We are in a race against time for smarter development

are we using science to build the future we want?

Are we using science for smarter development?

UNESCO Science Report (2021)

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Editor-in-Chief

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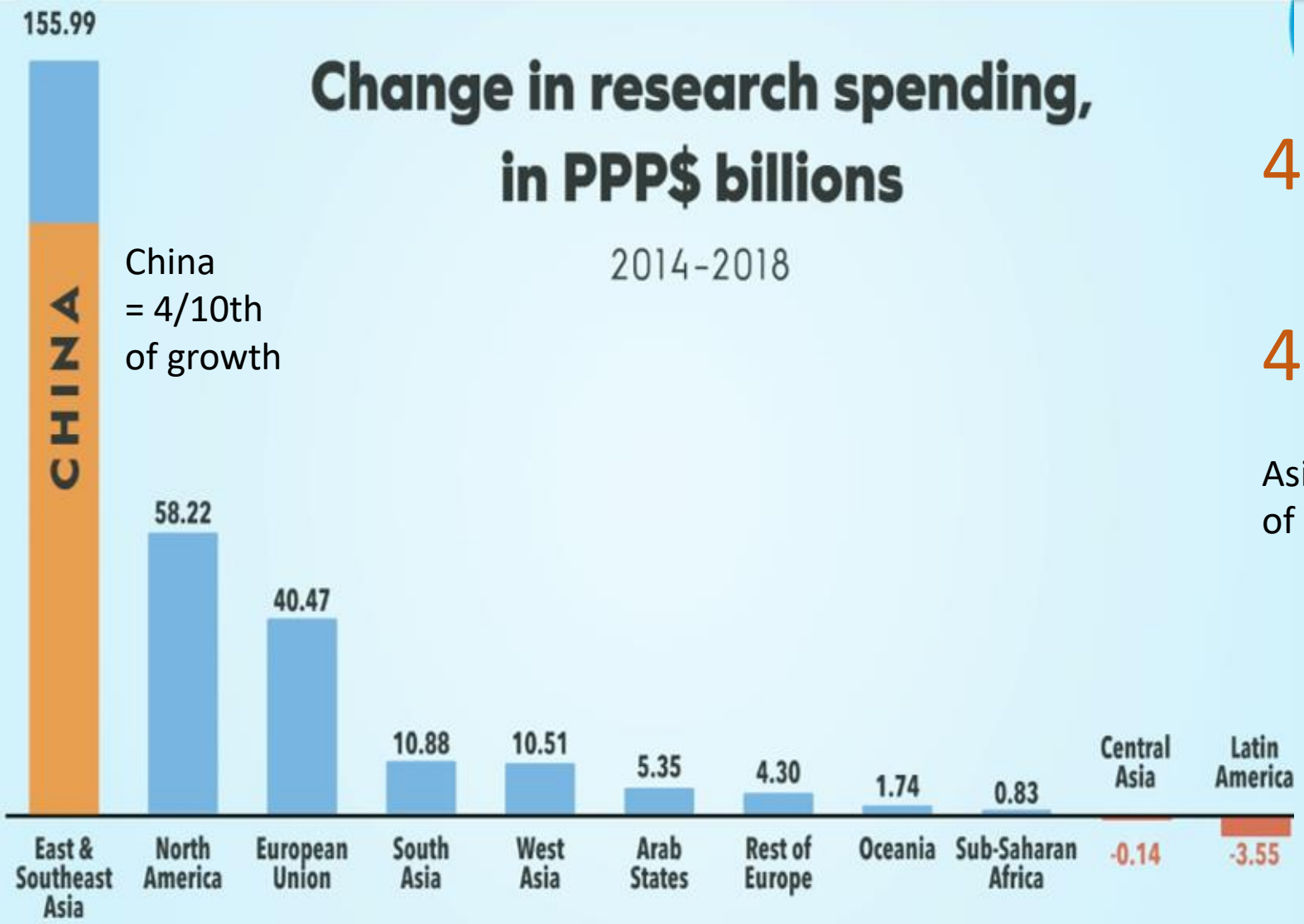
Research spending up in most regions but G20 still accounts for 9/10ths of input/output



China
= 4/10th
of growth

45.7%

42.3%

Asian share
of GERD

32

countries raised research spending by at least 0.1% of GDP: UAE, Jordan, Iran, Burkina Faso, Malaysia, Poland, Germany, etc

13

countries lowered research spending by at least 0.1% of GDP: Slovenia, Finland, Ireland, Kuwait, Ethiopia, etc.

Data source: UNESCO Institute for Statistics

Why the steep drop in research investment in Latin America?

Latin America: two primary growth patterns:

- **industrial exports**: goods imported then re-exported with little value addition
- **exports of natural resources**.

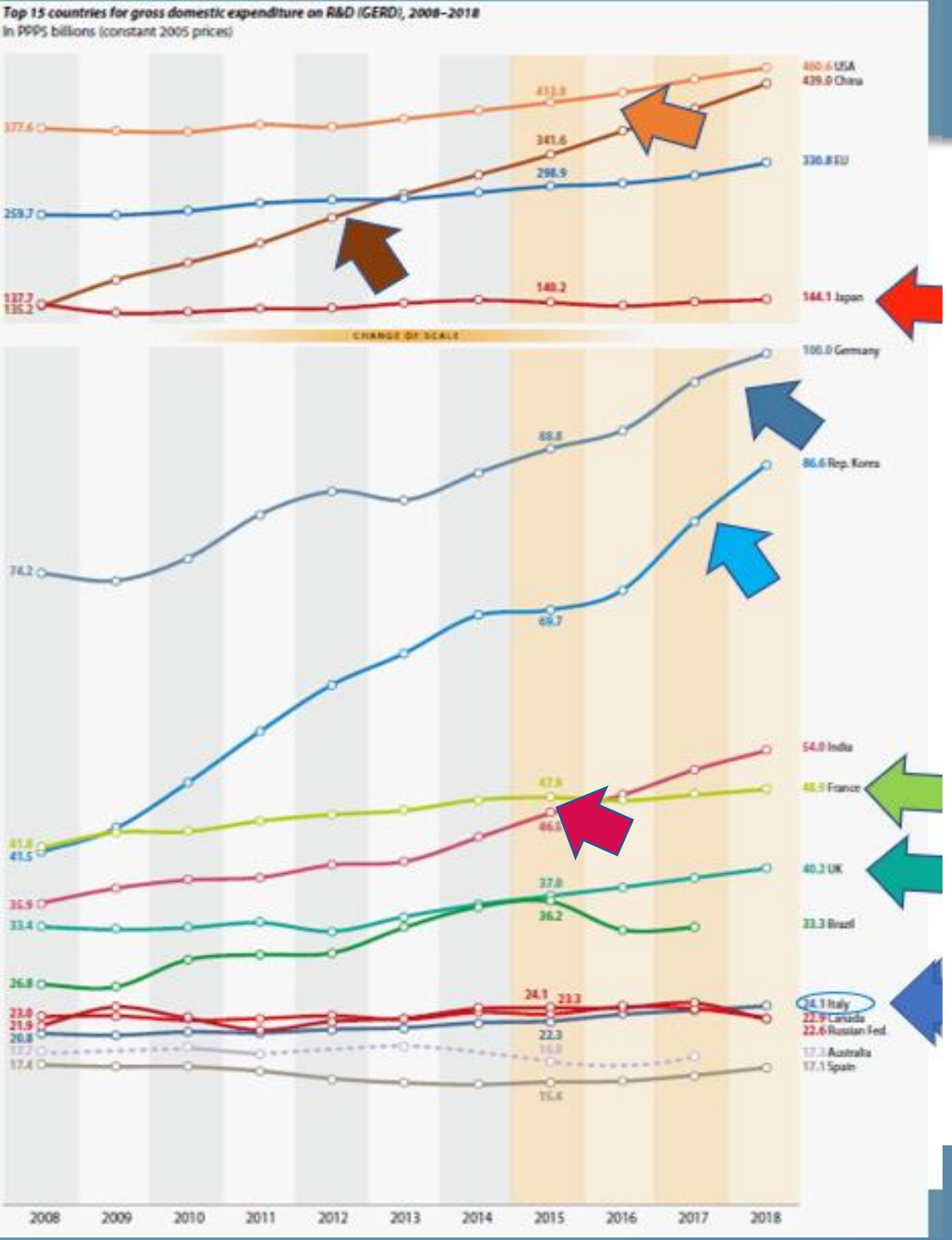
Neither growth pattern effective in producing innovation.

During commodities boom, investment channelled mainly towards economic expansion, rather than towards reinforcing existing infrastructure or supporting innovation and risk-taking.

Since end of commodities boom in 2014: stagnant economic growth, coupled with drop in research spending in Argentina, Brazil and Mexico.

Students practising maintenance on aircraft engines for the skilled technician training programme at Mexico's National Aeronautics University.
© Bénédicte Desrus

Top 15 countries for research spending, 2008-2018 (PPP$)



- Greater convergence: **China** and **USA** both raising research effort
- Strong growth in **Germany**, **Rep.Korea**
- Lethargic growth in **Japan**, **France**, **UK** and **Italy**
- **India** now spends more on research than **France**, **UK** and **Italy**

Japan's Society 5.0: towards a digital way of life

Japan's growth strategy, **Society 5.0 (2017)** : transforming the Japanese way of life by using digital technologies to compensate for a declining population.

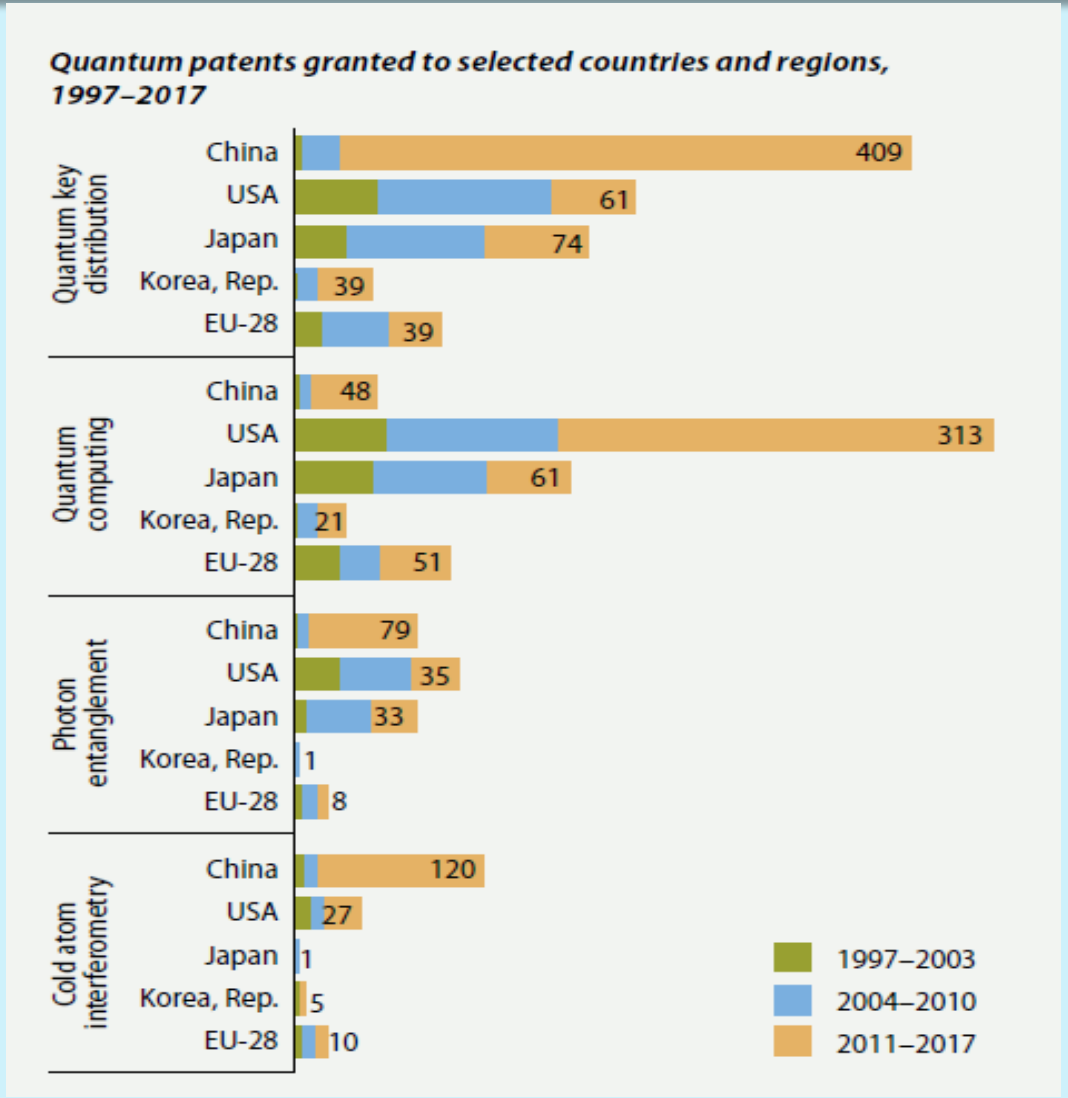
- If there are not enough staff in care homes, robots will help to look after people.
- With fewer people to work on farms, self-driving tractors will be used in the fields.
- Towns will receive decentralized energy services tailored to their needs.

By introducing AI into the workplace and wider society, it is hoped that depopulation and ageing will cease to be disadvantages in a less labour-intensive economy.

Under Society 5.0, flying drones will deliver goods to people living in depopulated areas.

China and USA leading output in AI, quantum patents

- China's mega-engineering programmes to 2030 include **quantum computing** and **brain science**.
- USA introduced **BRAIN initiative** (2016), plans to double government investment in research on **quantum information science and AI** between 2019 and 2022.
- 150 Chinese and 6 US universities among top 500 for publications on AI; USA has companies (IBM and Microsoft) with biggest AI portfolios.
- Chinese technology being taken up by other countries: receipts rose by 570% between 2010 and 2018 (Data: World Bank).
- China IP protection laws: making it easier for foreigners to do business in China and to protect strategic Chinese industries.
- Share of GERD on basic research: China: (5.5%), Japan (13%), USA (17%), 22%, Italy (22%), Switzerland (42%).



Data source: Travagnin (2019) *Patent Analysis of Selected Quantum Technologies*, Joint Research Centre, European Commission

Why is industry financing a growing share of basic research?

Share of basic research financed by industry (%)

Switzerland

10% (2012)

27% (2017)

USA

23% (2010)

30% (2017

Contributing factor:

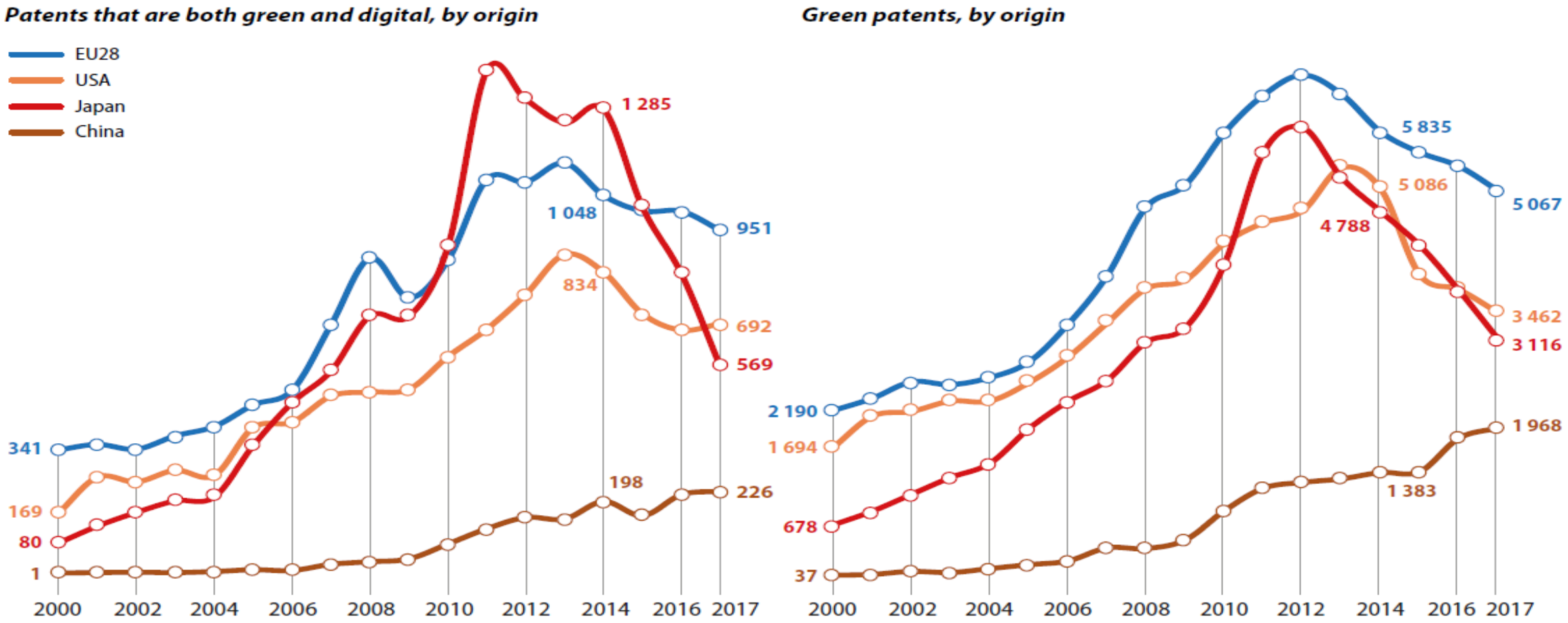
Big data analytics vital to tech-based industries:
social media, automotive, aeronautics, pharmaceuticals, etc..

e.g. AI being used to determine the structure of atoms and molecules for industrial applications:
computational materials science,
computational drug design.

Switzerland striving to expand innovation culture beyond pharma and chemicals giants: tax reform for research-intensive firms and Swiss Innovation Park (2016): advanced manufacturing (e.g. cyberphysical systems, 3D printing), smart buildings and robotics, etc., all reliant on big data

EU leading for green and digital patents in 2017

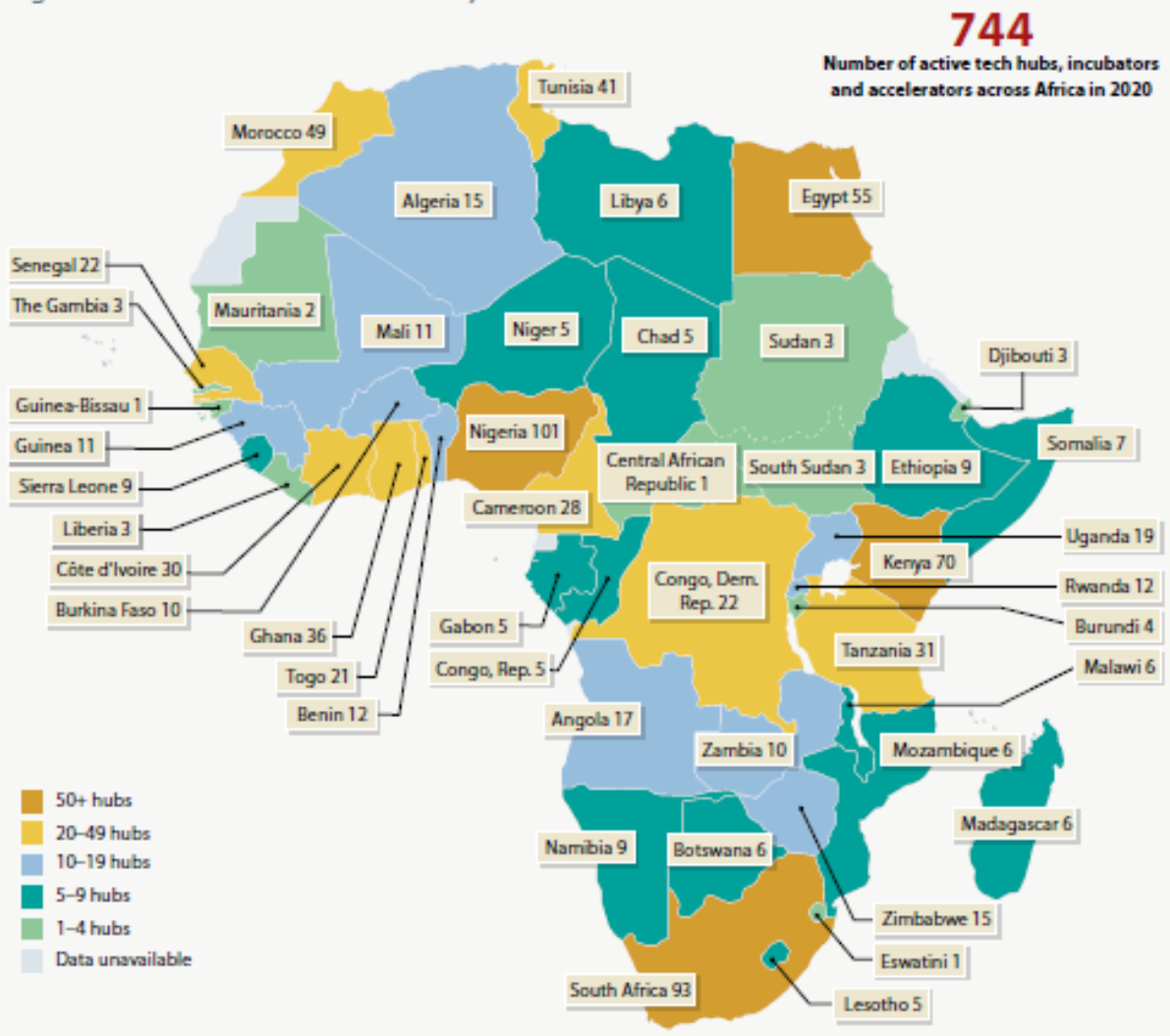
Figure 9.12: **Evolution in green and digital patents awarded to inventors from the European Union and selected countries, 2000–2017**



Source: EIB (2021), author's calculations based on PATSTAT data

Number of African tech hubs has more than doubled since 2016

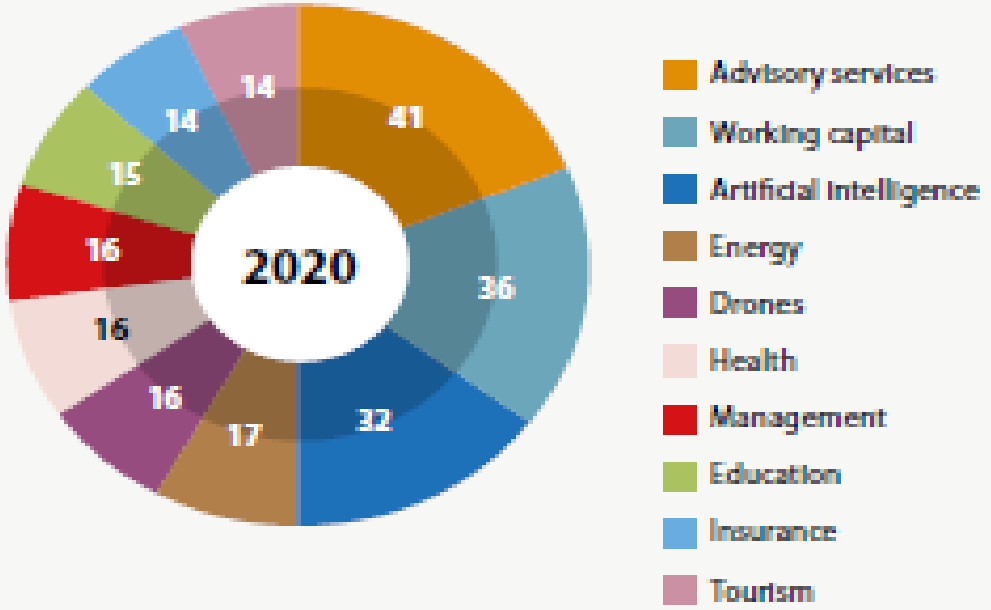
Figure 20.2: **Active tech hubs in Africa, 2020**



Data source: Briter Bridges

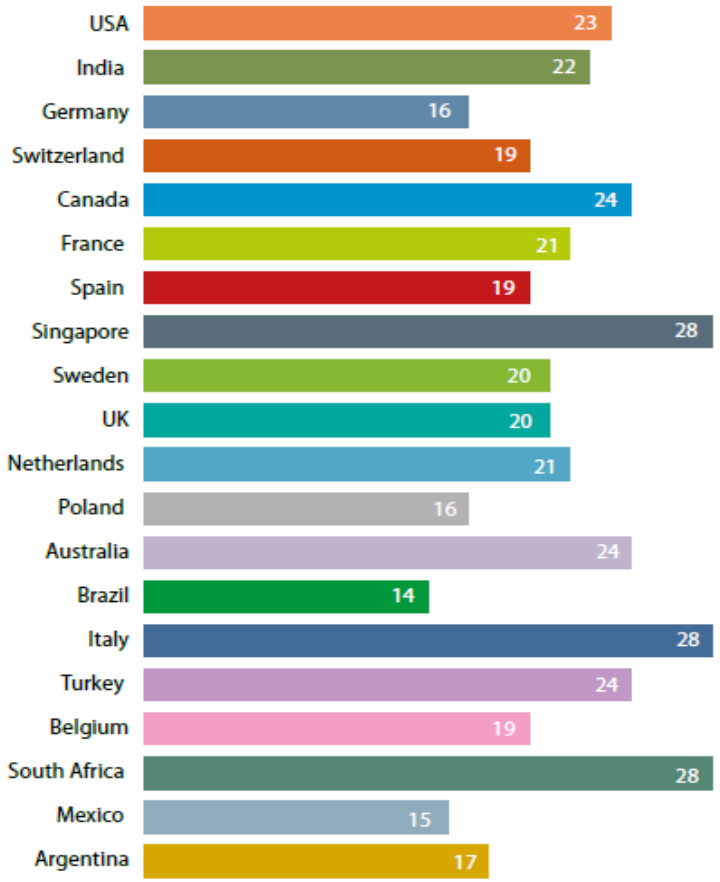
Start-up in Rep.Congo printing visors in 3D for Covid-19. © HOZ 3D

Number of products developed by African tech hubs in top ten product categories, 2020



Industry 4.0 could perpetuate gender imbalance in science and engineering

Figure 3.2: **Share of women in top 20 countries for share of professionals with AI skills, 2017 (%)**
In descending order for top countries



Source: WEF (2018) *The Global Gender Gap Report 2018*. World Economic Forum: Geneva.

Women remain a minority in:

- ❖ digital information technology,
- ❖ computing,
- ❖ physics,
- ❖ Mathematics
- ❖ engineering.

22%

= women AI professionals

28%*

= female graduates in engineering

In academia, female researchers have shorter, less well-paid careers. Their work is underrepresented in high-profile journals and they obtain less research funding than men.

In industry, women underrepresented in company leadership and technical roles. Corporate attitudes are evolving, however, as studies link investor confidence and greater profit margins to a diverse workforce.

* data source: UNESCO Institute for Statistics

Industry 4.0 could perpetuate gender imbalance in science and engineering

53%*
female bachelor's and master's graduates

44%*
female PhDs

33%*
female researchers

12%
women in academies of science

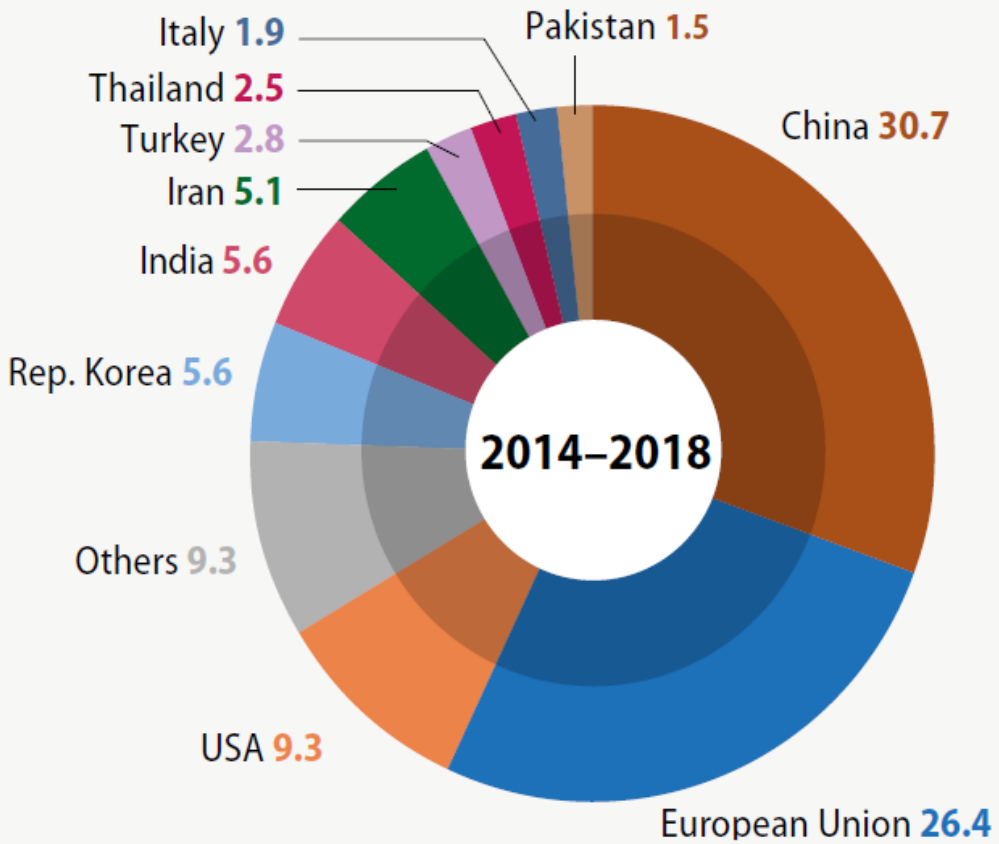
2%**
venture capital for tech women-led start-ups

data source: UNESCO Institute for Statistics*; TechRadius survey of 700 companies worldwide, 2019**

Worldwide, 14% more researchers (FTE), 2014-2018, but just 1.6% more expenditure per researcher

Contribution to growth in the number of researchers worldwide, 2014–2018 (%)

Top ten contributors and rest of the world



38

countries gained at least 15% more researchers per million inhabitants (FTE), biggest gains: Jordan, Mauritius, , Iran, Ethiopia, B&H, Honduras, Iraq, Oman

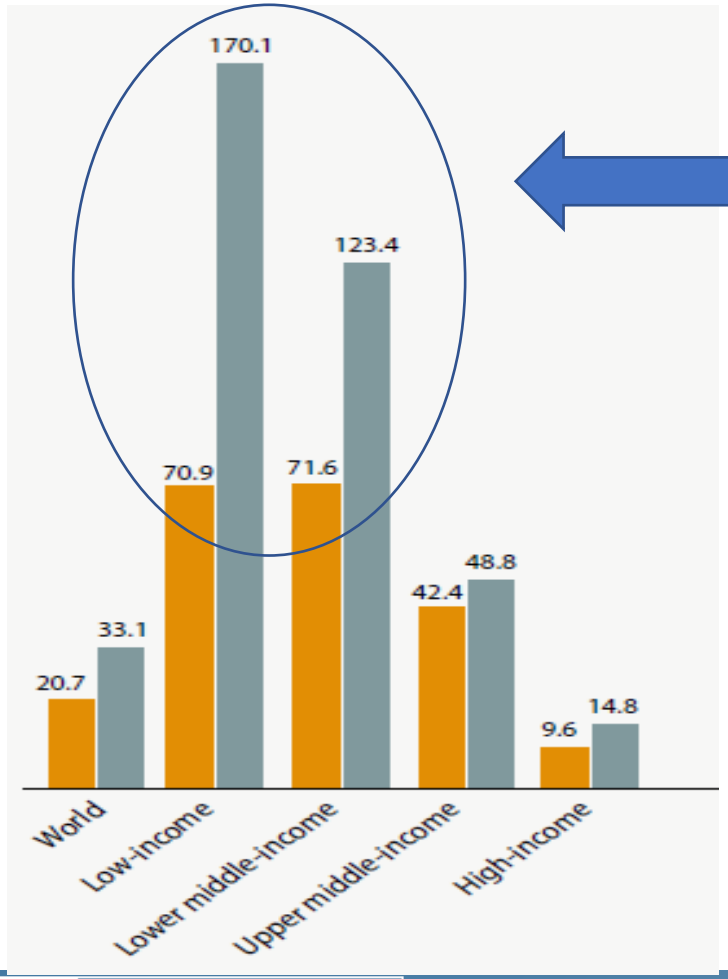
4

countries lost at least 15% of researchers per million inhabitants (FTE)

Data source: UNESCO Institute for Statistics

Strong growth in scientific publishing, 2015–2019, particularly in cross-cutting strategic tech

Growth in scientific publishing overall (%) (orange bars) and for cross-cutting strategic tech (%) (grey bars)

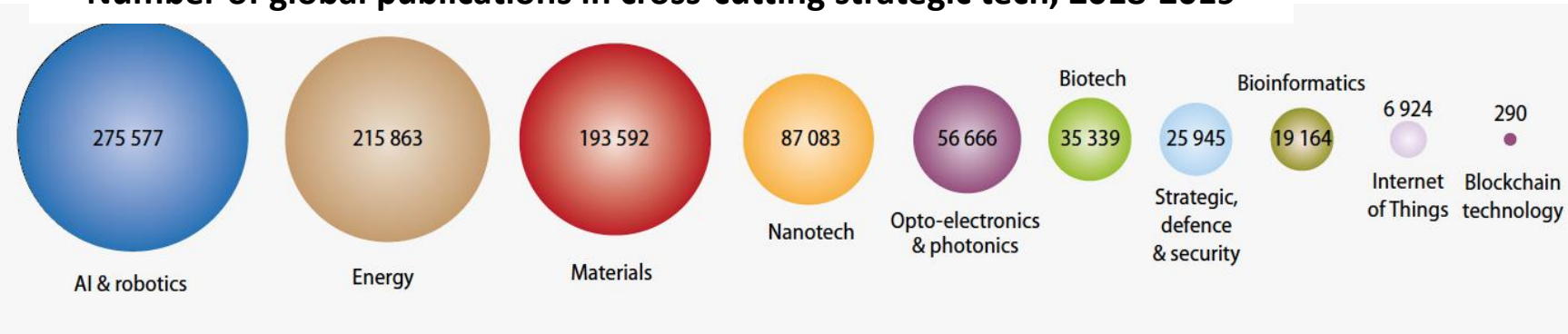


Data source: Scopus (Elsevier); data treatment by Science-Metrix

Cross-cutting strategic tech:

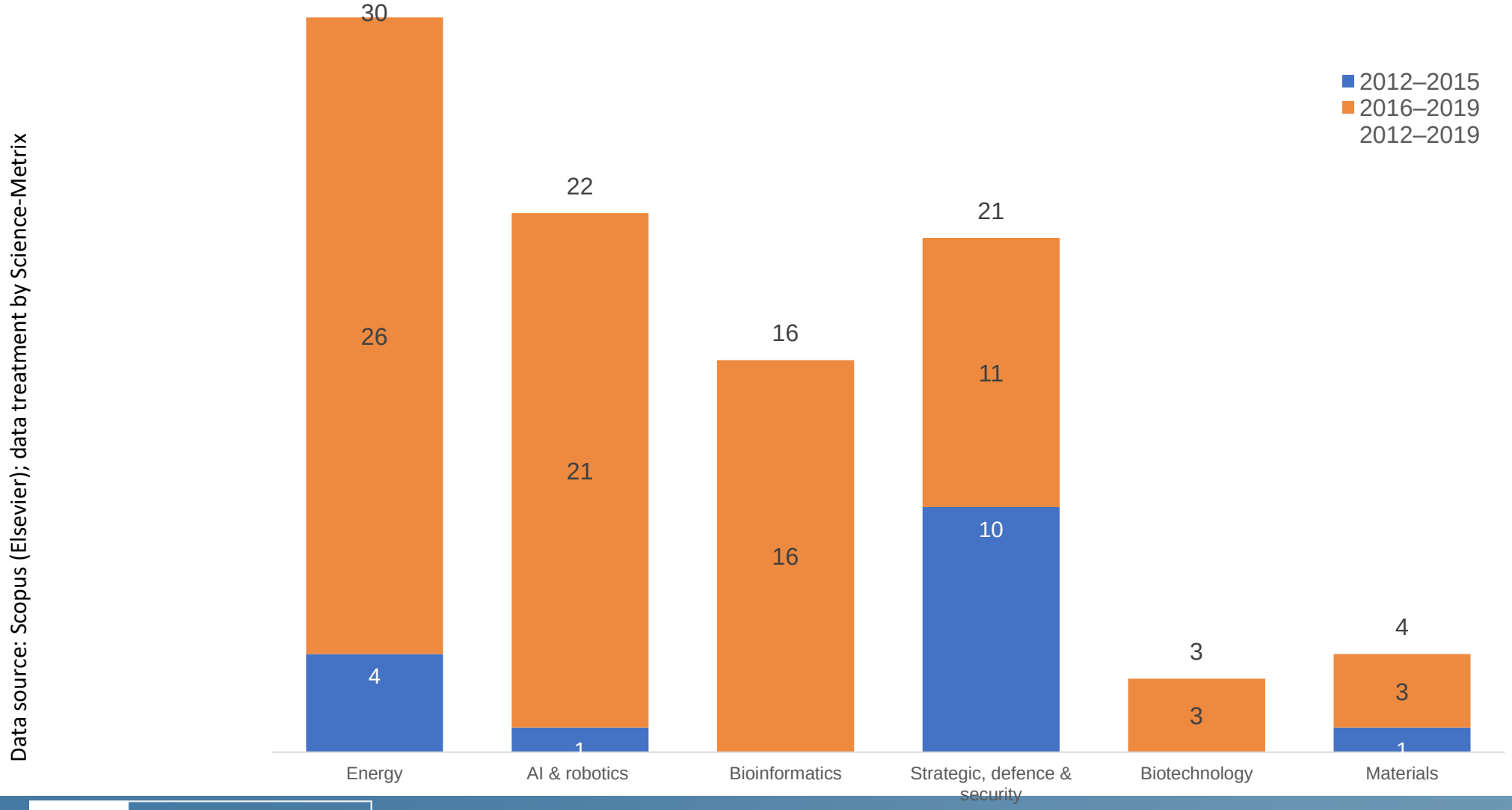
- Faster growth (+33%) than scientific publishing overall (+21%).
- 18% of scientific publications in 2019, behind health (34%).
- low- and lower middle-income countries show strongest growth
- output highest for **artificial intelligence**, **energy** and **materials science**:

Number of global publications in cross-cutting strategic tech, 2018-2019



Strong growth since 2016 in Afghan academic publishing on energy, AI and bio-informatics

see: https://en.unesco.org/news/need-protect-gains-afghan-science



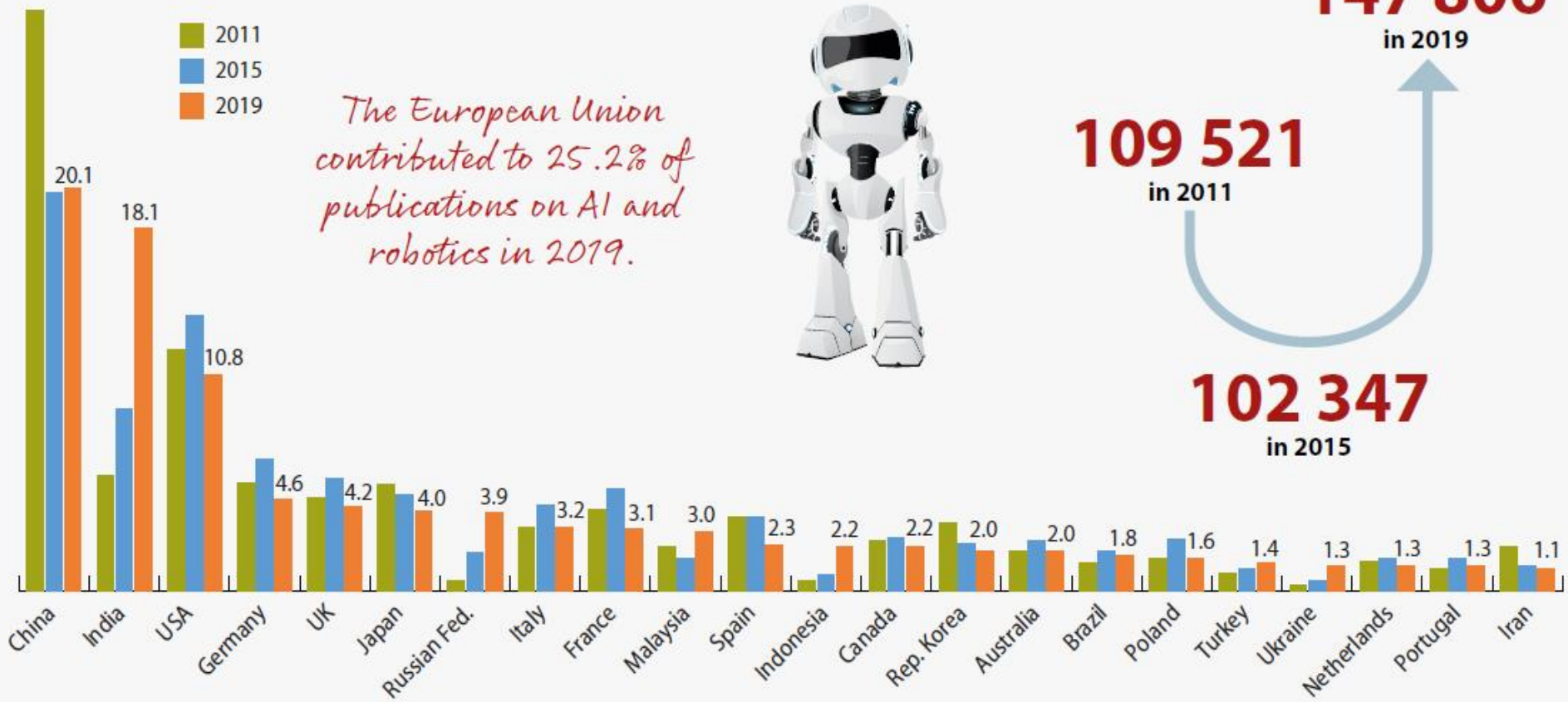
Data source: Scopus (Elsevier); data treatment by Science-Metrix

'Whoever becomes the leader in AI will rule the world' President Putin

Figure 1.13: **Trends in scientific publishing on artificial intelligence and robotics**

Share of global publications on AI & robotics, 2011, 2015 and 2019 (%)

Among countries contributing to at least 1% in 2019; data labels are for 2019



The European Union contributed to 25.2% of publications on AI and robotics in 2019.

Global publications on AI & robotics

147 806 in 2019

109 521 in 2011

102 347 in 2015

Data source: Scopus (Elsevier); data treatment by Science-Metrix

Strong growth in global share:

India,

Russian Federation,

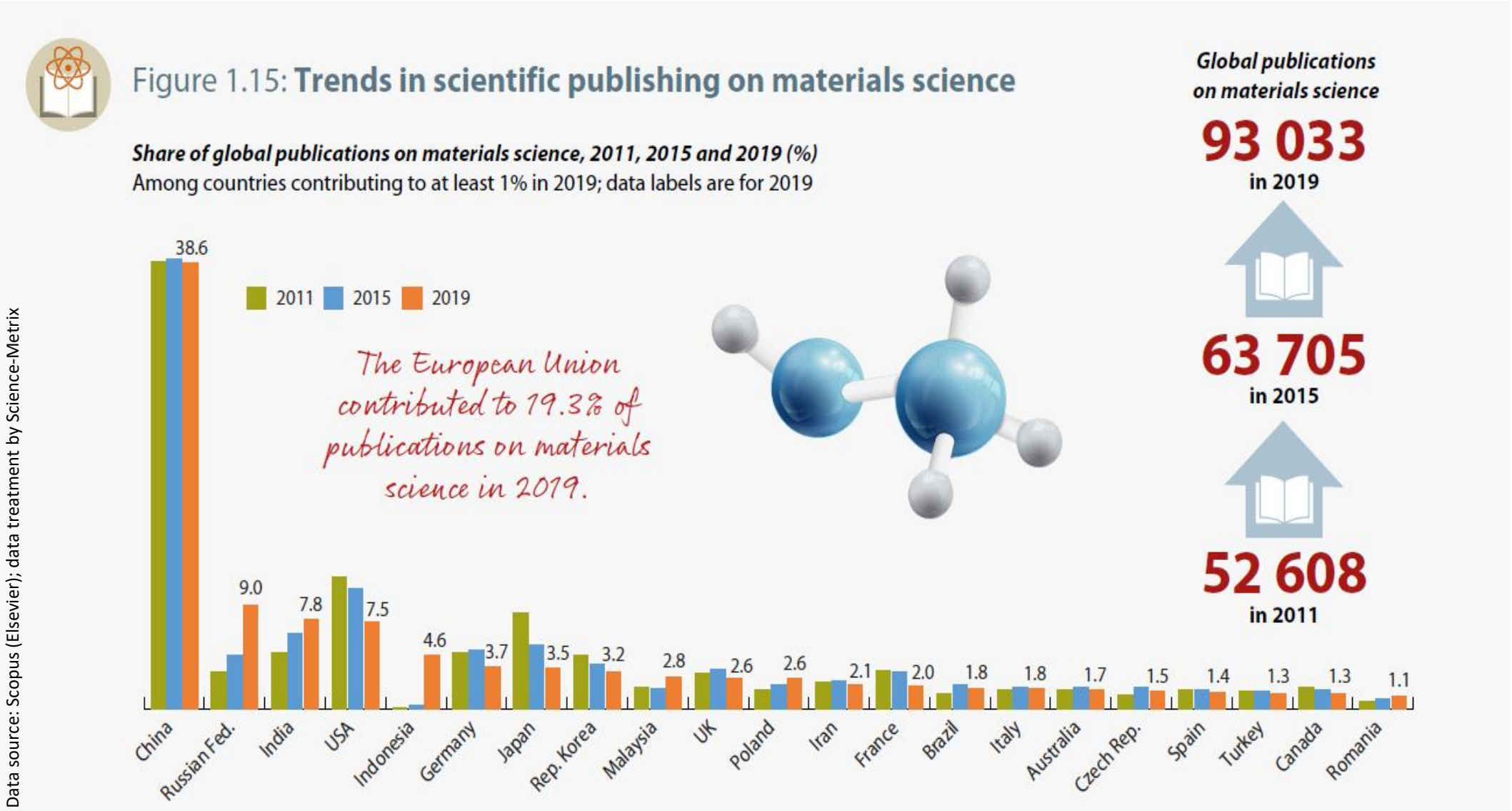
Malaysia, Indonesia

and Ukraine

Also:

in Morocco, Viet Nam, Colombia, Ecuador, Iraq, etc.

China dominates academic publishing on materials science



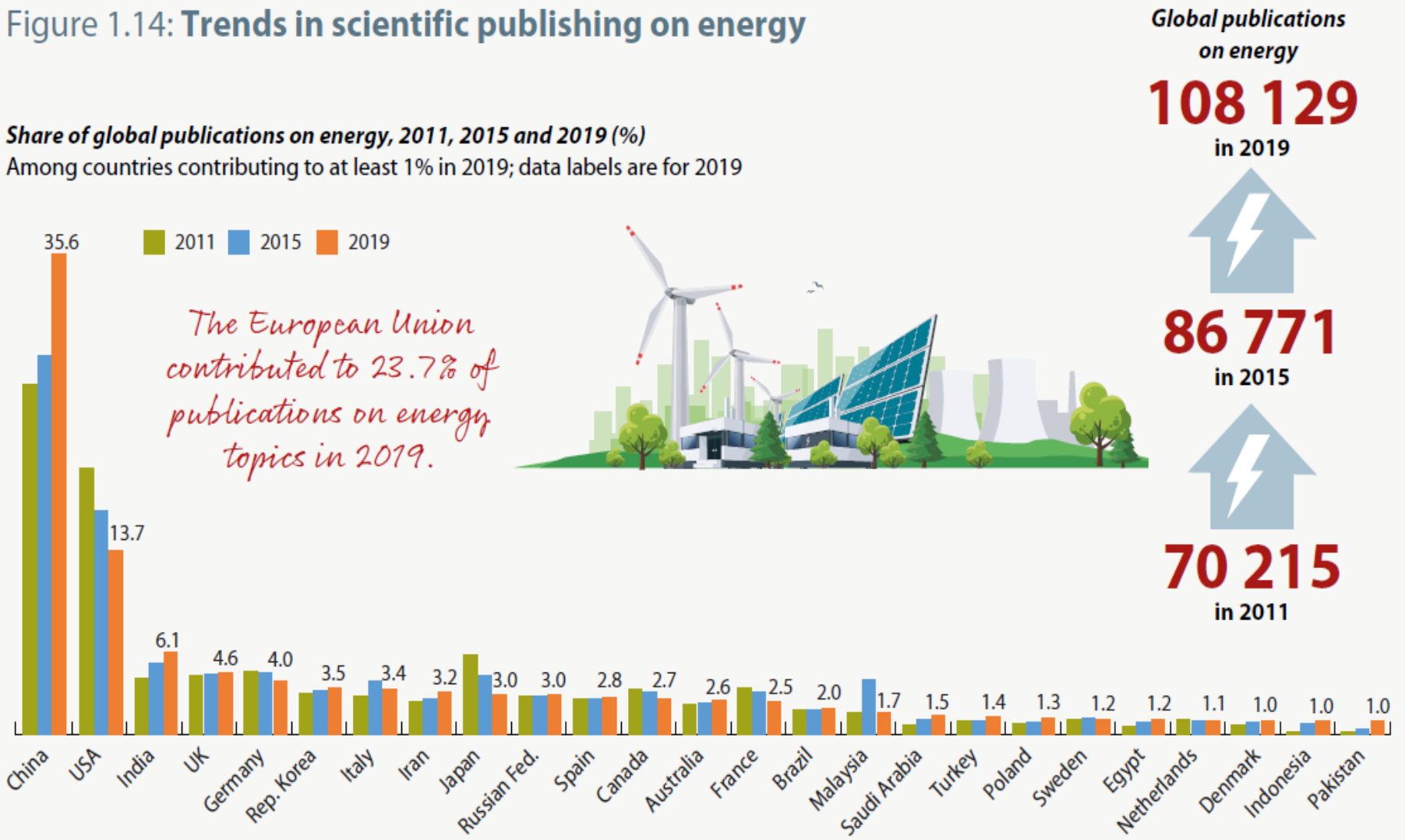
Data source: Scopus (Elsevier); data treatment by Science-Metrix

Strong growth in global share:
Russian Fed., India, Indonesia, Malaysia

also

Iraq, Viet Nam, South Africa, Nigeria, etc.

Energy research: China dominates academic energy research (includes fossil fuels and nuclear)

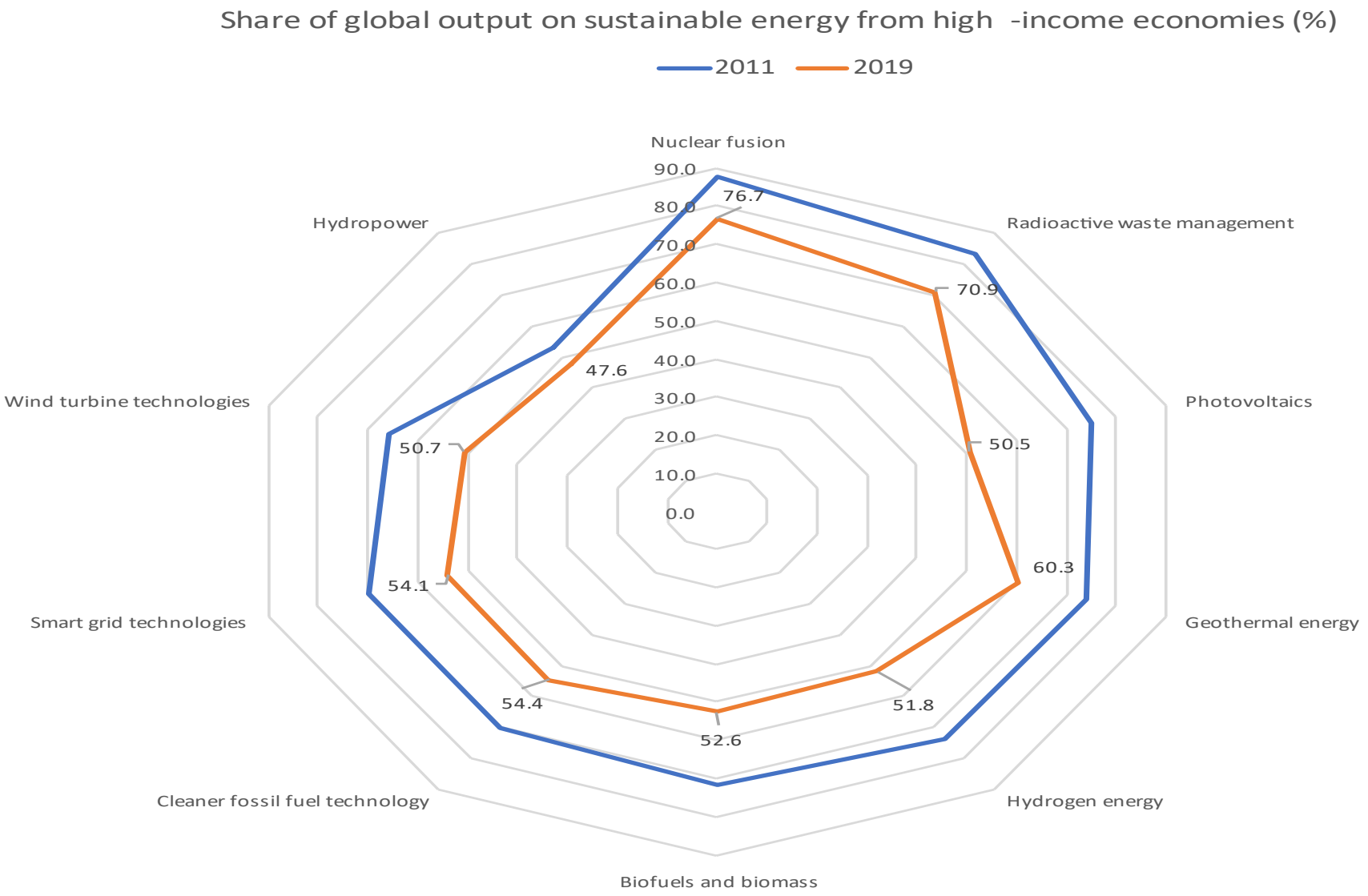


Data source: Scopus (Elsevier); data treatment by Science-Metrix

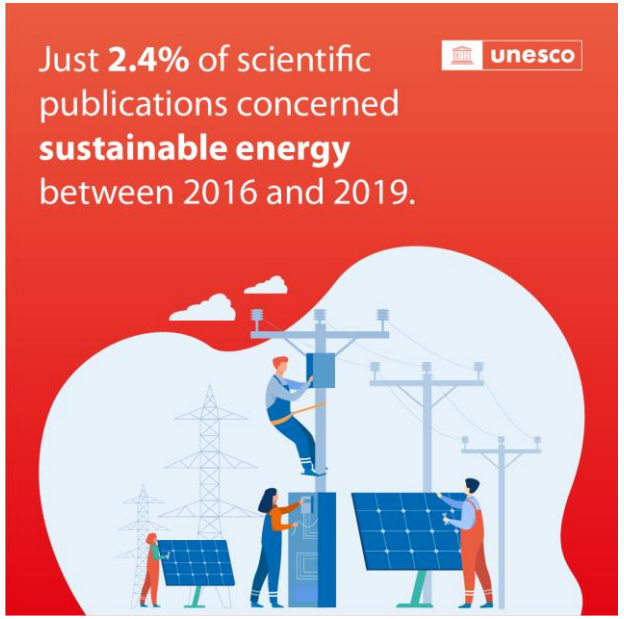
Strong growth in global share: China and India

Also Pakistan, Iraq, Morocco, Tunisia, Viet Nam, Ecuador, etc.

Sustainable energy research: share of high-income countries shrinking

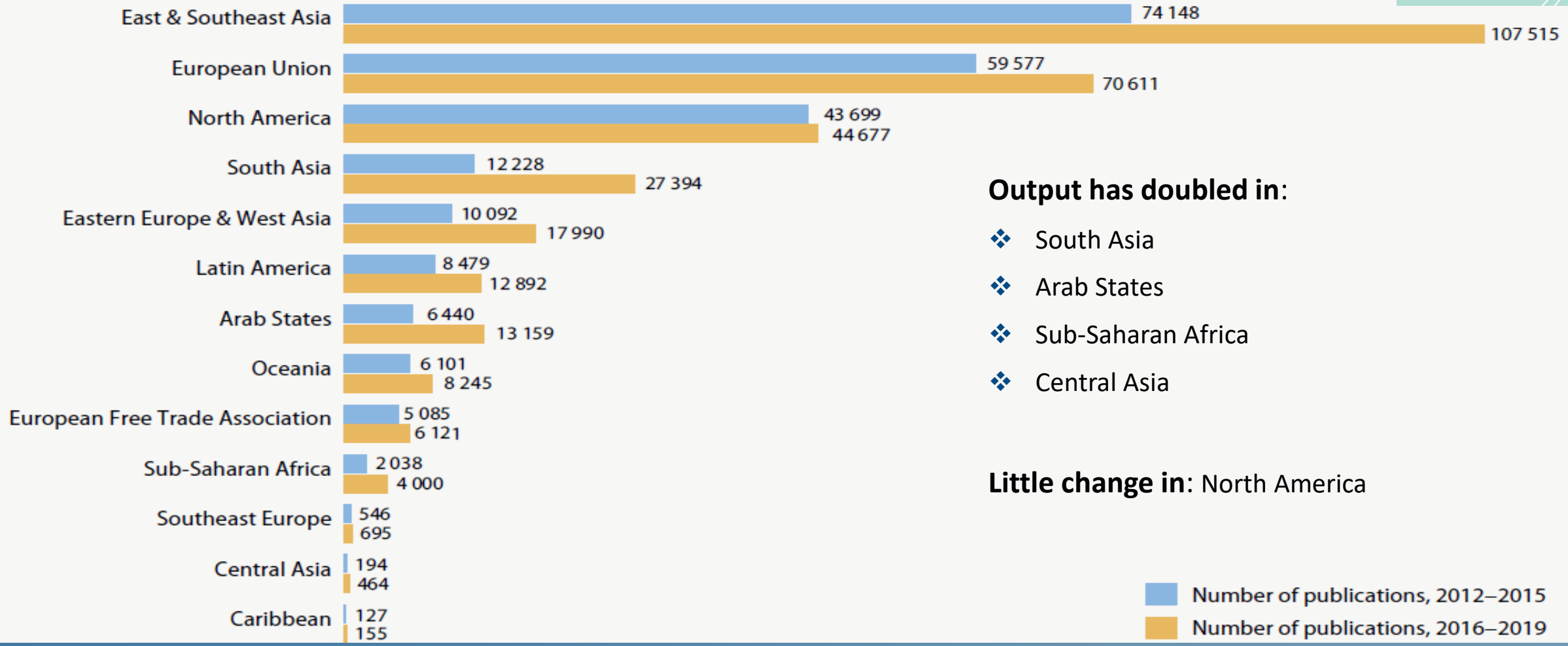


Data source: Scopus (Elsevier); data treatment by Science-Metrix



Developing countries publishing more than before on sustainable energy

Volume of scientific publications on nine SDG7 renewable energy topics by selected region, 2012–2015 and 2016–2019



Data source: Scopus (Elsevier); data treatment by Science-Metrix

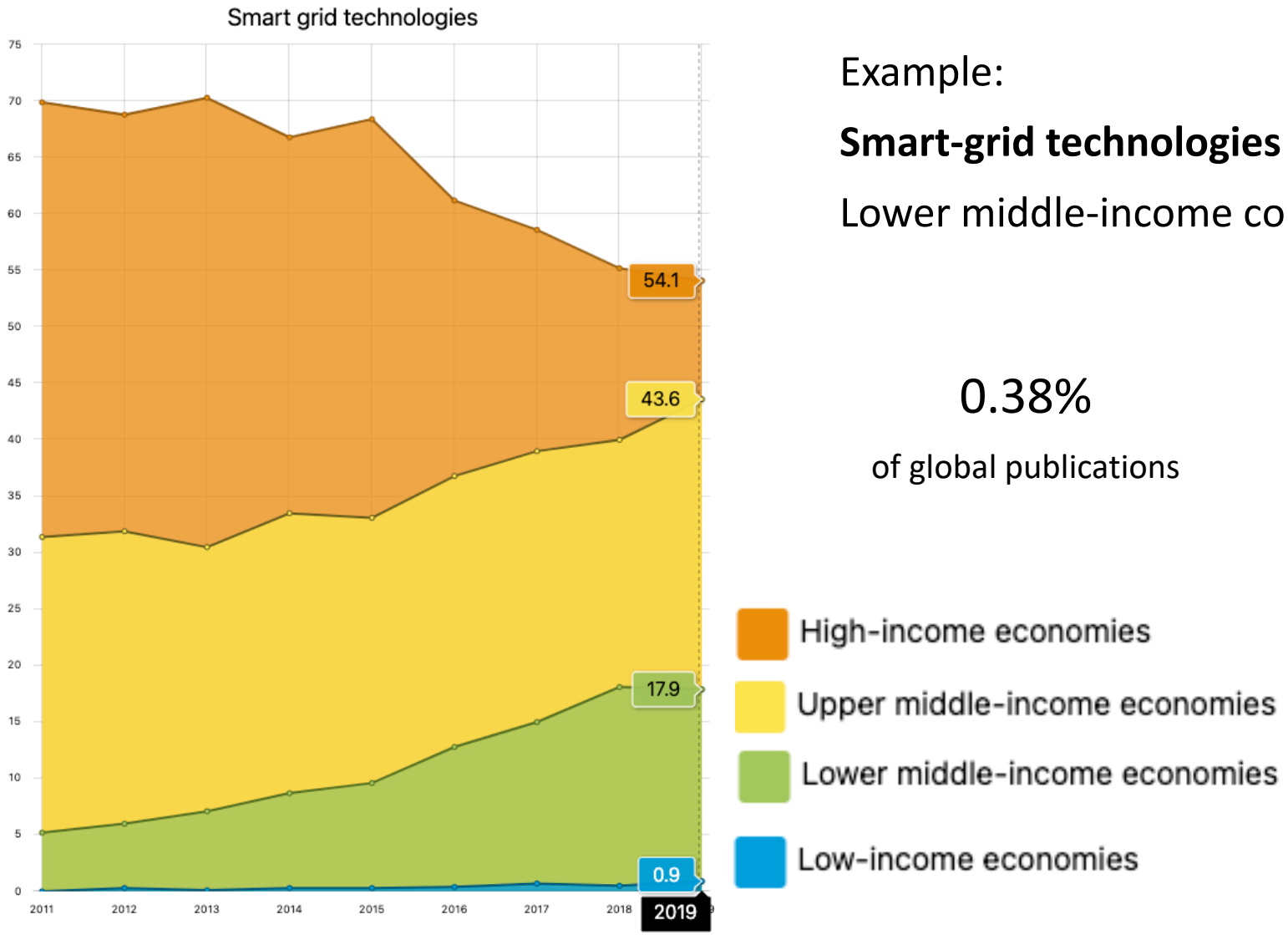
Output has doubled in:

- South Asia
- Arab States
- Sub-Saharan Africa
- Central Asia

Little change in: North America

Lower middle-income countries show strongest growth in sustainability science

Data source: Scopus (Elsevier); data treatment by Science-Metrix; data visualization by Values Associates



Example:

Smart-grid technologies

Lower middle-income countries: 5% ⇨ 18%

0.38%

of global publications

World total:

28 025 (2012–2015)

46 983 (2016– 2019)

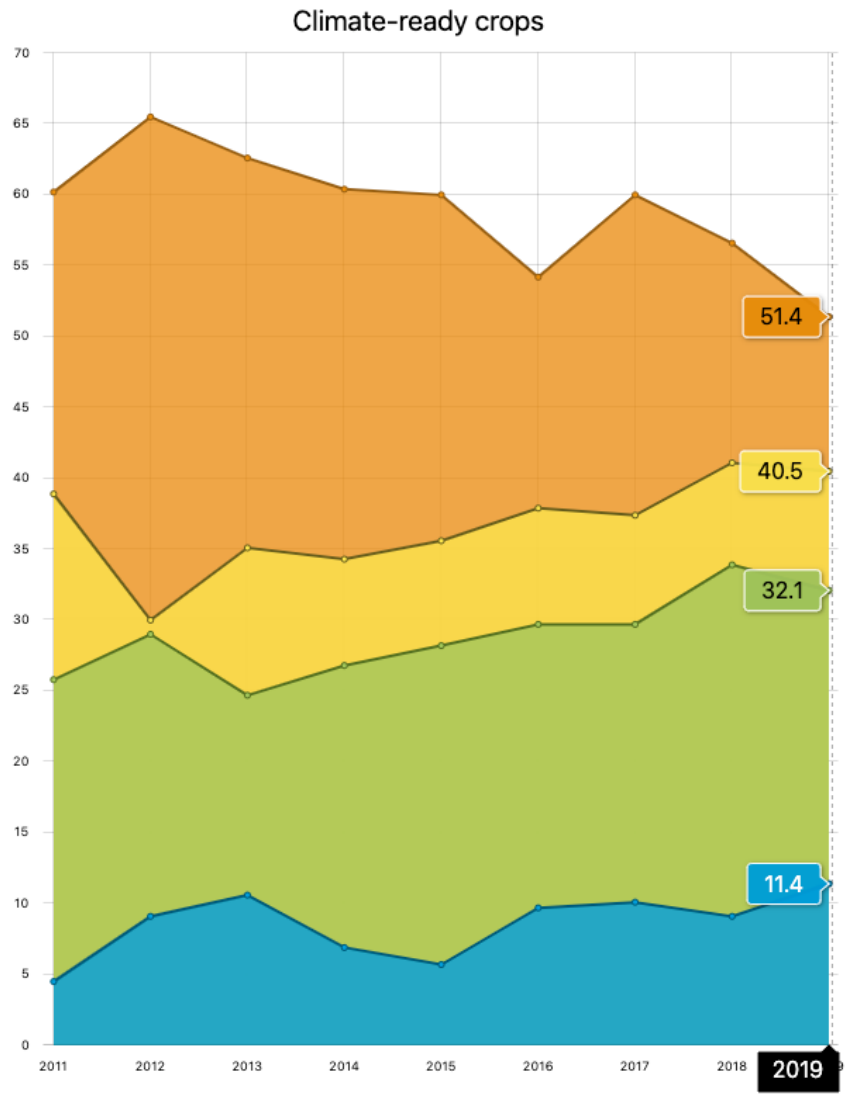
Examples of steep rise:

Philippines: 5/65

India: 1 624/5 177

Climate-ready crops: low-income countries publishing much more, strong intl collaboration

Data source: Scopus (Elsevier); data treatment by Science-Metrix; data visualization by Values Associates



Example:

Climate-ready crops: output has doubled from low starting point

Low-income countries 4.5% ⇨ 11.4%

0.02%

of global publications

High-income economies

Upper middle-income economies

Lower middle-income economies

Low-income economies

World total:

1 660 (2012–2015)

3 109 (2016– 2019)

Surge in countries such as:

Italy 78/137:

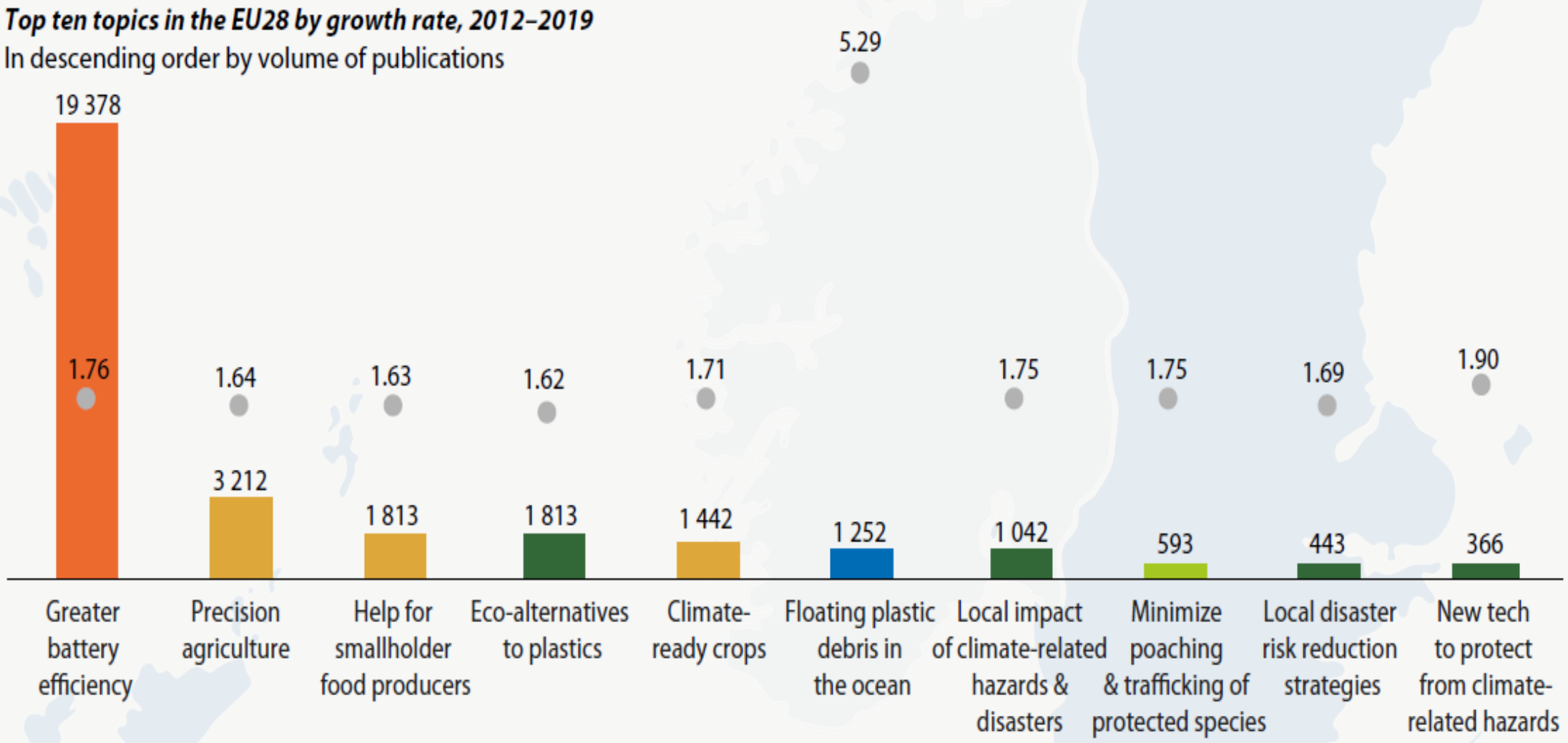
Mexico: 57/133

Australia: 121/235

Kenya: 39/93

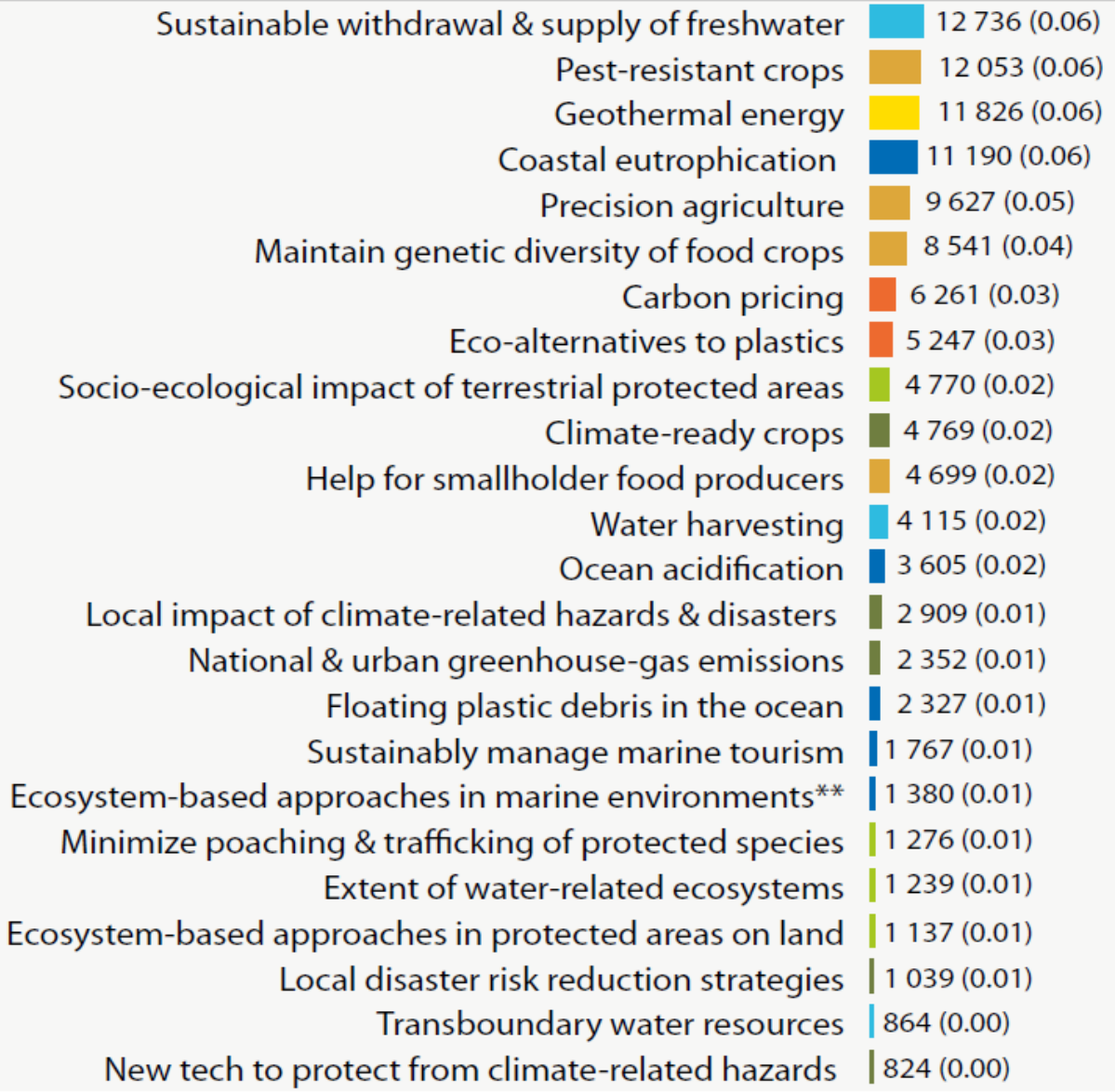
South Africa: 26/109

Priority SDG research topics for EU out of 56 studied by UNESCO



Data source: Scopus (Elsevier); data treatment by Science-Metrix

Sustainability science not a priority: selected research topics, 2012–2019



900,000

Number of scientific publications on **artificial intelligence & robotics** over same period

- SDG2: Zero hunger
- SDG3: Good health & well-being
- SDG6: Clean water & sanitation
- SDG7: Affordable & clean energy
- SDG9: Industry, innovation & infrastructure
- SDG13: Climate action
- SDG14: Life below water
- SDG15: Life on land

Data source: Scopus (Elsevier); data treatment by Science-Metrix

Thank you for your attention

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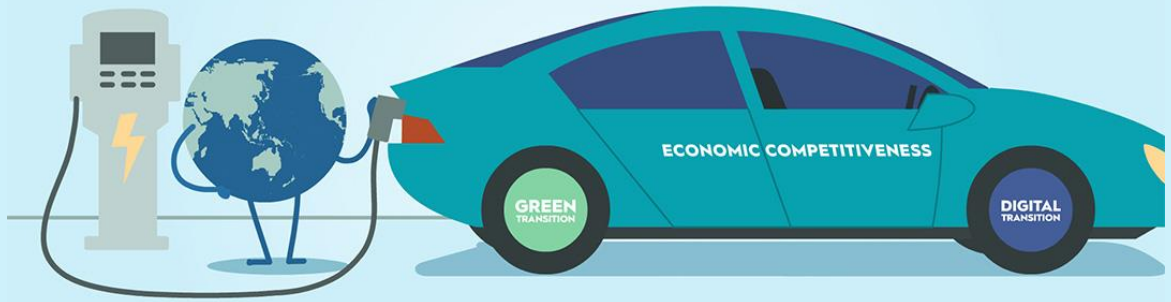
www.unesco.org/reports/science/2021/en



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