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Review

Mapping the Evidence on Care Home Decarbonisation: A Scoping Review Revealing Fragmented Progress and Key Implementation Gaps

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Abstract

Care homes are an energy-intensive component of the health and social care sector, with high demands on heating, lighting, laundry, catering and medical technologies. This constant energy use makes care homes a notable contributor to global greenhouse gas emissions. Decarbonising care homes presents an opportunity to reduce emissions, operational costs, and deliver health co-benefits by improving air quality and thermal comfort. This scoping review mapped the international evidence on decarbonisation in care homes to inform sustainable practice and policy development. Guided by Joanna Briggs Institute methodology, seven databases (CINAHL, EMBASE, IEEE, MEDLINE, PubMed, Scopus, and Web of Science) were searched. Eligible studies included care home facilities, residents or staff with data managed in Covidence and extracted using the "The Greenhouse Gas Protocol Corporate Standard Inventory Accounting". A total of 22 studies met the inclusion criteria. The evidence was concentrated around Scope 2 emissions, through efforts to monitor and reduce electricity use, while Scope 1 (facility emissions) and Scope 3 (supply chain emissions) remain comparatively underexplored. Evidence was fragmented and revealed risk aversion and care quality concerns related to adopting low-carbon technologies, as well as a growing interest in digital technologies and sustainable food procurement. Care homes should be prioritised within net zero healthcare frameworks, with targeted research, policy guidance, and investment to support decarbonisation.

Keywords: decarbonisation; carbon footprint; energy efficiency; greenhouse gas emissions; care homes

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1. Introduction

Climate change has been described as the greatest health threat of the 21st century [1]. Rising temperatures, extreme weather events, and deteriorating air quality are driving morbidity and mortality worldwide, with disproportionate impacts on vulnerable populations such as older adults, people with chronic illness, and residents of long-term care facilities [2]. Paradoxically, the health and social care sector, which aims to protect population wellbeing, contributes substantially to environmental harm. Globally, healthcare accounts for an estimated 4–5% of greenhouse gas (GHG) emissions, a carbon footprint comparable to that of major industrialised nations [3,4]. Within this, residential and long-term care facilities represent highly energy-intensive environments due to their reliance on heating, lighting, catering, laundry services, and increasingly, medical technologies [5,6].

This contradiction has prompted an urgent call for decarbonisation across all health sectors. Decarbonisation is the process of reducing or eliminating carbon dioxide and other greenhouse gas emissions [7]. This includes transitioning energy, transport, and industry to low-carbon or renewable alternatives [8]. Decarbonisation, therefore, is a key target of the Sustainable Development Goals [9,10], representing a mechanism for climate change mitigation. The World Health Organization's *Operational Framework for Climate-Resilient and Low-Carbon Health Systems* [1] calls for the integration of mitigation and adaptation strategies across all sectors of health. The *Alliance for Transformative Action on Climate and Health (ATACH)*, launched at COP26, represents a growing coalition of governments committed to climate-resilient, sustainable health systems [11,12]. Health Care Without Harm's (2021) *Global Roadmap for Healthcare Decarbonisation* [13] further sets out a trajectory for net zero health systems by 2050, aligned with the Sustainable Development Goals.

To date, most policy and research momentum has concentrated on hospitals and acute care facilities, where large-scale technical interventions (renewable energy, building retrofits, and anaesthetic gas substitution) have been documented and evaluated [3,14–17]. In contrast, long-term and residential care remains comparatively neglected in both research and policy, despite its expanding role in ageing societies worldwide. According to UN projections, the global population aged 60 years and older is expected to double from approximately 1.2 billion in 2024 to 2.1 billion by 2050, accounting for 26% of the population [18]. This will inevitably increase demand for residential and long-term care services, amplifying the energy consumption and greenhouse gas emissions of care homes.

Within the health sector, residential and long-term care facilities represent a distinct and increasingly important segment. These facilities, referred to as "care homes" (used in this review as an umbrella term), provide ongoing, full-time care for individuals who can no longer live independently due to age, frailty, or chronic illness [19]. Terminology varies internationally: in the United Kingdom (UK) and Ireland these are "care homes" or "nursing homes"; in the United States (USA) "nursing homes" or "long-term care facilities"; in Canada, "residential care"; in Australia, "Residential Aged Care Facilities (RACFs)"; and in parts of Asia, "elder care homes" [19]. While ownership structures also differ, ranging from predominantly private provision in the UK, mixed public–private models in Europe, heavily regulated systems in North America, and rapidly expanding but underregulated sectors in low- and middle-income countries (LMICs), the challenges are consistent. Despite structural differences, care homes across contexts share common characteristics. They are highly energy intensive, operating 24 h per day, generating substantial waste, relying on globalised supply chains for food, pharmaceuticals, and equipment, and most critically, serving highly vulnerable populations who are most at risk from the health effects of climate change due to frailty, multiple co-morbidities, and limited thermal regulation capacity [5,20,21].

Regulatory frameworks are beginning to integrate sustainability into long-term care, though unevenly across countries. In England, the Care Quality Commission (CQC) has recently incorporated environmental sustainability into its Well-Led domain under its Single Assessment Framework, which expects providers to reduce the carbon and environmental impacts of their operations [22]. In the European Union, the *Green Deal* emphasises energy-efficient buildings, including residential care [23]. While Canada and the USA have begun to incorporate sustainability into the long-term care sector, primarily through state and provincial building-energy regulations. For example, Ontario's *Energy*

& Water Reporting and Benchmarking for Large Buildings regulation requires retirement and care homes to report their annual energy and water consumption [24]. In the USA, state and municipal building performance standards such as Washington State's *Clean Buildings Performance Standard* and New York City's *Local Law 97* explicitly cover institutional occupancies, including care homes [25,26]. In contrast, many LMICs face limited regulatory and governance infrastructure for embedding sustainability into health and long-term care. As a result, facilities often depend on ad hoc, project-based, or donor-driven initiatives to implement climate mitigation or energy efficiency measures. Such disparities highlight the need for contextually adaptable decarbonisation strategies that align with local capacities and resources [1,11].

Decarbonisation interventions in care homes can deliver multiple co-benefits: they reduce greenhouse gas emissions, lower operational costs through energy efficiency, and improve health and wellbeing outcomes for residents by enhancing indoor environmental quality and reducing exposure to air pollution [3,27]. For example, retrofitting buildings for energy efficiency, transitioning to renewable energy, adopting sustainable procurement practices (e.g., food and medical supplies), and reducing waste streams are key strategies to lower the environmental impact of health and care facilities. Such interventions not only cut greenhouse gas emissions but can also improve indoor air quality, enhance thermal comfort, and strengthen financial resilience through reduced operating costs [1,13,27]. In addition, climate change mitigation strategies can have substantial health and economic gains, for example, through improved air quality, reduced morbidity, and enhanced wellbeing [28]. In resource-limited contexts, operational savings from efficiency gains may be reinvested into frontline care, addressing chronic staffing shortages and inequities in access. Understanding decarbonisation in care homes requires a systems perspective that accounts for the complexity and interdependencies of emission sources and intervention pathways. As decarbonisation involves interacting temporal and causal processes that operate at various system levels, net zero transitions require analysis of how decarbonisation actions take place while accounting for economic viability, stakeholder engagement, the regulatory environment, and organisational context [29].

Emissions occur concurrently across three domains as proposed by the GHG Protocol Initiative, a multi-stakeholder global partnership that has set standards to aid companies in the measurement and management of their GHG emissions [30]. This protocol defines three scopes for GHG accounting and reporting purposes: Scope 1 emissions, which are generated from direct on-site emissions such as heating, refrigerants, and transport; Scope 2 emissions, which result from purchased electricity; and Scope 3 emissions, which include supply chains, procurement, pharmaceuticals, catering, and waste [30]. Each emissions scope is shaped by both technological and operational choices. In practice, sequential actions such as measurement, evaluation, and phased implementation build on one another and entail feedback loops between technical change and behavioural adaptation [29]. Mapping these concurrent, sequential, and conditional relationships clarifies how systemic decarbonisation can most effectively be planned and achieved.

Current evidence is uneven across the three domains proposed by the GHG Protocol Initiative [30]. Scope 1 emissions (direct on-site emissions such as heating, refrigerants, and transport) and Scope 2 emissions (purchased electricity) are addressed to some degree in building efficiency and renewable energy research. By contrast, Scope 3 emissions (supply chains and waste) are much less studied, even though they often constitute the majority of healthcare's carbon footprint [31,32]. In long-term care settings, this evidence gap is especially acute because food systems, pharmaceuticals, and disposable products are integral to everyday operations. Although policy momentum is growing, there is no comprehensive synthesis of decarbonisation strategies tailored for long-term care. Without such a synthesis, providers and regulators across diverse settings lack evidence-based guidance needed to inform practice, training, or regulatory design.

To date, existing reviews of healthcare sustainability and decarbonisation have focused on hospitals or whole health systems [15,33,34], leaving care homes underrepresented despite their distinct energy use, procurement patterns, and contextual challenges. Accordingly, this review sought to map and synthesise evidence across all scopes to identify areas of concentration and neglect. It was hypothesised that existing evidence on decarbonisation within care homes would be uneven across the three GHG Protocol emission scopes, with Scope 2 (purchased electricity) likely to be most represented.

Overall, the present review aimed to chart the evidence related to decarbonisation in care homes in order to identify knowledge gaps and priority areas for future policy, practice, and investigation, via the following objectives: (1) to chart the range of decarbonisation strategies evaluated in care homes; (2) to synthesise evidence from studies measuring energy performance, carbon footprint, and efficiency in care homes; (3) to examine how care home residents, staff, and owners perceive and experience decarbonisation interventions, including facilitators and barriers to their implementation; and (4) to identify gaps in existing research regarding decarbonisation in care homes.

The remainder of this paper is structured as follows. The Methods section outlines the scoping review protocol to include eligibility criteria, search strategy, study selection process, data extraction, and synthesis approach. The Results section then presents the main findings of the included studies, mapped by GHG emission scope. The Discussion then interprets these findings in relation to the current literature, highlights research gaps and implications for policy and practice, and considers the limitations of the present review. Finally, the Conclusion section summarises the key contributions of this review and offers recommendations for future research in care home decarbonisation.

2. Materials and Methods

2.1. Protocol and Registration

This scoping review was conducted in line with the Joanna Briggs Institute (JBI) methodology for scoping reviews [35] and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist [36]. A protocol for this scoping review was registered prospectively on the Open Science Framework on 5th October 2025 (registration DOI: 10.17605/OSF.IO/7T243).

2.2. Eligibility Criteria

2.2.1. Types of Sources

Analytical observational studies, including prospective and retrospective cohort studies, case–control studies and analytical cross-sectional studies, were considered for inclusion. This review also considered descriptive observational study designs, including case series, individual case reports, and descriptive cross-sectional studies for inclusion. Studies were also considered that focused on qualitative data, including phenomenology, grounded theory, ethnography, and qualitative description. Systematic reviews identified were searched for relevant papers found in their reference sections that may not have been found in the database searches. Studies published in English only were included due to a lack of language diversity amongst the researchers. No date restrictions were applied, and grey literature was not included to maintain rigour and reliability by focusing on peer-reviewed publications. Further eligibility criteria were developed using the Population, Concept, and Context (PCC) framework as recommended by JBI [35].

Population

The population of interest were care homes. This consisted of participant samples which included care home facilities, care home residents and/or care home staff and owners. No restrictions were placed on care home type, gender, age, or ethnicity. Studies were considered for inclusion if at least some of the sample consisted of a care home and/or care home residents/staff, for example, those which included other buildings, or older adults living at home. However, the care home-specific data were extracted from these studies. Long-term hospital wards, rehabilitation units and skilled nursing facilities were not included due to the varying care structures, goals, and patient populations compared to care home settings.

Concept

Studies which reported factors related to decarbonisation were considered for inclusion. This included both quantitative and qualitative research, which reported on outcomes such as energy usage and carbon footprint, as well as experiences of decarbonisation strategies.

Context

No restrictions were placed on geographic location. Studies which monitored energy consumption of care homes, implemented or modelled decarbonisation strategies, and/or explored experiences of such strategies were all included.

2.3. Search Strategy

An initial limited search of MEDLINE and Google Scholar was undertaken to identify articles on the topic. The text words contained in the titles and abstracts of relevant articles and the index terms used to describe the articles were used to develop a full search strategy for MEDLINE (Supplementary Material S3). This search strategy, including all identified keywords and index terms, was adapted for each included database and received input from a subject librarian. To identify potentially relevant studies, seven bibliographic databases were searched on 13 October 2025: MEDLINE, Web of Science, IEEE, EMBASE, Scopus, PubMed, and CINAHL. The reference list and citations of all included sources of evidence were also screened for additional studies.

2.4. Selection of Sources of Evidence

Following the search, all identified citations were collated and uploaded into Covidence (https://www.covidence.org/ 13 October 2025), a screening and data extraction tool for streamlining the production of reviews. Following the removal of duplicates, TA carried out full screening of the title and abstracts; GM and SC independently repeated this for 50% of the records each. The same procedure was used for full-text screening. Disagreements throughout the screening process were resolved following a discussion between the authors.

2.5. Data Charting

Charting the data was carried out in Covidence, guided by the "JBI template source for evidence details, characteristics and results extraction instrument" [37]. TA conducted data extraction from the papers included in the scoping review, and this was checked for accuracy by SC independently. The data extracted included specific details about the author, year, setting, participants, study methods, outcomes, and key findings.

In accordance with JBI guidance for scoping reviews, a formal quality appraisal of the included studies was not undertaken. The purpose of this review was to chart the evidence related to decarbonisation in care home settings in order to identify knowledge gaps and priority areas for future policy, practice, and investigation, rather than to assess the methodological quality of existing evidence [36,38]

As recommended by JBI Scoping Review guidance, a structured qualitative content analysis approach was utilised to analyse and present the results of the included studies [35,39]. This followed three phases: (1) preparation, (2) organising, (3) reporting. These were in line with recommendations [39,40]. A deductive approach was taken to extract data according to The Greenhouse Gas Protocol Corporate Standard Inventory Accounting, with direct and indirect emissions as Scopes 1, 2, and 3 [30]. Results, therefore, from the charting process were collated into the following scopes: Scope 1 (direct emissions from owned or operated assets); Scope 2 (indirect emissions from purchased electricity); and Scope 3 (indirect emissions from the company's value chain).

3. Results

The search strategy yielded 6735 results. This was reduced by 53% after duplicates were removed, leaving 3165 records for title and abstract screening. Following title and abstract screening, 3087 records were excluded (45.84%) as they did not meet the inclusion criteria; this was primarily due to records focused on the wrong setting (e.g., hospitals and healthcare clinics) or the wrong outcomes (e.g., interventions to prevent or better manage disease), many records were also editorial statements or commentary pieces, while 3 records could not be found. A total of 75 records were therefore reviewed at the full-text stage. At this point, a further 0.79% were excluded. Therefore, after the full-text review stage, 22 articles were deemed eligible and included in the final review. A PRISMA-ScR flowchart has been provided to summarise the study identification process in Figure 1.

3.1. Characteristics of Included Studies

The 22 studies were published between 2014 and 2025 (Supplementary Material S1). The majority were published within the past six years (since 2019) (n = 20). Two were qualitative [41,42], and 20 were quantitative [43–62]. Included studies were conducted in a range of countries, most often the UK (n = 3) [41,42,50], followed by Australia (n = 2) [47,55], Italy (n = 2) [45,46], Turkey (n = 2) [43,52], Denmark (n = 2) [53,54], Spain (n = 2) [60,61], and Taiwan (n = 2) [48,56]. One study each from Austria [44], China [62], Croatia [59], Germany [57], Japan [51], Norway [49], and the USA [58] were included.

Seventeen studies reported only on care homes [42,43,45,46,48–50,52–56,58–62]. The others included care homes within a broader sample of varied building types [41,44,47,57]. Meanwhile, one study evaluated the use of electric vehicles to provide a shuttle service between a care home and hospital [51]. However, only care home-relevant findings were extracted from these studies.

Care home ownership was not always reported and included both private [58] and private not-for-profit companies [46,47,49,55,57], and public/state-owned homes [52,59] or state-provided meals [53,54]. One study included participants from homes of different ownership models, including family-owned, company-owned, and public-owned [42].

Both included qualitative studies utilised semi-structured interviews and thematic analysis [41,42]. A range of methods were utilised within the included quantitative studies. The majority utilised scenario modelling [43,45,49,51,53,58–62]. Meanwhile, others monitored energy consumption and emissions in specific facilities [44,46–48,50,52,54–57].

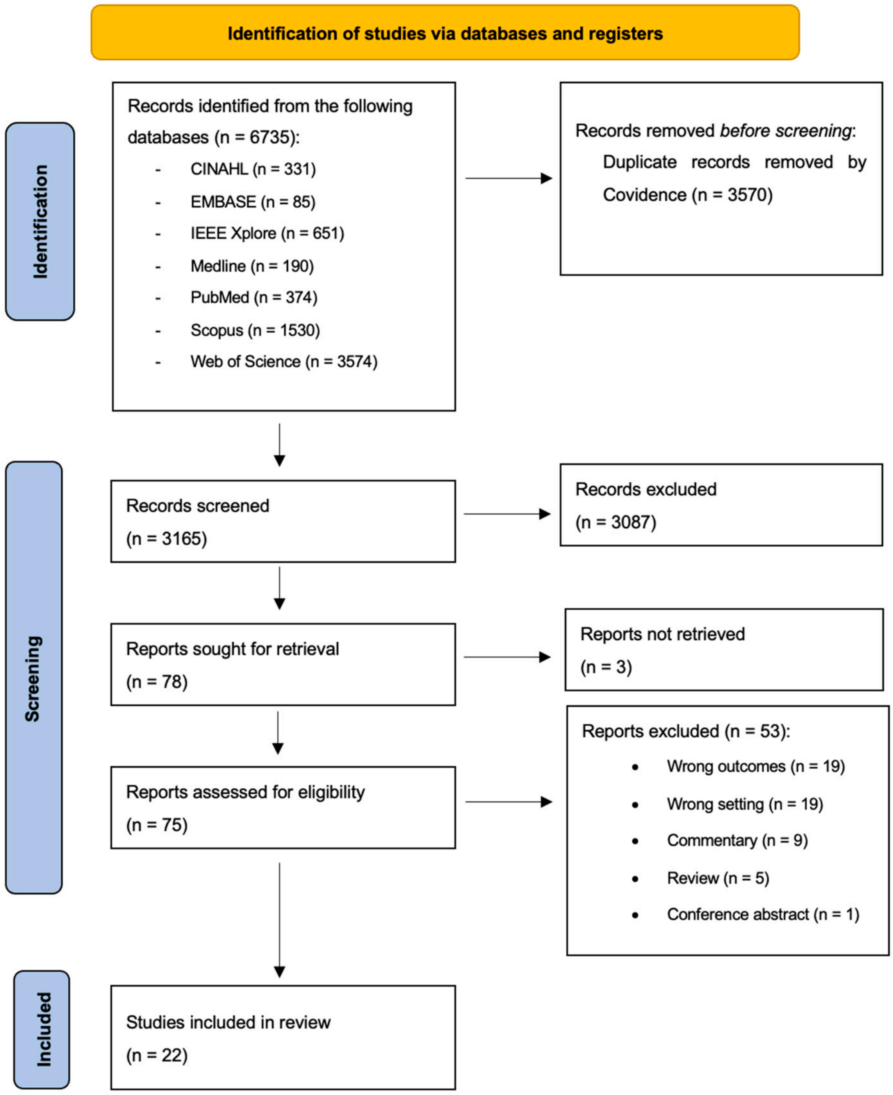

Figure 1. PRISMA flow diagram.

3.2. Greenhouse Gas Emissions

Results are presented in line with the three emission scopes of "The Greenhouse Gas Protocol Corporate Standard Inventory Accounting" [30].

First, however, one study measured emissions from Scopes 1, 2, and 3 from a health provider in Australia across one year [47]. Aged care was found to contribute 47.81% of the total greenhouse gas emissions of the health provider, while the health services and support services divisions contributed 49.16% and 3.03%, respectively. The Aged care division emissions from this health provider were composed of 11.78% Scope 1, 31.36% Scope 2, and 56.86% Scope 3. The top three contributors were from building energy (47.25%), which came mainly from electricity use (Scope 2) and gas combustion (Scope 1), followed by food and catering (15.41%), as well as water and waste (6.46%). Although it had been hypothesised that the health services division would have a higher carbon footprint, results showed health services and aged care divisions had comparable total emissions and therefore required equal emission reduction attention. Aged care showed some differences in the health services division. For example, food and catering (Scope 3) was responsible for 15.41% of emissions in aged care compared to only 4.16% of health services. Additionally, water and waste accounted for a greater percentage of emissions in aged care (6.46%) than in health services (3.06%). The remaining included studies have been reported below, organised by the emission scope measured and/or targeted.

3.2.1. Scope 1 Emissions

Scope 1 emissions are direct greenhouse gas emissions from facilities and assets owned or controlled by an organisation [30]. For care homes, this may include onsite combustion of gas for heating or the use of oil boilers, as well as any direct emissions from facility-owned vehicles. Although the majority of included studies did consider facility emissions, they measured and/or aimed to reduce aspects of indirect emissions, and so only three included studies were considered relevant for inclusion within this Scope 1 emissions domain [41,42,51].

Only one study directly explored an intervention to reduce Scope 1 emissions [51]. Statistical modelling was utilised to evaluate a transition from gasoline-powered shuttle buses to electric vehicles powered by on-site photovoltaic systems for a shuttle service between a care home and hospital. This eliminated direct emissions from vehicle fuel and resulted in a 10% reduction in total power demand during the first six months, therefore also reducing Scope 2 emissions [51].

Two included studies utilised qualitative methods to explore experiences of the implementation of low-carbon heating technologies within care homes in the UK [41,42]. One study interviewed residents, staff, and managers within care homes which had installed alternatives to conventional oil, gas, and electric heating systems, such as solar hot water panels, underfloor heating, ground-source heat pumps, and wind turbines [41]. Findings suggested that emissions reductions via low-carbon heating technologies may be overestimated, as devices such as electric fires were used to supplement the nature of "cosiness" and "glow" which was not provided by the low carbon systems. Therefore, the reduction in Scope 1 emissions potentially led to an increase in Scope 2 emissions as electrical devices were relied upon for psychological comfort. This finding highlights a critical trade-off: while low-carbon heating systems can reduce direct (Scope 1) emissions, the compensatory use of electric heating devices for psychological comfort may inadvertently increase indirect (Scope 2) emissions, thereby offsetting some of the anticipated environmental benefits.

Care home managers commented the following: *"for me it's psychological, like, if I can see the coal, I'll think then I'm warm"*; *"We installed a fire place and put an old fashioned glow fire, with glow, like coal-effect and [residents] say 'Now it's warm, we've got the fires on'… so it's important they can still relate to it and they can feel warm and safe in their environment and not feel there's no heating in the place."* In this same study, mock fires and lighting devices were described as adding domestic cosiness which underfloor heating could not provide, as one care home manager described: *"Sometimes they like to… actually see in their room and feel it's warm 'cos they say 'Where's the fire, where's the radiator?, my room is cold.' They're not of a generation that understands about underfloor heating."* Additionally, the glow of a fireplace was consistently discussed by participants in emotional terms, associated with cheeriness and friendliness. Finally, care home managers described continuity in thermal experience as important for their residents: *"that's what they're used to in their generation… it's coal fires, they're used to manually keeping warm so they can relate to that, so it's important they can still relate to it"* [41].

Similarly, another qualitative study explored the opinions of care home staff in the UK on the implementation of thermal technologies such as solar panels and heat pumps [42]. Adoption was shaped by business risk aversion and potential impact on care practices. Although care home owners and managers often saw the benefits of new sustainable technologies, these were deemed risky due to concerns over operational reliability, reputation, and regulatory scrutiny. Comments included the following: *"it could devastate a small business, if we had some sort of bug in the system… so I just wasn't prepared to risk that"*. Energy costs, although high, were deemed less important than maintaining occupancy and reputation: "Keeping your occupancy levels high, for instance, that is a much bigger factor… energy costs are way down the list of-it is a substantial cost, don't get me wrong—but it's certainly not the most important bit of the care home". However, more familiar interventions such as insulation were widely accepted as these were deemed "safer". In terms of care practices, underfloor heating, which provided a consistent thermal experience, was associated with positives such as avoiding the risks associated with hot water bottles, extra blankets, and radiators. However, staff and residents were prone to sore feet and swollen ankles due to the heat from the floor. Additionally, this study also highlighted the use of supplementary heating, such as a mock fireplace, to recreate a visual sense of a warm fire.

3.2.2. Scope 2 Emissions

Scope 2 emissions are indirect greenhouse gas emissions from the purchase of electricity, steam, heating, or cooling from a utility provider [30]. This may include grid-supplied electricity used to light, heat, and power care home buildings, including medical equipment and appliances. Emissions are not generated at the care home facility, but at the power plant [30]. The majority of studies were considered relevant to the Scope 2 emissions domain as they either measured purchased electricity consumption or aimed to reduce electricity usage. Two included studies monitored electricity consumption [44,52]. One monitored energy consumption using "smart technology", which also aimed to reduce consumption [48]. Others utilised modelling to evaluate the impacts of interventions such as passive design [50,58], retrofits [43,49,59,62]. One included study evaluated the installation of a more sustainable heat pump system [56], while another explored the potential of onsite photovoltaic systems [55]. Finally, two included studies implemented thermal comfort strategies and discussed the energy implications of these [60,61].

One study investigated the electricity consumption (used for heating, hot water, cooling, and appliances) and energy generation (via PV/ solar thermal generation) of nine buildings in Austria, including one care home, over 12 months [44]. Although this study did measure energy generation via PV and solar thermal systems, the care home included did not feature any such system, and so only Scope 2 emissions via purchased electricity were examined. The care home utilised an HVAC concept with the majority of heating provided by district heating and used an electric boiler only in the warmer months. Ventilation was supported by underground collectors, and the facility had a moderate insulation rating. Despite lacking renewable systems, this care home was considered energy efficient as its heating energy consumption was more than 50% lower than empirical literature values per care place. Recommendations for increased energy efficiency included the use of web-based monitoring systems with automated reports to fine-tune building systems for energy savings and comfort, and the retrofit of demand-based controllers for heat pumps and fans were recommended to minimise wasted power [44].

Another study also measured the energy performance of a care home in Turkey [52]. Annual electricity and natural gas use for heating/ cooling, hot water, laundry, and electrical equipment was measured. Although natural gas (Scope 1) contributed the majority of the care home's annual energy use, purchased electricity contributed 27% and was the main focus of this paper. Electricity was used mainly for space heating and cooling, hot and cold water, steam, lighting, computers, and other electrical appliances. Electrical equipment, including lighting, had the highest exergy efficiency, while space heating and cooling had the lowest exergy efficiency. Therefore, the authors recommended prioritisation of renewable energy integration for heating and cooling to reduce energy consumption.

In another study, the energy consumption of a care home was evaluated over a three-month period using "smart technology", including wireless sensing networks and smart power metres [48]. This enabled real-time tracking of occupancy, environmental conditions, and energy use, and informed adaptive systems such as smart lighting, dynamic HVAC adjustment, and machine learning models to predict meal demand. Scope 2 emissions were measured via purchased electricity usage for lighting, air conditioning, and meal preparation. The technology implemented resulted in approximately a 10% reduction in energy consumption for the care home, which demonstrated potential for real-time wastage detection and significant operational cost savings, while maintaining resident safety and comfort.

Two included studies utilised statistical modelling of passive design strategies in care homes to reduce Scope 2 emissions [50,58]. One focused on purchased electricity use, which was dominated by heating, followed by lighting and equipment, while cooling demand was minor due to only being required seasonally [50]. Passive design strategies, which included improving window U-values via upgrades from double to triple glazing, reducing infiltration rates, and optimising window-to-wall ratios, were found to reduce overall annual energy use by up to 28%. Additionally, heating demand could be reduced by 35.2% and cooling demand virtually eliminated when good practice building fabric was applied [50].

Similarly, other care homes' energy use was measured in a range of climates across the USA [58]. The greatest Scope 2 energy saving potential was found for reducing lighting and plug loads, adding insulation, and reducing air infiltration. Some measures showed varying results based on climate, for example, cool roofs and roof-mounted aluminium foil were effective for reducing cooling energy in hot climates but may worsen annual energy usage in cold or mild climates. Additionally, window-based measures, including aluminium foil and overhangs, reduced cooling loads in hot climates, but increased heating energy in mild or cold climates. The authors stressed that energy savings from passive measures are highly dependent on climate zone and often, energy savings and thermal resilience do not align; therefore, both climate-related resilience and energy savings should be balanced when designing and retrofitting care homes [58].

Four included studies evaluated retrofits and renovations in care homes [43,49,59,62]. One such study modelled a retrofitted care home in Shanghai with an activity space enclosed by a large glass curtain wall [62]. This glass resulted in fluctuations in indoor temperature and humidity and led to frequent use of air conditioning and curtain closures, which in turn resulted in energy waste and elevated Scope 2 emissions. Adding external shading could decrease cooling energy consumption by 26.8%, while the introduction of partial roof greening could contribute to further reductions in cooling loads [62].

Another study simulated how different combinations of natural stone as building material, natural insulation materials, roof systems, and green wall facades influenced the energy consumption of a care home in Turkey [43]. The largest reductions in building energy consumption (up to 31.3%) were achieved with the use of cellulose fibre insulation for walls and a green roof system (layered with vegetation, mineral wool insulation, vapour control, waterproofing, and drainage course). A green wall façade, however, was found to lead to increased solar gains in the hot Turkish climate and so resulted in higher energy consumption via increased cooling loads [43].

A similar method was utilised in a care home in Norway, which conducted a life cycle assessment of renovation strategies [49]. Upgrading insulation and windows reduced net energy use and delivered energy by approximately 50%. The authors argued that the building was limited in reaching full net zero energy due to a lack of space for on-site electricity generation via the installation of PV panels. Finally, another study evaluated the energy performance of care homes from different building periods in Croatia before and after renovation into a nearly zero-energy building, via modelling [59]. Retrofitting (thermal insulation of external walls, ground floors, and ceilings, replacing single- or double-glazed windows with triple glazing, incorporating thermal solar systems and condensing boilers, and improved cooling and ventilation) reduced energy needs by 81–89%. The construction period of 1971–1980 showed the highest energy savings due to having the poorest baseline performance [59].

Two studies explored the installation of more sustainable energy systems at care homes to reduce Scope 2 emissions by reducing power demand [55,56]. Installation of a novel heat pump system with an integrated cooling system was found to reduce electricity consumption by 67.35% [56]. This heat pump also resulted in significant improvements in ventilation, air quality, thermal comfort, and overall resident satisfaction [56]. As the heat pump replaced electric heaters, this study was considered a Scope 2 intervention. Another study advocated for a fairer renewable energy policy based on a per-bed capacity rather than facility limits for care homes based on analysis across 10 aged care communities in Australia [55]. This study suggested that on-site photovoltaic systems could result in significant financial savings, offset facility electricity demand, and help care homes move toward net zero electricity goals [55].

Finally, in relation to Scope 2 emissions, two studies implemented different models to increase thermal comfort within care homes across Spain, but also discussed the associated energy implications [60,61]. The first implemented adaptive consumption models in eight care homes (across two Mediterranean climates) using real data on energy consumption and environmental conditions during the cooling season [60]. Dynamic adjustment of HVAC temperature setpoints based on resident responses and outdoor conditions, rather than a fixed setpoint, resulted in average energy savings of up to 9.9% due to a reduction in cooling demand. The second study built upon their 2023 study to develop a neural network model to predict and optimise cooling consumption in care homes. This enabled more precise, adaptive control of operative temperature for residents, with models tailored to the older population, and resulted in energy savings of up to 23.4% [61].

3.2.3. Scope 3 Emissions

Scope 3 emissions include all indirect emissions (other than purchased electricity) that occur in a facility's value chain, for example, from purchased goods and services [30]. Five studies fell into the Scope 3 domain, each of which focused on food procurement and meal plans for care home residents. Two of these studies measured the climate impact of care home meal plans [46,57], two utilised modelling to explore how the greenhouse gas emissions associated with care home menus may be reduced [45,53], while one study evaluated the implementation of a strategy aimed at reducing these [54].

Two included studies measured the greenhouse gas emissions associated with care home menus [46,57]. One found 99% of menus in an Italian care home exceeded recommended CO_2 emissions for climate-friendly meals, and only 22% were adherent to the planetary health diet [63]. There was a strong inverse association between adherence to the planetary health diet and greenhouse gas emissions, while a high Modified-EAT-Lancet Diet Score [64] was strongly associated with a reduction in the carbon footprint. This suggested shifting towards planetary-health-compliant diets showed potential for reducing the carbon footprint and nutritional quality of care home food procurement.

Another study conducted a life cycle assessment of procured food for hospitals and care homes in Germany [57]. Extracted care home results show that animal-sourced foods were responsible for around 75% of food-related environmental impact, with meat alone accounting for 38% of greenhouse gas emissions. Diets were also found to be of poor nutritional quality as assessed by Healthy Eating Index scores [65]. The authors suggest dietary shifts in reducing meat and increasing plant-based foods would consistently lower Scope 3 emissions with minor cost increases and increased nutritional value [57].

Two included studies utilised scenario modelling to explore how greenhouse gas emissions of food procurement for care homes could be reduced [45,53]. The first study found that greenhouse gas emissions related to care home menus were inversely proportional to their cost, but substantial reductions in emissions could be achieved with small cost increases [45]. For example, a menu with a 12% reduction in greenhouse gas emissions could be achieved with a 1% cost increase, or a 15% reduction with a 4% cost increase. This was achieved via limiting animal-based foods, especially red and processed meat and emphasising plant-based foods, while ensuring a varied and nutritionally adequate menu [45]. Similarly, the second such study found that a more sustainable menu in care homes in Copenhagen could achieve an estimated 22% reduction in greenhouse gas emissions via reduction in meat and dairy products, more plant-based food, and more climate-friendly fats and cereals [53].

A final included study added to this previous literature conducted a mid-way evaluation of the food strategy aimed at reducing the greenhouse gas emissions associated with providing public meals to senior citizens by 25% in Copenhagen [54]. This strategy implemented updated menu guidelines, recipe databases, and tailored staff training. In care homes with full-day meal provision, a 10% reduction in greenhouse gas emissions was observed, while in central kitchens supplying hot meals to care homes, a 30% reduction was found. Reductions were attributed primarily to a decreased amount of ruminant meat [54].

3.3. Decarbonisation Strategies

The majority of studies explored a decarbonisation strategy, as synthesised within Table 1. Research and practice recommendations from the included papers have also been extracted and synthesised in accordance with the relevant decarbonisation strategy, as below.

Table 1. Decarbonisation strategies and outcomes across emission scopes.

Scope	Study	Decarbonisation Strategy	Outcome
Scope 1	Kumaoka et al., 2024 [51]	Replacement of shuttle buses between care home and hospital with electric vehicles charged via onsite photovoltaic systems.	Statistical modelling revealed the elimination of direct vehicle fuel emissions and a 10% reduction in total power demand during the first six months.
Scope 2	Balo et al., 2025 [43]	Retrofitting with sustainable material choices (e.g., natural stone, natural insulation materials, roof systems, green wall facades).	Modelling revealed up to 31.3% reductions in energy consumption with the use of cellulose fibre insulation and a green roof system.
	Beerman & Sauper et al., 2019 [44]	HVAC concept, district heating, electric boiler in warmer months, ventilation supported by underground collectors, moderate insulation rating.	Heating energy consumption > 50% lower than empirical literature values per care place.
	Fong et al., 2023 [48]	Smart technology: wireless sensing networks, smart power metres	10% reduction in energy consumption.
	González Fernández, 2023 [49]	Renovations, including upgraded insulation and windows.	Life cycle analysis suggested a 50% reduction in net energy use.

	Hou, 2020 [50]	Passive design strategies: improving window U-values, reducing infiltration rates, and optimising the window-to-wall ratio.	Statistical modelling revealed a 28% reduction in overall annual energy use, a 35.2% reduction in heating demand, and the elimination of cooling demand.
	Liu et al., 2022 [55]	Small-scale renewable target on a per-bed basis compared to a static limit for each site.	A 5 kWp/bed limit could help Australian aged care communities produce 349% more renewable energy and reduce 670,000 tonnes of emissions than the 100 kWp per community scenario.
	Lu et al., 2019 [56]	Heat pump system with an integrated cooling system.	Reduced electricity consumption by 67.35%.
	Sun et al., 2020 [58]	Passive and active energy efficiency measures, e.g., reducing lighting and plug loads, adding insulation, reducing air infiltration, and cool roofs.	Energy savings are highly dependent on climate zone; often, energy savings and thermal resilience do not align.
	Teni et al., 2019 [59]	Retrofit: thermal insulation of walls, floors and ceilings, upgraded windows, thermal solar systems and condensing boilers, and improved cooling and ventilation.	Reduced energy needs by 81–89%.
	Vergés et al., 2023 [60]	Adaptive consumption models, including dynamic adjustment of HVAC temperature.	Average energy savings of up to 9.9% due to a reduction in cooling demand.
	Vergés et al., 2024 [61]	Prediction and optimisation model for cooling consumption.	Tailored models resulted in up to 23.4% in energy savings.
	Zhou et al., 2024 [62]	Retrofit of an activity space with a glass curtain wall.	Modelling highlighted that the addition of external shading could decrease cooling energy consumption by 26.8%.
Scope 3	Benvenuti et al., 2019 [45]	Menu planning.	Small cost increases could achieve substantial emissions reductions: 1% cost increase led to 12% greenhouse gas emissions (achieved via limiting animal-based foods).
	Conti et al., 2024 [46]	Menu planning.	Increased adherence to the planetary health diet and a higher Modified-EAT-Lancet Diet Score are associated with lower greenhouse gas emissions.
	Lassen et al., 2021 [53]	Menu planning.	A 22% reduction in greenhouse gas emissions via a reduction in meat and dairy products, more plant-based food, and more climate-friendly fats and cereals.
	Lassen et al., 2025 [54]	Menu planning.	A 10–30% reduction in greenhouse gas emissions via updated menu guidelines, recipe databases, and tailored staff training.
	Pörtner et al., 2025 [57]	Menu planning.	Animal-sourced foods are responsible for around 75% of food-related

	environmental impact, with meat accounting for 38% of greenhouse gas emissions.

3.3.1. Renovations and Retrofits

Authors of included studies provided various recommendations in relation to building materials for new and retrofitted care homes. For example, renewable, locally sourced, and long-lasting construction materials may reduce embodied emissions in care home renovations [49]. Meanwhile, cellulose fibre insulation and green roofs can yield optimum energy savings as building strategies in care homes within hot climates [43]. However, further research on passive design strategies, such as green walls, is warranted to clarify their impact on the carbon footprint of care homes [50]. Additionally, lifecycle assessment and cost analysis are recommended to compare new builds with retrofits to inform future investment [59].

Smart monitoring systems and predictive management for energy use are recommended to reduce energy consumption in care homes while maintaining resident safety and comfort [48]. Existing heat pumps may be optimised via strategies such as disconnecting temperature storage tanks, prioritising spray humidification, retrofitting frequency converters, and installing pump controllers and web-based monitoring systems with automated energy reporting [44]. Small-scale renewable energy systems are advocated for within aged care, to factor in limitations such as roof space and grid capacity [55]. Regional and national collaboration is recommended to scale energy production from photovoltaic, geothermal or seawater systems to reduce operational emissions and help care homes reach zero-emission ambitions [49]. Additionally, policy change is recommended to evaluate care homes on a per-bed basis rather than facility limits [55].

3.3.2. Food Procurement, Menu and Diet Recommendations

All included studies which focused on Scope 3 emissions via food procurement and care home menus suggested minimisation of red meat and an increase in plant-based foods could result in reductions in greenhouse gas emissions [45,46,53,54,57]. Additionally, climate-friendly menu guidelines can also improve the nutritional quality of meals [45,46,57]. However, future research is recommended to evaluate these menus in real-world settings whilst monitoring their impacts on intake, nutrition, and quality of life [54]. Additionally, future nutritional research should consider individual characteristics, such as culture, and food choice behaviour when examining food-related emissions and quality [46].

3.4. Proposed Model

The main findings of this review have been synthesised into a model (Figure 2) to present the proposed decarbonisation interventions and net zero outcomes, identified within the included studies. Effect modifiers such as emissions measurement, operational constraints, risk aversion, and resident behaviours can act as either facilitators or barriers to the successful implementation of decarbonisation interventions within care homes. The mediation pathways, corresponding to the emissions of Scopes 1, 2, and 3, represent the mechanisms by which these interventions influence the achievement of net zero outcomes, including reduced emissions, lower costs, and associated health co-benefits.

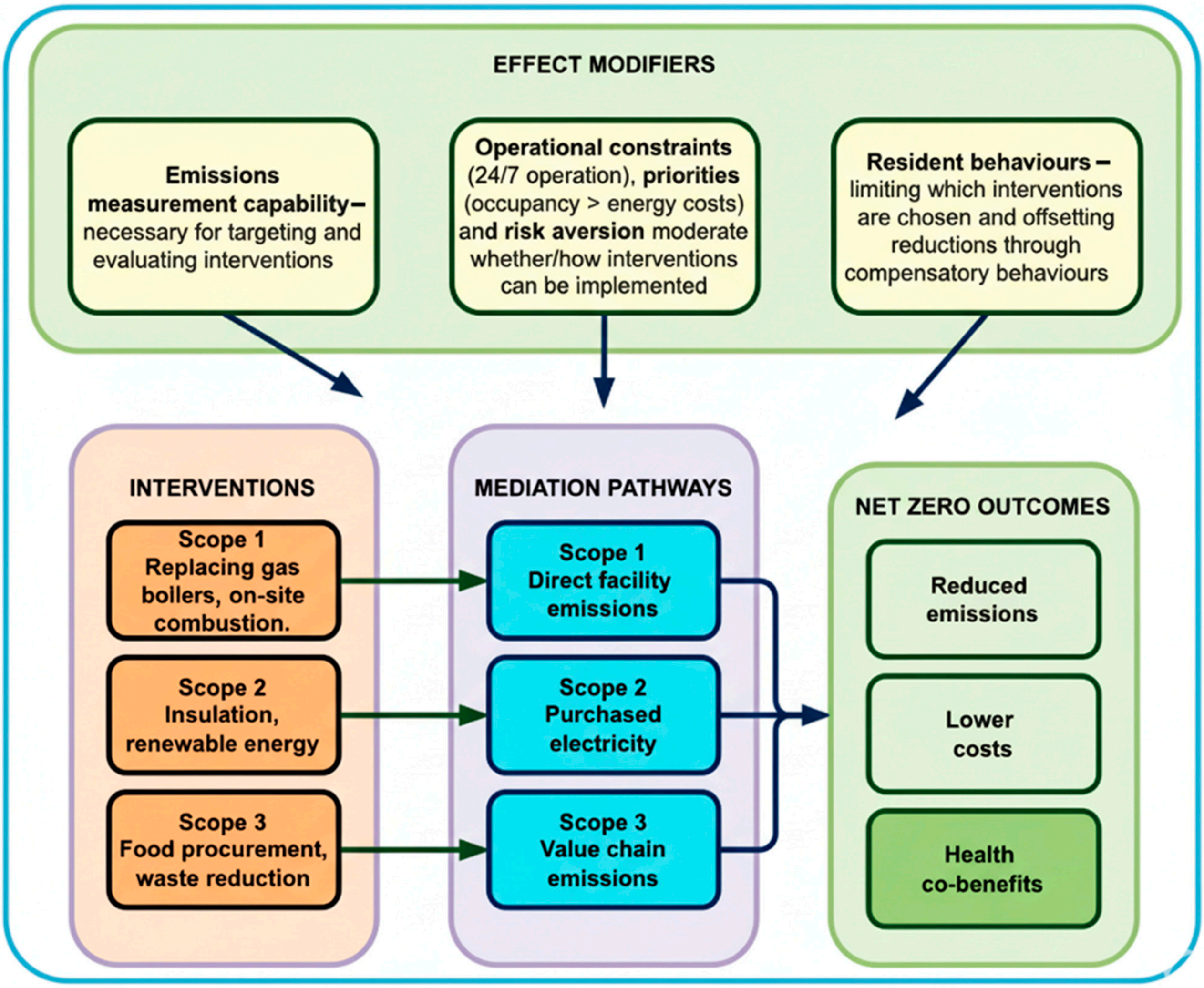

Figure 2. Proposed model for decarbonisation in care homes.

4. Discussion

This scoping review provides a synthesis of the emerging evidence base for decarbonisation efforts in care homes, highlighting both the progress made and the considerable gaps which persist in research, policy, and practice. This review identified a limited number of studies (n = 22) which explored decarbonisation in care home settings, most published since 2019. Despite this recent increase, decarbonisation within care homes remains an understudied area in relation to broader healthcare decarbonisation. Especially given the highly energy-intensive environment created due to a 24/7 reliance on heating, lighting, catering, laundry services, and medical technologies [5,6,47]. In addition, the under-representation of decarbonisation research in care homes is particularly concerning given the likelihood of increasing demands on the sector due to ageing societies globally [18].

The majority of included studies focused on Scope 2 emissions (purchased electricity) via monitoring of electricity consumption [44,48,52] or aiming to reduce this via passive design and retrofits [43,49,50,58,59,62], and more sustainable energy sources [55,56]. While these approaches have achieved or shown the potential to result in measurable energy savings, the organisational and behavioural factors influencing their implementation remain underexplored. This highlights a tendency to prioritise technical and infrastructural solutions, which may be easier to quantify and implement [14,66] over the more complex, and underexplored Scope 1 (facility emissions) and Scope 3 (supply chain emissions) domains.

Scope 3 emissions were explored in relation to food procurement and meal plans for care home residents via assessing and/or addressing the climate impact of meal plans [45,46,53,54,57]. Similarly to wider food production literature, plant-based foods were found to have significantly lower environmental impacts than animal-based foods [67]. These studies highlighted the significant contribution of food procurement to Scope 3 emissions in care homes, and therefore the opportunities which exist for reducing such emissions via the adaptation of menus, which showed promise in both carbon reduction and nutritional improvements [45,46,57]. A recent scoping review of food waste within residential aged care found that 20–30% of served food goes to waste, but a lack of interventions to address this [68]. This highlights the potential for changes in meal plans to not only decarbonise via food procurement but also by optimisation of consumption patterns to ensure the food service system is aligned with both resident preferences and decarbonisation goals. Within the present review, food procurement emerged as a promising, yet under-addressed, strategy for reducing Scope 3 emissions, with evidence indicating that menu re-design toward plant-based foods, and increased adherence to the planetary health diet [63], could substantially reduce carbon footprint, with minimal cost, alongside nutritional gains.

The exploration of Scope 1 emissions in care homes emerged as a significant gap in existing literature, with very few included studies considering the direct facility emissions of care homes [41,42,51]. These included studies, however, addressed another gap in the literature via qualitative exploration of stakeholders' perceptions of implementing decarbonisation strategies [41,42]. These highlighted that when low-carbon heating technologies, such as heat pumps and solar panels, are implemented, both staff and residents often rely on supplementary electrical heating devices for psychological comfort and cosiness (e.g., electric fires), which potentially diminishes expected emissions reductions while increasing Scope 2 emissions [41]. Additionally, care home managers and owners may be hesitant to adopt unfamiliar technologies due to concerns about their operational reliability, potential impacts on the care home's reputation, and regulatory scrutiny [42]. Although such practices may reduce energy costs, this was not as high a priority as maintaining occupancy levels, care quality, and reputation [42]. These findings highlight the importance of addressing psychological and cultural preferences and staff concerns when developing decarbonisation strategies.

Overall, the focus of existing research is largely related to the modelling of technical solutions such as retrofits and alternative energy sources. While substantial carbon savings may be possible with these strategies, in line with wider healthcare research, there has been limited attention paid to behavioural, organisational, and systems-wide factors which are necessary to embed and sustain decarbonisation in real-world operations [14,33,34,69]. However, the studies which do explore such factors highlight significant implementation barriers, including business risk aversion, and staff concerns about maintaining care quality [41,42]. These barriers point to the importance of context-sensitive implementation strategies and the need to engage stakeholders from multiple levels, including care home residents, staff, management, owners, as well as understanding of regulations and funding arrangements. Increased consideration of these factors may enhance the successful implementation and sustainability of decarbonisation interventions in this setting.

Several evidence gaps were identified. No included studies utilised comprehensive baseline carbon footprinting across all three scopes, making it difficult to benchmark progress or compare interventions, and emphasising the fragmented approach to emissions counting in this sector. With the exception of one Australian study, which measured Scope

1, 2, and 3 emissions of a health and aged care provider and found aged care contributed 47.8% of total greenhouse gas emissions, similar to the health services division [47]. This contradicts the assumption that health services have a higher carbon footprint compared to care homes, highlighting the substantial emissions of the care home sector and the need for equal attention to both health and aged care sectors in decarbonisation. Increased awareness of their comparable emissions may help to prioritise care homes within decarbonisation strategies. Furthermore, none of the included studies reported full cost–benefit analyses or economic evaluations tailored to care home interventions, leaving decision-makers with limited financial data to support investment decisions. This is an especially important gap to address due to risk aversion seen in the qualitative evidence [41,42]. Beyond economic considerations, there is a need to understand the gap between knowledge and action. For example, why care homes fail to implement known decarbonisation solutions despite available evidence. Implementation science approaches may help to identify organisational readiness factors, skill gaps among staff, and strategies for building capacity in energy management [70].

There is a need for comprehensive carbon footprinting tools covering all emission scopes in care homes. The development of a reliable, comprehensive measurement framework is crucial for tracking decarbonisation progress and benchmarking interventions, as well as supporting economic evaluations and investment priorities [71]. Rigorous implementation science approaches are also needed to identify the barriers, facilitators, and strategies for integrating decarbonisation interventions into routine practice [33,34].

Few studies explicitly linked decarbonisation strategies to resident health outcomes, representing a missed opportunity to align environmental sustainability and quality of care improvement. Health co-benefits such as reductions in respiratory infections, enhanced thermal comfort, and resident wellbeing were rarely considered or quantified, despite growing evidence from other sectors showing that net zero interventions can deliver substantial population health gains, including reduced mortality associated with enhanced air quality, active transport, and sustainable diets [28,72,73]. For older adults specifically, indoor air quality improvements linked to low-carbon infrastructure, removal of combustion-based energy sources, and improved ventilation can reduce exposure to pollutants, which may reduce respiratory symptoms and infection risks, a major cause of morbidity and mortality in care homes [74–76]. These co-benefits are not only important for resident health but also directly relevant to the operational goals of care homes [77]. Improved air quality, comfort, and wellbeing can enhance perceived quality of care, increase resident and family satisfaction, and contribute to organisational stability by reducing energy costs and creating healthier working environments for staff.

Some evidence from the included studies suggests that the adoption of renewable energy systems can enhance indoor environmental stability, thermal comfort, and resident satisfaction [56,60,61]. Thermal comfort may also represent a particular area of motivation for the care home sector due to the heightened vulnerability of residents to temperature extremes [78–80], necessitating greater attention to thermal comfort and resilience than typical hospital populations. Furthermore, the discussed dietary shifts toward plant-based meals lower greenhouse gas emissions but also improve the nutritional quality of meals to support cardiovascular health and digestive wellbeing in residents [45,46,53]. Health co-benefits are an explicit consideration in the development of EU climate change mitigation policies [81] and could similarly serve as a motivating factor for decarbonisation engagement in the care home sector.

Care homes represent a unique building use combining domestic, institutional, and workplace characteristics, simultaneously offering long-term living environments for older, often frail residents, and regulated workplaces for care staff [42]. Unlike hospitals, care homes operate continuously and lack closure periods for interventions such as retrofits. Care homes are also subject to diverse ownership and regulatory models [82,83]. This includes intense scrutiny from regulatory bodies such as the Care Quality Commission, which shapes risk-averse decision-making about adaptations to buildings or heating technologies [42]. Additionally, many care homes are dependent on maintaining high occupancy rates and are particularly sensitive to reputation and financial risk, further distinguishing this sector from other healthcare sectors. Innovative funding mechanisms, including grants, subsidies, and tailored financing models, are key enablers that warrant research to overcome these financial barriers. The varied regulation and funding, predominantly from the private sector, pose additional complexity not present in existing healthcare decarbonisation frameworks [1,71].

The proposed model (Figure 2) is the first to extend the WHO's Operational Framework for Building Climate Resilient and Low-Carbon Health Systems [29] to decarbonisation in the long-term care sector. This helps visualise how interventions and outcomes are moderated by operational, regulatory, psychological, and economic factors at multiple points, helping explain why decarbonisation remains challenging within the care home sector. By mapping these interactions, the proposed model offers a systems view of care home decarbonisation, shifting the focus from isolated technical fixes toward an understanding of how concurrent, sequential, and conditional relationships shape real-world outcomes and identify barriers that must be addressed for progress across all three emissions scopes.

4.1. Strengths and Limitations

A key strength of this scoping review lies in its comprehensive search strategy across multiple databases, which maximised the volume of peer-reviewed evidence included, and followed internationally recognised methodology for the conduct of scoping reviews [35]. The inclusion of both qualitative and quantitative evidence allowed for a richer, more nuanced synthesis, although qualitative data were limited to the UK [41,42]. The heterogeneity in methods used within the included studies, as well as varying outcome measures, may have limited the comparison of study findings, but the use of the GHG Protocol provided a clear and practical framework to organise the included studies and aids the interpretation of existing evidence. Additionally, to the authors' knowledge, this is the first review to specifically focus on care home decarbonisation, with other reviews in the area focusing on healthcare clinics, hospitals, and general practice [15,33,34,69].

Some limitations of the present review include limiting study eligibility to the English language, which may have excluded relevant literature not published in English. The exclusion of grey literature, such as policy reports and other non-peer-reviewed evidence, may also limit insights into real-world practice and innovation. Omitting these sources may reduce the comprehensiveness of this review, and potentially overlook policy developments or implementation experiences which have not been reported in academic journals. Finally, the heterogeneity of the interventions and outcomes explored in the included studies hinders direct comparisons and synthesis, pointing to the need for greater standardisation in future research. The focus of the majority of the included studies in high-income countries means the applicability, challenges, and opportunities for care home decarbonisation in low- and middle-income countries are not addressed.

4.2. Implications

Existing evidence highlights several benefits to implementing decarbonisation in care homes. For example, the potential health co-benefits of decarbonisation, including enhancement of air quality, thermal comfort, and nutritional quality of meals [46,53,56,60,61]. Increasing awareness of these health benefits may help to increase engagement with decarbonisation strategies. There is a need for care-home specific decarbonisation guidance, which may go beyond current frameworks such as the CQC's Single Assessment Framework [22]. For example, policy innovation, such as per-bed renewable quotas [55] or targeted financial incentives for care homes, could enable sector-wide progress.

Educational/training interventions for care home staff and owners may represent a promising route to build confidence, capability, and enhance buy-in. Education is a key driver of behaviour change [84] and may help bridge the gap between strategic policy objectives and on-the-ground implementation [33,34]. Providing structured education on decarbonisation and the health co-benefits may help staff understand the rationale behind low-carbon transitions and how these align with care quality goals. Developing robust business cases, with clear risk management and return on investment, could increase engagement with decarbonisation in the private sector. Introducing "safe", proven upgrades (e.g., insulation) as initial steps may ease implementation concerns, while engaging stakeholders (residents, families, staff, managers, and owners) in co-design of interventions may help ensure their acceptability and sustainability [85,86]. Future research should employ mixed methods to capture both technical outcomes and qualitative experiences, prioritise equity by including smaller, independent care homes, and comparison of rural-urban challenges, using longitudinal and systems-level approaches to map long-term and organisational impacts. This should involve stakeholders to ensure research outputs are relevant and actionable for both large corporate care homes and smaller independent providers.

Recently published priorities to support local government action on health and climate change in England, for example, underscore the need for locally relevant research on the economic, health, and equity impacts of decarbonisation strategies [87]. In line with findings emerging from this review, this suggests that meaningful engagement of residents, families, and staff in the design and evaluation of decarbonisation initiatives is essential for acceptability and uptake. Additionally, increased understanding of the economic costs and any potential co-benefits of decarbonisation is particularly important both for accelerating implementation and also for vulnerable populations, such as care home residents, to avoid widening health and social inequalities in efforts towards decarbonisation [87].

5. Conclusions

This review has identified several gaps in existing evidence. Notably, there is a lack of routine baseline carbon footprints for care homes, limited data on the comparative effectiveness and cost-efficiency of interventions tailored to resource-constrained settings, and insufficient research on the potential for decarbonisation to enhance care quality and resident wellbeing. These gaps are particularly significant given the acute operational and financial pressures faced by this sector. Promising emerging research areas which require further exploration include the integration of decarbonisation with climate adaptation, the use of digital technologies and smart systems, and circular economy approaches to procurement and waste.

Especially due to their comparable emissions with health services [47], care homes represent a critical, yet overlooked, sector in broader efforts to achieve healthcare decarbonisation and climate targets. The evidence base is fragmented, with substantial gaps remaining across all key emission scopes. Addressing decarbonisation in care homes requires a coordinated focus on organisational change, staff and resident engagement, together with robust economic analysis and evaluation of health co-benefits. Unlocking co-benefits, such as improved health, climate resilience, and economic savings, may depend on the adoption of multi-disciplinary, systems-based strategies. Future studies should prioritise the development and piloting of scalable interventions that may be feasible for stretched care home budgets and are sensitive to care quality concerns. As climate risks and regulatory pressures increase, there is an urgent need for such care home-tailored research, targeted policies, and dedicated guidance. This includes ensuring care homes are recognised within broader net zero healthcare frameworks and developing mechanisms for cross-sector learning from hospitals, hotels, and other 24/7 facilities with similar operational demands.

This scoping review may inform the development of future decarbonisation interventions for care homes. Priorities have been identified within energy efficiency, sustainable food systems, and behavioural adaptation. This review has highlighted the importance of addressing risk aversion and care quality concerns to deliver feasible, high-impact solutions and supports a focus on cost-effective, "safe" first interventions to build momentum in the sector. Decarbonisation initiatives should be integrated into wider quality improvement and strategic planning processes in social care, and care homes should be recognised as a priority sector within net zero healthcare frameworks to ensure adequate resources and attention. Recognising and resourcing care homes as priority settings for climate action is a necessary step toward achieving sustainable, high-quality healthcare for all.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su172410946/s1. Supplementary Material S1: Study characteristics table; Supplementary Material S2: PRISMA-ScR Checklist; Supplementary Material S3: Search Strategy.

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Abbreviations

The following abbreviations are used in this manuscript:

GHG	Greenhouse Gas
ATACH	Alliance for Transformative Action on Climate and Health
UK	United Kingdom
USA	United States of America
RACFS	Residential Aged Care Facilities
LMICs	Low- and Middle-Income Countries
CQC	Care Quality Commission
JBI	Joanna Briggs Institute
PRISMA-ScR	Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews
PCC	Population, Concept, and Context
PV	Photovoltaic
HVAC	Heating, Ventilation, and Air Conditioning

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