APPENDIX A. SEARCH STRINGS

Search strings used in each one of the databases on June 21, 2024. For Web of Science, the searching was carried out by "Topic" and filtered for "Computer Science" research area.

Scopus	TITLE-ABS-KEY ((sustainab* OR green OR "energy efficient" OR "energy consumption" OR ecolog* OR environment*) AND software AND ("systematic literature review" OR "systematic review" OR "research review" OR "research synthesis" OR "mapping study" OR "scoping study" OR "systematic mapping" OR "secondary study" OR "meta-study" OR "meta-analysis" OR "multi-vocal")) AND (LIMIT-TO (SUBJAREA , "COMP"))	1139
Web of Science	(sustainab* OR green OR "energy efficient" OR "energy consumption" OR ecolog* OR environment*) AND software AND ("systematic literature review" OR "systematic review" OR "research review" OR "research synthesis" OR "mapping study" OR "scoping study" OR "systematic mapping" OR "secondary study" OR "meta-study" OR "meta-analysis" OR "multi-vocal")	516
IEEE /Abstract	("Abstract":sustainab* OR "Abstract":green OR "Abstract":"energy efficient" OR "Abstract":"energy consumption" OR "Abstract":ecolog* OR "Abstract":environment*) AND ("Abstract":software) AND ("Abstract":"systematic literature review" OR "Abstract": "systematic review" OR "Abstract": "research review" OR "Abstract": "research synthesis" OR "Abstract": "mapping study" OR "Abstract": "scoping study" OR "Abstract": "systematic mapping" OR "Abstract": "secondary study" OR "Abstract": "meta-study" OR "Abstract": "meta-analysis" OR "Abstract":"multi-vocal")	176
IEEE /Title	("Document Title":sustainab* OR "Document Title":green OR "Document Title":"energy efficient" OR "Document Title":"energy consumption" OR "Document Title":ecolog* OR "Document Title":environment*) AND ("Document Title":software) AND ("Document Title":"systematic literature review" OR "Document Title": "systematic review" OR "Document Title": "research review" OR "Document Title": "research synthesis" OR "Document Title": "mapping study" OR "Document Title": "scoping study" OR "Document Title": "systematic mapping" OR "Document Title": "secondary study" OR "Document Title": "meta-study" OR "Document Title": "meta-analysis" OR "Document Title":"multi-vocal")	10
IEEE /Keywords	("Author Keywords":sustainab* OR "Author Keywords":green OR "Author Keywords":"energy efficient" OR "Author Keywords":"energy consumption" OR "Author Keywords":ecolog* OR "Author Keywords":environment*) AND ("Author Keywords":software) AND ("Author Keywords":"systematic literature review" OR "Author Keywords": "systematic review" OR "Author Keywords": "research review" OR "Author Keywords": "research synthesis" OR "Author Keywords": "mapping study" OR "Author Keywords": "scoping study" OR "Author Keywords": "systematic mapping" OR "Author Keywords": "secondary study" OR "Author Keywords": "meta-	12

	study" OR "Author Keywords": "meta-analysis" OR "Author Keywords":"multi-vocal")	
ACM /Abstract	[[Abstract: sustainab*] OR [Abstract: green] OR [Abstract: "energy efficient"] OR [Abstract: "energy consumption"] OR [Abstract: ecolog*] OR [Abstract: environment*]] AND [Abstract: software] AND [[Abstract: "systematic literature review"] OR [Abstract: "systematic review"] OR [Abstract: "research review"] OR [Abstract: "research synthesis"] OR [Abstract: "mapping study"] OR [Abstract: "scoping study"] OR [Abstract: "systematic mapping"] OR [Abstract: "secondary study"] OR [Abstract: "meta-study"] OR [Abstract: "meta-analysis"] OR [Abstract: "multi-vocal"]]	125
ACM /Title	[[Title: sustainab*] OR [Title: green] OR [Title: "energy efficient"] OR [Title: "energy consumption"] OR [Title: ecolog*] OR [Title: environment*]] AND [Title: software] AND [[Title: "systematic literature review"] OR [Title: "systematic review"] OR [Title: "research review"] OR [Title: "research synthesis"] OR [Title: "mapping study"] OR [Title: "scoping study"] OR [Title: "systematic mapping"] OR [Title: "secondary study"] OR [Title: "meta-study"] OR [Title: "meta-analysis"] OR [Title: "multi-vocal"]]	7
ACM /Keywords	[[Keywords: sustainab*] OR [Keywords: green] OR [Keywords: "energy efficient"] OR [Keywords: "energy consumption"] OR [Keywords: ecolog*] OR [Keywords: environment*]] AND [Keywords: software] AND [[Keywords: "systematic literature review"] OR [Keywords: "systematic review"] OR [Keywords: "research review"] OR [Keywords: "research synthesis"] OR [Keywords: "mapping study"] OR [Keywords: "scoping study"] OR [Keywords: "systematic mapping"] OR [Keywords: "secondary study"] OR [Keywords: "meta-study"] OR [Keywords: "meta-analysis"] OR [Keywords: "multi-vocal"]]	9

APPENDIX B. DATA EXTRACTION FORM

Final data extraction form used for identifying verbatim text fragments from primary articles. The form shows some verbatim text fragments from S24 as well as relevant synthesis applied. Italics text helps to identify relevant content within the primary study.

ID	S24	Dec 25, 2022/ Comments
Reference	Anwar, H., & Pfahl, D. (2017, August). Towards greener software engineering using software analytics: A systematic mapping. In 2017 43rd Euromicro Conference on Software Engineering and Advanced Applications (SEAA) (pp. 157-166). IEEE.	
Topic	Software analytics in green SE	
Sustainability focus	Green in software	
Objective	to provide an overview of the sub-domains, contribution types, research types, research methods, future research potentials and the role of software analytics in the field of green software engineering in 2015-16.	
Additional contribution	None	
SE area(s)	General	
Quality score	2.5	
	RQ2 -Quality	

Num. Primary papers	Screening of papers was done according to inclusion/exclusion criteria and 50 selected studies were classified after analysis and data extraction.	50
Num. Empirical papers	80% Validation + evaluation= 40. 84% of the studies used empirical methods while 16% of the studies used non empirical (theoretical research) methods	42
Num. Industrial papers	No information	NA
Year coverage	We included only papers published in the years 2015 and 2016 for our mapping study	2015-2016
Quality PP	Step 4: Finally we assessed the quality of the primary studies according to the criteria described in Table 4. If the quality points for a study are less than or equal to 3, then that primary study was excluded from the selection.	Table 4 describes four quality assessment items applied to selected articles. The primary studies should score more than 3. Appendix includes the list of 50 primary paper.
Strength of evidence/quality findings	Issues as regards researcher bias and comprehensiveness of research	Issues as regards value of synthesis
Validity threats	Researcher's bias: The choice of keywords for queries and classification of papers are biased by the knowledge and understanding of the first author. Search String validity, coverage and missing results: Search string validity could be liable in two ways. Either it is producing very few results (false negatives) or it is producing too many (false positives)… . Few studies like "software energy profiling: comparing releases of a software product" and "GreenOracle: estimating software energy consumption with energy measurement corpora" were still missing from the results and were not re-captured. Query evaluation in databases: we are not aware of the internal query evaluation mechanism of each online database that we used. We are not sure how was our query computed by these databases i.e. either it was a lazy or eager loading of data. Most of the results contain the terms "sustainability" and "energy-efficient", therefore, it is safe to assume that no bias was caused in results due to query evaluation.	Yes
Selection criterion	TABLE 3: INCLUSION AND EXCLUSION CRITERIA (2 in each category)	1
Searching	6 DBs ACM digital library, IEEE digital library, Science Direct, Springer, Wiley online E-journals and Web of Science	0.5
Synthesis	Mapping study No synthesis method description.	0
Quality assessment	Finally we assessed the quality of the primary studies according to the criteria described in Table 4. If the quality points for a study are less than or equal to 3, then that primary study was excluded from the selection.	0.5 Only summary
Description	Annex A: title of 50 pp. NO complete reference. Only title. Annex B: contribution type and pp	0.5

	Annex C; type of research paper Annex D: subdomain by type of research paper (+pp) Annex E: subdomain by contribution type (pp)	
	RQ3 – Sustainability concepts	Notes
Sustainability gral. Definition	*Sustainability/sustainable without definition* *"The capacity to endure"* *Definitions based on general dictionaries* *Brundtland definition*	NA
Motivation based on Sw or SE	*Awareness of sustainability within SE communities (persons)* *Impact of SE practices on sustainability* *Impact of sustainability on SE* *SDG as motivation for conducting research in SE* *Energy efficiency as important NFR for mobile sw (s11)* *Energy efficiency of robotic software systems (this- -s12)* *Sustainability in CSS related to durability. (this s13)* *Social factors related to high failure rates in software, but tend to be ignored (this S13)* *The least studied dimension: individual (S14)* *Software supports Green by software goals (S15)* *Software support goals of energy efficiency in industry (S22)*	Impact of SE practices on sustainability
	Traditionally, energy optimization research has focused at the hardware (e.g.,[15], [16]) and systems (e.g., [17], [18]) levels. Recent work [19]–[22] indicates that there is ample opportunity to improve energy consumption at the software level. Because software systems have such a significant impact on our everyday lives that changes towards environmental sustainability can ripple to other systems with which they interact and positively affect the industries in which they are used. This impact can be direct, indirect, or occur as a rebound effect. [23].	
Green computing	*Green computing/IT* *Green-based terms beyond software* *Green IT as synonym of sustainability*	NA
Green software definition	*Murugesan2012* *Taina2011* *Erdelyi2013* *Other* *New* *Only mentioned (S15)* *Green software as power efficient (s24)*	Green software as power efficient

	the software product will be power efficient or, in other words, green.	
Green software related terms	*Green in software* *Green by software* *Other green terms in the domain of software product*	NA
Sustainable software definition	*Sustainable software (Dick2010)* *Green and sustainable software (Naumann2011)* *Software sustainability as NFR (Raturi2014)* *Software sustainability as emergent property (Venters2014)* *Software sustainability as a composite NFR (Venters2013, 2021).* *Other (when authors cite another paper)* *New (when authors propose new definition)* *Software maintainable (S14)* *Sustainable includes both longer life and greener aspects (s19)* *Sustainable software (Penzen2014)* A sustainable software is the one which is developed and used in such a way that it leaves a minimum negative impact on users, environment, economy and society in general [2]. [2] M. Dick, S. Naumann, and N. Kuhn, “A Model and Selected Instances of Green and Sustainable Software,” What Kind Inf. Soc. Governance, Virtuality, Surveillance, Sustain. Resilience. IFIP Adv. Inf. Commun. Technol. 9th IFIP TC9 Int. Conf. HCC 9 2010 1st IFIP TC 11 Int. Conf. C, no. September, pp. 248–259, 2010.	Sustainable software paraphrased from dick2010Amodel
Considerations for defining Sustainable SE/ Green SE	*No agreement on sustainable SE definition* *No agreement on green SE definition* *Green or sustainable SE treated as synonyms* *Scope of sustainability in SE*	NA
Definition of sustainable SE or green SE	*Sustainable SE – Amsel2011* *Sustainable SE – Calero2017* *Sustainable SE – Dick2010Enhancing* *Green in SE – Calero2015* *Green and sustainable SE – Mahmoud2013* *Green and sustainable SE –Naumann2011* *Green and sustainable software development – Salam2016* *Others* New Rashid2018 green and sustainable SE (S17)	Green software engineering paraphrased based on Calero2015

	green software engineering consists of processes and practices that help produce sustainable software and everything related to the software product, be it development or maintenance, taking environmental aspects into account. [3] 3] C. Calero and M. Piattini, “Green in software engineering,” Green Softw. Eng., pp. 1–327, 2015.	
Approach for studying sustainability in SE	Sustainability is studied as NFR, as a quality property, as an emergent property, and as a framework. the question of energy efficiency has become one of the crucial parameters when users select a device. Energy efficiency aims at reducing the amount of energy required when providing products and services. Energy efficiency of a digital device has become part of its overall perceived quality. Most of the time, research focuses on non-functional requirements like performance and efficiency, where attributes like sustainable and energy efficacy are ignored RQ4. Dimensions - Background	As a quality attribute OR NFR
Dimensions	*Incidental reference to dimensions* *Inferred environmental dimension* *TBL (Brundtland)* *Three dimensions (Calero2017)* *Four dimensions (Technical) Lago2015* *Four dimensions (Human) Penzedstadler2012* *Five dimensions (Penzedstadler2013)* *Five dimensions (Karlskrona Manifesto)* *One dimension (social) S13* *One dimension (environmental) s20* *Five dimensions (Penzedstadler2014) S24* Green software engineering could be explored along five dimensions (Economic, Social, environmental, human/individual development and technical) [29]. [29] B. Penzenstadler, “Infusing green: Requirements engineering for green in and through software systems,” CEUR Workshop Proc., vol. 1216, no. 1, pp. 44–53, 2014.	Penzen2014Infusing green
Relationship between dimensions	*Intra-dimension (social)* *Intra-dimension (technical)* *Interdimension (technical, social)* *Interdimension (technical, environmental)* *General interactions (Diagram, tables)*	NA
Order effects	*Order effect focused on environment* *Order effect apply all dimensions (mentioned each one)* *Order effect as immediate (1st)*	Three order effect (penzen2014Safety)

	Order effect as enabling (2nd) *Order effect as systemic (3rd)* This impact can be direct, indirect, or occur as a rebound effect. [23] [23] B. Penzenstadler, A. Raturi, and D. Richardson, “Safety , Security , Now Sustainability◌ொ: for the 21st Century,” 2014.	
	RQ4 - Dimensions - Results	
Dimensions	*Incidental reference to dimensions* *Inferred environmental dimension* *TBL (Brundtland)* *Three dimensions (Calero2017)* *Four dimensions (Technical) Lago2015* *Four dimensions (Human) Penzedstadler2012* *Five dimensions (Penzedstadler2013)* *Five dimensions (Karlskrona Manifesto)* *Technical dimension (s24)* According to [29] sustainability in software engineering can have five dimensions: social, environmental, economics, technical and individual. We observed during analysis that almost 47 out of 50 (94%) of the selected studies were related to the technical dimension of sustainability. Within this technical dimension, only 11 studies used software analytical techniques in some capacity (see table 7). Frequently used techniques were static analysis, text mining and statistical analysis. [29] B. Penzenstadler, “Infusing green: Requirements engineering for green in and through software systems,” CEUR Workshop Proc., vol. 1216, no. 1, pp. 44–53, 2014.	Technical dimension (s24)
Relationship between dimensions	*Intra-dimension (social)* *Intra-dimension (technical)* *Interdimension (technical, social)* *Interdimension (technical, environmental)* *General interactions (Diagram, tables)*	NA
Order effects	*Order effect focused on environment* *Order effect apply all dimensions (mentioned each one)* *Order effect as immediate (1st)* *Order effect as enabling (2nd)* *Order effect as systemic (3rd)*	NA
Comments	Add comments about nature of information of primary papers	
	RQ5/RQ6 Topics, findings, research gaps	
General classifications	*Life cycle stages* *SE KA* *Type of paper (Wieringa2006)* *Research method*	Contribution, type of research paper,

	Contribution type *Settings (industrial/academic)* *Other* The types of contributions made by primary studies were taken from Petersen et al. [1], i.e., method, model, process, tool, and metric. Another facet in the classification scheme is the research type of primary stud validation research, evaluation research, solution paper, philosophical paper, opinion paper, and experience paper. TABLE 5: SUB-CATEGORIES FOR EMPIRICAL RESEARCH METHODS Of the selected primary studies 64% contributed a method, while 16% contributed a model and 12% of contributed a process. There were only a few tool and metric contributions (4% each). See Figures 2. We found that most publications were “validation” research (62% of all studies) using lab experiments and simulations. We could confirm the observation made by Penzenstadler et al. [27] that there exists a gap where these novice techniques, algorithms, models etc. presented in the validation studies needs to be actually implemented and tested in industry. “Evaluation” research was 18%,	
Sustainability classification	*Used previously sustainability classifications* *Created a new classification (how?)* *Definition of categories (yes/no)* *Classification of each primary paper* *Aggregated data per category* In order to identify sub-domains of green software engineering in primary studies, we examined the keywords from the selected primary studies and merged overlapping terms. From the remaining unique set of keywords, we removed the context-specific terms like the names of algorithms and techniques, as they were not suitable keywords for generalizing a category. Finally, the remaining set of keywords was merged based on synonyms to form domain categories… we classified the research domain into the following sub-domains: 1) Sustainable Mobile Applications, 2) Sustainable Software Design and Development, 3) Energy Aware Resource Scheduling/Management, 4) Green Computing in Networks, 5) Sustainable Requirement Engineering, 6) Green in big data, cloud and data centres, 7) Software Energy Consumption, 8) Other.	Subdomains identified by analyzing pp. No information about its definitions. 1) Sustainable Mobile Applications, 2) Sustainable Software Design and Development, 3) Energy Aware Resource Scheduling/Management, 4) Green Computing in Networks, 5) Sustainable Requirement Engineering, 6) Green in big data, cloud and data centres, 7) Software Energy Consumption, 8) Other.

Contextual information	*Identify the environment where findings may be useful. Use Petersen2009 Contextual factors* *Product, Process, (practices, tools, techniques), people, organization, market)* *Add: settings (industry sector, academia)*	NA
Domain	*Identify whether the review was conducted considering specific domains (banking, telecom., among others). When no information is explicitly specified, use NA.*	NA
Technology	*Identify the specific technology the SR is focused on. When no information is provided, use NA*	NA
Findings	*Propositions that answer research questions and provide new insights, including effectiveness of interventions. If there are tables of figures that show summary information, use them. Identify the section*. software analytics techniques that we considered when identifying the role of software analytics in the selected literature were "data mining", "prediction analysis", "statistical analysis", descriptive analytics and "pattern detection". Table 7 lists the primary studies that used software analytics as a vehicle for moving towards greener software engineering. We conclude that the current research provides novice and innovative techniques for green software engineering but the literature is missing experience papers by software professionals and practitioners. 11 out of 50 papers used software analytical methods like statistical analysis, static analysis etc. Future research in this field could be extended in the areas of sustainable software architecture, energy aware supporting tools and real-time automated analytical tools for software development. Energy aware software maintenance could also be a potential future direction within green software engineering.	Software analytics approaches: data mining, prediction analysis statistical analysis, descriptive analytics , pattern detection
Challenges	*Text fragments that address challenges, issues, and research gaps. Identify the type provided by authors and the section* Future research areas: High-level design i.e. software architecture is not addressed very frequently, thus, research on high-level design with respect to green software engineering and the effectiveness and evaluation of these design on the basis of sustainability could be a possible future direction of research. Most sub-domains of green software engineering are lacking supporting tools. We found only one study focusing on energy aware testing tools. Also, metrics explaining the correlation between energy usage and other quality attributes is an area that needs attention.	More research work on: software architecture Developing supporting tools, Metrics that explain correlations between energy usage and other quality attributes, Research on industrial settings, Energy aware maintenance is another research area.

Experience papers from industry and software practitioners could help in prioritizing the research goals as per the needs of industry. It could also help in validating the existing body of research.

Research methods like case studies and surveys evaluating the current industry practices are scarce, leaving a gap in the literature.

it is clear that researchers are already using both manual (e.g. S44, S9) and automated (e.g. S1, S42) software analytical methods in order to move towards greener software engineering. However, there is still room for improvement in terms of automated tools for supporting the overall system analysis so that software professionals better understand the energy usage during development

Energy aware software maintenance is another potential research direction within the domain of green software engineering that is not much explored.

APPENDIX C. LIST OF INCLUDED STUDIES

IDFinal	Reference
S01	Mourão, B. C., Karita, L., & do Carmo Machado, I. (2018, October). Green and sustainable software engineering-a systematic mapping study. In Proceedings of the 17th Brazilian Symposium on Software Quality (pp. 121-130).
S02	Moises, A. C., Malucelli, A., & Reinehr, S. (2018, October). Practices of Energy Consumption for Sustainable Software Engineering. In 2018 Ninth International Green and Sustainable Computing Conference (IGSC) (pp. 1-6). IEEE.
S03	Welter, M., Benitti, F. B. V., & Thiry, M. (2014, September). Green metrics to software development organizations: A systematic mapping. In 2014 XL Latin American Computing Conference (CLEI) (pp. 1-7). IEEE.
S04	Khan, F., Anwar, H., Pfahl, D., & Srirama, S. (2020, August). Software Techniques for Making Cloud Data Centers Energy-efficient: A Systematic Mapping Study. In 2020 46th Euromicro Conference on Software Engineering and Advanced Applications (SEAA) (pp. 479-486). IEEE.
S05	Wolfram, N., Lago, P., & Osborne, F. (2017, December). Sustainability in software engineering. In 2017 Sustainable Internet and ICT for Sustainability (SustainIT) (pp. 1-7). IEEE.
S06	Salam, M., & Khan, S. U. (2016, August). Developing green and sustainable software: Success factors for vendors. In 2016 7th IEEE International Conference on Software Engineering and Service Science (ICSESS) (pp. 1059-1062). IEEE.
S07	Calero, C., Bertoa, M. F., & Moraga, M. Á. (2013, May). A systematic literature review for software sustainability measures. In 2013 2nd international workshop on green and sustainable software (GREENS) (pp. 46-53). IEEE.
S08	Penzenstadler, B., Bauer, V., Calero, C., & Franch, X. (2012). Sustainability in software engineering: A systematic literature review. EASE 2012. 32-41.
S09	Lund, E. H., Jaccheri, L., Li, J., Cico, O., & Bai, X. (2019, May). Blockchain and sustainability: A systematic mapping study. In 2019 IEEE/ACM 2nd International Workshop on Emerging Trends in Software Engineering for Blockchain (WETSEB) (pp. 16-23). IEEE.

S10 Albuquerque, D., Moreira, A., Araujo, J., Gralha, C., Goulão, M., & Brito, I. S. (2021, October). A Sustainability Requirements Catalog for the Social and Technical Dimensions. In International Conference on Conceptual Modeling (pp. 381-394). Springer, Cham.

S11 Moreira, J. S., Alves, E. L., & Andrade, W. L. (2020, December). A Systematic Mapping on Energy Efficiency Testing in Android Applications. In 19th Brazilian Symposium on Software Quality (pp. 1-10).

S12 Swanborn, S., & Malavolta, I. (2020, September). Energy efficiency in robotics software: A systematic literature review. In Proceedings of the 35th IEEE/ACM International Conference on Automated Software Engineering Workshops (pp. 144-151).

S13 Gustavsson, J. L., & Penzenstadler, B. (2020, June). Blinded by Simplicity: Locating the Social Dimension in Software Development Process Literature. In Proceedings of the 7th International Conference on ICT for Sustainability (pp. 116-127).

S14 Nazir, S., Fatima, S., Chuprat, N., Sarkan, H., Nilam, N. F., & Sjarif, N. A. (2020). Sustainable Software Engineering: A Perspective of Individual Sustainability. International Journal on Advanced Science Engineering and Information Technology. (10)2: 676-683.

S15 Mendoza-Pittí, L., Gómez-Pulido, J. M., & Vargas-Lombardo, M. (2019). Arquitecturas de software para la eficiencia energética en edificaciones: una revisión sistemática. Revista Ibérica de Sistemas e Tecnologias de Informação, (E23), 40-52.

S16 Dlamini, G., Jolha, F., Kholmatova, Z., & Succi, G. (2022). Meta-analytical comparison of energy consumed by two sorting algorithms. Information Sciences, 582, 767-777.

S17 Rashid, N., & Khan, S. U. (2018). Agile practices for global software development vendors in the development of green and sustainable software. Journal of Software: Evolution and Process, 30(10), e1964.

S18 Rashid, N., & Khan, S. U. (2018). Using agile methods for the development of green and sustainable software: Success factors for GSD vendors. Journal of Software: Evolution and Process, 30(8), e1927.

S19 Salam, M., & Khan, S. U. (2018). Challenges in the development of green and sustainable software for software multisourcing vendors: Findings from a systematic literature review and industrial survey. Journal of Software: Evolution and Process, 30(8), e1939.

S20 García-Mireles, G. A., Moraga, M. Á., García, F., Calero, C., & Piattini, M. (2018). Interactions between environmental sustainability goals and software product quality: A mapping study. Information and Software Technology, 95, 108-129.

S21 Mansour, Y., Hammad, H., Waraga, O. A., & Talib, M. A. (2021, October). Energy Management Systems and Smart Phones: A Systematic Literature Survey. In 2021 International Conference on Communications, Computing, Cybersecurity, and Informatics (CCCI) (pp. 1-7). IEEE.

S22 Effenberger, F., & Hilbert, A. (2018). A literature review on energy information system software development: Research gaps and questions in industrial manufacturing. In In MKWI 2018-Multikonferenz Wirtschaftsinformatik. (pp. 905-911).

S23 Al Nidawi, H. S. A., Wei, K. T., Dawood, K. A., & Khaleel, A. (2017). Energy consumption patterns of mobile applications in android platform: a systematic literature review. Journal of Theoretical & Applied Information Technology, 95(24), 6776-6787.

S24 Anwar, H., & Pfahl, D. (2017, August). Towards greener software engineering using software analytics: A systematic mapping. In 2017 43rd Euromicro Conference on Software Engineering and Advanced Applications (SEAA) (pp. 157-166). IEEE.

S25 Marimuthu, C., & Chandrasekaran, K. (2017, February). Software engineering aspects of green and sustainable software: A systematic mapping study. In Proceedings of the 10th Innovations in Software Engineering Conference (pp. 34-44).

S26 Berntsen, K.R., Olsen, M.R., Limbu, N., Tran, A.T., Colomo-Palacios, R. (2017). Sustainability in Software Engineering - A Systematic Mapping. In: Mejia, J., Muñoz, M., Rocha, Á., San Feliu, T., Peña, A. (eds) Trends and Applications in Software Engineering. CIMPS 2016. Advances in Intelligent Systems and Computing, vol 537. Springer, Cham. (pp. 23-32) https://doi.org/10.1007/978-3-319-48523-2_3

S27 García-Mireles, G.A. (2017). Environmental Sustainability in Software Process Improvement: a Systematic Mapping Study. In: Mejia, J., Muñoz, M., Rocha, Á., San Feliu, T., Peña, A. (eds) Trends and Applications in Software Engineering. CIMPS 2016. Advances in Intelligent Systems and Computing, vol 537. (pp. 69-78) Springer, Cham. https://doi.org/10.1007/978-3-319-48523-2_7

S28 Debbarma, T., & Chandrasekaran, K. (2016, December). Green measurement metrics towards a sustainable software: A systematic literature review. In 2016 International Conference on Recent Advances and Innovations in Engineering (ICRAIE) (pp. 1-7). IEEE.

S29 Shevchuk, N., & Oinas-Kukkonen, H. (2016). Exploring green information systems and technologies as persuasive systems: A systematic review of applications in published research. Thirty Seventh International Conference on Information Systems, Dublin 2016. pp. 1-11

S30 Patón-Romero, J. D., & Piattini, M. (2016). Indicators for Green in IT Audits: A Systematic Mapping Study. Workshop on Measurement and Metrics for Green and Sustainable Software MeGSuS@ ESEM, 4-12.

S31 Rashid, N., & Khan, S. U. (2016, April). Developing Green and Sustainable Software using Agile Methods in Global Software Development: Risk Factors for Vendors. In ENASE (pp. 247-253).

S32 Procaccianti, G., Lago, P., & Bevini, S. (2015). A systematic literature review on energy efficiency in cloud software architectures. Sustainable Computing: Informatics and Systems, 7, 2-10.

S33 Al Hinai, M., & Chitchyan, R. (2014). Social Sustainability Indicators for Software: Initial Review. Third International Workshop on Requirements Engineering for Sustainable Systems, RE4SuSy 2014, co-located with 22nd International Conference on Requirements Engineering. pp. 21-27.

S34 Penzenstadler, B., Raturi, A., Richardson, D., Calero, C., Femmer, H., & Franch, X. (2014, May). Systematic mapping study on software engineering for sustainability (SE4S). In Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering (pp. 1-14).

S35 Koziolek, H. (2011, June). Sustainability evaluation of software architectures: a systematic review. In Proceedings of the joint ACM SIGSOFT conference--QoSA and ACM SIGSOFT symposium--ISARCS on Quality of software architectures--QoSA and architecting critical systems--ISARCS (pp. 3-12).

S36 Hamizi, I., Bakare, A., Fraz, K., Dlamini, G., & Kholmatova, Z. (2021, June). A Meta-analytical Comparison of Energy Consumed by Two Different Programming Languages. In International Conference on Frontiers in Software Engineering (pp. 176-200). Springer, Cham.

S37 Diirr, B., de Oliveira Neves, V., Cunha, A., dos Reis, A. B. K., & de Souza, J. F. (2021). Software Requirements for Disaster Management Systems: A Study of Literature and Practice.15th International Conference on Information Systems for Crisis Response and Management. Pp. 1042-1054.

S38 Alharthi, A. D., Spichkova, M., & Hamilton, M. (2019). Sustainability requirements for eLearning systems: a systematic literature review and analysis. Requirements Engineering, 24(4), 523-543.

S39 García-Mireles, G. A., Moraga, M. Á., García, F., & Piattini, M. (2017, June). A classification approach of sustainability aware requirements methods. In 2017 12th Iberian conference on information systems and technologies (CISTI) (pp. 1-6). IEEE.

S40 Mendoza-Pitti, L., Calderón-Gómez, H., Vargas-Lombardo, M., Gómez-Pulido, J. M., & Castillo-Sequera, J. L. (2021). Towards a service-oriented architecture for the energy efficiency of buildings: A systematic review. IEEE Access, 9, 26119-26137.

S41 Abdullah, R., Abdullah, S., Din, J., & Tee, M. (2015). A systematic literature review of green software development in collaborative knowledge management environment. International Journal of Advanced Computer Technology (IJACT), 4(1), 63-80.

S42 Andrikopoulos, V., Boza, R. D., Perales, C., & Lago, P. (2022). Sustainability in Software Architecture: A Systematic Mapping Study. 48th Euromicro Conference on Software Engineering and Advanced Applications (SEAA), Gran Canaria, Spain, 2022, pp. 426-433, doi: 10.1109/SEAA56994.2022.00073.

S43 Barisic, A., Cunha, J., Ruchkin, I., Moreira, A., Araújo, J., Challenger, M., Savić, D., & Amaral, V. (2022). Modelling Sustainability in Cyber-Physical Systems: A Systematic Mapping Study. https://hal.science/hal-03616678

S44 Imran, A., & Kosar, T. (2019). Software sustainability: a systematic literature review and comprehensive analysis. arXiv preprint arXiv:1910.06109.

S45 Raisian, K., Yahaya, J., & Deraman, A. (2016). Current challenges and conceptual model of green and sustainable software engineering. Journal of Theoretical & Applied Information Technology, 94(2), 428-443.

S46 Restrepo, L., Aguilar, J., Toro, M., & Suescún, E. (2021). A sustainable-development approach for self-adaptive cyber–physical system's life cycle: A systematic mapping study. Journal of Systems and Software, 180, 111010.

S47 Swacha, J. (2022). Models of Sustainable Software: A Scoping Review. Sustainability, 14(1), 551.

S48 Bozzelli, P., Gu, Q., & Lago, P. (2013). A systematic literature review on green software metrics, VU University Amsterdam.

S49 Khan, R. U., Khan, S. U., Khan, R. A., & Ali, S. (2015). Motivators in Green IT-outsourcing from Vendors Perspective: A Systematic Literature Review, Proceedings of Pakistan Academy of Sciences Journal, 52(4), 345-360.

S50 Degu, A. (2019). Android app memory and energy performance: Systematic literature review. IOSR J. of Comp. Eng., (21)3, 20-32. DOI: 10.9790/0661-2103052032.

S51 R. Ahmad, F. Baharom, & A. Hussain. (2014). A systematic literature review on sustainability studies in software engineering. In Knowledge Management International Conference (KMICe), Langkawi, Malaysia, (pp. 1-6).

S52 Shahab, A., Naseer, A., Zafar, M. N., & Nadeem, A. (2021, December). Detection of Energy Bugs in Android Applications: A Systematic Literature Review. In 2021 International Conference on Frontiers of Information Technology (FIT) (pp. 7-12). IEEE.

S53 Anwar, H., Fatima, I., Pfahl, D., & Qamar, U. (2021). Tool Support for Green Android Development. In In: Calero, C., Moraga, M.Á., Piattini, M. (eds). Software Sustainability (pp. 153-182). Springer, Cham.

S54 Kholmatova, Z.: Impact of programming languages on energy consumption for mobile devices. In: Proceedings of the 28th ACM Joint Meeting on European Software Engineering Conference and Symposium on the Foundations of Software Engineering, pp. 1693–1695 (2020)

S55 Volpato, T., Oliveira, B. R., Garcés, L., Capilla, R., & Nakagawa, E. Y. (2017, September). Two perspectives on reference architecture sustainability. In Proceedings of the 11th European Conference on Software Architecture: Companion Proceedings (pp. 188-194).

S56 Moises de Souza, A. C., Soares Cruzes, D., Jaccheri, L., & Krogstie, J. (2023, December). Social Sustainability Approaches for Software Development: A Systematic Literature Review. In International Conference on Product-Focused Software Process Improvement (pp. 478-494). Cham: Springer Nature Switzerland.

S57 Firmansyah, F., Sudirman, M. Y. D., , Putra, R. I. (2024). Integrating green computing into rational unified process for sustainable development goals: a comprehensive approach International Journal of Electrical and Computer Engineering (IJECE) Vol. 14, No. 3, June 2024, pp. 2868-2874 DOI: 10.11591/ijece.v14i3.pp2868-2874

S58 Araújo, G., Barbosa, V., Lima, L. N., Sabino, A., Brito, C., Fé, I., Rego, P., Choi, E., Min, D., Nguyen, T. A., & Silva, F. A. (2024). Energy consumption in microservices architectures: a systematic literature review. IEEE Access. 12, pp. 186710-186729, 2024, doi: 10.1109/ACCESS.2024.3389064

S59 Balanza-Martinez, J., Lago, P., Verdecchia, R. (2024). Tactics for Software Energy Efficiency: A Review. In: Wohlgemuth, V., Kranzlmüller, D., Höb, M. (eds) Advances and New Trends in Environmental Informatics 2023. ENVIROINFO 2023. Progress in IS. (pp. 115-140). Springer, Cham. https://doi.org/10.1007/978-3-031-46902-2_7.

S60 Schuler, A., & Kotsis, G. (2024). A systematic review on techniques and approaches to estimate mobile software energy consumption. Sustainable Computing: Informatics and Systems, 41, pp. 1-16, 100919.

S61 Ahmadisakha, S., & Andrikopoulos, V. (2024). Architecting for sustainability of and in the cloud: A systematic literature review. Information and Software Technology, 71, pp. 1-19, 107459.

S62 Haider, W., Ilyas, M., Khalid, S., & Ali, S. (2024). Factors influencing sustainability aspects in crowdsourced software development: A systematic literature review. Journal of Software: Evolution and Process, 36(6), pp. 1-23, e2630.

S63 Ribeiro, Q., Santos, A., Oliveira, K., Castro, J., & Lencastre, M. (2024, April). A View of the Technical, Individual, and Social Dimensions of Sustainable Software Systems: A Systematic Literature Review. In Proceedings of the 39th ACM/SIGAPP Symposium on Applied Computing (pp. 1169-1177).

S64 Chadli, K., Botterweck, G., & Saber, T. (2024, April). The Environmental Cost of Engineering Machine Learning-Enabled Systems: A Mapping Study. In Proceedings of the 4th Workshop on Machine Learning and Systems (pp. 200-207).

S65 Čelebić, V., & Bucaioni, A. (2023, September). A Systematic Mapping Study on the Role of Software Engineering in Enabling Society 5.0. In 2023 IEEE International Smart Cities Conference (ISC2) (pp. 1-8). IEEE. doi: 10.1109/ISC257844.2023.10293672.

S66 Fatima, I., & Lago, P. (2023, March). A review of software architecture evaluation methods for sustainability assessment. In 2023 IEEE 20th International Conference on Software Architecture Companion (ICSA-C) (pp. 191-194). IEEE.

S67 Huber, S., Lorey, T., & Felderer, M. (2023, September). Techniques for Improving the Energy Efficiency of Mobile Apps: A Taxonomy and Systematic Literature Review. In 2023 49th Euromicro Conference on Software Engineering and Advanced Applications (SEAA) (pp. 286-292). IEEE.

S68 Bambazek, P., Groher, I., & Seyff, N. (2023). Requirements engineering for sustainable software systems: a systematic mapping study. Requirements Engineering, 28(3), 481-505.

S69 McGuire, S., Schultz, E., Ayoola, B., & Ralph, P. (2023, May). Sustainability is stratified: Toward a better theory of sustainable software engineering. In 2023 IEEE/ACM 45th International Conference on Software Engineering (ICSE) (pp. 1996-2008). IEEE.

S70 Li, R., Liang, P., Soliman, M., & Avgeriou, P. (2022). Understanding software architecture erosion: A systematic mapping study. Journal of Software: Evolution and Process, 34(3), e2423.

S71 Paradis, C., Kazman, R., & Tamburri, D.A. (2021). Architectural tactics for energy efficiency: review of the literature and research roadmap. In: Hawaii International Conference on System Science, pp. 7197-7206.

S72	B. Dornauer and M. Felderer, "Energy-Saving Strategies for Mobile Web Apps and their Measurement: Results from a Decade of Research," 2023 IEEE/ACM 10th International Conference on Mobile Software Engineering and Systems (MOBILESoft), Melbourne, Australia, 2023, pp. 75-86, doi: 10.1109/MOBILSoft59058.2023.00017.
S73	Anne-Kathrin Peters, Rafael Capilla, Vlad Constantin Coroamă, Rogardt Heldal, Patricia Lago, Ola Leifler, Ana Moreira, João Paulo Fernandes, Birgit Penzenstadler, Jari Porras, and Colin C. Venters. 2024. Sustainability in Computing Education: A Systematic Literature Review. ACM Trans. Comput. Educ. 24, 1, Article 13 (March 2024), 53 pages. https://doi.org/10.1145/3639060
S74	Moises de Souza, A.C., Jaccheri, L. (2024). Designing for Inclusion and Diversity in Big Tech Reports: A Gray Literature Analysis. In: Antona, M., Stephanidis, C. (eds) Universal Access in Human-Computer Interaction. HCII 2024. Lecture Notes in Computer Science, vol 14697. Springer, Cham. https://doi.org/10.1007/978-3-031-60881-0_5
S75	Freed, M., Bielinska, S., Buckley, C., Coptu, A., Yilmaz, M., Messnarz, R., & Clarke, P. M. (2023, August). An Investigation of Green Software Engineering. In European Conference on Software Process Improvement (pp. 124-137). Cham: Springer Nature Switzerland.
S76	Pijnacker, B., van der Zwaag, J., & Pasveer, J. (2023). Tools for Measuring and Monitoring the Energy Efficiency of Software Systems: A Rapid Review. University of Groningen.
S77	Hunger, T., Arnold, M., & Pestinger, R. (2023). Risks and requirements in sustainable app development—A review. Sustainability, 15(8), 7018.
S78	Sun, Y., Fang, J., Chen, Y., Liu, Y., Chen, Z., Guo, S., Chen, X. & Tan, Z. (2023). Energy inefficiency diagnosis for Android applications: a literature review. Frontiers of Computer Science, 17(1), (pp. 1-16). 171201
S79	Lee, S. U., Fernando, N., Lee, K., & Schneider, J. G. (2024). A survey of energy concerns for software engineering. Journal of Systems and Software, 210, 111944.
S80	Trinh, E., Funke, M., Lago, P., & Bogner, J. (2024, April). Sustainability Integration of Artificial Intelligence into the Software Development Life Cycle. In 8th International Workshop on Green and Sustainable Software (GREENS'24). Pp. 1-8.

APPENDIX D. LIST OF EXCLUDED PAPERS

In total, 185 papers were assessed, 80 papers were included in this tertiary study (Appendix C. Included Studies) and 105 papers were excluded. From database search procedure, we excluded 34 papers by applying 3.3 Selection Criteria. From snowballing procedure, we excluded 71 papers.

Reference (from database search procedure)	Exclusion criterion
Andrikopoulos, V., Boza, R. D., Perales, C., & Lago, P. (2022, August). Sustainability in Software Architecture: A Systematic Mapping Study. In 2022 48th Euromicro Conference on Software Engineering and Advanced Applications (SEAA) (pp. 426-433). IEEE.	Duplicated
Dlamini, G., Jolha, F., Kholmatova, Z., & Succi, G. (2022). Meta-analytical comparison of energy consumed by two sorting algorithms. Information Sciences, 582, 767-777.	Duplicated
Moreira, A., Araújo, J., Gralha, C., Goulão, M., Brito, I. S., & Albuquerque, D. (2023). A social and technical sustainability requirements catalogue. Data & Knowledge Engineering, 143, 102107.	Duplicated
Fatima, I., Anwar, H., Pfahl, D., & Qamar, U. (2020). Tool Support for Green Android Development: A Systematic Mapping Study. ICSOFT, 409-417.	Extended by (S53)
Adil, M., Fronza, I., & Pahl, C. (2024). How did COVID-19 Impact Software Design Activities in Global Software Engineering—Systematic Review. International Journal of Software Engineering and Knowledge Engineering, 1-31.	No available
Ahmad, R., Hussain, A., & Baharom, F. (2016). A systematic review on characteristic and sub-characteristic for sustainable service-oriented architecture towards long living software. Advanced Science Letters, 22(5-6), 1756-1760.	No available

Acosta-Coll, M., Solano-Escorcia, A., Ortega-Gonzalez, L., & Zamora-Musa, R. (2021). Forecasting and communication key elements for low-cost fluvial flooding early warning system in urban areas. International Journal of Electrical and Computer Engineering.	No SE
Ahmadi-Assalemi, G., Al-Khateeb, H., Epiphaniou, G., & Maple, C. (2020). Cyber resilience and incident response in smart cities: A systematic literature review. Smart Cities, 3(3), 894-927.	No SE
Díaz-López, C., Martín-Blanco, C., De la Torre Bayo, J. J., Rubio-Rivera, B., & Zamorano, M. (2021). Analyzing the Scientific Evolution of the Sustainable Development Goals. Applied Sciences, 11(18), 8286.	No SE
dos Santos, V., Iwazaki, A. Y., Felizardo, K. R., de Souza, É. F., & Nakagawa, E. Y. (2021, October). Towards Sustainability of Systematic Literature Reviews. In Proceedings of the 15th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM) (pp. 1-6).	No SE
Michener, W. K. (2015). Ecological data sharing. Ecological informatics, 29, 33-44.	No SE
Rocha, G. D. S. R., de Oliveira, L., & Talamini, E. (2021). Blockchain Applications in Agribusiness: A Systematic Review. Future Internet, 13(4), 95.	No SE
Siyam, N., Alqaryouti, O., & Abdallah, S. (2019). Research issues in agent-based simulation for pedestrians evacuation. IEEE Access, 8, 134435-134455.	No SE
Townsend, J. H. (2015, September). Digital Taxonomy for Sustainability. In EnviroInfo/ICT4S (1) (pp. 289-299).	No SE
Webb, J. A., De Little, S. C., Miller, K. A., & Stewardson, M. J. (2012). Eco Evidence Database: a distributed modelling resource for systematic literature analysis in environmental science and management.	No SE
Wilson, A. W., & Patón-Romero, J. D. (2022, May). Gender equality in tech entrepreneurship: A systematic mapping study. In Proceedings of the Third Workshop on Gender Equality, Diversity, and Inclusion in Software Engineering (pp. 51-58).	No SE
García-Mireles, G. A., & Villa-Martínez, H. A. (2017, October). Practices for addressing environmental sustainability through requirements processes. In International Conference on Software Process Improvement (pp. 61-70). Springer, Cham.	No SR
Guamán, D., Pérez, J., Garbajosa, J., & Rodríguez, G. (2020, November). A Systematic-Oriented Process for Tool Selection: The Case of Green and Technical Debt Tools in Architecture Reconstruction. In International Conference on Product-Focused Software Process Improvement (pp. 237-253). Springer, Cham.	No SR
Jimenez-Ramos, L. M., Acosta, N. D., Lopez, J. P. B., & Uribe, J. P. V. (2020). To train software engineers with principles of sustainable development: A bibliometric study. In 2020 Congreso Internacional de Innovación y Tendencias en Ingeniería (CONIITI) (pp. 1-4). IEEE.	No SR
Karita, L., Mourão, B. C., & Machado, I. (2022, October). Towards a common understanding of sustainable software development. In Proceedings of the XXXVI Brazilian Symposium on Software Engineering (pp. 269-278).	No SR
Khan, R. U., & Khan, S. U. (2013, August). Green IT-outsourcing assurance model. In 2013 IEEE 8th International Conference on Global Software Engineering Workshops (pp. 84-87). IEEE.	No SR
Li, X., Yue, J., Wang, S., Luo, Y., Su, C., Zhou, J., ... & Lu, H. (2023). Development of Geographic Information System Architecture Feature Analysis and Evolution Trend Research. Sustainability, 16(1), 137.	No SR
Lin, W., Shi, F., Wu, W., Li, K., Wu, G., & Mohammed, A. A. (2020). A taxonomy and survey of power models and power modeling for cloud servers. ACM Computing Surveys (CSUR), 53(5), 1-41.	No SR
Rashid, N., Khan, S. U., Khan, H. U., & Ilyas, M. (2021). Green-Agile Maturity Model: An Evaluation Framework for Global Software Development Vendors. IEEE Access, 9, 71868-71886.	No SR
Tanveer, B. (2021, November). Sustainable software engineering-have we neglected the software engineer's perspective?. In 2021 36th IEEE/ACM International Conference on Automated Software Engineering Workshops (ASEW) (pp. 267-270). IEEE.	No SR

Valmohammadi, C., & Hejri, F. M. (2023). Designing a conceptual green process model in software development: A mixed method approach. International Journal of Information Management Data Insights, 3(2), 100204.	NO SR
Balogun, A. O., Almomani, M., Basri, S., Almomani, O., Capretz, L. F., Khan, A. A., ... & Baashar, Y. (2022). Towards the sustainability of small and medium software enterprises through the implementation of software process improvement: Empirical investigation. Journal of Software: Evolution and Process, 34(8), e2466.	No Sustainability
Nazir, S., Fatima, N., & Chuprat, S. (2019, December). Situational factors affecting software engineers sustainability: A vision of modern code review. In 2019 IEEE 6th International Conference on Engineering Technologies and Applied Sciences (ICETAS) (pp. 1-6). IEEE.	No Sustainability
Salido O., M. G., Borrego, G., Cinco, R. R. P., & Rodríguez, L. F. (2023). Agile software engineers' affective states, their performance and software quality: A systematic mapping review. Journal of Systems and Software, 204, 111800.	No Sustainability
Santos, RD; Stuart-Verner, B; de Magalhaes, CVC (2023).LGBTQIA plus (In)Visibility in Computer Science and Software Engineering Education. arXiv:2303.05953	No Sustainability
Jia, J., Zhang, P., & Capretz, L. F. (2016, May). Environmental factors influencing individual decision-making behavior in software projects: a systematic literature review. In Proceedings of the 9th International Workshop on Cooperative and Human Aspects of Software Engineering (pp. 86-92).	Sw Ecosystems
Siavashi, F., & Truscan, D. (2015, April). Environment modeling in model-based testing: concepts, prospects and research challenges: a systematic literature review. In Proceedings of the 19th International Conference on Evaluation and Assessment in Software Engineering (pp. 1-6).	Sw Ecosystems
Gürbüz, H. G., & Tekinerdogan, B. (2016, June). Software metrics for green parallel computing of big data systems. In 2016 IEEE International Congress on Big Data (BigData Congress) (pp. 345-348). IEEE.	Tertiary
Zolduoarrati, E., Licorish, S. A., & Stanger, N. (2023). Secondary studies on human aspects in software engineering: A tertiary study. Journal of Systems and Software, 200, 111654.	Tertiary

71 Candidate papers gathered from snowballing procedure were excluded by applying exclusion criteria (Section 3.3 Selection Criteria)

Reference (52 papers identified by snowballing procedure in first version, 19 from second version)= 71 excluded	Exclusion criterion
Sun, Y., Fang, J., Chen, Y., Liu, Y., Chen, Z., Guo, S., ... & Tan, Z. (2023). Energy inefficiency diagnosis for Android applications: a literature review. Frontiers of Computer Science, 17(1), 1-16.	Duplicated
Moreira, J. S., Alves, E. L., & Andrade, W. L. (2020, December). A Systematic Mapping on Energy Efficiency Testing in Android Applications. In 19th Brazilian Symposium on Software Quality (pp. 1-10).	Duplicated
Gustavsson, J. L., & Penzenstadler, B. (2020, June). Blinded by Simplicity: Locating the Social Dimension in Software Development Process Literature. In Proceedings of the 7th International Conference on ICT for Sustainability (pp. 116-127).	Duplicated
Anwar, H., & Pfahl, D. (2017, August). Towards greener software engineering using software analytics: A systematic mapping. In 2017 43rd Euromicro Conference on Software Engineering and Advanced Applications (SEAA) (pp. 157-166). IEEE.	Duplicated
Andrikopoulos, V., Boza, R. D., Perales, C., & Lago, P. (2022). Sustainability in Software Architecture: A Systematic Mapping Study. arXiv preprint arXiv:2204.11657.	Duplicated
Barisic, A., Cunha, J., Ruchkin, I., Moreira, A., Araújo, J., Challenger, M., ... & Amaral, V. (2022). Modelling Sustainability in Cyber-Physical Systems: A Systematic Mapping Study.	Duplicated
Zakaria, N. Z. H., Hamdan, A. R., Yahaya, J., & Deraman, A. (2016). User centric software quality model for sustainability: a review. Lecture Notes on Software Engineering, 4(3), 199.	Duplicated
Swacha, J. (2022). Models of Sustainable Software: A Scoping Review. Sustainability, 14(1), 551.	Duplicated

Anwar, H., Fatima, I., Pfahl, D., & Qamar, U. (2021). Tool Support for Green Android Development. In Software Sustainability (pp. 153-182). Springer, Cham.	Duplicated
Hina Anwar and Dietmar Pfahl. 2017. Towards greener software engineering using software analytics: A systematic mapping. In Software Engineering and Advanced Applications (SEAA), 2017 43rd Euromicro Conference on. IEEE, 157--166.	Duplicated
G. Procaccianti, P. Lago and S. Bevini, "A systematic literature review on energy efficiency in cloud software architectures", Sustainable Computing Informatics and Systems, vol. 7, pp. 2-10, Sep. 2015.	Duplicated
Anwar, H. and Pfahl, D. (2017). Towards greener software engineering using software analytics: A systematic mapping. In Proc. of the 43rd Euromicro Conf. On Soft. Eng. and Advanced Applications. IEEE.	Duplicated
Rashid N and Khan SU. Developing green and sustainable software using agile methods in global software development: risk factors for vendors. in Proceedings of the 11th International Conference on Evaluation of Novel Software Approaches to Software Engineering. 2016. SCITEPRESS-Science and Technology Publications, Lda.	Duplicated
Khan RU, Khan SU, Khan RA, Ali S. Motivators in green IT-outsourcing from vendor's perspective: a systematic literature review. J Proc Pakistan Acad Sci. 2015; 4: 345- 360.	Duplicated
G. Procaccianti, P. Lago, S. Bevini, A systematic literature review on energy efficiency in cloud software architectures, Sustain. Comput. Inf. Syst. 7 (2015) (S32) 2–10.	Duplicated
Ahmad R, Baharom F, Hussain A. A systematic literature review on sustainability studies in software engineering, in Knowledge Management International Conference (KMICe), Langkawi, Malaysia, 2014. (S51)	Duplicated
Andrikopoulos, V., Boza, R. D., Perales, C., & Lago, P. (2022, August). Sustainability in Software Architecture: A Systematic Mapping Study. In *2022 48th Euromicro Conference on Software Engineering and Advanced Applications (SEAA)* (pp. 426-433). IEEE. (comparar con S42)	Duplicated
Swacha, J. (2022). Models of sustainable software: A scoping review. *Sustainability*, *14*(1), 551.	Duplicated
Shahab, A., Naseer, A., Zafar, M. N., & Nadeem, A. (2021, December). Detection of Energy Bugs in Android Applications: A Systematic Literature Review. In *2021 International Conference on Frontiers of Information Technology (FIT)* (pp. 7-12). IEEE.	Duplicated
G. Procaccianti, S. Bevini, P. Lago Energy efficiency in cloud software architectures Proceedings of the 27th Conference on Environmental Informatics - Informatics for Environmental Protection, Sustainable Development and Risk Management, volume 1, Shaker Verlag GmbH (2013), pp. 291-299	Extended
Ibrahima, S. R. A., Yahaya, J., & Sallehudin, H. (2019). Quality and sustainability dimensions toward green software product: A review. Advancing Technology Industrialization Through Intelligent Software Methodologies, Tools and Techniques, 522-530.	No available
Schaffernak, H., Moesl, B., Url, P., Koglbauer, I. V., & Vorraber, W. Towards Sustainable Software Quality in Use: A Survey of Measures. *Available at SSRN 4709804*. (no available)	No available
Tanveer, B. (2021, November). Sustainable software engineering-have we neglected the software engineer's perspective?. In 2021 36th IEEE/ACM International Conference on Automated Software Engineering Workshops (ASEW) (pp. 267-270). IEEE.	No SE
Gürbüz, H. G., & Tekinerdogan, B. (2016, June). Software metrics for green parallel computing of big data systems. In 2016 IEEE International Congress on Big Data (BigData Congress) (pp. 345-348). IEEE.	No SE
Mukta, T. A., & Ahmed, I. (2020). Review on E-waste management strategies for implementing green computing. Int. J. Comput. Appl, 177, 45-52. NO	No SE
Bieser, J. C., & Hilty, L. M. (2018). Assessing indirect environmental effects of information and communication technology (ICT): A systematic literature review. Sustainability, 10(8), 2662.	No SE
Bieser, J. C., & Hilty, L. M. (2018). Assessing indirect environmental effects of information and communication technology (ICT): A systematic literature review. Sustainability, 10(8), 2662.	No SE
González, A. H. (2018). La sostenibilidad y el software. Dilemas contemporáneos: Educación, Política y Valores.	No SE
Scuri, S., Ferreira, M., Jardim Nunes, N., Nisi, V., & Mulligan, C. (2022, April). Hitting the Triple Bottom Line: Widening the HCI Approach to Sustainability. In Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (pp. 1-19).	No SE
Agrawal, M. N., Saini, M. J. K., & Wankhede, P. Review on Green Cloud Computing: A Step Towards Saving Global Environment.	No SE
Radu, L. D. (2017). Green cloud computing: A literature survey. Symmetry, 9(12), 295.	No SE
Shaheen, Q., Shiraz, M., Khan, S., Majeed, R., Guizani, M., Khan, N., & Aseere, A. M. (2018). Towards energy saving in computational clouds: taxonomy, review, and open challenges. IEEE Access, 6, 29407-29418.	No SE

Afshari, H., Agnihotri, S., Searcy, C., & Jaber, M. Y. (2022). Social sustainability indicators: A comprehensive review with application in the energy sector. Sustainable Production and Consumption.	No SE
Sabini, L., Muzio, D., & Alderman, N. (2019). 25 years of ‘sustainable projects’. What we know and what the literature says. International Journal of Project Management, 37(6), 820-838.	No SE
Pahl, C., Jamshidi, P., & Weyns, D. (2017). Cloud architecture continuity: Change models and change rules for sustainable cloud software architectures. Journal of Software: Evolution and Process, 29(2), e1849.	No SE
Anthony, B. J. (2016). Green information systems integration in information technology based organizations: an academic literature review. Journal of Soft Computing and Decision Support Systems, 3(6), 45-66. (No. information systems and IT. Maybe discussion)	No SE
Fernandez, H., Procaccianti, G., & Lago, P. (2015). Economic aspects of green ICT. In Green in Software Engineering (pp. 107-127). Springer, Cham. (NO. Discussion)	No SE
S. Asadi, A.R.C. Hussin and H.M. Dahlan, "Organizational research in the field of Green IT: A systematic literature review from 2007 to 2016", Telematics and Informatics, vol. 34, pp. 1191-1249, Nov. 2017. 3 order effect	No SE
Verdecchia R, Ricchiuti F, Hankel A, Lago P, Procaccianti G. Green ICT research and challenges. In: Advances and New Trends in Environmental Informatics. Springer; 2017: 37- 48.	No SE
Afzal S, Saleem MF, Jan F, Ahmad M. A review on green software development in a cloud environment regarding software development life cycle (SDLC) perspective. Int J Comput Trends Technol(IJCTT). 2013; 4: 3054- 3058.	No SE
Moghaddam, F. A., Lago, P., & Grosso, P. (2015). Energy-efficient networking solutions in cloud-based environments: A systematic literature review. ACM Computing Surveys (CSUR), 47(4), 1-32. NO software focused.	No SE
V. Chang, G. Wills, D. De Roure, A review of cloud business models and sustainability, in: 2010 IEEE 3rd International Conference on Cloud Computing, IEEE, 2010, pp. 43–50 (no sw oriented)	No SE
S.S. Gill, R. Buyya, A taxonomy and future directions for sustainable cloud computing: 360 degree view, ACM Comput. Surv. 51 (5) (2018) 1–33. (No SE) Revisar 3 dic 2024	No SE
Wee, C., & Yap, K. M. (2021). Gender diversity in computing and immersive games for computer programming education: a review. Internat. J. Adv. Comp. Sci. Appl, 12, 477-487. (no sustainability)	No SE
Nabila‘Aini, N., & Subriadi, A. P. (2022). Governance and practice approach of green information technology. *Procedia Computer Science*, *197*, 650-659.	No SE
Radu, L. D., & Popescul, D. (2024). Green Information Systems—A Bibliometric Analysis of the Literature from 2000 to 2023. *Electronics*, *13*(7), 1329.	No SE
Raisian, K., Yahaya, J., & Deraman, A. (2018). Exploring Potential Factors in Green and Sustainable Software Product. JOIV: International Journal on Informatics Visualization, 2(1), 23-27.	No SR
Chitchyan, R., Becker, C., Betz, S., Duboc, L., Penzenstadler, B., Seyff, N., & Venters, C. C. (2016, May). Sustainability design in requirements engineering: state of practice. In Proceedings of the 38th International Conference on Software Engineering Companion (pp. 533-542).	No SR
Penzenstadler, B., Khurum, M., & Petersen, K. (2014). State of the Practice for Sustainability as an Explicit Objective. In REFSQ Workshops (pp. 117-135).	No SR
Georgiou, S., Rizou, S., & Spinellis, D. (2019). Software development lifecycle for energy efficiency: techniques and tools. ACM Computing Surveys (CSUR), 52(4), 1-33. (No. Traditional)	No SR
EZE, B., & Olayiwola, J. O. (2020). A Review of the Efficiency of Smartphone Battery and Energy Usage in Technological Application for Sustainable Development. (NO. traditional)	No SR
Oliveira W, Oliveira R, Castor F (2017) A study on the energy consumption of android app development approaches. In: Proceedings of the IEEE/ACM 14th international conference on mining software repositories - MSR, May 2017, pp 42–52, doi: https://doi.org/10.1109/MSR. 2017.66 (no. experiment)	No SR
Dao, V., I. Langella, and J. Carbo. 2011. "From Green to Sustainability: Information Technology and an Integrated Sustainability Framework," The Journal of Strategic Information Systems (20:1), pp. 63-79. (Discussion. NO)	No SR
Volpato, T., Allian, A., & Nakagawa, E. Y. (2019, September). Has social sustainability been addressed in software architectures?. In Proceedings of the 13th European Conference on Software Architecture-Volume 2 (pp. 245-249). (No. discussion)	No SR
Andrikopoulos, V., & Lago, P. (2021). Software Sustainability in the Age of Everything as a Service. In Next-Gen Digital Services. A Retrospective and Roadmap for Service Computing of the Future (pp. 35-47). Springer, Cham. (No. discussion)	No SR

Georgiou, S., Rizou, S., Spinellis, D.: Software development lifecycle for energy efficiency: techniques and tools. ACM Comput. Surv. **52**(4), 1–33 (2019)	No SR
R.W. Ahmad, A. Gani, S.H.A. Hamid, F. Xia, M. Shiraz, A Review on mobile application energy profiling: Taxonomy, state-of-the-art, and open research issues, J. Netw. Comput. Appl. 58 (2015) 42. No SR	No SR
M.A. Hoque, M. Siekkinen, K.N. Khan, Y. Xiao, S. Tarkoma, Modeling, profiling, and debugging the energy consumption of mobile devices, ACM Comput. Surv. 48 (3) (2015) http://dx.doi.org/10.1145/2840723. No SR	No SR
T. Volpato, A. Allian, E.Y. Nakagawa, Has social sustainability been addressed in software architectures? in: Proceedings of the 13th European Conference on Software Architecture-Volume 2, 2019, pp. 245–249. (no SR)	No SR
Ahmad R W, Gani A, Hamid S H A, Shojafar M, Ahmed A I A, Madani S A, Saleem K, Rodrigues J J P C. A survey on energy estimation and power modeling schemes for smartphone applications. International Journal of Communication Systems, 2017, 30(11): e3234 (no SR)	No SR
Levy, M., Groen, E. C., Taveter, K., Amyot, D., Yu, E., Liu, L., ... & Mosser, S. (2023). Sustaining human health: A requirements engineering perspective. *Journal of Systems and Software*, *204*, 111792.	No SR
Venters, C. C., Capilla, R., Nakagawa, E. Y., Betz, S., Penzenstadler, B., Crick, T., & Brooks, I. (2023). Sustainable software engineering: Reflections on advances in research and practice. *Information and Software Technology*, 107316	No SR
Salama, M., Bahsoon, R., & Lago, P. (2019). Stability in software engineering: Survey of the state-of-the-art and research directions. IEEE Transactions on Software Engineering, 47(7), 1468-1510.	No sustainability
Zakaria, N. Z. H., Hamdan, A. R., Yahaya, J., & Deraman, A. (2016). User centric software quality model for sustainability: a review. Lecture Notes on Software Engineering, 4(3), 199.	No sustainability
S. Druskat, D. S. Katz, Mapping the research software sustainability space, arXiv preprint arXiv:1807.01772 (No, crearting diagrams and concepts relationships)	No sustainability
Rodriguez-Perez, G., Nadri, R., & Nagappan, M. (2021). Perceived diversity in software engineering: a systematic literature review. Empirical Software Engineering, 26(5), 1-38. (no sustainability)	No sustainability
Nazir, S., Fatima, N., & Chuprat, S. (2019, November). Individual Sustainability Barriers and Mitigation Strategies: Systematic Literature Review Protocol. In 2019 IEEE Conference on Open Systems (ICOS) (pp. 1-5). IEEE.	Protocol
Manteuffel and S. Ioakeimidis. A systematic mapping study on sustainable software engineering: A research preview. 9th SC@ RUG 2011--2012, page 35, 2012. (protocol)	Protocol
Nazir, S., Fatima, N., & Chuprat, S. (2019, November). Individual Sustainability Barriers and Mitigation Strategies: Systematic Literature Review Protocol. In *2019 IEEE Conference on Open Systems (ICOS)* (pp. 1-5). IEEE. (protocol)	Protocol
Jiang, S., Jakobsen, K., Bueie, J., Li, J., & Haro, P. H. (2022). A Tertiary Review on Blockchain and Sustainability with Focus on Sustainable Development Goals.	Tertiary
Godliauskas, P., & Lancer, N. The Well-being of Software Developers: A Systematic Literature Review.	Thesis

APPENDIX E. GENERAL PROFILE OF SELECTED SRS.

For venue: S = Symposium; C = Conference, J = Journal; W = Workshop; P = Preprint; B = book chapter; T= Technical report; N = No reference.

ID	Year	Language	Ven-ue	SR Type	SE Area	Country	Sustainability focus	Dimension	Orientation	Topic
S01	2018	English	S	SMS	General	Brazil	Green in Software	Environment	Process	Approaches for sustainable practices
S02	2018	English	C	SLR	General	Brazil	Green in Software	Environment	Process	Energy consumption related practices
S03	2014	Portu-guese	C	SMS	Software Quality	Brazil	Green in Software	Environment	Product	Green metrics
S04	2020	English	C	SMS	Software Design	Pakistan, Estonia	Green in Software	Environment	Product	Energy efficient software for cloud computing
S05	2017	English	C	SMS	General	The Netherlands, UK	Sustainable in Software	Environment, Social, Economic, Technical	Product, Process	Sustainability definition
S06	2016	English	C	SLR	General	Pakistan	Green Software	Environment	Organization	Critical success factors for software organizations
S07	2013	English	W	SLR	Software Quality	Spain	Green in Software	Environment, Technical	Product	Green measures
S08	2012	English	C	SLR	General	Germany, Spain	Green Software	Environment	Organization	Approaches for sustainable practices
S09	2019	English	W	SMS	Software Design	Norway, China	Green by Software	Environment	Product	Approaches for blockchain in smart energy and supply chain systems
S10	2021	English	C	SMS	Software Requirements	Portugal	Sustainable in Software	Technical, Social	Product	Sustainability requirements elicitation
S11	2020	English	S	SMS	Software Testing	Brazil	Green in Software	Environment	Product	Energy efficiency of Android apps
S12	2020	English	C	SLR	Software Quality	The Netherlands	Green in Software	Environment, Technical	Product	Energy efficiency of robotics software

S13	2020	English	C	SLR	Software Engineering Professional Practice	Sweden; Finland	Sustainable in Software	Social	Stakeholders	Social factors
S14	2020	English	J	SLR	Software Engineering Professional Practice	Malaysia, Pakistan	Sustainable in Software	Individual	Stakeholders	Challenges for the individual
S15	2019	Spanish	J	SLR	Software Design	Spain, Panama	Green by Software	Environment	Product	Energy efficiency for buildings supported by software
S16	2022	English	J	SLR; Meta-Analysis	Software Construction	Russia	Green in Software	Environment	Product	Energy efficiency of sorting algorithms
S17	2018	English	J	SLR	Software Process	Pakistan	Green in Software	Environment	Organization	Green agile practices
S18	2018	English	J	SLR	Software Process	Pakistan	Green in Software	Environment	Organization	Critical success factors for agile projects
S19	2018	English	J	SLR	Software Process	Pakistan	Green in Software	Environment	Organization	Challenges for developing green software
S20	2018	English	J	SMS	Software Quality	Mexico, Spain	Green in Software	Environment, Technical	Product	Relationship between sustainability and product quality
S21	2021	English	C	SLR	Software Design	UAE	Green in Software	Environment	Product	Energy efficiency of Smart phones
S22	2018	English	C	SLR	General	Germany	Green by Software	Environment	Product	Energy information systems for industrial manufacturers
S23	2017	English	J	SLR	Software Design	Malaysia, Iraq	Green in Software	Environment	Product	Energy consumption in mobile systems
S24	2017	English	C	SMS	General	Estonia	Green in Software	Environment	Product	Software analytics in green SE
S25	2017	English	C	SMS	General	India	Green in Software	Environment	Process	General Green SE
S26	2017	English	C	SMS	General	Norway	Green in Software	Environment	Process	General Green SE
S27	2017	English	C	SMS	Software Process	Mexico	Green in Software	Environment	Process	Green software process

S28	2016	English	C	SLR	Software Quality	India	Green in Software	Environment	Product	Green metrics
S29	2016	English	C	SLR	Software Design	Finland	Green by Software	Environment	Process	Principles for persuasive green systems
S30	2016	English	W	SMS	Software Process	Spain	Green in Software	Environment	Organization	Audits in green in IT
S31	2016	English	C	SLR	Software Process	Pakistan	Green in Software	Environment	Organization	Risks on developing green software
S32	2015	English	J	SLR	Software Design	The Netherlands, Italy	Green in Software	Environment	Product	Energy efficiency of cloud-based software architecture
S33	2014	English	W	SLR	Software Quality	United Kingdom	Sustainable by Software	Social	Stakeholders	Social sustainability indicators
S34	2014	English	C	SMS	General	USA, Spain, Germany	Green Software	Environment	Process	General
S35	2011	English	C	SLR	Software Design	Germany	Sustainable in Software	Technical	Product	Sustainable evaluation of software architectures
S36	2021	English	C	Rapid review; Meta-analysis	Software Construction	Russia	Green in Software	Environment	Product	Impact of programming languages on energy consumption
S37	2021	English	C	SMS	Software Requirements	Brazil	Sustainable by Software	Technical	Product	Software requirements for disaster management systems
S38	2019	English	J	SLR	Software Requirements	Australia	Sustainable in Software	Individual, Social, Technical, Environment, Economic	Product	Sustainability requirements for eLearning Systems
S39	2017	English	C	SMS	Software Requirements	Mexico, Spain	Sustainable Software	Environment	Process	Sustainable requirements methods and practices
S40	2021	English	J	SLR	Software Design	Spain, Panama	Green by Software	Environment	Product	Requirements for service-oriented software

										architecture for buildings
S41	2015	English	J	SLR	General	Malaysia	Green in Software	Environment, Technical	Product	Knowlege managment in green software development
S42	2022	English	C	SMS	Software Design	Netherlands	Sustainable Software	Technical, Social, Environment, Economic	Product	Sustainability of software architecture
S43	2022	English	P	SMS	Software Design	USA, Belgium, Serbia, Croacia, Protugal	Sustainable in Software	Technical	Product	Modelling of sustainable cyber-physical systems
S44	2019	English	P	SLR	General	USA	Sustainable in Software	Technical	Product	Principles for sustainable software
S45	2016	English	J	Systematic review	General	Malaysia	Sustainable Software	Environment	Process	Conceptualization of sustainability
S46	2021	English	J	SMS	General	Colombia, Venezuela, Spain	Sustainable in Software	Technical, Economic	Product	Development of self-adaptive cyber-physical systems
S47	2022	English	J	Scoping review	General	Poland	Green in Software	Environment	Process	Models for sustainable software
S48	2013	English	T	SLR	Software quality	Netherlands	Green in Software	Environment, Technical	Product	Green software metrics
S49	2015	English	J	SLR	General	Pakistan	Green by Software	Environment	Organization	Motivators for green IT outsourcing
S50	2019	English	J	SLR	Software Testing	Ethiopia	Green in Software	Environment, Technical	Product	Testing Android apps
S51	2014	English	C	SLR	General	Malaysia	Sustainable Software	Environment	Product	methods for sustainable software
S52	2021	English	C	SLR	Software Testing	Pakistan, Sweden	Green in Software	Environment	Product	Energy bugs in Android applications
S53	2021	English	B	SMS	Software Construc-tion	Estonia, Pakistan	Green in Software	Environment	Process	Tools for supporting green mobile development
S54	2020	English	C	Meta-analysis	Software Construction	Russia	Green in Software	Environment	Product	Energy consumption of programming languages

S55	2017	English	C	SMS	Software Design	Brazil, Spain	Sustainable in Software	Technical	Product	Sustainability of reference architectures
S56	2023	English	C	SLR	Software Engineering Professional Practice	Norway	Sustainable in Software	Social	Stakeholders	social aspects during software development
S57	2024	English	J	SLR	Software Process	Indonesia	Green in Software	Environment	Process	Green computing into RUP methodology
S58	2024	English	J	SLR	Software Design	Brazil, South Korea	Green in Software	Environment	Product	Energy consumption in microservice architectures
S59	2024	English	C	SLR	General	The Netherlands, Italy	Green in Software	Environment	Product	Energy efficiency tactics for optimizing application software energy consumption
S60	2024	English	J	SLR	Software Quality	Austria	Green in Software	Environment	Process	Approaches to profile the energy consumption on mobile devices
S61	2024	English	J	SLR	Software Design	The Netherlands	Sustainable in Software	Technical, Economic, Environment, Social	Product	Sustainability of software architecture solutions for the cloud
S62	2024	English	J	SLR	Software Process	Pakistan	Sustainable in software	Technical, Social, Environment, Economic	Process	Factors of crowdsourced software development that could influence software sustainability
S63	2024	English	C	SLR	Software Engineering Professional Practice	Brazil	Sustainable in Software	Individual, Technical	Stakeholders	Sustainability from software developers' perspective
S64	2024	English	C	SMS	Software Process	Ireland	Green in Software	Environment	Process	Approaches for environmental sustainability of MLOps for developing ML-Based systems

S65	2023	English	C	SMS	Software Engineering Professional Practice	Sweden, Montenegro	Sustainable by Software	Technical	Organization	SE technologies and challenges for fulfiling goals of Society 5.0
S66	2023	English	C	SLR	Software Design	The Netherlands	Sustainable in Software	Technical, Environment, Social, Economic	Process	Evaluation methods for software architecture sustainability assessment
S67	2023	English	C	SLR	Software Design	Austria, Germany	Sustainable in Software	Technical	Product	Techniques for improving energy efficiency of mobile apps
S68	2023	English	J	SMS	Software Requirements	Austria, Switzerland	Sustainable in Software	Environment, Technical, Economic, Social, Individual	Process	RE approaches for supporting the development of sustainable software systems
S69	2023	English	C	Scoping review + meta-synthesis	General	Canada	Sustainable in Software	Environment, Social, Economic, Technical, Individual.	Product, Process	Model of sustainable software engineering
S70	2022	English	J	SMS	Software Maintenance	The Netherlands, China	Sustainable in Software	Technical	Product	Impact and management of software architecture erosion
S71	2021	English	C	SLR	Software Design	United States, The Netherlands	Green in Software	Environment	Product	Software architectural tactics for design decisions as regards energy efficiency
S72	2023	English	C	SLR	Software Construction	Austria, Germany	Green in Software	Environment	Product	Energy-saving approaches for mobile web apps
S73	2024	English	J	SLR	Software Engineering Professional Practice	Sweden, Spain, Finland, Switzerland, Germany, Norway, The Netherlands, Portugal, United Kingdom	Sustainable Software	Environment, Economic, Individual, Social, Technical	Stakeholders	Computing education approaches for sustainability

S74	2024	English	C	GLR	Software Engineering Professional Practice	Norway	Sustainable in Software	Social	Organization	Inclusion and diversity actions within software development
S75	2023	English	C	MLR	General	Ireland, Turkey, Austria	Green in Software	Environment	Process	Approaches and challenges for green software engineering
S76	2023	English	N	Rapid review	Software Quality	The Netherlands	Green in Software	Environment	Process	Tools for measuring power efficiency of software
S77	2023	English	J	SLR	Software Requirements	Germany	Sustainable in Software	Environment, Social, Economic	Product	Users' requirements for sustainability in apps
S78	2023	English	J	Literature review (SMS)	Software Quality	China	Green in Software	Environment	Process	Energy debugging and optimization in Android applications
S79	2024	English	J	Literature review (SMS)	General	Australia	Green in Software	Environment	Product, Process	Energy concerns in software engineering
S80	2024	English	W	SLR	General	The Netherlands	Sustainable in Software	Environment, Social, Economic, Technical	Product	Impact on sustainability of integrating artificial intelligence into software development process

APPENDIX F. CHARACTERISTICS OF INCLUDED STUDIES WHITIN THIS TERTIARY STUDY.

ID	Number of Primary Papers	Number of Empirical Papers	Number of Industrial Papers	Year coverage
S01	75	16	NA	2003-2017
S02	23	NA	14	NA
S03	49	NA	NA	2009 –2014
S04	58	58	NA	2017-2019

S05	168	NA	NA	2002-2016
S06	74	NA	NA	2004-2015
S07	16	NA	NA	2003-2012
S08	96	NA	NA	2006-2012
S09	60	NA	NA	2014-2018
S10	12	NA	NA	2010-2018
S11	32	32	NA	2011-2019
S12	17	16	NA	1995-2020
S13	25	NA	NA	NA
S14	16	NA	NA	2010-2018
S15	35	NA	NA	2014-2019
S16	6	6	NA	2009-2019
S17	53	NA	NA	2000-2015
S18	80	NA	32	2001-2015
S19	54	NA	NA	2009-2015
S20	66	34	4	2006-2016
S21	72	NA	NA	2011-2020
S22	158	97	NA	2003-2016
S23	40	NA	NA	2009-2016
S24	50	42	NA	2015-2016
S25	82	45	Industry 3; industry & academia: 12	2010-2016
S26	36	NA	NA	2010-2016
S27	7	0	NA	2011-2015
S28	14	NA	NA	2011-2015
S29	6	6	NA	2009-2013
S30	13	5	NA	2008-2014
S31	42	NA	NA	NA
S32	26	16	2	2008-2012
S33	88	NA	NA	NA
S34	83	5	NA	1989-2013
S35	NA	NA	NA	NA

S36	17	17	NA	2012-2021
S37	25	NA	NA	2002-2020
S38	124	Unclear	NA	2005-2017
S39	16	11	NA	2009-2016
S40	97	NA	NA	2001-2020
S41	37	NA	NA	2010-2015
S42	58	24	NA	2003-2021
S43	105	Unclear	NA	2011-2020
S44	107	NA	NA	NA
S45	97	NA	NA	NA
S46	16	NA	NA	2013-2020
S47	41	Unclear	NA	2010-2021
S48	23	NA	NA	2001-2012
S49	82	Unclear	NA	1999-2013
S50	31	31	29 (29 in real world or open source app)	2012-2017
S51	175	NA	NA	NA
S52	27	27	NA	2012-2021
S53	51	NA	NA	2014-2020
S54	4	4	NA	2014-2017
S55	159	NA	NA	NA
S56	19	14	14	2013-2022
S57	3	NA	NA	2020-2023
S58	37	NA	NA	NA
S59	142	NA	8	2004-2022
S60	134	NA	NA	2011-2021
S61	31	NA	NA	2010-2023
S62	45	18	NA	2010-2020
S63	9	0	1	2019-2023
S64	52	NA	NA	2019-203
S65	29	NA	NA	2018-2022

S66	71	NA	NA	1999-2020
S67	91	NA	NA	2000-2022
S68	55	38	9	2011-2021
S69	243	125	NA	2012-2021
S70	73	NA	6	2006-2019
S71	39	NA	1	2005-2016
S72	44	NA	NA	2012-2022
S73	89	31	NA	2002-2021
S74	5	NA	5	2022-2023
S75	48	NA	NA	NA
S76	21	NA	NA	1999-2022
S77	25	25	NA	2014-2021
S78	55	NA	NA	2011-2019
S79	101	NA	NA	1999-2021
S80	34	NA	NA	2010-2022

APPENDIX G. QUALITY ASSESSMENT OF SRS

ID	Selection criteria	Searching	Synthesis	Quality Assessment	Description	Sum
S01	1	1	0	1	0	3
S02	0.5	0.5	0.5	0	0	1.5
S03	1	0.5	0	0	0	1.5
S04	1	0.5	0	1	1	3.5
S05	1	0.5	0	0	0	1.5
S06	1	1	0.5	0.5	1	4
S07	1	0.5	0	0	0	1.5
S08	1	0.5	0	0	0.5	2
S09	1	0.5	0	0	0	1.5
S10	0	0.5	0	0	0.5	1
S11	1	0.5	0	0	1	2.5

S12	1	0.5	0.5	0	0	2
S13	0	0	0	0	0.5	0.5
S14	0.5	0.5	0	0.5	0.5	2
S15	0.5	1	0	0	1	2.5
S16	0.5	1	1	1	1	4.5
S17	1	1	0	1	0	3
S18	1	1	0	1	0	3
S19	1	1	0	1	0	3
S20	1	0.5	1	1	1	4.5
S21	1	0.5	0	1	0	2.5
S22	0.5	0.5	0	0	0	1
S23	0.5	0.5	0	1	0.5	2.5
S24	1	0.5	0	0.5	0.5	2.5
S25	1	1	0	0	0	2
S26	1	0.5	0	0	0	1.5
S27	1	0.5	0	0	0	1.5
S28	1	0.5	0	0	1	2.5
S29	1	0.5	0	0	0.5	2
S30	1	0	0	0	1	2
S31	0	0.5	0	0	0	0.5
S32	1	0	1	0	1	3
S33	0.5	0.5	0	0	0	1
S34	1	0.5	0	0.5	0.5	2.5
S35	1	0.5	0	0	0	1.5
S36	1	0.5	1	1	1	4.5
S37	1	0.5	0	0	1	2.5
S38	1	1	0	0	1	3
S39	0.5	0.5	0	0	1	2
S40	0.5	1	0	0	1	2.5
S41	1	0	0	0	0	1
S42	1	1	0	0	0	2
S43	1	0.5	0	1	1	3.5
S44	0.5	0.5	0	0	0	1
S45	0.5	0.5	0	0	0	1
S46	1	0.5	0	0	1	2.5
S47	0.5	0.5	0	0	0	1
S48	1	1	0	0	0	2
S49	0.5	0.5	0	0	0.5	1.5

S50	1	0.5	0	0	0.5	2
S51	0.5	0.5	0	0	0	1
S52	1	0.5	0	1	0	2.5
S53	1	0.5	0.5	1	1	4
S54	0.5	0	0.5	0	1	2
S55	0	0.5	0	0	0	0.5
S56	0.5	0	1	1	1	3.5
S57	1	1	0	0	0.5	2.5
S58	0.5	0.5	0	0	0.5	1.5
S59	1	0	0.5	0.5	0.5	2.5
S60	1	1	0	0	1	3
S61	1	1	1	0	1	4
S62	1	1	0	0.5	0.5	3
S63	1	0.5	0.5	1	1	4
S64	1	1	0	0	1	3
S65	1	1	0.5	0	0.5	3
S66	1	0	0	0	1	2
S67	1	0.5	0.5	0	1	3
S68	1	1	0	0	1	3
S69	1	0.5	1	0	1	3.5
S70	1	1	1	0	1	4
S71	0	0.5	0	0	0.5	1
S72	1	0.5	0	0	1	2.5
S73	1	1	1	0	1	4
S74	0.5	0	0	0	0.5	1
S75	0	0	0	0	0	0
S76	1	0	0	0	1	2
S77	1	0	1	0	1	3
S78	0.5	0	0	0	1	1.5
S79	1	0.5	1	0	1	3.5
S80	1	0	0	0	1	2