7th FEIAP Convention

Engineering Resilience and Education

Building Blocks for the Net-Zero Future

May 1st, 2024 Taipei, Taiwan

Er. TAN Seng Chuan

President-Elect, World Federation of Engineering Organization

Emeritus President, The Institution of Engineers, Singapore

- The peak international organization for the engineering profession
- Founded in 1968
- Under the auspices of UNESCO
- 90+ national engineering institutions
- Representing some 30 million engineers

- Associate NGO at UNESCO
- Co-leader of the Scientific and Technological Community Major Group at the UN
- 13 x Standing Technical and Policy Implementation Committees and Working Groups
- Executive Council and Executive Board
- General Assembly
- Supported by a secretariat based in Paris

Engineering for Sustainable Development

UNESCO World Engineering Day for Sustainable Development - 4th March of the Year

A WFEO led initiative that celebrates engineers worldwide, launched in 2020

- Since WED 2022, two new international events are held: the 4 March LIVE streaming of engineers' events from around the world and the World Engineering Day Students Hackathon.

100+ Global Events - Webinars, Stream, Talks and Competitions, from over 80 countries covering all continents, reached more than 56 million via social media channels.

Every one of the UN Sustainable Development Goals is advanced through engineering

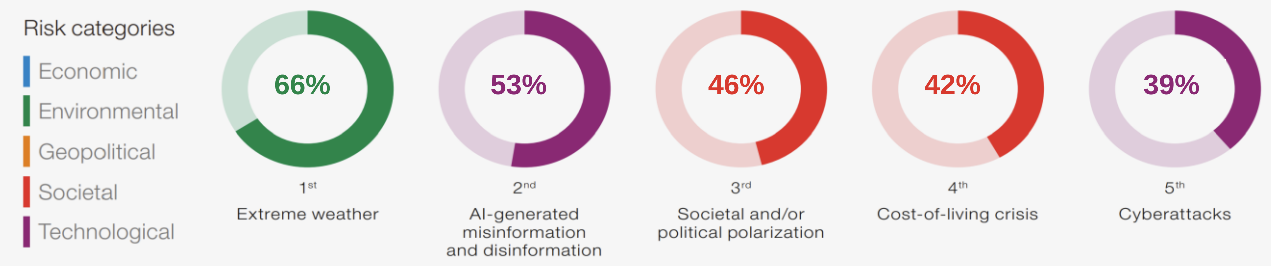
Impact of Climate Change

Global Risk - Current Risk Landscape

Global risks ranked by severity over a 2 year and 10-year period

- Trajectories relating to global warming and related consequences to Earth system (Climate change)
- Changes in the size, growth and structure of populations around the world (Demographic bifurcation)
- Developmental pathways for frontier technologies (Technological acceleration)
- Material evolution in the concentration and sources of geopolitical power (Geostrategic shifts)

Source
World Economic Forum Global Risks Perception Survey 2023-2024.



Rank	2 years	Rank	10 years
1st	Misinformation and disinformation	1st	Extreme weather events
2nd	Extreme weather events	2nd	Critical change to Earth systems
3rd	Societal polarization	3rd	Biodiversity loss and ecosystem collapse
4th	Cyber insecurity	4th	Natural resource shortages
5th	Interstate armed conflict	5th	Misinformation and disinformation
6th	Lack of economic opportunity	6th	Adverse outcomes of AI technologies
7th	Inflation	7th	Involuntary migration
8th	Involuntary migration	8th	Cyber insecurity
9th	Economic downturn	9th	Societal polarization
10th	Pollution	10th	Pollution

Mean near-surface temperature anomalies

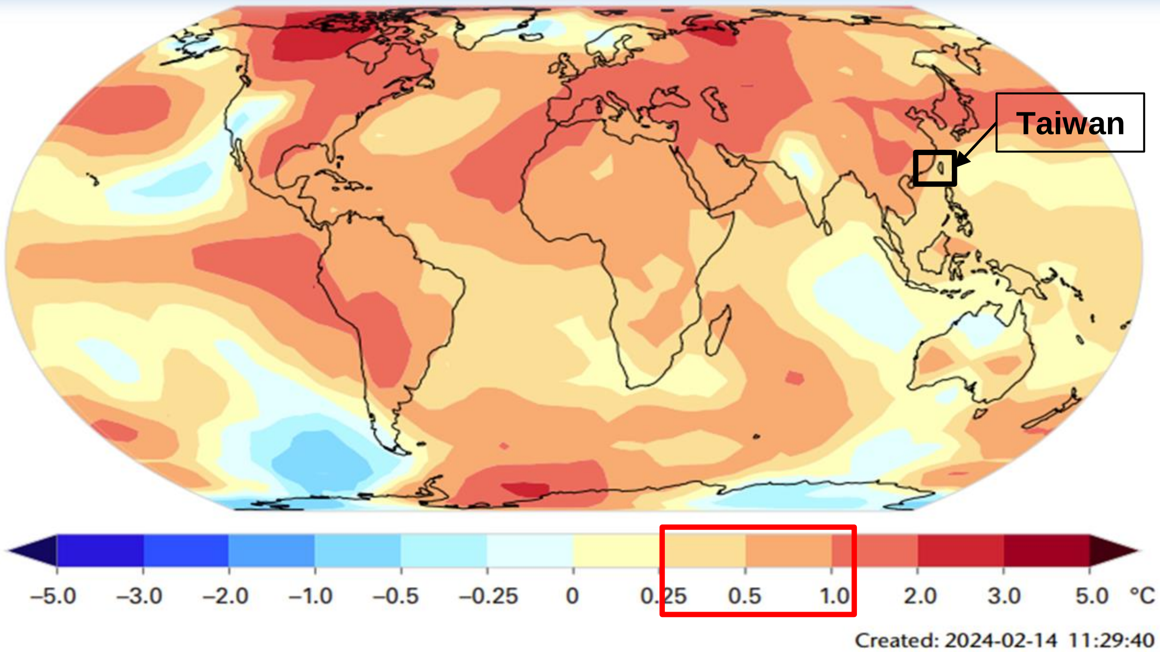
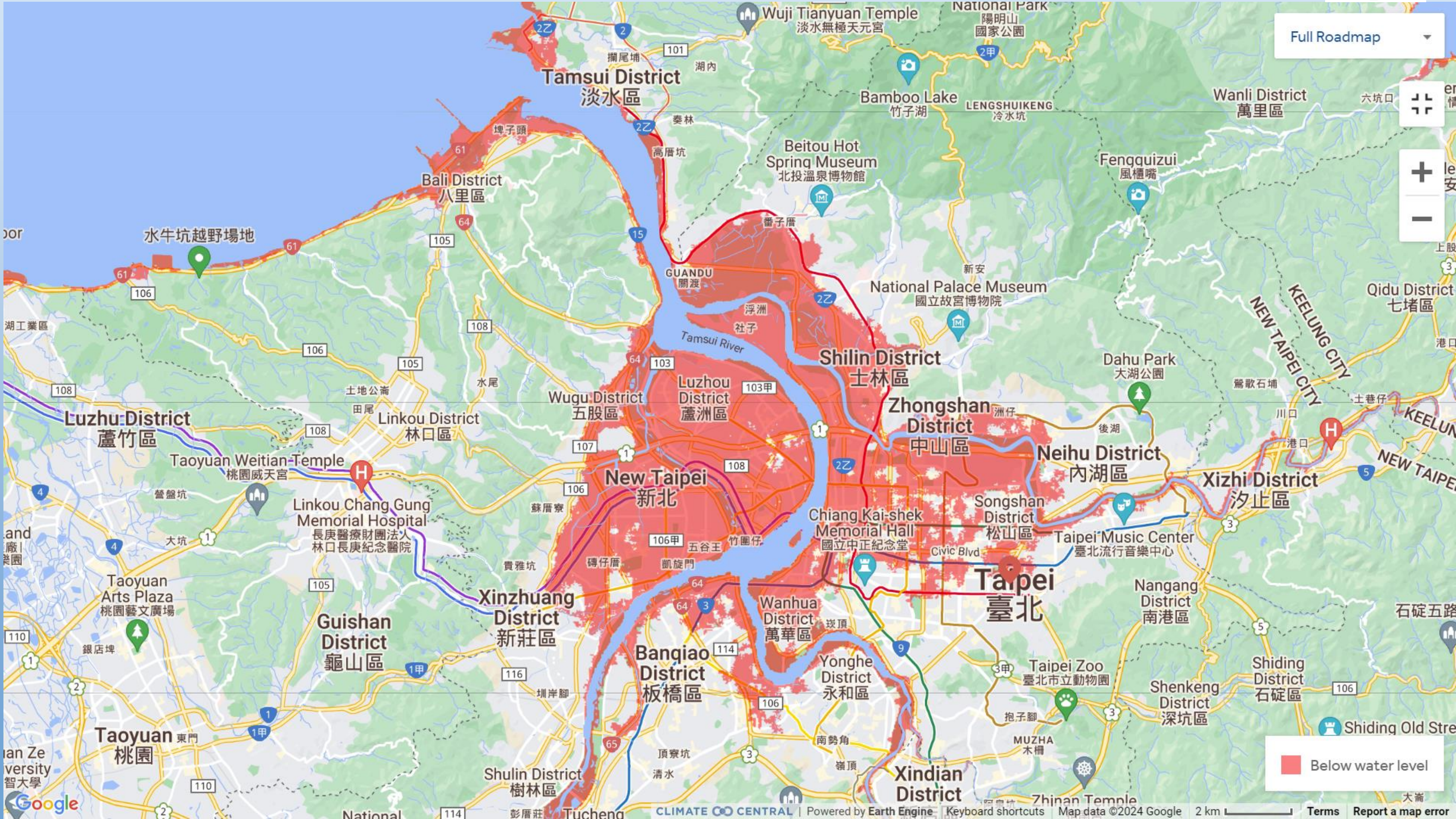


Figure 3. Mean near-surface temperature anomalies (difference from the 1991–2020 average) for 2023. Data are the median of six data sets as indicated in the legend, see Data set and methods for details.

Source: World Meteorological Organisation 2023

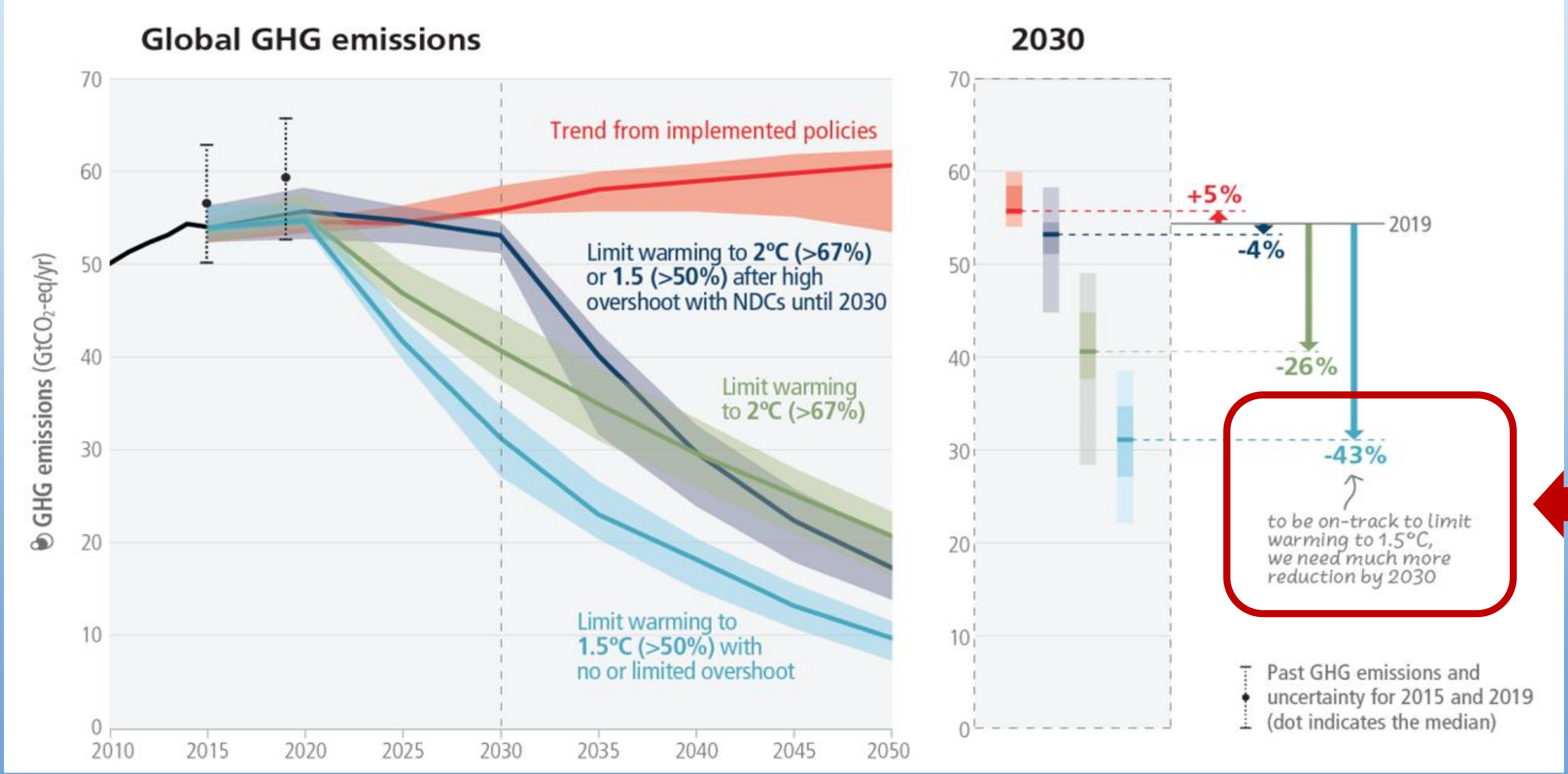
Sea Level Rise Scenarios in Taipei

- 1 m
- 2 m
- 3 m
- 4 m
- 5 m



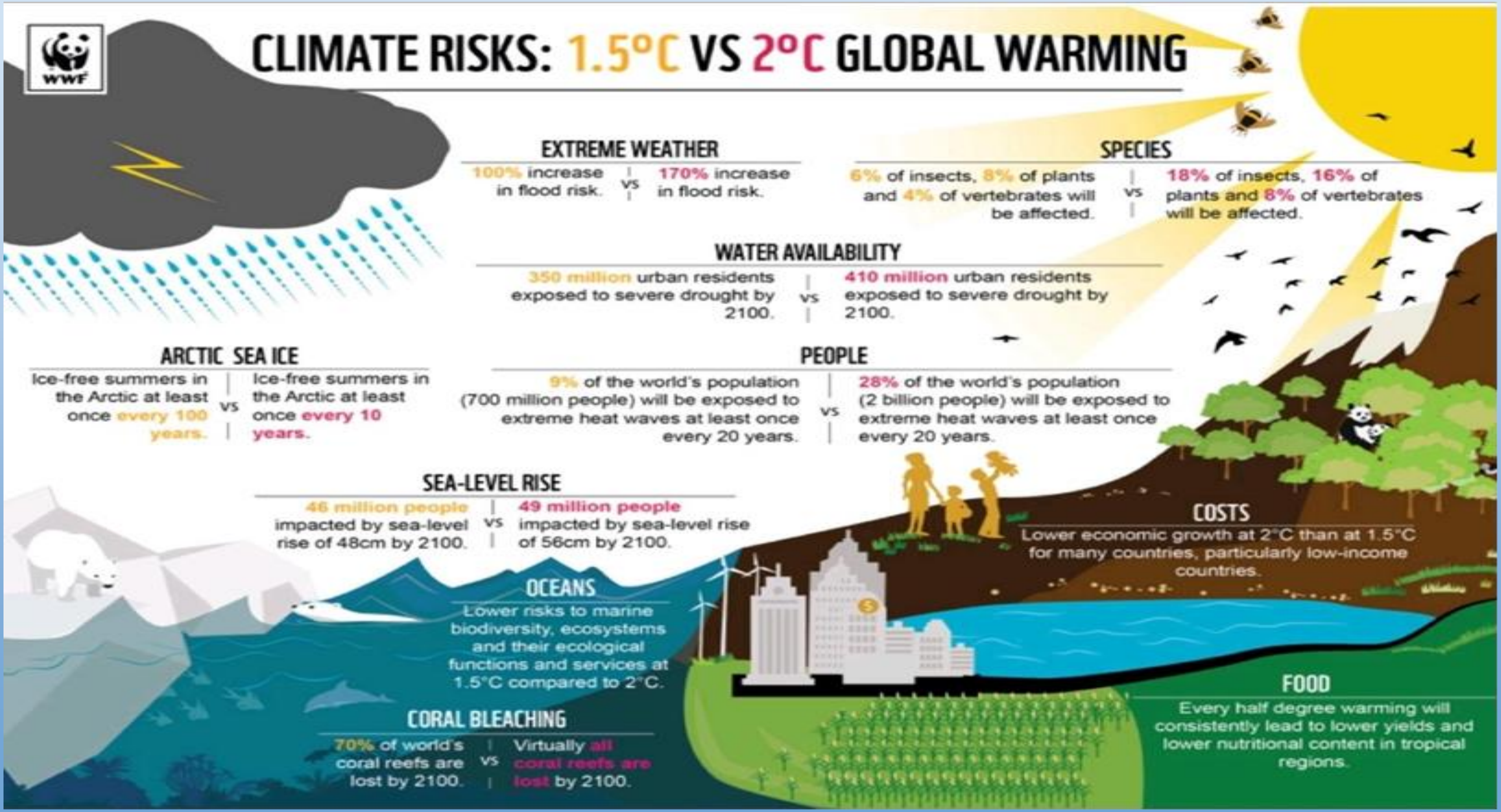
Source: Climate Central 2024

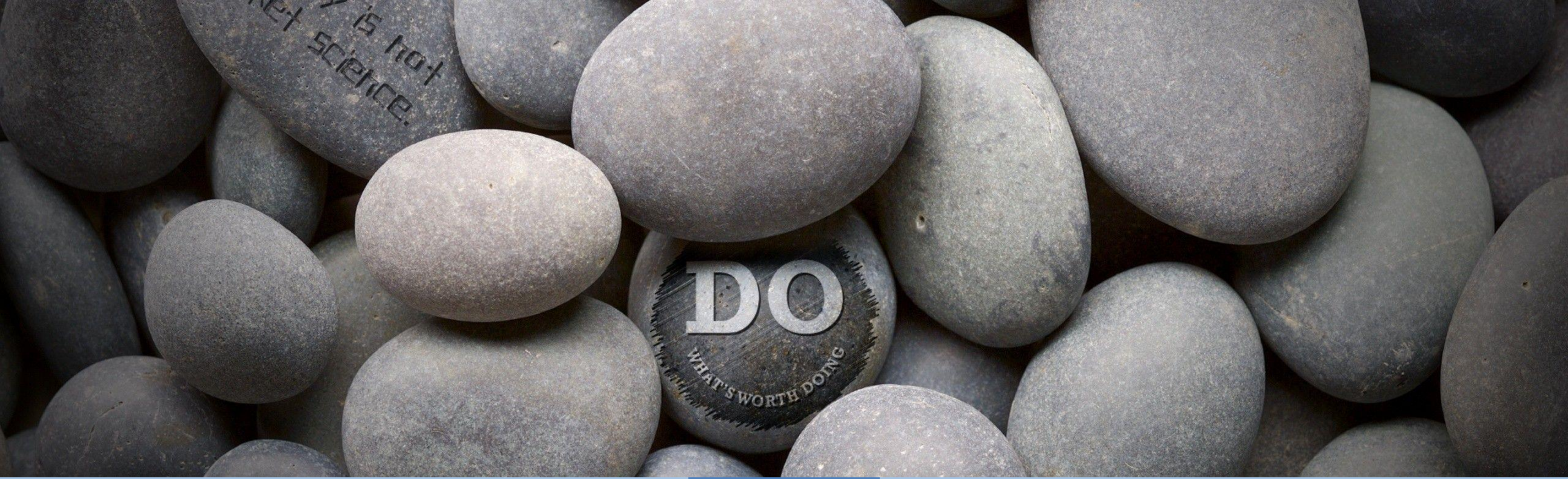
Projected Global GHG Emissions



Source: IPCC, 2023, AR6 Synthesis Report

Climate Risk – Global Warming





INFRASTRUCTURE DEVELOPMENT

Demand for Infrastructure in APAC

Developing Asia requires $26 trillion from 2016 to 2030, or $1.7 trillion per year to sustain economic growth, reduce poverty, and respond to climate change.

Table 4.6: Climate-adjusted Infrastructure Investment Needs under Low and High GDP Growth Scenarios, 2016–2030
($billion in 2015 prices)

Region	Low Growth Scenario				High Growth Scenario			
	Projected Average GDP Growth	Infrastructure Needs	Average	% of GDP	Projected Average GDP Growth	Infrastructure Needs	Average	% of GDP
Central Asia	2.1	526	35	7.9	4.1	605	40	7.6
East Asia	4.1	14,807	987	5.3	6.1	17,389	1,159	5.2
PRC	4.6	14,097	940	5.9	6.6	16,504	1,100	5.7
South Asia*	5.5	5,930	395	9.0	7.5	6,777	452	8.5
India	5.8	4,811	321	9.0	7.8	5,504	367	8.5
Southeast Asia	4.1	2,951	197	5.9	6.1	3,355	224	5.5
Indonesia	4.5	1,158	77	6.3	6.5	1,304	87	5.8
The Pacific	2.1	43	2.9	9.3	4.1	49	3.3	8.8
Asia and the Pacific	**4.3**	**24,257**	**1,617**	**6.0**	**6.3**	**28,175**	**1,878**	**5.8**

GDP = gross domestic product; PRC = People's Republic of China.
*Pakistan and Afghanistan are included in South Asia.
Source: ADB estimates.

Infrastructure Emissions and Adaptation Cost

Figure 2: Infrastructure sector contribution to total GHG emissions.[14,15,16]

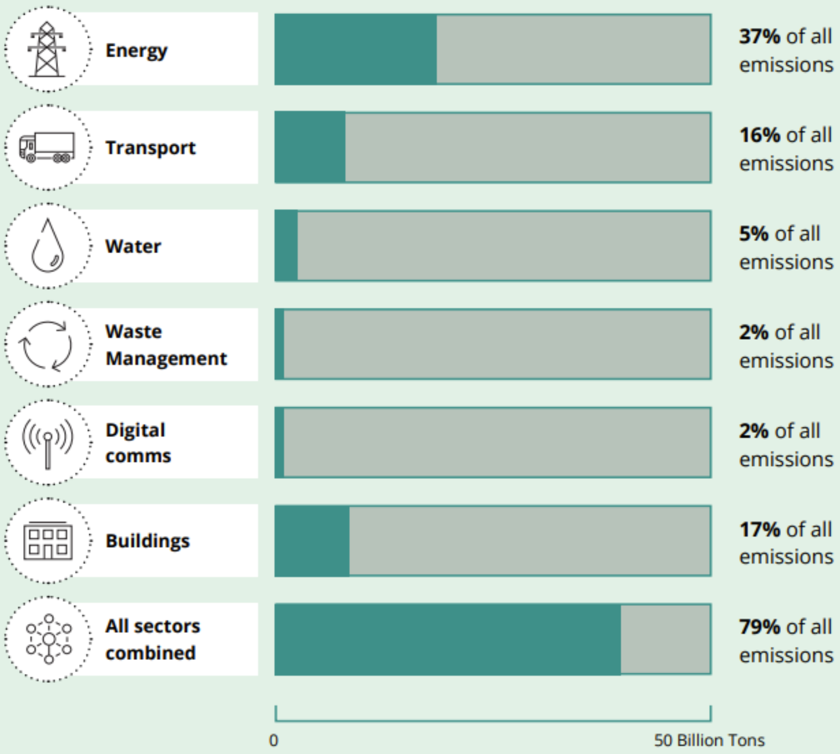
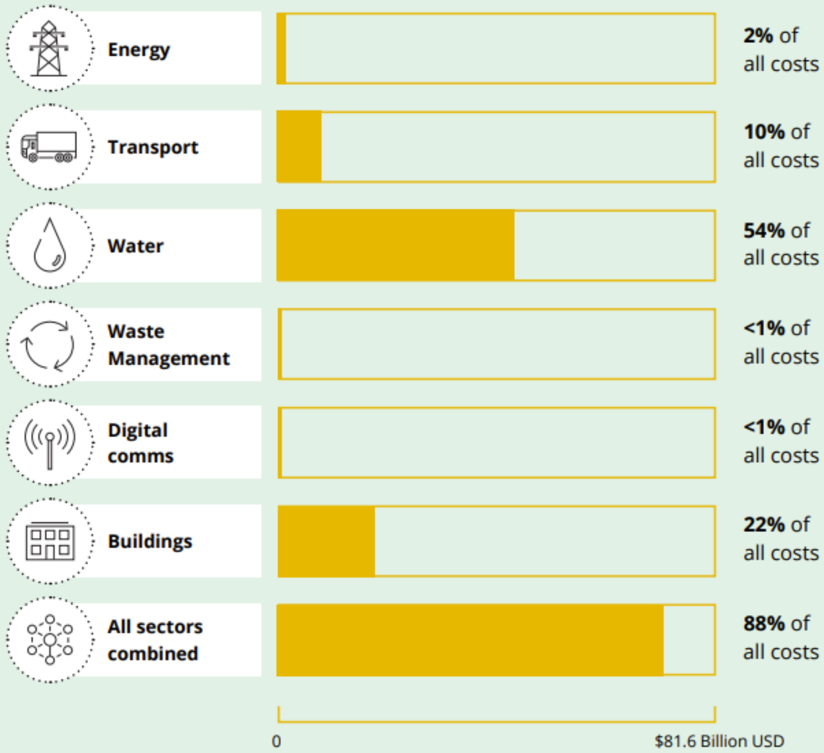


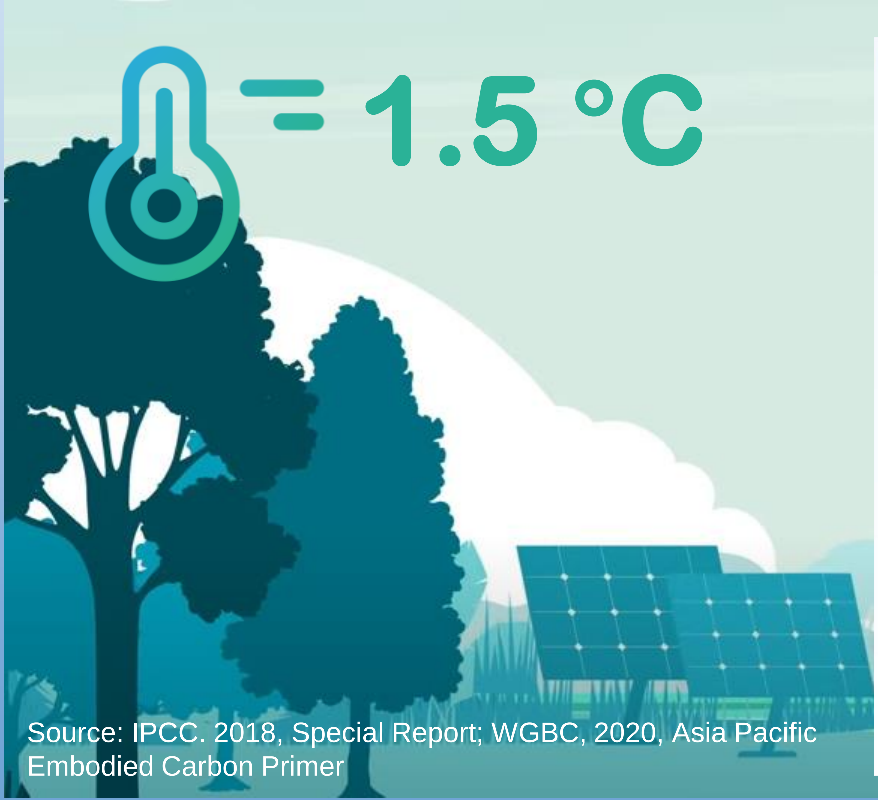
Figure 3: Infrastructure sector share of global climate adaptation costs (2010-50 estimates).[19]

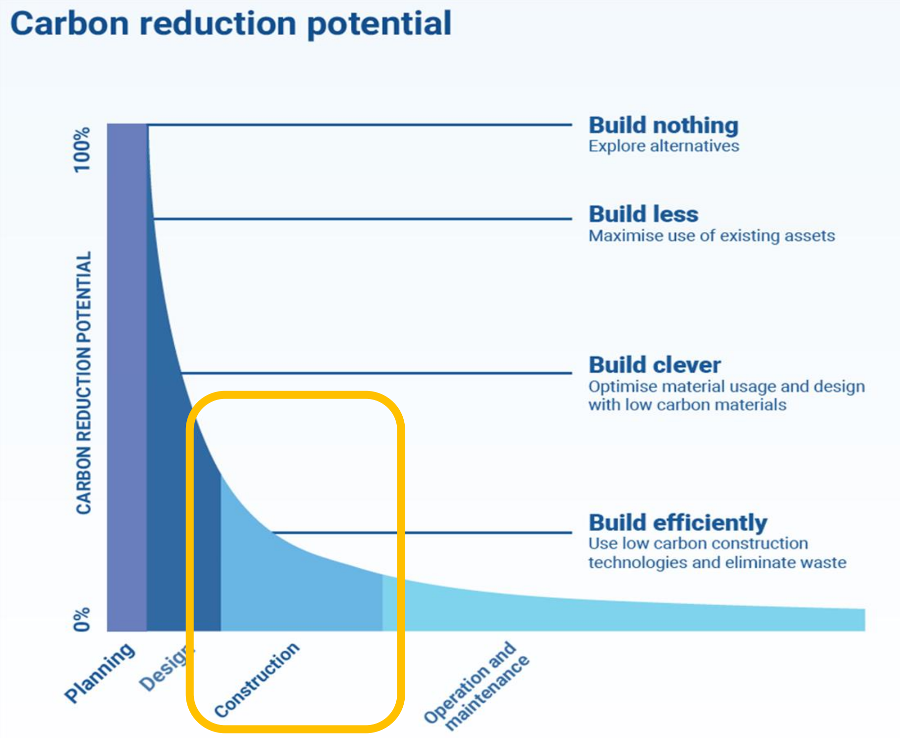


Source: UNEP, 2021, International Good Practice Principles for Sustainable Infrastructure

Carbon Reduction Potential Towards Net-Zero

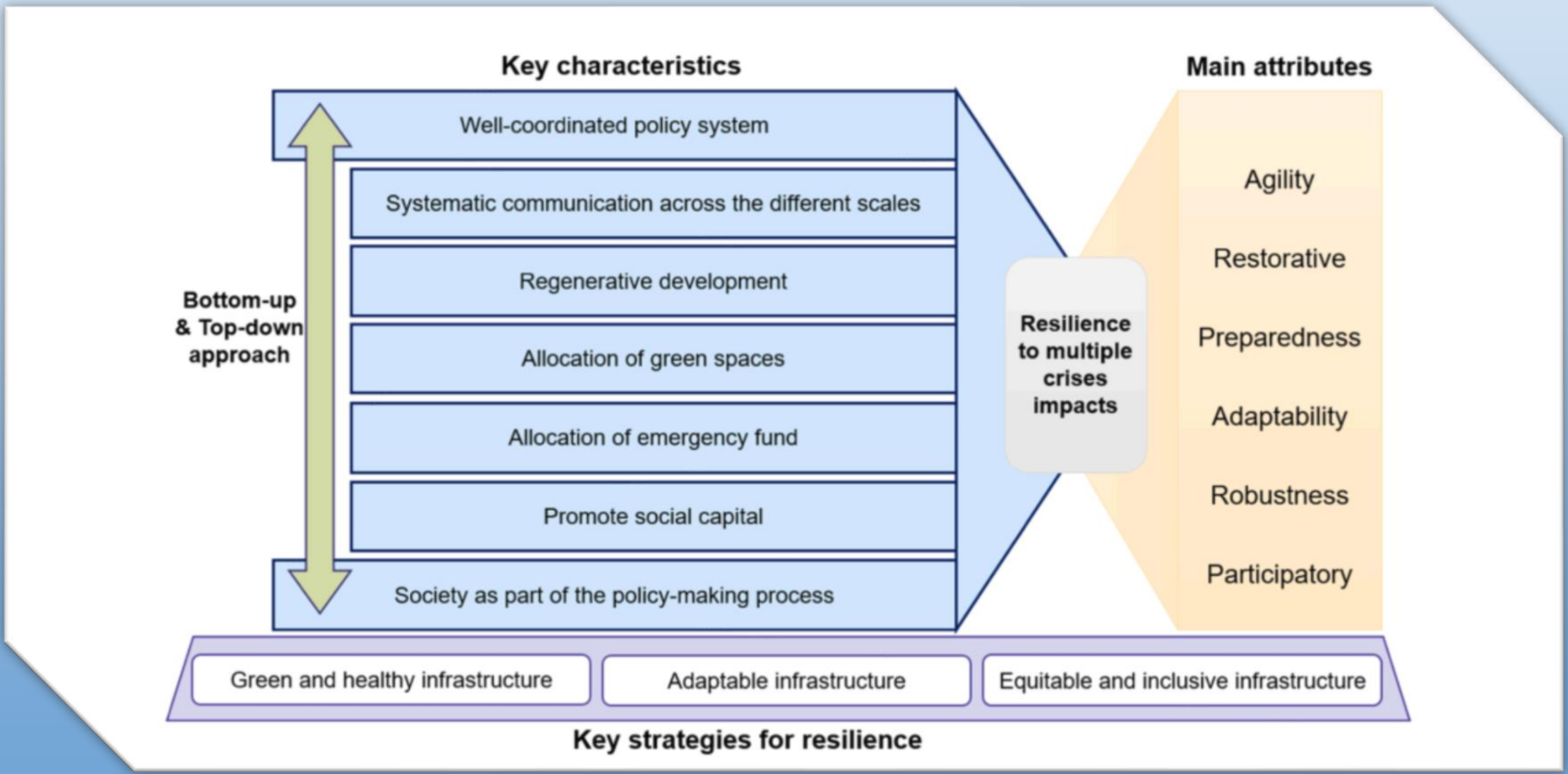
Global GHG Emissions must reach Net-zero between 2040 & 2055 to limit global temperature rise to 1.5°C.





Source: IPCC. 2018, Special Report; WGBC, 2020, Asia Pacific Embodied Carbon Primer

Framework of Resilient Infrastructures



Source: Science Direct: Sustainable Cities and Society, volume 87, 2022

INNOVATIVE TECHNOLOGY

Case Study (Singapore) - Food & Agriculture Sector

Agriculture Innovation to achieve a 30% of domestic food production by 2030

Growing Investments in AgriTech

- SEEDS Capital - Co-invest more than $65 m
- Research Innovation Enterprise 2020 Plan- $105m to ramp up R&D

IoT data analytics allow farms to control environmental conditions and the growth of crops.

Hydroponics Systems eliminate the need for pesticides and fertilizer, while optimising the nutritional value of harvested plants.

Credit: UNDP, Global Centre for Technology, Innovation and Sustainable Development

Case Study (Taiwan) - Taipei 101 Innovative Engineering

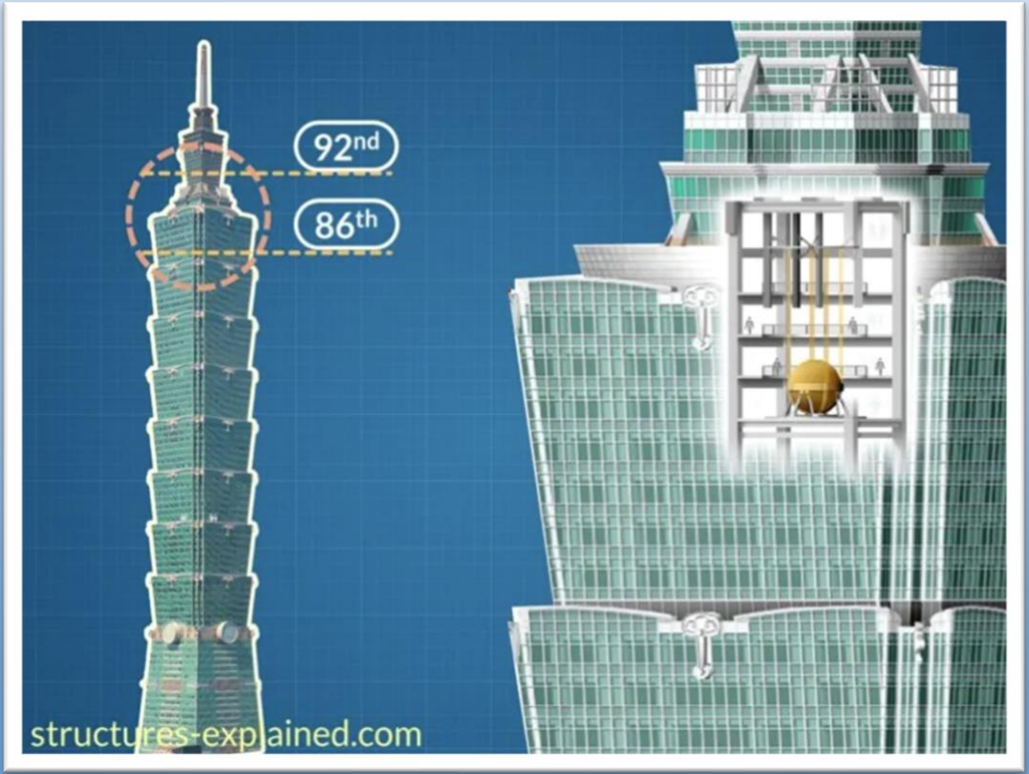
Exemplifies a resilient infrastructure

Advanced engineering combating natural disasters

Innovative tuned mass damper suspended within the tower

Reduces building's sway up to 40% during seismic activity

Withstood a powerful 7.4-magnitude earthquake with minimal damage



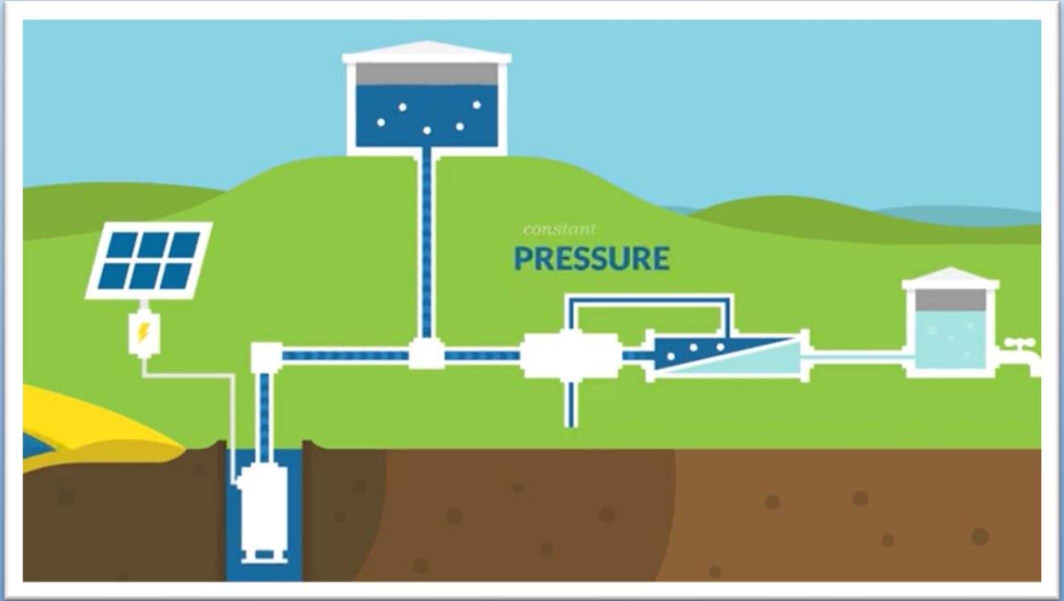
Source: Economic Times 2024

Case Study (Netherlands) - Solar Desalination

Clean water from abundant resources

Utilize solar energy to desalinate salt-water

Save up to 70% on water expenses	Sustainable using unlimited resources
Independent and reliable supply	Stress-free operation & remote monitoring



Source: Elemental Water Makers – Solar desalination project

Case Study (Singapore) - Infrastructure Sector

Some of the adaptive measures

Growing Investments in Adaptation Measures

- **Flood Resilience**
- **Protecting Coastal**

Upgrade of the Bukit Timah First Diversion Canal

Credit: The Business Times, Jan 12, 2021

Polder Development: It has a comprehensive water management system with interconnected drainage, Central pumping system and drainage pumping station

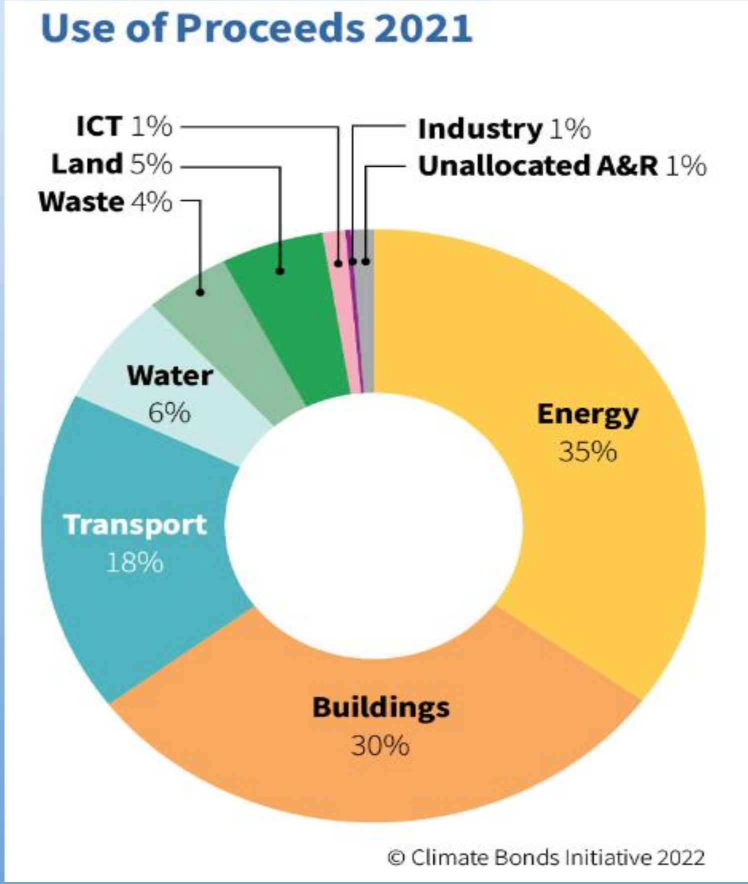
Credit: HDB

Engineering **for Sustainable Development**

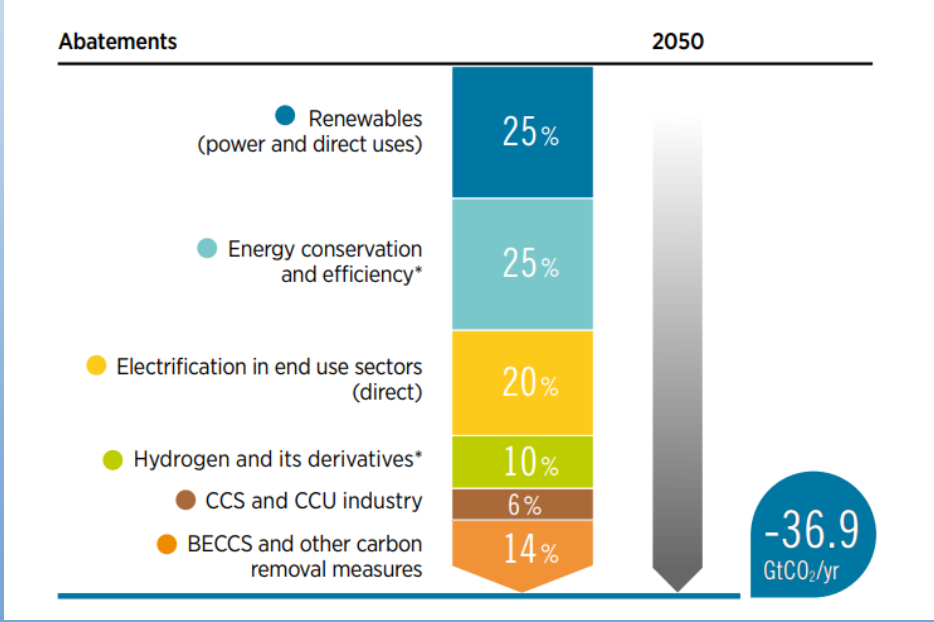
ENGINEERING EDUCATION

Knowledge sharing and collaboration

Opportunities Across Multiple Sectors



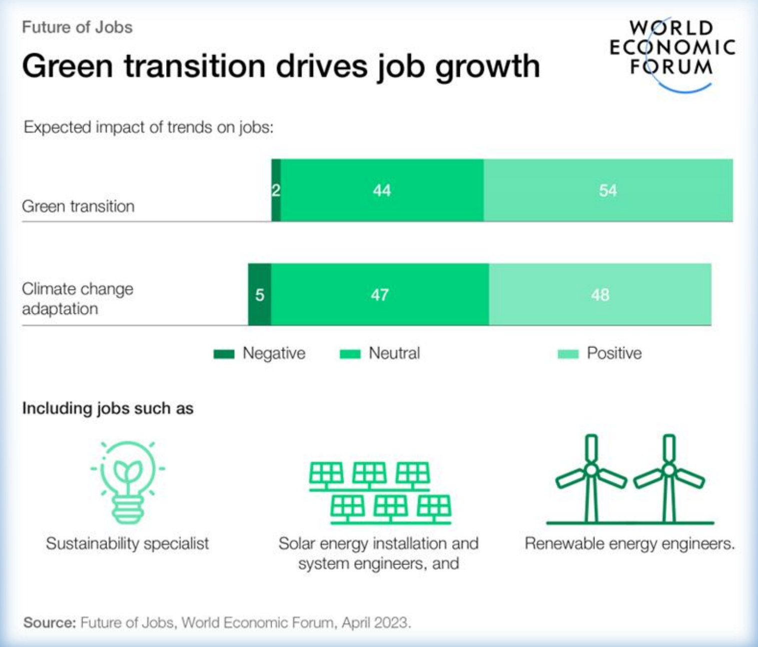
$500bn **Green Issuance** in 2021 channelled to engineering-centric

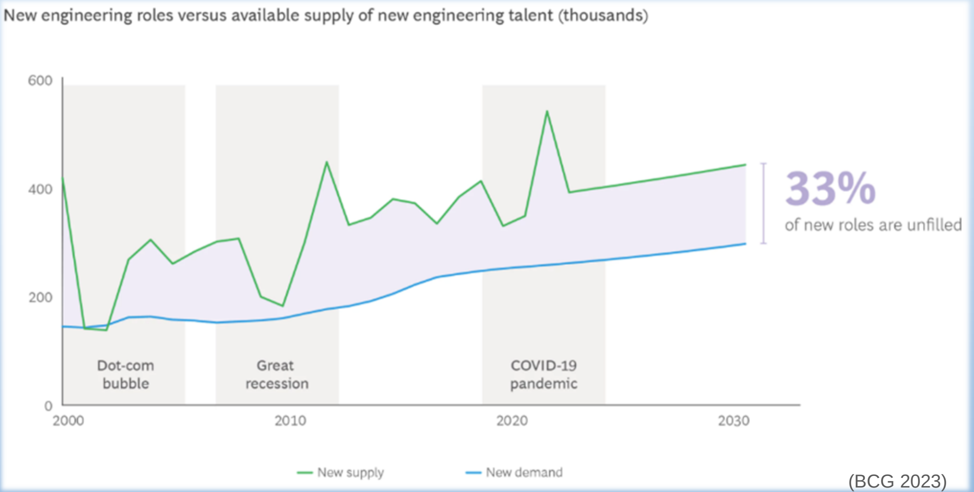


IRENA World Energy Transitions Outlook (2021)

Source: https://www.climatebonds.net/2022/01/500bn-green-issuance-2021-social-and-sustainable-acceleration-annual-green-1tn-sight-market

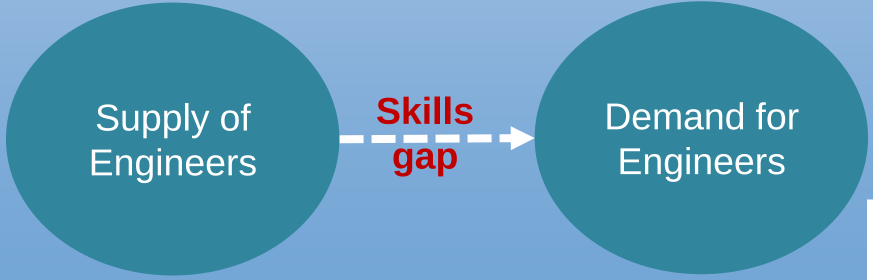
Global Demand for Engineers and Skills Gap





(BCG 2023)

Our analysis of Bureau of Labor Statistics (BLS) data also indicates that **demand for engineering skills will grow by about 13%** from 2023 to 2031. (BCG 2023)



Source: BCG 2023 & Weforum 2023

Global Shortage of Engineers

Taiwan's PSMC says chip engineer shortage top challenge in Japan

Chipmaker's local head proposes joint school to train young people

TOKYO -- A shortage of engineers is the "most difficult" challenge facing Taiwan's Powerchip Semiconductor Manufacturing Corp. (PSMC) as it prepares to build a plant in Japan, with a recent wave of global chipmakers investing in the country expected to exacerbate the battle for talent.

NIKKEI Asia

Civil engineer shortage leaves local govts in lurch

The declining number of civil engineers at local governments across Japan is starting to negatively affect authorities' abilities to respond to natural disasters.

According to the Land, Infrastructure, Transport and Tourism Ministry, the number of such engineers has fallen almost 30% in 20 years due to budget constraints and administrative reforms, forcing local governments to rely on limited personnel to handle disaster reconstruction projects.

THE JAPAN NEWS BY THE YOMIURI SHIMBUN

Japanese Ministry of Economy has predicted a deficit of over 700,000 engineers in Japan by 2030. (BCG 2023)

The UK faces a shortfall of 1m engineers by 2030, new research has found, threatening major infrastructure projects.

Demand for engineering expertise is on the rise, according to strategy firm Stonehaven, with 184 major engineering projects announced in the UK since 2020. Those projects have a total value of £542bn and are expected to create 1.2m jobs.

Institution of MECHANICAL ENGINEERS

SCRIPPS NEWS

The US is facing a critical shortage of high tech engineers

According to the U.S. Bureau of Labor Statistics, between 2016 and 2026 there has been and will be a shortfall of six million engineers, or more.

Global Level Climate Action: 2030 Agenda

Engineering plays a critical role in achieving all the SDGs

Future Engineering Education

Achieving the SDGs requires engineers who can deal with ill-defined, inter-disciplinary and complex challenges for the future

Recognized & Required Competencies

1. Normative Thinking
2. Strategic Thinking
3. Systems Thinking
4. Collaboration Competency
5. Critical thinking Competency
6. Self-awareness Competency
7. Integrated Problem-Solving Competency
8. Continuous Learning
9. Interdisciplinary Work Competences
10. Interpersonal Competences
11. Anticipatory Competency

Source: https://doi.org/10.1080/03043797.2022.2033955; https://en.unesco.org/sites/default/files/gap_pn1_-_esd_and_the_sdgs_policy_brief_6_page_version.pdf

Engineering Learning Platform and Professional Competency

- **WFEO Academy** – **online training for continuous education**
  - Part of the WFEO Engineering 2030 Plan to enable more countries to have more engineers with the right skills for sustainable development.
- **IEA** - **Graduate Attributes and Professional Competencies** (GAPC) international benchmark (2021)
  - Engineering graduates from all programs accredited under the IEA Washington Accord can be expected to **have an understanding of sustainability** in the context of engineering practice in their field.

INTERNATIONAL ENGINEERING ALLIANCE

Engineering **for Sustainable Development**

The world's engineers
united in rising to
the world's challenges.
For a better, sustainable world.

World Federation of Engineering Organizations
Fédération Mondiale des Organisations d'Ingénieurs

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