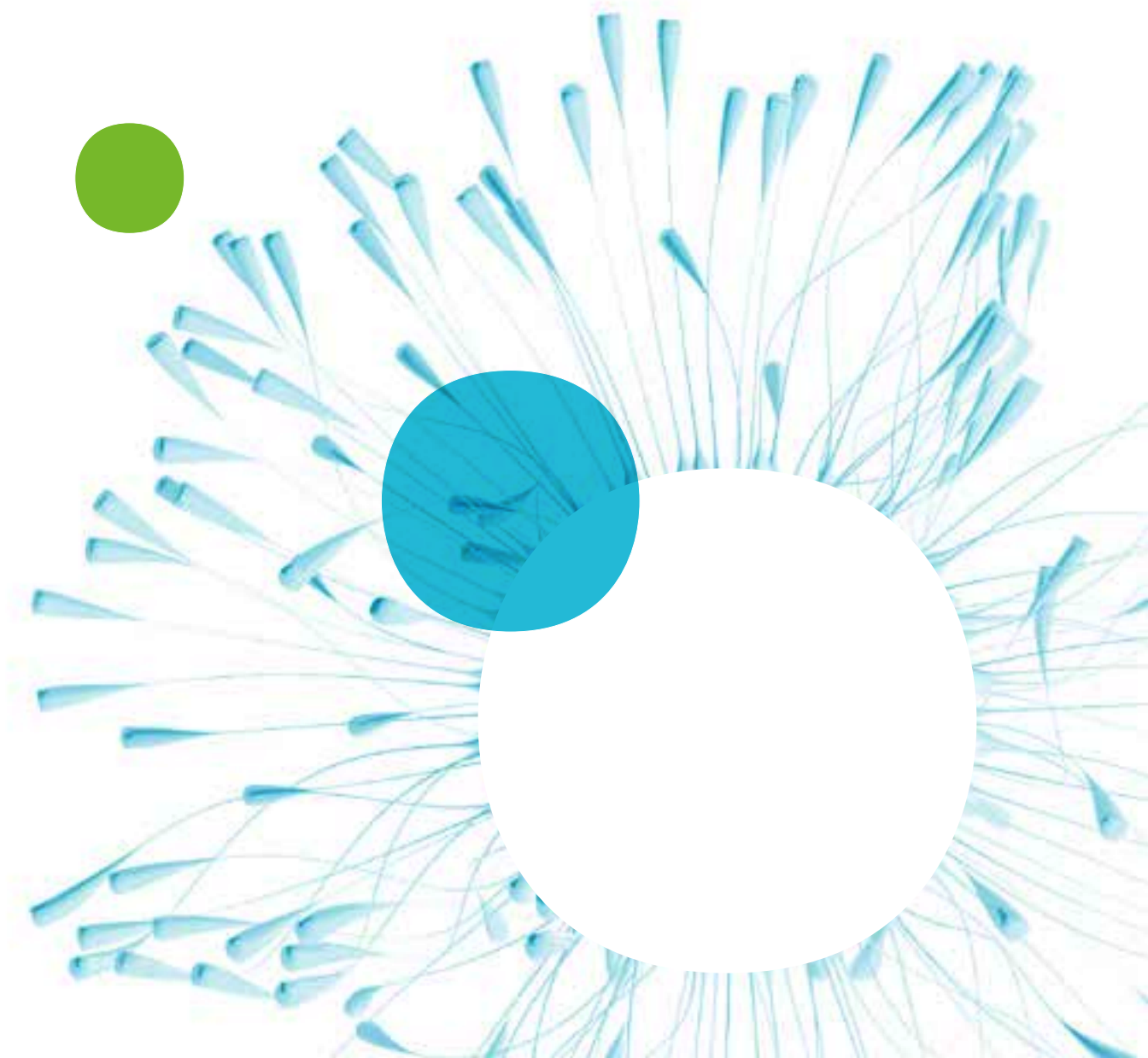


# Cluster ranking

The GII reveals the world's top 100 science and technology (S&T) clusters and identifies the most S&T-intensive top global clusters.



## The GII 2023 top 100 science and technology clusters

Recognizing that innovation output at the local level is equally as important as output at the national level, the Global Innovation Index (GII) continues to chart the world's largest top 100 science and technology (S&T) clusters (see Map 1). These are the geographical areas around the world where the highest density of inventors and scientific authors are located (see Appendix IV for details on the methodological adjustment employed).

For a second time, the GII 2023 also presents S&T clusters beyond the top 100, shedding light on clusters not normally highlighted within this section.

### Tokyo-Yokohama and four other Asian clusters lead the top 100 S&T clusters

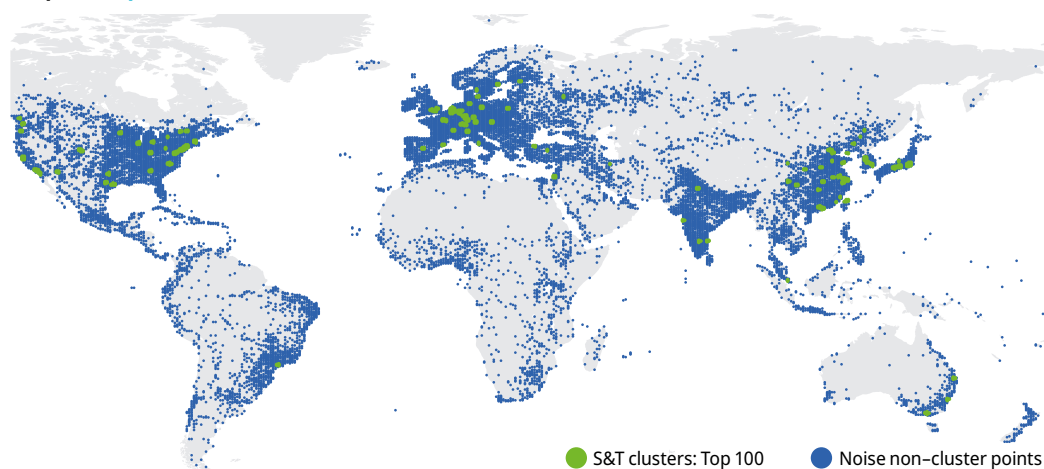
Among the top 100, Tokyo-Yokohama (Japan) is the top performing cluster, followed by Shenzhen-Hong Kong-Guangzhou (China and Hong Kong, China), Seoul (Republic of Korea), Beijing (China) and Shanghai-Suzhou (China).

Seoul (Republic of Korea) climbs one place to third in the rankings overtaking Beijing (China) in fourth, in 2023.<sup>1</sup>

Shanghai-Suzhou (China) rises one place to enter the top 5, primarily owing to a strong growth in PCT filings. San Jose-San Francisco, CA (United States) follows in sixth position.<sup>2</sup>

The four remaining top 10 clusters are unchanged on the previous year, with the exception of San Diego, CA, which climbs two places from 11<sup>th</sup> to 9<sup>th</sup> with New York City, NY dropping a place to 10<sup>th</sup> and Paris two places to 12<sup>th</sup>.

**Map 1** Top 100 clusters worldwide, 2023



Source: WIPO Statistics Database, May 2023.

Note: Noise refers to all inventor/author locations not classified in a cluster.

The highest climbers in the ranking are three clusters in China, namely, Zhenjiang (+15 positions), Hefei (+13) and Wuxi (+13). Following significant growth, Wuxi and Zhenjiang, together with another Chinese cluster, Fuzhou (+8 positions) enter the top 100 for the first time.

It is clusters in China that have recorded the largest increases in S&T output in 2023, the median increase equating to +12.1 percent, with that economy hosting the two fastest growing clusters globally – Hefei (+21.6 percent) and Qingdao (+19.4 percent).<sup>3</sup>

Clusters located in other middle-income economies besides China also experienced strong S&T output growth, four of which were in India, namely, Chennai (+10.3), Bengaluru (+7.9 percent), Mumbai (+7.1 percent) and Delhi (+5.4 percent).

High-income economy clusters generally grew at a slower pace than clusters in middle-income economies, with 26 out of the 67 high-income clusters actually experiencing negative net S&T

output for the period. That said, there are some notable exceptions to this trend among high-income economy clusters. In addition to San Diego, CA (+7.5 percent) and Seoul (+6.4 percent) already highlighted, Daejeon (Republic of Korea, +7.8 percent), Denver, CO (United States, +4.4 percent), Rome (Italy, +4.0 percent) and Milan (Italy, +3.7 percent) all experienced strong S&T output in comparison to other high-income clusters.

The top S&T clusters for each economy or cross-border region are shown in Table 6. The leading clusters per country remain unchanged from last year, except for Munich overtaking Cologne to become the leading German S&T cluster.

The cluster around Singapore now encapsulates Johor Bahru, Malaysia, which lies to the north of Singapore, with a significant amount of daily commuting occurring from Malaysia to Singapore.

**Table 6 Top S&T cluster by economy or cross-border region ranked among the top 100, 2023**

| Rank | Cluster name                 | Economy  | Top applicant                       | Top organization                  |
|------|------------------------------|----------|-------------------------------------|-----------------------------------|
| 1    | Tokyo-Yokohama               | JP       | Mitsubishi Electric                 | University of Tokyo               |
| 2    | Shenzhen-Hong Kong-Guangzhou | CN/HK    | Huawei                              | Sun Yat Sen University            |
| 3    | Seoul                        | KR       | Samsung Electronics                 | Seoul National University         |
| 4    | Beijing                      | CN       | BOE Technology                      | Tsinghua University               |
| 6    | San Jose-San Francisco, CA   | US       | Google                              | Stanford University               |
| 12   | Paris                        | FR       | PSA Automobiles                     | Sorbonne Universite               |
| 20   | London                       | GB       | Nicoventures Trading                | University College London         |
| 22   | Munich                       | DE       | BMW                                 | Technical University of Munich    |
| 26   | Amsterdam-Rotterdam          | NL       | TNO                                 | Utrecht University                |
| 27   | Taipei-Hsinchu               | TW*      | Hewlett-Packard                     | National Taiwan University        |
| 30   | Tel Aviv-Jerusalem           | IL       | Yeda Research and Development       | Hebrew University of Jerusalem    |
| 31   | Moscow                       | RU       | Samsung Electronics                 | Lomonosov Moscow State University |
| 33   | Singapore                    | SG/MY    | A*Star                              | National University of Singapore  |
| 34   | Tehran                       | IR       | Ghanbari, Ahmad                     | University of Tehran              |
| 38   | Stockholm                    | SE       | LM Ericsson                         | Karolinska Institutet             |
| 42   | Melbourne                    | AU       | Monash University                   | University of Melbourne           |
| 48   | Madrid                       | ES       | LM Ericsson                         | Complutense University of Madrid  |
| 49   | Zürich                       | CH       | ETH Zurich                          | ETH Zürich                        |
| 50   | Milan                        | IT       | Pirelli Tyre                        | University of Milan               |
| 51   | Brussels-Antwerp             | BE       | Agfa                                | KU Leuven                         |
| 52   | Toronto, ON                  | CA       | DH Technologies Development         | University of Toronto             |
| 56   | Bengaluru                    | IN       | Samsung Electronics                 | IISC - Bangalore                  |
| 59   | Istanbul                     | TR       | Sanovel Ilac Sanayi Ve Ticaret A.S. | Istanbul University               |
| 61   | Copenhagen                   | DK       | Novo Nordisk                        | University of Copenhagen          |
| 72   | São Paulo                    | BR       | Braskem                             | Universidade de São Paulo         |
| 73   | Helsinki                     | FI       | Nokia                               | University of Helsinki            |
| 76   | Vienna                       | AT       | Technische Universität Wien         | Medical University of Vienna      |
| 90   | Warsaw                       | PL       | Samsung Electronics                 | University of Warsaw              |
| 97   | Basel                        | CH/DE/FR | DSM IP Assets                       | University of Basel               |

Source: WIPO Statistics Database, May 2023.

Notes: Tables in this section use ISO alpha-2 country codes, with the following additions: TW\* = Taiwan, Province of China; IISC - Bangalore = Indian Institute of Science - Bangalore; TNO = Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek. Economy labels were assigned to a cluster, when at least 1 percent of a cluster's output occurred in a given economy.

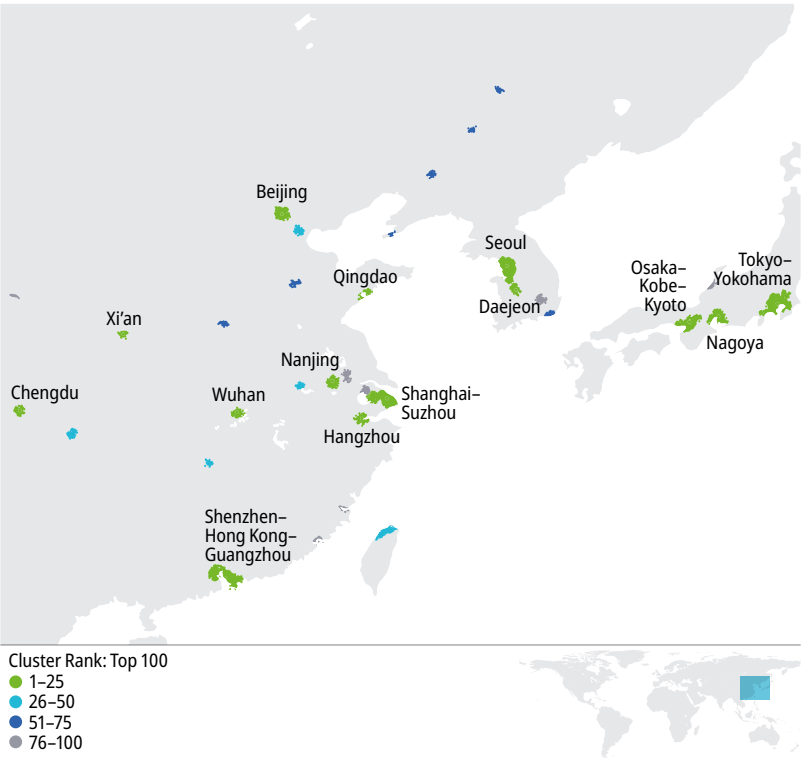
### China overtook the United States in number of top 100 S&T clusters

In 2023, as in previous years, the top 100 S&T clusters are concentrated in three regions, namely, Northern America, Europe and Asia, and more specifically in two countries: China and the United States (see Map 1).

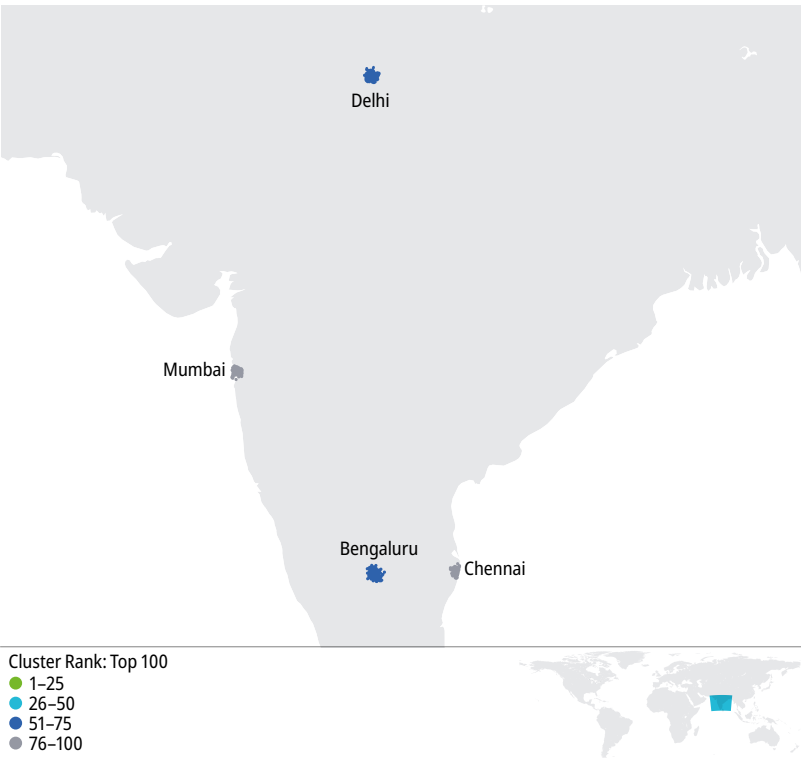
For the first time, in 2023, China is the economy that has the most clusters (24) ranked among the top 100, overtaking the United States with 21 clusters unchanged on the year (see Table 7). Germany follows, with nine clusters in the top 100, with Munich now that economy's number one cluster followed by Cologne and Stuttgart. Japan has four clusters in the top 100, with Tokyo-Yokohama (1<sup>st</sup>) and Osaka-Kobe-Kyoto (7<sup>th</sup>) ranking among the top 10 clusters. France has three clusters in the top 100.

Map 2 Top S&T clusters, East Asia, India, Türkiye and Israel, 2023

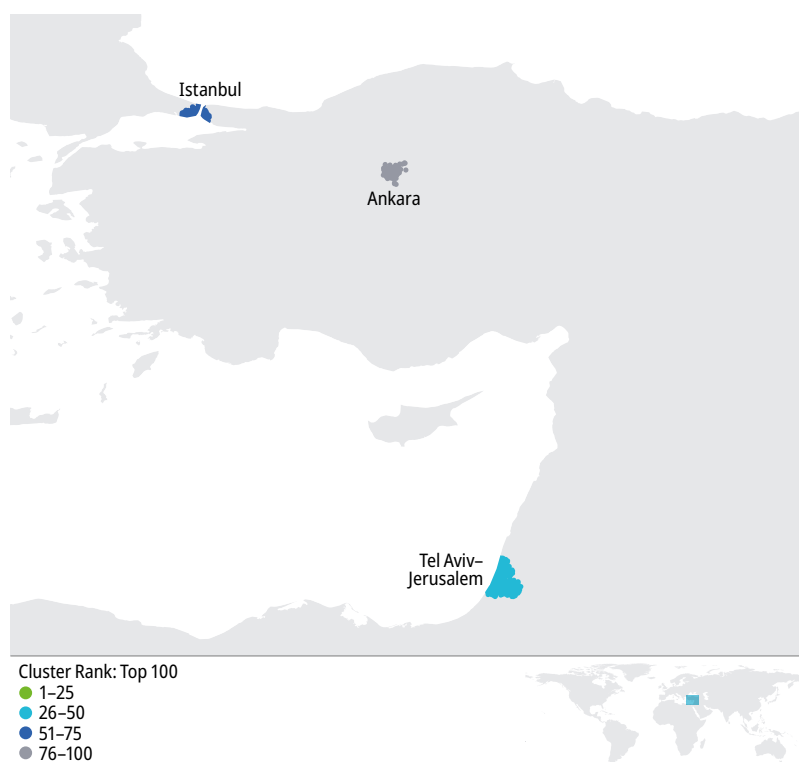
(a) East Asia



(b) India



## (c) Türkiye and Israel



Source: WIPO Statistics Database, May 2023.

With the exception of China, only five middle-income economies have clusters among the top 100:

- Brazil (1 cluster), with São Paulo, is the sole top 100 S&T cluster in Latin America;
- India (4), with Bengaluru, Delhi, Chennai and Mumbai;
- Islamic Republic of Iran (1), with Tehran;
- Russian Federation (1), with Moscow; and
- Türkiye (2), with Istanbul and Ankara.<sup>4</sup>

The two Indian clusters Chennai and Bengaluru experienced the biggest increases in density of inventors and scientific authors.

**Table 7 Economies with three or more top 100 S&T clusters, 2023**

| Economy | Economy name      | Top 100 clusters |
|---------|-------------------|------------------|
| CN      | China             | 24               |
| US      | United States     | 21               |
| DE      | Germany           | 9                |
| JP      | Japan             | 4                |
| CA      | Canada            | 4                |
| IN      | India             | 4                |
| KR      | Republic of Korea | 4                |
| FR      | France            | 3                |
| GB      | United Kingdom    | 3                |
| AU      | Australia         | 3                |

Source: WIPO Statistics Database, May 2023.

**Beyond the top 100, Bangkok, Buenos Aires, Cairo, Kuala Lumpur and Mexico City are top middle-income economy S&T clusters**

Based on the same parameters applied to produce the top 100 ranking S&T clusters globally, the GII 2023 has been able to identify clusters beyond the top 100. In all, 137 additional clusters were identified beyond the top 100, including 24 clusters based in the United States, 16 in China and 11 in each of France and the United Kingdom.

Table 8 identifies top S&T clusters in economies not covered previously in the top 100, including Portugal and Saudi Arabia, which each had two clusters. Two economies not previously identified as having an S&T cluster are Pakistan at Islamabad, mainly driven by academic publications by Quaid-i-Azam University, and Slovenia at Ljubljana, mainly driven by publications by the University of Ljubljana.

**Table 8 Top S&T clusters in extended ranking, economies not covered by the top 100 S&T clusters, 2023**

| Economy | Economy name   | Clusters beyond top 100 | Cluster name(s)   |
|---------|----------------|-------------------------|-------------------|
| PT      | Portugal       | 2                       | Lisbon and Porto  |
| SA      | Saudi Arabia   | 2                       | Dammam and Riyadh |
| AR      | Argentina      | 1                       | Buenos Aires      |
| CL      | Chile          | 1                       | Santiago          |
| CZ      | Czech Republic | 1                       | Prague            |
| EG      | Egypt          | 1                       | Cairo             |
| GR      | Greece         | 1                       | Athens            |
| HU      | Hungary        | 1                       | Budapest          |
| IE      | Ireland        | 1                       | Dublin            |
| MO      | Macao, China   | 1                       | Macau             |
| MX      | Mexico         | 1                       | Mexico City       |
| NZ      | New Zealand    | 1                       | Auckland          |
| NO      | Norway         | 1                       | Oslo              |
| PK      | Pakistan       | 1                       | Islamabad         |
| RO      | Romania        | 1                       | Bucharest         |
| RS      | Serbia         | 1                       | Belgrade          |
| SI      | Slovenia       | 1                       | Ljubljana         |
| TH      | Thailand       | 1                       | Bangkok           |

Source: WIPO Statistics Database, May 2023.

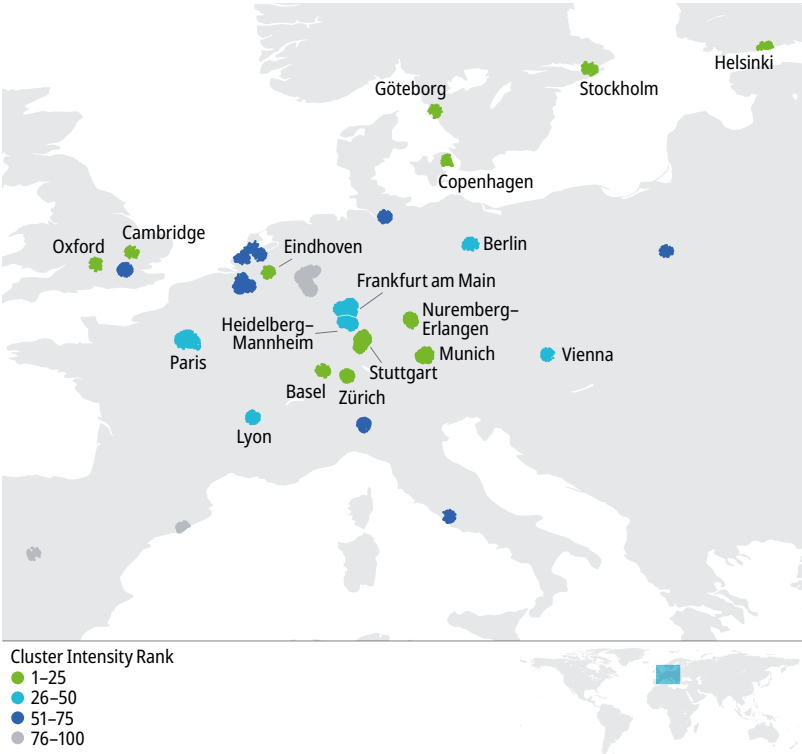
Middle-income economies, Argentina, Egypt, Mexico, Pakistan, Serbia and Thailand all host a top S&T cluster in the extended list, namely, Buenos Aires, Cairo, Mexico City, Islamabad, Belgrade and Bangkok, respectively.

#### **S&T intensity of the top 100 clusters: Europe and the United States occupy the top 5 spots, with Cambridge (United Kingdom) and San Jose–San Francisco, CA (United States) out in the lead**

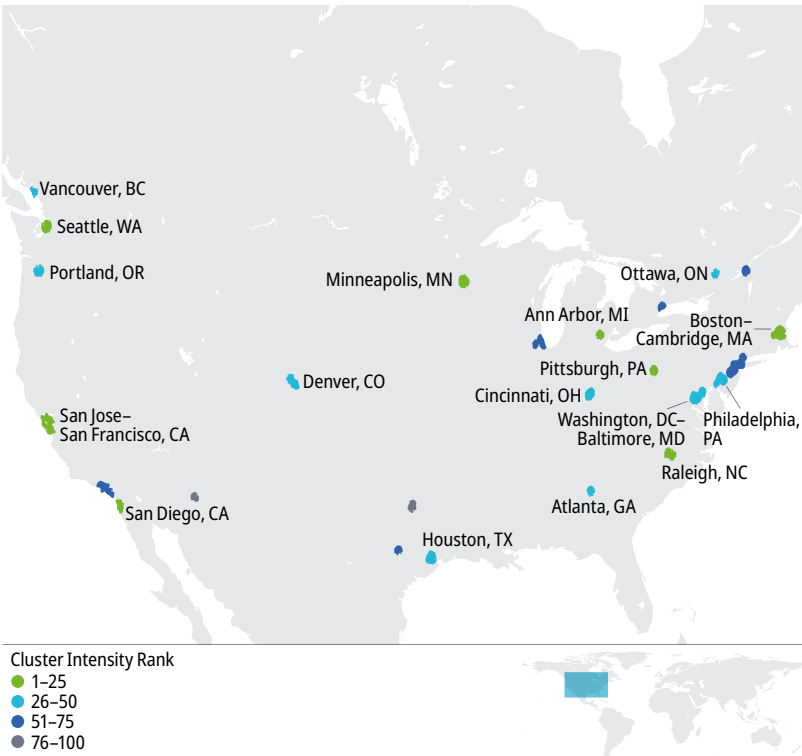
Since 2020, the GII has also presented the top 100 clusters ranked by S&T intensity, that is, the sum of their patent and scientific publication shares divided by population. This work draws on geospatial imagery in order to estimate the underlying population level (see Appendix IV).

Cambridge in the United Kingdom and San Jose–San Francisco, CA, in the United States were found to be the two most S&T-intensive clusters, followed by Oxford (United Kingdom), Eindhoven (Kingdom of the Netherlands) and Boston–Cambridge, MA (United States) (see Table 9). The most intensive S&T clusters are primarily located in Europe and the United States (see Map 3).

(a) Europe



(b) North America



Source: WIPO Statistics Database, May 2023.

## Daejeon (Republic of Korea) is the highest-ranking Asian S&T cluster by intensity.

Only three clusters were in the global top 10 and simultaneously in the top 10 for intensity, all in the United States, namely, San Jose–San Francisco, CA, Boston–Cambridge, MA and San Diego, CA.

Cambridge produced the most SCIE articles per capita, at just over 37,000 per one million people (see Appendix Table 4). It was closely followed by Oxford and Ann Arbor, MI (United States). Eindhoven leads on PCT filings per inhabitant, producing roughly 7,700 per one million people, followed by San Jose–San Francisco, CA.

**Table 9 Top 25 S&T clusters by S&T intensity, 2023**

| Rank per-capita <sup>a</sup> | Cluster name               | Economy  | Top Applicant            | Top scientific organization           |
|------------------------------|----------------------------|----------|--------------------------|---------------------------------------|
| 1                            | Cambridge                  | GB       | ARM                      | Cambridge University                  |
| 2                            | San Jose–San Francisco, CA | US       | Google                   | Stanford University                   |
| 3                            | Oxford                     | GB       | Oxford University        | Oxford University                     |
| 4                            | Eindhoven                  | NL       | Philips Electronics      | Eindhoven University of Tech.         |
| 5                            | Boston–Cambridge, MA       | US       | MIT                      | MIT                                   |
| 6                            | Daejeon                    | KR       | LG Chem                  | KAIST                                 |
| 7                            | Ann Arbor, MI              | US       | University of Michigan   | University of Michigan                |
| 8                            | San Diego, CA              | US       | Qualcomm                 | University of California San Diego    |
| 9                            | Seattle, WA                | US       | Microsoft                | University of Washington Seattle      |
| 10                           | Munich                     | DE       | BMW                      | Technical University of Munich        |
| 11                           | Kanazawa                   | JP       | Fujitsu                  | Kanazawa University                   |
| 12                           | Raleigh, NC                | US       | Duke University          | Duke University                       |
| 13                           | Göteborg                   | SE       | LM Ericsson              | University of Gothenburg              |
| 14                           | Beijing                    | CN       | BOE Technology           | Tsinghua University                   |
| 15                           | Stockholm                  | SE       | LM Ericsson              | Karolinska Institutet                 |
| 16                           | Helsinki                   | FI       | Nokia                    | University of Helsinki                |
| 17                           | Zürich                     | CH       | ETH Zürich               | ETH Zürich                            |
| 18                           | Tokyo–Yokohama             | JP       | Mitsubishi Electric      | University of Tokyo                   |
| 19                           | Basel                      | CH/DE/FR | DSM IP Assets            | University of Basel                   |
| 20                           | Copenhagen                 | DK       | Novo Nordisk             | University of Copenhagen              |
| 21                           | Nuremberg–Erlangen         | DE       | Siemens                  | University of Erlangen Nuremberg      |
| 22                           | Stuttgart                  | DE       | Robert Bosch             | Eberhard Karls University of Tübingen |
| 23                           | Minneapolis, MN            | US       | 3M Innovative Properties | University of Minnesota Twin Cities   |
| 24                           | Pittsburgh, PA             | US       | University of Pittsburgh | University of Pittsburgh              |
| 25                           | Seoul                      | KR       | Samsung Electronics      | Seoul National University             |

Source: WIPO Statistics Database, May 2023.

Notes: <sup>a</sup> Per capita figures refer to 1,000,000 of population. KAIST = Korea Advanced Institute of Science & Technology; MIT = Massachusetts Institute of Technology.

Seen through a lens focused on intensity, many clusters in Europe and the United States are seen to exhibit S&T activity that is more intensive than their Asian counterparts (see Map 3 and Table 9). The United States has eight clusters in the top 25 measured by S&T intensity. Following behind the United States is Germany, with three clusters in the top 25 (with Munich moving up rapidly to 10<sup>th</sup> spot), while the following four countries each have two clusters: the United Kingdom (with Cambridge and Oxford holding two of the top 3 rankings by intensity), Japan (with Kanazawa and Tokyo–Yokohama both improving their ranking), the Republic of Korea (with Seoul entering into the top 25) and Sweden (with Lund–Malmö dropping out of the top 25).

Clusters located in China show a relatively weaker performance, with regards to S&T intensity. However, there is one exception: Beijing. With a population estimated at almost 20 million, Beijing ranks 14<sup>th</sup> by intensity, mid-way between the smaller metropolises of Göteborg (13<sup>th</sup>) and Stockholm (15<sup>th</sup>) located in Sweden. Apart from Beijing, there is no other S&T cluster located in China or any other middle-income economy that ranks among the top 25 most intensive clusters globally.

India, however, does make it into the top 100 by S&T intensity for four clusters: Bengaluru, Chennai, Delhi and Mumbai.



## Endnotes

- 1 Seoul's improvement in ranking was primarily due to its merging with Cheonan-si, a city just to the south of Seoul whose patent and scientific publication density reached the clustering threshold for the first time this year.
- 2 See Appendix Table 3, noting that, relative to population, US cluster San Jose–San Francisco, CA, ranks second in the world, see section S&T intensity of the top 100 clusters
- 3 Net S&T output refers to a change in combined output of both components (PCT filings and SCIE articles) over time.
- 4 Istanbul deserves a closer look, as it underwent a steep decline in ranking. This decline was primarily driven by a large area to its southeast failing to meet density criteria and therefore no longer within the cluster boundary of Istanbul. When controlling for the cluster's boundaries, Istanbul had positive growth in both PCT filings and SCIE articles.

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