Energy&Climate
INTELLIGENCE UNIT

Zero Carbon Homes

How owners of new homes are paying over the odds for energy

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Executive Summary

The cost of keeping homes warm is the largest component of domestic energy bills, and represents the greatest challenge to fuel-poor households during the winter months. Maintaining comfortable temperatures at home is predominantly done by burning natural gas, a high-carbon fuel on which the UK is becoming increasingly import-dependent.

The easiest way to reduce the cost of heating homes is to increase building efficiency. By ensuring that less heat is wasted through windows, walls and roofs, less fuel needs to be burnt.

However, the UK is currently without a wide-reaching domestic energy efficiency scheme, and as such, carbon emissions from UK homes have risen slightly over the past two years.

This need not be the case. First devised in 2007, the Zero Carbon Homes policy would have required that new-build homes did not result in the net release of any carbon dioxide into the atmosphere during day-to-day running. This was to be achieved through a combination of reduced energy demand, generation of heat and power from onsite low-carbon energy sources, and abatement measures (such as planting trees) to offset emissions that could not be avoided.

The Zero Carbon Homes policy was set to be implemented from 2016, with all new homes built in England after the beginning of the year subject to new, tighter standards. Yet, despite the building industry having had nearly a decade to prepare, it was cancelled by then-Chancellor George Osborne just a few months before implementation.

This report finds that had the policy not been cancelled, occupants of new homes built since 2016 would be saving up to £200 per year on their energy bills, close to triple the average saving intended to result from the Government's recently-introduced energy price cap.

The total extra cumulative energy costs paid by owners of new homes to date (Jan 2016-June 2018) is more than £58 million, and could be as high as £1 billion by the end of 2020, when more than 700,000 new homes are expected to be occupied with families spending more on energy than they would have done otherwise.

Building a home to Zero Carbon Home standards would in theory increase the purchase price. However, the sum involved is small – 1-2% of the overall cost – and would be recouped through energy bill savings within years. The impact on price from the Help to Buy scheme is much greater; it has been estimated to add £50,000 to the cost of a new house.

England's housebuilding industry is currently constructing around 160,000 homes per year. Ensuring that these properties comply with the highest standards would allow industries involved in insulation and low-carbon heating to flourish, in addition to locking in lower bills for homeowners and renters.

The Government has stated that it would like to see 300,000 new homes built per year. Were this figure to be met, from 2019 onwards the additional cost in terms of gas wasted and the number of bills higher than necessary would be approximately doubled.

INTRODUCTION

The UK's energy system is one of Europe's most resilient.[1] However, it is still susceptible to shock events – as the 'Beast from the East' in March 2018 showed.[2] Declining oil and natural gas output from the North Sea means that the UK is becoming increasingly dependent on fuels imported from other countries,[3] and while the contribution that UK-based renewables are making to the electricity system is increasing, sectors such as heating and transport remain overwhelmingly dependent on fossil fuels.[4]

As the UK moves towards a low-carbon future, as mandated by both the Climate Change Act and Paris Agreement, aspects of daily life that have not been the focus of low carbon efforts will move into the limelight, alongside wind turbines and electric vehicles. One of these is heat; specifically, how we warm our homes. Here – in contrast to the economy as a whole – emissions have risen slightly since reaching a low in 2014 (Figure 1).[5]

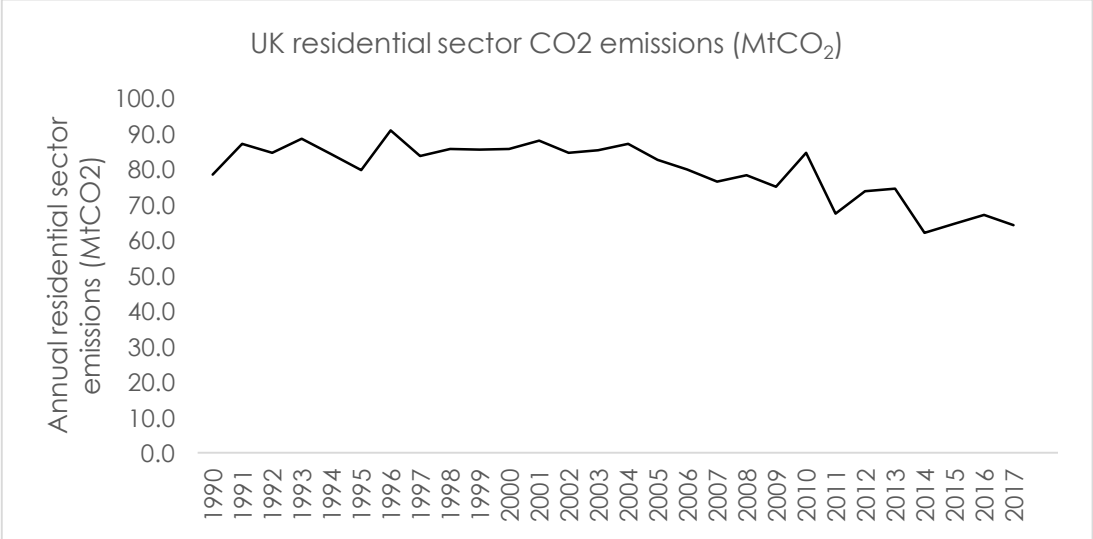

Figure 1: Progress in reducing carbon emissions from the residential sector has stalled. **Source**: BEIS

Decarbonising the UK's heat supply is no small feat, complicated by the fact that points of combustion are highly distributed across the nation – gas boilers are present in the vast majority of the UK's 27 million homes, for example. The UK also leans on natural gas as an energy source more than most other countries, due to historical political decisions made to take advantage of large hydrocarbon resources under the North Sea.

Heating the UK is responsible for around 40% of national energy consumption and around 25% of emissions.[6] Of this, homes are responsible for more than half (57%), with 80% of homes currently heated by natural gas.[7] Heat also represents the largest component of domestic energy bills and is therefore directly linked to fuel poverty concerns.

[1] https://www.gov.uk/government/speeches/greg-clark-speech-at-energy-uk
[2] https://www.ft.com/content/b13babaa-4632-11e8-8ae9-4b5ddcca99b3
[3] https://www.gov.uk/government/statistics/dukes-foreign-trade-statistics
[4] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/736148/DUKES_2018.pdf
[5] https://eciu.net/briefings/net-zero/net-zero-heat
[6] https://www.nea.org.uk/wp-content/uploads/2017/09/Heat-Decarbonisation-Report-2017.pdf
[7] http://www.ukerc.ac.uk/publications/sustainable-heating-in-the-uk-risks-and-opportunities.html

Gas use in the power sector has grown slightly over recent years, as both gas and renewables have filled the gap left by closing coal-fired power stations.[8] As such, the UK is growing increasingly reliant on a fossil fuel imported from overseas.

Reducing dependency on natural gas as a heating fuel will not only have impacts on energy imports and energy security, but will change the size and shape of energy bills. It will also open doors to a huge range of new technologies and processes. Carbon-free molecules such as hydrogen or ammonia may find uses as new gaseous energy vectors and be pumped through existing gas infrastructure, while the use of technologies that extract heat from the ground or pipe centrally-heated hot water around a pipeline network to heat multiple buildings may increase.

It is, however, difficult to forecast which low-carbon heat technology will be the 'right choice', as different characteristics and costs mean that one system is not ideally suited to all buildings.

But there is one area that all heat policy researchers agree on: before action is taken to decarbonise the supply of heat, policies to reduce the amount of energy that is wasted from buildings are essential.[9] The UK has some of the leakiest homes in Europe, leading to difficulties maintaining comfortable temperatures. This leads to higher bills, increases fuel poverty and results in negative health impacts.[10]

By reducing waste – and with it, demand – the amount of low-carbon heat required to keep the UK warm will plummet, making it easier and cheaper to meet the residual demand with a low-carbon source.

Despite this consensus, action to boost the efficiency of UK homes is no longer a central feature of Government plans, aside from a commitment in the Clean Growth Strategy for which details are yet to be released. The coalition-introduced Green Deal failed to bring about large-scale insulation of UK housing stock,[11] while the recently amended Energy Company Obligation is now only applicable to a small fraction of UK homes.[12]

Back in 2007, however, a policy was announced with the aim of ensuring that all homes built after 2016 would not release any carbon dioxide into the atmosphere during day-to-day operation. Three years later the scope of the policy was reduced to account for regulated energy (space heating, hot water, lighting and ventilation) alone. The original plans would have also included energy used in appliances and cooking.

A vital part of achieving the updated goal was bringing in stringent energy efficiency standards, slashing demand for heating in new-build homes. Further, housebuilders would be responsible for balancing any heating emissions with on-site mitigation measures, such as planting trees.

Three phases of new building regulations, introduced in 2010, 2013 and 2016 would have provided 'steps' to the policy goal, ensuring that housebuilders were not dealt a tranche of new standards on a single date.

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[8] https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes
[9] http://www.ukerc.ac.uk/publications/sustainable-heating-in-the-uk-risks-and-opportunities.html
[10] https://1010uk.org/articles/heating-homes-horrible-truth
[11] https://www.gov.uk/government/news/green-deal-finance-company-funding-to-end
[12] https://www.telegraph.co.uk/business/2018/04/08/government-cools-energy-efficiency-ambition-400-years/

Zero Carbon Homes was put into motion following a lacklustre response to voluntary emissions standards for new buildings,[13] and involved extensive consultation with housebuilders and relevant low-carbon industries to ensure that targets were sensible, meaningful and achievable.

The Government's initial impact assessment concluded that not implementing the Zero Carbon Homes policy would ultimately increase the annual national energy bill, as well as hindering progress towards meeting the UK's climate change targets.[14] It found no evidence that emissions from new homes would fall significantly without government intervention, and concluded that boosting demand for hi-tech houses would develop supply chains useful for exporting to overseas markets.

However, just months before Zero Carbon Home standards were set to come into effect – and despite having been already significantly watered down since initially announced – then-chancellor George Osborne cancelled the policy.[15] Citing extra costs involved in the construction of Zero Carbon Homes, press reports described how Mr Osborne's decision was a result of lobbying from the housebuilding industry, which at the time was pushing for the introduction of Help-to-Buy legislation that has been linked to higher house prices and record profits for the companies involved.[16]

While no longer explicitly on the Government's agenda, Zero Carbon Homes has not been entirely erased from memory.

Labour's recently released 'Green Transformation' includes a plan to reinstate the policy 'as soon as possible',[17] while a 2018 speech from the Prime Minister included a pledge to 'at least halve the energy usage of new buildings by 2030'.[18]

However, either course of action, even if implemented, clearly means that a generation of new homes is missing out on improvements due under the original 2016 target.

Measures to improve building efficiency and curb waste also resonate with the public. Surveys carried out by the Government show constantly high support for policies that reduce heat waste,[19] while polling carried out by conservative think-tank Bright Blue also shows strong support for improving building efficiency among Conservative Party voters.[20]

This report analyses the cost of the decision to scrap Zero Carbon Homes, using the most up-to-date Governmental and other publically available data, alongside projections into the future. It reveals the cumulative extra energy costs that the decision to scrap the scheme levied on owners of new-build homes constructed in England, and the amount of natural gas that has been burnt to meet this 'unnecessary' demand.

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[13] https://ac.els-cdn.com/S0301421515000063/1-s2.0-S0301421515000063-main.pdf?_tid=ba28bf9c-0dd6-4430-aeca-6020414a1d8e&acdnat=1536570221_6530954f125cf9015ee0c1c6cca19022

[14] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/6288/1905485.pdf

[15] researchbriefings.files.parliament.uk/documents/SN06678/SN06678.pdf

[16] https://www.ft.com/content/5a2171aa-a778-11e7-93c5-648314d2c72c

[17] https://www.labour.org.uk/wp-content/uploads/2018/09/The-Green-Transformation-.pdf

[18] https://www.gov.uk/government/speeches/pm-speech-on-science-and-modern-industrial-strategy-21-may-2018

[19] https://www.gov.uk/government/statistics/beis-public-attitudes-tracker-wave-26

[20] https://brightblue.org.uk/wp-content/uploads/2017/04/Green-conservatives-polling-report-Final.pdf

It extrapolates recent data to forecast cumulative financial and fuel costs going forwards, before drawing comparisons with market-leading 'Passivhaus' standards. It highlights that the cancellation of Zero Carbon Homes not only increased the fuel bills of affected households, but also led to significant amount of wasted fossil fuel, thereby increasing historic and future CO_2 emissions and making it more difficult for the UK to achieve its climate change targets.

Historical Costs

To meet the Zero Carbon Homes standard, new homes would require extensive insulation to reduce heat loss from walls, roofs and windows. The Government-backed 'Zero carbon hub', set up to liaise with the housebuilding industry and advise on standards, recommended a maximum space heating and cooling energy demand of 39-46 kWh/m^2/year.[21] For comparison, data from the Housebuilders Federation shows that the average space heating demand of the existing housing stock is nearly 300 kWh/m^2/year.[22]

The space heating and cooling demand of a property shows how much energy is needed to maintain a comfortable internal temperature. It is influenced by a number of factors; the speed at which heat is able to move through the building fabric (the U-value), wall permeability, and thermal bridging (links between rooms through which warm or cool air can travel), among others.[23]

This boost in efficiency would have slashed the amount of energy needed to keep new English homes warm. Since the beginning of 2016, more than 380,000 new homes have been built in England,[24] each of which would have adhered to Zero Carbon Home standards had the policy not been cancelled. Instead, data from the Housebuilders Federation shows that – while more efficient than the existing housing stock – the heating efficiency of new-build homes falls short of that needed to meet Zero Carbon Home standards.[25]

Current new-build homes can require 60% more energy to heat than an average Zero Carbon Home would have done.[26] Based on a steadily growing number of new builds, this equates to an additional 1-1.4 TWh of natural gas burned in heating from 2016 to the end of Q2 2018.[27] Calculations in this report assume that natural gas remains the main source of energy for heat, with emissions abated through either on-site or off-site measures, in accordance with Zero Carbon Homes standards.

Based on current retail gas prices, this extra heating demand will have cost a cumulative £43-58 million. Families who moved into their new homes since the start of 2016 will have been paying up to £198 more per year to heat their homes than if their home had been built to Zero Carbon Homes standards (table 1).[28] This is significantly greater than proposed average savings from the freshly-introduced Energy Price Cap (£76 per year), although it will affect a smaller number of households.

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[21] http://www.zerocarbonhub.org/zero-carbon-policy/fabric-energy-efficiency-standard
[22] https://www.hbf.co.uk/documents/7273/HBF_Report_-_YOUVE_GOT_THE_POWER_-_OCT_FINAL.pdf
[23] https://repository.uwl.ac.uk/id/eprint/4748/12/2%20AER7N636C.PDF
[24] Latest available data to end-Q2 2018
[25] https://www.hbf.co.uk/documents/7273/HBF_Report_-_YOUVE_GOT_THE_POWER_-_OCT_FINAL.pdf
[26] Average real-world space heating demand for new homes is 64 kWh/sq m/year (HBF data), compared with 39-46 kWh/sq m/year figure (from Zero Carbon Hub SAP calculations)
[27] Assuming heat provided by natural gas, with carbon abated. See methodology for further details
[28] See methodology for further details

Property type	Additional annual spend on energy bills
Flat	£55-75
Terrace home	£88-119
Large family home	£146-198

Table 1: Expected annual savings on energy bills for flats, terraced homes and larger family homes.[29]

The savings on energy costs would more than compensate for the extra costs of building to higher standards within a few years, even if it was passed onto consumers through a higher sale price. A 2016 study conducted for the Greater London Authority pegged the costs of meeting tighter Zero Carbon Home standards at 1.0-1.6% of build costs (equivalent to £980-£2,700 for an average three-bed semi-detached property).[30]

For contrast, research by the Resolution Foundation found that the average price of a new-build home increased by more than £50,000 since Help to Buy was introduced in early 2016.[31] A more recent study found that the Help to Buy scheme led to an 8% inflation in the cost of a new home.[32] These figures are significantly higher than the additional costs of bringing a new property up to Zero Carbon Homes standards during its construction, suggesting that the extra cost would have had minimal impact on the affordability of new homes.

It can also be argued that the sale price of a new home is dictated by wider trends, such as the levels of supply and demand in the housing market. As such, it is entirely possible that the additional cost of building Zero Carbon Homes would be absorbed by the developer.

The cancellation of Zero Carbon Homes will have also affected the UK's carbon emissions and, therefore, its progress towards meeting legally binding carbon budgets. The Energy Saving Trust has estimated that more than 43 million tonnes of avoidable carbon dioxide may be emitted from the UK's housing stock by 2050 if an effective efficiency policy is not implemented.[33]

Research by the Oxford Institute of Energy Studies found that the carbon emissions created by burning natural gas in modern boilers is in the range of 230-318 gCO_2/kWh.[34] Based on this figure, the additional emissions to the end of Q2 2018 caused by 'unnecessary' heating demand totalled 320,000-430,000 tonnes (0.32-45 $MtCO_2$) – equivalent, for example, to around 5% of national agricultural emissions.

29 Floor orea of flat assumed at 75 sq m, terrace home 120 sq m and family home 200 sq m
30 https://www.theccc.org.uk/wp-content/uploads/2016/10/Next-steps-for-UK-heat-policy-Committee-on-Climate-Change-October-2016.pdf There are slight discrepancies between GLA zero carbon home standards and those that were set to be implemented nationally, but it is not expected they would make a material difference to this figure.
31 https://www.which.co.uk/news/2018/09/is-help-to-buy-really-set-to-close/
32 https://www.propertywire.com/news/uk/using-help-to-buy-allows-first-time-buyers-to-buy-more-expensive-properties/
33 http://www.energysavingtrust.org.uk/clean-growth-plan-2050-ready-new-build-homes-policy
34 https://www.oxfordenergy.org/wpcms/wp-content/uploads/2018/09/OEF-116.pdf

FORECASTS

Assuming the current housebuilding rate of 38,000 homes per quarter continues into the future, by the end of 2020 the cost of scrapping Zero Carbon Homes – the cumulative cost of 'wasted' energy used to heat 'inefficient' new homes – will be between £770 million and £1 billion. The UK's housing stock will have burnt more than 21TWh of gas that it did not need to. This is the same amount of gas needed to fuel 1.4 million homes for a year.[35]

Based on average additional costs calculated earlier, the additional expense incurred by home-owners to 2030 in heating a new home occupied from the start of 2016 could be as high as £2,700 (Table 2). Were the additional cost of improving building standards passed on to the buyer, they would have been largely paid off during this decade. On top of this, lower bills would be locked in for the remainder of the property's lifetime.

The government has announced plans to halve the energy consumption of new homes by 2030. Based on the findings of this analysis, this delay would be costly.

Property type	Extra cost to heat by 2030
Flat	£770-1050
Terrace home	£1232-1666
Family home	£2044-2772

Table 2: Forecast savings on energy bills to 2030 for flats, terraced homes and larger family homes occupied since the start of 2016.

PASSIVHAUS

Despite being far more efficient than non-regulated new-build homes, Zero Carbon Homes standards are far from market-leading. The energy needed to heat a home built to Passivhaus standards is calculated at just 15 kWh/m^2/year, around one-third that of Zero Carbon Homes. Such low heating demand means Passivhaus homes can often be built without a heating system.

Passivhaus is an optional standard, yet is becoming increasingly popular. Globally, more than 65,000 homes have been built to Passivhaus standards.[36] Had Passivhaus been adopted in the UK in 2016, the cumulative heating bill to date of an average 100m^2 home would have been £109 million lower, rising to more than £1.8 billion by the end of 2020. The cumulative gas saving would also be significantly higher, at 44 TWh.

[35] Based on current BEIS (temperature adjusted) consumption figures of 14,011 kWh per year.
[36] http://www.passivhaustrust.org.uk/what_is_passivhaus.php

CONCLUSIONS

The UK remains heavily dependent on natural gas. By cancelling the Zero Carbon Homes policy months before it was due to come into effect, the difficulty of reducing emissions associated with heating English homes has increased, and will continue to increase as long as this policy gap remains unfilled.

In the absence of the Zero Carbon Homes policy, more than £58 million extra has been spent on heating less efficient homes than would have been needed had the policy been brought into effect. This corresponds to 1-1.4 TWh of natural gas, or the annual consumption of 1.3 million homes by the end of 2020. Each new-build home in existence today will cost up to £198 more per year to heat, significantly more than the average intended £76 saving from the Government's price cap.

Looking ahead, as the number of less efficient homes grows, so does the additional annual demand for heat. On current home building trends, more than 21 TWh of natural gas will have been wasted by 2020, adding £1 billion onto the cumulative cost of keeping British homes warm. By 2030, the cost of keeping a new home moved into at the start of 2016 warm will be up to £2,700 more than it would be had the home been constructed to Zero Carbon Home standards.

The consensus among academics and policy makers is that reducing demand through energy efficiency is the first action that should be taken in the quest to decarbonise heating supply in the UK. This task will be made increasingly difficult with the construction of each new home that consumes more energy than it needs to.

APPENDIX – METHODOLOGY

All figures in this report are taken from official Government releases, unless stated otherwise – with the most recent values covering the first two quarters in 2018. It is assumed that gas is still used to heat zero carbon homes, with emissions offset through on- or off-site mitigation measures. This is expected to change as zero carbon heating systems fall in cost and are installed in a greater number of homes, but current technologies mean that non-natural gas energy vectors are unlikely to make up a significant amount of the market currently. For an average home size of 100m^2, the following average quarterly heat energy demand were used:

	Quarterly consumption (kWh, 100m^2)
New build	1650
Zero Carbon Home (lower)	975
Zero Carbon Home (upper)	1150
Passivhaus	375

Real world energy use figures are used for homes built post-2016, compared with projected use derived from SAP calculations carried out by the Zero Carbon Hub.

Retail gas price assumed at 4.2p/kWh, with 38,000 homes built per quarter based on average build figures from Q1 2016 – Q1 2018. Forecasts based on current build levels continuing at the same rate (based on quarterly average since Q1 2016).