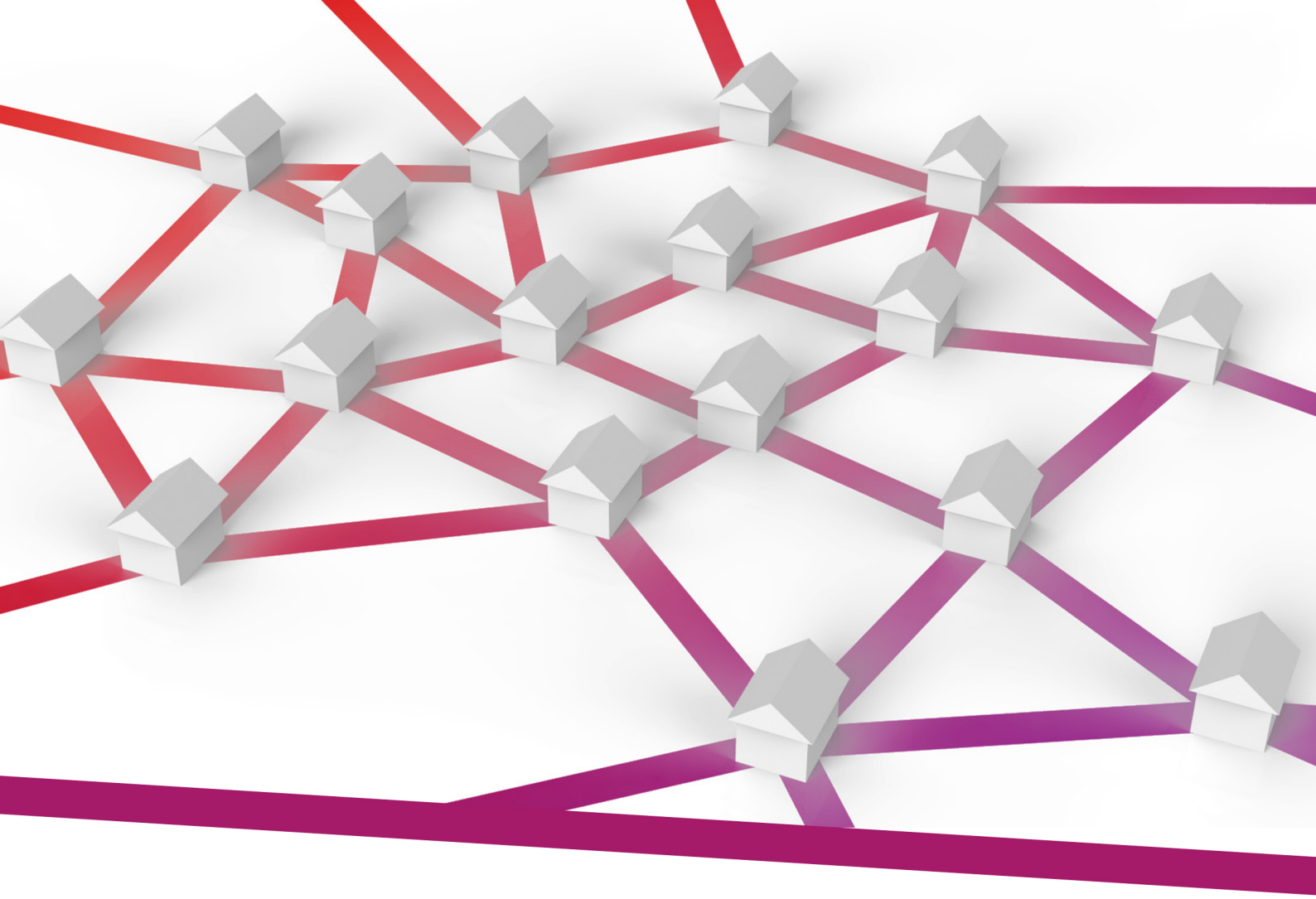

Connecting Homes for Health

Bringing affordable warmth to vulnerable off-gas households

Phase 1 review

NEA

Action for Warm Homes

Prepared by National Energy Action (NEA) for Northern Gas Networks (NGN)

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Glossary of Terms

FPNES	Fuel Poor Network Extension Scheme
ADRD	Alzheimer's Disease or Related Dementias
CHD	Coronary Heart Disease
CHP	Central Heating Programme
CIEH	Chartered Institute of Environmental Health
CMD	Common Mental Disorder
COPD	Chronic Obstructive Pulmonary Disorder
DBEIS	Department for Business, Energy and Industrial Strategy
ECO	Energy Company Obligation
EPC	Energy Performance Certificate
EST	Energy Saving Trust
GDN	Gas Distribution Network
HHSRS	Housing Health and Safety Rating System
HIA	Home Improvement Agency
HTT	Hard to Treat
IMD	Index of Multiple Deprivation
NICE	National Institute for Health and Care Excellence
Ofgem	Office of Gas and Electricity Markets
PHE	Public Health England
PHOF	Public Health Outcomes Framework
SAP	Standard Assessment Procedure
SCD	Sickle Cell Disease
WHO	World Health Organisation

Executive Summary

- This review has been prepared by National Energy Action (NEA) for Northern Gas Networks (NGN) with the intention of identifying a possible pathway for piloting revised and more inclusive criteria for connecting vulnerable households to the gas network. Such a pilot would go beyond currently eligibility criteria for the Fuel Poor Network Extension Scheme, and represents a voluntary and proactive move on the part of NGN.

- Households which are off the gas grid are some of the coldest and most energy inefficient in the UK, as well as some of the most expensive to heat. Many people living in such properties struggle to meet their energy needs for comfort and warmth, and are at risk from cold-related ill health. Connecting them to the gas grid could potentially bring threefold benefits relating to health, fuel poverty and carbon reduction.

- The current Fuel Poor Network Extension Scheme (FPNES) RIIO-GD1 Regulatory Framework will run until 2021, thus providing an opportunity for Gas Distribution Networks to assess whether current obligations for connecting fuel-poor households are able to cover the wider range of vulnerabilities which living in a cold home can cause or exacerbate, and which providing a gas grid connection could help alleviate. It is an opportunity to assess how far current frameworks address and capture additional indicators, such as health and wellbeing or environmental benefits.

- Whilst it is difficult to conclusively identify the direct, causal pathways of the relationship between cold homes and ill health, the fact that such a relationship does exist has nevertheless been strongly and repeatedly documented within the literature, and has been officially recognised by public bodies such as NICE and Public Health England (PHE). Narrative synthesis of the evidence makes clear the strong relationship that exists between cold homes and health.

- Cold and damp housing conditions have been shown to impact upon both excess winter mortality *and* morbidity. Studies have found that countries which experience harsher winters with lower outdoor temperatures than the UK actually experience fewer excess winter deaths, and have lower rates of excess winter morbidity, especially in relation to respiratory conditions. Various authors have argued that this is linked to the higher thermal efficiency standards of buildings in those countries, and correspondingly poor thermal standards within the UK housing stock. Across the UK, cold related morbidity and mortality are manifested at the general population level.

- Living in a cold and damp home has been shown to be strongly associated with the experience of respiratory disease amongst children and the elderly, and amongst those who are already suffering from chronic respiratory conditions. There is also a suggestion that cardio-respiratory responses to the cold might act to increase the risk of cardiovascular disease. Whilst findings from intervention studies have tended to rely on self-reported easing of symptoms, they nevertheless suggest the potential for significant and relatively

fast improvements to child health. Self-reported improvements to health in adults in themselves indicate at the very least an improvement in quality of life and perceived wellbeing, an outcome which should not be taken lightly. Whilst other confounding variables undoubtedly have an impact both on vulnerability to respiratory disease and the likelihood or extent of health improvements being made, the evidence base makes clear that cold homes are very likely to be amongst those variables which contribute to respiratory ill health in the first place.

- Whilst cardiovascular disease risk is multi-factorial, the relationship between it and the experience of cold both at a general population level and in studies assessing individual physiological response to the cold has nevertheless been repeatedly shown. The evidence base to date suggests that living in a warm home heated to recommended temperature thresholds might act to *mitigate* an individual's *susceptibility* to suffering from cardiovascular disease, lessening their vulnerability from that which it might have been had they regularly experienced colder indoor temperatures.

- The provision of affordable warmth to households can greatly act to reduce mental ill health and stress via a variety of routes. These include feeling warmer and more comfortable at home, worrying less about fuel bills and the cost of heating, having more control over a heating system, feeling less socially isolated and enabling a change in familial relationship dynamics through increased use of space within the home.

- Survival strategies employed by households trying to cope with cold homes and high energy costs can engender further knock-on effects on their health and wellbeing beyond that of the immediate physiological or psychosocial response to the cold.

- There exists a tension between targeting for health alone, and targeting to address vulnerability in the more complex sense. Interventions might seek to achieve significant health outcomes that are manifest at population level through a blanket targeting approach. Or, they might direct help at those households who are most vulnerable (in terms of deprivation) and who are least able to pay. This approach risks missing some households who are not deprived but nevertheless suffer from cold-related health conditions in an attempt to combine potential health gains with a reduction in deprivation (including the experience of fuel poverty). At the same time, restricting the target population to only those households that would qualify for help under the FPNES as it currently stands would still miss a significant number of low income, vulnerable households who are in or at risk of fuel poverty and who are suffering from the health impacts of living in a cold home.

- Given that excess winter mortality tends be associated with energy inefficient properties, and the provision of gas central heating can act to improve the SAP rating of a property, then providing gas grid connections and first time gas central heating could have the potential to achieve outcomes of interest to both the health and climate change agendas.

- Lessons from current best practice schemes tell us that evaluation of an intervention needs to be both realistic in terms of the outcomes it can expect to achieve from the outset, whilst employing a mixed-methods approach that can attempt to capture outcomes across a range of individual and population-level metrics. Importantly, it needs to allow for the influence of other confounding variables and, where possible, occur over a prolonged period of time.

- The review finds that off-gas households are some of the most energy inefficient properties in the country, contributing significantly to domestic sector carbon emissions. They are also some of the most expensive to heat, meaning that a significant proportion of off-gas households are in fuel poverty. They are therefore more likely to experience colder indoor temperatures which, as this review has shown, are a risk factor for respiratory and cardiovascular disease, mental ill health, and a range of other associated health conditions. A potential widening of FPNES criteria might therefore achieve additional health and environmental outcomes for households who are vulnerable and either in or on the edge of fuel poverty, but who fall outside the scope of current eligibility requirements.

Section 1: Introduction

The following review has been prepared by National Energy Action (NEA) for Northern Gas Networks (NGN) with the intention of identifying a possible pathway for piloting revised and more inclusive criteria for connecting vulnerable households to the gas grid. Such a pilot would go beyond currently eligibility criteria for the Fuel Poor Network Extension Scheme, and represents a voluntary and proactive move on the part of NGN. It relates to the need to develop a means of more effectively identifying and engaging with vulnerable households who may be suffering from the health impacts of living in a cold home, and to design interventions that provide appropriate assistance for those who are vulnerable but fall outside the eligibility criteria of current mandated energy efficiency schemes.

It also speaks to the need to identify ways in which specific bodies (in this case, Gas Distribution Networks (GDNs), can apply the NICE NG6 guideline on tackling excess winter deaths and the health impacts of living in a cold home. It is a means through which GDNs can contribute to the practical integration of preventative work to treat cold homes, as a social determinant of health, with the alleviation of associated clinical pressures on the health service. It therefore integrates GDNs and their service offerings for vulnerable consumers into a pathway for reducing fuel poverty and achieving Public Health and NHS outcomes.

The design of the pilot scheme will be informed by the information contained within this review, and will aim to:

- Test and measure the impact of applying health based and environmental eligibility criteria to the provision of gas grid connections and first time gas central heating measures on the health and wellbeing of vulnerable residents, as well as the energy efficiency of some of the most thermally inefficient housing stock in the UK (those that are off-gas)
- Integrate good practice application of NICE NG6 across sectors and develop recommendations for gas grid connection procedures which encompass a wider range of vulnerabilities associated with living in a cold home, rather than focussing on more narrow indicators of need
- Identify and set out a pathway for enabling the incorporation of health-based and environmental eligibility criteria into the Fuel Poor Network Extension Scheme (FPNES) following the end of the current RIIO-GD1 price control mechanism in 2021

The pilot will seek to achieve a number of outcomes, including:

1. Enable recommendations for the expansion of the FPNES eligibility criteria so that vulnerable households that fall outside the limits of current support can be helped
2. Enable recommendations for the improved targeting of central heating programmes (such as ECO)
3. Possible improved efficiencies for the delivery of the FPNES

4. The ability to safeguard households at risk of falling into fuel poverty in the future is improved
5. NICE recommendations for cross-sector partnerships that deliver on cold-related ill health outcomes are put into practice
6. Health and environmental improvements that can be achieved through combining gas grid connections with the provision of first time gas central heating measures are assessed and showcased through a practical pilot project
7. The evidence base to support calls for current mandated schemes (such as ECO) to fund central heating measures that match targets set under the FPNES is enhanced

This review represents the first stage in assessing the potential for incorporating health-based and environmental eligibility criteria into current gas grid connections procedures. It sets out the necessary background information that will inform the design of a pilot scheme to test them.

The document is divided into a number of sections. Section 1 sets out the background policy context within which the need to pilot revised eligibility criteria for the FPNES has become apparent. Section 2 then provides an overview of the known health and environmental impacts of cold and energy inefficient housing (especially in relation to properties that are off-gas), and explains why the extent of vulnerable individuals suffering from cold-related ill health may be greater than the population that falls within current eligibility criteria for the FPNES. It begins with a discussion of the state of current evidence regarding the health impacts of living in a cold home, before moving on to discuss in more detail the relationship between cold homes and: excess winter deaths, cardiovascular disease, respiratory disease, mental ill health, and other physical health conditions. It also discusses the complexities of targeting for health versus targeting according to multiple social vulnerabilities. Finally, the overlapping nature of the potential health and environmental outcomes of improving the energy efficiency of a dwelling via the provision of a gas grid connection and first time gas central heating measures are discussed.

Section 3 reviews existing health-based affordable warmth schemes. It explores how they have deployed particular targeting strategies, and how they have measured potential health or environmental impact. A number of case studies of good practice affordable warmth schemes are provided based on telephone interviews carried out with the scheme providers. The section provides practical insights as to why other schemes have found a widening of eligibility criteria to be beneficial to vulnerable households, and what considerations need to be made both in terms of the targeting techniques used and the type of outcomes that can realistically be measured following an intervention.

Section 4 provides a summary conclusion which sets out the case for piloting revised eligibility criteria for the FPNES.

1.1 Background

Households which are off the gas grid are some of the coldest and most energy inefficient in the UK, as well as some of the most expensive to heat. Many people living in such properties struggle to meet their energy needs for comfort and warmth, and are at risk from cold-related ill health.

Around half of the homes that fall into EPC[1] Bands F or G lack gas- or oil- fired central heating systems. These households are often reliant on more expensive fuels such as electricity, or costly fuels from unregulated sectors including oil, LPG or solid fuel. This means consumers can be excluded from engaging with the competitive energy market and accessing the cheapest deals or tariffs. In fact, having no access to mains gas in rural areas results in an estimated energy spend which is 40% higher than for households connected to the grid. [2] [3] [4] [5] Off-grid households might also be prevented from accessing the support which regulated suppliers are obligated to provide, such as the Priority Services Register.

Properties in Bands F and G have the worst thermal efficiencies within the UK housing stock, and generate more CO_2 emissions to maintain the same level of heat as a more energy efficient property.[6] They are also most likely to represent a Category 1 hazard for excess cold under the HHSRS. [7] [8] Households that are off the gas grid are 1.5 times more at risk of fuel poverty than those with a gas mains connection. Around 75% of households that are in fuel poverty live in E, F or G banded properties, and between them account for 90% of the fuel poverty gap. [9] [10] Of the F and G rated households in fuel poverty, 70% are off the gas grid network.[11]

Households that are off the gas grid have an average fuel poverty gap of £705. Those that are not connected to the gas network *and* live in rural areas have an average fuel poverty gap of £800.[12] This can rise in some households to increased spending on fuel of over £1,000. The Energy and Utilities Alliance estimates that providing a gas grid connection can bring bill savings of up to £1,843 per household, and reduce fuel poverty risk by up to 64%.[13] Whilst not all those living in Band F and G households will be in fuel poverty, such households are likely to demonstrate vulnerability to fuel

[1] An EPC is an Energy Performance Certificate. This contains information about the energy costs and energy use of a property, as well as recommending ways to improve its energy efficiency. It gives a property an energy efficiency rating from A (most efficient) to G (least efficient). These are calculated using SAP (Standard Assessment Procedure) scores, which assess the environmental and energy performance of a building.

[2] Grey, C., Jiang, S., and Poortinga, W. 2015, Arbed recipient's views and experiences of living in hard-to-heat, hard-to-treat houses in Wales: results from three focus groups conducted in South Wales, Welsh school of Architecture, Cardiff University: Cardiff WSA Working Paper Series ISSN 2050-8522

[3] Rural Services Network for the Commission for Rural Communities (2010) Understanding the real depth and impact of fuel poverty in rural England.

[4] Energy & Utilities Alliance, Jan 2017, Fuel Poverty – A Connected Solution. Available at http://eua.org.uk/uploads/587C9C8C18F22.pdf [Accessed 17/01/2017]

[5] Shortt, N. and Rugkåsa, J. 2007. "*The walls were so damp and cold" Fuel Poverty and Ill Health in Northern Ireland: Results from a housing intervention.* Health and Place. 13 (1) pp. 99-110.

[6] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[7] Jones, E., 2008. Tackling Fuel Poverty Using the Housing Health and Safety Rating System. Energy Efficiency Partnership for Homes, London

[8] Energy & Utilities Alliance, Jan 2017, Fuel Poverty – A Connected Solution. Available at http://eua.org.uk/uploads/587C9C8C18F22.pdf [Accessed 17/01/2017]

[9] Hills, J (2012) Getting the Measure of Fuel Poverty: Final Report of the Fuel Poverty Review. Centre for Analysis of Social Exclusion: Case Report 72

[10] Guertler P and Preston I (2009) Raising the SAP: Tackling fuel poverty by investing in energy efficiency. Consumer Focus.

[11] Hills, J (2012) Getting the Measure of Fuel Poverty: Final Report of the Fuel Poverty Review. Centre for Analysis of Social Exclusion: Case Report 72

[12] Hills, J (2012) Getting the Measure of Fuel Poverty: Final Report of the Fuel Poverty Review. Centre for Analysis of Social Exclusion: Case Report 72

[13] Energy & Utilities Alliance, Jan 2017, Fuel Poverty – A Connected Solution. Available at http://eua.org.uk/uploads/587C9C8C18F22.pdf [Accessed 17/01/2017]

poverty in the future should their circumstances change or income fall. Improving the energy efficiency of homes to the extent that it would be very difficult for a household to fall into fuel poverty is known as fuel poverty proofing, and estimates suggest that around 83% of households could be lifted out of fuel poverty by raising all properties in England to EPC Band B, or SAP 81.[14] Providing a gas grid connection and gas central heating measures can allow households to access cheaper energy, enable them to heat their homes to an adequate level (at a more affordable cost) and engage with the competitive energy market.

Households without access to central heating are 30% more likely to report health problems than those that do. [15] The provision of gas central heating has been shown to increase indoor temperatures by 1.89°C, and when combined with the provision of insulation this increases to 2.83°C. [16] Connecting a household to the gas grid could therefore potentially bring threefold benefits relating to health, fuel poverty and carbon reduction.

Since 2008, GDNs have been obliged to provide fuel poor households with a gas grid connection (where a gas connection is considered to be most appropriate means of assistance) under the Fuel Poor Network Extension Scheme RIIO-GD1.[17] Under the scheme, GDNs and IGTs (Independent Gas Transporters) work with partner organisations to help eligible households to switch to a natural gas or a heat network, and provide funding to cover connection costs. The average cost for connecting a household to the gas network is around £1,200, though homes which are closer to the grid can be connected more cheaply than those at a greater distance (around half of the households currently off the gas grid in Great Britain are within 23 metres of the mains network, and 80% are within half a kilometre [18]). It is a requirement of the scheme that funding be secured to cover the cost of installing a first-time gas central heating system in a property that is due to be connected to the grid. This includes the provision of a gas boiler, radiators, heating controls and internal pipework. However, many vulnerable and fuel poor households would be unable to meet the cost of installing a new central heating system themselves (between £2,000 and £4,000 per household) and so funding needs to be sourced from national schemes such as ECO (Energy Company Obligation). This can prove to be a lengthy process given that the FPNES is operated by Ofgem, and ECO by DBEIS (Department for Business, Energy and Industrial Strategy). Ofgem has set a target of connecting 91,203 households between 2013 and 2021 under the FPNES. However, a recent report by NEA found that schemes such as ECO are failing to support non-gas households in accessing first time gas central heating due to a prioritisation of low cost boiler replacements in on-gas properties within the Affordable Warmth element of the scheme. Difficulties in securing funding to cover the cost of central heating measures have led to a drop in the numbers of homes that are connected to the gas

[14] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[15] Barnes, M. et al., (2008). *The Dynamics of Bad Housing : The Impacts of Bad Housing on the Living Standards of Children.* London : National Centre for Social Research.

[16] Hong, S.H., Gilbertson, J., Oreszczyn, T., Green, G., Ridley, I., the Warm Front Study Group, 2009. The correlation between temperature measure and perception of thermal comfort: a field study of thermal comfort in low-income dwellings in England before and after energy efficient refurbishment. Building and Environment 44 (2009), 1228–1236.

[17] Ofgem (2016) Fuel Poor Network Extension Scheme [Online]. Available: https://www.ofgem.gov.uk/ofgem-publications/96992/486fuelpoornetworksextensionschemefactsheetv3-pdf [Accessed 26/08/2016].

[18] Energy & Utilities Alliance, Jan 2017, Fuel Poverty – A Connected Solution. Available at http://eua.org.uk/uploads/587C9C8C18F22.pdf [Accessed 17/01/2017]

grid through the FPNES since 2011/12[19]. Indeed, the Energy Utilities Alliance is making calls for the two schemes to work together in providing off-grid homes with a first time connection and central heating system. [20]

For a household to be considered for assistance under the Fuel Poor Network Extension Scheme, they must meet the following criteria:

- Live within the 25% most deprived areas in the UK, according to the Index of Multiple Deprivation (IMD)[21]
- Be eligible for support under the ECO Home Heating Cost Reduction Obligation (HHCRO) (Great Britain), Nest in Wales or the Home Energy Efficiency Programmes in Scotland. HHCRO eligibility requires that a household be in receipt of specified state benefits in order to access support.
- Be in fuel poverty based on the definition or indicator formally adopted by each nation.[22]

The current FPNES RIIO-GD1 Regulatory Framework will run until 2021, thus providing an opportunity for interested organisations to assess whether the obligations for connecting fuel-poor households as they stand are able to cover the wider range of vulnerabilities which living in a cold home can cause or exacerbate, and which providing a gas grid connection could help alleviate. It provides an opportunity to assess how far current frameworks enable and capture additional indicators, such as health and wellbeing or environmental benefits.

This coincides with a number of strategic recommendations and targets that have been released by official bodies. In terms of health and wellbeing, it overlaps with the release of the 2015 National Institute for Health and Care Excellence (NICE) guideline on excess winter deaths and illness and the health risks associated with cold homes (NG6)[23], as well as the publication of the NHS Five Year Forward Plan (2014)[24].

1.12 Health eligibility

The evidence review conducted by NICE highlights the significant impact which living in a cold home can have on health, and provides a number of recommendations to: meet a range of public health outcomes included under the Public Health Outcomes Framework (PHOF); improve the health and

[19] NEA (2017) In from the cold: The funding gap for non-gas fuel poor homes under ECO and a proposal to fill it. National Energy Action for the Gas Distribution Network Companies: National Grid Gas Distribution, Northern Gas Networks, SGN and Wales and West Utilities

[20] Energy & Utilities Alliance, Jan 2017, Fuel Poverty – A Connected Solution. Available at http://eua.org.uk/uploads/587C9C8C18F22.pdf [Accessed 17/01/2017]

[21] As of march 2017, Ofgem was consulting on proposed changes to current eligibility criteria for the FPNES, to reflect the removal of the Carbon Saving Community Obligation (CSCO) from ECO. The proposed changes would remove the requirement for a household to live within the 25% most deprived areas in the UK, according to the IMD

[22] Fuel poverty in England is measured using the Low Income High Costs (LIHC) indicator. A household is considered to be fuel poor if they have required fuel costs that are above average (the national median level) and, were they to spend that amount, they would be left with a residual income below the official poverty line. In Scotland, Wales and Northern Ireland a household is considered to be in fuel poverty if they spend 10% or more of their household income on energy.

[23] NICE. 2015. *Excess winter deaths and illness and the health risks associated with cold homes* [Online]. Available: https://www.nice.org.uk/guidance/ng6 [Accessed 20/03/ 2017].

[24] NHS. 2014. *Five year forward view* [Online]. Available: https://www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf [Accessed 20/03/2017].

wellbeing of vulnerable[25] groups living in cold homes; and help to relieve pressure on health and social care services (see Fig 1). It is important to note here that cold homes will impact upon both the NHS and Social Care Outcomes Frameworks as the issue is cross cutting, and embraces the two.

Fig 1. NG6 recommendations

Recommendation	Who Should Take Action
1. **Develop a strategy** to address the health consequences of cold homes	Health and wellbeing boards
2. Ensure there is a **single point of contact** health and housing **referral service** for people living in cold homes	Health and wellbeing boards
3. **Provide tailored solutions** via the single point of contact health and housing referral service for people living in cold homes	Health and wellbeing boards; local authorities; housing providers; energy utility and distribution companies; faith and voluntary sector organisations
4. **Identify people at risk** of ill health from living in a cold home	Primary health and home care practitioners
5. **Make every contact count** by assessing the heating needs of people who use primary health and home care services	Primary health and home care practitioners
6. **Non-health and social care workers** who visit people at home should **assess** their **heating needs**	People who do not work in health and social care services but who visit people at home (e.g. meter installers, faith and voluntary sector workers, housing professionals etc.)
7. **Discharge** vulnerable people from health or social care settings **to a warm home**	Secondary healthcare practitioners; social care practitioners
8. **Train health and social care practitioners** to help people whose homes may be too cold	NHS England, universities and other training providers
9. **Train housing professionals and faith and voluntary sector workers** to help people whose homes may be too cold	Training providers (e.g. Chartered Institute of Environmental Health, Chartered Institute of Housing etc.)
10. **Train heating engineers, meter installers and those providing building insulation** to help vulnerable people at home	Employers who install and maintain heating systems, electricity and gas meters and building insulation; training providers
11. **Raise awareness among practitioners and the public** about how to keep warm at home	Health and wellbeing boards; Public Health England; the [former] Department of Energy and Climate Change (N.B. now Department for Business, Energy and Industrial Strategy)
12. **Ensure buildings meet ventilation and other building and trading standards**	Building control officers; housing officers; environmental health officers; trading standards officers

[25] In this context, NICE defines someone as being vulnerable if they: have a cardiovascular, respiratory or mental health condition; have a disability; are 65 and older; live in a household with young children; are pregnant; or live on a low income

Recommendations are targeted at particular organisations: for example, Recommendation 3 (provide tailored solutions via the single point of contact health and housing referral service for people living in cold homes) names health and wellbeing boards, local authorities, housing providers, energy utility and ***distribution*** companies, as well as faith and voluntary sector organisations as being the key actors needing to take action. Similarly, Recommendation 6 also identifies the potential for organisations outside of the health and social care services (which might include distribution companies) to have a role in single point of contact referral services, and Recommendation 10 states that contractors, installers and engineers visiting people at home should be receive training that links cold homes and health. These recommendations clearly show that there is a role for GDNs in implementing the NICE guidance (and, hence, having a role in achieving health outcomes when addressing cold homes).

This also represents a means through which GDNs can engage with (and bridge) those parts of the health sector that address clinical concerns and the social determinants of health, in so far as they coincide with the health impacts of cold homes. For example, the NHS Five Year Forward View emphasises a need to scale up the focus on prevention and public health within current health service delivery.[26] In a context in which pressures upon the NHS are continually increasing, the King's Fund argues that this is to be done by "aspiring to shift investment into the community to provide alternatives to care in hospitals or care homes." [27] As part of this, Sustainability and Transformation Plans (STPs) require local NHS organisations to join together and develop health and care service plans that are 'place-based'. The Kings Fund argues that that shift to place-based planning should include "collaboration with **other services and sectors beyond the NHS** to focus on the broader aim of improving population health and wellbeing – not just on delivering better quality and more sustainable health care services." [28]

In order to engage and bridge this gap, GDNs need to identify where they are able to best deliver appropriate services, and where they can most effectively link with partner organisations in order to bring about health outcomes. Looking to incorporate health-based eligibility criteria into the provision of gas grid connections and first time gas central heating measures under the FPNES could contribute to the delivery of cross-sector actions that address the social determinants of health within the community, ultimately relieving pressure on an already stretched NHS.

1.13 Environmental eligibility

The new Fuel Poverty Strategy for England (2015) sets a target to "ensure that as many fuel poor households as is reasonably practicable achieve a minimum energy efficiency rating of Band C, by

[26] NHS, 2014, Five Year Forward View. Available: https://www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf [Accessed 03/11/2016]
[27] Ham, C., Buckley, T and Baylis, A (The Kings Fund), 2016, Policy Changes to implement the NHS five year forward view: a progress report. Available: https://www.kingsfund.org.uk/projects/five-year-forward-view-progress-report [Accessed 03/11/2016]
[28] The King's Fund, 2016, Sustainability and transformation plans (STPs) explained. Available: https://www.kingsfund.org.uk/topics/integrated-care/sustainability-transformation-plans-explained?gclid=CNGWm5DOjNACFdaRGwodga4KJg [Accessed 03/11/2016]

2030".[29] The strategy states that this target is "in line with the activity required to improve the energy efficiency of the wider housing stock in order to meet our carbon budgets". Since providing a vulnerable household with measures (such as a gas grid connection and gas central heating system) can improve the energy efficiency and SAP rating of a property, there is therefore potential for this overlap between vulnerability and environmental impact to be reflected in schemes such as the FPNES. Incorporating wider environmental eligibility criteria into the scheme could mean that it is more able to simultaneously provide support to vulnerable households and contribute towards UK carbon reduction targets. Indeed, there is a mutuality of outcomes across both agendas which can be achieved through joined up working.

Section 2: Health and environmental impacts of cold and energy inefficient housing

2.1 Cold homes and health

This section provides an overview of the range of physical and mental health conditions that have been associated with the experience of living in a cold home, and the extent of improvements to health that have been shown to occur as a result of energy efficiency interventions. The section identifies possible areas of physical and mental health upon which incorporating new health-based eligibility criteria into the FPNES may have an impact. It also demonstrates why current eligibility criteria for the FPNES may only capture a small proportion of households who are vulnerable to cold related ill health.

2.11 Quality of Evidence

There have been a substantial number of studies carried out to examine the relationship between fuel poverty, cold homes and health. Whilst it is difficult to conclusively identify the direct, causal pathways of this relationship,[30] the fact that such a relationship does exist has nevertheless been strongly and repeatedly documented within the literature, and has been officially recognised by public bodies such as NICE and Public Health England (PHE).

Much of the research carried out around excess winter mortality and morbidity has looked at large, routine data sets at population level, such as hospital admissions data. Evaluations of fuel poverty and housing interventions have tended to take a step-back from the analysis of population-wide trends to look at the more immediate, self-reported health impacts at an individual level (including indicators on physical and mental health and wellbeing).[31] [32] NICE has highlighted a need for intervention studies which combine both approaches (as they are better able to capture a wider

[29] HM Government, 2015, Cutting the Cost of Keeping Warm: A fuel poverty strategy for England. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/408644/cutting_the_cost_of_keeping_warm.pdf [Accessed 03/11/2016]

[30] Shortt, N. and Rugkåsa, J. 2007. "*The walls were so damp and cold" Fuel Poverty and Ill Health in Northern Ireland: Results from a housing intervention.* Health and Place. 13 (1) pp. 99-110. (page 100)

[31] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE) Review 2: Interventions and economic studies. London School of Hygiene & Tropical Medicine, Public Health England, University College London (page 6)

[32] Blackman, T., Harvey, J., Lawrence, M., Simon, A., 2001. Neighbourhood renewal and health: evidence from a local case study. Health & Place 7, 93–103.

range of health outcomes over both the short and long term), and which are large enough to give a sample size from which statistical significance can be derived.[33] Thomson and Petticrew similarly argue that studies seeking to demonstrate the effectiveness of interventions should take a holistic, mixed-methods approach employing both quantitative and qualitative techniques, as well as accounting for other confounding factors[34].

One of the charges made against the existing evidence base is that the range of methodologies used does not allow for an objective comparison of approaches, and so our ability to conclusively identify what works best, and where most impact can be achieved, is limited[35] [36]. A review carried out by PHE, for example, came to conflicting conclusions. In the first instance it states that "there is strong evidence that cold homes have a harmful effect on health, and there are good recommendations on home temperature thresholds in winter". However, directly following this it states "the findings of this literature review demonstrate that there is very limited robust evidence on which to base these recommendations." The basis of such conflicting conclusions arises from the fact that there have been very few randomised controlled trials, cohort or case control studies to demonstrate the relationship between cold homes and health to date. Most studies have been cross-sectional and conducted using a wide range of sample sizes and measurement techniques. Observational studies that measure the physiological effects of temperature change in the home have either done so using one-off temperature recordings that do not account for environmental or behavioural changes in exposure, or have been conducted in artificial, lab-based conditions that may not accurately reflect conditions or behaviours at home. Others have not have adjusted for other confounding variables such as smoking or pre-existing medical conditions[37]. Significant ethical problems also arise from the use of control groups in intervention studies, where denying potentially vulnerable individuals access to interventions that may be of benefit to their health would not be appropriate.[38]

However, it is important to note that whilst the methods used in intervention studies have varied significantly on the ground, this is not to say that such studies do not reflect good practice, or that that they have not employed innovative forms of intervention and measurement techniques. Often such schemes reflect new, coordinated initiatives at a local level, and have demonstrated impact within the confines of that particular study population.[39]

Most of our knowledge of the health outcomes of energy efficiency and fuel poverty interventions to date is qualitative, whilst quantitative methods have mainly been used in small-scale studies to

[33] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE) Review 2: Interventions and economic studies. London School of Hygiene & Tropical Medicine, Public Health England, University College London (page 41)

[34] Thomson, H., Petticrew, M., Morrison, D., 2001. Health effects of housing improvements: systematic review of interventionstudies. British Medical Journal 323, 187–190 (page 189)

[35] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 3: Delivery and implementation of approaches for the prevention of excess winter deaths and morbidity (2014) London school of Hygiene & Tropical Medicine, Public Health England, University College London. (page 27)

[36] NICE: Excess winter deaths and morbidity and the health risks associated with cold homes. Steve Morris, Public Health Advisory Committee C. PHE National Cold Weather Plan: Annual Seminar 2015, 7th July

[37] Public Health England, 2014b. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright. (page 55)

[38] Rudge J and Gilchrist R (2007) Measuring the Health Impacts of Temperatures in Dwellings: Investigating excess winter morbidity and cold homes in the London Borough of Newham. *Energy and Buildings*, 39, pp.847–858. (page 848)

[39] NICE: Excess winter deaths and morbidity and the health risks associated with cold homes. Steve Morris, Public Health Advisory Committee C. PHE National Cold Weather Plan: Annual Seminar 2015, 7th July

demonstrate health risk as an effect of cold indoor or outdoor temperatures, or to analyse larger population level data sets in relation to excess winter mortality and morbidity.[40] PHE argues that, whilst the findings of similar studies are consistent and support those of larger studies, they are too small as stand-alone research pieces to be able to make significant generalisations. However, despite such reservations around the robustness of the evidence base to date, PHE still felt it to be strong enough to warrant recommending a minimum indoor temperature threshold of 18°C[41]. This is where the tension involved in assessing the evidence arises: whilst existing studies do not allow for objective comparison and generalisation, the findings of those studies taken collectively indicate an overwhelming relationship between cold homes and health. This is why the NICE review incorporated the "best available evidence, **including testimony.**"[42] The findings of such studies cannot and should not be dismissed on the basis that they cannot be quantitatively or robustly generalised to the population level. Indeed, our ability to do so for an issue such as housing in the first place is notoriously difficult.

One of the difficulties here arises from being unable to isolate the impact of housing, or the cold, on health from other confounding variables.[43] [44] [45] Deprivation rarely occurs in isolation, and a household in fuel poverty is likely to be suffering from multiple forms of socio-economic deprivation. This makes it harder to isolate the causal pathways to poor health, as these factors will interact with one another in multiple and complex ways.[46] There are also differences in our ability to 'easily' capture or measure impact for certain groups within the population. For example, it is more difficult to measure health impact of interventions in adults suffering from long term health conditions related to living in cold homes over many years, than it is for children or older people, who respond to changes more immediately.[47] This is especially the case when studies do not measure changes to health in the long term,[48] and where other co-morbidity factors may exist.[49]

Despite the fact that significant physical health impacts following heating interventions have been found in children and older people and only *modestly* so for adults, Marmot nevertheless argues that larger scale studies "suggest impacts of cold temperatures as a function of poor housing on

[40] Grey, C., Jiang, S. and Poortinga, W. May 2015. Fuel Poverty, Thermal Comfort, and Health in Low Income Areas in Wales: Results from the First Wave of Data Collection for the Arbed Health Impact Study, Welsh School of Architecture, Cardiff Unviersity: Cardiff WSA Working Paper Series ISSN 2050-8522 (page 7)

[41] Public Health England, 2014b. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright. (page 59)

[42] NICE: Excess winter deaths and morbidity and the health risks associated with cold homes. Steve Morris, Public Health Advisory Committee C. PHE National Cold Weather Plan: Annual Seminar 2015, 7th July

[43] Harker L (2006) Chance of a lifetime: The impact of housing on children's lives. London: Shelter. (page 10)

[44] Shortt, N. and Rugkåsa, J. 2007. "*The walls were so damp and cold" Fuel Poverty and Ill Health in Northern Ireland: Results from a housing intervention.* Health and Place. 13 (1) pp. 99-110 (page 100)

[45] Blackman, T., Harvey, J., Lawrence, M., Simon, A., 2001. Neighbourhood renewal and health: evidence from a local case study. Health & Place 7, 93–103.

[46] Thomson, H. Morrison, D. and Petticrew, M. 2007. *The health impacts of housing-led regeneration: a prospective controlled study.* Journal of Epidemiology & Community Health 61 pp.211-214

[47] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty, (page 27) Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017}

[48] Thomson, H. Morrison, D. and Petticrew, M. 2007. *The health impacts of housing-led regeneration: a prospective controlled study.* Journal of Epidemiology & Community Health 61 pp.211-214

[49] Burholt V and Windle G (2006) Keeping warm? Self-reported housing and home energy efficiency factors impacting on older people heating homes in North Wales. *Energy Policy*, 34(10), pp.1198–1208

mortality and morbidity are almost certain across the *whole* population." [50] This once again reiterates the argument that the limitations of individual studies should not detract from the bigger picture of the significant impact that cold homes can have on health. When cross-sectional and observational studies have shown that housing *is* strongly and independently associated with ill health, despite methodological problems that make it difficult to generalise those findings,[51] [52] casting doubt on the relationship between cold homes and health cannot be justified, and can be problematic for achieving positive outcomes for those at risk from the cold. Boardman argues that "it is easier to find associations, than to establish causality and, to a certain extent, this is sufficient. The evidence for better housing is compelling."[53]

Indeed, whilst the variety of methods and sample sizes used in existing studies limits our ability to draw concrete conclusions, narrative synthesis of the evidence does allow for the strong relationship that exists between cold homes and health to be made clear.[54] [55] According to Liddell and Morris, the message which shines through such syntheses is very much *needed* in a context "where the development of policy is unlikely to be held back awaiting a final meta-analytical verdict." [56] And, as Boardman argues, "whilst it is preferable to understand the processes that are causing these excess winter deaths, and ultimately, the way to prevent them, the acceptance of a general link means that action can be taken to improve the energy efficiency of dwellings and improve the health of the present and future residents."[57]

The following sections will now draw out the main findings of studies which have examined the association between cold indoor temperatures and poor health to date, in order to illustrate the extent of harm which living in a cold home can cause or exacerbate in terms of the physical and mental (ill) health of an individual or family. By showing how far-reaching the health impacts of living in a cold home actually are, the need for affordable warmth schemes which recognise them within their eligibility criteria becomes visible.

2.12 Excess Winter Deaths and morbidity

Cold and damp housing conditions have been shown to impact upon both excess winter mortality and morbidity[58] [59] [60] [61] [62]. Studies have found that countries which experience harsher winters with

[50] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty, (page 27) Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]
[51] Thomson, H., Petticrew, M., Morrison, D., 2001. Health effects of housing improvements: systematic review of interventionstudies. British Medical Journal 323, 187–190
[52] Harris, J. Hall, J. Meltzer, H. Jenkins, R. Oreszczyn, T. and McManus, S. 2010. *Health, mental health and housing conditions in England.* National Centre for Social Research: London.
[53] Boardman. B. Introduction. In: Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London (page 5)
[54] Liddell, C. and Morris, C. 2010. *Fuel poverty and human health: a review of the recent evidence.* Energy Policy. 38, pp. 2987-97 (page 2995)
[55] Thomson, H. Thomas, S. Sellstrom, E. and Petticrew M. 2013. *Housing improvements for health and associated socioeconomic outcomes (Review).* The Cochrane Collaboration. Published by John Wiley & Sons, Ltd
[56] Liddell, C. and Morris, C. 2010. *Fuel poverty and human health: a review of the recent evidence.* Energy Policy. 38, pp. 2987-97 (page 2995)
[57] Boardman. B. Introduction. In: Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London (page 4)
[58] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

lower outdoor temperatures than the UK actually experience fewer excess winter deaths, and have lower rates of excess winter morbidity, especially in relation to respiratory conditions[63] [64] [65]. Various authors have argued that this is linked to the higher thermal efficiency standards of buildings in those countries, and correspondingly poor thermal standards within the UK housing stock.[66] [67] [68] One study comparing mortality statistics with national survey data on housing conditions revealed that higher rates of excess winter mortality were found in properties built before 1850 (28.2% winter excess compared to 15% in those built after 1980) and with lower thermal efficiency ratings. The study concluded that "not only were older, less thermally efficient and intrinsically colder houses associated with a greater seasonal excess of mortality, but also that such houses were specifically associated with vulnerability to cold-related mortality." [69] Mortality rates have been shown to increase along a steeper gradient in relation to decreasing outdoor temperature in areas where central hearing coverage is lower.[70] Other studies have similarly demonstrated significant associations between excess winter deaths amongst older people and a lack of central heating in the home. [71]

Harris *et al.* found that people with health conditions linked to the cold were more likely to have limited their use of fuel at home during the past year, and were more likely to be living in a cold and mouldy home. [72] Indeed, when falls in outdoor temperatures occur, the corresponding rise in mortality is greater amongst those living in homes with lower indoor temperatures. For every 1°C drop in outdoor temperature below 19°C, those living in the coldest 10% of homes see a corresponding increase in mortality of 2.8%, whilst those living in the warmest 10% of homes see a

[59] Evans, J., Hyndman, S., Stewart-Brown, S., Smith, D., Petersen, S., 2000. An epidemiological study of the relative importance of damp housing in relation to adult health. Journal of Epidemiology and Community Health 54, 677–686.
[60] Hajat S, Bird W and Haines A (2004) Cold weather and GP consultations for respiratory conditions by elderly people in 16 locations in the UK. *European Journal of Epidemiology*, 19, pp.959–968.
[61] Rudge, J, 2011: Indoor cold and mortality In: Braubach, M., Jacobs, D.E., Ormandy, D. (Eds) WHO Europe. Environmental burden of disease associated with inadequate housing. Methods for quantifying health impacts of selected housing risks in the WHO European Region. Available at : http://www.euro.who.int/__data/assets/pdf_file/0003/142077/e95004.pdf [Accessed 06/03/2017]
[62] Wilkinson, P. London, M. and Stevenson, S. (2000) Housing and winter death: epidemiological evidence. In: Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London
[63] Friends of the Earth, 2015, Briefing: Cold homes and respiratory ill-health in England and Sweden. A comparison of health service statistics.
[64] Department of Health. 2001. *Health Effects of Climate Change in the UK: An Expert Review*.
[65] Healy JD (2003) Excess winter mortality in Europe: a cross country analysis identifying key risk factors. *Journal of Epidemiology and Community Health*, 57(10), pp.784–789.
[66] Healy JD (2003) Excess winter mortality in Europe: a cross country analysis identifying key risk factors. *Journal of Epidemiology and Community Health*, 57(10), pp.784–789.
[67] Isaacs N and Donn M (1993) Health and Housing - Seasonality in New-Zealand Mortality. *Australian Journal of Public Health*, 17(1), pp.68–70.
[68] Rudge J and Gilchrist R (2007) Measuring the Health Impacts of Temperatures in Dwellings: Investigating excess winter morbidity and cold homes in the London Borough of Newham. *Energy and Buildings*, 39, pp.847–858.
[69] Wilkinson P, Landon M, Armstrong, B, Stevenson S, Pattenden S, McKee M and Fletcher T (2001) Cold Comfort: The Social and Environmental Determinants of Excess Winter Deaths in England, 1986–96. Bristol: The Policy Press (page 18)
[70] Khaw K-T. 1995.Temperature and cardiovascular mortality. *The Lancet;* 345: 337-38.
[71] Rudge J and Gilchrist R (2007) Measuring the Health Impacts of Temperatures in Dwellings: Investigating excess winter morbidity and cold homes in the London Borough of Newham. *Energy and Buildings*, 39, pp.847–858.
[72] Harris, J. Hall, J. Meltzer, H. Jenkins, R. Oreszczyn, T. and McManus, S. 2010. *Health, mental health and housing conditions in England.* National Centre for Social Research: London.

rise of only 0.9%.[73] Overall, those in the coldest quarter of homes have a 20% greater risk of dying during the winter than the warmest quarter.[74] [75]

It seems there is a complex interplay between disease risk and exposure to lower outdoor versus indoor temperatures. Evidence suggests that the two are linked, and that it is the "total experience of cold stress that matters". [76] It has been suggested that leaving a warm house and going into colder outdoor temperatures affords more protection than leaving a cold house. [77] The World Health Organisation (WHO) recommends that indoor temperatures be kept at 21°C in living rooms and 18°C in bedrooms for at least 9 hours a day, in order to prevent cold-related ill health.[78]

The physical effects of cold indoor temperatures can increase the risk of heart attacks and strokes via rising blood pressure, as well as causing or worsening respiratory illnesses. They can worsen arthritic and rheumatic conditions, as well as leading to increased falls and increased cases of influenza. [79] [80] [81] When the temperature falls below 16°C, respiratory function is impaired, and when it reaches 12°C increased strain is placed on the cardiovascular system[82]. When the temperature reaches 5-8°C, an increased risk of death can be observed at population level[83]. There is also a time lapse between when the outdoor temperature falls and the number of deaths increases: it takes 3 days after a cold spell for deaths from coronary thrombosis to peak, and 12 days for deaths from respiratory conditions. This indicates, according to Rudge and Gilchrist, a direct influence of cold temperatures on seasonal mortality. [84] In fact, estimates suggest that around 20% of excess winter deaths can be attributed to cold homes,[85] [86] [87] and some have placed a conservative estimate of 10%

[73] Wilkinson P, Landon M, Armstrong B, et al. Cold comfort: the social and environmental determinants of excess winter deaths in England, 1986-96. Bristol: Policy Press 2001.
[74] Public Health England, 2014b. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.
[75] Wilkinson P, Landon M, Armstrong, B, Stevenson S, Pattenden S, McKee M and Fletcher T (2001) Cold Comfort: The Social and Environmental Determinants of Excess Winter Deaths in England, 1986–96. Bristol: The Policy Press
[76] Press, V. (2003) Fuel poverty + health: A guide for primary care organisations, and public health and primary care professionals. National heart Forum: London (page 19)
[77] Rudge, J, 2011: Indoor cold and mortality In: Braubach, M., Jacobs, D.E., Ormandy, D. (Eds) WHO Europe. Environmental burden of disease associated with inadequate housing. Methods for quantifying health impacts of selected housing risks in the WHO European Region. Available at : http://www.euro.who.int/__data/assets/pdf_file/0003/142077/e95004.pdf [Accessed 06/03/2017]
[78] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 03/06/2017]
[79] Public Health England, 2014b. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.
[80] Shortt, N. and Rugkåsa, J. 2007. "*The walls were so damp and cold" Fuel Poverty and Ill Health in Northern Ireland: Results from a housing intervention.* Health and Place. 13 (1) pp. 99-110.
[81] Public Health England. 2014. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.
[82] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty, (page 26) http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf
[83] Public Health England. 2014. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.
[84] Rudge J and Gilchrist R (2007) Measuring the Health Impacts of Temperatures in Dwellings: Investigating excess winter morbidity and cold homes in the London Borough of Newham. *Energy and Buildings*, 39, pp.847–858.
[85] Press, V. (2003) Fuel poverty + health: A guide for primary care organisations, and public health and primary care professionals. National heart Forum: London
[86] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]
[87] Wilkinson P, Landon M, Armstrong, B, Stevenson S, Pattenden S, McKee M and Fletcher T (2001) Cold Comfort: The Social and Environmental Determinants of Excess Winter Deaths in England, 1986–96. Bristol: The Policy Press

of those being directly attributable to fuel poverty[88]. Put into perspective, "this means in England and Wales in 2013, cold homes killed over four times as many people as road and rail accidents; nearly four times as many people as drug misuse; and about as many people as alcohol. In terms of number of deaths, cold homes were thirty times more lethal than fire." [89]

Around half of UK excess winter deaths are caused by cardiovascular disease, and a third by respiratory disease.[90] Whilst these health conditions account for a significant proportion of year round mortality to begin with, research shows that the risk of dying from such conditions increases drastically over the winter[91] [92]. This is partly due to the fact that "a cold home can easily exacerbate pre-existing health complications, often leading to more chronic or unremitting conditions as well as preventable deaths." [93] Links between colder temperatures and increased respiratory-related morbidity, for example, have been repeatedly demonstrated within the literature[94]. For every 1°C drop in temperature below 5°C, GP consultations for respiratory illness in older people increase by 19%[95]. In addition, people suffering from Chronic Obstructive Pulmonary Disorder (COPD) are four times more likely to be admitted into hospital for respiratory complications during the winter months. [96] A study in the London Borough of Newham found the Fuel Poverty Index to be a predictor of hospital admissions for respiratory conditions in people aged over 65. [97] [98] [99] Similarly, winter bed pressures have been shown to be significantly heightened as a result of increased hospital admissions for respiratory conditions[100].

[88] Hills, J (2012) Getting the Measure of Fuel Poverty: Final Report of the Fuel Poverty Review. Centre for Analysis of Social Exclusion: Case Report 72

[89] Association for the Conservation of Energy (2015) Chilled to Death: The human cost of cold homes. Available: http://www.ukace.org/wp-content/uploads/2015/03/ACE-and-EBR-fact-file-2015-03-Chilled-to-death.pdf [accessed 03/03/2017] (page 5)

[90] Khaw K-T. 1995.Temperature and cardiovascular mortality. *The Lancet;* 345: 337-38

[91] Wilkinson P, Landon M, Armstrong, B, Stevenson S, Pattenden S, McKee M and Fletcher T (2001) Cold Comfort: The Social and Environmental Determinants of Excess Winter Deaths in England, 1986–96. Bristol: The Policy Press

[92] Rudge, J, 2011: Indoor cold and mortality In: Braubach, M., Jacobs, D.E., Ormandy, D. (Eds) WHO Europe. Environmental burden of disease associated with inadequate housing. Methods for quantifying health impacts of selected housing risks in the WHO European Region. Available at : http://www.euro.who.int/__data/assets/pdf_file/0003/142077/e95004.pdf [Accessed 06/03/2017]

[93] Energy & Utilities Alliance, Jan 2017, Fuel Poverty – A Connected Solution. Available at http://eua.org.uk/uploads/587C9C8C18F22.pdf [Accessed 17/01/2017]

[94] Elliot AJ, Cross KW, Fleming DM. Acute respiratory infections and winter pressures on hospital admissions in England and Wales 1990-2005. J Public Health (Oxf). 2008 30(1):91-8.

[95] Hajat S, Kovats RS and Lachowycz K (2007) Heat-related and cold-related deaths in England and Wales: who is at risk? *Occupational and Environmental Medicine*, 64(2), pp.93–100.

[96] Public Health England, 2014b. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

[97] Rudge J and Gilchrist R (2007) Measuring the Health Impacts of Temperatures in Dwellings: Investigating excess winter morbidity and cold homes in the London Borough of Newham. *Energy and Buildings*, 39, pp.847–858.

[98] Public Health England, Sept 2014, Local action on health inequalities: fuel poverty and cold home-related health problems. Health Equity Evidence Review 7

[99] Hajat S, Kovats RS and Lachowycz K (2007) Heat-related and cold-related deaths in England and Wales: who is at risk? *Occupational and Environmental Medicine*, 64(2), pp.93–100.

[100] Afza M and Bridgman S (2001) Winter emergency pressures for the NHS: Contribution of respiratory disease, experience in North Staffordshire district. *Journal of Public Health and Medicine*, 23, pp.312–313.

Further highlighting this link, intervention studies have found an association between the provision of heating measures and respiratory health.[101] [102] Evaluation of a small scale Boilers on Prescription scheme in Sunderland for sufferers of COPD found a 60% reduction in GP appointments and a 30% reduction in visits to A&E during the first year of the scheme.[103] Similarly, evaluation of the Warm Front scheme found that the 70% of households that did increase indoor temperatures to WHO levels following the receipt of heating measures did not show an increase in mortality risk with colder outdoor temperatures, whereas the mortality risk for those households who did not increase indoor temperatures actually increased by 2.2% with every 1°C fall in outdoor temperatures. The study estimated that the provision of heating and insulation to households increased the life expectancy of men by 10 days and women by 7 days. Modelling based on this finding showed that, if replicated at a population level, winter deaths would be reduced annually by 0.4 per 1000 occupants: "For a typical pensioner couple household, this means an estimated annual reduction of 80 deaths per 10,000 dwellings improved." **[104]** [105] Furthermore, evaluation of the Central Heating Programme in Scotland found that not only were residents saving money on their bills and heating their homes to a comfortable temperature but, of those that had reported respiratory, circulatory or rheumatic health conditions prior to the intervention, 40% said the condition had improved following the installation of central heating in their homes. [106]

Particular groups with sensitive or immature thermoregulatory systems and who are more likely to spend more time at home, such as the elderly and young children, may be at particular risk of suffering from the health effects of cold homes. [107] [108] This also includes those with underlying and chronic illness, especially cardiorespiratory disease.[109] [110] [111] Elderly people might have: a reduced ability to prevent heat loss from the body due to poor vasomotor responses to temperature; limited mobility due to existing rheumatic conditions; and limited ability to detect changes in temperature

[101] Howden-Chapman, P. et al., (2007). Effects of insulating houses on health inequality : Cluster randomised study in the community. *British Medical Journal*, doi:10.1136/bmj.39070.573032.80.

[102] Rudge, J, 2011: Indoor cold and mortality In: Braubach, M., Jacobs, D.E., Ormandy, D. (Eds) WHO Europe. Environmental burden of disease associated with inadequate housing. Methods for quantifying health impacts of selected housing risks in the WHO European Region. Available at : http://www.euro.who.int/__data/assets/pdf_file/0003/142077/e95004.pdf [Accessed 06/03/2017]

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[104] Green G and Gilbertson J (2008) Warm front: better health: Health impact evaluation of the warm front scheme. Sheffield: Sheffield Hallam University, Centre for Regional Social and Economic Research. (page 18)

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[108] Anderson, W. White, V. and Finney, A. 2010. *"You just have to get by" Coping with low incomes and cold homes.* Centre for Sustainable Energy. Available at: https://www.cse.org.uk/downloads/reports-and-publications/fuel-poverty/you_just_have_to_get_by.pdf [Accessed 06/03/2017]

[109] Public Health England, 2014b. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

[110] Energy & Utilities Alliance, Jan 2017, Fuel Poverty – A Connected Solution. Available at http://eua.org.uk/uploads/587C9C8C18F22.pdf [Accessed 17/01/2017]

[111] Jordan R, Hawker J, Ayres J, Adab P, Tunnicliffe W, Olowokure B, et al. Effect of social factors on winter hospital admission for respiratory disease: a case-control study of older people in the UK. Br J Gen Pract. 2008;58(551):e1-e9.

and adjust their behaviour or external temperature accordingly. [112] However, PHE stresses that people of all ages can experience cold-related ill health.[113]

This section has outlined how cold related morbidity and mortality are manifested at the general population level. But, why do colder indoor temperatures cause or exacerbate particular health conditions, and how do we know that providing affordable warmth can help alleviate them and/or improve wellbeing?

2.13 Respiratory disease and cold homes

People who suffer from respiratory conditions are more likely to have cold homes and live in a house that has mould. They are also more likely to be restricting their energy use due to worries over cost and be in fuel debt. Significantly, fuel debt has been found to be independently associated with suffering from a respiratory illness, whereas other kinds of debt have not. [114]

Sleeping in a cold bedroom has been shown to have a significant effect on respiratory health. [115] [116] Cold air can affect the bronchial lining of the respiratory tract, weakening the immune system and resistance to infection. [117] It causes the airways to constrict, which then stimulates the production of mucus. This increases the risk of both bronchitis and pneumonia. [118] The same effect can trigger broncho-constriction in people already suffering from asthma and COPD.[119]

Cold air can overcome the heat exchanging ability of the upper respiratory tract, meaning cold air is inhaled directly into the lower respiratory tract. A similar effect can occur due to a neural reflex which occurs during facial cooling. This can result in inflammation within the lower respiratory tract, and infections. [120] [121] If a person is already suffering from a chronic respiratory condition, then developing an acute respiratory infection can increase their risk of death. Elderly people are particularly vulnerable to this effect. [122] A study of people with COPD in Scotland, for example, found that those who spent fewer days with the living room heated to 21°C for 9 hours had significantly worse respiratory health.[123]

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[112] Collins, K.J., Hoinville, E., 1980. Temperature requirements in old age. Building Services Engineering Research and Technology 1, 165–172.

[113] Public Health England. 2014. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

[114] Harris, J. Hall, J. Meltzer, H. Jenkins, R. Oreszczyn, T. and McManus, S. 2010. *Health, mental health and housing conditions in England.* National Centre for Social Research: London.

[115] Mason, V., Roys, M., 2011. The Health Costs of cold dwellings. Building Research Establishment, Watford

[116] Pierse, N., Arnold, R., Keall, M., Howden-Chapman, P., Crane, J., Cunningham, M., 2013: Modelling the effects of low indoor temperatures on the lung function of children with asthma. In: J Epidemiol Community Health. 2013 Nov 1;67(11):918-25

[117] Mason, V., Roys, M., 2011. The Health Costs of cold dwellings. Building Research Establishment, Watford

[118] Public Health England. 2014. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

[119] Public Health England, Sept 2014, Local action on health inequalities: fuel poverty and cold home-related health problems. Health Equity Evidence Review 7

[120] Collins, K. (2000) Cold, cold housing and respiratory illness. In Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London

[121] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[122] Collins, K. (2000) Cold, cold housing and respiratory illness. In Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London

[123] Osman LM, Ayres JG, Garden C, Reglitz K, Lyon J, Douglas JG. 2008 Home warmth and health status of COPD patients. *European Journal of Public Health* 18(4): 399-405

Inflammatory responses during respiratory infections are furthermore related to the incidence of ischaemic heart disease as result of the increased production of fibrinogen, which is a clotting factor. This increases the risk of arterial thrombosis. It has been found that mild inflammatory reactions and a tendency towards hypercoagulability are associated with only short-term exposures to the cold.[124]

In moderately cold and wet winter conditions, the air within a cold home is likely to contain more moisture. When this comes into contact with already cold indoor surfaces, condensation occurs and mould growth develops. [125] Damp and mould within the home are associated with a 30-50% increase in respiratory problems,[126] and asthma sufferers are two to three times more likely to live in damp homes than people without the condition. [127] Whilst the physiological pathways between damp and ill health are unknown, it is likely that the presence of damp encourages the growth of mould and bacteria, which are known allergens and which can impact negatively upon health. [128] [129] [130] [131] [132] Asthma, allergic symptoms and upper respiratory tract infections have in particular been associated with living in a damp home with mould, especially in children. [133] [134] [135] [136] [137] Studies have found a significant correlation between the severity with which airflow is obstructed and the severity of dampness within a home, which indicates that there is a dose-response relationship between the two. [138]

Children who live in cold housing have been shown to be more than twice as likely to suffer from chest and breathing problems (such as asthma, and bronchitis)[139], and those living in damp and

[124] Collins, K. (2000) Cold, cold housing and respiratory illness. In Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London

[125] Collins, K. (2000) Cold, cold housing and respiratory illness. In Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London

[126] Fisk, W. Lei-Gomez, Q. and Mendell, M. 2007. *Meta-analyses of the associations of respiratory health effects with dampness and mold in homes*. Indoor Air 17 (4) pp.284-96.

[127] Press, V. (2003) Fuel poverty + health: A guide for primary care organisations, and public health and primary care professionals. National heart Forum: London

[128] Fisk, W. Lei-Gomez, Q. and Mendell, M. 2007. *Meta-analyses of the associations of respiratory health effects with dampness and mold in homes*. Indoor Air 17 (4) pp.284-96.

[129] Jaakkola, J.J.K., Hwang, B.F., Jaakkola, N., 2005. Home dampness and molds, parental atopy, and asthma in childhood: a six-year population-based cohort study. Environmental Health Perspectives 113, 357–361.

[130] Dales, R.E., Zwanenburg, H., Burnett, R., Franklin, C.A., 1991. Respiratory health effects of home dampness and molds amongst Canadian children. American Journal of Epidemiology 134, 196–203.

[131] Peat, J.K., Dickerson, J. and Li, J. (1998) Effects of damp and mould in the home on respiratory health: a review of the literature, Allergy, 53, 1 0-1.

[132] Harker L (2006) Chance of a lifetime: The impact of housing on children's lives. London: Shelter.

[133] Williamson, I., Martin, C., Mcgill, G., Monie, R., Fennerty, A., 1997. Damp housing and asthma: a case-control study. Thorax 52, 229–234.

[134] Bornehag CG, Sundell J, Hagerhed-Engman L, Sigsggard T, Janson S, Aberg N and the DBH Study Group, Dampness at home and its association with airway, nose and skin symptoms among 10,851 pre-school children in Sweden: a cross-sectional study, *Indoor Air*, 15 (S 10), 48-55, 2 005;

[135] Andriessen JW, Brunekreef B and Roemer W, Home dampness and respiratory health status in European children, *Clinical and Experimental Allergy*, 28 , 10, 1191- 1200, 1998;

[136] Koskinen O, Husman T, Meklin T and Nevalainen A, Adverse health effects in children associated with moisture and mould observations in houses, *International Journal of Environmental Health Research*, 9, (2), 143-156, 1999

[137] Collins, K. (2000) Cold, cold housing and respiratory illness. In Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London

[138] Williamson, I., Martin, C., Mcgill, G., Monie, R., Fennerty, A., 1997. Damp housing and asthma: a case-control study. Thorax 52, 229–234.

[139] Barnes, M. et al., (2008). *The Dynamics of Bad Housing : The Impacts of Bad Housing on the Living Standards of Children.* London : National Centre for Social Research.

mouldy conditions are up to three times more likely to do so.[140] Furthermore, an association between cold environmental temperatures and the incidence of sudden infant death syndrome four days later in children younger than 12 months old has also been suggested. [141] Many such infants present non-specific symptoms of respiratory ill health, and so may be more vulnerable to respiratory tract infections when the temperature drops. For each year children live in inadequately heated housing, the greater the incidence of chest and breathing problems such as asthma and bronchitis. Three to five years spent living in a cold home increases the chances of suffering from such a condition by 15%, one to two years does so by 11%, and for less than one year by 7%.[142] Other studies have found that children aged between 9 and 11 years living in damp homes are at a 32% greater risk of wheezing illness, and 97% more likely to experience breathing problems at night. [143]

Intervention studies have shown how adults and children experience a noticeable worsening of asthma and other breathing-related problems during the winter,[144] but that such conditions are often perceived to improve following a heating intervention.[145] [146] [147] After the provision of central heating measures through a pilot scheme in Cornwall, for example, the proportion of bedrooms that were unheated amongst recipient households dropped from 92% to 14%, and the presence of damp in a household dropped from 61% to 21%. Following the intervention, incidences of nocturnal coughing dropped from 'most nights' to only 'one or several nights in the previous months'. Before the installation of central heating, children in the study lost 9.3days per 100 school days due to asthma, and just 2.1 days afterwards. [148] Similarly, a study of an insulation intervention in New Zealand found a self-reported reduction in incidences of wheezing, colds and influenza by up to 50%.[149] [150] Another study following the provision of heating measures in New Zealand found that children experienced 21% fewer days of absence from school following the intervention, and that an improvement in asthma symptoms and reductions in sleep disturbances from wheezing and dry coughs occurred.[151]

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[140] Public Health England, Sept 2014, Local action on health inequalities: fuel poverty and cold home-related health problems. Health Equity Evidence Review 7

[141] Collins, K. (2000) Cold, cold housing and respiratory illness. In Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London

[142] Barnes M, Butt S, Tomaszewski W. The dynamics of bad housing: the impact of bad housing on the living standards of children. London: National Centre for Social Research, EAGA partnership, Shelter: 2008

[143] Harker L (2006) Chance of a lifetime: The impact of housing on children's lives. London: Shelter.

[144] NEA and The Children's Society (for National Grid Affordable Warmth Solutions), 2015, Making a House a Home: Providing affordable warmth solutions for children and families living in fuel poverty. Available at: http://www.nea.org.uk/wp-content/uploads/2016/01/Making-a-House-a-Home.pdf [Accessed 06/03/2017]

[145] Lloyd EL, McCormack C, McKeever M, and Syme M (2008) The effect of improving the thermal quality of cold housing on blood pressure and general health: a research note. *Journal of Epidemiology and Community Health*, 62,pp.793–797.

[146] Public Health England, 2014b. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

[147] Lloyd EL, McCormack C, McKeever M, and Syme M (2008) The effect of improving the thermal quality of cold housing on blood pressure and general health: a research note. *Journal of Epidemiology and Community Health*, 62,pp.793–797.

[148] Somerville M et al. 2000. Housing and health: does installing heating in their homes improve the health of children with asthma? *Public Health*; 114, 434-39.

[149] Howden-Chapman P, Mathson A, Crane J et al. Effect of insulating existing houses on health inequality: cluster randomised study in the community. *British Medical Journal* 2007 334(7591): 460

[150] Liddell, C. and Morris, C. 2010. *Fuel poverty and human health: a review of the recent evidence.* Energy Policy. 38, pp. 2987-97

[151] Free, S, Howden-Chapman P, Pierse N, Viggers H, Housing H, Health Study Research T. More effective home heating reduces school absences for children with asthma. *J Epidemiol Community Health* 2010 65(5): 379-86

However, one intervention found that eliminating damp and mould via the provision of new heating systems prevented the health of children in the study deteriorating further, rather than resulting in an improvement. The authors note that the presence of other confounding variables may have prevented full improvements in health being made by scheme recipients: "the contribution of financial difficulties to children's health indicates that isolated improvements to housing alone are insufficient to ameliorate symptoms in areas of multiple disadvantage." [152] [153]

Living in a cold and damp home, then, has been shown to be strongly associated with the experience of respiratory disease amongst children and the elderly, and amongst those who are already suffering from chronic respiratory conditions. There is also a suggestion that cardio-respiratory responses to the cold might act to increase the risk of cardiovascular disease. The fact that there is a link between respiratory ill health and the experience of cold temperatures is repeatedly documented within the literature. Whilst findings from intervention studies have tended to rely on self-reported easing of symptoms, they nevertheless suggest the potential for significant and relatively fast improvements to child health. Self-reported improvements to health in adults in themselves indicate at the very least an improvement in quality of life and perceived wellbeing, an outcome which should not be taken lightly. Whilst other confounding variables undoubtedly have an impact both on vulnerability to respiratory disease and the likelihood or extent of health improvements being made, the evidence base makes clear that cold homes are very likely to be amongst those variables which contribute to respiratory ill health in the first place.

2.14 Cardiovascular conditions and the cold

Analysis of coronary events amongst people aged between 35 and 64 in 21 countries found them to be more likely to result in fatalities when outdoor temperatures were colder. [154] More specifically, deaths from ischaemic heart disease and cerebrovascular disease have been shown to react to short-term temperature reductions, representing significant cold exposure risk at population level.[155] For example, Shiue and Shiue estimate that 9% of hypertension in Scotland could be prevented by maintaining indoor temperatures above 18°C.[156] Overall, increased plasma fibrinogen levels and factor VII clotting during the winter months account for a 15% and 9% rise in coronary heart disease, respectively.[157]

Raised blood pressure is caused by a narrowing of the blood vessels, resulting in increased blood viscosity.[158] Systolic and diastolic blood pressure have both been shown to increase as an effect of

[152] Hopton, J., Hunt, S., 1996. The health effects of improvements to housing: a longtiudinal study. Housing Studies 11, 271–286. (page 283)
[153] Blackman, T., Harvey, J., Lawrence, M., Simon, A., 2001. Neighbourhood renewal and health: evidence from a local case study. Health & Place 7, 93–103.
[154] Public Health England, Sept 2014, Local action on health inequalities: fuel poverty and cold home-related health problems. Health Equity Evidence Review 7
[155] Donaldson GC, Robinson D, Allaway SL. 1997. An analysis of arterial disease mortality and BUPA health screening in men, in relation to outdoor temperature. *Clinical Science*; 92: 261-68.
[156] Shiue, I. & Shiue, M., 2014. Indoor temperature below 18°C accounts for 9% population attributable risk for high blood pressure in Scotland *In:* Int J Cardiol. 2014 Jan 15;171(1):e1-2.
[157] Woodhouse PR et al. 1994. Seasonal variations of plasma fibrinogen and factor VII in the elderly: winter infectionsand death from cardiovascular disease. *The Lancet*; 343: 435-39.
[158] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

cold temperatures and poor housing.[159] [160] Increased blood pressure results in more cardiac work, thus increasing the risk of myocardial ischaemia. At the same time, vasoconstriction places more stress on the blood vessels causing vascular damage. [161] This in turn increases the risk of thrombosis, potentially resulting in heart attacks and strokes.[162] [163] [164]

Time-series analyses have found that prolonged haemoconcentration and hypertension (increased blood viscosity and pressure) start to occur almost immediately following a fall in temperature, and can last for up to 2 days afterwards.[165] In older people, blood pressure rises when they are exposed to temperatures below 12°C for more than two hours,[166] [167] although other studies suggest that the association actually begins with exposure to indoor temperatures below 18°C[168].

Studies have found that 1°C drop in living room temperature results in a 1.3mmHg rise in systolic blood pressure and a 0.6mmHg rise in diastolic blood pressure amongst those aged 65-74.[169] It has been suggested that high levels of cold-related deaths amongst the elderly could be related to their higher baseline level of arterial disease, which in turns makes them more susceptible to thrombosis resulting from changes to the blood which would not affect people who are young and fit.[170]

Repeated acute rises in blood pressure in response to cold stress may result in chronic hypertension, [171] and leaving a cold home and going out into the cold results in greater cardiovascular stress than leaving a home which is warm. The practice of spatial constriction amongst the fuel poor, which means only one room in a house is heated, can mean people moving from one room to another experience the same fluctuations in cold stress effect as they would when going outside. Studies of various European countries have shown that, where cold stress is avoided by going outdoors less, wearing warmer clothing and increasing physical activity when outside, rates of cold-related mortality are lowered - even in areas that experience the harshest winters. Conversely, behaviours

[159] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 1: Factors determining vulnerability to winter- and cold-related mortality/morbidity. London School of Hygiene & Tropical Medicine, Public Health England, University College London

[160] Collins, et al., 1985. Effects of age on body temperature and blood pressure in cold environments. Clinical Science 69, 465–470.

[161] Khaw K-T. 1995.Temperature and cardiovascular mortality. *The Lancet;* 345: 337-38.

[162] Press, V. (2003) Fuel poverty + health: A guide for primary care organisations, and public health and primary care professionals. National heart Forum: London

[163] Keatinge WR et al. 1984. Increase in platelet and red cell counts, blood viscosity and arterial pressure during mild surface cooling: factors in mortality from coronary and cerebral thrombosis in winter. *British Medical Journal*; 289:1405-08.

[164] Neild, P.J.Syndercombe-Court, D., Keatinge, W.R., Donaldson, G.C., Mattock, M., Caunce, M., 1994: Cold induced increases in erythrocyte count, plasma cholesterol and plasma fibrinogen of elderly people without a comparable rise in Protein C or Factor X. *Clinical Science* 86(1):43-8.

[165] Keatinge et al. 1984. Increase in platelet and red cell counts, blood viscosity and arterial pressure during mildsurface cooling: factors in mortality from coronary and cerebral thrombosis in winter. *British Medical Journal*; 289:1405-08

[166] Goodwin J. Cold stress, circulatory illness and the elderly. In: Rudge J, Nicol F (eds.) 2000.*Cutting the Cost of Cold*.

[167] Collins. K. J, 1986, Low indoor temperatures and morbidity in the elderly, *Age and Ageing 15:212-220*

[168] Public Health England, 2014b. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

[169] Woodhouse PR, Khaw K-T, Plummer M. 1993. Seasonal variation of blood pressure and its relationship to ambient temperature in an elderly population. *Journal of Hypertension*; 11 (11): 1267-74.

[170] Keatinge WR et al. 1984. Increase in platelet and red cell counts, blood viscosity and arterial pressure during mild surface cooling: factors in mortality from coronary and cerebral thrombosis in winter. *British Medical Journal*; 289:1405-08.

[171] Lloyd EL, McCormack C, McKeever M, and Syme M (2008) The effect of improving the thermal quality of cold housing on blood pressure and general health: a research note. *Journal of Epidemiology and Community Health*, 62,pp.793–797.

that risk cold stress (going outside often with poorly insulating clothing) combined with thermally inefficient homes increase the risk of cold-related mortality in the UK. [172]

Saeki *et al.* suggest that heating bedrooms to 22°C at night could result in fewer clinical and haemorrhagic strokes, after they found such temperatures to be associated with lower morning systolic blood pressures and smaller sleep-trough morning blood pressure surges than people who slept in bedrooms heated to only 12°C. [173] This does seem to be reflected in the findings of some heating intervention evaluations. For example, an evaluation of a heating and insulation scheme in a Glasgow tower block found that both diastolic and systolic blood pressure levels were reduced amongst residents post-intervention. One recipient claimed that they "would have been dead if it had not been for the intervention." [174] The evaluation of the Scottish Central Heating Programme also found that self-reported data provided by recipients indicated a reduced probability of receiving a first-time diagnosis of heart disease or high blood pressure, though this was not verified by longitudinal monitoring of clinical records. [175]

In all, evidence would suggest an association between the experience of colder indoor temperatures and the risk of suffering from cardiovascular disease. Whilst cardiovascular disease risk is itself multi-factorial, the relationship between it and the experience of cold both at a general population level and in studies assessing individual physiological response to the cold has nevertheless been repeatedly shown. The evidence base to date suggests that living in a warm home heated to recommended temperature thresholds might act to *mitigate* an individual's *susceptibility* to suffering from cardiovascular disease, lessening their vulnerability from that which it might have been had they regularly experienced colder indoor temperatures.

2.15 Mental Health and Wellbeing

There are multiple pathways through which feeling cold at home, and experiencing fuel poverty, can impact upon mental health. For example, Alzheimer's Disease or related dementias (ADRD) has been found to be a significant contributor to excess winter mortality in the UK. People suffering from ADRD tend to see competence worsen around independently managing the basic needs of shelter and food – which can make managing heating and energy routines at home difficult to maintain. People with ADRD often experience disturbances in their thermoregulation, which can again contribute to difficulties in managing an appropriate heating regime. However, it is not clear whether this is a physiological response to neurodegeneration, or if it is an effect of people perceiving themselves to be colder than they are. The causes behind increased risk of dying during the winter for sufferers of ADRD are complex, and are part of an intertwining of factors which cumulatively combine to create vulnerability. Indeed, "this complexity alone could explain why the association between EWD and dementia has for so long gone un-noticed. However, as with any

[172] Goodwin, J. (2000) Cold Stress, circulatory illness and the elderly. In Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London

[173] Saeki, K., Obayashi, K., Iwamoto, J., Tanaka, Y., Tanaka, N., Takata, S., Kubo, H., Kamoto, N., Tomioka, K., Nezu, S., Kurumatani, N., 2013. Influence of room heating on ambulatory pressure in winter: a randomised controlled study.

[174] Lloyd EL, McCormack C, McKeever M, and Syme M (2008) The effect of improving the thermal quality of cold housing on blood pressure and general health: a research note. *Journal of Epidemiology and Community Health*, 62,pp.793–797.

[175] Platt, S. Mitchell, R. Petticrew, M. Walker, J. Hopto, J. Martin, C. Corbet, J. and Hope, S. 2007. *The Scottish Executive Central Heating Programme: assessing impacts on health*. Edinburgh.

trajectory of cumulative risk, finding ways to remove even a few risk factors from the mix will substantively lower people's vulnerability." [176]

Aside from conditions such as ADRD, it has been particularly evidenced within the literature that cold and damp homes can impact upon mental health and wellbeing more generally.[177] [178] [179] [180] Fuel poverty and its "cumulative stresses" have been shown to affect the subjective well-being of households, over and above the alleviation of financial strain. [181] [182] It is difficult to measure and directly associate demand on mental health services and cold weather, and so studies have tended to rely on the self-reported mental health and sense of wellbeing of scheme recipients. [183] Nevertheless, Shortt and Rugkåsa argue that "the consistent pattern of improvements in mental health [and housing improvements] would suggest a greater sense of connection between mental wellbeing and housing deprivation." **[184]**

People themselves tend to associate colder indoor temperatures with an exacerbation of physical ill health, as well as causing both depression and anxiety. Whilst lay beliefs often link cold homes with a worsening or deterioration of health, studies have shown that people are unlikely to perceive them as having *caused* those conditions in the first place. Such perceptions, however, do not necessarily mean an absence of actual causality.[185]

People reporting difficulties in paying their fuel bills are four times more likely to suffer from mental ill health. [186] NATCEN found that 10% of people suffering from a Common Mental Disorder (CMD) were not able to keep their homes warm enough during the winter and 15% reported mould in their homes, compared with 3% and 8% of people without CMD. Similarly, 27% of people with CMD reported having used less fuel than needed due to concerns over paying for their energy and 6% were seriously behind in paying energy bills or were at risk of disconnection, compared with 12%

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[176] Chesshire Lehmann Fund: Understanding Fuel Poverty, June 2016. Gray B, Allison S, Thomas B, Morris C and Liddell C. Univeristy of Ulster. Excess winter deaths among people living with Alzheimer's Disease or related dementias (ADRD (page 27)

[177] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 1: Factors determining vulnerability to winter- and cold-related mortality/morbidity. London School of Hygiene & Tropical Medicine, Public Health England, University College London

[178] Press, V. (2003) Fuel poverty + health: A guide for primary care organisations, and public health and primary care professionals. National heart Forum: London

[179] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[180] Public Health England, Sept 2014, Local action on health inequalities: fuel poverty and cold home-related health problems. Health Equity Evidence Review 7

[181] Biermann, P. (2016), "How fuel poverty affects subjective well-being: Panel evidence from Germany". Oldenburg Discussion Papers in Economics. University of Oldenburg

[182] Grey, C., Jiang, S., Nascimento, C., Rodgers, S., Johnson, R., Lyons, R. and Poortinga, W. (2017) The short-term health and psychosocial impacts of domestic energy efficiency investments in low-income areas: a controlled before and after study. In MBC Public Health 17(140)

[183] Public Health England. 2014. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

[184] Shortt, N. and Rugkåsa, J. 2007. "*The walls were so damp and cold" Fuel Poverty and Ill Health in Northern Ireland: Results from a housing intervention.* Health and Place. 13 (1) pp. 99-110.

[185] Harrington, B. Heyma, B. Merleau-Ponty, N. Stockton, H. Ritchie, N. and Heyman, A. 2005. *Keeping warm and staying well: findings from the qualitative arm of the Warm Homes Project.* Health and Social Care in the Community 13 (3), pp. 259-267

[186] Gilbertson, J. Grimsley, M. and Green, G. for the Warm Front Study Group. 2012. *Psychosocial routes from housing investment to health gain. Evidence from England's home energy efficiency scheme.* Energy Policy. 49, pp. 122–133.

and 2% without CMD. Even when other confounding factors were adjusted for, being unable to keep homes warm enough during the winter and suffering from problem debt (including fuel debt) were predictors of CMD. [187]

Children who live in poor housing (which includes inadequately heated homes) are more likely to suffer from a range of adverse health conditions. [188] As well as delaying physical growth and cognitive development, it can impact upon mental health (through anxiety and depression), and affect or cause respiratory problems. [189] It can also impact upon a child's motivation and lead to a greater sense of helplessness. Children in poor housing have less task persistence than those in better housing, as well as suffering from more psychological symptoms[190]. Whilst the effects of cold homes upon child health can be difficult to isolate and disentangle from the multitude of causal factors associated with poor quality housing, this has been shown to occur independently of household income, and intervention studies have repeatedly shown associated improvements in mental health following heating and advice interventions. [191] [192] Children experiencing energy insecurity at home have a greater chance of experiencing child and household food insecurity, hospitalisation since birth, developmental risks and general poor health. [193]

A study by NATCEN found that 28% of young people living in cold homes manifested multiple mental health risks, as opposed to 4% for those living in warm homes. 10% of young people living in cold homes did not feel happy in their home, compared to just 2% for those living in warm homes. Inadequately heated homes where independently shown to be the only housing quality indicator associated with 4 or more negative mental health outcomes in young people. Young people in cold homes that practice spatial shrinking in order to stay warm are also more likely to look for privacy outside the home in places such as parks and shopping centres. Indeed, after controlling for other confounding variables, fuel poverty was shown to be significantly associated with an increase in the likelihood of young people engaging in risk-taking behaviours (such as alcohol and tobacco abuse), as well as truancy. [194] [195] Young people from cold homes were also more likely to worry about being bullied or being mugged than those living in warm homes. [196] [197] Experiencing inadequate heating at

[187] Harris, J. Hall, J. Meltzer, H. Jenkins, R. Oreszczyn, T. and McManus, S. 2010. *Health, mental health and housing conditions in England.* National Centre for Social Research: London.

[188] Public Health England. 2014. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

[189] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[190] Evans G, Saltzman H and Cooperman J (2001) Housing quality and children's socioemotional health. *Environmental Behaviour*, 33(3), pp.389–399.

[191] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[192] Harker L (2006) Chance of a lifetime: The impact of housing on children's lives. London: Shelter.

[193] Cook, J.T., et al., 2008. A brief indicator of household energy security: associations with food security, child health, and child development in US infants and toddlers. Pediatrics 122, e867–e875.

[194] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[195] Barnes, M. et al., (2008). *The Dynamics of Bad Housing : The Impacts of Bad Housing on the Living Standards of Children.* London : National Centre for Social Research.

[196] Liddell, C. (2008) 'Policy Briefing – The Impact of Fuel Poverty on Children'. Belfast: Ulster University & Save the Children. Available at: http://tinyurl.com/STC-Policy-Briefing-FP [Accessed 06/03/2017]

[197] Barnes, M. et al., (2008). *The Dynamics of Bad Housing : The Impacts of Bad Housing on the Living Standards of Children.* London : National Centre for Social Research.

home can also affect the educational attainment of children, especially when they are unable to find an appropriate and comfortable space in which to do homework. [198] [199]

The social isolation which the experience of living in a cold home and in fuel poverty can engender can have a significant impact upon mental health and wellbeing. People may be reluctant to invite guests into a cold or damp home, or be unwilling to leave the house in search of social contact/other places of warmth due to reduced incomes, a fear of falling during winter conditions, or anticipating the discomfort of returning to a cold home. [200] People who suffer from health conditions or disabilities which make leaving the house difficult mean they are unable to escape cold indoor temperatures, and are left feeling both cold and alone at home[201]. Furthermore, damp and mould within a home can cause significant stress in terms of being unable to maintain a clean house with recurring and visible mould, being embarrassed to invite people into the home where visible mould or the smell of damp is present, and causing additional worry for the health of family members, especially children or people with existing respiratory conditions. Indeed, dampness has been shown to be associated with mental ill health even after other confounding variables have been controlled for. [202]

Whilst living in a cold home and experiencing fuel poverty can worsen mental health, intervention studies have shown that heating and advice interventions which improve thermal comfort and problems with damp and condensation can have a significant impact on the self-reported mental health and wellbeing of recipients. [203] Over and above relief from financial strain, improvements to mental health are often associated in perceived increased value for money from heating systems, as well as greater control over heating management and improved thermal comfort levels in the home.[204] Improved warmth within a home can also allow for more privacy and improved social relationships through increased use of space. [205] Being able to heat (and therefore use) more rooms within the home can improve quality of life by positively enabling social functioning and having a beneficial effect for relationships between family/household members.[206]

Improving social relationships can have a knock-on effect upon the experience of poor mental health. An improved sense of well-being has been significantly self-reported by recipients of

[198] [198] NEA and The Children's Society (for National Grid Affordable Warmth Solutions), 2015, Making a House a Home: Providing affordable warmth solutions for children and families living in fuel poverty. Available at: http://www.nea.org.uk/wp-content/uploads/2016/01/Making-a-House-a-Home.pdf [Accessed 06/03/2017]

[199] Public Health England. 2014. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

[200] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[201] Grey, C., Jiang, S., and Poortinga, W. 2015, Arbed recipient's views and experiences of living in hard-to-heat, hard-to-treat houses in Wales: results from three focus groups conducted in South Wales, Welsh school of Architecture, Cardiff University: Cardiff WSA Working Paper Series ISSN 2050-8522

[202] Hopton JL, Hunt SM. 1996. Housing condition and mental health in a disadvantaged area in Scotland. *Journal of Epidemiology and Community Health*; 50: 56-61.

[203] Shortt, N. and Rugkåsa, J. 2007. "*The walls were so damp and cold" Fuel Poverty and Ill Health in Northern Ireland: Results from a housing intervention.* Health and Place. 13 (1) pp. 99-110.

[204] Liddell, C. and Morris, C. 2010. *Fuel poverty and human health: a review of the recent evidence.* Energy Policy. 38, pp. 2987-97

[205] Thomson, H., Thomas, S., Sellstrom, E., and Petticrew, M., (2013): Housing improvements for health and associated socio-economic outcomes (Review) The Cochrane Collaboration: Available at: http://www.thecochranelibrary.com/details/file/4426391/CD008657.html [Accessed 06/03/2017]

[206] Shortt N, Rugkasa J. "The walls were so damp and cold" fuel poverty and ill health in Northern Ireland: results from a housing intervention. *Health Place* 2007; **13**(1): 99-110.[206]

schemes, such as Warm Front. Evaluations of Warm Front and the Scottish CHP found that, in the short and medium term, the provision of heating measures improved the mental health of recipients, especially in those suffering from borderline anxiety and depression. Indeed, recipients who maintained bedroom temperatures of 21°C were 50% less likely to suffer from these conditions as those who maintained bedrooms ar 15°C. [207] The Warm Front evaluation found that participants experienced an improvement to the thermal comfort of their homes, with mean indoor temperature increasing by 1.9°C. [208] They practiced less spatial shrinking, were less anxious and a quarter experienced improvements to their moods. This led to an improved sense of overall wellbeing. [209] [210] Around 66% of participants felt more comfortable at home, and a quarter said that they felt more relaxed and content following the intervention. A third of recipients were able to use more space within the house, and had more confidence in their new heating system. [211] Indeed, "this increase in being at ease was also associated with ideas about being and feeling more at home – a sense of 'living' rather than just 'surviving' there." [212] Participants felt more in control, had increased self-esteem and felt more positively about 'home'. Recipients of heating and insulation measures were almost 40% less likely to report high levels of psychological distress following the intervention than they did prior to it. The incidence of CMDs fell from 300 to 150 per 1000 residents following the provision of measures.[213] However, it is important to note that whilst the provision of central heating measures to households did lead to a more positive sense of home and of more control over their environment, some people experienced a sense of powerlessness during the installation, which suggests that future schemes should consider taking into account the mental health journey of a household throughout each stage of an intervention. [214]

An evaluation of a scheme to provide households with first time central heating measures in Tamworth found that, prior to the intervention, families described significant psychological and emotional effects of living in a cold home. Families were feeling moody and grumpy, as well as being disgusted by damp and mould. People also felt frustrated at their inability to get rid of damp, and to adequately dry clothes at home. Following the intervention, families felt warmer at home, and were rationing spending on energy and other essentials less. Having more flexibility within household budgets also allowed for money to spent on small treats such as pocket money for children and days out. Family relationships improved, more rooms in the home could be used, and participants

[207] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]
[208] Hong, S.H., Gilbertson, J., Oreszczyn, T., Green, G., Ridley, I., the Warm Front Study Group, 2009. The correlation between temperature measure and perception of thermal comfort: a field study of thermal comfort in low-income dwellings in England before and after energy efficient refurbishment. Building and Environment 44 (2009), 1228–1236.
[209] Gilbertson, J. Stevens, M. Stiell, B. and Thorogood, N. (For the Warm Front Study Group). 2006. *Home is where the hearth is. Grant recipients views of the Warm Front Scheme.* Social Science and Medicine, 63, pp. 946-956.
[210] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE) Review 2: Interventions and economic studies. London School of Hygiene & Tropical Medicine, Public Health England, University College London.
[211] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]
[212] Gilbertson, J. Stevens, M. Stiell, B. and Thorogood, N. (For the Warm Front Study Group). 2006. *Home is where the hearth is. Grant recipients views of the Warm Front Scheme.* Social Science and Medicine, 63, pp. 946-956. (page 12)
[213] Green G and Gilbertson J (2008) Warm front: better health: Health impact evaluation of the warm front scheme. Sheffield: Sheffield Hallam University, Centre for Regional Social and Economic Research.
[214] Gilbertson, J. Stevens, M. Stiell, B. and Thorogood, N. (For the Warm Front Study Group). 2006. *Home is where the hearth is. Grant recipients views of the Warm Front Scheme.* Social Science and Medicine, 63, pp. 946-956.

reported a greater sense of wellbeing. [215] Similarly, the Changes4Warmth (C4W) study found that feeling better able to heat homes as a result of lower fuel bills and extra income meant that people were less anxious, and felt more 'in control' of their energy bills as a result of the energy behaviour advice they received. [216] Indeed, the worry of receiving an unmanageable fuel bill can be a significant cause of anxiety amongst those who struggle to heat their homes[217].

One consideration when providing housing improvements is that the mental and physical health of residents may worsen should their rent be increased as a result of improvements made to a landlord's property. This may cause further financial stress or oblige tenants to move to cheaper and poorer quality housing, and should be taken into account when designing schemes within the private rented sector. [218] Similarly, the alleviation of fuel-related financial stress does not necessarily mean that other problem debt will be resolved, or that other forms of deprivation will be prevented. Overall, however, the evidence base to date suggests overwhelmingly that the provision of affordable warmth to households can greatly act to reduce mental ill health and stress via a variety of routes. These include feeling warmer and more comfortable at home, worrying less about fuel bills and the cost of heating, having more control over a heating system, feeling less socially isolated and enabling a change in familial relationship dynamics through increased use of space within the home.

2.16 Other health conditions

Other conditions that can be affected or worsened by the cold include Sickle Cell Disease (SCD). Being cold can trigger a crisis for sufferers of SCD (potentially leading to organ failure), and comfortable temperatures for sufferers range from 20°C and 30°C. People living with the condition may need to stay indoors during cold weather, again making the need for constant warmth at home even more pressing. However, the cost of keeping homes warm enough to prevent a crisis can be prohibitive for people who may already be trying to cope with low or reduced incomes. SCD is a condition which is not well reflected in Disability Living or Jobseekers Allowance, making patients vulnerable to sanctions should they miss appointments. Others are vulnerable to dismissal from work due to regular sick absences and hospital visits. Even when people try to avoid high energy bills by heating only one room, a crisis can be triggered by the temperature shock of moving through the house from a warm room to a cold one. Given that SCD-related hospital admissions can cost between £637 and £11,367 a time, it has been argued that part or fully subsidising the heating bills of SCD sufferers (with an average fuel bill of £1,200 per year) would be more cost effective to the NHS, and improve the overall health and wellbeing of this group. [219] [220]

[215] NEA and The Children's Society (for National Grid Affordable Warmth Solutions), 2015, Making a House a Home: Providing affordable warmth solutions for children and families living in fuel poverty Available at: http://www.nea.org.uk/wp-content/uploads/2016/01/Making-a-House-a-Home.pdf [Accessed 06/03/2017]

[216] Chesshire Lehmann Fund: Understanding Fuel Poverty, June 2016. Sherrif, G. and Fyson. M. "I was frightened to put the heating on". Evaluating the Changes4Warmth approach to cold homes and mental health. (pg. 22-24).

[217] Grey, C., Jiang, S., and Poortinga, W. 2015, Arbed recipient's views and experiences of living in hard-to-heat, hard-to-treat houses in Wales: results from three focus groups conducted in South Wales, Welsh school of Architecture, Cardiff University: Cardiff WSA Working Paper Series ISSN 2050-8522

[218] Thomson H, Petticrew M and Morrison D, *Housing improvement and health gain: a summary and systematic review*, MRC Social and Public Health Sciences Unit, 2 002.

[219] Chesshire Lehmann Fund: Understanding Fuel Poverty, June 2016. Cronin de Chavez, Centre for Health and Social Care Research, Sheffield Hallam University. Keeping Warm with Sickle Cell Disease.

Living in a cold home has also been associated with experiencing aches, pains, underlying joint and muscular problems as well as skin conditions (such as dry skin and eczema) as well as physical numbness in the extremities.[221] Arthritic and rheumatic pain can worsen as a result of living in cold and damp housing, and have been shown to improve following the provision of central heating measures.[222 223 224 225 226] Colder indoor temperatures can also affect strength and dexterity, increasing the risk of falls and accidents amongst the elderly.[227 228 229] Furthermore, fuel poverty and inadequate heating at home can increase the risk of carbon monoxide poisoning due to the inappropriate use of flueless heat sources.[230 231]

2.17 Social determinants of health

According to the Public Health Outcomes Framework (PHOF), action to address the health impacts of cold homes can be linked to other indicators that fall within the social determinants of health.[232]

Living in fuel poverty and a cold home can lead to increased social isolation. This is a risk factor for both depression and coronary heart disease (CHD), demonstrating the complex intertwining of cold-related ill health with multiple and psychosocial factors.[233] Similarly, spending already limited resources on fuel may mean families cut back on other essentials, such as food. Poor diet brings the long term health risks of cancer and CHD.[234]

Low incomes and high energy costs can mean having to reduce consumption of energy and under-heating homes, which can have impacts upon cold-related ill health. However, paying for energy can

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[220][220] Cronin de Chavez, 2015, Keeping Warm with Sickle Cell Disease Research Project: Report for the Chesshire Lehmann Fund, Sheffield Hallam University: Centre for Health and Social Care Research

[221] NEA and The Children's Society (for National Grid Affordable Warmth Solutions), 2015, Making a House a Home: Providing affordable warmth solutions for children and families living in fuel poverty Available at: http://www.nea.org.uk/wp-content/uploads/2016/01/Making-a-House-a-Home.pdf [Accessed 06/03/2017]

[222] Press, V. (2003) Fuel poverty + health: A guide for primary care organisations, and public health and primary care professionals. National heart Forum: London

[223] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[224] Shortt, N. and Rugkåsa, J. 2007. "*The walls were so damp and cold" Fuel Poverty and Ill Health in Northern Ireland: Results from a housing intervention.* Health and Place. 13 (1) pp. 99-110.

[225] Liddell, C. and Morris, C. 2010. *Fuel poverty and human health: a review of the recent evidence.* Energy Policy. 38, pp. 2987-97

[226] Gilbertson, J. Stevens, M. Stiell, B. and Thorogood, N. (For the Warm Front Study Group). 2006. *Home is where the hearth is. Grant recipients views of the Warm Front Scheme.* Social Science and Medicine, 63, pp. 946-956.

[227] Press, V. (2003) Fuel poverty + health: A guide for primary care organisations, and public health and primary care professionals. National heart Forum: London

[228] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[229] Public Health England. 2014. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

[230] Ormandy, D. and Ezratty, V. 2012. *Health and thermal comfort: From WHO guidance to housing strategies.* Energy Policy 49, pp. 116–121

[231] Public Health England, 2014b. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright

[232] Public Health England. 2014. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

[233] Rosengren, A. Hawken, S. Ounpuu, S. Sliwa, K. Zubaid, M. Almahmeed, W. Blackett, K. Sitthi-amorn, C. Sato, H. Yusuf, S. and INTERHEART investigators. 2004. *Association of psychosocial risk factors with risk of acute myocardial infarction in 11119 cases and 13648 controls from 52 countries (the INTERHEART study): case-control study.* Lancet. 364 (9438) pp.953-62.

[234] Press, V. (2003) Fuel poverty + health: A guide for primary care organisations, and public health and primary care professionals. National heart Forum: London

also represent budgetary compromises elsewhere, and may mean that families spend less on food, choosing between heating or eating.[235] [236] [237] One study found that 65% of low income households that had cut back spending on energy had also done so for spending on food, and 59% of those reducing expenditure on food had done the same for spending on heating. [238] Choosing between heating and eating can act to increase the risk of malnutrition and affect infant weight gain. [239] [240] It is also possible that this could impact upon other illnesses that may require particular dietary content or calorific intake, such as diabetes or TB. [241] A study conducted amongst low income families in the US found that families decreased their spending on food by the same amount that they had to spend on extra fuel during colder periods. Ultimately, this resulted in adults consuming 147 fewer calories, adults with children consuming 241 fewer calories and children consuming 197 fewer calories per day during the winter. [242] [243] Another US study found that infants from families in receipt of the winter fuel subsidy were 30% more likely to be admitted to hospital or primary care clinics in their first 3 years of life, and were 20% more likely to be underweight than families who do not receive the subsidy. [244] In contrast, evaluation of the Warm Front scheme found that 10% of households felt they could buy more food (and of a better quality) following the receipt of central heating measures. Furthermore, 20% felt better able to cook at home since kitchens that were previously too cold were now comfortable to work in. [245] By increasing the energy efficiency of a property, reducing fuel bills and maximising income, then, families may find that have more resources to spend on other basic essentials, such as food. [246]

Households that practice spatial shrinking will often only heat one room in the house in order to avoid paying higher fuel costs. This can have a variety of knock-on effects beyond immediate cut-backs on other essentials that will impact upon wellbeing in the long term. For example, it can create difficulties for children trying to complete homework in the same room as other family members, and competing for space around the heating source. This can be detrimental to educational

[235] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]
[236] Anderson, W. White, V. and Finney, A. 2010. *"You just have to get by" Coping with low incomes and cold homes.* Centre for Sustainable Energy. Available at: https://www.cse.org.uk/downloads/reports-and-publications/fuel-poverty/you_just_have_to_get_by.pdf [Accessed 06/03/2017]
[237] Beatty, T. Blow, l. and Crossley, T. 2011. Is there a heat or eat trade off in the UK? London: Institute of Fiscal Studies.
[238] Anderson, W. White, V. and Finney, A. 2010. *"You just have to get by" Coping with low incomes and cold homes.* Centre for Sustainable Energy. Available at: https://www.cse.org.uk/downloads/reports-and-publications/fuel-poverty/you_just_have_to_get_by.pdf [Accessed 06/03/2017]
[239] Cooper, N., Purcell, S., and Jackson, R. 2014, Below the breadline: The relentless rise of food poverty in Britain, Church Action on Poverty, Oxfam, The Trussell Trust
[240] Public Health England. 2014. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.
[241] Grey, C., Jiang, S., and Poortinga, W. 2015, Arbed recipient's views and experiences of living in hard-to-heat, hard-to-treat houses in Wales: results from three focus groups conducted in South Wales, Welsh school of Architecture, Cardiff University: Cardiff WSA Working Paper Series ISSN 2050-8522
[242] Bhattacharya J, DeLeire T, Haider S and Currie J (2003) Heat or Eat? Cold Weather Shock and Nutrition in Poor American Families. *American Journal of Public Health*, 93(7), pp.1149–1154.
[243] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty, http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf
[244] Liddell, C. (2008) 'Policy Briefing – The Impact of Fuel Poverty on Children'. Belfast: Ulster University & Save the Children http://tinyurl.com/STC-Policy-Briefing-FP
[245] Gilbertson, J. Stevens, M. Stiell, B. and Thorogood, N. (For the Warm Front Study Group). 2006. *Home is where the hearth is. Grant recipients views of the Warm Front Scheme.* Social Science and Medicine, 63, pp. 946-956.
[246] Public Health England. 2014. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

attainment in the long term. [247] Fuel poverty, for example, has been associated with poorer attainment in mathematics in children aged 4-5 years. [248] In contrast, having access to affordable warmth has the potential to reduce school or work absence. [249] [250] It is clear, then, that the survival strategies employed by households trying to cope with cold homes and high energy costs can engender further knock-on effects on their health and wellbeing beyond that of the immediate physiological or psychosocial response to the cold.

2.18 The cost of cold-related ill health

So far, this review has discussed the health risks associated with cold homes at both an individual level and in terms of the general population. However, for each case of cold-related mortality or morbidity there is of course an associated cost to the health service. For example, in 2013/14, hospital admissions for chronic lower respiratory disease and pneumonia accounted for 3.2 million NHS bed days. Each bed-day costs £2,756, meaning these conditions cost the NHS £875 million in bed provision alone. This excludes other hospital and primary care costs. [251] Each emergency admission into hospital costs the NHS £2,500, every GP appointment costs £45, and a single prescription costs an average of £41.35. From this alone, the annual cost to the NHS of COPD is estimated to be more than £800 million.[252]

For every cold-related death there are around eight non-fatal hospital admissions. This represents significant added pressure to the NHS as a result of cold housing. [253] In 2011, Mason and Roys argued that properties with poor SAP ratings were costing the NHS £192 million according to the CIEH HHSRS calculator, £35 million of which came from within the private rented sector. Estimating costs within the private rented sector using the BRE Category 1 calculator put the figure as being between £37 million and £674 million depending on exact SAP rating and occupancy.[254] Others have put the annual NHS costs of treating cold-related illness of people living in the private sector at over £850million. [255]

In 2010 Nicol calculated that the total cost of tackling Category 1 hazards in English homes would be around £17.6 billion. Not improving those homes would result in annual NHS treatment costs of £600 million, meaning the investment could be recouped through health savings alone within 29 years. The same study calculates annual savings to the NHS by tackling Category 1 hazards in Wales

[247] Press, V. (2003) Fuel poverty + health: A guide for primary care organisations, and public health and primary care professionals. National heart Forum: London

[248] Chesshire Lehmann Fund: Understanding Fuel Poverty, June 2016. Robinson, L. Centre for Evaluation and Monitoring (CEM), Durham University, Exploring the experiences of families living in fuel poverty and its impact on children's education at school entry.

[249] Thomson, H. Thomas, S. Sellstrom, E. and Petticrew M. 2013. *Housing improvements for health and associated socioeconomic outcomes (Review).* The Cochrane Collaboration. Published by John Wiley & Sons, Ltd

[250] Public Health England, Sept 2014, Local action on health inequalities: fuel poverty and cold home-related health problems. Health Equity Evidence Review 7

[251] Friends of the Earth, 2015, Briefing: Cold homes and respiratory ill-health in England and Sweden. A comparison of health service statistics.

[252] Energy & Utilities Alliance, Jan 2017, Fuel Poverty – A Connected Solution. Available at http://eua.org.uk/uploads/587C9C8C18F22.pdf [Accessed 17/01/2017]

[253] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[254] Mason, V., Roys, M., 2011. The Health Costs of cold dwellings. Building Research Establishment, Watford

[255] Public Health England. 2014. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

of £67 million, and £33 million in Ireland. Across the UK, it would amount to £760 million in NHS savings each year.[256]

The Fuel Poverty Strategy for Northern Ireland undertook a cost-benefit analysis of investments to deliver affordable warmth, totalling £109 million between 2001 and 2008. The study found that 12% of the investment could be recovered from the NHS savings resulting from improvements to children's health (especially in relation to respiratory conditions and allergies) and mental health. The NHS savings accruing from improvements to the health of adults and older people meant an additional 42% of the initial investment could be recovered. Liddell estimates that 100% of the initial investment could be further recouped through carbon offsetting over the lifetime of the energy efficiency measures provided. [257]

Indeed Marmot argues that improving the energy efficiency of homes in England would be recouped through savings to energy spending, reductions in health costs, the mitigation of climate change as well as the correlated environmental and social benefits that would accrue as a result of improved quality of life for those people currently suffering in cold homes. In terms of healthcare costs alone, it has been estimated that for each £1 invested to keep people warm at home, health cost savings of 42p are generated for the NHS. [258]

These savings estimates have been reflected in a number of smaller-scale intervention studies, demonstrating cost-effectiveness at a local level. An intervention study in New Zealand, for example, found that providing households with insulation resulted in accrued benefits (fewer visits to the GP, fewer admissions into hospital, reduced absences from work and school, and reductions in CO2 emissions) which were twice the value of the cost of carrying out the retrofit. [259] Likewise, the evaluation of the Kirklees Warm Zone Project found that providing insulation to households generated a savings benefit of £2.28 million as a result of improvements to mental health. The provision of central heating measures generated a benefit of £1.27 million. In all, the project generated 20p worth of health benefits per each pound spent.[260] Another study found that residents of an estate that received housing improvements (including affordable warmth measures) had annual health costs of only £72 per person. Residents of a similar but unimproved estate had annual health costs of £512 per person. Finally, it has been shown that the health costs of residents living in poor housing can be up to 50% higher than a comparable sample taken from the General Households Survey. [261]

The total cost of cold and damp housing to the nation as a whole - incorporating NHS, social services and correlated economic losses through work and school absence – is unknown. However, it is clear that cold-related illnesses (including respiratory conditions, cardiovascular disease, and rheumatic

[256] Nicol, S. 2010, The Real Cost of Poor Housing, BRE (Building Research Establishment)
[257] Liddell, C. (2008) 'Policy Briefing – The Impact of Fuel Poverty on Children'. Belfast: Ulster University & Save the Children. Available at: http://tinyurl.com/STC-Policy-Briefing-FP [Accessed 06/03/2017]
[258] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]
[259] Chapman, R., Howden-Chapman, P., Viggers, H., O'Dea, D., Kenndy, M., 2009. Retrofitting houses with insulation: a cost–benefit analysis of a randomised community trial. Journal of Epidemiology and Community Health 63, 271–277.
[260] Liddell C, Morris C, Lagdon S. Kirklees Warm Zone: The Project and its Impacts on Well-being: Department for Social Development, Northern Ireland, 2011
[261] Press, V. (2003) Fuel poverty + health: A guide for primary care organisations, and public health and primary care professionals. National heart Forum: London

conditions) cost the NHS a substantial amount each year. [262] This highlights the overlapping nature of schemes that look to provide affordable warmth to vulnerable households, and the wider need to reduce pressures on the health service.

2.19 Targeting for health?

In this review we have seen how the experience of cold indoor temperatures, and the cumulative effects of fuel poverty, can lead to an increased risk of respiratory and cardiovascular disease as well as mental ill health and a range of other associated health conditions. We have also seen how interventions that seek to provide households with affordable warmth have demonstrated significant self-reported improvements to both mental and physical health. However, if schemes seek to achieve health-based outcomes for those suffering in cold homes, how should their interventions be targeted so as to ensure help still reaches those most in need?

This is an important question to ask, given that the distribution of excess winter deaths is spread quite widely across the population, rather than being concentrated only in those who are officially fuel poor or have existing illness. In fact, there is no significant socio-economic gradient in terms of who is vulnerable to cold-related morbidity and mortality. [263] [264] [265] This therefore suggests that, whilst low incomes represent greater vulnerability to fuel poverty, the range of people suffering from cold-related illness may be wider than those who fall within the eligibility criteria of current mandated schemes such as ECO and the FPNES. Indeed, "intervention strategies that are aimed only at low income and fuel poor households will not address a substantial part of the population burden of winter- and cold-related mortality/morbidity." [266]

The Marmot Review put forward the concept of proportionate universalism, whereby actions to "reduce the steepness of the social gradient in health…must be universal, but with a scale and intensity that is proportionate to the level of disadvantage". This concept refers to the fact that a "greater intensity of action is likely to be needed for those with greater social and economic disadvantage, but focusing solely on the most disadvantaged will not reduce the health gradient, and will only tackle a small part of the problem."[267]

Schemes looking to improve cold-related ill health in so far as it overlaps with other forms of vulnerability therefore need to be realistic about the extent of improvement at a population level that they will see. The widespread distribution of cold-related mortality and morbidity means that

[262] Peters, J. and Stevenson, M. (2000) Modelling the health cost of cold housing. In Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London.
[263] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 1: Factors determining vulnerability to winter- and cold-related mortality/morbidity. London School of Hygiene & Tropical Medicine, Public Health England, University College London
[264] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]
[265] Wilkinson P, Pattenden S, Armstrong B, Fletcher A, Kovats RS, Mangtani P, and McMichael AJ (2004) Vulnerability to winter mortality in elderly people in Britain: population based study. *British Medical Journal*, 329(7467), pp.647–651.
[266] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 1: Factors determining vulnerability to winter- and cold-related mortality/morbidity. London School of Hygiene & Tropical Medicine, Public Health England, University College London (page 68)
[267] The Marmot Review (2010) Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England Post-2010 (page 16)

schemes will need to ensure that help continues to be targeted at those who are the most vulnerable in society and who are least able to independently achieve affordable warmth at home. At the same time, restricting eligibility to the extent that it is defined within ECO and the FPNES also means that others who are likely to be extremely vulnerable (but who are on or just above the threshold of said eligibility requirements) might be forced to suffer from cold-related ill health without adequate support being provided. This means it may be more relevant to try to capture significant health outcomes within particular groups of vulnerable households rather than measuring how far the effects of heating improvements are manifest at a general population level.

This is an important point to recognise since vulnerability to living in a cold home may manifest itself in different ways. People living in social housing, for example, tend to have lower energy costs than people living in the private-owned or private-rented sector, as well as higher indoor temperatures.[268] [269] People living in the private rented sector are 124% more likely to be in fuel poverty than those who are not. [270] This is because much of the social housing stock has received energy efficiency improvements following the introduction of the Decent Homes Standard in 2000. Improvements to the energy efficiency of properties in the private rented sector are less widespread, given that private landlords are only obliged to address violations of the HHSRS, which does not include specified minimum requirements for thermal efficiency. [271] It is therefore necessary to take tenure and its effect on lowering indoor temperatures into account when seeking to provide affordable warmth, as living in the private sector could signify vulnerability to cold-related ill health.

However, it is important to note that whilst social housing tenants tend to live in houses that are more thermally efficient, they are still vulnerable to experiencing colder indoor temperatures as energy costs increase. [272] Income as well as the energy efficiency of a house will impact upon a family's ability to heat a home – when costs rise too far, and incomes fall, the ability of those on low incomes (including social housing tenants) to maintain higher indoor temperatures is compromised.[273] Indeed, people living in poverty in the wider sense are 600% more likely to be in fuel poverty than those who are not. [274]

NICE argues that for key groups of people vulnerable to cold related ill health, interventions could be justified on the basis of health benefits alone. [275] These groups include: children, older people,

[268] Wilkinson P et al. 2001. *Cold Comfort:The Social and Environmental Determinants of Excess Winter Death in England,1986-1996*. Bristol: The Policy Press

[269] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[270] Energy & Utilities Alliance, Jan 2017, Fuel Poverty – A Connected Solution. Available at http://eua.org.uk/uploads/587C9C8C18F22.pdf [Accessed 17/01/2017]

[271] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[272] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 1: Factors determining vulnerability to winter- and cold-related mortality/morbidity. London School of Hygiene & Tropical Medicine, Public Health England, University College London

[273] Wilkinson P, Landon M, Armstrong, B, Stevenson S, Pattenden S, McKee M and Fletcher T (2001) Cold Comfort: The Social and Environmental Determinants of Excess Winter Deaths in England, 1986–96. Bristol: The Policy Press

[274] Energy & Utilities Alliance, Jan 2017, Fuel Poverty – A Connected Solution. Available at http://eua.org.uk/uploads/587C9C8C18F22.pdf [Accessed 17/01/2017]

[275] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE) Review 2: Interventions and economic studies. London School of Hygiene & Tropical Medicine, Public Health England, University College London.

people living with disabilities and those with chronic illness.[276] [277] [278] Other groups that are likely to be vulnerable to health impacts of cold homes include those in energy inefficient housing - especially that which was built before the Code for Sustainable Homes was introduced in 2007.[279] Overall, however, NICE argues that the provision of energy efficiency and affordable warmth interventions would be of benefit to the general population: "[a national intervention scheme] is most readily justified if the health, social, environmental and economic objectives are considered together." [280] However, it must also be noted that low income groups within the population have higher baseline, age-specific mortality rates throughout the year, which mean that increases in risk can give rise to a greater seasonal excess. Whilst excess winter deaths are widely distributed across the population, then, targeting interventions at low income groups could still help to reduce health inequalities. [281] As Marmot claims, "addressing energy inefficient housing and bringing all homes up to a minimum standard of thermal efficiency would have the strongest positive impact on the poorest households, even though households from a variety of socio-economic backgrounds are likely to be residents of such properties." [282]

At the same time, it has been suggested that broader targeting can act as a means to futureproof people from the effects of cold related ill health *before* they become vulnerable. Whilst individuals with existing chronic respiratory or cardiovascular conditions are at a higher relative risk of cold-related morbidity and mortality than others of the same age within the general population, it is likely that most excess winter mortality and morbidity will occur in people who do not form part of this group. Targeting interventions only on the basis of pre-existing conditions could therefore miss those who actually succumb to excess seasonal risk. Indeed, "vulnerability to cold is widely distributed throughout the population and is recognised to be a fluid 'state' which people, through various stages in their life, may move into and move out of. It is a multifactorial concept and not necessarily confined to individual characteristics such as health status or age alone." This is why PHE suggest minimum indoor temperatures of 18°C at a population wide basis, since this is the minimum temperature below which health risks start to manifest in a sedentary person in suitable clothing. [283] Affordable warmth schemes, therefore, need to strike a balance between identifying and targeting certain vulnerable groups *and* making measures available to the wider population more generally. [284]

[276] Press, V. (2003) Fuel poverty + health: A guide for primary care organisations, and public health and primary care professionals. National heart Forum: London

[277] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[278] Harker L (2006) Chance of a lifetime: The impact of housing on children's lives. London: Shelter.

[279] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[280] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE) Review 2: Interventions and economic studies. London School of Hygiene & Tropical Medicine, Public Health England, University College London.

[281] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 1: Factors determining vulnerability to winter- and cold-related mortality/morbidity. London School of Hygiene & Tropical Medicine, Public Health England, University College London

[282] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[283] Public Health England, 2014b. *Cold weather Plan for England. Making the case: why long-term strategic planning for cold weather is essential to health and wellbeing.* Crown Copyright.

[284] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 3: Delivery and implementation of approaches for the prevention of excess winter deaths and morbidity (2014) London school of Hygiene & Tropical Medicine, Public Health England, University College London.

When looking to achieve health-based outcomes, then, is important to consider that: "[whilst] the combination of housing characteristics and household income provide a reasonable basis for identifying households at greatest risk…consideration must also be given to the improvement of indoor temperatures in other dwellings, which collectively account for a substantial part of preventable winter deaths. The fact that many of these households will have good incomes implies a more complex strategy than simply providing grants to up-grade dwellings occupied by those on low incomes." [285]

There is therefore a tension between targeting for health alone, and targeting to address vulnerability in the more complex sense. Interventions might seek to achieve significant health outcomes that are manifest at population level through a blanket targeting approach. Or, they might direct help at those households who are most vulnerable (in terms of deprivation) and who are least able to pay. This approach risks missing some households who are not deprived but nevertheless suffer from cold-related health conditions in an attempt to combine potential health gains with a reduction in deprivation (including the experience of fuel poverty).

Section 3 of this report explores this issue in more detail, and examines how different affordable warmth schemes have managed this targeting tension.

2.2: The Environmental impact of energy efficiency

Marmot argues that improving the energy efficiency of the UK housing stock would allow for a combination of wider benefits to be achieved in the long term. [286] This is because there is an overlap between the provision of affordable warmth, the mitigation of climate change, and improvements to health. [287] [288] [289] [290] [291] [292] Those who are likely to suffer most from the health impacts of climate change are likely to be those already vulnerable to fuel poverty and the health impacts of living in a cold home today. Similarly, improving energy efficiency of homes can have immediate health benefits, and contribute to carbon savings. By doing so, it may also mitigate future health consequences of climate change. [293] [294] [295] [296] This indicates that schemes looking to achieve health

[285] Wilkinson P, Landon M, Armstrong, B, Stevenson S, Pattenden S, McKee M and Fletcher T (2001) Cold Comfort: The Social and Environmental Determinants of Excess Winter Deaths in England, 1986–96. Bristol: The Policy Press
[286] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]
[287] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 1: Factors determining vulnerability to winter- and cold-related mortality/morbidity. London School of Hygiene & Tropical Medicine, Public Health England, University College London
[288] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 3: Delivery and implementation of approaches for the prevention of excess winter deaths and morbidity (2014) London school of Hygiene & Tropical Medicine, Public Health England, University College London.
[289] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]
[290] Dear, K. and McMichael, AJ. 2011. *Editorial: The health impacts of cold homes and fuel poverty.* British Medical Journal. 342, d2807.
[291] Hills, J (2012) Getting the Measure of Fuel Poverty: Final Report of the Fuel Poverty Review. Centre for Analysis of Social Exclusion: Case Report 72
[292] WHO, 2006. Housing, Energy and Thermal Comfort: A review of 10 countries within the WHO European Region. World Health Organization for Europe, Copenhagen
[293] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]
[294] Dear, K. and McMichael, AJ. 2011. *Editorial: The health impacts of cold homes and fuel poverty.* British Medical Journal. 342, d2807.

outcomes for the most vulnerable in society should consider incorporating potential environmental benefit into their eligibility criteria.

The Energy Saving Trust (EST) estimates that the cost of bringing all F and G banded homes (which we know are likely to be off-gas) up to a Band E would be £12.5 billion. This would save 9.4Mt of CO_2, which accounts for almost 2% of the UK's total CO_2 emissions. Bringing all homes up to a SAP81 (Band B) would cost up to £28 million in England, and up to £64 billion across the whole of the UK. This could reduce domestic sector CO_2 emissions by half. This is an important consideration, given that around a quarter of UK CO_2 emissions are generated through domestic energy use, and 70% of such emissions are due to space and water heating. [297]

Housing which would be considered hard-to-treat (HTT) accounts for 62millionMt of CO_2 emissions each year, whilst the housing stock as a whole accounts for 123millionMt of CO_2. Therefore, whilst HTT properties represent 42% of the housing stock, they account for over half of domestic sector CO_2 emissions. Importantly, 72% of the HTT housing stock is off the gas network and comprises dwellings with solid walls. [298]

Given that excess winter mortality tends be associated with energy inefficient properties[299], and the provision of gas central heating can act to improve the SAP rating of a property, then providing gas grid connections and first time gas central heating could have the potential to achieve outcomes of interest to both the health and climate change agendas. At the same time, it is important to recognise that health and environmental agendas may intersect in multiple (and sometimes conflicting) ways. For example, evaluation of the Warm Front scheme found that the provision of heating measures actually lead to increased fuel consumption within the home, even after allowing for higher average internal temperatures.[300] Schemes looking to achieve outcomes across both indicators therefore need to consider how to integrate the two post-intervention, for example through the provision of energy efficient behaviour advice. In contrast, health benefits were sometimes compromised by residents reducing fuel consumption due to difficulties in understanding new heating systems and controls, or for fear of maintaining higher indoor temperatures and increasing fuel bills. At other times, it related to lay beliefs regarding the health benefits of lower indoor temperatures, particularly amongst certain elderly recipients.[301] Whilst theoretically beneficial for carbon reduction targets, such practices are not beneficial for health nor do they necessarily represent energy efficient behaviours. These potentially disrupting variables should be

[295] McGeehin, M.A., Mirabelli, M., 2001. The potential impacts of climate variability and change on temperature-related morbidity and mortality in the United States. Environmental Health Perspectives 109 (Suppl. 2), 185–189

[296] WHO, 2006. Housing, Energy and Thermal Comfort: A review of 10 countries within the WHO European Region. World Health Organization for Europe, Copenhagen

[297] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

[298] Rural Services Network for the Commission for Rural Communities (2010) Understanding the real depth and impact of fuel poverty in rural England.

[299] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 1: Factors determining vulnerability to winter- and cold-related mortality/morbidity. London School of Hygiene & Tropical Medicine, Public Health England, University College London

[300] Green G and Gilbertson J (2008) Warm front: better health: Health impact evaluation of the warm front scheme. Sheffield: Sheffield Hallam University, Centre for Regional Social and Economic Research

[301] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]

taken into account when designing schemes that seek to work across the health and climate change agendas, so as to ensure appropriate messaging and advice is being provided to households.

Section 3: Current practice in targeting and outcome measurement

NICE and the WHO recommend that interventions for improving cold related ill health include moves to increase internal temperatures within the home, as well as expanding the space within the home that can be heated to comfortable temperatures. This can be done in the long and the short term through: the provision of energy efficiency and heating measures; income maximisation activities and the delivery of energy efficiency advice. [302] [303] Such schemes also require successful partnership working between various sectors. [304] [305] However, Section 2 of this review has shown that schemes will not only need to develop appropriate targeting mechanisms, but they will also need to capture impact across both a self-reported and more clinically based spectrum. This section will explore how current affordable warmth schemes looking to achieve health based and energy efficiency outcomes have managed this tension, and why they have decided to pursue a particular approach. This transfer of learnings between schemes will help to develop a more informed targeting and evaluation approach for the proposed Connecting Homes for Health pilot.

3.1 Scheme Targeting

Schemes that target interventions according to individual risk of cold-related ill health can work effectively in partnership with health professionals who can refer individuals in to services on offer. This can help to target interventions at individuals who are at risk but hard to reach. [306] However, it has already been noted that targeting on the basis of individual health risk runs the risk of missing other more vulnerable members of the population that succumb to cold related ill health or morality. Targeting on an area-wide basis rather than individual basis could help to solve this and, for purposes of the proposed pilot, it would be more cost effective to provide first time gas-grid connections on a street-by-street basis. [307] However, this also runs the risk of spreading help across a population that manifests different levels and types of vulnerabilities, thus diluting the potential for helping the most vulnerable.

In order to understand how other schemes currently seeking to achieve health outcomes through the provision of affordable warmth measures have negotiated this complex tension within targeting, NEA carried out a number of semi-structured telephone interviews with a selection of good practice

[302] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE) Review 2: Interventions and economic studies. London School of Hygiene & Tropical Medicine, Public Health England, University College London

[303] Ormandy, D. and Ezratty, V. 2012. *Health and thermal comfort: From WHO guidance to housing strategies.* Energy Policy 49, pp. 116–121

[304] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 3: Delivery and implementation of approaches for the prevention of excess winter deaths and morbidity (2014) London school of Hygiene & Tropical Medicine, Public Health England, University College London.

[305] Boardman. B. Introduction. In: Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London

[306] Press, V. (2003) Fuel poverty + health: A guide for primary care organisations, and public health and primary care professionals. National heart Forum: London

[307] Energy & Utilities Alliance, Jan 2017, Fuel Poverty – A Connected Solution. Available at http://eua.org.uk/uploads/587C9C8C18F22.pdf [Accessed 17/01/2017]

scheme providers. These are detailed in the case study boxes below, and reveal why targeting needs to be more flexible than is currently allowed within current FPNES eligibility in order to reach those who are most in need.

Box 1: Islington Shine Box 1: Islington SHINE

In Islington, eligibility criteria for the Warmth on Prescription programme were developed using a mixture of wider evidence and local demographic information (including morbidity levels according to different health conditions within the borough). A range of health conditions are included in the criteria, varying from those for which a clearer link between cold homes and health has been shown to exist (respiratory disease and mental ill health, for example), to those for which the link is less direct (such as people suffering from cancer or autoimmune diseases who spend more time at home and have higher energy needs in order to stay warm). The scheme does not limit its eligibility to those who would come under the Low Income High Costs definition of fuel poverty, since they have found the cost threshold to be set too high for the typical household in London. Properties in the area tend to be smaller, and so the average bill tends to be lower than the national median bill. That does not mean, however, that residents can afford to pay for their energy, and the national median bill is considered by the scheme to be too high to be an adequate measure of ability to meet energy costs.

Most clients coming in to the scheme have a multiplicity of problems that combine to make them more vulnerable. Clients are therefore ranked according to a weighted scoring system, which allocates scores to different household characteristics according to how much they are considered to increase the vulnerability of that household. The weighted scoring system covers factors such as presence and severity of mental and physical health conditions, number of vulnerable people in a property, the ages of the people within the household, household income, age of property and its energy efficiency rating. Referrals that come in through the health service are also given a higher weighting than those they come from elsewhere (including self-referrals). In order to qualify for help, the combined score of the household needs get above a particular threshold. The intention behind this is to consider the total impact of improving the property on the whole household and, therefore, the ultimate cost to the health service. It also allows households who may not qualify for help under other schemes to access support through the programme.

The problem with the current criteria for mandated schemes, according to the SHINE representative, is that it doesn't really take into account the total cost to society, and the potential savings to society from improving a property. Ultimately, they said, "where money is tight I think there is a strong argument for spending it where it can have the most impact. It's about looking at cost effectiveness in a more holistic way."

Box 2: Dudley Home Improvement Agency (HIA)

The Winter Warmth Service provided by Dudley HIA is open to any resident of Dudley. However, the scheme is actively promoted only amongst frontline health and social care professionals in order to target people who might be suffering from cold-related mental and physical health conditions. The only direct referral mechanism comes from the discharge nurse in the cardiology department of the local hospital. Otherwise, the team will go out and spend time with respiratory teams and mental health groups in order to raise awareness of the service offered. In practice, the representative said that they had found that referrals from professionals who do not see patients in their home are not as good quality as those that come from professionals who are able to witness what conditions are like within the home: "we do have referrals from people that come straight from hospital, but often when you go out to see them, they've got the health condition but the home that they're living in is actually very adequately warm. We've found that the referrals that come from professionals that actually see them in their home tend to be the sort of people who are struggling to keep warm, keep healthy, and are the most vulnerable and most desperate for help."

For that reason, the scheme has stopped doing wider advertising and promotional work, in order to try and reach those that are most vulnerable. Rather than making health conditions form part of a set of eligibility criteria, then, the targeting of health professionals who visit patients in the home acts as a means of reaching the most vulnerable both in terms of health risk and level of deprivation. The scheme does employ financial criteria, set at a maximum income threshold of £18,000, in order to reach those most in need of help.

Box 3: Warm Homes Oldham

The Warm Homes Oldham scheme overlaps loose health-based eligibility criteria with fuel poverty risk criteria in order to ensure more households are able to receive help whilst also continuing to target the most vulnerable. Households suffering from cold-related physical illness (broadly categorised as respiratory, cardiovascular or musculoskeletal disease) or mental ill health and which fall into particular age groups (16 and under, pregnant or over 50) are able to access help from the scheme if the improvements offered to them would be expected to lift them out of fuel poverty under the 10% definition, or if the improvements would be expected to reduce the level of fuel poverty by over a third and bring the new energy bill within reach of the household. A broader eligibility criteria like this means that the scheme can take a wider marketing approach, and attempt to reach more households who may not otherwise have qualified for help under other current schemes.

Box 4: Derbyshire Healthy Homes

The Derbyshire Healthy Home programme has taken a multi-pronged approach to targeting in order to maximise the various routes through which the most vulnerable households can be engaged.

The first route entails the use of a data-matching agreement with GP surgeries. Information on housing tenure and the receipt of council-managed benefits information is mapped onto the postcodes that fall within the catchment area of a GP surgery. GPs are then asked to write to patients who are identified as living in a private sector home, are in receipt of council benefits and who are registered with a cold sensitive health condition on their patient QOF register (Quality Outcome Framework). Households in need of help are then able to contact the scheme for support. This process itself is adapted to suit the needs and operating models of individual GP practices, to ensure they remain engaged. Here, flexibility has been identified as key to working with a range of GP partners. By using this method, the scheme is able to generate around a third of its referrals.

In keeping with the need for flexibility, however, the programme managers have accounted for residents who may find it difficult to engage with a letter, or an approach from their GP. For example, some residents may have low literacy levels, or may have mental health issues which mean they do not engage with society. Others are mistrustful of such approaches due to negative past experiences, a distrust of 'authority', are too proud or frightened to ask for help, or have a poor relationship with their GP practice. Others still may not respond because, even though they are suffering from a particular health condition, they may in fact be experiencing adequate warmth at home.

All services are highlighted as being free to eligible householders. This has a significant impact upon the response rate and take up of services from householders that otherwise would be unable to afford help themselves. However, the scheme found that identifying households on the basis of the property EPC may inadvertently exclude low income households who have been in the same property for a long time (and hence do not have an EPC). Rather than imposing restrictive eligibility criteria, then, households are able to simply tell the project officers what is wrong with their property, and they are able to judge whether they are need of small or large affordable warmth measures.

One way of targeting based on household need has been to work with trusted local partners that actually go into people's homes. This includes housing and environmental officers, as well as the fire and rescue services. As a result, "we get a lot of extreme jobs which helped people who were really desperate. You don't need a data merge to understand that someone is in poverty if you're in their home and you can see it. It's apparent, really, as are the health conditions". The key word here is that of 'trusted' in terms of the partners involved. The scheme has found that they are more likely to get referrals from organisations and frontline workers with whom they have a longstanding relationship, who are familiar with what the scheme aims to achieve and who know they can trust the scheme to deliver for their patients or clients.

Learnings from the Healthy Homes project show that a multi-pronged approach that is flexible enough to adapt to the local context and the differing engagement requirements of households *and* partners can be most effective when trying to reach the most vulnerable in society.

Box 5: Durham Warm and Healthy Homes Project

Durham County Council's Warm and Healthy Homes project commenced in 2013 to improve the health and wellbeing of patients living in cold damp private sector housing by addressing exposure to excess winter deaths and decreasing hospital admissions. This is achieved by providing grants to install new central heating and insulation measures to provide warmer homes, advice on managing fuel debt, energy saving and fuel tariff advice.

Funding is provided by Public Health with delivery by the Council's Housing and Regeneration Service. The project is closely linked to the County Durham Affordable Warmth Strategy and Joint Strategic Needs Assessment.

Front line health and social care practitioners based in GP surgeries, hospitals and clinics receive training on the referral process using a range of mechanisms. This includes health and social care team meetings, e-mail updates and GP surgery meetings. A referral card system provides an easy access referral system whilst also providing confirmation of the eligibility criteria.

The project provides a countywide coverage enabling households with a long term health condition living in a cold, damp home to be assisted. Close working with the Clinical Commissioning Groups (CCG) has resulted in recruitment of a CCG Warm Homes Champion to ensure the project is embedded into front line practices and in 2017 the project received an award from the NEA.

Possible approaches to targeting have also been discussed extensively within the literature. For example, the Arbed 2 scheme is a street-by-street or community based programme that targets low-income neighbourhoods that have a mixture of tenures, but a high proportion of hard-to-treat homes and an increased risk of fuel poverty. All homes within each area are offered free energy efficiency measures and are not means-tested. [308] This kind of approach has been found to cause problems, however, when funding for measures depends on government schemes. Evaluation of an intervention in Wales found that, whilst the use of more flexible eligibility criteria meant more vulnerable households could be identified, funding under existing grant schemes was only available for those people who were in receipt of benefits. People who nevertheless fulfilled other vulnerability criteria (such as low income and the presence of a cold-related health condition) but were not on benefits were therefore classed as ineligible. The study authors therefore recommended that future policy redefine eligibility to enable other vulnerable households to access help. [309]

Rudge and Gilchrist argue that the economies of scale which can be achieved through the use of a whole street approach can be supplemented with the application of Fuel Poverty Risk statistics in order to identify areas in need of energy efficiency improvements and where health impacts can be manifest.[310] NICE similarly notes that successful schemes to date have used tools such as disease

[308] Grey, C., Jiang, S., and Poortinga, W. 2015, Arbed recipient's views and experiences of living in hard-to-heat, hard-to-treat houses in Wales: results from three focus groups conducted in South Wales, Welsh school of Architecture, Cardiff University: Cardiff WSA Working Paper Series ISSN 2050-8522

[309] Burholt V and Windle G (2006) Keeping warm? Self-reported housing and home energy efficiency factors impacting on older people heating homes in North Wales. *Energy Policy*, 34(10), pp.1198–1208

[310] Rudge J and Gilchrist R (2007) Measuring the Health Impacts of Temperatures in Dwellings: Investigating excess winter morbidity and cold homes in the London Borough of Newham. *Energy and Buildings*, 39, pp.847–858.

registers to identify individuals at risk, or have analysed geographical data to identify areas that are likely to contain a high number of at risk households. [311]

A pilot study to test new health based and environmental eligibility criteria for the FPNES would therefore need to take into account the balance that must be present within scheme targeting between achieving health outcomes and directing help towards the most vulnerable. At the same time, restricting the target population to those households who would qualify for help under the FPNES as it currently stands would still miss a significant number of low income, vulnerable households in or at risk from fuel poverty and who are suffering from the health impacts of living in a cold home.

3.2 Capturing outcomes

How have the effects of providing affordable warmth measures to households been measured by current schemes? Evaluation studies are more likely to find a (sometimes statistically significant) association between the provision of affordable warmth and particular health outcomes, rather than identifying a clinical explanation. Such evidence would need to be developed through large scale studies able to apply biomedical techniques of measurement and monitoring over a longer time period. This is generally not within the scope of schemes looking to provide affordable warmth to vulnerable households within a given area, over a particular time frame, and within a limited budget. However, incorporating a composite measure of physical and mental health can still allow for a broad range of effects to be captured within a study. [312]

Liddell and Morris argue that evaluation of schemes should be able to measure (and distinguish between) self-reported/perceived improvements to health and demonstrable improvements (through changes in use of health services, changes in prescriptions or changes to symptoms). They also state that evaluations should seek to capture a broad range of physical and mental health conditions across a variety of age groups. Longer term monitoring is also needed to better demonstrate impact,[313] and methods should be tailored to the needs of people suffering from different physical and mental health conditions.[314]

In our telephone interviews with scheme providers, we asked how they have attempted to capture the impact of their interventions, and why they decided upon the particular measurement methods in question. The interviews revealed that one of the most important aspects of effective evaluation is in being realistic about the nature of the improvements that a scheme can expect to engender.

[311] Evidence Review & Economic Analysis of Excess Winter Deaths for the National Institute for Health and Care Excellence (NICE). Review 3: Delivery and implementation of approaches for the prevention of excess winter deaths and morbidity (2014) London school of Hygiene & Tropical Medicine, Public Health England, University College London.

[312] Green, G. Ormandy, D. Brazier, J and Gilbertson. J. (2000) Tolerant Building: the impact of energy efficiency measures on living conditions and health status. In Rudge, J., Nicol, F. (Eds.), Cutting the Cost of Cold: Affordable warmth for healthier homes. Taylor & Francis, London.

[313] Liddell, C. and Morris, C. 2010. *Fuel poverty and human health: a review of the recent evidence.* Energy Policy. 38, pp. 2987-97

[314] Chesshire Lehmann Fund: Understanding Fuel Poverty, June 2016. Sherrif, G. and Fyson. M. "I was frightened to put the heating on". Evaluating the Changes4Warmth approach to cold homes and mental health. (pg. 22-24).

Box 6: Islington SHINE

When discussing how the impact of the programme is measured, the SHINE representative noted that even when you are able to access health service data, that data needs to be interpreted very carefully. Ideally, measurement would occur over a period of time to give a 3 year average period. Anything less than that, then "you are potentially presenting misleading information because everywhere is different." This is because EWD statistics can fluctuate naturally. So, "if I were to claim that from year 1 to year 2 EWDs went down in the Borough I'd be holding myself to fortune because due to reasons outside of our control it could go up in year 3."

Ultimately, they emphasised that "what you're trying to prove is a weakening of the trajectory". Since people helped by the scheme suffering particular health conditions are unlikely to be cured as a result of the intervention, the scheme looks to measure whether, over a three year period, there has been in a significant reduction in what their predicted use of the health service would have been had they not received the intervention. "It's ultimately about showing that you made them less sick than they would have been…..If you predict that over 3 years their health service use will increase by 20%, but actually you've found that it's only gone up by 10%, that's a saving." They emphasised that it's about slowing down a worsening of the condition, or easing of symptoms, rather than preventing or curing it.

Much of this relates to the fact that mental and physical health conditions are multifactorial, and controlling for one contributing factor does not necessarily mean that other variables that impact upon the condition will likewise diminish. "Rather than elimination, then, it's about mitigating impact, and making life better for that individual." Overall, it comes down to having realistic expectations regarding what a scheme can achieve and where the impact will be seen. The representative explained how "we're proving that there is an association between being cold and these conditions at a population level. What I don't think we can provide is the curative/preventative impact at an individual level because there are too many other factors. Like a lot of public health interventions you are subject to people living out in the real world, and doing things you don't want them to do, and other external factors. You can improve someone's property, put in triple glazing, the best insulation in the world, but if they get flu they may still fall very ill or die." They explained that "what can be very difficult is getting a metric of the difference you've made to their health service usage. I don't think anyone has really cracked that one yet because there are so many different factors and you are actually only trying to prove a reduction in predicted usage rather than a reduction per se."

Measuring the use of health service without accounting for other factors can also complicate findings. For example, older people might go to the GP because they are lonely and need someone to talk to, not necessarily because they are ill. Therefore even before and after studies could potentially fall victim to events they haven't adjusted or account for. "So it's about acknowledging that there are external factors that you can do little or nothing about, but also that in any case you made an impact. It's about recognising that there are external factors and trying to allow for them". They noted that you are most likely to see most impact by helping the most vulnerable to start with, as analysing results at a general population level are unlikely to be statistically significant.

Box 7: Dudley Home Improvement Agency

Evaluation of the Winter Warmth service focuses on self-reported health outcomes, based on a set of general health and wellbeing questions administered before an intervention and 3 months later. This aims to capture stress and confidence levels, whether a client has greater peace of mind, and whether they feel warmer or more comfortable at home. Again, this comes down to being realistic about the extent of impact the scheme might expect to see: "I think you really are going to struggle to 'improve' most health conditions, and what you're mainly affecting is how comfortable they're feeling, their pain and discomfort levels and overall improving wellbeing. I think that's the main thing you're going to gain from being warm, rather than actually improving someone's particular health condition.

The representative also highlighted the fact that cold-related ill health conditions to do not occur in isolation, and that vulnerability is multifactorial: "It's also important to make sure that we're not just helping to make people warmer and affordably able to keep warm, but we're also helping them to remain safe and independent at home in every way. So we try to include a wider remit into our activities, and make on average an extra 2, 3 or even 4 onward support referrals for every person we see." This might be to a falls service, a befriending service, health training services for issue such as weight management, giving up smoking and healthy eating, or onto management programmes for the management of pain and health conditions. The addition of such variables, whilst forming part of a holistic package of support designed to address poor health and wellbeing from a number of intersecting angles, means that it can be difficult to isolate the effect of affordable warmth improvements when trying to assess scheme outcomes.

Box 8: Warm Homes Oldham

The Warm Homes Oldham scheme aims to improve the health and life satisfaction of recipients. As highlighted within the previous two case studies, evaluation of outcomes according to this aim has focussed on self-reported results by residents, and found that the most common improvements were to stress levels, emotional wellbeing and perceived quality of life. Evaluation of the scheme also highlighted the need to account for differential uptake of behaviour change advice amongst residents, which could potentially disrupt any modelling based on estimated energy savings. The time of year at which self-reported outcomes are measured could also influence results, with data ideally being captured over the winter period.

Box 9: Derbyshire Healthy Homes

The Derbyshire Healthy Homes scheme similarly emphasises the need to be realistic about which outcomes can be effectively measured. In a context in which some recipients receive small measures (which are not accounted for in an EPC assessment), and others a new central heating system (which are covered by an EPC), it can be difficult to judge the overall environmental impact of a scheme. Similarly, where households may previously not have had any heating system within the home, the provision of large measures might actually result in increased household expenditure on energy. This complicates the extent to which claims of savings on fuel bills can be made for some households.

The Healthy Homes scheme highlights the importance of making sure households have access to additional advice around tariff switching, metering problems, and fuel debt. Scheme recipients are also able to access a range of supporting services, such as minor adaptations, and the provision of trips and falls monitors. Households can access white goods e.g. fridges and services such as loft and low level house clearance. The idea is to offer vulnerable people a package of enabling services, tailored to individual need. Whilst the cumulative effects of such services will likely combine to create greater long term improvements to health and wellbeing, the inclusion of additional confounding variables to an intervention (which are specifically designed for individuals, not a cohort) will make measuring and isolating the effect of providing affordable warmth measures more difficult.

The health outcomes of the scheme can actually become most apparent through the qualitative interactions with households of scheme officers. These provide an extensive build-up of anecdotal evidence as to how recipients perceive their own wellbeing. Here, the key to accessing information on self-reported improvements to health and wellbeing is based on the good relationships members of the team will build with households over multiple visits and tailored discussions. This can sometimes provide more insights into the impact of the scheme rather than attempting to model clinical outcomes based on a differential group of recipients that represent different characteristics. Recipients will display a multitude of confounding variables (such as age, severity and type of existing health conditions) that from the start may influence the extent of improvement to health or wellbeing an individual might expect to see in the first place.

Other studies mentioned within the literature have taken a variety of approaches to evaluation. For the Arbed programme in Wales, this involved distributing a pre-intervention questionnaire during the heating season to recipient households, as well as to a matched control group. Questions covered a range of topics including: housing and housing conditions, heating and heating behaviours, subjective thermal comfort, fuel poverty, dietary choices, social isolation, financial stress, and health and wellbeing. [315]

Green and Gilbertson note that delaying the receipt of measures to households forming part of a control group would not be ethical, and so sequencing evaluations so as to occur both pre-and post-intervention represents the most ethical means of comparing/measuring outcomes. [316] An

[315] Grey, C., Jiang, S. and Poortinga, W. May 2015. Fuel Poverty, Thermal Comfort, and Health in Low Income Areas in Wales: Results from the First Wave of Data Collection for the Arbed Health Impact Study, Welsh School of Architecture, Cardiff Unviersity: Cardiff WSA Working Paper Series ISSN 2050-8522

[316] Green G and Gilbertson J (2008) Warm front: better health: Health impact evaluation of the warm front scheme. Sheffield: Sheffield Hallam University, Centre for Regional Social and Economic Research.

intervention in Tamworth which provided connections to the mains gas grid and first time central heating measures was evaluated via a year-long qualitative study comprising a pre and post intervention as well as a follow-up phase. The study used a mixed-methods approach comprising semi-structured interviews, questionnaires and observation. The research highlighted the importance of GDNs being able to supplement first-time gas grid connections with appropriate central heating measures and advice to households, in order to see health and wellbeing benefits manifest within a family. [317] It also showed how the delivery of tailored advice around energy efficiency and the use of systems and controls is extremely important if households are to derive maximum benefit from their new systems. [318]

Evaluation of a fuel poverty reduction programme in Northern Ireland combined the use of a pre- and post- intervention questionnaire to establish the energy efficiency of the property and health status of the household with the use of data loggers to record internal temperatures both pre- and post-intervention. This was supplemented by a number of in-depth interviews and focus groups. The evaluation found a reduction in condensation, mould and damp in homes, and an increase in thermal comfort within the home. It is also found reductions in the self-reporting of arthritis and rheumatism, and in the use of health services. [319]

As highlighted within the Derbyshire Health Homes case study, it is important to recognise the depth of understanding which the use of qualitative methods can bring to a study. Assessment of the Warm Front scheme employed the use of semi-structured interviews with households, with topics covering: thermal comfort and conditions in the home pre- and post-intervention; how the home was used; family life and social relations; health and wellbeing of household members; the cost of keeping warm; as well as recipient experiences of the scheme itself. [320] Indeed, Liddell and Morris argues that the wider incorporation of qualitative methods into scheme evaluation can significantly add to the insights derived – especially in terms of our understanding as to how [self-reported] impacts become apparent. [321]

Lessons from current schemes, then, tell us that evaluation of the effectiveness of an intervention needs to be both realistic in terms of the outcomes it can expect to achieve from the outset, whilst employing a mixed-methods approach that can attempt to capture outcomes across a range of individual and population-level metrics. Importantly, it needs to allow for the influence of other confounding variables and, where possible, occur over a prolonged period of time.

[317] NEA and The Children's Society (for National Grid Affordable Warmth Solutions), 2015, Making a House a Home: Providing affordable warmth solutions for children and families living in fuel poverty. Available at: http://www.nea.org.uk/wp-content/uploads/2016/01/Making-a-House-a-Home.pdf [Accessed 06/03/2017]
[318] Friends of the Earth and Marmot Review Team, 2011, The Health Impacts of Cold Homes and Fuel Poverty. Available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf [Accessed 06/03/2017]
[319] Shortt, N. and Rugkåsa, J. 2007. "*The walls were so damp and cold" Fuel Poverty and Ill Health in Northern Ireland: Results from a housing intervention.* Health and Place. 13 (1) pp. 99-110.
[320] Gilbertson, J. Stevens, M. Stiell, B. and Thorogood, N. (For the Warm Front Study Group). 2006. *Home is where the hearth is. Grant recipients views of the Warm Front Scheme.* Social Science and Medicine, 63, pp. 946-956.
[321] Liddell, C. and Morris, C. 2010. *Fuel poverty and human health: a review of the recent evidence.* Energy Policy. 38, pp. 2987-97

Section 4: Connecting Homes for Health

This review has shown that there is a case within the evidence base for incorporating health-based and environmental eligibility criteria into affordable warmth schemes that seek to provide gas grid connections and first time central heating measures to vulnerable households. Off-gas households are some of the most energy inefficient properties in the country, contributing significantly to domestic sector carbon emissions. They are also some of the most expensive to heat, meaning that a significant proportion of off-gas households are in fuel poverty. They are therefore more likely to experience colder indoor temperatures which, as this review has shown, are a risk factor for respiratory and cardiovascular disease, mental ill health, and a range of other associated health conditions. The widening of FPNES criteria would therefore have the potential to achieve additional health and environmental outcomes for households who are vulnerable and either in or at risk of fuel poverty, but who fall outside the scope of current eligibility requirements. However, the review has also highlighted a need to balance scheme targeting in such a way that help can reach those who are suffering from multiple deprivations (such as low income, fuel poverty, energy inefficient housing) and are at risk from cold related ill health. This means health outcomes would be unlikely to manifest at a general population level. The review has also revealed that effective evaluation of a pilot scheme to test such eligibility criteria will need to capture outcomes at both an individual and, where possible, a population level. Ideally, this should incorporate a mixed-methods approach that is carried out over a longer time period and which is able to account for other potentially confounding variables.