

Carbon Peak and Carbon Neutrality in the Building Sector: A Bibliometric Review

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Abstract: Due to large energy consumption and carbon emissions (ECCE) in the building sector, there is huge potential for carbon emission reduction, and this will strongly influence peak carbon emissions and carbon neutrality in the future. To get a better sense of the current research situation and future trends and to provide a valuable reference and guidance for subsequent research, this study presents a summary of carbon peak and carbon neutrality (CPCN) in buildings using a bibliometric approach. Three areas are addressed in the review through the analysis of 364 articles published from 1990–2021: (1) Which countries, institutions, and individuals have conducted extensive and in-depth research on CPCN in buildings, and what is the status quo of their collaboration and contributions? (2) What subjects and topics have aroused wide interest and enthusiasm among scholars, and what are their time trajectories? (3) What journals and authors have grabbed the attention of many scholars, and what are the research directions related to them? Moreover, we propose future research directions. Filling these gaps will enrich the research body of CPCN and overcome current limitations by developing more methods and exploring other practical applications.

Keywords: building energy; carbon peak; carbon neutrality; bibliometric study

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1. Introduction

The building and construction industries, as well as the policies and standards promulgated therein, not only affect social and economic development [1], but are also closely related to environmental protection [2,3]. When it meets people's needs through buildings [4], it will inevitably impact the environment throughout the entire lifecycle of a building [5]. The building sector, one of the three major sectors in terms of energy consumption (i.e., industry, transportation, construction) and one of the main areas of responsibility for direct and indirect carbon emissions, accounted for 36% of the final energy consumption and 38% of the total carbon emissions in 2019 [6]. With the development of cities and rapid economic growth worldwide, the rapid growth of energy consumption and carbon emissions (ECCE) in the building sector has attracted more and more attention from countries around the world [7–11]. Due to the huge ECCE of the building sector, the carbon emission abatement potential of the construction industry will significantly influence the carbon peak and carbon neutrality (CPCN) in the future [12], aroused great attention from academics and industry practitioners.

The existence of a carbon emissions peak means that there will be a steady decline in carbon emissions after reaching a plateau [13]. Carbon neutrality refers to the total amount

of greenhouse gas emissions produced by an enterprise, organization, or individual within a certain amount of time and the realization of a zero-carbon emissions status by offsetting these carbon emissions through forest planting, energy saving, and emission reduction [14,15]. Developed countries and major economies have developed their own targets to curb greenhouse gas emissions and are trying to do their part [16–20]. For example, China, a major emitter of greenhouse gases, has made a commitment to reach its carbon emissions peak by 2030 and to achieve a carbon neutral status by 2060 [21]. The United States aims to decrease its carbon dioxide emissions by 17% by 2020 and by 83% by 2050 compared with 2005 levels [22]. The UK has set the objective of cutting greenhouse gas emissions by at least 20% by 2050 compared with 1990 levels [23].

From 1990 to 2021, research on CPCN in the building sector was diverse and active. Since the CPCN of the building sector should be considered from the perspective of the lifecycle, research in this area either covers a single phase (design, construction, and operation) or the entire lifecycle. For example, You et al. calculated the overall carbon dioxide emissions of residential buildings through their lifecycles [24]. Zhang et al. discussed the trends in ECCE in China's building sector from 2000 to 2016 using the China Building Construction Model based on the life cycle assessment method [25]. Danatzko et al. analyzed energy use by structural parts made up of different materials throughout the life cycle to achieve sustainable design [26]. Sozer et al. changed the building envelope during the design phase to improve energy efficiency [27]. Lam et al. revealed that the participation of stakeholders impacts other factors through the implementation of green codes in the construction phase [28]. Chen et al. investigated the changes in carbon emissions on different emission scales during the operation phase of civil buildings from 30 provinces of China [29]. Research on CENCN in buildings can also focus on commercial buildings and residential buildings [30,31]. For example, Ma et al. measured carbon emission abatement in commercial buildings in China based on the Kaya-LMDI method [32,33]. Hong et al. studied the energy efficiency of small commercial buildings using an energy analysis tool [34]. Zhang et al. analyzed the road map of carbon neutrality in the operation stage of commercial buildings and made a comparison between China and the United States [35,36]. Tian et al. investigated the status quo of near (net) zero-energy residential buildings in Beijing [37]. Zheng, Wei, and Wang et al. conducted a household survey on the energy consumption characteristics of Chinese residents [38]. In addition to the CPCN study on urban buildings, Yao et al. and Zhang et al. analyzed the reduction of ECCE in rural buildings and found that the energy use of rural residents has significantly shifted from non-commercial energy to commercial energy [39,40].

In the existing literature, there are various reviews on the research of CPCN in buildings, but these tend to focus on a limited part of the method [41–44], technologies [45–50], or on the macro research subjects of systems and laws [8,51–56]. For instance, Ali and Xiao reviewed the method for estimating building embodied carbon and the strategy for reducing it [57]; Ma, Cai, and Wu reviewed the implementation of the China Act on the Energy Efficiency of Civil Buildings (2008) over the past decade [58]. Chau et al. reviewed the research progress on the assessment of energy and carbon emissions during a building's lifecycle [59]. However, to the best of our knowledge, few studies have outlined the research trend and cooperation network for CPCN in the building sector, and most review articles have determined research topics from a subjective point of view. To get a better sense of the current research situation and future trends and to provide a valuable reference and guidance for subsequent research, we needed to address three problems.

- Which countries, institutions, and individuals have conducted extensive and in-depth research on CPCN in buildings, and what is the status quo of their cooperation and contributions?
- What subjects and topics have aroused wide interest and enthusiasm among scholars, and what are their time trajectories?
- What journals and authors have grabbed the attention of many scholars, and what are the research directions related to them?

Bibliometrics can be used to observe the state of technology and science during the overall production of scientific literature [60], and citation analysis is a common method used in bibliometrics to visualize the results of the analysis and map knowledge fields, so as to master the research frontiers hidden in the literature knowledge [5]. The research results presented in this article summarize the current situation in this area of research, identify the hot spots and knowledge gaps in the literature, and indicate potential future research directions.

The rest of the paper is presented as follows: Section 2 contains the data retrieved and describes the data processing methods used. Section 3 is the main part of this paper. Section 3.1 explains the changes in the number of annual publications for the top ten countries and the trend for the cumulative number of publications. Section 3.2 contains three parts, presented in Sections 3.2.1–3.2.3: the cooperative relationships and contributions of the authors, research institutions, and countries are analyzed. Section 3.3 describes the disciplines and topics related to CPCN in buildings. This section consists of Section 3.3.1 (subject category co-occurrence network) and Section 3.3.2 (keywords co-occurrence analysis). The last part (i.e., Section 3.4) of Section 3, which describes the intellectual structure of CPCN in buildings, is also subdivided into three parts, Sections 3.4.1–3.4.3, which present a co-citation analysis of journals, documents, and author. Section 4 discusses the current research gaps and future research. Section 5 presents the conclusions.

2. Materials and Methods

2.1. Data Retrieved

Through a comparative analysis of the statistics retrieved from the Scopus and Web of Science (WOS) databases, it was determined that the articles and references retrieved by these two databases were highly similar [61]. Since the core set of WOS databases contains high-quality data, groundbreaking content, and a longer history than Scopus, we chose the ‘Science Citation Index Expanded (SCI-EXPANDED)’ and ‘Social Sciences Citation Index (SSCI)’ of the core set of WOS databases to retrieve the data originally used for analysis [62]. Since journal articles usually provide deeper research and higher quality information than other types of publications [5], the literature types chosen were research articles and review articles. The language was set as English. The time period of the articles was set to 1990–2021, as the focus of this research was on the development of this topic following the adoption of the United Nations Framework Convention on Climate Change in 1992. We expected our data to reveal the trends that have emerged in the past 30 years.

The input data we reviewed were generated from a combination of the results of multiple subject search queries on WOS (Table 1). First, literature in research fields and topics was retrieved through different retrieval queries, and the results are shown as Set #1–Set #5 in Table 1. According to the WOS database retrieval rules, ‘*’ and ‘TS’ stand for fuzzy search and publication article topics, respectively. Then, through the Boolean operation “And” operation symbol to locate the four topics to the research field, the results Set #6–Set #9 were obtained. The amount of literature in Set #6 and Set #7 shows that many scholars have conducted studies on ECCE in the field of buildings. Based on the research on ECCE in the building sector, this review focused on the research topic of CPCN in buildings, so finally, Set #8 and Set #9 were combined by the “OR” operation symbol. Hence, a list of 364 publication records was gathered for the review analysis, including 328 research articles and 36 review papers. Each record consisted of the author, affiliate, country/region, year of publication, source journal, title, abstract, keywords, and references.

Table 1. Topic search queries used for data collection.

Set	Search Queries	Time Span	Publications	Articles	Reviews
#1	TS = (building OR construction)	1990–2021	1,198,060	1,142,270	55,790
#2	TS = (“energy consumption *” OR “energy demand *” OR “energy use *”)	1990–2021	116,712	109,202	7510
#3	TS = (“carbon emission *” OR “CO ₂ emission *”)	1990–2021	48,553	45,656	2897
#4	TS = (“carbon emission * peak” OR “energy demand * peak” OR “energy peak” OR “carbon peak” OR “CO ₂ peak”)	1990–2021	2014	1995	19
#5	TS = (“carbon neutrality” OR “carbon neutral” OR “net zero emission” OR “nearly zero emission”)	1990–2021	2150	1793	357
#6	#2 AND #1	1990–2021	22,949	21,433	1516
#7	#3 AND #1	1990–2021	7042	6522	520
#8	#4 AND #1	1990–2021	100	99	1
#9	#5 AND #1	1990–2021	270	235	35
#10	#9 OR #8	1990–2021	364	328	36

Note: * means fuzzy search.

2.2. Data Processing Methods

In the Bibliometrics field, different types of knowledge mapping software (Publish or Perish, CiteSpace, VOSviewer, HistCite, and BibExcel, etc.) have different features and limitations [63]. Since VOSviewer (version 1.6.16, Nees Jan van Eck and Ludo Waltman, Leiden University, Leiden, Netherlands). performs well in the visualization of contributions and cooperation, it was used to analyze the contributions and cooperation of institutions and authors. At the same time, CiteSpace software can be used to carry out co-occurrence and co-citation analyses and can be used to visualize the knowledge field of bibliographic records [64]. Thus, it can be used to analyze the co-occurrence of keywords and subjects as well as the co-citation of journals, documents, and authors. It is worth noting that compared with manual reviews, bibliometric reviews can draw more objective conclusions by examining the quantitative and unbiased links between different studies. They can supplement manual reviews but cannot replace them [65].

3. Results

3.1. The Publication Trends

The annual distribution of CPCN in the building sector reflects the development speed and knowledge accumulation status of this field [63]. According to the data in Set #10 retrieved from the “Web of Science Core Collection”, and as shown in Figure 1, the annual publication volume has increased year-by-year. Initially, steady growth began in 2005 through publications from England and Australia. Publications began to increase rapidly in 2015, indicating that the Paris Agreement for energy saving and emission reduction policies in various countries around the world had a significant impact and caused experts and scholars in various countries to conduct research in the field of CPCN in buildings [66–68]. In 2020, the growth rate of literature publishing accelerated significantly in line with the occurrence of the 2020 Climate Ambition Summit initiated by the United Nations and relevant countries to commemorate the fifth anniversary of the Paris

Agreement. It is clear that the 2020 Climate Ambition Summit further mobilized the international community to strengthen climate action and advance the multilateral process [69].

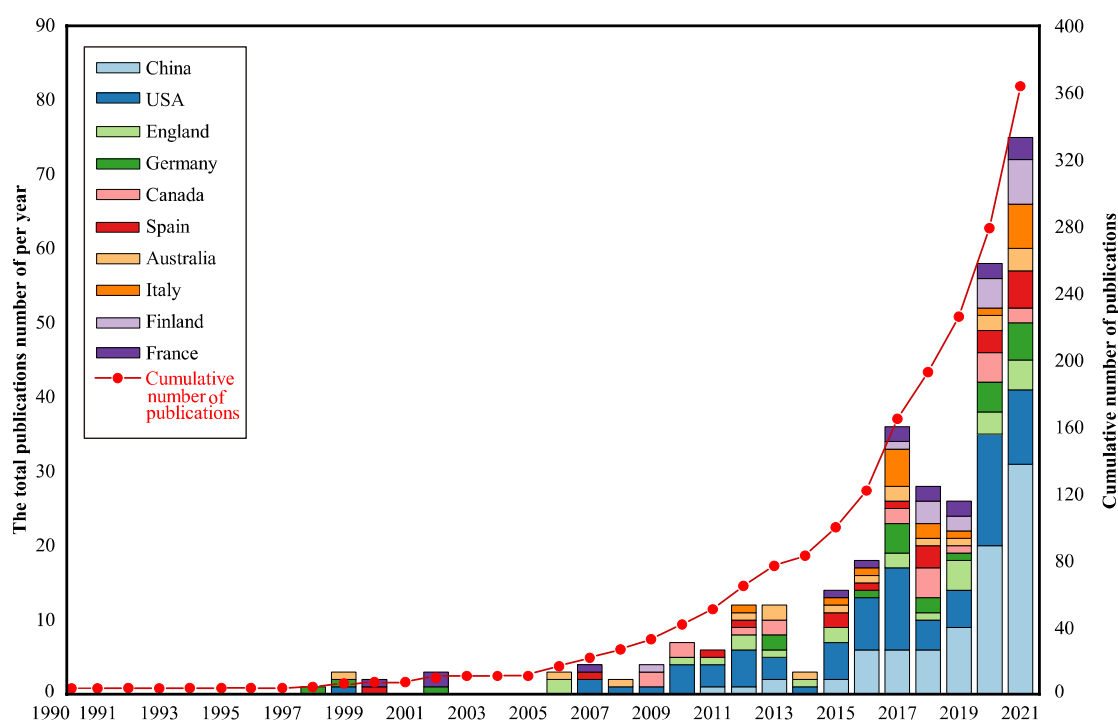


Figure 1. Annual change curves for articles published in the field of CPCN in buildings (1990–2021).

Figure 1 also shows the annual publication changes for the top ten countries. What is noteworthy in terms of publication volume is that among the top 10 countries the only developing country is China, while the rest are all developed countries. However, global sustainable development needs joint effort from all countries, so this means that developing countries need to conduct more cooperative research with developed countries, and developed countries should provide more help to developing countries. Publications from China have maintained rapid growth, especially in 2016. This trend is also consistent with the development of the “Thirteenth Five-Year Plan for Controlling Greenhouse Gas Emissions” issued by the State Council of China in 2016 [70,71]. Publications on CPCN in buildings from the USA, England, Italy, Germany, Canada, France, Australia, India, and Spain have generally shown an upward trend. In addition, the cumulative number of publications has increased exponentially.

3.2. Contributions and Cooperation from Three Aspects: Author, Institution, and Country

3.2.1. Author Contributions and Collaboration

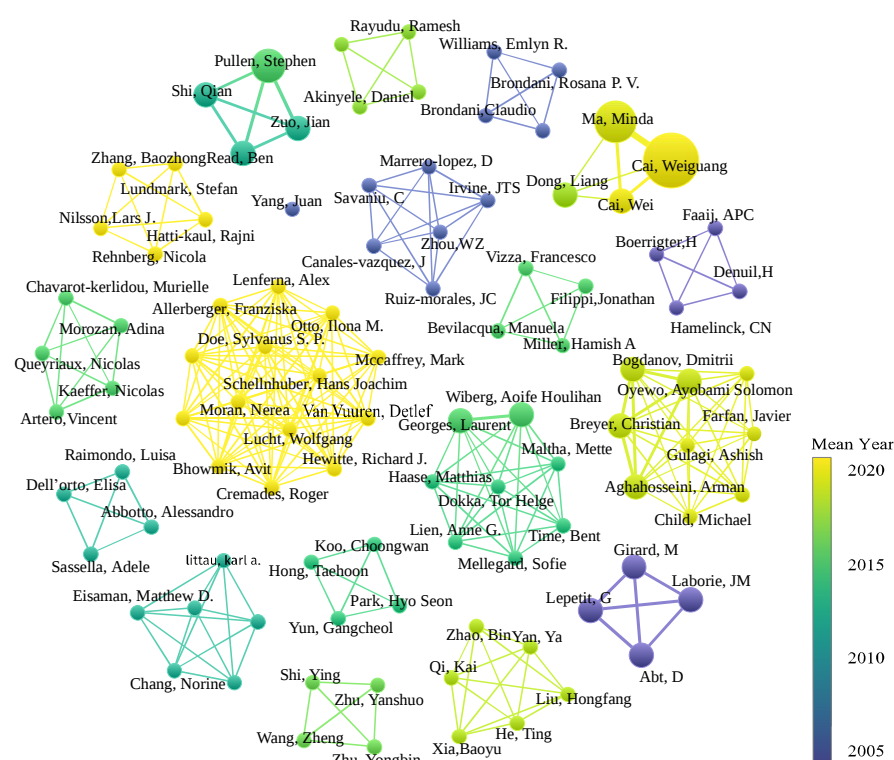
The analysis of the author’s cooperation and contributions to the CPCN in the building sector can provide some guidance for scholars seeking cooperation in similar fields. Table 2 lists the top 10 authors who have published the most articles in the field of CPCN in buildings. We can see that the number of articles published by authors in this field is relatively small. Prof. Cai Weiguang from Chongqing University has published six articles in this field and ranks first both in terms of the number of papers and the total number of citations. He is followed by Ma Minda from Tsinghua University, who has published four papers on the subject and is ranked first in citations per paper. It is worth noting that the first, second, fifth, and seventh authors in the top 10 are from China, two are from Australia, and two are from Finland.

Table 2. Top 15 authors with the most publications on CPCN in buildings.

Rank	Author	Country	Organization	Documents	Citations	TLS ^a	CPP ^b
1	Cai, Weiguang	China	Chongqing University	6	267	17	44.50
2	Ma, Minda	China	Tsinghua University	4	262	8	65.50
3	Pullen, Stephen	Australia	University of South Australia	3	99	8	33.00
4	Junnla, Seppo	Finland	Aalto University	3	13	10	4.33
5	Cai, Wei	China	Southwest University	2	121	6	60.50
6	Bogdanov, Dmitrii	Finland	Lappeenranta University of Technology	2	120	11	60.00
7	Dong, Liang	China	City University of Hong Kong	2	113	10	56.50
8	Meil, Jamie	Canada	Athena Sustainable Materials Institute	2	106	3	53.00
9	Zuo, Jian	Australia	The University of Adelaide	2	75	11	37.50
10	Georges, Laurent	Norway	Norwegian University of Science and Technology	2	75	11	37.50

Note: ^a Total Link Strength; ^b Citations Per Paper.

The total link strength (TLS), analyzed with the VOSviewer software, reveals the frequency of cooperation between cooperating authors, institutions, and countries based on available publications. The TLS shown in Table 2 indicates preliminary cooperation among scholars, but the frequency of cooperation is relatively low. This also can be observed in Figure 2.

**Figure 2.** Overlay visualization map of co-authors.

VOSviewer software was used to carry out overlay visual mapping for the TLS of the top 100 authors. In Figure 2, the node size represents the number of co-authored articles. The links between nodes represent collaboration, and a larger link width indicates closer collaboration between authors [63]. In Figure 2, we can see the contribution and cooperation degrees of experts more intuitively than in Table 2. Different nodes come together to form a cluster, with frequent cooperation within a cluster but less cooperation between clusters.

Different node colors in the figure represent the different average publication times for an author's articles. The warmer the node color, the closer the publication time of the author's article. This indicates whether an author is currently active in this research field, with active authors including Prof. Cai Weiguang and Cai Wei. On the contrary, the colder the node, the longer the publication time of the author's article. A cold node indicates that the authors have done preliminary basic research for the development of this field, for example, Prof. Girard M., Laborie J.M., Lepetit G., and Abt, D.

3.2.2. The Most Influential and Productive Institutions

Table 3 lists the top 15 research institutions in terms of the number of articles published. Chongqing University ranks first for the total number of published articles and the total number of citations, with the number of published articles accounting for 2.20% of the total number. The Chinese Academy of Sciences has also published eight articles, while the National University of Singapore and the Aalto University have published seven articles each. It is worth noting that in terms of the average number of citations, the University of Washington ranks first with 47 citations per article.

Table 3. Top 15 institutions with the most publications on the CPCN in buildings.

Rank	Institution	Country	Publications	Percentage	Citations	TLS ^a	CPP ^b
1	Chongqing University	China	8	2.20%	308	15	38.50
2	Chinese Academy of Sciences	China	8	2.20%	137	13	17.13
3	National University of Singapore	Singapore	7	1.92%	61	5	8.71
4	Aalto University	Finland	7	1.92%	19	0	2.71
5	Tsinghua University	China	6	1.65%	162	24	27.00
6	Lawrence Berkeley National Laboratory	USA	5	1.37%	178	21	35.60
7	The Hong Kong Polytechnic University	China	5	1.37%	130	7	26.00
8	Southeast University	China	5	1.37%	44	5	8.80
9	North China Electric Power University	China	5	1.37%	14	0	2.80
10	University of Washington	USA	4	1.10%	188	20	47.00
11	Stockholm University	Sweden	4	1.10%	92	20	23.00
12	National Institute for Environmental Studies	Japan	4	1.10%	89	9	22.25
13	Swiss Federal Institute of Technology	Switzerland	4	1.10%	71	3	17.75
14	The University of Tennessee	USA	4	1.10%	61	12	15.25
15	The University of Michigan	USA	4	1.10%	54	6	13.50

Note: ^a Total Link Strength; ^b Citations Per Paper.

Figure 3 shows the number of articles published by institutions and the partnerships between institutions. Each circular node represents a research institution, and the node size represents the number of articles issued by the institution. The links between nodes represent cooperation. The wider the link width, the closer the cooperation between institutions [63]. Different colors indicate different clusters of institution cooperation. Nodes of the same color belong to the same cluster, which means that the kinship between these nodes is stronger. In Figure 3, there are seven clusters altogether. Although Cluster #5 has only three main items, Tsinghua University has the highest total link strength. Lawrence Berkeley National Laboratory follows Tsinghua University with a total link strength of 21, and it is shown to cooperate relatively frequently with Chongqing University and the Chinese Academy of Sciences.

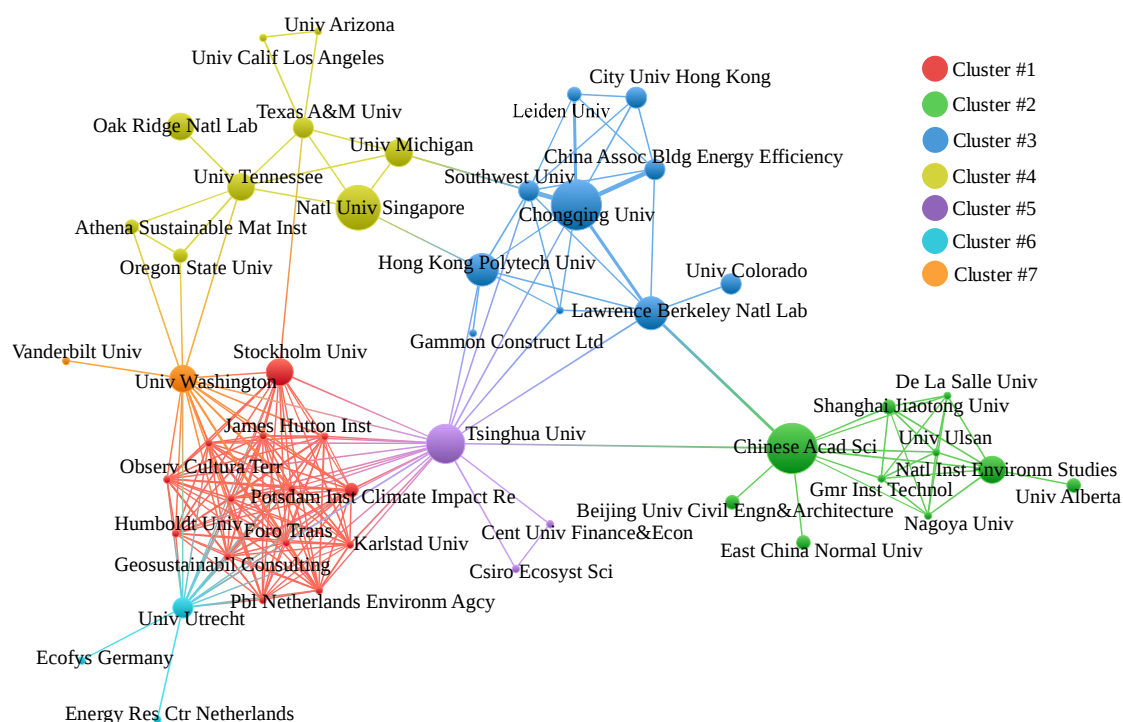


Figure 3. Knowledge domain map of institutional contributions and collaboration.

3.2.3. The Most Influential and Productive Countries

Table 4 lists the 20 countries with the most published articles. The numbers of articles published and of citations are significantly higher in China and the USA than in other countries. Similarly, China and the United States are also in the top two in terms of total link strength, indicating that both countries are actively engaged in collaborative research with other countries.

Table 4. Top 20 countries with the most publications on CPCN in buildings.

No.	Country	Start year	Publications	Centrality	Citations	Citations Per Paper	Total Link Strength
1	China	2011	84	0.05	1656	19.71	48
2	USA	1999	77	0.27	1401	18.19	53
3	England	2006	24	0.16	745	31.04	15
4	Germany	1998	22	0.43	760	34.55	30
5	Canada	2009	20	0.12	534	26.70	9
6	Spain	2000	19	0.58	193	10.16	22
7	Australia	1999	18	0.3	424	23.56	13
8	Italy	2012	18	0.05	312	17.33	16
9	France	2000	17	0.05	291	17.12	17
10	Finland	2009	17	0.11	189	11.12	8
11	Netherlands	2004	12	0	669	55.75	16
12	Japan	1993	12	0.05	139	11.58	7
13	Sweden	2001	11	0	183	16.64	18
14	India	2010	10	0.16	255	25.50	8
15	Scotland	2006	9	0.6	477	53.00	15
16	Norway	2009	8	0	180	22.50	3
17	South Korea	2014	8	0.05	132	16.50	11
18	Belgium	2002	8	0.11	97	12.13	10
19	Switzerland	2017	8	0	93	11.63	12
20	Singapore	2010	7	0	61	8.71	5

Each individual knowledge network is composed of publications produced over a period of time, which is called a time slice. These independent networks were integrated by CiteSpace to form an overview to express how the field of science has evolved over time [72]. In Figure 4, the corresponding 3-year slice, 1990–2021, shows the networks of the 100 countries with the most publications. CiteSpace describes the changing trends and patterns that are emerging in such networks using various visual attributes [72]. In Figure 4, the node size represents the number of articles produced by a country. The number of articles published in the time slice of each country is described by the citation tree ring: the thicker the citation tree-ring, the greater the number of articles published in that time period. The structural attributes of the nodes are represented by purple rings. The thickness of the purple ring indicates its degree of betweenness centrality (BC). BC is a measure related to the transformational potential of scientific contributions. Nodes with a purple ring often connect different phases of the development of a scientific field.

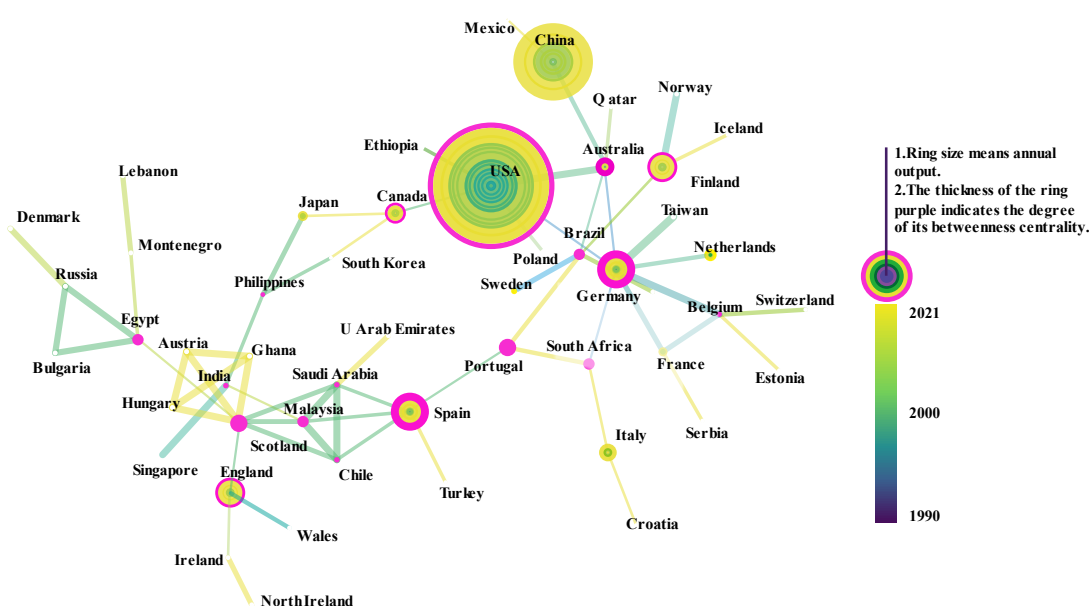


Figure 4. Mapping knowledge domains of coauthoring countries.

It can be seen intuitively from Figure 4 that Scotland (BC = 0.6), Spain (BC = 0.58), Germany (BC = 0.43), Australia (BC = 0.3), and the USA (BC = 0.27) have thick purple rings, which indicates that research articles published by these countries are of high value. This conclusion is also consistent with the data presented in Table 4.

3.3. Disciplines and Topics Involved in CPCN in Buildings

In 1990–2021, different research themes and topics related to CPCN in buildings were explored. Co-occurrence analysis not only detects research hotspots and trends for an item, it can also explain the affinities relationship between different items. We used the co-occurrence analysis module from CiteSpace to generate category and keyword co-occurrence knowledge maps for the data extracted from the WOS database.

3.3.1. Subject Category Co-Occurrence Network

Which disciplines are involved in CPCN in buildings? In the WOS database, each article belongs to at least one subject category [5]. A co-occurrence network of subject categories in CPCN in buildings was generated to show the research trends in and relationships between different subject categories. In terms of the attributes of the CiteSpace co-occurrence analysis module, we set the time slice as 3 years, conducted data visualization for the top 100 subjects in each time slice, and set a threshold of 100 in the knowledge

graph to display the node label. Figure 5 shows a network with 88 nodes and 365 links, demonstrating that this research topic covers at least 88 subject categories and involves interdisciplinary research. The size of the node represents the number of articles contained in the category. The most common categories are ‘Environmental Sciences & Ecology’, ‘Energy & Fuels’, ‘Engineering’, and ‘Environmental Sciences’. Although ‘Materials Science’, ‘Urban Studies’ and ‘Architecture’, etc., are much smaller than the other categories, they are also marked for reference. Table 5 lists the top 20 subject categories by the number of articles. The years in Table 5 represent when the first article on this research topic was published in each subject category. Research in the ‘Materials Science’, ‘Physics’, and ‘Materials Science, and Multidisciplinary’ fields began earlier than other disciplines, while papers on ‘Environmental Sciences & Ecology’, ‘Environmental Science’, ‘Science & technology’, and ‘Green & Sustainable Science & Technology’ were published relatively late, but these areas have developed rapidly.

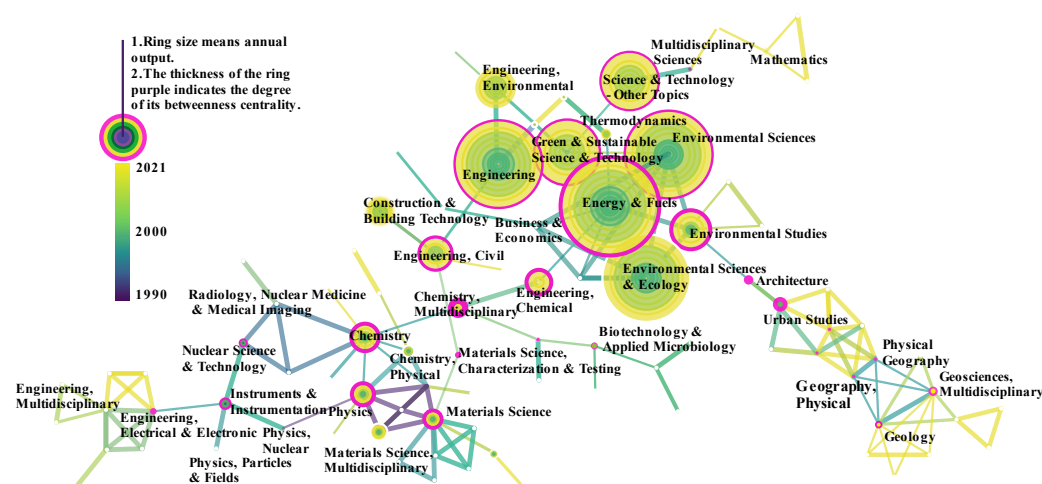


Figure 5. Subject categories involved in CPCN in buildings.

Table 5. Top 20 subject categories with the most publications on CPCN in buildings.

Rank	Subject Categories	Years	Count	Centrality
1	Environmental Sciences & Ecology	2007	124	0.01
2	Energy & Fuels	1999	118	0.56
3	Engineering	2001	118	0.23
4	Environmental Sciences	2007	107	0.26
5	Science & Technology—other Topics	2006	97	0.16
6	Green & Sustainable Science & Technology	2009	82	0.34
7	Environmental Studies	2007	59	0.54
8	Engineering, Environmental	2009	48	0.03
9	Construction & Building Technology	2011	42	0
10	Engineering, Civil	2011	39	0.25
11	Chemistry	2000	35	0.57
12	Materials Science	1993	28	0.38
13	Physics	1993	27	0.34
14	Engineering Chemical	2006	24	0.52
15	Materials Science, Multidisciplinary	1993	23	0
16	Nuclear science & technology	2000	20	0.13
17	Thermodynamics	1999	18	0.03
18	Instruments & Instrumentation	2002	17	0.3
19	Chemistry, Physical	2007	14	0.07
20	Physics, Nuclear	1998	14	0.2

In Figure 5, a purple circle means that the node has a high degree of BC, for example, Chemistry (BC = 0.57), Energy & Fuels (BC = 0.56), Environmental Studies (BC = 0.54), Engineering Chemical (BC = 0.52). This represents the turning points that connect different stages of research and have key impacts on the development of CPCN in buildings. The colors of link and node rings (from cold color to warm color) correspond to the years from 1990 to 2021. Figure 5 illustrates that the number of articles published in most disciplines has increased significantly since start of the 21st century.

CiteSpace divides the co-occurrence network of subject categories into clusters so that subject categories are closely linked in the same cluster but loosely connected between different clusters. As shown in Figure 6, the most common subject categories are mainly covered by Cluster #1 and Cluster #3, which indicates that using the log-likelihood ratio test method (LLR), the research content from ‘Engineering’, ‘Green & Sustainable Science & Technology’, ‘Engineering Environmental’, and ‘Engineering Civil’ can be extracted and summarized as ‘Recycled Aggregate’, and the research content from ‘Environmental Studies’, ‘Environmental Sciences’, ‘Energy & Fuels’, and ‘Environmental Sciences & Ecology’ can be extracted and summarized as ‘Greenhouse Gas Emissions’.

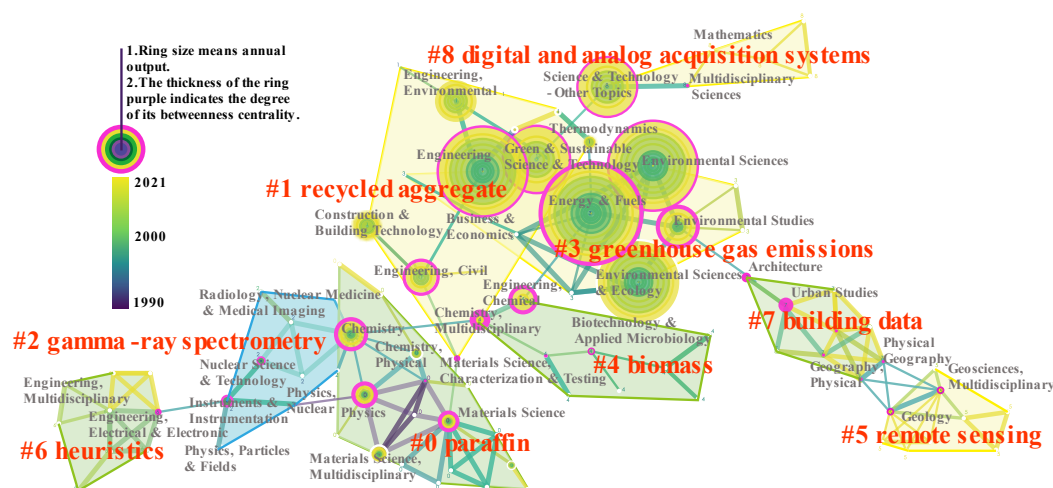


Figure 6. Cluster map of the co-occurrence of subject categories.

3.3.2. Keyword Co-Occurrence Analysis

Topics related to CPCN in the building sector can be described using keywords assigned to each article in the data set. The WOS database contains two types of keywords: the ‘author keywords’ provided by the author and the ‘keywords plus’ provided by the journals [5]. We used two sets of keywords from 364 records to make a timeline view using CiteSpace software. Figure 7 shows the research progress for each cluster, and this can be used to understand the changes in research topics. Each cluster is composed of several keywords, among which the clustering keywords are ranked on the right side of the Figure 7, and the time when the keywords first appear is presented at the top. The curved line in Figure 7 indicates the co-occurrence of different keywords. The thickness of the line shows the frequency of co-occurrence: the larger the cross node, the higher the intensity of the keyword bursts. It can be seen from Figure 7 that node ‘System’ (Cluster #0), node ‘Life Cycle Assessment’ (Cluster #1), node ‘Energy consumption’ (Cluster #2), node ‘CO₂ emission’ (Cluster #2), node ‘Energy consumption’ (Cluster #2), node ‘Energy’ (Cluster #4), node ‘Performance’ (Cluster #4), and node ‘Impact’ (Cluster #6) have strong bursts. This shows that these topics have been widely studied by scholars, and this can be more accurately understood from Table 6. It is worth noting that a large number of keywords appeared in 2010 and continue to be studied so far. This shows that although the United

Nations Climate Change Conference held in Copenhagen in December 2009 failed to produce the new international legal framework for man-made climate change [73], the Copenhagen Accord that resulted from the conference successfully promoted scientific research, and research in the field of buildings has been a positive response to the Copenhagen Accord.

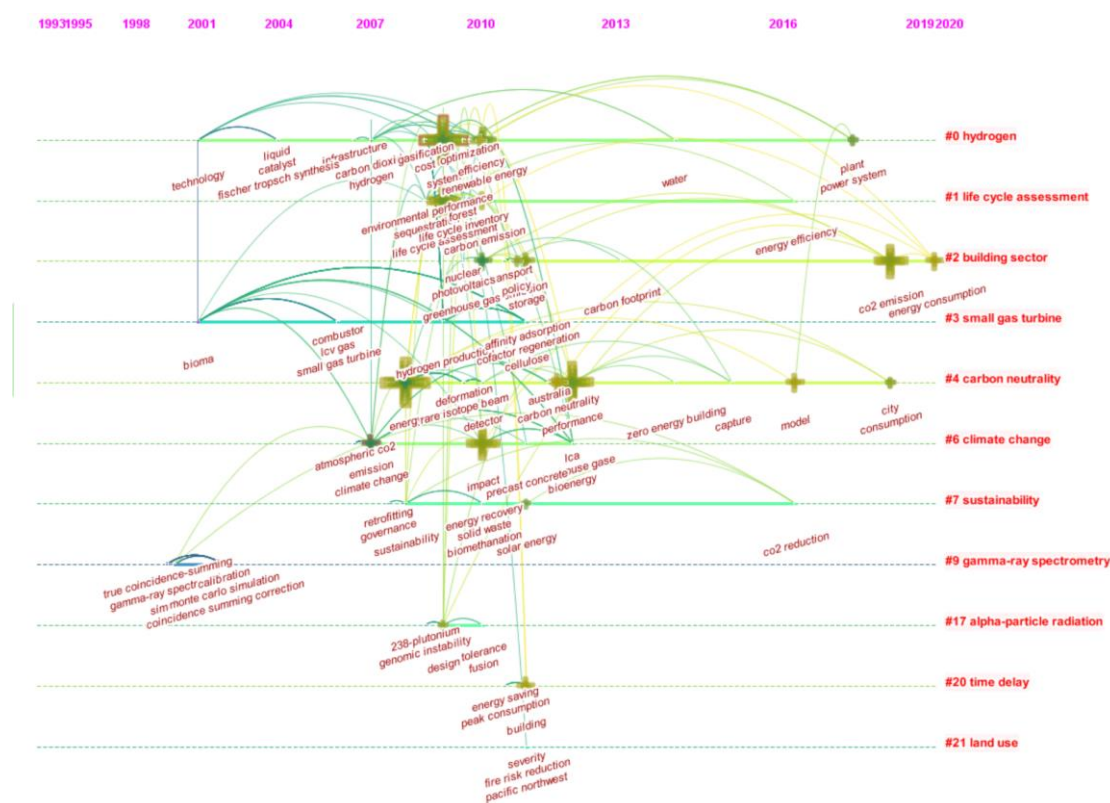


Figure 7. Keyword co-occurrence timeline view.

Table 6 lists the top 17 keywords with the strongest co-occurrence bursts (Red line segment represents the year of co-occurrence bursts), among which ‘System’, ‘Impact’, and ‘CO₂ emission’ rank as the top three. ‘Emission’, ‘Greenhouse gas emission’, and ‘Climate change’ appeared relatively early. In 2020, the topics of ‘Energy consumption’, ‘Building’, ‘Carbon emission’, ‘Efficiency’, ‘Carbon emission’, and ‘Model’ have attracted wide attention from scholars. It is particularly noteworthy that although ‘Impact’ and ‘CO₂ emission’ appeared in 2018, they have high co-occurrence bursts, which indicates that these topics have caught the eye of many scholars in the last three years.

Table 6. Top 17 keywords with the strongest co-occurrence bursts for CPCN in buildings.

No.	Keywords	Strength	Begin	End	1990–2021
1	Emission	4.19	2012	2017	
2	Greenhouse gas emission	3.78	2012	2019	
3	Climate change	3.48	2012	2017	
4	System	7.92	2014	2021	
5	Performance	6.58	2014	2021	

6	Energy	6.02	2016	2021	
7	Life cycle assessment	5.52	2016	2021	
8	Renewable energy	4.52	2016	2019	
9	Design	3.9	2016	2019	
10	Impact	7.9	2018	2021	
11	CO ₂ emission	7.68	2018	2021	
12	Energy consumption	5.36	2020	2021	
13	Building	5.19	2020	2021	
14	Carbon emission	4.65	2020	2021	
15	Efficiency	4.65	2020	2021	
16	Carbon neutrality	4.32	2020	2021	
17	Model	4.16	2020	2021	

3.4. The Intellectual Structure of CPCN in Buildings

In 1973, Small, an intelligence scientist from the United States, first proposed the concept of using co-citations to measure the relationship degree between documents [74]. At the same time that Small came up with this idea, Soviet intelligence scientist Marshakova had a similar idea.

When two articles/journals are frequently cited together, it is obvious that the two articles/journals are related in some respects. It has been proven that the network created in this method of co-citation can identify the research priorities of the scientific community, and the citation burst is a valuable means to track the development trend of research priorities [72].

3.4.1. Journal Co-Citation Analysis

The intensity and duration of the burst state are two important attributes of citation bursts. Table 7 lists the strongest citation burst journals for the entire dataset from 1990 to 2021 (Red line segment represents the year of co-citation bursts). ‘P. Natl. Acad. Sci. Usa’ and ‘Energ. Environ. Sci.’ are not only the earliest journals with citation bursts but also have lasted for the longest: 12 years. Although ‘Sustainability’ appeared late in the citation surge, the citation intensity was high, reaching 11.36 and producing the highest intensity of citation bursts, indicating that high-quality articles appeared in the journal. In the last two years, the journals ‘Energies’, ‘Energy Proced.’, ‘Energ. Econ.’ and ‘Appl. Energ.’ have had the strongest citation bursts, showing that relevant articles in these journals are worth referring to.

Table 7. Top 20 Cited Journals with the Strongest Citation Bursts.

No.	Cited Journals	Strength	Begin	End	1990–2021
1	P. Natl. Acad. Sci. Usa	9.04	2008	2019	
2	Energ. Environ. Sci.	8.30	2008	2019	

3	Int. J. Hydrogen Energ.	6.65	2008	2016	
4	Biomass Bioenerg.	5.32	2008	2013	
5	Bioresource Technol.	4.63	2008	2013	
6	Environ. Sci. Technol.	4.36	2008	2016	
7	J. Am. Chem. Soc.	4.87	2011	2016	
8	Environ. Res. Lett.	4.73	2011	2019	
9	Climate Change	3.79	2011	2013	
10	Sol. Energy	7.04	2014	2019	
11	Build. Res. Inf.	4.93	2014	2016	
12	Phys. Chem. Chem. Phys.	3.62	2014	2016	
13	Chem. Rev.	3.62	2014	2016	
14	Energ. Buildings	3.57	2014	2019	
15	Sustainability	11.36	2017	2021	
16	Energies	8.28	2017	2021	
17	Nat. Clim. Change	6.12	2017	2019	
18	Energy Proced.	4.98	2017	2021	
19	Energ. Econ.	4.48	2017	2021	
20	Appl. Energ.	4.37	2017	2021	

3.4.2. Document Co-Citation Analysis

A research article usually quotes many references. The document co-citation analysis can not only determine the potential knowledge structure of a knowledge field, but it can also prove the number and authority of the cited documents. In order to determine the distribution of documents on CPCN in the building sector, we used CiteSpace to collect the top 10 documents with the most frequent co-citations in the references. Meanwhile, we obtained the number of citations from these 10 documents according to the WOS database, and this is presented in Table 8.

Table 8. The top 10 most co-cited articles.

Rank	Cited References	Year	Co-Citation Times		Centrality
	Author, Year, Journal, Volume, Page, Doi		Times	Cited	
1	Zhou N., 2018, Nat. Energy, V3, P978, doi:10.1038/s41560-018-0253-6	2018	6	85	0
2	Ma M.D, 2017, J. Clean. Prod., V143, P784, doi:10.1016/j.jclepro.2016.12.046	2017	5	93	0
3	Tan X.C., 2018, Energ. Policy, V118, P429, doi:10.1016/j.enpol.2018.03.072	2018	5	55	0
4	Fargione J., 2008, Science, V319, P1235, doi:10.1126/science.1152747	2008	4	2434	0
5	Sartori I., 2012, Energ. Buildings, V48, P220, doi:10.1016/j.enbuild.2012.01.032	2012	4	442	0
6	Dong K.Y., 2018, Renew. Sust. Energ. Rev., V94, P419, doi:10.1016/j.rser.2018.06.026	2018	4	94	0
7	Ma M.D., 2018, Sci. Total Environ., V634, P884, doi:10.1016/j.scitotenv.2018.04.043	2018	4	75	0
8	Lin B.Q., 2015, Build. Environ., V92, P418, doi: 10.1016/j.buildenv.2015.05.020	2015	4	61	0
9	McNeil M.A., 2016, Energ. Policy, V97, P532, doi:10.1016/j.enpol.2016.07.033	2016	4	49	0

10	Wu C.B., 2018, J. Clean. Prod., V172, P466, doi:10.1016/j.jclepro.2017.10.216	2018	4	46	0
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It can be seen from Table 8 that 8 of the top 10 highly cited papers have been published since 2015, indicating that research on CPCN in buildings has developed rapidly in the past five years. Specifically, research articles by Zhou N. (2018), Ma M.D. (2017), and Tan X.C. (2009) received six, five, and five co-citations, respectively, placing these articles in the top three. Zhou N. et al. (2018) explored the ECCE of China's building sector in 2050 through four scenarios with different application degrees of new energy efficiency or renewable energy policies and predicted the peak times of different scenarios. Moreover, it is pointed out that the focus of energy savings and carbon emission abatement in the building sector should be on a system that can achieve energy efficiency rather than on technology, and the impact of individual policies should be assessed in future studies. Further, the behavior of human and occupants should be given extra consideration [75]. We searched 85 papers citing this article through WOS (Table A1 in the Appendix A) and found 3 papers with high numbers of citations: Ma M.D. (2019) with 104 citations, Liang Y. (2019) with 73 citations, and Ma M.D. (2020) with 70 citations. In terms of the three highly cited papers, Ma M.D. et al. (2019) analyzed the factors mitigating the carbon dioxide (CO₂) intensity in China based on a household scale through decomposition and found that the housing price–income ratio, housing purchasing power, and population size per household are three housing economic indicators linked to a significantly reduced CO₂ intensity [76]. Liang Y. et al. (2019) used decomposition and decoupling methods to determine the decoupling effect of residential buildings in China and explored the decoupling modes of four megacities by mapping the carbon Kuznets curves of residential buildings [77]. The third article, also from Ma M.D. (2020), through the construction of China's energy and emission peak historical carbon emission reduction assessment and simulation, showed that residential construction will produce peak carbon emissions in 2037, and through a sensitivity analysis, concluded that, per capita, building area and urban residential building energy consumption have the most significant impacts on the emissions peak of uncertainty [7].

Considering that it is difficult to quantify the factors affecting the national building energy savings (NBES), Ma M.D. et al. (2017), the author of the second article presented in Table 8, proposed a method that combines the IPAT model and LMDI decomposition (Logarithmic Mean Divisia Index, LMDI) to calculate the national building energy savings. By comparing the China's calculated NBES with the official plan, it was found that China has exceeded its building energy-efficiency target [44]. On this basis, Ma M.D. et al. (2017) (i.e., the seventh article in Table 8) decomposed five driving forces of Chinese commercial building carbon emissions (CCBCE) to assess carbon abatement in Chinese commercial building value in 2001–2015, further breaking down the research from NBES to CCBCE [78].

In the third article from 'Energ. Policy' presented in Table 8, Tan X.C. et al. (2018) developed a bottom-up model to predict the future carbon emissions trend for China's building sector. This shows that, under the policy scenario, the low-carbon policy of the construction industry can only slow down but not completely curb carbon dioxide emissions. Research shows that coordinated emission reduction between sectors has a better effect than coordinated emission reduction by one sector [79].

From the 4th to the 10th articles in Table 8, although there were four co-citations in total, the total citation times differed greatly. The 4th article by Fargione J. (2008) from 'SCIENCE' was cited 2434 times, while that by Sartori I. (2012) from 'Energ. Buildings' was cited 50 times. Fargione J. et al. (2008) proposed that although biofuels are a potential low-carbon energy source, different production methods determine whether biofuels can save carbon [80]. Sartori I. et al. (2012) proposed a consistent definition framework that includes five standards and corresponding sub-standards to describe the characteristics of net zero energy buildings [81]. Lin B.Q. et al. (2015) conducted empirical research on

the determinants of carbon dioxide emissions in relation to building energy and evaluated the carbon dioxide emission reduction potential of buildings [82]. The 9th article is also from the ‘Energ. Policy’. McNeil M.A. et al. (2016) quantified the potential impact of energy efficiency projects in China’s building sector on energy saving and emission reduction by using a bottom-up modeling framework [83].

3.4.3. Author Co-Citation Analysis

If an author has a high number of co-citations, we consider their research to be of high value. In order to further understand the scholars in this field who have attracted attention, we analyzed their strongest citation bursts, as shown in Table 9 (Red line segment represents the year of co-citation bursts). Professor Metz B. and Professor Lewis N.S. had the longest citation burst duration of five years, followed by Sartori I. It is noteworthy that Zhang Y. had the highest burst intensity, although the burst state only lasted for two years. The citation outbreak years of the four authors were all after 2010, which indicates that the articles of these four authors have played important reference value in the past decade and have aroused the interest of other scholars.

Table 9. Top 4 Cited Authors with the Strongest Citation Bursts.

No.	Cited Authors	Strength	Begin	End	1990–2021
1	Metz B.	3.8	2011	2016	
2	Lewis N.S.	3.68	2011	2016	
3	Sartori I.	3.61	2014	2019	
4	Zhang Y.	4.47	2017	2019	

We also selected the top 10 co-cited authors, with co-citations ranging from eight to six (Table 10). The top four cited authors with the strongest citation bursts all appear in Table 10, ranking 9th, 8th, 5th and 1st according to the number of co-citations. For the articles retrieved from the subject search, there were five articles by five authors. Notably, Chen X. (1st author) and Zhang Y. (2020) topped the list. By working together at the sectoral level, the two scholars predicted emission peaks for four carbon pillar industries: industry, construction, transport, and agriculture. Compared with the Chinese government’s commitment for CO₂ emissions to peak around 2030 [84], they found that the peak time was six years later, and it was concluded that the delay was mainly due to the industrial, building, and transportation sectors. This research provides a reference for us to further determine the time of peak carbon emissions in the building sector [85].

Table 10. Top 10 most co-cited Authors.

Rank	Author	Year	Co-Citations	Title	Times Cited
1	Zhang Y.	2017	8	Analysis on the carbon emission peaks of China’s industrial, building, transport, and agricultural sectors	44
2	Chen X.	2020	8	Analysis on the carbon emission peaks of China’s industrial, building, transport, and agricultural sectors	44
3	Zhou N.	2020	8	Exploring potential pathways towards urban greenhouse gas peaks: A case study of Guangzhou, China	9
4	Lin B.Q.	2020	8	/	0
5	Sartori I.	2014	7	/	0

6	Wang J.	2020	7	Energy demand and carbon emission peak forecasting of Beijing based on leap energy simulation method	0
7	Wang Y.	2020	7	Feasibility assessment of the carbon emissions peak in China's construction industry: Factor decomposition and peak forecast	14
				Feasibility of peaking carbon emissions of the power sector in China's eight regions: decomposition, decoupling, and prediction analysis	7
8	Lewis N.S.	2011	6	/	0
9	Metz B.	2011	6	/	0
10	Zhang Y.J.	2020	6	/	0

Compared to the research on the potential of energy efficiency and carbon dioxide emissions in the Chinese building sector conducted by Zhou N. et al. (2018), which was mentioned in the previous section, Zhou N. et al. (2019) took Guangzhou as an example to study the potential pathway of the urban greenhouse gas peak from the city level. The research revealed that, in the long run, the energy-saving strategy of the construction industry will be very important to Guangzhou [86]. Similarly, Wang J. et al. (2020) predicted the energy demand and peak carbon emissions for Beijing and found that enhancing the energy efficiency of the tertiary industry and improving the industrial structure is an effective way to decrease energy use and carbon emissions [87].

Two articles by Wang Y. analyzed the factors leading to peak carbon emissions production by China's building industry and the feasibility of reaching peak carbon emissions in the eight major regions of China's power industry. The results show that GDP has the highest cumulative contribution to carbon emissions in the building sector in China [88] and is also the main factor affecting the carbon emissions of the power industry in eight regions [89].

4. Discussion

This study reviewed literature on CPCN in buildings from 1990 to 2021 and summarized current research hotspots. It should be pointed out that the above research content was determined through an objective analysis and does not cover all topics that need to be researched.

At present, research on CPCN in the building sector is mainly focused on developed countries and major economies [90–94], and further cooperation between authors, institutions, and countries is needed to keep the global temperature rise to below 1.5 °C above pre-industrial levels [95]. Take China, for example, the reduction of the ECCE potential of China's building sector has been estimated under various scenarios [7,75,79,96,97]. India is one of the top three emitters worldwide, and its energy demand increases obviously with the rapid growth of economy and population [98]. In the upcoming two decades, India's CO₂ emissions are expected to increase by 50%, and buildings are one of the main drivers. The building sector in India accounted for 24% of the nationwide CO₂ emissions in 2019, and the indirect emissions released by the building sector nearly tripled from 2000 to 2017. India's urbanization level aims to reach 40% in the next one decade, which will promote the increase of ECCE in the building sector significantly at the same time [99]. As the ECCE of non-developed countries in the world will experience the levels of their predecessors with economic and population growth, research on CPCN in the building sector

of developing countries cannot be ignored [96,100]. So, by expanding the data set, especially the future ECCE research in developing countries [101], the research scope can be extended from the country to the world, and the civil building peak carbon emission under different emission standards in different countries can be researched from a global perspective.

At the provincial and municipal building sector level, potential paths for urban CPCN have also been extensively explored [102–105], and further detailed research on CPCN has been carried out for commercial and residential buildings [52,106–108]. For example, Wu et al. conducted a modeling analysis on Qingdao's future CO₂ emissions (including the number of emission peaks and the time of occurrence) using the STIRPAT model [109]. Huang et al. calculated the carbon footprint of Xiamen city and conducted a low-carbon scenario analysis [110]. Li et al. took Jiangsu Province as an example to analyze how to achieve the carbon emission peak for the provincial building sector [111]. Goomi et al. [112], Farzaneh et al. [113], and Jing et al. [114] developed low-carbon development models for different cities to evaluate low-carbon development scenarios in the city system. With the growth of economy and population, the construction area of the county seat has grown steadily [115]. Based on the data from the China Statistical Yearbook, we illustrated the changes of construction area and population size in county seat in China (see Figure 8) [116]. It shows the growth of population and construction area have the same trend, which means the decrease of ECCE in the county seat faces the huge challenge. Most of the existing studies on CPCN in the building sector focused on the city level, and study with case area focused on the county level has been barely discussed [117]. The potential of energy saving and emission abatement in county seat is worth researching.

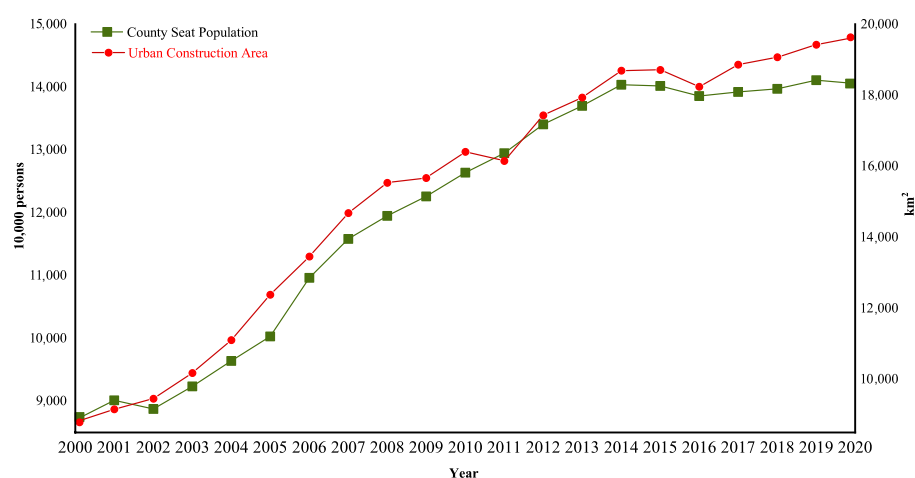


Figure 8. Changes of population size and construction area of county seat in China (2000–2020).

The thermal integrity of residential buildings in rural areas is poor [118,119], and the comfort level is not as good as that of cities [120,121]. In China, the energy use of rural residential buildings accounts for nearly 14% of the total building energy consumption [122]. According to the China Statistical Yearbook, in 2020, stock of China's rural residential buildings reached 26.6 billion m², which is the equivalent of constructing an entire New York City every month for over three decades [116]. Besides, the floor area per capita in rural residential buildings increased from 24.8 m² in 2000 to 47.3 m² in 2018 [123]. With the implementation of the rural revitalization plan issued by the Chinese government [124], the ECCE of rural residential buildings will keep the increase to meet the demand of rural household and also to obtain a goal of thermal comfort in the future [125–129]. Since research on the CPCN of rural residential buildings is scarce at present, it will become necessary in the future.

Based on the existing review and analysis, in order to further refine the work on CPCN in the building sector, this review paper proposes the above three future research directions.

5. Conclusions

This paper conducted a bibliometric analysis on literature published on CPCN in the building sector. Knowledge maps were obtained through information visualization techniques. This paper presents the research hotspots and development trends on CPCN in buildings and provides references for researchers to explore further.

By analyzing the contributions of and cooperation among authors, institutions, and countries as well as the trend of published articles, we can conclude that although the number of articles is relatively small at present, it has grown rapidly since 2005, especially in developed countries and China. The United States and China cooperate the most with other countries, and other countries cooperate less with each other. Collaboration among most institutions and authors is relatively rare and non-extensive.

The co-occurrence analysis on disciplines and themes revealed that the most common disciplines are 'Environmental Sciences & Ecology', 'Energy & Fuels', 'Engineering', 'Environmental Sciences and Materials Science, Physics', and 'Materials Science'. Multidisciplinary research in this field started earlier than other disciplines, while the environmental science and science technology areas were introduced to this field relatively late but have developed rapidly. The 'Chemistry', 'Energy & Fuels', 'Environmental Studies', and 'Engineering Chemical' areas have high centrality, indicating that they are turning points connecting different years of research and have greatly influenced the development of CPCN in buildings. Through a cluster analysis of disciplines, the 'Green & Sustainable', 'Science & Technology', 'Engineering', 'Engineering Civil', and 'Engineering Environmental' research content can be extracted and summarized as Recycled Aggregate, and the 'Energy & Fuels', 'Environmental Studies', 'Environmental Sciences', and 'Environmental Sciences & Ecology' research content can be extracted and summarized as Greenhouse Gas Emissions.

As indicated by the analysis of keyword co-occurrence, a large number of keywords appeared in 2010 and continue to be studied. 'System', 'Life Cycle Assessment', 'Energy consumption', 'CO₂ emission', 'Energy consumption', 'Energy consumption', 'Energy consumption', 'Performance', and 'Impact' have strong co-occurrence bursts. This shows that these topics have been widely studied by scholars, and although 'Impact' and 'CO₂ emission' appeared in 2018, they showed high co-occurrence bursts, which indicates that these topics have attracted significant attention among scholars in the past three years.

In terms of aspects of the intellectual structure of CPCN in buildings, the analysis of journal co-citations showed that 'P. Natl. Acad. Sci. USA' and 'Energy Environ. Sci.' are not only the earliest journals with citation bursts but also have lasted the longest: 12 years. Although the citation surge for 'Sustainability' appeared late, the citation intensity was high. This journal had the highest intensity of citation bursts, indicating that high-quality articles appeared in the journal. In the last two years, the journals 'Energies', 'Energy Proced.', 'Energy Econ.', and 'Appl. Energy' had the strongest citation bursts, which shows that the relevant articles in these journals are worth referring to. Through further analysis of article co-citations, we found that these authors and their articles have aroused the interest of other scholars: Zhou N. (2018), Ma M.D. (2017), and Tan X.C. (2009) received six, five, and five co-citations, respectively, ranking them within the top three. These were followed by Fargione J. (2008), Sartori I. (2012), Lin B.Q. (2015), and McNeil M.A. (2016). In addition, the analysis of the authors' strongest citation bursts found that the citation bursts of Professors Metz B. and Lewis N.S. lasted the longest, followed by that of Professor Sartori. The citation outbreak years of the four authors are all after 2010, which indicates that the articles by these four authors have had important reference value in the past decade and have aroused the interest of other scholars.

This article provides practitioners and researchers with a comprehensive overview of the current situation, future agenda, and research gaps of CPCN in the building sector. Researchers should fill in the knowledge gaps according to the recommended directions, thereby expanding the research body of CPCN in the building sector.

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Abbreviations

BC	betweenness centrality
CPCN	Carbon peak and carbon neutrality
CCBCE	Chinese commercial building carbon emissions
ECCE	Energy consumption and carbon emissions
IPAT	I = Human Impact, P = Population, A = Affluence, T = Technology
LMDI	Logarithmic Mean Divisia Index
NBES	National building energy savings
TLS	Total link strength

Appendix A

Table A1. Citing articles of ‘Zhou N., 2018, NAT. ENERGY, V3, P978, doi:10.1038/s41560-018-0253-6’.

Rank	Citing Articles	Type	Times Cited	Reference
	Author, Year, Journal, Volume, Page/Article Number, doi			
1	Ma M.D., 2019, <i>Energ. Convers. Manage.</i> , V198, Article No.111915, doi:10.1016/j.enconman.2019.111915	Article	104 [‡]	[76]
2	Liang Y., 2019, <i>Sci. Total Environ.</i> , V677, P315-327, doi:10.1016/j.scitotenv.2019.04.289	Article	73 [‡]	[77]
3	Ma M.D., 2020, <i>Appl. Energy</i> , V273, Article No.115247, doi:10.1016/j.apenergy.2020.115247	Article	70 [‡]	[7]
4	Liu W., 2019, <i>J. Energy Chem.</i> , V1, Article No. 100008, doi:10.1016/j.enchem.2019.100008	Review	40	[130]
5	Langevin J., 2019, <i>Joule</i> , V3, P2403-2424, doi:10.1016/j.joule.2019.07.013	Article	27	[131]
6	Zhang X.G., 2019, <i>J. Co₂ Util.</i> , V33, P394-404, doi:10.1016/j.jcou.2019.06.019	Article	27	[132]

7	Jiang J.J., 2019, <i>Renew. Sust. Energ. Rev.</i> , V112, P813–833, doi:10.1016/j.rser.2019.06.024	Review	23	[133]
8	Zhang X., 2020, <i>Appl. Energ.</i> , V261, Article No. 114353, doi:10.1016/j.apenergy.2019.114353	Article	22	[134]
9	Khanna N., 2020, <i>Appl. Energ.</i> , V242, P12–26, doi:10.1016/j.apenergy.2019.03.116	Article	21	[135]
10	Li B., 2019, <i>Sci. Total Environ.</i> , V706, Article No.135716, doi:10.1016/j.scitotenv.2019.135716	Article	20	[88]
11	Cao Z., 2019, <i>Appl. Energ.</i> , V238, P 442–452, doi:10.1016/j.apenergy.2019.01.106	Article	19	[136]
12	Pan Y., 2020, <i>Appl. Energ.</i> , V268, Article No.114965, doi:10.1016/j.apenergy.2020.114965	Article	16	[137]
13	Dai B.M., 2020, <i>Energ. Convers. Manage.</i> , V209, Article No.112594, doi:10.1016/j.enconman.2020.112594	Article	15	[138]
14	Guo S.Y., 2021, <i>Energy</i> , V214, Article No. 119063, doi:10.1016/j.energy.2020.119063	Article	13	[92]
15	Duan H.M., 2020, <i>J. Clean. Prod.</i> , V260, Article No. 120929, doi:10.1016/j.jclepro.2020.120929	Article	12	[139]
16	Xian Y.J., 2019, <i>J. Clean. Prod.</i> , V221, P457–468, doi:10.1016/j.jclepro.2019.02.266	Article	10	[140]
17	Wang Y.S., 2020, <i>J. Clean. Prod.</i> , V251, Article No. 119637, doi:10.1016/j.jclepro.2019.119637	Article	9	[141]
18	Li W., 2019, <i>J. Mater. Chem. A</i> , V7, P25010–25019, doi:10.1039/c9ta09227g	Article	9	[142]
19	Chen Y.X., 2020, <i>Energ. Buildings</i> , V222, Article No.110100, doi:10.1016/j.enbuild.2020.110100	Article	8	[143]
20	Zhang S.C., 2021, <i>Energ. Buildings</i> , V241, Article No. 110938, doi:10.1016/j.enbuild.2021.110938	Article	7	[144]
21	Mata E., 2020, <i>Environ. Res. Lett.</i> , V15, Article No.113003, doi:10.1088/1748-9326/abb69f	Review	7	[145]
22	Zhu W.N., 2020, <i>J. Clean. Prod.</i> , V269, Article No. 122438, doi:10.1016/j.jclepro.2020.122438	Article	7	[146]
23	Liu W., 2019, <i>Energ. Convers. Manage.</i> , V199, Article No. 111943, doi:10.1016/j.enconman.2019.111915	Article	7	[147]
24	Deb C., 2021, <i>Renew. Sust. Energ. Rev.</i> , V144, Article No.110990, doi:10.1016/j.rser.2021.110990	Review	6	[148]
25	Zhang S.C., 2020, <i>Energy</i> , V213, Article No. 118792, doi:10.1016/j.energy.2020.118792	Article	6	[149]
26	Memon S., 2020, <i>Energ. Buildings</i> , V227, Article No. 110430, doi:10.1016/j.enbuild.2020.110430	Article	6	[150]
27	Liu Q.B., 2020, <i>Energ. Buildings</i> , V224, Article No. 110242, doi:10.1016/j.enbuild.2020.110242	Article	6	[151]
28	Yu B.Y., 2020, <i>Ecol. Econ.</i> , V13, Article No.3210, doi:10.1016/j.ecolecon.2020.106706	Article	6	[152]
29	Ding C., 2021, <i>Energies</i> , V14, Article No. 7461, doi:10.3390/en13123210	Article	6	[153]
30	Li H.M., 2021, <i>Energ. Buildings</i> , V244, Article No. 111011, doi:10.1016/j.enbuild.2021.111011	Article	5	[154]
31	Li H.R., 2021, <i>Energ. Convers. Manage.</i> , V231, Article No. 113648, doi:10.1016/j.enconman.2020.113648	Article	5	[155]

32	Liu P., 2020, Appl. Energ., V277, Article No. 115546, doi:10.1016/j.apenergy.2020.115546	Article	5	[156]
33	Zhang L.H., 2020, J. Clean. Prod., V271, Article No.122696, doi:10.1016/j.jclepro.2020.122696	Article	5	[157]
34	Mathew D., 2020, IET Power Electron., V13, P1487–1499, doi:10.1049/iet-pel.2019.1237	Review	5	[158]
35	Li L.X., 2021, Energy, V227, Article No. 120460, doi:10.1016/j.energy.2021.120460	Article	4	[159]
36	Mahapatra B., 2021, Energy, V227, Article No. 120485, doi:10.1016/j.energy.2021.120485	Article	4	[160]
37	Nematchoua M.K., 2020, Renew. Energ., V162, P81–97, doi:10.1016/j.renene.2020.07.141	Article	4	[161]
38	Levesque A., 2021, Environ. Res. Lett., V16, Article No. 054071, doi:10.1088/1748-9326/abdf07	Article	3	[162]
39	Yan B., 2021, Renew. Energ., V54, P 2193–2220, doi:10.1007/s10462-020-09902-w	Review	3	[163]
40	Shi Q.W., 2020, Sustainability, V12, Article No. 2695, doi:10.3390/su12072695	Article	3	[164]
41	Wu W.T., 2020, Renew. Sust. Energ. Rev., V117, Article No. 109516, doi:10.1016/j.rser.2019.109516	Article	3	[165]
42	Yu L., 2021, Ieee Internet Things, V8, P 12046–12063, doi:10.1109/JIOT.2021.3078462	Review	2	[166]
43	Zhong X.Y., 2021, J. Clean. Prod., V305, Article No.127098, doi:10.1016/j.jclepro.2021.127098	Article	2	[167]
44	Nam E., 2021, J. Clean. Prod., V300, Article No.126962, doi:10.1016/j.jclepro.2021.126962	Article	2	[168]
45	Wang S.Y., 2021, Build. Environ., V195, Article No. 107777, doi:10.1016/j.buildenv.2021.107777	Article	2	[169]
46	Malek M., 2021, Materials, V14, Article No.1888, doi:10.3390/ma14081888	Article	2	[170]
47	Zhang T., 2021, Resour. Conserv. Recy., V164, Article No.105124, doi:10.1016/j.resconrec.2020.105124	Article	2	[171]
48	Lin J., 2019, Sci. Rep-uk, V9, Article No. 16095, doi:10.1038/s41598-019-52653-0	Article	2	[172]
49	Shimoda Y., 2021, Appl. Energ., V303, Article No. 117510, doi:10.1016/j.apenergy.2021.117510	Article	1	[173]
50	Li W., 2021, Therm. Sci. Eng. Prog., V25, Article No. 101033, doi:10.1016/j.tsep.2021.101033	Article	1	[174]
51	Tang B.J., 2021, Appl. Energ., V298, Article No. 117213, doi:10.1016/j.apenergy.2021.117213	Article	1	[12]
52	Edelenbosch O.Y., 2021, Technol. Forecast Soc. Change, V170, Article No. 120887, doi:10.1016/j.techfore.2021.120887	Article	1	[175]
53	Tang B.J., 2021, J. Clean. Prod., V 307, Article No. 127206, doi:10.1016/j.jclepro.2021.127206	Article	1	[176]
54	Zhao Y.J., 2021, Renew. Sust. Energ. Rev., V 145, Article No. 111091, doi:10.1016/j.rser.2021.111091	Article	1	[177]
55	Yue H., 2021, J. Clean. Prod., V 301, Article No. 126978, doi:10.1016/j.jclepro.2021.126978	Article	1	[178]
56	Nibedita B., 2021, Environ. Sci. Pollut. R., V28, P56938–56954, doi:10.1007/s11356-021-14642-7	Article	1	[179]

57	Cao X.Y., 2021, <i>Energ. Buildings</i> , V 236, Article No. 110767, doi:10.1016/j.enbuild.2021.110767	Article	1	[180]
58	Meuer J., 2021, <i>Energ. Buildings</i> , V 235, Article No. 110710, doi:10.1016/j.enbuild.2020.110710	Article	1	[181]
59	Cheng S.L., 2021, <i>Environ. Sci. Technol.</i> , V55, P 813–822, doi:10.1021/acs.est.0c04026	Article	1	[182]
60	Shi Q.W., 2020, <i>Sustainability</i> , V12, Article No.10432, doi:10.3390/su122410432	Article	1	[183]
61	Zhang L.H., 2020, <i>J. Clean. Prod.</i> , V272, Article No. 122760, doi:10.1016/j.jclepro.2020.122760	Article	1	[184]
62	Liu Y.S., 2022, <i>Renew. Sust. Energ. Rev.</i> , V154, Article No. 111811, doi:10.1016/j.rser.2021.111811	Article	0	[185]
63	Li K., 2022, <i>Appl. Energy</i> , V306, Article No. 118098, doi:10.1016/j.apenergy.2021.118098	Article	0	[117]
64	Meng M., 2022, <i>Energy</i> , V239, Article No. 121912, doi:10.1016/j.energy.2021.121912	Article	0	[186]
65	Yamaguchi Y., 2022, <i>Appl. Energy</i> , V306, Article No. 117907, doi:10.1016/j.apenergy.2021.117907	Article	0	[187]
66	Al Shawa B., 2021, <i>Energ. Buildings</i> , V254, Article No.111634, doi:10.1016/j.enbuild.2021.111634	Review	0	[188]
67	Lin J., 2021, <i>Appl. Energy</i> , V304, Article No. 117741, doi:10.1016/j.apenergy.2021.117741	Article	0	[189]
68	Zhang S.C., 2021, <i>Energ. Policy</i> , V159, Article No. 112661, doi:10.1016/j.enpol.2021.112661	Article	0	[190]
69	Su C., 2021, <i>Energies</i> , V14, Article No. 7461, doi:10.3390/en14227461	Article	0	[191]
70	Zhong X.Y., 2021, <i>Nat. Commun.</i> , V12, Article No. 6126, doi:10.1038/s41467-021-26212-z	Article	0	[192]
71	Fan G.J., 2021, <i>Front. Earth Sci.</i> , V9, Article No. 694729, doi:10.3389/feart.2021.694729	Article	0	[193]
72	Jia J.J., 2021, <i>Energ. Effic.</i> , V14, Article No. 65, doi:10.1007/s12053-021-09974-9	Article	0	[194]
73	Liu J.L., 2021, <i>Renew. Sust. Energ. Rev.</i> , V149, Article No. 111336, doi:10.1016/j.rser.2021.111336	Article	0	[195]
74	Wang L., 2021, <i>Appl. Energy</i> , V299, Article No. 117303, doi:10.1016/j.apenergy.2021.117303	Article	0	[196]
75	Zhang S.C., 2021, <i>Adv. Clim. Chang. Res.</i> , V12, P734–743, doi:10.1016/j.accre.2021.07.004	Article	0	[197]
76	Chi F.A., 2021, <i>Sol. Energy</i> , V225, P1026–1047, doi:10.1016/j.solener.2021.08.020	Article	0	[198]
77	Liu Q.C., 2021, <i>J. Ind. Ecol.</i> , doi:10.1111/jiec.13182	Article	0	[199]
78	Yang X.Y., 2021, <i>Int. J. Life Cycle Ass.</i> , V26, P1721–1734, doi:10.1007/s11367-021-01960-8	Article	0	[200]
79	Yue H., 2021, <i>Energ. Effic.</i> , V14, Article No. 60, doi:10.1007/s12053-021-09979-4	Review	0	[201]
80	Vand B., 2021, <i>Energ. Convers. Manage.</i> , Article No. 114178, doi:10.1016/j.enconman.2021.114178	Article	0	[202]
81	Jiang J.J., 2021, <i>Environ. Sci. Technol.</i> , V55, P7225–7236, doi:10.1021/acs.est.0c06952	Article	0	[203]

82	Tong H., 2019, J. Clean. Prod., V45, P10989–10996, doi:10.1039/d1nj01464a	Review	0	[204]
83	Gou S.W., 2021, Arab. J. Geosci., V14, Article No. 803, doi:10.1007/s12517-021-07104-4	Article	0	[205]
84	Fan G.J., 2021, Oil Gas Sci. Technol., V76, Article No. 30, doi:10.2516/ogst/2021007	Article	0	[206]
85	Yue H., 2021, Appl. Energy., V282, Article No. 116241, doi:10.1016/j.apenergy.2020.116241	Article	0	[207]
Note: † Highly cited paper.				

References

- Chang, C.-C. A multivariate causality test of carbon dioxide emissions, energy consumption and economic growth in China. *Appl. Energy* **2010**, *87*, 3533–3537. <https://doi.org/10.1016/j.apenergy.2010.05.004>.
- Zuo, J.; Zhao, Z.-Y. Green building research—current status and future agenda: A review. *Renew. Sustain. Energy Rev.* **2014**, *30*, 271–281. <https://doi.org/10.1016/j.rser.2013.10.021>.
- Wan, K.K.W.; Li, D.H.W.; Pan, W.; Lam, J.C. Impact of climate change on building energy use in different climate zones and mitigation and adaptation implications. *Appl. Energy* **2012**, *97*, 274–282. <https://doi.org/10.1016/j.apenergy.2011.11.048>.
- Santamouris, M. Innovating to zero the building sector in Europe: Minimising the energy consumption, eradication of the energy poverty and mitigating the local climate change. *Sol. Energy* **2016**, *128*, 61–94. <https://doi.org/10.1016/j.solener.2016.01.021>.
- Zhao, X.B.; Zuo, J.; Wu, G.D.; Huang, C. A bibliometric review of green building research 2000–2016. *Archit. Sci. Rev.* **2019**, *62*, 74–88. <https://doi.org/10.1080/00038628.2018.1485548>.
- Global Alliance for Buildings and Construction. Towards a Zero-Emission, Efficient and Resilient Buildings and Construction Sector. 2019. Available online: <https://www.worldgbc.org/news-media/2019-global-status-report-buildings-and-construction> (accessed on 30 November 2021).
- Ma, M.; Ma, X.; Cai, W.; Cai, W. Low carbon roadmap of residential building sector in China: Historical mitigation and prospective peak. *Appl. Energy* **2020**, *273*, 115247. <https://doi.org/10.1016/j.apenergy.2020.115247>.
- Lu, H.; Ma, X.; Ma, M.; Zhu, S. Energy price prediction using data-driven models: A decade review. *Comput. Sci. Rev.* **2021**, *39*, 100356. <https://doi.org/10.1016/j.cosrev.2020.100356>.
- Eom, J.; Clarke, L.; Kim, S.H.; Kyle, P.; Patel, P. China's building energy demand: Long-term implications from a detailed assessment. *Energy* **2012**, *46*, 405–419. <https://doi.org/10.1016/j.energy.2012.08.009>.
- Pérez-Lombard, L.; Ortiz, J.; Pout, C. A review on buildings energy consumption information. *Energy Build.* **2008**, *40*, 394–398. <https://doi.org/10.1016/j.enbuild.2007.03.007>.
- Li, X.; Dong, M.; Jiang, D.; Li, S.; Shang, Y. The effect of surface roughness on normal restitution coefficient, adhesion force and friction coefficient of the particle-wall collision. *Powder Technol.* **2020**, *362*, 17–25. <https://doi.org/10.1016/j.powtec.2019.11.120>.
- Tang, B.-J.; Guo, Y.-Y.; Yu, B.; Harvey, L.D.D. Pathways for decarbonizing China's building sector under global warming thresholds. *Appl. Energy* **2021**, *298*, 117213. <https://doi.org/10.1016/j.apenergy.2021.117213>.
- Wang, M.; Wang, P.; Wu, L.; Yang, R.-P.; Feng, X.-Z.; Zhao, M.-X.; Du, X.-L.; Wang, Y.-J. Criteria for assessing carbon emissions peaks at provincial level in China. *Adv. Clim. Chang. Res.* **2021**, *13*, 131–137. <https://doi.org/10.1016/j.accre.2021.11.006>.
- Wu, X.; Tian, Z.; Guo, J. A review of the theoretical research and practical progress of carbon neutrality. *Sustain. Oper. Comput.* **2022**, *3*, 54–66. <https://doi.org/10.1016/j.susoc.2021.10.001>.
- Zou, C.; Xue, H.; Xiong, B.; Zhang, G.; Pan, S.; Jia, C.; Wang, Y.; Ma, F.; Sun, Q.; Guan, C.; et al. Connotation, innovation and vision of “carbon neutrality”. *Nat. Gas Ind. B* **2021**, *8*, 523–537. <https://doi.org/10.1016/j.ngib.2021.08.009>.
- UNFCC. Copenhagen Accord. In Proceedings of the United Nations Climate Change Conference in Copenhagen, Copenhagen, Denmark, 7–18 December 2009.
- Berardi, U. Building Energy Consumption in US, EU, and BRIC Countries. *Procedia Eng.* **2015**, *118*, 128–136. <https://doi.org/10.1016/j.proeng.2015.08.411>.
- Fang, K.; Li, C.; Tang, Y.; He, J.; Song, J. China's pathways to peak carbon emissions: New insights from various industrial sectors. *Appl. Energy* **2022**, *306*, 118039. <https://doi.org/10.1016/j.apenergy.2021.118039>.
- Qi, Y.; Stern, N.; He, J.-K.; Lu, J.-Q.; Liu, T.-L.; King, D.; Wu, T. The policy-driven peak and reduction of China's carbon emissions. *Adv. Clim. Chang. Res.* **2020**, *11*, 65–71. <https://doi.org/10.1016/j.accre.2020.05.008>.
- Broadstock, D.; Ji, Q.; Managi, S.; Zhang, D. Pathways to carbon neutrality: Challenges and opportunities. *Resour. Conserv. Recycl.* **2021**, *169*, 105472. <https://doi.org/10.1016/j.resconrec.2021.105472>.
- Mallapaty, S. How China could be carbon neutral by mid-century. *Nature* **2020**, *586*, 482–483. <https://doi.org/10.1038/d41586-020-02927-9>.
- The White House. Administration Announces U.S. Emission Target for Copenhagen; President to Attend Copenhagen Climate Talks; Office of the Press Secretary, The White House: Washington, DC, USA, 2009.
- HM Government. *Climate Change Act 2008*; The Stationery Office Limited, London, UK, 2008.

24. You, F.; Hu, D.; Zhang, H.; Guo, Z.; Zhao, Y.; Wang, B.; Yuan, Y. Carbon emissions in the life cycle of urban building system in China—A case study of residential buildings. *Ecol. Complex.* **2011**, *8*, 201–212. <https://doi.org/10.1016/j.ecocom.2011.02.003>.
25. Zhang, Y.; Yan, D.; Hu, S.; Guo, S. Modelling of energy consumption and carbon emission from the building construction sector in China, a process-based LCA approach. *Energy Policy* **2019**, *134*, 110949. <https://doi.org/10.1016/j.enpol.2019.110949>.
26. Danatzko, J.M.; Sezen, H.; Chen, Q. Sustainable design and energy consumption analysis for structural components. *J. Green Build.* **2013**, *8*, 120–135. <https://doi.org/10.3992/jgb.8.1.120>.
27. Sozer, H. Improving energy efficiency through the design of the building envelope. *Build. Environ.* **2010**, *45*, 2581–2593. <https://doi.org/10.1016/j.buildenv.2010.05.004>.
28. Lam, P.T.I.; Chan, E.H.W.; Poon, C.S.; Chau, C.K.; Chun, K.P. Factors affecting the implementation of green specifications in construction. *J. Environ. Manag.* **2010**, *91*, 654–661. <https://doi.org/10.1016/j.jenvman.2009.09.029>.
29. Chen, M.; Ma, M.; Lin, Y.; Ma, Z.; Li, K. Carbon Kuznets curve in China's building operations: Retrospective and prospective trajectories. *Sci. Total Environ.* **2022**, *803*, 150104. <https://doi.org/10.1016/j.scitotenv.2021.150104>.
30. Ma, M.; Pan, T.; Ma, Z. Examining the Driving Factors of Chinese Commercial Building Energy Consumption from 2000 to 2015: A STIRPAT Model Approach. *J. Eng. Sci. Technol. Rev.* **2017**, *10*, 28–34. <https://doi.org/10.25103/jestr.103.05>.
31. Yan, R.; Ma, M.; Pan, T. Estimating energy savings in Chinese residential buildings from 2001 to 2015: A decomposition analysis. *J. Eng. Sci. Technol. Rev.* **2017**, *10*, 107–113. <https://doi.org/10.25103/jestr.101.15>.
32. Ma, M.; Cai, W.; Cai, W. Carbon abatement in China's commercial building sector: A bottom-up measurement model based on Kaya-LMDI methods. *Energy* **2018**, *165*, 350–368. <https://doi.org/10.1016/j.energy.2018.09.070>.
33. Ma, M.; Cai, W. Do commercial building sector-derived carbon emissions decouple from the economic growth in Tertiary Industry? A case study of four municipalities in China. *Sci. Total Environ.* **2019**, *650*, 822–834. <https://doi.org/10.1016/j.scitotenv.2018.08.078>.
34. Hong, T.; Piette, M.A.; Chen, Y.; Lee, S.H.; Taylor-Lange, S.C.; Zhang, R.; Sun, K.; Price, P. Commercial building energy saver: An energy retrofit analysis toolkit. *Appl. Energy* **2015**, *159*, 298–309. <https://doi.org/10.1016/j.apenergy.2015.09.002>.
35. Zhang, S.; Xiang, X.; Ma, Z.; Ma, M.; Zou, C. Carbon neutral roadmap of commercial building operations by mid-century: Lessons from China. *Buildings* **2021**, *11*, 510. <https://doi.org/10.3390/buildings11110510>.
36. Zhang, S.; Ma, M.; Li, K.; Ma, Z.; Feng, W.; Cai, W. Historical carbon abatement in the commercial building operation: China versus the US. *Energy Econ.* **2022**, *105*, 105712. <https://doi.org/10.1016/j.eneco.2021.105712>.
37. Tian, Z.; Zhang, S.; Li, H.; Jiang, Y.; Dong, J.; Zhang, B.; Yi, R. Investigations of Nearly (net) Zero Energy Residential Buildings in Beijing. *Procedia Eng.* **2015**, *121*, 1051–1057. <https://doi.org/10.1016/j.proeng.2015.09.102>.
38. Zheng, X.; Wei, C.; Qin, P.; Guo, J.; Yu, Y.; Song, F.; Chen, Z. Characteristics of residential energy consumption in China: Findings from a household survey. *Energy Policy* **2014**, *75*, 126–135. <https://doi.org/10.1016/j.enpol.2014.07.016>.
39. Yao, C.; Chen, C.; Li, M. Analysis of rural residential energy consumption and corresponding carbon emissions in China. *Energy Policy* **2012**, *41*, 445–450. <https://doi.org/10.1016/j.enpol.2011.11.005>.
40. Zhang, L.; Yang, Z.; Chen, B.; Chen, G. Rural energy in China: Pattern and policy. *Renew. Energy* **2009**, *34*, 2813–2823. <https://doi.org/10.1016/j.renene.2009.04.006>.
41. Zhang, X.; Luo, L.; Skitmore, M. Household carbon emission research: An analytical review of measurement, influencing factors and mitigation prospects. *J. Clean. Prod.* **2015**, *103*, 873–883. <https://doi.org/10.1016/j.jclepro.2015.04.024>.
42. Lu, H.; Ma, X.; Ma, M. A hybrid multi-objective optimizer-based model for daily electricity demand prediction considering COVID-19. *Energy* **2021**, *219*, 119568. <https://doi.org/10.1016/j.energy.2020.119568>.
43. Cai, W.; Liu, C.; Jia, S.; Chan, F.T.S.; Ma, M.; Ma, X. An emergy-based sustainability evaluation method for outsourcing machining resources. *J. Clean. Prod.* **2020**, *245*, 118849. <https://doi.org/10.1016/j.jclepro.2019.118849>.
44. Ma, M.; Yan, R.; Du, Y.; Ma, X.; Cai, W.; Xu, P. A methodology to assess China's building energy savings at the national level: An IPAT-LMDI model approach. *J. Clean. Prod.* **2017**, *143*, 784–793. <https://doi.org/10.1016/j.jclepro.2016.12.046>.
45. Ahmad, A.S.; Hassan, M.Y.; Abdullah, M.P.; Rahman, H.A.; Hussin, F.; Abdullah, H.; Saidur, R. A review on applications of ANN and SVM for building electrical energy consumption forecasting. *Renew. Sustain. Energy Rev.* **2014**, *33*, 102–109. <https://doi.org/10.1016/j.rser.2014.01.069>.
46. Fadzli Haniff, M.; Selamat, H.; Yusof, R.; Buyamin, S.; Sham Ismail, F. Review of HVAC scheduling techniques for buildings towards energy-efficient and cost-effective operations. *Renew. Sustain. Energy Rev.* **2013**, *27*, 94–103. <https://doi.org/10.1016/j.rser.2013.06.041>.
47. Huseien, G.F.; Shah, K.W. A review on 5G technology for smart energy management and smart buildings in Singapore. *Energy AI* **2022**, *7*, 100116. <https://doi.org/10.1016/j.egyai.2021.100116>.
48. Tetteh, E.K.; Amankwa, M.O.; Yeboah, C.; Amankwa, M.O. Emerging carbon abatement technologies to mitigate energy-carbon footprint- a review. *Clean. Mater.* **2021**, *2*, 100020. <https://doi.org/10.1016/j.clema.2021.100020>.
49. Wang, F.; Harindintwali, J.D.; Yuan, Z.; Wang, M.; Wang, F.; Li, S.; Yin, Z.; Huang, L.; Fu, Y.; Li, L.; et al. Technologies and perspectives for achieving carbon neutrality. *Innovation* **2021**, *2*, 100180. <https://doi.org/10.1016/j.xinn.2021.100180>.
50. Xiang, X.; Ma, X.; Ma, Z.; Ma, M.; Cai, W. Python-LMDI: A tool for index decomposition analysis to building carbon emissions. *Buildings* **2022**, *12*, 83. <https://doi.org/10.3390/buildings12010083>.
51. Yang, Z.; Liu, B.; Zhao, H.B. Energy saving in building construction in China: A review. *Int. J. Green Energy* **2004**, *1*, 209–225. <https://doi.org/10.1081/ge-120038753>.

52. Lu, M.; Lai, J. Review on carbon emissions of commercial buildings. *Renew. Sustain. Energy Rev.* **2020**, *119*, 109545. <https://doi.org/10.1016/j.rser.2019.109545>.
53. GhaffarianHoseini, A.; Dahlan, N.D.; Berardi, U.; GhaffarianHoseini, A.; Makaremi, N.; GhaffarianHoseini, M. Sustainable energy performances of green buildings: A review of current theories, implementations and challenges. *Renew. Sustain. Energy Rev.* **2013**, *25*, 1–17. <https://doi.org/10.1016/j.rser.2013.01.010>.
54. Han, S.; Yao, R.; Li, N. The development of energy conservation policy of buildings in China: A comprehensive review and analysis. *J. Build. Eng.* **2021**, *38*, 102229. <https://doi.org/10.1016/j.jobte.2021.102229>.
55. Verma, P.; Kumari, T.; Raghubanshi, A.S. Energy emissions, consumption and impact of urban households: A review. *Renew. Sustain. Energy Rev.* **2021**, *147*, 111210. <https://doi.org/10.1016/j.rser.2021.111210>.
56. Wang, Y.; Mauree, D.; Sun, Q.; Lin, H.; Scartezzini, J.L.; Wennersten, R. A review of approaches to low-carbon transition of high-rise residential buildings in China. *Renew. Sustain. Energy Rev.* **2020**, *131*, 109990. <https://doi.org/10.1016/j.rser.2020.109990>.
57. Akbarnezhad, A.; Xiao, J.Z. Estimation and minimization of embodied carbon of buildings: A review. *Buildings* **2017**, *7*, 5. <https://doi.org/10.3390/buildings7010005>.
58. Ma, M.; Cai, W.; Wu, Y. China act on the energy efficiency of civil buildings (2008): A decade review. *Sci. Total Environ.* **2019**, *651*, 42–60. <https://doi.org/10.1016/j.scitotenv.2018.09.118>.
59. Chau, C.K.; Leung, T.M.; Ng, W.Y. A review on Life Cycle Assessment, Life Cycle Energy Assessment and Life Cycle Carbon Emissions Assessment on buildings. *Appl. Energy* **2015**, *143*, 395–413. <https://doi.org/10.1016/j.apenergy.2015.01.023>.
60. Pouris, A.; Pouris, A. Scientometrics of a pandemic: HIV/AIDS research in South Africa and the World. *Scientometrics* **2011**, *86*, 541–552. <https://doi.org/10.1007/s11192-010-0277-6>.
61. Archambault, E.; Campbell, D.; Gingras, Y.; Lariviere, V. Comparing of science bibliometric statistics obtained from the Web of Science and Scopus. *J. Am. Soc. Inf. Sci. Technol.* **2009**, *60*, 1320–1326. <https://doi.org/10.1002/asi.21062>.
62. Singh, V.K.; Singh, P.; Karmakar, M.; Leta, J.; Mayr, P. The journal coverage of Web of Science, Scopus and Dimensions: A comparative analysis. *Scientometrics* **2021**, *126*, 5113–5142. <https://doi.org/10.1007/s11192-021-03948-5>.
63. Tan, H.; Li, J.; He, M.; Li, J.; Zhi, D.; Qin, F.; Zhang, C. Global evolution of research on green energy and environmental technologies: A bibliometric study. *J. Environ. Manag.* **2021**, *297*, 113382. <https://doi.org/10.1016/j.jenvman.2021.113382>.
64. Niazi, M.A. CiteSpace: A Practical Guide for Mapping Scientific Literature. *Complex Adapt. Syst. Model.* **2016**, *4*, 3. <https://doi.org/10.1186/s40294-016-0036-5>.
65. Li, X.; Wu, P.; Shen, G.Q.; Wang, X.; Teng, Y. Mapping the knowledge domains of Building Information Modeling (BIM): A bibliometric approach. *Autom. Constr.* **2017**, *84*, 195–206. <https://doi.org/10.1016/j.autcon.2017.09.011>.
66. Morgan, J. Paris COP 21: Power that Speaks the Truth? *Globalizations* **2016**, *13*, 943–951. <https://doi.org/10.1080/14747731.2016.1163863>.
67. Torstad, V.H. Participation, ambition and compliance: Can the Paris Agreement solve the effectiveness trilemma? *Environ. Polit.* **2020**, *29*, 761–780. <https://doi.org/10.1080/09644016.2019.1710322>.
68. Andresen, S.; Skjaeseth, J.B.; Jevnaker, T.; Wettstad, J. The Paris Agreement: Consequences for the EU and Carbon Markets? *Politics Gov.* **2016**, *4*, 188–196. <https://doi.org/10.17645/pag.v4i3.652>.
69. The Climate Ambition Summit 2020 celebrated this year five years of the adoption of the Paris Agreement. *Future Food* **2020**, *8*, 76–76.
70. Ma, M.D.; Yan, R.; Cai, W.G. Energy savings evaluation in public building sector during the 10th–12th FYP periods of China: An extended LMDI model approach. *Nat. Hazards* **2018**, *92*, 429–441. <https://doi.org/10.1007/s11069-018-3210-6>.
71. State_Council, 2016. “Thirteenth Five-Year Plan” Work Plan for Controlling Greenhouse Gas Emissions, Beijing, China. Available online: http://www.gov.cn/zhengce/content/2016-11/04/content_5128619.htm (accessed on 16 August 2021). (In Chinese)
72. Chen, C.M.; Hu, Z.G.; Liu, S.B.; Tseng, H. Emerging trends in regenerative medicine: A scientometric analysis in CiteSpace. *Expert Opin. Biol. Ther.* **2012**, *12*, 593–608. <https://doi.org/10.1517/14712598.2012.674507>.
73. Macintosh, A. Keeping warming within the 2 °C limit after Copenhagen. *Energy Policy* **2010**, *38*, 2964–2975. <https://doi.org/10.1016/j.enpol.2010.01.034>.
74. Small, H. Cocitation in scientific literature—New measure of relationship between 2 documents. *J. Am. Soc. Inf. Sci.* **1973**, *24*, 265–269. <https://doi.org/10.1002/asi.4630240406>.
75. Zhou, N.; Khanna, N.; Feng, W.; Ke, J.; Levine, M. Scenarios of energy efficiency and CO₂ emissions reduction potential in the buildings sector in China to year 2050. *Nat. Energy* **2018**, *3*, 978–984. <https://doi.org/10.1038/s41560-018-0253-6>.
76. Ma, M.; Ma, X.; Cai, W.; Cai, W. Carbon-dioxide mitigation in the residential building sector: A household scale-based assessment. *Energy Convers. Manag.* **2019**, *198*, 111915. <https://doi.org/10.1016/j.enconman.2019.111915>.
77. Liang, Y.; Cai, W.; Ma, M. Carbon dioxide intensity and income level in the Chinese megacities’ residential building sector: Decomposition and decoupling analyses. *Sci. Total Environ.* **2019**, *677*, 315–327. <https://doi.org/10.1016/j.scitotenv.2019.04.289>.
78. Ma, M.; Cai, W. What drives the carbon mitigation in Chinese commercial building sector? Evidence from decomposing an extended Kaya identity. *Sci. Total Environ.* **2018**, *634*, 884–899. <https://doi.org/10.1016/j.scitotenv.2018.04.043>.
79. Tan, X.; Lai, H.; Gu, B.; Zeng, Y.; Li, H. Carbon emission and abatement potential outlook in China’s building sector through 2050. *Energy Policy* **2018**, *118*, 429–439. <https://doi.org/10.1016/j.enpol.2018.03.072>.
80. Fargione, J.; Hill, J.; Tilman, D.; Polasky, S.; Hawthorne, P. Land clearing and the biofuel carbon debt. *Science* **2008**, *319*, 1235–1238. <https://doi.org/10.1126/science.1152747>.

81. Sartori, I.; Napolitano, A.; Voss, K. Net zero energy buildings: A consistent definition framework. *Energy Build.* **2012**, *48*, 220–232. <https://doi.org/10.1016/j.enbuild.2012.01.032>.
82. Lin, B.; Liu, H. CO₂ emissions of China's commercial and residential buildings: Evidence and reduction policy. *Build. Environ.* **2015**, *92*, 418–431. <https://doi.org/10.1016/j.buildenv.2015.05.020>.
83. McNeil, M.A.; Feng, W.; de la Rue du Can, S.; Khanna, N.Z.; Ke, J.; Zhou, N. Energy efficiency outlook in China's urban buildings sector through 2030. *Energy Policy* **2016**, *97*, 532–539. <https://doi.org/10.1016/j.enpol.2016.07.033>.
84. Harvey, L.D.D. Reducing energy use in the buildings sector: Measures, costs, and examples. *Energy Effic.* **2009**, *2*, 139–163. <https://doi.org/10.1007/s12053-009-9041-2>.
85. Chen, X.; Shuai, C.; Wu, Y.; Zhang, Y. Analysis on the carbon emission peaks of China's industrial, building, transport, and agricultural sectors. *Sci. Total Environ.* **2020**, *709*, 135768. <https://doi.org/10.1016/j.scitotenv.2019.135768>.
86. Huang, Y.; Liao, C.; Zhang, J.; Guo, H.; Zhou, N.; Zhao, D. Exploring potential pathways towards urban greenhouse gas peaks: A case study of Guangzhou, China. *Appl. Energy* **2019**, *251*, 113369. <https://doi.org/10.1016/j.apenergy.2019.113369>.
87. Wang, J.; Cai, H.; Li, L. Energy demand and carbon emission peak forecasting of Beijing based on leap energy simulation method. *Glob. Nest. J.* **2020**, *22*, 565–569. <https://doi.org/10.30955/gnj.003387>.
88. Li, B.; Han, S.; Wang, Y.; Wang, Y.; Li, J.; Wang, Y. Feasibility assessment of the carbon emissions peak in China's construction industry: Factor decomposition and peak forecast. *Sci. Total Environ.* **2020**, *706*, 135716. <https://doi.org/10.1016/j.scitotenv.2019.135716>.
89. Wang, Y.; Su, X.L.; Qi, L.; Shang, P.P.; Xu, Y.H. Feasibility of peaking carbon emissions of the power sector in China's eight regions: Decomposition, decoupling, and prediction analysis. *Environ. Sci. Pollut. Res.* **2019**, *26*, 29212–29233. <https://doi.org/10.1007/s11356-019-05909-1>.
90. Jiang, J.; Ye, B.; Liu, J. Research on the peak of CO₂ emissions in the developing world: Current progress and future prospect. *Appl. Energy* **2019**, *235*, 186–203. <https://doi.org/10.1016/j.apenergy.2018.10.089>.
91. Berardi, U. A cross-country comparison of the building energy consumptions and their trends. *Resour. Conserv. Recycl.* **2017**, *123*, 230–241. <https://doi.org/10.1016/j.resconrec.2016.03.014>.
92. Guo, S.; Yan, D.; Hu, S.; Zhang, Y. Modelling building energy consumption in China under different future scenarios. *Energy* **2021**, *214*, 119063. <https://doi.org/10.1016/j.energy.2020.119063>.
93. Peng, C.; Yan, D.; Guo, S.; Hu, S.; Jiang, Y. Building energy use in China: Ceiling and scenario. *Energy Build.* **2015**, *102*, 307–316. <https://doi.org/10.1016/j.enbuild.2015.05.049>.
94. Gil, L.; Bernardo, J. An approach to energy and climate issues aiming at carbon neutrality. *Renew. Energy Focus* **2020**, *33*, 37–42. <https://doi.org/10.1016/j.ref.2020.03.003>.
95. United Nations. Paris Agreement–Status of Ratification. 2018. Available online: <https://unfccc.int/process/the-paris-agreement/status-of-ratification> (accessed on 26 August 2021).
96. Yu, S.; Eom, J.; Evans, M.; Clarke, L. A long-term, integrated impact assessment of alternative building energy code scenarios in China. *Energy Policy* **2014**, *67*, 626–639. <https://doi.org/10.1016/j.enpol.2013.11.009>.
97. Su, K.; Lee, C.-M. When will China achieve its carbon emission peak? A scenario analysis based on optimal control and the STIRPAT model. *Ecol. Indic.* **2020**, *112*, 106138. <https://doi.org/10.1016/j.ecolind.2020.106138>.
98. Energy Information Administration. Analysis—Energy Sector Highlights. 2020. Available online: <https://www.eia.gov/international/overview/country/IND> (accessed on 10 January 2022).
99. RMI, India. Reducing Embodied Carbon Is Key to Meeting India's Climate Targets. 2021. Available online: <https://www.eia.gov/consumption/residential/> (accessed on 10 January 2022).
100. Goldemberg, J. The evolution of the energy and carbon intensities of developing countries. *Energy Policy* **2020**, *137*, 111060. <https://doi.org/10.1016/j.enpol.2019.111060>.
101. De La Peña, L.; Guo, R.; Cao, X.; Ni, X.; Zhang, W. Accelerating the energy transition to achieve carbon neutrality. *Resour. Conserv. Recycl.* **2022**, *177*, 105957. <https://doi.org/10.1016/j.resconrec.2021.105957>.
102. Tan, S.; Yang, J.; Yan, J.; Lee, C.; Hashim, H.; Chen, B. A holistic low carbon city indicator framework for sustainable development. *Appl. Energy* **2017**, *185*, 1919–1930. <https://doi.org/10.1016/j.apenergy.2016.03.041>.
103. Chen, L.; Cai, W.; Ma, M. Decoupling or delusion? Mapping carbon emission per capita based on the human development index in Southwest China. *Sci. Total Environ.* **2020**, *741*, 138722. <https://doi.org/10.1016/j.scitotenv.2020.138722>.
104. Ma, M.; Cai, W.; Cai, W.; Dong, L. Whether carbon intensity in the commercial building sector decouples from economic development in the service industry? Empirical evidence from the top five urban agglomerations in China. *J. Clean. Prod.* **2019**, *222*, 193–205. <https://doi.org/10.1016/j.jclepro.2019.01.314>.
105. Fang, K.; Tang, Y.; Zhang, Q.; Song, J.; Wen, Q.; Sun, H.; Ji, C.; Xu, A. Will China peak its energy-related carbon emissions by 2030? Lessons from 30 Chinese provinces. *Appl. Energy* **2019**, *255*, 113852. <https://doi.org/10.1016/j.apenergy.2019.113852>.
106. Yang, Y.; Li, B.; Yao, R. A method of identifying and weighting indicators of energy efficiency assessment in Chinese residential buildings. *Energy Policy* **2010**, *38*, 7687–7697. <https://doi.org/10.1016/j.enpol.2010.08.018>.
107. Kavgić, M.; Hilliard, T.; Swan, L. Opportunities for Implementation of MPC in Commercial Buildings. *Energy Procedia* **2015**, *78*, 2148–2153. <https://doi.org/10.1016/j.egypro.2015.11.300>.
108. Xiang, X.; Ma, X.; Ma, Z.; Ma, M. Operational Carbon Change in Commercial Buildings under the Carbon Neutral Goal: A LASSO-WOA Approach. *Buildings* **2022**, *12*, 54.

109. Wu, C.B.; Huang, G.H.; Xin, B.G.; Chen, J.K. Scenario analysis of carbon emissions' anti-driving effect on Qingdao's energy structure adjustment with an optimization model, Part I: Carbon emissions peak value prediction. *J. Clean. Prod.* **2018**, *172*, 466–474. <https://doi.org/10.1016/j.jclepro.2017.10.216>.
110. Huang, W.; Li, F.; Cui, S.-H.; Li, F.; Huang, L.; Lin, J.-Y. Carbon Footprint and Carbon Emission Reduction of Urban Buildings: A Case in Xiamen City, China. *Procedia Eng.* **2017**, *198*, 1007–1017. <https://doi.org/10.1016/j.proeng.2017.07.146>.
111. Li, D.; Huang, G.; Zhu, S.; Chen, L.; Wang, J. How to peak carbon emissions of provincial construction industry? Scenario analysis of Jiangsu Province. *Renew. Sustain. Energy Rev.* **2021**, *144*, 110953. <https://doi.org/10.1016/j.rser.2021.110953>.
112. Gomi, K.; Shimada, K.; Matsuoka, Y. A low-carbon scenario creation method for a local-scale economy and its application in Kyoto city. *Energy Policy* **2010**, *38*, 4783–4796. <https://doi.org/10.1016/j.enpol.2009.07.026>.
113. Farzaneh, H. Development of a Bottom-up Technology Assessment Model for Assessing the Low Carbon Energy Scenarios in the Urban System. *Energy Procedia* **2017**, *107*, 321–326. <https://doi.org/10.1016/j.egypro.2016.12.163>.
114. Jing, Q.; Bai, H.; Luo, W.; Cai, B.; Xu, H. A top-bottom method for city-scale energy-related CO₂ emissions estimation: A case study of 41 Chinese cities. *J. Clean. Prod.* **2018**, *202*, 444–455. <https://doi.org/10.1016/j.jclepro.2018.08.179>.
115. Yang, L.; Ma, Z.; Ma, M.; Xu, Y. Decarbonization, Environmental Regulation, and Economic Boom: An Indicator Assessment Based on the Industrial Waste. *Front. Energy Res.* **2022**, *9*, 838852. <https://doi.org/10.3389/fenrg.2021.838852>.
116. CSY, 2020. *China Statistical Yearbook*; China Statistical Publishing House: Beijing, China, 2020.
117. Li, K.; Ma, M.; Xiang, X.; Feng, W.; Ma, Z.; Cai, W.; Ma, X. Carbon reduction in commercial building operations: A provincial retrospection in China. *Appl. Energy* **2022**, *306*, 118098. <https://doi.org/10.1016/j.apenergy.2021.118098>.
118. Du, Q.; Han, X.; Li, Y.; Li, Z.; Xia, B.; Guo, X. The energy rebound effect of residential buildings: Evidence from urban and rural areas in China. *Energy Policy* **2021**, *153*, 112235. <https://doi.org/10.1016/j.enpol.2021.112235>.
119. Yang, X.; Jiang, Y.; Yang, M.; Shan, M. Energy and environment in Chinese rural housing: Current status and future perspective. *Front. Energy Power Eng. China* **2010**, *4*, 35–46. <https://doi.org/10.1007/s11708-010-0001-5>.
120. Zhuang, Z.; Li, Y.; Chen, B. Thermal storage performance analysis on Chinese kang. *Energy Build.* **2009**, *41*, 452–459. <https://doi.org/10.1016/j.enbuild.2008.11.006>.
121. Tonooka, Y.; Liu, J.; Kondou, Y.; Ning, Y.; Fukasawa, O. A survey on energy consumption in rural households in the fringes of Xian city. *Energy Build.* **2006**, *38*, 1335–1342. <https://doi.org/10.1016/j.enbuild.2006.04.011>.
122. Building Energy Research Center of Tsinghua University. *2020 Annual Report on China Building Energy Efficiency*; China Architecture and Building Press: Beijing, China, 2020. (In Chinese)
123. MOHURD. To Celebrate the 70th Anniversary of the Founding of the People's Republic of China, the Press Center Held the Second Press Conference. 2019. Available online: https://www.mohurd.gov.cn/xinwen/jryw/201909/20190926_241997.html (accessed on 14 December 2021). (in Chinese)
124. Zeng, X.; Zhao, Y.; Cheng, Z. Development and research of rural renewable energy management and ecological management information system under the background of beautiful rural revitalization strategy. *Sustain. Comput. Inform. Syst.* **2021**, *30*, 100553. <https://doi.org/10.1016/j.suscom.2021.100553>.
125. Li, J.; Chen, C.; Liu, H. Transition from non-commercial to commercial energy in rural China: Insights from the accessibility and affordability. *Energy Policy* **2019**, *127*, 392–403. <https://doi.org/10.1016/j.enpol.2018.12.022>.
126. Hu, X.; Xiang, Y.; Zhang, H.; Lin, Q.; Wang, W.; Wang, H. Active-passive combined energy-efficient retrofit of rural residence with non-benchmarked construction: A case study in Shandong province, China. *Energy Rep.* **2021**, *7*, 1360–1373. <https://doi.org/10.1016/j.egy.2021.02.045>.
127. Zhuang, Z.; Li, Y.; Chen, B.; Guo, J. Chinese kang as a domestic heating system in rural northern China—A review. *Energy Build.* **2009**, *41*, 111–119. <https://doi.org/10.1016/j.enbuild.2008.07.013>.
128. Xiaohua, W.; Zhenmin, F. Rural household energy consumption with the economic development in China: Stages and characteristic indices. *Energy Policy* **2001**, *29*, 1391–1397. [https://doi.org/10.1016/S0301-4215\(01\)00037-4](https://doi.org/10.1016/S0301-4215(01)00037-4).
129. Wang, P.; Liu, Q.; Qi, Y. Factors influencing sustainable consumption behaviors: A survey of the rural residents in China. *J. Clean. Prod.* **2014**, *63*, 152–165. <https://doi.org/10.1016/j.jclepro.2013.05.007>.
130. Liu, W.; Lustig, W.P.; Li, J. Luminescent inorganic-organic hybrid semiconductor materials for energy-saving lighting applications. *EnergyChem* **2019**, *1*, 100008. <https://doi.org/10.1016/j.enchem.2019.100008>.
131. Langevin, J.; Harris, C.B.; Reyna, J.L. Assessing the Potential to Reduce U.S. Building CO₂ Emissions 80% by 2050. *Joule* **2019**, *3*, 2403–2424. <https://doi.org/10.1016/j.joule.2019.07.013>.
132. Zhang, X.; Ranjith, P.G. Experimental investigation of effects of CO₂ injection on enhanced methane recovery in coal seam reservoirs. *J. CO₂ Util.* **2019**, *33*, 394–404. <https://doi.org/10.1016/j.jcou.2019.06.019>.
133. Jiang, J.; Ye, B.; Liu, J. Peak of CO₂ emissions in various sectors and provinces of China: Recent progress and avenues for further research. *Renew. Sustain. Energy Rev.* **2019**, *112*, 813–833. <https://doi.org/10.1016/j.rser.2019.06.024>.
134. Zhang, X.; Geng, Y.; Shao, S.; Wilson, J.; Song, X.; You, W. China's non-fossil energy development and its 2030 CO₂ reduction targets: The role of urbanization. *Appl. Energy* **2020**, *261*, 114353. <https://doi.org/10.1016/j.apenergy.2019.114353>.
135. Khanna, N.; Fridley, D.; Zhou, N.; Karali, N.; Zhang, J.; Feng, W. Energy and CO₂ implications of decarbonization strategies for China beyond efficiency: Modeling 2050 maximum renewable resources and accelerated electrification impacts. *Appl. Energy* **2019**, *242*, 12–26. <https://doi.org/10.1016/j.apenergy.2019.03.116>.

136. Cao, Z.; Liu, G.; Duan, H.; Xi, F.; Liu, G.; Yang, W. Unravelling the mystery of Chinese building lifetime: A calibration and verification based on dynamic material flow analysis. *Appl. Energy* **2019**, *238*, 442–452. <https://doi.org/10.1016/j.apenergy.2019.01.106>.
137. Pan, Y.; Zhang, L. Data-driven estimation of building energy consumption with multi-source heterogeneous data. *Appl. Energy* **2020**, *268*, 114965. <https://doi.org/10.1016/j.apenergy.2020.114965>.
138. Dai, B.; Zhao, X.; Liu, S.; Yang, Q.; Zhong, D.; Hao, Y.; Hao, Y. Energetic, exergetic and exergoeconomic assessment of transcritical CO₂ reversible system combined with dedicated mechanical subcooling (DMS) for residential heating and cooling. *Energy Convers. Manag.* **2020**, *209*, 112594. <https://doi.org/10.1016/j.enconman.2020.112594>.
139. Duan, H.; Wang, D.; Pang, X.; Liu, Y.; Zeng, S. A novel forecasting approach based on multi-kernel nonlinear multivariable grey model: A case report. *J. Clean. Prod.* **2020**, *260*, 120929. <https://doi.org/10.1016/j.jclepro.2020.120929>.
140. Xian, Y.; Yang, K.; Wang, K.; Wei, Y.-M.; Huang, Z. Cost-environment efficiency analysis of construction industry in China: A materials balance approach. *J. Clean. Prod.* **2019**, *221*, 457–468. <https://doi.org/10.1016/j.jclepro.2019.02.266>.
141. Wang, Y.; Wu, T.; Li, H.; Skitmore, M.; Su, B. A statistics-based method to quantify residential energy consumption and stock at the city level in China: The case of the Guangdong-Hong Kong-Macao Greater Bay Area cities. *J. Clean. Prod.* **2020**, *251*, 119637. <https://doi.org/10.1016/j.jclepro.2019.119637>.
142. Li, W.; Xia, X.X.; Li, S. Large-scale evaluation of cascaded adsorption heat pumps based on metal/covalent-organic frameworks. *J. Mater. Chem. A* **2019**, *7*, 25010–25019. <https://doi.org/10.1039/c9ta09227g>.
143. Chen, Y.; Yang, C.; Pan, X.; Yan, D. Design and operation optimization of multi-chiller plants based on energy performance simulation. *Energy Build.* **2020**, *222*, 110100. <https://doi.org/10.1016/j.enbuild.2020.110100>.
144. Zhang, S.; Fu, Y.; Yang, X.; Xu, W. Assessment of mid-to-long term energy saving impacts of nearly zero energy building incentive policies in cold region of China. *Energy Build.* **2021**, *241*, 110938. <https://doi.org/10.1016/j.enbuild.2021.110938>.
145. Mata, E.; Korpala, A.K.; Cheng, S.H.; Navarro, J.P.J.; Filippidou, F.; Reyna, J.; Wang, R. A map of roadmaps for zero and low energy and carbon buildings worldwide. *Environ. Res. Lett.* **2020**, *15*, 19. <https://doi.org/10.1088/1748-9326/abb69f>.
146. Zhu, W.; Feng, W.; Li, X.; Zhang, Z. Analysis of the embodied carbon dioxide in the building sector: A case of China. *J. Clean. Prod.* **2020**, *269*, 122438. <https://doi.org/10.1016/j.jclepro.2020.122438>.
147. Liu, W.; Chen, C.; Wu, H.; Guo, C.; Chen, Y.; Liu, W.; Cui, Z. Environmental life cycle assessment and techno-economic analysis of domestic hot water systems in China. *Energy Convers. Manag.* **2019**, *199*, 111943. <https://doi.org/10.1016/j.enconman.2019.111943>.
148. Deb, C.; Schlueter, A. Review of data-driven energy modelling techniques for building retrofit. *Renew. Sustain. Energy Rev.* **2021**, *144*, 110990. <https://doi.org/10.1016/j.rser.2021.110990>.
149. Zhang, S.; Xu, W.; Wang, K.; Feng, W.; Athienitis, A.; Hua, G.; Okumiya, M.; Yoon, G.; Cho, D.w.; Iyer-Raniga, U.; et al. Scenarios of energy reduction potential of zero energy building promotion in the Asia-Pacific region to year 2050. *Energy* **2020**, *213*, 118792. <https://doi.org/10.1016/j.energy.2020.118792>.
150. Memon, S.; Eames, P.C. Design and development of lead-free glass-metallic vacuum materials for the construction and thermal performance of smart fusion edge-sealed vacuum glazing. *Energy Build.* **2020**, *227*, 110430. <https://doi.org/10.1016/j.enbuild.2020.110430>.
151. Liu, Q.; Ren, J. Research on the building energy efficiency design strategy of Chinese universities based on green performance analysis. *Energy Build.* **2020**, *224*, 110242. <https://doi.org/10.1016/j.enbuild.2020.110242>.
152. Yu, B.; Yang, X.; Zhao, Q.; Tan, J. Causal Effect of Time-Use Behavior on Residential Energy Consumption in China. *Ecol. Econ.* **2020**, *175*, 106706. <https://doi.org/10.1016/j.ecolecon.2020.106706>.
153. Ding, C.; Zhou, N. Using Residential and Office Building Archetypes for Energy Efficiency Building Solutions in an Urban Scale: A China Case Study. *Energies* **2020**, *13*, 16. <https://doi.org/10.3390/en13123210>.
154. Li, H.; Qiu, P.; Wu, T. The regional disparity of per-capita CO₂ emissions in China's building sector: An analysis of macroeconomic drivers and policy implications. *Energy Build.* **2021**, *244*, 111011. <https://doi.org/10.1016/j.enbuild.2021.111011>.
155. Li, H.; Sun, B.; Zhang, C. Capacity design of a distributed energy system based on integrated optimization and operation strategy of exergy loss reduction. *Energy Convers. Manag.* **2021**, *231*, 113648. <https://doi.org/10.1016/j.enconman.2020.113648>.
156. Liu, P.; Lin, B.; Zhou, H.; Wu, X.; Little, J.C. CO₂ emissions from urban buildings at the city scale: System dynamic projections and potential mitigation policies. *Appl. Energy* **2020**, *277*, 115546. <https://doi.org/10.1016/j.apenergy.2020.115546>.
157. Zhang, L.; Ma, X.; Wang, Y.; Song, R.; Li, J.; Yuan, W.; Zhang, S. The increasing district heating energy consumption of the building sector in China: Decomposition and decoupling analysis. *J. Clean. Prod.* **2020**, *271*, 122696. <https://doi.org/10.1016/j.jclepro.2020.122696>.
158. Mathew, D.; Naidu, R.C. Investigation of single-stage transformerless buck-boost microinverters. *IET Power Electron.* **2020**, *13*, 1487–1499. <https://doi.org/10.1049/iet-pel.2019.1237>.
159. Li, L.; Cao, X.; Wang, P. Optimal coordination strategy for multiple distributed energy systems considering supply, demand, and price uncertainties. *Energy* **2021**, *227*, 120460. <https://doi.org/10.1016/j.energy.2021.120460>.
160. Mahapatra, B.; Irfan, M. Asymmetric impacts of energy efficiency on carbon emissions: A comparative analysis between developed and developing economies. *Energy* **2021**, *227*, 120485. <https://doi.org/10.1016/j.energy.2021.120485>.
161. Nematchoua, M.K.; Asadi, S.; Reiter, S. Influence of energy mix on the life cycle of an eco-neighborhood, a case study of 150 countries. *Renew. Energy* **2020**, *162*, 81–97. <https://doi.org/10.1016/j.renene.2020.07.141>.

162. Levesque, A.; Pietzcker, R.C.; Baumstark, L.; Luderer, G. Deep decarbonisation of buildings energy services through demand and supply transformations in a 1.5 degrees C scenario. *Environ. Res. Lett.* **2021**, *16*, 15. <https://doi.org/10.1088/1748-9326/abdf07>.
163. Yan, B.; Hao, F.; Meng, X. When artificial intelligence meets building energy efficiency, a review focusing on zero energy building. *Artif. Intell. Rev.* **2021**, *54*, 2193–2220. <https://doi.org/10.1007/s10462-020-09902-w>.
164. Shi, Q.W.; Gao, J.X.; Wang, X.; Ren, H.; Cai, W.G.; Wei, H.F. Temporal and Spatial Variability of Carbon Emission Intensity of Urban Residential Buildings: Testing the Effect of Economics and Geographic Location in China. *Sustainability* **2020**, *12*, 23. <https://doi.org/10.3390/su12072695>.
165. Wu, W.; Zhang, W.; Benner, J.; Malkawi, A. Critical evaluation of analytical methods for thermally activated building systems. *Renew. Sustain. Energy Rev.* **2020**, *117*, 109516. <https://doi.org/10.1016/j.rser.2019.109516>.
166. Yu, L.; Qin, S.Q.; Zhang, M.; Shen, C.; Jiang, T.; Guan, X.H. A Review of Deep Reinforcement Learning for Smart Building Energy Management. *IEEE Internet Things J.* **2021**, *8*, 12046–12063. <https://doi.org/10.1109/jiot.2021.3078462>.
167. Zhong, X.; Hu, M.; Deetman, S.; Rodrigues, J.F.D.; Lin, H.-X.; Tukker, A.; Behrens, P. The evolution and future perspectives of energy intensity in the global building sector 1971–2060. *J. Clean. Prod.* **2021**, *305*, 127098. <https://doi.org/10.1016/j.jclepro.2021.127098>.
168. Nam, E.; Jin, T. Mitigating carbon emissions by energy transition, energy efficiency, and electrification: Difference between regulation indicators and empirical data. *J. Clean. Prod.* **2021**, *300*, 126962. <https://doi.org/10.1016/j.jclepro.2021.126962>.
169. Wang, S.; Liu, Y.; Cao, Q.; Li, H.; Yu, Y.; Yang, L. Applicability of passive design strategies in China promoted under global warming in past half century. *Build. Environ.* **2021**, *195*, 107777. <https://doi.org/10.1016/j.buildenv.2021.107777>.
170. Malek, M.; Jackowski, M.; Lasica, W.; Kadela, M. Influence of Polypropylene, Glass and Steel Fiber on the Thermal Properties of Concrete. *Materials* **2021**, *14*, 18. <https://doi.org/10.3390/ma14081888>.
171. Zhang, T.; Tan, Q.; Zhang, S.; Zhang, T.; Zhang, W. A participatory methodology for characterizing and prescribing water-energy-food nexus based on improved casual loop diagrams. *Resour. Conserv. Recycl.* **2021**, *164*, 105124. <https://doi.org/10.1016/j.resconrec.2020.105124>.
172. Lin, J.; Khanna, N.; Liu, X.; Teng, F.; Wang, X. China's Non-CO₂ Greenhouse Gas Emissions: Future Trajectories and Mitigation Options and Potential. *Sci. Rep.* **2019**, *9*, 10. <https://doi.org/10.1038/s41598-019-52653-0>.
173. Shimoda, Y.; Sugiyama, M.; Nishimoto, R.; Momonoki, T. Evaluating decarbonization scenarios and energy management requirement for the residential sector in Japan through bottom-up simulations of energy end-use demand in 2050. *Appl. Energy* **2021**, *303*, 117510. <https://doi.org/10.1016/j.apenergy.2021.117510>.
174. Li, W.; Liu, Z.; Li, S. The optimal step locations for high-performance adsorption heat pumps under various working conditions. *Therm. Sci. Eng. Prog.* **2021**, *25*, 101033. <https://doi.org/10.1016/j.tsep.2021.101033>.
175. Edelenbosch, O.Y.; Rovelli, D.; Levesque, A.; Marangoni, G.; Tavoni, M. Long term, cross-country effects of buildings insulation policies. *Technol. Forecast. Soc. Chang.* **2021**, *170*, 120887. <https://doi.org/10.1016/j.techfore.2021.120887>.
176. Tang, B.; Zou, Y.; Yu, B.; Guo, Y.; Zhao, G. Clean heating transition in the building sector: The case of Northern China. *J. Clean. Prod.* **2021**, *307*, 127206. <https://doi.org/10.1016/j.jclepro.2021.127206>.
177. Zhao, Y.J.; Fan, G.J.; Song, K.P.; Li, Y.L.; Chen, H.; Sun, H. The experimental research for reducing the minimum miscibility pressure of carbon dioxide miscible flooding. *Renew. Sust. Energy. Rev.* **2021**, *145*, 11. <https://doi.org/10.1016/j.rser.2021.111091>.
178. Yue, H.; Worrell, E.; Crijns-Graus, W.; Zhang, S. The potential of industrial electricity savings to reduce air pollution from coal-fired power generation in China. *J. Clean. Prod.* **2021**, *301*, 126978. <https://doi.org/10.1016/j.jclepro.2021.126978>.
179. Nibedita, B.; Irfan, M. The role of energy efficiency and energy diversity in reducing carbon emissions: Empirical evidence on the long-run trade-off or synergy in emerging economies. *Environ. Sci. Pollut. Res.* **2021**, *28*, 56938–56954. <https://doi.org/10.1007/s11356-021-14642-7>.
180. Cao, X.; Yao, R.; Ding, C.; Zhou, N.; Yu, W.; Yao, J.; Xiong, J.; Xu, Q.; Pan, L.; Li, B. Energy-quota-based integrated solutions for heating and cooling of residential buildings in the Hot Summer and Cold Winter zone in China. *Energy Build.* **2021**, *236*, 110767. <https://doi.org/10.1016/j.enbuild.2021.110767>.
181. Meuer, J.; Lamaro, F.; Vetterli, N. Embedding energy optimization in organizations: A case study of a Swiss decentralized renewable energy system. *Energy Build.* **2021**, *235*, 110710. <https://doi.org/10.1016/j.enbuild.2020.110710>.
182. Cheng, S.L.; Fan, W.; Meng, F.X.; Chen, J.D.; Liang, S.; Song, M.L.; Liu, G.Y.; Casazza, M. Potential Role of Fiscal Decentralization on Interprovincial Differences in CO₂ Emissions in China. *Environ. Sci. Technol.* **2021**, *55*, 813–822. <https://doi.org/10.1021/acs.est.0c04026>.
183. Shi, Q.W.; Ren, H.; Cai, W.G.; Gao, J.X. How to Set the Proper CO₂ Reduction Targets for the Provincial Building Sector of China? *Sustainability* **2020**, *12*, 22. <https://doi.org/10.3390/su122410432>.
184. Zhang, L.; Song, G.; Ma, X.; Zhan, C.; Zhang, S. Decarbonising residential building energy towards achieving the intended nationally determined contribution at subnational level under uncertainties. *J. Clean. Prod.* **2020**, *272*, 122760. <https://doi.org/10.1016/j.jclepro.2020.122760>.
185. Liu, Y.; Wang, Y.; Shi, C.; Zhang, W.; Luo, W.; Wang, J.; Li, K.; Yeung, N.; Kite, S. Assessing the CO₂ reduction target gap and sustainability for bridges in China by 2040. *Renew. Sustain. Energy Rev.* **2022**, *154*, 111811. <https://doi.org/10.1016/j.rser.2021.111811>.
186. Meng, M.; Qu, D. Understanding the green energy efficiencies of provinces in China: A Super-SBM and GML analysis. *Energy* **2022**, *239*, 121912. <https://doi.org/10.1016/j.energy.2021.121912>.

187. Yamaguchi, Y.; Kim, B.; Kitamura, T.; Akizawa, K.; Chen, H.; Shimoda, Y. Building stock energy modeling considering building system composition and long-term change for climate change mitigation of commercial building stocks. *Appl. Energy* **2022**, *306*, 117907. <https://doi.org/10.1016/j.apenergy.2021.117907>.
188. Al Shawa, B. The ability of Building Stock Energy Models (BSEMs) to facilitate the sector's climate change target in the face of socioeconomic uncertainties: A review. *Energy Build.* **2022**, *254*, 111634. <https://doi.org/10.1016/j.enbuild.2021.111634>.
189. Lin, J.; Zhong, X.; Wang, J.; Huang, Y.; Bai, X.; Wang, X.; Shah, N.; Xie, S.; Zhao, Y. Relative optimization potential: A novel perspective to address trade-off challenges in urban energy system planning. *Appl. Energy* **2021**, *304*, 117741. <https://doi.org/10.1016/j.apenergy.2021.117741>.
190. Zhang, S.; Wang, K.; Xu, W.; Iyer-Raniga, U.; Athienitis, A.; Ge, H.; Cho, D.w.; Feng, W.; Okumiya, M.; Yoon, G.; et al. Policy recommendations for the zero energy building promotion towards carbon neutral in Asia-Pacific Region. *Energy Policy* **2021**, *159*, 112661. <https://doi.org/10.1016/j.enpol.2021.112661>.
191. Su, C.; Urban, F. Carbon Neutral China by 2060: The Role of Clean Heating Systems. *Energies* **2021**, *14*, 7461. <https://doi.org/10.3390/en14227461>.
192. Zhong, X.; Hu, M.; Deetman, S.; Steubing, B.; Lin, H.X.; Hernandez, G.A.; Harpprecht, C.; Zhang, C.; Tukker, A.; Behrens, P. Global greenhouse gas emissions from residential and commercial building materials and mitigation strategies to 2060. *Nat. Commun.* **2021**, *12*, 6126. <https://doi.org/10.1038/s41467-021-26212-z>.
193. Fan, G.J.; Zhao, Y.J.; Zhang, X.D.; Li, Y.L.; Chen, H. Research on Minimum Miscible Pressure Between Crude Oil and Supercritical Carbon Dioxide System in Ultra-Low Permeability Reservoir by the Long-Slim-Tube Experiment Method. *Front. Earth Sci.* **2021**, *9*, 9. <https://doi.org/10.3389/feart.2021.694729>.
194. Jia, J.J.; Xu, J.H. Estimating residential electricity demand's response to price policy and income dynamics in China. *Energy Effic.* **2021**, *14*, 23. <https://doi.org/10.1007/s12053-021-09974-9>.
195. Liu, J.L.; Yin, M.J.; Xia-Hou, Q.R.; Wang, K.; Zou, J. Comparison of sectoral low-carbon transition pathways in China under the nationally determined contribution and 2 degrees C targets. *Renew. Sust. Energ. Rev.* **2021**, *149*, 13. <https://doi.org/10.1016/j.rser.2021.111336>.
196. Wang, L.; Lee, E.W.M.; Hussian, S.A.; Yuen, A.C.Y.; Feng, W. Quantitative impact analysis of driving factors on annual residential building energy end-use combining machine learning and stochastic methods. *Appl. Energy* **2021**, *299*, 117303. <https://doi.org/10.1016/j.apenergy.2021.117303>.
197. Zhang, S.-C.; Yang, X.-Y.; Xu, W.; Fu, Y.-J. Contribution of nearly-zero energy buildings standards enforcement to achieve carbon neutral in urban area by 2060. *Adv. Clim. Change Res.* **2021**, *12*, 734–743. <https://doi.org/10.1016/j.accre.2021.07.004>.
198. Chi, F.a.; Wang, R.; Wang, Y. Integration of passive double-heating and double-cooling system into residential buildings (China) for energy saving. *Sol. Energy* **2021**, *225*, 1026–1047. <https://doi.org/10.1016/j.solener.2021.08.020>.
199. Liu, Q.C.; Liu, L.T.; Liu, X.J.; Li, S.G.; Liu, G. Building stock dynamics and the impact of construction bubble and bust on employment in China. *J. Ind. Ecol.* **2021**, *25*, 1631–1643. <https://doi.org/10.1111/jiec.13182>.
200. Yang, X.Y.; Zhang, S.C.; Wang, K. Quantitative study of life cycle carbon emissions from 7 timber buildings in China. *Int. J. Life Cycle Assess.* **2021**, *26*, 1721–1734. <https://doi.org/10.1007/s11367-021-01960-8>.
201. Yue, H.; Worrell, E.; Crijns-Graus, W.; Liu, W.; Zhang, S.H. Saving energy in China's industry with a focus on electricity: A review of opportunities, potentials and environmental benefits. *Energy Effic.* **2021**, *14*, 28. <https://doi.org/10.1007/s12053-021-09979-4>.
202. Vand, B.; Ruusu, R.; Hasan, A.; Manrique Delgado, B. Optimal management of energy sharing in a community of buildings using a model predictive control. *Energy Convers. Manag.* **2021**, *239*, 114178. <https://doi.org/10.1016/j.enconman.2021.114178>.
203. Jiang, J.J.; Ye, B.; Shao, S.; Zhou, N.; Wang, D.S.; Zeng, Z.Z.; Liu, J.G. Two-Tier Synergic Governance of Greenhouse Gas Emissions and Air Pollution in China's Megacity, Shenzhen: Impact Evaluation and Policy Implication. *Environ. Sci. Technol.* **2021**, *55*, 7225–7236. <https://doi.org/10.1021/acs.est.0c06952>.
204. Tong, H.; Li, H.B.; Zhou, Z.N.; Cidanpuchi; Wang, F.C.; Liu, W. Strategies for optimizing the luminescence and stability of copper iodide organic-inorganic hybrid structures. *New J. Chem.* **2021**, *45*, 10989–10996. <https://doi.org/10.1039/d1nj01464a>.
205. Gou, S.W.; Li, H.; Li, J.Y.; Zhao, Y. Effective means to alleviate the greenhouse effect: Case study of history match simulations on a brief CO₂ injection into less-deep low-rank coal seams. *Arab. J. Geosci.* **2021**, *14*, 18. <https://doi.org/10.1007/s12517-021-07104-4>.
206. Zhao, Y.; Fan, G.; Li, Y.; Zhang, X.; Chen, H.; Sun, H. Research for reducing minimum miscible pressure of crude oil and carbon dioxide and miscible flooding experiment by injecting citric acid isopentyl ester. *Arab. J. Chem.* **2020**, *13*, 9207–9215. <https://doi.org/10.1016/j.arabjc.2020.11.005>.
207. Yue, H.; Worrell, E.; Crijns-Graus, W. Impacts of regional industrial electricity savings on the development of future coal capacity per electricity grid and related air pollution emissions—A case study for China. *Appl. Energy* **2021**, *282*, 116241. <https://doi.org/10.1016/j.apenergy.2020.116241>.