

The importance of household energy efficiency for health and well-being

Discussion Paper



Acknowledgements

The authors wish to thank the following for their advice, support and enthusiasm during the production of this briefing (in alphabetical order by first name):

- Ben Saltmarsh, National Energy Action Cymru
- Bethan Edwards, Marie Curie
- Bethan Proctor, Community Housing Cymru
- Joanna Seymour, Warm Wales
- Kristian James, Public Health Wales
- Louise Woodfine, Public Health Wales
- Peter Smith, National Energy Action UK
- Sarah Scotcher, Community Housing Cymru
- The Cross-Party Group on Fuel Poverty, Welsh Parliament

Cover image credit © Nick Beer / Shutterstock.com

Additional Reading

This paper builds upon recent publications regarding housing and health produced by Public Health Wales' World Health Organization Collaborating Centre (WHO CC) on Investment for Health and Well-being, including:

- [Improving winter health and well-being and reducing winter pressures in Wales: A preventative approach](#)
- [Making a Difference Housing and Health: A case for investment](#)
- [No place like home? Exploring the health and well-being impact of COVID-19 on housing and housing insecurity](#)
- [A COVID-19 pandemic world and beyond: The public health impact of Home and Agile Working in Wales](#)
- [A Health Impact Assessment of the 'Staying at Home and Social Distancing Policy' in Wales in response to the COVID-19 pandemic](#)
- [The Full Cost of Poor Housing in Wales](#)
- [The case for investing in prevention: Housing](#)

These reports, and many others, are available via the WHO CC website www.phwwhocc.co.uk

Feedback on this paper is welcomed, and we would particularly like to know if it has been useful in improving or informing your work and practice – please email publichealth.policy@wales.nhs.uk to let us know, or to sign-up to the Polisi Team's email distribution list for future publications.

Contents

Introduction.....	4
What do we mean by 'energy efficiency'?	5
Evidence	6
What is the impact of energy inefficiency on health?	8
Impact of cold homes on chronic conditions and terminal illness.....	11
Radon and indoor air quality	11
General well-being and mental health impacts	12
Why does focusing on household energy efficiency matter for the wider economy and wider society?	13
Evidence Gaps	14
Current Policy & Legislative Context.....	14
Welsh policy context	14
British policy context.....	15
International policy context.....	16
COVID-19 and household energy efficiency	17
Conclusion.....	18
Policy Considerations	19
Ideas for Further Research.....	19
Take-home messages	20
References	21
Appendix 1: Search Strategy	25

Introduction

Improving the energy efficiency of Welsh housing stock is of increasing significance in light of the recent declaration from the previous Welsh Government of a 'climate emergency' in Wales (Welsh Government 2019b). Energy inefficiency is one of the three factors that the Welsh Government's energy efficiency strategy cites as determining whether a household will be in fuel poverty, alongside household income and energy prices (Welsh Government 2016, sec.3.4). Inefficient housing results in people using more energy to heat their homes, which in turn results in greater costs to the consumer, increased emissions into the environment and, in most cases, the burning of fossil fuels. Ambitions to increase household energy efficiency are also impacted by social and economic factors, such as the cost of improvement measures to householders.

Examples of Energy Efficiency Improvements

Some examples of energy efficiency measures include:

- Replacing old boilers/central heating systems with new, efficient models
- Cavity Wall Insulation
- Loft Insulation
- Solar power panels
- Retrofitting e.g. replacing single-glazed windows

At present, Wales' housing stock is some of the least energy efficient in Europe (Decarbonisation of Homes in Wales Advisory Group 2019). In the context of the United Kingdom, Wales has the oldest housing stock and the lowest proportion of dwellings with an EPC rated 'C' or above (Statistics for Wales 2019a). As of 2018, there were 155,000 households living in fuel poverty*, equivalent to 12% of all households in Wales, with households in the private rented sector more likely to be in fuel poverty (Welsh Government 2020a). Given the COVID-19 pandemic, and its impact on personal finances and the increase in people being at home for prolonged periods, it is likely that this number will increase. Furthermore, in the context of climate change, around 15% of Wales' carbon emissions come from homes (Decarbonisation of Homes in Wales Advisory Group 2019).

Energy efficiency measures can have a positive impact on the wider economy. Research from Europe, published in 2012, showed that for every €1million invested in upgrading the energy efficiency of buildings, 19 new jobs could be created (Janssen and Staniaszek 2012).

* Defined in the Welsh Government (2021b) and as defined in the *Warm Homes and Energy Conservation Act 2000*, a household is to be regarded as living "in fuel poverty" if a member of a household is living on a "lower income" in a home which cannot be kept "warm" at "reasonable cost".

Aside from population health benefits, other primary drivers for the move towards energy efficiency include increasing consumer energy prices, new technological innovations, government policy objectives in relation to climate change and decarbonisation, and growing concerns about the environmental impact of energy use. Such factors have an interconnectedness with health from a wider determinants of health perspective[†] and, as such, are also factors considered within this paper.

Whilst this paper cannot consider and represent all of the evidence on this broad topic it is envisaged that it will help to inform those with an interest in making the case for household energy efficiency and health and well-being from a population and individual perspective.

What do we mean by 'energy efficiency'?

For the purpose of this paper, we define energy efficiency as '**maximising home energy performance at low economic, environmental and societal cost**'. Energy efficiency does not mean turning all light bulbs off, or only putting the television on for an hour in the evening – rather, it is about finding ways to make the energy we use less cost-intensive and harming to the environment. Advances in consumer technology have helped to improve energy efficiency in products within the home, such as the switch from traditional light bulbs to Light Emitting Diodes (LEDs) or the switch from Cathode-ray tube (CRT) based computer monitors and televisions to Liquid Crystal Displays (LCDs).

However, the efficiency of the building itself, such as its ability to retain heat, remains a challenge, often requiring extensive retrofitting depending upon the age of the property, and construction methods and materials used at the time of building. Residents can also take action for their property to self-generate energy, through innovations such as thermal heat pumps or solar panels for electricity.

52% of Welsh dwellings fall within the 'D' Energy Performance Certificate (EPC) band, according to data from 2017-18

Source: Statistics for Wales, 2019a

Put simply, improving energy efficiency means getting more from the energy we use *and* ensuring homes can retain the heat energy generated within them.

In the context of this paper, when we talk about 'home energy', or simply, 'energy', we are referring to a residential properties' heating. A range of fuels provide energy to homes, such as coal, gas and solar, and a variety of housing interventions can reduce dependency on energy supplies e.g. cavity wall insulation, energy-efficient boilers and smart home adaptations. This paper does not talk about other utilities, such as water supply.

[†] The wider determinants of health are those external factors, such as education, transport and housing, which impact upon our health.

The energy efficiency of both homes and household items is commonly measured through the Energy Performance Certificate (EPC). The EPC originates in European Union legislation and is presented in a chart rating properties from A (very efficient) to G (not efficient). The closer to an 'A' rating, the lower the anticipated energy costs to the consumer. Electronic equipment is often sold with a similar schematic to inform consumers about potential running costs for the item; there have been recent changes to the labelling for consumer products to remove the '+++' labels, which were seen as confusing (Which 2021).

For residential properties, an EPC is required when selling or renting out the property – as such, any properties that haven't changed hands since 2008 may not have a current EPC. Once issued, an EPC is valid for ten years. Listed buildings, which cannot be modified with energy efficiency measures because of their listed status, are often exempt from the requirement for an EPC.

Evidence

How energy efficient are Welsh households currently?

Residential buildings make up the bulk of energy emissions from buildings in Wales, with 82% of all building emissions, and 7.5% of total Welsh energy emissions, according to 2016 figures. Between 1990 and 2016, there has been a 31% reduction in total emissions from buildings in Wales (Welsh Government 2019a, p.82), but there is still a great deal to do to improve residential energy efficiency and thus reduce emissions.

The latest data on energy efficiency in Welsh residences was published in October 2019, covering the reporting year 2017/2018 (Statistics for Wales 2019a). This data confirms that the energy efficiency of homes in Wales has improved over the last decade, and social housing has the highest percentage of homes with an Energy Performance Certificate (EPC) rating of C or above.

The charts below outlines some of the inequities in energy efficiency in dwellings; reproduced from the Welsh Housing Conditions Survey results[‡] (Statistics for Wales 2019b).

[‡] All charts based on sample size of 2,550. Results based on < 30 responses are not shown.

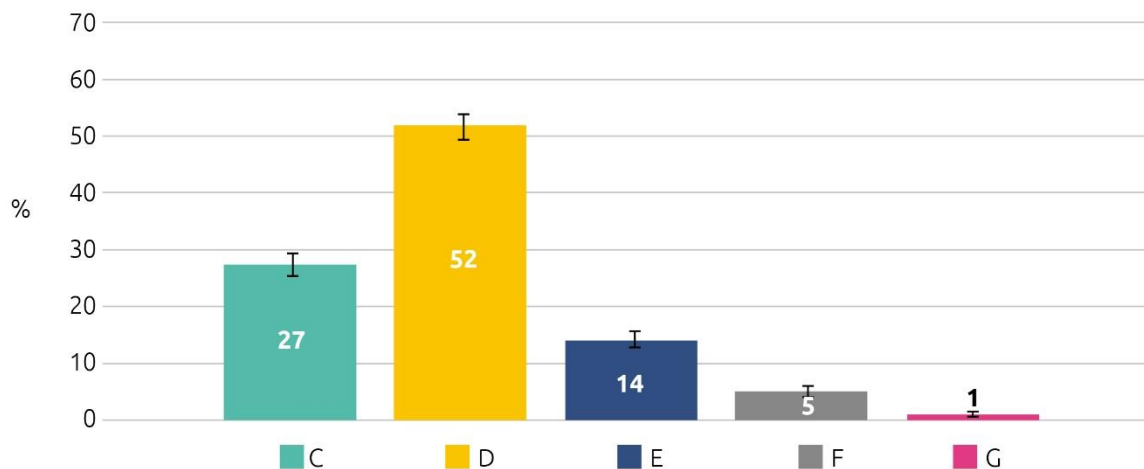


Figure 1 - Energy Performance Certificate (EPC) band, 2017-18. Source: Statistics for Wales, 2019b

Figure 1 illustrates the energy efficiency of dwellings in Wales according to their energy performance rating. This shows that over 50% of homes were of D-rated energy efficiency, which is the median level (The numbers of properties in Band A are below reporting levels).

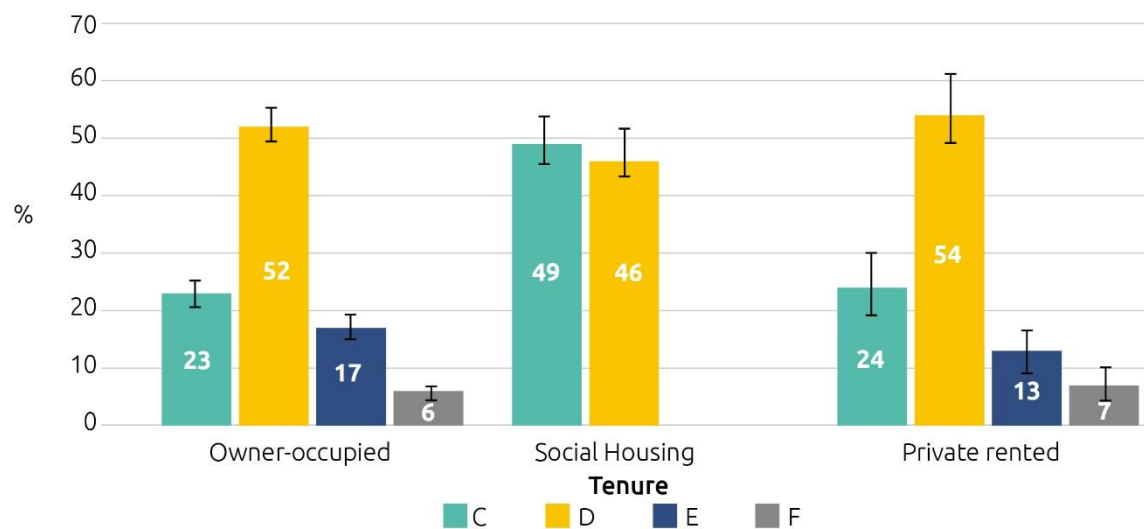


Figure 2 - Energy Performance Certificate (EPC) band, by Tenure, 2017-18. Source: Statistics for Wales, 2019b

Figure 2 outlines the energy efficiency performance of properties in Wales by tenure type. This shows that across tenures, most properties fall within the C and D bands, with little variance between owner-occupied and private rented tenures. Social Housing is on the whole more energy efficient than any other tenure type, with no E and F rated properties, and over double the percentage of Band C properties compared to other tenure types.

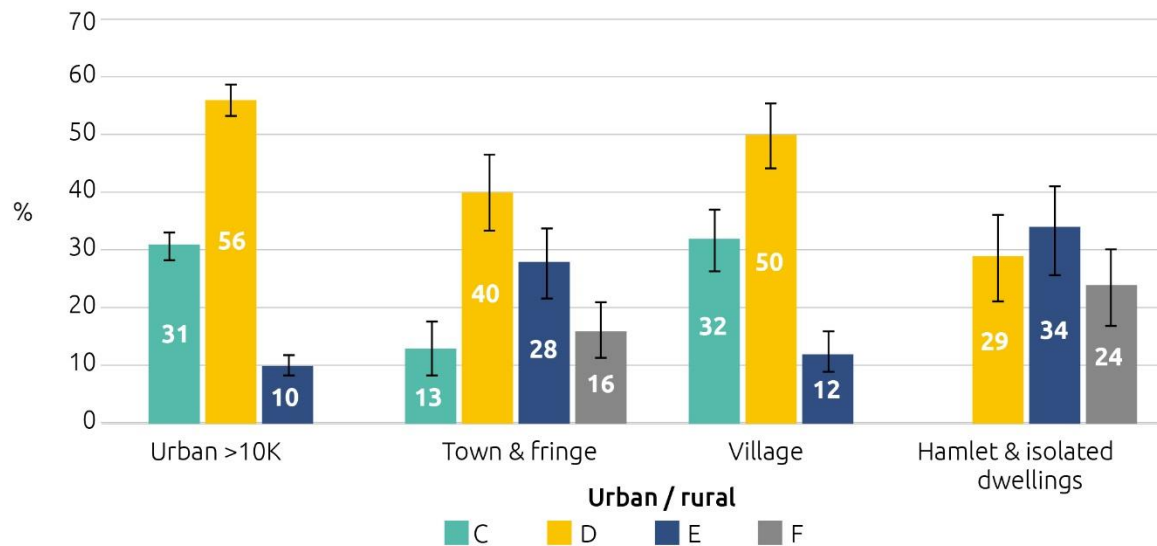


Figure 3 - Energy Performance Certificate (EPC) band, by Urban / rural, 2017-18. Source: Statistics for Wales, 2019b

Figure 3 outlines the energy efficiency of dwellings according to whether they are in urban or rural settings. From this, we can see a mixed picture of energy efficiency, with urban and village dwellings presenting a similar picture, whilst hamlets and isolated dwellings have the worst ratings

What is the impact of energy inefficiency on health?

To understand the importance of energy efficiency to health, we must consider how inefficient energy use impacts upon health.

Recent work published by Public Health Wales, exploring winter health impacts, considered that the direct health impact of energy efficiency measures is mixed, with limited evidence in relation to advice on energy efficiency improvements (Public Health Wales 2019a, p.8). However, this work found that in the UK, 10% of excess winter deaths can be partly attributed to fuel poverty, with 30% of these deaths linked to living in a cold home (Public Health Wales 2019a, p.48).

We know that health service costs for addressing ill-health caused by energy inefficiency are substantial. A strong argument for return on investment in energy efficiency measures is made within a recent report from Public Health Wales (2019b). It showed that for every £1 spent on improving warmth in vulnerable households, there are £4 of health benefits, and every £1 spent on insulation interventions provides a return of £1.87[§]. A recent report

[§] Currency converted from findings of an intervention carried out in New Zealand

from the Future Generations Commissioner for Wales and New Economics Foundation (2021) considers that a strong retrofit programme for homes in Wales could save the NHS £4.4bn by 2040.

'Significant health benefits from energy efficiency interventions were identified for children in particular..., as well as for people in poor health... and for vulnerable groups as a whole...'

Source: Maidment et al., 2014

Maidment et al. (2014) conducted a meta-analysis looking at thirty-six separate studies involving over 33,000 participants and found that, on average, energy efficiency measures led to a 'small but significant improvement in the health of residents'. Further, this review highlighted that **people with low incomes saw greater positive outcomes for their health and well-being from energy efficiency interventions**. Studies that reported on the general health of participants showed smaller impacts of energy efficiency measures on health. However, where research studies involved objective clinical measures,

such as blood pressure measurements, larger effects on health outcomes were noted. The three factors that most influenced the impact of energy efficiency interventions on health and well-being were:

1. the number of different measures installed – studies which focused on one intervention had greater effects than programmes which introduced two or more forms of energy efficiency measures. The authors consider that this could be representative of an intervention solving a known health-harming problem, such as damp
2. the recipients and their setting – the authors found that positive health effects were found for children and people in poor health
3. which aspects of health were measured as part of the study design.

Evens et al. (2017) explored the links between health, housing and energy. This article briefly reviews literature largely from US implementation of energy efficiency programmes and shows that energy efficiency has a positive impact on health, with declines in asthma and cardiovascular diseases (CVD) noted. Further, the authors consider how best utility companies can incorporate health outcomes into their initiatives.

A study exploring the health impacts of energy performance investments in low-income areas found no evidence of direct physical health benefits from a specific intervention, but there were improvements in subjective well-being, such as warmer homes making people feel less socially isolated; whilst also making

'Improving the energy efficiency of homes provides social and economic benefits to people living in them.'

However, area-based programmes may not improve chronic health conditions, reduce the number of hospital visits or reduce costs for the health service.'

Source: Poortinga et al., 2018

their homes easier and cheaper to warm. The study analysed the health records of people who'd received energy efficiency measures to consider whether this correlated with decreased emergency hospital admissions. The study also concluded that the intervention raised indoor temperature and contributed to a reduction in energy usage, but there was no clear evidence of improvement in chronic conditions. A health economic assessment found no clear cost reductions to the health service due to a lack of association between emergency hospital admissions and energy performance investments, and the researchers called for future housing improvement programmes to incorporate health and economic assessments at the outset (Poortinga et al. 2018).

Willand et al. (2015) have considered the impacts on health from home warmth, fuel affordability and indoor air quality. This review found that lower humidity and increased warmth in winter had benefits for cardiovascular health. From a mental well-being

'There are strong indications that warmth and energy efficiency interventions which are targeted at those in most need deliver at least short-term improvements in health.'

Source: Gibson et al., 2011

perspective, the authors also found that there was a perception that home energy efficiency improvements increased the resident's feelings of autonomy and improved their social status. The authors also found little evidence of negative health impacts, such as the risks of indoor air pollution and radon coupled with lack of adequate ventilation and the increased risk of climate-related overheating, but the authors stressed 'the risk should not be dismissed.'

On cardiovascular health, Willand et al. highlighted 'scarce yet promising' evidence of health improvement, alongside other general health improvements from self-reported feedback, however

the review also highlights studies with inconclusive or mixed results (2015, p.195).

Gibson et al. (2011) undertook a systematic review of interventions linked to housing and health. In relation to warmth and energy efficiency, the authors found 'compelling' evidence for interventions targetted at vulnerable individuals, such as older people and those with preexisting health conditions, and that these interventions have 'the clearest positive impacts on health'.

The latest UK Fuel Poverty Monitor (NEA & Energy Action Scotland 2021) further reinforces the health risks of households living in colder conditions due to the costs of energy or poor energy efficiency, citing concerns for people living with respiratory disease, cardiovascular disease, mental ill-health and implications of poor nutrition outcomes if people cut back on food spending to pay for energy bills.

Impact of cold homes on chronic conditions and terminal illness

The impact of home energy improvements on older people with chronic obstructive pulmonary disease (COPD) was the subject of a trial in Aberdeen (Osman et al. 2010). In 45 patients who had installed energy efficiency upgrades, significant improvements in respiratory system measures were noted along with lower energy costs and improved energy efficiency ratings. However, this trial also showed that COPD patients were unlikely to take up energy efficiency improvements if they were offered it.

A recent report from Marie Curie (2020) in England has considered the impacts of fuel poverty in the context of terminal illness. Whilst this is focused on fuel poverty impacts and not directly on household energy efficiency, it is clear from the research that there are people experiencing terminal illness, chronic conditions or weakened immune systems in inefficiently heated houses, with examples cited such as people choosing not to heat their homes because of fuel costs and placing newspapers in windows to keep warmth indoors. It's noted that cold, damp conditions that lead to mould can increase the chances of infection, which can be more severe for people with advanced cancer, and cold and damp can increase the risk of arthritic symptoms, increasing the risk of falls for frail patients. Thus, poor household energy efficiency may contribute to exacerbating the conditions and anxieties of people living with a terminal illness. The report also calls for NICE guideline NG6 (NICE 2015), on the health risks associated with cold homes, to be embraced by health services, particularly in relation to recommendations such as assessing the heating needs of people using their services and a single-point of contact health and housing referral service for vulnerable people.

The latest UK Fuel Poverty Monitor report (NEA & Energy Action Scotland 2021) highlights the need for people living with Sickle Cell Disease (SCD) to live within a temperature range of 20° -30° C, and considers whether fully or partly subsidising the heating costs of SCD-affected individuals would be more cost effective, given the high cost of hospital admissions for these individuals.

Radon and indoor air quality

After tobacco smoking, radon - a colourless, odourless radioactive gas - is the second leading cause of lung cancer worldwide. It is the highest form of radiation exposure in the home (Public Health England 2020).

An observational study of radon measurements taken from 470,689 UK homes between 1980 and 2015 linked the data with information about the residences from the Home Energy Efficiency database (Symonds et al. 2019). This found that energy efficiency improvements that make homes more 'airtight' increased radon levels, with homes with double glazing, loft insulation and wall insulation having higher radon measurements. Amongst the implications the authors identified, it was noted that some energy efficiency measures may have an adverse affect on indoor air quality, which may increase exposure to radon and thus may increase incidence of radon-related lung cancer.

Another study in England modelled the effect of reduced indoor ventilation on deaths from radon-related lung cancer (Milner et al. 2014). This found that if a house was more air tight without additional ventilation provided, this increased radon concentration by an estimated 56.6% - this in turn could result in an additional 4,700 life years lost** and a peak of 278 deaths. Thus, the authors concluded that reduced ventilation through energy efficiency improvements risked increasing exposure to radon and the chances of acquiring lung cancer. A later study from the same authors (Hamilton et al. 2015) concluded that if appropriate ventilation was implemented alongside retrofitting, health could be improved by reducing occupant's exposure to air pollutants and the cold.

Aside from concerns regarding radon, other scholars have looked at the impact of retrofitting on indoor air quality. One review found that increases in indoor temperatures reduced average relative humidity levels, but a mixed picture was found in relation to whether retrofitting with energy efficiency measures reduced incidences of condensation, dampness and mould – indeed, five cited studies covered within this review reported 'conflicting findings or new mould', indicating some concern over the potential for indoor air quality to decrease in response to energy efficiency measures (Willand et al. 2015, p.195).

Evidence showed that adverse health effects because of a lack of adequate ventilation were rare, but insufficient ventilation was found to be a factor in some instances of mould and high levels of indoor carbon monoxide (Willand et al. 2015, p.197).

The Climate Change Committee's recent advice report to Welsh Government recommended a more nuanced approach to policy-making, with one example being home energy efficiency improvements also benefitting indoor air quality (Climate Change Committee 2020, p.108).

General well-being and mental health impacts

The Willand et al. review (2015) highlighted some evidence on how new reliable heating systems increased resident's feelings of control and reduction of anxiety but also featured evidence that indicated adverse psychological impacts related to residents not understanding how to use their energy efficiency improvements. It was also noted that householders presented with higher stress levels if homes were found to be too cold. This review also included evidence in relation to the positive impacts of energy efficiency interventions on matters such as perceptions of personal autonomy, more control over personal finances and self-esteem improvements related to having a modern home.

Another study demonstrated that the effect of interventions to improve the warmth of houses in deprived communities in Glasgow did not lead to improved perceptions of

** 'Life years lost', or 'Years of life are lost' (YLL) as taking into account the age at which deaths occur by giving greater weight to deaths at a prematurely younger age, and lower weight to deaths at older age.

energy affordability and also those who reported greater financial difficulties also reported declining mental health (Curl and Kearns 2017). This indicates that alongside the improvements made to properties, interventions need to include appropriate guidance and information for the residents.

Why does focusing on household energy efficiency matter for the wider economy and wider society?

"A Welsh housing decarbonisation programme would create £19.32bn in extra GDP, £3.54bn of net tax benefit and 26,500 new jobs in Wales by 2030."

Future Generations
Commissioner for Wales and
New Economics Foundation
(2021)

Improving direct health outcomes is not the primary objective behind efforts to improve household energy efficiency. Policy-makers and non-governmental organisations are predominantly focused upon the need to deliver affordable, cleaner energy within societies and sectors to deliver against decarbonisation and climate change objectives. Furthermore, a focus on the affordability of energy, with links to the fuel poverty agenda, is noted. These are all important aspects that have an impact on health and well-being, even if not explicitly expressed as such.

Some have considered the potential for investment in energy efficiency improvements as a means for creating new jobs. A report from the Climate Change Committee (2020) considered energy efficiency retrofits as a source

for new job creation, whilst the recent report from the Future Generations Commissioner for Wales and New Economics Foundation (2021) also saw the potential for creating new industries, skills and around 26,500 jobs.

The Future Generations Commissioner's report also explores the broader benefits of retrofitting for decarbonisation and the Welsh economy. This report suggests that a well managed retrofitting programme could save a total of £8.3bn in fuel costs by 2040, whilst also highlighting the potential benefits for the foundational economy, with potential increased local spending (Future Generations Commissioner for Wales and New Economics Foundation 2021).

Investment in energy efficiency measures can improve financial outcomes for homeowners. A research report exploring the effect of EPC ratings on house prices in England showed that average house prices increased for more energy efficient homes (Department of Energy & Climate Change 2013).

It remains paramount that in the drive to increase uptake of energy efficiency improvements, consumers receive accurate advice, and that the vulnerable are protected against scams and misselling. A Citizens Advice report (2021) explored three years worth of data where people have sought advice from their service about home improvements related to energy efficiency. This report shows examples of misselling to vulnerable

individuals, such as a person who was sold solar PV panels and was told they would receive £85 per month for selling excess energy back to the grid. They invested in this purchase in the expectation that this would help to repay the outlay – this was not the case and the individual has had to cut back on their heating to save money.

Evidence Gaps

An extensive Cochrane Review (Thomson et al. 2013) looking into housing improvements for health calls for more evidence on energy efficiency measures and this remains a current issue. A broad evidence base on the long-term health benefits of energy efficiency measures is lacking, and research related to particular interventions and/or how specific health conditions are affected by energy efficiency measures remains sparse. It is worth noting that a lack of evidence is not necessarily lack of effect, so further research on the health impacts of energy efficiency interventions is to be encouraged.

Further, it would be beneficial for evaluations of interventions introduced to improve energy efficiency to incorporate assessment of health and well-being improvements wherever practicable.

Current Policy & Legislative Context

Responsibilities for policy & legislation related to household energy efficiency in Wales is a mix of devolved and non-devolved powers. Below is a snapshot of the domestic and international policy context regarding energy efficiency.

Welsh policy context

In Wales, the promotion of energy efficiency is devolved to Welsh Government, as is the power to set building standards for new-build properties. Welsh Government have introduced programmes such as Nest and Arbed through its Warm Homes programme to fund energy efficiency improvements in eligible households (Noebels and Corbyn 2021). However, the regulation of energy efficiency remains a reserved power at UK level.

Wales' current energy efficiency strategy was published in 2016 and covers ten years until 2026 (Welsh Government 2016). This strategy acknowledged that energy efficiency is 'the most effective tool that we have within our powers to tackle fuel poverty and a warmer home can also have a positive impact on people's wellbeing and health'.

A new strategy to tackle fuel poverty was released in 2021 (Welsh Government 2021b), and whilst this paper does not focus on fuel poverty, there is clear connection with the energy efficiency agenda, with for instance actions to continue investment and delivery of household energy efficiency improvements to support households in fuel poverty and the need to improve 'winter resilience' for people at risk of ill-health or premature death through living in a cold home.

The Welsh Government Warm Homes programme provides energy efficiency measures to houses meeting eligibility criteria. Two schemes have been delivered within this programme: Nest and Arbed. Arbed offers energy efficiency improvements in specific locations, namely those places in severe fuel poverty (Arbed Am Byth 2021), whilst the Nest scheme provides advice on home energy efficiency improvements (Welsh Government 2021a). Welsh Government are due to consult on the next iteration of the Warm Homes programme later this year.

Alongside advice on saving energy and water, the Nest scheme also provides energy efficiency improvements such as a free replacement boiler or central heating to eligible applicants. The eligibility criteria for these improvements include those who have specific health conditions such as chronic respiratory, circulatory or mental health conditions; recipients must also be living on a low income. An evaluation of Nest showed that the scheme was reaching those in need of support, with over half surveyed able to heat their home better following advice from the scheme, and some households reporting health improvements (Miller Research (UK) Ltd and Brook Lyndhurst Ltd 2015, p.58).

A current pilot scheme is exploring the best way to deliver in-home energy advice (Welsh Government 2020b), linked to a goal within the new fuel poverty strategy (Welsh Government 2021b). This pilot aims to test and measure how effective in-home advice and support provision about energy is as a means to tackle fuel poverty; it is being trialled in Gwynedd, Ceredigion and Caerphilly and delivered in partnership with a range of third-sector organisations. At the time of writing this paper, the pilot is due to run until the end of March 2022 and evidence from this pilot will help to determine the future of in-home energy advice provisions.

British policy context

Regulation of energy providers, energy pricing, energy networks and consumer protection are some of the powers related to this topic that remain reserved to the UK Government, as are powers to set standards for energy efficiency in buildings. Aside from nuclear energy, energy policy is devolved to Northern Ireland, therefore the initiatives highlighted in this section are at a Great Britain level. There are a range of policy interventions with a link to domestic energy efficiency improvements. The UK Government's Clean Growth Strategy (HM Government 2018) has targeted 'fuel poor' homes to have at least an EPC C rating by 2030 and aspires for as many homes as possible to have this rating by 2035.

The UK Government introduced the Energy Company Obligation (ECO) in 2013 and this went through two iterations, firstly in 2013-2015 and secondly in 2015-2017. This obligated the major energy suppliers to support low-income households with energy efficient improvements, retrofitting existing homes. Energy UK, the energy industry body, stated in its 2020 report on the energy market and infrastructure in the UK that 221,000 ECO measures were installed in 2019 (Energy UK 2020, p.14). At the time of writing, the next iteration of ECO is currently being consulted on by the UK Government (Department for Business, Energy & Industrial Strategy 2021).

Smart meters are one measure introduced through UK Government policy and legislation. These help customers to have an at-a-glance understanding of how much energy is being generated in their property and the costs associated with this. As of 2019, 37% of all meters in domestic and non-domestic premises were smart, with 4.5 million installed in 2019 alone (Energy UK 2020, p.14)

The Clean Growth Strategy aims to deliver £3.6bn worth of upgrades to around a million homes through the ECO, whilst also extending support for home energy efficiency improvements until 2028 (HM Government 2018).

There are regulations in place governing energy efficiency standards in dwellings^{††}. For instance, the *Energy Efficiency (Private Rented Property) (England and Wales) Regulations 2015* established a Minimum Energy Efficiency Standards (MEES) for privately rented property in England and Wales and, since April 2020, landlords are no longer able to let or continue to let properties covered by the MEES Regulations if they have an EPC rating below E, unless they have a valid exemption in place. In line with a recent UK Government consultation, it is anticipated that this will move to a minimum energy efficiency rating of 'C' for new tenancies from 2025 onwards, and all tenancies from 2028 (Department for Business, Energy & Industrial Strategy 2020).

In Wales, Rent Smart Wales have worked to identify which properties were below the minimum standard and has signposted landlords to sources of support to make energy improvements to meet the standard (Welsh Government 2020c).

International policy context

The United Nations Sustainable Development Goals (UN SDGs) include a goal to achieve affordable and clean energy. Target 7.3 of the UN SDGs aims to double the global rate of improvement in energy efficiency (United Nations 2021). According to 2020's annual report on progress against the UN SDGs, the global energy efficiency improvement rate is falling short of the 3% needed, at 1.7% in 2017^{‡‡} (United Nations 2020a).



Figure 4 - UN SDG 7

According to the United Nations (UN), the energy sector emits three-quarters of global greenhouse gases. It acknowledges the decarbonisation of energy as one of several 'overarching global priorities' (2020c, p.10). In its latest World Economic Situation and Prospects (WESP), which highlights global economic risks such as trade disputes and political uncertainty, the UN calls for a cleaner energy mix worldwide. It declares increased energy efficiency as 'one of the most cost-effective methods to improve energy

^{††} A full overview of UK energy efficiency-related policies related to residential properties can be found at <https://www.iea.org/policies?topic=Energy%20Efficiency&country=United%20Kingdom§or=Residential>

^{‡‡} Note that this relates to energy efficiency generally, not just household energy efficiency

supply security, enhance competitiveness and welfare, and decrease the environmental and health impacts of energy use' (United Nations 2020b, p.70). Yet, the report also acknowledges a slowing of energy efficiency gains since 2015. It is important to note in the context of this paper that the United Nations are referring to energy efficiency in the whole, rather than just in relation to domestic property.

The International Energy Agency's policies database (2021) summarises national, sub-national and international policies on energy efficiency worldwide and is an essential reference for policy learning on this topic. At the time of writing this paper, nearly 800 policies associated with residential energy efficiency are listed within the database.

COVID-19 and household energy efficiency

The COVID-19 pandemic has had ramifications across society, and knock-on effects regarding energy usage have been observed. Policy measures such as mandating some workers to work from home or people staying at home during lockdown periods or as a result of self-isolation requirements have impacts on energy consumption within the home, particularly during colder months when residents are more likely to be heating their homes. Citizens Advice (2020) reported that 48% of consumers were using more energy than normal due to spending more time at home and using more energy as a result of this.

Public Health Wales' recent Health Impact Assessment on Home and Agile Working in Wales explored the impacts of 'stay at home' policies introduced during the pandemic. In interviews conducted to support this work, participants highlighted concerns about increased household costs, including energy, particularly for those living on low incomes (Public Health Wales 2021, pp.57, 59). This is further borne out by the latest edition of the Fuel Poverty Monitor (NEA and Energy Action Scotland 2020), which identified five key impacts on households living in fuel poverty:

1. Increase in household energy usage;
2. Reduction of household income because of lost jobs or furlough measures;
3. Energy rationing due to wider affordability concerns;
4. Reductions in smart meter/ECO installations;
5. Challenges in accessing support, particularly in households digitally excluded or in households where English is an additional language.

Further findings from the Fuel Poverty Monitor included three quarters of respondents being concerned that the pandemic would result in increasing fuel debts during the winter of 2020.

A briefing from the Wales Centre for Public Policy (2020) considers upgrading housing in Wales as one initiative to support recovery from the COVID-19 pandemic, with investment in renewable heating for properties that are 'off-gas' as one policy suggestion.

Conclusion

This paper has considered factors linking household energy efficiency improvements to health, well-being and wider societal objectives. *Figure 5* summarises some of the key focus points considered in this work and their interconnectedness.

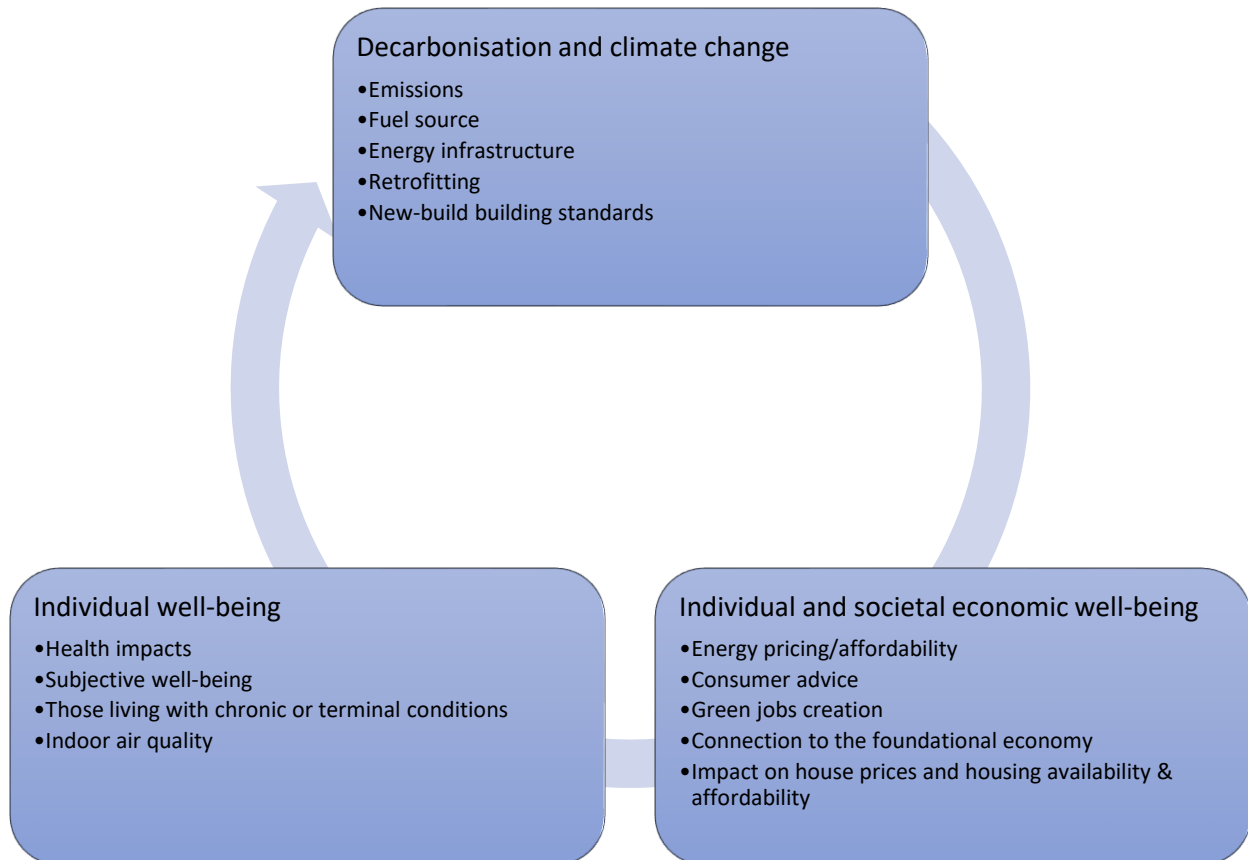


Figure 5 - Household Energy Efficiency: focus points

This paper has highlighted that efforts to improve household energy efficiency can have a positive impact on ambitions for decarbonisation and climate change, and can also lead to improvements in health and well-being; however, the evidence base is limited, and there is the need to mitigate any possible negative impacts, such as lack of adequate ventilation.

Going forward, evaluations of household energy efficiency measures would benefit from consideration of whether the initiative has improved the resident's health or their subjective well-being. Acknowledging the interconnectedness of health, energy efficiency and individual and societal economic well-being through policy is to be encouraged.

Policy Considerations

- Efforts to connect the health impacts of energy inefficiency to the energy policy agenda, for example linking the health harms of inefficient household energy with fuel poverty, climate change and decarbonisation agendas is an important consideration in future policy developments.
- There is significant benefit to improving the energy efficiency of existing homes as well as regulating for efficiency measures as standard to new homes. This is relevant to the continuation of the offer of a package of affordable energy efficiency measures to residents/owners of current housing stock, particularly those with chronic health conditions, along with detailed guidance, information and advice about energy efficiency. Information and advice provision will be required for those who are digitally excluded.
- Putting more focus on the energy efficiency of rural dwellings may help to reduce inequities. The latest data shows greater inefficiency in dwellings in hamlets or otherwise isolated settings.
- A year-round strategy for energy efficiency and fuel poverty, focusing on summer months and not just winter fuel costs, will enable a future-proofed approach.
- For those discharged from hospital, those facing terminal illness or those with chronic respiratory conditions, particularly in winter months, support mechanisms will ensure residents' conditions are not exacerbated by cold and/or damp living conditions.
- Uptake of the recommendations from NICE guidance NG6 by NHS Wales is to be encouraged where feasible and practicable to minimise excess winter deaths and illnesses associated with cold homes.
- Policies from around the world regarding energy efficiency in the home are listed on the International Energy Agency policies database – this provides insight into energy efficiency measures being taken worldwide and can be a starting point for developing any new policies on this topic.

Ideas for Further Research

- Research exploring the direct health impact of energy efficiency improvements is currently mixed. Evaluations of interventions to improve household energy efficiency could consider any tangible health and well-being outcomes, particularly long-term benefits.
- Research on energy efficiency and health and well-being outcomes in private sector residences (private rental or owner-occupied sectors) is to be encouraged.
- Research connecting energy efficiency and fuel poverty, and their combined impact on health and well-being, would be welcomed.
- The meta-analysis from Maidment et al. (2014) highlighted that studies with objective measures of health resulted in larger effects on health than self-reporting methods; it

is therefore important that any future research considers using objective analysis of health outcomes to clearly quantify the health benefit of energy efficiency measures.

Take-home messages

- Wales' social housing sector provides the most energy efficient homes. Therefore, a renewed focus on improving the energy efficiency of private sector residences is to be encouraged.
- Measures to improve energy efficiency throughout homes in Wales have the potential to protect and improve health and well-being, and save people money in the medium to long-term. However, some negative effects on health are noted, such as lower levels of ventilation affecting indoor air quality. Broad evaluation of both positive and negative health outcomes is essential to appraise energy efficiency measures from a household and a population health perspective; Health Impact Assessment would be a useful approach when considering energy efficiency interventions.
- Improving energy efficiency in the home will contribute to a reduction in fossil fuel dependence, help tackle fuel poverty, and reduce the number of cold homes. However, appropriate ventilation measures need to be implemented as part of any retrofitting programme, to reduce the risk of declining indoor air quality or exposure to radon.
- Supporting individuals to understand and respond to the energy performance of their home is crucial; further work could be done to promote the benefits of energy efficiency, including why introducing energy efficiency improvements to the home is important for an individual's health as well as the wider financial savings and environmental benefits. The introduction of behaviour change methodologies to increasing the uptake of energy efficiency measures could be an approach.

References

Arbed Am Byth 2021. Arbed Am Byth. Available at: <http://www.arbedambyth.wales/> [Accessed: 21 July 2021].

Citizens Advice 2020. *Recovery or Ruin? The role of accessible support in helping energy consumers through the crisis*. London: Citizens Advice. Available at: [https://www.citizensadvice.org.uk/Global/CitizensAdvice/Energy/Recovery%20or%20ruin%20\(1\).pdf](https://www.citizensadvice.org.uk/Global/CitizensAdvice/Energy/Recovery%20or%20ruin%20(1).pdf) [Accessed: 22 July 2021].

Citizens Advice 2021. *Home truths: The challenge and experience of making home energy improvements*. London: Citizens Advice. Available at: <http://www.citizensadvice.org.uk/about-us/our-work/policy/policy-research-topics/energy-policy-research-and-consultation-responses/energy-policy-research/home-truths-the-challenge-and-experience-of-making-home-energy-improvements/> [Accessed: 22 July 2021].

Climate Change Committee 2020. *Advice Report: The path to a Net Zero Wales*. Climate Change Committee. Available at: <https://gov.wales/sites/default/files/publications/2021-03/the-path-to-a-net-zero-wales-advice-report.pdf> [Accessed: 21 July 2021].

Curl, A. and Kearns, A. 2017. Housing improvements, fuel payment difficulties and mental health in deprived communities. *International Journal of Housing Policy* 17(3), pp. 417–443. doi: 10.1080/14616718.2016.1248526.

Decarbonisation of Homes in Wales Advisory Group 2019. *Better Homes, Better Wales, Better World. Decarbonising existing homes in Wales*. Cardiff: Decarbonisation of Homes in Wales Advisory Group. Available at: <https://gov.wales/sites/default/files/publications/2019-07/independent-review-on-decarbonising-welsh-homes-report.pdf> [Accessed: 12 March 2021].

Department for Business, Energy & Industrial Strategy 2020. *Improving the Energy Performance of Privately Rented Homes in England and Wales*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/946175/prs-consultation-2020.pdf [Accessed: 16 August 2021].

Department for Business, Energy & Industrial Strategy 2021. *Design of the Energy Company Obligation ECO4: 2022-2026*. Available at: <https://www.gov.uk/government/consultations/design-of-the-energy-company-obligation-eco4-2022-2026> [Accessed: 16 August 2021].

Department of Energy & Climate Change 2013. *An investigation of the effect of EPC ratings on house prices*. London: UK Government. Available at: <https://www.gov.uk/government/publications/an-investigation-of-the-effect-of-epc-ratings-on-house-prices> [Accessed: 21 July 2021].

Energy UK 2020. *Energy in the UK 2020*. London: Energy UK. Available at: <https://www.energy-uk.org.uk/publication.html?task=file.download&id=7655> [Accessed: 21 July 2021].

Evens, A. et al. 2017. Utilities and health: Energy efficiency as a common link. *The Electricity Journal* 30(5), pp. 10–14. doi: 10.1016/j.tej.2017.04.009.

Future Generations Commissioner for Wales and New Economics Foundation 2021. *Homes fit for the future: The retrofit challenge. How will we finance the decarbonisation of homes in Wales to support our net zero ambitions? Technical Summary*. Cardiff: Future Generations Commissioner for Wales. Available at: <https://www.futuregenerations.wales/wp-content/uploads/2021/07/ENG-Tech-Summary-Financing-the-decarbonisation-of-housing-in-Wales.pdf> [Accessed: 16 July 2021].

Gibson, M. et al. 2011. Housing and health inequalities: A synthesis of systematic reviews of interventions aimed at different pathways linking housing and health. *Health & Place* 17(1), pp. 175–184. doi: 10.1016/j.healthplace.2010.09.011.

Hamilton, I. et al. 2015. Health effects of home energy efficiency interventions in England: a modelling study. *BMJ Open* 5(4), p. e007298. doi: 10.1136/bmjopen-2014-007298.

HM Government 2018. *The Clean Growth Strategy. Leading the way to a low carbon future*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf [Accessed: 19 July 2021].

International Energy Agency 2021. *Policies Database*. Available at: <https://www.iea.org/policies> [Accessed: 21 July 2021].

Janssen, R. and Staniaszek, D. 2012. *How Many Jobs? A Survey of the Employment Effects of Investment in Energy Efficiency of Buildings*. Brussels: The Energy Efficiency Industrial Forum. Available at: <https://euroace.org/wp-content/uploads/2016/10/2012-How-Many-Jobs.pdf> [Accessed: 21 July 2021].

Maidment, C.D. et al. 2014. The impact of household energy efficiency measures on health: A meta-analysis. *Energy Policy* 65, pp. 583–593. doi: 10.1016/j.enpol.2013.10.054.

Marie Curie 2020. *The vicious cycle of fuel poverty and terminal illness*. London: Marie Curie. Available at: <https://www.mariecurie.org.uk/globalassets/media/documents/policy/policy-publications/2020/fuel-poverty-and-terminal-illness.pdf> [Accessed: 22 July 2021].

Miller Research (UK) Ltd and Brook Lyndhurst Ltd 2015. *Evaluation of the Nest energy efficiency scheme*. Cardiff: Welsh Government. Available at: <https://gov.wales/sites/default/files/statistics-and-research/2019-07/150310-evaluation-nest-energy-efficiency-scheme-en.pdf> [Accessed: 21 July 2021].

Milner, J. et al. 2014. Home energy efficiency and radon related risk of lung cancer: modelling study. *BMJ* 348, p. f7493. doi: 10.1136/bmj.f7493.

NEA and Energy Action Scotland 2020. *UK Fuel Poverty Monitor 2019-20. Executive Summary*. Newcastle Upon Tyne: NEA. Available at: <https://www.nea.org.uk/wp-content/uploads/2020/07/UK-FPM-2019-EXEC-REPORT.pdf> [Accessed: 16 August 2021].

NEA and Energy Action Scotland 2021. *UK Fuel Poverty Monitor 2020-21*. Newcastle Upon Tyne: NEA. Available at: <https://www.nea.org.uk/wp->

content/uploads/2021/11/0000_NEA_Fuel-Poverty-Report-and-Exec-Summary_v2.pdf [Accessed: 7 December 2021].

NICE 2015. Excess winter deaths and illness and the health risks associated with cold homes NICE guideline [NG6]. Available at: <https://www.nice.org.uk/guidance/ng6> [Accessed: 22 July 2021].

Noebels, M. and Corbyn, C. 2021. A guide for constituents: Energy, environment and countryside projects. Available at: <https://research.senedd.wales/media/rsedsu10/funding-guide-2021-english.pdf> [Accessed: 7 June 2021].

Osman, L.M. et al. 2010. A randomised trial of home energy efficiency improvement in the homes of elderly COPD patients. *European Respiratory Journal* 35(2), pp. 303–309. doi: 10.1183/09031936.00187708.

Poortinga, W. et al. 2018. The health impacts of energy performance investments in low-income areas: a mixed-methods approach. *Public Health Research* 6(5). doi: 10.3310/phr06050.

Public Health England 2020. Radon. Available at: <https://www.gov.uk/government/collections/radon> [Accessed: 17 June 2021].

Public Health Wales 2019a. *Improving winter health and well-being and reducing winter pressures in Wales. A preventative approach*. Cardiff: Public Health Wales NHS Trust. Available at: <https://phw.nhs.wales/news/winter-health-how-we-can-all-make-a-difference/report/> [Accessed: 21 July 2021].

Public Health Wales 2019b. *Making a Difference. Housing and Health: A Case for Investment*. Cardiff: Public Health Wales NHS Trust. Available at: <https://phw.nhs.wales/files/housing-and-health-reports/a-case-for-investment-report/> [Accessed: 21 July 2021].

Public Health Wales 2021. *A COVID-19 pandemic world and beyond: The public health impact of Home and Agile Working in Wales. Supporting Information Report*. Cardiff: Public Health Wales NHS Trust. Available at: https://phwwhocc.co.uk/whiasu/wp-content/uploads/sites/3/2021/05/PHW_HIA_Home_Working_Supplementary_information.pdf [Accessed: 21 July 2021].

Statistics for Wales 2019a. Welsh Housing Conditions Survey 2017-18: Energy Efficiency of Dwellings. Available at: <https://gov.wales/sites/default/files/statistics-and-research/2019-10/welsh-housing-conditions-survey-energy-efficiency-dwellings-april-2017-march-2018-795.pdf> [Accessed: 21 July 2021].

Statistics for Wales 2019b. Welsh Housing Conditions Survey: results viewer. Available at: <https://gov.wales/welsh-housing-conditions-survey-results-viewer> [Accessed: 21 July 2021].

Symonds, P. et al. 2019. Home energy efficiency and radon: An observational study. *Indoor Air* 0(0). Available at: <https://onlinelibrary.wiley.com/doi/abs/10.1111/ina.12575> [Accessed: 21 July 2021].

Thomson, H. et al. 2013. Housing improvements for health and associated socio-economic outcomes. *Cochrane Database of Systematic Reviews* (2). Available at: <https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD008657.pub2/full> [Accessed: 16 May 2019].

United Nations 2020a. *The Sustainable Development Goals Report 2020*. New York: United Nations. Available at: <https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf> [Accessed: 20 July 2021].

United Nations 2020b. *World Economic Situation and Prospects 2020*. New York: United Nations. Available at: https://unctad.org/en/PublicationsLibrary/wesp2020_en.pdf [Accessed: 21 July 2021].

United Nations 2020c. *World Economic Situation and Prospects 2020. Executive Summary*. New York: United Nations. Available at: https://unctad.org/en/PublicationsLibrary/wesp2020_summary_en.pdf [Accessed: 21 July 2021].

United Nations 2021. Goal 7 - Ensure access to affordable, reliable, sustainable and modern energy for all. Available at: <https://sdgs.un.org/goals/goal7> [Accessed: 20 July 2021].

Wales Centre for Public Policy 2020. Recovery from the Coronavirus pandemic: Renewable energy, housing and town centres. Available at: <https://www.wcpp.org.uk/wp-content/uploads/2020/11/Recovery-from-the-Coronavirus-pandemic.-Renewable-energy-housing-and-town-centres.pdf> [Accessed: 21 July 2021].

Welsh Government 2016. *Energy Efficiency in Wales. A strategy for the next 10 years 2016–2026*. Cardiff: Welsh Government. Available at: <https://gov.wales/sites/default/files/publications/2019-06/energy-efficiency-strategy.pdf> [Accessed: 21 July 2021].

Welsh Government 2019a. Prosperity for all: A low carbon Wales. Available at: <https://gov.wales/low-carbon-delivery-plan> [Accessed: 2 June 2021].

Welsh Government 2019b. Welsh Government makes climate emergency declaration. Available at: <https://gov.wales/welsh-government-makes-climate-emergency-declaration> [Accessed: 9 June 2021].

Welsh Government 2020a. Fuel poverty estimates for Wales: 2018. Available at: <https://gov.wales/fuel-poverty-estimates-wales-2018> [Accessed: 16 August 2021].

Welsh Government 2020b. In-home domestic energy advice pilot: guidance. Available at: <https://gov.wales/home-domestic-energy-advice-pilot-guidance-html> [Accessed: 7 January 2021].

Welsh Government 2020c. Stricter energy efficiency rules set to apply to all private rental homes in Wales. Available at: <https://gov.wales/stricter-energy-efficiency-rules-set-apply-all-private-rental-homes-wales> [Accessed: 22 July 2021].

Welsh Government 2021a. Nest. Available at: <https://nest.gov.wales> [Accessed: 21 July 2021].

Welsh Government 2021b. Tackling fuel poverty 2021 to 2035. Available at: <https://gov.wales/tackling-fuel-poverty-2021-2035> [Accessed: 9 March 2021].

Which 2021. New energy label: what it means for your home. Available at: <https://www.which.co.uk/news/2021/03/what-does-the-new-energy-label-mean-for-you-and-your-home/> [Accessed: 3 June 2021].

Willand, N. et al. 2015. Towards explaining the health impacts of residential energy efficiency interventions – A realist review. Part 1: Pathways. *Social Science & Medicine* 133, pp. 191–201. doi: 10.1016/j.socscimed.2015.02.005.

Appendix 1: Search Strategy

The PubMed database was searched using the following strings:

- "energy efficiency" AND "Home" OR "Hous*"
- (heating[MeSH Terms]) AND (housing[MeSH Terms])
- (((heating[MeSH Terms]) AND (housing*[MeSH Terms])) AND ("energy efficiency"[Title/Abstract]))

The search looked for results since 2010, in the English language. This search was conducted originally in 2019 and an update to the search was performed on 11/01/2021 and 09/06/2021 to extract any additional papers published since the first search. At all times, searches focused on the first 50 results.

The websites of the Welsh Government, National Assembly for Wales (now Welsh Parliament), and UK Government were searched for current policy papers and associated publications, using the following keywords and variations thereof: 'energy efficiency', 'home energy', 'domestic energy', 'low carbon', 'housing' and 'household'.