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Global Insights into the Adoption and Behavioral Aspects of Energy Storage: A bibliometric study

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Abstract
This study presents a bibliometric analysis of global research on energy storage adoption using ScientoPy, VOSviewer, and Biblioshiny. Findings reveal a shift from technical studies to behavioral economics, policy, and consumer adoption. Key themes include technology adoption, regulation, economic feasibility, and renewable energy integration, with the United States, China, and Australia leading global research. Emerging trends highlight investment strategies and digital storage, offering insights for policymakers and industry stakeholders. This study provides a data-driven foundation for advancing energy storage adoption, shaping future research, and supporting the transition to sustainable energy systems.

Keywords: Adoption; Behavioral; Energy Storage

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1.0 Introduction

The global transition toward sustainable energy systems has brought energy storage technologies to the forefront, given their critical role in enhancing grid stability, improving energy efficiency, and facilitating the integration of renewable sources such as solar and wind. As the energy landscape continues to evolve, the adoption of energy storage systems is increasingly shaped not only by technical and economic considerations but also by behavioral, regulatory, and policy-related factors (Hansen et al., 2022). Understanding these behavioral dimensions is essential for designing effective policies, improving public acceptance, and ensuring the successful large-scale deployment of storage technologies.

Although considerable research has focused on technical performance, cost-effectiveness, and grid integration, studies examining consumer behavior, public perception, and socio-political influences remain fragmented (Md Zaini et al., 2023, 2024; Zhang et al., 2021). Factors such as risk perception, trust in technology, financial incentives, and institutional frameworks significantly affect adoption patterns, rendering energy storage deployment highly context-specific (Chen et al., 2023). Additionally, disparities in policy environments, market structures, and societal attitudes further contribute to the variability in adoption rates across regions. These challenges underscore the need for a comprehensive assessment of global research trends and behavioral factors influencing energy storage uptake.

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In response to this gap, the study aims to explore a comprehensive bibliometric analysis to map the global research landscape on energy storage adoption, with a particular emphasis on behavioral aspects. The objectives are to investigate publication patterns from 2007 to February 2025 using data from Scopus and Web of Science, and to analyze publication trends, citation impact, keyword co-occurrence, and research collaboration networks through bibliometric tools such as ScientoPy, VOSviewer, and Biblioshiny, in order to identify dominant research themes and interdisciplinary linkages within the field.

The findings of this study offer data-driven insights for researchers, policymakers, and industry stakeholders to support evidence-based decisions and facilitate broader adoption of energy storage technologies. The methodology section details the data collection process and analytical framework, while the findings and discussion reveal emerging themes, research clusters, and evolving scholarly priorities. Finally, the conclusion emphasizes the growing importance of behavioral insights in shaping policies, driving investment strategies, and accelerating the transition to sustainable energy systems.

2.0 Literature Review

Energy storage technologies have become essential components in the transition to sustainable energy systems, particularly for enhancing grid reliability and supporting renewable energy integration. While earlier studies predominantly focused on technical and economic performance, recent research recognizes the importance of behavioral, regulatory, and social dimensions in shaping adoption outcomes (Hansen et al., 2022).

Behavioral factors such as trust in technology, risk perception, and personal motivation significantly influence consumer decisions. For instance, Ecker et al. (2018) highlight the appeal of energy independence in private storage adoption, while Alipour et al. (2022) examine motivational barriers in residential PV-battery systems. These studies suggest a shift towards user-centric adoption frameworks.

Policy and regulatory contexts also play a vital role. Laws et al. (2017) discuss the impact of utility pricing on consumer behavior, while do Nascimento and Rüther (2020) emphasize the effectiveness of time-of-use tariffs in encouraging storage adoption. These findings underscore the need for supportive and adaptive policy designs.

Geographically, adoption trends vary widely. Countries like the U.S., China, and Australia lead in both research and implementation, driven by strong policy backing and public investment. Regional differences in market structures and social attitudes necessitate context-specific adoption strategies (Chen et al., 2023).

In conclusion, the literature reveals a growing interdisciplinary interest in energy storage adoption. However, behavioral-focused studies remain fragmented. A bibliometric approach is thus timely and valuable to synthesize global research patterns, identify emerging themes, and guide future policy and investment directions.

3.0 Methodology

This study employs a rigorous bibliometric analysis to systematically evaluate the global research landscape on energy storage adoption and behavioral aspects, identifying key trends, influential contributors, and thematic evolutions. By leveraging quantitative bibliometric techniques, this study provides a structured and reproducible framework to assess research productivity, interdisciplinary linkages, and emerging scholarly directions in the field.

3.1 Data Collection and Source Selection

To ensure a comprehensive and high-impact dataset, both the Scopus and Web of Science (WoS) databases were utilized as primary sources. These databases were selected for their extensive coverage of peer-reviewed literature, multidisciplinary indexing, and high citation reliability (Junid et al., 2024; Supian et al., 2024). A structured search query was applied to retrieve relevant publications as in Table 1.

Table 1. Database, search string, and keyword

Database	Search String
Scopus	TITLE (("behav*" OR "adop*") AND "energy" AND "storage") AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re") OR LIMIT-TO (DOCTYPE , "cp"))
WoS	TI=((adoption OR behavioral) AND energy storage) and English (Languages) and Article or Proceeding Paper or Book Chapters (Document Types)

This query was executed across Scopus and WoS, covering the period from 2007 to February 2025, to capture both historical advancements and emerging research trends in the domain. The initial search yielded 63 records from both databases, which were merged and subjected to a rigorous screening process. Non-relevant publications, duplicates, and non-peer-reviewed literature were systematically removed, resulting in a refined dataset of 39 publications for analysis.

3.2 Bibliometric Analysis Tools and Framework

This study employs ScientoPy, VOSviewer, and Biblioshiny (R) for a comprehensive bibliometric analysis of publication trends, citation networks, and research themes.

The analysis follows a structured three-tiered approach: (1) Performance analysis, examining publication trends, key authors, institutions, and journals; (2) Science mapping, using keyword co-occurrence to track thematic shifts and identify research gaps; and (3) Network analysis, exploring collaboration patterns and thematic evolution through citation and clustering techniques, as shown in Fig.1.

3.3 Analytical Approach and Research Significance

This bibliometric analysis quantifies scholarly output and identifies key interdisciplinary links in energy storage adoption and behavior. The findings offer valuable insights for researchers, policymakers, and industry stakeholders, supporting data-driven decisions in policy, consumer engagement, and sustainability. By mapping research evolution, this study lays a foundation for future investigations, guiding strategic approaches to behavioral challenges and technology adoption.

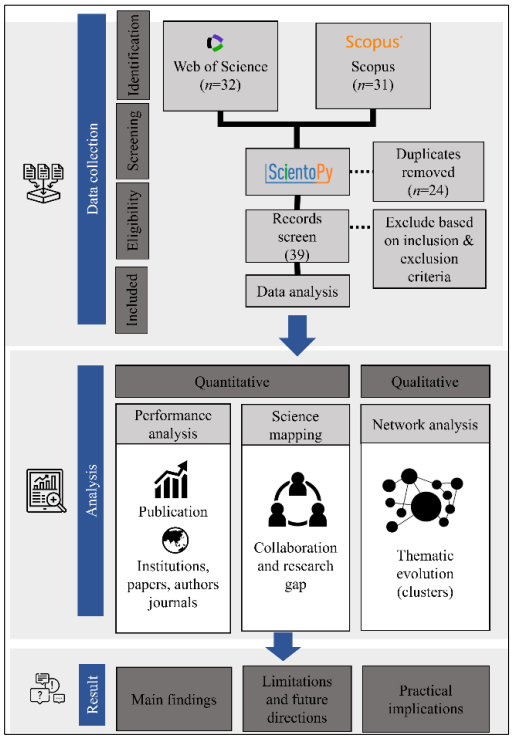

Fig. 1: The study flowchart adapted from (Sitimuawanah et al., 2024)

4.0 Findings

The bibliometric analysis of behavioral and adoption aspect of energy storage provided important insights into the research field. The process of document selection and duplication removal from Scopus and WoS database, for a bibliometric analysis is shown in Fig.2.

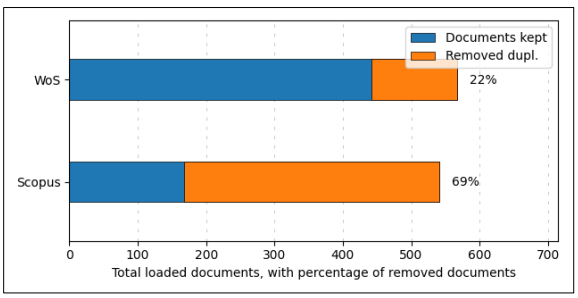

Fig. 2: Document selection and duplication removal process for behavioral and adoption aspect of energy storage from Scopus and WoS Database

As shown in Fig. 2, the document selection process involved filtering and removing duplicates from both Scopus and Web of Science (WoS) databases. 69% of the documents from Scopus were identified as duplicates and removed, leaving only a subset for analysis. In contrast, 22% of WoS documents were removed due to duplication, indicating a lower redundancy rate. The final dataset consists of documents retained from both databases, covering publications from 2007 to February 2025.

4.1 Publication Trends

The publication trend on adoption and behavioral aspect of energy storage, as shown in Fig. 3, reveals a clear and growing interest in this area over the years, particularly starting from 2007.

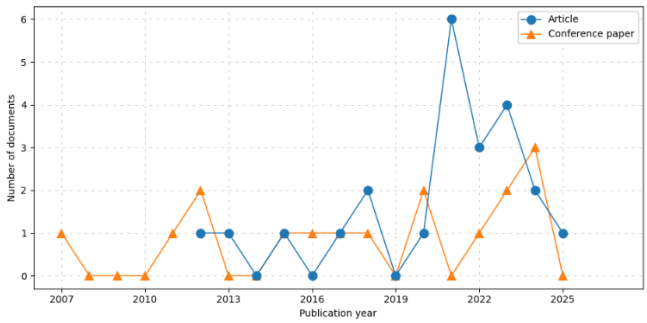

Fig. 3: Annual publication trends of adoption and behavioral aspect of energy storage

Fig. 3 shows the publication trends in energy storage adoption and behavior from 2007 to 2025, distinguishing between journal articles and conference papers. Conference papers have fluctuated but grown steadily, especially after 2022, peaking in 2024, indicating increased dissemination at academic and industry forums. Journal articles have followed a gradual upward trend, with a notable rise from 2020 and a peak of six articles in 2021, maintaining steady output in 2022 and 2023. The publication trend reflects growing interest in energy storage adoption and behavior, with conference papers fostering early discussions and journal articles providing peer-reviewed insights, indicating a balanced, evolving field.

The distribution of publications across various journals and conference proceedings related to the adoption and behavioral aspects of energy storage is shown in Fig. 4.

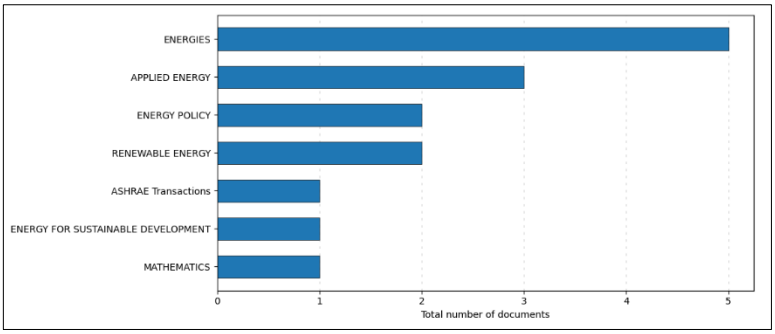

Fig. 4: Trend of publications distribution across various journals and conference proceedings of adoption and behavioral aspect of energy storage

Fig. 4 shows that research on energy storage adoption and behavior is widely published across various journals. "Energies" leads with 5 publications, followed by "Applied Energy" (3), and "Energy Policy" and "Renewable Energy" (2 each). Other contributions appear in "ASHRAE Transactions," "Energy for Sustainable Development," and "Mathematics" (1 each). This distribution highlights the interdisciplinary nature of the field, spanning renewable energy, policy, sustainability, and technical modeling, emphasizing the broad academic and practical significance of energy storage research.

The distribution of publications on adoption and behavioral aspects of energy storage across various countries, showing both the total number of documents and the percentage of recent publications (from 2007 to February 2025), is depicted in Fig. 5.

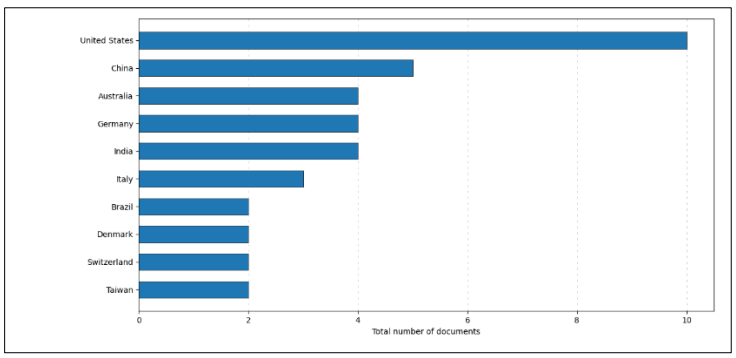

Fig. 5: Trend of publications distribution of adoption and behavioral aspects of energy storage across countries

Fig. 5 illustrates the global distribution of research publications on energy storage adoption and behavioral studies, highlighting key contributing countries. The United States leads with the highest number of publications, reflecting its strong research focus and investment in advancing energy storage adoption. Following this, China, Australia, Germany, and India also demonstrate significant contributions, indicating active engagement in exploring technological, policy, and behavioral aspects of energy storage integration. Meanwhile, Italy, Brazil, Denmark, Switzerland, and Taiwan contribute a smaller but notable number of publications, showing broader international participation in the field. This distribution underscores the global nature of energy storage research, with major economies driving advancements while emerging contributors expand the research landscape. The presence of diverse countries in this domain highlights a growing interdisciplinary interest, covering aspects such as policy frameworks, consumer adoption behavior, and energy transition strategies.

4.2 Key Research Areas

The keyword analysis identified several key research areas within the field of adoption and behavioral aspects of energy storage. The distribution of author keywords in publications related to adoption and behavioral aspects of energy storage, highlighting trends before and after 2022, is shown in Fig. 5.

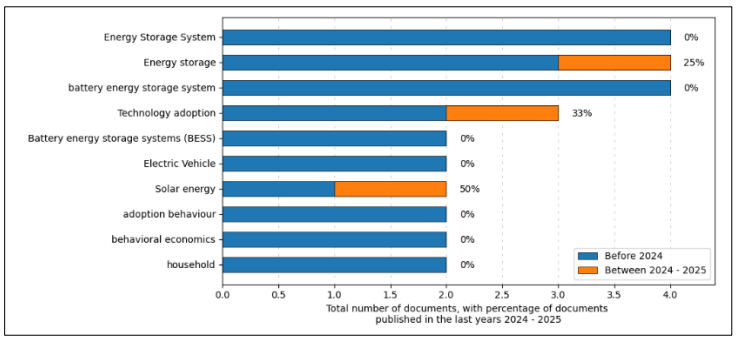

Fig. 5: Annual publication trends of adoption and behavioral aspects of energy storage on keyword analysis

Fig. 5 highlights key research topics in energy storage adoption and behavior, with publication trends over time. "Energy storage" (4 papers) and "Technology adoption" (3 papers) show recent growth, with 25% and 33% of publications in 2024-2025, respectively. "Solar energy" (2 papers) has the highest recent share, with 50% published in 2024-2025, indicating a rising focus on solar-powered storage. Other topics, including "Energy Storage System" (4 papers), "Battery Energy Storage System (BESS)" (3 papers), "Electric Vehicle" (3 papers), "Adoption Behavior" (3 papers), "Behavioral Economics" (3 papers), and "Household" (3 papers), show no recent publications, suggesting prior research saturation.This trend signals a shift towards advanced energy storage adoption, with increasing focus on solar energy and technology integration.

4.3 Citation Analysis

Table 2 presents highly cited articles on the adoption and behavioral aspects of energy storage, highlighting their impact based on citation counts from Scopus and WoS (as of February 2025). These studies contribute significantly to understanding consumer motivations, economic factors, and policy influences shaping energy storage adoption. The most cited article by Laws et al. (2017) has 85 citations and examines the utility death spiral and how electricity rate structures influence the adoption of residential solar photovoltaics and energy storage. Similarly, Ecker et al. (2018) (54 citations) explores the behavioral economics of energy independence vs. control in private storage adoption, emphasizing consumer decision-making factors. Recent studies, such as Alipour et al. (2022) (37 citations), investigate motivations and barriers in residential solar PV and battery adoption, while Saboori et al. (2021) (31 citations) introduces a novel approach to mobile battery energy storage for EV charging, promoting sustainable mobility adoption. The most recent article by Liu et al. (2023) (17 citations) examines how the adoption of photovoltaic and storage systems impacts public transport, showcasing emerging trends in energy integration for sustainable mobility. Overall, the articles in Table 2 reflect the growing interdisciplinary focus on energy storage adoption, incorporating economic, technological, and behavioral perspectives. These findings underscore the critical role of policy frameworks, consumer behavior, and market structures in accelerating energy storage adoption and integration.

Table 2. The most cited papers with at least 10 citations

References	Title	Year	Cited by	Document Type
(Laws et al., 2017)	On the utility death spiral and the impact of utility rate structures on the adoption of residential solar photovoltaics and energy storage	2017	85	Article
(Ecker et al., 2018)	Independence without control: Autarky outperforms autonomy benefits in the adoption of private energy storage systems	2018	54	Article
(Mazzoni et al., 2021)	A techno-economic assessment on the adoption of latent heat thermal energy storage systems for district cooling optimal dispatch & operations	2021	41	Article

(Persson & Westermark, 2013)	Low-energy buildings and seasonal thermal energy storages from a behavioral economics perspective	2013	39	Article
(Alipour et al., 2022)	Exploring residential solar PV and battery energy storage adoption motivations and barriers in a mature PV market	2022	37	Article
(do Nascimento & Rüther, 2020)	Evaluating distributed photovoltaic (PV) generation to foster the adoption of energy storage systems (ESS) in time-of-use frameworks	2020	36	Article
(Saboori et al., 2021)	Optimal Management of Mobile Battery Energy Storage as a Self-Driving, Self-Powered and Movable Charging Station to Promote Electric Vehicle Adoption	2021	31	Article
(Pradhan et al., 2021)	The adoption of Seawater Pump Storage Hydropower Systems increases the share of renewable energy production in Small Island Developing States	2021	29	Article
(Römer et al., 2015)	Smart energy for Robinson Crusoe: an empirical analysis of the adoption of IS-enhanced electricity storage systems	2015	19	Article
(Liu et al., 2023)	Impacts of photovoltaic and energy storage system adoption on public transport: A simulation-based optimization approach	2023	17	Article

4.4 Network Analysis

The network visualization of author keywords in adoption and behavioral aspect of energy storage is depicted in Fig. 6, highlights several prominent research clusters and interconnected themes within the field.

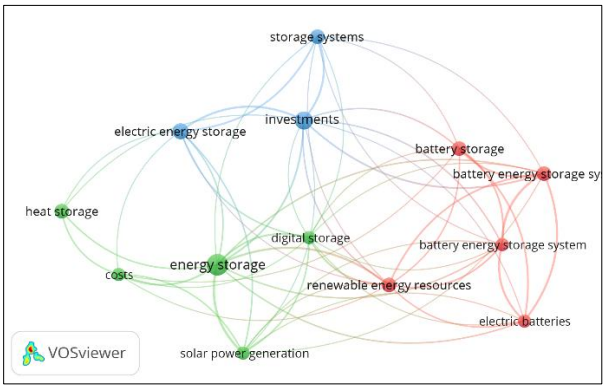

Fig. 6: Network visualisation of the authors keywords of the adoption and behavioral aspect of energy storage publication

Fig. 6 presents a keyword co-occurrence network related to energy storage adoption, generated using VOSviewer. The central node, "energy storage," serves as the primary hub, highlighting its strong connections to various themes such as renewable energy, investments, and battery technologies. The network is structured into three main research clusters, reflecting key areas of focus. The blue cluster centers around "storage systems," "electric energy storage," and "investments," indicating a strong research emphasis on the economic feasibility and large-scale implementation of energy storage solutions. The green cluster includes keywords such as "solar power generation," "costs," and "heat storage," suggesting a focus on sustainability, financial viability, and renewable energy integration. Meanwhile, the red cluster is dominated by "battery storage," "battery energy storage system," and "electric batteries," highlighting research on battery technologies and their role in supporting renewable energy resources. The dense interconnections among these keywords indicate an evolving research landscape, where studies are increasingly focusing on the technological, economic, and environmental aspects of energy storage adoption. Additionally, the presence of "digital storage" suggests a growing interest in data-driven optimization and smart energy management, pointing towards future advancements in intelligent storage solutions and sustainable energy transitions.

5.0 Discussion

The findings of this bibliometric analysis reveal a significant evolution in the scholarly discourse surrounding energy storage technologies, particularly with the incorporation of behavioral, economic, and regulatory dimensions. The upward trajectory in publication trends, especially from 2020 onwards, underscores a heightened global interest in understanding the multifaceted drivers of energy storage adoption beyond technical feasibility. This shift reflects a growing recognition of the socio-technical nature of energy transitions, where consumer behavior, trust in technology, and policy instruments play critical roles in facilitating widespread deployment.

Geographically, the concentration of research output in countries such as the United States, China, and Australia highlights the influence of national energy policies and investment in shaping the research landscape. These nations demonstrate strong alignment between academic inquiry and practical implementation, suggesting a robust research-to-policy pipeline. The dominance of certain keywords such as "technology adoption," "solar energy," and "digital storage" in recent years signals emerging priorities focused on decentralization, consumer participation, and intelligent storage systems.

Notably, the clustering and co-occurrence of keywords suggest a convergence of disciplines, where behavioral economics, energy policy, and engineering intersect to address complex adoption challenges. However, the limited presence of recent publications under previously dominant themes such as "BESS" and "household adoption" may indicate thematic saturation or a shift towards broader system-level integration. This highlights an opportunity for future research to explore novel intersections, particularly involving AI-driven analytics, market-based incentives, and equity-focused adoption frameworks.

Collectively, these insights underscore the importance of interdisciplinary collaboration and evidence-based policymaking in accelerating the global transition to sustainable energy systems. By systematically mapping the evolution of research on energy storage adoption, this study provides a foundation for guiding strategic investments, aligning academic inquiry with societal needs, and identifying gaps for targeted future exploration.

6.0 Conclusion

This bibliometric analysis of energy storage adoption and behavioral research provides a comprehensive overview of global trends from 2007 to February 2025, revealing a shift from technically focused studies to more interdisciplinary approaches that integrate behavioral economics, regulatory frameworks, and policy analysis. The findings highlight increased research activity post-2020, with the United States, China, and Australia emerging as key contributors, and underscore growing emphasis on technology adoption, renewable integration, economic feasibility, and consumer behavior. However, the study is limited by its reliance on selected databases (Scopus and Web of Science), which may exclude relevant grey literature or regional studies not indexed in these platforms. Additionally, keyword-based bibliometric tools may overlook nuanced or emerging themes not yet well-represented in publication metadata.

To address ongoing challenges in energy storage adoption, it is recommended that policymakers enhance public trust through transparent regulations and targeted incentives, while researchers should prioritize user-centered studies that account for regional, cultural, and socio-economic factors. Future research should also deepen investigations into underexplored areas such as behavioral resistance to new energy technologies, the impact of misinformation, and equitable access to energy storage solutions. Furthermore, advancing the integration of AI-driven analytics, real-time energy monitoring, and cross-sectoral policy modeling will be essential to support smarter, more resilient energy systems. By offering a structured, data-driven understanding of the evolving research landscape, this study provides valuable guidance for strategic collaboration, investment, and innovation in the global energy transition.

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Paper Contribution to Related Field of Study

This study offers a bibliometric analysis of global research on energy storage adoption, revealing a shift from technical to behavioral and policy-focused studies. Key trends and emerging themes—such as solar integration and digital storage—provide valuable insights to guide future research, policymaking, and sustainable technology adoption.

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