2 emissions – Total**	88.40 kg CO_2/kWh
Annual CO_2 emissions – Unregulated loads only	49.41 kg CO_2/kWh

* Figure does not include cooling
** Includes unregulated loads

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L

Project name

Typical Office

As designed

Date: Sun Mar 01 15:40:30 2009

Administrative information

Building details

Address: West Southall, Ealing,

Certification tool

Calculation engine: Apache

Calculation engine version: "5.9.0"

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 5.9.0

BRUKL compliance check version: v3.1.a

Occupier details

Name: National Grid Property Limited

Telephone number:

Address: , ,

Certifier details

Name: Yianni Spanos

Telephone number: 020 8649 6600

Address: 9th Floor - Sunley House 4 Bedford Park, Croyd

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

1.1	Calculated CO2 emission rate from notional building	60.9 KgCO2/m2.annum
1.2	Improvement factor	0.2
1.3	LZC benchmark	0.1
1.4	Target CO2 Emission Rate (TER)	43.8 KgCO2/m2.annum
1.5	Building CO2 Emission Rate (BER)	39 KgCO2/m2.annum
1.6	Are emissions from building less than or equal to the target?	BER =< TER
1.7	Are as built details the same as used in BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services systems should be no worse than the design limits

2.1 Are the U-values better than the design limits? Better than design limits

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Limit}$	$U_{i\text{-}Calc}$	Surface where this maximum value occurs*
Wall**	0.35	0.13	0.7	0.27	FRST0031:Surf[15]
Floor	0.25	0.13	0.7	0.13	GRND0010:Surf[0]
Roof	0.25	0.14	0.35	0.14	SCND0008:Surf[0]
Windows***, roof windows, and rooflights	2.2	0.78	3.3	0.78	GRND0009:Surf[3]
Personnel doors	2.2	0.28	3	0.72	GRND0009:Surf[1]
Vehicle access & similar large doors	1.5	0	4	0	No Vehicle access doors in building
High usage entrance doors	6	0	6	0	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m2K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m2K)]
$U_{i\text{-}Limit}$ = Limiting individual element U-values [W/(m2K)]
$U_{i\text{-}Calc}$ = Calculated individual element U-values [W/(m2K)]

* There might be more than one surface exceeding the limiting standards.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standards are similar to those for windows
*** Display windows and similar glazing are not required to meet the standard given in this table.

2.2 Is air permeability no greater than the worst acceptable standard? No greater than worst acceptable standard

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

2.3 Are all building services standards acceptable?

2.3a-1 Toilets (Underfloor Heating no heat recovery) HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system. For a multiple boiler system the limiting efficiency for any individual boiler is 0.80		
Efficiency check	**Limiting Specific Fan Power**	**This building**
SFP	1.8	1.8

2.3a-2 Corridors and toilets (mech. vent. no heat recovery) HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system. For a multiple boiler system the limiting efficiency for any individual boiler is 0.80		
Efficiency check	**Limiting Cooling Nominal efficiency**	**This building**
Cooling efficiency	2.25	3.13
Efficiency check	**Limiting Specific Fan Power**	**This building**
SFP	2.5	1.8

2.3a-3 Active chilled beams HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system. For a multiple boiler system the limiting efficiency for any individual boiler is 0.80		
Efficiency check	**Limiting Cooling Nominal efficiency**	**This building**
Cooling efficiency	2.25	3.13
Efficiency check	**Limiting Specific Fan Power**	**This building**
SFP	2.5	1.8

2.3b- "No DHW systems in project"

2.4	Does fixed internal lighting comply with England and Wales Building Regulations Part L paragraphs 49 to 61?	Separate submission
2.5	Are energy meters installed in accordance with GIL65?	Separate submission

Criterion 3: The spaces in the building without air-conditioning have appropriate passive control measures to limit the effects of solar gains

3.1	Method of showing compliance with England and Wales Building Regulations Part L in paragraph 64?	Separate submission

Criterion 4: The performance of the building, as built, is consistent with the BER

4.1	Have the key features of the design been included (or bettered) in practice?	Separate submission
4.2	Is the level of thermal bridging acceptable?	Separate submission
4.3	Has satisfactory documentary evidence of site inspection checks been produced?	Separate submission

4.4 Design air permeability

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

4.5	Has evidence been provided that demonstrates that the design air permeability has been achieved satisfactorily?	Separate submission
4.6	Has commissioning been completed satisfactorily?	Separate submission
4.7	Has evidence been provided that demonstrates that the ductwork is sufficiently airtight?	Separate submission

Criterion 5: Providing information

5.1	Has a suitable building log-book been prepared?	Separate submission

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area (m2)	6105	6105
External area (m2)	6806	6806
Weather	LON	LON
Infiltration	1	1
W/K	1724.78	4728.22
W/m2K	0.25	0.69
Alpha	13.81	10

Building Use

% area	Building Type
108	**Office**
	Primary school
	Secondary school
	Further education universities
	Primary health care buildings
	Nursing residential homes and hostels
	Hospital
	Hotel
	Restaurant/public house
	Sports centre/leisure centre
	Sports ground arena
	Retail
	Warehouse and storage
	Theatres/cinemas/music halls and auditoria
	Social clubs
	Community/day centre
	Libraries/museums/galleries
	Prisons
	Emergency services
	Crown and county courts
	Airport terminals
	Bus station/train station/seaport terminal
	Workshops/maintenance depot
	Telephone exchanges
	Industrial process building
	Launderette
	Dwelling
	Retail warehouses
	Miscellaneous 24hr activities

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat kWh/m2	Cool kWh/m2	Aux kWh/m2	Heat SSEEF	Cool SSEER	Heat G SEFF	Cool G SEER
[ST] Active chilled beams, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	10.2	190.4	3.6	25.6	10.9	0.79	2.06	0.89	2.5
	Notional	428.3	81.5	152.5	10.1	6.7	0.78	2.25	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	4.3	140.5	1.5	23.4	21.2	0.81	1.67	0.89	2.5
	Notional	350.1	70	124.7	8.6	5.6	0.78	2.25	----	----
[ST] Central heating using air distribution, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	34.3	0	10.9	0	45.8	0.87	0	0.89	0
	Notional	442.3	0	157.5	0	0	0.78	0	----	----

WYG Engineering

Healthcare Facilities

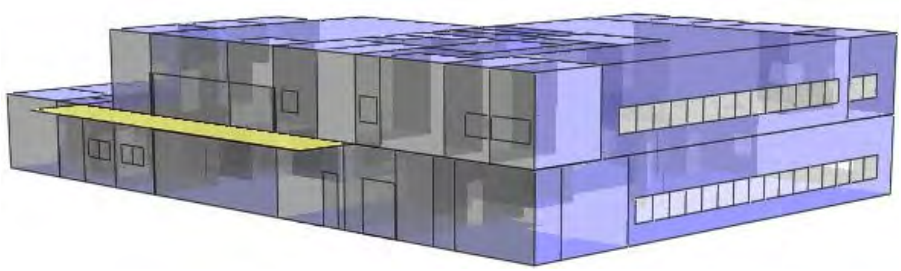

Figure 7 3D representation of the indicative healthcare building

Minimum system specification requirements

4. Modeled Performance Specifications for the indicative healthcare building: -

Heating:	LTHW Boiler
Fuel type:	Natural Gas
Generator Seasonal Efficiency:	0.8900
Cooling:	Natural Ventilation

Room Description	NCM Building activity Hours and Operational Profile
Offices	NCM Hosp: A&E consulting/treatment/work areas
Special	NCM Hosp: Ward offices
Toilets	NCM Hosp: Toilet
Circulation	NCM Hosp: Circulation area

Table 4 NCM Building activity and Operational Profile

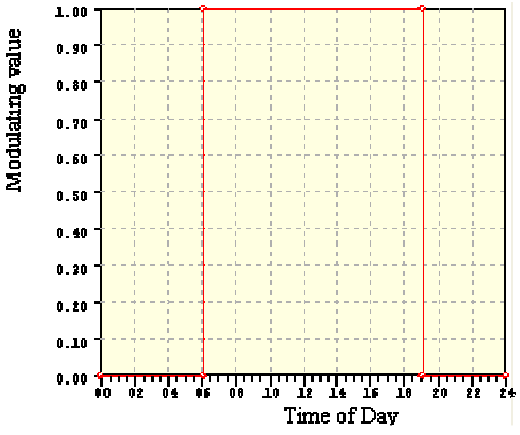

Figure 8 Modulating value for unregulated equipment operational profile

Peak Heat demand	18.85 W/m²
Peak Cooling demand	28.24 W/m²
Peak Power demand*	28.50 W/m²
Annual CO_2 emissions - Heat	8.99 kg CO_2/kWh
Annual CO_2 emissions – Cooling	20.41kgCO_2/kWh
Annual CO_2 emissions – Power**	98.31kgCO_2/kWh
Annual CO_2 emissions – Total**	51.83kgCO_2/kWh
Annual CO_2 emissions – Unregulated loads only	19.43kgCO_2/kWh

* Figure does not include cooling
** Includes unregulated loads

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L

Project name

Typical Healthcare

As designed

Date: Mon Mar 02 09:53:58 2009

Administrative information

Building details

Address: West Southall, Ealing,

Certification tool

Calculation engine: Apache

Calculation engine version: "5.9.0"

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 5.9.0

BRUKL compliance check version: v3.1.a

Occupier details

Name: National Grid Property Limited

Telephone number:

Address: , ,

Certifier details

Name: Yianni Spanos - WYG

Telephone number: 020 8649 6600

Address: 9th Floor - Sunley House 4 Bedford Park, Croyd

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

1.1	Calculated CO2 emission rate from notional building	58.2 KgCO2/m2.annum
1.2	Improvement factor	0.15
1.3	LZC benchmark	0.1
1.4	Target CO2 Emission Rate (TER)	44.5 KgCO2/m2.annum
1.5	Building CO2 Emission Rate (BER)	32.4 KgCO2/m2.annum
1.6	Are emissions from building less than or equal to the target?	BER =< TER
1.7	Are as built details the same as used in BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services systems should be no worse than the design limits

2.1 Are the U-values better than the design limits? Better than design limits

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Limit}$	$U_{i\text{-}Calc}$	Surface where this maximum value occurs*
Wall**	0.35	0.14	0.7	0.14	ROOM0081:Surf[3]
Floor	0.25	0.14	0.7	0.14	ROOM0102:Surf[0]
Roof	0.25	0.14	0.35	0.14	ROOM0081:Surf[0]
Windows***, roof windows, and rooflights	2.2	0.68	3.3	0.68	ROOM0081:Surf[1]
Personnel doors	2.2	0.64	3	0.64	ROOM0111:Surf[2]
Vehicle access & similar large doors	1.5	0	4	0	No Vehicle access doors in building
High usage entrance doors	6	0	6	0	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m2K)] $U_{i\text{-}Limit}$ = Limiting individual element U-values [W/(m2K)]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m2K)] $U_{i\text{-}Calc}$ = Calculated individual element U-values [W/(m2K)]

* There might be more than one surface exceeding the limiting standards.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standards are similar to those for windows

*** Display windows and similar glazing are not required to meet the standard given in this table.

The format of this compliance document is in draft form as the final layout is still being checked by the Building Control Officers

2.2 Is air permeability no greater than the worst acceptable standard? No greater than worst acceptable standard

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

2.3 Are all building services standards acceptable?

2.3a-1 VRV with HR (e.g.Offices) HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system. For a multiple boiler system the limiting efficiency for any individual boiler is 0.80.		

2.3a-2 Electricity & extracts only (ex. Toilets) HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.95
0.84 is the overall limiting efficiency for a single or a multiple boiler system. For a multiple boiler system the limiting efficiency for any individual boiler is 0.80.		

2.3a-3 Electricity + Natural Ventilation (ex. Corridors) HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.95
0.84 is the overall limiting efficiency for a single or a multiple boiler system. For a multiple boiler system the limiting efficiency for any individual boiler is 0.80.		

2.3a-4 VRV without HR (ex. main circulation areas) HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system. For a multiple boiler system the limiting efficiency for any individual boiler is 0.80.		

2.3a-5 IT hubs HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system. For a multiple boiler system the limiting efficiency for any individual boiler is 0.80.		

2.3b-1 VRV with HR (e.g.Offices) DHW system standard is acceptable

Efficiency check	Limiting DHW heat source seasonal efficiency	This building
DHW heat source efficiency	0.73	0.79

2.3b-2 Electricity & extracts only (ex. Toilets) DHW system standard is acceptable

Efficiency check	Limiting DHW heat source seasonal efficiency	This building
DHW heat source efficiency	0.73	0.85

2.3b-3 Electricity + Natural Ventilation (ex. Corridors) DHW system standard is acceptable

Efficiency check	Limiting DHW heat source seasonal efficiency	This building
DHW heat source efficiency	0.73	0.85

2.3b-4 VRV without HR (ex. main circulation areas) DHW system standard is acceptable

Efficiency check	Limiting DHW heat source seasonal efficiency	This building
DHW heat source efficiency	0.73	0.79

2.3b-5 IT hubs DHW system standard is acceptable

Efficiency check	Limiting DHW heat source seasonal efficiency	This building
DHW heat source efficiency	0.73	0.79

2.4	Does fixed internal lighting comply with England and Wales Building Regulations Part L paragraphs 49 to 61?	Separate submission
2.5	Are energy meters installed in accordance with GIL65?	Separate submission

Criterion 3: The spaces in the building without air-conditioning have appropriate passive control measures to limit the effects of solar gains

3.1	Method of showing compliance with England and Wales Building Regulations Part L in paragraph 64?	Separate submission

Criterion 4: The performance of the building, as built, is consistent with the BER

4.1	Have the key features of the design been included (or bettered) in practice?	Separate submission
4.2	Is the level of thermal bridging acceptable?	Separate submission
4.3	Has satisfactory documentary evidence of site inspection checks been produced?	Separate submission

4.4 Design air permeability

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

4.5	Has evidence been provided that demonstrates that the design air permeability has been achieved satisfactorily?	Separate submission
4.6	Has commissioning been completed satisfactorily?	Separate submission
4.7	Has evidence been provided that demonstrates that the ductwork is sufficiently airtight?	Separate submission

Criterion 5: Providing information

5.1	Has a suitable building log-book been prepared?	Separate submission

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area (m2)	1325	1325
External area (m2)	2568	2568
Weather	LON	LON
Infiltration	1	1
W/K	472.65	1813.99
W/m2K	0.18	0.71
Alpha	19.02	10

Building Use

% area	Building Type
	Office
	Primary school
	Secondary school
	Further education universities
	Primary health care buildings
	Nursing residential homes and hostels
100	**Hospital**
	Hotel
	Restaurant/public house
	Sports centre/leisure centre
	Sports ground arena
	Retail
	Warehouse and storage
	Theatres/cinemas/music halls and auditoria
	Social clubs
	Community/day centre
	Libraries/museums/galleries
	Prisons
	Emergency services
	Crown and county courts
	Airport terminals
	Bus station/train station/seaport terminal
	Workshops/maintenance depot
	Telephone exchanges
	Industrial process building
	Launderette
	Dwelling
	Retail warehouses
	Miscellaneous 24hr activities

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat kWh/m2	Cool kWh/m2	Aux kWh/m2	Heat SSEEF	Cool SSEER	Heat G SEFF	Cool G SEER
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	16	0	5.3	0	7.4	0.84	0	0.89	0
	Notional	201.1	0	76.5	0	4.7	0.73	0	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	0	0	0	0	4.2	0.84	0	0.89	0
	Notional	0	0	0	0	2.7	0.73	0	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	0.8	0	0.3	0	8	0.84	0	0.89	0
	Notional	154.2	0	58.7	0	5.1	0.73	0	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	0	0	0	0	3	0.89	0	0.95	0
	Notional	11.1	0	4.2	0	1.9	0.73	0	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	0	0	0	0	7.5	0.89	0	0.95	0
	Notional	136.8	0	52	0	4.8	0.73	0	----	----

Sports Pavilion

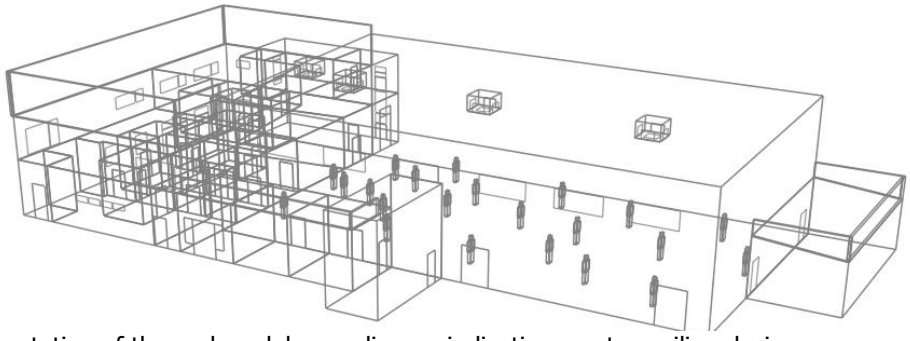

Figure 9 Presentation of thermal model regarding an indicative sports pavilion design

Minimum system specification requirements

5. Modeled Performance Specifications for the indicative healthcare building: -

Heating:	LTHW Boiler
Fuel type:	Natural Gas
Generator Seasonal Efficiency:	0.8900
Cooling:	Mechanical Ventilation

Room Description	NCM Building activity Hours and Operational Profile
Court Hall	NCM SportCtr: Toilet
Fitness Suite	NCM SportCtr: Toilet

Table 5 NCM Building activity and Operational Profile

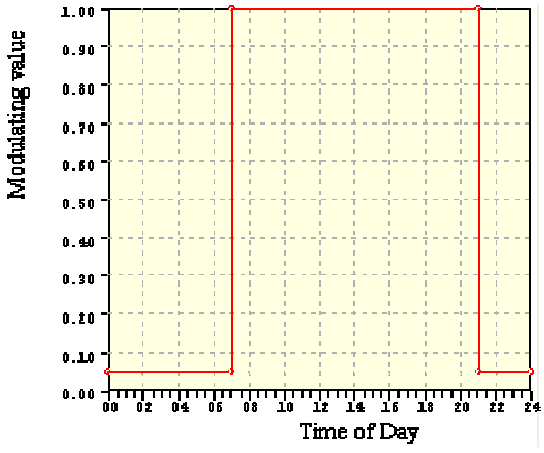

Figure 10 Modulating value for unregulated equipment operational profile

Peak Heat demand	58.53 W/m²
Peak Power demand*	15.53 W/m²
Annual CO_2 emissions - Heat	30.37 kg CO_2/kWh
Annual CO_2 emissions – Power**	75.38 kg CO_2/kWh
Annual CO_2 emissions – Total**	37.64 kg CO_2/kWh
Annual CO_2 emissions – Unregulated loads only	22.94 kg CO_2/kWh

* Figure does not include cooling

** Includes unregulated loads

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L

Project name

Sports Pavillion

As designed

Date: Mon Mar 02 15:22:57 2009

Administrative information

Building details

Address: West Southall, Ealing,

Certification tool

Calculation engine: Apache

Calculation engine version: "5.9.0"

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 5.9.0

BRUKL compliance check version: v3.1.a

Occupier details

Name: National Grid Property Limited

Telephone number:

Address: , ,

Certifier details

Name: Yianni Spanos - WYG

Telephone number: 020 8649 6600

Address: 9th Floor- Sunley House 4 Bedford Park, Croyd

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

1.1	Calculated CO2 emission rate from notional building	32.3 KgCO2/m2.annum
1.2	Improvement factor	0.15
1.3	LZC benchmark	0.1
1.4	Target CO2 Emission Rate (TER)	24.7 KgCO2/m2.annum
1.5	Building CO2 Emission Rate (BER)	14.7 KgCO2/m2.annum
1.6	Are emissions from building less than or equal to the target?	BER =< TER
1.7	Are as built details the same as used in BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services systems should be no worse than the design limits

2.1 Are the U-values better than the design limits? Better than design limits

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Limit}$	$U_{i\text{-}Calc}$	Surface where this maximum value occurs*
Wall**	0.35	0.14	0.7	0.14	GRND0000:Surf[2]
Floor	0.25	0.13	0.7	0.13	GRND0000:Surf[0]
Roof	0.25	0.14	0.35	0.14	GRND0000:Surf[1]
Windows***, roof windows, and rooflights	2.2	0.61	3.3	0.61	GRND0000:Surf[7]
Personnel doors	2.2	0.63	3	0.63	GRND0000:Surf[5]
Vehicle access & similar large doors	1.5	0	4	0	No Vehicle access doors in building
High usage entrance doors	6	0	6	0	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m2K)] $U_{i\text{-}Limit}$ = Limiting individual element U-values [W/(m2K)]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m2K)] $U_{i\text{-}Calc}$ = Calculated individual element U-values [W/(m2K)]

* There might be more than one surface exceeding the limiting standards.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standards are similar to those for windows

*** Display windows and similar glazing are not required to meet the standard given in this table.

The format of this compliance document is in draft form as the final layout is still being checked by the Building Control Officers

2.2 Is air permeability no greater than the worst acceptable standard? No greater than worst acceptable standard

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

2.3 Are all building services standards acceptable?

2.3a-1 Corrected - Main HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system. For a multiple boiler system the limiting efficiency for any individual boiler is 0.80		

2.3b-1 Corrected - Main DHW system standard is acceptable

Efficiency check	Limiting DHW heat source seasonal efficiency	This building
DHW heat source efficiency	0.73	0.79

2.4	Does fixed internal lighting comply with England and Wales Building Regulations Part L paragraphs 49 to 61?	Separate submission
2.5	Are energy meters installed in accordance with GIL65?	Separate submission

Criterion 3: The spaces in the building without air-conditioning have appropriate passive control measures to limit the effects of solar gains

3.1	Method of showing compliance with England and Wales Building Regulations Part L in paragraph 64?	Separate submission

Criterion 4: The performance of the building, as built, is consistent with the BER

4.1	Have the key features of the design been included (or bettered) in practice?	Separate submission
4.2	Is the level of thermal bridging acceptable?	Separate submission
4.3	Has satisfactory documentary evidence of site inspection checks been produced?	Separate submission

4.4 Design air permeability

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

4.5	Has evidence been provided that demonstrates that the design air permeability has been achieved satisfactorily?	Separate submission
4.6	Has commissioning been completed satisfactorily?	Separate submission
4.7	Has evidence been provided that demonstrates that the ductwork is sufficiently airtight?	Separate submission

Criterion 5: Providing information

5.1	Has a suitable building log-book been prepared?	Separate submission

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area (m2)	1263	1263
External area (m2)	3613	3613
Weather	LON	LON
Infiltration	1	1
W/K	546.86	2572.36
W/m2K	0.15	0.71
Alpha	23.12	10

Building Use

% area	Building Type
	Office
	Primary school
	Secondary school
	Further education universities
	Primary health care buildings
	Nursing residential homes and hostels
	Hospital
	Hotel
	Restaurant/public house
112	**Sports centre/leisure centre**
	Sports ground arena
	Retail
	Warehouse and storage
	Theatres/cinemas/music halls and auditoria
	Social clubs
	Community/day centre
	Libraries/museums/galleries
	Prisons
	Emergency services
	Crown and county courts
	Airport terminals
	Bus station/train station/seaport terminal
	Workshops/maintenance depot
	Telephone exchanges
	Industrial process building
	Launderette
	Dwelling
	Retail warehouses
	Miscellaneous 24hr activities

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat kWh/m2	Cool kWh/m2	Aux kWh/m2	Heat SSEEF	Cool SSEER	Heat G SEFF	Cool G SEER
[ST] Central heating using water: radiators, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	25.9	0	8.6	0	4.9	0.84	0	0.89	0
	Notional	269.1	0	102.4	0	3.1	0.73	0	----	----

Multi-storey Car Park

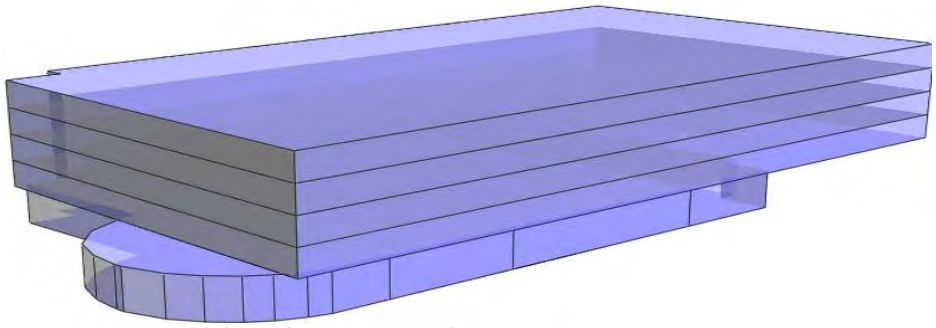

Figure 11 3D representation of the indicative car park

Minimum system specification requirements

6. Modelled Performance Specifications for the indicative multi storey car par: -

Heating:	n/a
Fuel type:	n/a
Generator Seasonal Efficiency:	n/a
Cooling:	none

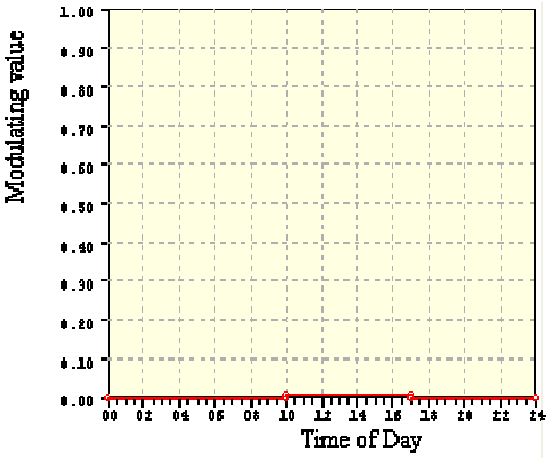

Figure 12 Modulating value for unregulated equipment operational profile

Peak Power demand	1.71 W/m²
Annual CO_2 emissions – Power*	15 kg CO_2/kWh
Annual CO_2 emissions – Total*	6.33 kg CO_2/kWh

* Includes lighting only

Cinemas

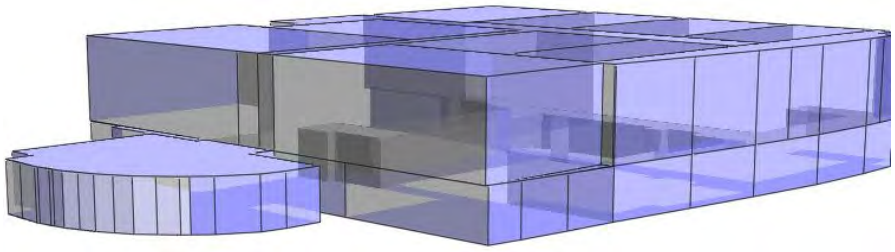

Figure 13 3D representation of the indicative cinema unit

Minimum system specification requirements

7. Modelled Performance Specifications for the indicative healthcare building: -

Heating:	LTHW Boiler
Fuel type:	Natural Gas
Generator Seasonal Efficiency:	0.8900
Cooling:	Air cooled
Nominal EER:	3.1250
SFP:	1.6 W/ (l/s)

Room Description	NCM Building activity Hours and Operational Profile
Cinema	NCM Theatre: Display area

Table 6 NCM Building activity and Operational Profile

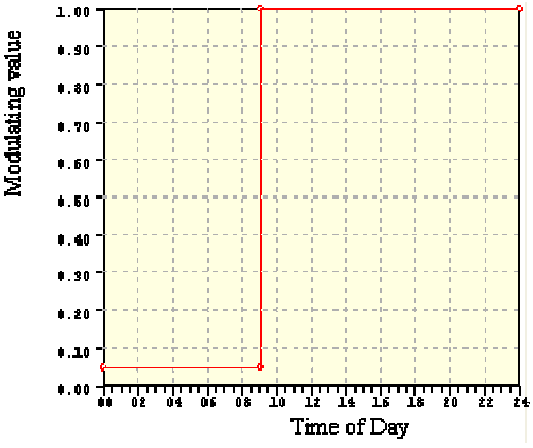

Figure 14 Modulating value for unregulated equipment operational profile

Peak Heat demand	84.10 W/m²
Peak Cooling demand	14.56 W/m²
Peak Power demand*	37.04 W/m²
Annual CO_2 emissions - Heat	79.90 kg CO_2/kWh
Annual CO_2 emissions – Cooling	2.78 kg CO_2/kWh
Annual CO_2 emissions – Power**	165.72 kg CO_2/kWh
Annual CO_2 emissions – Total**	86.45 kg CO_2/kWh
Annual CO_2 emissions – Unregulated loads only	39.35 kg CO_2/kWh

* Figure does not include cooling
** Includes unregulated loads

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L

Project name

Typical Cinema

As designed

Date: Mon Mar 02 10:52:31 2009

Administrative information

Building details

Address: West Southall, Ealing,

Certification tool

Calculation engine: Apache

Calculation engine version: "5.9.0"

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 5.9.0

BRUKL compliance check version: v3.1.a

Occupier details

Name: National Grid Property

Telephone number: 01932580333

Address: Crest House Pyrcroft Road Chertsey, Surrey, K

Certifier details

Name: Yianni Spanos - WYG

Telephone number: 020 8649 6600

Address: 9th Floor - Sunley House 4 Bedford Park, Croyd

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

1.1	Calculated CO2 emission rate from notional building	70.1 KgCO2/m2.annum
1.2	Improvement factor	0.2
1.3	LZC benchmark	0.1
1.4	Target CO2 Emission Rate (TER)	50.5 KgCO2/m2.annum
1.5	Building CO2 Emission Rate (BER)	47.1 KgCO2/m2.annum
1.6	Are emissions from building less than or equal to the target?	BER =< TER
1.7	Are as built details the same as used in BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services systems should be no worse than the design limits

2.1 Are the U-values better than the design limits? Better than design limits

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Limit}$	$U_{i\text{-}Calc}$	Surface where this maximum value occurs*
Wall**	0.35	0.14	0.7	0.14	DTRM0030:Surf[2]
Floor	0.25	0.13	0.7	0.13	DTRM0030:Surf[0]
Roof	0.25	0.13	0.35	0.13	DTRM0030:Surf[1]
Windows***, roof windows, and rooflights	2.2	0.76	3.3	0.76	FYR_0000:Surf[3]
Personnel doors	2.2	0	3	0	No Personnel doors in building
Vehicle access & similar large doors	1.5	0	4	0	No Vehicle access doors in building
High usage entrance doors	6	0	6	0	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m2K)] $U_{i\text{-}Limit}$ = Limiting individual element U-values [W/(m2K)]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m2K)] $U_{i\text{-}Calc}$ = Calculated individual element U-values [W/(m2K)]

* There might be more than one surface exceeding the limiting standards.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standards are similar to those for windows

*** Display windows and similar glazing are not required to meet the standard given in this table.

The format of this compliance document is in draft form as the final layout is still being checked by the Building Control Officers

2.2 Is air permeability no greater than the worst acceptable standard? No greater than worst acceptable standard

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

2.3 Are all building services standards acceptable?

2.3a-1 Cinema/Bowling generic system HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system For a multiple boiler system the limiting efficiency for any individual boiler is 0.80		
Efficiency check	**Limiting Cooling Nominal efficiency**	**This building**
Cooling efficiency	2.25	3.13
Efficiency check	**Limiting Specific Fan Power**	**This building**
SFP	2.5	1.6

2.3b-1 Cinema/Bowling generic system DHW system standard is acceptable

Efficiency check	Limiting DHW heat source seasonal efficiency	This building
DHW heat source efficiency	0.73	0.78

2.4	Does fixed internal lighting comply with England and Wales Building Regulations Part L paragraphs 49 to 61?	Separate submission
2.5	Are energy meters installed in accordance with GIL65?	Separate submission

Criterion 3: The spaces in the building without air-conditioning have appropriate passive control measures to limit the effects of solar gains

3.1	Method of showing compliance with England and Wales Building Regulations Part L in paragraph 64?	Separate submission

Criterion 4: The performance of the building, as built, is consistent with the BER

4.1	Have the key features of the design been included (or bettered) in practice?	Separate submission
4.2	Is the level of thermal bridging acceptable?	Separate submission
4.3	Has satisfactory documentary evidence of site inspection checks been produced?	Separate submission

4.4 Design air permeability

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

4.5	Has evidence been provided that demonstrates that the design air permeability has been achieved satisfactorily?	Separate submission
4.6	Has commissioning been completed satisfactorily?	Separate submission
4.7	Has evidence been provided that demonstrates that the ductwork is sufficiently airtight?	Separate submission

Criterion 5: Providing information

5.1	Has a suitable building log-book been prepared?	Separate submission

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area (m2)	4444	4444
External area (m2)	10277	10277
Weather	LON	LON
Infiltration	1	1
W/K	1453.34	6796.22
W/m2K	0.14	0.66
Alpha	24.75	10

Building Use

% area	Building Type
	Office
	Primary school
	Secondary school
	Further education universities
	Primary health care buildings
	Nursing residential homes and hostels
	Hospital
	Hotel
	Restaurant/public house
	Sports centre/leisure centre
	Sports ground arena
	Retail
	Warehouse and storage
100	**Theatres/cinemas/music halls and auditoria**
	Social clubs
	Community/day centre
	Libraries/museums/galleries
	Prisons
	Emergency services
	Crown and county courts
	Airport terminals
	Bus station/train station/seaport terminal
	Workshops/maintenance depot
	Telephone exchanges
	Industrial process building
	Launderette
	Dwelling
	Retail warehouses
	Miscellaneous 24hr activities

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat kWh/m2	Cool kWh/m2	Aux kWh/m2	Heat SSEEF	Cool SSEER	Heat G SEFF	Cool G SEER
[ST] Dual-duct VAV, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	20.6	50.5	9.5	10	25.5	0.6	1.4	0.89	2.5
	Notional	258.7	127.9	86.6	21.3	23.7	0.83	1.67	---	---

WYG Engineering

Typical Hotel

Figure 15 3D representation of the indicative hotel development

Minimum system specification requirements

8. Modelled Performance Specifications for the indicative hotel development: -

Heating:	LTHW Boiler
Fuel type:	Natural Gas
Generator Seasonal Efficiency:	0.8900
Cooling:	Air cooled
Nominal EER:	2.5000
SFP:	1.6 W/ (l/s)

Room Description	NCM Building activity Hours and Operational Profile, i.e. unregulated loads
Bedroom	NCM Hotel: Bedroom
Bathroom	NCM Hotel: Bathroom
Living room	NCM Hotel: Common room/staff room/lounge
Corridor	NCM Hotel: Circulation area

Table 7 NCM Building activity and Operational Profile

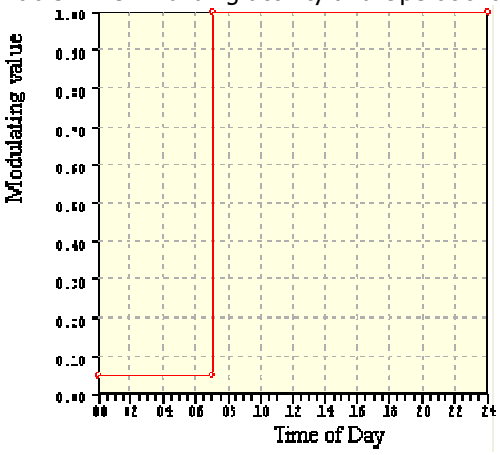

Figure 16 Modulating value for unregulated equipment operational profile

Peak Heat demand	91.02 W/m²
Peak Cooling demand	16.65 W/m²
Peak Power demand*	18.27 W/m²
Annual CO_2 emissions - Heat	228.44 kg CO_2/kWh
Annual CO_2 emissions – Cooling	7.89 kg CO_2/kWh
Annual CO_2 emissions – Power**	71.27 kg CO_2/kWh
Annual CO_2 emissions – Total**	77.27 kg CO_2/kWh
Annual CO_2 emissions – Unregulated loads only	30.87 kg CO_2/kWh

* Figure does not include cooling
** Includes unregulated loads

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L

Project name

Typical Hotel

As designed

Date: Mon Mar 02 13:00:07 2009

Administrative information

Building details

Address: West Southall, Ealing,

Certification tool

Calculation engine: Apache

Calculation engine version: "5.9.0"

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 5.9.0

BRUKL compliance check version: v3.1.a

Occupier details

Name: National Grid Property Limited

Telephone number:

Address: , ,

Certifier details

Name: Yianni Spanos - WYG

Telephone number: 020 8649 6600

Address: 9th Floor - Sunley House 4 Bedford Park, Croyd

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

1.1	Calculated CO2 emission rate from notional building	75.4 KgCO2/m2.annum
1.2	Improvement factor	0.2
1.3	LZC benchmark	0.1
1.4	Target CO2 Emission Rate (TER)	54.3 KgCO2/m2.annum
1.5	Building CO2 Emission Rate (BER)	46.4 KgCO2/m2.annum
1.6	Are emissions from building less than or equal to the target?	BER =< TER
1.7	Are as built details the same as used in BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services systems should be no worse than the design limits

2.1 Are the U-values better than the design limits? Better than design limits

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Limit}$	$U_{i\text{-}Calc}$	Surface where this maximum value occurs*
Wall**	0.35	0.14	0.7	0.14	001B0003:Surf[2]
Floor	0.25	0.13	0.7	0.13	001B0004:Surf[0]
Roof	0.25	0.14	0.35	0.14	001B0009:Surf[0]
Windows***, roof windows, and rooflights	2.2	0.78	3.3	0.78	001B0003:Surf[1]
Personnel doors	2.2	0.78	3	0.78	001C0000:Surf[1]
Vehicle access & similar large doors	1.5	0	4	0	No Vehicle access doors in building
High usage entrance doors	6	0	6	0	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m2K)] $U_{i\text{-}Limit}$ = Limiting individual element U-values [W/(m2K)]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m2K)] $U_{i\text{-}Calc}$ = Calculated individual element U-values [W/(m2K)]

* There might be more than one surface exceeding the limiting standards.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standards are similar to those for windows

*** Display windows and similar glazing are not required to meet the standard given in this table.

The format of this compliance document is in draft form as the final layout is still being checked by the Building Control Officers

2.2 Is air permeability no greater than the worst acceptable standard? No greater than worst acceptable standard

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

2.3 Are all building services standards acceptable?

2.3a-1 Main system HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system For a multiple boiler system the limiting efficiency for any individual boiler is 0.80		
Efficiency check	**Limiting Cooling Nominal efficiency**	**This building**
Cooling efficiency	2.25	2.5
Efficiency check	**Limiting Specific Fan Power**	**This building**
SFP	2.5	1.8

2.3b- "No DHW systems in project"

2.4	Does fixed internal lighting comply with England and Wales Building Regulations Part L paragraphs 49 to 61?	Separate submission
2.5	Are energy meters installed in accordance with GIL65?	Separate submission

Criterion 3: The spaces in the building without air-conditioning have appropriate passive control measures to limit the effects of solar gains

3.1	Method of showing compliance with England and Wales Building Regulations Part L in paragraph 64?	Separate submission

Criterion 4: The performance of the building, as built, is consistent with the BER

4.1	Have the key features of the design been included (or bettered) in practice?	Separate submission
4.2	Is the level of thermal bridging acceptable?	Separate submission
4.3	Has satisfactory documentary evidence of site inspection checks been produced?	Separate submission

4.4 Design air permeability

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

4.5	Has evidence been provided that demonstrates that the design air permeability has been achieved satisfactorily?	Separate submission
4.6	Has commissioning been completed satisfactorily?	Separate submission
4.7	Has evidence been provided that demonstrates that the ductwork is sufficiently airtight?	Separate submission

Criterion 5: Providing information

5.1	Has a suitable building log-book been prepared?	Separate submission

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area (m2)	5930	5930
External area (m2)	7911	7911
Weather	LON	LON
Infiltration	1	1
W/K	1566.89	5708.4
W/m2K	0.2	0.72
Alpha	17.67	10

Building Use

% area	Building Type
	Office
	Primary school
	Secondary school
	Further education universities
	Primary health care buildings
	Nursing residential homes and hostels
	Hospital
100	**Hotel**
	Restaurant/public house
	Sports centre/leisure centre
	Sports ground arena
	Retail
	Warehouse and storage
	Theatres/cinemas/music halls and auditoria
	Social clubs
	Community/day centre
	Libraries/museums/galleries
	Prisons
	Emergency services
	Crown and county courts
	Airport terminals
	Bus station/train station/seaport terminal
	Workshops/maintenance depot
	Telephone exchanges
	Industrial process building
	Launderette
	Dwelling
	Retail warehouses
	Miscellaneous 24hr activities

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat kWh/m2	Cool kWh/m2	Aux kWh/m2	Heat SSEEF	Cool SSEER	Heat G SEFF	Cool G SEER
[ST] Fan coil systems, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	44.9	36.4	15.4	7.6	38	0.81	1.34	0.89	2
	Notional	293.8	67.1	98.3	11.2	38.5	0.83	1.67	----	----

Residential Development

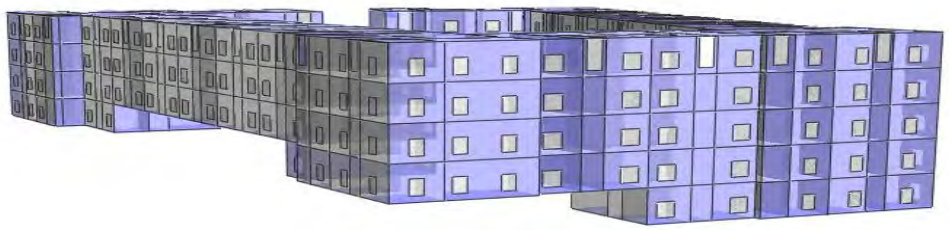

Figure 17 3D representation of one block of the indicative residential development

Minimum system specification requirements

9. Modeled Performance Specifications for the indicative hotel development: -

Heating:	LTHW Boiler
Fuel type:	Natural Gas
Generator Seasonal Efficiency:	0.8900
Cooling:	Air cooled
Mechanical Ventilation:	Whole house heat recovery
SFP:	1.6 W/ (l/s)

Room Description	NCM Building activity Hours and Operational Profile, i.e. unregulated loads
Bedroom	Dwell: Bedroom (2006 Database)
Bathroom	Dwell: Toilet (2006 Database)
Living room	Dwell: Lounge (2006 Database)
Corridor	Dwell: Circulation area (2006 Database)

Table 8 NCM Building activity and Operational Profile – IES Modelling

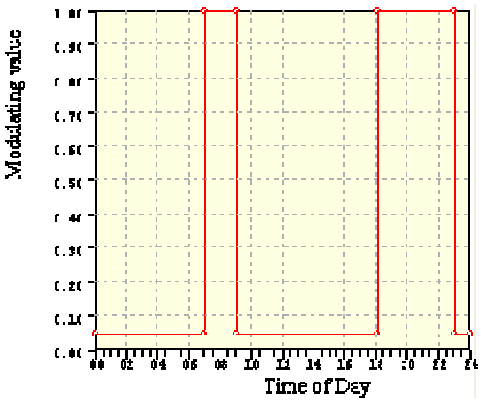

Figure 18 Modulating value for unregulated equipment operational profile

Peak Space Heating demand	20.61 W/m²
Peak DHW demand	7.43 W/m²
Peak Combined Heating demand	22.04 W/m²
Peak Power demand*	19.49 W/m²
Annual CO_2 emissions - Space Heat	14.97 kg CO_2/kWh
Annual CO_2 emissions - DHW	20.01 kg CO_2/kWh
Annual CO_2 emissions – Total Heating	34.97 kg CO_2/kWh
Annual CO_2 emissions – Power*	62.59 kg CO_2/kWh
Annual CO_2 emissions – Total*	82.60 kg CO_2/kWh
Annual CO_2 emissions – Unregulated loads only **	15.3 kg CO_2/kWh

* Includes unregulated loads

** According to the Code for Sustainable Homes Guide, BRE. Appliances and Cooking loads Calculations, Ene 7, CfSH Guide, p.60

Establishing energy consumption of Residential areas

The estimated energy demand for the proposed residential areas was established on an annual basis. However, as the data have been produced by SAP: 2005, by using information about the actual proposal, it is not possible to identify the actual split up between the months; therefore, the annual CO_2 emission figures are only presented. The energy consumption of appliances, such as cooking and computers, has been calculated the Code for Sustainable Homes methodology. IES summary figures are presented in page "Appendix 1 – 36" and analytically in Appendix 2 and have been compared with the data below. The net annual CO_2 emissions under both studies (i.e. SAP and IES modelling) are the same.

Notes for Next Page:

- TER = Target Emissions Rate, according to the minimum requirements of Building Regulations 2006.
- DER = Dwelling(s) Emission Rate, as design and after energy efficiency measures.
- SAP Reports are available after request

Dwelling(s)	Floor area (m^2)	$kgCO_2/m^2$		% Improvement
		TER	DER	
Flat 1	48.64	30.36	20.46	32.00
Flat 2	46.61	26.81	19.16	28.00
Flats 3, 4	56.16	26.90	18.76	30.00
Flat 5	56.80	26.06	17.86	31.00
Flat 6	56.92	31.72	20.40	35.00
Flats 7, 12	56.80	26.79	18.66	30.00
Flats 8, 9, 10, 11	56.16	24.83	17.85	28.00
Flat 13	56.92	31.72	20.40	35.00
Flat 14	56.80	25.96	18.33	29.00
Flat 15	56.80	26.63	19.33	27.00
Flat 16	56.92	31.99	20.97	34.00
Flat 17	59.25	26.41	18.54	29.00
Flats 18, 19, 20, 21	46.61	26.81	18.88	29.00
Flats 22, 23	56.16	24.83	17.83	28.00
Flats 24, 48	48.64	26.15	18.24	30.00
Flat 25	46.61	23.18	17.41	24.00
Flat 26, 28	56.16	21.29	16.15	24.00
Flat 27	56.16	24.83	17.86	28.00
Flat 29	56.80	22.42	16.51	26.00
Flats 30, 54	56.92	27.79	18.83	32.00
Flats 31, 36, 55	56.80	23.08	16.74	27.00
Flats 32, 33, 34, 35	56.16	21.29	16.15	24.00
Flat 37, 61	56.92	27.79	18.16	34.00
Flats 38, 62	56.80	22.33	16.48	26.00
Flats 39, 63, 77	56.80	22.93	16.70	27.00
Flats 40, 64, 78	56.92	28.05	18.60	33.00
Flats 41, 65	59.25	22.60	16.59	26.00
Flats 43, 43, 44, 45	46.61	23.18	17.82	23.00
Flats 46, 47, 70, 71	56.16	21.29	16.14	24.00
Flat 49	46.61	25.87	19.16	25.00
Flats 50, 51, 52	56.16	23.91	17.86	25.00
Flat 53	56.80	23.69	17.75	25.00
Flats 56, 57, 58, 59	56.16	23.91	17.85	25.00
Flats 60, 74	56.80	25.83	18.66	27.00
Flats 66, 67, 68, 69	46.61	25.87	18.94	26.00
Flat 72	48.64	29.27	21.40	26.00
Flat 73	56.92	29.77	20.18	32.00
Flat 75	56.92	30.72	20.40	33.00
Flat 76	56.80	25.02	18.33	26.00
Flat 79	59.25	24.48	17.30	29.00
Flats 80, 81	56.16	23.91	17.83	25.00
Flat 82	56.80	27.69	19.55	29.00
Flat 83	56.92	30.99	20.97	32.00
Flat 84	59.25	27.42	19.46	29.00
House 1	72.70	23.16	16.67	27.00
House 2	72.70	23.16	16.66	28.00
House 3	89.12	21.66	15.51	28.00
House 4	53.99	29.75	20.25	31.00
House 5	80.46	21.63	15.86	26.00
House 6	82.90	24.06	16.66	30.00
House 7	87.70	20.94	15.27	27.00
House 8	72.70	23.16	16.87	27.00
House 9	72.70	23.16	16.69	27.00
House 10	87.63	22.94	16.38	28.00

Food Retail

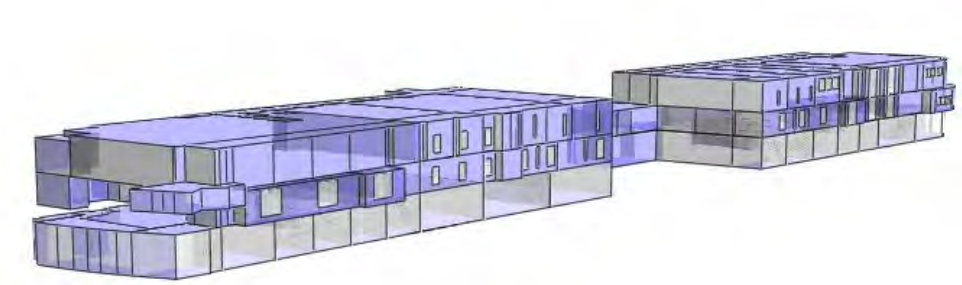

Figure 19 3D representation of one block of the indicative food retail development

Minimum system specification requirements

10. Modelled Performance Specifications for the indicative food retail development: -

Heating:	LTHW Boiler
Fuel type:	Natural Gas
Generator Seasonal Efficiency:	0.8900
Cooling:	Air cooled
Nominal EER:	4.15000
SFP:	1.6 W/ (l/s)

Room Description	NCM Building activity Hours and Operational Profile, i.e. unregulated loads
Food Retail	NCM Ret: Sales area – chilled/speculative

Table 9 NCM Building activity and Operational Profile

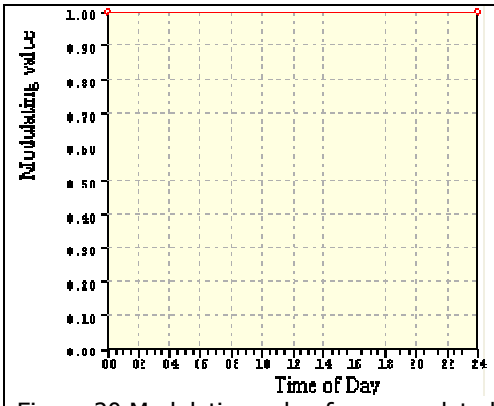

Figure 20 Modulating value for unregulated equipment operational profile

Peak Heat demand	3.82 W/m²
Peak Cooling demand	78.78 W/m²
Peak Power demand*	151.77W/m²
Annual CO_2 emissions - Heat	4.40 kg CO_2/kWh
Annual CO_2 emissions – Cooling	154.78 kg CO_2/kWh
Annual CO_2 emissions – Power**	705.25 kg CO_2/kWh
Annual CO_2 emissions – Total**	363.78 kg CO_2/kWh
Annual CO_2 emissions – Unregulated loads only	250.98 kg CO_2/kWh

* Figure does not include cooling
** Includes unregulated loads

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L

Project name

Typical Food Retail

As designed

Date: Mon Mar 02 13:37:51 2009

Administrative information

Building details

Address: West Southall, Ealing, GU15 3PT

Certification tool

Calculation engine: Apache

Calculation engine version: "5.9.0"

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 5.9.0

BRUKL compliance check version: v3.1.a

Occupier details

Name: National Grid Property Limited

Telephone number:

Address: , ,

Certifier details

Name: Yianni Spanos - WYG

Telephone number: 020 8649 6600

Address: 9th Floor - Sunley House 4 Bedford Park, Croyd

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

1.1	Calculated CO2 emission rate from notional building	164.2 KgCO2/m2.annum
1.2	Improvement factor	0.2
1.3	LZC benchmark	0.1
1.4	Target CO2 Emission Rate (TER)	118.2 KgCO2/m2.annum
1.5	Building CO2 Emission Rate (BER)	112.8 KgCO2/m2.annum
1.6	Are emissions from building less than or equal to the target?	BER =< TER
1.7	Are as built details the same as used in BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services systems should be no worse than the design limits

2.1 Are the U-values better than the design limits? Better than design limits

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Limit}$	$U_{i\text{-}Calc}$	Surface where this maximum value occurs*
Wall**	0.35	0.14	0.7	0.14	A1__0000:Surf[2]
Floor	0.25	0.14	0.7	0.14	A1__0000:Surf[0]
Roof	0.25	0.15	0.35	0.15	A1__0000:Surf[1]
Windows***, roof windows, and rooflights	2.2	0	3.3	0	No windows or rooflights in building
Personnel doors	2.2	0	3	0	No Personnel doors in building
Vehicle access & similar large doors	1.5	0	4	0	No Vehicle access doors in building
High usage entrance doors	6	0	6	0	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m2K)] $U_{i\text{-}Limit}$ = Limiting individual element U-values [W/(m2K)]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m2K)] $U_{i\text{-}Calc}$ = Calculated individual element U-values [W/(m2K)]

* There might be more than one surface exceeding the limiting standards.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standards are similar to those for windows

*** Display windows and similar glazing are not required to meet the standard given in this table.

The format of this compliance document is in draft form as the final layout is still being checked by the Building Control Officers

2.2 Is air permeability no greater than the worst acceptable standard? No greater than worst acceptable standard

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

2.3 Are all building services standards acceptable?

2.3a-1 Retail Non food HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system For a multiple boiler system the limiting efficiency for any individual boiler is 0.80		
Efficiency check	**Limiting Cooling Nominal efficiency**	**This building**
Cooling efficiency	Limiting cooling efficiency not specified	4.15
Efficiency check	**Limiting Specific Fan Power**	**This building**
SFP	2.5	1.8

2.3b- "No DHW systems in project"

2.4	Does fixed internal lighting comply with England and Wales Building Regulations Part L paragraphs 49 to 61?	Separate submission
2.5	Are energy meters installed in accordance with GIL65?	Separate submission

Criterion 3: The spaces in the building without air-conditioning have appropriate passive control measures to limit the effects of solar gains

3.1	Method of showing compliance with England and Wales Building Regulations Part L in paragraph 64?	Separate submission

Criterion 4: The performance of the building, as built, is consistent with the BER

4.1	Have the key features of the design been included (or bettered) in practice?	Separate submission
4.2	Is the level of thermal bridging acceptable?	Separate submission
4.3	Has satisfactory documentary evidence of site inspection checks been produced?	Separate submission

4.4 Design air permeability

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

4.5	Has evidence been provided that demonstrates that the design air permeability has been achieved satisfactorily?	Separate submission
4.6	Has commissioning been completed satisfactorily?	Separate submission
4.7	Has evidence been provided that demonstrates that the ductwork is sufficiently airtight?	Separate submission

Criterion 5: Providing information

5.1	Has a suitable building log-book been prepared?	Separate submission

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area (m2)	99	99
External area (m2)	21945	21945
Weather	LON	LON
Infiltration	1	1
W/K	3156.03	15485.4
W/m2K	0.14	0.71
Alpha	24.34	10

Building Use

% area	Building Type
	Office
	Primary school
	Secondary school
	Further education universities
	Primary health care buildings
	Nursing residential homes and hostels
	Hospital
	Hotel
	Restaurant/public house
	Sports centre/leisure centre
	Sports ground arena
100	**Retail**
	Warehouse and storage
	Theatres/cinemas/music halls and auditoria
	Social clubs
	Community/day centre
	Libraries/museums/galleries
	Prisons
	Emergency services
	Crown and county courts
	Airport terminals
	Bus station/train station/seaport terminal
	Workshops/maintenance depot
	Telephone exchanges
	Industrial process building
	Launderette
	Dwelling
	Retail warehouses
	Miscellaneous 24hr activities

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat kWh/m2	Cool kWh/m2	Aux kWh/m2	Heat SSEEF	Cool SSEER	Heat G SEFF	Cool G SEER
[ST] Active chilled beams, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	0	949.9	0	86.6	13.7	0.79	3.05	0.89	3.69
	Notional	42.4	923.9	14.2	153.7	32.6	0.83	1.67	----	----

Non- Food Retail

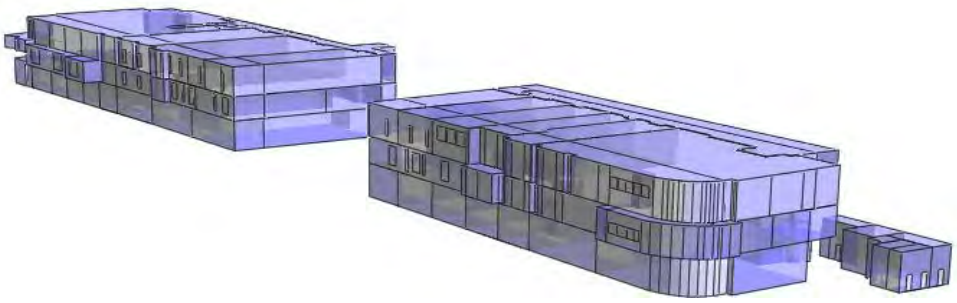

Figure 21 3D representation of one block of the indicative non food retail development

Minimum system specification requirements

11. Modelled Performance Specifications for the indicative non-food retail development: -

Heating:	LTHW Boiler
Fuel type:	Natural Gas
Generator Seasonal Efficiency:	0.8900
Cooling:	Air cooled
Nominal EER:	4.15000
SFP:	1.6 W/ (l/s)

Room Description	NCM Building activity Hours and Operational Profile, i.e. unregulated loads
Non Food Retail	NCM Ret: Speculative retail space

Table 10 NCM Building activity and Operational Profile

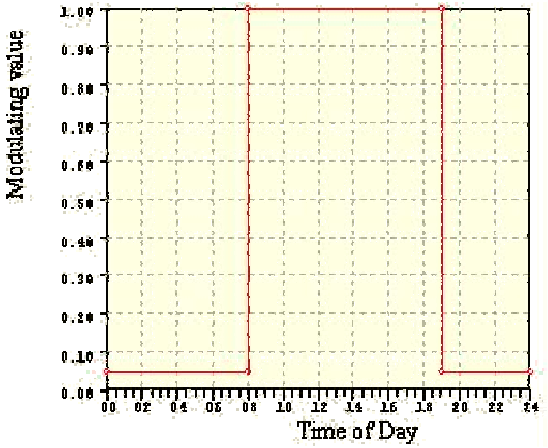

Figure 22 Modulating value for unregulated equipment operational profile

Peak Heat demand	94.52 W/m²
Peak Cooling demand	26.08 W/m²
Peak Power demand*	82.38 W/m²
Annual CO_2 emissions - Heat	13.65 kg CO_2/kWh
Annual CO_2 emissions – Cooling	18.80 kg CO_2/kWh
Annual CO_2 emissions – Power**	278.07 kg CO_2/kWh
Annual CO_2 emissions – Total**	127.90 kg CO_2/kWh
Annual CO_2 emissions – Unregulated loads only	56.00 kg CO_2/kWh

* Figure does not include cooling

** Includes unregulated loads

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L

Project name

Typical Non Food Ret

As designed

Date: Mon Mar 02 13:31:49 2009

Administrative information

Building details

Address: West Southall, Ealing,

Certification tool

Calculation engine: Apache

Calculation engine version: "5.9.0"

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 5.9.0

BRUKL compliance check version: v3.1.a

Occupier details

Name: National Grid Property Limited

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Certifier details

Name: Yianni Spanos - WYG

Telephone number: 020 8649 6600

Address: 9th Floor - Sunley House 4 Bedford Park, Croyd

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

1.1	Calculated CO2 emission rate from notional building	130.2 KgCO2/m2.annum
1.2	Improvement factor	0.2
1.3	LZC benchmark	0.1
1.4	Target CO2 Emission Rate (TER)	93.7 KgCO2/m2.annum
1.5	Building CO2 Emission Rate (BER)	71.9 KgCO2/m2.annum
1.6	Are emissions from building less than or equal to the target?	BER =< TER
1.7	Are as built details the same as used in BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services systems should be no worse than the design limits

2.1 Are the U-values better than the design limits? Better than design limits

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Limit}$	$U_{i\text{-}Calc}$	Surface where this maximum value occurs*
Wall**	0.35	0.14	0.7	0.14	A1__0000:Surf[2]
Floor	0.25	0.14	0.7	0.14	A1__0000:Surf[0]
Roof	0.25	0.15	0.35	0.15	A1__0000:Surf[1]
Windows***, roof windows, and rooflights	2.2	0	3.3	0	No windows or rooflights in building
Personnel doors	2.2	0	3	0	No Personnel doors in building
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High usage entrance doors	6	0	6	0	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m2K)] $U_{i\text{-}Limit}$ = Limiting individual element U-values [W/(m2K)]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m2K)] $U_{i\text{-}Calc}$ = Calculated individual element U-values [W/(m2K)]

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m3/(h.m2) at 50 Pa	10	1.3

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2.3a-1 Retail Non food HVAC system standard is acceptable

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Heat source efficiency	0.84	0.89
0.84 is the overall limiting efficiency for a single or a multiple boiler system For a multiple boiler system the limiting efficiency for any individual boiler is 0.80		
Efficiency check	**Limiting Cooling Nominal efficiency**	**This building**
Cooling efficiency	Limiting cooling efficiency not specified	4.15
Efficiency check	**Limiting Specific Fan Power**	**This building**
SFP	2.5	1.8

2.3b- "No DHW systems in project"

2.4	Does fixed internal lighting comply with England and Wales Building Regulations Part L paragraphs 49 to 61?	Separate submission
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4.2	Is the level of thermal bridging acceptable?	Separate submission
4.3	Has satisfactory documentary evidence of site inspection checks been produced?	Separate submission

4.4 Design air permeability

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	1.3

4.5	Has evidence been provided that demonstrates that the design air permeability has been achieved satisfactorily?	Separate submission
4.6	Has commissioning been completed satisfactorily?	Separate submission
4.7	Has evidence been provided that demonstrates that the ductwork is sufficiently airtight?	Separate submission

Criterion 5: Providing information

5.1	Has a suitable building log-book been prepared?	Separate submission

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area (m2)	99	99
External area (m2)	21945	21945
Weather	LON	LON
Infiltration	1	1
W/K	3156.03	15485.4
W/m2K	0.14	0.71
Alpha	24.34	10

Building Use

% area	Building Type
	Office
	Primary school
	Secondary school
	Further education universities
	Primary health care buildings
	Nursing residential homes and hostels
	Hospital
	Hotel
	Restaurant/public house
	Sports centre/leisure centre
	Sports ground arena
100	**Retail**
	Warehouse and storage
	Theatres/cinemas/music halls and auditoria
	Social clubs
	Community/day centre
	Libraries/museums/galleries
	Prisons
	Emergency services
	Crown and county courts
	Airport terminals
	Bus station/train station/seaport terminal
	Workshops/maintenance depot
	Telephone exchanges
	Industrial process building
	Launderette
	Dwelling
	Retail warehouses
	Miscellaneous 24hr activities

HVAC Systems Performance

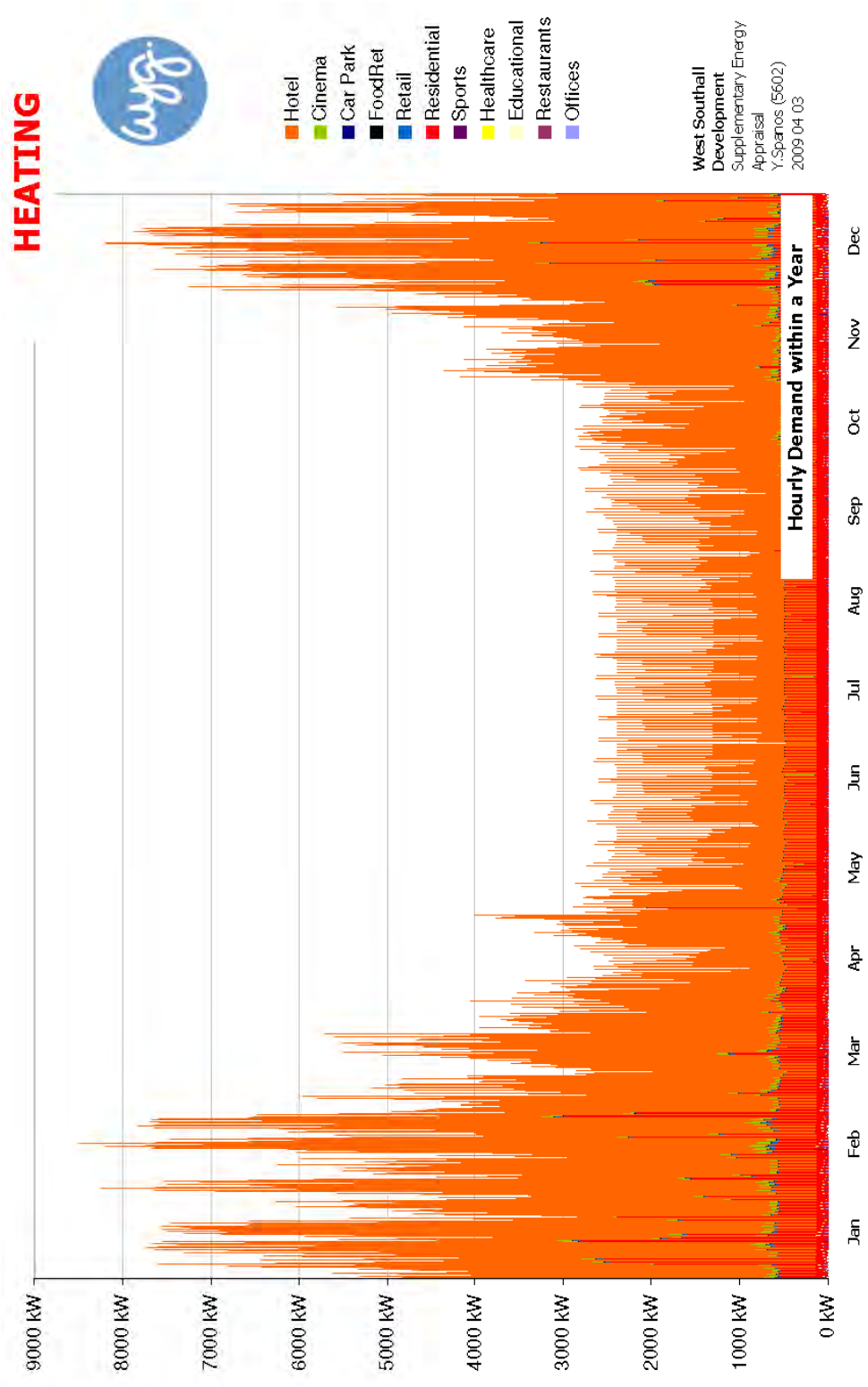
System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat kWh/m2	Cool kWh/m2	Aux kWh/m2	Heat SSEEF	Cool SSEER	Heat G SEFF	Cool G SEER
[ST] Active chilled beams, [HS] LTHW boiler, [FT] Natural Gas										
	Actual	3.1	192	1.1	17.5	13.7	0.79	3.05	0.89	3.69
	Notional	211.1	519.8	70.6	86.5	32.6	0.83	1.67	----	----

National Grid Property Ltd

Appendix 2: Indicative Only Energy Consumption Projections after Detailed Studies

Addendum to the West Southall Masterplan Energy Strategy

Appendix 2 – Contents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Offices
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Supplementary Energy Appraisal
Y.Spanos (5602)
2009 04 03
Hourly Demand within a Year
9000 kW
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7000 kW
6000 kW
5000 kW
4000 kW
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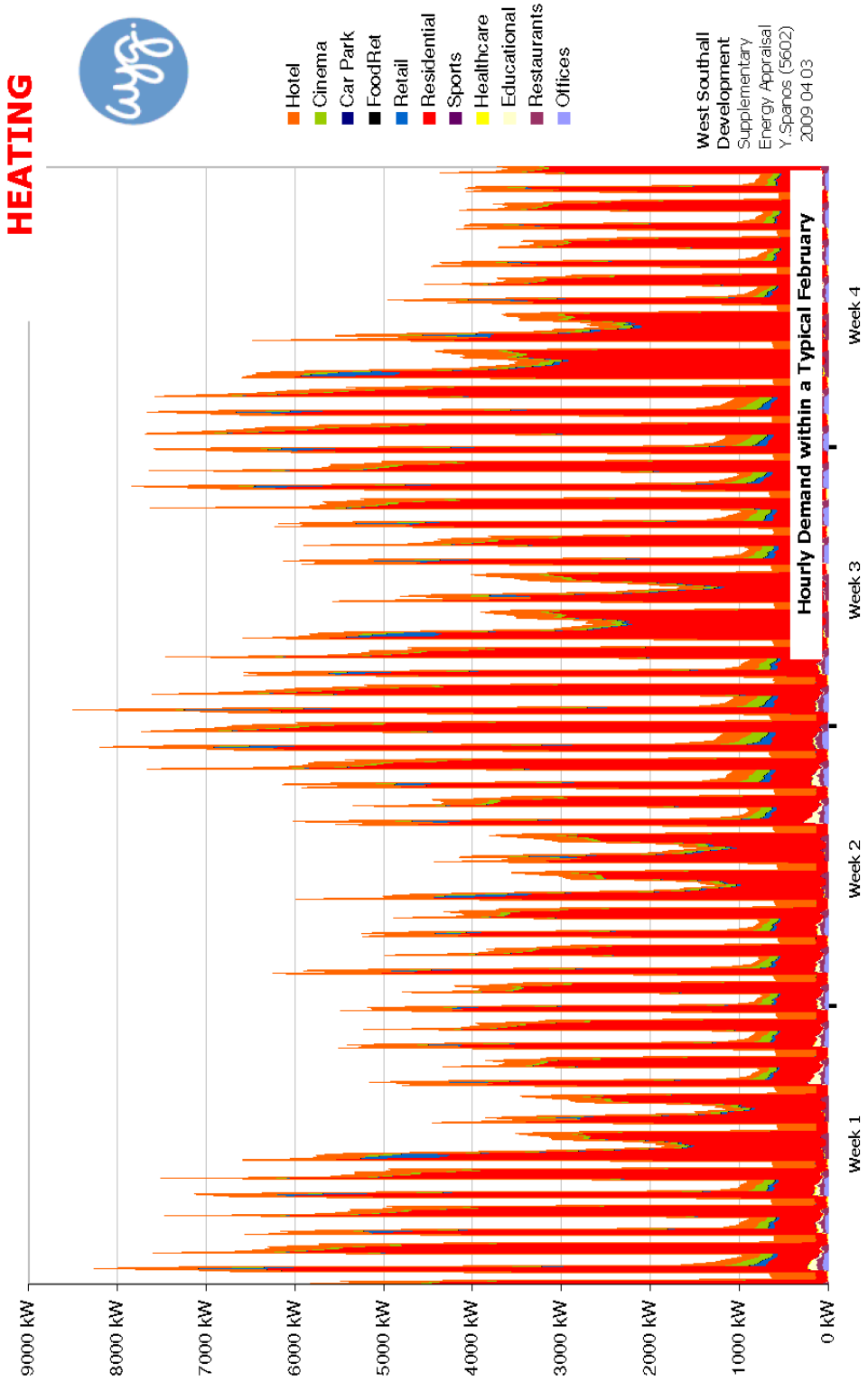
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Y.Spanos (5602)
2009 04 03
Hourly Demand within a Typical February
9000 kW
8000 kW
7000 kW
6000 kW
5000 kW
4000 kW
3000 kW
2000 kW
1000 kW
0 kW
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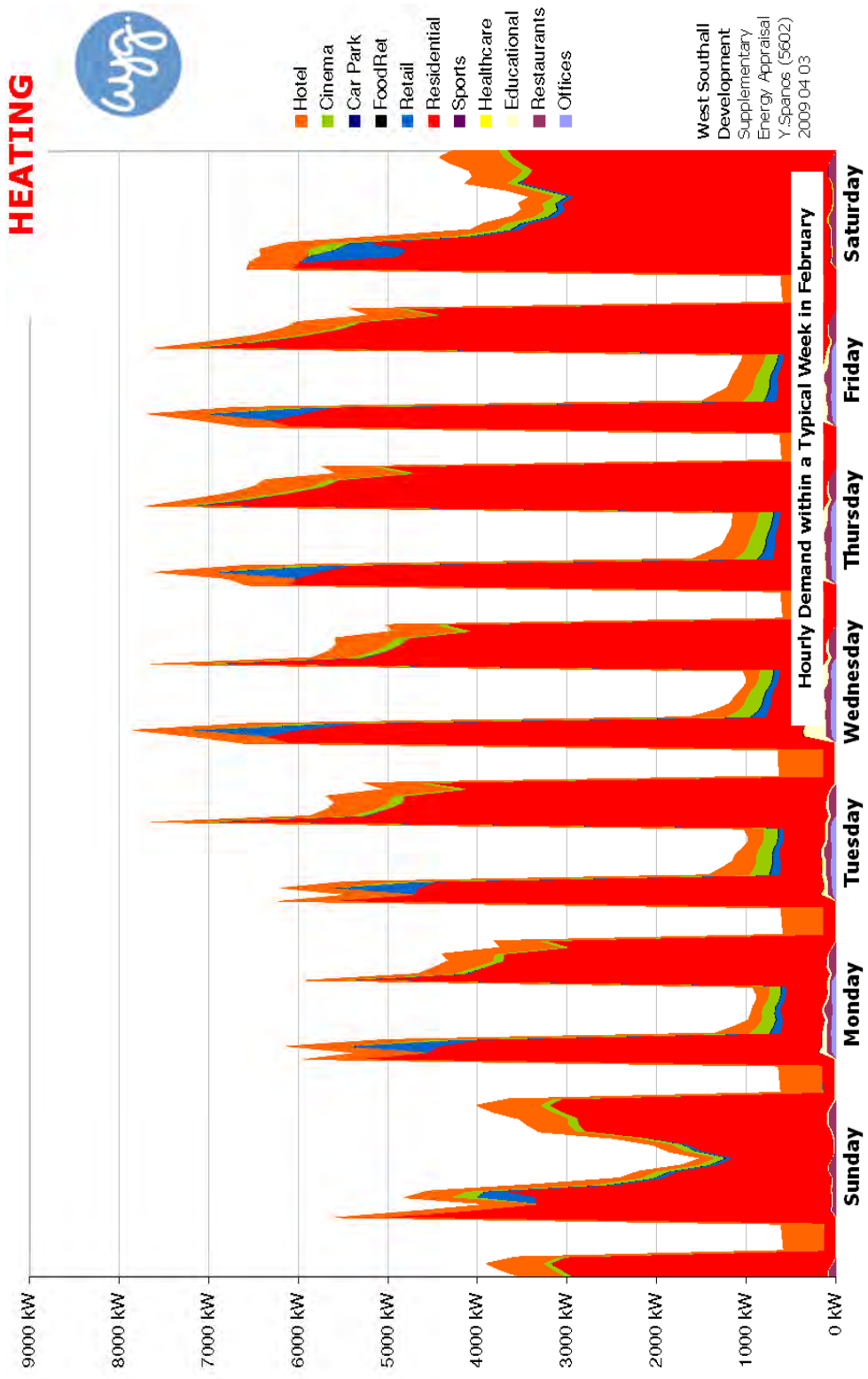
Week 3
Week 4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Energy Appraisal
Y.Spanos (5602)
2009 04 03
Hourly Demand within a Typical Week in February
Sunday
Monday
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Wednesday
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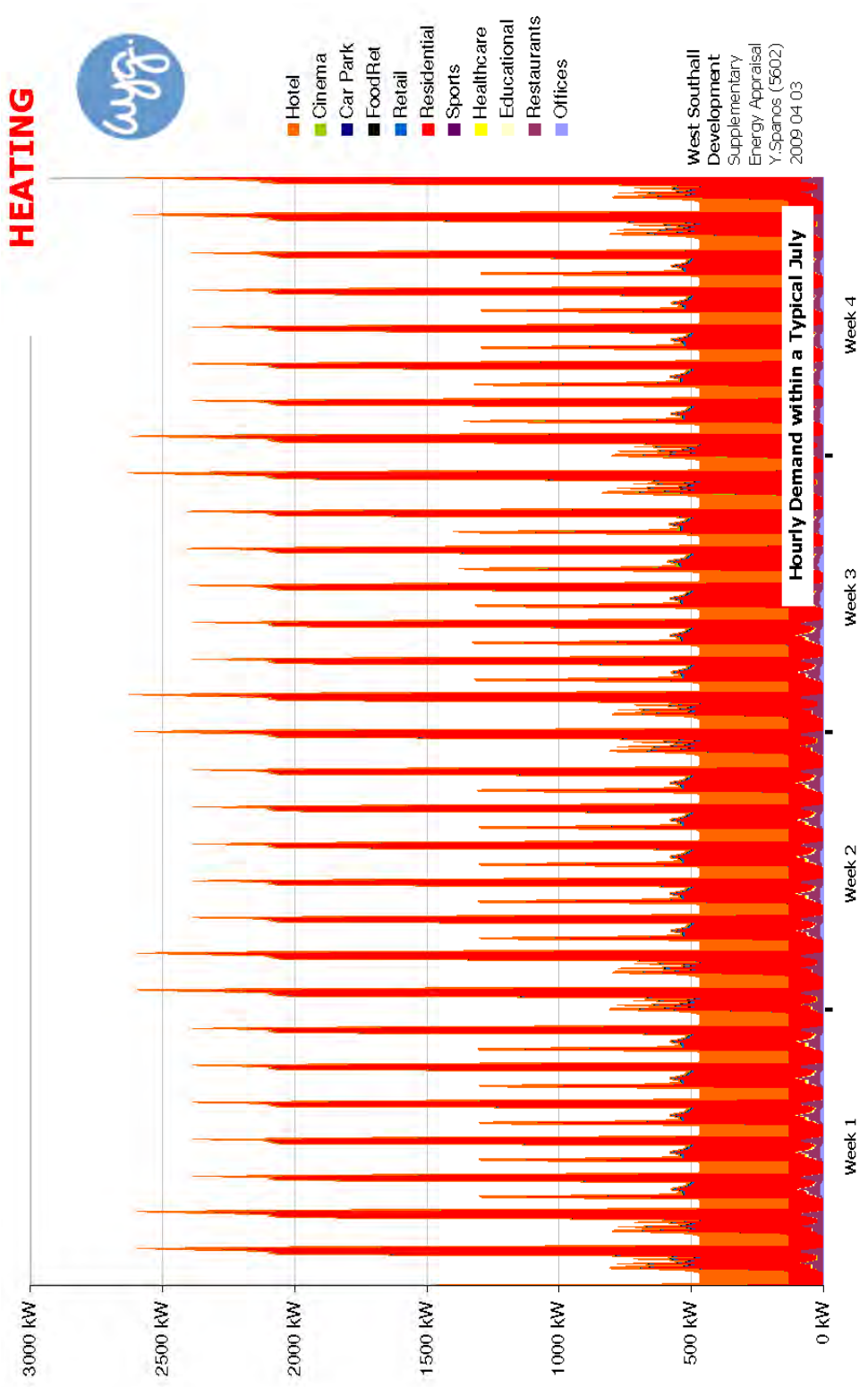
2000 kW
1000 kW
0 kW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West Southall Development
Supplementary Energy Appraisal
Y.Spanos (5602)
2009 04 03
Hourly Demand within a Typical July
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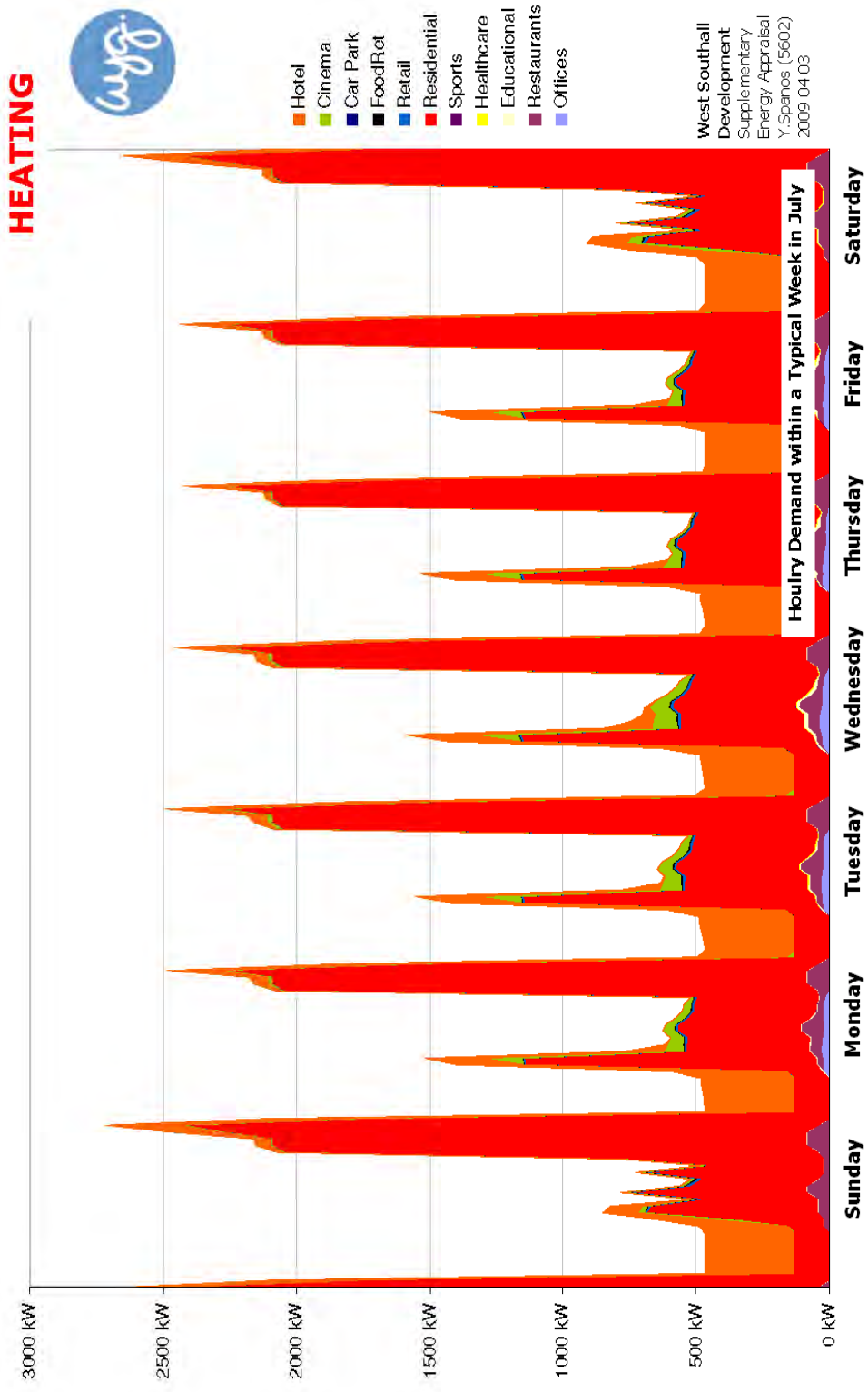
2500 kW
2000 kW
1500 kW
1000 kW
500 kW
0 kW
Week 1
Week 2
Week 3
Week 4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Houlry Demand within a Typical Week in July
3000 kW
2500 kW
2000 kW
1500 kW
1000 kW
500 kW
0 kW
Sunday
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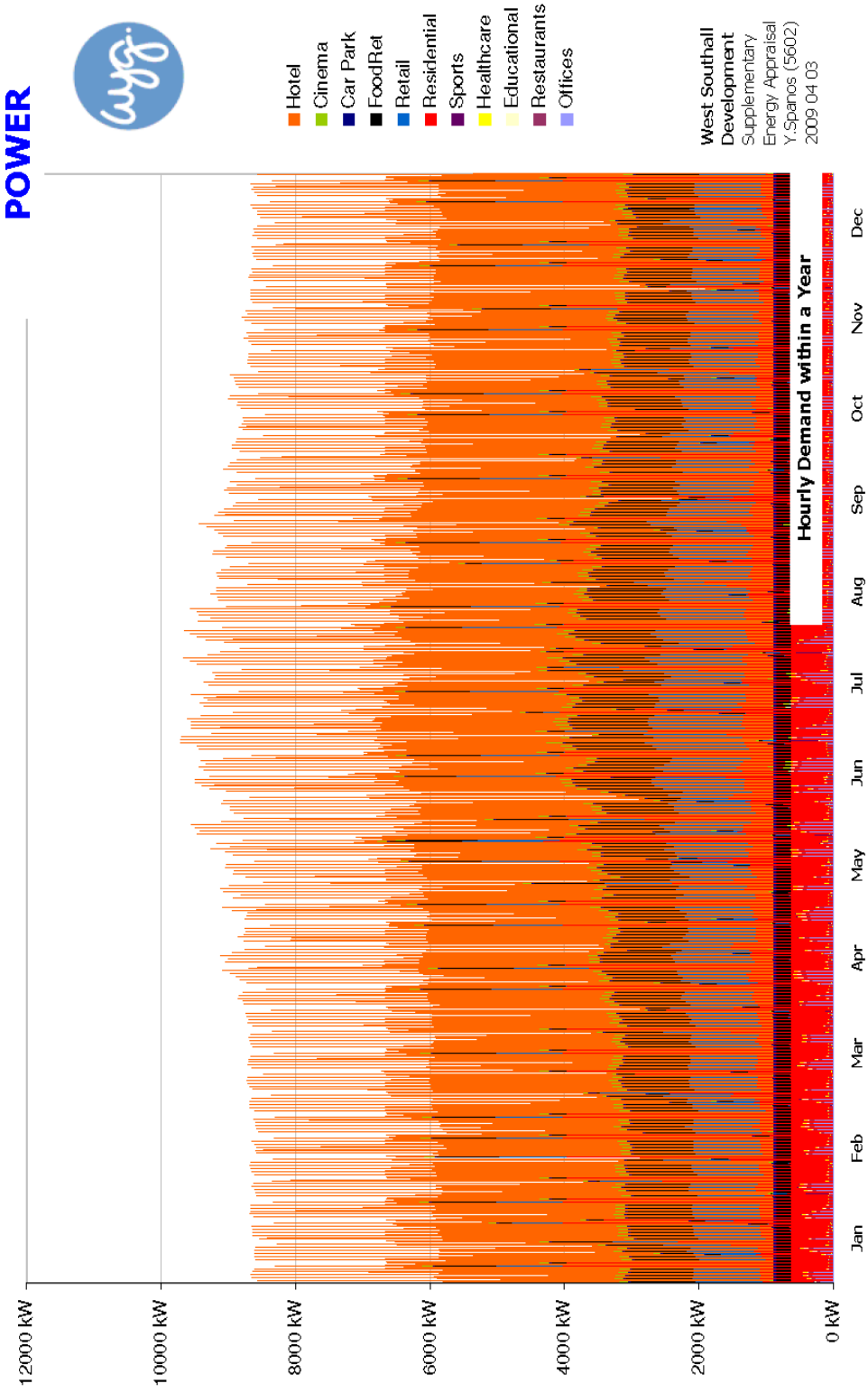
Thursday
Friday
Saturday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West Southall
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Supplementary
Energy Appraisal
Y.Spanos (5602)
2009 04 03
Hourly Demand within a Year
12000 kW
10000 kW
8000 kW
6000 kW
4000 kW
2000 kW
0 kW
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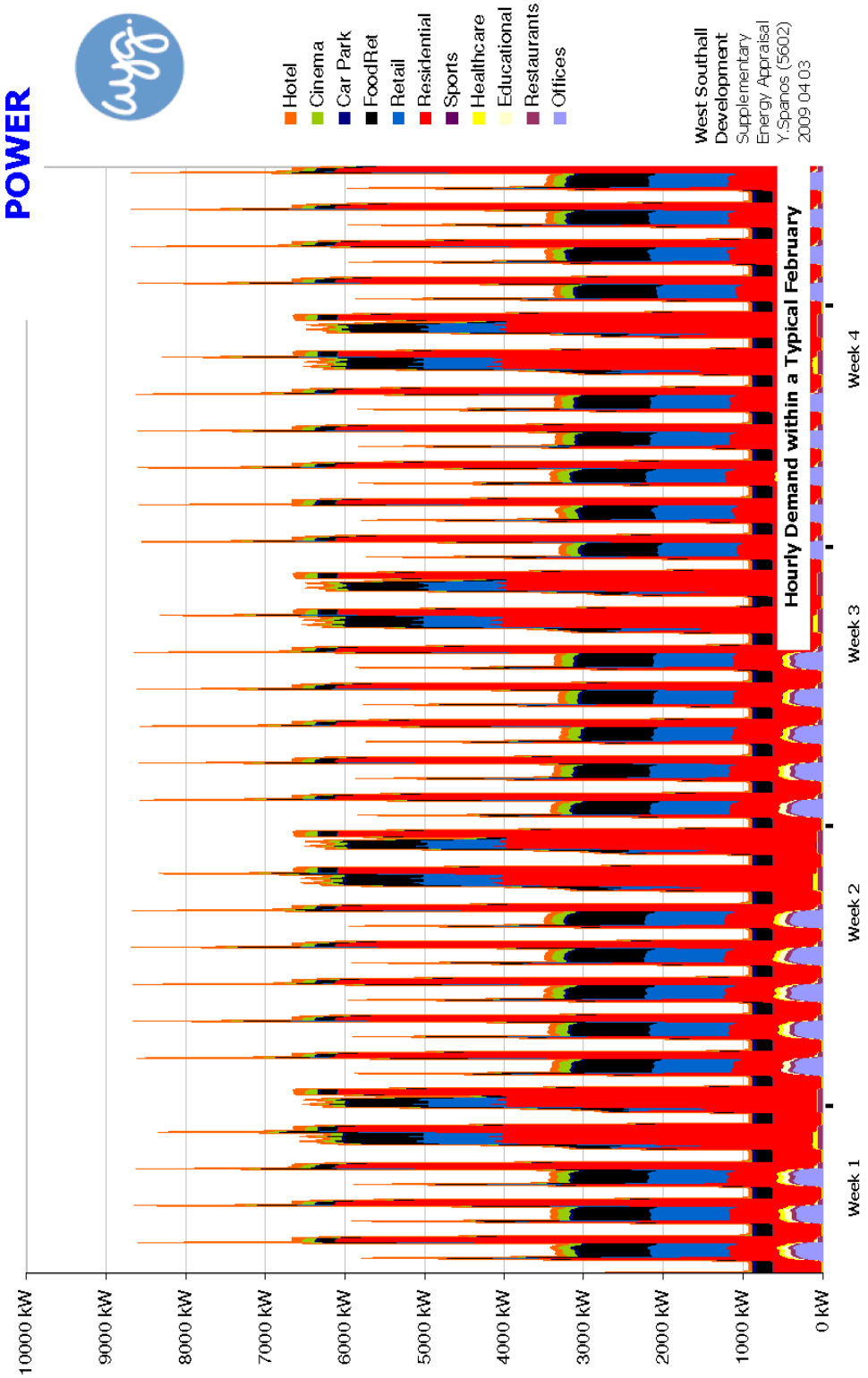
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10000 kW
9000 kW
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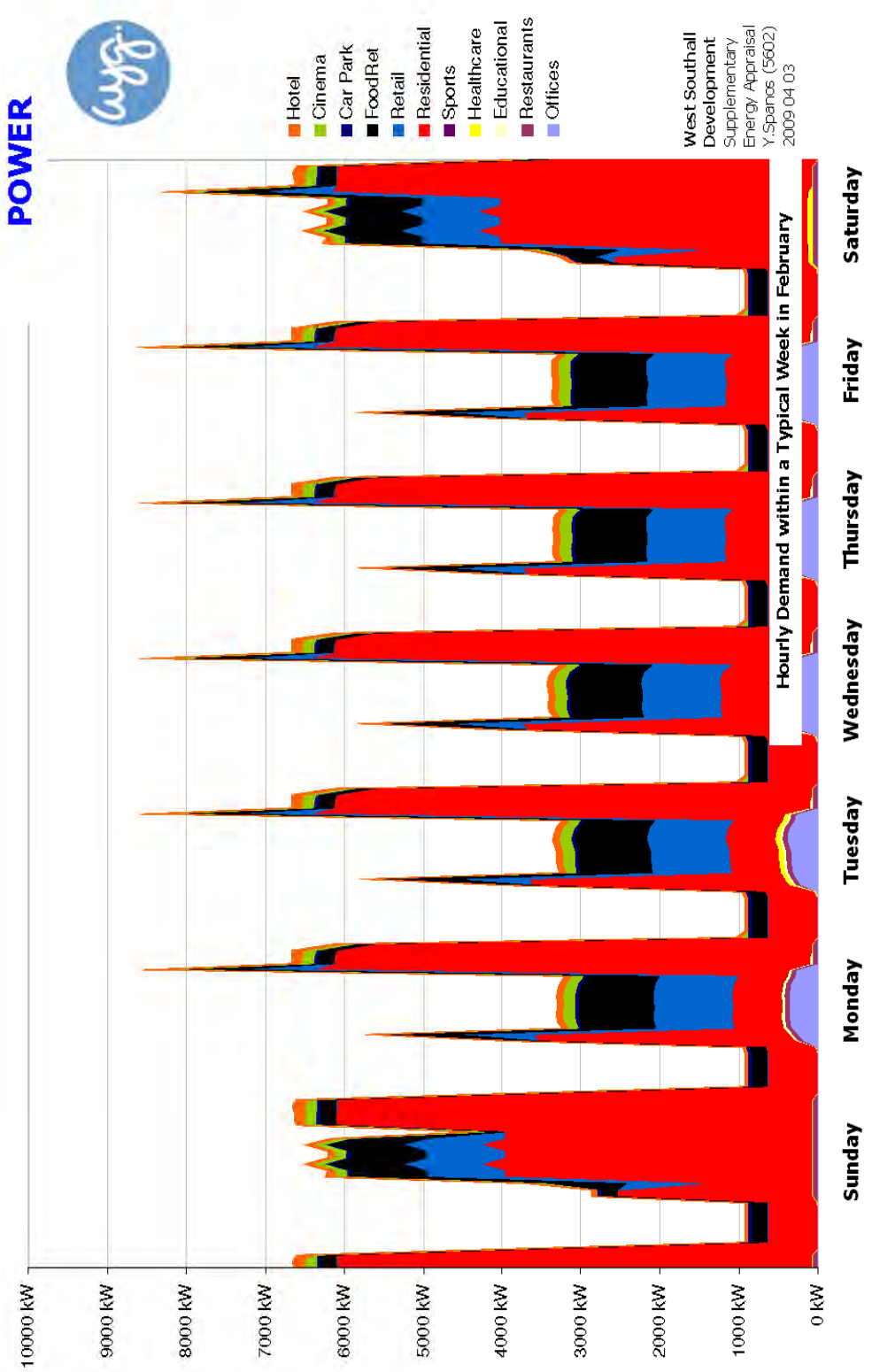
Week 4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Y.Spanos (5602)
2009 04 03
Hourly Demand within a Typical Week in February
Sunday
Monday
Tuesday
Wednesday
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Saturday
10000 kW
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8000 kW
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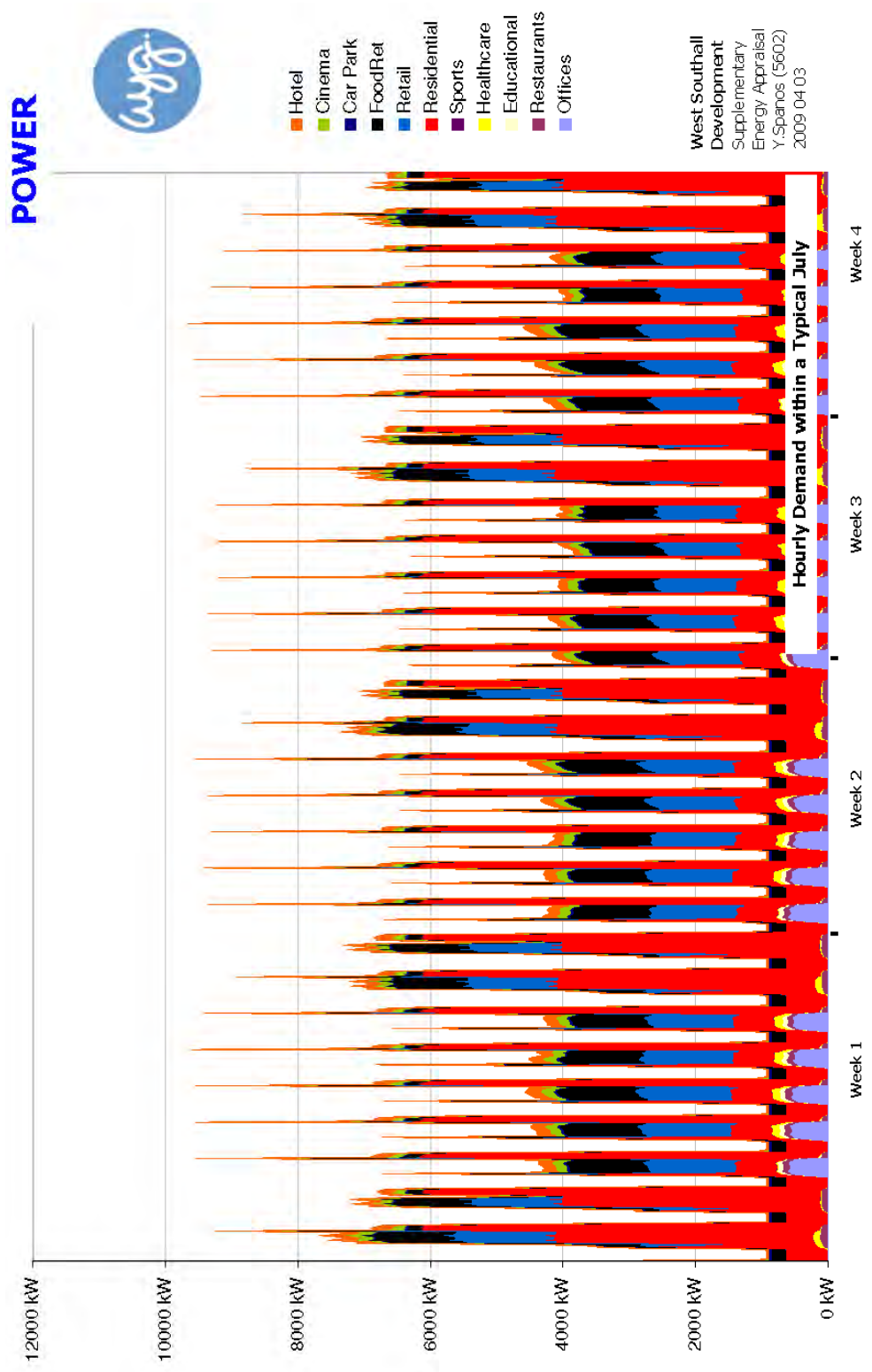
2000 kW
1000 kW
0 kW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Y.Spanos (5602)
2009 04 03
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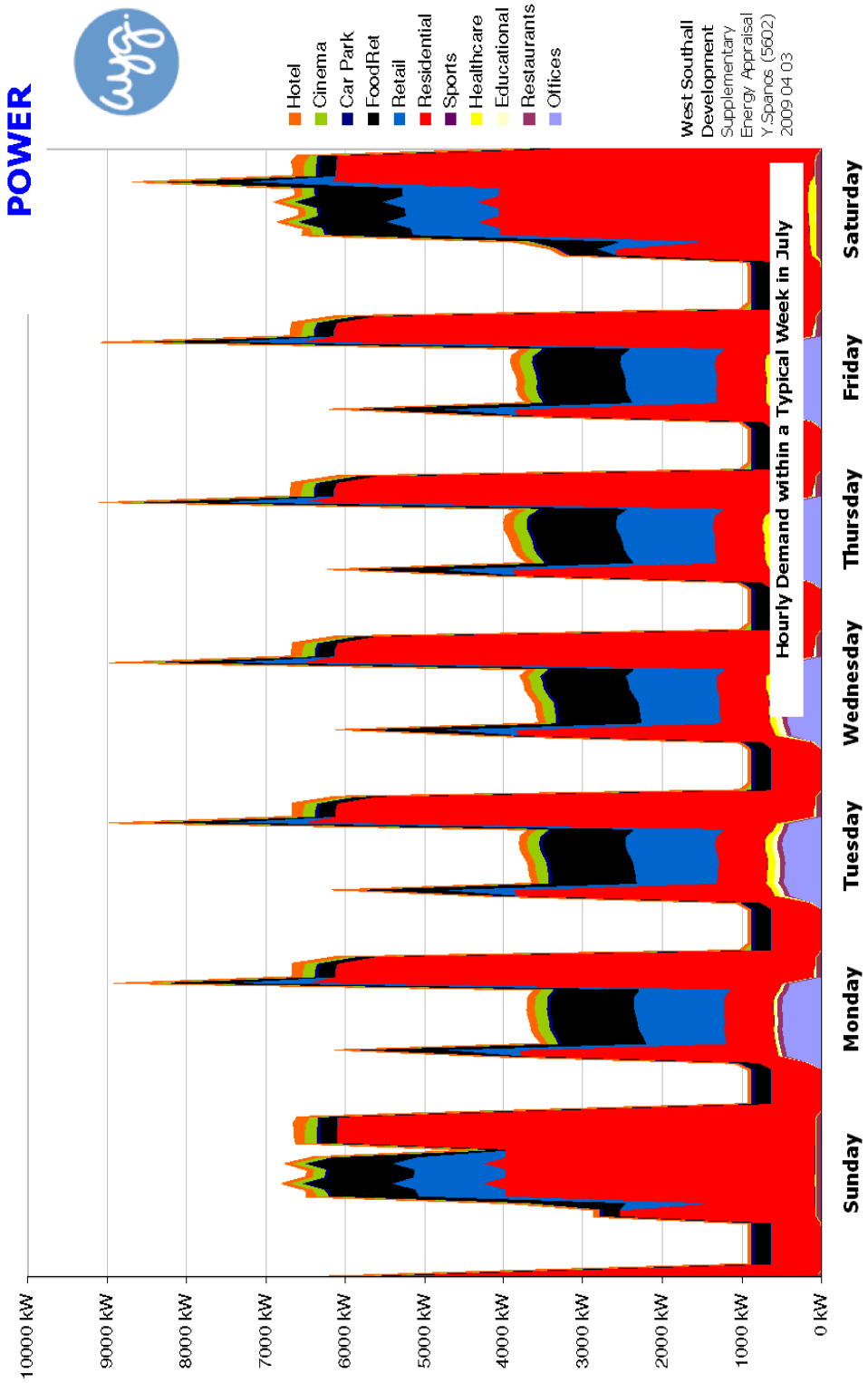
12000 kW
10000 kW
8000 kW
6000 kW
4000 kW
2000 kW
0 kW
Week 1
Week 2
Week 3
Week 4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West Southall
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2009 04 03
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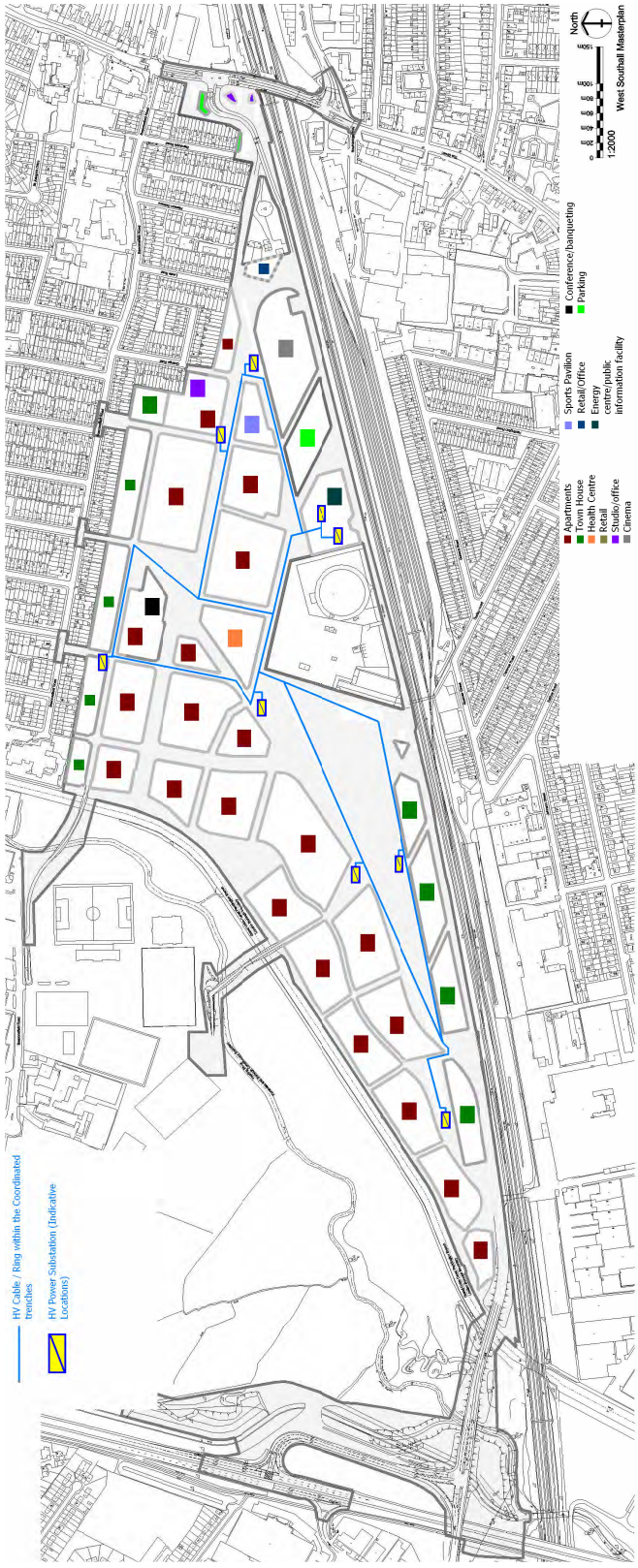
10000 kW
9000 kW
8000 kW
7000 kW
6000 kW
5000 kW
4000 kW
3000 kW
2000 kW
1000 kW
0 kW
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday

National Grid Property Ltd

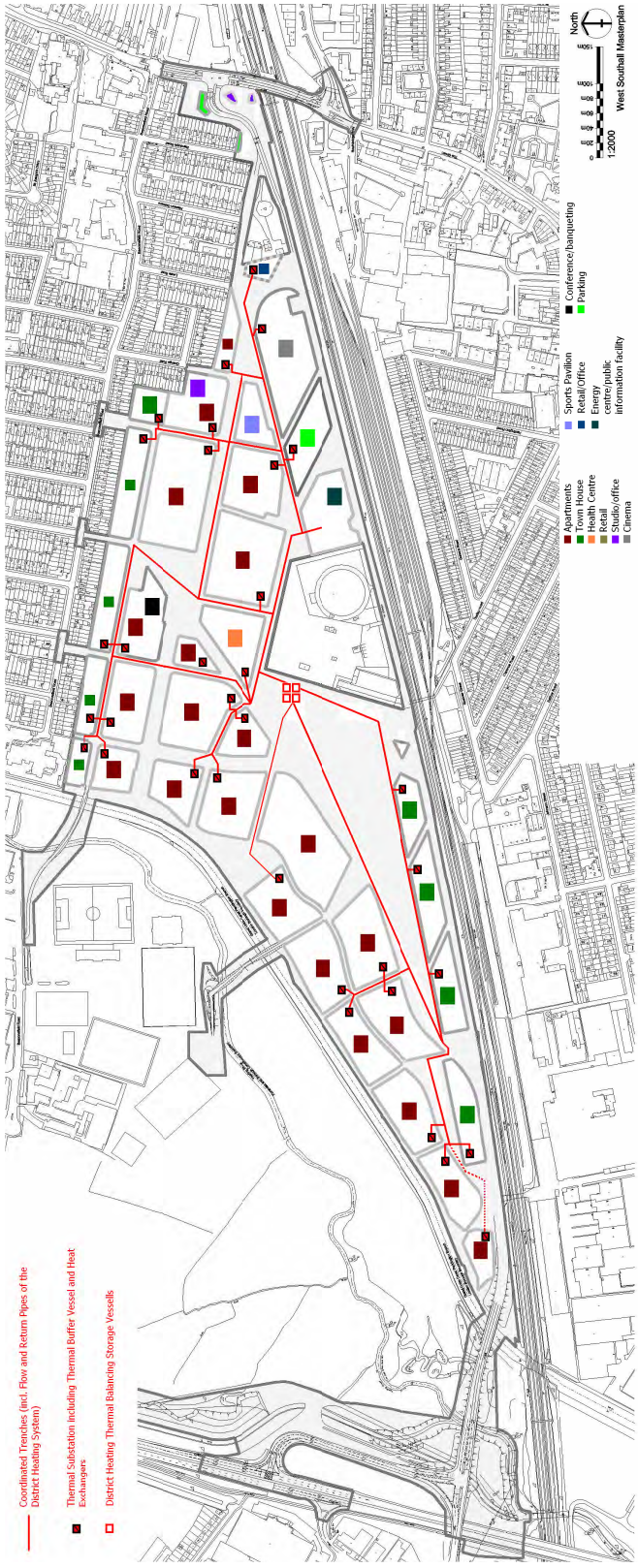
Appendix 3: Indicative District Heat and Power Distribution Networks

Addendum to the West Southall Masterplan Energy Strategy

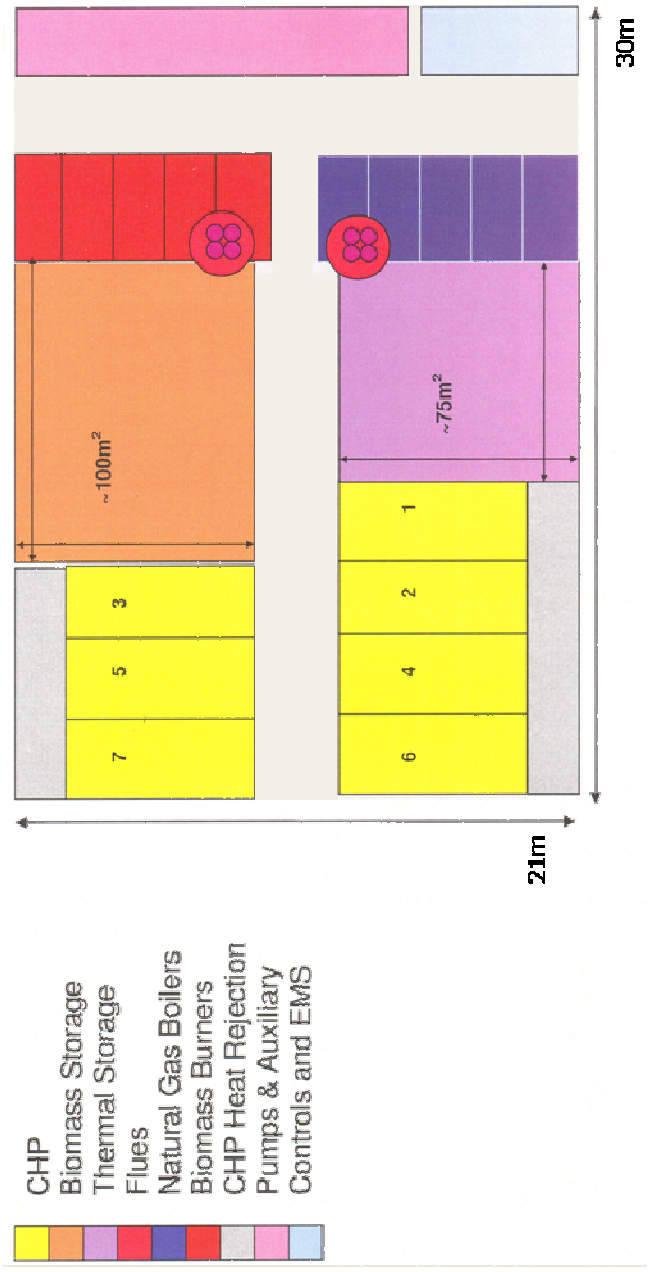
Appendix 3 – Contents



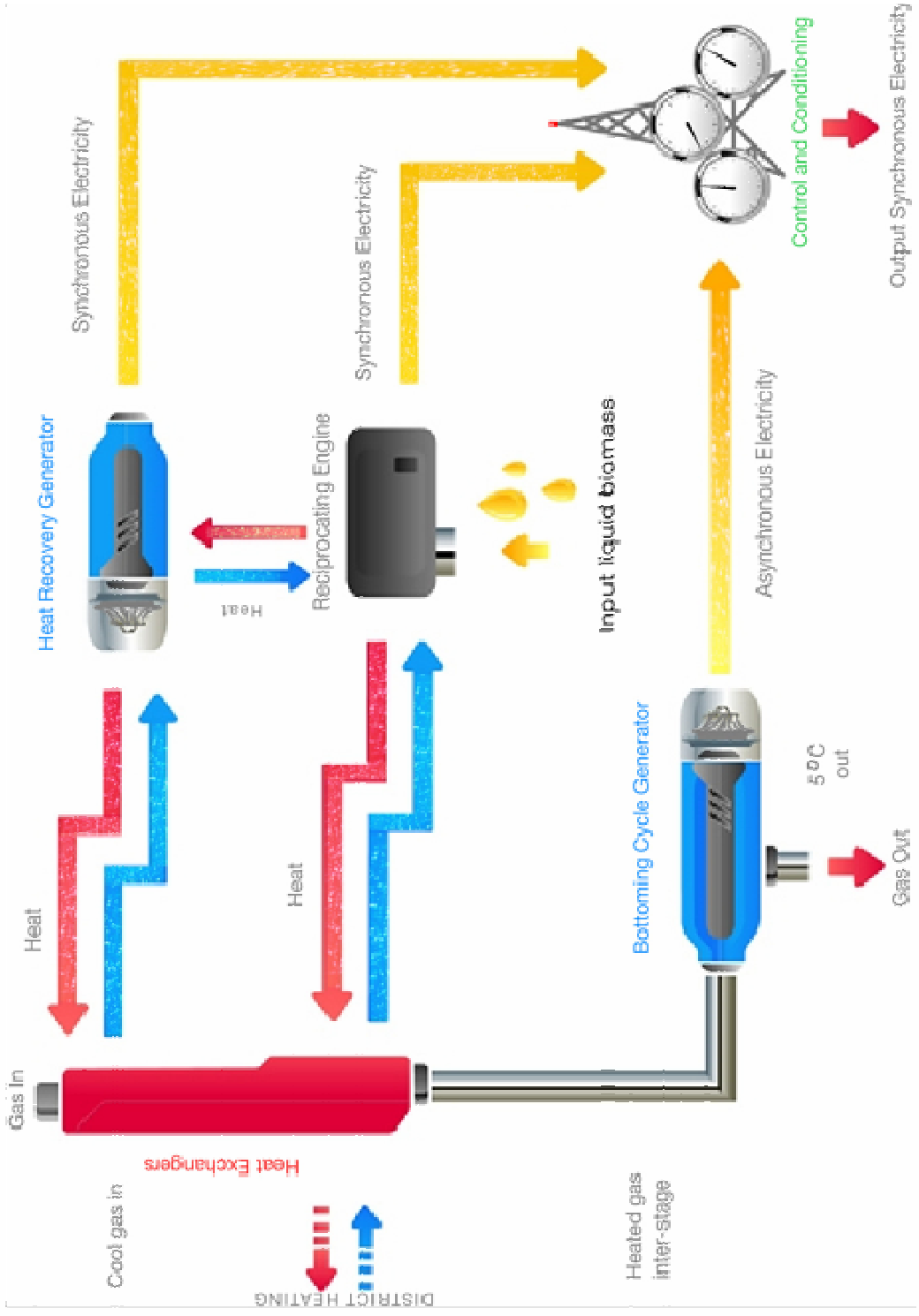
Indicative Power (High Voltage) Distribution Network



Indicative Heat Distribution Network



Primary Strategy 1 (On Site CHP Energy Centre with Biomass)



Primary Strategy 2 (Turbo Expanders/Combined Cycle System)