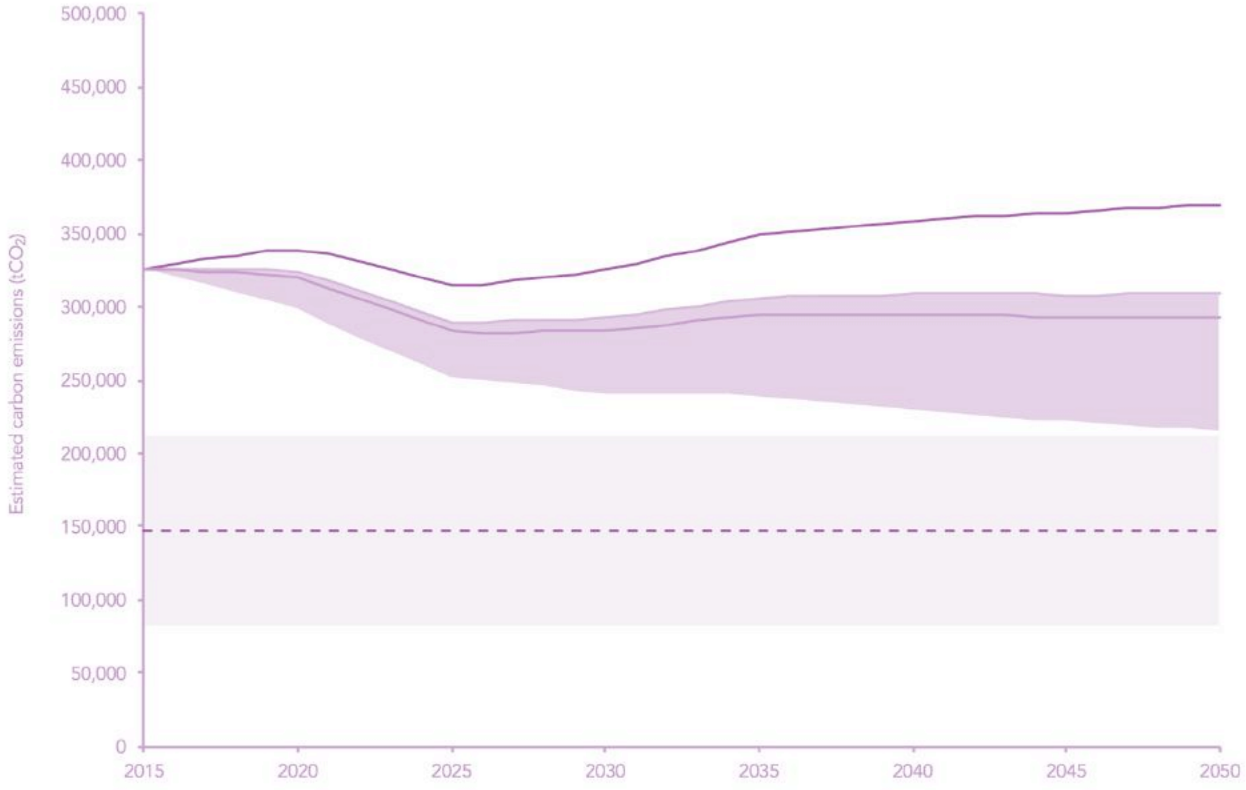
LONDON BOROUGH OF TOWER HAMLETS



LBTH CARBON POLICY EVIDENCE BASE

October 2016

A study carried out by Etude, on behalf of the London Borough of Tower Hamlets

1.0

EXECUTIVE SUMMARY

1.0 EXECUTIVE SUMMARY

EVIDENCE OF THE NEED FOR POLICY ES6 (CHAPTER 2.0)

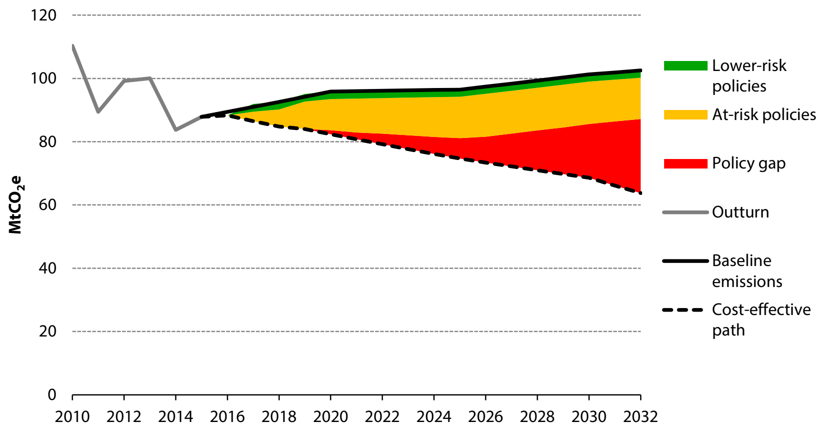
1. There is overwhelming scientific consensus that significant climate change is happening. It is leading to rising temperatures and sea levels, causing extreme weather, damaging ecosystems, reducing the productivity of crops and changing the natural environment. Public action is needed to substantially reduce greenhouse gas (GHG) emissions, which would not happen at sufficient scale without intervention as those who produce GHG emissions do not directly face the consequences of their actions, and do not necessarily take into account these consequences when taking decisions.

National policy

2. The UK's commitments are set in the context of global efforts to reduce GHG emissions in order to limit temperature rises to below 2°C or preferably 1.5°C.

3. The **Climate Change Act 2008** sets a carbon emission reduction target of 80% by 2050 compared with a 1990 baseline. The Act also establishes the supporting framework of carbon budgets. The Government has published on 30th June 2016 the fifth carbon budget. The budget level is equivalent to a 56.9% reduction on 1990 levels by 2030.

   However, the 2016 progress report to Parliament prepared by the Committee on Climate Change includes a conclusion that progress on buildings emissions continued to stagnate in 2015, putting at risk the reduction objectives.



Source: DECC (2015) *Updated emissions projections*; CCC analysis.
Notes: The cost-effective pathway includes the 3Mt of abatement from biomethane in buildings in 2030, in order to be consistent with DECC's assessment of policy impacts.

Figure 1.01 – Assessment of current and planned policies – all buildings (Source: DECC and Committee on Climate Change)

4. The **Planning and Compulsory Purchase Act** requires local planning authorities to include "*policies designed to secure that the development and use of land in the local planning authority's area contribute to the mitigation of, and adaptation to, climate change*".

Regional policy

5. The Mayor of London has set a target to reduce London's carbon dioxide emissions by 60% of their 1990 level by 2025. 80% of carbon emissions in London are associated with buildings.

6. Policy 5.2 (Minimising carbon dioxide emissions) requires carbon dioxide emissions reduction in buildings leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019. The current required improvement over Part L 2013 is 35% and the zero carbon requirement has started to apply to planning applications from October 2016.

London Borough of Tower Hamlets policy

7. Of the 33 Local Authorities in Greater London, Tower Hamlets produces the third highest level of total carbon emissions (1,703.5 ktCO_2) after the City of Westminster and the London Borough of Hillingdon.

8. The London Borough of Tower Hamlets is proposing to amend policy DM29 and replace it with policy ES6.

Policy ES6 - Achieving a zero carbon borough

All development will be required to meet the CO_2 emission reduction standards of:

Residential development

Year	Improvement over 2013 Building Regulations
2016 – 2031	Zero Carbon (Minimum 45% reduction on-site with the remaining regulated carbon dioxide emissions to 100% to be off-set through a cash in lieu contribution for carbon savings projects elsewhere in the borough, as outlined in the Planning Obligations SPD (2016))

Non-residential development

Year	Improvement over 2013 Building Regulations
2016 – 2019	45% CO_2 emissions reduction
2019 – 2031	Zero Carbon (Minimum 45% reduction on-site with the remaining regulated carbon dioxide emissions to 100% to be off-set through a cash in lieu contribution for carbon savings projects elsewhere in the borough, as outlined in the Planning Obligations SPD (2016))

9. Figure 1.02 on the adjacent page shows the projected reduction in residential CO_2 emissions over time for different energy efficiency standards for new buildings.

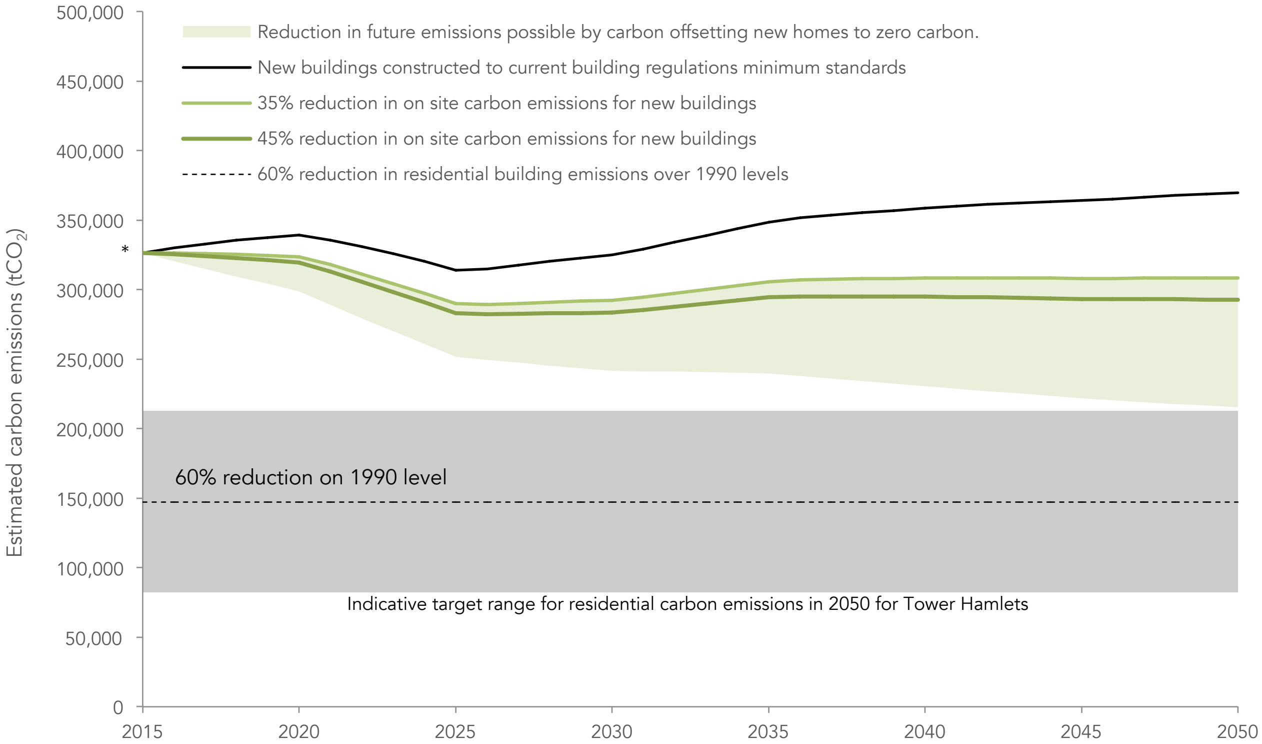


***Figure 1.02 - Projected CO_2 emissions from residential buildings in London Borough of Tower Hamlets taking into account projected changes to the carbon content of electricity 2015-2050*[*].**

10. Based on our review of available and projected data, the following observations have been made:

    - The number of households in Tower Hamlets is set to increase by 20% before 2025, and will nearly double before 2050 against a 2015 baseline.
    - The majority of existing dwellings will still exist in 2050 and could make up over half of the housing stock in Tower Hamlets. This is less than the commonly cited 80% of dwellings in 2050 already existing at a UK level due to locally higher rates of development.
    - A 45% on-site carbon reduction policy requirement contributes more effectively to the overall carbon target than a 35% carbon reduction policy requirement as more carbon reductions would be delivered by new buildings.
    - Even a 45% on-site carbon reduction policy requirement for new buildings only achieves a marginal carbon reduction over the next 35 years. Zero carbon new homes are required to deliver meaningful reductions in residential emissions.
    - It is highly likely that significant energy efficiency retrofit and heating system upgrades will be required in existing dwellings to meet the future emissions targets for Tower Hamlets. These could be partially funded by carbon offsetting funds from new buildings.

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[*] From DECC local authority data the actual carbon emissions from domestic properties in LBTH in 2014 was 291.1 $ktCO_2$. This is a marked decrease on previous years and outside the general rate of decline, it is also known that 2014 was a milder winter period. To avoid using an outlier as the baseline year a 3-year rolling average figure has been considered.

EVIDENCE OF FEASIBILITY OF POLICY ES6 (CHAPTER 3.0)

Literature review

11. Other evidence bases, policy impact assessments and research reports into CO_2 reductions and zero carbon buildings were reviewed. They indicated that:

    - A high level of on-site CO_2 reduction can be achieved through on-site and near-site measures. This level generally varies between a 19% improvement on Part L 2013 and a 56% improvement on Part L 2013 for most building types.
    - Carbon offsetting is a necessary mechanism to provide flexibility in terms of policy compliance for new buildings while contributing to fund CO_2 reductions in existing buildings.
    - The report *Greater London Authority Non-Domestic Carbon Dioxide Emissions Target: Feasibility and Viability Study, GLA, David Lock Associates, Hoare Lea, Gardiner & Theobald (2015)* commissioned by the GLA can be considered as a an evidence base to support a policy requiring a target of 45% improvement on Part L 2013 for new non-domestic developments.
    - As there is no available assessment of the feasibility of achieving a 45% improvement on Part L 2013 for new domestic development, energy modelling was required to constitute the evidence base required to support a policy requiring a target of 45% improvement on Part L 2013 and carbon offsetting to achieve 'Zero Carbon' for new domestic developments.

Analysis of a large sample of energy statements submitted to LBTH

12. Approximately 65 energy statements submitted to the London Borough of Tower Hamlets over the last 3 years were reviewed. Figure 1.03 on the adjacent page represents the level of on-site carbon reduction targeted in the energy statement. Planning applications are presented in chronological order.

13. It should be noted that current policy DM29 requiring a 45% improvement over Part L 2013 for all developments started to be applied from April 2014.

14. The last full year with monitoring data available (2014 – 2015) suggests that 100% of schemes submitted were policy compliant through a combination of on-site measure and offsetting. 45% of schemes achieved the policy requirements without the need for carbon offsetting. Comparable numbers are expected for 2015-2016.

15. 23 of the planning applications reviewed indicated that they will meet the 45% planning policy requirement with a carbon offset contribution. This shows the benefit of this approach as it provides a flexible mechanism to applicants in order to comply with Policy[1].

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[1] It should be noted that the information provided initially in the Energy Statements (e.g. overall carbon reduction) is often improved through the planning process. Although it is captured by the planning consent it is generally not captured in the final Energy Statement.

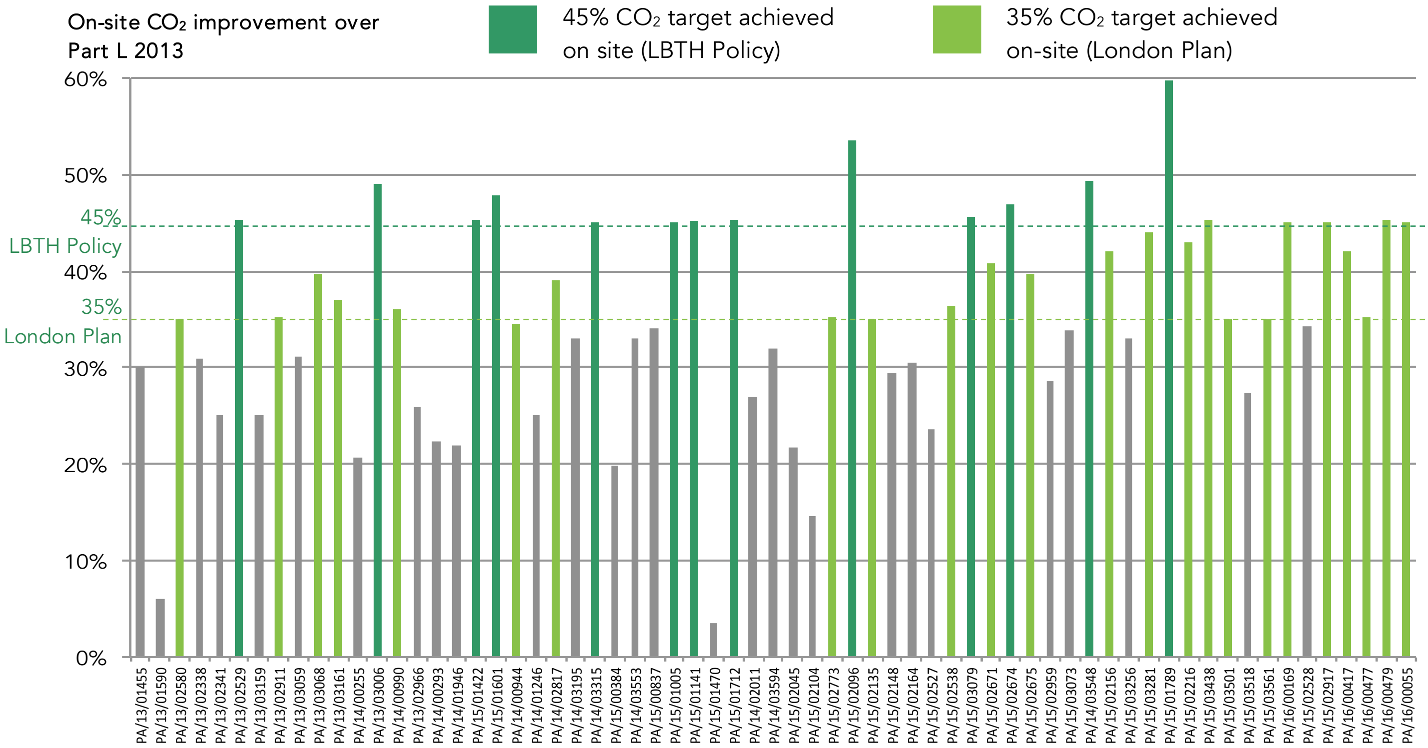


Figure 1.03 – On-site CO₂ reductions targeted in the 65 energy statements reviewed (ordered chronologically)

Focus on residential developments (CHAPTER 4.0)

16. Energy modelling was undertaken to constitute the evidence base to support a policy requiring a target of 45% improvement on Part L 2013 and carbon offsetting to achieve ‘Zero Carbon’ for new domestic developments.

17. Three different building types were considered: a medium-rise block of flats, a high-rise building and a small row of terraced houses. Typical dimensions and designs were assumed. This allowed a range of fabric specifications and engineering services to be tested. In order to simplify the understanding of the testing, three ‘packages’ of measures were tested: standard practice, good practice and best practice. In parallel, these cases were modelled against four different heating strategies (baseline, average, low carbon, very low carbon) and with and without roof-mounted PVs. This allows a practical assessment of whether achieving the carbon targets using different approaches is feasible.

18. The estimated improvement against Part L 2013 was calculated for each of the case studies and is given in Table 1.01 on the following page.

19. The following general conclusions can be drawn from this analysis.
    - Energy efficient specifications should be encouraged as they help to significantly reduce CO_2 emissions. Should only the ‘good practice’ and ‘best practice’ specifications be considered, the statistics would be as follows (out of 48 cases that were modelled):
        - **0** are not compliant with Part L 2013;
        - **12** are compliant with Part L 2013 but not with GLA and LBTH policies;

  - **6** are compliant with the GLA policy but not LBTH's;
  - **30** are compliant with GLA and LBTH policies.
- PVs help to significantly reduce CO$_2$ emissions, particularly on terraced houses and medium blocks of flats. A large roof coverage (rather than a minimum proportion of PVs) should be encouraged.
- Reducing the carbon content of heat supply is very important. Applicants should be encouraged to estimate the carbon content of heat supply proposed, now and in the future (e.g. 2030).

🟥 Not compliant with Part L 2013	🟧 0% < x < -35%	🟩 -35% < x < -45% (London Plan compliant)	■ -45% < x (LBTH Policy)

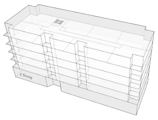
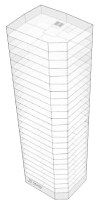
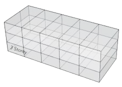
			Heating system – carbon content of heat			
Housing type	**Fabric performance**	**PV provision**	250 gCO$_2$/kWh	200 gCO$_2$/kWh	150 gCO$_2$/kWh	100 gCO$_2$/kWh
Medium rise flats 	Standard practice ★	No PV	5%	-12%	-29%	-46%
		PV	-65%	-82%	-99%	-116%
	Good practice ★★	No PV	-13%	-25%	-38%	-51%
		PV	-83%	-96%	-108%	-121%
	Best practice ★★★	No PV	-27%	-37%	-48%	-58%
		PV	-97%	-108%	-118%	-129%
High rise flats 	Standard practice ★	No PV	16%	-3%	-21%	-40%
		PV	0%	-19%	-37%	-56%
	Good practice ★★	No PV	-3%	-17%	-32%	-47%
		PV	-19%	-33%	-48%	-63%
	Best practice ★★★	No PV	-21%	-33%	-45%	-56%
		PV	-37%	-49%	-61%	-72%
Terrace housing 	Standard practice ★	No PV	7%	-10%	-28%	-45%
		PV	-126%	-143%	-160%	-178%
	Good practice ★★	No PV	-15%	-27%	-39%	-51%
		PV	-148%	-160%	-172%	-184%
	Best practice ★★★	No PV	-39%	-47%	-55%	-63%
		PV	-171%	-179%	-187%	-195%

Table 1.01 – Estimated Part L performance using different fabric and services specifications, PV areas and carbon contents of heat supply. The table demonstrates that significant CO$_2$ reductions over Part L 2013 are technically feasible through a combination of good/best practice specifications, low carbon heat and PVs. In some cases the level of performance achieved exceeds Zero Carbon.

COST ANALYSIS

20. The cost of achieving Zero Carbon is made up of two components:

    - the **building costs**, which include all building costs (walls, roofs, ventilation system, heating system, etc.) as well as the costs of any renewable energy system (PVs is used as a proxy for renewable energy in this study).
    - the **carbon offsetting** costs, which are based on a rate of £1,800 per tonne of residual CO_2.

21. The case of district heating is particular and the costs can be split between 'infrastructure costs' (e.g. district energy centre, primary distribution network) and building costs (e.g. heat substation, secondary network and heat interface units). Only the latter costs have been included in this study.

22. Three cost plans were prepared by *Gordon Hutchinson Chartered Quantity Surveyors*: a 'Medium Rise Flats' cost plan, a 'High Rise Flats' cost plan and a 'Terrace Housing' cost plan. These three cost plans were then adjusted to represent the 'standard', the 'good practice' and the 'best practice' specifications. These cost plans are all based on traditional heating solutions (central gas boilers for the medium rise flats and the high rise flats and individual gas boilers for the terraced houses) together with a wet heating system. Additional costs for lower carbon alternatives (e.g. connection to district heating, individual air source heat pumps, centralised ground source heat pump system, etc.) were estimated. The cost of optional PVs is also given.

23. Additional costs have been estimated against a 'reference cost' which is equivalent to the most economic combination to achieve Part L 2013 compliance (i.e. assuming that there is no other policy requirement to reduce CO_2 emissions – the 'no policy' black line on Figure 2.05). The cost estimates are all based on standard specifications, a traditional heating system and a small area of PVs:

    - for medium rise flats: the reference costs are estimated at £138,595/unit;
    - for high rise flats: the reference costs are estimated at £191,638/unit;
    - for terraced houses: the reference costs are estimated at £273,645/unit;.

Summary of additional costs above Part L 2013

24. The minimum costs of achieving Zero Carbon compared with the most economic combination to achieve compliance with Part L 2013 are likely to be:

    - £2,887 for medium rise flats (i.e. 2.1% of the reference costs);
    - £1,820 for high rise flats (i.e. 0.9% of the reference costs);
    - £4,713 for terraced houses (i.e 1.7% of the reference costs).

25. Seeking to achieve all or the maximum of carbon savings on-site is generally a more expensive strategy. For mid-rise flats and terraced houses this would represent achieving Zero Carbon on-site, hence why these costs are relatively high:

    - up to £12,618 for medium rise flats (i.e. up to 9.1% of the reference costs);
    - up to £ £12,058 for high rise flats (i.e. up to 6.3% of the reference costs);
    - up to £32,890 for terraced houses (i.e. up to 12.0% of the reference costs).

26. Generally, as can be expected, it shows that improved fabric specifications, better ventilation systems, lower carbon heating systems and PVs lead to additional costs. However, it should also be noted that the benefits of good quality design to reduce these costs are not factored in the analysis as it is purely based on a comparison of specifications.

27. Part L 2013 should however not be used as the standard against which additional costs are calculated. Instead, the GLA's requirement to achieve a 35% CO_2 reduction on-site and to offset the residual regulated CO_2 emissions should be used as the reference to assess the additional costs potentially incurred by the proposed LBTH carbon policy. The GLA policy has already been tested and found to be viable, therefore this report does not seek to assess the GLA policy but focuses instead on the difference between the GLA requirement and LBTH proposed policy: respectively '35% on-site CO_2 reduction + offsetting to Zero Carbon' and '45% on-site CO_2 reduction + offsetting to Zero Carbon'.

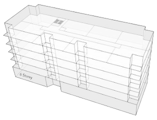
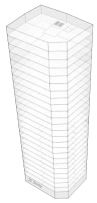
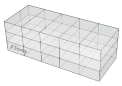
			Heating system – carbon content of heat			
Housing type	Fabric performance	PV provision	250 gCO_2/kWh	200 gCO_2/kWh	150 gCO_2/kWh	100 gCO_2/kWh
Medium rise flats 	Standard practice ★	No PV	5%	-12%	-29%	-46%
		PV	-45%	-45%	-45%	-46%
	Good practice ★★	No PV	-13%	-25%	-38%	-51%
		PV	-45%	-45%	-45%	-51%
	Best practice ★★★	No PV	-27%	-37%	-48%	-58%
		PV	-45%	-45%	-48%	-58%
High rise flats 	Standard practice ★	No PV	16%	-3%	-21%	-40%
		PV	0%	-19%	-37%	-45%
	Good practice ★★	No PV	-3%	-17%	-32%	-47%
		PV	-19%	-33%	-45%	-47%
	Best practice ★★★	No PV	-21%	-33%	-45%	-56%
		PV	-37%	-45%	-45%	-56%
Terrace housing 	Standard practice ★	No PV	7%	-10%	-28%	-45%
		PV	-45%	-45%	-45%	-45%
	Good practice ★★	No PV	-15%	-27%	-39%	-51%
		PV	-45%	-45%	-45%	-51%
	Best practice ★★★	No PV	-39%	-47%	-55%	-63%
		PV	-45%	-47%	-55%	-63%

Table 1.02 – Estimated on-site Part L performance using different fabric and services specifications, PV areas and carbon contents of heat supply – Combinations used for the cost comparison between the GLA and LBTH policies

28. As it can be seen from the above table Part L performance (when achieved by PVs) has therefore been capped at 45%.

29. The cells highlighted in **red** highlight the combinations which do not achieve Part L 2013 compliance from energy efficiency only and are therefore not policy compliant.

The cells highlighted in **orange** represent the combinations which do not achieve the 35% on-site CO$_2$ reduction required by the GLA. However, offsetting these CO$_2$ emissions can be deemed policy compliant.

The cells highlighted in **light green** represent the combinations which achieve the 35% on-site CO$_2$ reduction required by the GLA but do not achieve the 45% on-site CO$_2$ reduction required by LBTH.

The cells highlighted in **dark green** represent the combinations which achieve the 45% on-site CO$_2$ reduction required by LBTH and the cells highlighted in **darker green** the combinations which exceed the 45% on-site CO$_2$ reduction.

30. The proposed LBTH carbon policy only introduces additional costs for the combinations where on-site CO$_2$ performance from fabric efficiency and low carbon heat is higher than 35% but lower than 45%. In these cases, additional PVs are required to achieve the 45% on-site performance and they would not be required if the scheme was to comply with the GLA requirements only. On the other hand, this reduces the residual emissions and therefore less carbon offsetting is required. This cost difference is the one analysed in this study.

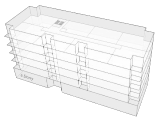
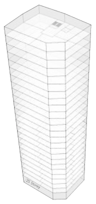
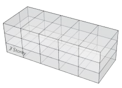
			Heating system – carbon content of heat			
			250 gCO$_2$/kWh	200 gCO$_2$/kWh	150 gCO$_2$/kWh	100 gCO$_2$/kWh
Housing type	Fabric performance	PV provision				
Medium rise flats 	Standard practice ★	No PV	🟥	£0	£0	-
		PV	£225	£225	£225	-
	Good practice ★★	No PV	£0	£0	£0	-
		PV	£225	£225	£151	-
	Best practice ★★★	No PV	£0	£0	-	-
		PV	£225	£171	-	-
High rise flats 	Standard practice ★	No PV	🟥	£0	£0	£0
		PV	£0	£0	£47	-
	Good practice ★★	No PV	£0	£0	£0	-
		PV	£0	£0	£219	-
	Best practice ★★★	No PV	£0	£0	£0	-
		PV	£53	£219	£7	-
Terrace housing 	Standard practice ★	No PV	🟥	£0	£0	£0
		PV	£493	£493	£493	£5
	Good practice ★★	No PV	£0	£0	£0	-
		PV	£493	£493	£287	-
	Best practice ★★★	No PV	£0	-	-	-
		PV	£312	-	-	-

Table 1.03 – Estimated additional costs of the proposed LBTH policy compared with the GLA requirements (per unit)

31. For the combinations which do not achieve the 35% CO_2 reduction required by the GLA, the additional costs of the proposed LBTH policy is £0 as the same degree of carbon offsetting to Zero Carbon would be required to comply with the GLA or LBTH carbon requirements.

32. The same applies to the combinations exceeding the 45% CO_2 reduction required by LBTH without PVs. These exemplar (and more expensive schemes) are encouraged by LBTH but these approaches are not mandatory, similarly to exemplar approaches encouraged but not required by the GLA's requirements.

33. The following additional costs of the proposed LBTH carbon policy compared with the GLA requirements have therefore been estimated to be comprised between:

- **£0 and £225/unit for medium rise flats;**
- **£0 and £219/unit for high rise flats;**
- **£0 and £493/unit for terraced houses.**

2.0

CLIMATE CHANGE AND THE NEED FOR ACTION

2.0 CLIMATE CHANGE AND THE NEED FOR ACTION

This section summarises the evidence demonstrating the need for the proposed policy for reducing CO_2 emissions from buildings. After a short explanation of the scientific and international consensus, it provides a summary of the policy context.

2.1 Climate change

There is overwhelming scientific consensus that significant climate change is happening. This is evidenced in the latest assessment of the Intergovernmental Panel on Climate Change (IPCC AR5). Climate change is leading to rising temperatures and sea levels, causing extreme weather, damaging ecosystems, reducing the productivity of crops and changing the natural environment. Many impacts are already being detected globally.

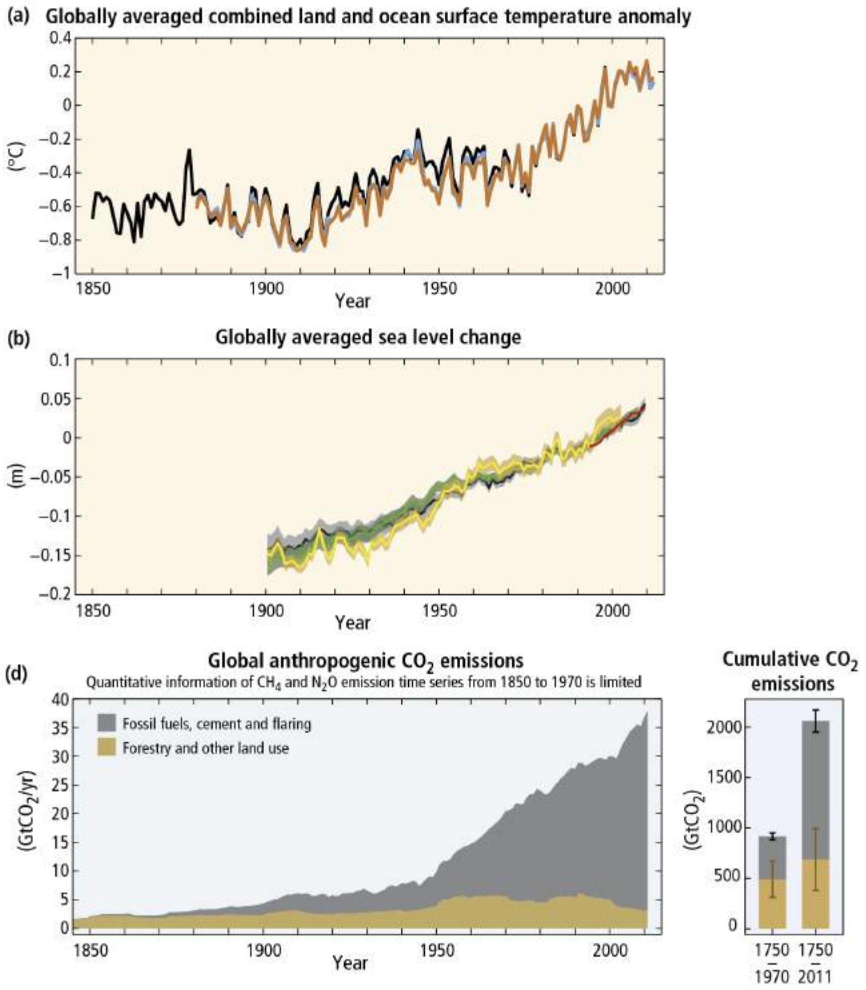


Figure 2.01 – Surface temperatures, sea level and anthropogenic CO_2 emissions (Source: IPCC AR5, 2014)

It is extremely likely that human activity is the predominant cause of climate change through emissions of greenhouse gases (GHG).

Public action is needed to substantially reduce GHGs, which would not happen at sufficient scale without intervention. Those who produce GHG emissions do not directly face the consequences of their actions, and do not necessarily take into account these consequences when taking decisions.

Climate change is also a global phenomenon in both its causes and consequences, and its impacts are persistent. It is considered by the Government as one of the most serious long-term risks to our economic and national security.

2.2 International context

The UK's commitments are set in the context of global efforts to reduce GHG emissions.

The Paris Agreement (2015)

International negotiations on climate change are governed through the United Nations Framework Convention on Climate Change (UNFCCC). The most recent negotiations concluded with the Paris Agreement in December 2015. This Agreement reaffirms global ambition to limit temperature rises to below 2°C and binds every country to the collective ambition which should guide national plans to reduce emissions. The Agreement also contains a further collective aspirational goal to reduce emissions in line with keeping the temperature increase to 1.5°C.

In total, 188 countries, including all of the G20, have now announced mitigation targets for the post-2020 period. Collectively they represent a significant reduction in emissions relative to the current emissions pathway. However, targets announced by countries in advance of the Paris Agreement collectively fell short of what is needed to meet the below 2°C objective. The Paris Agreement therefore created a mechanism of five-yearly cycles to look at and increase the level of global ambition. This should result in countries increasing the ambition of their targets.

The UK role in meeting the 2°C objective

The Paris Agreement committed countries to a collective global temperature target of 'well below 2°C' and obliges them to 'pursue efforts' to limit temperature rise to 1.5°C. Analysis suggests that the appropriate contribution from the UK to the global 2°C objective could be equivalent to a 58% to 62% reduction in emissions from 1990 levels by 2030.

EU directive (2010/31/EU)

Article 9 of the EU directive (2010/31/EU) requires member states to ensure that all new buildings are nearly zero energy buildings by 2020, and that public authority new buildings are nearly zero energy after 31st December 2018. Member states are required to have intermediate targets for improving the energy performance of new buildings to meet the 2020 timeframe. The status of this EU directive will be affected by the UK leaving the EU following the referendum in June 2016.

2.3 National policy context

2.3.1 Climate Change Act 2008

The aim of the Climate Change Act 2008 is to enable the UK to become a low carbon economy and reduce carbon emissions by 80% by 2050 compared with a 1990 baseline. This target was advised by the Committee on Climate Change (CCC) as an appropriate share of global action to limit global surface warming to around 2°C above pre-industrial levels by 2100. The Act also establishes the supporting framework of carbon budgets.

2.3.2 The Fifth Carbon Budget

As required by the Climate Change Act 2008 the Government has set the fifth carbon budget, a five-year cumulative limit on the level of the net UK carbon account over 2028-32, in order to meet the UK's 2050 target. In its advice for the fifth carbon budget level, the CCC reaffirmed the appropriateness of the UK's 80% target for a global 2° Celsius pathway.

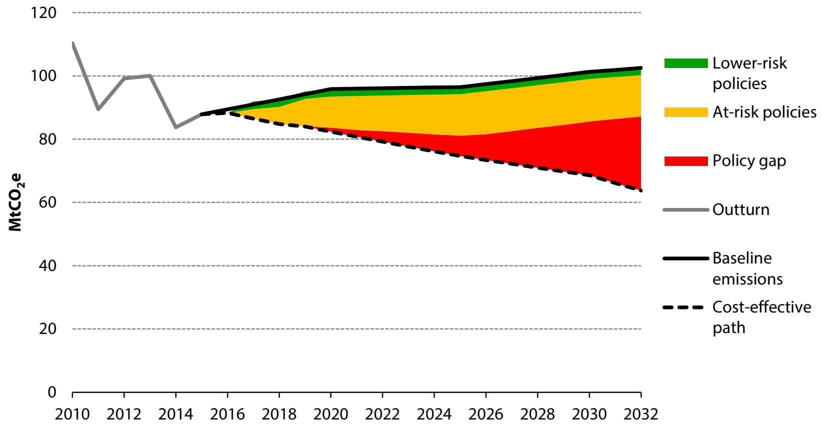
The fifth carbon budget has been published on 30th June 2016.

The budget level is 1,765 million tonnes of carbon dioxide equivalent ($MtCO_{2e}$). It is equivalent to a 56.9% reduction on 1990 levels by 2030.

2.3.3 Meeting carbon budgets – 2016 progress report to Parliament

This report, prepared by the Committee on Climate Change, was presented to Parliament pursuant to Section 36(1) of the Climate Change Act 2008. It reviews progress towards meeting the carbon budgets and the 2050 emission reduction target.

Its key findings for buildings include the conclusion that progress on buildings emissions continued to stagnate in 2015, putting at risk the reduction objectives.



Source: DECC (2015) *Updated emissions projections*; CCC analysis.
Notes: The cost-effective pathway includes the 3Mt of abatement from biomethane in buildings in 2030, in order to be consistent with DECC's assessment of policy impacts.

Figure 2.02 – Assessment of current and planned policies – all buildings (Source: DECC and Committee on Climate Change)

The table below, also extracted from *Chapter 3 – Buildings* of the Committee on Climate Change latest report provides a more detailed assessment of which policies currently form the policy gap or are at risk.

Abatement option	**2015 policy**	**Change in 2015/16**	**2016 policy**
Building-scale low-carbon heat in existing buildings to 2021	● Amber RHI	RHI funding committed to 2020/21 at reduced level and consultation	● Amber
Building-scale low-carbon heat in existing buildings from 2021	● Red No policy	No change	● Red
Building-scale low-carbon heat in new buildings	● Amber Zero Carbon Homes	Regulations cancelled	● Red
Residential energy efficiency, able-to-pay	● Red Green Deal	Green Deal cancelled mid-2015	● Red
Residential energy efficiency, low income	● Amber ECO	Decreased funding and targets from 2017	● Amber
Non-residential energy efficiency	● Amber CRC/CCL, ESOS	Simplification of CRC/CCL and reporting requirements consultation	● Amber
Heat networks	● Amber Feasibility studies	£320m capital funding announced	● Amber
Hydrogen	● Red No policy	Small-scale feasibility studies	● Amber Need for strategy

Notes: Key - Red: Policy gap; Amber: Policy at risk; Green: Effective policy in place.

Table 2.01 – Assessment of policies to drive abatement options in the building sector (Source: Committee on Climate Change)

Among the policy requirements identified by the Committee on Climate Change in order to deliver the carbon budgets, the following is relevant to new buildings:

Standards to ensure new-build properties are highly energy efficient and use low-carbon heating systems by default. On energy efficiency these should result in new buildings having low energy consumption without leading to overheating.

2.3.4 Planning and Compulsory Purchase Act

The Planning and Compulsory Purchase Act requires local planning authorities to:

1. Include "*policies designed to secure that the development and use of land in the local planning authority's area contribute to the mitigation of, and adaptation to, climate change" - Section 19 (1A) of the Planning and Compulsory Purchase Act 2004 (Inserted by 2008 Planning Act*).
2. Deliver sustainable development through the planning system:

   "39 – Sustainable development
   This section applies to any person or body which exercises any function— (a) under Part 1 in relation to a regional spatial strategy; (b) under Part 2 in relation to local development documents; (c) under Part 6 in relation to the Wales Spatial Plan or a local development plan. (2) The person or body must exercise the function with the objective of contributing to the achievement of sustainable development". (P&CP Act 2004)

2.3.5 Planning and Energy Act 2008

The Planning and Energy Act (2008) states the following

"1. Energy policies

(1) A local planning authority in England may in their development plan documents, and a local planning authority in Wales may in their local development plan, include policies imposing reasonable requirements for:

(a) a proportion of energy used in development in their area to be energy from renewable sources in the locality of the development;

(b) a proportion of energy used in development in their area to be low carbon energy from sources in the locality of the development;

(c) development in their area to comply with energy efficiency standards that exceed the energy requirements of building regulations."

The potential evolution of the Planning and Energy Act 2008 is discussed in Appendix A.

2.4 Greater London context

2.4.1 Current CO_2 emissions

The Mayor has set a target to reduce London's carbon dioxide emissions by 60% of their 1990 level by 2025.

80% of carbon emissions are associated with London's buildings.

The most recent measurement of London's CO_2 emissions is the LEGGI 2013. It shows that in 2013 London's CO_2 emissions were 40.19 $MtCO_2$. The 1990 level was 45.1 $MtCO_2$.

CO_2 emissions per capita are approximately 4.11 tCO_2/capita/yr.

2.4.2 Carbon reduction targets

London Plan

The London Plan is the overall strategic plan for London, setting out an integrated economic, environmental, transport and social framework for the development of London over the next 20–25 years. It includes a number of policies in relation to climate change. The most relevant to this study are policies 5.1 and 5.2.

Policy 5.1 Climate change mitigation

Strategic: *the Mayor seeks to achieve an overall reduction in London's carbon dioxide emissions of 60 per cent (below 1990 levels) by 2025. It is expected that the GLA Group, London boroughs and other organisations will contribute to meeting this strategic reduction target, and the GLA will monitor progress towards its achievement annually.*

LDF preparation: *within LDFs boroughs should develop detailed policies and proposals that promote and are consistent with the achievement of the Mayor's strategic carbon dioxide emissions reduction target for London.*

Policy 5.2 Minimising carbon dioxide emissions

Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:
1. Be lean: use less energy
2. Be clean: supply energy efficiently
3. Be green: use renewable energy

The Mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.

Residential buildings:

Year	*Improvement on 2010[2] Building Regulations*
2010-2013	*25% CO_2 emissions reduction*
2013-2016	*40% CO_2 emissions reduction*
2016-2031	*Zero Carbon*

Non-residential buildings:

Year	*Improvement on 2010[1] Building Regulations*
2010-2013	*25% CO_2 emissions reduction*
2013-2016	*40% CO_2 emissions reduction*
2016-2019	*As per building regulations*
2019-2031	*Zero Carbon*

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[2] The targets in the London Plan are expressed against Part L 2010:
- a 25% reduction on Part L 2010 is deemed equivalent to a 19% reduction on Part L 2013
- a 40% reduction on Part L 2010 is deemed equivalent to a 35% reduction on Part L 2013

Evolution of the London Plan

The new London Plan is currently being prepared and it is expected to be published in 2017.

Energy guidance on preparing energy assessments (2016)

The purpose of an energy assessment is to demonstrate that climate change mitigation measures comply with energy related planning policies. This guidance note sets out how to prepare an energy assessment.

Residential developments

The energy guidance provides additional clarification regarding the requirement for new residential developments to comply with the 'zero carbon' target set in London Plan Policy 5.2B. This target was to align with the then expected introduction of 'zero carbon homes' through Part L of the Building Regulations. However, the Government announced in July 2015 that it '*does not intend to proceed with the zero carbon allowable solutions carbon offsetting scheme, or the proposed 2016 increase in on-site energy efficiency standards, but will keep energy efficiency standards under review*'.

The GLA have advised in this energy guidance that the London Plan policy seeking 'zero carbon homes' remains in place. It indicates that:

"Zero carbon was tested through the needs and viability assessment for the original alteration and the assessment indicated that the standards would not compromise housing viability."

According to the GLA's definition, 'zero carbon' homes are homes forming part of major development applications where the residential element of the application achieves at least a 35% reduction in regulated carbon dioxide emissions (beyond Part L 2013) on-site. The remaining regulated carbon dioxide emissions, to 100%, are to be off-set through a cash in lieu contribution to the relevant borough that is ring fenced to secure delivery of carbon dioxide savings elsewhere (in line with policy 5.2).

The GLA guidance also confirms that the 'zero carbon' target will be implemented for Stage 1 schemes received by the Mayor on or after the 1st October 2016.

As far as carbon offsetting is concerned, the Mayor's Housing Standard's Viability Assessment assumed a carbon off-set price of £60 per tonne of carbon dioxide for a period of 30 years. The guidance states that:

"Where the borough applies a carbon dioxide off-set price of £60 per tonne, it is not considered necessary for boroughs to carry out a further viability assessment of the policy approach."

Non-residential development

The energy guidance confirms that the London Plan policy setting out the Building Regulations target for non-residential development (35% reduction against Part L 2013) remains in place. However, it highlights that a needs assessment and feasibility and viability study tested a 50% CO_2 reduction target for non-domestic development (beyond Part L 2013) and showed that for a number of non-residential development types a 50% carbon reduction target (beyond Part L 2013) would be technically feasible. The study also found that for most locations a 50% target would be financially viable.

2.5 The London Borough of Tower Hamlets

2.5.1 Current CO_2 emissions

Of the 33 Local Authorities in Greater London, Tower Hamlets produces the third highest level of total carbon emissions (1,703.5 $ktCO_2$) after the City of Westminster and the London Borough of Hillingdon.

Data from DECC suggests that per capita CO_2 emissions is reducing but is still high at approximately 5.99 tonnes CO_2/capita/yr. This can be compared to a national average of approximately 5.35 tonnes CO_2/capita/yr and a Greater London average of approximately 4.11 tonnes CO_2/capita/yr.

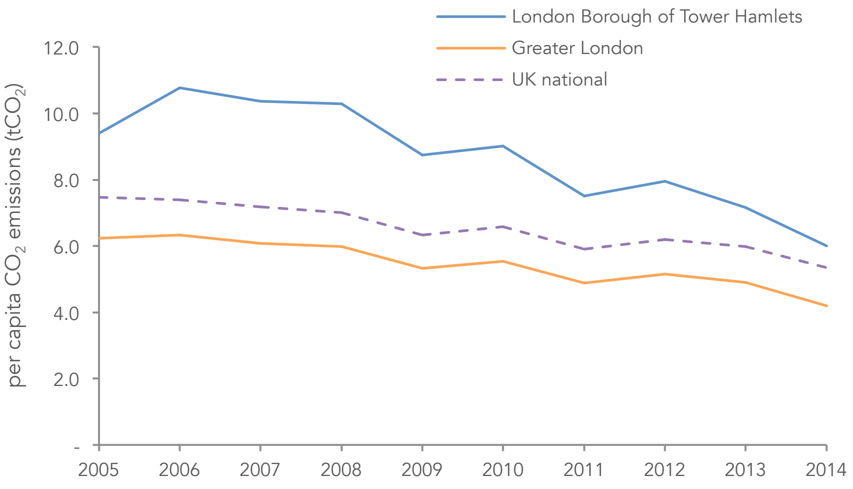

Figure 2.03 – Measure of per capita CO_2 emissions at local authority level for the industrial, domestic and transport sectors (Source: DECC)

2.5.2 Carbon reduction targets

LBTH Core Strategy

The Core Strategy is the key spatial planning document for Tower Hamlets, setting out the spatial vision for the borough and how it will be achieved. It is one of the key tools to realise the vision of the Community Plan. The Core Strategy was formally adopted by the Council in September 2010 and includes the following policies.

SO3 - Achieving wider sustainability

Tower Hamlets will achieve environmental, social and economic development simultaneously; the improvement of one will not be to the detriment of another. Where trade-offs between competing objectives are unavoidable, these will be transparent and minimised. This will be realised by […] mitigating and adapting the *built environment to climate change by limiting carbon emissions from development, delivering decentralised and renewable or low carbon energy and minimising vulnerability to a changeable climate.*

SO24 - Working towards a zero-carbon borough

Achieve a zero carbon borough in the 21st century, with a 60% reduction in carbon emissions by 2025.

SP11 - Working towards a zero-carbon borough

1. *Implement a borough-wide carbon emission reduction target of 60% below 1990 levels by 2025.*
2. *Ensure that all new homes are built in-line with government guidance to reach zero carbon by 2016, and that all new non-domestic development reaches zero-carbon by 2019.*

LBTH Managing Development Document (2013)

In addition to policies SO23, SO24 and SP11, LBTH Managing Development Document Policy DM29 sets out carbon reduction as well as sustainable design and construction requirements within the borough as follows.

DM29 - Achieving a zero carbon borough and addressing climate change

Development will be required to be accompanied by an Energy Assessment to demonstrate its compliance with the following:

Residential development

Year	*Improvement on 2010[3] Building Regulations*
2011-2013	*35% CO_2 emissions reduction*
2013-2016	*50% CO_2 emissions reduction*
2016-2031	*Zero Carbon*

Non-residential development

Year	*Improvement on 2010[2] Building Regulations*
2011-2013	*35% CO_2 emissions reduction*
2013-2016	*50% CO_2 emissions reduction*
2016-2019	*As per building regulations*
2019-2031	*Zero Carbon*

2. Development will be required to connect to or demonstrate a potential connection to a decentralised energy system unless it can be demonstrated that this is not feasible or viable.

3. The sustainable retrofitting of existing development with provisions for the reduction of carbon emissions will be supported.

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[3] The DM29 targets are expressed against Part L 2010.
- a 35% reduction on Part L 2010 is deemed equivalent to a 30% reduction on Part L 2013
- a 50% reduction on Part L 2010 is deemed equivalent to a 45% reduction on Part L 2013

4. Sustainable design assessment tools will be used to ensure climate change mitigation measures are maximised within development.

The London Borough of Tower Hamlets is proposing to amend policy DM29 and replace it with the following policy.

Policy ES6 - Achieving a zero carbon borough

All development will be required to meet the CO_2 emission reduction standards of:

Residential development

Year	Improvement over 2013 Building Regulations
2016 – 2031	Zero Carbon (Minimum 45% reduction on-site with the remaining regulated carbon dioxide emissions to 100% to be off-set through a cash in lieu contribution for carbon savings projects elsewhere in the borough, as outlined in the Planning Obligations SPD (2016))

Non-residential development

Year	Improvement over 2013 Building Regulations
2016 – 2019	45% CO_2 emissions reduction
2019 – 2031	Zero Carbon (Minimum 45% reduction on-site with the remaining regulated carbon dioxide emissions to 100% to be off-set through a cash in lieu contribution for carbon savings projects elsewhere in the borough, as outlined in the Planning Obligations SPD (2016))

2.5.3 Why is this policy needed? The LBTH Carbon path

Increase of housing supply

The Greater London Authority has set a total housing build target for London and individual targets required to meet this for each borough. For the London Borough of Tower Hamlets this target is equivalent to a 20% increase in the number of households by 2025.

The annual increase in number of households in the borough by 2050 has been estimated using the DCLG household projections 2014-2039. Dates up to 2050 have been extrapolated from this profile. The total numbers have been compared against other sources for projected starts on site, population growth, as well as historic housing density data in order to give a realistic representation of growth.

The number of households has been used as an indicator for the number of occupied dwellings. Empty properties and second homes are therefore not counted, which should provide a more realistic picture when predicting energy consumption. When referred to in this report 'dwellings' are taken to mean occupied dwellings.

The number of existing occupied dwellings that are demolished and replaced as part of new building development is not known, however it has been estimated as 10% of the starts on site. This is taken as a conservative estimate, with any increase in the rate of replacement likely to have a positive impact on operational carbon emissions from buildings.

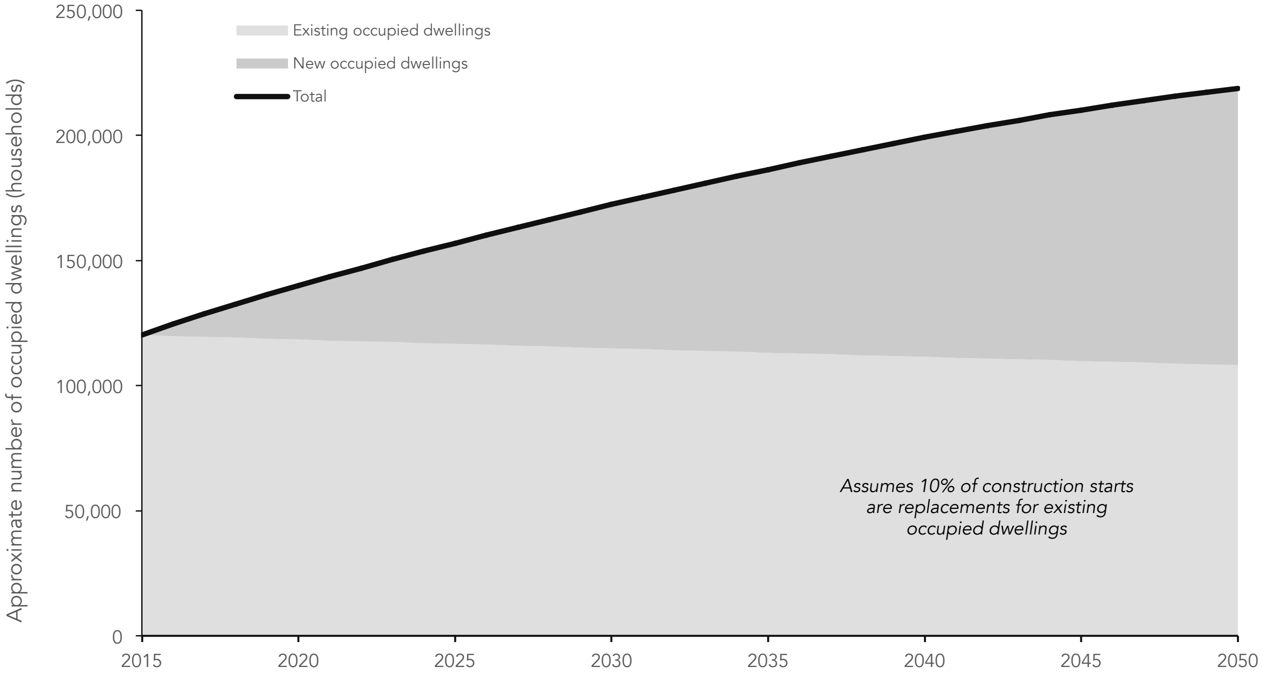

Figure 2.04 - Projected growth in the number of dwellings in Tower Hamlets 2015-2050

CO_2 emission projections in the London Borough of Tower Hamlets

Modelling from the GLA and DECC shows that reductions in new build residential building energy consumption need to contribute over 5% of the total CO_2 reductions to meet the Mayor's 2025 targets[4]. The major opportunities for delivering this are energy efficiency, and reducing the carbon content of heat and electricity[5].

To show how the carbon targets for new builds can contribute to this reduction the carbon emissions due to residential buildings in Tower Hamlets have been estimated. There is significant uncertainty in this projection; however, it demonstrates a relatively conservative case and allows relative comparison between approaches.

DECC reporting of actual CO_2 emissions from domestic buildings in LBTH have been used to estimate the average electricity and heating energy consumption per household. This accounts for different usage patterns and energy performance between dwellings, and ensures that all dwellings emissions are included.

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[4] Climate Change Mitigation and Energy Strategy Model Data – Mayor of London 2011.

[5] It has been assumed that energy efficiency and low carbon heat are both on-site or near-site decisions whereas low carbon electricity is related mainly to off-site decisions (e.g. national and regional electricity infrastructure). Notable exceptions are the on-site / near-site generation of electricity by PVs and heating systems using electricity (e.g. heat pumps).

Estimates for the reduction in energy consumption for new buildings and the likely rate and scale of housing replacement have then been used to predict the CO_2 emissions from residential buildings up to 2050.

Figure 2.05 shows the projected reduction in residential CO_2 emissions over time for different energy efficiency standards for new buildings.

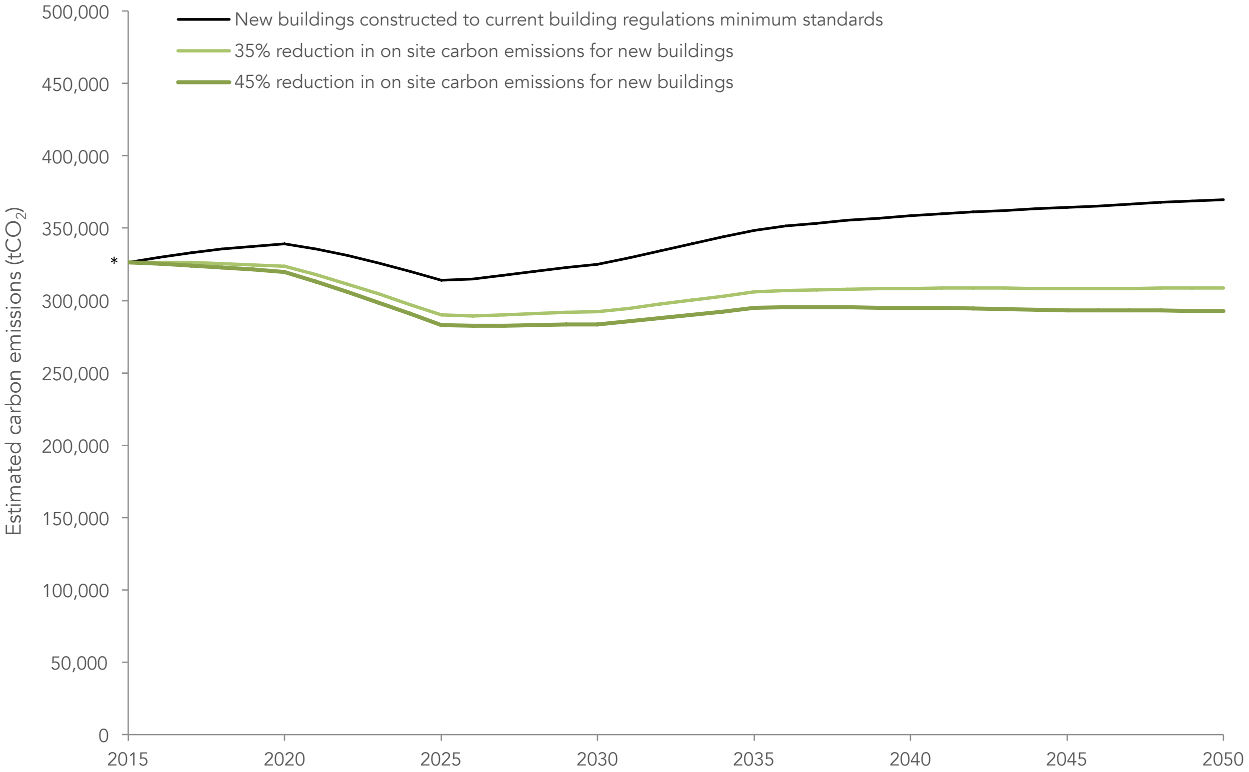

Figure 2.05 - Projected CO_2 emissions from residential buildings in the London Borough of Tower Hamlets taking into account projected changes to the carbon content of electricity 2015-2050* and showing the effect of different carbon reduction targets for new buildings.

The estimated projected emissions show that:

- If new residential buildings are constructed to the current minimum standards set in the building regulations their share of carbon emissions in Tower Hamlets will increase over time. The increase in emissions from rising household numbers is balanced somewhat by the reduction in carbon content of the electricity grid.
- A 35% reduction over the current minimum standards in the building regulations is the minimum required to prevent further increase in carbon

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* From DECC local authority data the actual carbon emissions from domestic properties in LBTH in 2014 was 291.1ktCO_2. This is a marked decrease on previous years and outside the general rate of decline, it is also known that 2014 was a milder winter period. To avoid using an outlier as the baseline year a three year rolling average figure has been taken as a conservative start point.

emissions due to the increasing number of households and occupied dwellings.

- A 35% to 45% on-site carbon reduction target for new build gives an initial reduction as the grid decarbonises, followed by a slight rebound and levelling off as the number of households increases and the carbon content of the grid stabilises.
- A 45% on-site carbon reduction policy requirement contributes more effectively to the overall carbon target than a 35% carbon reduction policy requirement.

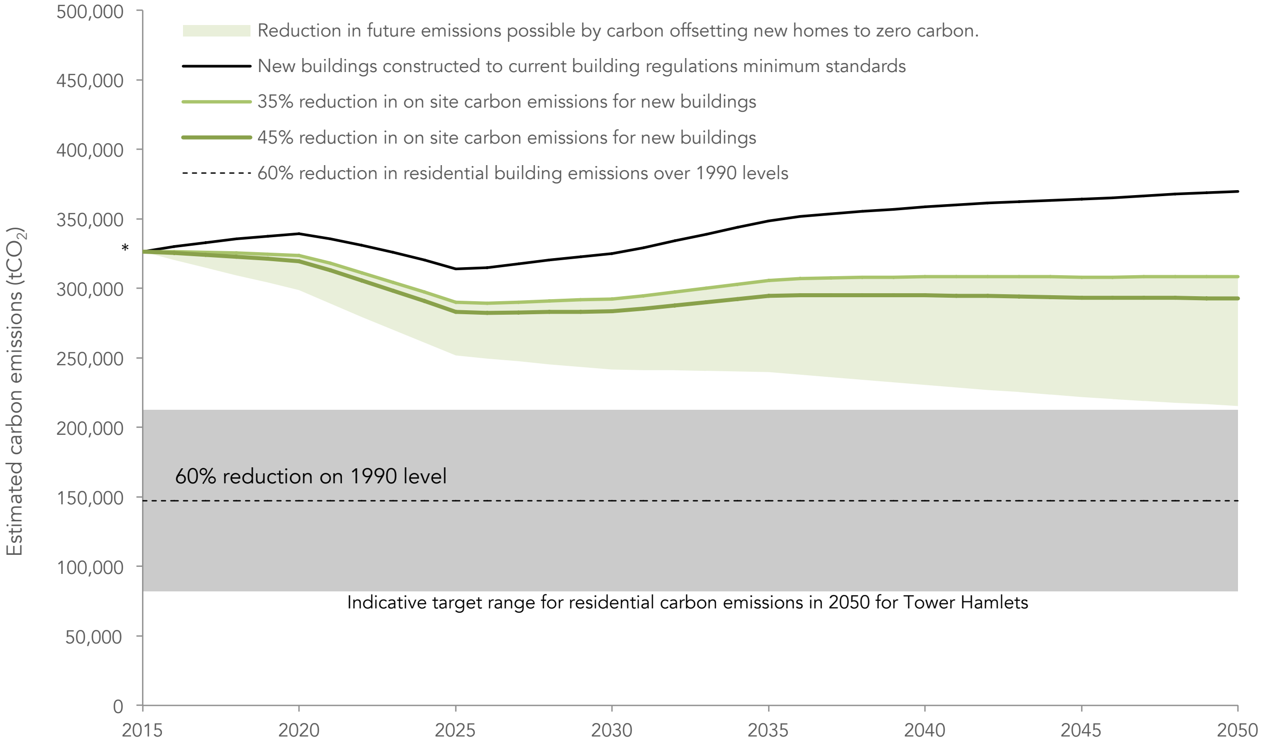

Figure 2.06 - Projected CO_2 emissions from residential buildings in the London Borough of Tower Hamlets taking into account projected changes to the carbon content of electricity 2015-2050*, showing the effect of zero carbon targets for new buildings through carbon offsetting and comparing this to the total carbon targets for residential buildings in LBTH.

The zero carbon estimated projected emissions show that:

- Using carbon offsetting to achieve zero carbon on new homes gives a clear reduction in residential emissions.
- Reductions from new buildings alone cannot meet the 2050 target range, even in the zero carbon scenario. Extensive domestic energy efficiency refurbishment will also be required.

For most carbon emission saving measures the most cost effective time to implement them in buildings is during the initial construction. Given this the

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[*] See previous footnote

maximum carbon savings viable should be targeted on site in order to reduce the future cost of upgrading the existing building stock.

Identifying a target for residential carbon emissions in LBTH

To put the reduction in carbon emissions from residential buildings in LBTH into perspective a target range of emissions for domestic buildings in the borough in 2050 has been included in figure 2.06. Very little information on the contribution to emissions reductions required from each sector is available, however, an attempt at estimating this was considered valuable to put LBTH policy decisions into context with UK wide targets.

The target range has been arrived at through two different analyses. Firstly, using the most recent numbers on required carbon reductions from the Committee on Climate Change 5th Carbon budget. From the Sectoral Scenarios (*Fifth carbon budget, November 2015 – Committee on Climate Change)* a reduction in total direct building emissions over 2014 values of 21-95% by 2050 is projected. Applying this % reduction to the total 2014 dwelling carbon emissions in Tower Hamlets gives a very approximate indication of the sorts of savings that may be required. The 50th percentile of this range is plotted as the more likely range of scenarios.

Secondly, the carbon emissions in 1990 for London are estimated at 45,100 $ktCO_2$, applying the current LBTH share of emissions (4.8%) and the estimated share of emissions for residential buildings (17%) gives a baseline 1990 emissions figure of 368 $ktCO_2$. LBTH have set a target reduction of 60% for carbon emissions from residential buildings which gives 147 $ktCO_2$.

There are a number of limitations with this approach, however significant further work would be required to give a better estimate that is outside the scope of this report.

2.6 Conclusion

The London Borough of Tower Hamlets is proposing a revised carbon policy in order to contribute to the UK's and Greater London's efforts to mitigate climate change. The evidence summarised in Section 2.0 helps to demonstrate that these policies are required and that efforts to reduce CO_2 emissions from new and existing buildings need to be pursued.

From the estimate of the LBTH carbon path the following observations can be made:

1. The number of households in Tower Hamlets is set to increase by 20% before 2025, and will nearly double before 2050 against a 2015 baseline.
2. The majority of existing dwellings will still exist in 2050 and could make up over half of the housing stock in Tower Hamlets. This is less than the commonly cited 80% of dwellings in 2050 already existing at a UK level due to locally higher rates of population increase.
3. A 45% on-site carbon reduction policy requirement contributes more effectively to the overall carbon target than a 35% carbon reduction policy requirement.

4. Even a 45% on-site carbon reduction policy requirement for new builds only achieves a small carbon reduction over the next 35 years. Net zero carbon new homes are required to give meaningful reductions in residential emissions.
5. It is highly likely that significant energy efficiency retrofit and heating system upgrades will be required in existing dwellings to meet the future emissions targets for Tower Hamlets. These could be partially funded by carbon offsetting funds from new buildings. The LBTH Carbon Offsetting Solutions Study identifies significant potential for retrofit projects within the borough (for more details, please refer to the Carbon Offsetting Solutions Study 2016).

3.0

REVIEW OF AVAILABLE EVIDENCE

3.0 REVIEW OF AVAILABLE EVIDENCE

The purpose of this section is to summarise existing evidence which would contribute to supporting the new LBTH carbon policy. It is split up into two sections:

- Section 3.1 summarises the review of other evidence bases, policy impact assessments and research reports into CO_2 reductions and Zero carbon buildings;
- Section 3.2 provides a summary of the review of approximately 65 energy statements submitted to the London Borough of Tower Hamlets in the last three years. These 65 energy statements constitute a representative sample of the planning applications being submitted to LBTH.

3.1 Existing evidence

A short summary of the main conclusion(s) of each document and of its relevance to this evidence base is given below. For clarity, the documents are presented in chronological order.

Definition of Zero Carbon Homes and Non-Domestic Buildings, **Consultation**, CLG (2008)

This consultation document is based on the original and more ambitious definition of Zero Carbon which included unregulated energy uses and required Zero Carbon to be achieved on-site. One of its conclusions is that a 100% reduction in regulated emissions appeared to be at the top end of what was realistic and that it involved a significant cost premium.

It suggests two alternative on-site reduction targets:

- A 44% reduction on Part L 2006 (deemed equivalent to a 19% reduction on Part L 2013), which it considers technically robust. However, the report suggests that the level of residual carbon emissions would be significant.
- A 70% reduction on Part L 2006 (deemed equivalent to a 56% reduction on Part L 2013). The report indicates that there are less technological and cost issues with this target than with the 100% on-site target but it also acknowledges that there are a number of technologies which get close to, but do not quite reach this level of CO_2 reduction.

The analysis suggests that an on-site CO_2 reduction comprised between 44% and 70% on Part L 2006 (deemed equivalent to between 19% and 56% on Part L 2013) would be appropriate and that carbon offsetting would be a cost effective way to offset the residual carbon emissions.

Promoting Zero Carbon Development, Core Strategy PPS1A Evidence Base, Islington Council, Fulcrum Consulting (2009)

This analysis investigates the level of carbon emissions likely to be technically feasible in Islington, based on energy modelling on 8 types of developments (e.g. high density mixed-use development, new residential infill development). It also investigates the possibility of setting up a carbon offset fund in order to support the delivery of the Council's zero carbon policy and investigates the impact on viability.

The carbon reductions investigated relate to **total** carbon emissions (regulated and unregulated). Regulated CO_2 emissions relate to Part L 2006. Although it is difficult to provide a direct equivalence, with a conservative assumptions that unregulated CO_2 emissions represent only a third of total CO_2 emissions, the 35-50% total reduction on CO_2 emissions referred to in the report can be considered to be equivalent to 32-64% on Part L 2013.

This report was used as the evidence base for Islington Council's policy and concludes that:

- the CO_2 reduction targets should be adopted for major schemes based on the financial viability information provided in the report;
- the average extra cost per unit is estimated to be £7,500 which is considered relatively minor compared to land costs and costs of construction;
- a carbon reduction fund should be implemented.

This evidence base can also support the approach to carbon reduction encouraged by LBTH policy. It should also be noted that considerable design, product, technological and cost efficiency advancements have occurred over the last 6 years.

Promoting Zero Carbon Development Phase 2, Islington Council, AECOM, David Langdon (2010)

This report, which also constitutes an evidence base for Islington Council Core Strategy Zero Carbon policy, focuses on minor schemes. It considers seven typical planning applications (e.g. 7 flats) and investigates the technical feasibility and financial viability of several building fabric and services options.

The report conclusions include the following:

- for minor new build domestic developments: an on-site 25% CO_2 reduction on Part L 2010 (deemed equivalent to a 19% CO_2 reduction on Part L 2013) and carbon offsetting for all residual CO_2 emissions (regulated and unregulated) would not have an adverse impact on viability.
- for minor mixed-use developments: the Council should adopt a case by case approach during the planning process.

Carbon Compliance – Setting an appropriate limit for Zero Carbon New Homes, Zero Carbon Hub (2011)

This report considers a range of dwelling and development types and technologies. It reviews options for achieving an on-site reduction in regulated CO_2 emissions of between 44% and 100% on Part L 2006 (deemed equivalent to a 19% and a 100% reduction on Part L 2013 respectively). In total about 14,000 combinations of dwelling type, fabric standard, mix of technologies and carbon limits were modelled.

The report was prepared over five months and led by an expert Task Group which, together with associated working groups, comprised some 100 people from 50 different organisations. Members were drawn from the house building and supply industries, related professional bodies, trade associations, consumer representatives and bodies with a specific interest in environmental objectives.

The report shows that end-terrace houses and mid-terrace houses can achieve a level of performance comprised between 44% and 70% on Part L 2006 (deemed equivalent to a 19% and a 56% reduction on Part L 2013 respectively), with better specifications and more PVs required for the higher levels of performance.

The report shows that a 4-storey block of flats can generally achieve a level of performance comprised between 44% and 70% on Part L 2006 (deemed equivalent to a 19% and a 56% reduction on Part L 2013 respectively) although a higher PV coverage is required and individual heating solutions are less able to achieve the higher levels than shared energy solutions.

This study has informed the energy modelling strategy carried out specifically to support the LBTH carbon policy.

Cost analysis: Meeting the Zero Carbon Standard, Zero Carbon Hub, Sweett (2014)

This report is a summary of the cost assessment undertaken in order to understand the scale of additional costs associated with achieving the Zero Carbon Standard for homes (i.e. zero regulated CO_2 emissions). It is based on the methodology proposed by the Zero Carbon Hub: Fabric Energy Efficiency Standard (FEES), Carbon Compliance and Allowable Solutions (i.e. carbon offsetting).

It concludes that there has been a continuing reduction in the cost of meeting the Zero Carbon Standard, with particular reductions seen in the cost estimate for solar PVs, airtightness and thermal bridging components.

In summary, the following additional costs of building to the proposed Zero Carbon standard compared to Part L 2013 are considered to be reasonable:

- £2,200-£2,400 for a typical 56m^2 apartment in a low-rise block;
- £3,700-£4,700 for a typical 76m^2 end-terraced or mid-terraced house.

The report also highlights that costs are likely to reduce further in the future.

Greater London Authority Housing Standards Review: Viability Assessment, GLA, David Lock Associates, Hoare Lea, Gardiner & Theobald (2015)

This viability study was commissioned by the GLA to determine the impact of the new national housing standards within London Plan policy on the viability of development in London. It also investigated the impact of requiring new homes to be Zero Carbon from 2016.

One of the key conclusions is that based on the viability modelling summarised in the report:

"The cumulative impact of the optional step free access requirement and the move to Zero Carbon homes on the deliverability and viability of housing development in London affects the viability of fewer than 5% of the test outcomes, which is insufficient to be considered a challenge to the overall viability of housing delivery across London."

Greater London Authority Non-Domestic Carbon Dioxide Emissions Target: Feasibility and Viability Study, GLA, David Lock Associates, Hoare Lea, Gardiner & Theobald (2015)

This study was commissioned by the GLA to determine the potential impact of increasing the regulated carbon reduction policy from a 35% CO_2 reduction on Part L 2013 to a 50% CO_2 reduction on Part L 2013 for non-domestic developments.

Part L 2013 modelling was undertaken to estimate the CO_2 emission reductions achievable for seven building types, selected to represent a range of referable, new non-domestic development types in London. Due to the wide variety of development in London, the selection of seven tested building types is seen as reasonable by the authors who consider that these should be viewed as case studies supporting the overall viability appraisal.

For each building type, a 'baseline' scheme was defined to represent a design that would meet the current London Plan target of a 35% CO_2 reduction on Part L 2013, through a combination of on-site measures (fabric, services, and low carbon technologies) and carbon offset measures.

Technical improvements were then applied to each of these baseline schemes to assess their potential for further on-site carbon dioxide emission reductions under Part L 2013, excluding connection to wider networks but including on-site low carbon technology where deemed appropriate (e.g. CHP, PVs). The improvements tested were informed by the background research and consultation. The potential for additional savings from heat networks was also assessed, after all on-site improvement measures had been applied. The report concludes that:

"Overall, in certain circumstances it is expected that the proposed 50% target will be technically achievable through maximised on-site savings and connection to low carbon heat networks. In other cases it is expected that, after savings from on-site measures are maximised and connection made to low carbon heat networks where available, a certain level of carbon offset contribution will be required for most building types to meet the proposed 50% target."

The viability of increasing the CO_2 target was then tested, using two scenarios: maximised on-site CO_2 emissions reductions and offset payments for the required remaining carbon savings or all additional CO_2 emissions reductions over the baseline scheme achieved through offset payments. Extracts of the two key recommendations of the report are reproduced below:

*"**Recommendation 1 – Proposed target:** a target of 50% improvement on Part L 2013 is considered viable, provided that flexibility is retained on how it is met, on a case by case basis. "*

*"**Recommendation 2 – Approach to achieving CO_2 reductions:** due to the variety of development in London (both in building types and locations), it is recommended that the CO_2 target continues to be approached as an overall combination of on-site savings, contribution from low-carbon heat networks, and carbon dioxide offsets (after savings from on-site measures and district energy have been maximised)."*

It should be noted that the first recommendation was not taken forward by the GLA in the revisions to the London Plan.

3.2 Review of energy assessments

65 energy statements submitted in support of planning applications to the London Borough of Tower Hamlets in the last three years were reviewed as part of this study. These 65 energy statements constitute a representative sample of the planning applications being submitted to LBTH. The two main objectives of the review were:

- to investigate the scale of on-site CO_2 reduction considered achievable in each Energy Statement[6];
- to determine which planning applications had offered to contribute to the LBTH carbon offset fund to meet the requirements of DM29 (i.e. 45% reduction on Part L 2013).

On-site CO_2 reductions

The figure below represents the level of carbon reduction targeted in the energy statement. Planning applications are presented in chronological order.

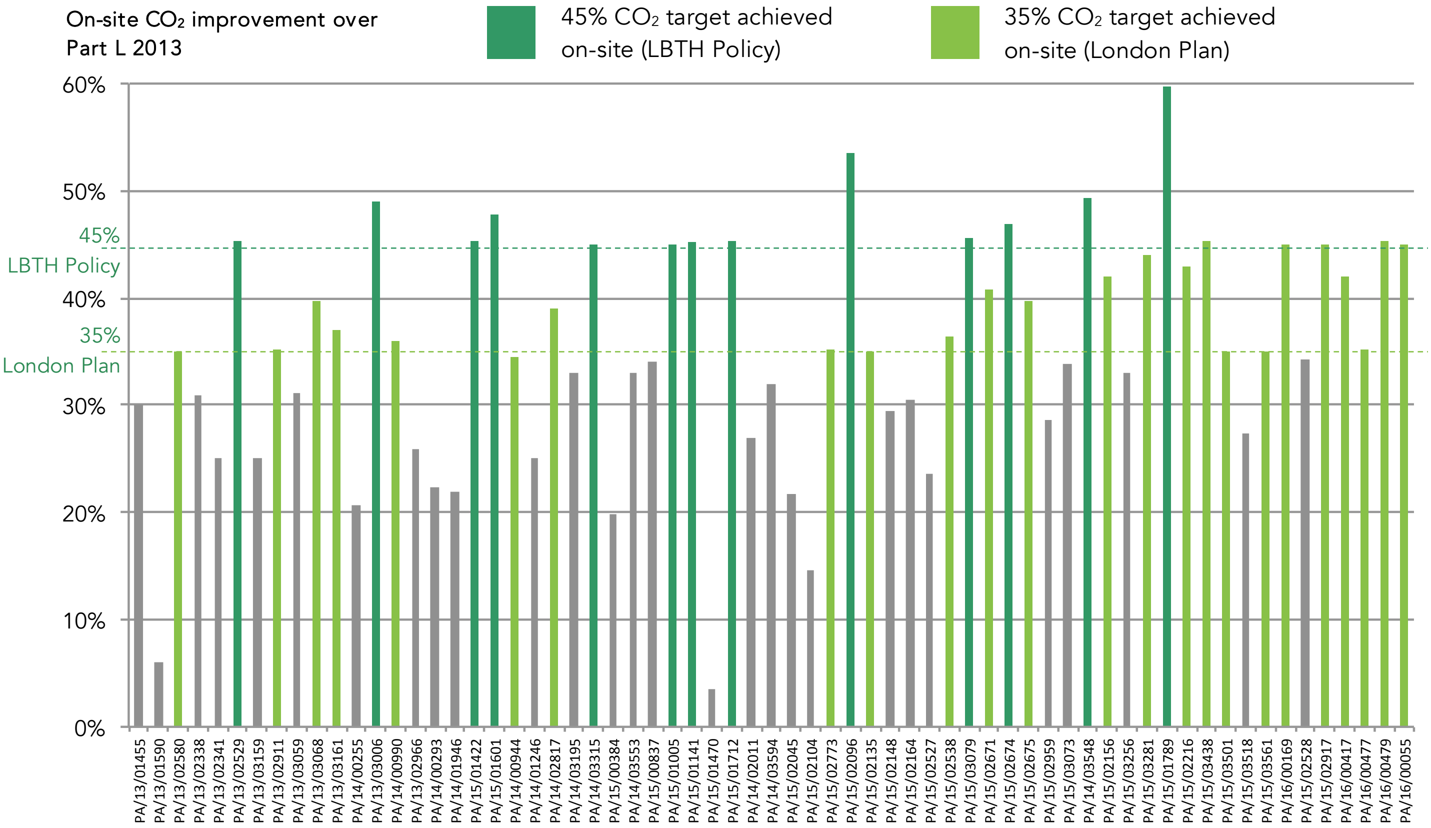

Figure 3.01 – On-site CO_2 reductions targeted in the 65 energy statements reviewed (ordered chronologically)

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[6] It should be noted that carbon reductions in 20 energy statements out of the total of 65 were expressed against Part L 2010. As it is impossible to translate these levels of performance against Part L 2013 without access to the energy calculations, a notional 5 percentage points was applied to the performance against Part L 2010, e.g. a 40% improvement over Part L 2010 was deemed equivalent to a performance of 35% improvement over Part L 2013.

23 of these planning applications indicated that they will meet the 45% planning policy requirement with a carbon offset contribution. This shows the benefit of this approach as it provides a flexible mechanism to applicants in order to comply with Policy[7].

Moreover, it should de noted that DM29 started to be applied from April 2014. Therefore the applications submitted before then did not have to comply with DM29.

The last full year with monitoring data available (2014 – 2015) suggests that 100% of schemes submitted were policy compliant through a combination of on-site measure and offsetting. 45% of schemes achieved the policy requirements without the need for carbon offsetting. Comparable numbers are expected for 2015-2016.

3.3 Conclusion

Existing evidence demonstrates that:

1. A high level of on-site CO_2 reduction can be achieved through on-site and near-site measures. This level generally varies between a 19% improvement on Part L 2013 and a 56% improvement on Part L 2013 for most building types.
2. A large number of planning applications submitted demonstrates that achieving the 45% CO_2 reduction target (either entirely through on-site measures or with a carbon offsetting contribution) does not affect viability.
3. Carbon offsetting is a necessary mechanism to provide flexibility in terms of policy compliance for new buildings while contributing to fund CO_2 reductions in existing buildings.
4. The report *Greater London Authority Non-Domestic Carbon Dioxide Emissions Target: Feasibility and Viability Study, GLA, David Lock Associates, Hoare Lea, Gardiner & Theobald (2015)* commissioned by the GLA can be considered as a an evidence base to support a policy requiring a target of 45% improvement on Part L 2013 for new non-domestic developments.
5. Further energy modelling is required to constitute the evidence base required to support a policy requiring a target of 45% improvement on Part L 2013 and carbon offsetting to achieve 'Zero Carbon' for new domestic developments (please refer to Section 4.0).

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[7] It should be noted that the information provided initially in the Energy Statements (e.g. overall carbon reduction) is often improved through the planning process. Although it is captured by the planning consent it is generally not captured in the final Energy Statement.

4.0

FOCUS ON RESIDENTIAL DEVELOPMENTS

4.0 FOCUS ON RESIDENTIAL DEVELOPMENTS

As indicated in the conclusion of Section 3.0, further energy modelling wa required to constitute the evidence base to support a policy requiring a target of 45% improvement on Part L 2013 and carbon offsetting to achieve 'Zero Carbon' for new domestic developments. Energy modelling was therefore undertaken using the SAP methodology and is summarised in this section.

4.1 Approach to energy modelling

The majority of residential dwellings in Tower Hamlets are apartments. They represent 80% of the current stock. This is increasing with the number of apartments growing by 36% between the 2001 and 2011 census compared to only a 10% rise in house numbers. According to the LBTH Housing Evidence Base (2013), this proportion of apartments is considerably higher than both London and the UK as a whole. 39% of existing residential dwellings are two bedroom properties, with 27% and 22% being one and three bedroom respectively. There is a recognised shortage of accommodation with three or more bedrooms in the borough and this is encouraged in new developments. In terms of energy performance, the variety of new dwellings in Tower Hamlets is very large in terms of:

- **Building type** (high-rise, medium-rise, low-rise, end/mid terrace);
- **Typology** (e.g. 1B / 2B / 3B / 4B apartment or house);
- **Dimensions** (e.g. floor area, floor-to-ceiling height);
- **Design** (e.g. envelope area to floor area ratio, window proportions);
- **Fabric specifications** (e.g. window U-value, airtightness);
- **Engineering services** (e.g. ventilation system, heating system).

In order to capture the majority of cases, three different building types were considered: a medium-rise block of flats, a high-rise building and a small row of terraced houses. Typical dimensions and designs were assumed. This allowed a range of fabric specifications and engineering services to be tested. In order to simplify the understanding of the testing, three 'packages' of measures were tested: standard practice, good practice and best practice. In parallel, these cases were modelled against four different heating strategies (baseline, average, low carbon, very low carbon) and with and without roof-mounted PVs. This allows a practical assessment of whether achieving the carbon targets using different approaches is feasible.

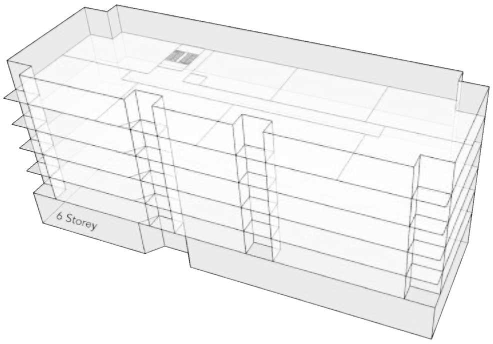
Once combined, these cases are considered to provide a fair representation of the scale of performance likely to be achieved by new applicants, although it is important to bear in mind that these calculations do not cover all cases. In total 690 individual dwelling calculations were underaken. Finally, it should be noted that the number of approaches modelled also allows an assessment of how different balances between building fabric improvements and Low and Zero carbon technologies (LZC) can achieve the carbon targets, and how much additional carbon offset contribution would be required to achieve Zero Carbon, based on the residual regulated CO_2 emissions in each case. A cost comparison between the cases has also been carried out.

4.2 Types of dwellings assessed

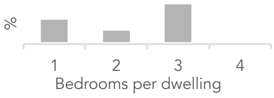
4.2.1 Case study development types

Three development types have been used as case studies and have been modelled using the SAP methodology. A high proportion of flatted accommodation has been included, with a bias towards more dense development which reflects current trends in Tower Hamlets.

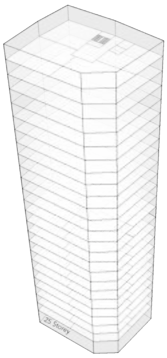
Medium rise flats



Accommodation type (no. of dwellings)	Flats (48)
Gross floor area (Net residential)	3,960m^2 (3,125m^2)
Building footprint area (w x d)	750m^2 (16.5m x 45.6m)
No. of storeys	6
Floor to floor height (ceiling height)	3m (2.5m)
Glazed fraction of wall[8] by external area (internal area)	36% (45%)
Breakdown of accommodation	Examples of construction: *Concrete frame with masonry infill and rainscreen cladding; Cavity wall masonry; Insulated timber structural frame on concrete slab.*

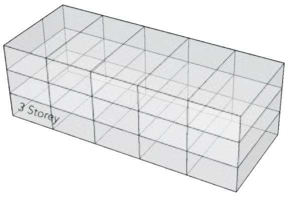


High rise flats



Accommodation type (no. of dwellings)	Flats (96)
Gross floor area (Net residential)	8,000m^2 (6,000m^2)
Building footprint area (w x d)	380m^2 (17.5m x 21.6m)
No. of storeys	25 (ground floor commercial)
Floor to floor height (ceiling height)	3.2m (2.5m)
Glazed fraction of wall by external area (internal area)	47% (51%)
Breakdown of accommodation	Examples of construction: Concrete or steel structural frame with curtain walling; Concrete structural frame with masonry infill and rainscreen cladding.

Terrace housing



Accommodation type (no. of dwellings)	Houses (5)
Gross floor area (Net residential)	840m^2 (780m^2)
Building footprint area (w x d)	306m^2 (10.7m x 28.6m)
No. of storeys	3
Floor to floor height (ceiling height)	3m (2.6m)
Glazed fraction of wall by external area (internal area)	30% (32%)
Breakdown of accommodation	Examples of construction: Insulated timber structural frame with cavity brick façade; Full fill cavity wall masonry.

Figure 4.01 – Case study development types

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[8] Defined as the proportion of the external elevation that is glass or a glazing system.

4.2.2 Building fabric and services performance

General building industry information as well as our own experience of fabric and services specifications was used to establish the performance parameters representing ‘standard practice’, ‘good practice’ and ‘best practice’.

These values were also verified against the range of fabric and energy efficiency performance targets assumed in the energy statements reviewed.

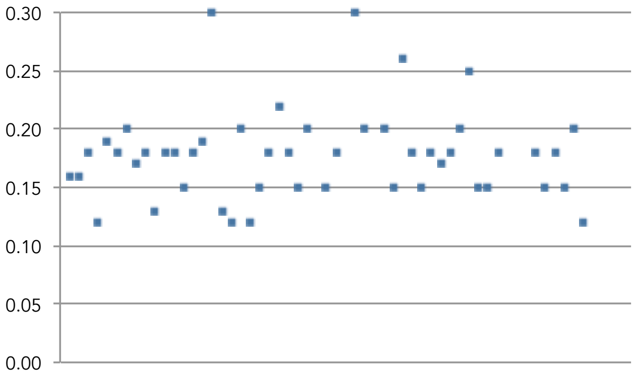


Figure 4.02 – Range of ***External Wall*** *U-values in energy assessments reviewed (W/m².K)*

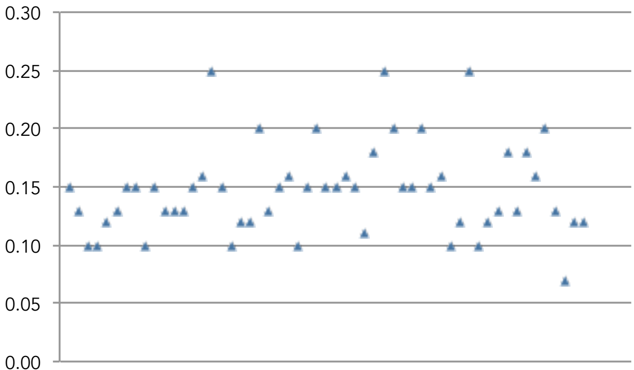


Figure 4.03 – Range of ***Floor*** *U-values in energy assessments reviewed (W/m².K)*

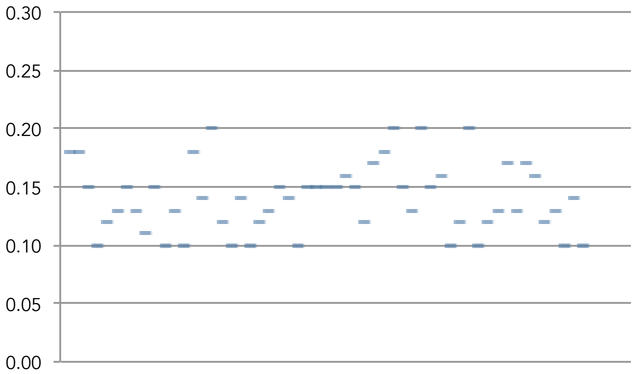


Figure 4.04 – Range of ***Roof*** *U-values in energy assessments reviewed (W/m².K)*

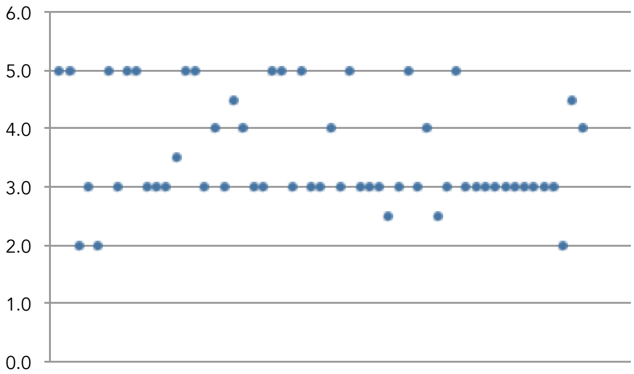


Figure 4.05 – Range of ***air permeability rates*** *targeted in energy assessments reviewed (m³/h/m² at 50Pa)*

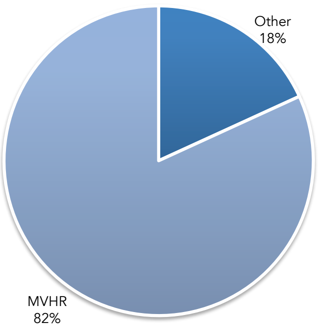


Figure 4.06 – Proportion of developments with ***MVHR*** *(among energy assessments reviewed)*

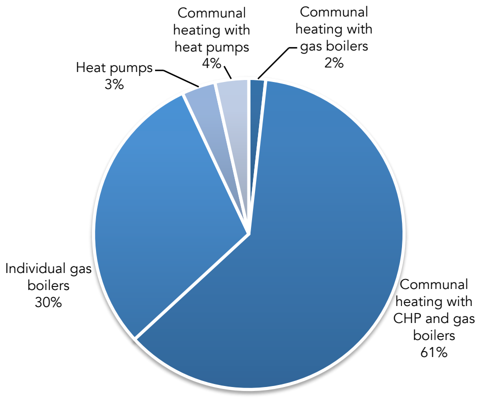


Figure 4.07 – ***Heating systems*** *among energy assessments reviewed)*

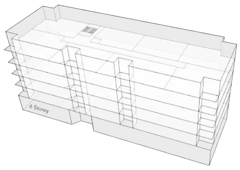
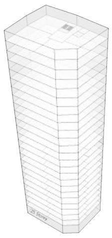
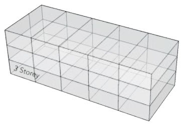
House type	Element	Performance		
		Standard ★	Good practice ★★	Best practice ★★★
Medium rise flats 	Average floor U-value	0.11 W/m^{2}K	0.10 W/m^{2}K	0.08 W/m^{2}K
	Average wall U-value	0.18 W/m^{2}K	0.13 W/m^{2}K	0.10 W/m^{2}K
	Average roof U-value	0.15 W/m^{2}K	0.12 W/m^{2}K	0.10 W/m^{2}K
	Average window U-value	1.40 W/m^{2}K	1.20 W/m^{2}K	0.90 W/m^{2}K
	Thermal bridge y-value[9]	ACD	ACD	BPD
	Ventilation	Continuous mechanical extract (MEV) (System 2)[10]	Good quality MVHR with efficiency >90% (System 4)	Designed MVHR system with efficiency >90% (System 4)
	Effective system heat recovery efficiency (SFP)	0% (0.4 W/l/s)	90% (0.6 W/l/s)	90% (0.4 W/l/s)
	Air tightness	<5m^3/m^{2}h	<3m^3/m^{2}h	<1m^3/m^{2}h
High rise flats 	Average floor U-value	0.20 W/m^{2}K	0.18 W/m^{2}K	0.15 W/m^{2}K
	Average façade U-value	1.4 W/m^{2}K	1.1 W/m^{2}K	0.8 W/m^{2}K [11]
	Average roof U-value	0.18 W/m^{2}K	0.15 W/m^{2}K	0.10 W/m^{2}K
	Average window U-value	*Included in façade U-value*		
	Thermal bridge y-value	*Included in façade U-value*		
	Ventilation	Good quality MVHR with efficiency >90% (System 4)	Good quality MVHR with efficiency >90% (System 4)	Designed MVHR system with efficiency >90% (System 4)
	Heat recovery efficiency (SFP)	90% (0.6 W/l/s)	90% (0.6 W/l/s)	90% (0.4 W/l/s)
	Air tightness	<3m^3/m^{2}h	<2m^3/m^{2}h	<1m^3/m^{2}h
Terrace housing 	Average floor U-value	0.15 W/m^{2}K	0.11 W/m^{2}K	0.08 W/m^{2}K
	Average wall U-value	0.16 W/m^{2}K	0.13 W/m^{2}K	0.10 W/m^{2}K
	Average roof U-value	0.15 W/m^{2}K	0.12 W/m^{2}K	0.10 W/m^{2}K
	Average window U-value	1.40 W/m^{2}K	1.20 W/m^{2}K	0.80 W/m^{2}K
	External door U-value	1.60 W/m^{2}K	1.60 W/m^{2}K	1.20 W/m^{2}K
	Thermal bridge y-value	0.10 W/m^{2}K	0.08 W/m^{2}K	0.04 W/m^{2}K
	Ventilation	Continuous mechanical extract (MEV) (System 2)	Good quality MVHR with efficiency >90% (System 4)	Designed MVHR system with efficiency >90% (System 4)
	Heat recovery efficiency (SFP)	0% (0.4 W/l/s)	90% (0.6 W/l/s)	90% (0.4 W/l/s)
	Air tightness	<5m^3/m^{2}h	<3m^3/m^{2}h	<1m^3/m^{2}h

Figure 4.08 – Case study development types

Each case study development type has been assessed with the above ranges of specifications. They have been grouped in three categories: 'Standard', 'Good

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[9] ACD = Accredited Construction Details; BPD = Best Practice calculated thermal bridging

[10] System numbers are as defined in the Building Regulations Approved Document Part F 2010.

[11] Average façade U-values in this range are unlikely to be possible with curtain walling systems. This assumes a rainscreen cladding system or similar is used.

practice' and 'Best practice'. It should be noted that the 'Standard' category is meant to represent the type of specifications expected on developments with no particular focus on energy efficiency, whereas the 'Good practice' and 'Best practice' categories are meant to represent two grades of energy efficient specifications. In addition to the variable assumptions for each development type a number of common factors have been used. These are summarised in the table below.

Element	**Performance**
Glass solar transmittance (g-value)	0.50
Energy efficient lighting	100%

Table 4.01 – Other 'fixed' performance factors

4.2.3 Heating system

The vast majority of new buildings in Tower Hamlets are either connected to the gas network, a district heating network, or use electricity to provide space heating and hot water. The following heating systems have been considered in this study.

Heating systems	**Description**
Individual Gas Boiler	Modern condensing gas boiler operating at an efficiency of 90%
Communal Gas Boilers	Modern condensing gas boilers supplying heat to an entire building, operating at an efficiency of 90% with 5% losses in the distribution system
Electrical Heating	Any form of electrical resistance heating system such as night storage heaters, electric radiators, electric blower fires, electric underfloor heating
Air Source Heat Pump	Air source heat pump operating at a seasonal average efficiency of 245%
Ground Source Heat Pump	Ground source heat pump operating at a seasonal average efficiency of 282%
District Heating: CHP 50% - Gas 50%	Modern district heating system with 20% network losses. Gas fired combined heat and power plant supply 50% of the heat to the network and the remaining 50% is supplied by large gas boilers.
District Heating: CHP 70% - Gas 30%	Modern district heating system with 20% network losses. Gas fired combined heat and power plant supply 70% of the heat to the network and the remaining 30% is supplied by large gas boilers.
District Heating: GSHP 70% - Gas 30%	Modern district heating system with 20% network losses. Ground source heat pumps supply 70% of the heat to the network and the remaining 30% is supplied by large gas boilers.

Table 4.02 – Heating systems considered in this study

Note: the assumed coefficients of performance for heat pumps are based on the average system performance factors reported in the Energy Saving Trust's second phase of heat pump field trials. *The heat is on: heat pump field trials: phase 2. London: Energy Saving Trust (2013)*

The carbon content of the heat provided varies considerably between systems and will change over time. Assuming SAP 2012 carbon factors, these systems would be generating heat with the following average carbon content (at the dwelling point):

Heating systems	**Carbon content of heat**
Individual Gas Boiler	240 gCO_2/kWh
Communal Gas Boilers	253 gCO_2/kWh
Electrical Heating	519 gCO_2/kWh
Air Source Heat Pump	212 gCO_2/kWh
Ground Source Heat Pump	184 gCO_2/kWh
District Heating: CHP 50% - Gas 50%	198 gCO_2/kWh
District Heating: CHP 70% - Gas 30%	157 gCO_2/kWh
District Heating: GSHP 70% - Gas 30%	251 gCO_2/kWh

Table 4.03 – SAP 2012 Carbon contents of heat of systems considered in this study

However, the emissions associated with the generation of electricity are forecasted to decrease substantially in the near future, as shown in figure 4.09 below.

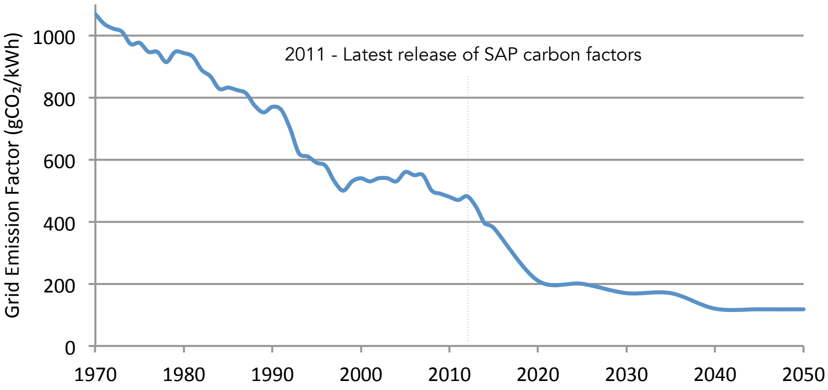


Figure 4.09 - Past and projected future CO_{2e} emissions factors for grid electricity assumed in this study

Figure B.02 (Appendix B) shows, based on conservative projections provided by the National Grid in 2016, how the carbon content of heat delivered by different heating systems may be expected to develop over time due to the changing carbon content of the electricity supply (and the associated grid-displaced electricity).

Planning policy should be based on the current carbon contents (as used in the current Building Regulations) but also seek to anticipate the likely carbon contents over the next few years. As planning policy relates to CO_2 reduction objectives by 2025 and 2050, it is also useful to take into account likely future carbon contents to check their adequacy with the overall policy objective.

In order to capture the variability of carbon contents of heat of various heating system, both between them and over time, four 'bands' of carbon contents of heat were therefore considered: 250-200gCO_2/kWh, 200-150gCO_2/kWh, 150-100gCO_2/kWh and 100-0gCO_2/kWh.

The calculations were undertaken against the four 'maximum' carbon contents of heat values (respectively 250gCO_2/kWh, 200gCO_2/kWh, 150gCO_2/kWh and 100gCO_2/kWh) to represent a worst case scenario for each of the bands. Results are therefore presented with reference to a particular carbon content of heat rather than a specific technology. Examples of how this heat could be provided based on current technology are given, and detailed costing is provided for the most cost effective of these (at the present time).

Carbon content figure for calculations (gCO_2/kWh)	**Carbon content range** (gCO_2/kWh)	**Example technologies**
250	200 - 250	• Individual gas boilers • District heating with less than 60% of heat supplied by CHP and the remainder supplied by gas boilers
200	150 - 200	• District Heating with 60-80% of heat supplied by CHP and the remainder supplied by gas • District heating with 70% of heat supplied by ground source heat pumps and 30% by gas boilers • Electric heating (from 2024)
150	100 - 150	• Air source heat pumps • District heating with 70% of heat supplied by ground source heat pumps and 30% by gas boilers (from 2023)
100	0 - 100	• Ground source heat pumps • Air source heat pumps (from 2020)

Table 4.04 – Carbon contents of heat assumed in the calculations (assumed to be the worst case of the range) and associated systems able to deliver this range of carbon contents (based on current technology)

4.2.4 Renewable energy

In addition to the different levels of building fabric performance each housing type has been tested against two specifications for renewable energy: a baseline case including no renewable energy generation and an example showing a high level of on-site renewable energy generation.

Given the urban context of the London Borough of Tower Hamlets, solar photovoltaic panels (PVs) are recognised as the most likely and suitable technology for building mounted electricity generation. This has been corroborated by the energy statements review in Section 3.2.

The area of PV feasible on site is based on the building footprint area and is summarised for each case in the table below.

Housing type	**Element**	**Performance**	
		No PV	**Good practice PV**
Medium rise apartments	Total PV area	0m^2	450m^2
	PV area/m^2 NIA	0 m^2/m^2	0.144 m^2/m^2
	Roof coverage	0%	60%
High rise apartments	Total PV area	0 m^2	200m^2
	PV area/m^2 NIA	0 m^2/m^2	0.034 m^2/m^2
	Roof coverage	0%	53%
Terraced houses	Total PV area	0m^2	250m^2
	PV area/m^2 NIA	0m^2/m^2	0.320 m^2/m^2
	Roof coverage	0%	82%

Table 4.04 – PV area assumed for each of the scenarios modelled

4.3 Method of assessment

In total 690 individual dwelling calculations were undertaken in order to test the various scenarios for each of the dwellings. Given the high number of individual SAP calculations required, they were undertaken using a SAP parametric modelling tool developed by Etude. This SAP parametric modelling tool replicates the SAP methodology and allows very high numbers of cases to be calculated simultaneously. 5no. dwellings have been modelled using Stroma fSAP 2012 to verify the calculation tool results. The maximum error was 2.9% which was considered acceptable.

4.4 Performance against Part L 2013

The estimated improvement against Part L 2013 was calculated for each of the case study. For the medium rise and high rise buildings, apartments on a typical floor and the top floor were modelled and an area-weighted average was calculated to estimate the performance of the whole building. This approximation is considered acceptable. The following colour codes have been used to facilitate the understanding of the results table below:

🟥	Not compliant with Part L 2013
🟧	0% < x < -35%
🟩	-35% < x < -45% (London Plan compliant)
🟩	-45% < x (LBTH Policy)

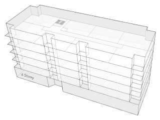
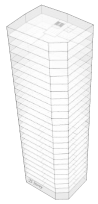
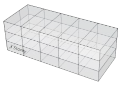
Housing type	Fabric performance	PV provision	Heating system – carbon content of heat			
			250 gCO_2/kWh	200 gCO_2/kWh	150 gCO_2/kWh	100 gCO_2/kWh
Medium rise flats 	Standard practice ★	No PV	5%	-12%	-29%	-46%
		PV	-65%	-82%	-99%	-116%
	Good practice ★★	No PV	-13%	-25%	-38%	-51%
		PV	-83%	-96%	-108%	-121%
	Best practice ★★★	No PV	-27%	-37%	-48%	-58%
		PV	-97%	-108%	-118%	-129%
High rise flats 	Standard practice ★	No PV	16%	-3%	-21%	-40%
		PV	0%	-19%	-37%	-56%
	Good practice ★★	No PV	-3%	-17%	-32%	-47%
		PV	-19%	-33%	-48%	-63%
	Best practice ★★★	No PV	-21%	-33%	-45%	-56%
		PV	-37%	-49%	-61%	-72%
Terrace housing 	Standard practice ★	No PV	7%	-10%	-28%	-45%
		PV	-126%	-143%	-160%	-178%
	Good practice ★★	No PV	-15%	-27%	-39%	-51%
		PV	-148%	-160%	-172%	-184%
	Best practice ★★★	No PV	-39%	-47%	-55%	-63%
		PV	-171%	-179%	-187%	-195%

Table 4.05 – Estimated Part L performance using different fabric and services specifications, PV areas and carbon contents of heat supply

In summary the key findings of this analysis are the following:

Medium rise block of flats

1. With 'standard practice' specifications and a high carbon content of heat (250gCO_2/kWh), the block of flats fails to comply with Part L 2013 by 5%.
2. Further energy efficiency measures help to significantly reduce regulated CO_2 emissions with 'good practice' specifications and 'best practice' specifications respectively leading to improvements over Part L 2013 of 13% and 27%.
3. All cases with the roof-mounted PV installation (60% roof coverage) exceed the LBTH on-site requirements with improvements over Part L 2013 ranging from 65% to 129%.
4. Lower carbon contents of heat supply significantly help to improve performance against Part L 2013 enabling even the 'standard' specifications with no PVs to achieve a 46% improvement against Part L 2013 with a carbon content of heat of 100g CO_2/kWh.
5. Overall, out of 24 cases modelled:
    - **1** is not compliant with Part L 2013;
    - **5** are compliant with Part L 2013 but not with GLA and LBTH policies;
    - **2** are compliant with the GLA policy but not LBTH's;
    - **16** are compliant with GLA and LBTH policies.
6. Of the above **16**, it should also be noted that **6** cases could achieve Zero Carbon on-site.

High rise block of flats

7. With 'standard practice' specifications and a high carbon content of heat (250gCO_2/kWh), the block of flats fails to comply with Part L 2013 by 16%.
8. Further energy efficiency measures help to reduce regulated CO_2 emissions with 'good practice' specifications and 'best practice' specifications respectively leading to improvements over Part L 2013 of 3% and 21%.
9. Due to the small area of PVs in relation to the number of units, the contribution from PVs is more limited, reducing regulated CO_2 emissions by a further 16% on average.
10. Lower carbon contents of heat supply significantly help to improve performance against Part L 2013 enabling the 'standard' specifications with PVs to achieve a 56% improvement against Part L 2013 and the 'good practice' specifications with no PVs to achieve a 47% improvement against Part L 2013 with a carbon content of heat of 100g CO_2/kWh.
11. Overall, out of 24 cases modelled:
    - **1** is not compliant with Part L 2013;
    - **11** are compliant with Part L 2013 but not with GLA and LBTH policies;
    - **4** are compliant with the GLA policy but not LBTH's;
    - **8** are compliant with GLA and LBTH policies.
12. Of the above **8**, **none** of the cases could achieve Zero Carbon on-site.

Terraced houses

13. With ‘standard practice’ specifications and a high carbon content of heat (250gCO$_2$/kWh), the row of terraced houses fails to comply with Part L 2013 by 7%.

14. Further energy efficiency measures help to very significantly reduce regulated CO$_2$ emissions with ‘good practice’ specifications and ‘best practice’ specifications respectively leading to improvements over Part L 2013 of 15% and 39%.

15. All cases with the large roof-mounted PV installation (82% roof coverage) exceed the LBTH on-site requirements and even comply with the Zero Carbon requirements on-site with improvements over Part L 2013 ranging from 126% to 195%.

16. Lower carbon contents of heat supply significantly help to improve performance against Part L 2013 enabling even the ‘standard’ specifications with no PVs to approach a 45% improvement against Part L 2013 with a carbon content of heat of 100g CO$_2$/kWh.

17. Overall, out of 24 cases modelled:

    - **1** is not compliant with Part L 2013;
    - **4** are compliant with Part L 2013 but not with GLA and LBTH policies;
    - **3** are compliant with the GLA policy but not LBTH’s;
    - **16** are compliant with GLA and LBTH policies.

18. Of the above **16**, it should also be noted that **12** cases could achieve Zero Carbon on-site.

General conclusions

19. Energy efficient specifications should be encouraged as they help to significantly reduce CO$_2$ emissions. Should only the ‘good practice’ and ‘best practice’ specifications be considered, the statistics would be as follows (out of 48 cases)

    - **0** are not compliant with Part L 2013;
    - **12** are compliant with Part L 2013 but not with GLA and LBTH policies;
    - **6** are compliant with the GLA policy but not LBTH’s;
    - **30** are compliant with GLA and LBTH policies.

20. PVs help to significantly reduce CO$_2$ emissions, particularly on terraced houses and medium blocks of flats. A large roof coverage (rather than a minimum proportion of PVs) should be encouraged.

21. Reducing the carbon content of heat supply is very important. Applicants should be encouraged to estimate the carbon content of heat supply proposed, now and in the future (e.g. 2030).

22. The carbon offsetting policy is well adapted to the variability of building types and designs, providing a flexible route to Zero Carbon.

4.5 Cost comparison

The cost of achieving Zero Carbon is made up of two components:

- the **building costs**, which include all building costs (walls, roofs, ventilation system, heating system, etc.) as well as the costs of any renewable energy system (PVs is used as a proxy for renewable energy in this study).
- the **carbon offsetting** costs, which are based on a rate of £1,800 per tonne of residual CO_2.

The case of district heating is particular and the costs can be split between 'infrastructure costs' (e.g. district energy centre, primary distribution network) and building costs (e.g. heat substation, secondary network and heat interface units). Only the latter costs have been included in this study.

4.5.1 Comparing the costs against a Part L 2013 compliant cost

The purpose of this initial analysis is to compare the costs of the various combinations in order to achieve Zero Carbon and to compare them with a single cost reference for each case study: the most economic combination to comply with Part L 2013.

General approach

Three cost plans were prepared by *Gordon Hutchinson Chartered Quantity Surveyors*: a 'Medium Rise Flats' cost plan, a 'High Rise Flats' cost plan and a 'Terrace Housing' cost plan. These three cost plans were then adjusted to represent the 'standard', the 'good practice' and the 'best practice' specifications.

These cost plans are all based on traditional heating solutions (central gas boilers for the medium rise flats and the high rise flats and individual gas boilers for the terraced houses) together with a wet heating system. Additional costs for lower carbon alternatives (e.g. connection to district heating, individual air source heat pumps, centralised ground source heat pump system, etc.) were estimated. The cost of optional PVs is also given.

It should be noted that the following assumptions have been made:

- Construction costs are based on Q3 2016 costs;
- Professional fees and planning fees are not included;
- Preliminaries have been assumed at 20% of the construction value;
- Overheads and profits have been assumed at 5% of the construction value;
- Contingencies have been assumed at 15% of the construction value.

The cost plans and a summary of exclusions can be found in Appendix.

Estimating the cost of lower carbon heating alternatives

- Lower carbon factors can be delivered in different ways and the cost analysis sought to identify the minimum additional cost required to achieve a targeted carbon content of heat. For example if both an individual air source heat pump system and a (more expensive) communal ground source heat pump system were deemed to be capable of achieving a carbon content of less than, say, 100 gCO_2/kWh, then only the cost of the most economic alternative (air source heat pump in this case) was considered as 'additional costs'.

- The additional costs of district heating are difficult to estimate as they vary significantly between local community systems for which all infrastructure is funded by the development and the costs of larger scale systems for which a heat substation needs to be provided and where the district heating provider would 'only' charge connection (on a per kW basis) and the cost of any additional infrastructure if the network is not in the development's immediate vicinity. Generally, a conservative assumption for additional costs of £2,500-£2,800/unit for a conventional district heating system and £3,500-£3,900/unit for a lower carbon district heating system have therefore been made. The more expensive end of the scale applies to terraced houses.
- Individual air source heat pumps were considered to represent an additional cost of £4,000/unit for apartments and £5,000/unit for houses.

Estimating the cost of PV systems

In some cases, the inclusion of PVs would exceed the Zero Carbon requirements as the PV system would offset more than the regulated CO_2 emissions. For the purpose of the cost analysis, only the PV area required to achieve a maximum 100% improvement over Part L 2013 has been included in the cost analysis.

Setting a 'reference' cost

Additional costs have been estimated against a 'reference cost' which is equivalent to the most economic combination to achieve Part L 2013 compliance (i.e. assuming that there is no other policy requirement to reduce CO_2 emissions – the 'no policy' black line on Figure 2.05). The cost estimates are all based on standard specifications, a traditional heating system and a small area of PVs:

- for medium rise flats: the reference costs are estimated at £138,595/unit;
- for high rise flats: the reference costs are estimated at £191,638/unit;
- for terraced houses: the reference costs are estimated at £273,645/unit;.

Summary of additional costs above Part L 2013

The minimum costs of achieving Zero Carbon compared with the most economic combination to achieve compliance with Part L 2013 are likely to be:

- £2,887 for medium rise flats (i.e. 2.1% of the reference costs);
- £1,820 for high rise flats (i.e. 0.9% of the reference costs);
- £4,713 for terraced houses (i.e 1.7% of the reference costs).

Seeking to achieve all or the maximum of carbon savings on-site is generally a more expensive strategy. For mid-rise flats and terraced houses this would represent achieving Zero Carbon on-site, hence why these costs are relatively high:

- up to £12,618 for medium rise flats (i.e. up to 9.1% of the reference costs);
- up to £ £12,058 for high rise flats (i.e. up to 6.3% of the reference costs);
- up to £32,890 for terraced houses (i.e. up to 12.0% of the reference costs).

Generally, as can be expected, it shows that improved fabric specifications, better ventilation systems, lower carbon heating systems and PVs lead to additional costs. However, it should also be noted that the benefits of good quality design to reduce these costs are not factored in the analysis as it is purely based on a comparison of specifications.

4.5.2 Assessing the additional costs of LBTH carbon policy over the London Plan

Section 4.5.1 identifies the likely additional costs (above the minimum costs required to comply with Part L 2013) of several strategies which an applicant could use in order to achieve Zero Carbon. However, four important elements should be noted when considering the additional costs of the proposed LBTH carbon policy:

- Firstly, Part L 2013 should not be used as the standard against which additional costs should be calculated. Instead, the GLA's requirement to achieve a 35% CO_2 reduction on-site and to offset the residual regulated CO_2 emissions should be used as the reference to assess the additional costs potentially incurred by the proposed LBTH carbon policy. The two policies to be compared are therefore the GLA and LBTH residential carbon policies: respectively '35% on-site CO_2 reduction + offsetting' to 'Zero Carbon and 45% on-site CO_2 reduction + offsetting to Zero Carbon'.
- Secondly, both the GLA and LBTH set in their policy a minimum on-site CO_2 reduction (respectively 35% and 45%) but do not specify how to achieve it. Although greater (and more expensive) efforts in terms of fabric specifications, low carbon heating supply and renewable energy are encouraged, the applicant is ultimately free to select the most economically attractive combination to achieve the on-site carbon reduction required.
- Similarly, both the GLA and LBTH set in their policy a requirement to offset the residual regulated CO_2 emissions. Although a greater on-site performance is possible, they both offer the possibility to offset the residual regulated CO_2 emissions through carbon offsetting at a comparable rate.
- Finally, if it can be demonstrated that achieving the required CO_2 reduction on-site (respectively 35% and 45%) is not technically and/or commercially viable, the applicant's energy strategy can be deemed policy compliant if the total residual CO_2 emissions are offset.

For these reasons, a comparison was made for each the combination modelled of the additional costs of achieving the proposed LBTH's zero carbon policy against the costs of achieving the GLA's zero carbon policy.

The cells highlighted in red represent the combinations which do not achieve Part L 2013 compliance from energy efficiency only and are therefore not policy compliant.

The cells highlighted in orange represent the combinations which do not achieve the 35% on-site CO_2 reduction required by the GLA. However, offsetting these CO_2 emissions can be deemed policy compliant.

The cells highlighted in light green represent the combinations which achieve the 35% on-site CO_2 reduction required by the GLA but do not achieve the 45% on-site CO_2 reduction required by LBTH.

The cells highlighted in dark green represent the combinations which achieve the 45% on-site CO_2 reduction required by LBTH and the cells highlighted in darker green the combinations which exceed the 45% on-site CO_2 reduction.

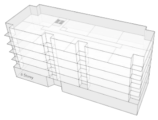
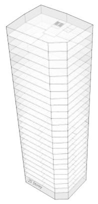
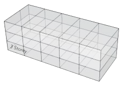
			Heating system – carbon content of heat			
			250 gCO_2/kWh	200 gCO_2/kWh	150 gCO_2/kWh	100 gCO_2/kWh
Housing type	**Fabric performance**	**PV provision**				
Medium rise flats 	Standard practice ★	No PV	5%	-12%	-29%	-46%
		PV	-45%	-45%	-45%	-46%
	Good practice ★★	No PV	-13%	-25%	-38%	-51%
		PV	-45%	-45%	-45%	-51%
	Best practice ★★★	No PV	-27%	-37%	-48%	-58%
		PV	-45%	-45%	-48%	-58%
High rise flats 	Standard practice ★	No PV	16%	-3%	-21%	-40%
		PV	0%	-19%	-37%	-45%
	Good practice ★★	No PV	-3%	-17%	-32%	-47%
		PV	-19%	-33%	-45%	-47%
	Best practice ★★★	No PV	-21%	-33%	-45%	-56%
		PV	-37%	-45%	-45%	-56%
Terrace housing 	Standard practice ★	No PV	7%	-10%	-28%	-45%
		PV	-45%	-45%	-45%	-45%
	Good practice ★★	No PV	-15%	-27%	-39%	-51%
		PV	-45%	-45%	-45%	-51%
	Best practice ★★★	No PV	-39%	-47%	-55%	-63%
		PV	-45%	-47%	-55%	-63%

Table 4.05 – Estimated on-site Part L performance using different fabric and services specifications, PV areas and carbon contents of heat supply – Combinations used for the cost comparison between the GLA and LBTH policies

As it can be seen from the above table Part L performance (when achieved by PVs) has been capped at 45%.

The proposed LBTH carbon policy only introduces additional costs for the combinations where on-site CO_2 performance from fabric efficiency and low carbon heat is higher than 35% but lower than 45%. In these cases, additional PVs are required to achieve the 45% on-site performance and they would not be required if the scheme was to comply with the GLA requirements only. On the other hand, this reduces the residual emissions and therefore less carbon offsetting is required. This cost difference is the one analysed in this study.

For the combinations which do not achieve the 35% CO_2 reduction required by the GLA, the additional costs of the proposed LBTH policy is £0 as the same degree of carbon offsetting to Zero Carbon would be required to comply with the GLA or LBTH carbon requirements.

The same applies to the combinations exceeding the 45% CO_2 reduction required by LBTH. These exemplar (and more expensive schemes) are encouraged by LBTH but these approaches are not required, similarly to exemplar approaches encouraged but not required by the GLA's requirements.

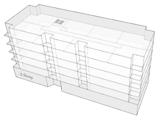
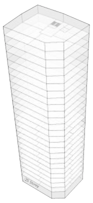
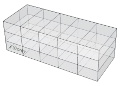
Housing type	Fabric performance	PV provision	Heating system – carbon content of heat			
			250 gCO_2/kWh	200 gCO_2/kWh	150 gCO_2/kWh	100 gCO_2/kWh
Medium rise flats 	Standard practice ★	No PV	🟥	£0	£0	-
		PV	£225	£225	£225	-
	Good practice ★★	No PV	£0	£0	£0	-
		PV	£225	£225	£151	-
	Best practice ★★★	No PV	£0	£0	-	-
		PV	£225	£171	-	-
High rise flats 	Standard practice ★	No PV	🟥	£0	£0	£0
		PV	£0	£0	£47	-
	Good practice ★★	No PV	£0	£0	£0	-
		PV	£0	£0	£219	-
	Best practice ★★★	No PV	£0	£0	£0	-
		PV	£53	£219	£7	-
Terrace housing 	Standard practice ★	No PV	🟥	£0	£0	£0
		PV	£493	£493	£493	£5
	Good practice ★★	No PV	£0	£0	£0	-
		PV	£493	£493	£287	-
	Best practice ★★★	No PV	£0	-	-	-
		PV	£312	-	-	-

Table 4.06 – Estimated additional costs of the proposed LBTH policy compared with the GLA requirements (per unit)

The following additional costs of the proposed LBTH carbon policy compared with the GLA requirements have been estimated:

- £0 and £225/unit for medium rise flats;
- £0 and £219/unit for high rise flats;
- £0 and £493/unit for terraced houses.

5.0

CONCLUSION

5.0 CONCLUSION

This section summarises the key conclusions of this document.

5.1 Evidence of need

The London Borough of Tower Hamlets is proposing a revised carbon policy in order to contribute to the UK's and Greater London's efforts to mitigate climate change. The evidence summarised in Section 2.0 helps to demonstrate that these policies are required and that efforts to reduce CO_2 emissions from new and existing buildings need to be pursued.

From the estimate of the LBTH carbon path the following observations can be made:

1. The number of households in Tower Hamlets is set to increase by 20% before 2025, and will nearly double before 2050 against a 2015 baseline.
2. The majority of existing dwellings will still exist in 2050 and could make up over half of the housing stock in Tower Hamlets. This is less than the commonly cited 80% of dwellings in 2050 already existing at a UK level due to locally higher rates of population increase.
3. A 45% on-site carbon reduction policy requirement contributes more effectively to the overall carbon target than a 35% carbon reduction policy requirement.
4. Even a 45% on-site carbon reduction policy requirement for new builds only achieves a small carbon reduction over the next 35 years. Net zero carbon new homes are required to give meaningful reductions in residential emissions.
5. It is highly likely that significant energy efficiency retrofit and heating system upgrades will be required in existing dwellings to meet the future emissions targets for Tower Hamlets. These could be partially funded by carbon offsetting funds from new buildings.

5.2 Literature review

6. Studies reviewed suggest that an on-site carbon performance comprised between a 19% and a 56% improvement over Part L 2013 is achievable technically and financially.
7. Studies reviewed suggest that carbon offsetting is a suitable mechanism to deal with the variability of new build projects, technical and financial viability.
8. One of the conclusions of the Greater London Authority Housing Standards Review: Viability Assessment, GLA, David Lock Associates, Hoare Lea, Gardiner & Theobald (2015) is that "*the cumulative impact of the optional step free access requirement and the move to zero carbon homes on the deliverability and viability of housing development in London affects the viability of fewer than 5% of the test outcomes, which is insufficient to be considered a challenge to the overall viability of housing delivery across London.*"
9. Two key recommendations of the Greater London Authority Non-Domestic Carbon Dioxide Emissions Target: Feasibility and Viability Study, GLA, David Lock Associates, Hoare Lea, Gardiner & Theobald (2015) include: "Recommendation 1 – Proposed target: A target of 50% improvement on Part L 2013 is considered viable, provided that flexibility is retained on how it is met, on a case by case basis. "

10. "Recommendation 2 – Approach to achieving CO_2 reductions: Due to the variety of development in London (both in building types and locations), it is recommended that the CO_2 target continues to be approached as an overall combination of on-site savings, contribution from low-carbon networks, and carbon dioxide offsets (after savings from on-site measures and district energy have been maximised)." It should be noted that the first recommendation was not taken forward by the GLA in the revisions to the London Plan.

5.3 Review of energy assessments

11. A large number of planning applications reviewed complied with the 45% improvement over Part L 2013 required by the existing carbon policy.

12. The last full year with monitoring data available (2014 – 2015) suggests that 100% of schemes submitted were policy compliant through a combination of on-site measure and offsetting. 45% of schemes achieved the policy requirements without the need for carbon offsetting. Comparable numbers are expected for 2015-2016.

5.4 Focus on residential developments

On-site carbon performance

13. Energy efficient specifications should be encouraged as they help to significantly reduce CO_2 emissions. Should only the 'good practice' and 'best practice' specifications be considered, the statistics would be as follows (out of 48 cases):

    - **0** are not compliant with Part L 2013;
    - **12** are compliant with Part L 2013 but not with GLA and LBTH policies;
    - **6** are compliant with the GLA policy but not LBTH's;
    - **30** are compliant with GLA and LBTH policies.

14. PVs help to significantly reduce CO_2 emissions, particularly on terraced houses and medium blocks of flats. A large roof coverage (rather than a minimum proportion of PVs) should be encouraged.

15. Reducing the carbon content of heat supply is very important. Applicants should be encouraged to estimate the carbon content of heat supply proposed, now and in the future (e.g. 2030).

Costs

16. The minimum costs of achieving Zero Carbon compared with the most economic combination to achieve compliance with Part L 2013 is likely to be:

    - £2,887 for medium rise flats (i.e. 2.1% of the reference costs);
    - £1,820 for high rise flats (i.e. 0.9% of the reference costs);
    - £4,713 for terraced houses (i.e 1.7% of the reference costs).

17. Seeking to achieve all or the maximum of carbon savings on-site is generally a more expensive strategy. For mid-rise flats and terraced houses this would represent achieving Zero Carbon on-site, hence why these costs are relatively high:

    - up to £12,618 for medium rise flats (i.e. up to 9.1% of the reference costs);

- up to £ £12,058 for high rise flats (i.e. up to 6.3% of the reference costs);
- up to £32,890 for terraced houses (i.e. up to 12.0% of the reference costs).

18. Generally, as can be expected, it shows that improved fabric specifications, better ventilation systems, lower carbon heating systems and PVs lead to additional costs. However, it should also be noted that the benefits of good quality design to reduce these costs are not factored in the analysis as it is purely based on a comparison of specifications.

19. Part L 2013 should not be used as the standard against which additional costs should be calculated. Instead, the GLA's requirement to achieve a 35% CO_2 reduction on-site and to offset the residual regulated CO_2 emissions should be used as the reference to assess the additional costs potentially incurred by the proposed LBTH carbon policy. The two policies to be compared are therefore the GLA and LBTH residential carbon policies: respectively '35% on-site CO_2 reduction + offsetting to Zero Carbon' and '45% on-site CO_2 reduction + offsetting to Zero Carbon'.

20. The following additional costs of the proposed LBTH carbon policy compared with the GLA requirements have been estimated:

    - £0 and £225/unit for medium rise flats;
    - £0 and £219/unit for high rise flats;
    - £0 and £493/unit for terraced houses.

6.0

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6.0 REFERENCES

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A

APPENDIX A:

Planning and Energy Act 2008

Potential evolution

Section 43 of the Deregulation Act 2015 includes a prospective change to section 1c of the Planning and Energy Act:

'Subsection (1)(c) does not apply to development in England that consists of the construction or adaptation of buildings to provide dwellings or the carrying out of any work on dwellings.'

This prospective change would come into force on a day to be appointed by the Secretary of State in a commencement order. To date a commencement order has not been made for the prospective change. The Legislation.gov.uk website sets out information on Section 43:

'Section 43: Amendment of Planning and Energy Act 2008.

This section is related to section 42. It is a corollary of the restriction of technical housing standards to those found in building regulations that an amendment is made to the Planning and Energy Act 2008. Section 1(1)(c) of that Act provides that local planning authorities may include in their plans requirements that development in their area meets higher standards of energy efficiency than are required by building regulations.

This is inconsistent with the consolidation of technical standards for housing in building regulations, and the amendment will disapply the provision in England in relation to development that consists of the construction or alteration of buildings to provide dwellings, or the carrying out of any work on dwellings. ***Government policy meanwhile is that new dwellings meet a zero net carbon emissions standard from 2016.***

The provision to be amended forms part of the law of England and Wales, but the amendment will affect its application in England only. ***It comes into force on a day to be appointed by the Secretary of State in a commencement order****.'*

Section 43 was introduced in the context at that time of tightening national energy efficiency standards. The Government has since announced a change in approach and a delay in implementing the 2016 zero carbon requirements. Amber Rudd noted in her speech of 21st July 2015 that the implementation of zero carbon policy had been 'postponed'. Therefore, the tightening of building regulations anticipated for 2016, and delivery of zero carbon homes, has changed since the Deregulation Act was given assent.

Ministerial statement

A written Ministerial Statement (Planning Update: Written statement - HCWS488 "the Planning Update") states the following:

'…For the specific issue of energy performance, local planning authorities will continue to be able to set and apply policies in their Local Plans which require compliance with energy performance standards that exceed the energy requirements of Building Regulations until commencement of amendments to the Planning and Energy Act 2008 in the Deregulation Bill 2015.

This is expected to happen alongside the introduction of zero carbon homes policy in late 2016. The government has stated that, from then, the energy performance requirements in Building Regulations will be set at a level equivalent to the *(outgoing) Code for Sustainable Homes Level 4. Until the amendment is commenced, we would expect local planning authorities to take this statement of the government's intention into account in applying existing policies and not set conditions with requirements above a Code level 4 equivalent.'*

The ministerial statement adds weight to the argument that the commencement of S.43 of the Deregulation Act was intended to coincide with the new Building Regulations 2016 and Zero Carbon proposals. This is further backed up by the Hansard extract from the deliberation of the Deregulation Bill which states:

"In the Grand Committee on the Bill for this Act in the House of Lords the Minister said as follows:

"This is in no sense intended to lower standards; it is intended to continue the process of raising energy efficiency standards and to achieve zero-carbon aims. I was already briefed to make the point that the noble Lord, Lord McKenzie, just helpfully made. This is not intended to commence until it replaces the other standards. The code on which representation has been made is a fairly complex piece of legislation. Those parts will not be abandoned; they will be incorporated into the building regulations. I stress that we are raising standards, not lowering them. I will make sure that I can say that with confidence again on Report, because I recognise the concerns of noble Lords.

"By 2016, the Government plan to have tightened building regulations to deliver zero-carbon housing. I repeat that the Section 1(1)(c) amendment will not be commenced until then; meanwhile there will be no dip in standards. We intend to consolidate necessary standards to ensure that sustainable housing can be built. The current situation means that insufficient housing is being built because authorities are applying too many different standards, making sites unviable. This is a rationalisation, not a deregulation of the sort that lowers standards and enables people to move further away from the zero-carbon housing that we all very much want.'

(Hansard, October 30, 2014 http://www.publications.parliament.uk/pa/ld201415/ldhansrd/text/141030-gc0001.htm)

B

APPENDIX B:

Carbon content of heat for various heating systems

The following heating systems have been considered in this study.

Heating systems	Description
Individual Gas Boiler	Modern condensing gas boiler operating at an efficiency of 90%
Communal Gas Boilers	Modern condensing gas boilers supplying heat to an entire building, operating at an efficiency of 90% with 5% losses in the distribution system
Electrical Heating	Any form of electrical resistance heating system such as night storage heaters, electric radiators, electric blower fires, electric underfloor heating
Air Source Heat Pump	Air source heat pump operating at a seasonal average efficiency of 245%
Ground Source Heat Pump	Ground source heat pump operating at a seasonal average efficiency of 282%
District Heating: CHP 50% - Gas 50%	Modern district heating system with 20% network losses. Gas fired combined heat and power plant supply 50% of the heat to the network and the remaining 50% is supplied by large gas boilers.
District Heating: CHP 70% - Gas 30%	Modern district heating system with 20% network losses. Gas fired combined heat and power plant supply 70% of the heat to the network and the remaining 30% is supplied by large gas boilers.
District Heating: GSHP 70% - Gas 30%	Modern district heating system with 20% network losses. Ground source heat pumps supply 70% of the heat to the network and the remaining 30% is supplied by large gas boilers.

As the emissions associated with the generation of electricity are forecasted to decrease substantially in the near future (see figure below), the associated carbon contents of heat of the majority of heating system will also vary over time.

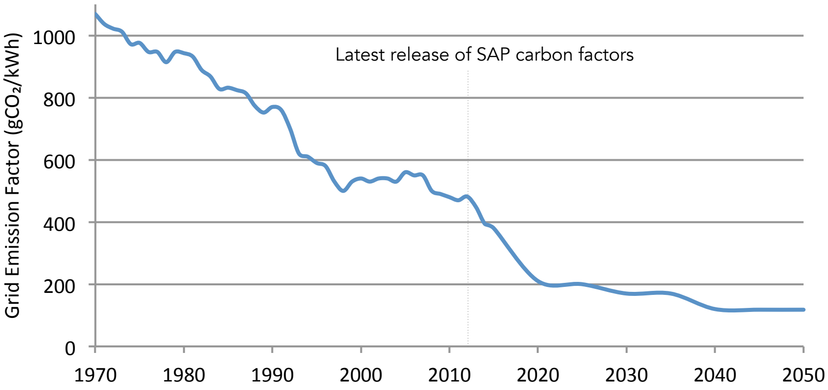

Figure B.01 - Past and projected future CO_{2e} emissions factors for grid electricity assumed in this study

The figure below therefore shows, based on conservative projections provided by the National Grid in 2016, how the carbon content of heat delivered by different heating systems may be expected to develop over time due to the changing carbon content of the electricity supply.

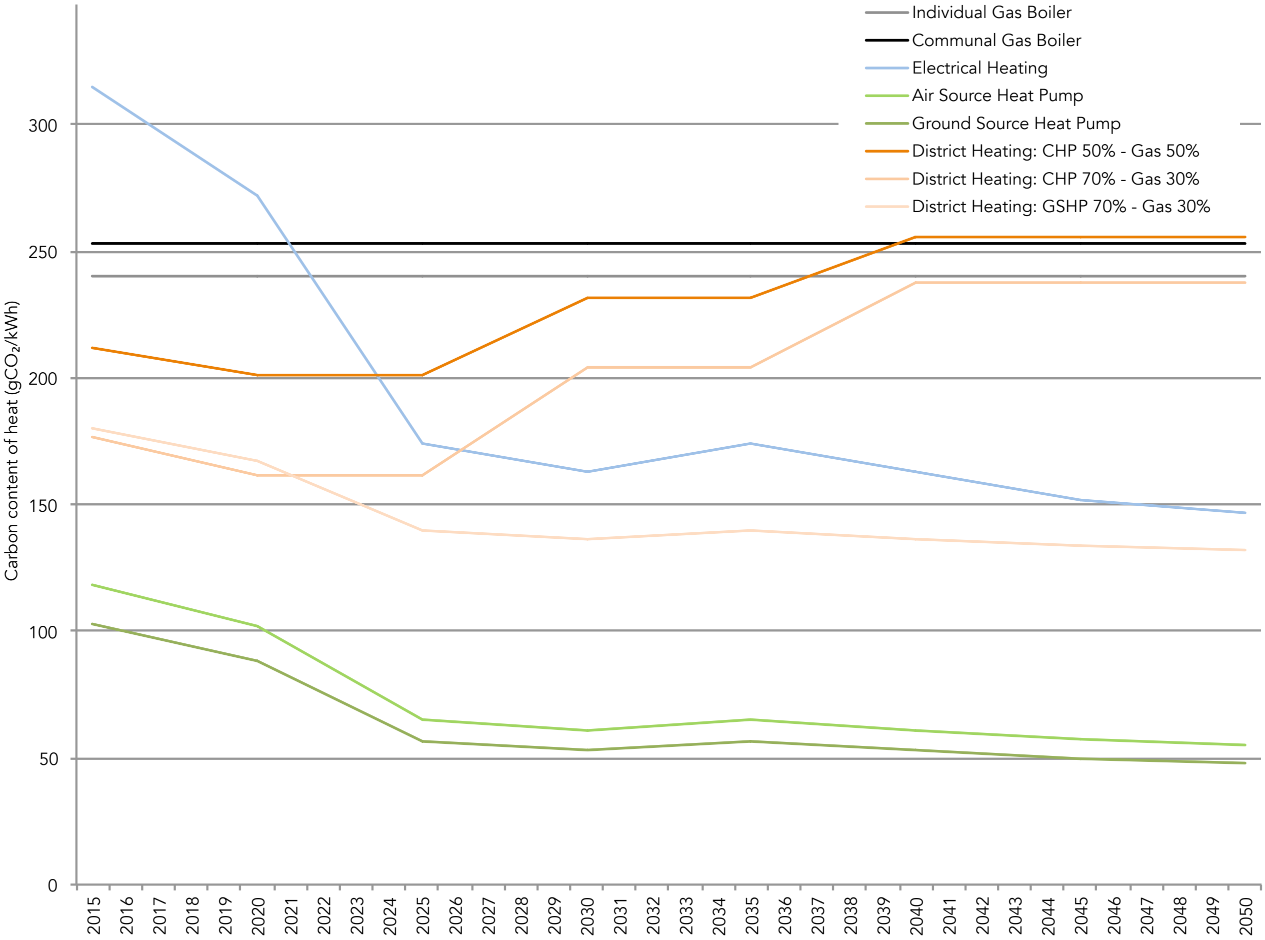

Figure B.02 - Carbon content of heat from different heating technologies
Developed using data from the National Grid Future Energy Scenarios, 2016

As it can be seen, carbon contents of heat supplied by various heating systems will evolve over time due to the decreasing carbon contents of grid-supplied electricity and grid-displaced electricity.

In order to capture the variability of carbon contents of heat of various heating system, both between them and over time, four 'bands' of carbon contents of heat were therefore considered: 250-200gCO_2/kWh, 200-150gCO_2/kWh, 150-100gCO_2/kWh and 100-0gCO_2/kWh.

The calculations were undertaken against the four maximum carbon contents of heat values (respectively 250gCO_2/kWh, 200gCO_2/kWh, 150gCO_2/kWh and 100gCO_2/kWh) to represent a worst case scenario for each of the bands. Results are therefore presented with reference to a particular carbon content of heat rather than a specific technology. Examples of how this heat could be provided based on current technology are given, and detailed costing is provided for the most cost effective of these (at the present time).

Carbon content figure for calculations (gCO₂/kWh)	**Carbon content range** (gCO₂/kWh)	**Example technologies**
250	200 - 250	• Individual gas boilers • District heating with less than 60% of heat supplied by CHP and the remainder supplied by gas boilers
200	150 - 200	• District Heating with 60-80% of heat supplied by CHP and the remainder supplied by gas • District heating with 70% of heat supplied by ground source heat pumps and 30% by gas boilers • Electric heating (from 2024)
150	100 - 150	• Air source heat pumps • District heating with 70% of heat supplied by ground source heat pumps and 30% by gas boilers (from 2023)
100	0 - 100	• Ground source heat pumps • Air source heat pumps (from 2020)

Please note that the table above is not meant to be comprehensive and to cover all potential technologies and systems able to deliver these carbon contents. Its purpose is merely to indicate that delivering these carbon contents is already possible with readily available technology and should therefore become easier over time.

C

APPENDIX C:

Cost plans

GORDON HUTCHINSON
CHARTERED QUANTITY SURVEYORS

LONDON BOROUGH OF TOWER HAMLETS
CARBOB POLICY EVIDENCE BASE PROJECT

5 AUGUST 2016

MEDIUM RISE FLATS

CONCEPTUAL COST PLAN

Item	Description	Total Standard £	Total Good Practice £	Total Best Practice £
	SUMMARY			
	GROSS FLOOR AREA **[m2]**	**3,960**	**3,960**	**3,960**
0	DEMOLITIONS AND ALTERATIONS	0	0	0
1A	SUBSTRUCTURE	338,400	344,890	350,980
2	SUPERSTRUCTURE			
2A	FRAME	1,386,000	1,386,000	1,386,000
2B	UPPER FLOORS	105,000	105,000	105,000
2C	ROOF	90,400	98,100	105,800
2D	STAIRS	30,000	30,000	30,000
2E,F	EXTERNAL WALLS/WINDOWS AND EXTERNAL DOORS	556,775	601,155	674,510
2G	INTERNAL WALLS AND PARTITIONS	125,000	125,000	125,000
2H	INTERNAL DOORS	162,000	162,000	162,000
	TOTAL: SUPERSTRUCTURE	2,455,175	2,507,255	2,588,310
3	INTERNAL FINISHES			
3A	WALL FINISHES	236,923	242,318	247,713
3B	FLOOR FINISHES	182,800	182,800	182,800
3C	CEILING FINISHES	119,070	122,370	125,670
	TOTAL: INTERNAL FINISHES	538,793	547,488	556,183
4A	FITTINGS AND FURNISHINGS	264,000	264,000	264,000
5	SERVICES			
5A	SANITARY APPLIANCES	144,000	144,000	144,000
5C-G	MECHANICAL SERVICES	335,480	429,230	491,730
5H,L	ELECTRICAL SERVICES	458,160	458,160	458,160
5J	LIFT AND CONVEYOR INSTALLATIONS	60,000	60,000	60,000
5N	BUILDER'S WORK IN CONNECTION WITH SERVICES	34,146	37,896	40,396
	TOTAL: SERVICES	1,031,786	1,129,286	1,194,286
6	EXTERNAL WORKS			
6A	SITE WORKS	50,000	50,000	50,000
6B	DRAINAGE	43,000	43,000	43,000
6C	EXTERNAL SERVICES	144,000	144,000	144,000
	TOTAL: EXTERNAL WORKS	237,000	237,000	237,000
	TOTAL: WORKS	4,865,154	5,029,919	5,190,759
	ON-COSTS			
7A	PRELIMINARIES	729,773	729,773	729,773
7B	OVERHEADS AND PROFIT	335,696	345,581	355,232
7C	CONTINGENCIES	711,675	732,633	753,092
	TOTAL: ON-COSTS	1,777,143	1,807,987	1,838,097
	TOTAL: CONSTRUCTION AT CURRENT COST 3RD QUARTER 2016	**£6,642,297**	**£6,837,906**	**£7,028,855**
	Cost/m2	**£1,677**	**£1,727**	**£1,775**
	OPTIONS			
1	Photovoltaic Panels	£0	£140,000	£140,000
2.1	Connection to a district heating network	£160,000	£160,000	£160,000
2.2	Connection to a communal heating network	£230,000	£230,000	£230,000
2.3	Air source heat pump to each dwelling	£260,000	£260,000	£260,000
2.4	Central ground source heat pump [Assuming sufficient space on site]	£740,000	£740,000	£740,000

MAIN EXCLUSIONS

1 Costs "Broad Brush" at 3rd Quarter 2016
2 Asbestos Survey and Removal
3 Extensive contaminated soil removal subject to further investigation
4 Diversion of under and overground services
5 Data and Telecommunication Installations
6 Loose Furniture and Equipment
7 Professional Fees and Expenses
8 Planning Fees & Building Control Fees. Party Wall Surveyor and other survey fees. BREEAM
9 Inflation on construction costs
10 Value Added Tax

LONDON BOROUGH OF TOWER HAMLETS **5 AUGUST 2016**
CARBOB POLICY EVIDENCE BASE PROJECT

HIGH RISE FLATS

CONCEPTUAL COST PLAN

Item	Description	Total Standard £	Total Good Practice £	Total Best Practice £
	SUMMARY			
	GROSS FLOOR AREA **[m2]**	**8,000**	**8,000**	**8,000**
0	DEMOLITIONS AND ALTERATIONS	0	0	0
1A	SUBSTRUCTURE	570,000	570,000	570,000
2	SUPERSTRUCTURE			
2A	FRAME	2,080,000	2,080,000	2,080,000
2B	UPPER FLOORS	1,098,000	1,098,000	1,098,000
2C	ROOF	93,760	97,250	107,720
2D	STAIRS	125,000	125,000	125,000
2E,F	EXTERNAL WALLS/WINDOWS AND EXTERNAL DOORS	3,038,575	3,198,500	3,518,350
2G	INTERNAL WALLS AND PARTITIONS	480,750	480,750	480,750
2H	INTERNAL DOORS	337,100	337,100	337,100
	TOTAL: SUPERSTRUCTURE	7,253,185	7,416,600	7,746,920
3	INTERNAL FINISHES			
3A	WALL FINISHES	412,634	417,394	422,154
3B	FLOOR FINISHES	508,875	508,875	508,875
3C	CEILING FINISHES	238,375	239,175	239,975
	TOTAL: INTERNAL FINISHES	1,159,884	1,165,444	1,171,004
4A	FITTINGS AND FURNISHINGS	528,000	528,000	528,000
5	SERVICES			
5A	SANITARY APPLIANCES	288,000	288,000	288,000
5C-G	MECHANICAL SERVICES	1,259,000	1,259,000	1,379,000
5H,L	ELECTRICAL SERVICES	967,500	967,500	967,500
5J	LIFT AND CONVEYOR INSTALLATIONS	250,000	250,000	250,000
5N	BUILDER'S WORK IN CONNECTION WITH SERVICES	74,295	74,295	77,895
	TOTAL: SERVICES	2,838,795	2,838,795	2,962,395
6	EXTERNAL WORKS			
6A	SITE WORKS	50,000	50,000	50,000
6B	DRAINAGE	62,000	62,000	62,000
6C	EXTERNAL SERVICES	192,000	192,000	192,000
	TOTAL: EXTERNAL WORKS	304,000	304,000	304,000
	TOTAL: WORKS	12,653,864	12,822,839	13,282,319
	ON-COSTS			
7A	PRELIMINARIES	2,530,773	2,530,773	2,530,773
7B	OVERHEADS AND PROFIT	759,232	767,681	790,655
7C	CONTINGENCIES	2,391,580	2,418,194	2,490,562
	TOTAL: ON-COSTS	5,681,585	5,716,647	5,811,989
	TOTAL: CONSTRUCTION AT CURRENT COST 3RD QUARTER 2016	**£18,335,449**	**£18,539,486**	**£19,094,308**
	Cost/m2	**£2,292**	**£2,317**	**£2,387**
	OPTIONS			
1	Photovoltaic Panels	£0	£70,000	£70,000
2.1	Connection to a district heating network	£350,000	£350,000	£350,000
2.2	Connection to a communal heating network	£490,000	£490,000	£490,000
2.3	Air source heat pump to each dwelling	£560,000	£560,000	£560,000
2.4	Central ground source heat pump [Assuming sufficient space on site]	£1,670,000	£1,670,000	£1,670,000

MAIN EXCLUSIONS

1 Costs "Broad Brush" at 3rd Quarter 2016
2 Asbestos Survey and Removal
3 Extensive contaminated soil removal subject to further investigation
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5 Data and Telecommunication Installations
6 Loose Furniture and Equipment
7 Professional Fees and Expenses
8 Planning Fees & Building Control Fees. Party Wall Surveyor and other survey fees. BREEAM
9 Inflation on construction costs
10 Value Added Tax

LONDON BOROUGH OF TOWER HAMLETS
CARBOB POLICY EVIDENCE BASE PROJECT

5 AUGUST 2016

TERRACE HOUSING

CONCEPTUAL COST PLAN

Item	Description	Total Standard £	Total Good Practice £	Total Best Practice £
	SUMMARY			
	GROSS FLOOR AREA **[m2]**	**840**	**840**	**840**
0	DEMOLITIONS AND ALTERATIONS	0	0	0
1A	SUBSTRUCTURE	107,100	110,880	115,810
2	SUPERSTRUCTURE			
2A	FRAME	0	0	0
2B	UPPER FLOORS	64,800	64,800	64,800
2C	ROOF	68,140	71,420	75,100
2D	STAIRS	37,500	37,500	37,500
2E,F	EXTERNAL WALLS/WINDOWS AND EXTERNAL DOORS	213,850	226,040	249,120
2G	INTERNAL WALLS AND PARTITIONS	66,500	66,500	66,500
2H	INTERNAL DOORS	25,000	25,000	25,000
	TOTAL: SUPERSTRUCTURE	475,790	491,260	518,020
3	INTERNAL FINISHES			
3A	WALL FINISHES	60,173	62,228	64,283
3B	FLOOR FINISHES	42,480	42,480	42,480
3C	CEILING FINISHES	25,900	27,300	28,700
	TOTAL: INTERNAL FINISHES	128,553	132,008	135,463
4A	FITTINGS AND FURNISHINGS	32,500	32,500	32,500
5	SERVICES			
5A	SANITARY APPLIANCES	25,000	25,000	25,000
5C-G	MECHANICAL SERVICES	73,600	98,800	115,600
5H,L	ELECTRICAL SERVICES	84,000	84,000	84,000
5J	LIFT AND CONVEYOR INSTALLATIONS	0	0	0
5N	BUILDER'S WORK IN CONNECTION WITH SERVICES	7,880	9,140	9,980
	TOTAL: SERVICES	190,480	216,940	234,580
6	EXTERNAL WORKS			
6A	SITE WORKS	30,000	30,000	30,000
6B	DRAINAGE	14,000	14,000	14,000
6C	EXTERNAL SERVICES	25,000	25,000	25,000
	TOTAL: EXTERNAL WORKS	69,000	69,000	69,000
	TOTAL: WORKS	1,003,423	1,052,588	1,105,373
	ON-COSTS			
7A	PRELIMINARIES	120,411	120,411	120,411
7B	OVERHEADS AND PROFIT	89,907	93,840	98,063
7C	CONTINGENCIES	145,649	152,021	158,862
	TOTAL: ON-COSTS	355,966	366,271	377,335
	TOTAL: CONSTRUCTION AT CURRENT COST 3RD QUARTER 2016	**£1,359,389**	**£1,418,859**	**£1,482,708**
	Cost/m2	**£1,618**	**£1,689**	**£1,765**
	OPTIONS			
1	Photovoltaic Panels	£0	£80,000	£80,000
2.1	Connection to a district heating network	£19,000	£19,000	£19,000
2.2	Connection to a communal heating network	£26,000	£26,000	£26,000
2.3	Air source heat pump to each dwelling	£34,000	£34,000	£34,000
2.4	Central ground source heat pump [Assuming sufficient space on site]	£240,000	£240,000	£240,000

MAIN EXCLUSIONS

1 Costs "Broad Brush" at 3rd Quarter 2016
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