sustainability

MDPI

Review

Gaps in Reporting Greenhouse Gas Emissions by German Hospitals—A Systematic Grey Literature Review

Claudia Quitmann *, Rainer Sauerborn and Alina Herrmann

Institute of Global Health Heidelberg, University Hospital Heidelberg, 69120 Heidelberg, Germany; rainer.sauerborn@uni-heidelberg.de (R.S.); alina.herrmann@uni-heidelberg.de (A.H.)
* Correspondence: claudia.quitmann@uni-heidelberg.de

Abstract: To mitigate the negative (health) consequences of climate change, the Paris Agreement demands a radical reduction of greenhouse gas (GHG) emissions. The health sector contributes considerably to climate change worldwide. In Germany it is responsible for 6.7% of national GHG emissions. The transition to low-carbon hospitals requires detailed knowledge of the amount and sources of GHG emissions. This study aimed at capturing the status quo of GHG emission reporting by German hospitals and at examining characteristics of the reports. Therefore, we performed a grey literature review with pre-defined inclusion and exclusion criteria. The search strategy comprised hand-searching specific databases, targeted websites and web search engines via a standardized set of search terms. We found 232 German hospitals reporting their GHG emissions, representing 12% of all hospitals. Yet, only 62 hospitals (3%) met the inclusion criteria for further analysis. These reports do not comprise all energy-related GHG emissions, omit GHG emissions occurring up- and downstream of hospitals and mainly include CO_2, but leave out other GHG. Consequently, there are severe gaps regarding GHG emissions reports of German hospitals. If Germany wants to comply with the Paris Agreement, hospitals need to be obliged to follow a standardized methodology to report and reduce GHG emissions.

Keywords: GHG emissions; hospitals; climate policy; climate change mitigation

Citation: Quitmann, C.; Sauerborn, R.; Herrmann, A. Gaps in Reporting Greenhouse Gas Emissions by German Hospitals—A Systematic Grey Literature Review. *Sustainability* **2021**, *13*, 1430. https://doi.org/10.3390/su13031430

Academic Editor: Pallav Purohit
Received: 30 November 2020
Accepted: 25 January 2021
Published: 29 January 2021

1. Introduction

Climate change is posing threats to human health, for instance, through increased mortality in extreme weather events or by decreasing agricultural yields and rising sea levels, endangering human livelihoods [1]. However, in the climate change discourse, health and the health sector have more nuanced roles than that. The health sector, including "all organizations, institutions and resources devoted to producing health actions" [1], will not only be impacted by climate change, but will also be key in adapting to climate change and to motivate climate-friendly behaviour [2,3]. At the same time, the health sector is also a relevant contributor to rising levels of GHG emissions and thereby to climate change. In Germany, the health sector is responsible for 6.7% (55.1 Mt CO_2) of the country's GHG emissions [4]. One third of the GHG emissions are energy-related [5]: either direct from sources owned or controlled by healthcare facilities (Scope 1) or indirect from purchased electricity, steam, heating and cooling consumed by the healthcare facilities (Scope 2). Two-thirds of the GHG emissions are produced up- and downstream of health facilities, e.g., along supply chains and disposal of medical equipment and pharmaceuticals (Scope 3).

Ambitious targets for climate change mitigation exist. On the international level, the Paris Agreement, which entered into force in 2016, aims at keeping the global average temperature increase below 2 °C and pursing efforts to limit the increase to 1.5 °C above pre-industrial levels [6]. On the European level, the European Green Deal endeavors to achieve a climate neutral European Union by 2050 [7]. On the national level, the Klimaschutzgesetz

(Federal Climate Change Act) passed by the German Federal Government in 2019, commits to a 55% reduction in GHG emissions by 2030 compared to the 1990 levels [8].

To meet the targets on international, European and national level, all sectors, including the health sector, need to undergo changes. Such changes will need to be radical in nature and therefore have been referred to in Germany as "Große Transformation," a societal transformation towards sustainability [9]. Moreover, the fundamental maxim in medical ethics—"first, do no harm"—is violated by exceeding the unavoidable contribution to climate change as this negatively affects human health [10].

Especially German hospitals have to cut their GHG emissions as they are energy- and resource-intensive [11]. An Austrian study showed that hospitals are responsible for about one-third of the GHG emissions of the Austrian health sector [12]. In Germany, no such numbers exist, yet hospitals account for about 25% of German healthcare spending [13], which gives an idea about the share of GHG emissions, as financial indicators such as GDP correlate with GHG emissions [14].

To begin the transition to low-carbon hospitals, an EU-funded project formulated a list of "Simple Steps to Reduce the Climate Impact of Healthcare." The steps are (1) mapping the GHG emissions of hospitals, (2) identifying emission sources with the greatest impact, (3) working with measures to reduce the impact and (4) evaluating the results [15]. Consequently, before being able to reduce GHG emissions of German hospitals, it is vital to perform step 1 and 2. In order to map the GHG emissions (step 1) and identify GHG emission sources with greatest impacts (step 2), it is important to see how many German hospitals do report on their GHG emissions and to examine characteristics of the reports with regard to comprehensiveness and assessed GHG emissions sources.

As peer-reviewed literature did not provide the required information, a systematic grey literature review was performed. The search strategy included hand-searching specific databases and websites and using web search engines. To validate this strategy, websites of all hospitals in the federal state of Saarland were hand-searched.

This review identified severe gaps in the current status of GHG emissions reports of German hospitals. Only few German hospitals report their GHG emissions focusing on low-hanging fruits which account for a small fraction of the actual GHG emissions of the hospital. To meet GHG reduction targets, German hospitals should be obliged to follow a standardized methodology to report and reduce their GHG emissions.

2. Materials and Methods

Peer-reviewed literature search: First, we performed an electronic literature search of all articles published between 2000 and July 2020 via PubMed, Web of Science and Scopus (see Appendix A). We scanned titles and short descriptions. For promising publications, we also scanned abstracts. However, none of the articles met the inclusion criteria which will be presented below.

Grey literature search: Consequently, we performed a systematic grey literature review, providing data not found within the conventional repositories of published literature. Since no protocol for rigorous systematic grey literature reviews exists [16], we had to enter uncharted waters and therefore developed a novel approach to a grey literature review. To assure transparency, we developed a search plan, and documented assumptions and decisions. The search plan (see Figure 1) comprised three different search strategies: (1) specific databases, (2) specific websites, (3) web search engines. Finally, we validated the search strategy by scanning websites of all hospital of one German federal state.

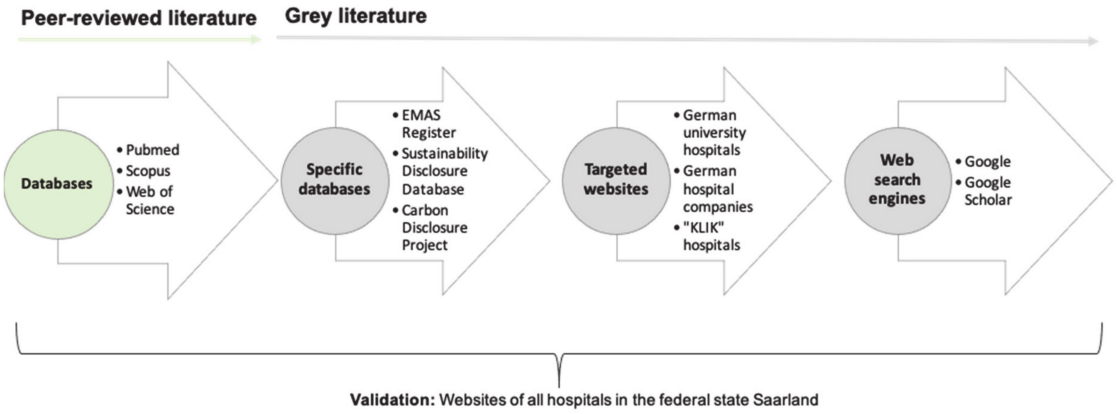

Figure 1. A systematic approach to a grey literature review.

(1) Specific databases: We identified suitable databases by a web search, discussions with a librarian from Heidelberg University and a Google Dataset search. The following three databases were included, because they provide GHG emission reports of hospitals worldwide: Eco Management and Audit Scheme (EMAS) Register, Sustainability Disclosure Database, Carbon Disclosure Project. Available search features differed. We used the appropriate filters available and added search terms (see Appendix B). To find reports of EMAS-certified hospitals we searched via Google. If a report could not be found, we contacted the responsible person named in the EMAS-database up to two times.

(2) Specific websites: University hospitals and hospital companies were of special interest to this review, as they play an important role in German patient care regarding the number of patients treated. Moreover, university hospitals are research-oriented and often pioneers in various fields, raising the expectation to be leading in climate change mitigation. Furthermore, hospitals that participated in the project "KLIK–Klimamanager für Kliniken" ("KLIK-Climate managers for hospitals") were of particular interest as this project trained hospital staff as climate managers and aimed at reducing German hospitals' GHG emissions. "KLIK" was funded by the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety from 2014 to 2016 [17]. For these reasons, we hand-searched websites of 35 full members of the Verband der Universitätsklinika Deutschlands e.V. [18], 10 hospital companies each with more than 150.000 cases per year [19] and 44 websites of hospitals that participated in the project "KLIK-Klimamanager für Kliniken" [20]. We searched for potentially relevant documents by entering predefined search terms (see Appendix C) into the websites search functions. If no search function was available, we did a Google search using the hospital's or company's name and the search terms.

(3) Web search engines: We conducted searches in two popular web search engines: Google (www.google.de) and Google Scholar (http://scholar.google.com/). A controlled key word search is not possible in these engines. Consequently, we performed text searches in the main search screens using different combinations of search terms (see Appendix D). Moreover, Google filters results based on the geographic location, browser version and previously entered search strings reducing reproducibility [21]. As it is impossible to screen all retrieved results from Google search, we had to rely on the relevancy ranking bringing the most relevant results to the top. We reviewed the first six pages of each search's hits (representing 60 results), using the title and the short text underneath. All hints on possible relevant documents were followed up using Google. We decided to review six pages as it seemed to capture many of the most relevant hits while still being feasible to screen.

Table 1 gives an overview on the search steps and related number of hits of hospitals with GHG emission reports and on hits of hospitals with GHG emission reports meeting the inclusion criteria. Duplicates are only mentioned once in the first place, in which they were found.

Table 1. Overview on hits within the peer-reviewed and grey literature searches.

	Source	Hospitals with GHG Emission Reports	Hospitals for Detailed Analysis
Peer-reviewed literature	Scopus	0	0
	PubMed	0	0
	Web of Science	0	0
Specific databases	Eco Management and Audit Scheme register	49	49
	Sustainability Disclosure Database	0	0
	Carbon Disclosure Project	0	0
Targeted websites	Websites of all full members of "Verband der Universitätsklinika Deutschlands e.V."	2	2
	Websites of hospital companies with more than 150,000 cases/year	175	5
	Websites of hospitals that participated in "KLIK–Klimamanager für Kliniken"	0	0
Web search engines	Google	6	6
	Google Scholar	0	0
	Total	232	62

Search terms within identified documents: As the reviewed documents generally do not have an abstract, we predefined search terms based on our knowledge of the literature (see Appendix E) to enter into the Adobe Acrobat search function. In about 10% of the documents, the search function did not work (e.g., because the documents were saved pictures without OCR), so we scanned the table of content for promising chapters. Full text reading was impossible, as the documents comprised too many pages (e.g., as they are general annual reports of hospitals).

Inclusion and exclusion criteria for further analysis: Within the research team we defined inclusion and exclusion criteria (see Table 2), which were important for the further analysis of the reports. For instance, combined GHG emission data for hospitals, ambulatory healthcare centers and prevention centers were not eligible for further analysis because ambulatory healthcare centers and prevention centers are known to show a different distribution of GHG emissions to emission sources [12].

Data extraction: We extracted data on the hospital's name, reporting year, reporting unit (CO_2 or CO_2 equivalents), considered emission sources, the main emission source, and mention of the Scope concept. To extract complementary data (number of beds, ownership) on the included hospitals, we used the Deutsches Krankenhaus Verzeichnis [22] or performed an additional Google search.

Validation: As described above, conducting a grey literature review is less comprehensive than a conventional systematic literature review. To validate our grey literature search plan, we identified all hospitals in the German federal state of Saarland via Deutsches Krankenhaus Verzeichnis [22]. The search strategy for these 24 hospitals was the same as for targeted websites. We decided to choose the Saarland as the number of hospitals was feasible to hand-search. The validation was successful, because the website search did not bring up a new hospital.

Table 2. Inclusion and exclusion criteria for further analysis.

Category	Inclusion Criteria	Exclusion Criteria
Type of Facility	• Hospital	• Health institution other than hospital (e.g., day clinics, ambulatory healthcare centers, rehabilitation facilities) • Combined data for hospitals and other health institutions, so it is impossible to identify the emissions of the hospitals
Country	• Germany	• Other
Language	• English, German	• Other
Presented numbers	• Absolute numbers presented on GHG emissions (e.g., CO_2, N_2O, CH_4) of hospitals	• No absolute numbers on GHG emissions (e.g., CO_2, N_2O, CH_4) (only graphs without numbers) • Reports on emissions reduction without giving information on status quo of GHG emissions
Year of reporting	• ≥2000	• <2000

3. Results

3.1. All German Hospitals with GHG Emissions Reports

We found 232 hospitals with any kind of GHG emission reporting. These are 12% (232 of 1925) of all German hospitals [23]. More than three quarter of hospitals (78%) with GHG emissions reports are in private, 18% in public and 4% in non-profit ownership. In contrast, with regard to all German hospitals, 37% are privately, 29% publicly and 34% are non-profit owned. Consequently, in relation to the total number of hospitals in a given ownership, GHG emission reports exist for 25% of all private hospitals, but only for 8% of public hospitals and even only for 1% of non-profit hospitals.

Only 62 hospitals meet the inclusion criteria for further analysis (see Table 2). These are 3% of all German hospitals. A full list of included hospital can be found in Appendix F. The 170 hospitals which report GHG emissions, but do not meet the inclusion criteria, present combined GHG emission data for hospitals, ambulatory healthcare centers and prevention centers of the Helios or Asklepios company [24,25].

3.2. Further Analysis of 62 Hospitals with GHG Emission Reports Meeting the Inclusion Criteria

3.2.1. Size of Hospitals

GHG emissions reports meeting the inclusion criteria can be found for hospitals of different sizes, varying from 25 to 3011 beds. The median number of beds is 335. In absolute figures, hospitals of different sizes are similarly strongly represented. However, regarding the share of hospitals with GHG emissions reports depending on size, hospitals with >500 beds tend more towards GHG emissions reporting (7.9%) compared to hospitals with <500 beds (2.2%).

3.2.2. Location of Hospitals

Within Germany, there are differences regarding the share of hospitals with GHG emissions reports meeting the inclusion criteria. This share ranges from 0–14% coverage of hospitals, depending on the federal state. Compared to the total number of hospitals in each federal state, the Free Hanseatic City of Bremen has the highest reporting rate (2 of 14 hospitals, equaling 14%), followed by Bavaria (28 of 354 hospitals, equaling 8%) [22].

3.2.3. Reporting Framework

Most of the hospitals meeting the inclusion criteria for further analysis (81%) are or were certified by the *Eco Management and Audit Scheme* (EMAS). EMAS is a voluntary management instrument developed by the European Commission for companies or other organizations to assess, report and improve their environmental performance [26]. In

general, EMAS is not sector-specific. However, for some sectors sectoral reference documents (e.g., tourism, agriculture) exist, but not for the health sector [27]. Since EMAS addresses various environmental aspects, core indicators are energy efficiency, material efficiency, water, waste, biodiversity and emissions. Although EMAS demands GHG emissions reporting, it does not offer a methodology but references European or international standards [26]. Consequently, EMAS-certified hospitals apply different methodologies that are often not specified. One included hospital (2%) follows the *Global Reporting Initiative*, although it is not officially certified by this initiative. The *Global Reporting Initiative* offers its reporting standards for various environmental aspects, including GHG emissions, free of charge. Like EMAS, the *Global Reporting Initiative* does not offer a hospital-specific standard. Out of the included hospitals, 18% do not follow a reporting standard.

3.2.4. Reported Greenhouse Gases

Sixty percent of the reports include CO_2 as the only GHG in their GHG emission reporting. Forty percent of the hospitals also include other GHGs (e.g., methane (CH_4), nitrous oxide (N_2O) and hydrofluorocarbons (HFCs)).

3.2.5. Reported Scopes

The GHG protocol is a well-established and widely used standard for GHG emissions reporting in many sectors, including the health sector [28]. The GHG protocol distinguishes three Scopes [29]:

- Scope 1 comprises direct GHG emissions from sources that are owned or controlled by the company, e.g., emissions from combustion in owned or controlled boilers or vehicles.
- Scope 2 comprises indirect GHG emissions from purchased electricity, steam, heating and cooling consumed by the company.
- Scope 3 comprises all other indirect emissions due to activities of the company not included in Scope 2. These emissions occur from sources not owned or controlled by the company, e.g., upstream (extraction and production) and downstream (disposal) of purchased materials.

GHG emissions from Scope 1 and 2 are included by 95% and 90% of the hospitals in their reports, respectively. None of the include hospitals takes Scope 3 emissions into account (see Figure 2). Two hospitals do not specify the included emission sources (n/s), so no attribution to Scope 1–3 was possible. Ten percent of the hospitals refer to the scope concept of the GHG protocol.

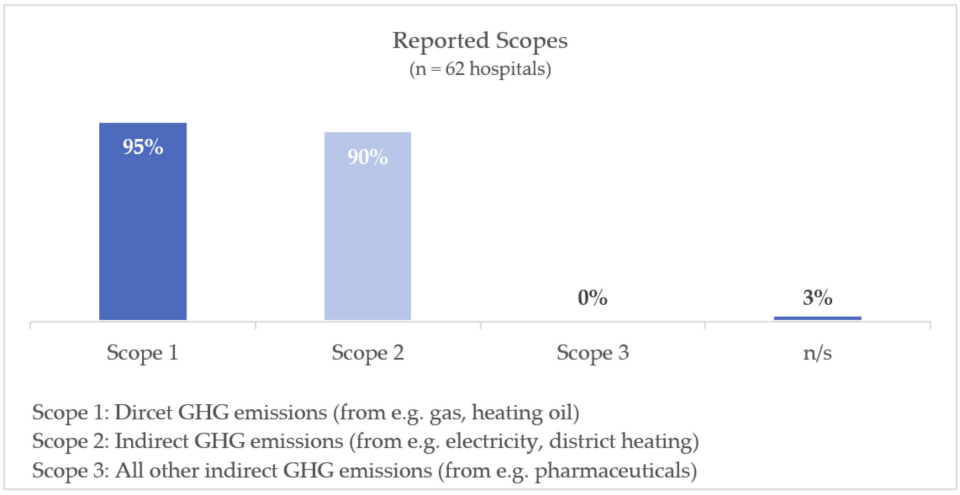

Figure 2. Percentage of reported Scopes for all included GHG emission reports (62 hospitals).

3.2.6. Reported Emissions Sources

Among Scope 1 and 2 emissions, electricity (90%), natural gas (77%) and heating oil (65%) are the emission sources reported most commonly. Fewer hospitals report GHG emissions of company vehicles (40%), district heating (34%), refrigerants (16%) and anesthetic gases (2%) (see Figure 3). Other reported emissions sources are bio heat (cold-heat-coupling) and cold-water supply, both attributable to Scope 1 and 2 as well. On average, hospitals include 3.6 different emission sources. The median is 4.

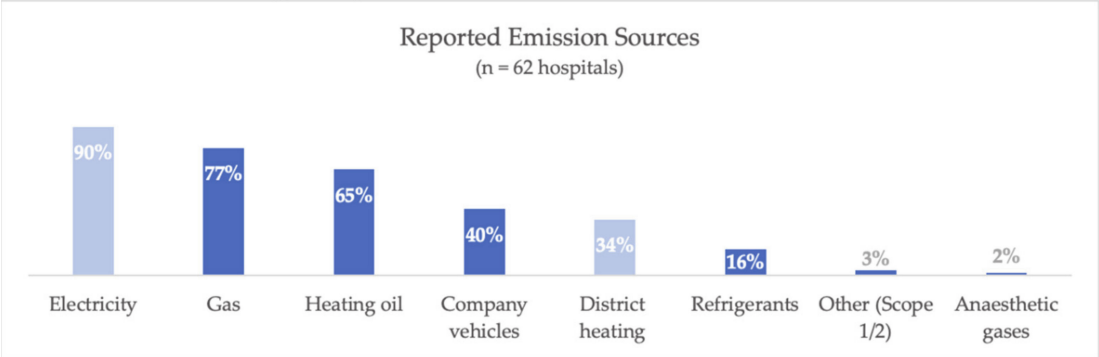

Figure 3. Percentage of reported emission sources for all included GHG emission reports (62 hospitals).

It is important to mention, that "reported emission sources" refers to all emission sources that were considered by the hospital's GHG emissions report, regardless of whether the source actually emitted GHG or not, e.g., renewable electricity does not lead to GHG emissions.

About half of the included hospitals (53%) do not specify their main emission source. Besides that, either electricity (21%) or natural gas (24%) are the main emission source.

4. Discussion

4.1. Gaps in GHG Emissions Reporting

This review identified four serious gaps in GHG emissions reporting of German hospitals:

1. Small proportion of hospitals with GHG emissions reporting
2. Incomplete reporting on Scope 1 and 2 emission sources
3. No reporting on Scope 3 emission
4. Frequent omission of GHG other than CO_2

(Gap 1) Small proportion of hospitals with GHG emissions reporting

We only found 232 out of 1925 (12%) German hospitals reporting their GHG emissions. For many of these hospitals, GHG emissions were presented as combined data for hospitals and other health institutions (e.g., rehabilitation facilities, day clinics). Only 62 (3%) German hospitals have reports, which refer specifically and transparently only to hospitals. Thus, there is a clear under-reporting.

(Gap 2) Incomplete reporting on Scope 1 and 2 emission sources

Hospitals do not report their Scope 1 and 2 emissions in sufficient detail. On average, the hospitals include three to four emission sources. For instance, electricity and natural gas are considered by more than three-quarters. On the contrary, emissions from companies' vehicles, district heating, anesthetic gases and refrigerants are only considered by less than 50%. However, these are also relevant contributing emission sources that should be considered [12,30]. In addition, more than half of the included hospitals do not specify their main emission source. In doing so, they disregard the second step ("identifying emission sources with greatest impact") of the four-step concept to reduce climate impact of healthcare as formulated by the CLIRE project. However, this step is crucial for the development of targeted and efficient mitigation strategies [15].

(Gap 3) No reporting on Scope 3 emissions

None of the hospitals reports Scope 3 emissions which are indirect GHG emissions occurring up- and downstream of hospitals e.g., along supply and disposal chains of purchased goods. However, Scope 3 emissions are responsible for the lion's share (66%) of the German health sector's GHG emissions [5]. For example, pharmaceuticals are an important Scope 3 emission source [12,31,32] that is currently excluded. Consequently, existing reports are incomplete. They do not deliver a robust basis for efficient and targeted mitigation measures. Moreover, it should be noted that the exclusion of Scope 3 emissions can create false incentives. Buying sterilized or laundered goods, for example, is a possibility to outsource energy-intensive services. If Scope 3 emissions are not included, outsourcing will falsely lead to a reduction of the reported GHG emissions of a hospital.

(Gap 4) Frequent omission of GHG other than CO_2

About two-thirds of the hospitals only report CO_2 leaving other GHG (e.g., methane, nitrous dioxide) out of their consideration although they account for 12% of the general German GHG emissions [33]. For hospitals, other GHG are of particular importance as amongst others anesthetic gases are important emission sources of e.g., N_2O. This is neglected when excluding them [30,34].

4.2. Discussion of Reasons for the Existing Gaps

In Germany, no legal obligation for hospitals to report their GHG emissions exists. Our investigation has shown that only a few German hospitals report their GHG emissions on a voluntary basis. Those who do are mainly hospitals of the private sector. Climate Change and GHG emission reporting is increasingly considered in Corporate Social Responsibility Reports in the private sector and used as a tool to create a positive image and protect legitimacy of the private company [35]. Looking at a quote of Tedros Adhanom Ghebreyesus, Director General of the World Health Organization, it becomes clear that hospitals indeed have a reason to report on their impacts on health-threatening climate change, as "Places of healing should be leading the way, not contributing to the burden of disease" [36]. Yet, so far it seems that this motivation for GHG emission reporting is not a sufficient incentive for the lion's share of German hospitals. That might be the case, because the health sector is not yet as present as a perpetrator of climate change in public debate as is, for instance, the aviation sector.

Furthermore, voluntary reporting of GHG emissions is linked to various barriers. The main problems hospitals face with regard to EMAS are the high initial effort required for registration, as well as a lack of knowledge and staff awareness [37]. Moreover, hospitals are challenged to balance the patients' needs alongside financial and environmental issues, such as GHG emissions reporting [38]. Among these issues, the environmental one often has the lowest priority [39,40].

Since there is neither a legal obligation for GHG emissions reporting, nor a guideline, the existing reports are heterogeneous and insufficient. About 80% of the hospitals reporting GHG emissions are EMAS-certified, an environmental management system covering a broad range of aspects. EMAS can improve overall environmental performance. However, there is no robust and comprehensive guideline for GHG emissions reporting of hospitals since gaps 2 to 4, as this review has shown, remain.

Moreover, a lacking awareness could be a reason for the existence of these gaps. This can be especially assumed for insufficient specification of the main emission source: Although this information should principally be available because it is ascertained during the data collection process, it is often not published.

Regarding gap 3, the assessment of Scope 3 emissions can be complex and difficult for multiple reasons. On the one hand, including Scope 3 emission can require expert knowledge that might not be available in hospitals. On the other hand, primary data on supply chains might be scarce and suppliers might not want or be able to disclose the requested data [41].

4.3. Policy Recommendations

To our knowledge, this is the first study to investigate GHG emissions reporting of German hospitals. The presented results lead us to the following recommendations for future policy:

(1) **A legal obligation for German hospitals to report GHG emissions should be introduced** (addressing gap 1).

As pointed out, there is no legal obligation in Germany and only few hospitals report their GHG emissions (gap 1). On the contrary, hospitals in France are included in the decree no. 2011-829 relating to the GHG emissions reporting and the territorial climate-energy plan [42]. Following this decree, hospitals of a certain size as legal entities have to report direct and indirect emissions emitted by the use of electricity, heat or steam. This corresponds to a partial coverage of Scope 1 and 2. The inclusion of further emission sources is recommended. Data generated through a legal obligation, such as the amount and sources of GHG emissions, would be the starting point for the urgently needed reduction of GHG emissions by hospitals [43,44]. The need for robust data is also emphasized by the German Conference of Health Ministers in 2020 [45].

Currently, the German health sector is responsible for 6.7% of the national GHG emissions with hospitals being a main contributor [4,12]. Without the COVID-19 recession, Germany would not have met its 2020 climate protection target. Massive economic slumps were the main factor reducing GHG emissions in 2020, rather than progress in climate policy [46]. Consequently, it is assumed to be only a temporary reduction [46]. This emphasizes the need for all sectors, including the health sector, to exhaust all possibilities to reduce GHG emissions. As the English National Health Service has demonstrated, considerable progress can be made in reducing a health sector's GHG emissions, especially in hospitals [47]. Consequently, reducing GHG emissions of German hospitals could contribute to meeting national targets with respect to the *Paris Agreement*, the *European Green Deal* and the German *Federal Climate Change Act*.

So far, the health sector has not been held responsible for its GHG emissions, either by the Intended Nationally Determined Contribution of the EU and its Member States to the Paris Agreement (international level), nor by the European Green Deal (European level), nor by the German Federal Climate Change Act and the related *Climate Action Plan 2050* (national level). In contrast, these policies clearly define the GHG reduction targets for other sectors (energy, industry, transport, buildings, agriculture) [7,8,48,49]. Moreover, they draw the line between climate change and its impacts on human health, but they fail to see the health sector as a perpetrator and to hold it responsible.

Nonetheless, the health sector itself is becoming increasingly aware of its own responsibility: In England, the National Health Service does not rest on appearing as a cross-sectional sector in the explicitly mentioned sectors (energy, industry, transport, buildings, agriculture). In October 2020, the English National Health Service was announced as the first national health sector to become climate neutral by 2045 [47]. In Germany, the 93rd German Conference of Health Ministers calls on the health sector to collect and evaluate climate- and energy-relevant data of hospitals, to take mitigation measures derived from these data and to see this as a permanent task of the health sector [45].

(2) **A standardized methodology for GHG emissions reporting of hospitals should be provided** (addressing gaps 2 to 4)

As demonstrated, there is no standardized methodology for GHG emissions reports of German hospitals, and the existing reports are incomplete and unrepresentative of the assumed GHG emissions (gaps 2 to 4). It is neither reasonable nor expectable that each hospital will develop its own methodology. Consequently, a standardized methodology should be provided which comprehensively considers Scope 1, 2 and 3, is tailored to hospitals and allows the comparison of different hospitals and over time.

In France, the Agency for Ecological Transition (Agence de la transition écologique) published a guide for healthcare facilities to support their GHG emissions reports on

obligatory (Scope 1 and 2) and recommended emission sources (additional Scope 1 and 2 emission sources and Scope 3) [43]. This guide could be a starting point for the development of a guide including a standardized methodology for German hospitals.

If international, European or national policies would follow the model of the English National Health Service and set an ambitious GHG reduction target for the health sector, a legal obligation and a standardized methodology for GHG emissions reporting could be an important instrument for monitoring compliance. Moreover, this could be the basis for penalty payments for excess GHG emissions comparable to the existing regulations for the automobile industry on a European level [50].

4.4. Research Recommendations

As for research, the development of a standardized methodology for GHG emissions reporting should be supported and continuously updated. The definition of achievable reduction targets for the health sector and the creation of related pathways should also be supported. That means that concrete measures to reduce GHG emissions in hospitals need to be developed, implemented and evaluated. There are several studies showing that reducing GHG emissions in the health sector can also lead to substantial direct health co-benefits. For instance, serving plant-based meals for patients and staff instead of red meat can reduce GHG emissions and the individual risk of colorectal cancer [51,52]. Furthermore, rational use of medication reduces over-prescription reduces not only GHG emissions, but also costs and unintended side-effects [53]. Yet, the effects of such GHG reduction measures with health co-benefits need further investigation. Moreover, a detailed estimate of the GHG emissions of the German health sector should be conducted following the examples of England or Austria [12,30].

4.5. Strengths and Limitations

This review has shown that it is valuable to break new ground regarding the search strategy because grey literature is an important data source. Only our novel approach gave us the opportunity to answer our research questions and contribute to the discourse on climate change and the health sector—the focus on peer-reviewed literature would not have made this possible. However, the characteristics of grey literature make a comprehensive search difficult. The validation search showed that the developed search strategy was successful in finding relevant data. Nonetheless, we may have missed German hospitals with published GHG emissions reports.

We did not compare hospitals in terms of absolute GHG emissions (in tons) for the following reasons: First, a quality assessment of the provided data was impossible, because many hospitals did not provide information on the methodology used for their GHG emission reports. Second, the comparability is limited since hospitals considered a variable number of GHG emission sources. Third, the reports refer to different years, ranging from 2008 to 2019. In sum, this underlines all the more the need for a standardized methodology for GHG emission reporting by hospitals in Germany and elsewhere.

Author Contributions: C.Q. and R.S. conceptualized the study and C.Q. and AH drafted the methodology, C.Q. and A.H. performed the analysis and data curation, C.Q. wrote the original draft while R.S. and A.H. reviewed and edited the draft and the visualizations. R.S. and A.H. supervised the work. All authors have read and agreed to the published version of the manuscript.

Funding: C.Q. holds a scholarship of the Heidelberg Graduate School of Global Health funded by the Else Kröner-Fresenius-Stiftung. This research received no other external funding.

Acknowledgments: We acknowledge financial support by the Else Kröner-Fresenius-Stiftung within the Heidelberg Graduate School of Global Health, by Deutsche Forschungsgemeinschaft within the funding programme Open Access Publishing, by the Baden-Württemberg Ministry of Science, Research and the Arts and by Ruprecht-Karls-Universität Heidelberg. Moreover, we would like to thank Bernd Franke of the "ifeu–Institut für Energie- und Umweltforschung Heidelberg GmbH" for comments and help to refine the manuscript.

Conflicts of Interest: A.H. is member of the German Climate Change and Health Alliance (KLUG e.V.). The Else Kröner-Fresenius-Stiftung had no role in the design, execution, interpretation or writing of the study. The other authors declare no conflict of interest.

Appendix A

Table A1 shows the search terms used for the different databases providing peer-reviewed literature.

Table A1. Search terms for data bases providing peer-reviewed literature.

Database	Search Terms	Relevant Hits
Web of Science	TS = ((“hospital”) OR (“health care facility”) OR (“healthcare facility”) OR (“infirmary”)) AND TS = ((“carbon footprint”) OR (“CO2 emission”) OR (“climate footprint”) OR (“greenhouse gas”) OR (“greenhouse gas inventory”) OR (“greenhouse gas emission”) OR (“greenhouse gas protocol”))	0
PubMed	((“hospital”) OR (“health care facility”) OR (“healthcare facility”) OR (“infirmary”)) AND ((“carbon footprint”) OR (“CO2 emission”) OR (“climate footprint”) OR (“greenhouse gas”) OR (“greenhouse gas inventory”) OR (“greenhouse gas emission”) OR (“greenhouse gas protocol”))	0
Scopus	TITLE-ABS-KEY(((“hospital”) OR (“health care facility”) OR (“healthcare facility”) OR (“infirmary”)) AND ((“carbon footprint”) OR (“CO2 emission”) OR (“climate footprint”) OR (“greenhouse gas”) OR (“greenhouse gas inventory”) OR (“greenhouse gas emission”) OR (“greenhouse gas protocol”)))	0

Appendix B

Table A2 shows the different databases which were consulted and the filters which were applied.

Table A2. Specific databases and with the applied filters.

Name	Filters	Hits	Relevant Hits	URL
Sustainability Disclosure Database	• Sector: health care services AND • Report type: GRI–G3 (Environmental Standards, GRI 305 = emissions) AND • Country: Germany • (without country filter: 63 hits)	0	0	https://database.globalreporting.org/search/
Eco Management and Audit Scheme (EMAS)	• NACE: 86.10 (hospital activities) • Country: Germany	33	28 (some hits comprise several hospitals → 49 EMAS certified hospitals included)	https://webgate.ec.europa.eu/emas2/public/registration/list
Carbon Disclosure Project (CDP)	• Country: Germany • Program: Climate Change • Search terms: hospital, clinic, infirmary	12	0	https://www.cdp.net/en/responses?utf8=%E2%9C%93&queries%5Bname%5D=

Appendix C

Table A3 shows the different search terms that were used for the different website categories.

Table A3. Search terms that were used for the different websites.

Website Category	Search Terms	Relevant Hits
Websites of the 35 German University Hospitals	• Nachhaltigkeit • CO2-Emission • Treibhausgas • Umweltschutz • Klimaschutz • Fußabdruck	2
Websites of 10 hospital companies (with >150,000 cases/year)	• Nachhaltigkeit • CO2-Emission • Treibhausgas • Umweltschutz • Klimaschutz • Fußabdruck	5
Websites of hospitals that participated in the project "KLIK–Klimamanager für Kliniken"	• Nachhaltigkeit • CO2-Emission • Treibhausgas • Umweltschutz • Klimaschutz • Fußabdruck • KLIK	0 (after excluding EMAS-certified hospitals, university hospitals and hospital companies)

Appendix D

Table A4 shows the search terms that were used for the different web search engines.

Table A4. Search terms used for the different web search engines.

Web Search Engine	Search Terms	Relevant Hits
Google German	• Treibhausgasemissionen Krankenhaus • CO2 Emissionen Krankenhaus • Emission Krankenhaus • Treibhausgasbilanz Krankenhaus • CO2 Fußabdruck Krankenhaus • Umwelterklärung Krankenhaus • Umweltbericht Krankenhaus • Treibhausgasemissionen Klinik • CO2 Emissionen Klinik • Emission Klinik • Treibhausgasbilanz Klinik • CO2 Fußabdruck Klinik • Umwelterklärung Klinik • Umweltbericht Klinik	6 (after excluding EMAS-certified hospitals, university hospitals and hospital companies)
Google English	• sustainability report hospital • greenhouse gas protocol hospital • carbon footprint hospital • environmental report hospital • environmental audit hospital • Sustainability Development Management hospital • sustainability plan hospital • carbon footprint hospital • Carbon audit hospital	0

Table A4. *Cont.*

Web Search Engine	Search Terms	Relevant Hits
Google Scholar	• "Carbon footprint" AND "hospital OR healthcare facility" • "Greenhouse gas emissions" AND "hospital OR healthcare facility" • "climate footprint" AND "hospital OR healthcare facility" • "Greenhouse gas assessment" AND "hospital OR healthcare facility" • "Greenhouse gas" AND "hospital OR healthcare facility" • "Emission" AND "hospital OR healthcare facility" • "Greenhouse gas inventory" AND "hospital OR healthcare facility" • "Greenhouse gas protocol" AND "hospital OR healthcare facility" • "co2 emission" AND "hospital OR healthcare facility" • "carbon emission" AND "hospital" • "carbon emission" AND "hospital OR healthcare facility"	0

Appendix E

Table A5 shows the different search terms that were used within included GHG emissions reports.

Table A5. Search terms used within included GHG emissions reports.

• Emission
• CO2
• Scope
• Fußabdruck
• Kohlenstoff
• Treibhausgas
• THG

Appendix F

Table A6 shows all hospitals that met the inclusion criteria and were consequently included in the further analysis.

Table A6. Hospitals meeting the inclusion criteria for further analysis.

Names of the Hospitals Meeting the Inclusion Criteria
Bezirkskrankenhaus Günzburg [54]
Bezirkskrankenhaus Kaufbeuren [55]
Charité Berlin [56]
DIAKO Bremen [57]
DRK Klinikservicegesellschaft Sachsen mbH (Standort: DRK Krankenhaus Chemnitz-Rabenstein) [58]
DRK Klinikservicegesellschaft Sachsen mbH (Standort: DRK Krankenhaus Lichtenstein) [58]
Evangelische Krankenhaus Köln-Weyertal [59]

Table A6. *Cont.*

Names of the Hospitals Meeting the Inclusion Criteria
Fachklinik Heiligenfeld [60]
Klinikum Idar-Oberstein–SHG-Kliniken [61]
Katholische Kliniken Emscher-Lippe: St. Antonius-Krankenhaus [62]
Katholische Kliniken Emscher-Lippe: St. Barbara-Hospital [62]
Katholische Kliniken Emscher-Lippe: St. Josef-Hospital [62]
Klinik Heiligenfeld Standort Uffenheim [60]
Klinik Heiligenfeld Standort Waldmünchen [60]
Kliniken Landkreis Heidenheim gGmbH [63]
Klinikum Bremen Mitte [64]
Klinikum Chemnitz gGmbH [65]
Klinikum Kulmbach [66]
Klinikum Landsberg am Lech [67]
Klinikum Oldenburg [68]
Klinikum Penzberg [69]
Klinikum Saarbrücken [70]
Klinikum Seefeld [69]
Klinikum Starnberg [69]
Klinikverbund Kempten –Oberallgäu Standort: Klinik Immenstadt [71]
Klinikverbund Kempten –Oberallgäu Standort: Klinik Oberstdorf [71]
Klinikverbund Kempten –Oberallgäu Standort: Klinik Sonthofen [71]
Klinikverbund Kempten –Oberallgäu Standort: Klinikum-Kempten [71]
Krankenhaus Rotthalmünster [72]
Krankenhaus Vilshofen [72]
Krankenhaus Wegscheid [72]
Kreisklinik Wolfratshausen gGmbH [73]
Luitpoldklinik Heiligenfeld [60]
LVR Klinik Bedburg-Hau [74]
LVR Klinik Bedburg-Hau Außenstelle: Sternbuschklinik Kleve [74]
LVR Klinik Bonn [75]
LVR Klinik Düren [76]
LVR Klinik Düsseldorf [77]
LVR Klinik Köln [78]
LVR Klinik Langenfeld [79]
LVR Klinik Viersen [80]
LVR Klinik Mönchengladbach [81]
LWL Klinik Lengerich [82]
LWL Klinik Münster [83]
München Klinik Standort Bogenhausen [84]
München Klinik Standort Harlaching [84]
München Klinik Standort Neuperlach [84]
München Klinik Standort Schwabing [84]
München Klinik Standort Thalkircher Straße [84]
Orthopädische Universitätsklinik Friedrichsheim [85]
Parkklinik Heiligenfeld [60]

Table A6. *Cont.*

Names of the Hospitals Meeting the Inclusion Criteria
Rhön-Klinikum AG: Universitätsklinikum Gießen und Marburg, Standort Gießen [86]
Rhön-Klinikum AG: Universitätsklinikum Gießen und Marburg, Standort Marburg [86]
Rhön-Klinikum AG: Campus Bad Neustadt [86]
Rhön-Klinikum AG: Klinikum Frankfurt (Oder) GmbH [86]
Rhön-Klinikum AG: Zentralklinik Bad Berka GmbH [86]
Rosengarten Klinik Heiligenfeld [60]
Sankt Josef-Hospital Xanten [87]
St. Barbara-Klinik Hamm-Heessen GmbH [88]
Städtisches Klinikum Karlsruhe [89]
Städtisches Klinikum Karlsruhe: Psychiatrische Kliniken [89]
Universitätsklinikum Jena [90]

References

1. Haines, A.; Ebi, K. The Imperative for Climate Action to Protect Health. *New Engl. J. Med.* **2019**, *380*, 263–273. [CrossRef] [PubMed]
2. World Health Organization. *The World Health Report 2000: Health Systems: Improving Performance*; World Health Organization: Geneva, Switzerland, 2020.
3. Herrmann, A.; de Jong, L.; Kowalski, C.; Sauerborn, R. Health Co-benefits of climate change mitigation measures-how households and policy makers can benefit. *Bundesgesundheitsblatt Gesundh. Gesundh.* **2019**, *62*, 556–564. [CrossRef] [PubMed]
4. World Health Organization. *Operational Framework for Building Climate Resilient Health Systems*; World Health Organization: Geneva, Switzerland, 2015.
5. Pichler, P.P.; Jaccard, I.S.; Weisz, U.; Weisz, H. International comparison of health care carbon footprints. *Environ. Res. Lett.* **2019**, *14*, 064004. [CrossRef]
6. Health Care Without Harm. Appendix C Health Care Emissions National Snapshot. In *Health Care's Climate Footprint—How the Health Sector Contributes to the Global Climate Crisis and Opportunities for Action*; ARUP: London, UK, 2019; Available online: https://noharm-global.org/sites/default/files/documents-files/5959/Apendix%20C%20National%20Emissions%20Snapshots.pdf (accessed on 9 November 2020).
7. United Nations. Paris Agreement. In *Report of the Conference of the Parties to the United Nations Framework Convention on Climate Change (21st Session, 2015: Paris)*; HeinOnline: Getzville, NY, USA, 2015.
8. European Commission. *The European Green Deal*; Europäische Komission: Brussels, Belgium, 2019.
9. Bundes-Klimaschutzgesetz. *Bundes-Klimaschutzgesetz vom 12. Dezember 2019 (BGBl. I S. 2513)*; BGBl. I: Berlin, Germany, 2019; p. 2513.
10. WBGU. Welt im Wandel: Gesellschaftsvertrag für eine Große Transformation. 2011. Available online: https://web.archive.org/web/20130122222145/http://www.bmbf.de/de/16204.php. (accessed on 9 November 2020).
11. World Health Organization; Health Care Without Harm. *Healthy Hospitals, Healthy Planet, Healthy People—Addressing Climate Change in Health Care Settings: Discussion Draft*; WHO: Geneva, Switzerland, 2009.
12. Weisz, U.; Pichler, P.-P.; Jaccard, I.S.; Haas, W.; Matej, S.; Bachner, F.; Nowak, P.; Weisz, H. Carbon emission trends and sustainability options in Austrian health care. *Resour. Conserv. Recycl.* **2020**, *160*, 104862. [CrossRef]
13. Statistisches Bundesamt (Destatis). Gesundheitsausgaben nach Einrichtungen (2018). 2020. Available online: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Gesundheit/Gesundheitsausgaben/Tabellen/einrichtungen.html. (accessed on 27 November 2020).
14. Lyeonov, S.; Pimonenko, T.; Bilan, Y.; Mentel, G.; Štreimikienė, D. Assessment of green investments' impact on sustainable development: Linking gross domestic product per capita, greenhouse gas emissions and renewable energy. *Energies* **2019**, *12*, 3891. [CrossRef]
15. CLIRE. Simple Steps to Reduce the Climate Impact of Healthcare. 2016. Available online: https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=CLIRE_Guide_Reduction_Impact_Climate_Healthcare.pdf (accessed on 27 November 2020).
16. Godin, K.; Stapleton, J.; Kirkpatrick, S.i.; Hanning, R.M.; Leatherdale, S.T. Applying systematic review search methods to the grey literature: A case study examining guidelines for school-based breakfast programs in Canada. *Syst. Rev.* **2015**, *4*, 138. [CrossRef] [PubMed]
17. BUND. KLIK von 2014 Bis 2016. 2020. Available online: https://www.klik-krankenhaus.de/das-projekt/klik-von-2014-bis-2016 (accessed on 28 August 2020).

18. Verband der Universitätsklinika Deutschlands. Übersicht der Universitätsklinika in Deutschland. 2020. Available online: https://www.uniklinika.de/die-deutschen-universitaetsklinika/uebersicht-der-universitaetsklinika/ (accessed on 16 September 2020).
19. A & S-Aktuell. Ranking der 20 Größten Klinik-Unternehmen in Deutschland nach Anzahl der Stationären Fälle im Jahr 2012. Available online: https://de.statista.com/statistik/daten/studie/433300/umfrage/ranking-der-20-groessten-klinik-unternehmen-in-deutschland-nach-fallzahl/ (accessed on 15 September 2020).
20. BUND. Teilnehmende Krankenhäuser KLIK 2014 bis 2016. 2020. Available online: https://umap.openstreetmap.fr/de/map/klik-green_333681#3/48.98/34.89 (accessed on 6 November 2020).
21. Ellen Bates, M. Is Google Hiding My News? *Online Medford* **2011**, *35*, 64.
22. Deutsche Krankenhaus TrustCenter und Informationsverarbeitung GmbH. Deutsches Krankenhausverzeichnis. 2020. Available online: https://www.deutsches-krankenhaus-verzeichnis.de/app/suche (accessed on 1 September 2020).
23. Statistisches Bundesamt (Destatis). Anzahl der Deutschen Krankenhäuser nach Trägerschaft in den Jahren 2000 bis 2018. 2020. Available online: https://de.statista.com/statistik/daten/studie/157072/umfrage/anzahl-der-krankenhaeuser-nach-traegerschaft/ (accessed on 15 September 2020).
24. Helios Kliniken. Nachhaltigkeitsbericht 2019 (Helios Kliniken, Sustainability Report 2019). 2020. Available online: https://www.helios-gesundheit.de/fileadmin/UWS_Unternehmen/Nachhaltigkeit/Helios_Nachhaltigkeitsbericht2019.pdf (accessed on 7 August 2020).
25. Asklepios. Nachhaltigkeitsbericht 2019 (Sustainability Report 2019). 2020. Available online: https://www.asklepios.com/konzern/unternehmen/investors/nachhaltigkeitsbericht/ (accessed on 25 August 2020).
26. Bundesministerium für Umwelt Naturschutz und Nukleare Sicherheit and Umweltbundesamt. Umweltkennzahlen in der Praxis—Ein Leitfaden zur Anwendung von Umweltkennzahlen in Umweltmanagementsystemen mit dem Schwerpunkt auf EMAS. 2013. Available online: https://www.umweltbundesamt.de/sites/default/files/medien/376/publikationen/umweltkennzahlen_in_der_praxis_leitfaden_barrierefrei.pdf (accessed on 14 August 2020).
27. EMAS. Sectoral Reference Documents. 2020. Available online: https://ec.europa.eu/environment/emas/emas_publications/sectoral_reference_documents_en.htm (accessed on 14 October 2020).
28. Health Care Without Harm. *Health Care's Climate Footprint—How the Health Sector Contributes to the Global Climate Crisis and Opportunities for Action*; ARUP: London, UK, 2019; Available online: https://noharm-global.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint_092319.pdf (accessed on 9 November 2020).
29. World Business Council for Sustainable Development; World Resources Institute. *The Greenhouse Gas Protocol—A Corporate Accounting and Reporting Standard, Revised Edition*; WBCSD: Washington, DC, USA, 2004.
30. National Health Service and Sustainable Development Unit. *Reducing the Use of Natural Resources in Health and Social Care—2018 Report*; National Health Service and Sustainable Development Unit: Cambridge, UK, 2018.
31. Malik, A.; Lenzen, M.; McAlister, S.; McGain, F. The carbon footprint of Australian health care. *Lancet Planet Health* **2018**, *2*, e27–e35. [CrossRef]
32. Wu, R. The carbon footprint of the Chinese health-care system: An environmentally extended input-output and structural path analysis study. *Lancet Planet Health* **2019**, *3*, e413–e419. [CrossRef]
33. Umweltbundesamt. Anteil von CO2 an den Treibhausgasemissionen in Deutschland in den Jahren 1990 bis 2018. 2020. Available online: https://de.statista.com/statistik/daten/studie/312536/umfrage/anteil-von-co2-an-den-treibhausgasemissionen-in-deutschland/ (accessed on 4 September 2020).
34. Sulbaek, A.; Nielsen, O.J.; Wallington, T.J.; Karpichev, B.; Sander, S.P. Medical intelligence article: Assessing the impact on global climate from general anesthetic gases. *Anesth. Analg.* **2012**, *114*, 1081–1085.
35. Allen, M.W.; Craig, C.A. Rethinking corporate social responsibility in the age of climate change: A communication perspective. *Int. J. Corp. Soc. Responsib.* **2016**, *1*, 1–11. [CrossRef]
36. Health Care Without Harm. Health Care Climate Footprint Report. Available online: https://noharm-europe.org/ClimateFootprintReport (accessed on 20 January 2021).
37. Seifert, C. The Barriers for Voluntary Environmental Management Systems—The Case of EMAS in Hospitals. *Sustainability* **2018**, *10*, 1420. [CrossRef]
38. Jameton, A.; McGuire, C. Toward sustainable health-care services: Principles, challenges, and a process. *Int. J. Sustain. High. Educ.* **2002**, *3*, 113–127. [CrossRef]
39. Dunphy, J.L. Healthcare professionals' perspectives on environmental sustainability. *Nurs. Ethics* **2014**, *21*, 414–425. [PubMed]
40. Pencheon, D. Making health care more sustainable: The case of the English NHS. *Public Health* **2015**, *129*, 1335–1343. [CrossRef] [PubMed]
41. Corina, R. Closing the Scope 3 Reporting Gap. 2020. Available online: https://avieco.com/news-insights/closing-the-scope-3-reporting-gap/ (accessed on 30 September 2020).
42. République Francaise. Décret no 2011-829 du 11 Juillet 2011 Relatif au Bilan des Émissions de Gaz à Effet de Serre et au Plan Climat-Énergie Territorial. 2011. Available online: https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000024353784&categorieLien=id (accessed on 15 July 2020).

43. Agence de la Transition Écologique. Réalisation d'un Bilan D'émissions de Gaz à Effet de Serre—Guide Sectoriel Établissements Sanitaires et Médico-Sociaux (Agency for Ecological Transition, Greenhouse Gas Emissions Assessment—Sector Guide for Health and Medico-Social Institutions). 2020. Available online: https://www.ademe.fr/sites/default/files/assets/documents/guide-sectoriel-etablissements-sanitaires-et-medico-sociaux-2020-010896.pdf (accessed on 27 November 2020).
44. NHS England. *NHS England Carbon Emissions Carbon Footprinting Report, September 2008 (Updated August 2009)*; Sustainable Development Commission: London, UK, 2009.
45. Gesundheitsministerkonferenz. Beschlüsse der 93. *GMK (2020) TOP: 5.1 Der Klimawandel—Eine Herausforderung für das Deutsche Gesundheitswesen (Conference of Health Ministers, Resolutions of the 93rd Conference of Health Ministers (2020) Agenda Item: 5.1 Climate change—A Challenge for the German Health Care System).* 2020. Available online: https://www.gmkonline.de/Beschluesse.html?id=1018&jahr= (accessed on 27 November 2020).
46. Agora Energiewende. Die Energiewende im Corona-Jahr: Stand der Dinge 2020. Rückblick auf die Wesentlichen Entwicklungen Sowie Ausblick auf 2021. *(Agora Energy Transition, The Energy Transition in the Corona Year: State of Affairs in 2020. Review of the Main Developments and Outlook for 2021.).* Available online: https://static.agora-energiewende.de/fileadmin2/Projekte/2021/2020_01_Jahresauswertung_2020/200_A-EW_Jahresauswertung_2020_WEB.pdf (accessed on 14 January 2021).
47. NHS England. Delivering a "Net Zero" National Health Service. 2020. Available online: https://www.england.nhs.uk/greenernhs/wp-content/uploads/sites/51/2020/10/delivering-a-net-zero-national-health-service.pdf (accessed on 27 November 2020).
48. Council of the European Union. Intended Nationally Determined Contribution of the EU and its Member States. 2015. Available online: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Germany%20First/LV-03-06-EU%20INDC.pdf (accessed on 11 January 2021).
49. Bundesministerium für Umwelt Naturschutz und nukleare Sicherheit. Klimaschutzplan 2050—Klimaschutzpolitische Grundsätze und Ziele der Bundesregierung. 2016. Available online: https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klimaschutzplan_2050_bf.pdf (accessed on 27 November 2020).
50. European Commission. Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 Setting CO2 Emission Performance Standards for New Passenger Cars and for New Light Commercial Vehicles, and Repealing REGULATIONS (EC) No 443/2009 and (EU) No 510/2011. 2019. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0631&from=EN (accessed on 27 November 2020).
51. Behrens, G.; Gredner, T.; Stock, C.; Leitzmann, M.F.; Brenner, H.; Mons, U. Cancers Due to Excess Weight, Low Physical Activity, and Unhealthy Diet. *Dtsch. Aerzteblatt Int.* **2018**, *115*, 578–585.
52. World Health Organization. Q & A on the Carcinogenicity of the Consumption of Red Meat and Processed Meat. 2015. Available online: https://www.who.int/news-room/q-a-detail/cancer-carcinogenicity-of-the-consumption-of-red-meat-and-processed-meat (accessed on 11 January 2021).
53. Northumbria Healthcare NHS Foundation Trust. Shine 2012 Final Report—A Clinico-Ethical Framework for Multidisciplinary Review of Medication in Nursing Homes. 2014. Available online: https://www.health.org.uk/sites/default/files/Shine2012_NorthumbriaHealthcareNHSFoundationTrust_report.pdf (accessed on 27 November 2020).
54. Bezirkskrankenhaus Günzburg. Umwelterklärung 2014 (Community Hospital Günzburg, Environmental Declaration 2014). Available online: https://www.bkh-guenzburg.de/fileadmin/Daten_haeuser/Daten_guenzburg/PDF/pdf/Umwelterkl%C3%A4rung_2014.pdf (accessed on 11 January 2021).
55. Bezirkskrankenhaus Kaufbeuren. Umwelterklärung 2012 (Community Hospital Kaufbeuren, Environmental Declaration 2012). 2012. Available online: https://www.bezirkskrankenhaus-kaufbeuren.de/fileadmin/Daten_haeuser/Daten_kaufbeuren/Pdfs/Umwelterkl%C3%A4rung_2012_neu.pdf (accessed on 11 January 2021).
56. Günther, R.; Einhäupl, K.M. Klimaschutzvereinbarung zwischen dem Land Berlin Senatsverwaltung für Umwelt, Verkehr und Klimaschutz und der Charité—Universitätsmedizin Berlin. 2019. Available online: https://www.berlin.de/sen/uvk/_assets/klimaschutz/klimaschutz-in-der-umsetzung/vorbildrolle-oeffentliche-hand/klimaschutzvereinbarung_charite_2019-2028.pdf (accessed on 11 January 2021).
57. DIAKO-Diakonissenanstalt Evangelisches Diakonie Krankenhaus. Evangelisches Diakonie-Krankenhaus. *Umwelterklärung 2018 mit den Umweltbilanzen des Jahres 2017 (DIAKO Protestant Diakonie Hospital, Environmental Statement 2018 with the Environmental Balances of the Year 2017).* 2018. Available online: https://diako.1kcloud.com/ep1vyZJg/#22 (accessed on 11 January 2021).
58. DRK-Deutsches Rotes Kreuz. Klinikservicegesellschaft Sachsen mbH. *Aktualisierte Umwelterklärung 2020 Standorte Chemnitz und Lichtenstein (DRK Clinic Service Company Saxony, Updated Environmental Statement 2020 Chemnitz and Lichtenstein Sites).* Available online: https://rab.drk-khs.de/fileadmin/user_upload/Umwelterklaerung_2019_Rev.pdf (accessed on 11 January 2021).
59. Evangelische Krankenhaus Köln-Weyertal. Umwelterklärung 2011 (Protestant Hospital Köln-Weyertal, Environmental Declaration 2011). Available online: http://www.evk-koeln.de/fileadmin/user_upload/KHKW/Dokumente/umwelterklaerung_2011_internet_12042012.pdf (accessed on 11 January 2021).
60. Heiligenfeld GmbH. Umwelterklärung 2018 nach Eco-Management and Audit Scheme (EMAS) der Europäischen Union (Environmental Statement 2018 According to Eco-Management and Audit Scheme (EMAS) of the European Union). 2018. Available online: https://www.heiligenfeld.de/fileadmin/user_upload/Ueber_uns/Auszeichnungen/Umwelterklaerung_Heiligenfeld_Kliniken_181_JKOE.pdf (accessed on 11 January 2021).

61. Klinikum Idar-Oberstein GmbH. Nachhaltigkeitsbericht 2014 (Hospital Idar-Oberstein, Sustainability Report 2014). 2014. Available online: https://docplayer.org/64192817-Klinikum-idar-oberstein-gmbh.html (accessed on 18 August 2020).
62. Katholische Kliniken Emscher-Lippe. Erste Umwelterklärung 2017 (Catholic Hospitals, First Environmental Declaration 2017). 2017. Available online: https://www.kkel.de/fileadmin/user_upload/Erste_Umwelterklaerung_KKEL_final_22.12.207.pdf (accessed on 10 August 2020).
63. Klinken Landkreis Heidenheim gGmbH. Umweltbericht 2018 (Clinics Heidenheim Administrative District, Environemtal Declaration 2018). Available online: https://kliniken-heidenheim.de/2019_04-UE-Umweltbericht_2018.pdf (accessed on 10 August 2020).
64. Klinikum Bremen Mitte. Umwelterklärung 2014 (Bremen Center Hospital, Environmental Declaration 2014). 2014. Available online: https://www.gesundheitnord.de/fileadmin/daten/kbm_pdf/oekologie/Umwelterkl%C3%A4rung_2014.pdf (accessed on 11 January 2021).
65. Klinikum Chemnitz gGmbH. Umweltbericht 2018 (Hospital Chemnitz, Environmental Report 2018). Available online: https://www.klinikumchemnitz.de/fileadmin/user_upload/Institute_Abteilungen/Hygiene/Umweltbericht_Klinikum_Chemnitz_2018.pdf (accessed on 11 January 2021).
66. Klinikum Kulmbach. Umwelterklärung 2017 (Hospital Kulmbach, Environmental Declaration 2017). Available online: https://www.klinikum-kulmbach.de/fileadmin/user_upload/Rubriken/Qualitaetsmanagement/Umwelterkl%C3%A4rung%202017%20blau%20Stand%2009.04.2018.pdf (accessed on 11 January 2021).
67. Klinikum Landsberg am Lech. Umwelterklärung 2019 (Hospital Landsberg am Lech, Environmental Declaration 2019). 2019. Available online: https://www.klinikum-landsberg.de/wp-content/uploads/Umwelterklarung_Klinikum_Landsberg_2019.pdf (accessed on 11 January 2021).
68. Klinikum Oldenburg. Umwelterklärung 2015 (Oldenburg Hospital, Environmental Declaration 2015). 2015. Available online: https://www.klinikum-oldenburg.de/files/kol_qmh_umwelterklaerung_2015.pdf (accessed on 18 August 2020).
69. Starnberger Klinken GmbH. Umwelterklärung (Starnberg Hospitals, Environmental Declaration). 2019. Available online: https://www.klinikum-seefeld.de/files/2019-STA-PDFs/Umwelterklrung-2019.pdf#page=16&zoom=auto,-278,593 (accessed on 11 January 2021).
70. Klinikum Saarbrücken. Team Blau Zeigt Grünes Engagement und Halbiert CO2-Ausstoß (Hospital Saarbrücken, Team Blue Shows Green Commitment and Halves CO2 Emissions). 2020. Available online: https://www.klinikum-saarbruecken.de/pressemitteilung/news/team-blau-zeigt-gruenes-engagement-und-halbiert-co2-ausstoss/?tx_news_pi1%5Bday%5D=24&tx_news_pi1%5Bmonth%5D=7&tx_news_pi1%5Byear%5D=2020&cHash=8fd02739e49a84111d3d7b4a8d3067f9 (accessed on 2 September 2020).
71. Klinikverbund Kempten Oberallgäu gGmbH. Aktualisierte Umwelterklärung 2018 (Hospital Association Kempten Oberallgäu, Updated Environmental Declaration 2019). Available online: https://www.emas.de/fileadmin/user_upload/ue/reg/DE-104-00061_Klinikverbund-OA.pdf (accessed on 5 August 2020).
72. Alfred Schmatz and Landkreis Passau Krankenhaus GmbH. Aktualisierte Umwelterklärung 2019. 2019. Available online: https://ge-passau.de/wp-content/uploads/2019/06/190227-akt.-Umwelterkl%C3%A4rung-2019.pdf (accessed on 11 January 2021).
73. Kreisklinik Wolfratshausen gGmbH. Umwelterklärung 2019 (Community Hospital Wolfratshausen, Environmental Declaration 2019). 2019. Available online: https://www.kreisklinik-wolfratshausen.de/downloads/qm/Umwelterklaerung%202019%20KK%20Wolfratshausen.pdf (accessed on 11 January 2021).
74. LVR-Klinik Bedburg-Hau. Aktualisierte Umwelterklärung 2020 (LVR-Hospital Bedburg-Hau, Updated Environmental Declaration 2020). 2020. Available online: https://klinik-bedburg-hau.lvr.de/media/lvr_klinik_bedburg_hau/dokumente/aktuelles/veroeffentlichungen/umwelt/Umwelterklaerung_LVR-Klinik_Bedburg-Hau_2020.pdf (accessed on 5 August 2020).
75. LVR-Klinik Bonn. Aktualisierte Umwelterklärung 2019 (LVR-Hospital Bonn, Updated Environmental Declaration 2019). Available online: https://klinik-bonn.lvr.de/media/lvr_klinik_bonn/ueber_uns/qualitaetsmanagement/dokumente/umwelterklaerung-lvr-klinik-bonn.pdf (accessed on 11 January 2021).
76. LVR Klinik Düren. Aktualisierte Umwelterklärung 2019 (LVR-Hospital Düren, Updated Environmental Declaration 2019). 2019. Available online: https://klinik-dueren.lvr.de/media/lvr_klinik_dueren/dokumente/pdf/umweltmanagement/LVR-Klinik_Dueren_Umwelterklaerung_2019.pdf (accessed on 11 August 2020).
77. LVR-Klinikums Düsseldorf. Aktualisierte Umwelterklärung 2019 (LVR-hospital Düsseldorf, Updated Environmental Declaration 2019). 2019. Available online: https://klinikum-duesseldorf.lvr.de/media/lvr_klinik_duesseldorf/pdf_download/2019_3/Umwelterklaerung_2019x.pdf (accessed on 18 August 2020).
78. LVR Klinik Köln. Aktualisierte Umwelterklärung 2020 (LVR-Hospital Köln, Updated Environmental Declaration 2020). 2020. Available online: https://klinik-koeln.lvr.de/media/lvr_klinik_koeln/downloaddateien/Umwelterklaerung_2017-LVR-Klinik-Koeln.pdf (accessed on 5 August 2020).
79. LVR-Klinik Langenfeld. Konsolidierte EMAS-Umwelterklärung 2020 (LVR-Hospital Langenfeld, Consolidated EMAS Environmental Declaration 2020). 2020. Available online: https://klinik-langenfeld.lvr.de/media/lvr_klinik_langenfeld/first_spirit/ueberuns/1.5_qualitaetsmanagement_1/Umwerlterklaerung_2019.pdf (accessed on 11 August 2020).

80. LVR-Klinik Viersen. Konsolidierte Umwelterklärung 2018 (LVR-Hospital Viersen, Consolidated Environmental Declaration 2019). 2018. Available online: https://klinik-viersen.lvr.de/media/lvr_klinik_viersen/klinik/qualitaetsmanagement/umwelterklaerung/Umwelterklaerung_2018.pdf (accessed on 5 August 2020).
81. LVR-Klinik Mönchengladbach. Aktualisierte Umwelterklärung 2019 (LVR-Hospital Mönchengladbach, Updated Environmental Declaration 2019). 2019. Available online: https://klinik-moenchengladbach.lvr.de/media/lvr_klinik_moenchengladbach/ueber_uns/umweltmanagement/LVR_Moenchengladbach_Umwelterklaerung_2019.pdf (accessed on 5 August 2020).
82. LWL-Klinik Lengerich. Aktualisierte Umwelterklärung 2019 (LWL-Hospital Lengerich, Updated Environmental Declaration 2019. Available online: https://www.lwl-klinik-lengerich.de/media/filer_public/b1/b1/b1b18fb6-c4ac-4628-93fe-111066ec2a58/umwelterklaerung_le_2019.pdf (accessed on 11 January 2021).
83. LWL-Klinik Münster. Umwelterklärung 2017 (LWL-Hospital Münster, Environmental Declaration 2017). 2017. Available online: https://www.emas.de/fileadmin/user_upload/ue/reg/DE-156-00070_LWL-Klinik-Muenster.pdf (accessed on 11 January 2021).
84. Axel, F.; Susanne, D.; Dietmar, P. *Gemeinsame Aktualisierte Umwelterklärung 2019 der München Klinik (MüK) Standorte: Bogenhausen Harlaching Neuperlach Schwabing Thalkirchner Straße Akademie*; (Joint updated Environmental Statement 2019 of München Klinik (MüK) Locations: Bogenhausen, Harlaching, Neuperlach, Schwabing, Thalkirchner Straße Akademie); München Klinik: Munich, Germany, 2019.
85. Orthopädische Universitätsklinik Friedrichsheim. Umwelterklärung 2019 (Orthopedic University Hospital Friedrichsheim, Environmental Declaration 2019). 2019. Available online: https://orthopaedische-universitaetsklinik.de/fileadmin/pdf/Umwelterklaerung_OUF_2019.pdf (accessed on 11 August 2020).
86. Rhön Klinikum, AG. Umwelt—Effizientes Umweltmanagement (Rhön Hospital Corporation, Environment—Efficient Environmental Management). 2020. Available online: https://www.rhoen-klinikum-ag.com/konzern/verantwortung/fortschrittsberichte/fortschrittsbericht-2015/umwelt.html (accessed on 18 August 2020).
87. Sankt Josef-Hospital Xanten. Umwelterklärung 2018 des Sankt Josef-Hospital Xanten (Environmental Declaration 2018 of the Sankt Josef-Hospital Xanten). 2018. Available online: https://www.sankt-josef-hospital.de/umwelterklaerung/ (accessed on 5 August 2020).
88. St.Barbara-Klinik Hamm-Heessen GmbH. *Umwelterklärung 2008 (St. Barbara Hospital Hamm-Heessen GmbH, Environmental Declaration 2008).* Available online: https://www.barbaraklinik.de/fileadmin/daten/mandanten/sbh/wir-ueber-uns/dateien/Umwelterkl%C3%A4rung_2008_Brosch%C3%BCre.pdf (accessed on 1 November 2020).
89. Städtisches Klinikum Karlsruhe. Konsolidierte Umwelterklärung 2019 (Municipal Hospital Karlsruhe, Consolidated Environmental Declaration 2019). 2019. Available online: https://www.klinikum-karlsruhe.de/fileadmin/Redaktion/UEber_uns/Zertifikate_und_Auszeichnungen/2019_11_13__EMAS-Umwelterkaerung_2019_komplett.pdf (accessed on 11 January 2021).
90. Universitätsklinikum Jena. Umweltschutzbericht 2018 (University Hospital Jena, Environmental Protection Report 2018). 2019. Available online: https://www.uniklinikum-jena.de/MedWeb_media/Corporate+Design+Bilder/Sonstige+Bilder+und+Dateien/Umweltbericht+2018.pdf (accessed on 11 January 2021).