We are in a race against time for smarter development

are we using science to build the future we want?

UNESCO Science Report (2021)

Are policies and research aligning to drive the dual green and digital transition?

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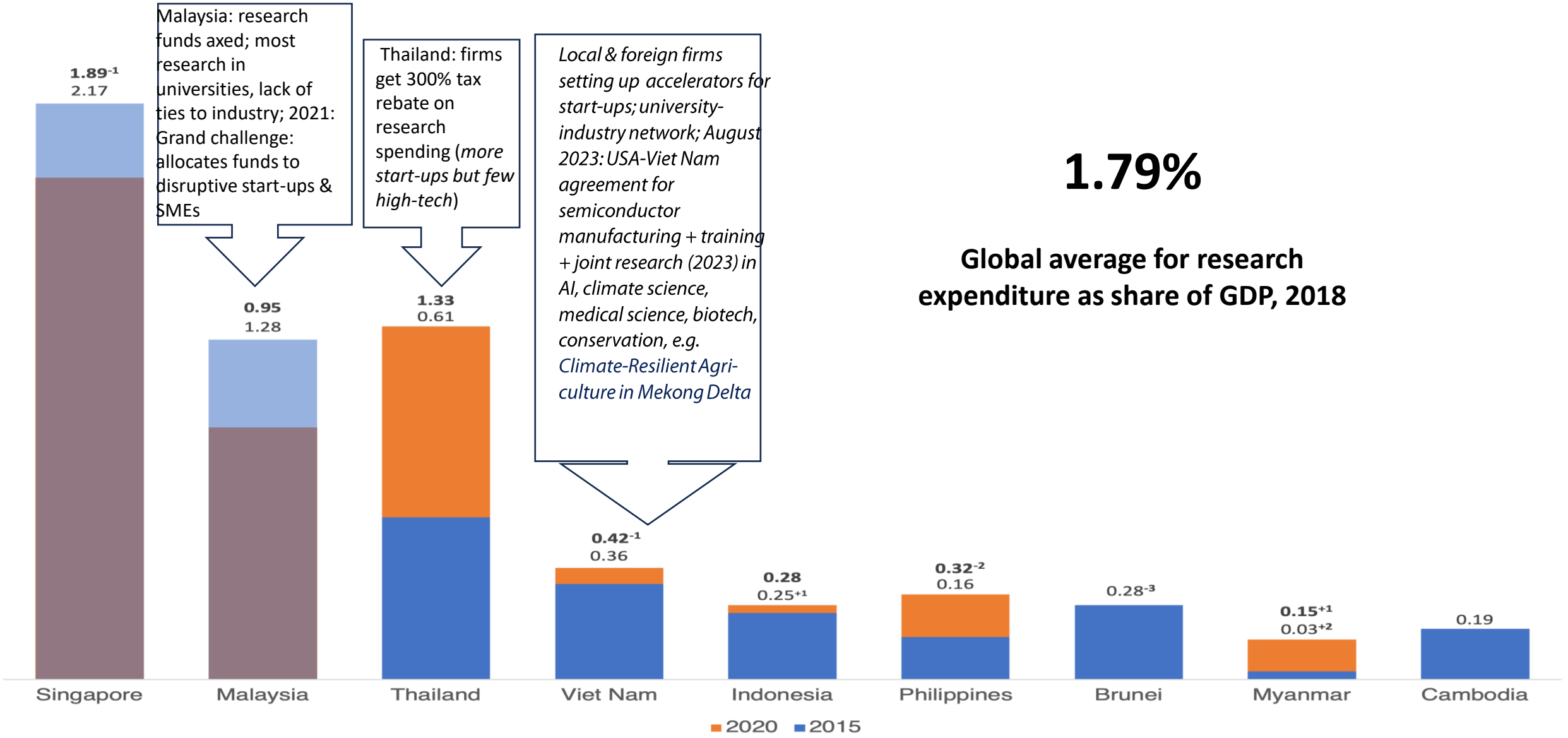
Editor-in-Chief, UNESCO Science Report

Manilla, 19 September 2023

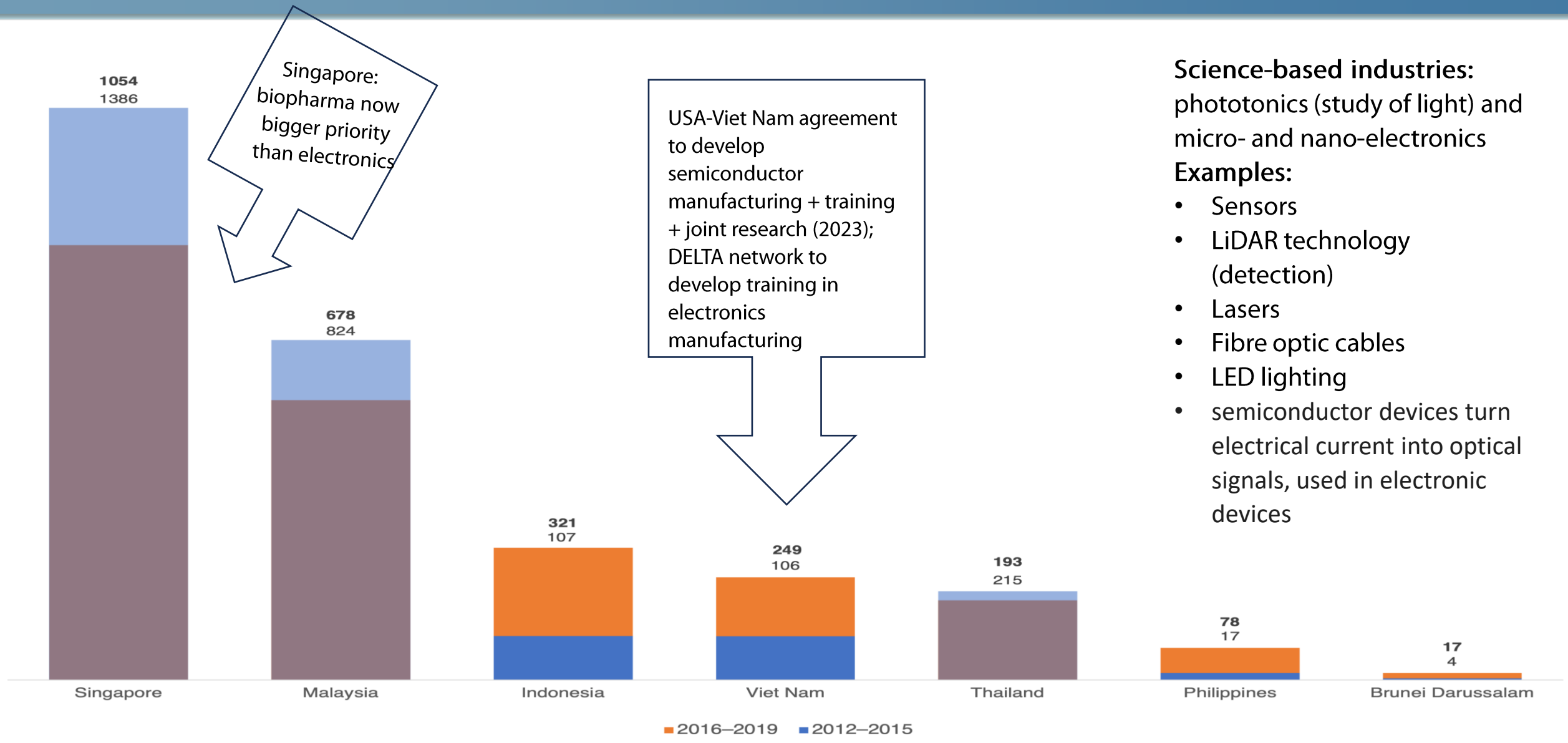
Raising their research effort: Thailand, Viet Nam, Philippines and Myanmar



1.79%

Global average for research expenditure as share of GDP, 2018

Drop in output in opto-electronics in leading ASEAN countries



Science-based industries: phototonics (study of light) and micro- and nano-electronics

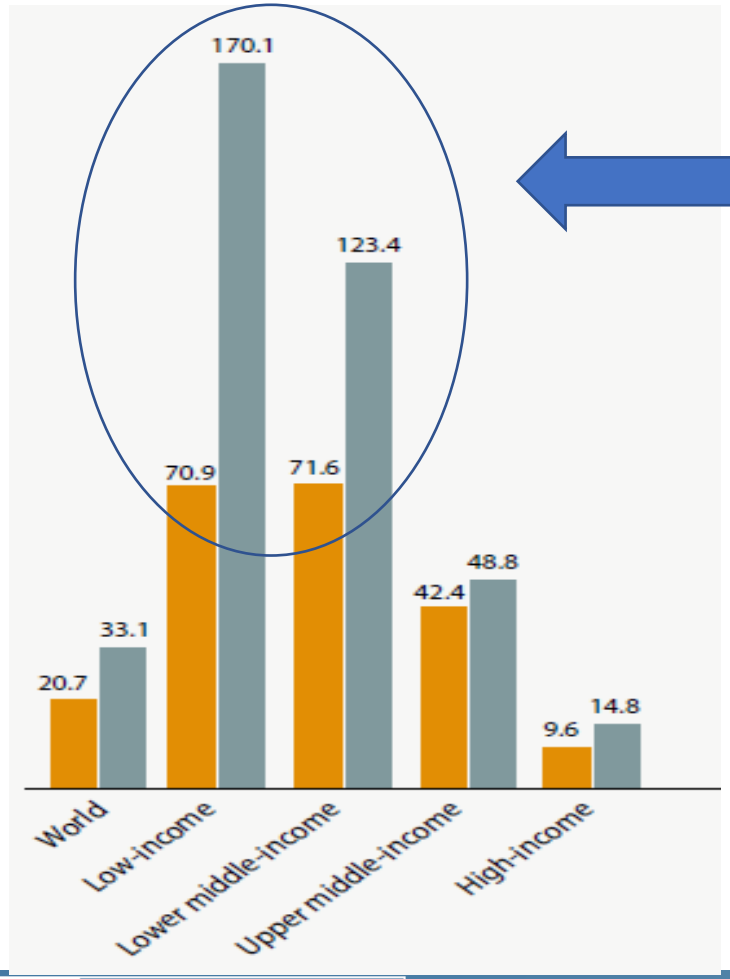
Examples:

- Sensors
- LiDAR technology (detection)
- Lasers
- Fibre optic cables
- LED lighting
- semiconductor devices turn electrical current into optical signals, used in electronic devices

Industry 4.0: Strong growth in scientific publishing in cross-cutting strategic tech, 2015–2019

scientific publishing overall (%)

publications on cross-cutting strategic tech (%)

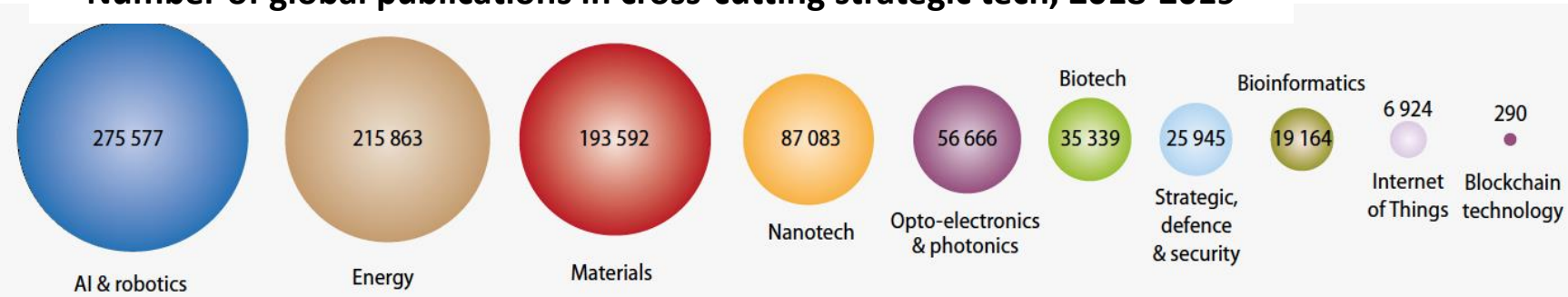


Data source: Scopus (Elsevier); data treatment by Science-Metrix

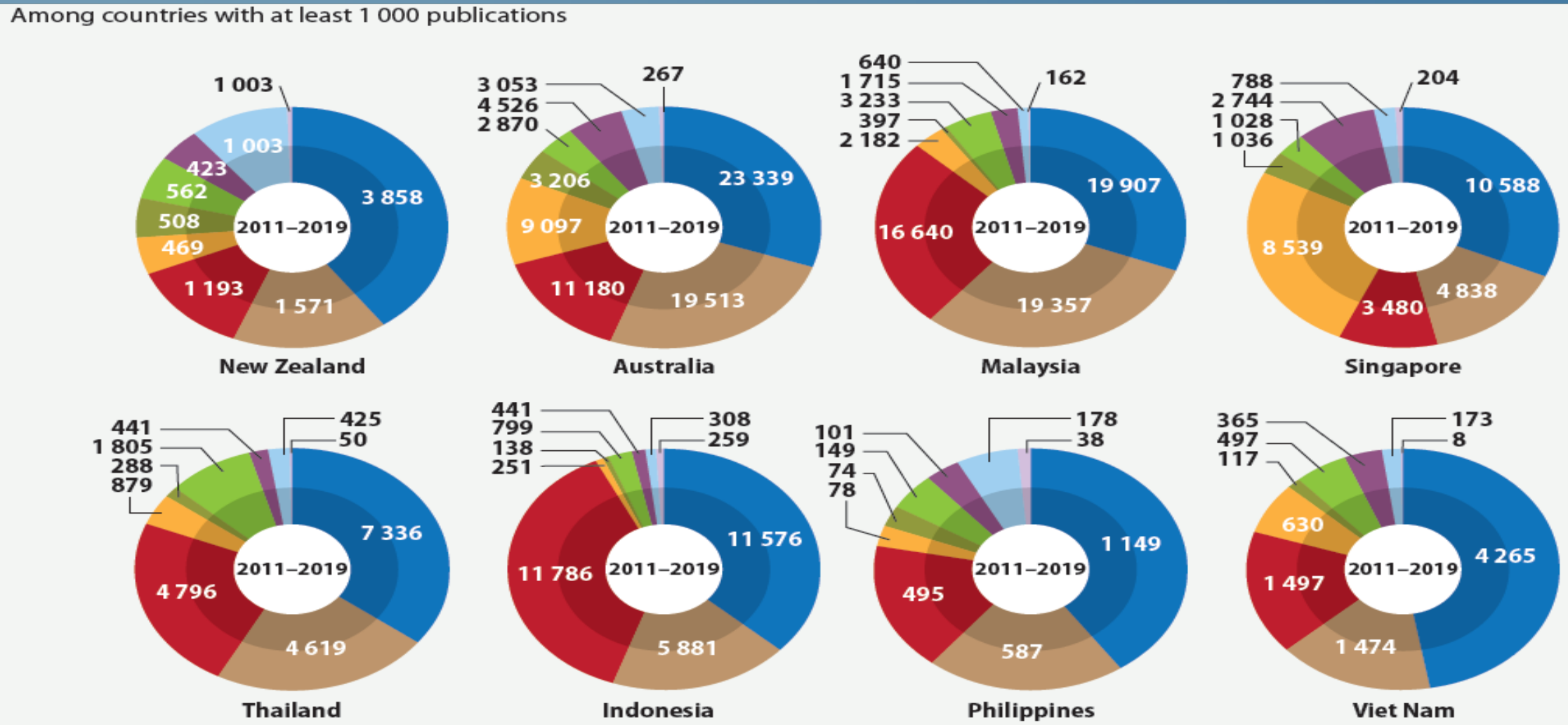
Cross-cutting strategic tech:

- 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

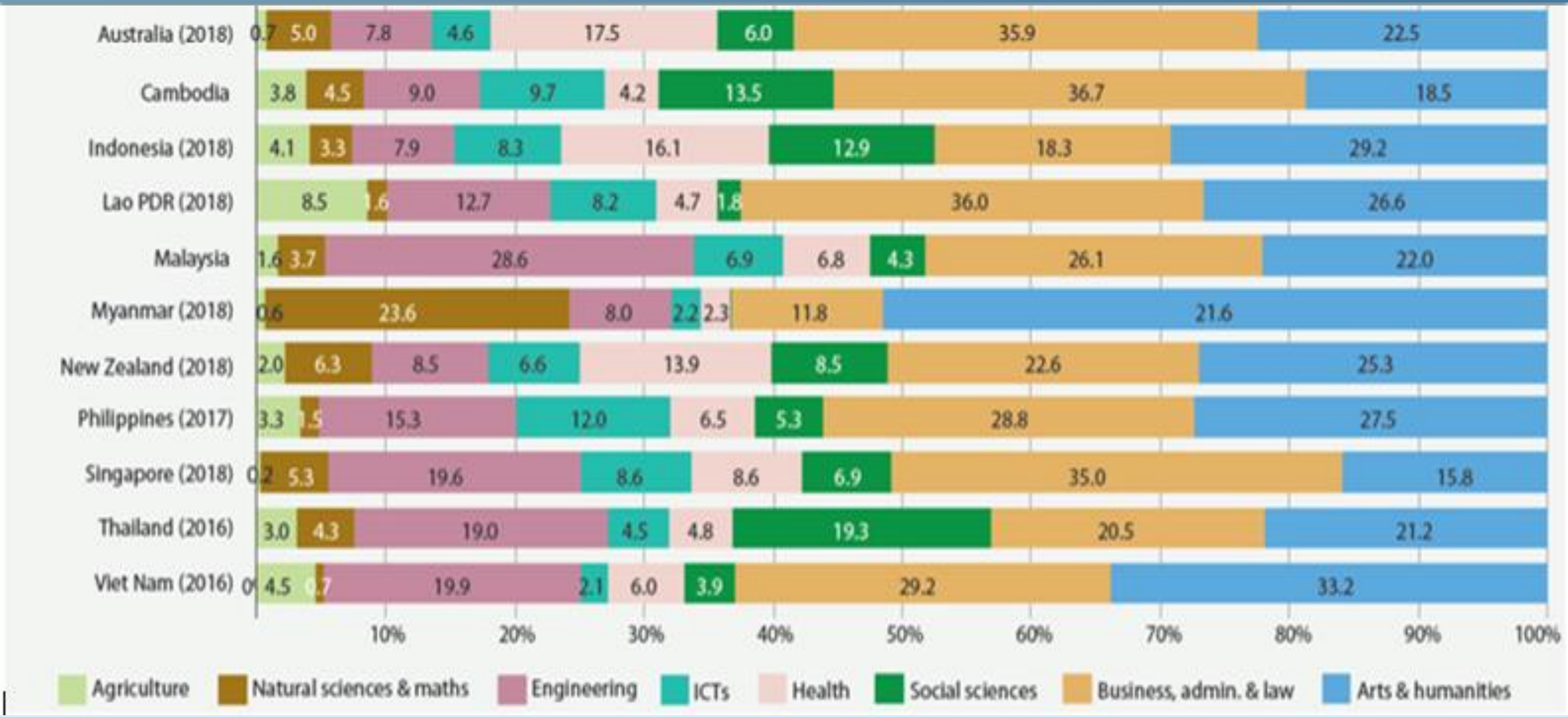


ASEAN: ¾ of strategic tech publications on AI & robotics, energy and materials, except Singapore (less) and Malaysia/Indonesia (more)



A high ratio of engineering and ICT graduates in most ASEAN countries

2019 or closest year, %)



The green and digital transitions are linked

- Sensors could *increase efficiency of energy and materials*
  (e.g. automatic lighting triggered by movement)
- Smart meters could *forecast supply and demand* for energy
- New-generation batteries and digital tech could favour '*green' transportation and renewable energy*
- *Solar and wind energy* could 'green' energy consumption by data centres/cloud infrastructure

- *Energy consumption* could rise if digital technologies not more energy-efficient; currently: 5-9% of global electricity use (EU, 2022)
- Greater use of digital technologies could increase *electronic waste* to 75 million tonnes by 2030 (EU, 2022)
- Digitalisation will increase *water usage*,
  e.g. to cool data centres or for microchip manufacturing.
- Risk of *overdemand for minerals* used in digital tech for green tech: e.g. batteries for electric cars, solar panels, wind turbines, etc

Source: European Commission (2022) *Strategic Foresight Report: Twinning the Green and Digital Transitions in the New Geopolitical Context*

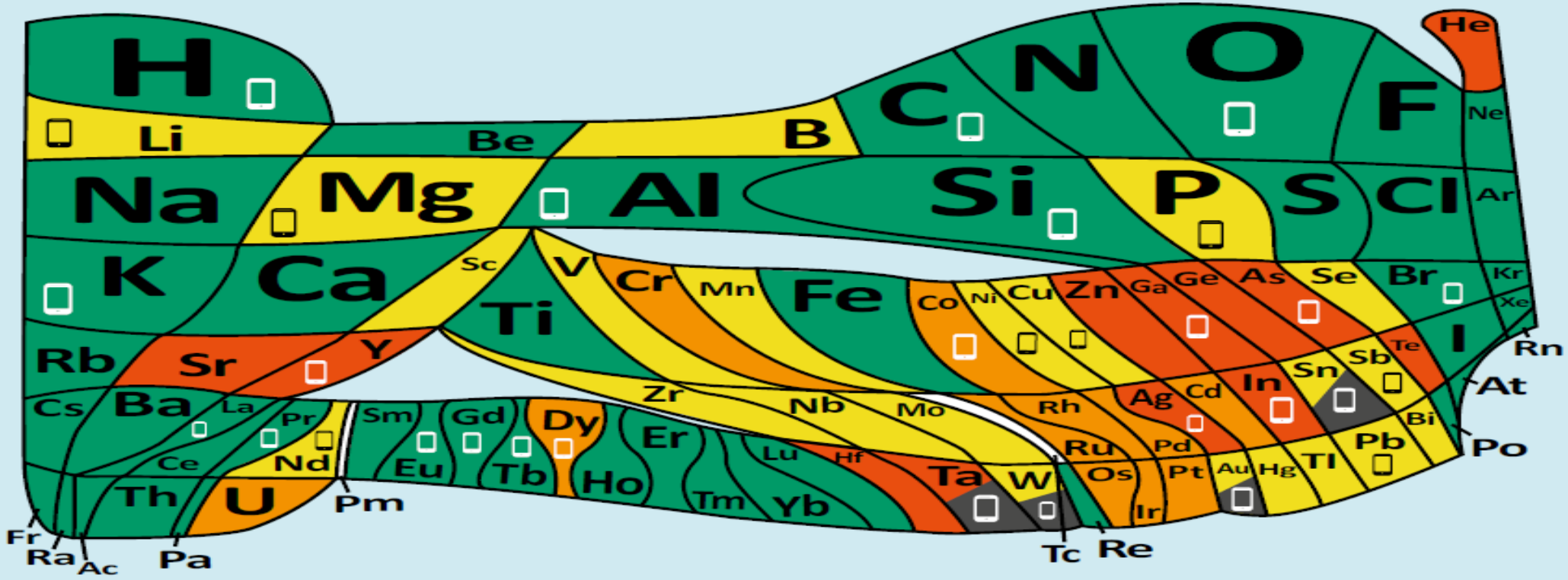
Half of the 90 natural elements that exist could be in short supply in the next 100 years

United Nations Educational, Scientific and Cultural Organization

2019 IYPT International Year of the Periodic Table of Chemical Elements

The 90 natural elements that make up everything

How much is there? Is that enough?



Serious threat in the next 100 years

Rising threat from increased use

Limited availability, future risk to supply

Plentiful Supply

Synthetic

From conflict minerals

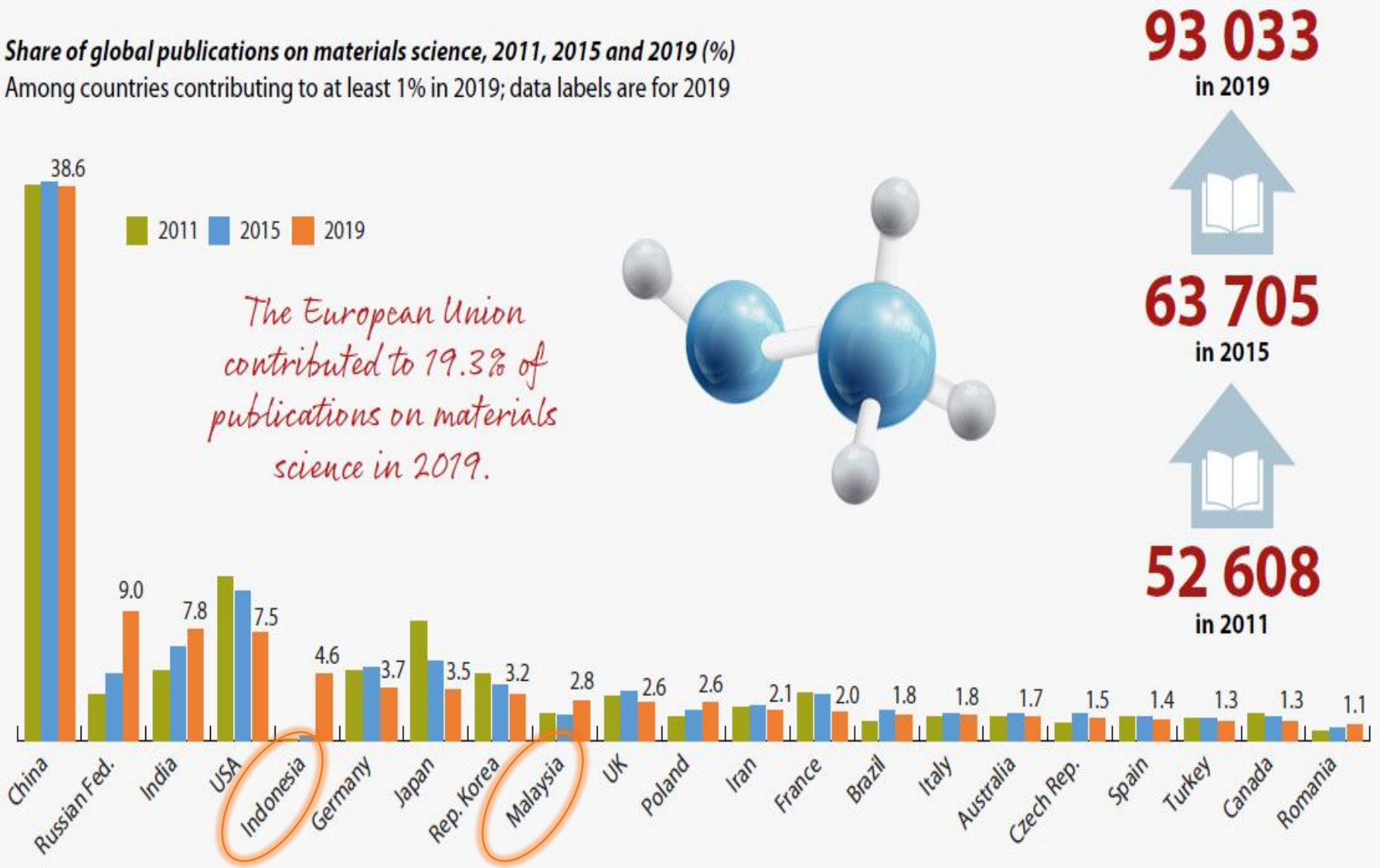
Elements used in a smart phone

Inspired by WF Sheehan's 'A Periodic Table with Emphasis' published in Chemistry, 1976, 49, 17-18'

Read more and play the video game **http://bit.ly/euchems-pt**

EuChemS European Chemical Society

Materials science: Indonesia and Malaysia in top 10 for output



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

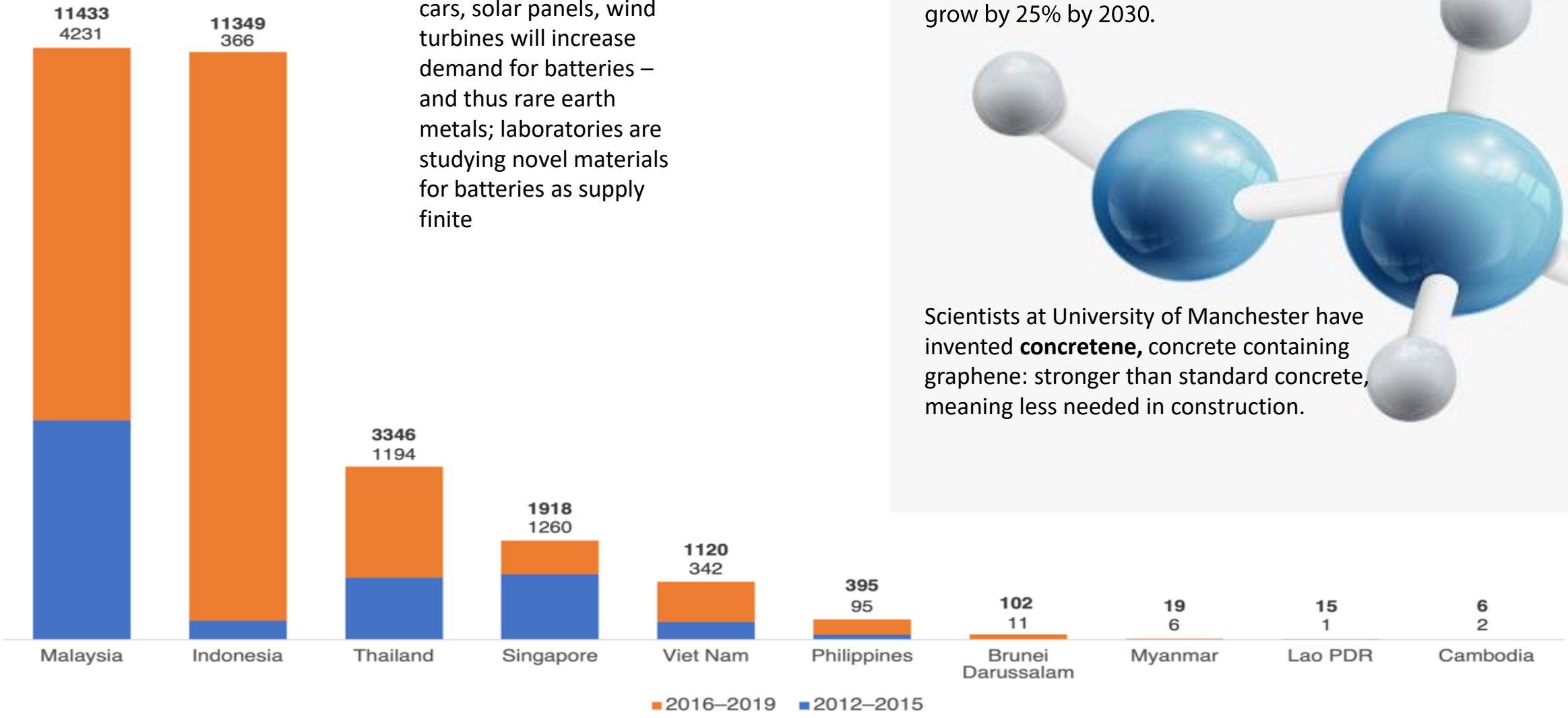
Strong growth in global share: Russian Fed., India, Indonesia, Malaysia

also

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

Strong growth in ASEAN output in materials science

Data labels for 2016–2019



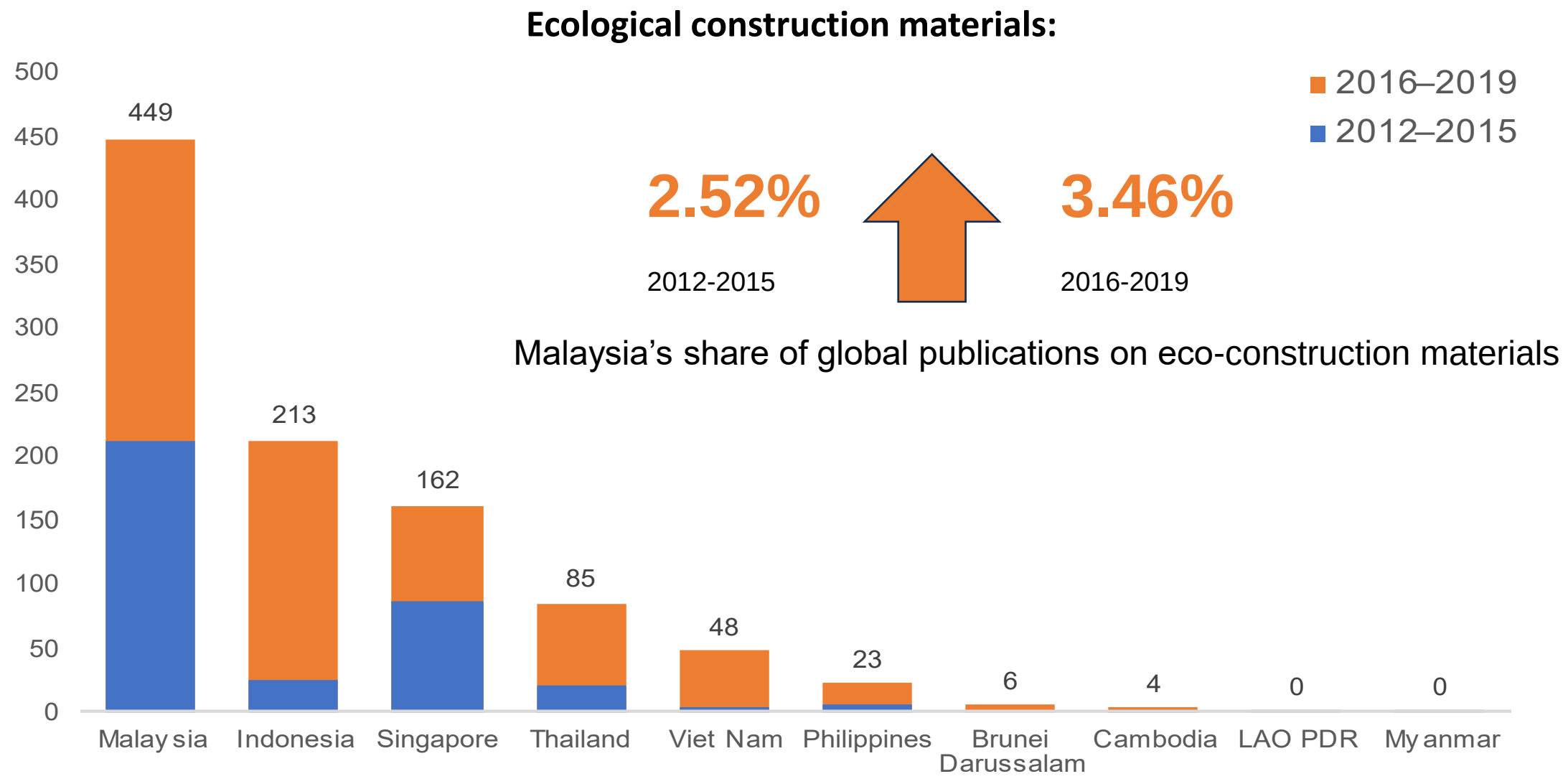
Data source: Scopus (Elsevier); data treatment by Science-Metrix

The spread of electric cars, solar panels, wind turbines will increase demand for batteries – and thus rare earth metals; laboratories are studying novel materials for batteries as supply finite

Concrete: ¾ is sand, demand for cement could grow by 25% by 2030.

Scientists at University of Manchester have invented **concretene,** concrete containing graphene: stronger than standard concrete, meaning less needed in construction.

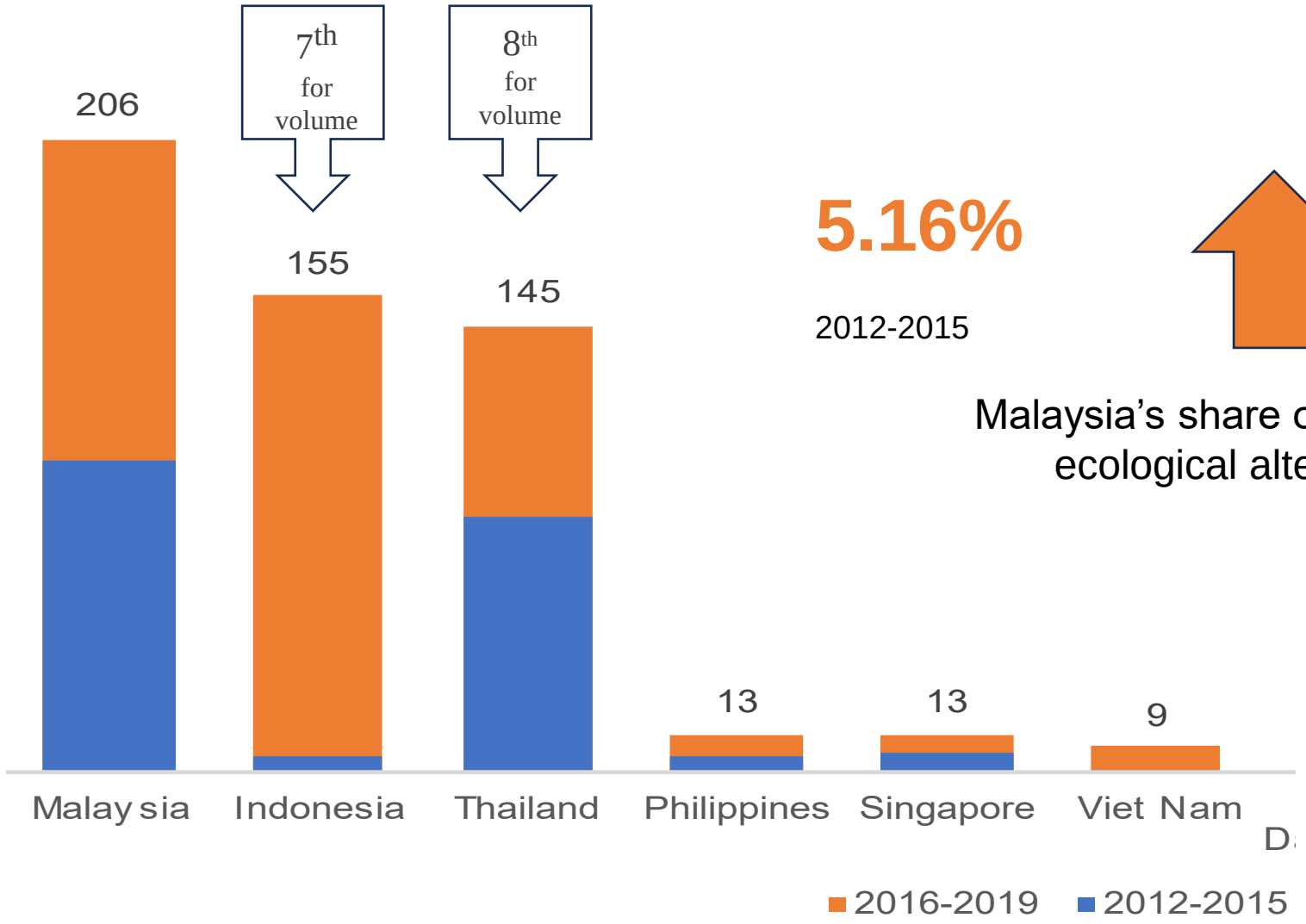
Ecological construction materials: ASEAN output (globally, 0.11% of scientific publications, 2012-2019)



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

Ecological alternatives to plastics (globally: 0.03% of output): Thailand publishing 9 times average intensity

Data labels for 2016–2019



5.16%

2012-2015

6.30%

2016-2019

Malaysia's share of global publications on ecological alternatives to plastics

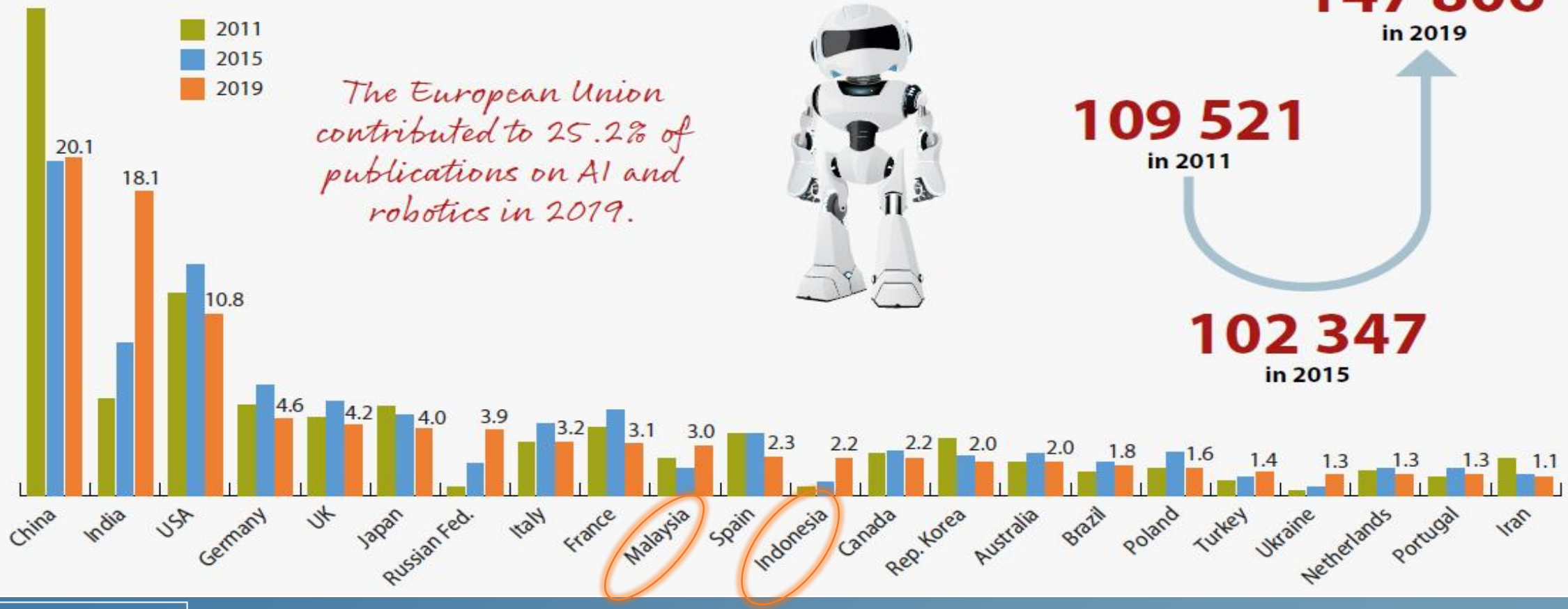
China decided in 2017 to stop importing low-quality plastic waste for recycling (had previously accepted 45% of global total).

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

'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

Artificial intelligence & robotics: output in ASEAN countries

Malaysia: *National AI Roadmap* (2021)

Thailand: Eastern Economic Corridor for Innovation: tech transfer to companies from research institutes and universities for: automation, robotics and intelligent systems; *Thailand 4.0 strategy* (e.g. electric vehicles, smart electronics; robotics for industry).

Viet Nam: 2021 *National Strategy on AI R&D and application*

Industry 4.0: Concerns that SMEs may struggle to remain competitive

Helping firms remain competitive by:

- digitalizing their business processes
- transitioning to 'smart' factories (with cyber-physical systems like robots)
- Developing e-financial services

Malaysia: Smart Automation Grants (up to 50%) for firms in services sector (*National Policy on Industry 4.0*)
Smart Manufacturing Experience Centre: gives companies access to platforms where they can trial their invention;

Philippines: SETUP 4.0 offering loans to micro-enterprises and SMEs to help them innovate in Industry 4.0 fields (*Inclusive Innovation Industrialization Strategy);*

Thailand: Eastern Economic Corridor of Innovation: high-tech start-up innovation hub; transferring tech to 10 sectors targeted by *Thailand 4.0 strategy* (e.g. electric vehicles, smart electronics; robotics for industry);

Singapore: Standards Mapping (good practices) to help companies upgrade their Industry 4.0 capabilities;

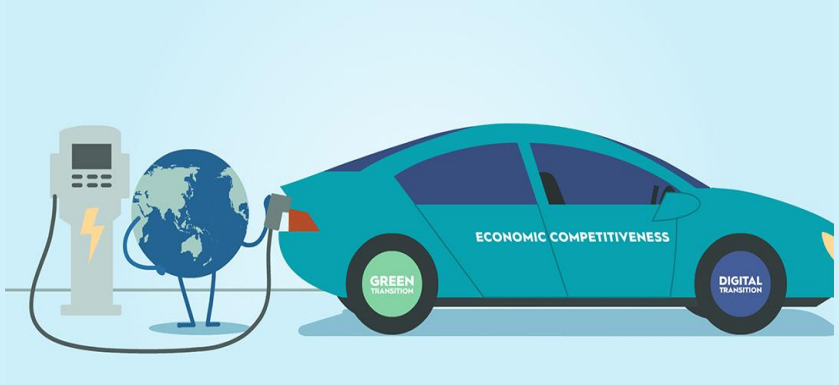
Viet Nam: FPT Technology Research Institute (former IT services company) offers firms and organizations digital transformation services

Smart cities should also be green

Singapore (existing city)

- 80% public housing
- Smart homes and city equipped by Housing and Development Board with sensors and other tech to provide efficient services and reduce waste (e.g. smart buses, wastewater treatment)

Smart Nation, 2014



Philippines (new city)

- New Clark City: driverless public transport, efficient wastewater system, built to withstand flooding (built inland, wide drainage, no-build zones)
- Partnership with Japanese govt

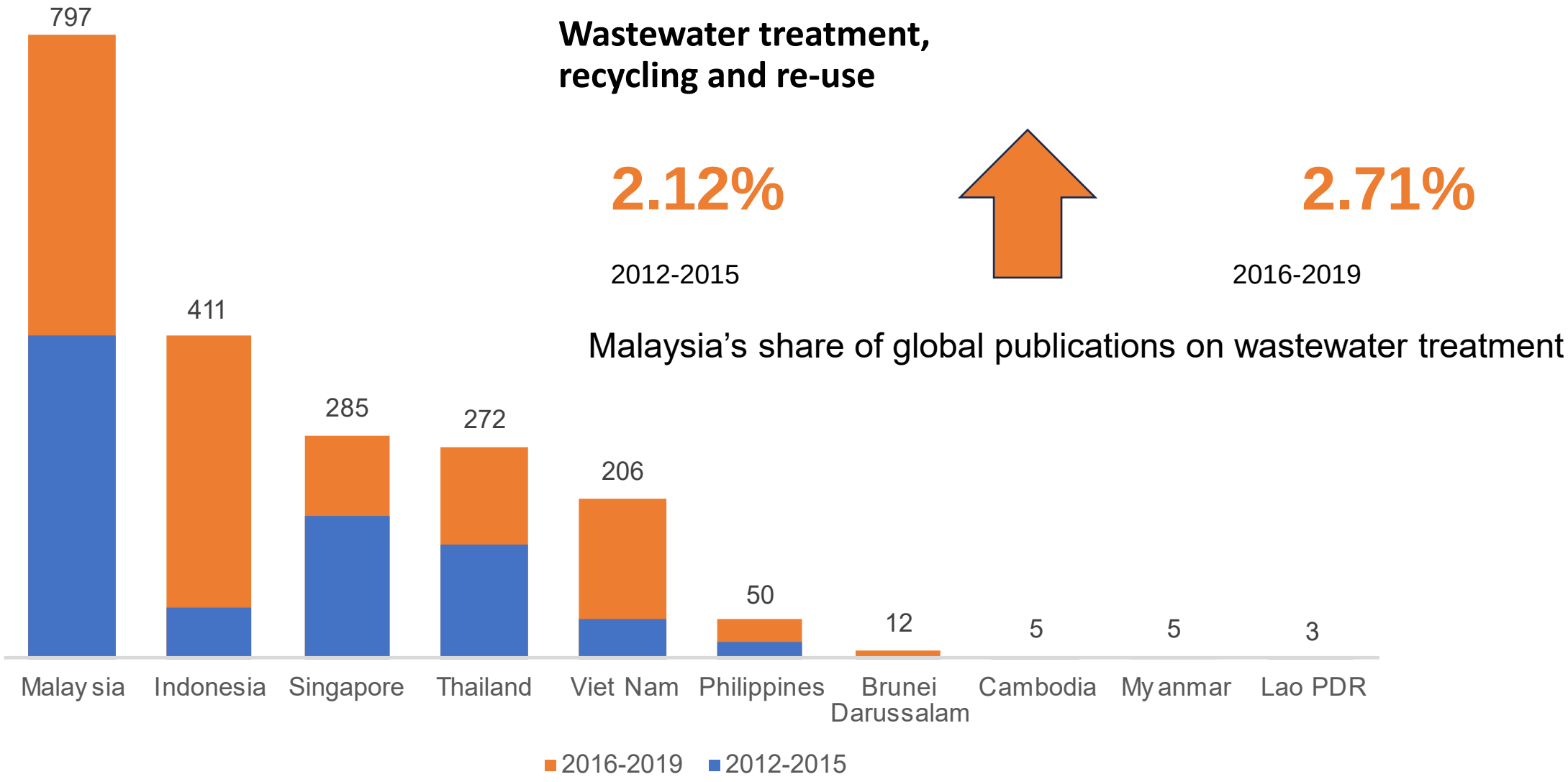
Thailand (existing districts)

'Smart' Innovation districts

- National Innovation Agency provides funds to allow start-ups to test their unproven ideas/tech to see which suit local needs
- Involves also universities, local experts, residents, hospitals, businesses

Wastewater treatment, recycling and re-use: output in ASEAN countries (global trend: 0.24% of publications)

(*Data labels for 2016–2019*

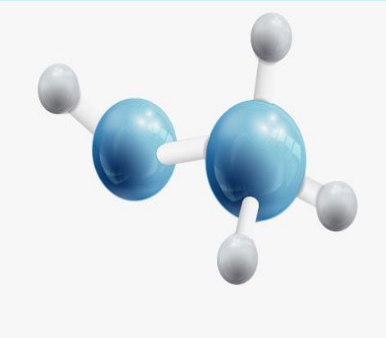


Data source: Scopus (Elsevier); data treatment by Science-Metrix; data visualization by Values Associates

Many of tomorrow's technologies will come from science-based industries (from the lab)

European Union's industrial priorities:

- robotics
- photonics and micro-electronics
- high-performance computing/ data cloud infrastructure
- advanced materials and technologies
- blockchain
- quantum technologies
- industrial biotechnology
- biomedicine
- nanotechnologies
- pharmaceuticals



China's 10 cutting-edge manufacturing sectors *(Made in China 2025)*

- advanced robotics and AI;
- new synthetic materials;
- emerging biomedicine;
- electric cars and other new energy vehicles;
- next-generation IT and telecommunications;
- agricultural technology;
- aerospace engineering;
- advanced electrical equipment;
- high-end rail infrastructure;
- hi … ineering

USA's industrial priorities:

- robotics & AI
- photonics and micro-electronics
- high-performance computing/data cloud infrastructure
- advanced textiles and other materials
- blockchain
- quantum technologies
- industrial biotechnology
- biomedicine
- nanotechnologies
- pharmaceuticals
- semiconductor and hybrid electronics
- agrifood
- 3D printing
- biomanufacturing

European Green Deal (2021-2027) prioritizing 'green' transition (and digital transition)

INDUSTRIAL STRATEGY :

- create new markets for climate-neutral and circular products (e.g. since 2021, manufacturers must make appliances last longer)

- *Sustainable Europe Investment Plan (2020) to* mobilize public and private investment of € 1 trillion+

- Includes *Just Transition Mechanism*, e.g. fund to cushion job losses from phasing out polluting industries to limit turbulence in vulnerable countries.

RESEARCH & INNOVATION

- smart specialization by regions within countries and new mission-oriented policies (e.g. 100 climate-smart cities by 2050)

- ***European Innovation Council:*** identifies next-generation tech, accelerates commercial applications and supports rapid upscaling of start-ups. Special entity manages equity investments from private investors.

A reason to decarbonize ASEAN exports: EU's Carbon Border Adjustment Mechanism

How can governments hold domestic industry to higher environmental standards than their foreign competitors without undermining the competitiveness of their own industries?

- operational from October 2023
- buffers European companies that commit to decarbonization

- Makes carbon-rich imports pay higher customs duties and/or tariffs;

- imports of cement, iron and steel, aluminum, fertilizers and electricity first affected, perhaps later: hydrogen, organic chemicals and polymers like plastics

- aligned with World Trade Organization rules, may be emulated by Canada, China and Japan, etc

<u>If ASEAN countries don't decarbonize their exports to the EU, they may pay higher customs duties and/or tariffs.</u>

Schemes in Asia to accelerate green transition

Sri Lanka
Battle for Solar Energy
(funding: public/private):
Businesses and households buy small rooftop solar plants

- Consumers sell surplus electricity to national grid *OR* bank it for later use

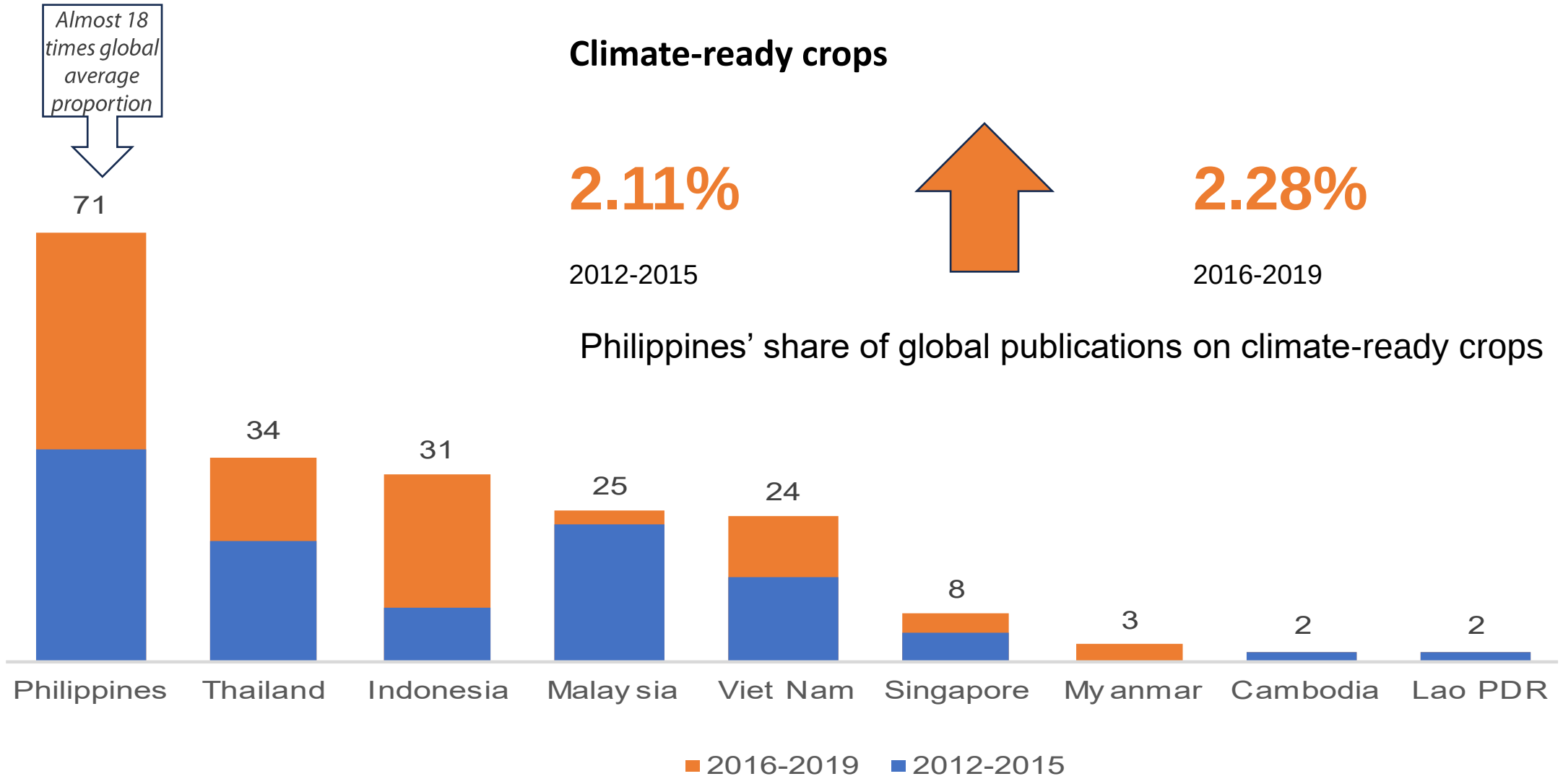
Cambodia
Moratorium on hydropower development
(funding: public):
Hydropower: 61% electricity consumption (2018)
all development halted until 2030 after report found dams risked devastating fish stocks.
Environment & Natural Resources Code to protect environment (2023)

India
Encouraging purchase of electric & hybrid vehicles (buses, 2-wheelers, etc)
(funding: public):

- 12-14% reduction in goods & services tax on electric vehicles
- Tax deduction on interest paid on loans to buy electric vehicles

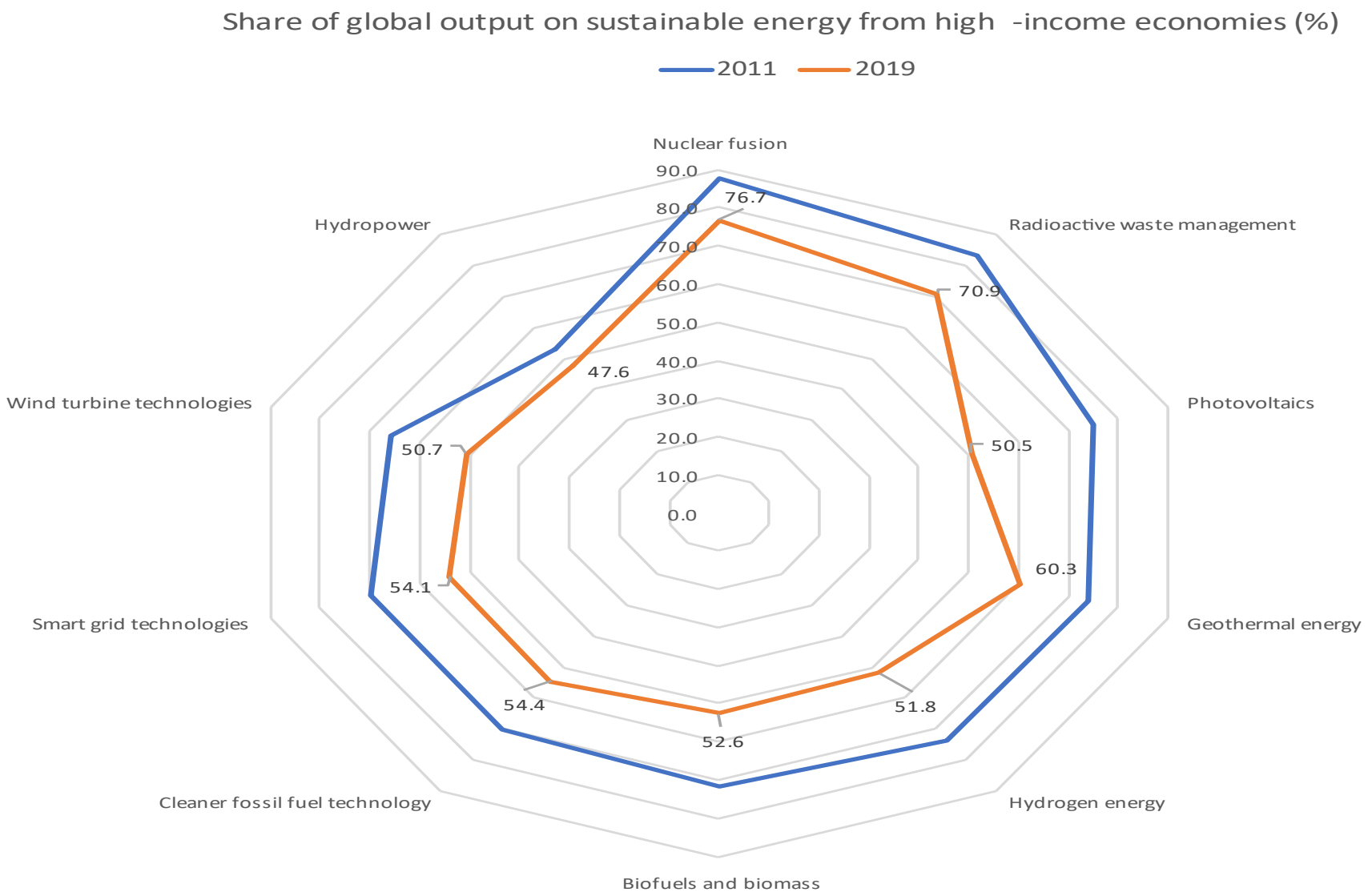
Philippines investing in climate-ready crops (global trend: 0.02% of all publications but strong growth)

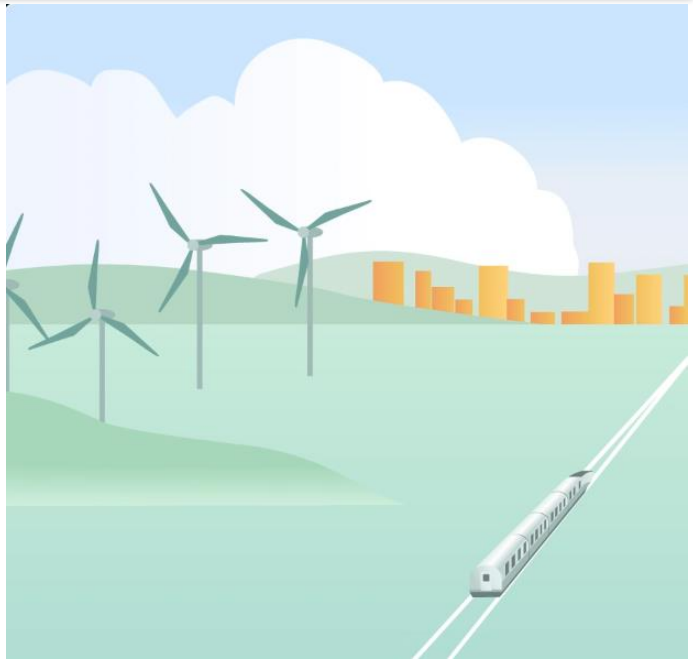
Data labels for 2016–2019



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

Sustainable energy research: share of high-income countries shrinking

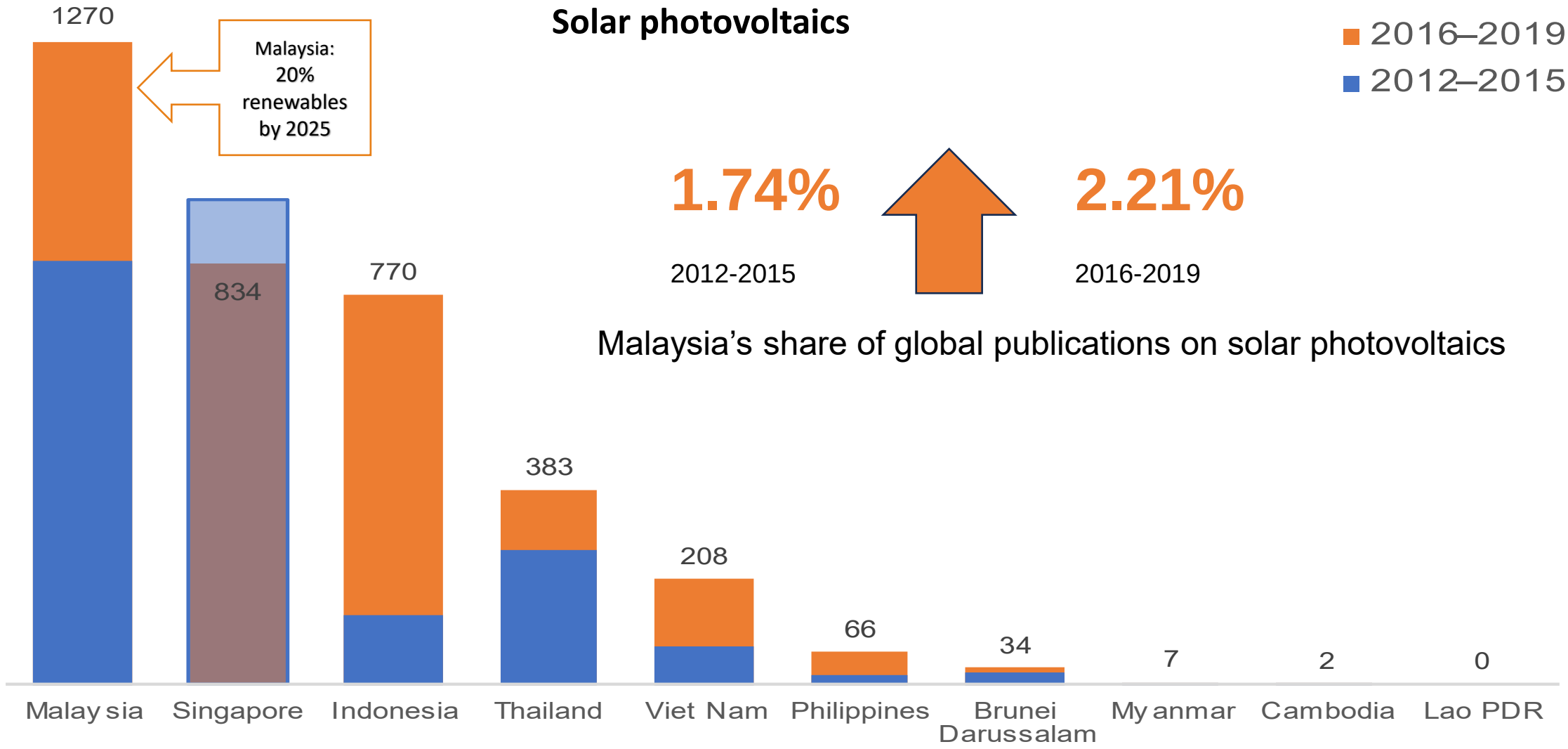




Data source: Scopus (Elsevier); data treatment by Science-Metrix

Solar photovoltaics: output in ASEAN countries (global trend: 0.53% of global scientific publications, 2012-2019)

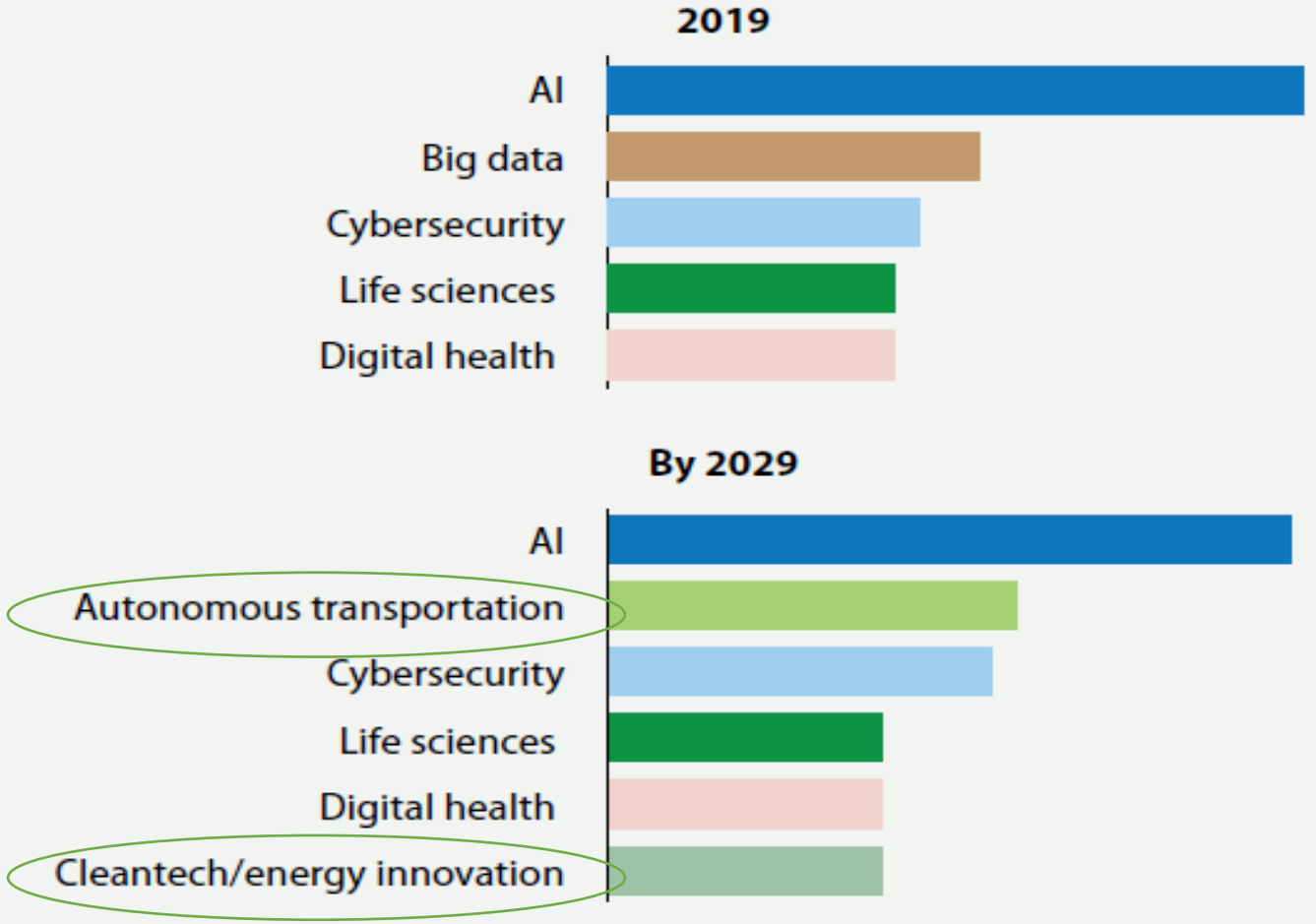
Data labels for 2016–2019



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

USA: clean energy tech and autonomous transportation among most promising fields for innovation by 2029

Survey responses from US entrepreneurs and start-ups asked to identify promising fields in the innovation economy in 2019 and by 2029

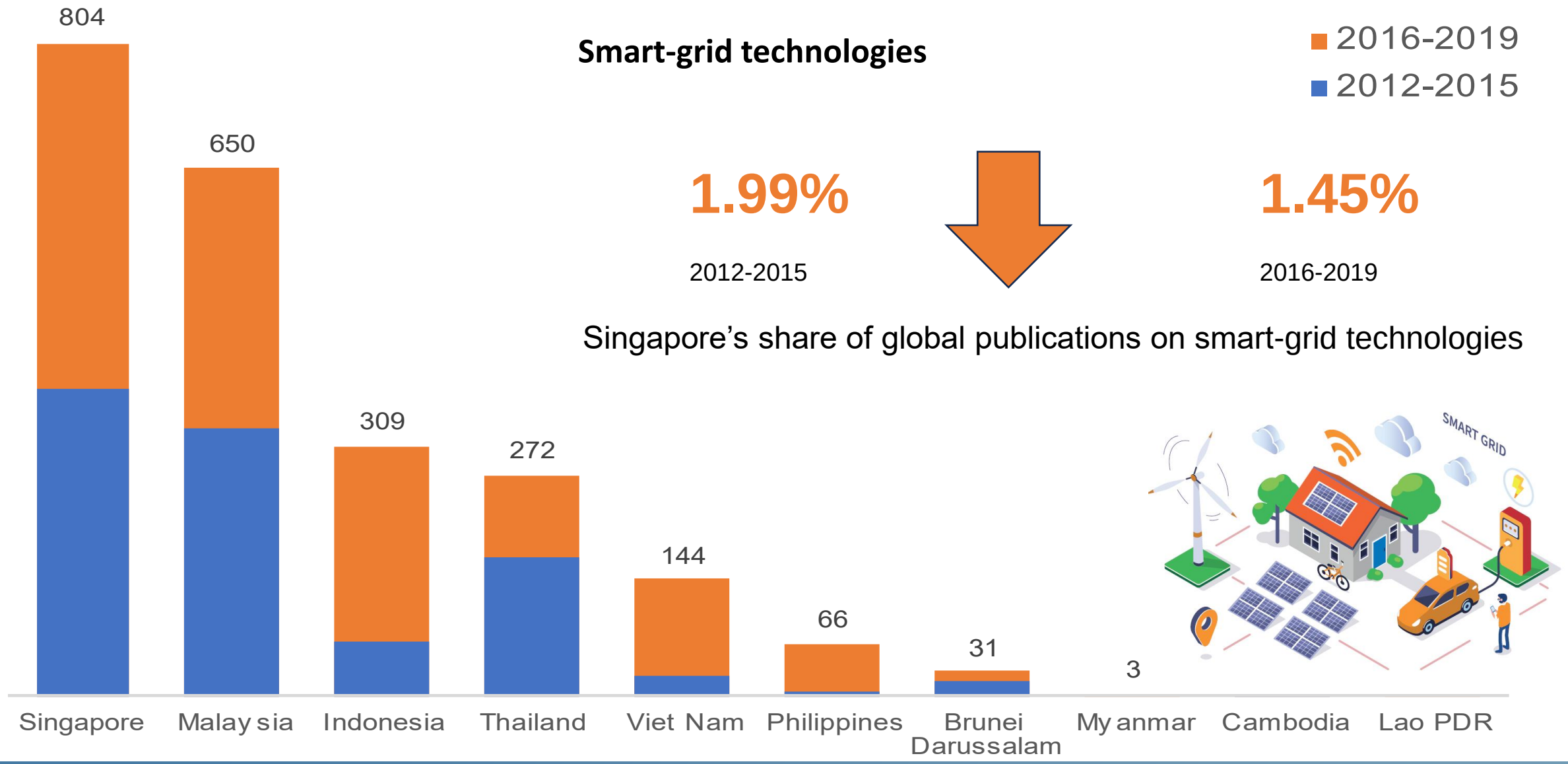


Source: UNESCO Science Report, citing Silicon Valley Bank (2019) *US Startup Outlook 2019*

Despite growth, Singapore's global share of output on smart-grid tech is down, as strong growth globally

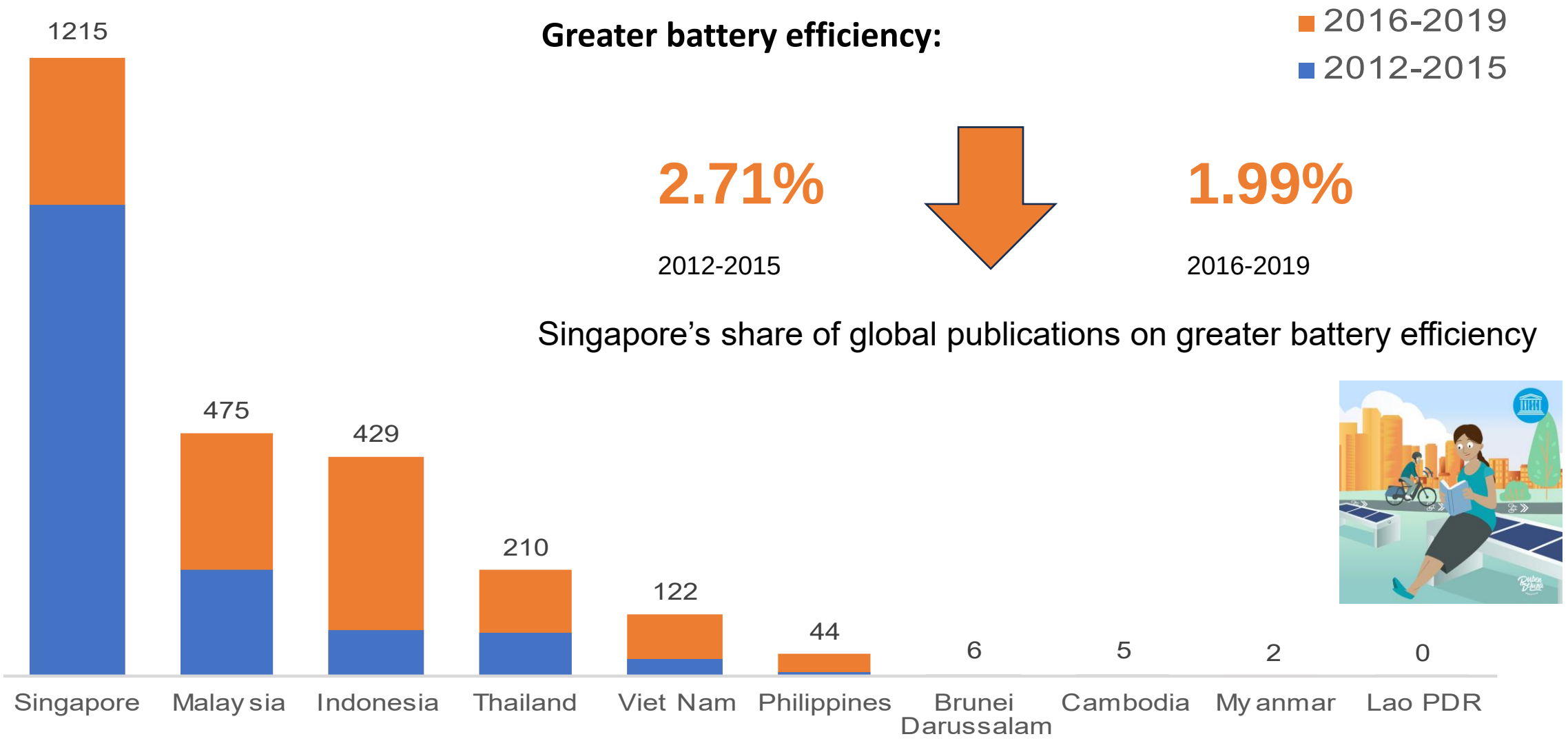
Data labels for 2016–2019 (globally: 0.38% of all publications; 68% increase 2012-2019)

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



Greater battery efficiency: ASEAN output (global trend: 0.48% of all publications, strong growth of 79%)

Data labels for 2016-2019



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