Asia-Pacific Economic Cooperation

WFEO / FMOI

Regional Industry-Academia Collaboration for Talent Development and Inclusive Growth: Skill Training, Internship, Jobs and Women

Engineering Education Cultivation:
Transformation for Sustainable Development, Diversity and Inclusion

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World Federation of Engineering Organisations (WFEO)
7 May 2021

TOPICS

1. **Engineering and the World Federation of Engineering Organizations**

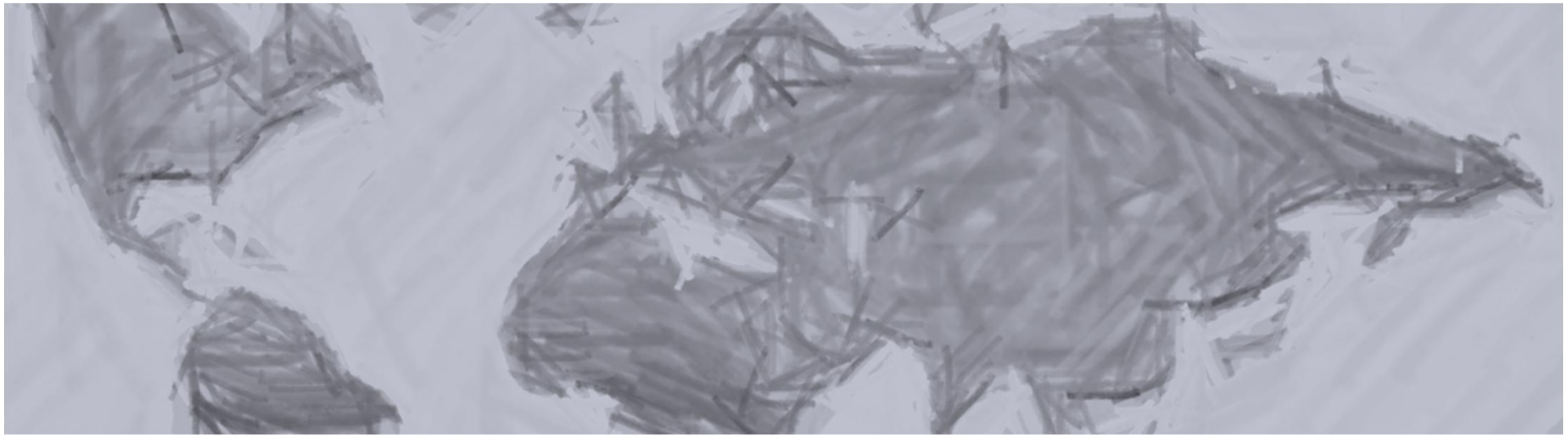
2. **Engineering challenges for the 21st Century**

3. **The Diversity imperative for engineering**

4. **Positive steps for real change – the transformation of engineering education for a molre diverse and inclusive profession**

TOPICS

1. **Engineering and the World Federation of Engineering Organizations**



The World Federation of Engineering Organizations:

- The peak body for professional engineering organizations
- Founded in 1968
- Under the auspices of UNESCO
- 100+ national professional engineering institutions
- 12 international and continental/regional professional engineering institutions
- Representing 30 million engineers

Engineering for Sustainable Development

Algeria
Argentina
Australia
Bahrain
Bangladesh
Belize
Bolivia
Brazil
Bulgaria
Cameroon
Canada
Chile
China
Chinese Taipei
Colombia
Costa Rica
Croatia
Cuba
Cyprus
Czech Republic
Ecuador
Egypt
Ethiopia
Fiji
France
Germany
Ghana
Greece
Honduras
Hong Kong, China
Hungary
India
Iraq
Italy
Ivory Coast
Japan
Jordan
Kenya
Korea
Kuwait
Lebanon
Libya
Macedonia (FYROM)
Madagascar
Malawi
Malaysia
Malta
Mauritius
Mexico
Moldavia
Mongolia
Montenegro
Morocco
Nepal
New Zealand
Nigeria
Pakistan
Palestine
Peru
Poland
Portugal
Puerto Rico
Qatar
Romania
Russia
Rwanda
Saudi Arabia
Senegal
Serbia
Sierra Leone
Singapore
Slovakia
Slovenia
South Africa
Spain
Sri Lanka
Sudan
Switzerland
Syria
Tanzania
The Philippines
Tunisia
Turkey
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
Uruguay
Yemen
Zambia
Zimbabwe

Founded under the auspices of UNESCO and Recognised NGO

Co-Chair - Major Science and Technology Group at UN

Representation at major UN Organisations

Based in Paris at UNESCO

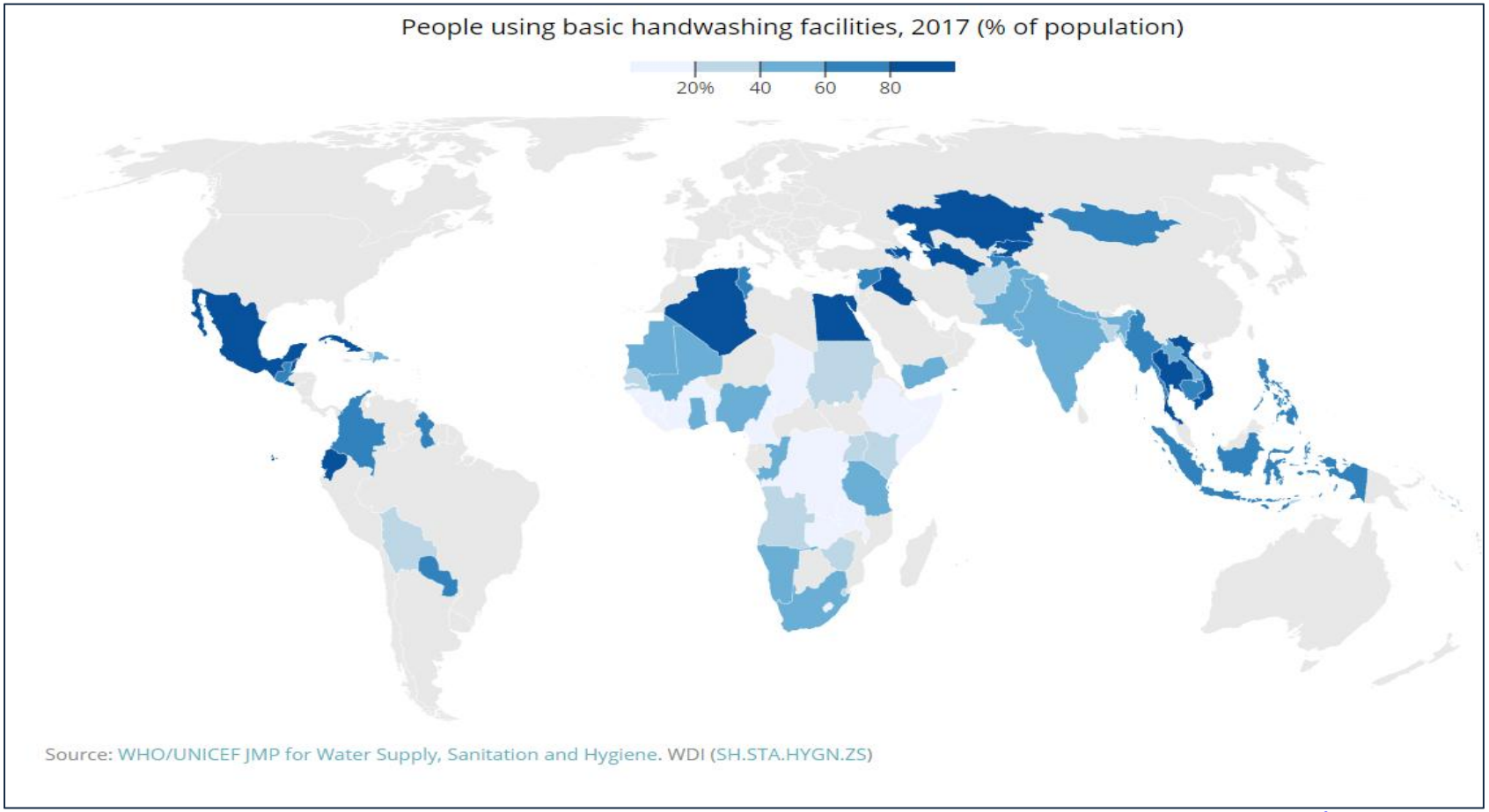
Engineering and the UN Sustainable Development Goals

- **A key objective of the World Federation of Engineering Organizations is to advance the UN SDGs through engineering**
- **We need to ensure that we have more engineers with the right skills to develop the technologies and engineering solutions for sustainable development**

TOPICS

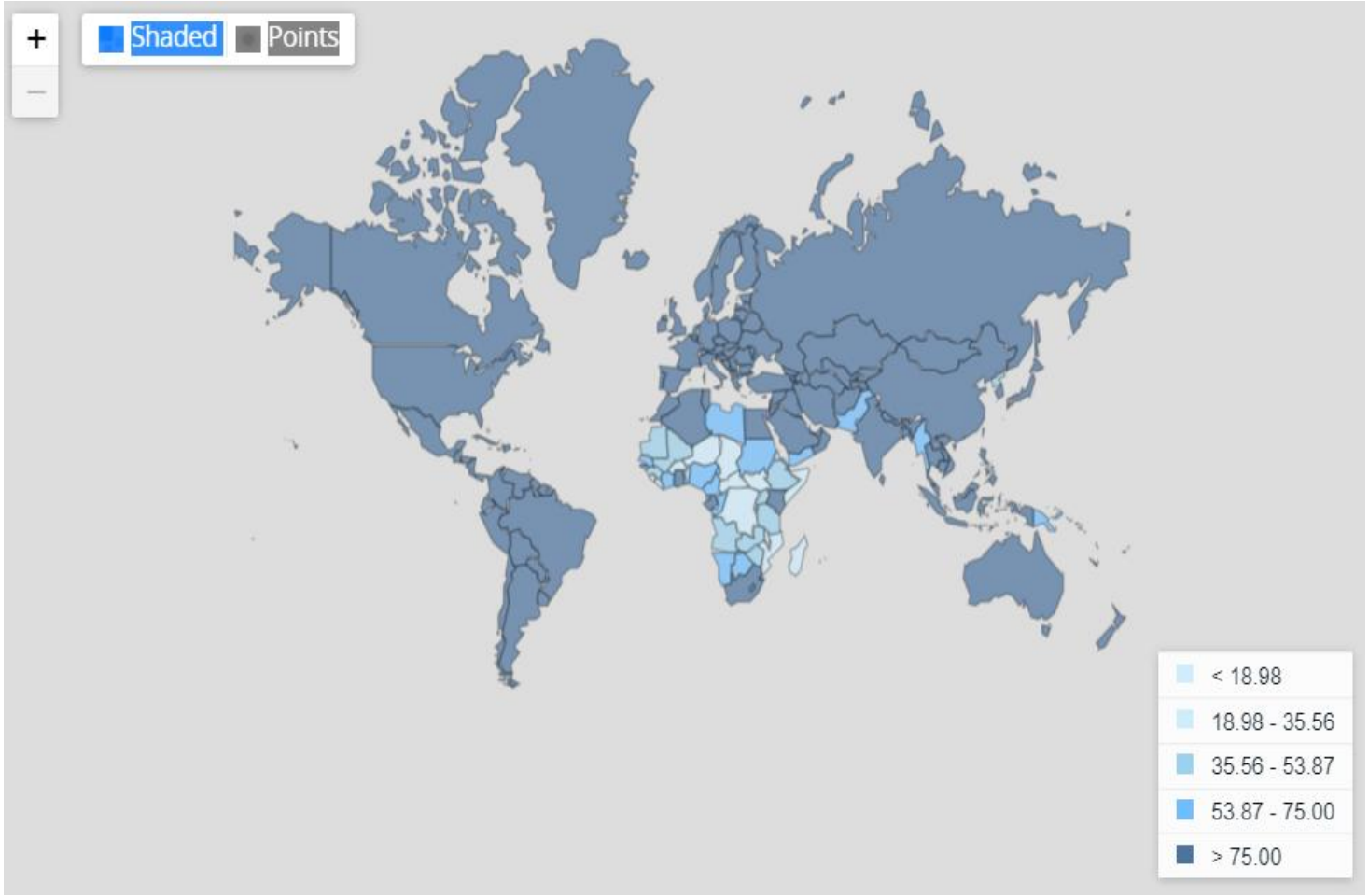
2. Engineering challenges for the 21st Century

Percent of Population with access to basic handwashing facilities, 2017



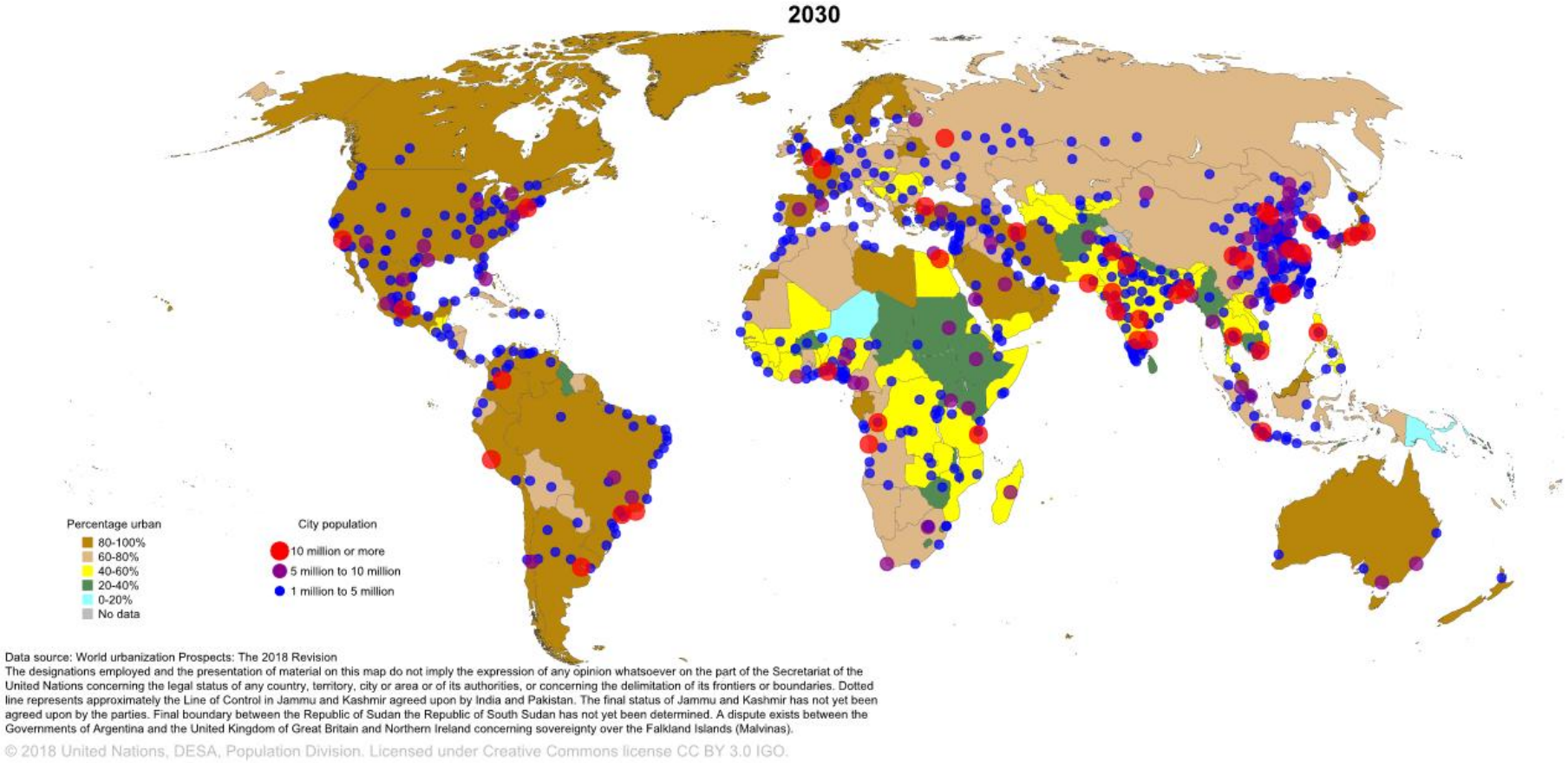
Source, World Bank SDG Atlas 2020, https://datatopics.worldbank.org/sdgatlas/goal-6-clean-water-and-sanitation/

Percent of Population with access to electricity, 2018



Source: World Bank Data, 2018, https://data.worldbank.org/indicator/SH.STA.ACSN?view=map

Largest Cities in the World in 2030

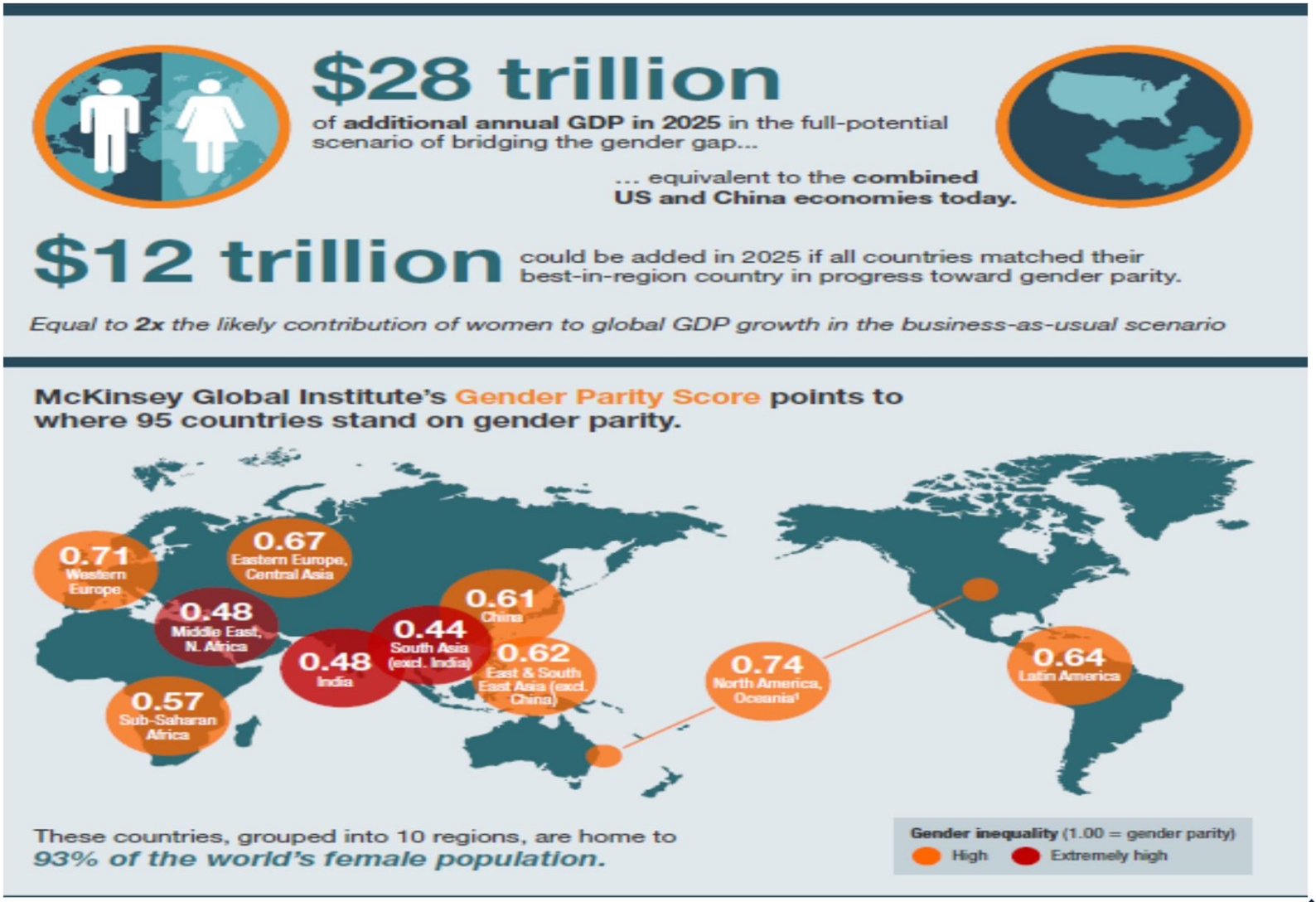


Source: UN: https://population.un.org/wup/Maps/

TOPICS

3. The Diversity Imperative for sustainable development

THE POWER OF PARITY

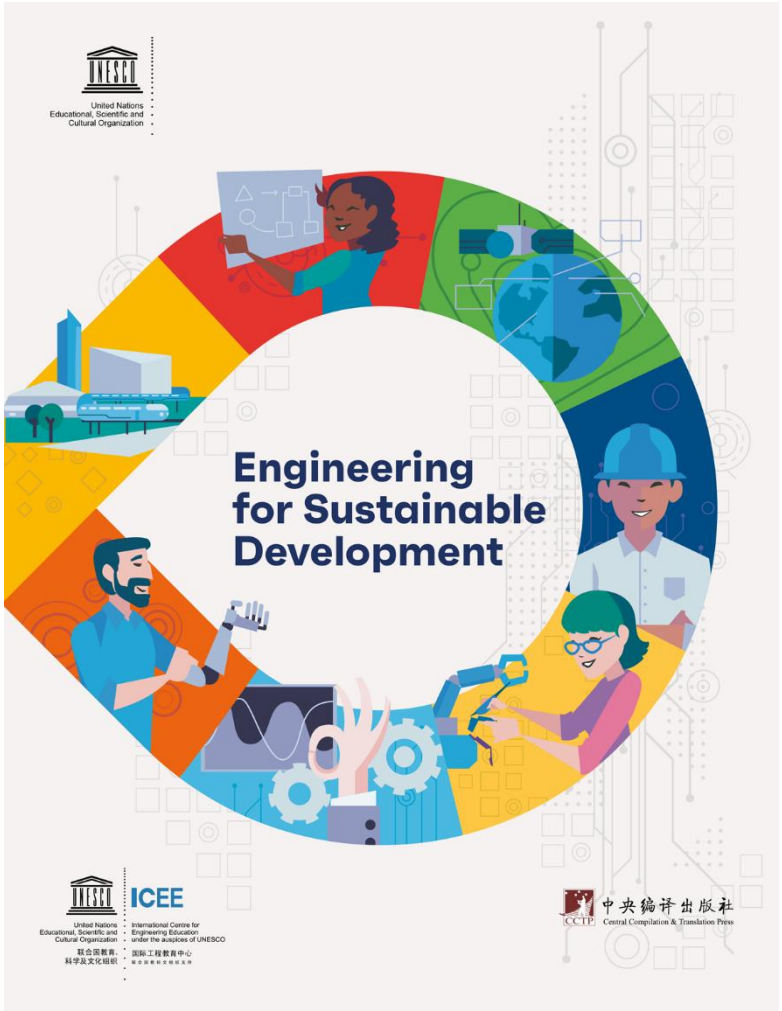


Source: McKinsey Global Institute, 2015

“The clear objective of our time is parity' rooted in women's empowerment” – UN chief Guterres

at Commission on Status of Women New York March 2017 -

UNESCO Engineering Report – Engineering for Sustainable Development, 4 March 2021



EN http://on.unesco.org/Eng2021, FR: http://on.unesco.org/Ing2021

ES http://on.unesco.org/Ingen21

***Engineering* for Sustainable Development**

Hero message on the need to encourage more women and girls into engineering

The UN Secretary General agrees on the need for more women engineers, Twitter, 5 March 2021, Celebrating World Engineering Day

Engineers need to ensure that women benefit from new technologies and also participate in the technology revolution so no one is left behind

Women engineers working on high voltage electrical systems. © Chinese Society for Electrical Engineering, Chapter 1, UNESCO Engineering Report.

- **We need more engineers especially women engineers!**
- **Engineers have developed technologies with enormous transformative potential in the digitally connected future workforce - including advanced automation, telecommunications, robotics and artificial intelligence.**
- **Women engineers are needed to contribute as diversity of thought is vital for innovation and the development of solutions that reflect community standards, values and aspirations for sustainable development.**
- **New technologies empowering women - mobile communications and the internet, for access to banking, entrepreneurship and improved outcomes for health, education and childcare.**

WHY WE NEED DIVERSITY IN ENGINEERING

RELEVANCE & SUSTAINABILITY

- Relevant team – Members of the engineering team are similar to the community – in terms if age, ethnicity, gender etc.
- Sustainable solutions – diverse teams will understand and reflect community and stakeholder values and expectations and maintain the social license to operate
- New technologies increasing disruption – Successful navigation of disruptive technologies needs diverse teams

GOVERNANCE

- Ethically sound – promotes good governance
- Efficient – makes best use of all human resources and brain power
- Equal opportunity for all – a basic human right

PERFORMANCE

- Encourages innovation and reduces risk, better decisions, avoids "group think", ensure a wide range of perspectives are considered
- Enhances business performance – financial, customer relationships, safety, sustainability
- Enhances reputation

Diversity is an opportunity that cannot be ignored

TOPICS

4. Working together for real change

A key goal is to ensure that engineering graduates have the attributes and skills to meet current and future needs by employers, industry and the community

Partnering with our international peers

- **This project has been progressed in partnership with our peer international organisations in engineering**
- **Together we are working on joint objectives in education, training and sustainable development**
- **Partnerships with:**
  - **International Engineering Alliance (IEA)**
  - **International Federation of Engineering Education Societies (IFEES)**
  - **Federation of International Consulting Engineers (FIDIC)**
  - **International Network for Women Engineers and Scientists (INWES)**
  - **International Centre for Engineering Education (ICEE, UNESCO Category II Centre) at Tsinghua University, China**
  - **International Science Technology and Innovation Centre for South-South Cooperation (ISTIC, Malaysia, UNESCO Category II Centre)**

UNESCO is a key partner for the review of engineering benchmarks for Graduate Attributes and Professional Competencies

The second UNESCO Engineering Report – "Engineering for the SDGs" recommends:

1. *"Government, engineering educators, industry and professional engineering institutions need to collaborate to increase the number and quality of engineers.*

2. *There is also a need to work in partnership to develop the necessary international engineering education benchmarks for sustainable development.*

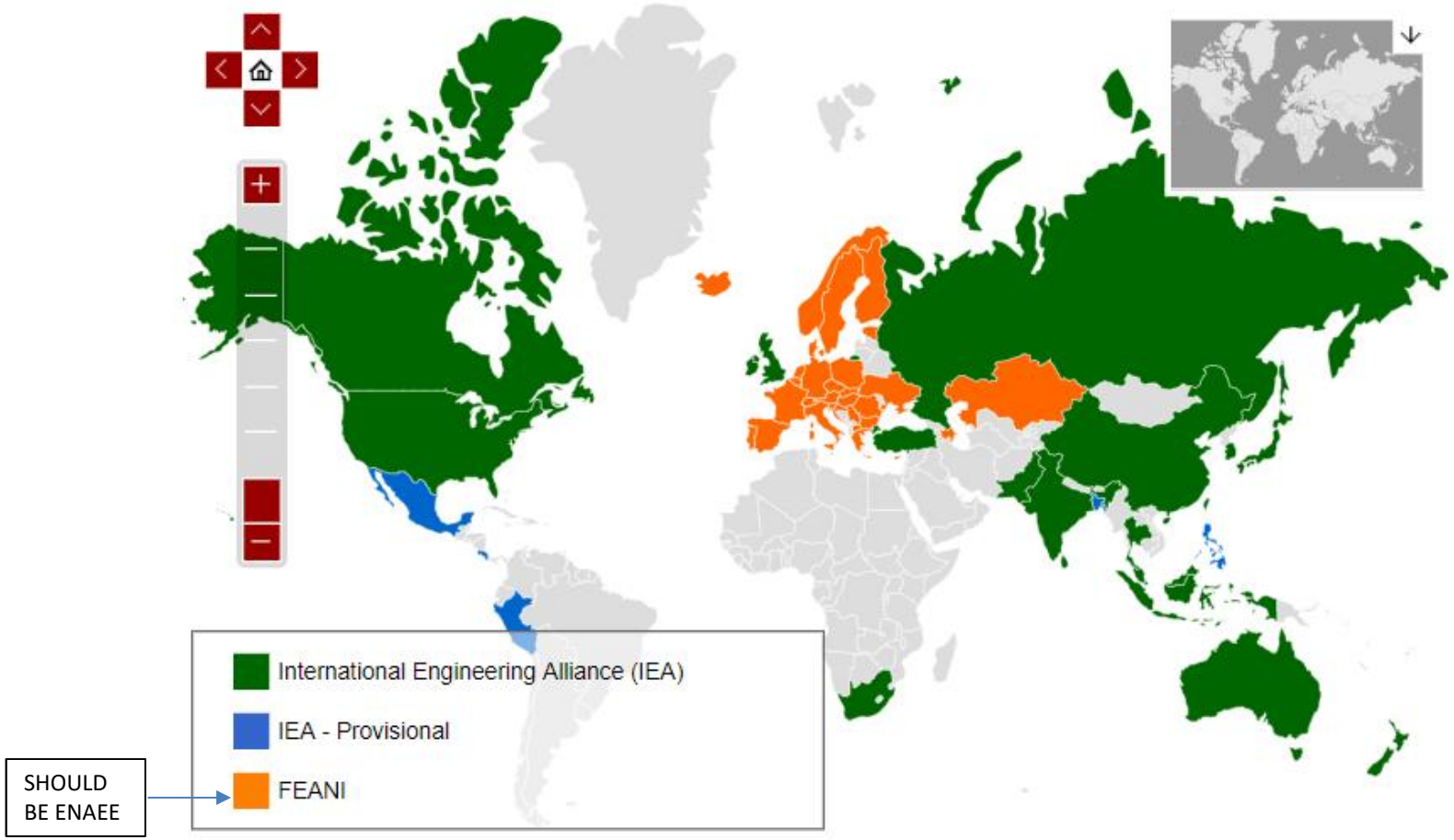
3. *These need to be recognised across the world and form the basis of national engineering education systems for engineers with the right skills especially Asia, Africa and Latin America."*

The International Engineering Alliance (IEA) and the benchmark Framework for Graduate Attributes and Professional Competencies (GAPC)

- **IEA is an umbrella organisation that provides governance for the three Accords and four Agreements that provide international multilateral recognition of graduate attributes and professional competencies across 30 countries.**
- **For graduation after tertiary engineering education course*:**
  - **Washington Accord – Professional Engineer usually 4-5 years**
  - **Sydney Accord – Engineering Technologist usually – 3-4 years**
  - **Dublin Accord – Engineering Technician usually -2 years**
- **After graduation for professional registration, after a period of work experience:**
  - **Intl. Professional Engr. Agreement – Prof. Engineer**
  - **Intl. Technologist Engr. Agreement – Eng. Technologist**
  - **Intl. Associate Engr. Agreement – Eng. Technician**
  - **APEC Engineering Agreement – APEC Region- Prof. Engineer**

* Note: The duration of academic formation will normally be at least sixteen years (Washington Accord), fifteen years (Sydney Accord) and 13 years (Dublin Accord).

Reach of International Engineering Alliance (IEA) Graduate Attribute and Professional Competency (GAPC) Benchmark



Source: https://www.engc.org.uk/international-activity/international-relationships-map/

The IEA GAPC Benchmark: Context

- **GAPC are stated generically and are applicable to all engineering disciplines**
- ***Graduate attributes* form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The attributes are clear, succinct statements of the expected capability.**
- ***Professional competency profiles* record the elements of competency necessary for competent performance that the professional is expected to be able to demonstrate in a holistic way at the stage of attaining registration.**

- **The graduate attributes identify the distinctive roles of *engineers, technologists and technicians***
- **The professional competency profiles are written for each of the three categories: *engineer, engineering technologist and engineering technician* at the point of registration**

Example – civil engineering - skills needed by engineers of the future

- **It is estimated that 90% of the work of civil engineers is embedded in the excellent codes and standards that underpin much of civil engineering. These can be used to build automated systems that may take over routine design work and tasks that once took many months of effort will be processed by a computer in a matter of hours.**
- **Building Information Modelling (BIM), Simulation, optimization, and automation are transforming civil engineering and will be used for many tasks with little human intervention.**

Engineering needs more brain power not muscle power

***Engineering* for Sustainable Development**

Key areas for change

1. **Accommodate future needs** of engineering professionals and the profession – strengthen the required attributes on team work, communication, ethics, sustainability.
2. **Emerging technologies** – incorporate digital learning, active work experience, lifelong learning.
3. **Emerging and future engineering disciplines and practice areas** – while retaining discipline independent approach, enhance the skills on data sciences, other sciences, life-long learning.
4. **Incorporate UN Sustainable Goals** - in the development of solutions that consider diverse impacts – technical, environment, social, cultural, economic, financial and global responsibility **AND LEAVE NO ONE BEHIND**
5. **Diversity and Inclusion** – include these considerations within ways of working in teams, communication, compliance, environment, legal etc. systems.
6. **Intellectual agility, creativity and innovation** – emphasize critical thinking and innovative processes in design and development of solutions

Structure of GAPC Framework

The GAPC Comprises five tables:

1. **Table 1: Range of Problem Solving Capabilities** that distinguish the 4-5-year programs with engineer graduates from those that have a teaching duration of 3-4 years for technologists or 2 years for graduating technicians. Distinguishes between complex, broadly-defined and well-defined engineering problems.
2. **Table 2: Range of Engineering Activities** for an engineer, a technologist, and a technician, respectively.
3. **Table 3: Knowledge and Attitude Profile** of a graduate of an engineering program, i.e. the minimum requirements for the curriculum
4. **Table 4: Graduate Attribute Profiles the qualifications** (assimilated knowledge, skills, and attitudes) of an engineer/technologist/technician at the time of graduation.
5. **Table 5: Professional Competency Profiles** specifies the range of competency profiles for a qualified engineer/technologist/technician. These need to be attained, not only during school education but also, through lifelong learning and professional development to practice at an appropriate level.

Table 4 : Graduate Attribute Profile

- **Table 4: Graduate Attribute Profile - the qualifications (assimilated knowledge, skills, and attitudes) of a professional engineer/technologist (3-4 year)/technician (2-3 year) are described.**
- **In this presentation - focus is on the professional engineer – usually 4-5 year degree.**
- **Attributes for technologists and technicians are described in the full in on the UNESCO WFEO IEA Working Group webpage which is available on the WFEO website https://bit.ly/3fg8Fdh**

GAPC Table 4: Graduate Attribute Profile

Graduate attributes cover:

1. Engineering knowledge
2. Problem analysis
3. Design and development of solutions
4. Investigation and research
5. Usage of appropriate tools

KNOWLEDGE

6. The engineer and society
7. Human, social and environmental impacts
8. Ethics

ENGINEER & SOCIETY

9. Individual and collaborative team work
10. Communication
11. Project Management and Finance
12. Preparation for lifelong learning

WAYS TO WORK

GAPC Table 4: Graduate Attributes (1)

BASICS + COMPUTING SKILLS

LATEST THINKING, CONSIDER IMPACTS FOR SUSTAINABLE DEVELOPMENT – FOR A BETTER WORLD

Differentiating Characteristic	… for Washington Accord Graduate	
Engineering Knowledge: Breadth, depth and type of knowledge, both theoretical and practical	**WA1:** Apply knowledge of mathematics, natural science, computing and engineering fundamentals, and an engineering specialization as specified in WK1 to WK4 respectively to develop ~~the~~ solutions to ~~of~~ complex engineering problems	o the o ence and
Problem Analysis Complexity of analysis	**WA2:** Identify, formulate, research literature and analyse *complex* engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences with holistic considerations for sustainable development* (WK1 to WK4)	The graduate is exp ted to apply the latest thinking and holistically consider the implications for sustainable development
Design/development of solutions: Breadth and uniqueness of engineering problems not previously been identified or codified	**WA3:** Design creative solutions for *complex* engineering problems and design systems, components or processes that meet identified ~~specified~~ needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource, cultural, societal, and environmental considerations as required (WK5)	A graduate is expected to consider the whole of life cost and net zero carbon impacts of solutions from cradle to cradle

DIFFERENT PERPECTIVES, CREATIVITY, INNOVATION, CRITICAL THINKING, SUSTAINABILITY

GAPC Table 4: Graduate Attributes (2)

Differentiating Characteristic	… for Washington Accord Graduate	Rationale for Change
Investigation: Breadth and depth of investigation and experimentation	**WA4:** Conduct investigations of *complex* engineering problems using research methods including research-based knowledge, i ~~(WK8) ar~~ nents, analysis mation to provid	The graduate is expected be able to research latest technologies, trends and thinking and including data analysis, draw conclusions
~~**Modern**~~ **Tool Usage:** Level of understanding of the appropriateness of technologies and ~~the~~ tool	**WA5:** Create, select and a appropriate techniques, and IT tools, including pr engineering problems ~~wi~~ (WK2 and WK6)	The graduate is expected to use data, modelling and computational techniques to simulate possible solutions while understanding the limitations of the analysis and implications of assumptions made, using critical thinking.
The Engineer and the World: Level of knowledge and responsibility for sustainable development	nable development* outcomes ability, and health and safety rk in solving WK5, and WK7)	The engineer must be able to consider broad outcomes for sustainable development – previous attribute that was more narrow has been replaced.

LATEST RESEARCH AND TRENDS, CRITICAL THINKING

USE OF DATA AND MODELLING AND COMPUTATIONAL TOOLS

CONSIDER HUMAN SOCIAL ECONOMIC AND ENVIRONMENTAL IMPACTS

CONSIDER BROAD OUTCOMES FOR SUSTAINABLE DEVELOPMENT

GAPC Table 4: Graduate Attributes (3)

Differentiating Characteristic	… for Washing	Rationale for Change
Ethics: Understanding and level of practice	**WA7:** Apply eth… ethics ~~and re~~… and adhere t… Demonstrate… …and inclusion (WK9~~7~~)	Ethical responsibilities for compliance with national and international laws and for diversity and inclusion has been added – a strong enforcement of the engineers' ethical responsibility for being inclusive.
Individual and Collaborative Team work: Role in and diversity of team	**WA8:** Function effectively as an individual, and as a member or lead… …and in multi-discipli… (WK9)	The importance of working effectively in diverse teams by ethnicity, gender, age, location etc. has …added
Communication: Level of communication according to type of activities performed	**WA9:** Co… *complex* engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make ef… ~~in~~… le…	The importance of inclusive communication, written and verbal, taking account of cultural, language and other differences, has been added

ETHICS – BROADLY – TECHNOLOGY, DATA, HUMAN, COMPLY WITH LAWS, DIVERSITY AND INCLUSION

A VOICE FOR EVERYONE - WORKING COLLABORATIVELY IN DIVERSE TEAMS IN THE BROADEST SENSE

CONSIDER DIFFERENT PERSPECTIVES - INCLUSIVE COMMUNICATION – LANGUAGE, CULTURE, LEARNING DIFFERENCES

GAPC Table 4: Graduate Attributes (4)

Differentiating Characteristic	… for Washington Accord Graduate	Rationale for Change
Project Management and Finance: Level of management required for differing types of activity	**WA10:** ~~Demonstrate~~ Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.	The engineer must apply knowledge and understand economic and management issues as a team leader.
Lifelong learning: ~~Preparation for and depth of continuing learning.~~ Duration and manner	**WA11:** Recognize the … preparation and abil… independent and life-long learning ii) adaptability to new and emerging, technologies and iii) critical thinking in the broadest context of technological change (WK8)	The importance of creativity, adapting and learning about emerging technologies and technological change and critical thinking, has been added

INTELLECTUAL AGILITY, TECHNICAL, ECONOMIC, MANAGEMENT AND LEADERSHIP

CREATIVITY, INNOVATION, CRITICAL THINKING

ADAPT TO NEW AND EMERGING TECHNOLOGIES

GENDER NEUTRAL LANGUAGE THROUGHOUT THE FRAMEWORK

Changing engineering education and professional competencies – for greater women's participation

Consultation and Partnership with International Engineering Alliance and other international organisations in engineering – educators, industry and women - to change Engineering Education Benchmarks for Graduate Attributes and Professional Competencies.

See: http://www.wfeo.org/consultation-with-wfeo-members-and-partners-on-proposed-updated-iea-benchmark-for-graduate-attributes-and-professional-competencies/#Webinar-Diversity&Inclusion

World Engineering Day for Sustainable Development

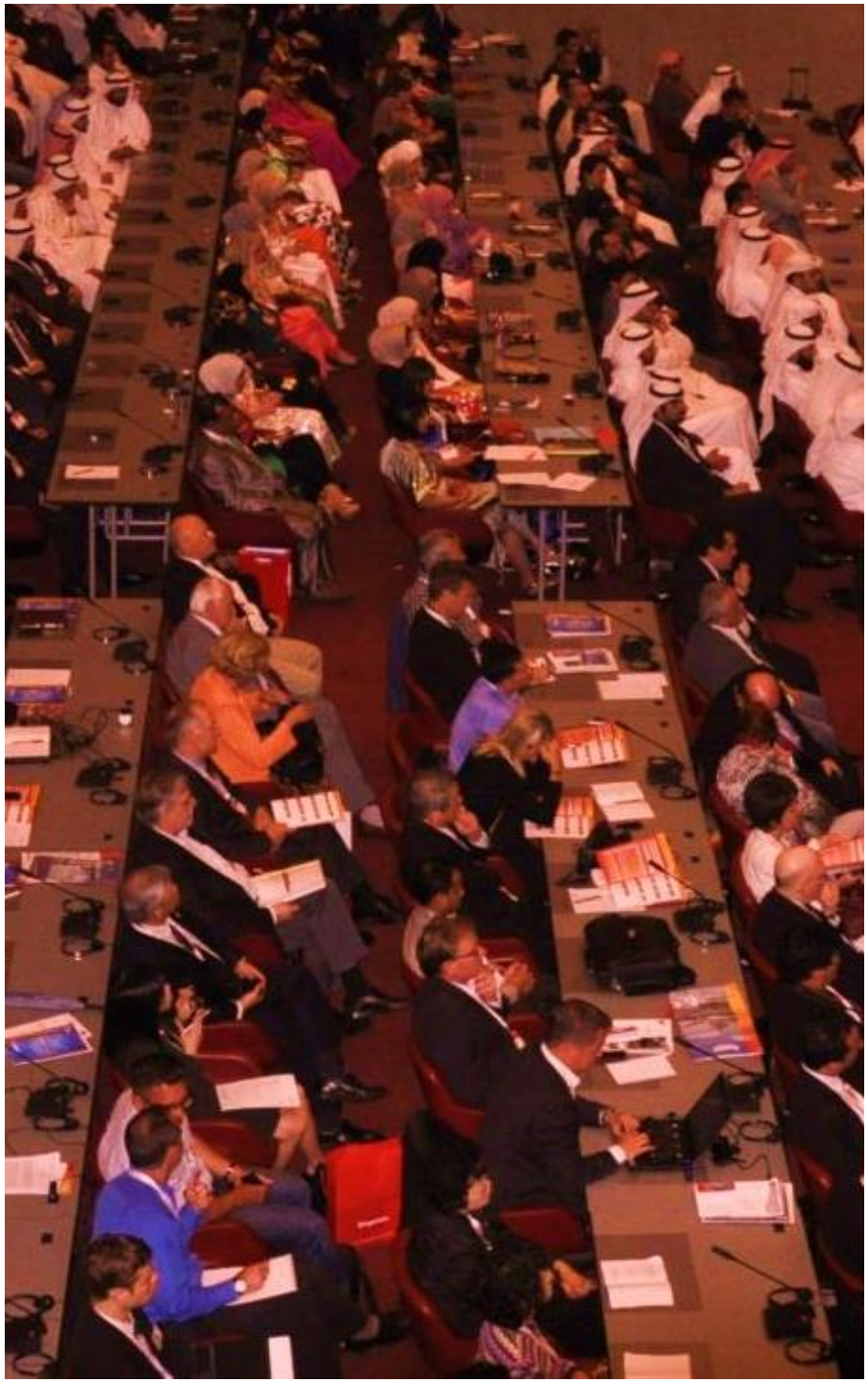
Creating Global Awareness of the need for Diversity

- **4th March every year**
- **Declared by UNESCO as an international day**
- **An opportunity to engage with people, government, policy makers, students on the importance of engineering in our societies**
- **Encourage young people, boys and girls, to consider engineering as a career for positive change for a better sustainable world**
- **Its our celebration of engineering!!**

WORLD ENGINEERING DAY FOR SUSTAINABLE DEVELOPMENT

See: https://worldengineeringday.net/

WOMEN ENGINEERS CAN CREATE THE WORLD WE WANT



Engineering for Sustainable Development

- Participation
- Influence
- Representation

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

WFEO / FMOI

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

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