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for Applications Beyond Electricity

Nuclear Energy and Cogeneration for Desalination : A Comparative Bibliometric Analysis of Global Research Trends

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Desalination Addresses Water Scarcity—but Increases Energy Demand

1 The real problem : Water scarcity

Growing freshwater demand and limited conventional water resources increase the need for alternative water supplies.

2 The established response : Desalination

- Reverse osmosis uses electricity.
- MSF and MED require heat and electricity.
- The environmental and economic performance therefore depends strongly on the energy source

3 The remaining problem : Desalination shifts part of the water problem into an energy problem.

High energy demand influences: water-production costs; carbon emissions; energy-system requirements; long-term deployment feasibility.

A Low-Carbon Option

Nuclear energy + cogeneration

Low-carbon heat source

Reactor produces electricity and useful process heat from one plant

Electricity → RO

Membrane desalination driven by low-carbon power

Extracted heat → MED / MSF

Otherwise-wasted steam drives thermal distillation

But how well developed is the research supporting this option?

Desalination technologies are well developed, but the evidence needed to compare nuclear and other cogeneration options remains limited.

A

The literature is fragmented

Nuclear desalination has often been studied separately from the broader cogeneration-desalination literature.

B

The relationship between the fields is unclear

It remains unclear: how rapidly each research stream is growing; which countries, journals, and authors lead; where nuclear and non-nuclear research overlap; whether nuclear desalination is central or peripheral to the wider field.

C

Deployment-oriented evidence remains limited

Deployment decisions run on levelized cost — LCOE, LCOH, LCOW — with transparent CAPEX, discount rate, plant life and capacity factor. The field's dominant vocabulary is thermodynamic, not economic.

Research Question

Where does nuclear desalination stand within the wider cogeneration-desalination research landscape?

Science Mapping with Bibliometric Methodology

PRISMA-STYLE RECORD FLOW

3,105

retrieved — Scopus 1,507 · WoS 1,598

Data preparation

Records merged, deduplicated, screened and metadata standardized in R

1,973

Publications included in the final analysis

4,176

authors

394

journals

1,311

institutions

88

countries

81,643

cited references

WHAT IS NEW HERE

Comparative classification of final dataset

- Nuclear desalination
- Non-nuclear cogeneration
- Records addressing both

Classification based on terms in titles, abstracts, and author keywords

Performance

TP · TC · CP · C/CP
countries · institutions

Science mapping

Co-authorship analysis
Co-keywords analysis

Tools

R
VOSviewer

Rapid Publication Growth After 2019, While Recent Citation Ratios Reflect Short Citation Windows

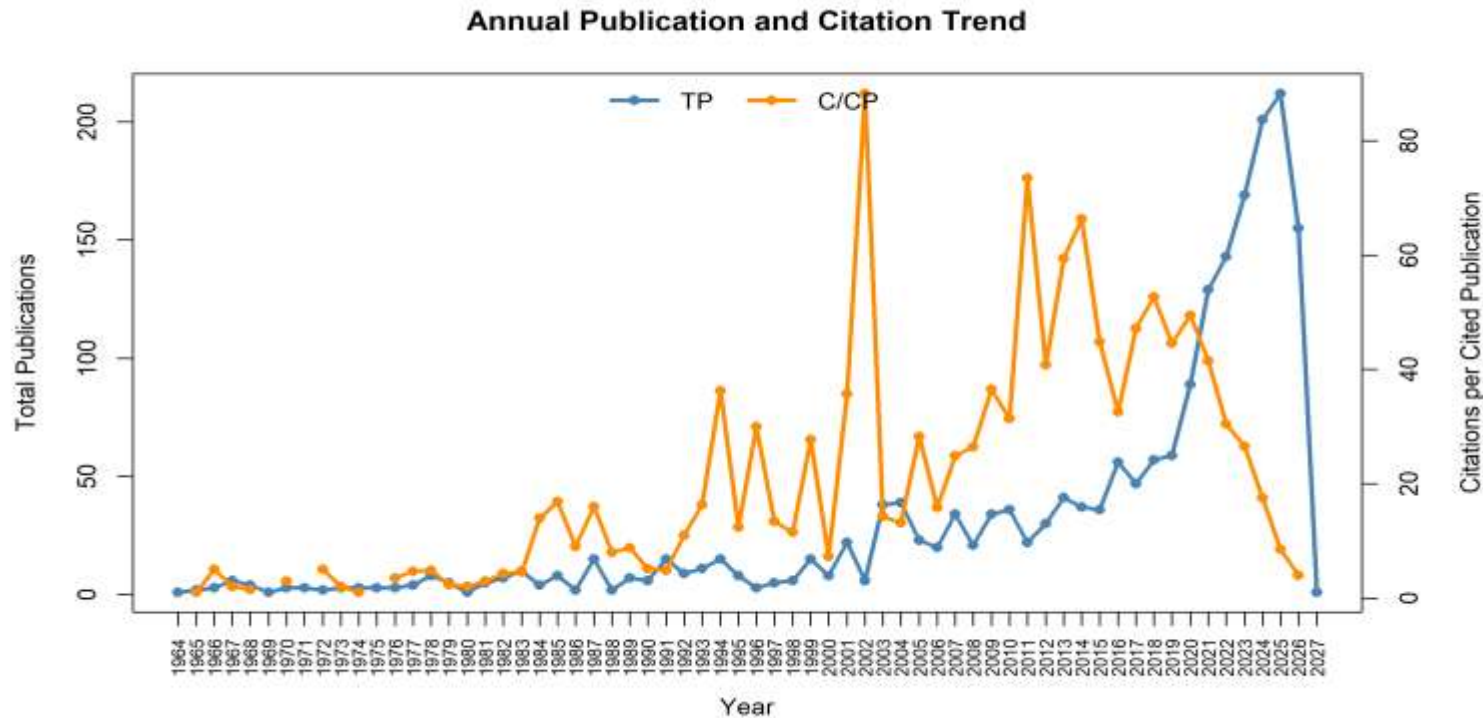


Fig. 1 — Annual total publications (blue line) and citations per cited publication, C/CP (line). 2026 is partial: retrieval July 2026.

2019

the inflection point — three decades of intermittent output give way to sustained expansion

> 200

publications in 2025, the highest annual output on record

C/CP Interpretation

Citations per CITED publication — total citations divided by papers with at least one citation, not by all papers.

The recent fall reflects short citation windows and a growing denominator — not declining quality.

Publication Activity Has Diversified Beyond Desalination into Energy and Sustainability Journals

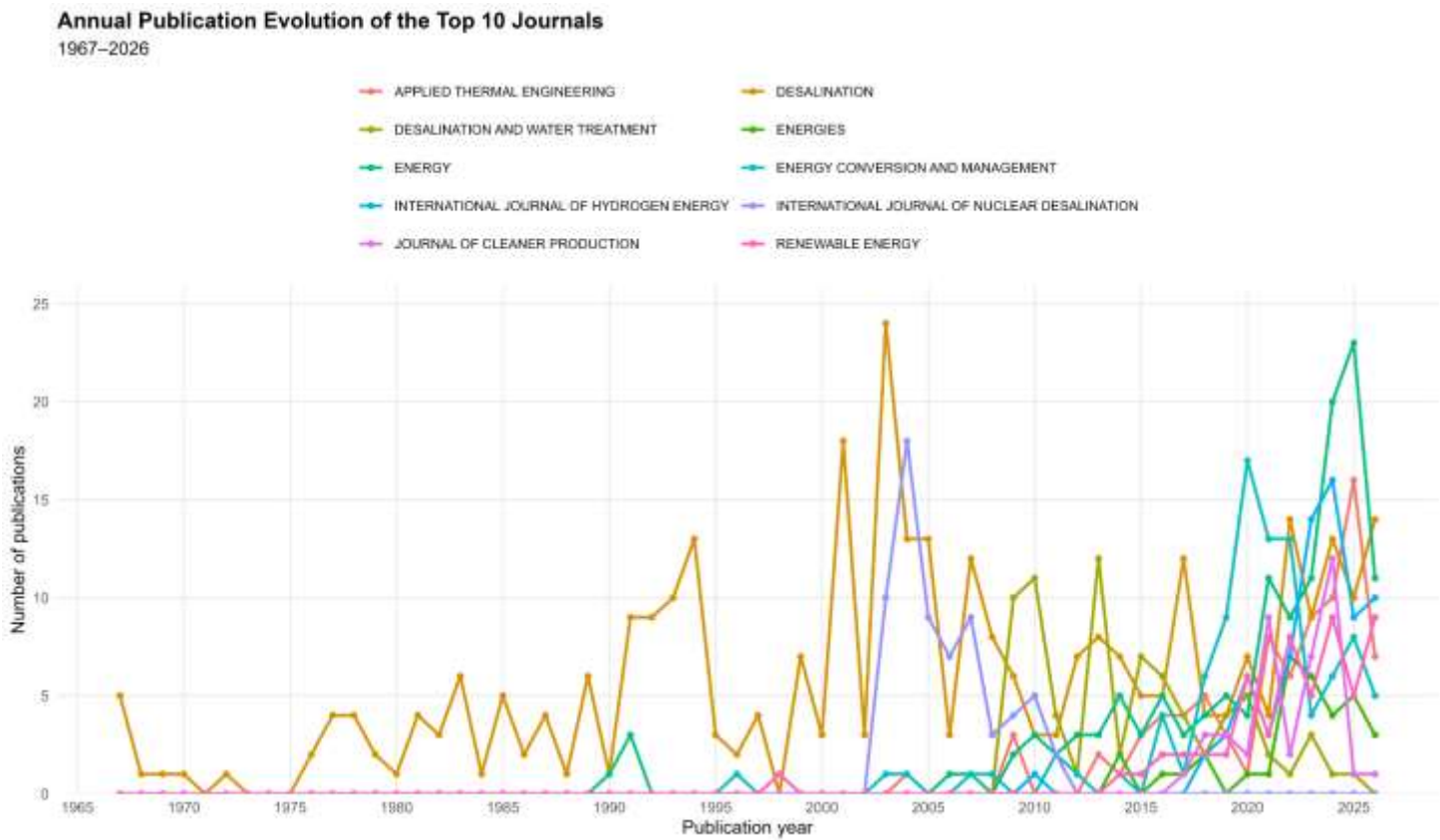


Fig. 2 — Annual publication evolution of the ten leading journals, 1967–2026.

The final dataset spans 394 journals, confirming substantial diffusion beyond a small specialist core

- 1 One continuous anchor**

Desalination is the only leading journal publishing across nearly the whole period, and remains the long-run citation anchor.
- 2 Nuclear desalination had a concentrated specialist phase**

Int. J. Nuclear Desalination shows one concentrated mid-2000s burst, then little. The nuclear stream grew through a narrow, time-bounded outlet structure.
- 3 Publication outlets diversified after 2018**

Energy · Energy Conversion and Management · Applied Thermal Engineering · Hydrogen Energy · Renewable Energy · Energies · Cleaner Production

A global field with a geographic blind spot

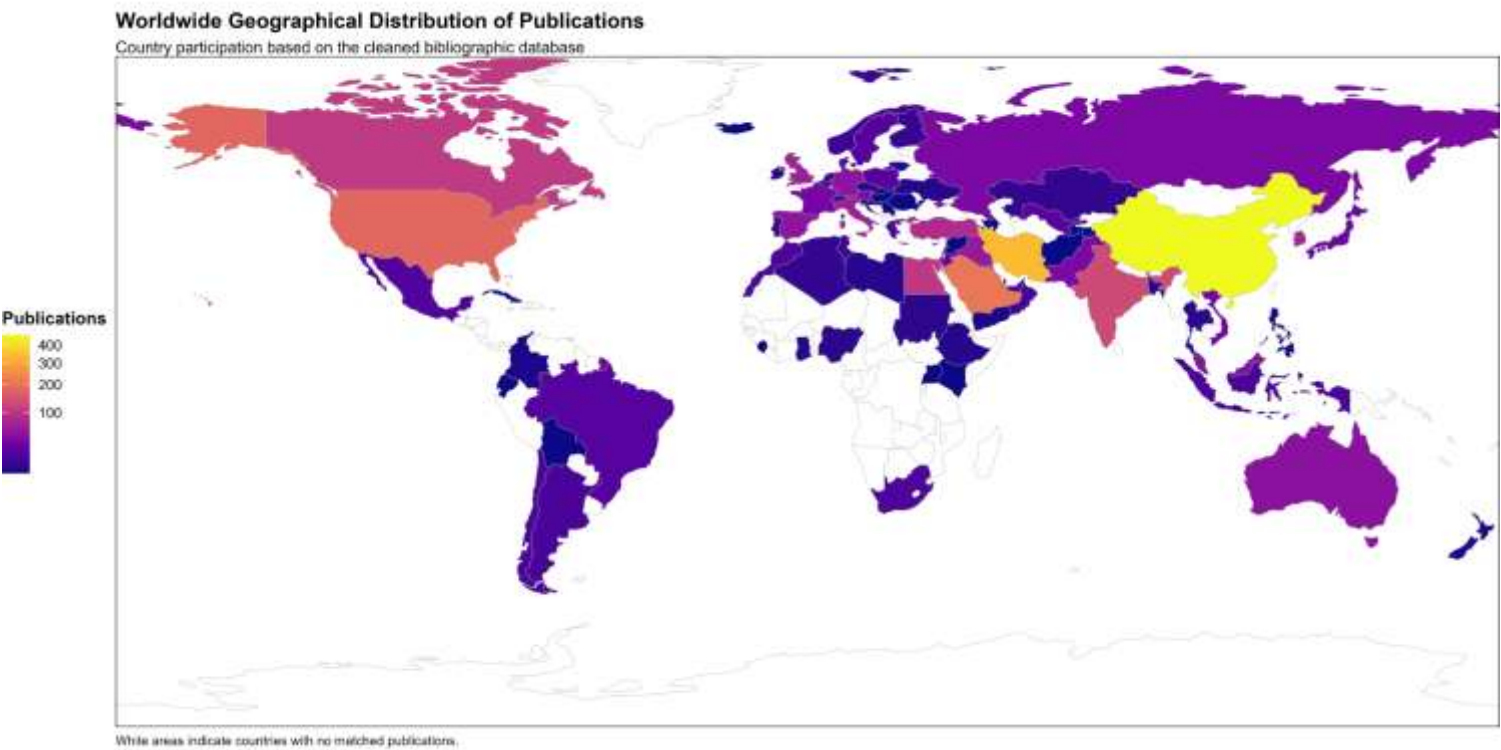


Fig. 3 — Worldwide distribution of publications based on cleaned affiliation-country metadata. White areas indicate countries with no matched publications.

88

countries represented

1,311

institutions

1

Output remains concentrated

China has the highest publication output, followed by Iran, Saudi Arabia, the United States, India, Canada, Egypt, Türkiye, South Korea and Kuwait.

Underrepresented Regions

Many countries across Sub-Saharan Africa, Central America, and parts of Asia have few or no matched publications in the dataset.

Why this matters: desalination performance and cost are highly location-dependent, so broader geographic evidence is needed for locally relevant decisions.

A Connected Field—but Without a Dense Field-Wide Collaboration Core



Fig. 6 — co-authorship co-occurrence network. Node size reflects collaboration prominence; colour marks one of 15 detected clusters.

1

15 collaboration clusters
Two hubs — Zhang Ying and Dincer Ibrahim — bridge several otherwise separate groups.

2

But no dense field-wide core
The network is elongated and only partly integrated, with many smaller peripheral groups and short collaboration chains.

3

Collaboration remains team-centred
Much of the collaboration occurs within relatively distinct research teams rather than across the entire field

4,176

authors

WHY THIS MATTERS
International collaboration exists, but limited connections between research communities may reduce the exchange of methods, datasets, and evaluation practices.

Collaboration remains team centered

Nuclear Desalination Is Established—but Newer Themes Are Emerging Elsewhere

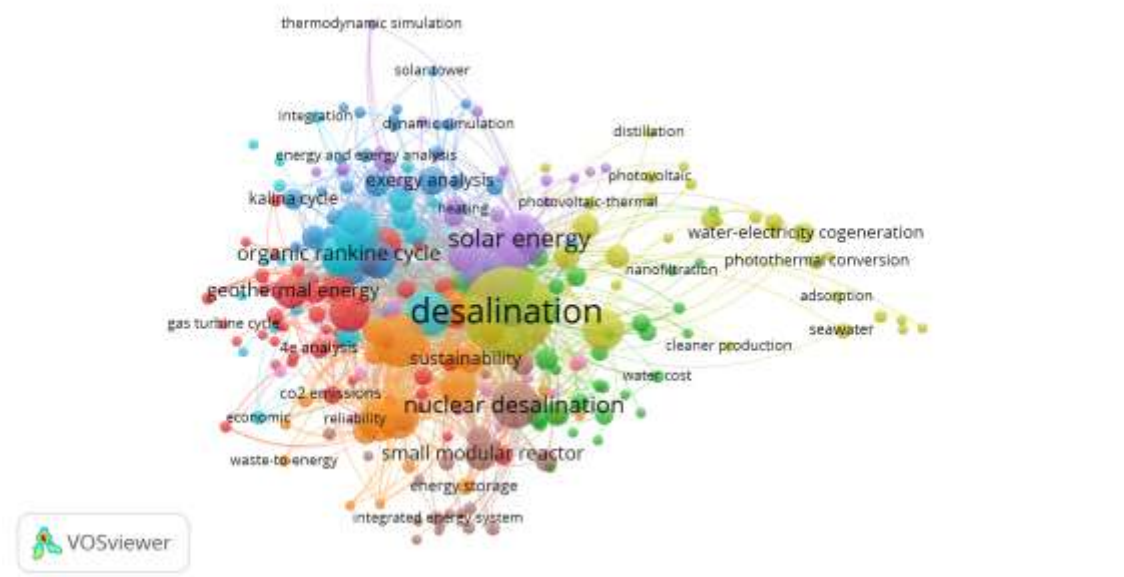


Fig. 7 — keywords co-occurrence network. 859 of 7,358 keywords at minimum occurrence 5; nine clusters.

STRUCTURE: nine clusters, one interconnected core

Desalination · solar energy · organic Rankine cycles · geothermal · exergy · sustainability · nuclear desalination · small modular reactors. Nuclear desalination is embedded, not isolated.

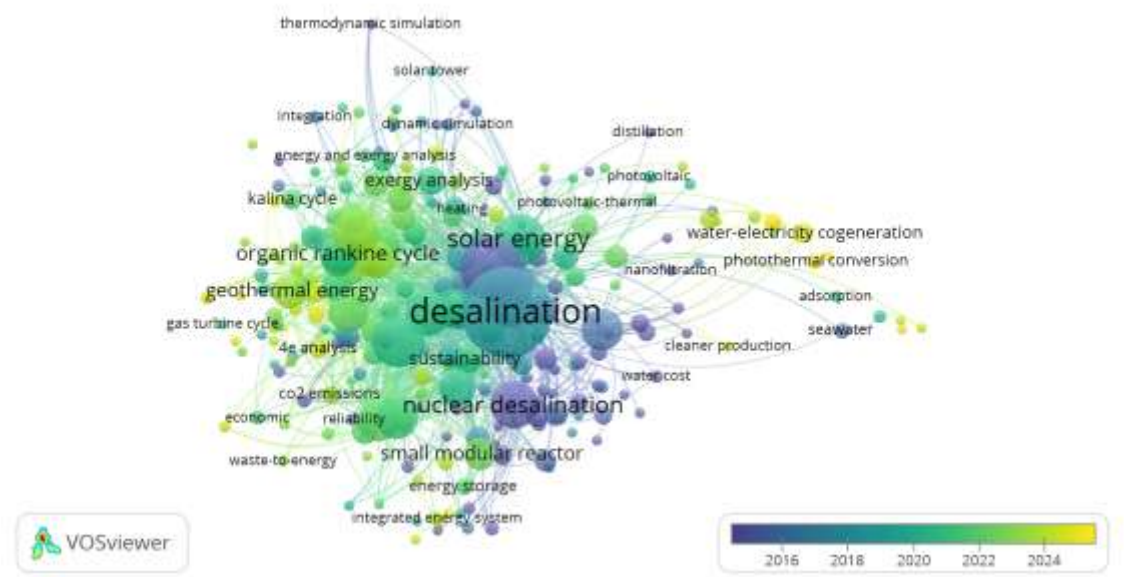


Fig. 8 — keywords overlay visualization. The same network coloured by average publication year. Yellow-green = most recent vocabulary.

TIMING: newer themes are emerging elsewhere

Nuclear desalination and SMR sit in older-to-middle years. The newest vocabulary is photothermal conversion, adsorption, geothermal and ORC work.

Nuclear Desalination Is Not Yet a Central Theme, and Economic Metrics Remain Weakly Integrated

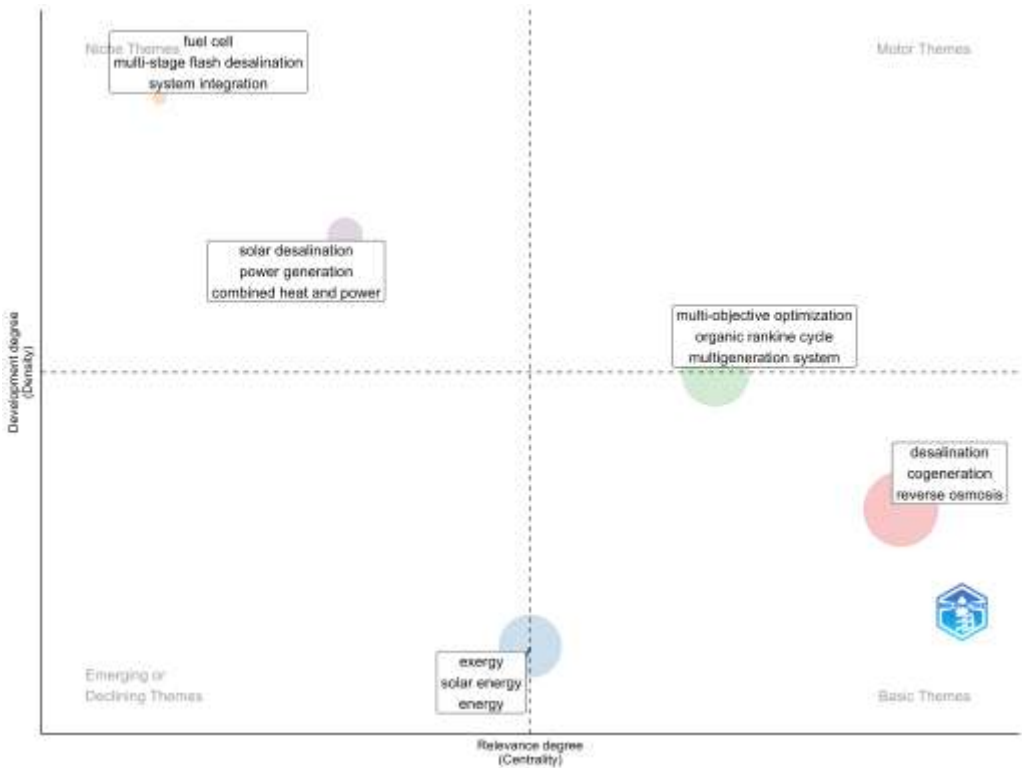


Fig. 9 — Thematic map: author keywords, minimum frequency 5, walktrap clustering.

Basic theme

desalination · cogeneration · reverse osmosis

Toward motor

multi-objective optimization · ORC · multigeneration system

Niche

fuel cell, MSF desalination, system integration; solar desalination, power generation, CHP

Emerging or declining

exergy · solar energy · energy — likely reconfiguring, not disappearing

The Main Gap Is Decision-Ready Economic Evidence

A thresholded map cannot prove LCOE, LCOH and LCOW are absent from the literature. It does show they are not part of the field's dominant shared vocabulary.

Thank you !!!

Nuclear desalination is technically connected to the wider field, but stronger comparative and economic evidence is still needed for deployment decisions.

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*Energy policy · energy economics · low-carbon systems ·
the energy–water nexus*