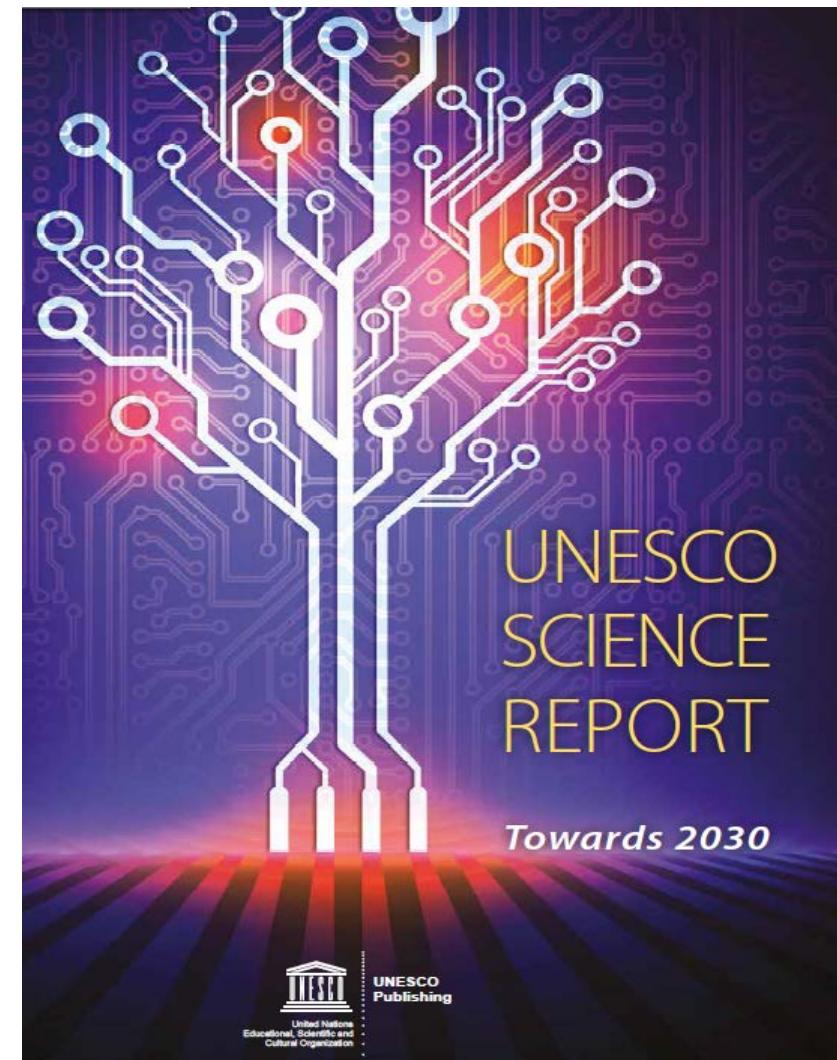


Policy challenges for tomorrow's resilient societies

Resilience is the capability of systems and individuals to cope with significant adversity or risk.

Susan Schneegans
Editor-in-Chief, UNESCO Science Report
s.schneegans@unesco.org



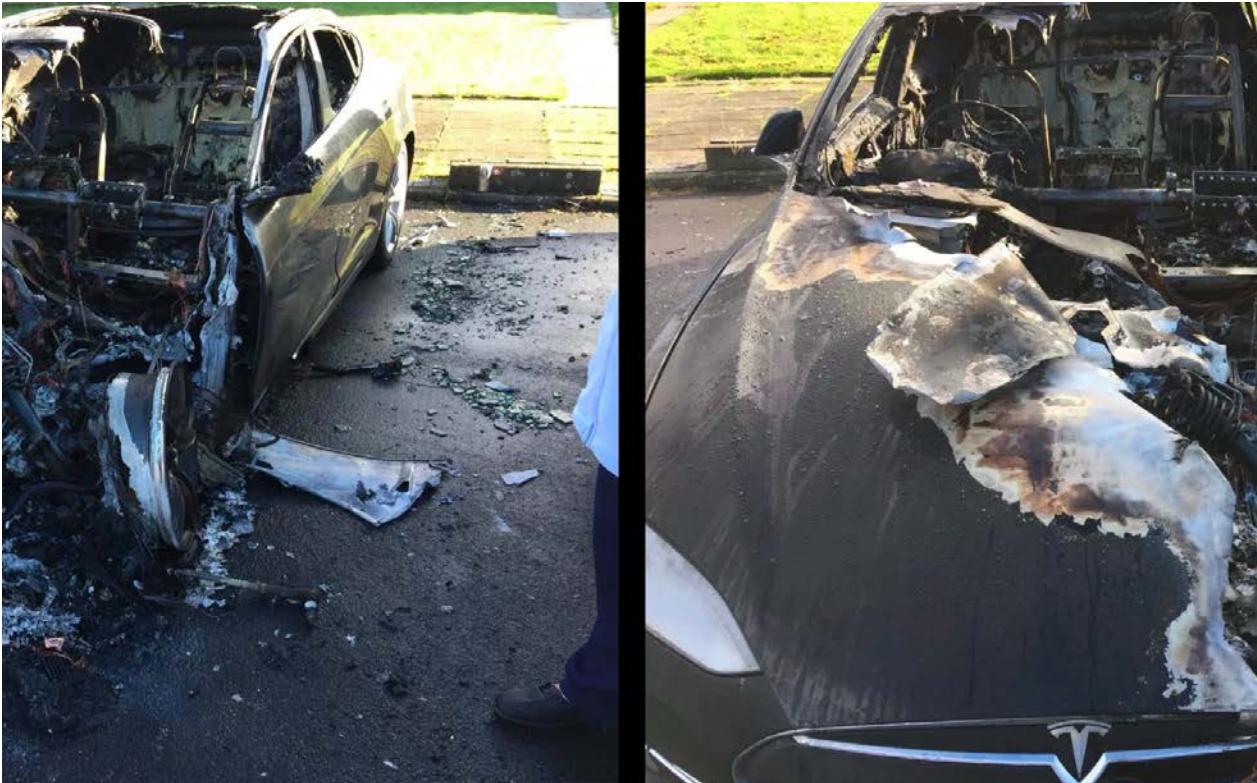


More sustainable technologies needed

All technologies consume natural resources and pollute the air, water and atmosphere.

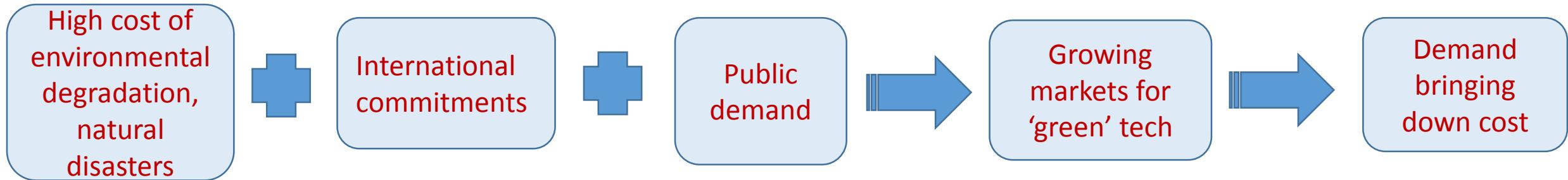
Technology will be needed to reach the SDGs
but it will have to be *sustainable*.

e.g. Need to make lithium-ion batteries more efficient and safer; in cars, they can fuel hot fires producing toxic fumes and are hard to extinguish.





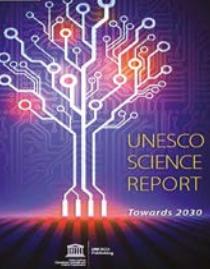
Green tech: an unstoppable trend



- **India** cancels plans to build ca 14 GW of coal-fired power plants, May 2018. Lower cost of solar energy making it uneconomical to build coal-fired power plants.
- **Japan** restored subsidies for solar energy after Fukushima disaster (2011)
- **European** environment industry rare economic sector to flourish after 2008.
- European Commission proposes banning single-use plastics and forcing manufacturers to clean up waste (May 2018)
- Countries/ cities banning single-use plastics: **Kenya, Rwanda, Chilean/US** cities, **Indian** State of Karnataka



Rep. Korea: catch-up technology development model outdated



Plans to revitalize manufacturing by:

- making country more entrepreneurial and creative
- reinforcing ties between basic sciences and business: building international Science Business Belt, with basic science institute on site, heavy ion accelerator
- spending *more than anyone else* on research: 5% of GDP by 2017 (4.2% in 2013)
- doubling investment in green technology





Rep. Korea: planning to lead in green tech

Plans to lead in green technology

- **Green Technology Center Korea** (think tank, 2013)
- **Green Climate Fund** (2012) hosts fund set up by UN after Copenhagen, 2009
- **Global Green Growth Institute** (2010) works with public and private partners in developing countries and emerging economies to put green growth at the heart of economic planning.
- **Green tech** strategic focus (see figure)
- Top 30 Korean private companies invested KRW 22.4 trillion (circa US\$26.2 billion) in **green tech** 2011-2013.

Figure 25.2: The Republic of Korea's strategic technologies for 2013–2017

Budget share (%)

Information technology convergence and new industry:

- Next-generation (5G) communication technology
- Advanced materials
- Environment-friendly automobiles, etc.

Future growth engine:

- Solar energy
- Space launch vehicle, etc.

Health and longevity:

- Personalized drug treatment
- Biochips for disease diagnosis
- Stem cell technology
- Robot technology for health services, etc.

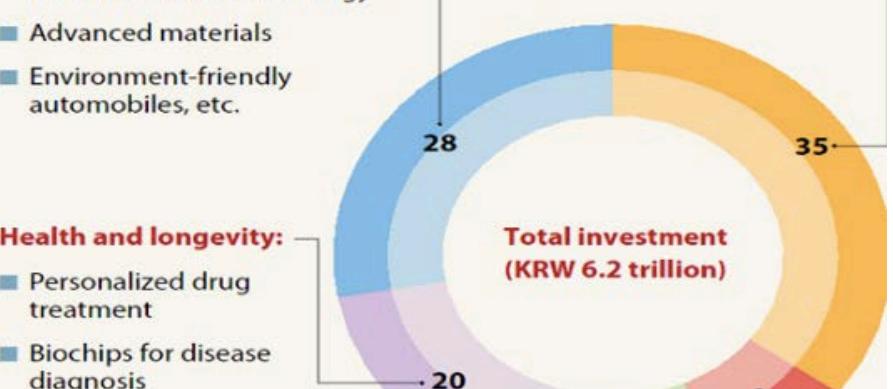
Total investment (KRW 6.2 trillion)

Clean and comfortable environment:

- High energy-efficient buildings, etc.

Safe society:

- Social disaster prediction and response:
 - nuclear safety
 - environmental disaster risk reduction, etc.
- Food safety evaluation and enhancement, etc.





Priority: technology to tackle climate change



Philippines: vulnerable to hurricanes

Investing heavily in critical infrastructure and tools:

- Doppler radars
- 3D disaster-simulation models from Light Detection and Ranging (LiDAR) technology
- installation of locally developed sensors for accurate and timely disaster information
- building local capability to apply, replicate and produce technologies.



Cambodia: climate change adaptation strategy

Climate Change Strategic Plan 2014–2023 partly to protect agriculture, financial support from European Union and others.



India pioneering ‘pro-poor innovation’



Frugal innovation (*jugaad*)
often runs independently of power grid:

- Grammateller solar-powered ATM for rural areas
- Portable *Chotukool* refrigerator runs on batteries
- Oorja home-cooking fuel and stove combines micro-gasification stove with a biomass-based pellet fuel
- Portable electrocardiogramme



China: basic science key to becoming 'innovation nation' by 2020



China

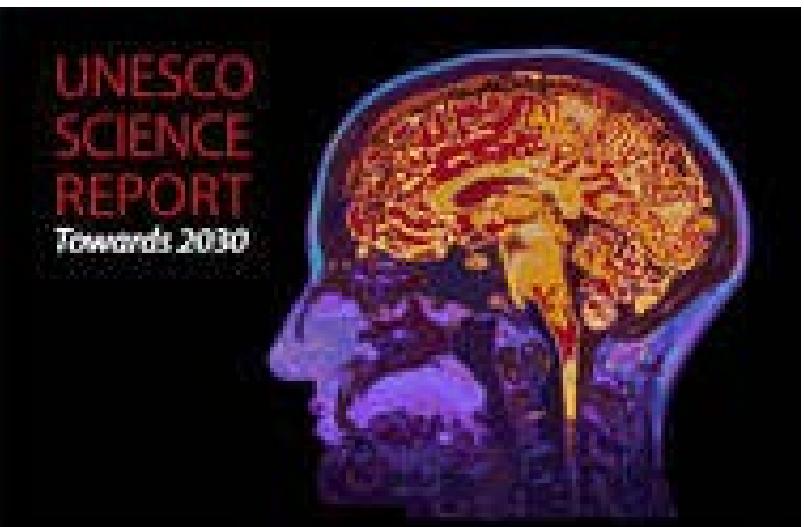
- Massive public investment in research and training
- World's biggest patent office since 2013 (85% domestic inventors)
- Has overtaken USA for volume of researchers **and** scientific publications
- Most industrial robots: 31% global market share (but Rep. Korea, Singapore, Germany and Japan most automated)
- Powerful supercomputers, investing in Internet of Things

But China still reliant on foreign core technologies

- Only 5% of research spending for **basic research** (about 17% in EU, Russian Fed., USA).
- China's strengths lie in physical sciences, now investing in **brain research** (cognitive sciences contribute to artificial intelligence)

"China's political and scientific leadership has come to realize that the country's pursuit of innovation could be in jeopardy without breakthroughs in basic research."

Cong Cao, 2018, author of chapter on China, UNESCO Science Report



Green tech revolution will demand strong investment in research



Global research spending grew faster than global economy, 2007-2013

- Global population (+7%)
- Global economy (+20%)
- Research expenditure (+31%)
- Number of researchers (+21%, FTE)
- Scientific publications (+23%)



Most Asian countries need to raise research funding effort

Asia:

- 59% global population,
- 42% research spending
- 43% researchers

Japan, China, Rep. Korea:

- 23% population,
- 34% research spending
- 32% researchers

1.4%

Global average ratio of research spending to GDP for **upper middle-income** countries

Two upper middle-income Asian countries have reached this ratio.

China; Iran; Kazakhstan; Malaysia; Maldives; Thailand; Turkey; Turkmenistan

0.5%

Global average ratio of research spending to GDP for **lower middle-income** countries

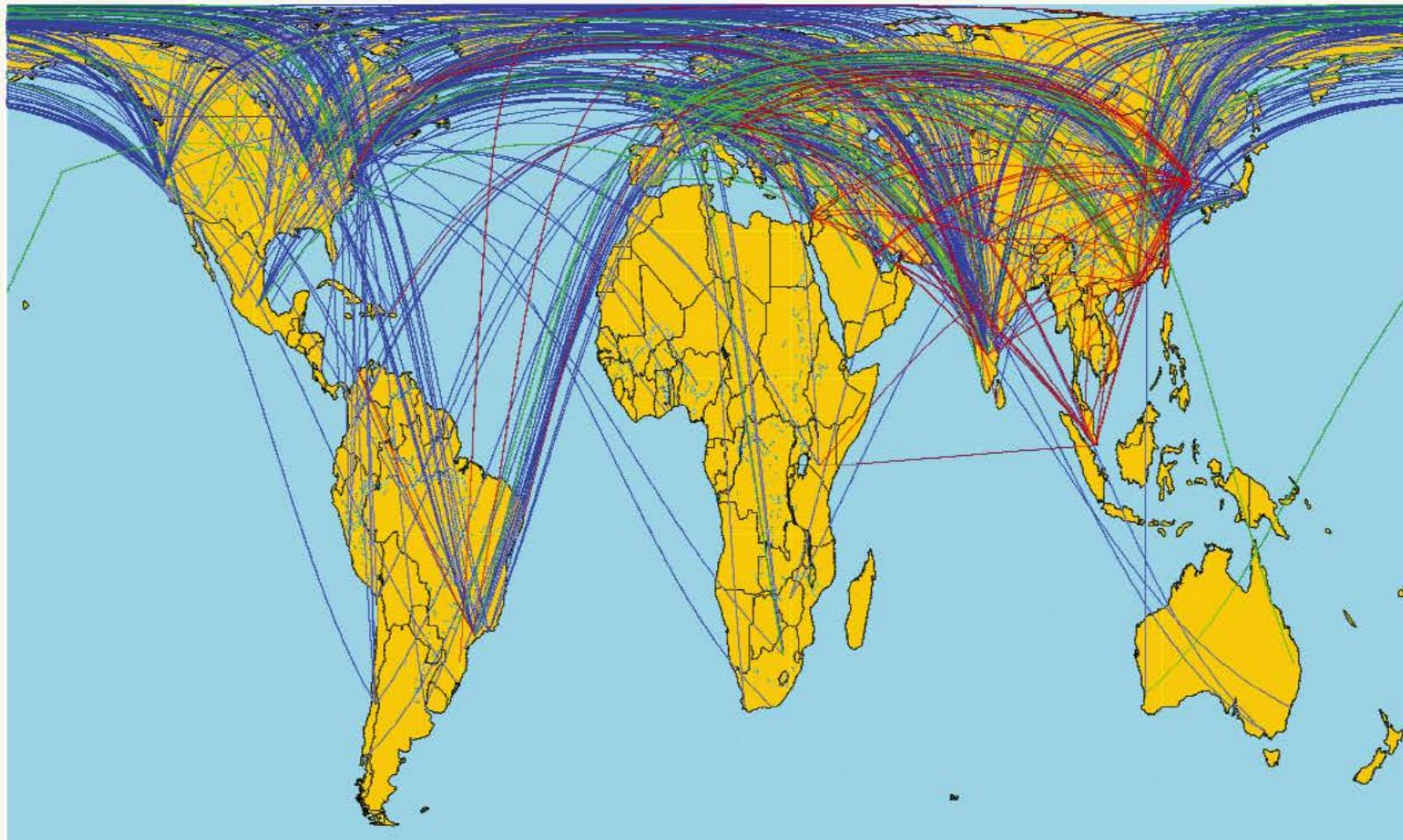
India has passed this ratio, Viet Nam is close.

Bhutan; **India**; Indonesia; Kyrgyzstan; Lao PDR; Pakistan; Papua New Guinea; Philippines; Sri Lanka; Timor-Leste; Uzbekistan; Viet Nam

More research projects for South but unevenly spread



Modest flow of research projects to, and from, most developing countries, 2003–2014



KEY

Blue

Flows from traditionally R&D-intensive countries to 'new' countries in terms of R&D

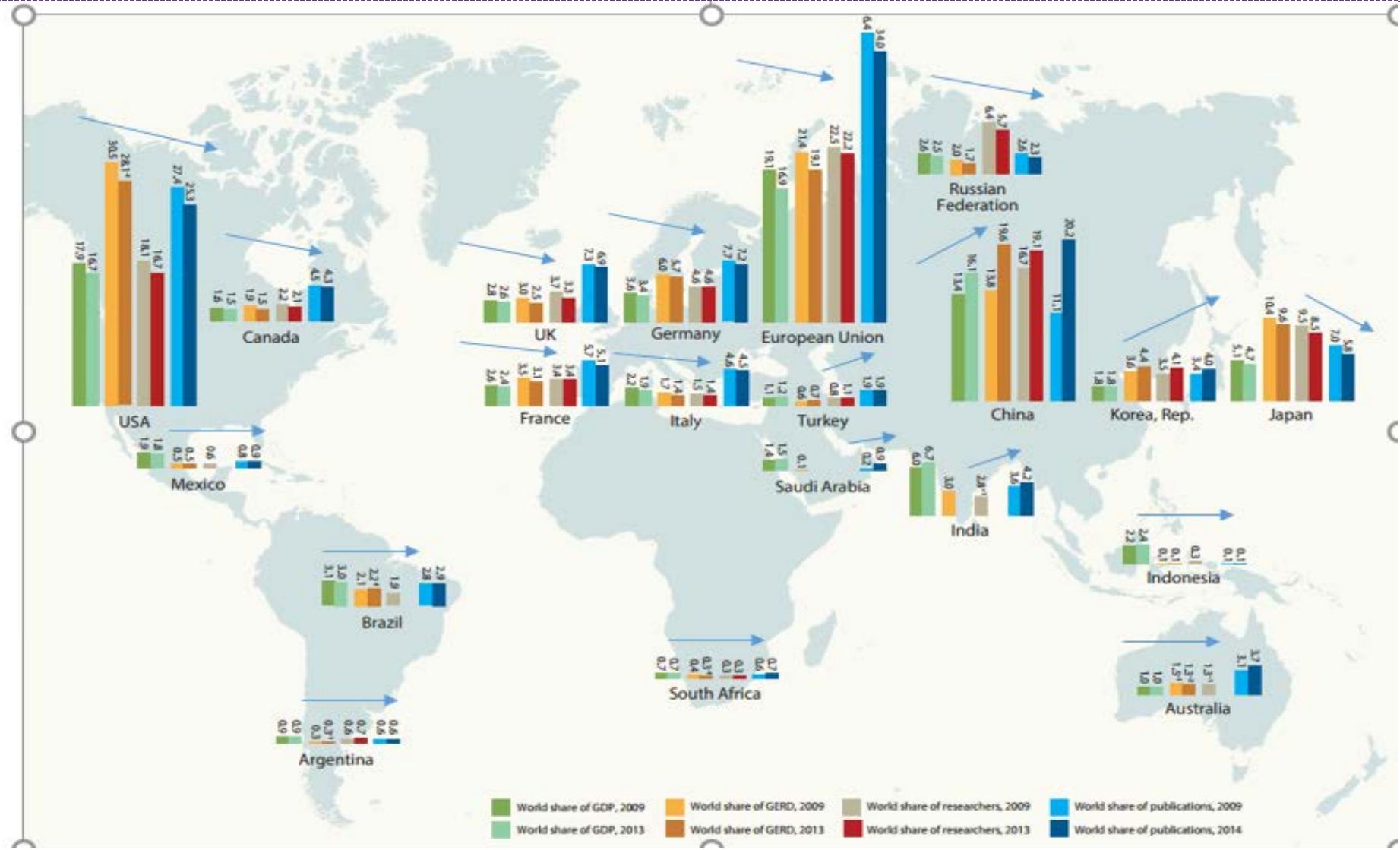
Green

Flows from 'new' countries to traditionally R&D-intensive countries

Red

Flows between 'new' countries

G20 still accounts for 92% of research spending

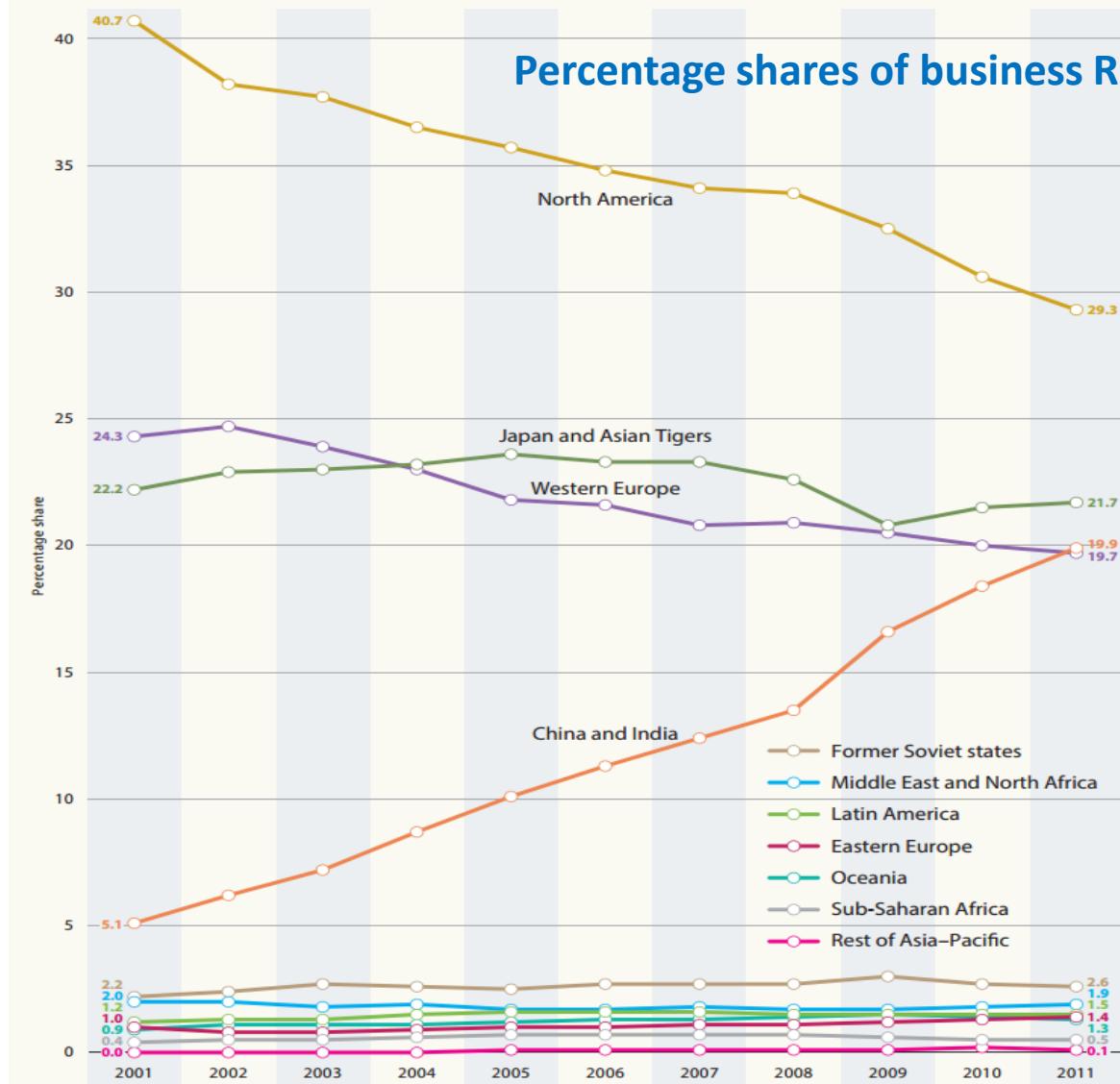


But strong growth in China and Rep. Korea

Shares of USA and EU down to 47%

Little change in Southern Hemisphere

Strong growth in business research spending in Asia



Businesses in China and India now spend as much on research as Western Europe

And businesses in Japan and the Asian Tigers spend *more* than Western Europe

Asian Tigers: Taiwan (China), Hong Kong (China), Indonesia, Malaysia, Philippines, Rep. Korea, Singapore, Thailand and Viet Nam

Fellow Asians and Australians among Southeast Asian's top research collaborators

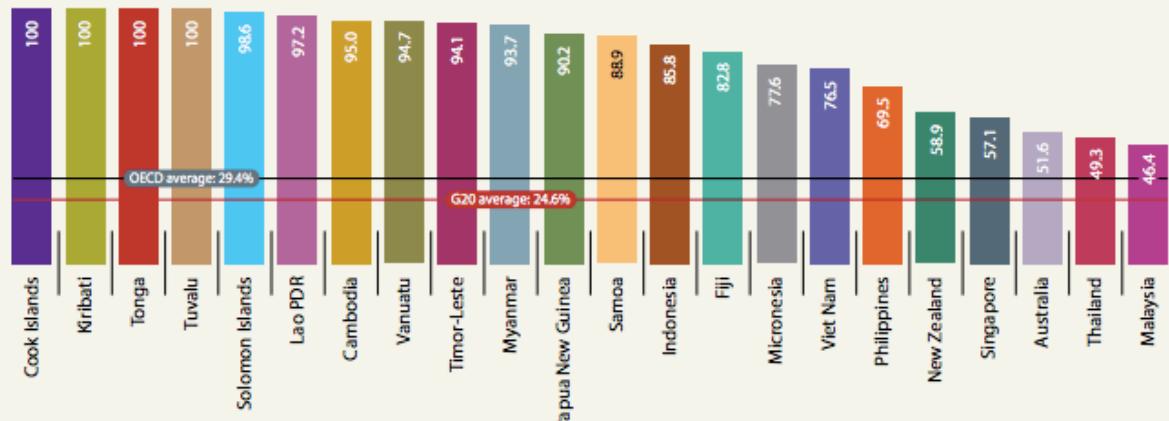


Main foreign partners, 2008–2014 (number of papers)

	1st collaborator	2nd collaborator	3rd collaborator	4th collaborator	5th collaborator
Australia	USA (43 225)	UK (29 324)	China (21 058)	Germany (15 493)	Canada (12 964)
Cambodia	USA (307)	Thailand (233)	France (230)	UK (188)	Japan (136)
Cook Islands	USA (17)	Australia/ New Zealand (11)		France (4)	Brazil/Japan (3)
Fiji	Australia (229)	USA (110)	New Zealand (94)	UK (81)	India (66)
Indonesia	Japan (1 848)	USA (1 147)	Australia (1 098)	Malaysia (950)	Netherlands (801)
Kiribati	Australia (7)	New Zealand (6)	USA/Fiji (5)		Papua New Guinea (4)
Lao PDR	Thailand (191)	UK (161)	USA (136)	France (125)	Australia (117)
Malaysia	UK (3 076)	India (2 611)	Australia (2 425)	Iran (2 402)	USA (2 308)
Micronesia	USA (26)	Australia (9)	Fiji (8)	Marshall Islands (6)	New Zealand/ Palau (5)
Myanmar	Japan (102)	Thailand (91)	USA (75)	Australia (46)	UK (43)
New Zealand	USA (8 853)	Australia (7 861)	UK (6 385)	Germany (3 021)	Canada (2 500)
Papua New Guinea	Australia (375)	USA (197)	UK (103)	Spain (91)	Switzerland (70)
Philippines	USA (1 298)	Japan (909)	Australia (538)	China (500)	UK (410)
Samoa	USA (5)	Australia (4)	Ecuador/Spain/ New Zealand/France/ China/Costa Rica/Fiji/ Chile/Japan/Cook Islands (1)		
Singapore	China (11 179)	USA (10 680)	Australia (4 166)	UK (4 055)	Japan (2 098)
Solomon Islands	Australia (48)	USA (15)	Vanuatu (10)	UK (9)	Fiji (8)
Thailand	USA (6 329)	Japan (4 108)	UK (2 749)	Australia (2 072)	China (1 668)
Tonga	Australia (17)	Fiji (13)	New Zealand (11)	USA (9)	France (3)
Vanuatu	France (49)	Australia (45)	USA (24)	Solomon Islands/ New Zealand/Japan (10)	
Viet Nam	USA (1 401)	Japan (1 384)	Korea, Rep. (1 289)	France (1 126)	UK (906)

Small or fledgling science systems have very high rates of foreign collaboration

Share of papers with foreign co-authors, 2008–2014



Scientific integration now part of regional integration could ASEAN take inspiration from EU model?



ASEAN Economic Community (est. 2015):

strengthen scientific capacity through *ASEAN Plan of Action on STI 2016–2020* by:

- fostering exchanges among researchers, mobility of technicians
- enhancing role of ASEAN University network (30 members)



Shanghai Cooperation Organization

- Russian Glonass and Chinese Beidou satellite navigation systems announce merger and development of regional system (2018): Central Asia (5), India, Pakistan

Economic Cooperation Organization

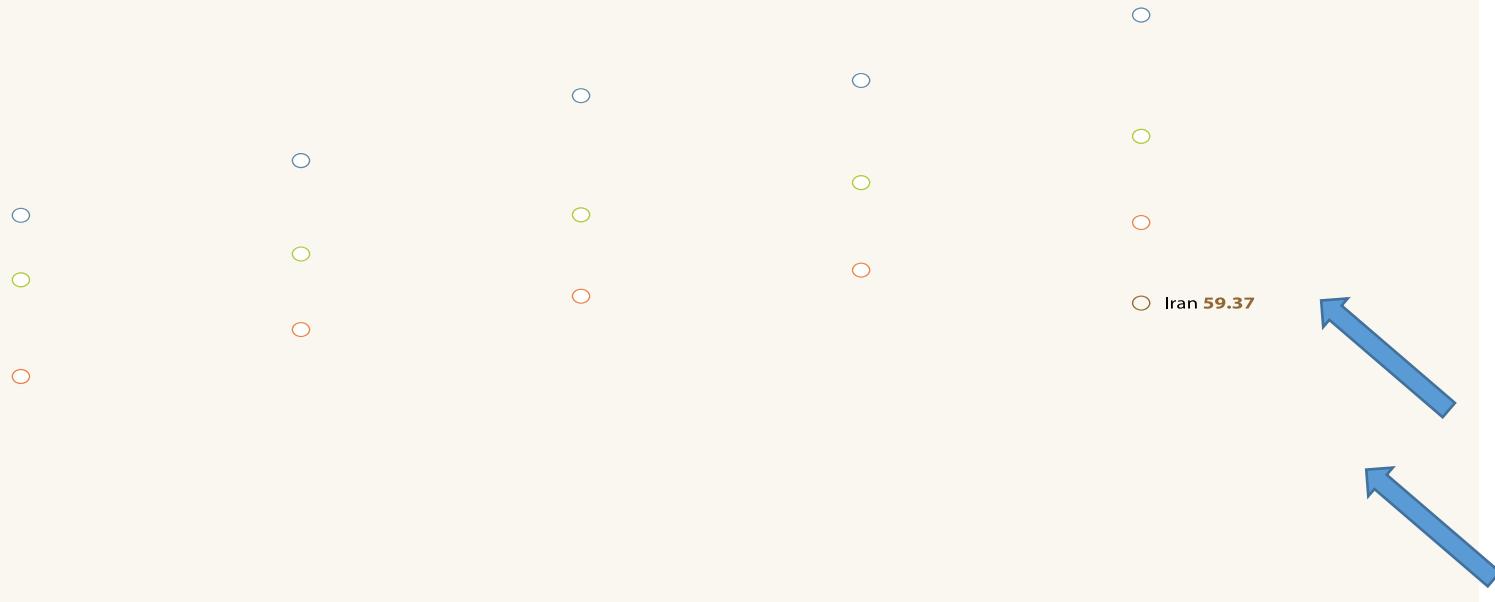
Iran's Econano Network promoting scientific and industrial development of nanotechnology among members:
Afghanistan, Azerbaijan, Iran, Kazakhstan, Kyrgyzstan, Pakistan, Tajikistan, Turkey, Turkmenistan, Uzbekistan

Two countries to watch for nanotechnology: Iran and Malaysia



Iran performs well for the number of nanoarticles per million inhabitants

Other countries are given for comparison



**Quantity of papers
progressing faster than
quality for now**

(Thomson Reuters' Web of
Science, Science Citation
Index Expanded, 2014)

ASEAN countries can learn from one another

Singapore

Incubator for Disruptive Enterprises and Start-ups (IDEAS)

- Launched by National Research Foundation (NRF) with Innosight Ventures Ptd Ltd, a Singapore-based venture capital firm (2013).
- 85% of funding comes from NRF and rest from incubator.
- Differs from US model, where corporations like Google, LinkedIn support disruptive start-ups, as more cost-effective for them than acquiring new technology.



ASEAN countries can learn from one another

Malaysia

Malaysian Palm Oil Board

- Created through merger of two public institutes by law in 2000.
- Cess (tax) imposed on palm oil industry for every tonne of palm oil and palm kernel oil produced
- Tax used to fund research grants with universities and public research institutes
- Rise in new technologies commercialized from 16 to 20 (2013-2014)
- Innovation in areas such as biodiesel and alternate uses for palm biomass and organic waste, including wood and paper products.



And learn from other Asian countries

Saudi Arabia

Imagination and Ingenuity Institute (NGO)

- Master's and PhD students with local and international patent invited to apply for a grant in specific areas, such as social innovation.
- Then invited to pitch their idea to an international jury made up of scientists and business leaders.
- 12/50 candidates selected for grant.
- Each assigned mentor to help him or her develop business plan.
- Each taught how to pitch their idea to different audiences.
- Young inventors pitch their project to room full of potential investors.



Japan and Malaysia 8th ex aqueo for hosting PhD students in science and engineering



Ten countries host 89%
of international PhD students in
science and engineering fields.

Malaysia plans to attract
200,000 students by 2020
(56,000+ in 2012, double number in 2007,
mainly from)

