

Assessment of the greenhouse gas
mitigation potential of green hydrogen.
An implementation roadmap for Mexico

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SOBRE ENERGÍA Y MEDIO AMBIENTE A.C.



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1. Project implementation GESI guide

The social dimension of a new green economy is one of the three pillars of the sustainable development model—social, economic, and environmental development. As humanity makes enormous efforts to sustain itself, we must ensure that everyone can live dignified lives (Schlör, et al., 2017). The 17 UN Sustainable Development Goals (SDGs) recognize the interdependency between the three spheres; gender equality and social inclusion, also known by the acronym GESI, are two cross-cutting principles represented in goals 5 and 10 of the SDGs. The two goals emphasize the relationship between the environment, the economy and the society, particularly for women and other marginalized groups that do not have uniform access to rights and opportunities across the world and thus will experience the negative impacts of climate change on a more severe extent (UN, 2016; UK PACT, 2021b), also known as asymmetrical impacts (Cameron, et al., 2013), which in turn could unfold into greater inequality (UK PACT, 2021a). In other words, the relationship between social inequality and climate change is characterized by a vicious cycle (Islam & Winkel, 2017). Developing countries must overcome the great challenge of developing and lifting people out of poverty while acting on climate change, a demand that wealthy countries did not have to meet when their economies grew and the middle class could meet aspirations based on consumerism and fossil fuel energy production (Edward, et al., 2013).

Marginalized groups are any group of people that has been historically and systematically subject to discrimination and exclusion derived from stereotypes and prejudice towards the individual gender identity, ethnicity, physical ability, income, or religion, among other aspects. Marginalization is a multi-dimensional and structural phenomenon that results in negative impacts to the individuals that belong to marginalized groups, mainly a higher risk of inequalities, due to unequal distribution of development and power relationships (NCCDH, 2021; EIGE, 2021; CONAPO, 2013). **Inequality is multidimensional and can take many forms, from a global to a household scale.** For example, it can be seen in income and assets disparities across regions—in 2016, the top 1% received 22% of global income—and also among people of different age, sex, abilities, ethnicity, origin or religion, to name the main **characteristics that can define the opportunities of an individual in a society, including capabilities, assets and activities that make up livelihoods and participation in public decision making and public resources** (UNDP, 2021; Islam & Winkel, 2017), **as well as the capacity to acquire or generate such opportunities** (CONAPO, 2013).

Women experience constraints, both social and cultural, that place them in inferior social positions, limit their access to income, education, public voice, and survival mechanisms (Edward, et al., 2013). Nevertheless, it is proven **that empowering women and girls helps economic growth and development**, and while remarkable progress has been made in the past 20 years, women in many regions still undergo problems such as lower education, less access to the labour market, unequal division of unpaid care and domestic work, discrimination in leadership positions, less rights on land and property, poorer healthcare, violence based on gender, etc., in comparison to boys and men (UNDP, 2021). Any effort directed towards the achievement of Gender Equality should also address inequalities that affect non-binary individuals, while social inclusion must ensure that every individual takes part in society and a Just Transition for workers and communities effectively occurs (UK PACT, 2021b).

The GESI framework aims to actively challenge existing gender norms, promote positions of social and political influence. The shift from a fossil-based energy matrix to a renewable-based energy matrix must incorporate the GESI perspective in the assessments, plans and

actions. GESI-centred interventions are **intersectional**—the idea that all inequalities are linked—, which leads to better designed climate actions as intersectionality allows a more comprehensive understanding of community needs, and community prosperity needs the input from everyone (UK PACT, 2021c; UK PACT, 2021b). Critical intersectionality means to pay attention to how power and social and political relations shape the world to avoid falling into oversimplified dichotomies such as men-versus-women or victim-or-steward issues (Djoudi, et al., 2016). It is worth to note that the concept of community is frequently used to refer to a homogenous body, but in practice, communities are constituted by individuals with specific interests regarding economic position, age, gender, ethnic backgrounds, etc., so approaching the communities to understand their unique position is key, instead of making assumptions (SDG Fund, 2017).

Social inclusion must build resilient and accountable societies and expand opportunities for everyone, helping individuals overcome obstacles to fully participate in society and being able to shape their own future. This requires participation from all areas of society: governments, communities, civil society, the private sector, and other stakeholders. People should be able to drive their own solutions, which can be boosted by building on participatory approaches and the own values of communities, which provides more engagement. Any project should stand for transparency, accountability, non-discrimination, and public participation (The World Bank, 2021).

1.1. GESI and energy at a global scale

Policy making and product development need to know how the population relates to energy. The lack of access to modern energy sources prevails in poor households and increases the risk of living under poverty, because energy deprivation means people cannot refrigerate food, wash clothes using a washing machine, or do activities at night with artificial light. Cooking with modern energy sources, like electricity or gas, helps prevent health problems related to burning coal, wood, or waste, traditional fuels that prevail in the poorest households (Our World in Data, 2021). There are distinct household consumption patterns between men and women, as women spend more time doing unpaid work in households that involve energy use, like cooking and laundry. On the other hand, men (in European countries) consume more energy because of transport use and eating out. Perceptions of technologies also show gender differences: overall, men support nuclear energy more than women, and they are more likely to be early adopters of clean technologies (e.g. electric vehicles) (IEA, 2018).

According to IEA (2018; 2020; 2021), the energy sector is one of the least gender diverse sectors, but a clean energy transition needs innovative and inclusive solutions for which women are key drivers, as well as for novel business models. A thorough assessment of women participation in the energy sector is difficult due to data scarcity and complexity in the area, but some information is available. Gender differences exist in research and development in academia and industry and there are distinctive themes in research themes; less than one third of employees in fields of scientific research and development correspond to women. In 2016, the renewable energy sector had a 35% participation of women in the workforce. A study from 2014 that analysed 72 countries revealed that only 6% of ministerial positions responsible for national energy policies and programs were held by women. Women are listed in less than 11% of patent applications regarding combustion apparatus, engines, pumps, and power, and only above 15% of climate change mitigation technologies. In start-ups, about 11% of energy founders are women, while a 20% is observed across all sectors.

Gender stereotypes, work-family balance, insufficient career promotion and mentoring programmes, salary gaps, mobility requisites and complex work schedules are embedded in the cultures around the world and determine the low representation of women in STEM (IEA, 2018; IRENA, 2019). In 2008, in OECD countries, women represent more than 50% of university degrees but 30% within science and technology (IEA, 2018). Even though women finish their university studies with better qualifications than men, before turning 30 they earn 10% less than them (GIZ-CONUEE, 2018a). Women reach fewer roles in senior positions than in men in the energy sector overall, although some variations occur in subsectors. Water, mining of metal ores and chemicals manufacturing have more than 20% of women in senior roles, while extractive industries, mining of coal and lignite, and the manufacture of coke and refined petroleum products have less than 15% (IEA, 2020)

The positive impacts of increasing women's access to energy are well documented, particularly clean cooking technologies. In developing countries, women spend on average 1.4 hours per day collecting firewood, 4 hours cooking and several hours doing household chores, thus being more exposed to indoor pollution than men. It is frequent for girls to stay at home to assist in household labour, which keeps them from attending school and increases the exposure to poor quality indoor air, elevating the risk of developing respiratory problems. The access to electricity allows families to use electric appliances, reducing the amount of time spent on household work and freeing time to do other activities like studying or getting paid work, and opens the door to the possibility of using the internet and mobile phones, which represent opportunities for businesses, greater access to information and paid work (IEA, 2018; Our World in Data, 2021).

1.2. National GESI context

Mexico is a multicultural country with a vast number of ethnic groups, traditions, and lifestyles, but also with pronounced inequalities. The government evaluates social exclusion on a national level through the National Population Council (CONAPO), a governmental body that calculates the Social Exclusion Index (or IM, for *índice de marginación*) by state and municipality, integrating several socio-economic indicators: access to education¹, housing², population distribution³, and income⁴. IM is useful for policy makers, as it is a measure of the social exclusion level of each geographical unit, ranging from very high, high, medium, low, and very low (CONAPO, 2020).

The southeast part of the country is most affected by inequalities, although some municipalities in the northwest also suffer from very high levels of social exclusion. In 2020, the states of Guerrero, Chiapas and Oaxaca showed the highest IM, and 10.5% of the national population (13.2 million inhabitants) live in these states (Figure 3). One in three municipalities showed high and very high social exclusion levels, with a population of 11.4 million inhabitants affected, or 9.1% of the total population. On the other hand, 48% of

¹ Percentage of illiteracy among the population above 15 years old; and percentage of the population above 15 years old without basic education.

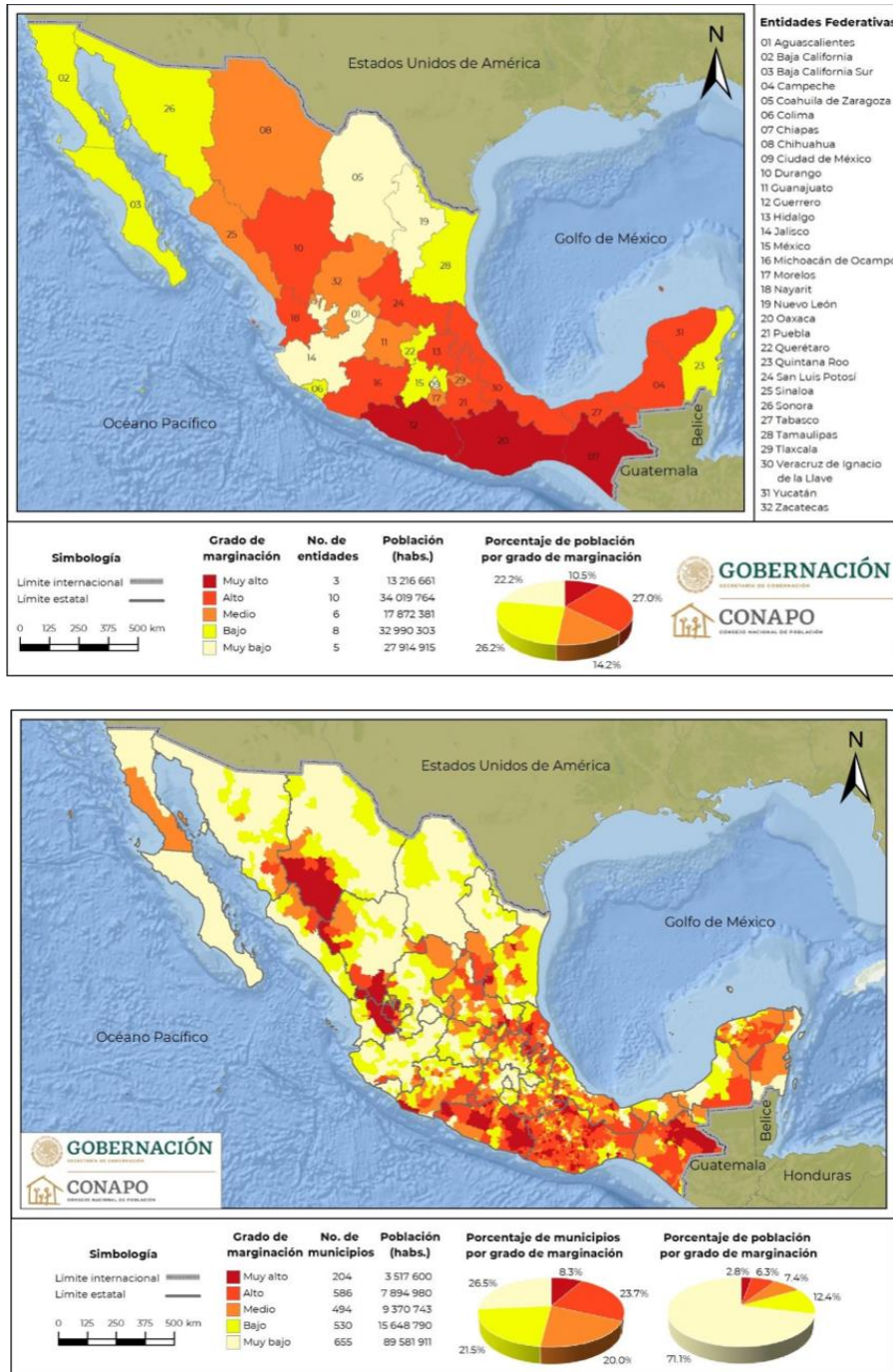
² Percentage of occupants in private households without toilets and sewage; percentage of occupants in private households without electricity; percentage of occupants in private households without municipal water; percentage of occupants in private households with earthen floor; and percentage of overcrowded private households.

³ Percentage of population living in settlements with less than five thousand inhabitants.

⁴ Percentage of the population employed with an income up to two minimum wages.

municipalities showed low and very low levels of social exclusion, with 83% of the national population living in those municipalities (Figure 4) (CONAPO, 2020).

Figure 1.1. Social Exclusion Index in Mexico by state and municipality, 2020.



Reference: (CONAPO, 2020).

Several causes converge in the phenomenon of marginalization in Mexico, and its effects are also present in a varied range of situations. Social exclusion can be seen, for example, in the exclusion of lower income families from the financial system; 35% of the population

had no financial products in 2018, but in the southeast region this percentage gets up to 40%, while in the northeast region only accounted for 18%. This problem is related to a lack of financial infrastructure, as 49% of municipalities do not have any bank branch and 22% had no access to any financial system channel (branches, ATM, mobile banking, etc.), but also to the high rate of informal jobs. Small and medium-sized enterprises (SMEs) employ around 70% of the population, but over 70% of SMEs are informal enterprises, which restricts their access to credits and other financial services (Cámara de Diputados, 2019).

The informal sector is less productive than its formal counterpart, does not give rights to workers and offers low paying jobs. 16% of the working population receive less than one minimum wage, and 19% of them work in the informal sector. Data from the National Institute of Statistics and Geography (INEGI) shows that, in 2018, informality rates were higher in the poorer states like Oaxaca (81.1% of informality) and Chiapas (78.6%), while northern states like Nuevo León and Coahuila have the lowest rates (35.6% and 35.9%, respectively). For the same year, 60% of young people worked in the informal sector (Cámara de Diputados, 2019).

As for the relationship between marginalization and energy, data from INEGI reveals that 98.7% of the households have electricity, but almost 2 million inhabitants who live in small remote communities do not have access to this service. State energy public policies have been limited in regards of human rights. The rights of communities, indigenous people, social groups, and urban groups who live in areas where energy related activities occur have not been fully recognized. The current federal government pledged to recognize these rights, generate spaces for consultation and participation in energy generation projects, and promote communal renewable energy projects to eradicate vulnerability, poverty, and energy marginalization (Cámara de Diputados, 2019).

Energy poverty⁵ is caused mainly by low income and the use of inefficient equipment and implies the lack of one or more basic economic goods or services⁶. In Mexico, income level, the size of the locality, the level of education and sex of the head of household are the main factors that explain energy poverty. Around 40% of households lived under energy poverty between 2008 and 2010, with notorious regional differences—the states of the northern border along with Aguascalientes, Colima, Mexico City and Michoacán show the lowest energy poverty levels, while states in the southeast, like Guerrero, Oaxaca and Chiapas are the most energy-poor. 47% of the total energy use at homes is used to heat water and 27.5% to cook food. The most deprived economic assets are thermal comfort equipment (33% of the households lack them), efficient refrigerators (21.1%) and gas or electric stoves (16.6%) (García-Ochoa & Graizbord, 2016).

Gender equality is meant to be a cross-cutting issue in climate change policies and norms attaining the energy transition, such as the Framework Law on Climate Change of 2012, NDCs, or the sixth national communication on Climate Change, which recognizes women as powerful agents of change in mitigation and adaptation (GGGI, 2020).

⁵ Also known as fuel poverty, a concept that emerged during the first oil crisis (1973), which caused families to be unable to meet their heat needs, resulting in a spike in deaths and respiratory illnesses. The most known definition of energy poverty is when a household cannot enjoy adequate energy services by using 10% of their income, but other definitions have been created to better represent the relationship with energy by including objective (i.e., equipment) and qualitative (how people feel about their energy consumption) indicators. Relative energy deprivation occurs when a household cannot satisfy the needs that are at the time considered basic or indispensable according to the customs and culture of society.

⁶ This is, lighting, entertainment, water heating, food cooking, food cooling, and thermal comfort in the home.

No official measurement of gender equality equivalent to the IM is carried out by the government, although gender equality is a priority on federal plans and strategies, and INEGI has a Specialized Technical Committee on Information on a Gender Perspective since 2010. In 2018 the National Institute for Women (INMUJERES) worked alongside secretariats, entities, and other departments of the Federal Public Administration to incorporate a gender perspective in the State actions, and in 2019, the transversal axis number 1 (gender equity, inclusion, and non-discrimination) was added to the National Development Plan (PND) 2019-2024⁷. The transversal axis number 1 is intended to mind and diagnose the disparities among groups of people that experience multiple discrimination due to their ethnicity (indigenous and afro Mexicans), ability status, sexual and gender identity, income (those who live or are vulnerable to live in poverty), and territorial inequalities (INMUJERES, 2019; Cámara de Diputados, 2019; GGGI, 2020). However, there is much work to be done in all areas, including data sourcing. For example, the industrial codes (NAICS) that serve socio-economic survey purposes, do not distinguish between people working in renewable energy and fossil fuel generation, neither in a gender-disaggregated manner (GGGI, 2020).

The work by INMUJERES in the current administration also resulted in the delivery of the National Programme for Equality between Women and Men (PROIGUALDAD), based on PND's Guiding Principle: Leave no one behind, leave no one outside. PROIGUALDAD has two priority objectives that are directly related to the energy transition. First is to maximize the economic autonomy of women to close historical inequality gaps by promoting actions to impulse permanency and promotion of women in the public sector of energy, science, technology, communications, and transport. Second is to create conditions to recognize, reduce and redistribute domestic and care work among families, the State, the community, and the private sector, by promoting strategies that allow access to affordable energy in households, as well as its rational use to reduce women's energy poverty (INMUJERES, 2020).

Gender violence is a grave threat to women of all ages in the country, and it is the intention of the government to aid victims, prevent damage and eliminate violence. Other actions include the certification of the Mexican Standard NMX-R-025-SCFI-2015 (Equality at work and non-discrimination) at workplaces; giving grants to the Women Administrations of the Federal Entities (IMEF) to incorporate the Transversal Gender Perspective policy in the states and municipalities; and creating the PROEQUIDAD programme, directed towards the IMEFs to start projects to prevent pregnancy among teenagers, from a perspective that takes into account human rights, intersectionality, and gender studies to promote autonomy, health, education, work, personal and community growth for girls and teenagers (INMUJERES, 2019).

The PND 2019-2024 (Cámara de Diputados, 2019) recognizes the following gender-based problems:

- Higher education shows a gender bias. Women represent 74% and 67% of the individuals who pursue a career in education and health sciences, respectively, are underrepresented in areas such as engineering, manufacturing, and construction, where only 29% of professionals are women, as well as in agronomy and veterinary (38%).

⁷ Published in the Annex XVIII-Bis of the Parliament Gazette (Cámara de Diputados, 2019).

- Referring to OECD numbers, the gender gap in the labour market prevails, as young women face a probability three times higher than men of not having access to education, not having a paid work and not receiving training at work.
- Payment for work sees important gender gaps, as well as between indigenous and non-indigenous individuals. According to INEGI, women in Mexico can get between 25% and 50% less money for the same jobs in comparison to men with the same level of education, and 17% of the indigenous population has an income 7% lower than non-indigenous population.
- There is also a gender gap in the pension system caused by lesser participation rates of women in the workforce and lower income than men. The National Commission for the Retirement Savings System (CONSAR) estimates that women get 70 pesos for each 100 pesos a man receives at the end of their work life.
- Unpaid work at households is unequally distributed, which in turn acts as a barrier for women to enter the workforce. Women spend, on average, 43 hours per week doing domestic work and caregiving tasks, almost three times more than men (who spend 16 hours per week).
- According to INEGI:
 - Women experience a lower access to financial services than men, with 38% of women not having any financial product, compared to 28% of their male counterparts, in 2018.
 - Data shows that the rate of informal jobs is higher for women than for men, and higher for younger people, so young women are more vulnerable to have low paying jobs with no rights. The informality rate of INEGI for non-agricultural jobs in 2018 was 56% for women and 49% for men.
 - In 2018, women participation in the workforce was 43.5% (inferior to other countries in Latin America), notably lower than 77.4% of men. Young women are three times more likely than men to not work or study—a situation known as being *nini* in Mexico. A study by the Center of Studies of the Public Finances (CEPF) revealed that Chiapas, one of the poorest states, has the highest number of *ninis* (age between 15 and 24), with 28.35% of the population being *ninis*, of which 48.46% are women, positioning Chiapas as the state with the highest percentage of *ninis* that are women. The southeast states present higher rates of women *ninis* (29.37% to 48.46%) than states in the north (18.21% to 29.37%) (CEPF, 2018).

The National Council for the Evaluation of Social Development Policy (CONEVAL) has published a series of studies since 2008 to evaluate gender inequality and poverty and develop a system of indicators that consider several factors affecting gender inequality (housing, income, paid and unpaid work). CONEVAL's definition of poverty⁸ is closely related to social exclusion because it is a condition that determines the life of individuals in a detrimental manner, restricting their exercise of rights and, overall, the opportunities to live better lives (Consejo Nacional de Evaluación de la Política de Desarrollo Social, 2021). The results of the study in 2018 show the following facts about women and men living under poverty:

⁸ Limitations or lack of capacities, opportunities, options, decisions, functioning, resources, and social, economic, and political participation, as well as restrictions on the exercise of the rights to food, housing, education, health, and other social development elements (Consejo Nacional de Evaluación de la Política de Desarrollo Social, 2021, p. 18). Access to basic household services is an indicator of poverty and is composed by four dimensions: access to water, access to drainage, access to electricity and access to fuels to cook (García-Ochoa & Graizbord, 2016).

- Around 40% of household heads live in poverty. 30% of these household heads from 14 to 44 years, both men and women, are considered educationally backward, but a gender gap was observed starting at 45 years. Between 45 and 65 years, 39.4% of women head of households present educational deficit, against 33.7% of men. The group of 65 years and above show the highest gaps and educational deficit, with 85.9% for women and 80.4% for men. For heads of household not living under poverty, 38.6% of women and 31.6% of men over 65 present educational backwardness, and only 10% of household heads between 14 and 64 years are living under this situation, regardless of their gender.
- The rate of fertility among teenagers in rural zones got up to 91.9% in 2016, against a 64.5% in urban zones.
- Young women (16 to 24 years) with children who do not live under poverty enter the labour market more than women without children, but in poverty both mothers and those without children enter the labour market equally.
- Domestic work overload results in many restrictions for women to enjoy economic autonomy, e.g., a lower participation in the labour market, impossibility to be employed, less eligibility for quality jobs and lower payment than men.
- Women who are in the most productive ages in terms of work and fertility (14 to 44 years) spent the highest number of hours caring for others, regardless of their poverty situation. Women spend between 1.2 and 2 times more hours than men to take care of other people in the household. Domestic work requires between 2.2 and 3.2 more time for women than men, and there is a correlation between increase in poverty and increase in time destined to domestic unpaid work.
- Poor households run by women tend to have a higher number of members who economically depend on the head of household than households run by men and are more economically vulnerable.
- The incidence of poverty increases when the household head is very young or very old. 45% of the population lives under poverty and their household head is either between 14 and 44 years or above 65, but if their age is between 45 to 65 years, the percentage falls to 40%. Precarious jobs that do not pay their workers are more common among the population of 65 and over, with elderly women being most vulnerable.
- More women (38.8%) take part-time jobs than men (16.4%).
- 52.0% of women do some type of extra domestic work, or job, versus 82.8% of men. Working women do more unpaid work than men (8.2% vs. 3.8%, respectively).
- Salaries for women were found to be 24.0 Mexican pesos (MXN) per hour, while men receive 26.7 MXN per hour, on average.
- 51.1% of women have never contributed to any kind of social security institution, while only 41.1% of men are in the same situation. Not all employers offer social security; 60% of the employed population not living under poverty and 95% of the employed population living under poverty do not have access to social security. Women turn to indirect help for their health, such as relatives or social programmes, especially when living under poverty; 95% of poor women are not holders of social security affiliations, in contrast with 85% of poor men, 70% of women and 50% of men who are not poor.
- Around 40% of the employed population who do not live under poverty do not have an employment contract, while for those living under poverty the figure gets up to 80%.
- The labour market is segregated in a way that most men (63.8%) work in occupations considered masculine, that offer higher wages, and women concentrate (34.7%) in other activities, considered feminine, with lower wages on average.

- Women perceive around one third of the total monetary income, regardless their poverty status, and depend more than men of indirect sources of income, a situation that is aggravated for those living under poverty—women who do not live under poverty rely on indirect sources of income to cover around 8% of their total income, but poor women get around a third of their income this way. The percentage for men, on average, is almost 5%.

Both CONEVAL's and PND's assessments set the tone to establish goals and determine the areas where actions have the biggest potential to deliver best results.

1.3. GESI-relevant energy initiatives in Mexico

Increasing the participation of marginalized groups in the development and growth of the country is a shared goal for the public and private sectors. Gender equality started gaining attention from climate change experts after the creation of the Clean Development Mechanisms (CDM, instruments of the Kyoto Protocol). As developing countries were recipients of CDM projects, networks of women in the energy field started to grow (UNDP, 2008). This section presents initiatives relevant for the development of green hydrogen in Mexico as successful of GESI action in the energy field, tackling specific issues such as education, networking, and financial opportunities.

1.3.1. Sustainable Energy Programme (PES)

The objective of the programme was to improve the conditions framing renewable energy and energy efficiency, for which a gender approach is crucial. Temporary special measures will be generated to accelerate the empowerment of women in the sector through renewable energy and energy efficiency. The PES based their actions on three lines (GIZ, 2015):

- Awareness. In 2013, the programme launched the "Initiative to raise awareness and train the Mexican population in the saving and efficient use of energy with a gender focus," through an Alliance of Public Private Cooperation (PPP) with Grupo Salinas (GS). A gender diagnosis was made to identify the training and awareness needs for each target group, nationwide, according to the consumption habits, knowledge and expectations of men and women in relation to energy. Training and awareness were addressed through public events (around 7,000 participants over 19 sessions), a media campaign (reaching approximately 10 million people), a guide to good practice for gender-sensitive energy saving and efficiency was distributed (4,500 copies), and training using videos and face-to-face interaction for 40,000 employees of GS.
- Training and certification. An estimate of 135,000 high-level experts, professionals, and technicians are needed in the Mexican context of the energy transition over the next 4 years, but gender inequality is present in vocational orientation and when young people are choosing their careers—activities traditionally considered feminine or masculine. A pilot project to train and certify women in Labour Competence Standards (promotion of savings in the integral performance of the energy systems of the house and installation of solar heating system of thermosiphon water in sustainable housing) was executed and a guide for trainers was developed.
- Design of financial mechanisms. A financial mechanism for water solar heating systems for SMEs was implemented in cooperation with a commercial ally—Módulo

Solar⁹— and a financial ally –PROMUJER¹⁰—. The two actors had a joint selling agreement, and awareness-raising, training and promotion activities were carried out, addressing issues such as the operation and characteristics of a solar heater, and the implications of climate change.

The work of PES relied on documenting results and impacts using surveys, interviews, training evaluations, systematization of experiences, among other instrument to monitor advances that help strengthen or correct implementation routes.

1.3.2. Optima Energía

Optima Energía is a Mexican private enterprise that offers energy services (energy efficiency and intelligent infrastructure solutions) to local governments from Monterrey, Nuevo León (Optima Energía, 2021). The company is the first private borrower of the Inter-American Development Bank (IDB) to sign the CEO Statement on the United Nations Women’s Empowerment Principles, committing to identify and implement measures to promote gender diversity and talent development opportunities for women in business. It also launched a gender certification program through the Mexican Standard for labour equality between women and men (NMX-R-025-SCFI-2012) to ensure equality and inclusion in the workplace, which will attract the best talent. Furthermore, Optima Energía is conducting an internship program in Monterrey, Mexico, pledging that at least 50 percent of the selected interns each year will be women (IDB Invest, 2020).

1.3.3. Red de Mujeres en Energía de México (RMEM)

The Women in Energy Network of Mexico was created in 2015 and is a diverse, dynamic, and self-managed group with more than 230 members. Their main channel of communication is through instant messaging apps. A census made in 2020 revealed that 5% of the members do not live in Mexico, whether because they are studying abroad or reside permanently in other countries. The rest of the members live in Mexico, with a majority (more than 80%) coming from Mexico City, which has derived in a centralized scope of activities, a situation that is considered an issue by some of the members. Only six women are part of native communities (INEEL, 2020; Comisión Económica para América Latina y el Caribe (CEPAL), 2020)

Other facts derived from the census are:

- 42.42% of the members are aged between 30 and 39, 32.32% 21 to 29, 16.16% 40 to 49, 5.05% 60 and above, and 4.04% are between 50 and 59 years.
- 57% have postgraduate studies (45.56% hold a master’s degree, and 11.11% have doctoral degrees), and overall have reached higher education than their parents.
- 60% of the members are engineers with undergraduate, masters or doctoral degrees, while economic-administrative degrees stand in second place.
- 72.22% declared that they had control over which career path to follow, 13.33% based their choice on suggestions from friends and family, 11.11% personally knew someone who worked in the energy area, and 3.33% did not choose their career, but someone assigned it to them.

⁹ One of the largest companies in its field and leader in the manufacture and installation of solar equipment in Mexico (Módulo Solar, 2021).

¹⁰ A non-profit organisation that aids development by promoting inclusion, health and education through financial programmes that target low-income women in Latin America (Pro Mujer, 2021).

- Gender-related problems during education were reported to be low, with 8.8% of all members having experienced such issues during undergraduate studies and 13.33% in their doctoral studies. However, 59% feel they sometimes have to work more than their men colleagues to get the same level of recognition, and 14% feel they have to work more always. 58% consider that sometimes they experience gender discrimination at work and 5% experience it always. 57% say they think they have been discriminated against for awards, promotions, or participation in events for being women.
- 53% stated that sometimes violent comments are made about women in their workplace and 26% reported witnessing or having experienced physical or sexual violence against women in their workplaces. 39% complained (not specified where or with whom), 35% sought advice or guidance, and 26% did nothing. Of the group who decided to do nothing, 37.5% replied that they did not want to have problems at work, 25% did not give importance to the event, 25% did not know what to do and 12.5% feared that their reputation would be damaged. 50% of women who witnessed violence took no action for fear of damaging their reputation or fear of problems at work. It is concerning that 25% did not know what to do, noting the very low level of culture regarding gender-based violence and the lack of information on how to respond.
- 80% got a job during their first six months after completing their studies, 18% between 6-18 months, and 2% after two years. 33% work for public institutions, 29% for private enterprises, 21% in academia and research, and 17% are studying, retired, or looking for a job.
- 35% of the economically active members are employees, 24% consultants, 14% researchers, 13% have managerial positions, 7% are entrepreneurs and 7% teachers.
- Only 36% of the interviewed population had personnel under their supervision. 43.66% are in support and administrative services, 38% are in middle management positions such as sub-directorates or coordination, and just 18% are in senior management and decision-making positions.
- The high academic level of the group is not reflected in the level of their jobs or in their level of income. 45% of the members have an income between one and seven times the minimum wage¹¹.
- 63% of the hierarchical superiors of the interviewed members are men and 78% of the superiors of their superiors are men. 74% of interviewees declared that between six and ten of their ten closest collaborators were men.

Masculinization in the energy sector contributes to discrimination towards women, and discrimination and violence are highly normalized, and women who are not able to cope with such a hostile environment are forced to abandon their economic activities. RMEM aims to gather women professionals in a solid group to boost their individual and collective potential via networking, information sharing, access to expert advice, constant communication and building a sense of belonging, motivation, and strengthening the presence of women in energy. RMEM also wants to empower other women (indigenous, rural, and highly marginalized) who are in the “basic needs” sphere of energy usage to improve their living conditions. In 2020, they announced the next launch of their website and work plans for 2021 (INEEL, 2020; Comisión Económica para América Latina y el Caribe (CEPAL), 2020).

¹¹ 2,686.14 MXP per month at the time of the study.

1.3.4. Red Mujeres en Energía Renovable y Eficiencia Energética (REDMEERE)

The Women in Renewable Energy and Energy Efficiency Network, REDMEERE, started as a concept in 2015. In 2016, REDMEERE was officially launched on a national level and since 2017 it has been consolidating and expanding its scope. The German Corporation for International Cooperation GmbH, GIZ, has been a supporter since its creation. The network consists of more than 760 members, and more than 40 allied institutions, from all over the country. Several nodes of the network cover the national territory in Tijuana, Coahuila, Monterrey, Baja California Sur, Tamaulipas, Hidalgo, Tabasco, Aguascalientes, Mexico City, Veracruz, Colima, Morelos, Oaxaca, and Chiapas (GIZ, 2018).

REDMEERE's aim is to "promote a renewable energy and energy efficiency sector that promotes sustainable and human development where women and men can reach their full potential and develop under conditions of substantive equality" (GIZ, 2018). In 2017, the INEEL signed a letter of accession to REDMEERE (Transición Energética, 2019).

The following data was shared about the members of REDMEERE (GIZ, 2018):

- 20% are men allies
- 7 out of 10 have a university degree, and 3 out of 10 have a master's degree related to energy
- 70% works in the renewable energy sector, and 30% to energy efficiency
- 59% are breadwinners
- 14% have been denied a job for being women
- 47.3% have doubted their technical capabilities for being women
- 31.3% have been discriminated from technical and field works

The network has three main lines of action (GIZ, 2018):

- A cross-cutting line of awareness and visibility
- Capacity building
- Leadership and empowerment
- Knowledge management

Their work has focused on (GIZ, 2017; GIZ, 2018):

- Awareness
- Training and certification, in collaboration with CAMEXA, ECOVES and CENCER. For example:
 - Standards EC0325 (Installation of thermosiphon water solar heating systems in sustainable housing), EC0431 (Promotion of savings in the overall performance of housing energy systems) and EC0586.01 (Installation of photovoltaic systems in housing, businesses, and industries)
 - "Solar Women" trainings
 - In 2017, two training sessions were offered to the members. The first session included a short course about energy efficiency on steam (in collaboration with Spirax Sarco), a visit to Intertécnica (manufacturer of hot water and heat generators) and the Solar Concentration Plant of the Institute of Engineering of the UNAM and participated in the Workshop of solar cookers in collaboration with the Autonomous Metropolitan University. On the second

- session, the members visited INEEL, received training, visited a biodigester in Milpa Alta and participated in networking activities
- Financial mechanisms.
 - A financial mechanism was developed for the implementation of a Pilot Project for Solar Water Heating in SMEs, in collaboration with Módulo Social and Pro Mujer.
 - Institutional strengthening
 - Public agenda positioning
 - In 2018 SENER, GIZ and REDMEERE collaborated to reach an important milestone: a space was opened to a woman to serve on the Energy Transition Council
 - The Gender Roadmap for the Energy Transition was proposed by GIZ and REDMEERE to create the first nationwide strategy to achieve gender equality and women's empowerment in the renewable energy and energy efficiency areas. It has not been published yet, and in 2018 it was determined that the baseline needed research on women in the energy sector
 - Providing the gender-responsive centre

REDMEERE also launched the Promesa REDMEERE scholarship, with the objective of linking young people with great potential in the sector with outstanding professionals, offering economical support to young women interested in research stays or professional internships (GIZ, 2018). Furthermore, a pilot mentorship program started in 2018, in which 10 apprentices and 10 young women with at least 5 years of experience in the energy sector will work together (Energía Hoy, 2018).

In addition, REDMEERE announced the Gender Roadmap for the Energy Transition in 2018, with the objective of achieving gender equality and women empowerment within the energy transition through an assessment on gender inequalities in the sector, as well as identifying actions and agreements that are needed to reach substantive gender equality in the medium term, while promoting sustainable development. Four phases were described (conceptualization, baseline creation, roadmap building, and presentation of results) for the roadmap project, which also aims to lead up to the signing of the Agreement for Gender Quality in the Energy Transition (Energía Hoy, 2018; REDMEERE, GIZ, SENER, 2018).

The report shows that in 2018, 1,203,745 students registered in careers related to the energy sector, and 33% of these students were women. 57% of women students study conventional energy topics (versus 76% of men) and 43% study renewable or sustainable energy topics (almost twice as the 24% of men), so women seem to be more prepared to join the renewables sector at the entry-level and their participation will increase (GGGI, 2020).

1.3.5. Mujeres en Energía Renovable México

This group aims to support women within the management and senior management teams within the organizations. It promotes social, educational and inclusion initiatives to achieve emission reduction targets through the promotion of renewable energy projects, the empowerment of women and of vulnerable or limited access to energy sectors. Education is also an important topic to promote new opportunities, so they have participated in the development of videos, books, and educational content for distribution in schools and higher education institutions and created high-reaching digital content on social media and magazine articles. MERM has also distributed a monthly newsletter to inform and

communicate with women on different empowering topics, with a database of 1,000 people (MERM, 2021).

The group has expanded and created a coalition of Latin American women to promote women's leadership and inclusive participation in the energy sector, working together with other women's networks in the region to achieve significant emission reductions through energy improvement, efficiency practices and diversification of energy supply, known as the Latin American Network of Women in Renewable Energy (RED MERL) (MERM, 2021).

MERM accepts any interested person, women or men, who can pay the membership fee, which is divided by group ages (MERM, 2021):

- Younger than 24 years: 1,500 MXN
- Entrepreneur and up to 30 years: 3,500 MXN
- Above 30 years: 5,000
- For companies who want an individual to join: 10,000 MXN.

Being a member gives access to the events in MERM's platform, networking events, discounts on activities and workshops, opportunity to volunteer, and access to mentoring programs and labour exchange (MERM, 2021).

1.3.6. Energy Cluster Coahuila

The Energy Cluster in Coahuila, with financial support of the British Embassy, developed the *Gender Baseline Study for the Energy Sector*, to get to know the situation of women in the sub-sectors of hydrocarbons, electricity, renewable energy, and energy efficiency, in the states of Campeche, Jalisco, Nuevo León, Sonora, Tabasco and Veracruz. The study was presented in Mexico City in 2019 and confirmed that the participation of women in the energy sector is reduced, especially for hydrocarbons, and occupational segregation and discrimination against women are normalized practices. For example, women are assigned mainly administrative and secretarial roles, but not technical. On average, 19% of those who work in the national energy sector are women. Contrary to what might be expected regarding wage gender gaps, women enjoy higher salaries due to a 95% of women working in the energy sector being employed by PEMEX and CFE, but no information is available about the jobs of the remaining percentage of women. The Energy Cluster Coahuila has also found that one of the main barriers for women who want to participate in the energy and renewable energy sectors is the low enrolment in technical and vocational educational and training (TVET)—only 28% of total enrolments in TVET are women. Furthermore, the creation of capacities for joining the renewables sector may not be taking place in States where RE projects will be established, which means that workers need easy access to information on labour opportunities and assurances of benefits to relocate (Global Energy, 2019; COEES, 2019; GGGI, 2020).

1.3.7. Women's Energy Network México Chapter

The México Chapter was founded in 2017 with the purpose of allowing Mexican women to join forces within the energy industry. Several programs are listed on their website, for example, communities, empower magazine, podcasts, webinars, and a career centre. However, the materials and information are only available for members. Individual

memberships cost 125 USD per year, which may be an obstacle for women who cannot afford it. A government membership is also offered at 60 USD per year, and is only for federal, state, or local government employees (Women's Energy Network, 2021).

1.4. Social impact of hydrogen projects

Parting from a systemic point of view, projects must take into consideration the specific social issues that are related to hydrogen to plan the best way to address them and offer sound, GESI-based solutions. The dynamics of social systems are neither singular nor linear (Cameron, et al., 2013). Hydrogen is an instrument with the potential to transform energy systems away from fossil fuels, but also to transform the societies in which hydrogen will be produced and consumed (Schlör, et al., 2017).

Schlör et al. (2017) did an analysis of the social conditions throughout the life cycle of hydrogen from a Social Life Cycle Assessment (S-LCA) approach¹², using 23 indicators in five social impact categories—labour rights/welfare basis, health and safety, human rights/social participation, governance/democracy and freedom, and community infrastructure/decent life—to evaluate the social effects of producing hydrogen with a 6 MW alkaline water electrolyser in Germany, Austria, and Spain¹³. They calculated the social risk, understood as negative external effects, associated to the risk of hydrogen production. Some indicators were considered to have more weight than others in the total risk assessment, such as risk of no adequate labour laws, excessive working time, risk of fatal injuries, no access to improved drinking water and sanitation, risk of gender inequality, and fragility of the legal system. The authors found that hydrogen production implies impact to other countries, e.g., China, Russia, and India, because of globalized trade routes and the need of production elements and intermediate products. The social risk is more affected by the democratic and social structures of the affected societies (social cohesion), rather than the people's working conditions. In other words, the countries not only import intermediate products for hydrogen production, but also the social risks generated in the countries that produce the intermediate products.

In developing nations with abundance of renewable sources of energy, hydrogen can increase energy security, as traditional energy can show high variance in costs and availability due to various factors. Hydrogen can create jobs and opportunities for the locals, as new infrastructure will be built, and transport, distribution and energy generation systems will be operated. Furthermore, its use, unlike fossil fuels¹⁴ or biomass¹⁵, do not impact negatively on the air quality, thus contributing enhance to the health of the population. Ultimately, hydrogen can help develop the national energy system development in a resilient manner, as well as a new industrial market. Mobility and power provision are the main uses that will detonate green hydrogen growth in developing countries on the short term, but the agricultural sector is another possible user thanks to the production of green fertilizers (ESMAP, 2020). These transformations can also build more resilient and cohesive

¹² Using the UNEP/SETAC guidelines for social life cycle assessment of products, in combination with the social theory of Amartya Sen.

¹³ The system boundaries include the system's construction (cell stacks, gas separator for oxygen and hydrogen, tanks, heat exchangers, pumps and power electronics) and operation (electricity, deionized water, potassium hydroxide solution, process steam, and nitrogen). Hydrogen compression, storage and use were not evaluated.

¹⁴ The energy demand of industries in developing countries is traditionally met by coal, petroleum-based fuels, and biofuels. The rapid growth of economies under development must be supported by a transition to clean energy sources (ESMAP, 2020).

¹⁵ Approximately 4.5% of the global energy supply in 2015 was sourced from traditional biomass in developing countries (ESMAP, 2020, p. 4). Biomass is mostly used by poor women (UNDP, 2008).

communities and improve living conditions overall if gender and social inclusion issues are included as key elements of new hydrogen projects.

ESMAP (2020) has stated that a country's capacity to implement green hydrogen solutions will depend on the availability of individuals with the technical knowledge and expertise to handle, install and maintain hydrogen systems. This means that capacity building can be a requirement if the specialized workforce cannot meet the emerging demand. Some of the case studies that were revised [in the previous sections] reported job creation as an important outcome, given that the development and maintenance of a hydrogen economy relies on a highly skilled workforce, ranging from engineers, economists, etc., as well as an informed citizenship. The following projects reported either observed or expected job-impact:

- In Canada, Glencore RAGLAN mine renewable electrical micro-grid integrates wind energy with hydrogen production in a remote site, eliminating the need for diesel. Eleven ongoing jobs and 60 temporary jobs (during construction and engineering) were created. Additionally, the reduction in diesel use may help to increase social acceptance of mining activities and avoid the health-related issues to the surrounding population (TUGLIQ Energy Co., 2019).
- HyNet Northwest, announced as the first hydrogen energy and Carbon Capture, Usage and Storage (CCUS) infrastructure project, expects to maintain around 345,000 manufacturing jobs in the Northwest of the UK and 6,000 additional new jobs (Cadent, 2018).
- Drax Zero Carbon Humber Cluster aims to become the first zero carbon industrial complex in the world, helping protect 55,000 jobs in the Humber industrial area in Britain and creating as many as 49,700 direct, indirect and induced jobs—for example, welders, pipe fitters and machine installer and technicians during construction (Vivid Economics, 2020).
- Silver Frog, a Solar-to-Hydrogen project in Europe, expects to create at least 6,000 jobs (Fuel Cells Works, 2019b) (Hydrogen for Climate Action, 2019).
- The Eyre Peninsula Gateway Project in South Australia will integrate green electrolysis from wind and solar energy with ammonia production. The project will create jobs and economic benefits for the whole Eyre Peninsula (Government of South Australia, 2021).

However, the direct inclusion of GESI is missing from the reports. In the following pages, a description of the specific challenges relevant within the Mexican population is presented, as well as a guide to develop projects from a GESI perspective considering the local dynamics between the energy sector and the social dimension that is found in the country. The hydrogen roadmap implementation for Mexico follows the lines of UK PACT, which is committed to build a more resilient, empowering, and transformative economy by **explicitly integrating the GESI principles and climate action** (UK PACT, 2021a).

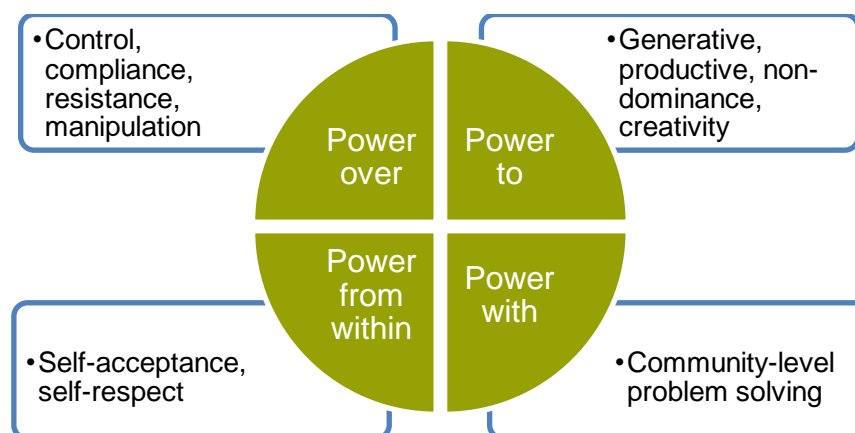
1.5. Implementation of GESI principles in hydrogen projects

The case studies presented in the Mexican initiatives section are examples of groups that want to transform the way people think and act towards social inclusion and gender equality, and they share important elements such as diagnosing vulnerabilities and areas of opportunity, consulting the groups they pretend to help, and involving them in the projects.

Next, several considerations and steps that must be put into action to implement the GESI perspective in projects are described.

The work on climate change and gender seldom recognizes structural inequalities and gendered power relations (Djoudi, et al., 2016). The unsustainable patterns that have shaped our economy must be changed (Schlör, et al., 2017), and the embedded assumptions about gender and power must be challenged (Djoudi, et al., 2016). **GESI Transformative Change** refers to the **transformation of unequal power relations** through change in roles, status, and the redistribution of resources by addressing the root causes of inequality, promoting the value of historically discriminated individuals, and working across several levels simultaneously. More specifically, for climate projects, attention must be given to **create opportunities for individuals** to actively challenge the underlying social, political, and economic structures that produce marginalization and inequality (UK PACT, 2021c). Transformative Change addresses the process of empowerment and the many forms that power can be observed.

Figure 1.2. Transformative change forms of power.



Reference: Based on (UK PACT, 2021c).

The integration of GESI principles into climate action means to recognize the justice and equity issues related to climate transitions in a way that projects abate emissions and strengthen knowledge and access to resources, change power relations and tackle discrimination (UK PACT, 2021a; Cameron, et al., 2013), support the reduction of poverty (UK PACT, 2021c), commit to be explicitly¹⁶ inclusive, anti-racist and anti-discriminatory to ensure the emissions reductions also account for social positive impact (UK PACT, 2021b). The project should show clearly how it is building GESI into the programming, **how it is aiming to achieve the highest level possible for the project concept on the mainstreaming levels framework and provide strong evidence to demonstrate the commitment** (UK PACT, 2021c). Climate action must consider that the initial inequalities of an individual increases their exposure to the negative effects of climate change, increasing their susceptibility to damage caused by climate change and also decreasing their relative

¹⁶ It has been noted by UK PACT that it is not correct to assume that actions and strategies are neutral or even inclusive towards discriminated groups simply because there is no intention in doing harm. It is easy to unintentionally reinforce discriminatory practices and perpetuate inequality. In other words, no action is neutral by itself; so, the desirable minimum is to at least do no harm, and in the best case make a positive impact. This idea is known as Do-No-Harm (UK PACT, 2021c).

ability to cope with such damage and recover (Islam & Winkel, 2017), so any project should address this issues in a way that the communities can become resilient and sustainable.

True involvement of marginalized groups means that a project does not fall in tokenism. **Tokenism** refers to the **apparent involvement** of a group but hides a lack of real change or real impact. It is often seen when only one person of a marginalized group is consulted or invited to participate, and it is notably hard to recognize from the majority perspective. It does not come from an intentional lack to involve marginalized groups, but rather from a traditional way of working that does not value input and involvement from all the stakeholders of a project, and only counts on ticking boxes to give the illusion of compliance or tolerance, instead of adding value to all parties (University of New Hampshire Institute on Disability, 2021; Snape, et al., 2014).

It is key for those in managerial positions, such as any authority involved in the project and project managers, to understand the importance of GESI action so they can communicate the message to the people under their supervision. Involving marginalized groups can be challenging at the interpersonal and organizational levels, because if something is not seen to have value, it is less likely to be embedded into projects and thus will remain tokenistic without reaching its potential (Snape, et al., 2014). A profound understanding of the social dynamics should allow for the identification of the root causes of vulnerability and the design of effective solutions, otherwise potential solutions could exacerbate rather than reduce existing injustices (Djoudi, et al., 2016).

1.5.1. Recommendations

Below, actions, attitudes and strategies are presented for the development of projects from a GESI perspective, under an open, participative, and positive, but critic, mindset. The project developers must listen, learn and be aware of their own biases towards marginalised groups. Involvement from upper management is key for the successful implementation of GESI strategies. Good versus bad simplifications of the social complexities must be challenged, as everybody can perpetuate discriminatory practices, even if they do not intend to, but at the same time, the potential to end the cycles of inequalities is within every individual. The recommended elements for GESI implementation in projects are as follows:

- **Recognising** that those individuals that are part of marginalized groups are **autonomous individuals** with interests, concerns, needs, knowledge, and opinions, and are stakeholders of the project.
- **Understanding involvement** as an individual component of the project and recognizing the value of team cohesion. Involvement includes the communities, local authorities, and the project's team, as well as other stakeholders. Participation is, on a basic level, about facilitating change.
- Having **clarity and specificity** on the **structure and expected results** that the project aims to create.
- Building **open and transparent systems of participation, decision making and reporting**, with **accountability** as a central element.

- **Reaching outside the usual** contacts or organizations and **making space for new points of view.**
- Involving marginalized groups as **early as possible** in the lifetime of the project so they can better **participate, accept, and get ownership** of the project.
- Involving marginalized groups in a deep way to have meaningful impact, instead of only relying on a meeting at the beginning and at the end of the project¹⁷.
- **Capturing and retaining diverse talent**, for example, by offering **work-life balance resources** and **creating support and mentoring networks.**
- Expanding the scope of engagement by **including multiple individuals of multiple marginalised groups.**
- **Asking questions** to the marginalized groups (their concerns, needs, and opinion on the project's scope and performance, to name a few).
- **Providing preparation and training** before meetings and always offering help and assistance. It is convenient to develop a training agenda to build on already established knowledge and strengthen capacities while new abilities emerge. Resources such as digital content and person-to-person communications are good examples, because some participants may have problems with reading or writing, so a specific assessment must be made to tailor the communication and training resources.
- Actively **encouraging participation and proactive behaviour**—an “open floor” or “open door” policy is not enough—, to understand issues, define agreements and co-responsibilities
- **Hearing and responding to feedback**, because by doing so, the project will count with invaluable information for the design of effective actions regarding problems, obstacles, and possible solutions
- Having a **clearly defined communication strategy** between participants
- Keeping track of **who is participating and who is not**, so those individuals who are less vocal, and sometimes most vulnerable, are heard
- Keeping track of **retention of stakeholders** (for how long staff, volunteers and other participants participate in the project)
- Preventing information gaps and long periods of adaptation when personnel rotation occurs can be addressed with **permanent information strategies and maintenance of an active institutional memory**
- Keeping track of **changes in the decision-making process**, because when genuine engagement with new perspectives occurs, the work will inevitably unfold in a more dynamically, creatively, and collaboratively manner
- **Actively challenging cultural and social norms, e.g., the potential for tokenism, at every stage of the project**
- **Relying on a figure from each cabinet of the state and municipal governments, as well as of all interested communities**

¹⁷ There is a common concern that a specific group of stakeholders will not understand or will not be interested in the regular operations of a project, and results in the group being given simplified and inaccurate explanations of the project's objective, scope, and progress. However, the more they are involved and informed, the more they will understand, contribute, positively impact, and ultimately own the project (Supple, et al., 2015).

- Incompatibilities and communication problems can arise when working with various agencies, which can be addressed by **distributing the work** in smaller groups (three or four) and **creating an administrative agenda** to define shared channels and procedures, reduce costs and have a more efficient management. (University of New Hampshire Institute on Disability, 2021; Snape, et al., 2014; Supple, et al., 2015; SDG Fund, 2017; IRENA, 2019; GIZ-CONUEE, 2018b; Cameron, et al., 2013; The World Bank, 1994).

Stakeholder Empowerment in projects can be observed in a scale, the lowest level being GESI-blind and non-participative actions such as therapy and manipulation. Above them, minimum compliance options are found, such as Placation, Consultation and Informing, all of which are a form of tokenism and are not considered enough action. The highest level is recognized Citizen Power actions, like Partnerships, Delegated Power, both of which address empowerment, while the ideal step is Citizen Control, which allows for Transformative Change (along with Delegated Power), altering the structures and institutions that allowed marginalization and exclusion (UK PACT, 2021c). According to UK PACT, the project cycle for ensuring effective GESI mainstreaming is as follows:

Figure 1.3. Project cycle steps to ensure GEDI mainstreaming.



Reference: Based on (UK PACT, 2021c).

1.5.2. A case of water in Mexico

One of the effects of climate change is increased exposure to water insecurity, particularly for people living in rural areas and marginalized groups in countries with lower human development indexes (Cameron, et al., 2013; Islam & Winkel, 2017). Water availability is a requirement to produce hydrogen, and access to high-purity water can pose a barrier in some countries (ESMAP, 2020). According to the Hydrogen Council (2021), from a lifecycle perspective, between 10 and 7,000 kg of water are needed per kg of hydrogen, depending on the technology and route used to produce the gas. Gross water demand is most pronounced with water needs for biomass cultivation and cooling of thermal power plants

(biogenic waste streams and dry-cooling systems are recommended for regions prone to water supply stress or already under supply risk¹⁸). Gross water demand with photovoltaic (PV) and wind power for water electrolysis is very low¹⁹. (On the other hand, Power-to-X plants at gigawatt-scale can be a significant point-demand for water, especially in arid regions, where seawater desalination with adequate effluent management is an option. Water desalination for Power-to-X plants requires marginal additional energy.

Access to drinking water and sanitation are human rights, and the criteria of availability, quality, accessibility, and affordability determine how broad water and sanitation services are in communities. Having access to clean water is important to eradicate poverty, protect and maintain health, and empowering women (SDG Fund, 2017). Women in rural areas often collect water for the various house needs, travelling long distances and confronting hazardous scenarios (Islam & Winkel, 2017). In the following paragraphs, a brief description of water related issues in Mexico is presented alongside a case study of a programme that aimed to make a positive impact in water availability within communities in three southeast states, using some of the guidance that has been presented on the implementation of projects that part from a GESI perspective.

In Mexico, access to piped water has risen from a national coverage of 75.4% in 1990²⁰ to 93.7% in 2015²¹, according to the National Water Commission (CONAGUA) (Revollo-Fernández & Rodríguez-Tapia, 2021). Two thirds of the hydric resources in the country exist under the social ownership system (ejidal and communal) (Cámara de Diputados, 2019), but water is managed by the municipal authorities, who often face problems related to weak management and financial capacities (SDG Fund, 2017).

In 2016, 82% of the first decile of the population in terms of income of households (this is, lowest income) did not have access to piped water. However, the percentage of population with access to water lacks information on the continuity of service and the quality of the water that is delivered, both common issues in the country that the communities solve via rainwater collection, well water, rivers, streams, cisterns, bottled water, and carbonated drinks (the last two for drinking purposes). The INEGI informed that in 2016, 67% of households in the country received water daily, 14% every third day, 3.9% once per week and the rest one in a while (Revollo-Fernández & Rodríguez-Tapia, 2021).

There is a correlation between the use of alternative sources of water used by households and the inequality in terms of affordability, affecting more negatively the low-income deciles: the decile with less income spends three times more of its income on access to piped water than higher income deciles, the financial cost of other sources (cisterns, bottled water) is 5 times greater for the first decile than for the tenth decile and the economic cost of water of the first six income deciles show affordability problems, with an almost seven-fold difference between the first and last deciles. Dwellings with no access, or access but irregular supply of water, have to spend a greater part of their income on getting water than if they had access to the public system. On the other hand, approximately 26% (8 million) of the households in Mexico have access to piped drinking water without paying for it, and 36% of

¹⁸ The bio-CH₄ (energy crops) + SMR route requires 7,427.6 kg of water per kg of hydrogen, while the bio-CH₄ (waste) + SMR route only uses 18 (Hydrogen Council, 2021, p. 8).

¹⁹ 19.1 and 11.0 kg_{water}/kg_{hydrogen}, respectively (Hydrogen Council, 2021, p. 8).

²⁰ 87% of the urban population and 46.5% of rural population had access to piped water.

²¹ 97.2% of the urban population and 85% of rural population.

those households belong to the three highest income deciles (Revollo-Fernández & Rodríguez-Tapia, 2021).

A case study made by the SDG Fund based on the joint programme *Establishing effective and democratic water and sanitation management in Mexico to support the achievement of the MDGs* in the states of Chiapas, Tabasco and Veracruz found that even though a large part of the national water resources is concentrated in the southeast, water availability and sanitation services coverage show strong contrasts due to socioeconomic, ethnic and gender inequalities, as well as high levels of economic privatization, and a high risk from climate events. The team aimed to develop democratic and transparent water governance, and better participation of the society, with emphasis on the role of women, instead of investing on infrastructure. It was found that in homes without access to water, mainly women and children are responsible of collecting water²². They spend a lot of time and energy in doing so, often being exposed to danger, and sacrificing participation in other activities (education, generation of income, involvement in politics, relaxation, and recreation), i.e., increasing vulnerability (SDG Fund, 2017).

After compiling and sharing information related to water and sanitation services (legal and economic framework, availability, and access to water in the communities, impacts on health), the team proceeded to institutionalize the gender perspective in public policy and the water authorities, in a way that water management and natural disasters were approached considering gender issues, while providing technical assistance and training to the municipal institutions. Local committees were created in some municipalities to manage water disinfection and install domestic drinking water systems, encouraging the participation of women. Their participation in decision making on Water Boards and committees, matters of transparency and access to information was promoted; counsel and education in management issues, water and sanitation monitoring were offered. Water kiosks were deployed in many rural communities, connected with nearby wells and ferrocement tanks with filtration systems to collect rainwater. These solutions are simple and easy to maintain, so the communities will be able to manage them by local committees (mostly composed by women, but not limited in any way to other interested individuals).

Several changes followed the programme implementation, for example: a gender equality focused municipal water agenda for each state was created, two citizen's guides were designed (inclusive participation in water management and rights), the State Water Law of Tabasco was reformed, reforms to the Water and Sustainability Law took place to strengthen the trustees (with emphasis on community management) in Chiapas, the Veracruz Women's Institute increased the budget dedicated to issues relating to water management, and the Chiapas Institute for Public Information reproduced the methodologies developed by the programme to encourage the participation of women and the indigenous population in 23 more municipalities.

The SDG Fund programme had positive results by basing their work in the promotion of women participation, hearing, and attending their concerns and needs. By understanding the local problems and expectations, adequate actions were taken to facilitate the ownership of projects by target groups, resulting in sustainable outcomes and stronger, more resilient communities, paving the way with the first steps towards an inclusive and more participative public policy. Water issues in Mexico are specific to each municipality and their solutions

²² This situation is also described on a global level by the WRI (2013), and in Mexico in the PND (Cámara de Diputados, 2019).

must be tailored to deliver best results. The successful development of green hydrogen production projects will depend on building a close relationship with the communities, local authorities, and enterprises.

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