IEEE SA
STANDARDS ASSOCIATION

INDUSTRY CONNECTIONS REPORT

DIITA-GENDER EQUALITY AND SOCIAL INCLUSION (GESI) WORKSTREAM WHITE PAPER

GENDER AND TECHNOLOGY: THE CASE OF THE ENERGY SECTOR

Authored by

Reihana Mohideen
University of Melbourne, Australia

Co-authored by

Anna Åberg
Chalmers University of Technology, Sweden

Iven Mareels
Federation University of Australia

IEEE

Documents
Document Sharing Hub

Full document details: IEEE DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper

TRADEMARKS AND DISCLAIMERS

IEEE believes the information in this publication is accurate as of its publication date; such information is subject to change without notice. IEEE is not responsible for any inadvertent errors.

The ideas and proposals in this specification are the respective author's views and do not represent the views of the affiliated organization.

ACKNOWLEDGMENTS

Special thanks are given to the following reviewers of this paper:

Greg Adamson

Peter Annear

Pankaj Batra

Rashi Gupta

Sally Musonye

Francesco Tornieri

Priyantha Wijayatunga

The Institute of Electrical and Electronics Engineers, Inc. 3 Park Avenue, New York, NY 10016-5997, USA

Copyright © 2022 by The Institute of Electrical and Electronics Engineers, Inc.

All rights reserved. 4 November 2022. Printed in the United States of America.

PDF: STDVA25736 978-1-5044-9133-4

IEEE is a registered trademark in the U. S. Patent & Trademark Office, owned by The Institute of Electrical and Electronics Engineers, Incorporated. All other trademarks are the property of the respective trademark owners.

IEEE prohibits discrimination, harassment, and bullying. For more information, visit http://www.ieee.org/web/aboutus/whatis/policies/p9-26.html.

No part of this publication may be reproduced in any form, in an electronic retrieval system, or otherwise, without the prior written permission of the publisher.

Find IEEE standards and standards-related product listings at: http://standards.ieee.org.

Copyright © 2022 IEEE. All rights reserved.

Documents
Document Sharing Hub

Full document details: IEEE DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper

NOTICE AND DISCLAIMER OF LIABILITY CONCERNING THE USE OF IEEE SA INDUSTRY CONNECTIONS DOCUMENTS

This IEEE Standards Association ("IEEE SA") Industry Connections publication ("Work") is not a consensus standard document. Specifically, this document is NOT AN IEEE STANDARD. Information contained in this Work has been created by, or obtained from, sources believed to be reliable, and reviewed by members of the IEEE SA Industry Connections activity that produced this Work. IEEE and the IEEE SA Industry Connections activity members expressly disclaim all warranties (express, implied, and statutory) related to this Work, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; quality, accuracy, effectiveness, currency, or completeness of the Work or content within the Work. In addition, IEEE and the IEEE SA Industry Connections activity members disclaim any and all conditions relating to: results; and workmanlike effort. This IEEE SA Industry Connections document is supplied "AS IS" and "WITH ALL FAULTS."

Although the IEEE SA Industry Connections activity members who have created this Work believe that the information and guidance given in this Work serve as an enhancement to users, all persons must rely upon their own skill and judgment when making use of it. IN NO EVENT SHALL IEEE OR IEEE SA INDUSTRY CONNECTIONS ACTIVITY MEMBERS BE LIABLE FOR ANY ERRORS OR OMISSIONS OR DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS WORK, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Further, information contained in this Work may be protected by intellectual property rights held by third parties or organizations, and the use of this information may require the user to negotiate with any such rights holders in order to legally acquire the rights to do so, and such rights holders may refuse to grant such rights. Attention is also called to the possibility that implementation of any or all of this Work may require use of subject matter covered by patent rights. By publication of this Work, no position is taken by the IEEE with respect to the existence or validity of any patent rights in connection therewith. The IEEE is not responsible for identifying patent rights for which a license may be required, or for conducting inquiries into the legal validity or scope of patents claims. Users are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. No commitment to grant licenses under patent rights on a reasonable or non-discriminatory basis has been sought or received from any rights holder. The policies and procedures under which this document was created can be viewed at http://standards.ieee.org/about/sasb/iccom/.

This Work is published with the understanding that IEEE and the ICCom members are supplying information through this Work, not attempting to render engineering or other professional services. If such services are required, the assistance of an appropriate professional should be sought. IEEE is not responsible for the statements and opinions advanced in this Work.

Copyright © 2022 IEEE. All rights reserved.
Documents
Document Sharing Hub
Full document details: IEEE DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper

TABLE OF CONTENTS

1. INTRODUCTION 5

1.1. GENDER AND TECHNOLOGY: HISTORICAL PERSPECTIVE 5
1.2. LESSONS FROM THE COVID-19 PANDEMIC 7
1.3. IEEE POLICY 10
1.4. UN POLICY 11
1.5. THE GESI WORK STREAM: STATEMENT OF PURPOSE 11

2. GESI CONSIDERATIONS IN ENERGY PRODUCTION, DISTRIBUTION, AND USE 13

2.1. BARRIERS 13
2.1.1. AFFORDABILITY 13
2.1.2. ACCESS TO LIVELIHOOD OPPORTUNITIES AND EMPLOYMENT 14
2.2. WOMEN'S UNPAID LABOR TIME 15
2.3. THRESHOLD LEVELS TO IMPACT ON GENDER RELATIONS 15
2.4. GESI BENEFITS OF ELECTRIFICATION 16
2.4.1. INDOOR AIR POLLUTION 16
2.4.2. SAFETY 17
2.4.3. IMPROVING ACCESS TO INFORMATION 17
2.4.4. DIGITAL DIVIDE 17
2.4.5. RENEWABLE ENERGY 17

3. CONCLUDING POINTS: PATHWAYS 18

3.1. WOMEN IN STEM EMPLOYMENT AND EDUCATION 18

3.2. ENABLING POLICY ENVIRONMENT 23

4. REFERENCES 25

APPENDIX A THEORETICAL APPROACHES 32

Documents
Document Sharing Hub

Full document details: IEEE DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper

1. INTRODUCTION

1.1. GENDER AND TECHNOLOGY: HISTORICAL PERSPECTIVE

Climate change and the environmental crisis pose an existential threat for humanity. The challenge is to achieve environmental sustainability, as outlined by the United Nations Sustainable Development Goals (SDGs); if we do not succeed, we will not succeed as a world society. Technology has a role to play in reinforcing the attainment of environmental sustainability (and the UN SDG) and not perpetuating the inequities.

The inequality in technological development has always been exploited to further power structures, and wherever inequalities become too large, society has experienced traumatic reset periods. In order to benefit all, a more democratic development of technology should be preferred.

The benefits from the development of technology have been unequally distributed (see Figure 1) and have had many unintended consequences. Each technology is surrounded by a sociotechnical system, embedding the technology in a historically changing context of power structures, institutions, economics, politics, and users. Many of these sociotechnical systems have gained momentum and created path dependencies, for example, car infrastructure. Such path dependencies can be both technical and societal.

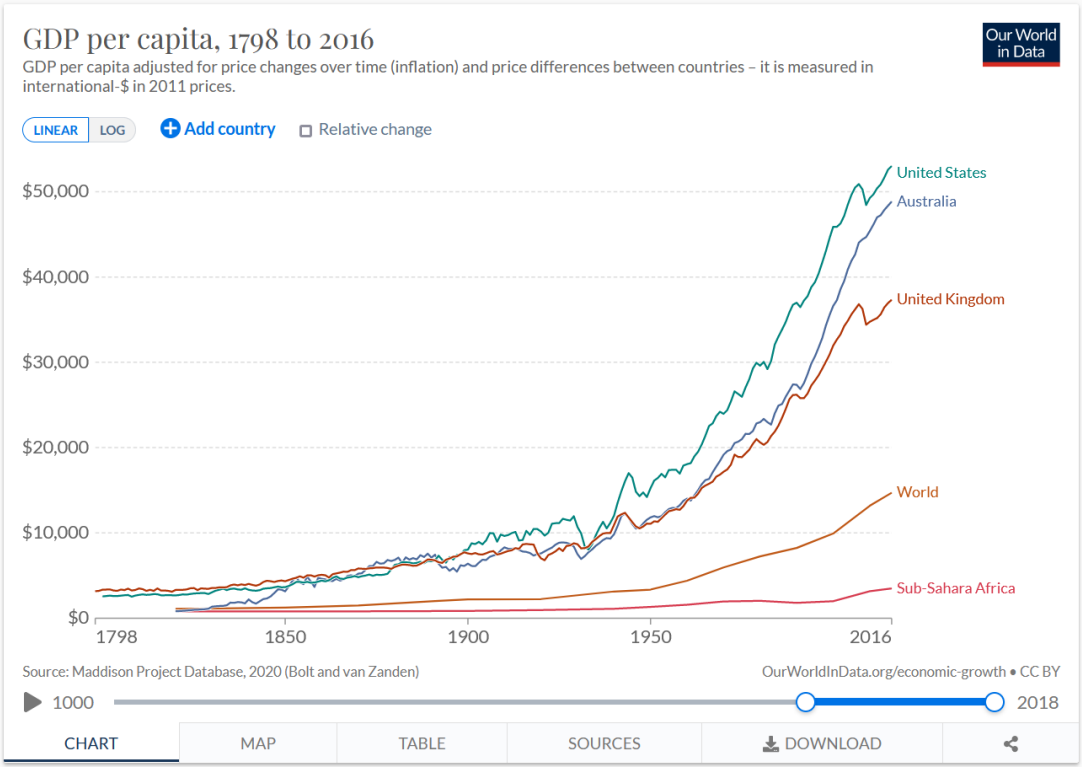
Gross domestic product (GDP) per capita is a good indicator of productivity. Since the Industrial Revolution, productivity has been closely tied to technology.

The degree to which it has been possible for actors to participate in technological decision-making, innovation, and use has been connected to power (economic, political, etc.) and cultural context in all countries. Barriers to participation and use have been both formal and informal.

There is a high correlation between GDP and energy use, and energy demand has long tracked economic growth. Over the second half of the twentieth century, with living standards in the West and other advanced economies rising, the growth in energy demand accelerated. Those dynamics have continued into this century with China helping power global GDP and global energy demand continuing to rise as well. However, some studies suggests that we are beginning to see a decoupling between the rates of economic growth and energy demand, which in the decades ahead will become even more pronounced (see Sharma, Smeets, and Tryggestad, 2019 [1]).

Copyright © 2022 IEEE. All rights reserved.
Documents
Document Sharing Hub
Full document details: IEEE DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper

FIGURE 1 **Unequal distribution of GDP/capita—English-speaking world, world, and sub-Saharan Africa[1]**



This paper does not attempt to address all these challenges. It aims to address social inclusion considerations, with a focus on gender equality. The purpose is to learn from this and to consider how these lessons can be applied and extrapolated to other domains.

In the case of gender, formal barriers in many countries have historically come in the form of banning women from spaces of political power and (technological) education, from having economic autonomy, from being allowed to hold certain employment, and from being able to register patents. Informal barriers have come in the form of gender roles. Some of these barriers have disappeared, but gender is still an important part of our social contexts and continues to influence the sociotechnical system. Often, new technologies strengthen already existing power structures, including gender structures. However, technology can also play an emancipatory role.

Today, with the challenge of the need for a transition to sustainable societies, it is important to remember this embeddedness of technology. The transition could perpetuate earlier inequalities or create more participatory

[1] Source: https://ourworldindata.org/economic-growth

Copyright © 2022 IEEE. All rights reserved.
Documents
Document Sharing Hub
Full document details: IEEE DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper

technologies. As many formal barriers have disappeared in many countries, the informal barriers of gender structures remain and are difficult to tear down. Therefore, we need to be aware of these informal barriers when we design technology and the policies that govern technology, in order to avoid perpetuating unacceptable power structures.

Because of an increased understanding of these formal and informal gender barriers, the need for a *just transition*—that is, a fast and fair transition for everyone—to a carbon-neutral society is gathering international momentum. The Silesia Declaration puts Just Transition on the global policy scene as a priority (UN, 2018 [2]). Just Transition principles are also underscored in the UN's Sustainable Development Goals (SDGs) as part of the 2030 Agenda for Sustainable Development. The Just Transition framework provides important opportunities for the incorporation of gender equality and social inclusion (GESI) considerations.

1.2. LESSONS FROM THE COVID-19 PANDEMIC

One of the global features of the COVID-19 pandemic has been that it has highlighted inequalities within nation-states. The poor and marginalized and excluded groups have suffered disproportionately from the disease itself. This is partly caused by living in overcrowded conditions and depending on public transport, working in jobs that cannot be done from home, and lacking the financial security to not work for periods of time.

Inequalities in health care have naturally affected outcomes of the pandemic. A stark picture of health-care inequality between countries is presented by the United Nations Development Programme (UNDP) 2019 life expectancy figures (Conceição et al., 2020 [3]). Most countries in Western Europe, along with Japan, Australia, South Korea, and New Zealand, have an average life expectancy of more than 80 years, while the average for sub-Saharan Africa is 61. The global average life expectancy is 73 years.

Figures from the World Health Organization (WHO) for health expenditure per capita show a great disparity between countries, indicating a central cause of health inequality (WHO [4]). However, comparing the sets of statistics for health expenditure per capita and average life expectancy indicates that per capita expenditure is not the sole determinant of outcomes. Japan's average life expectancy is more than five years higher than that of the United States, but the country spends less than half as much per capita on health. Cuba achieved a life expectancy roughly equal to that of the United States with approximately a quarter of the per capita health expenditure.

The reasons for this apparent discrepancy, including general inequality in society and the extent to which the

Copyright © 2022 IEEE. All rights reserved.
Documents Document Sharing Hub
Full document details: IEEE DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper

respective health systems are run on a commercial or for-profit basis, are relevant to the causes of health inequality within nations, which can be as significant as health inequality between nations. For example, before the pandemic, there was a 15.5-year gap in male life expectancy between different suburbs of Glasgow (WHO, 2018 [5]) and an 8.5-year gap between Indigenous and non-Indigenous life expectancy in Australia (AIHW, 2020 [6]).

Affordability of medicine is a major factor in health inequality and is the reason why illnesses such as malaria, pneumonia, tuberculosis, and HIV are significant causes of death in poorer countries and communities but not in more affluent ones (WHO, 2018 [5]). Both the purchasing power of individuals and the willingness—and ability—of governments to subsidize pharmaceuticals are relevant. The legitimacy of pharmaceutical companies' intellectual property rights was the subject of controversy before the COVID-19 pandemic and has become more in focus because of the lack of access to COVID vaccines in poorer countries, which is responsible not only for greater death rates in poorer countries but for prolonging the pandemic globally. By April 2022, 60% of the world's population was fully vaccinated and 22% had received an additional booster dose, but the rates of high- and middle-income countries and those of low-income countries varied greatly. While high- and middle-income countries had 80% of the population fully vaccinated and more than half receiving boosters, in the lower-income countries of Burundi, Congo, Haiti, Yemen, Papua New Guinea, Madagascar, South Sudan, Cameroon, Chad, Mali, Tanzania, Malawi, Senegal, Niger, Nigeria, and Burkina Faso, 10% or less of the population had received a single dose (Holder, 2022 [7]).

In addition to the cost of procurement, the rollout of COVID-19 vaccines has been hampered in less developed countries by lack of infrastructure, both in health care and transport. This has been exacerbated by the mRNA vaccines needing extremely cold storage.

Lockdowns and loss in employment has hit workers in the informal sector with "casualized" labor, especially for hard, physical work. Many of these workers are women, migrants, and people from other vulnerable groups. These workers have mostly been excluded from pandemic-related welfare and income substitution programs. This sector needs to be regulated in keeping with national and international labor standards, such as those stipulated by the International Labour Organization (ILO).

Lockdowns, and other necessary restrictions on people's movement and activity brought about by the pandemic, have increased the vulnerability of those communities that already face persecution or discrimination from law enforcement. There has also been increased violence against women in nearly all countries where stay-at-home orders have been put in place.

Documents
Document Sharing Hub
Copyright © 2022 IEEE. All rights reserved.
Full document details: IEEE DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper

Paradoxically, the pandemic has revealed that in many countries, the lowest paid workers with the worst employment conditions play some of the most essential roles in health care and in the general functioning of society. Workers in low-paying jobs often face greater occupational health and safety hazards compared to formally employed workers and often lack job security, benefits, social protection, or means for collective bargaining. The pandemic also revealed a global deficiency in services supporting people with disabilities and those in aged care.

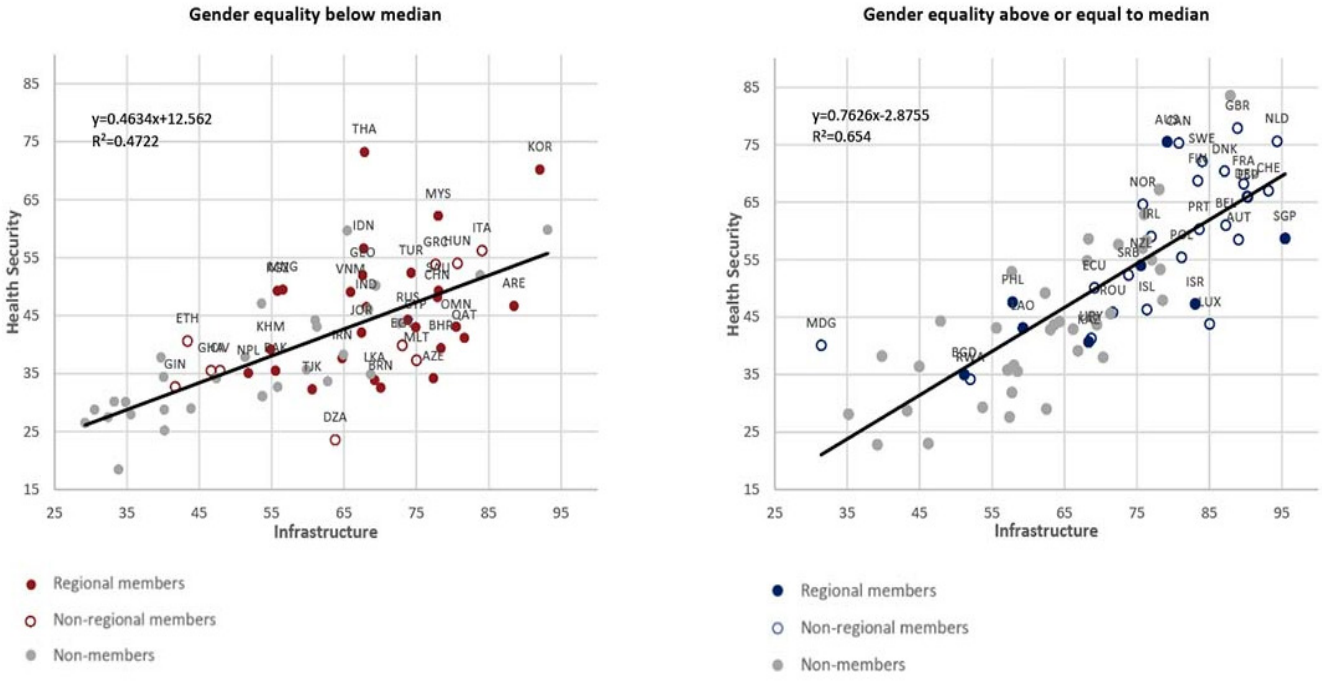
The pandemic in concert with other events—such as the US-China trade dispute and, more recently, the Russia-Ukraine war and the resulting Western economic sanctions against Russia—has exposed the world's dependency on global supply chains that are actually quite brittle. At the outset, the rapid escalation of COVID-19 from an outbreak in a Chinese provincial city (Wuhan) to a global pandemic was accelerated by this globalized system of production. The transport of goods all over the world before, during, and after production is also dependent on large-scale labor migration. Lockdowns, border closures, and labor shortages caused by the pandemic, plus the more recent removal of Ukrainian and Russian grain and Russian hydrocarbons from global markets, have caused shortages, inflation, and other economic issues worldwide.

Global supply chains are also a major source of carbon dioxide (CO_2) emissions. Early on in the pandemic, there were hopes that the disruptions would lead to emissions reductions; this seemed initially borne out after lockdowns of China's large industrial cities and the suspension of most international air travel. However, the resulting dip in emissions proved to be temporary and shallow (UNEP, 2021 [8]).

The pandemic showed the interrelatedness and interconnectedness between our health and infrastructure systems and social inequity. Figure 2 examines the correlation between general infrastructure (e.g., capturing roads, rail transport, air transport, sea transport, electricity, and water infrastructure) and health security by levels of gender equality. While the correlation in both cases is positive, it is stronger in countries with high gender equality compared to countries with low gender equality; that is, in countries with higher gender equality, investments in infrastructure may have a greater impact on improving health security.

Documents
Document Sharing Hub
Copyright © 2022 IEEE. All rights reserved.
Full document details: IEEE DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper

FIGURE 2 Correlation between infrastructure and health security in countries with high and low gender equality, 2019[2]



1.3. IEEE POLICY

The IEEE Mission Statement describes its core purpose as being "to foster technological innovation and excellence for the benefit of humanity." The Code of Ethics includes the following:

> To treat all persons fairly and with respect, to not engage in harassment or discrimination, and to avoid injuring others.
>
> - to treat all persons fairly and with respect, and to not engage in discrimination based on characteristics such as race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression.
>
> To uphold the highest standards of integrity, responsible behavior, and ethical conduct in professional activities.
>
> - to hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, to protect the privacy of others, and

[2] Source: https://www.aiib.org/en/news-events/media-center/blog/2020/COVID-19-Infrastructure-and-Women.html

Copyright © 2022 IEEE. All rights reserved.
Documents Document Sharing Hub
Full document details: IEEE DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper

to disclose promptly factors that might endanger the public or the environment.

- to improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems.

1.4. UN POLICY

The paper is guided by the following UN policies and UN SDGs:

- "Equality between women and men is seen both as a human rights issue and as a precondition for, and indicator of, sustainable people-centered development."
- "Enhance the use of enabling technology…to promote the empowerment of women" (Goal 5, Target 5.b).
- "Ensure universal access to affordable, reliable and modern energy services" (Goal 7, Target 7.1).
- "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all." (Goal 8).
- "Take immediate and effective measures to eradicate forced labor, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labor, including recruitment and use of child soldiers, and by 2025 end child labor in all its forms." (Goal 8, Target 8.7).
- Others: Goal 3 (good health and well-being), Goal 11 (inclusive, safe, resilient, and sustainable cities and human settlements), and Goal 13 (climate action).

1.5. THE GESI WORK STREAM: STATEMENT OF PURPOSE

The GESI work stream draws from over ten years of development practice integrating GESI interventions in power sector projects in developing countries, amounting to over a billion dollars in investments. Our methodology and tools draw from this body of work.

The activities of the work stream overlap with the scope of IEEE's Dignity, Inclusion, Identity, Trust, and Agency (DIITA) activity, specifically to identify barriers to gender equality and social inclusion with a focus on technical standards for affordability and accessibility that support the progress of practical technologies to address these barriers.

Copyright © 2022 IEEE. All rights reserved.
Documents Document Sharing Hub
Full document details: IEEE DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper

Accepting the premise that "equality between women and men is a human right issue," a key question to address is: How can GESI considerations be incorporated in the development of technology? or What planning and policy framework is required to ensure that GESI considerations are adequately addressed in the development and the adoption of technology?

The intended impact is that GESI considerations are systematically addressed in system design, as well as through policy and planning in the IEEE community, and for GESI to foster and advance technology that benefits human society as a whole.

We have identified the following key elements to frame our concept of gender equality in a technical context:

a. Technology, its development, and innovation should enable and not prevent gender equality. This requires that women are drawn into the processes by which technology is designed, developed, and used.

b. Women and girls, as well as men and boys, should be able to afford and access appropriate technologies and should not be excluded from doing so because of their gender.

c. An empowering environment should be created through policy, regulations, and standards-based solutions.

Intersecting vulnerabilities need to be recognized. Some groups of women are more vulnerable than others because of factors including, but not limited to, relative wealth, class, caste, race, ethnicity, and geography; this is relevant to the assessment of vulnerabilities and capabilities for building resilience (Mohideen, 2021 [9]).

Evaluation of social and economic consequences is important, and all efforts in this space should be monitored through appropriate metrics. The metrics we pursue should be standardized across the world and be accessible and reported on a regular basis in order to obtain insights and replicate successes. The metrics will be associated with the following:

- Demographic information about access to electrical energy/power and internet and communication technology
- Demographic information about access to education, health services, safe water on demand, sanitation, and public transport
- Demographic information on work, employment, and labor force participation

Copyright © 2022 IEEE. All rights reserved.
Documents Document Sharing Hub
Full document details: IEEE DIITA-Gender Equality and Social Inclusion (GESI) Workstream White Paper