“Investments support for Sustainable Development Goal 7: Research gaps in the context of post-COVID-19 recovery”

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INVESTMENTS SUPPORT FOR SUSTAINABLE DEVELOPMENT GOAL 7: RESEARCH GAPS IN THE CONTEXT OF POST-COVID-19 RECOVERY

Abstract

Successful achievement of the 17 Sustainable Development Goals (SDGs), including SDG 7: Affordable and Clean Energy, is impossible without proper financial support, especially after the devastating impact of the COVID-19 pandemic. Despite more than million academic papers related to SDG 7, only very few of them address the financial aspects of achieving SDG 7. To test the hypothesis, "SDG 7 related academic studies ignore the issue of investment in general and responsible investment in particular", a meta-analysis is performed that includes a number of specific instruments and technics such as SciVal by Elsevier, VosViewer, Google trends, Google Books Ngram Viewer and Google Data. The results show a lack of appropriate academic support (methodology, empirical results, econometric models etc.) for practitioners to fill the existing financial gap and successfully achieve SDG 7. Among 1.2 million SDG 7 related papers, less than 100 deal with the financial gap problem measured by trillions of dollars in achieving SDG 7. This paper identifies the most promising and relevant topics for study related to SDG 7 and investment: the impact of the pandemic on decisions in the energy sector; efficiency of SDG 7 investment support and methodology for its assessment; green bonds, green loans, sovereign green bonds as responsible investment tools to advance SDG 7.

Keywords alternative energy, responsible investment, meta-analysis, post-pandemic economic recovery

JEL Classification F64, G18, Q42, Q48

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INTRODUCTION

The adoption of the UN Sustainable Development Goals (SDGs) defined the main directions of human development until 2030 and created additional investment opportunities (United Nations, 2015, 2020; Naumenkova et al., 2022).

SDG 7: Affordable and Clean Energy is a climate-oriented goal focused on mitigating the climate change effects and achieving energy efficiency and sustainability by 2030. It is also the most commercialized goal as renewable energy technologies are in demand and investment attractive. The transition to a climate-neutral economy based on advanced circular technologies, including renewable energy, is declared in the European Green Deal. At the same time, ensuring progress in SDG 7 is in line with its sufficient funding.

The issue of SDG 7 funding is extremely important. The size of an investment gap to achieve SDG 7 in key 6 sectors, such as demand for energy, telecommunications, technology, energy and electricity, water and sanitation, primary energy supply chains, and transport, is estimated at $6.3 trillion. The clean energy sector needs $1 trillion annu-

ally for 36 years, to avoid more severe climate change. According to the latest estimations of World Bank experts, infrastructure investments in transport, food, energy and water resource management should be up to $637 billion in below-average and low-income countries and $2.74 trillion in transition economies annually until 2030 (World Bank, 2019). Transition to low-carbon and climate-neutral energy technologies widens this gap, especially with the negative influence of the COVID-19 pandemic. One more important fact is the huge research gap in investments in SDG 7.

To characterize academic landscape related to this issue, papers over the period 2010–2022 are analyzed. More special research areas were SDG 7 and the investment gap, SDG 7 and responsible investment. The research area of SDG 7 and COVID-19 has actualized scholarly output with recent economic challenges and opportunities for post-pandemic recovery.

1. LITERATURE REVIEW

During the pandemic, according to UNCTAD, only in 2020 the investments decreased by a third. In the first three quarters of 2020, the value of recently announced "green" investments decreased by 40% (UNCTAD, 2020). Compared with other infrastructure sectors, investments in renewable energy have been increased by 2/3 of investment in 2020, contrasted to 2019. The reason for this increase may be the more active use of responsible investment tools. 12 countries have issued $60 bln green sovereign bonds (Fatin, 2020) to increase private investment in sustainable recovery projects; 10 more countries plan such emission in 2021. The SDG 7 progress is vital for post-crisis recovery. The total value of COVID-19 "rescue packages" in the G20 countries exceeds $6 trillion (The Smith School of Enterprise and the Environment, 2020). In the United Kingdom, energy conservation and carbon reduction are crucial elements of an economic recovery package that includes zero greenhouse gas emissions (Allan et al., 2020).

Strong investment context in renewable energy is described by Čeryová et al. (2020). The authors evaluate the efficiency of renewable energy production, funded from public investment facilities. The impact of public investments on electricity generation was characterized as statistically insignificant.

The core in the last two-year academic outputs (starting from December 2019) is studying the situation in the energy sector and investment support in this field under the pandemic influence. Moreover, this impact is quite disproportionate.

Celik et al. (2021) investigate the impact of COVID-19 on renewable energy production development in the context of energy sustainability, global warming and environmental pollution (level of energy products).

At the level of energy generating companies and companies operating in closed-loop supply chain (CLSC), the role of SDG 7 and investment in it is described in Genc (2021).

Jiang et al. (2021), Navon (2021), and Hoang et al. (2021) investigate the impacts, challenges, lessons, emerged opportunities of the COVID-19 pandemic on energy demand, supply, technologies and clean energy strategies at the global level.

Lahcen (2020) evaluates the role of green transition to low energy-intensive economic growth in case of post-pandemic recovery and the COVID-19 impact on macroeconomic parameters. According to Madurai Elavarasan (20210, investment in overcoming the effects of COVID-19 in SDG 7 is the most important, as it is the driver relating to other goals too.

Interconnection and dependencies in the energy sector caused by different types of investment supports are investigated by Costa et al. (2021), García et al. (2021), Norouzi et al. (2021), and Micheli (2021).

The opinion of García et al. (2021) remains credible in terms of the meta-analysis made in order to investigate the existence of a significant research gap in forecasting investments and energy management in pandemic circumstances.

So, to spend investment and recovery funds efficiently to promote SDG 7 progress and overcome the pandemic disruptions, appropriate academic

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support is needed: theoretical and methodological background, methodology, empirical results, econometric models, investment instruments etc. First, bridging an academic gap is vital for this under researched areas.

The key idea of this study is to demonstrate that there is currently no sufficient academic basis to successfully achieve SGD7. The following hypothesis is tested in this paper:

H1: SDG 7 related academic studies ignore the issue of investment in general and responsible investment in particular.

To test the hypothesis, a meta-analysis is proposed.

2. META-ANALYSIS METHODOLOGY

This paper uses a number of specific meta-analysis instruments, including SciVal and In-built Scopus instruments by Elsevier as a specific platform for bibliometric analysis, VosViewer as a software for academic network investigation and range of Google instruments (Trends, Books Ngram Viewer and Data). Data periods differ depending on the meta-analysis instrument used; they cover all available data for now. A description of each method, time framing and specifics of the current study are summarized in Table 1.

Each research area in SciVal, queries via in-built Scopus instruments (then imported in VOSViewer), Google Books Ngram Viewer and Google Public Data Explorer were formed using logic operator AND as of December 25, 2022, so they were defined as follows:

- SDG AND 7 AND Affordable and Clean Energy;
- SDG AND 7 AND Investment;
- SDG AND 7 AND Responsible AND Investment;
- SDG AND 7 AND Investment AND Gap;
- SDG AND 7 AND COVID-19.

Finally, Google Trends allows comparing such queries as SDG 7, Responsible investment and Investment Gap.

The hypothesis is tested in this paper: SDG-7 related academic literature ignores the issue of investment in general and responsible investment in particular.

3. RESULTS AND DISCUSSION

SciVal contains 8,240,903 papers covering 16 SDGs. The distribution of these studies is shown in Figure 1. SDG 7: Affordable and Clean Energy is the second largest research area after SDG 3: Good Health and Well Being with quote of study 11,7%.

Table 1. Key methodology instruments and their usage in this study

Instrument	Description	Current study features	Coverage period
SciVal by Elsevier	Software tool for complex analysis and visualizing academic landscape via a comprehensive analysis of papers indexed in Scopus	Static, dynamic, cluster analysis. Subject areas, institutions, sectors, courtiers, journals, key phrases, topics and topic cluster analysis. ASJC is used for topic classification	2010–2022 in some cases 2016–2022
In-built Scopus instruments by Elsevier	Scopus publications analysis tools	Preliminary analysis of papers main characteristics	2010–2022
VosViewer	Software to create bibliometric networks, for example	In-depth co-occurrence and co-authorship network analysis within the bibliometric map	2010–2022
Google Trends	Aggregation of internet requests for specific searching terms	Comparative dynamics and regional structure analysis	2004 – December 25, 2022
Google Books Ngram Viewer	Analysis of the frequency of term appearance in Google Books	Ngram for pre-defined research terms within linguistic corpus "English 2019"	1960–2019; 2000–2019
Google Public Data Explorer	A public data visualization tool that facilitates its analysis, spreading and interpretation	Comparison of information and analytical support (data sets) for each research area	2018 – December 25, 2022

Source: Authors' elaboration via SciVal by Elsevier.

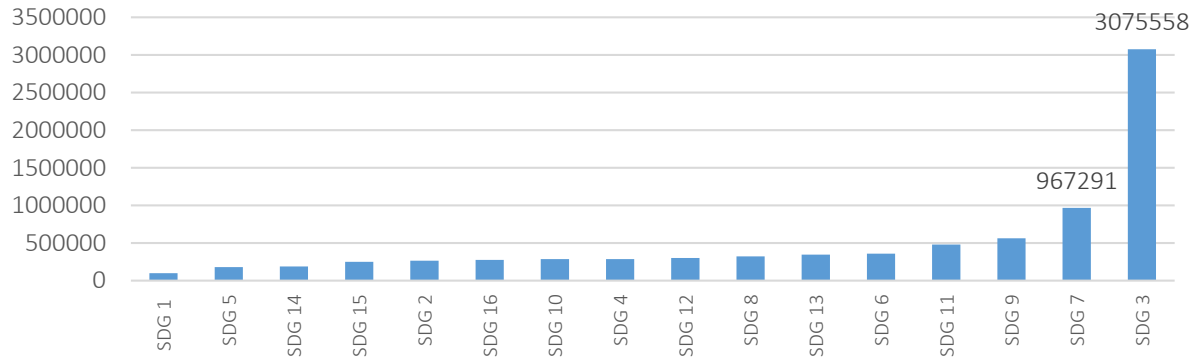

Figure 1. SDG-related papers in SciVal in 2017–2022

The analysis is provided for the following search queries in four research areas: SDG 7: Affordable and Clean Energy, SDG 7 and Investment, SDG 7 and Responsible Investment, SDG 7 and Investment Gap as of December 25, 2022. SDG 7 and COVID-19 is an additional supplementary research area. The results are summarized in Table 2.

As can be seen, there is a significant gap between the studies of SDG 7 (more than 1.2 million publications as of Dec 25, 2022) and investment-related areas: only 0.187% of all research topics related to SDG 7 with the keywords "investment". The situation is much worse for the cases of SDG 7 and Responsible Investment, SDG 7 and Investment Gap, they account for 0.04% of the total academic output.

SDG 7 and COVID-19 research area is relevant only during the last three years. Despite this, it is presented in more papers than SDG 7 and Responsible Investment, SDG 7 and Investment Gap and covers 47 topics grouped by 30 thematic clusters.

Dynamic analysis of four research areas by the number of academic publications (Table 3) provides some evidence such as:

1) The adoption of the UN SDG system in 2015 is the breaking point for SDG 7 and Investment studies, while the clean energy topic showed a steady increase in year after year for the analyzed period.

2) Despite the incompleteness of the analysis period, the years 2020–2022 are indicative in the context of the SDG 7 and COVID-19 research area as the number of publications exceeds those for the investment research areas.

3) Among the world's academic scholars, publications by European institutions make up half in investment research areas.

The research area of SDG 7 and COVID-19 is characterized by the largest number of subject areas, which indicates its multidisciplinarity and exploratory origin. The data presented in Appendix A show that engineering and energy sciences have the largest share among the SDG 7 subject areas. Economics is not dominant in any of the research areas, including investment. The largest share of all investment research areas is Economics, Econometric and Finance in the

Table 2. State-of-the-art analysis of SDG 7 and investment research areas in 2010–2022 as of December 25, 2022

Source: Authors' elaboration via SciVal by Elsevier.

Area	Topics		Topics cluster		Publications worldwide		Citation worldwide	
	Quantity	Quote	Quantity	Quote	Quantity	Quote	Quantity	Quote
SDG 7	36941	100,000%	1445	100,000%	1284886	100,000%	26655869	100,000%
SDG 7 and Investment	69	0,187%	34	2,353%	108	0,008%	4033	0,015%
SDG 7 and Responsible Investment	13	0,035%	10	0,692%	17	0,001%	208	0,001%
SDG 7 and Investment Gap	14	0,038%	12	0,830%	15	0,001%	123	0,000%
SDG 7 and COVID-19	47	0,127%	30	2,076%	69	0,005%	812	0,003%

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Table 3. Dynamic analysis of SDG 7 and investment research areas in 2010–2022 as of December 25, 2022

Source: Compiled by authors via SciVal by Elsevier.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
SDG 7 Affordable and Clean energy													
World	62479	78534	85717	94556	104905	107704	116796	128848	141149	155886	145864	172742	181592
SDG 7 and Investment gap													
World	0	0	0	0	0	0	1	2	1	4	2	4	5
SDG 7 and Investment													
World	0	0	0	0	0	2	4	9	6	16	23	45	60
SDG 7 and Responsible Investment													
World	0	0	0	0	0	2	0	0	1	4	3	10	10
SDG 7 and COVID-19													
World	0	0	0	0	0	0	0	0	0	0	9	25	33

research areas SDG 7 and Investment and SDG 7 and Investment gap.

The data presented in Appendix B characterize the most productive institutions by sector and country in 2016–2022, as of December 25, 2022. While analyzing the research areas in terms of countries, it should be noted that their distribution is as follows: within SDG 7, the absolute leaders of the top 10 are institutions from China (9 out of 10); within SDG 7 and Investment, SDG 7 and Investment Gap is Switzerland (3 institutions out of 10), SDG 7 and Responsible Investment is South Africa (3 institutions), SDG 7 and COVID-19 is Australia (4 institutions). In terms of sectors, the outright leaders in all research areas are academic institutions. Among public institutions, the leaders in terms of outputs in the research areas are the Chinese Academy of Sciences, the Ministry of Education, CNRS (France), the South African Medical Research Council, the World Health Organization.

Characterizing the research areas in the top 10 publications indexed by the Scopus database (Appendix C), it is essential to note that publications in all areas are presented in the journal Energies, except SDG 7 and COVID-19 maximally. Other journals are found in only two areas (e.g. Sustainability, The Lancet, Renewable and Sustainable Energy Reviews, Applied Energy, World Development). Their thematic is different, and investment issues are covered not only in economic journals because of their interdisciplinarity. However, there is no correlation between the journal ranking by the SCImago Journal Rank and the volume of scholarly output in each area.

The analysis of keywords and phrases within SDG 7 (Figure 2) is consistent with the conclusions obtained during the investigation of subject fields in the research areas. Engineering and energy topics are predominant. Instead, SDG 7 and Investment is not represented among the most relevant 50 keywords.

Source: Authors' elaboration via SciVal by Elsevier.

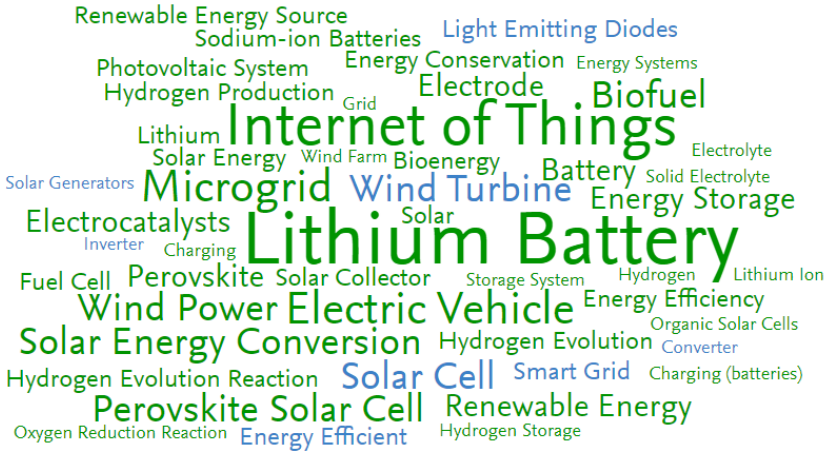

Figure 2. Key phrases analysis results for SDG 7 research area in 2016–2022

Table 4. Top 1% research area clusters in 2016–2021 by prominence

Source: Authors' elaboration via SciVal by Elsevier.

Topic Cluster	Prominence percentile	Scholarly output	Publication Share, % Topics
SDG 7: Affordable and Clean Energy			
Electricity; Energy; Economics	99.264	23,000	34%
SDG 7 and Investment			
Electricity; Energy; Economics	99.264	25	0.04
SDG 7 and Responsible Investment			
Cause-Related Marketing; CSR; Philanthropy	99.922	1	0.01%
SDG 7 and Investment Gap			
Cause-Related Marketing; CSR; Philanthropy	99.922	1	0.01%
SDG 7 and COVID-19			
SDG; Agenda; United Nations	97.683	2	0,19%

Listing the most latter-day research topics (top 1% for 2016–2021 by the level of prominence in the form of Snowball metrics within each of the studied areas (Appendix D and Table 4) provides additional evidence:

1. The energy issue is predominant for SDG 7.

2. SDG 7 and Investment, SDG 7 and Investment gap is concentrated within economic areas (Economics, Econometric and Finance, Business, Management and Accounting) in the field of corporate social activities and philanthropy. This conclusion at the level of topics within the research areas is confirmed by grouping these topics into clusters (Table 4). Despite the high values of the prominence percentiles, the volume of scientific output and the share of publications on SDG 7 and Investment, SDG 7 and Responsible Investment, SDG 7 and Investment Gap indicate their insufficient study and representation. The same idea is proved in Čeryová et al. (2020).

3. The topics of SDG 7 and COVID-19 are primarily interdisciplinary and exploratory, as evidenced by the scattering of Snowballs across the diagram, but the predominant research cluster for this area is SDG; Agenda; United Nations.

At the same time, the topic of financial markets, volatility, exchange rates during a COVID-19 pandemic is an entire new thematic direction of economic orientation among 112 new topics identified by SciVal in 2021 (Figure 3). This is also well-described in wide range of recent studies published in response of pandemic challenges (Allan et al., 2020; Celik et al., 2021; Jiang et al., 2021; Navon, 2021; Hoang et al., 2021).

Before making the in-depth cluster analysis by keywords and authorship of publications using

Source: Authors' elaboration via SciVal by Elsevier.

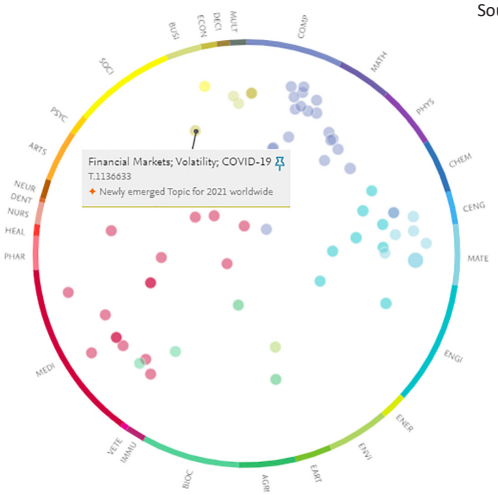

Figure 3. Newly emerged topics for SDG 7 in 2021

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Source: Authors' elaboration via VosViewer.

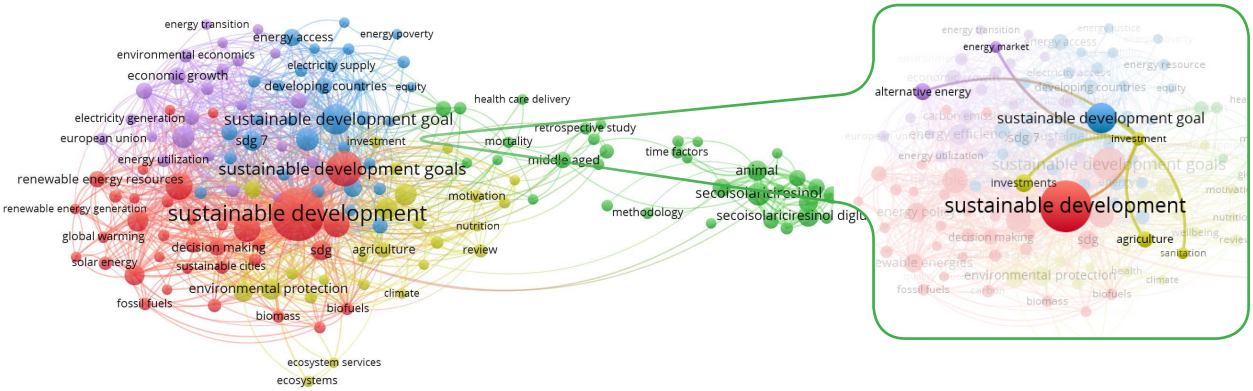

Figure 4. Co-occurrence map of SDG 7 publications

VOS Viewer, the scientific output was systematized through in-built Scopus instruments. In particular, in the research areas SDG 7 and Investment, SDG 7 and Responsible Investment, SDG 7 and Investment Gap, SDG 7 and COVID-19, 61 works were filtered for 2010–2021, and in the research area SDG 7 – 396 works. These studies were imported separately into aggregate research areas in VOS Viewer (version 1.6.16) to build bibliometric maps.

A bibliometric map of publications within the research area SDG 7 (Figure 4) within five identified clusters allows identifying the role and place of publications on investment support and its close connection with sustainable development, SDGs, alternative energy and energy market (in the context of SDG 7). However, there is an irrelevant green cluster (medical sciences) that was excluded. Other clusters are rather interdisciplinary and focus on sustainable development. Energy issues are presented in each of them, and investment topic is relatively modest.

Thematic network connections and four existing clusters of scientific publications under the research areas SDG 7 and Investment, SDG 7 and Responsible Investment, SDG 7 and Investment Gap, SDG 7 and COVID-19 (Figure 5) show that energy issues (green cluster) intersect with the central and most researched by the number of studies on the sustainable development theme (red cluster) in the field of clean energy. The topic of the blue cluster (SDG 7 and COVID-19, SDG, sustainability) is the newest. Although the yellow "investment cluster" does not contain a significant amount of studies on responsible investment or bridging the investment gap, it has strong network links with other clusters, which indicates the importance of studying SDG 7 and Investment.

Meta-analysis results allow identifying the most relevant works related to SDG 7 and Investment,

Source: Authors' elaboration via VosViewer.

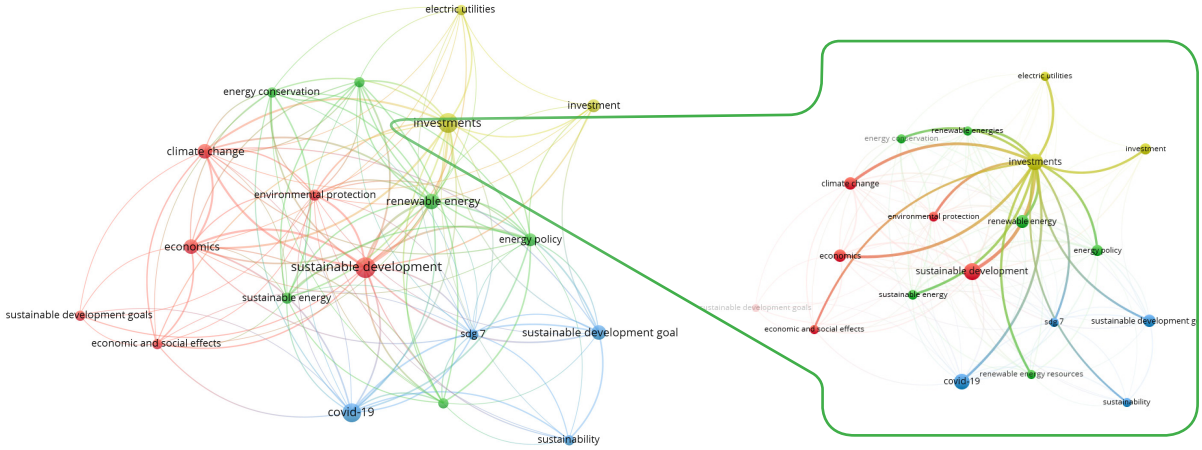

Figure 5. Co-occurrence map of SDG 7 publications and investment related research areas

SDG 7 and Responsible Investment and SDG 7 and Investment Gap in general and in the context of post-pandemic sustainable economic recovery (Tables E1 and E2 of Appendix E). Based on these works, their key results are presented.

Three main geographical aspects in these studies were identified: global, European, and African. Global aspects are represented in Vo (2020) (sustainable energy investigation in US), Shindina et al. (2018) (social and economic properties of the energy market). Gyamfi et al. (2021), for E7 economies for the period 2000–2018, proved a crucial role of bioenergy consumption in sustainability. They insist on the activation of private and public investment in clean energy. The case of Germany in bioenergy technologies is presented in Kalu et al. (2021), the European context in Streimikiene (2020), Norvay in Koilo (2020), and Visegrad countries in Štreimikienė (2021).

Włodarczyk et al. (2021) investigate the relationship between sustainability and clean energy sources in 5 clusters of EU countries. Onat et al. (2021) add to these research developments conclusions on eco-energy efficiency in EU member states. Shevchenko et al. (2021) used the same context of Green Deal and SDG implementation readiness in Ukraine. Plastun et al. (2020) use SDG achievement ranking (including SDG 7) for searching a relationship between ESG (environmental, social and governance criteria) disclosure regulation and SDG in top 50 world economies within the set of parametrical and non-parametrical statistical methods.

Third, African group of studies includes, for example, Oguntuase and Windapo (2021). They provide a review at the level of some instruments of responsible investment, in particular green bonds. It is important to emphasize that it will contribute not only to the SDG 7 progress, but also to SDG 3, 6, 7, 12 and 13. Practically, this aspect was studied using data from Nigeria.

Eales (2020), on the example of financing SDG 7 in Malawi, describes the features of social investment in the context of social entrepreneurship. Amoako and Insaidoo (2021) studied the impact of foreign direct investment on SDG 7 progress in Ghana. Quitzow et al. (2019) highlight the importance of official development assistance (ODA) in the energy sector, especially for renewable energy sources. However, the authors note that the SDG 7 and Investments remains insufficient. As in Fatin (2020) and Allan et al. (2020), there is a strong evidence base related to the necessity of huge investment support of renewables as a possible way to post-pandemic economic recovery.

African experience in SDG 7 and Investments, in particular Sub-Saharan African (SSA) countries, is also described by Chirambo (2018) and Michaelowa (2021). According to Kyoto Protocol's Clean Development Mechanism, Michaelowa (2021) highlighted the features of investing in climate finance and energy policy instruments, especially in the cases of Ethiopia, Madagascar and South Africa. In the same region, F. Yang and M. Yang (2018) prove higher economic efficiency and environmental friendliness of private investment-based financial model in rural electrification for the poorest households in SSA. Nevertheless, the development of such models should be accelerated because Falchetta (2021) estimates that achieving SDG 7 targets requires about $30bn of investment annually until 2030. Middle East and North African countries are the objects in energy consumption, CO^2 emissions and economic growth in Maalej and Cabagnols (2020). Tiba and Belaid (2021) find the interconnection between renewable energy and overall sustainable development (on the example of 25 African countries).

The instruments of Google are used to analyze the popularity of research areas among Internet users, especially in Google Books resources and publicly available datasets.

When Google Trends is used, the keywords "Investment" and "COVID-19" are not included in the search, since, in the first case, the query statistics from 2004 significantly exceed the number of queries for other keywords (SDG 7, Responsible investment and Investment Gap). Eventually, this does not allow them to be compared. In the second case, the statistics are available only for the last two years and are incomparable with other queries. Dynamics for SDG 7, Responsible investment and Investment Gap is presented in Figure 6.

The analysis of Internet user queries in 2004–2022 shows the boost of responsible investment and in-

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Source: Authors' elaboration via Google trends (https://bit.ly/3xkTdol).

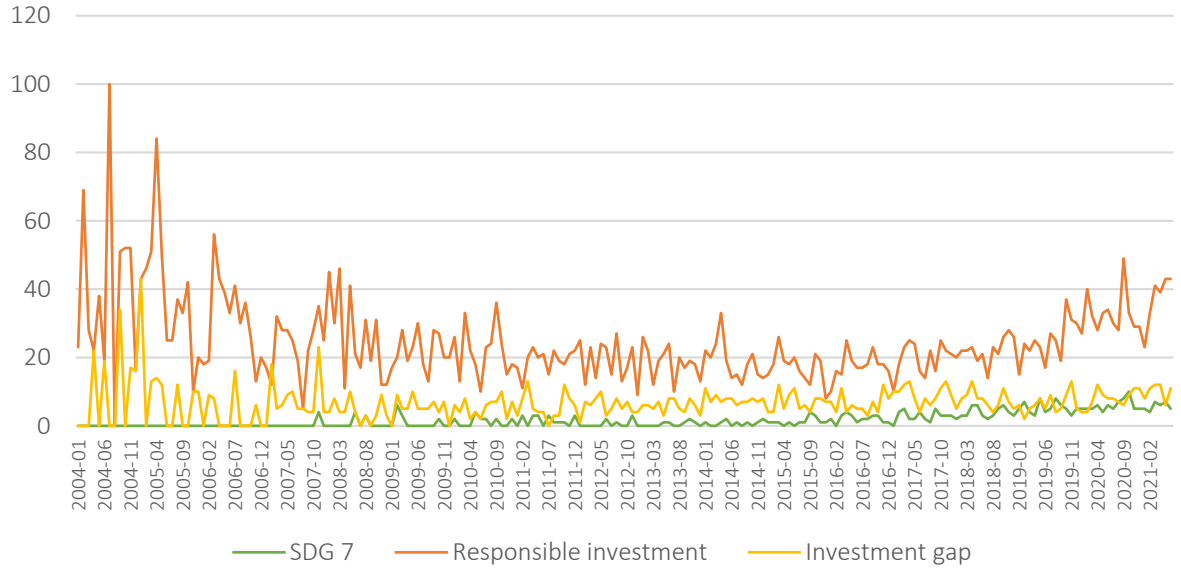

Figure 6. Internet queries related to SDG 7, Responsible investment and Investment Gap in 2004–2022

vestment gap in 2004–2006. As to responsible investment, it is from 2020 and till the present time. It is explained by the intensification of governments' efforts to invest in sustainable economic recovery. The topic of affordable and clean energy has been of interest to Internet users since 2007. In addition, until 2015, it had little popularity compared to responsible investment and the gap topics. It intensified somewhat after the adoption of SDG 7 in 2015 at the New York Summit.

The country aspect of the study of Internet users' interest in search queries of SDG 7, Responsible investment and Investment Gap in 2004–2022 (Figure 7) shows the prevalence of Responsible investment topic in New Zealand, Singapore, Australia and Hong Kong (100% of all queries for the three keywords), Japan and Germany (85 and 83%), the Philippines, the US, and the United Kingdom (74, 70 and 75% of queries, respectively).

The topic of the investment gap is of interest to a relatively small share of users (22-28%) in the USA, the UK, and India. In other countries, it is not even considered. Similar conclusions can be drawn for SDG 7. Users in only six of the top 10 countries

Source: Authors' elaboration via Google trends (https://bit.ly/3xkTdol).

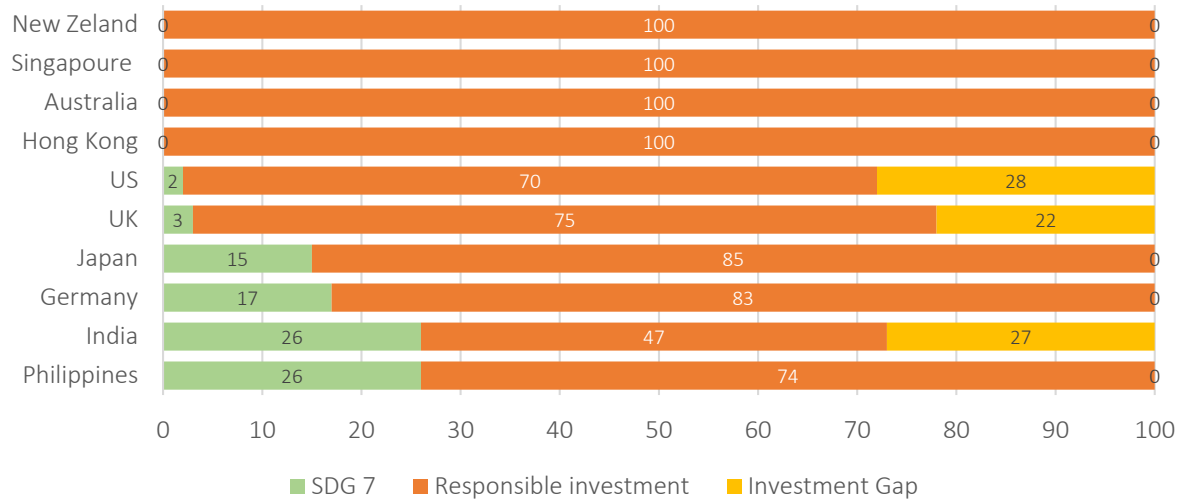

Figure 7. Internet users' interest in SDG 7, Responsible investment and Investment Gap in 2004–2022: top 10 countries, %

Source: Authors' elaboration via Google Books Ngram Viewer (https://bit.ly/3gOz8AG).

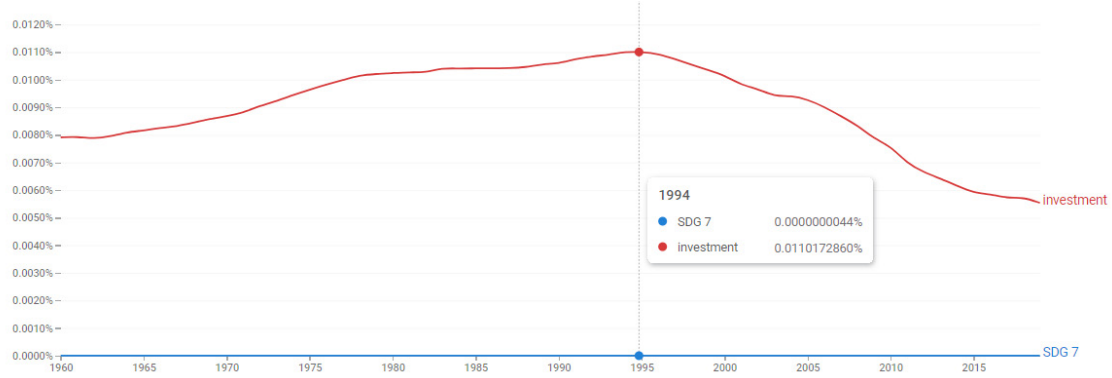

Figure 8. Ngram on the research terms of SDG 7 and Investment in 1960–2019

search from 2% (the USA) to 26% (India and the Philippines) for information regarding SDG 7.

Google Books analysis of the research topic (SDG 7 and Investment, SDG 7 and Investment gap, SDG 7 and Responsible Investment, SDG 7 and COVID-19) is generalized in Figures 8-11.

In particular, the pairwise comparison of frequencies according to SDG 7 and Investment (Figure 8) indicates a significant scientists' interest in the investment topic in the rather former chronological horizons. It is from the 60s of the 20th century. A surge in publishing activity was noted in the 1990s. While the frequencies for SDG 7 are pretty insignificant and approach 0.

Comparison of the frequency's dynamics for SDG 7 and Investment gap indicates greater attention to the topic of the investment gap in financing sustainable development compared to SDG 7, and the asynchrony of these frequencies before the adoption of SDGs in 2015 (Figure 9).

The coincidence of studies in this research area and their intensification have been observed in the last six years. It indicates the development of interest in the problems of overcoming the investment gap in achieving SDG 7.

As for the coincidence of scientific research on SDG 7 and responsible investment, the following conclusions can be made according to the data presented in Figure 10. Despite the significant predominance of references to responsible investing, there is a divergence between the ngrams concerning SDG 7 and Responsible Investment after 2015.

The only ngram that demonstrates the predominance of the SDG 7 topic is presented in Figure 11. A comparative analysis of SDG 7 and

Source: Authors' elaboration Google Books Ngram Viewer (https://bit.ly/3gmO2z2).

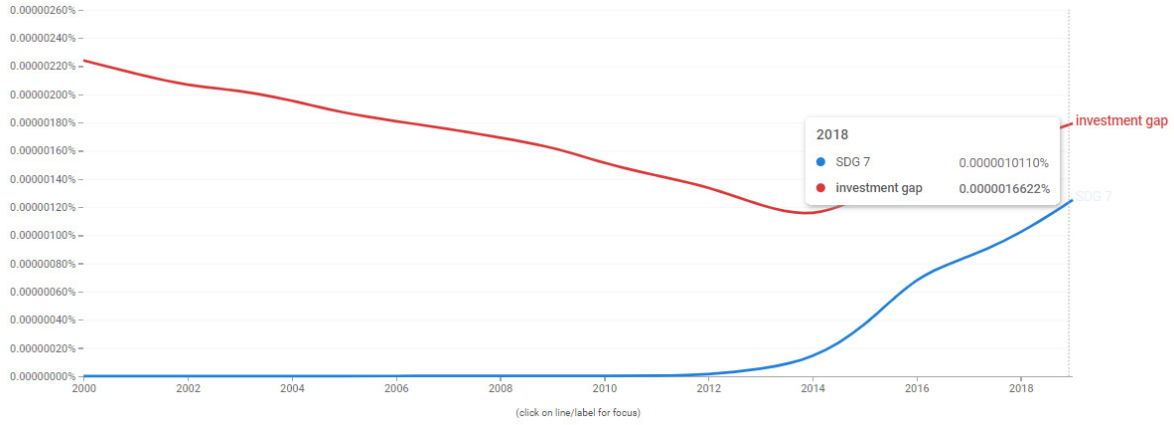

Figure 9. Ngram on the research terms of SDG 7 and Investment gap in 2000–2019

http://dx.doi.org/10.21511/imfi.20(1).2023.14

Source: Authors' elaboration via Google Books Ngram Viewer (https://bit.ly/3cxSuIY).

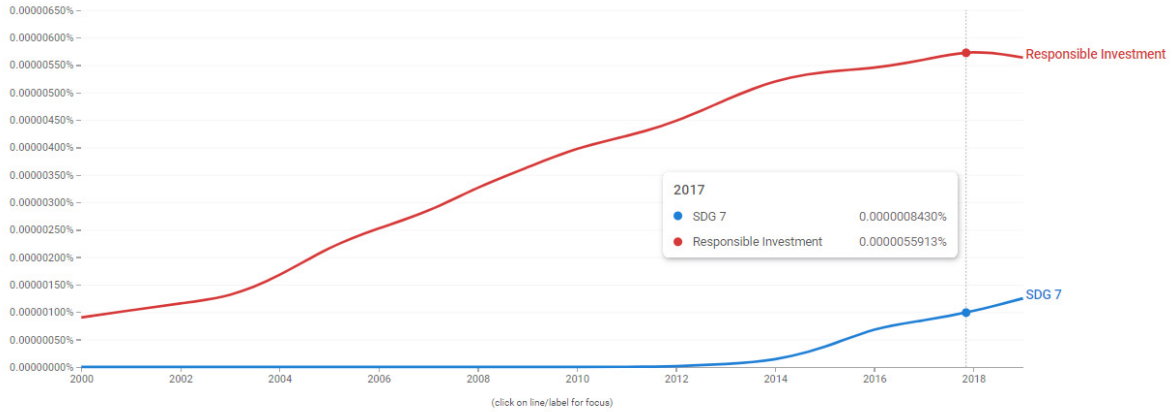

Figure 10. Ngram on the research terms of SDG 7 and Responsible Investment in 2000–2019

Source: Authors' elaboration via Google Books Ngram Viewer (https://bit.ly/3gCKibE).

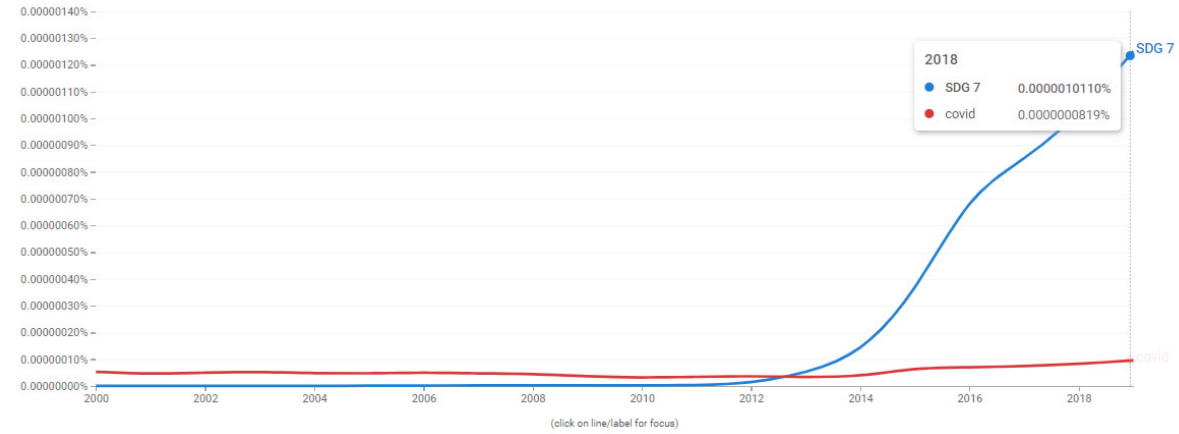

Figure 11. Ngram on the research terms of SDG 7 and COVID-19 in 2000–2019

COVID-19 proves that COVID-19 in Google Books sources is characterized by only a 2-year study time frame.

Using the Google Public Data Explorer toolkit, it was found that the largest number of data sets is characterized by the most significant research area SDG 7 (more than 100 data sets, see Appendix F for details). First, this is due to the fact that the data sources are presented both in terms of targets and objectives of SDG 7 and in terms of countries and the level of their progress in achieving this goal.

The World Bank and UN DESA Statistics Division are the most comprehensive and complete databases on SDG 7. These datasets cover both SDG 7 and other research areas. SDG 7 and investment do not yet have enough information and analytical support and research in the context of the pandemic impact on progress towards this goal (1-17 data sets depending on the area).

CONCLUSIONS

This paper explores the current academic landscape of investment in SDG 7 with additional focus on the impact of COVID-19 on progress towards SDG 7. It is presumed and tested as a research hypothesis that SDG-7 related academic studies ignore the issue of investment in general and responsible investment in particular. As a methodological basis, meta-analysis of academic sources devoted to SDG-7 and its

investment support was used. A number of specific interments and technics such as SciVal by Elsevier, in-built Scopus instruments, VosViewer, Google tools were included in meta-analysis.

Meta-analysis results show the significant prevalence of the SDG 7 related publications among all 16 SDGs represented in the research areas of SciVal and Scopus by Elsevier. However, among 1.2 million studies directly devoted to SDG 7, the topic of investment is very narrow, as well as responsible investment and investment gap.

SciVal analysis of the SDG 7 publication structure, dynamics and state of art proves that core areas in this publication is engineering and technical studies. Keyword analysis proves the absence of the investment-related search terms with SDG links.

VosViewer and built-in Scopus instrument analysis give a clearer view of cluster publications with very slight investment focus on the sustainable development and its investment support on the bibliometric map in co-occurrence mode.

A group of Google instruments (Google Trends, Google Books Ngram, and Google Data) illustrates the rise in internet user interest in SDG-7 and investment related research areas over the past decade.

To sum it up, the hypothesis tested is not rejected: There is a huge academic gap in investment related research areas connected with SDG 7. Clear energy and renewable energy sources investment and responsible investment support are newly emerged clusters of academic landscape in the context of sustainability. The prominent areas of research in this cluster are new green investment instruments, assessment of their implementation both for the progress in SDG 7 and issuers financial performance, methodological basis for decision making related investment in renewables and energy green transition in the context of post-pandemic recovery.

Closing the investment and research gap in achieving SDG 7 by 2030 also requires good analytical and information support, as well as specific focus on responsible investments. The results suggest there is significant scientific interest to the SDG 7 itself, but investment in SDG 7 aspects remains an under-explored area. As a result, practitioners do not have enough academic support to advance progress towards SDG 7.

AUTHOR CONTRIBUTIONS

Conceptualization: Inna Makarenko, Yuriy Bilan, Dalia Streimikiene, Larysa Rybina.
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Supervision: Inna Makarenko, Yuriy Bilan, Dalia Streimikiene, Larysa Rybina.
Validation: Inna Makarenko, Yuriy Bilan, Dalia Streimikiene, Larysa Rybina.
Visualization: Inna Makarenko, Yuriy Bilan, Dalia Streimikiene, Larysa Rybina.
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APPENDIX A. Research area by subjects in 2016–2022

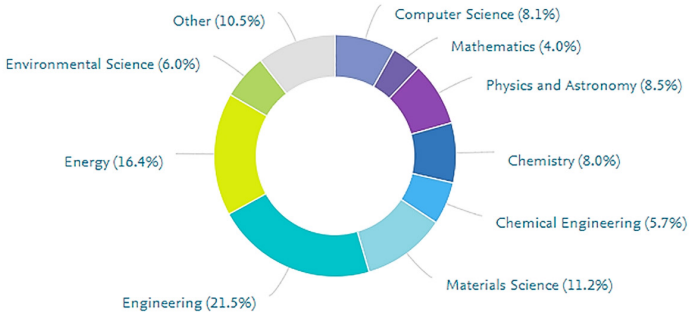

Figure A1. Structural analysis by subjects for the case of SDG 7

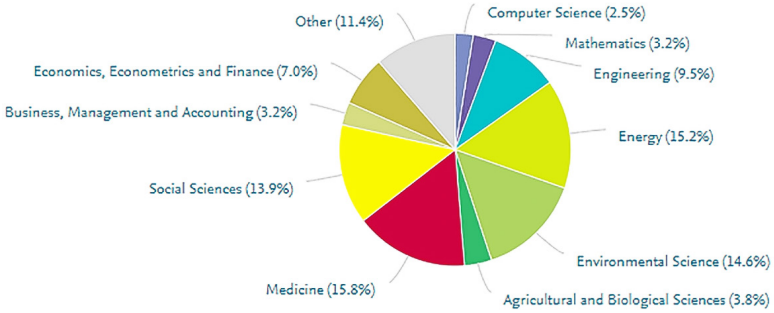

Figure A2. Structural analysis by subjects for the case of SDG 7 and Investment

Source: Compiled by authors via SciVal by Elsevier.

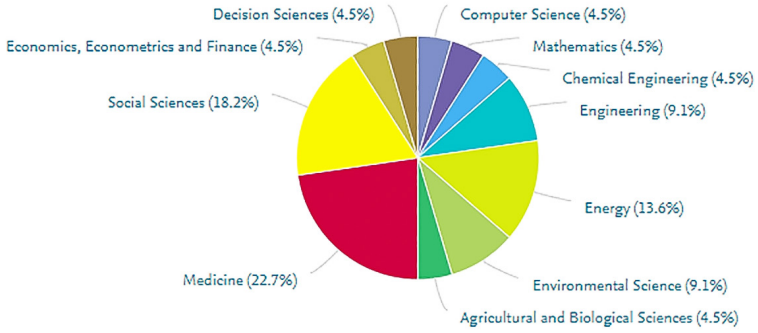

Figure A3. Structural analysis by subjects for the case of SDG 7 and Responsible Investment

Source: Compiled by authors via SciVal by Elsevier.

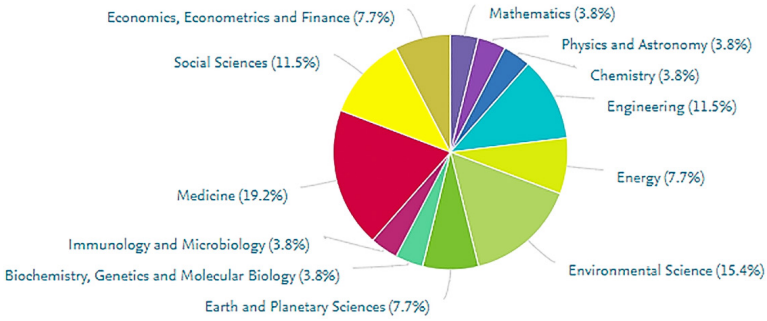

Figure A4. Structural analysis by subjects for the case of SDG 7 and Investment Gap

http://dx.doi.org/10.21511/imfi.20(1).2023.14

Source: Compiled by authors via SciVal by Elsevier.

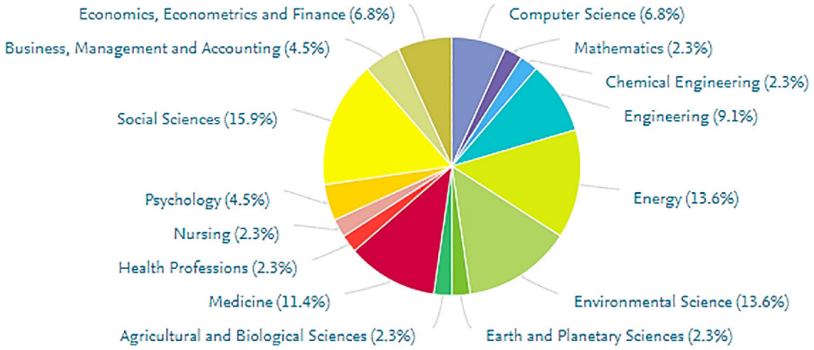

Figure A5. Structural analysis by subjects for the case of SDG 7 and COVID-19

APPENDIX B

Table B1. Top 10 institutions, sectors and countries in each research area by scholarly output in 2016–2022

Source: Compiled by authors via SciVal by Elsevier.

	Institution	Sector	Country	Output
No.	**SDG 7**			
1	Chinese Academy of Sciences	Government	China	25904
2	Ministry of Education, China	Government	China	23318
3	CNRS	Government	France	11010
4	Tsinghua University	Academic	China	10274
5	University of Chinese Academy of Sciences	Academic	China	8422
6	North China Electric Power University	Academic	China	6792
7	Zhejiang University	Academic	China	6774
8	Shanghai Jiao Tong University	Academic	China	6554
9	Huazhong University of Science and Technology	Academic	China	6373
10	University of Science and Technology of China	Academic	China	6207
	Total			111628
No.	**SDG 7 and Investment**			
1	World Health Organization	Government	Switzerland	7
2	Imperial College London	Academic	United Kingdom	7
3	University of the Witwatersrand	Academic	South Africa	6
4	Johns Hopkins University	Academic	United States	6
5	University of Ibadan	Academic	Nigeria	5
6	South African Medical Research Council	Government	South Africa	5
7	University of Melbourne	Academic	Australia	5
8	University of Basel	Academic	Switzerland	5
9	Swiss Tropical and Public Health Institute	Government	Switzerland	5
10	University of Washington	Academic	United States	5
	Total			56
No.	**SDG7 and Responsible Investment**			
1	University of Béjaïa	Academic	Algeria	1
2	University of Ibadan	Academic	Nigeria	1
3	Makerere University	Academic	Uganda	1
4	University of Cape Town	Academic	South Africa	1
5	University of Stellenbosch	Academic	South Africa	1
6	University of the Witwatersrand	Academic	South Africa	1
7	China Medical University Taichung	Academic	Taiwan	1
8	Asia University Taiwan	Academic	Taiwan	1
9	Friedrich-Alexander University Erlangen-Nürnberg	Academic	Germany	1
10	Ludwig Maximilian University of Munich	Academic	Germany	1
	Total			10

Table B1 (cont.). Top 10 institutions, sectors and countries in each research area by scholarly output in 2016–2022

	Institution	Sector	Country	Output
No.	**SDG 7 and Investment Gap**			
1	World Health Organization	Government	Switzerland	3
2	Mansoura University	Academic	Egypt	2
3	University of Basel	Academic	Switzerland	2
4	Swiss Tropical and Public Health Institute	Government	Switzerland	2
5	Ludwig Maximilian University of Munich	Academic	Germany	2
6	London School of Hygiene and Tropical Medicine	Academic	United Kingdom	2
7	Karolinska Institutet	Academic	Sweden	2
8	King Saud University	Academic	Saudi Arabia	2
9	Johns Hopkins University	Academic	United States	2
10	University of Béjaïa	Academic	Algeria	1
	Total			20
No.	**SDG 7 and COVID-19**			
1	Anna University	Academic	India	2
2	Harvard University	Academic	United States	2
3	Amref Health Africa	Other	Kenya	2
4	University of Stellenbosch	Academic	South Africa	1
5	University of the Witwatersrand	Academic	South Africa	1
6	Deakin University	Academic	Australia	1
7	Murdoch University	Academic	Australia	1
8	University of Melbourne	Academic	Australia	1
9	University of Queensland	Academic	Australia	1
10				
	Total			13

APPENDIX C

Table C1. Top 10 journals by scholarly output in each Research Area in 2016–2022

	Scopus Source	Publications	SJR
No.	**SDG 7**		
1	International Journal of Hydrogen Energy	14433	1,212
2	Energies	9456	0,598
3	ACS applied materials & interfaces	7082	2,535
4	Journal of Materials Chemistry A	6878	3,637
5	Renewable Energy	6590	1,825
6	Energy	6434	1,961
7	IOP Conference Series: Materials Science and Engineering	6114	-
8	Journal of Power Sources	5818	2,139
9	Journal of Physics: Conference Series	5754	0,21
10	Applied Energy	5691	3,035
No.	**SDG 7 and Investment**		
1	Energies	5	0,598
2	Sustainability	4	0,612
3	The Lancet	3	13,103
4	Renewable and Sustainable Energy Reviews	3	3,522
5	The Lancet Global Health	3	7,97
6	Climate Policy	2	1,764
7	Environmental Science and Pollution Research	2	0,845
8	Applied Energy	2	3,035
9	World Development	2	2,386
10	PLoS Medicine	2	4,847

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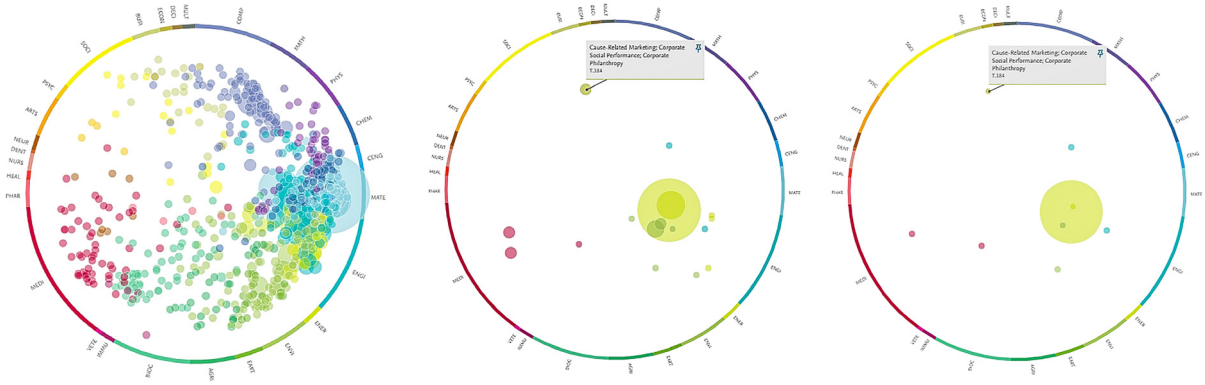
Table C1 (cont.). Top 10 journals by scholarly output in each Research Area in 2016–2022

	Scopus Source	Publications	SJR
No.	**SDG 7 and Responsible Investment**		
1	BMC Pregnancy and Childbirth	1	1,299
2	Law and Contemporary Problems	1	0,229
3	Health Policy and Planning	1	1,608
4	Health Research Policy and Systems	1	1,269
5	Annals of Operations Research	1	1,068
6	Environmental Science and Pollution Research	1	0,845
7	Mitigation and Adaptation Strategies for Global Change	1	0,994
8	Energies	1	0,598
9	Biofuels, Bioproducts and Biorefining	1	0,931
10	World Development Perspectives	1	0,306
No.	**SDG 7 and Investment Gap**		
1	The Lancet Global Health	2	7,97
2	The Lancet	1	13,103
3	Health Research Policy and Systems	1	1,269
4	Environmental Science & Technology	1	2,851
5	Climate Policy	1	1,764
6	Energies	1	0,598
7	Sustainability	1	0,612
8	Proceedings of the International Astronautical Congress, IAC	1	-
9	World Development Perspectives	1	0,306
10	Lecture Notes in Civil Engineering	1	0,108
No.	**SDG 7 and COVID-19**		
1	World Development	2	2,386
2	Journal of Cleaner Production	1	1,937
3	Journal of Interpersonal Violence	1	0,887
4	Journal of Risk Research	1	0,665
5	Prospects	1	0,2
6	Children and Youth Services Review	1	0,816
7	Renewable and Sustainable Energy Reviews	1	3,522
8	Applied Energy	1	3,035
9	International Journal of Environmental Research and Public Health	1	0,747
10	IOP Conference Series: Earth and Environmental Science	1	-

Note: SJR – SCImago Journal Rank.

APPENDIX D



SDG 7 | SDG 7 and Investment | SDG 7 and Responsible Investment

Figure D1. Top 1% topics in each research area SDG 7, SDG 7 and Investment, SDG 7 and Responsible Investment in 2016–2022

Source: Compiled by authors via SciVal by Elsevier.

SDG 7 and Investment Gap | SDG 7 and COVID-19

Note: COMP – Computer Science; MATH – Mathematics; PHYS – Physics and Astronomy; CHEM – Chemistry; CENG – Chemical Engineering; MATE – Materials Science; ENGI – Engineering; ENER – Energy; ENVI – Environmental Science; EART – Earth and Planetary Sciences; AGRI – Agricultural and Biological Sciences; BIOC – Biochemistry, Genetics and Molecular Biology; IMMU – Immunology and Microbiology; VETE – Veterinary; MEDI – Medicine; PHAR – Pharmacology, Toxicology and Pharmaceutics; HEAL – Health Professions; NURS – Nursing; DENT – Dentistry; NEUR – Neuroscience; ARTS – Arts and Humanities; PSYC – Psychology; SOCI – Social Sciences; BUSI – Business, Management and Accounting; ECON – Economics, Econometrics and Finance; DECI – Decision Sciences; MULT – Multidisciplinary.

Figure D2. Top 1% topics research area SDG 7 and Investment Gap, SDG 7 and COVID-19 in 2016–2022

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APPENDIX E

Table E1. List of papers based on a bibliometric map of publications related to SDG 7 and Investment and SDG 7 and Responsible investment, SDG 7 and Investment Gap

No.	Study	Authors	Year	Bibliometric data
1.	An investigation into the anthropogenic effect of biomass energy utilization and economic sustainability on environmental degradation in E7 economies	Gyamfi, B.A., Ozturk, I., Bein, M.A., & Bekun, F.V.	2021	Biofuels, Bioproducts and Biorefining 15(3), 840-851
2.	Assessing the sustainable development and renewable energy sources relationship in EU countries	Włodarczyk, B., Firoiu, D., Ionescu, G.H., (...), Szturo, M., & Markowski, L.	2021	Energies 14(8), 2323
3.	Implementing the United Nations sustainable development Goals to supply chains with behavioural consumers	Genc, T.S.	2021	Annals of Operations Research Article in Press
4.	Mobilising private climate finance for sustainable energy access and climate change mitigation in Sub-Saharan Africa	Michaelowa, A., Hoch, S., Weber, A.-K., Kassaye, R., & Hailu, T.	2021	Climate Policy 21(1), 47-62
5.	Green Bonds and Green Buildings: New Options for Achieving Sustainable Development in Nigeria	Oguntuase, O.J., & Windapo, A.	2021	Advances in 21st Century Human Settlements, 193-218
6.	Sustainable Delivery Models for Achieving SDG7: Lessons from an Energy Services Social Enterprise in Malawi	Eales, A., Frame, D., Coley, W., Bayani, E., & Galloway, S.	2020	2020 IEEE Global Humanitarian Technology Conference, GHTC 2020 9342877
7.	Considering the environmental impacts of bioenergy technologies to support German energy transition	Kalu, A., Vrzel, J., Kolb, S., (...), Pfaffenberger, F., & Ludwig, R.	2021	Energies 14(6),1534
8.	Advancing a global transition to clean energy – the role of international cooperation	Quitzow, R., Thielges, S., Goldthau, A., Helgenberger, S., & Mbungu, G.	2019	Economics 13,2019-48
9.	SDGs and the ability to manage change within the European green deal: The case of Ukraine.	Shevchenko, H., Petrushenko, M., Burkynskyi, B., & Khumarova, N.	2021	Problems and Perspectives in Management, 19(1), 53-67
10.	Energy consumption, CO^2 emissions and economic growth in MENA countries.	Maalej, A., & Cabagnols, A.	2020	Environmental Economics, 11(1), 133-150
11.	Energy efficiency and green solutions in sustainable development: evidence from the Norwegian maritime industry	Koilo, V.	2020	Problems and Perspectives in Management, 18(4), 289-302
12.	Sustainable agriculture & energy in the U.S.: A link between ethanol production and the acreage for corn.	Vo, H. D.	2020	Economics and Sociology, 13(3), 259- 268
13.	SDGs and ESG disclosure regulation: is there an impact? Evidence from Top-50 world economies.	Plastun, A., Makarenko, I., Khomutenko, L., Osetrova O., & Shcherbakov, P.	2020	Problems and Perspectives in Management, 18(2), 231-245
14.	Externalities of power generation in Visegrad countries and their integration through support of renewables.	Štreimikienė, D.	2021	Economics and Sociology, 14(1), 89-102
15.	The role of regulatory, market and governance risk for electricity access investment in sub-Saharan Africa	Falchetta, G., Dagnachew, A.G., Hof, A.F., & Milne, D.J.	2021	Energy for Sustainable Development 62,136-150
16.	Modelling the nexus between sustainable development and renewable energy: the African Perspectives	Tiba, S., & Belaid, F.	2021	Journal of Economic Surveys 35(1), 307-329
17.	How eco-efficient are electric vehicles across Europe? A regionalized life cycle assessment-based eco-efficiency analysis	Onat, N.C., Abdella, G.M., Kucukvar, M., (...), Kumbaroğlu, G., & Bulu, M.	2021	Sustainable Development Article in Press
18.	Potential of investments into renewable energy sources.	Čeryová D., Bullová T., Adamičková I., Turčeková N. and Bielik P	2020	Problems and Perspectives in Management, 18(2), 57-63
19.	Ranking of Baltic States on progress towards the main energy security goals of European energy union strategy.	Streimikiene, D.	2020	Journal of International Studies, 13(4), 24-37
20.	Green bonds of supranational financial institutions: On the road to sustainable development.	Versal, N., & Sholoiko, A.	2022	Investment Management and Financial Innovations, 19(1), 91-105
21.	Pragmatic model for sustainable energy policy: Networking between the government and key players in Bahrain	Dessouky, N. F. E	2021	Problems and Perspectives in Management, 19(1), 387-396

Table E1 (cont.). List of papers based on a bibliometric map of publications related to SDG 7 and Investment and SDG 7 and Responsible investment, SDG 7 and Investment Gap

No.	Study	Authors	Year	Bibliometric data
22.	Increasing the productivity of manufacturing firms in Cameroon in a sustainable way: Renewable or non-renewable energy?	Bertrand, N. A. S., & Etienne, K. L.	2022	Environmental Economics 13(1), 28-37
23.	Economic growth and environmental degradation paradox in ASEAN: A simultaneous equation model with dynamic panel data approach.	Supriyanto, W. R. A.; Arintoko, D. R., & Nunik, K.	2022	Environmental Economics, 13(1), 171-184
24.	The economic and social drivers of renewable energy development in OECD countries.	Melnyk, L., Sommer, H., Kubatko, O., Rabe, M., & Fedyna S.	2020	Problems and Perspectives in Management, 18(4), 37-48
25.	Externalities of power generation in Visegrad countries and their integration through support of renewables.	Štreimikienė, D.	2021	Economics and Sociology, 14(1), 89-102
26.	Energy poverty and impact of Covid-19 pandemics in Visegrad (V4) countries.	Streimikiene, D.	2022	Journal of International Studies, 15(1), 9-25
27.	The interplay between technological innovation, energy efficiency, and economic growth: Evidence from 30 European countries.	Koilo, V., Honningdal, O., & Emblemsvag, G.	2022	Problems and Perspectives in Management, 20(3), 448-464
28.	Renewable energy technologies in households: Challenges and low carbon energy transition justice.	Streimikiene, D.	2022	Economics and Sociology, 15(3), 108-120

Table E2. List of papers based on a bibliometric map of publications related to SDG 7 and COVID-19

No.	Study	Authors	Year	Bibliometric data
1.	Analysis of the impact of COVID-19 pandemic on the Brazilian distribution electricity market based on a socioeconomic regulatory model	Costa, V.B.F., Bonatto, B.D., Pereira, L.C., & Silva, P.F.	2021	International Journal of Electrical Power and Energy Systems, 132, 107172
2.	Short-term impact of the COVID-19 lockdown on the energy and economic performance of photovoltaics in the Spanish electricity sector	Micheli, L., Solas, Á.F., Soria-Moya, A., Almonacid, F., & Fernández, E.F.	2021	Journal of Cleaner Production, 308, 127045
3.	Impacts of COVID-19 pandemic on the global energy system and the shift progress to renewable energy: Opportunities, challenges, and policy implications	Hoang, A.T., Sandro Nižetić, Olcer, A.I., (...), Bandh, S.A., & Nguyen, X.P.	2021	Energy Policy, 154, 112322
4.	A retrospective analysis of the impact of the COVID-19 restrictions on energy consumption at a disaggregated level	García, S., Parejo, A., Personal, E., (...), Biscarri, F., & León, C.	2021	Applied Energy, 287, 116547
5.	Restrictions and Driving Forces for Renewable Energy Production Development and Electrical Energy Demand in General and during COVID-19	Celik, D., Meral, M.E., & Waseem, M.	2021	12th International Symposium on Advanced Topics in Electrical Engineering, ATEE 2021 9425216
6.	The impact of COVID-19 on the electricity sector in Spain: An econometric approach based on prices	Norouzi, N., Zarazua de Rubens, G.Z., Enevoldsen, P., & Behzadi Forough, A.	2021	International Journal of Energy Research, 45(4), 6320-6332
7.	Considering the environmental impacts of bioenergy technologies to support German energy transition	Kalu, A., Vrzel, J., Kolb, S., (...), Pfaffenberger, F., & Ludwig, R.	2021	Energies, 14(6), 1534
8.	Impacts of COVID-19 on energy demand and consumption: Challenges, lessons and emerging opportunities	Jiang, P., Fan, Y.V., & Klemeš, J.J.	2021	Applied Energy, 285, 116441
9.	Effects of the COVID-19 pandemic on energy systems and electric power grids – A review of the challenges ahead	Navon, A., Machlev, R., Carmon, D., (...), Belikov, J., & Levron, Y.	2021	Energies, 14(4), 1056
10.	COVID-19 and household energy implications: what are the main impacts on energy use? Open Access	Cheshmehzangi, A.	2020	Heliyon 6(10), e05202
11.	Rural electrification in sub-Saharan Africa with innovative energy policy and new financing models	Yang, F., Yang, M.	2018	Mitigation and Adaptation Strategies for Global Change, 23(6), 933-952
12.	Envisioning the UN Sustainable Development Goals (SDGs) through the lens of energy sustainability (SDG 7) in the post-COVID-19 world	Madurai Elavarasan, R., Puga-zhendhi, R., Jamal, T. (...), Chopra, S.S., & Nadarajah, M.	2021	Applied Energy, 292,116665

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APPENDIX F

Table F1. Examples of source in each research areas, generated via Google Public Data Explorer as of December 25, 2022

	Source	Updating
No.	**SDG 7 (more than 100 datasets)**	
1	World Bank (2020). Tracking SDG7 - The Energy Progress Report Application [Dataset]. https://datacatalog.worldbank.org/dataset/tracking-sdg7-energy-progress-report-application	Jun 12, 2020
2	Pamela Jagger; Robert Bailis; Ahmad Dermawan; Noah Kittner; Ryan McCord (2019). SDG 7: Affordable and Clean Energy – How Access to Affordable and Clean Energy Affects Forests and Forest-Based Livelihoods [Dataset]. http://doi.org/10.1017/9781108765015.009	Dec 12, 2019
3	UN DESA Statistics Division (2020). Indicator 7.2.1: Renewable energy share in the total final energy consumption (percent) [Dataset]. https://www.sdg.org/datasets/3cece1f2bb4e49efa22d45bc34076805	Aug 17, 2020
No.	**SDG 7 and Investment (17 datasets)**	
1	ISS ESG (2020). ISS ESG Impact & EU Sustainable Development Goals (SDG) Solutions (9,700 issuers globally) [Dataset]. https://datarade.ai/data-products/impact-eu-sdgs-solutions-iss-esg	Nov 20, 2020
2	World Bank (2019). Selected Countries - Geothermal Investments [Dataset]. http://cloud.csiss.gmu.edu/uddi/fi/dataset/geothermal-investments	Jun 13, 2019
3	UN DESA Statistics Division (2020). Indicator 7.a.1: International financial flows to developing countries in support of clean energy research and development and renewable energy production including in hybrid systems (millions of constant 2017 United States dollars) [Dataset]. https://www.sdg.org/datasets/086d631bf5ef4a96aedb07238346e343	Aug 17, 2020
No.	**SDG 7 and Responsible Investment (7 datasets)**	
1	World Bank (2019). World - Regulatory Indicators for Sustainable Energy [Dataset]. http://cloud.csiss.gmu.edu/uddi/he/dataset/world-regulatory-indicators-for-sustainable-energy-2016	Jun 13, 2019
2	Refinitiv (2021). ESG Data [Dataset]. https://www.refinitiv.com/en/financial-data/company-data/esg-data	May 15, 2021
3	ISS ESG (2020). ISS ESG Impact & EU Sustainable Development Goals (SDG) Solutions (9,700 issuers globally) [Dataset]. https://datarade.ai/data-products/impact-eu-sdgs-solutions-iss-esg	Nov 20, 2020
No.	**SDG 7 and Investment Gap (1 datasets)**	
1	Sustainable Development Solutions Network (2020). Sustainable Development Goal Index, 2020 [Dataset]. https://knoema.com/SDGIX2019/sustainable-development-goal-index-2020	Jun 30, 2020
2	–	–
3	–	–
No.	**SDG 7 and COVID-19 (2 datasets)**	
1	Pamela Jagger; Robert Bailis; Ahmad Dermawan; Noah Kittner; Ryan McCord (2019). SDG 7: Affordable and Clean Energy – How Access to Affordable and Clean Energy Affects Forests and Forest-Based Livelihoods [Dataset]. http://doi.org/10.1017/9781108765015.009	Dec 12, 2019
2	Sachverständigenrat für Verbraucherfragen, Berlin, Nachhaltiger Konsum: Repräsentativbefragung zu Kenntnissen, Akzeptanz, Verhalten, Erwartungen und Einstellungen im Kontext von SDG 12 [Dataset]. http://doi.org/10.4232/1.13730	–
3	–	–